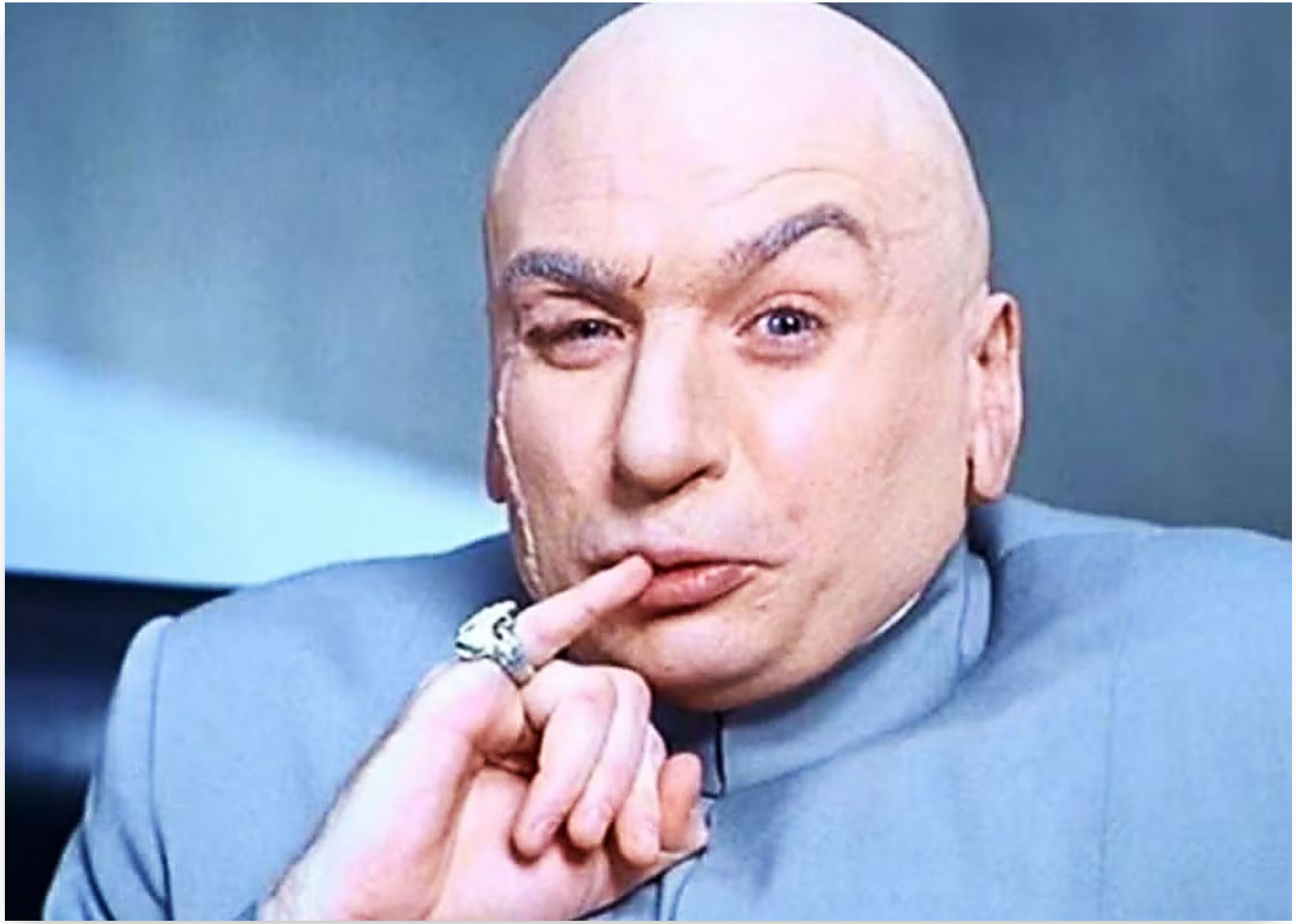


Robots With Freaking Laser Beams:

What's New With Novel Technology

Lynn M. Sosnoskie

Cornell AgriTech

New York State Agricultural Experiment Station

POTENTIAL YIELD LOSSES DUE TO UNMANAGED WEEDS IN MAJOR NORTH AMERICAN CROPS

(BMP'S EMPLOYED BUT NO WEED CONTROL)

Soltani et al. (2016) Weed Technol. 30:979-984

50% potential yield loss in CORN (loss of $26.7 billion/yr)

