

# Sense and Spray Weed Management

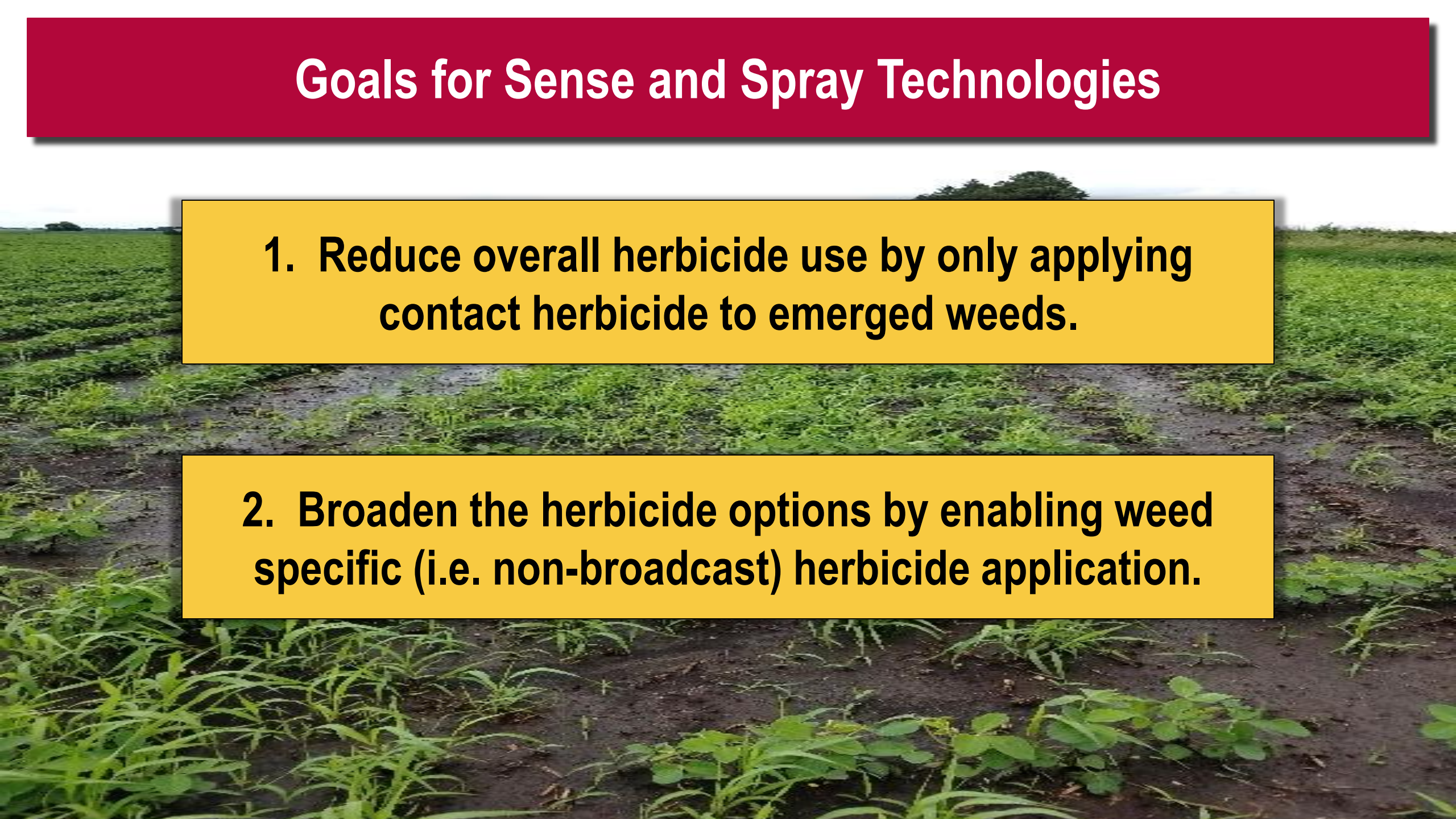
## *Disruptive Technologies for Disruptive Pests*

***Matt Darr, Iowa State University***





# Goals for Sense and Spray Technologies



**1. Reduce overall herbicide use by only applying contact herbicide to emerged weeds.**

**2. Broaden the herbicide options by enabling weed specific (i.e. non-broadcast) herbicide application.**



## 1979 - Volume #3, Issue #2, Page #04

[ [Sample Stories From This Issue](#) | [List of All Stories In This Issue](#) | [Print this story](#) | [Read this issue](#) ]

[«Previous](#)   [Next»](#)

### Fastest Gun In The West

When Minnesota farmer Kenn Kass, of Tracy, got tired of walking to chop volunteer corn out of his soybean fields, he did something about it.

