
IT'S NOT WHAT YOU SPRAY,
IT'S HOW YOU SPRAY IT
2022 Indiana CCA Conference
Bryan Young

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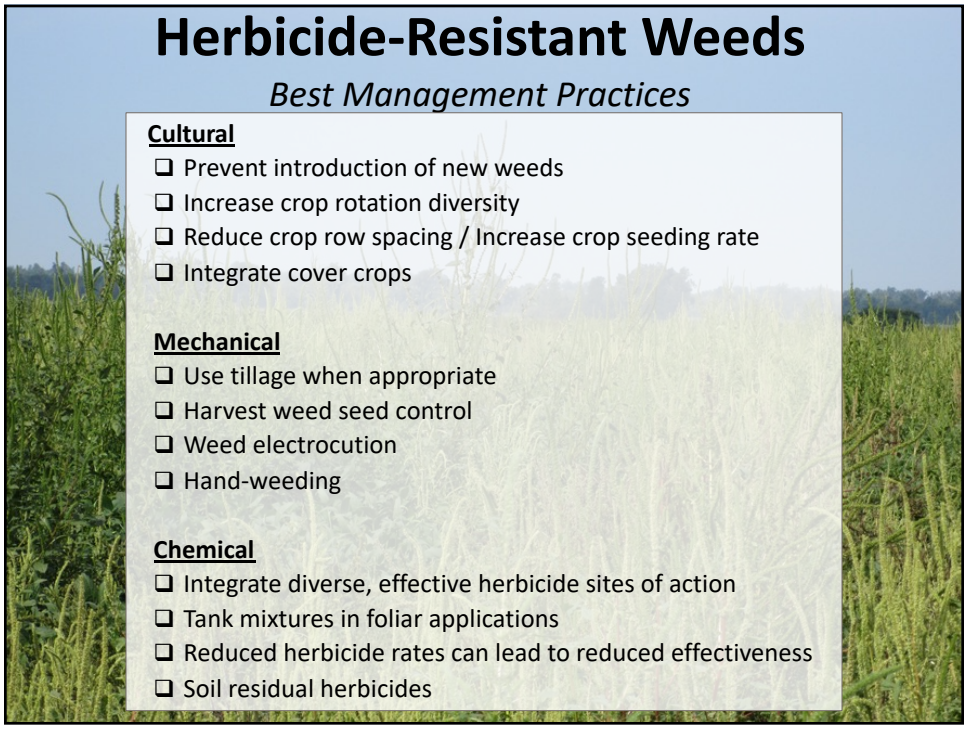
Herbicide-Resistant Weeds
Best Management Practices
Cultural
❑ Prevent introduction of new weeds
❑ Increase crop rotation diversity
❑ Reduce crop row spacing / Increase crop seeding rate
❑ Integrate cover crops
Mechanical
❑ Use tillage when appropriate
❑ Harvest weed seed control
❑ Weed electrocution
❑ Hand-weeding
Chemical
❑ Integrate diverse, effective herbicide sites of action
❑ Tank mixtures in foliar applications
❑ Reduced herbicide rates can lead to reduced effectiveness
❑ Soil residual herbicides

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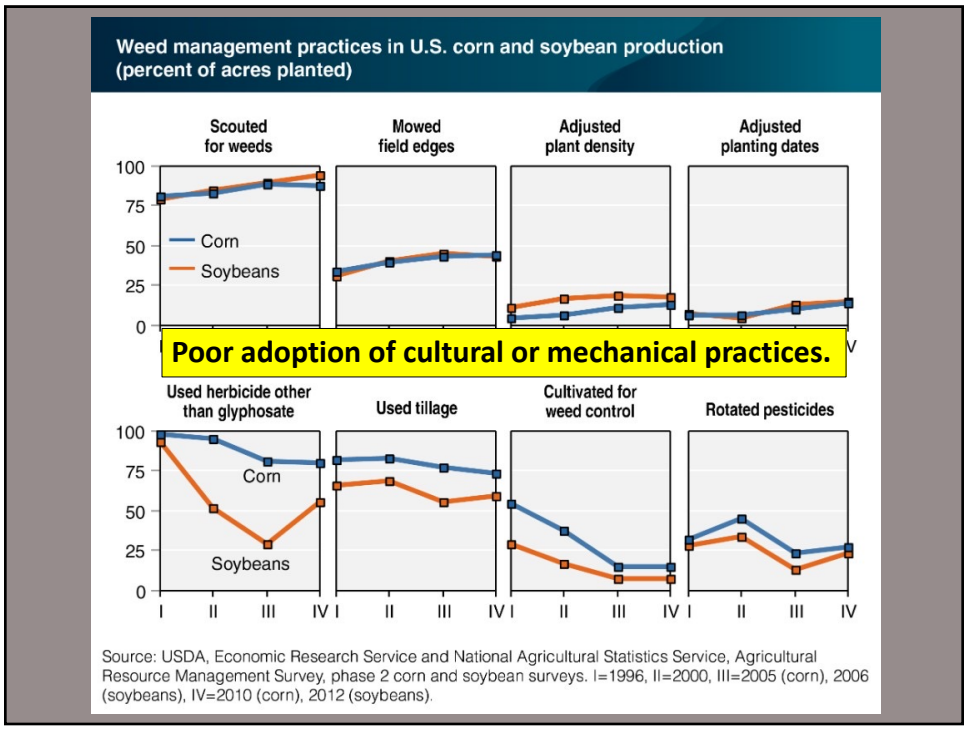