Soltani et al. (2017) Weed Technol. 31:1-7

52% potential yield loss in SOYBEAN (loss of $17.2 billion/yr)

Soltani et al. (2018) Weed Technol. 32:341-346

71.4% potential yield loss in DRY BEAN ($722 million/yr)


Worker Hazards


Ecosystem Disruption


Contaminants

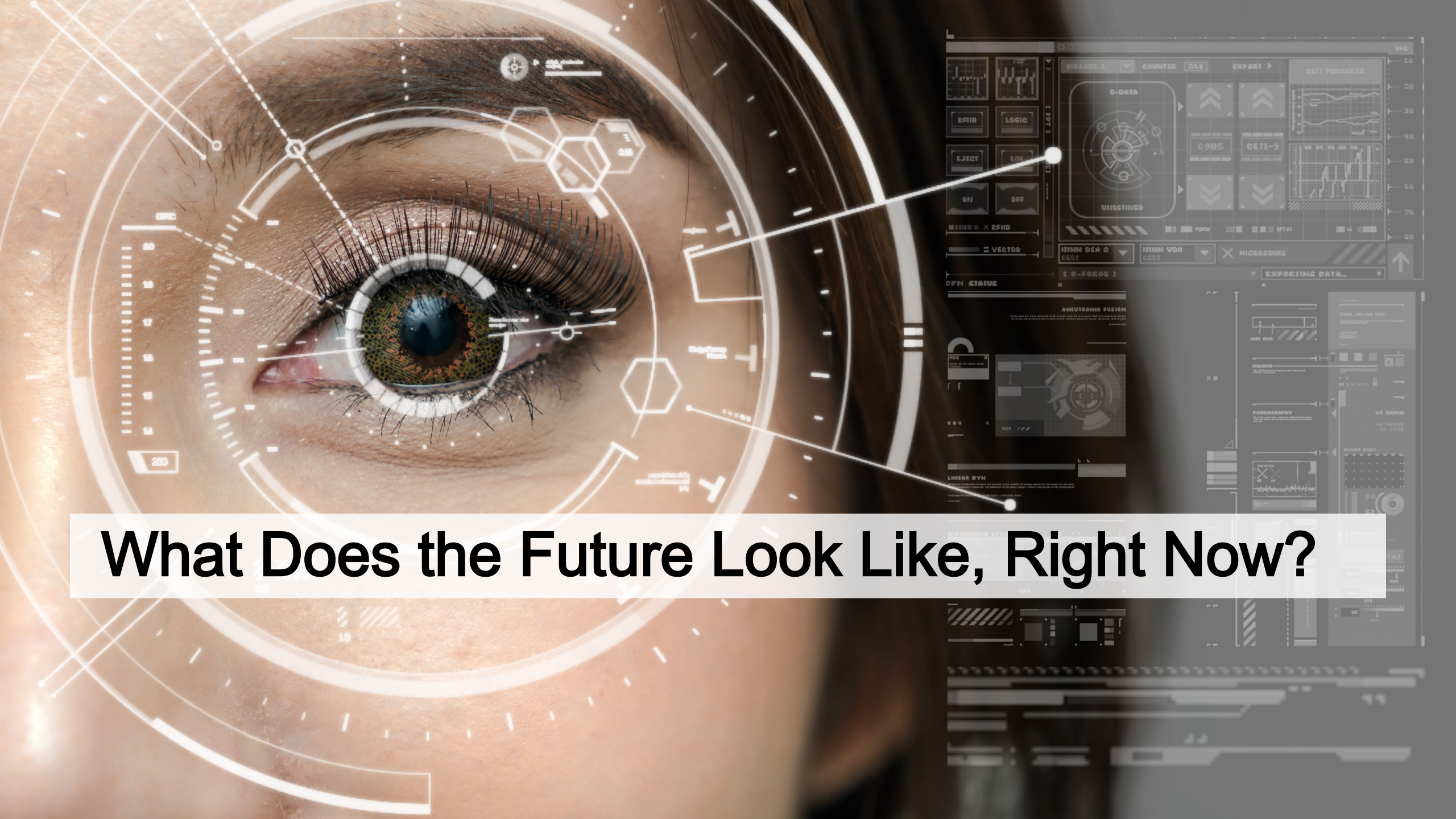

Harvestability Concerns

Some Challenges with Non-Chemical Weed Control

- Labor Intensity and Cost: Hand-weeding is expensive and difficult to source.
- Reduced Efficiency in High Weed Pressure: Organic methods can be less effective in fields with heavy weed infestations or perennial weeds.
- Soil Disturbance: Mechanical weed control can lead to soil erosion, compaction, and depletion of organic matter.
- Timeliness and Weather Dependence: Many practices are time-sensitive and weather-dependent, reducing their reliability under changing weather environments.
- Selective Weed Control: Lack of precision in targeting specific weeds without affecting crops.

