



# Robotics and Automation for Weed Management

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# Robotics and automation for weed management

What challenges do farmers want to overcome with robotics and automation?

What technology is needed to achieve those goals?

What's the status of robotics and automation for weed management?

Where do we go from here?





# Presentation goal

The goal of this presentation **IS NOT** to convince you that these tools are the right fit for your farming operation today or to tell you which tool to purchase

The goal of this presentation **IS** to show you what the future of weed management will soon look like beyond specialty crops - different but bright!

# Let's get the concessions out of the way!



Photo source: Smithsonian National Museum of American History

These tools are currently expensive

These tools operate slower and cover less ground than large spray rigs

Therefore, their first adoption is in high-value specialty crops where herbicides are applied often and cause injury, and handweeding is costly if available

BUT the technology is changing at breakneck pace!

Rapid  
evolution... in  
one year



Photo source: [carbonrobotics.com](http://carbonrobotics.com)

# Current challenges in weed management that could be addressed by robotics

Simply put:

Herbicide resistance is out of control

New herbicide sites of action are few and far between

Regulation will continue to limit use

In specialty crops, existing herbicide programs can be injurious and reduce high-value crop yield and quality

Hand-weeding labor availability is limited



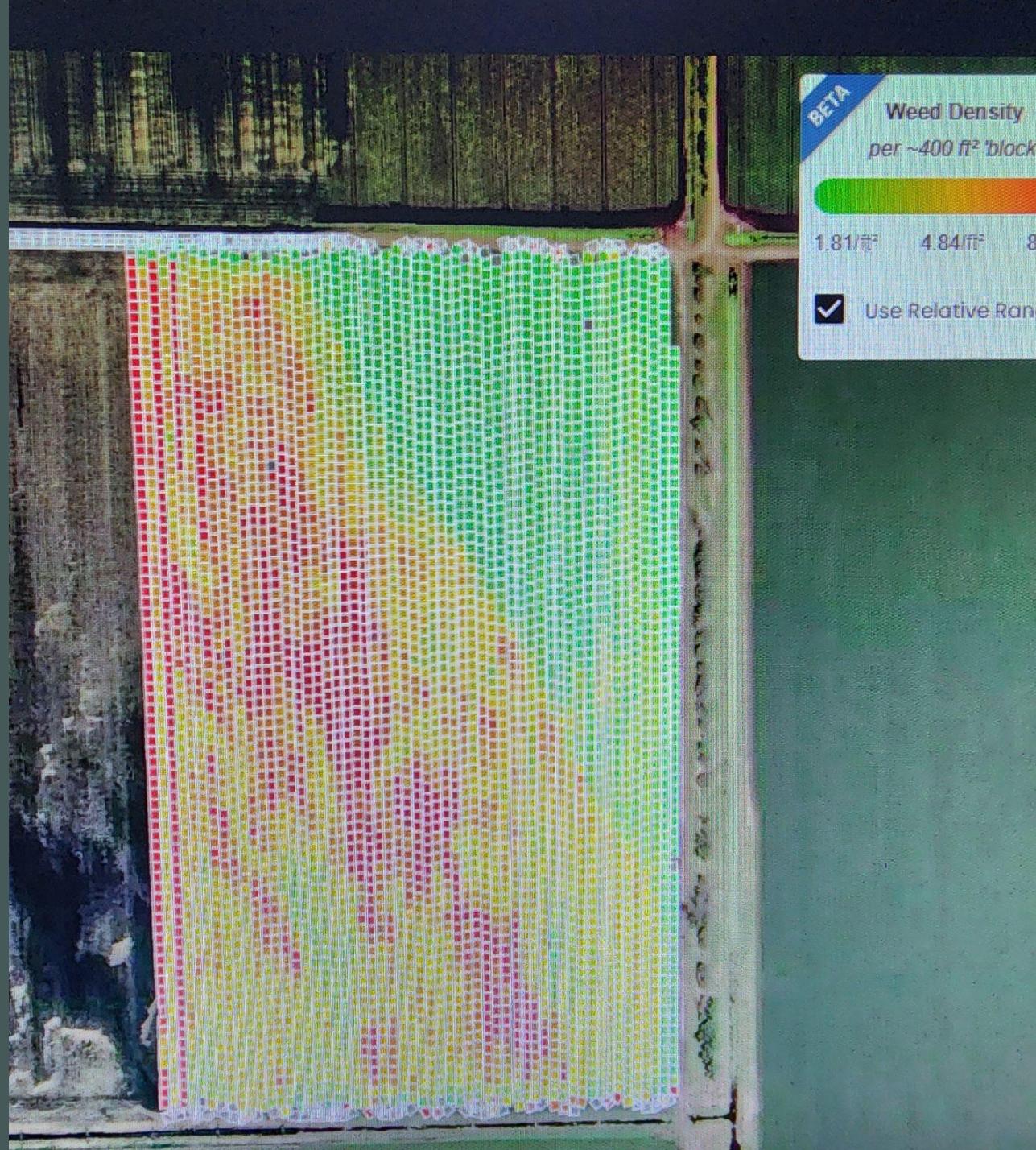
# What technology is needed to achieve these goals?

