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Drone Spraying in Indian Agriculture

Case Studies & Measured Benefits

Accelerating precision crop care in India

India-focused case studies | Quantified outcomes | Regulatory-ready operations

Why Drone Spraying for India – The Context

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Fragmented Landholdings

86% of Indian farmers operate on less than 2 hectares. Small, irregular plots and wet paddy fields limit heavy machinery access, making drones the ideal aerial solution.

Labor & Safety Crisis

Acute labor scarcity during peak seasons drives up costs. Manual backpack spraying causes heat stress and severe chemical exposure for operators.

Critical Timing Windows

Narrow windows for pest/disease control in paddy, cotton, and horticulture require rapid coverage that manual labor cannot match.

95%

Water Reduction

Manual: 150–200 L/acre

Drone: 8–12 L/acre

Key Advantages

- Faster coverage (20x vs manual)
- Reduced operator exposure
- Access to waterlogged fields
- Better chemical uniformity
- Precise spot spraying capability

How We Measured Benefits

Standardized metrics for evaluating drone performance vs. conventional methods

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Throughput

Speed of coverage compared to manual labor. Critical for narrow disease control windows.

`ha/hr | acres/day | min/acre`

Water Volume

Drastic reduction in water usage, solving logistical challenges in water-scarce regions.

`L/ha | L/acre`

Chemical Use

Reduction in active ingredient usage while maintaining efficacy (within label compliance).

`% Change vs. Label/Manual`

Efficacy & Coverage

Pest/disease control incidence and droplet density on target surfaces.

`% Control | Drops/cm²`

Economics

Cost comparison for farmers and ROI potential for service providers.

`₹/acre Custom Rate | ROI`

Drift & Safety

Off-target movement analysis and operator exposure reduction levels.

`Buffer Distance | Exposure Risk`

Verified Data Sources

- PJTSAU SOP Trials (2024)
- KVK Field Demonstrations
- State Agriculture Dept. Reports
- FPO Pilot Service Logs

Case Study: Punjab (Paddy)

Faster, Safer, Lower Water Usage in Waterlogged Fields

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Trial Setup & Context

- Location: Punjab, Kharif Paddy Season
- Equipment: Multi-rotor UAV (30–40 kg class)
- Parameters: 8–10 L/acre volume, coarse-medium droplets

Water Usage	Time Efficiency	Cost Benefit
95% ↓	**4x ↑**	**~25% ↓**
200L → 10L/acre	30 min → 7 min/acre	₹800 → ₹600/acre

Drone operation over mature paddy field in Punjab

Farmers verifying coverage with water-sensitive paper

Key Implications for Farmers

Timely Window Spraying

Rapid coverage ensures disease control even in waterlogged fields where laborers struggle to walk.

Case Study: Maharashtra (Mango Orchards)

Canopy Coverage on Slopes: Konkan & Western Ghats

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Conventional Airblast

WATER VOLUME

800–1,000 L/ha

COVERAGE UNIFORMITY

Variable

Poor on upper canopy & inner leaves

FIELD IMPACT

High Impact

Heavy soil compaction & tractor ruts on slopes

ACCESSIBILITY

Limited

Cannot reach steep/terraced zones

VS

Drone Spraying

WATER VOLUME

30–50 L/ha ↓ 95%

COVERAGE UNIFORMITY

+35% Deposition

Superior lower-leaf & inner canopy penetration

FIELD IMPACT

Zero Impact

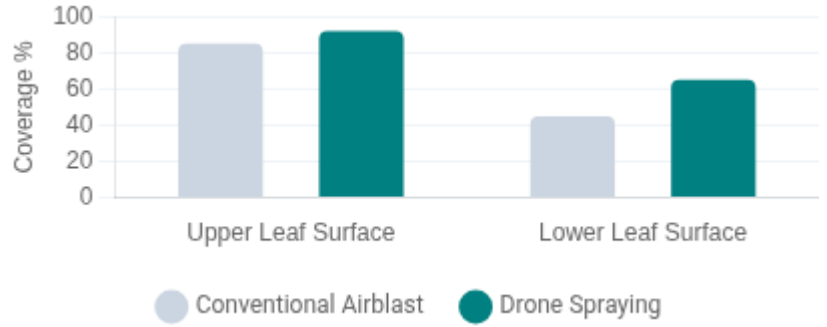
Aerial application eliminates soil damage

