

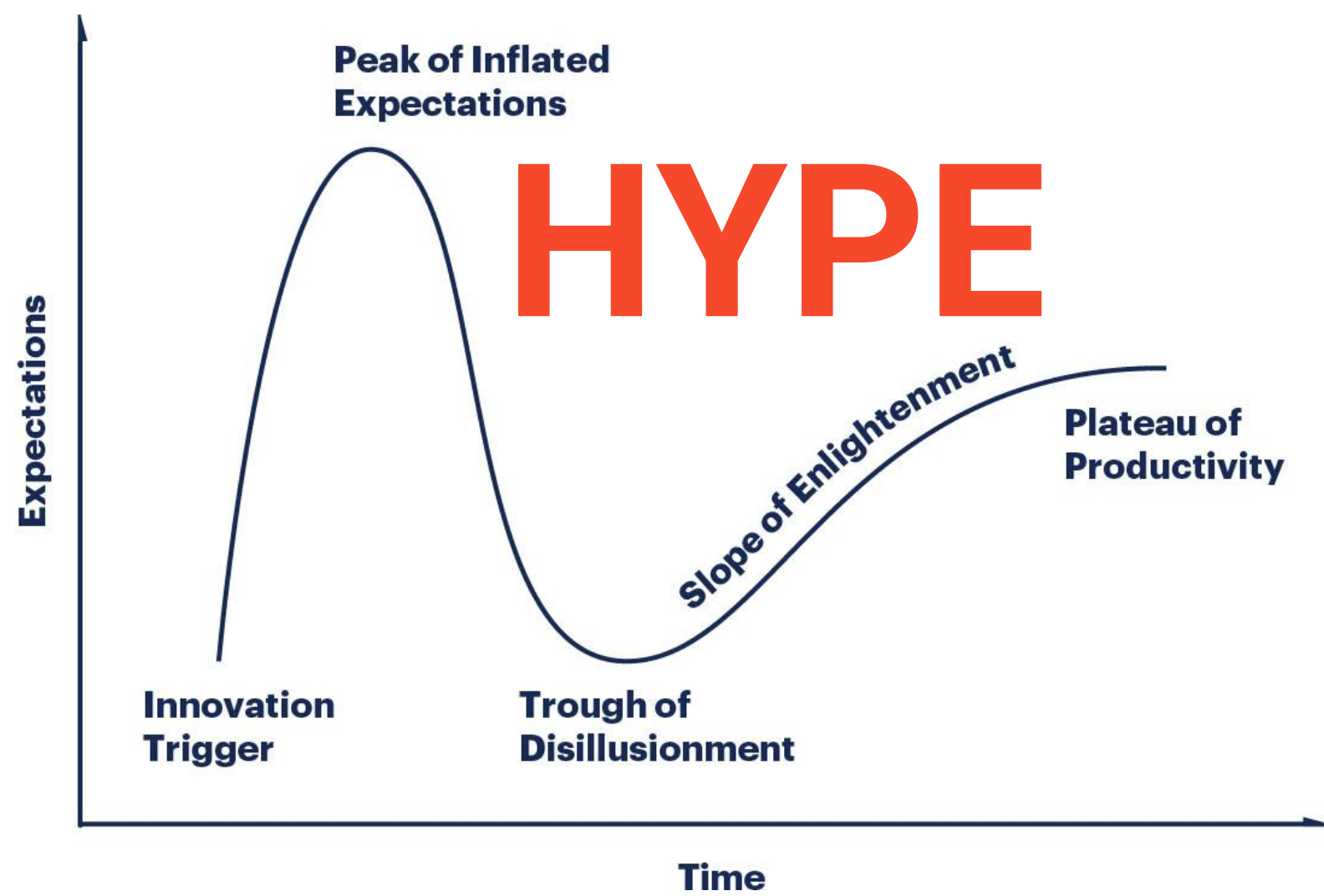


Meet

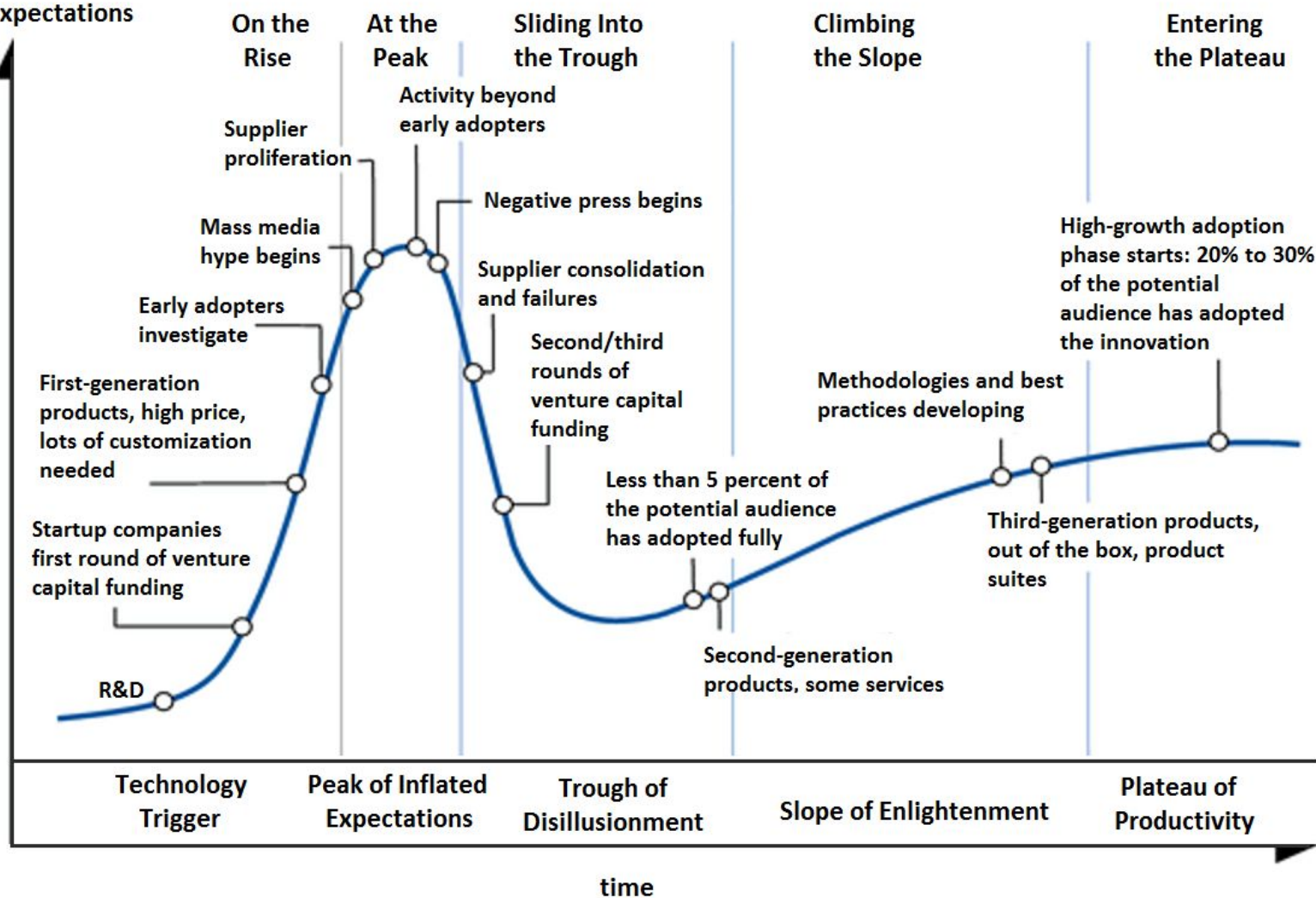
Kray Protection

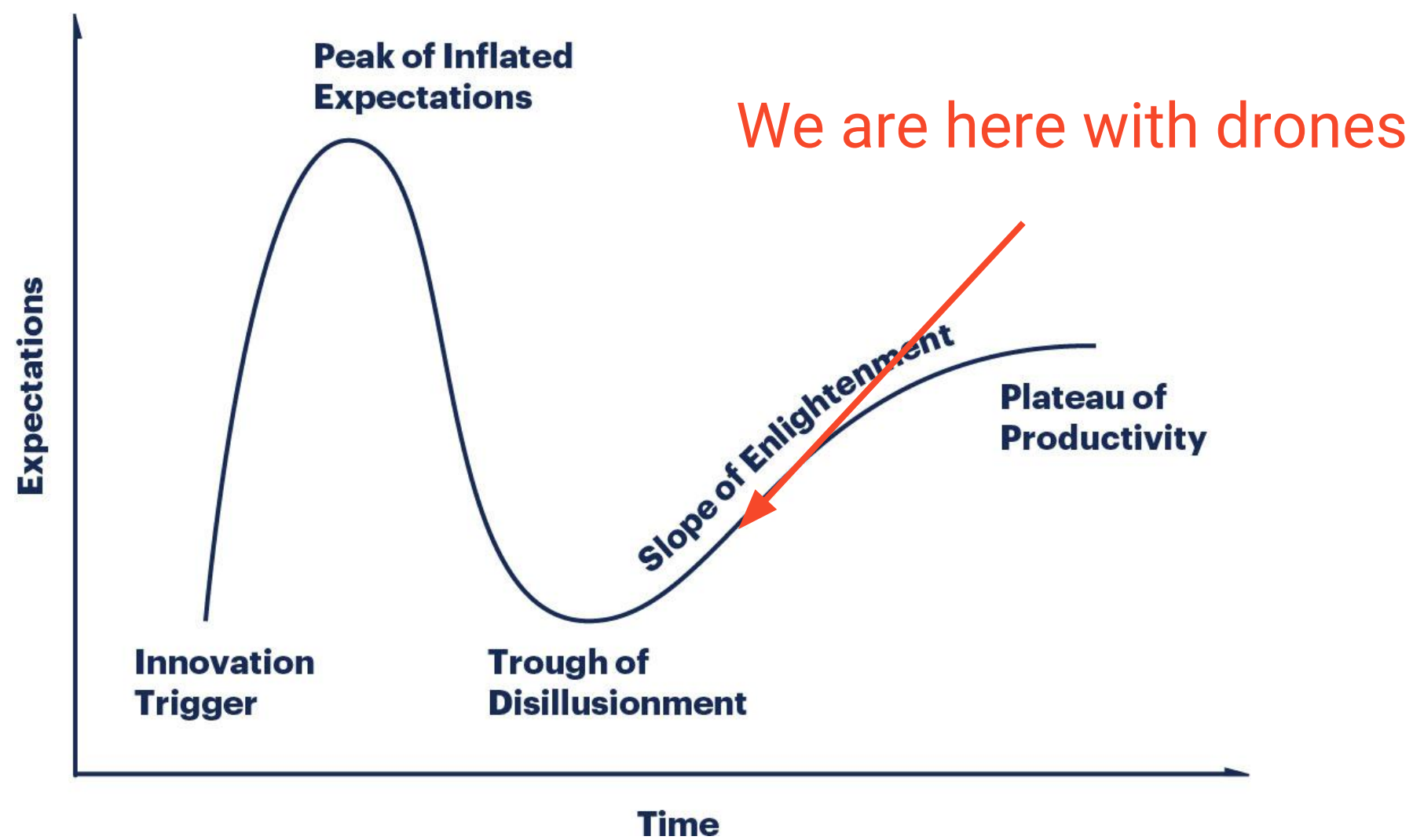
the industrial
productivity drone for
crop spraying





expectations





XactSense Titan disaster relief multirotor drone

- 20 KG payload
- Delivery, Lidar and camera assesement



AEE F100

- 20x+ automated zoom in EO and IR
- Manual/automated target detection
- Automated tracking



What's in common?