Novel Technology For Future Weed Management

- Westwood et al. (2018) Weed Management in 2050: Perspectives on the Future of Weed Science. Weed Science, 66:275-285.
- Brainard et al. (2023) A survey of weed research priorities: key findings and future directions. Weed Science, 71:330-343.
- Korres et al. (2019) New directions for integrated weed management: modern technologies, tools, and knowledge discovery. Advances in Agronomy, 155:243-319.


What Does the Future Look Like, Right Now?

Current Tools with New Delivery Mechanisms

Autonomous Tool Carrying Platforms

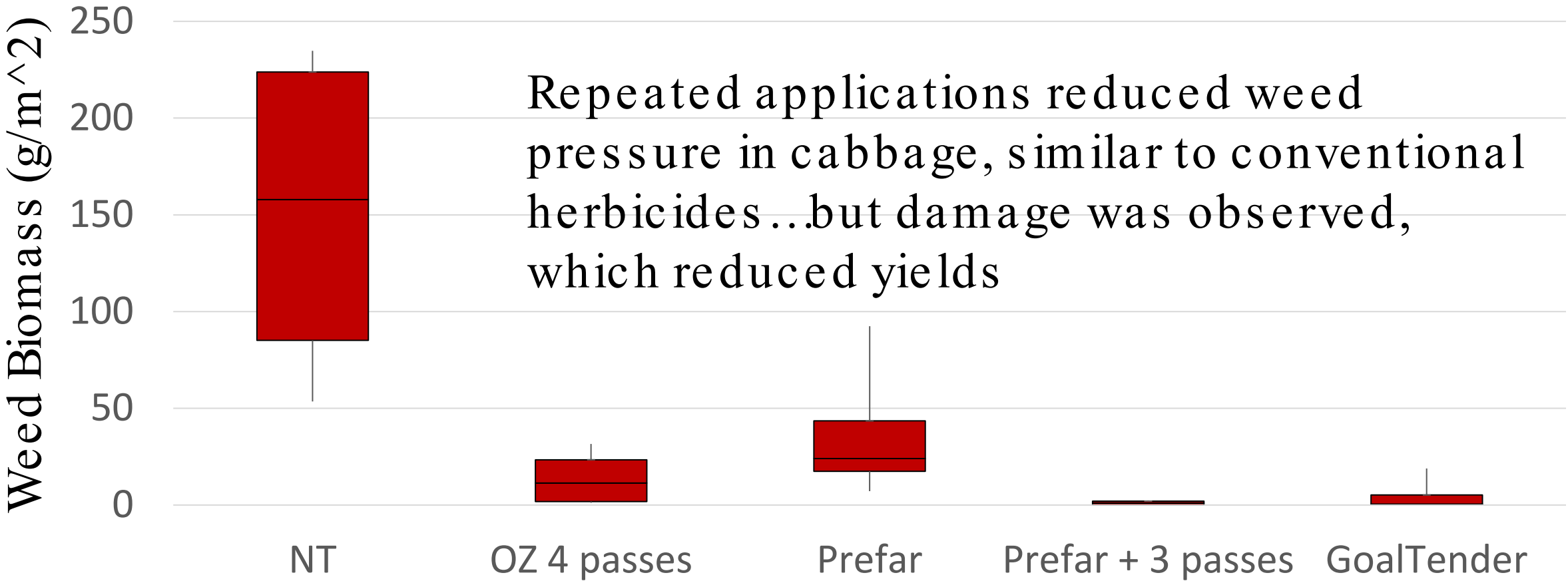
Naio Technologies Oz and Orio
Farm-ng Amiga

