SMART INDIA HACKATHON 2025

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TITLE PAGE

- **Problem Statement ID –** SIH25118
- **Problem Statement Title-** Student Innovation: Swadeshi for Atmanirbhar Bharat - Smart Automation
- **Theme-** Smart Automation
- **PS Category-** Hardware
- **Team ID-** 99022
- **Team Name-** Spark Minds-2005

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PestiRover

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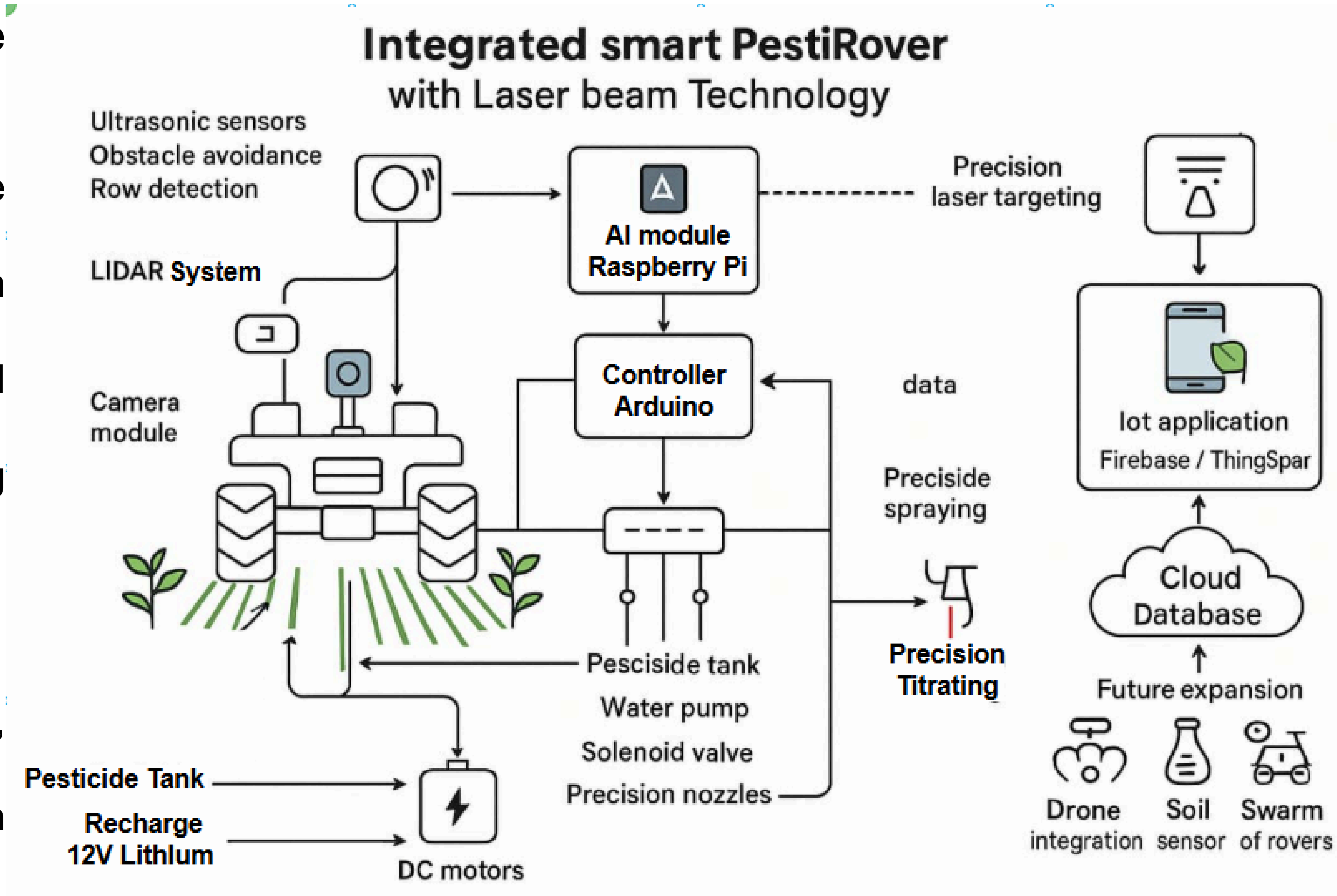
Proposed Solution

The PestiRover is an Autonomous Edge AI Rover for precision, variable-rate and chemical applications

- **Diagnosis & Location:** Camera (CNN) and Laser Scanner instantly diagnose the leaf and precisely locate the Infected Spot.
- **Vario-Dose Logic:** The system assigns an Infection Severity Score based on the diagnosis to calculate the minimal chemical dose required.
- **Hyper-Accuracy:** The Laser's accurate spot location data guides the PWM Valve/Pump to spray the dose exactly where it's needed.
- **Safety:** Anemometer/Rain Sensor acts as a mandatory interlock, halting spraying to prevent chemical drift or washout.