Result: The Ken-Ride Spot Sprayer. Now, rather than the slow job of walking fields and pulling, chopping or hoeing volunteer corn or stubborn weeds, four persons seated on the Ken-Ride each operate an 18-in. spray wand. A total of 10 acres per hour can be spot-sprayed, traveling 5 mph, reports Kass.

Broadcast spraying is also possible with this "fastest new spray gun in the West". Operators flip a quarterturn valve to broadcast-spray a heavily-infested area, then resume spot spraying in areas of sparser infestation. Eight 40-in. rows, or twelve 30-in. rows, can be sprayed broadcast. If the crop needs cultivating, a rear mounted cultivator can be used behind the tractor, with riders up front to spot spray isolated weeds. Or, the driver can broadcast spray with or without riders as he cultivates.

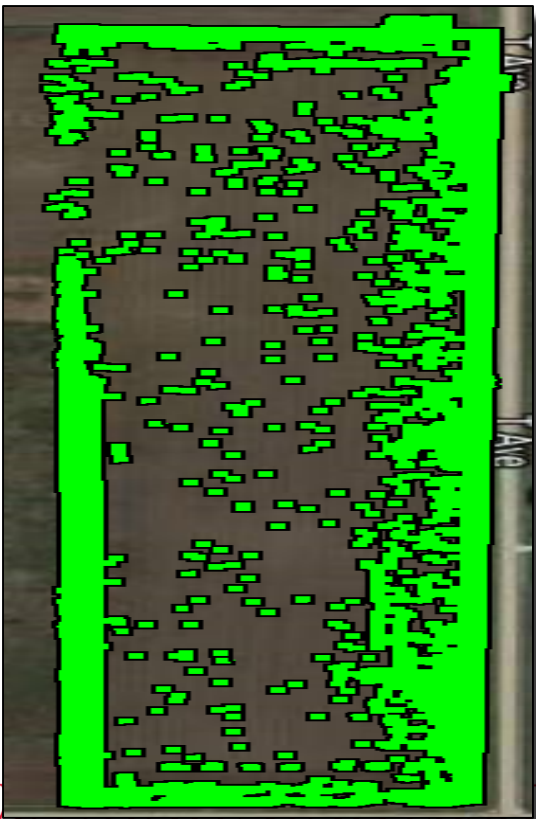
Kass really didn't think seriously about marketing the machine until he noticed that every time he used the Ken-Ride, somebody asked him to make them one, or to borrow his rig. Last fall, Kass contracted with a manufacturer to produce the machine. They are readily available for the 1979 cropping season, at a suggested retail price of \$1,235, fob.



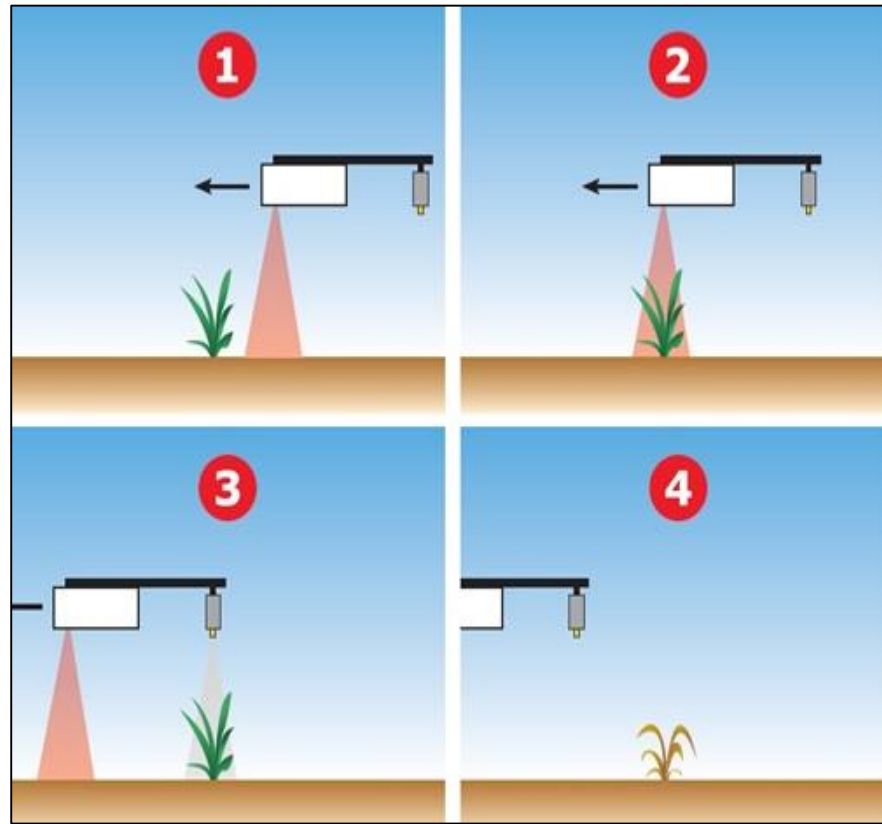
Each rider operates an 18-in. spray gun. Rig will also broadcast spray at all or any one station.