Naïo Oz Autonomous Seeding - Weeding Robot

- GPS guided, with RTK correction, using crop maps
- Work output: 0.25 acre/hour
- Weight: 330 lb
- Traction: 650 lb
- Energy:100% electric
- Autonomy: Up to 8 hours

naïo Technologies *https://www.naio-technologies.com/en/home/*

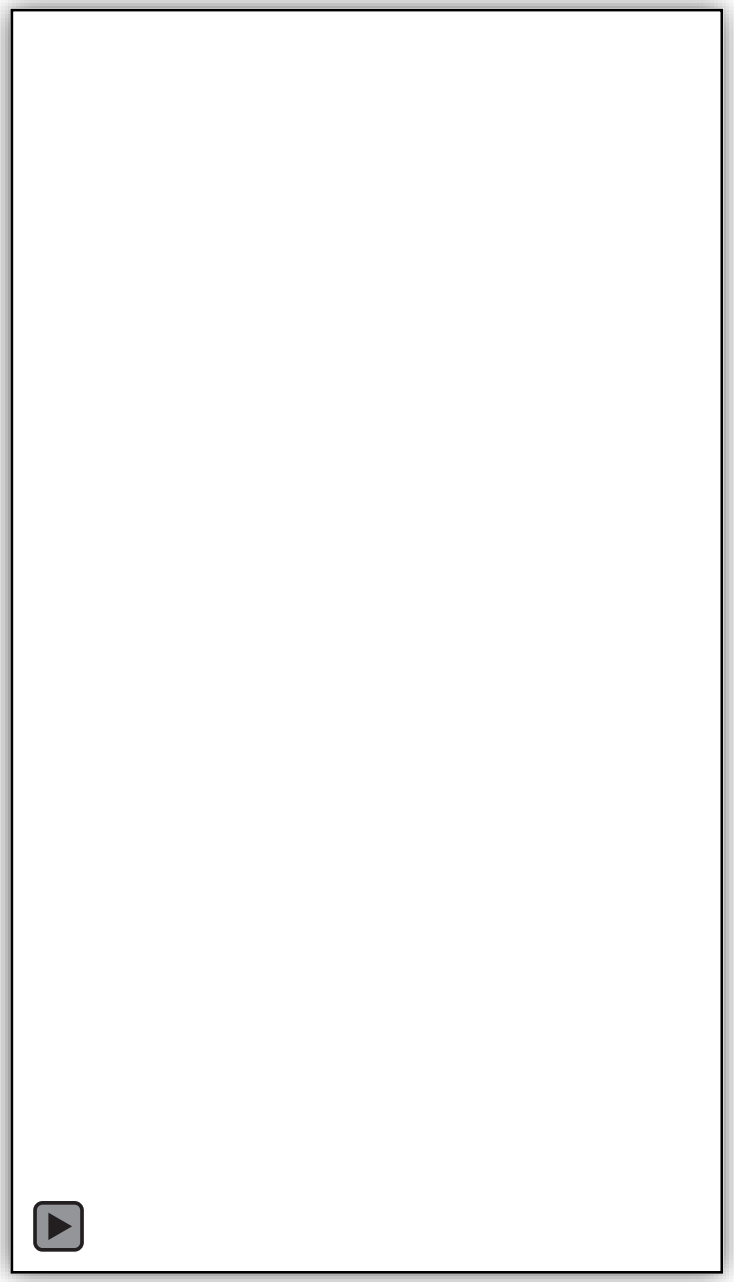
Naïo Oz Mechanical Cultivation – Cabbage 2023