How it Addresses the Problem & Uniqueness

- **Problem Addressed:** Replace inefficient blanket spraying with soot treatment, achieving 70-90% chemical Reduction.
- **Innovation:** Unique combination of Severity-Based Dosage(AI Score) with Laser-Accurate Diagnosis and Spot Localization.
- **Impact:** Reduces chemical waste, operating costs, and creates a visual plant health heatmap.
- **Data-Driven:** Spraying events are logged via 4G/5G to plant health dashboard for predictive analysis.

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TECHNICAL APPROACH

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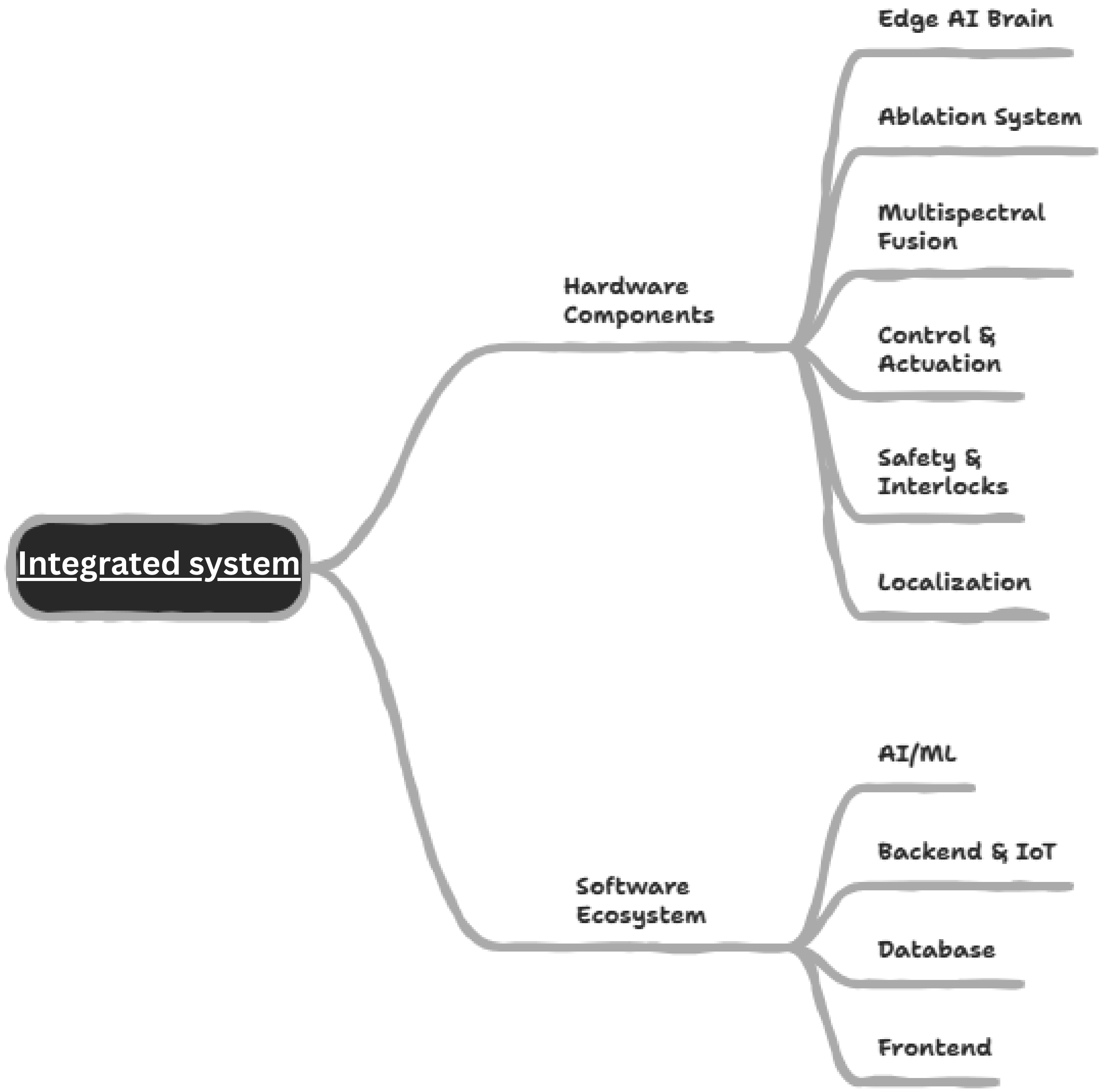
1. Integrated Hardware and Sensing System