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# 'Recent' Herbicide Innovations

- No new herbicide MOA groups commercialized since 1998 (HPPD)
- 'Newest' Actives
  - Halauxifen-methyl (Elevore; Auxin)
  - Tolpyralate (Shieldex; HPPD)
  - Tiafenacil (Reviton; PPO)
  - Pyridate? (Tough; PSII)

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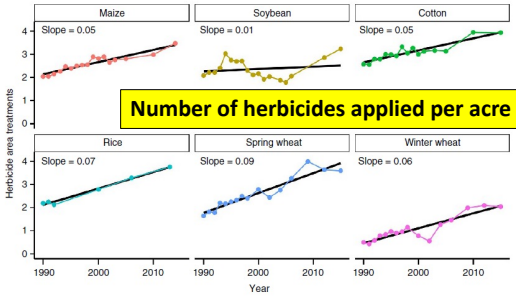
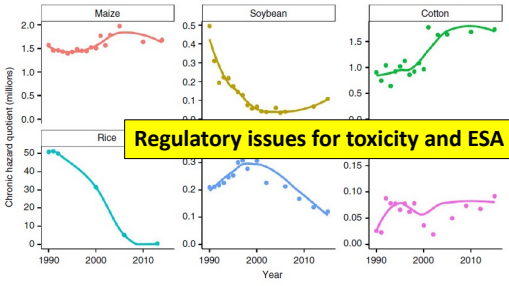
Kniss (2017)
*Nat. Commun.*
8, 14865




**Number of herbicides applied per acre increasing.**

**Figure 1 | Herbicide area-treatments for six crops in the United States 1990 to 2015.** Area-treatments are an estimate of the number of herbicide treatments applied to each field. Linear regression *P* value for soybean = 0.271; all other crops $P < 0.001$.




**Regulatory issues for toxicity and ESA will continue.**

**Figure 3 | Herbicide chronic hazard quotients for six crops 1990 to 2015.** Hazard quotient is the number of chronic rat (oral, 24 month) NOEL values applied per hectare. Mann-Kendall tests for monotonic trend: maize (tau = 0.50, $P = 0.006$); soybean (tau = −0.69, $P < 0.001$); cotton (tau = 0.60, $P = 0.001$); rice (tau = −0.87, $P = 0.024$); spring wheat (tau = 0.02, $P = 0.964$); winter wheat (tau = 0.10, $P = 0.620$).

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# Technologies for Battling Weeds


**ALL CURRENT/FUTURE TECHNOLOGIES REQUIRE AN INTEGRATED PROGRAM APPROACH**


Enlist Weed Control System

LIBERTYLINK GT27

ROUNDUP READY XTEND CROP SYSTEM


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# Herbicide-Resistant Weeds

*Best Management Practices*

**Cultural**

- ❑ Prevent introduction of new weeds
- ❑ Increase crop rotation diversity
- ❑ Reduce crop row spacing / Increase crop seeding rate
- ❑ Integrate cover crops

**Mechanical**

- ❑ Use tillage when appropriate
- ❑ Harvest weed seed control
- ❑ Weed electrocution
- ❑ Hand-weeding

**Chemical** *Focus on herbicides is still too extensive!*

- ❑ Integrate diverse, effective herbicide sites of action
- ❑ Tank mixtures in foliar applications
- ❑ Soil residual herbicides – ***Preferred!***
- ❑ Reduced herbicide rates can lead to reduced effectiveness

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# Technologies for Battling Weeds


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# Technologies for Battling Weeds

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ROUNDUP READY XTEND CROP SYSTEM

Farmer Mindset: ***"Grab that jug!"***

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**Future Growth Opportunities**