It is just hard to design them!

UAS benefit value = *UAS Complexity* * Problem Significance



kray.technology

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Demand for food will rise by 50-70% in 2050. It requires farmers to be more productive to meet the demand and stay competitive.



Traditional crop protection methods become obsolete



Slowdown in productivity



Outsourcing is overpaid with risk surcharges



Significant yield losses



High cost of application

Outsourcing of crop protection is overpaid



Crop protection impacts up to 70% of yield so it is a critical activity for farmers

24-48 hours window for the application is the farmer's highest risk and core business competence

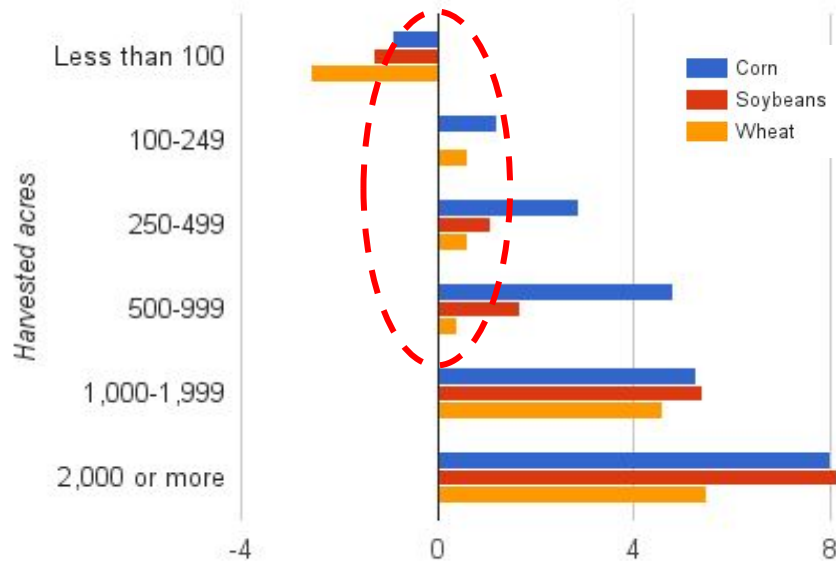
Outsourcing to crop protection services is expensive - \$25-50 per Ha (\$10-20 per acre)

Ground sprayers and ag planes cause significant yield losses



Typical crop field with acreage of 100 ha


Close to 0 profit rates



** Class-average rates of return on equity, USDA, 2008-20011*

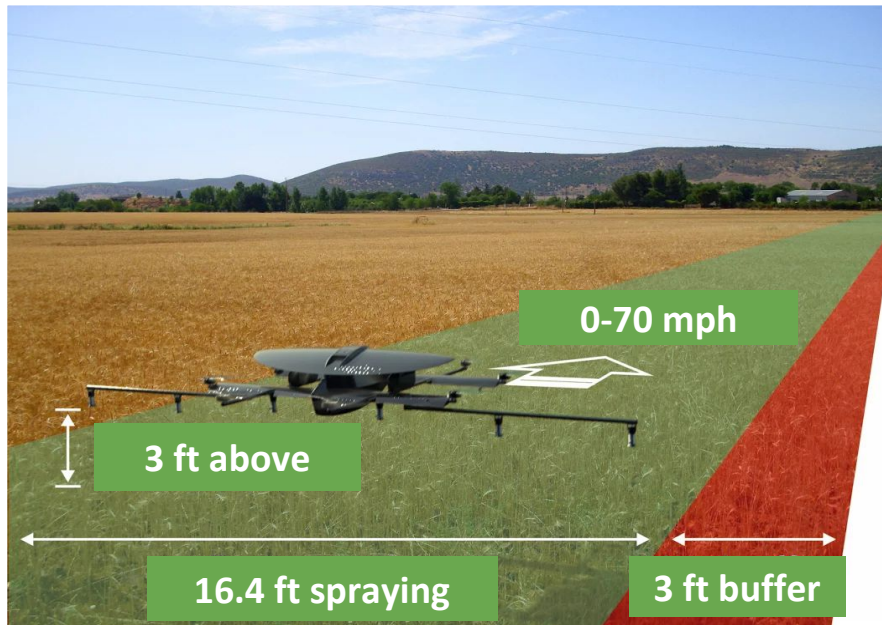
Farmers, with acreage less than 1000 acres have near to 0 profit rate.

They are mostly family farms and now it is the question of survival for them.

A man in a black t-shirt and jeans stands in a field of green crops, looking at a large, multi-rotor drone flying in the sky. The drone has a central body and multiple arms with propellers. The background shows a line of trees under a blue sky with white clouds.

That's why we created **Kray Protection** –
the robotic solution built to replace crop
dusting planes and ground sprayers