ACCESSIBILITY

100% Access

Easily covers steep, terraced, & irregular plots

Lower Leaf Deposition Improvement



Operational Implications

- **Access to steep terrain:** Drones successfully sprayed terraced orchards previously accessible only by hand labor.
- **Reduced runoff:** Ultra-low volume application minimizes chemical runoff into water bodies in high-rainfall zones.
- **Canopy penetration:** Downwash from rotors pushes droplets deep into dense mango foliage for better pest

Case Study: Karnataka Vegetables

Spot & Block Sprays in Chili/Tomato

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Trial Setup & Context

- Location: Northern Karnataka (Chili/Tomato)
- Method: Prescription maps for hotspot sprays
- Parameters: 10–20 L/ha variable rate application

Labor Reduction	Water Savings	Coverage
40% ↓	95% ↓	25 ac ↑
vs knapsack teams	Drastic volume cut	Per day across plots

Drone operation over chili plantation in Karnataka

Farmers inspecting crop health post-spray

Key Implications for Farmers

Resistance Management

Timely interventions prevent pest buildup and reduce chemical resistance.

Case Study: PJTSAU Rice SOP Trials (Telangana)

Standardized Protocol Validation & Impact Assessment

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Key Findings

- **Pesticide Reduction:** Achieved 15–20% reduction in active ingredient usage compared to conventional aerial/ground spraying while maintaining label compliance.
- **Optimized Volume:** Validated ~30 L/ha as the optimal UAV spray volume for consistent coverage without runoff.
- **Efficacy Parity:** Demonstrated on-par pest control efficacy with managed drift through controlled droplet size and flight height.

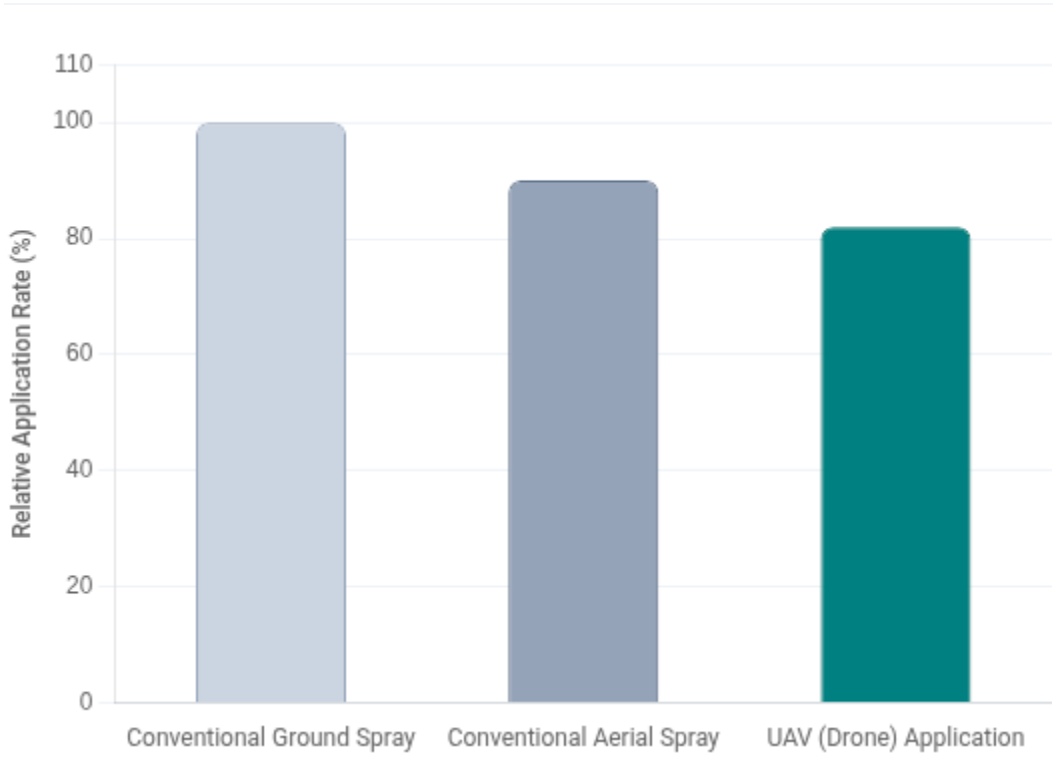
15-20%

Chemical Reduction

30 L/ha

Optimal Spray Volume

Source: PJTSAU Standard Operating Protocols for Drone Pesticide Application in Rice (2024)