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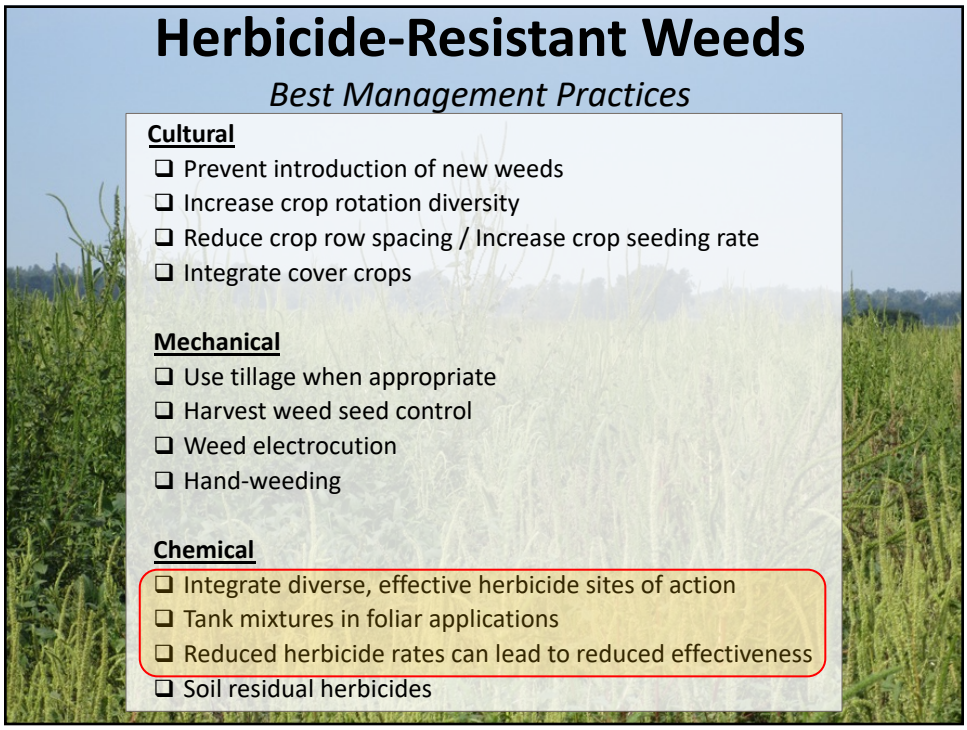
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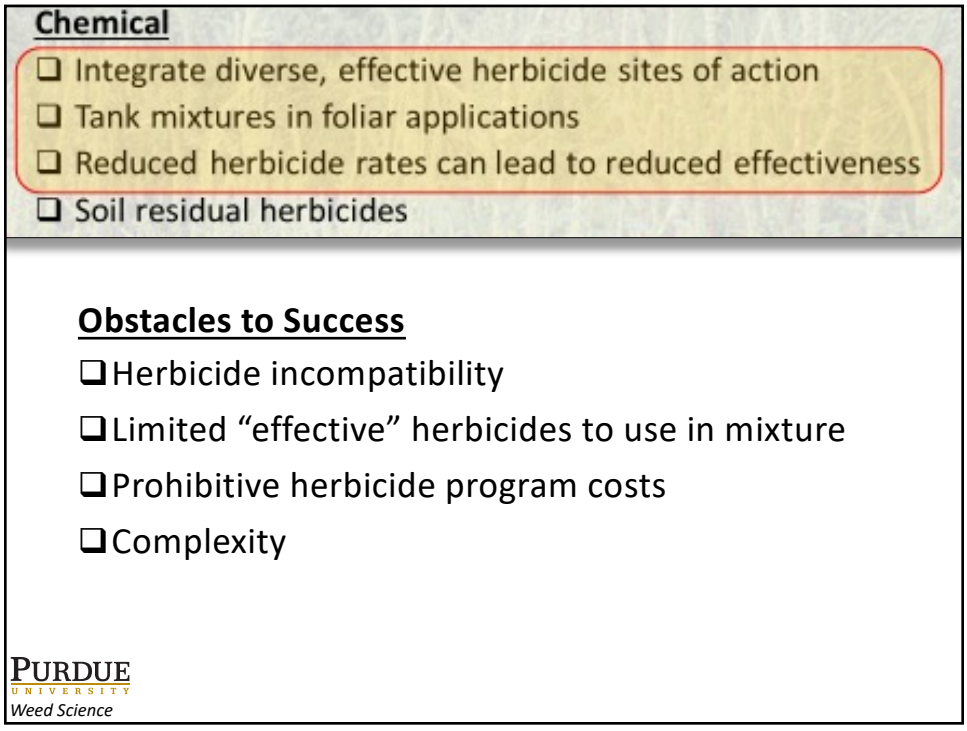
Chemical
❑ Integrate diverse, effective herbicide sites of action
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❑ Reduced herbicide rates can lead to reduced effectiveness
❑ Soil residual herbicides
Obstacles to Success
❑ Herbicide incompatibility
❑ Limited "effective" herbicides to use in mixture
❑ Prohibitive herbicide program costs
❑ Complexity
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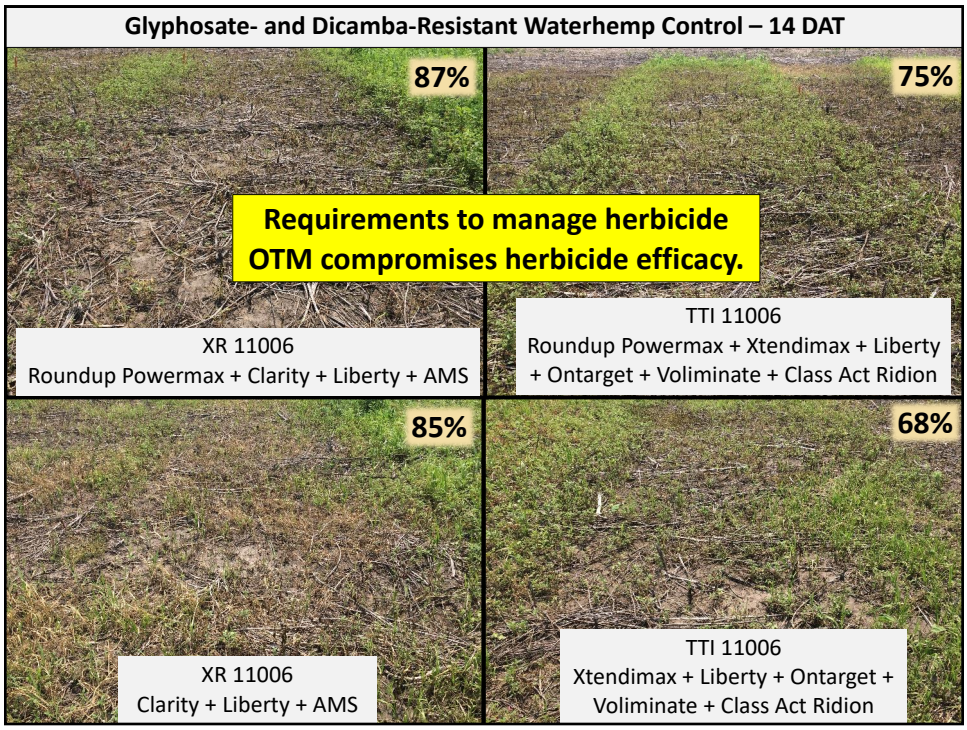
Glyphosate- and Dicamba-Resistant Waterhemp Control – 14 DAT
87%
75%
Requirements to manage herbicide OTM compromises herbicide efficacy.
XR 11006
Roundup Powermax + Clarity + Liberty + AMS
TTI 11006
Roundup Powermax + Xtendimax + Liberty + Ontarget + Voliminate + Class Act Ridion
85%
68%
XR 11006
Clarity + Liberty + AMS
TTI 11006
Xtendimax + Liberty + Ontarget + Voliminate + Class Act Ridion