Kray Protection solution for mid-size farm



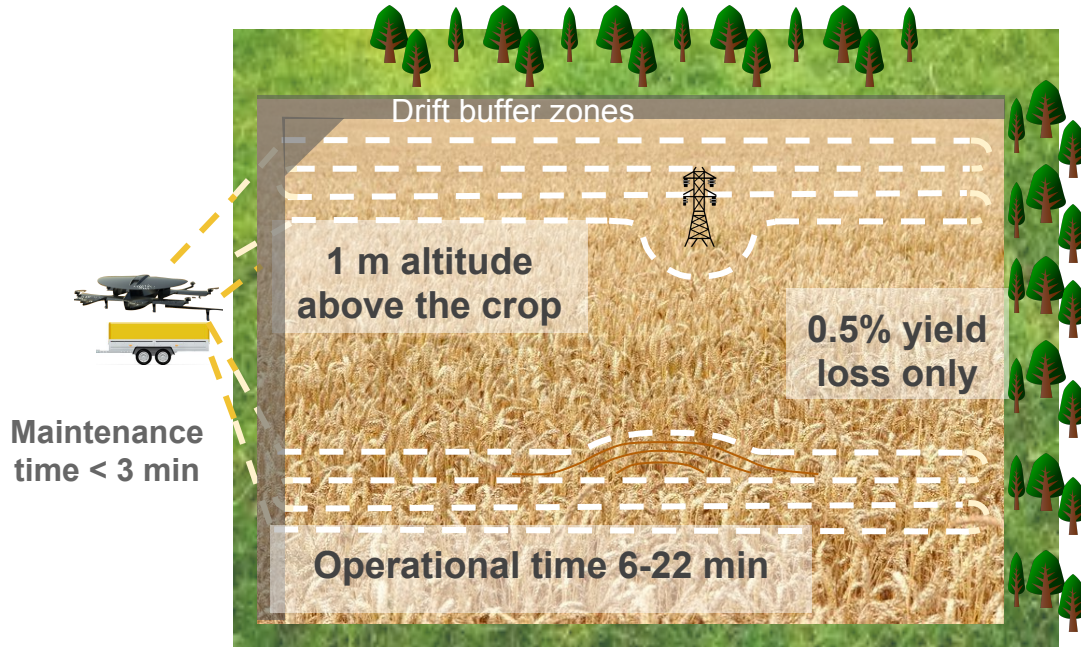
1200 acres of coverage
per day

Saves up to 70% of
pesticides

One-tenth of the cost

Nearly zero yield losses

Enhanced productivity of crop protection application



One-button solution with full flight cycle automation

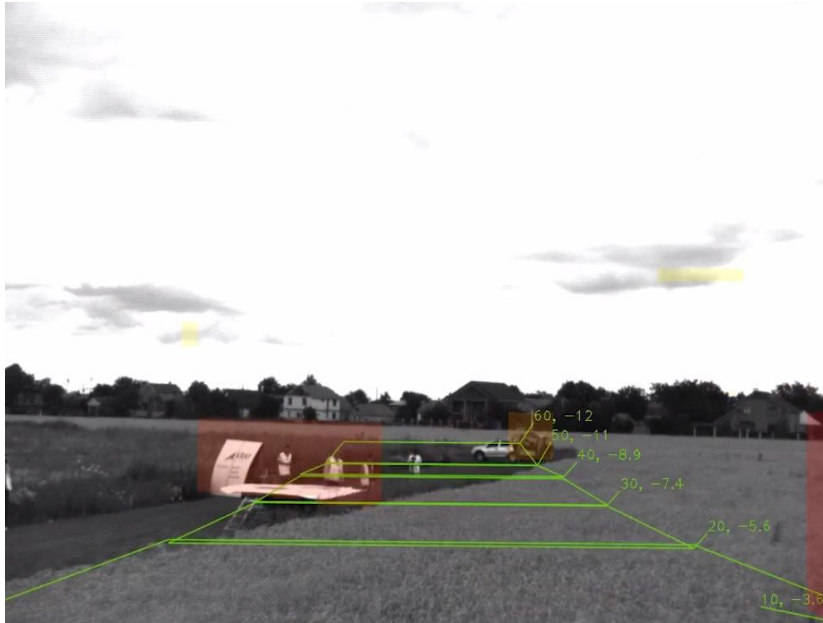
Compound multirotor flies fast within field borders eliminating unprocessed area

Computer vision maintain lowest flight altitude reducing drifts and increasing spraying quality

High-quality ultra-low volume spraying saves pesticides and prevents water waste

Up to 85% of time is spent productively, driving daily productivity to 700-1200 acres/day

Self-flying drone with an advanced computer vision system



Kray Protection drone flies at 70 mph speed and 3 feet altitude above the crop. Advanced computer vision follows terrain and avoids obstacles in real time.

Advanced computer vision and RTK GNSS - based control system automates the flight with 2-4 inches precision.

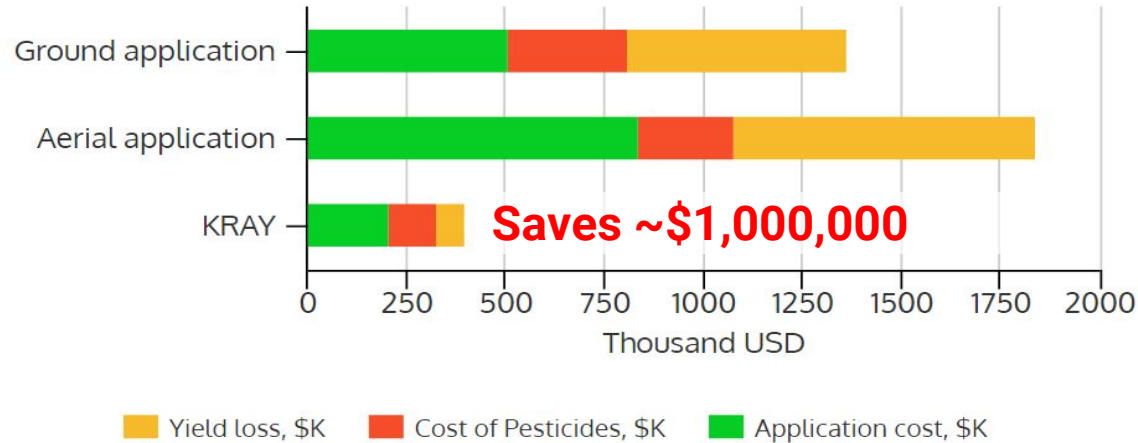
World's most precise aerial application with minimal drift and minimal evaporation.

Elevation maps are being collected automatically.

What makes
Kray Protection an
advantageous
solution?



Cost savings



Kray Protection
saves \$1M in 6
years for 5K acres
farm

New generation of crop protection technology



5D Precision of application

We combine spatial precision of fertilization with the ability to adjust application rate in a specific time.