Case Study: KVK Shajapur (Madhya Pradesh)

Paddy/Soy Demo: Custom Hire Viability & Water Savings

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Trial Setup & Context

- Location: Shajapur, Madhya Pradesh (Paddy/Soybean)
- Method: UAV demo with water-sensitive paper validation
- Focus: Time-motion study & water volume comparison

KVK demonstration of drone spraying technology in MP

Speed / Throughput	Water Efficiency	Custom Rate
~10 min	95% ↓	₹500-600
Per Acre Coverage	200L → 10L/acre	Per Acre (Typical)

Farmers evaluating spray coverage efficiency

Key Implications for Custom Hiring

Viable Business Model

Proven unit economics supports rural entrepreneurship and custom hiring centers (CHCs).

Case Study: Andhra Pradesh (Paddy)

Throughput & Input Savings: Coastal AP (Tillering-Booting Windows)

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Manual Knapsack

THROUGHPUT / CAPACITY

~0.15 ha/hr

Labor-intensive, slow coverage

WATER USAGE

200–300 L/ha

High water requirement

CHEMICAL INPUT

100% Standard Rate

Standard label dosage applied

RESPONSE TIME

Slow (Days)

Critical delays during pest outbreaks

VS

Drone Fleet

THROUGHPUT / CAPACITY

2.6 ha/hr

~17x faster coverage speed

WATER USAGE

10–15 L/ha ↓

95% water saving achieved

CHEMICAL INPUT

75% of Std Rate ↓

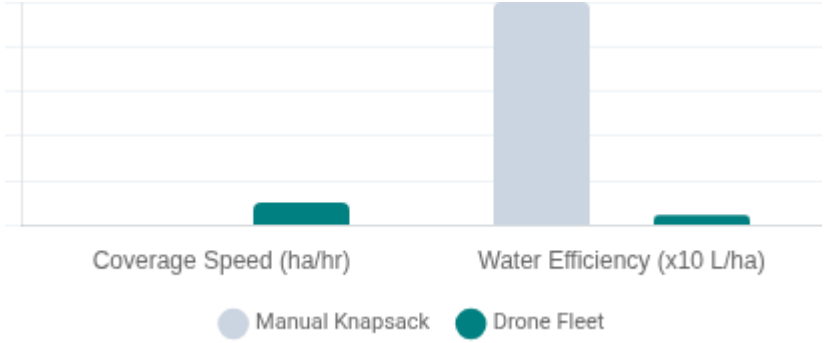
25% reduction (SOP-guided)

RESPONSE TIME

Rapid (Hours)

Immediate response capability

Operational Efficiency Gains



Strategic Implications

- **Cyclone-Window Spraying:** Rapid coverage capability allows entire village clusters to be treated during short windows before/after cyclones.
- **FPO Fleet Potential:** High throughput (2.6 ha/hr) validates the economic model for Farmer Producer Organizations to own custom hire fleets.
- **SOP-Guided Savings:** Protocols allowing 25% chemical reduction maintain efficacy while significantly lowering input costs for farmers.

Sources: KVK/DAATTC & Dept. of Agriculture Demonstrations (Andhra

Case Study: Tamil Nadu Herbicide Trial

UAV vs. Knapsack: Comparative Analysis in Rice/Maize Plots

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Trial Outcomes

- **Optimized Application:** Comparable weed control efficacy achieved with 30 L/ha UAV volume versus 500 L/ha knapsack volume, matching AI rates.
- **Operational Efficiency:** Validated optimal flight parameters of 2-3m AGL altitude with Coarse droplet spectrum for drift management.
- **Safety & Soil Health:** Significant reduction in operator chemical exposure and minimization of soil compaction compared to manual walking.