- **Edge AI Brain:** NVIDIA Jetson AGX Orin (AI processing & system control).
- **Ablation System:** IPG Fibre Laser, Galvo Scanner, Optronics Driver(Precision laser control).
- **Multispectral Fusion:** Mica Sense Red Edge, FLIR Global Shutter, Intel RealSense 3D (Data fusion for stress/depth mapping).
- **Control & Actuation:**STM32 Microcontroller, Dynamixel Pro+, Servo /Linear Actuators(Real-time Servo/Linear Actuators).
- **Safety & Interlocks**: Dual PIR /Ultrasonic Sensors, Laser Shutter, Anemometer, Rain Sensor(Anto halt in risky condition).
- **Localization:** High-Precision RTK-GPS(Centimetre-level mapping and navigation).

2.Intelligent Software & Cloud Ecosystem

- **AI/ML** : PyTorch/TFLite (Trained on YOLO & Efficient Net for detection), custom Spectral Analysis(Laser data interpretation).
- **Backend & IoT** :AWS IoT Core, Node.js/Python API(Scalable data handling).
- **Database:** PostgreSQL / MongoDB(Strores Health maps & user data).
- **Frontend**: React/Next.js (Interactive farmer dashboard for monitoring & planning).



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FEASIBILITY AND VIABILITY

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1.Analysis of Feasibility

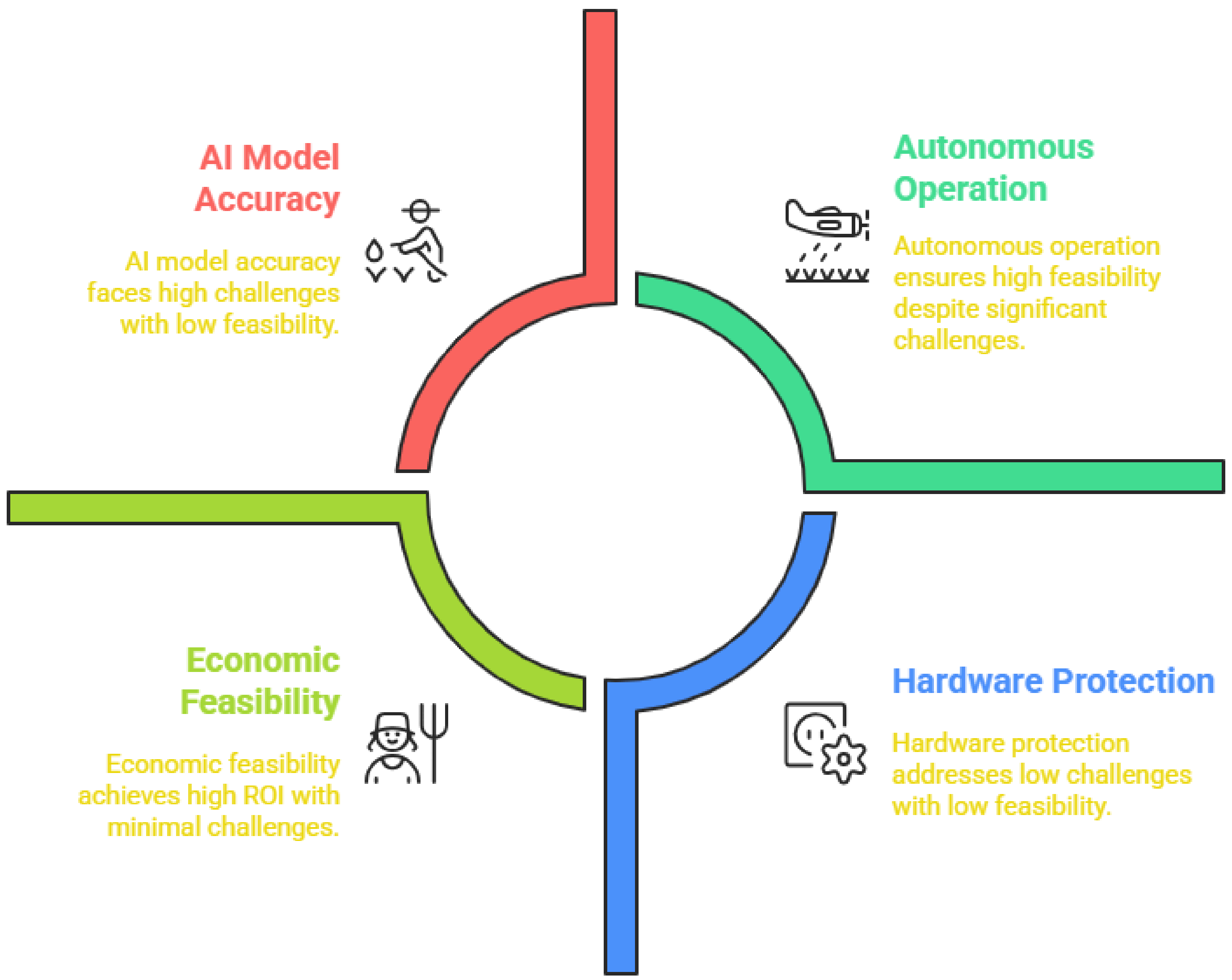
- **Technical Feasibility:** It Focuses on Integrating Technologies like laser,valves into a reliable system.
- **Economic Feasibility:** It Achieves High ROI through 70-90% pesticide savings,effectively balancing the initial hardware investment.
- **Operational Feasibility:**It is the Autonomous operation with 4G/5G monitoring enables continuos and lowers labor dependency.