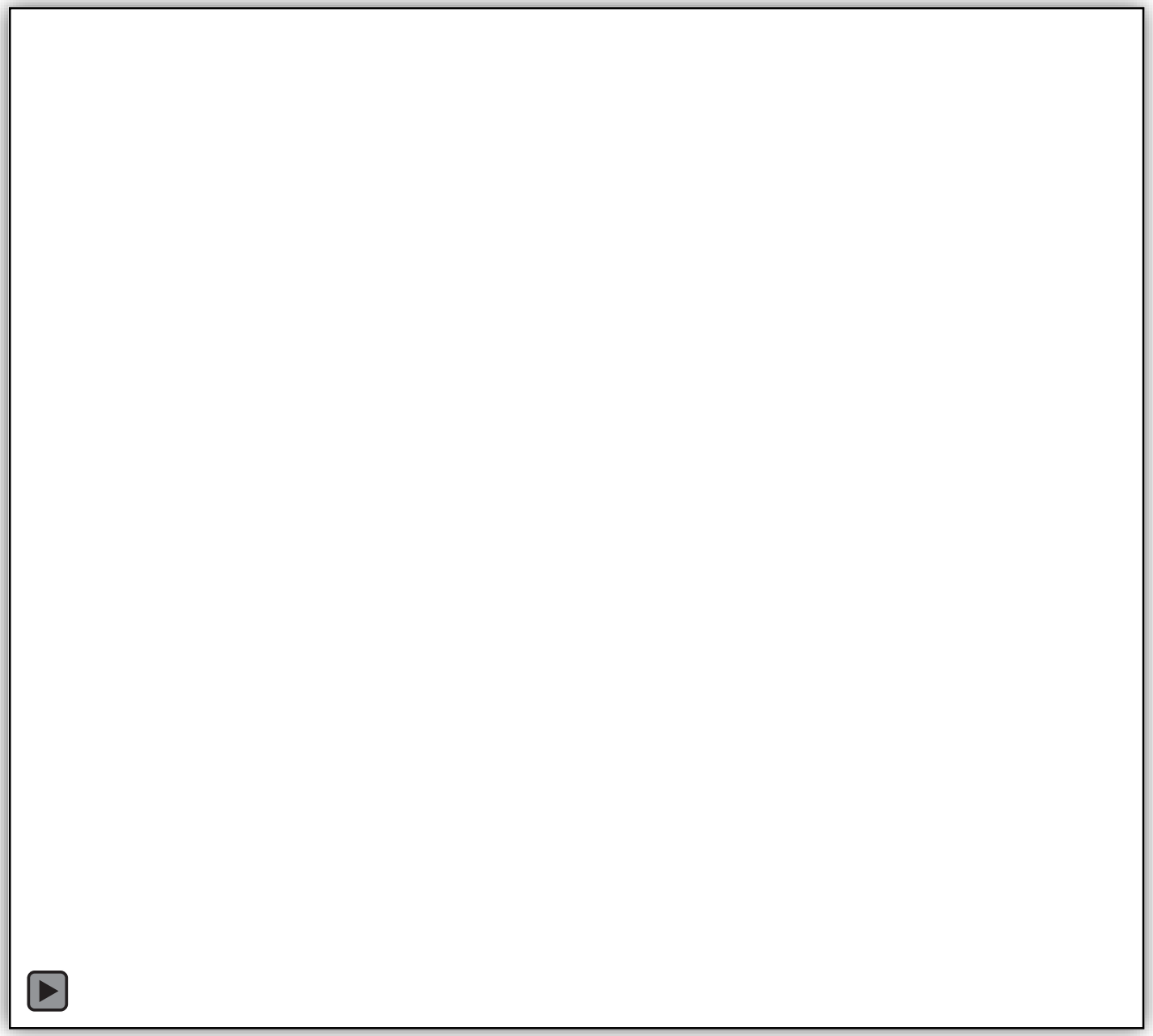


Repeated applications reduced weed pressure in cabbage, similar to conventional herbicides…but damage was observed, which reduced yields