# Today's Marketplace for Sense and Spray Technology

## Aerial Imagery Based Prescriptive Weed Map



## Sensor Targeting Green Vegetation



## Camera Targeting Specific Weeds





# Imagery Sources for Weed Detection



**Satellite**

**Resolution:** 30m to 30cm

**Timing:** Monthly to daily

**Cost:** \$0.1/ac to free

**Capacity:** Global daily coverage

**Availability:** Global



**Traditional Aircraft**

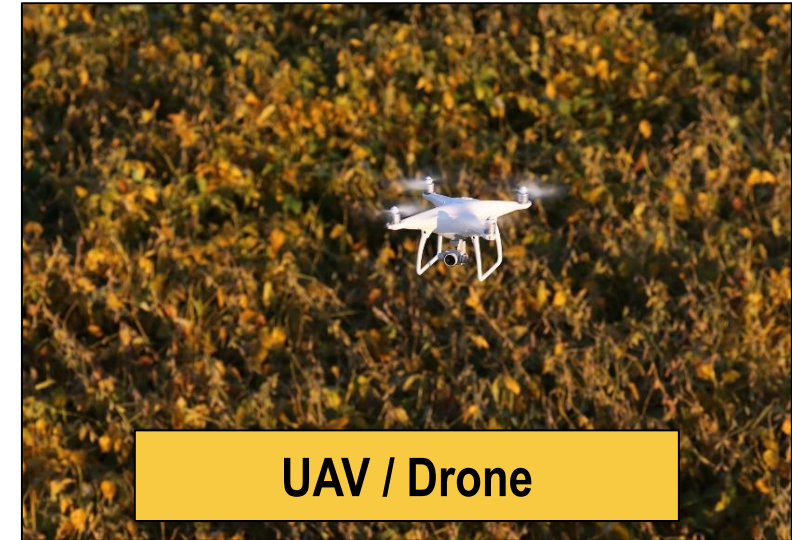
**Resolution:** 1m to 15cm

**Timing:** On demand

**Cost:** \$2.50/ac to \$1.00/ac

**Capacity:** 100,000+ ac/day

**Availability:** Regional



**UAV / Drone**

**Resolution:** 50cm to 2cm

**Timing:** On demand

**Cost:** ???

**Capacity:** 1,000 ac/day

**Availability:** Local



# Imagery Resolution Requirements for Weed Detection



- **Rule of Thumb = 4 pixels per weed**
- A **major outbreak of weeds** can be identified by high resolution **satellite** imagery but it is likely far beyond the point of control.
- **Well established weeds** can be identified by low altitude **aircraft** and still be controlled with herbicide.
- **Small or newly emerged weeds** can only be identified with high resolution achieved from low altitude **UAV** technology.



## Size Matters in Weed Control





# Commercial Solution for UAV Based Weed Identification

## WEED MAPS

FieldAgent's weed maps use computer vision to study every photo of your field, and accurately identify the location, and density of weeds. At the field edge and without an internet connection, FieldAgent takes your high-resolution images, analyzes them, and delivers you the results in a color-coded map, giving you an exact snapshot of weed pressure and location in a field.

By leveraging weed maps, you are able to produce map-layers and shapefiles that identify areas with weeds. Then, use this critical data to apply chemicals with precision.

Weed Maps are available through FieldAgent at \$0.25/acre.