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Just Give Weeds The Finger!
Greater than 6"
Good Luck!
2"
Ideal
3-4"
Good
4-6"
Marginal
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## Intelligent Sprayers and Automation

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# Technology Guided Foliar Applications


WeedSeeker ("Green on Brown" sensing) released in U.S. mid-1990s……

….but glyphosate was cheaper and easier.

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# Intelligent Sprayers and Automation

## Why Now?

## Human Failure……

- ❖ At implementing sound weed management
- ❖ To be cost effective (labor costs too much)

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# Robotics and Automation

*Value Proposition*

- ❑ Timely and accurate weed scouting
- ❑ Site-specific weed management
  - Increase efficiency of tools
- ❑ Precision herbicide application
  - Green on Brown/Green on Green
- ❑ Chemical and mechanical methods




Computer Vision Applications


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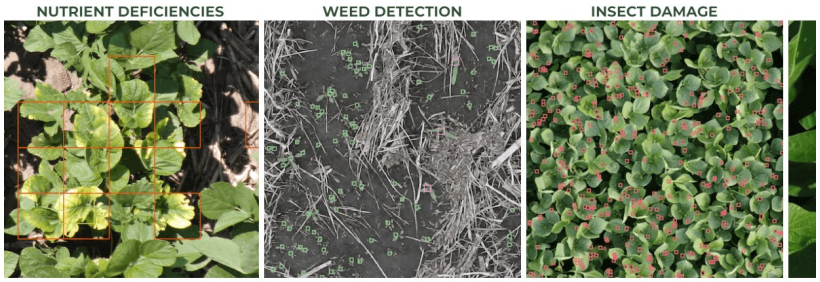
# Robotics and Automation

*Value Proposition (cont'd)*

**Continual quantification of success**




https://taranis.ag/

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# UAV Herbicide Applications

- ❑ Initial use imaging for field diagnosis
- ❑ Early applications for fungicides