**Detect:** Accurate, high-resolution imaging

**Interpret:** Artificial intelligence to separate weeds vs. crops in real time

**Control:** Novel control tools to manage weeds without crop damage

**Bonus:** automate the processes above



Novel weed control tools:  
“spot  
sprayers”



Novel weed control tools:  
“spot cultivators”



# Novel weed control tools: laser weeders



# Comparison of the Ecorobotix ARA and LaserWeeder in onions

Research conducted in the 2025 season, building from LaserWeeder optimization studies in 2024

Large-scale replicated plots on a commercial onion farm

Four treatments:

1. Conventional grower standard herbicide program (6 applications)
2. LaserWeeder (4x)\*
3. Ecorobotix ARA (4x)
4. LaserWeeder (4x) + Ecorobotix ARA (4x)

\*LaserWeeder and Ecorobotix treatments also had a PRE herbicide at planting and at 6-lf onions



# Grower standard herbicide program



# LaserWeeder



# Ecorobotix ARA



LaserWeeder  
+  
Ecorobotix  
ARA



# LaserWeeder vs. grower standard herbicide program



# Handweeding time

	Handweeding time			
	5-30	6-12	6-20	6-30
	minutes ha <sup>-1</sup>			
Herbicide standard	279.7 a	66.3 a	142.2 a	75.8 b
LaserWeeder	25.9 b	0 b	0 b	0 b
Ecorobotix ARA	166.7 ab	185.4 a	338.7 a	643.7 a
LaserWeeder + Ecorobotix ARA	52.9 ab	0 b	0 b	56.2 b

# Onion growth and yield

	Onion stand			Onion leaves			Onion diameter		Harvested bulbs	Bulb yield
	5-30	6-20	6-30	6-20	6-30	7-21	7-21	8-18	8-18	8-18
	plants 0.25 m <sup>-2</sup>			leaves plant <sup>-1</sup>			mm		no A <sup>-1</sup>	cwt A <sup>-1</sup>
<b>Herbicide standard</b>	21.3	19.3	20.0	3.2 b	4.5 b	8.0 b	40.1 b	57.8	158,491	454 b
<b>LaserWeeder</b>	20.7	23.0	22.7	4.2 a	6.3 a	9.2 a	52.4 a	67.3	207,257	655 a
<b>Ecorobotix ARA</b>	20.7	20.7	21.7	3.5 ab	5.2 b	8.5 ab	45.6 ab	62.1	197,388	515 ab
<b>LaserWeeder + Ecorobotix ARA</b>	23.0	21.7	22.0	3.8 ab	5.2 b	8.7 ab	47.3 ab	65.3	197,388	610 a

# LaserWeeder

## Positives

Sub-millimeter accuracy

Rapid and responsive algorithm adaptations

Can be used very early in crop season

Nearly 100% weed control and elimination of handweeding

Yield increases can be substantial

Can now be remotely operated

## Negatives

No residual weed control

Slower than other technologies, but pace is increasing

Upfront cost

# LaserWeeder accuracy



# Ecorobotix ARA

## Positives

Significant herbicide use reduction

Operates faster than other modern weed control technologies

Can be used to target specific hard-to-control weed species

## Negatives

No broadcast residual weed control

Can't be used as early in the season, which allows weeds to escape control range

Weeds very close to the crop are either not sprayed well or risk crop injury

Note: herbicides and rates still need to follow labels!



# Small-scale tool carriers



# Where do these novel tools best fit now?

In crops where:

Labor availability and/or cost limit production

Weed management tools are limited

Sub-lethal herbicide injury impacts crop yield and quality

Crop value is high



# Where do we go from here?

Robotics, automation and novel control tools are advancing rapidly

Our primary focus is to find ways to increase implement coverage and speed without compromising weed control

With integration of herbicides and other weed management tactics to optimize control and productivity



A dark-colored horse is captured in a full gallop, moving from left to right across the frame. The horse's mane and tail are blurred due to its speed. The background is a solid, medium-grey color. The overall image has a high-contrast, somewhat desaturated appearance.

“If I asked people what they  
really wanted, they would  
have said faster horses”

Henry Ford