# UAV Based Weed Detection



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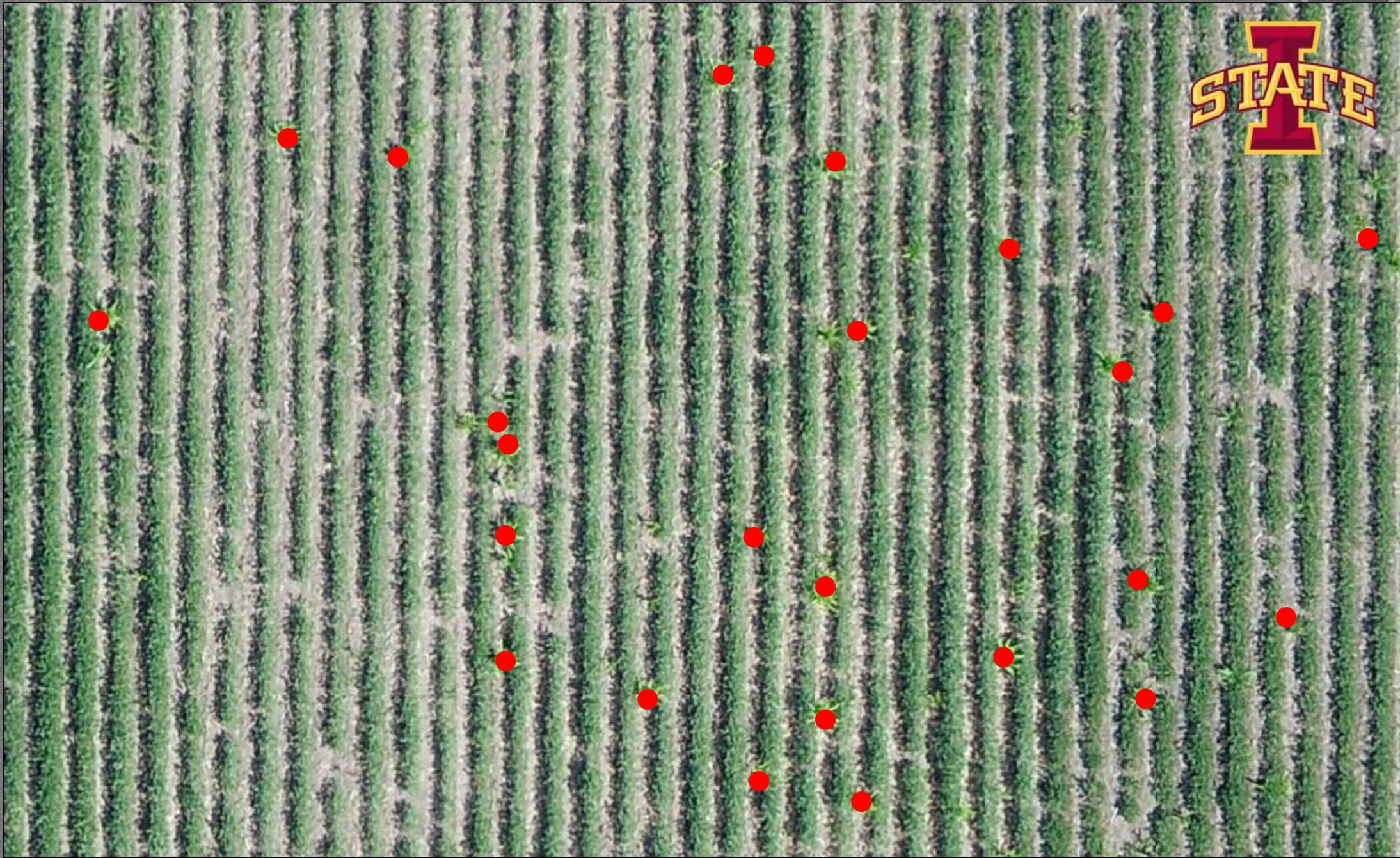