**Pros**

- Late-season
- Small, confined field areas
- Relatively low cost

**Cons**

- Limited payload
- 1 to 5 acres per fill?
- Labor intensive per acre


**Are herbicides applied in this system really optimized as a BMP?**

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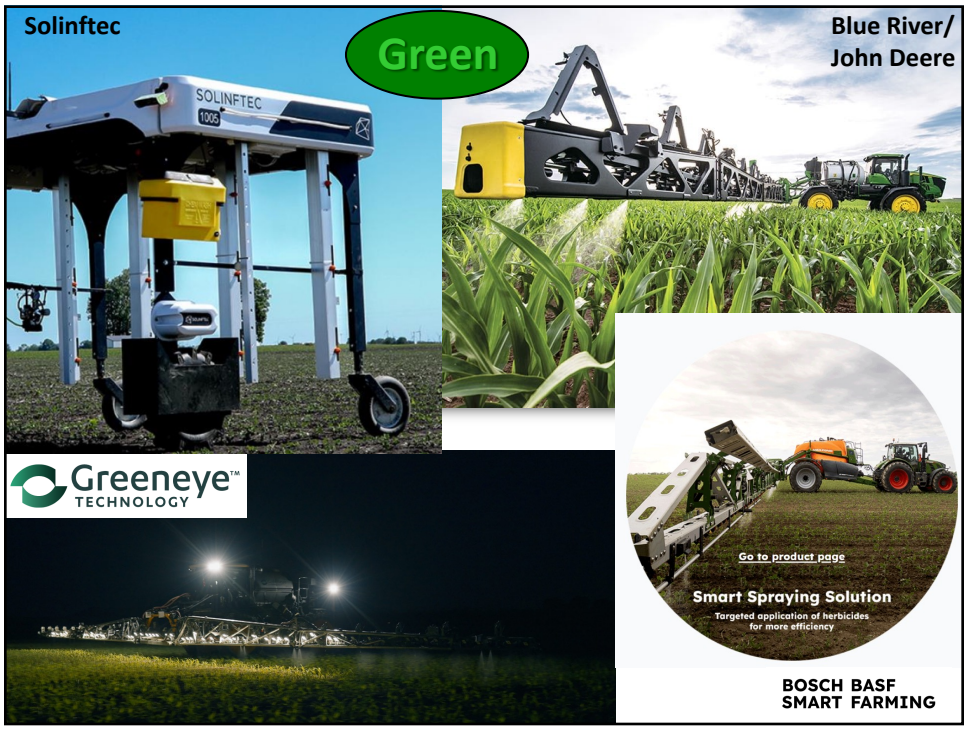


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# Machine Learning and Selective Spray Application

**Benefits**

- ❑ Reduce foliar herbicide costs
- ❑ Reduce environmental loading and impact
  - Will EPA capture this value?
- ❑ Potential to reduce crop injury for some herbicides
- ❑ Improve management of herbicide-resistant weeds
  - ???? – Tell me more
- ❑ Increase herbicide actives available/commercialized
  - Herbicide actives considered too injurious may result in minor injury when selectively applied
    - Will this pertain to developmental herbicides largely considered non-selective or marginally selective?
  - "Expensive" herbicides for mass production may now be cost effective if not applied broadcast
- ❑ Field maps of weed infestations by species?

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# Machine Learning and Selective Spray Application

**Challenges**

- ❑ Initial equipment costs
- ❑ Potential cost for annual subscriptions for additional features
- ❑ Complexity
  - Crop and weed model updates
  - Sensitivity settings to spray weed targets
  - How much spray do I mix for 40 acres?
- ❑ "Long" shadows can create large problems
- ❑ Gaining more favorable EPA regulations for selective applications
- ❑ Crop row spacing and spray travel direction
- ❑ Weeds under the crop row
- ❑ Compatible with PWM, direct injection, and high travel speeds

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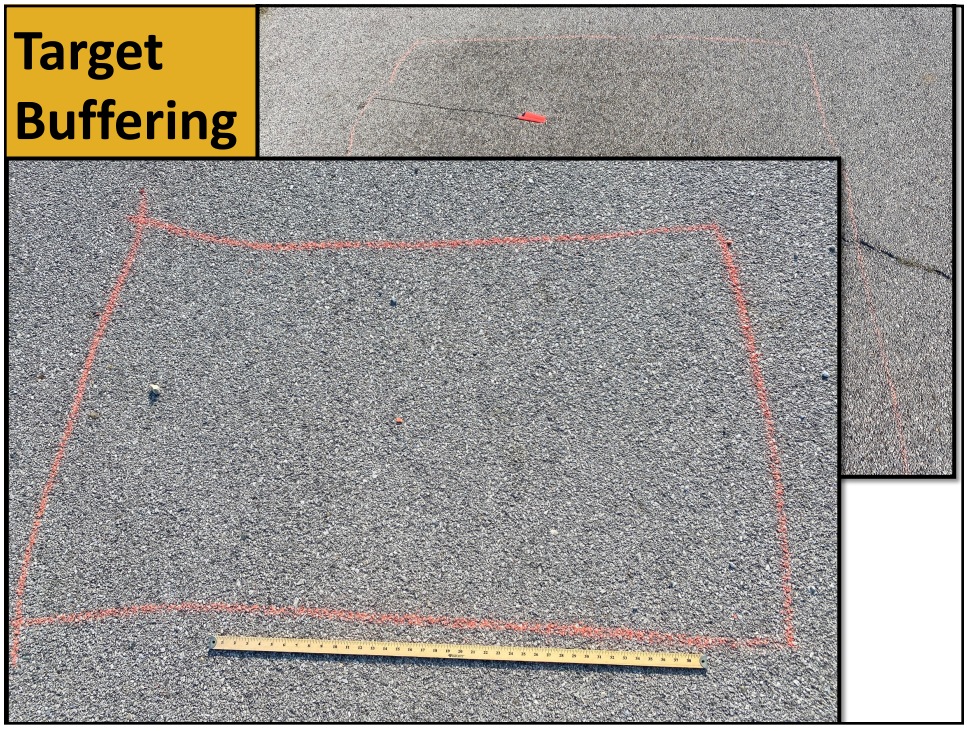
# Target Buffering