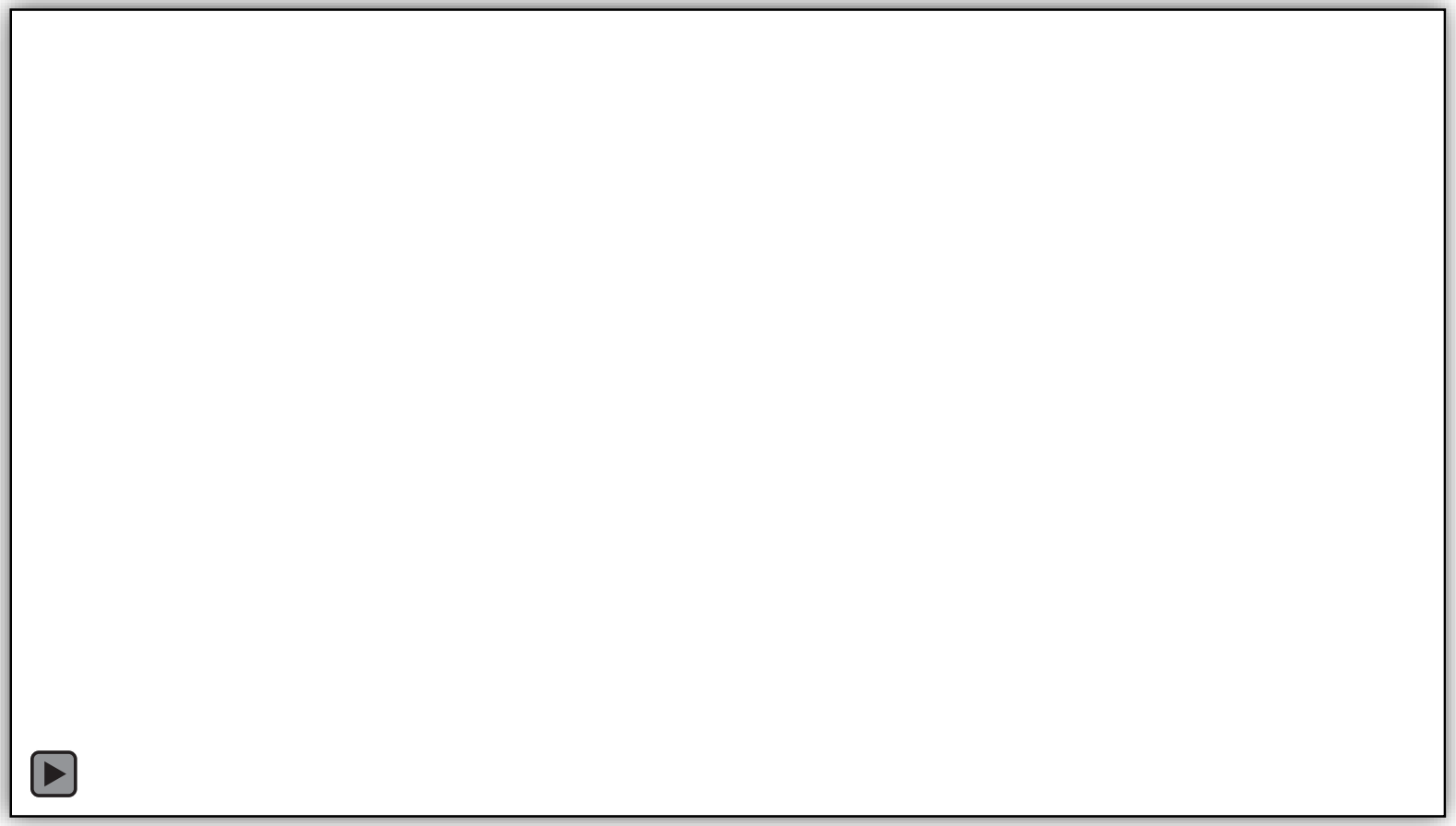
- I am fully prepared to admit that “I” may be the problem…
- Poor crop selection, poor tool selection
- Lack of operation experience
- Poor soil type (this machine does not like sticky soils or rocks…probably true for other small autonomous robots)

Autonomous Robots and Between Row Cover Cropping





Farm-ng Amiga



New Tools

Electric Weeders

Old School Manufacturing Weed Zapper

ELECTRICAL WEED CONTROL (EWC)

Controls weeds by applying an electric current directly to unwanted vegetation

The flow of electricity through the plant generates heat, which causes water in cells to vaporize and tissues to burst and die