2.Potential Challenges and Risks

- **AI Model Accuracy:** It Might accurately not spot the localisation and serverity assessment across crops and disease types.
- **Real-time Latency:** It reduces latency between laser/AI detection and PWM valve actuation to ensure precise and timely spray targeting.
- **Field Robustness:** It Ensures protection of sensitive electronics and optics from dust,moisture and vibration.
- **Data Acquisition:** Securing a high-quality labeled dataset linking sensor data to severity scores for precise model training.

3.Strategies For Overcoming Challenges

- **Model Robustness:** It transfers learning and partner with agricultural experts to optimize data augmentation and field validation.
- **Hardware Protection:** It Deploy IP67-rated enclosures and aniti-vibration mounts industrial-grade for hardware durability.
- **Data Stratergy:** It Implements Structured ,field-specific data collection to rapidly build a localised training dataset



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IMPACT AND BENEFITS

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1. Potential Impact on the Target Audience

- Affordable Precision: PestiRover offers an affordable retrofit solution for small and medium landholder to adopt AI driver precision farming.
- Immediate Economic Savings: Empowers farmers to achieve 60-80% pesticide reduction while minimizing chemical overuse risks.
- Sustainable Adoption: Supports Agri-cooperatives and NGOs advancing sustainable farming and chemical-free practices in communities.
- Policy Evaluation: Provides actionable data for government services to monitor disease spread and evaluate policy impact.

2. Benefits of the Solution

Economic Benefits

- Significant ROI: Reduces chemical and water usage by 60-80%, enhancing overall profitability.
- Yield Optimization: Severity-based dosing ensures precise treatment, minimizing yield loss and maintaining quality
- Operational Efficiency: Automation lowers labor costs and improves field productivity.

Environment and Social Benefits

- Environment Protection: Targets only infected areas, reducing chemical runoff and soil contamination.
- Food Safety: Lowers pesticide residues on crops, supporting a healthier food supply.
- Farmer Safety: Minimizes direct exposure to hazardous chemicals during application.

VDSS Impact and Benefits

Characteristic	Target Audience	Solution
Economic	Affordable precision farming	Significant ROI
Environmental	Sustainable adoption	Environmental protection
Social	Policy evaluation	Food and farmer safety
Operational	Immediate economic savings	Yield optimization and efficiency

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RESEARCH AND REFERENCES

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AI-IoT Smart Agriculture Pivot for Plant Disease Detection and Treatment
Link: https://www.nature.com/articles/s41598-025-98454-6?utm_source
This study proposes an AI-IoT system integrated with a central pivot irrigation system for plant disease detection and treatment.

Efficient Deployment of Peanut Leaf Disease Detection Models on Edge AI Devices
Link:https:https://arxiv.org/abs/2412.18635?utm_source
This study explores the deployment of crop leaf disease detection models on edge AI devices. It discusses the feasibility and advantages of using lightweight deep learning network.

Optical coherence tomography for early detection of crop infection
Link:https://doi.org/10.1186/s13007-025-01411-7
Uses optical coherence tomography (OCT) to detect infection in wheat (Septoria). This is an optical method, good for early detection before server symptoms.

Efficient Deployment of Peanut Leaf Disease Detection Models on Edge AI Devices
Link:https://doi.org/10.3390/agriculture15030332
Exactly on peanut leaf disease detection, deploying models on edge devices.

Feature	PestiRover	Manual Spraying	Drone Spraying	Traditional Sprayers
Infection-level detection	✅	❌	✅	❌
Automated pesticide control	✅	❌	✅	❌
Cost efficiency	✅	✅	❌	✅
Environment friendly	✅	✅	❌	✅
Targeted spraying	✅	❌	✅	✅
AI-based decision making	✅	❌	❌	❌