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## Travel Speed and Response Time

| MPH | Feet/Sec | mSec/Foot |
|---|---|---|
| 5 | 7.3 | 137 |
| 10 | 14.7 | 68 |
| 15 | 22 | 45 |
| 20 | 29.3 | 34 |

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## Two Tank / Two Boom System

**Benefits**

- ❑ Resolve negative herbicide interactions
- ❑ Alleviate EPA concerns for off-target impact of herbicide combinations
- ❑ Allow for greater herbicide optimization
  - Adjuvants
  - Carrier volume
  - Droplet size

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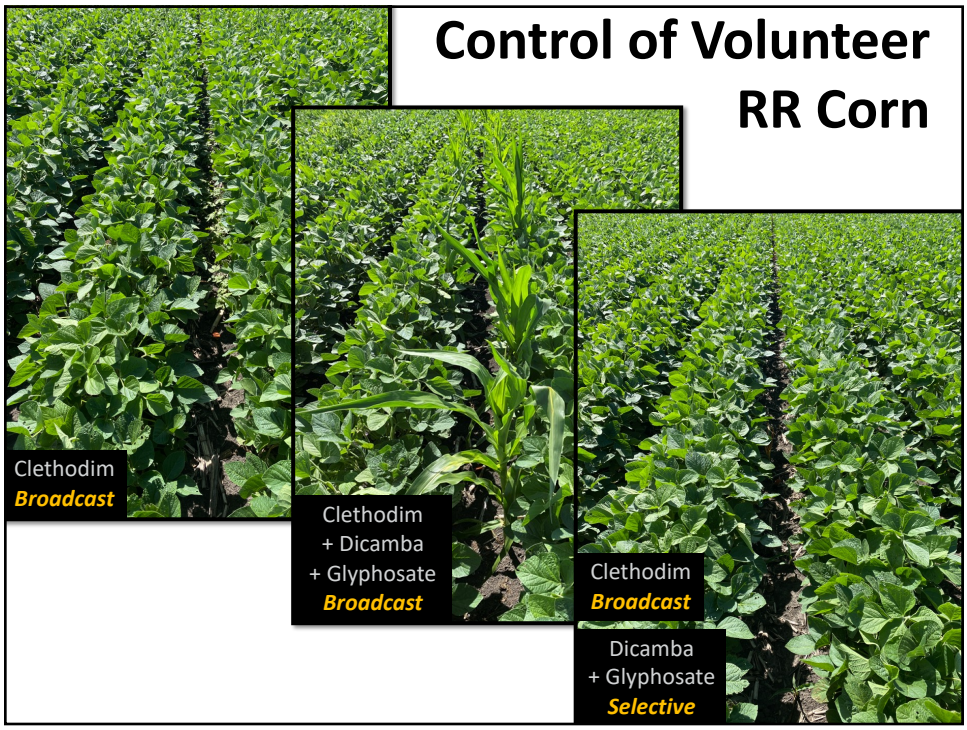
Control of Volunteer RR Corn
Clethodim
Broadcast
Clethodim
+ Dicamba
+ Glyphosate
Broadcast
Clethodim
Broadcast
Dicamba
+ Glyphosate
Selective

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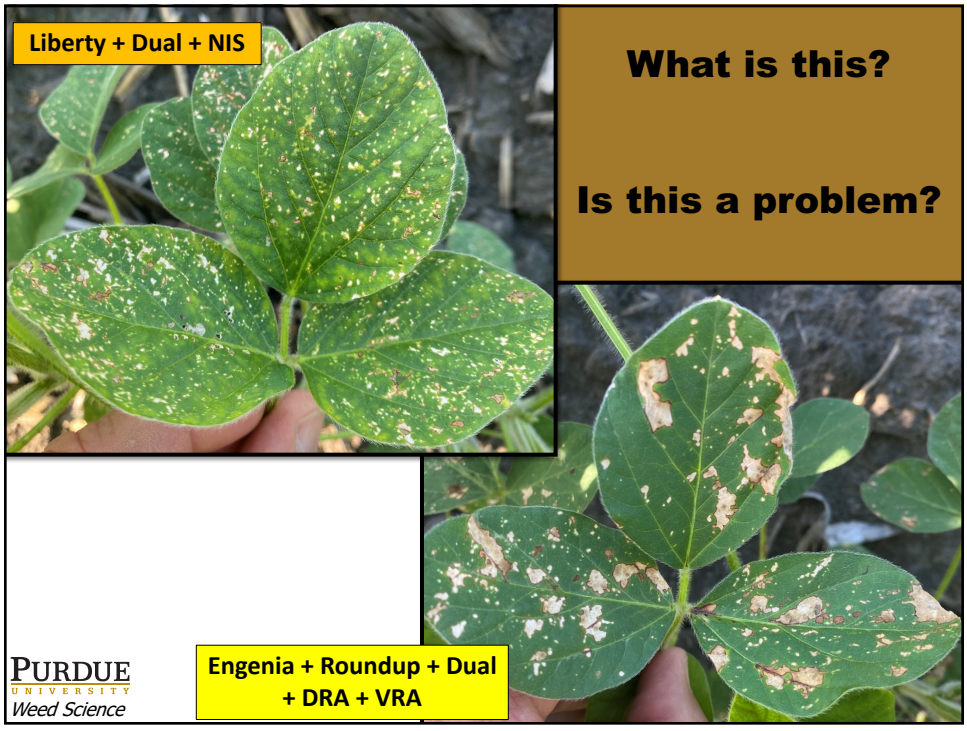
Liberty + Dual + NIS
What is this?
Is this a problem?
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Engenia + Roundup + Dual
+ DRA + VRA