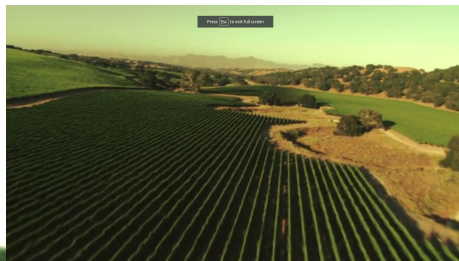
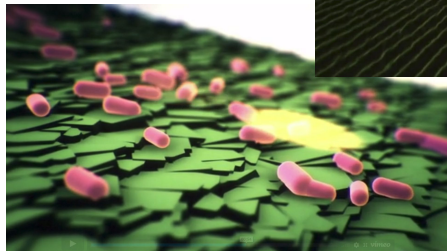
High yields with frequent fertilization and crop control

Up to **48% yield rise** on winter wheat (Forbes & Manhattan case)

Yield gains with frequent foliar dressing

Proven success stories

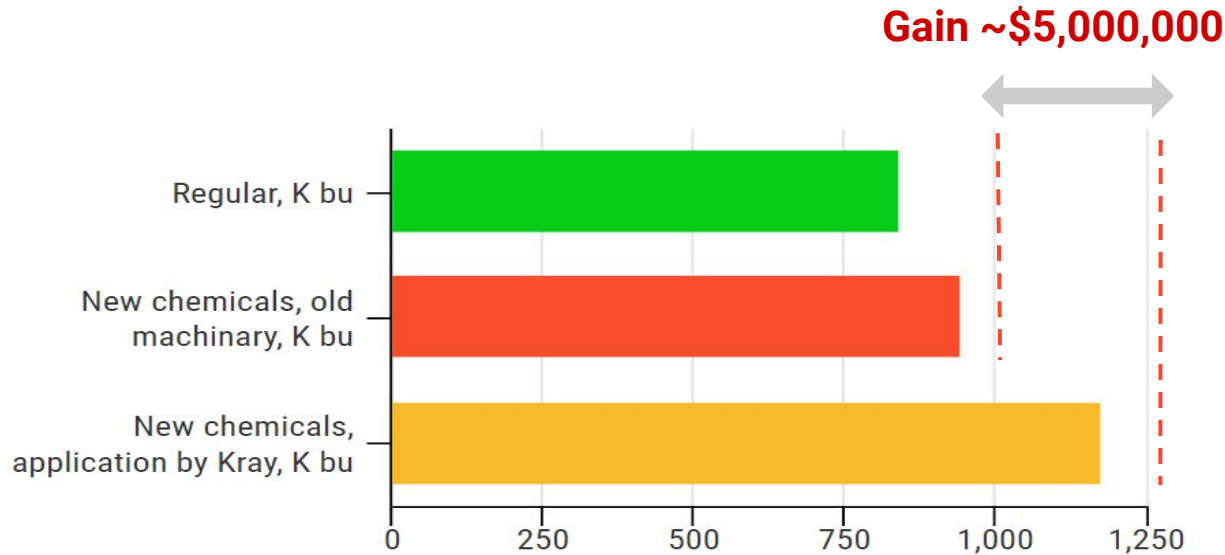
- [New Leaf Symbotics](#) (USA)
- [Forbes & Manhattan Ag division](#) (Canada)
- [Birano](#) (USA)



Kray brings lab yields to the field

By using Kray Protection farmers could apply with 5D Precision for in-time plant nutrition that could significantly increase yields.

More gains with foliar dressing



Wheat

average yield 168.5

bushels per acre

average price \$4*

for 6 years and

5000 acres

* - Crop Production 2015 Summary, USDA, 2016

Kray Protection datasheet



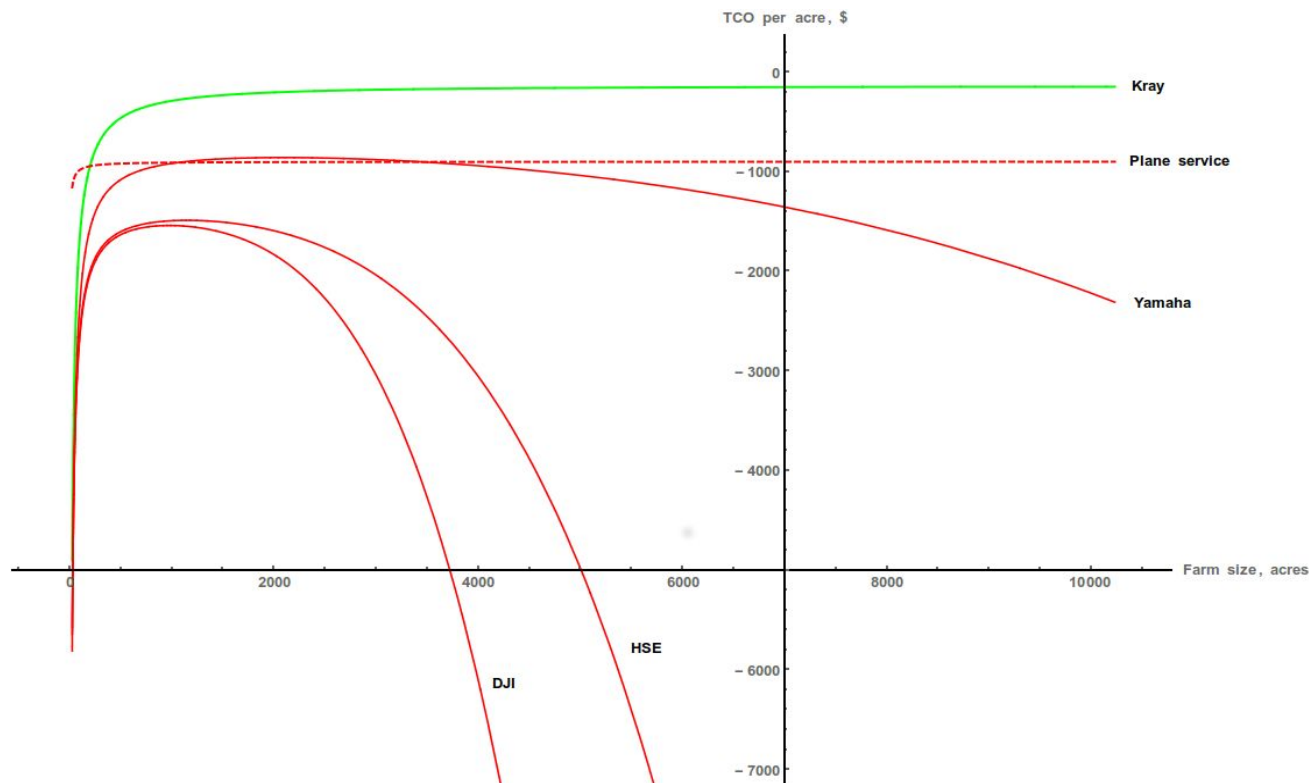
★	Take-off weight	40 kg
★	Type	Compound octocopter
★	Diameter, by motor axes	200 cm
★	Diameter, by prop tips	275 cm
★	Height	90 cm
★	Chemicals tank	22.5 l
★	Application strip width	5 m
★	Application dosage	1-5 kg/hectare
★	Operational speed	30.5 m/s
★	Ground-based obstacle avoidance	automated, from 1 m height
★	Operational altitude	1 m above surface level
★	Round time	up to 15 min
★	Round coverage	up to 14 hectare
★	Performance	up to 46 hectare/hour