94%

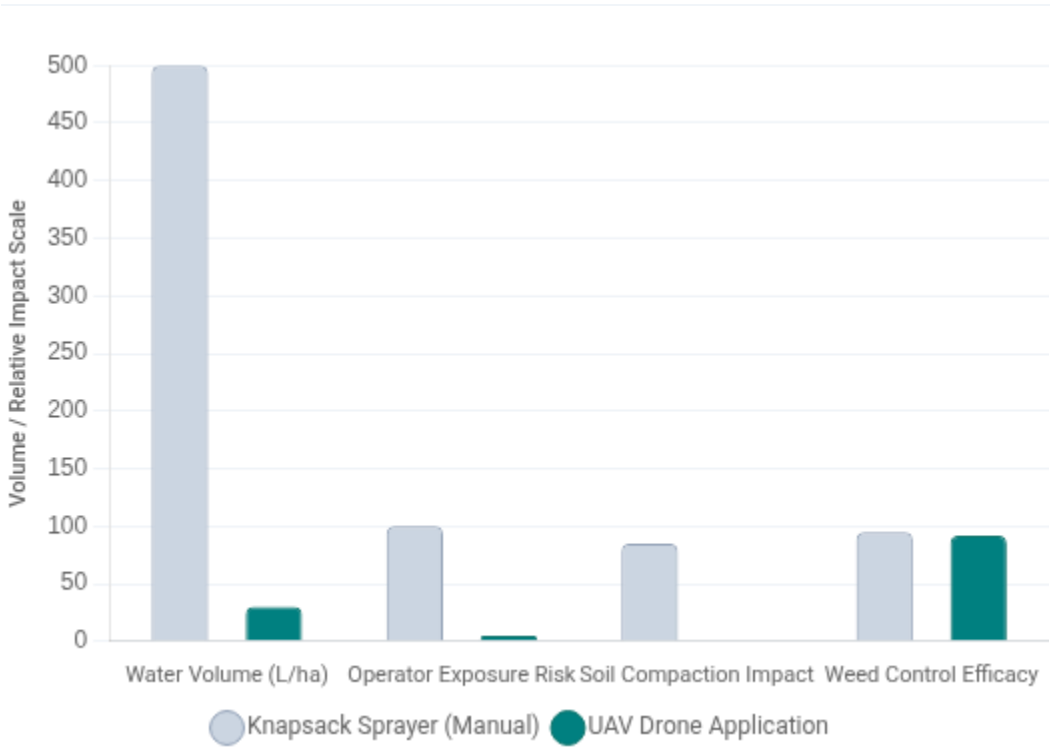
Water Savings (30L vs 500L)

2-3m

Optimal Flight Altitude (AGL)

Source: TNAU/PAJANCOA Field Trials & Extension Proceedings (2024-2025)

Water Volume & Application Efficiency Comparison



Case Study: KVK Vriddhachalam (Tamil Nadu)

Unit Economics for Rural Custom Hiring Centers

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Operations Snapshot

- Location: Cuddalore District, Tamil Nadu
- Crew: 1 Pilot + 1 Visual Observer (VO)
- Asset Utilization: 1 Drone + 3-4 Batteries + Fast Charger

Daily Capacity	Service Rate	Efficiency
30 acres	**₹600 /acre**	**10 min**
Optimized logistics flow	Range: ₹500 - ₹600	Per acre turnaround

Certified pilot managing operations during peak season

Drone deployed for multi-crop spraying service

Business Implications

Viable Rural Entrepreneurship

Clear unit economics allow rural youth to operate profitable custom hiring centers with minimal overhead.

Operate Responsibly: Evidence-Based Cautions

Compliance, Safety & Standards in the Indian Context

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Label Compliance

CIB&RC Regulations

- **Aerial Labeling:** Use only products/crops approved for aerial application by CIB&RC.
- **State Advisories:** Strictly follow local agricultural university (SAU) and state dept. guidelines.
- **Dosage Adherence:** Maintain prescribed active ingredient rates; do not under-dose.

Drift Management

Critical Operational Standard

- **Flight Parameters:** Maintain low flight height (1.5–2.5m above canopy) per SOPs.
- **Droplet Size:** Ensure appropriate nozzle selection (Medium/Coarse) to minimize fines.
- **Buffers:** Respect buffer zones near water bodies, aquaculture, and bee boxes.

Pilot Training

DGCA Requirement

- **RPTO Certification:** All pilots must be trained and certified by DGCA-approved RPTOs.
- **Airspace Rules:** Adhere to Green/Yellow/Red zone restrictions (Digital Sky platform).
- **UIN Registration:** Ensure all drones have Unique Identification Numbers (UIN).