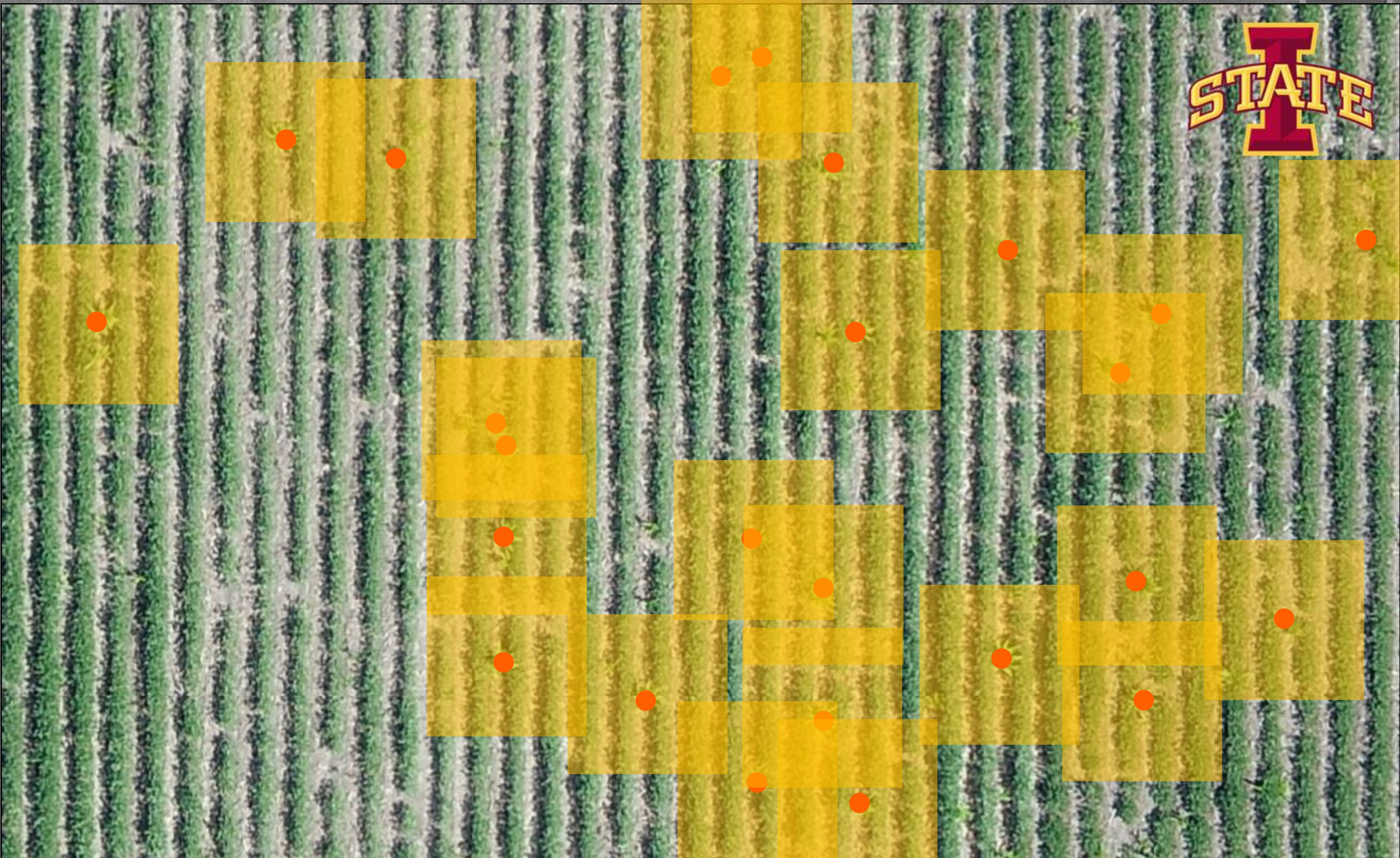
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