Competitors



	HSE AG-6A+ v2	SprayingDrone	DJI Agras MG-1	Kray Protection
The cover speed	10.8 Ha/h	8.6 Ha/h	4 Ha/h	54 Ha/h
Operation speed	0-5 m/s	0-5 m/s	0-5 m/s	0-30 m/s
Platform type	Multicopter	Multicopter	Multicopter	Compound multicopter
Tank capacity	5.3 gal	4 gal	2.6 gal	5.8 gal
Flight time	15-30 min	10-25 min	10 min	6-22 min
Spraying techniques	6 hydraulic	6 hydraulic	4 hydraulic	6 rotary atomizers
Droplet size	60 – 180 µm	no data	no data	10-100 µm
Applicability for ULV	low	low	low	high
Ground station	no	no	no	yes

Competition for total cost of owning per acre



From the currently competing unmanned solutions, only the Kray UAS is applicable in the industrial scale

ROI for farmer >> 500%

Yield gains can push ROI several times higher

Competition advantages



	Swarmbot	DJI	Yamaha	Plane service	KRAY
Application cost	Good	Poor	Medium	Medium	Excellent
Yield losses	Poor	Poor	Poor	Poor	Good
Chemicals saving	No	No	No	Depends	Yes
Total cost of owning	Medium	Poor	Medium	Medium	Excellent
Yield rise potential	Medium	Poor	Poor	Poor	Good
Wet ground/high crop applicability	Poor	Good	Good	Good	Good
Technology scalability	Medium	Poor	Poor	Poor	Good

Competitors **have limited economical benefits and yield rise potential**

No simple solution that solves all problem due to complex problem chain domain

On high-value crops ground-based spraying robots may benefit for a short time

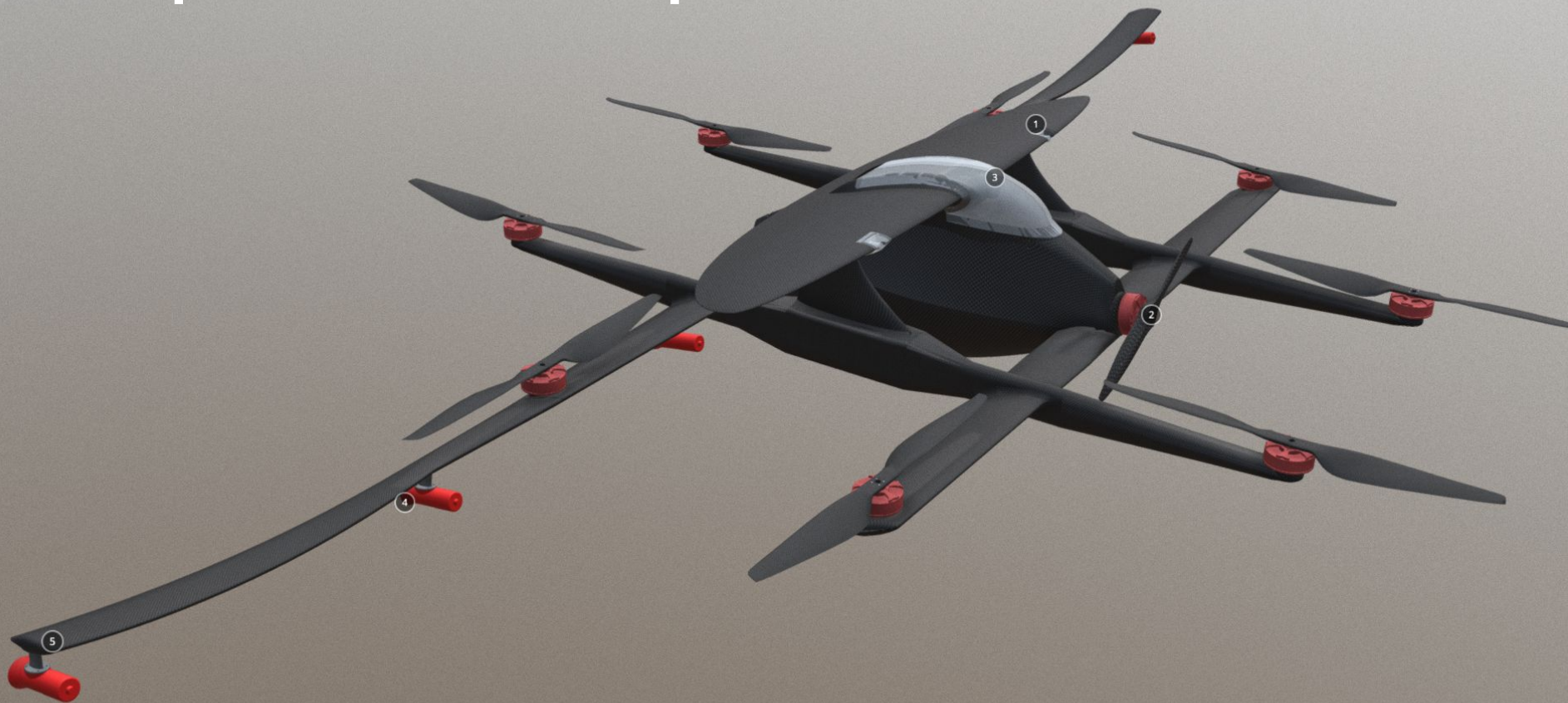
At complex application conditions aerial spraying solutions may benefit for a time