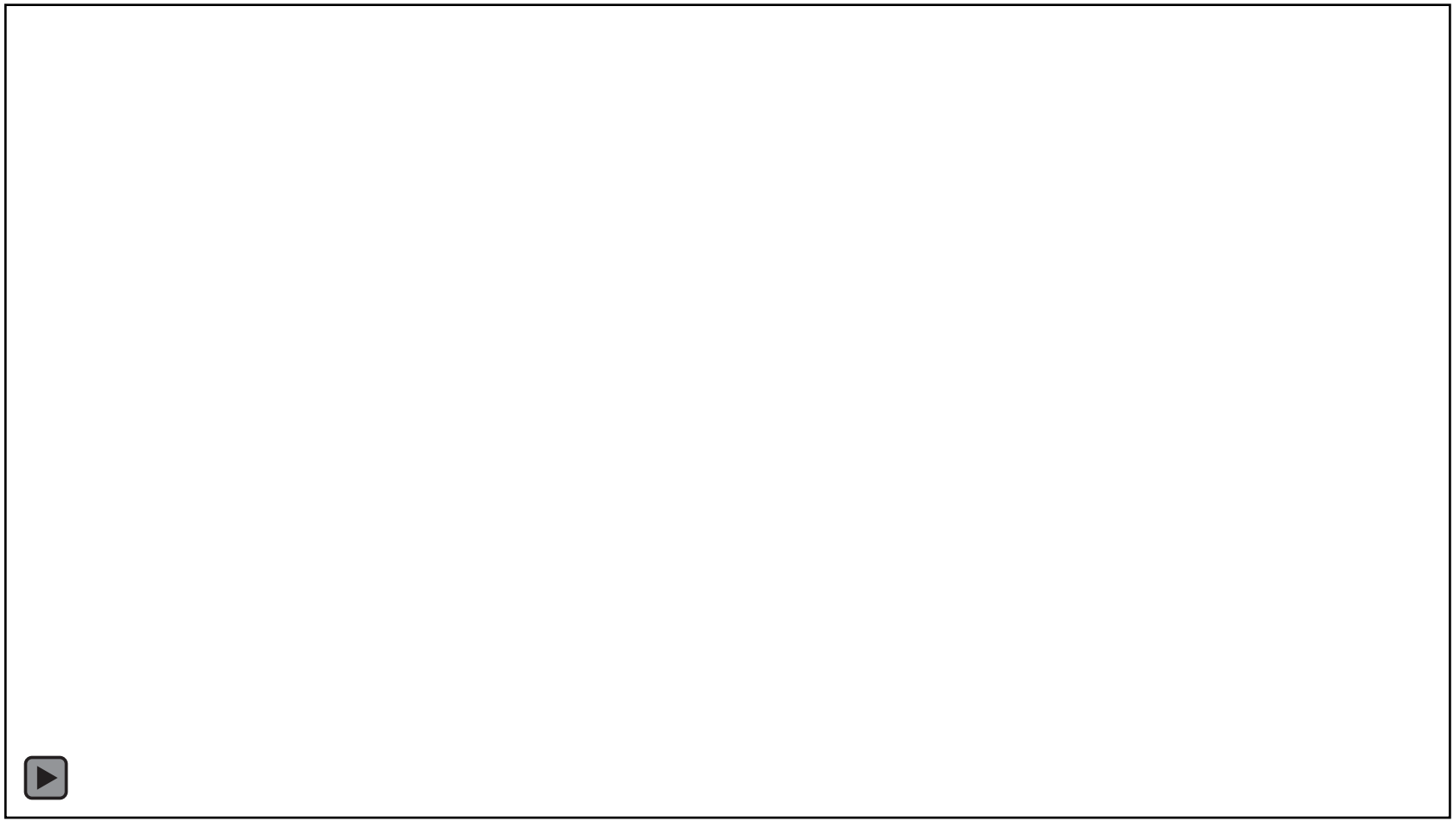
Touted benefits include no disturbance of the soil surface, no chemical application

First patents for electrical weed control devices were issued in the 1890's and explored in sugar beets in 1980's

Lots of recent, renewed interest because of herbicide resistant weeds and rising labor costs

Weed Zapper™ is a tractor-towed, PTO-driven unit that produces electricity that charges a front-mounted metal bar
Weeds above the canopy that contact the bar are electrocuted

Weed Zapper in Operation



Weed Technology

www.cambridge.org/wet

Research Article

Cite this article: Schreier H, Bish M, Bradley KW (2022) The impact of electrocution treatments

The impact of electrocution treatments on weed control and weed seed viability in soybean

Haylee Schreier[1], Mandy Bish[2] and Kevin W. Bradley[3]

[1]Graduate Student, Department of Plant Sciences and Technology, University of Missouri, Columbia, Missouri; [2]Extension Specialist, Department of Plant Sciences and Technology, University of Missouri, Columbia, Missouri and [3]Professor, Department of Plant Sciences and Technology, University of Missouri, Columbia, Missouri

Electrocution controlled late-season herbicide-resistant weeds, efficacy influenced by plant height, moisture, and growth stage

Weed Science

www.cambridge.org/wsc

Research Article

Cite this article: Rowland AV, Menalled UD, Pelzer CJ, Sosnoskie LM, DiTommaso A, Ryan MR (2023) High seeding rates, interrow mowing, and electrocution for weed management in organic no-till planted soybean. Weed Sci. **71:** 478–492. doi: 10.1017/wsc.2023.45

Received: 22 May 2023
Revised: 2 August 2023

High seeding rates, interrow mowing, and electrocution for weed management in organic no-till planted soybean