Operational Safety

Standard Operating Procedure

- **PPE Mandatory:** Full PPE for mixing/loading crew to prevent exposure.
- **Decontamination:** Strict tank cleaning and triple-rinse waste disposal.
- **Battery Safety:** Proper storage and charging protocols to prevent fire hazards.
- **Emergency Plan:** First aid kit and emergency contacts readily available on site.

Documentation

Best Practice

- **Flight Logs:** Maintain detailed mission logs (area, time, product).
- **Traceability:** Record chemical batch/lot numbers for every application.

Etherealflights Rollout Plan – India

Strategic Implementation Roadmap: Service, Compliance & Operations

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PHASE 1

Service Model

- Custom hire rates: ₹500–700/acre based on crop & terrain
- Seasonal bulk packages for Farmer Producer Organizations (FPOs)
- Subscription models for high-value orchard management

PHASE 2

Compliance

- UIN/UAOP registration for all fleet drones
- DGCA RPTO partnerships for pilot certification
- Strict adherence to state-specific SOPs & CIB&RC guidelines

PHASE 3

Operations

- Standardized battery/generator kits for field autonomy
- Mobile water bowsers & field mixing protocols
- Spare parts inventory management for rapid repair

PHASE 4

Data & Tech

- Digital flight logs & input volume tracking
- Client dashboards for spray verification & billing
- Deposition card analysis for quality assurance

PHASE 5

Partnerships

- Collaborations with KVKs & State Ag Departments
- Financial tie-ups with banks/NBFCs for operator loans
- Insurance providers for crop & drone coverage

ROI Snapshot & Next Steps

Financial Viability & Implementation Roadmap

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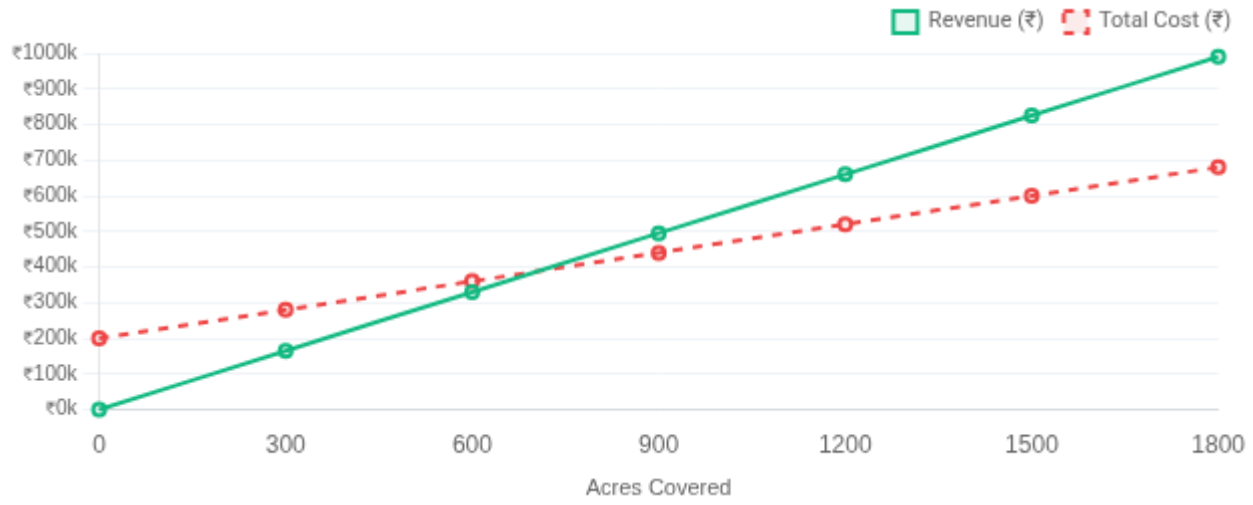
25-35
ACRES/DAY CAPACITY

900-1,200
BREAKEVEN ACRES

₹550
TARGET RATE/ACRE

Breakeven Analysis (Season)



Strategic Next Steps

1 Pilot Clusters Launch
Initiate operations in Punjab, Telangana, Karnataka, and Tamil Nadu high-density zones.

2 KVK Joint Trials
Co-run efficacy validation trials with local Krishi Vigyan Kendras for farmer trust.

3 Operator Financing
Partner with banks/NBFCs for drone financing packages for rural entrepreneurs.

Book a Field Demo
Schedule a live demonstration in your district

Enroll as Operator
Join our network of certified pilots