Aerial platform challenges

- Highly efficient flight at wide speed range without transition modes
- Precise control of 14 feet boom at 3 feet altitude
- High payload / platform weight ratio
- Automatic precision vertical landing



Compound multirotor platform



Platform results

- Precise direct attitude/altitude control with lifting rotors
- Thrust rotor is efficient for higher speeds
- Fixed-wings carry up to 70% of drone weight
- 2.5 payload / platform weight ratio
- Custom precision sensor fusion and advance control systems
- 3 patent pending in the aircraft and control systems

Kray Protection platform



Take-off weight	77 lbs
Type	Compound octocopter
Central wing area	5.8 ft ²
Beam wings area	10.2 ft ²
Diameter	6.5 ft
Application boom	14 ft
Operational speed	70 mph
Round time	up to 15 min

Computer vision challenges

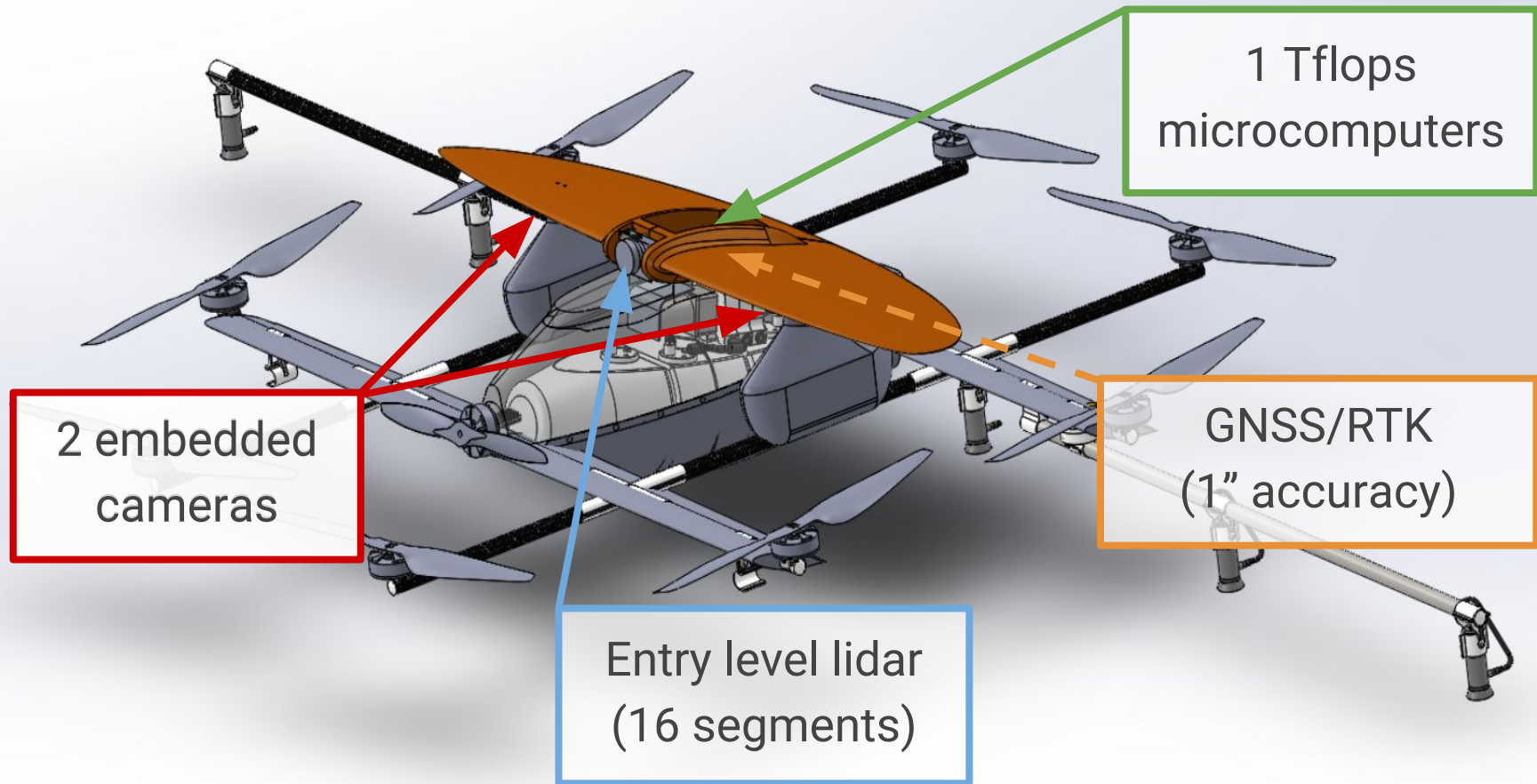


- High performance on-board
- Small view angle: sophisticated reconstruction is required
- High precision of terrain relief estimation
- 300 feet range scene reconstruction