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# Two Tank / Two Boom System

**Challenges**

- Initial cost
- Reduced tank size for broadcast applications
  - Fewer acres sprayed per tank relative to conventional sprayer
  - How much carrier do I need for soil residual herbicides?
- Complexity of building the best herbicide strategy
- Mixing and loading time increases

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# Will Regulation from EPA Change with Selective Applications?

- Variable rate herbicide applications
  - By weed size
  - By soil type
- Will an application to 5% of the field always be considered a broadcast application?
- Can herbicide application rates be increased if herbicide residue levels in crop are reduced from selective applications?
- If herbicide dose is reduced in field margins, or at least only applied to 5% of the area in the perimeter spray pass, will this impact labeling for endangered species?

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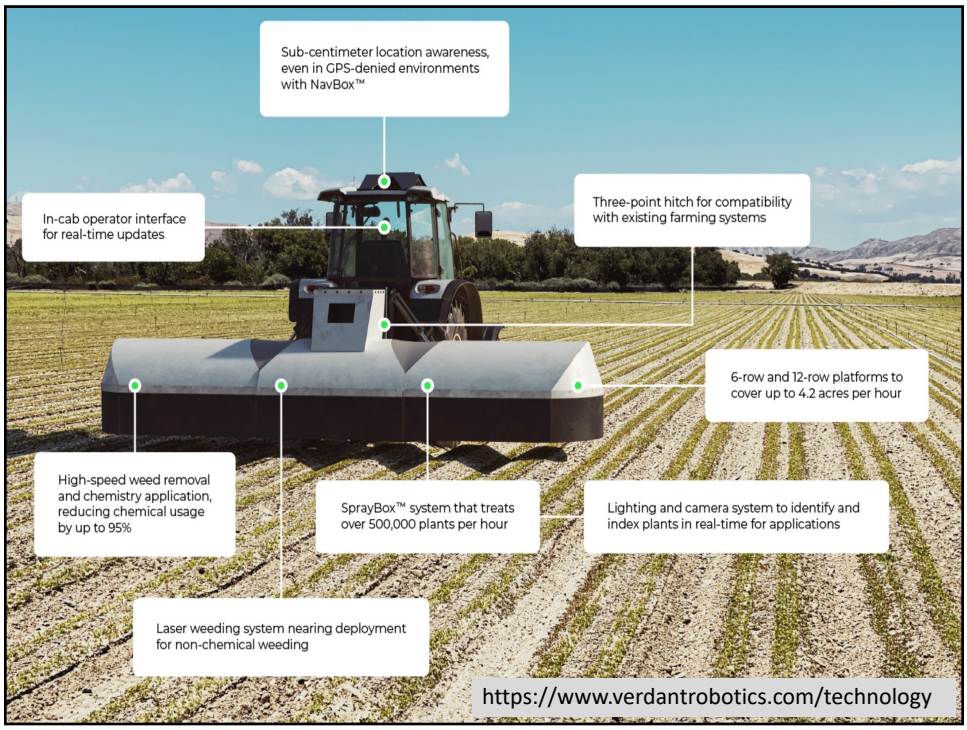


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# Robotics and Automation

*Platforms*

- ❑ New spray vehicle configurations
- ❑ Automation of implements
  - Configured with traditional vehicle (tractor, sprayer)
- ❑ Retrofit of current equipment

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*Amaranth Family (Amaranthaceae)*

| ID | Scientific Name | Common name | Sample Image #1 | Sample Image #2 | Sample Image #3 |
|---|---|---|---|---|---|
| 166 | *Chenopodium album* | Common lambsquarters |  |  |  |
| 581 | *Chenopodium simplex* | Maple-leaved goosefoot |  | | |
| 488 | *Amaranthus blitoides* | Mat amaranth |  | | |
| 459 | *Chenopodiastrum murale* | Nettleleaf goosefoot |  | | |