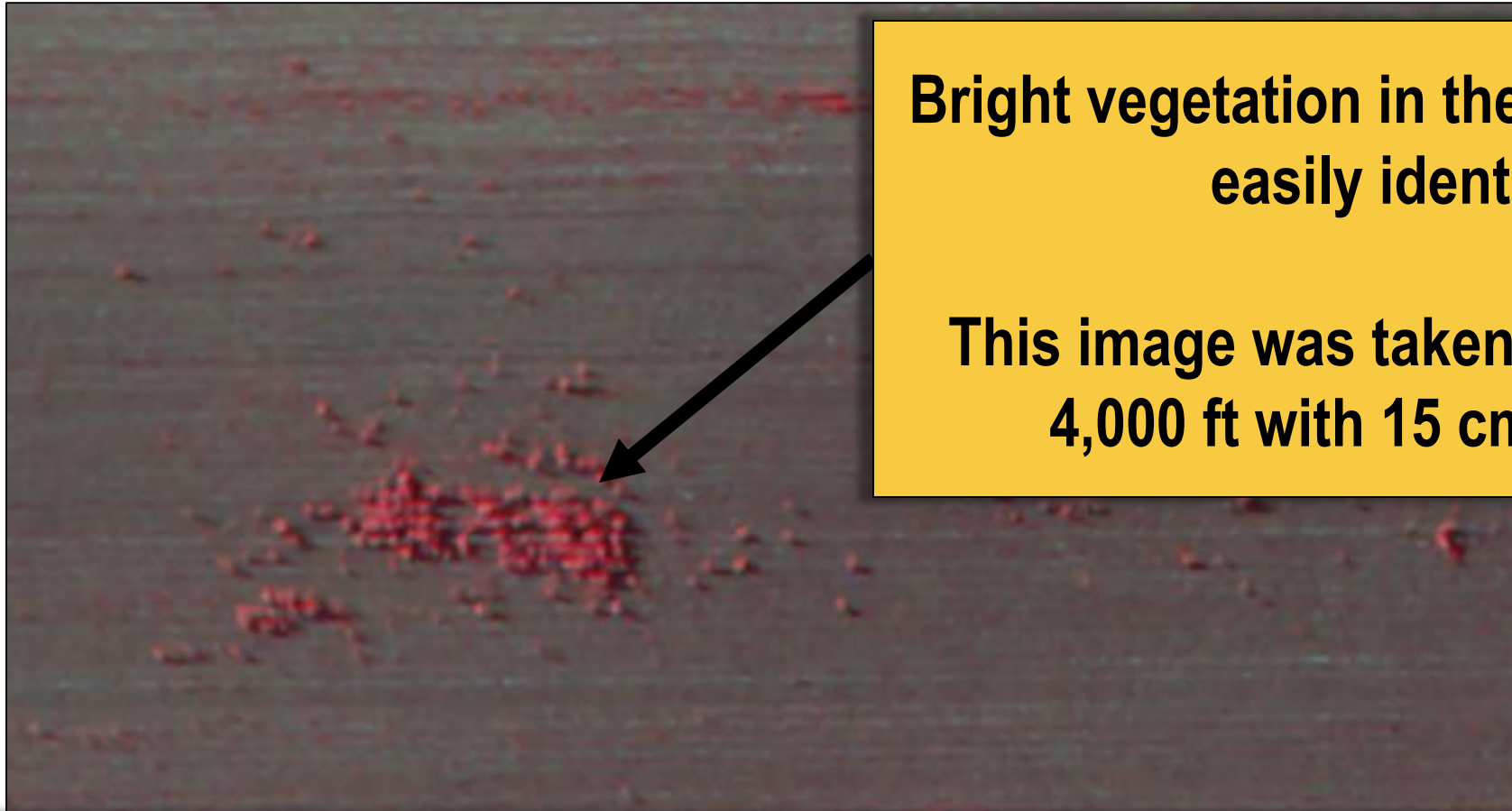