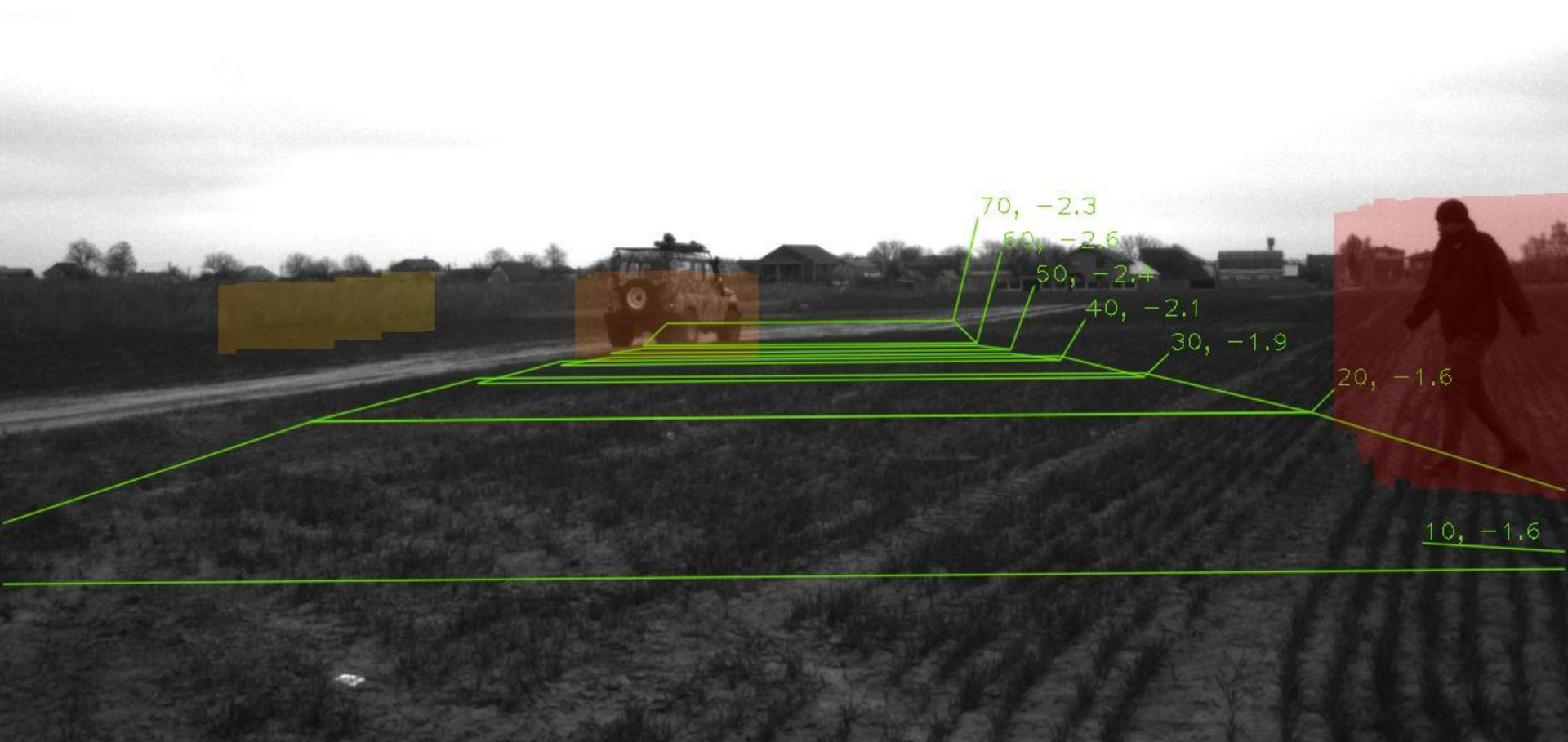
Computer vision system results



- Full-scale reconstruction of the scene
- Advanced scene sensor fusion
- 5 inch scene estimation accuracy
- 6DOF estimation with 100 Hz frequency
- Patent pending in scene reconstruction



Real-time computer vision system AR screen



Spraying system challenges



- Low drop size is required due to reduced volume
- Very tight control is required on drop size
- Wide range of flow rates required due to different rates and speeds
- Improvements in deposition quality required

Pressurized nozzles vs Rotary Atomizers



Nozzles

Rotary Atomizers

Cost Low

High

Weight Low

Medium

Droplet size control Poor

Good to excellent

Work mode On/off control

Smooth control

Variable rate applicability Medium

Excellent

ULV applicability Poor

Good

Various pumps vs Peristaltic pump



	Various pump	Peristaltic pump
Cost	Low	High
Weight	Low	Medium
Flow rate control	Poor	Excellent
Work mode	On/off control	Smooth control
Solution viscosity calibration	Required	Not required
Solution isolation	No	Yes
Chemical resistance	Poor to medium	Excellent

No charge vs Electrostatic charge



	No charge	Electrostatic charge	Two-phase charge
Cost	No	Medium	High
Weight	No	Medium	Medium
Drop deposition control	Poor	Good	Excellent
Surface distribution	Poor to Medium	Good	Good
Pesticide drift potential	High	Medium	Low
Pesticide applicability	Medium	Good	Excellent

Spraying system results



- Precise atomization with narrow drop size distribution
- Wide range of flow rates with the stable drop size
- Physical tuning and re-calibration eliminated
- Electrostatic spraying with the stable charge/mass ratio
- Patent-pending two-phase charge technology
- 4 patent pending in the electrostatic charge and flow/drop control

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