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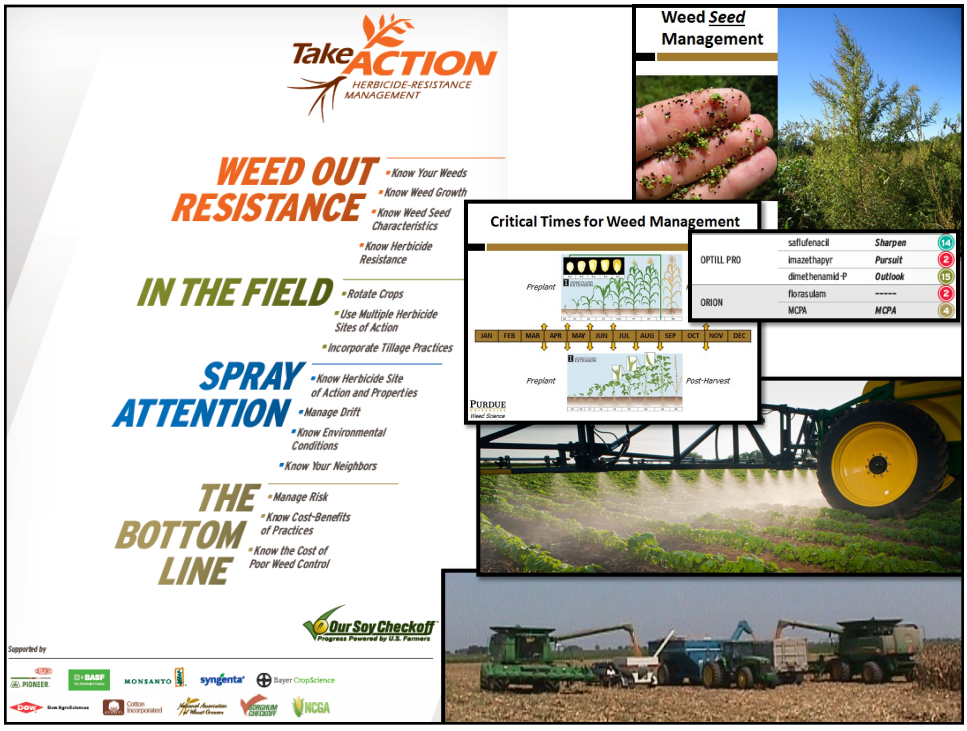


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ADVANCEMENTS IN PRECISION APPLICATION AND SITE-SPECIFIC WEED MANAGEMENT TECHNOLOGIES:
Will These be the Major Frameshift Change We've Been Waiting For?
It Depends

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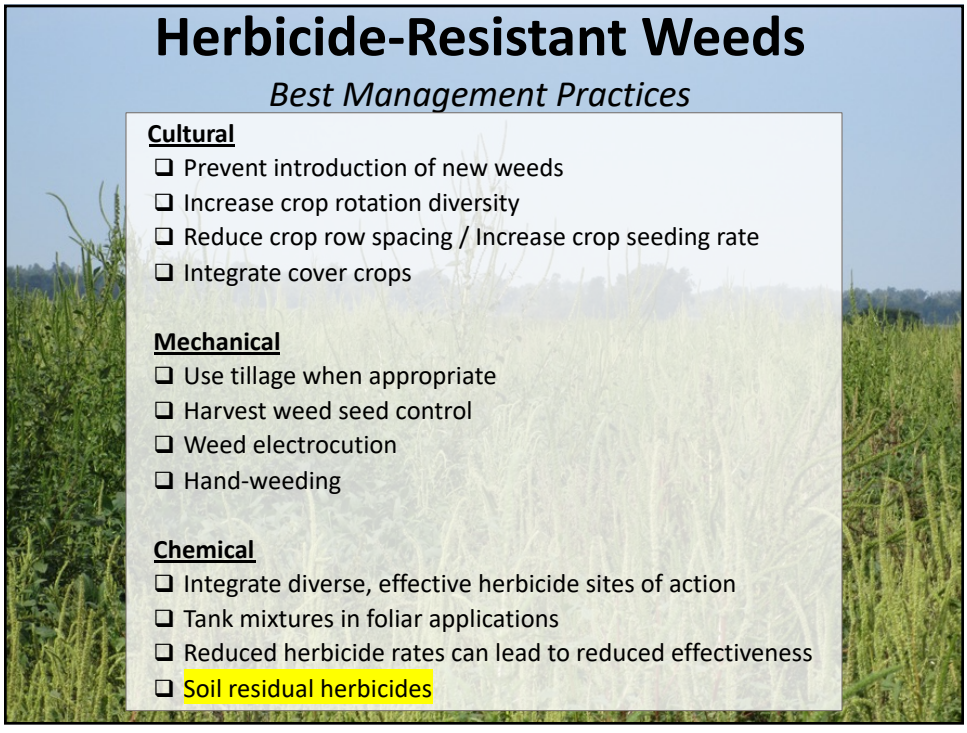
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