# Understanding Weed Control





# Identifying Weeds with Aircraft Based Aerial Imagery



**Bright vegetation in the near infrared spectrum is easily identified as weeds.**

**This image was taken in late May by a plane at 4,000 ft with 15 cm imagery resolution.**

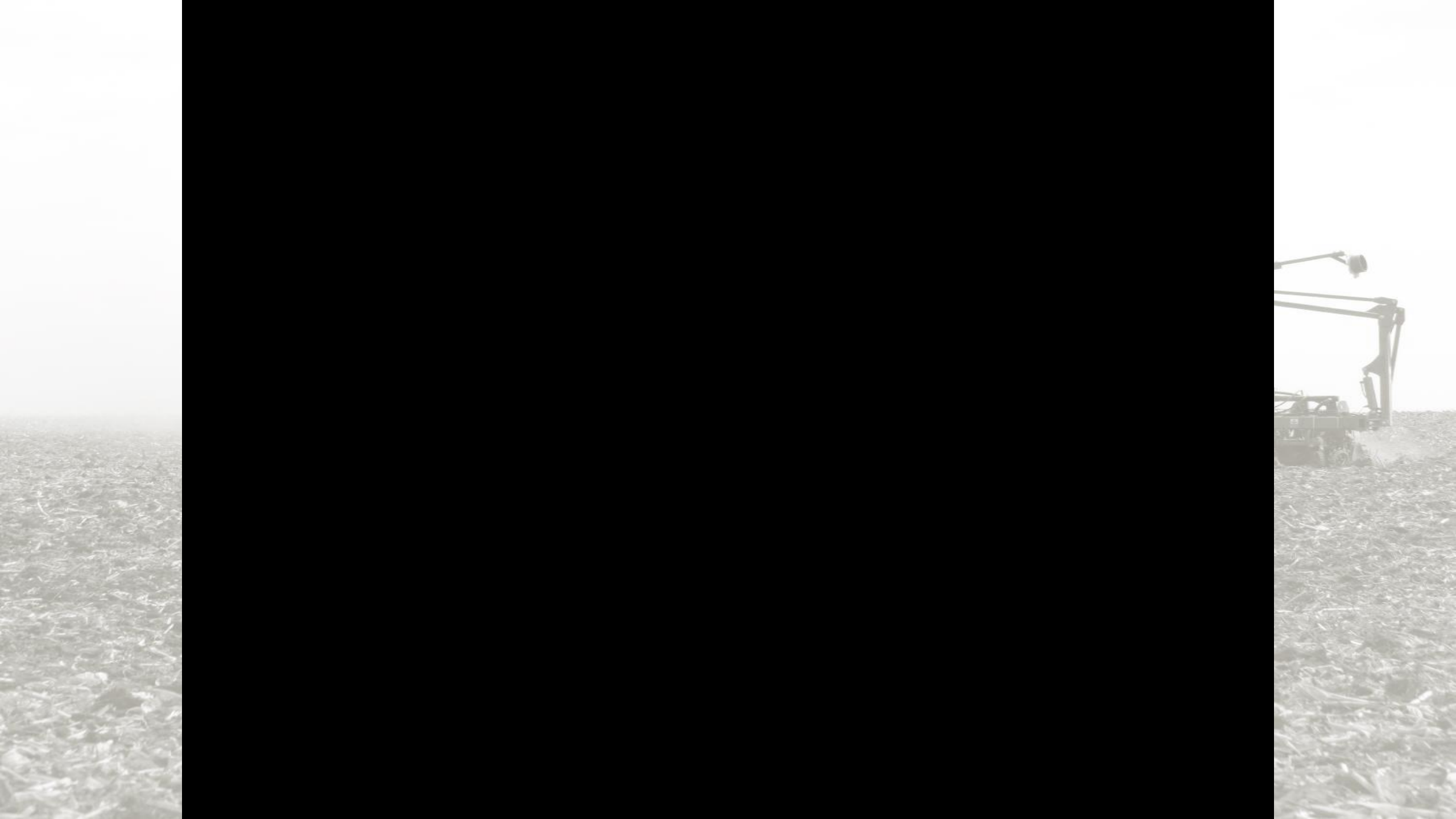
**Although the cost and capacity of aircraft is attractive, the timing and weed growth stage are a challenge for strong weed control.**



# Machine Based Sense and Spray Systems

- Sensor technology to detect and spray all plant vegetation
  - Similar concept to crop sensors for nitrogen management (GreenSeeker, OptRx, etc)
  - Works day and night
  - Does not distinguish crops from weeds, sprays all green vegetation
  - Example: [Weed-It](#)
- Camera technology to detect individual weeds within standing crop
  - Reliant on daylight operating conditions or heavy artificial lighting
  - Limited ground speed to allow for weed detection
  - Resolution requirements will drive a shift away from traditional nozzles
  - Example: [Blue River Technology](#)











# Hover Spraying



[www.joyance.tech](http://www.joyance.tech)



# Considerations and Risks for Sense and Spray Technologies

## *Integration with Weed Management Plans*

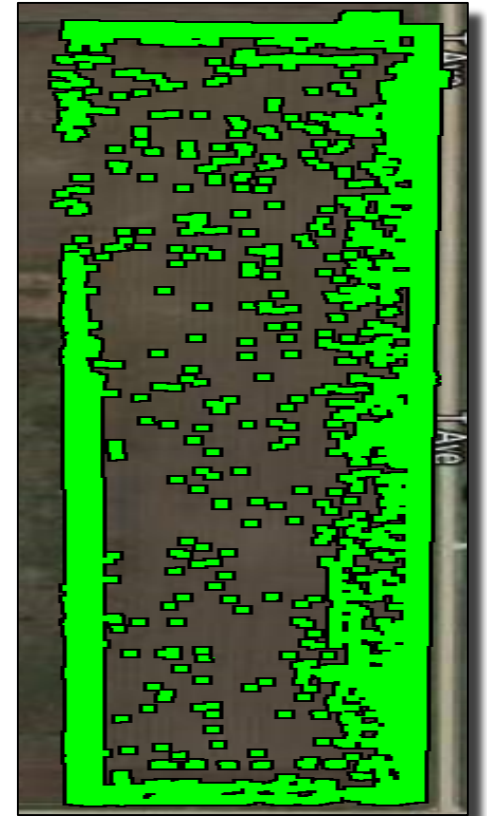
- Sense and Spray technologies are focused on better use of **contact herbicide** as part of a total weed management plan that **includes residual herbicide**.
- The end game for Sense and Spray is much broader than just reducing chemical use. It also offers the unique capabilities to address **weed resistance** through diversified chemistry.
- First adopters of this technology will be in regions with the strong weed challenges:
  - Southern cotton production (slow canopy closure, resistant Palmer Amaranth)
  - Fruit and vegetable production with limited herbicide options
  - No-till production with limited mechanical weed control



# Considerations and Risks for Sense and Spray Technologies

## *Aerial Imagery Based Prescription Weed Mapping*

- Aerial imagery weed mapping and weed prescriptions are **available today and do work**.
  - These require high resolution imagery that may require dedicated UAV flights.
  - These systems work in regions where weeds have been adequately classified and trained in the software prediction. Weeds are different regionally and **these solutions will be regionally based**.
  - Expected contact herbicide reduction for this technology is between **40 – 70%** depending on weed pressure.
  - Scalability of these systems are currently a challenge to meet the tight application windows for many cropping systems.



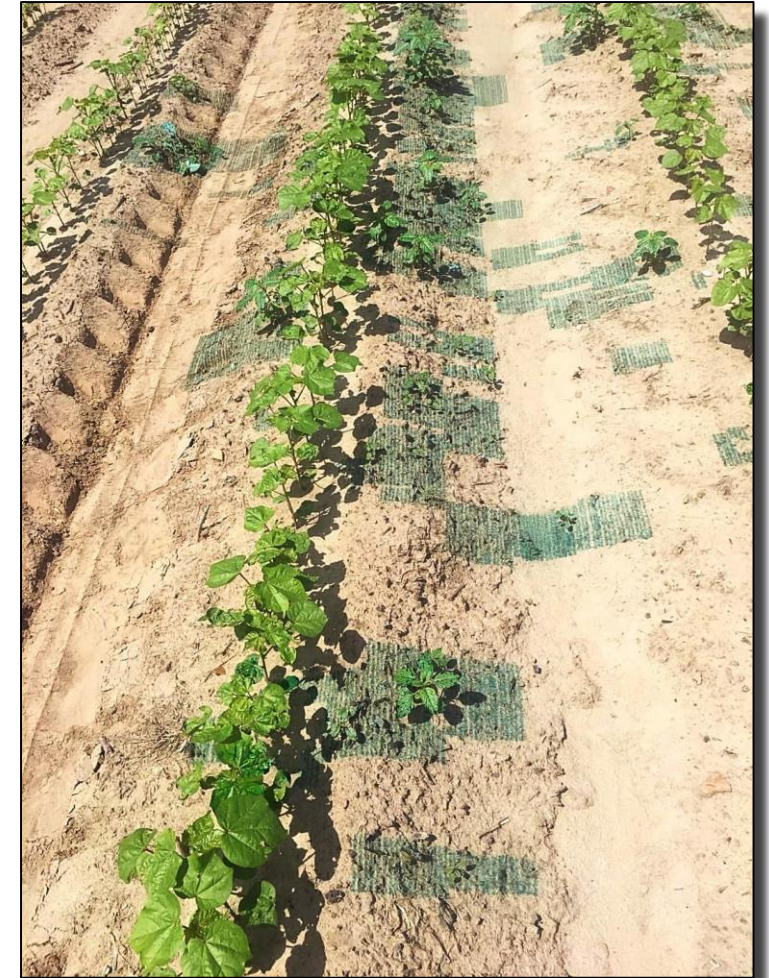
**Central Iowa in 2018 had 3 working days dry enough to spray in the month of June.**



# Considerations and Risks for Sense and Spray Technologies

## *On Machine Sense and Spray Technologies*

- On-machine Sense and Spray technologies are the more likely **end game** but will take ~5 years to fully commercialize into row crop production systems.
  - Realistic contact herbicide reduction of **90%+** is feasible.
  - Will require slower herbicide application speeds and improved boom height stability.
  - Will require shifts from traditional overlapping nozzles to high definition nozzle solutions.
  - Initially limited to day light application periods.





# Considerations and Risks for Sense and Spray Technologies

## *Drone Based Autonomous Spraying*

- Drone technologies are a reality for future state herbicide management.
  - Advances in battery / power technologies are required to meet cost and capacity requirements.
  - Drone based solutions are limited to **contact herbicides** and will not displace traditional sprayers for residual herbicide application in row crops.
  - US adoption for drone based sprayers will required large shifts in aviation policy and substantial infrastructure investment.







***Dr. Matt Darr, Iowa State University  
Agricultural and Biosystems Engineering***