Annika V. Rowland[1], Uriel D. Menalled[2], Christopher J. Pelzer[3], Lynn M. Sosnoskie[4], Antonio DiTommaso[5] and Matthew R. Ryan[6]

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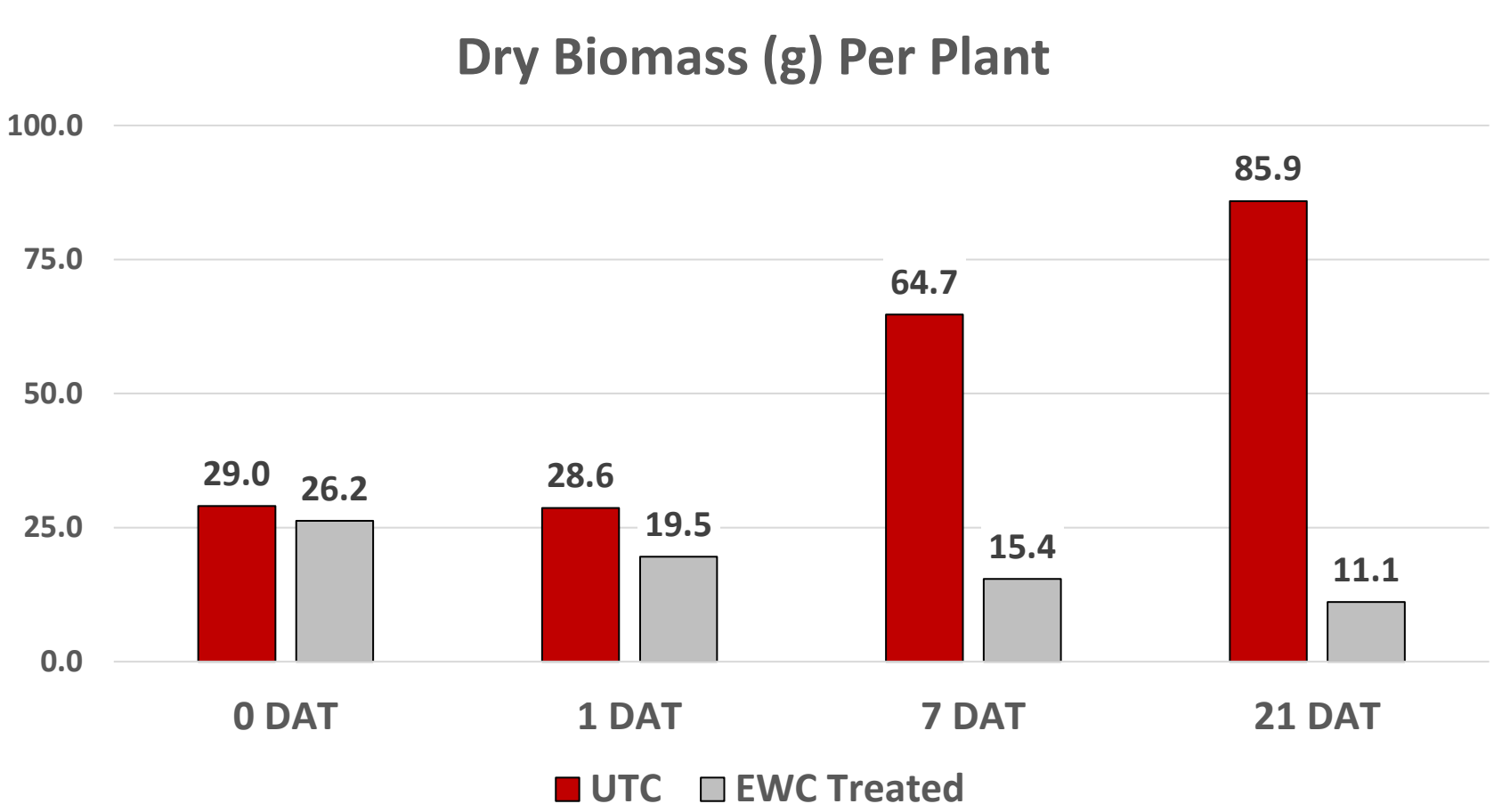
Treatments that included interrow mowing reduced weed biomass by at least 60% and increased soybean yield by 14%, weed electrocution alone did not improve weed suppression

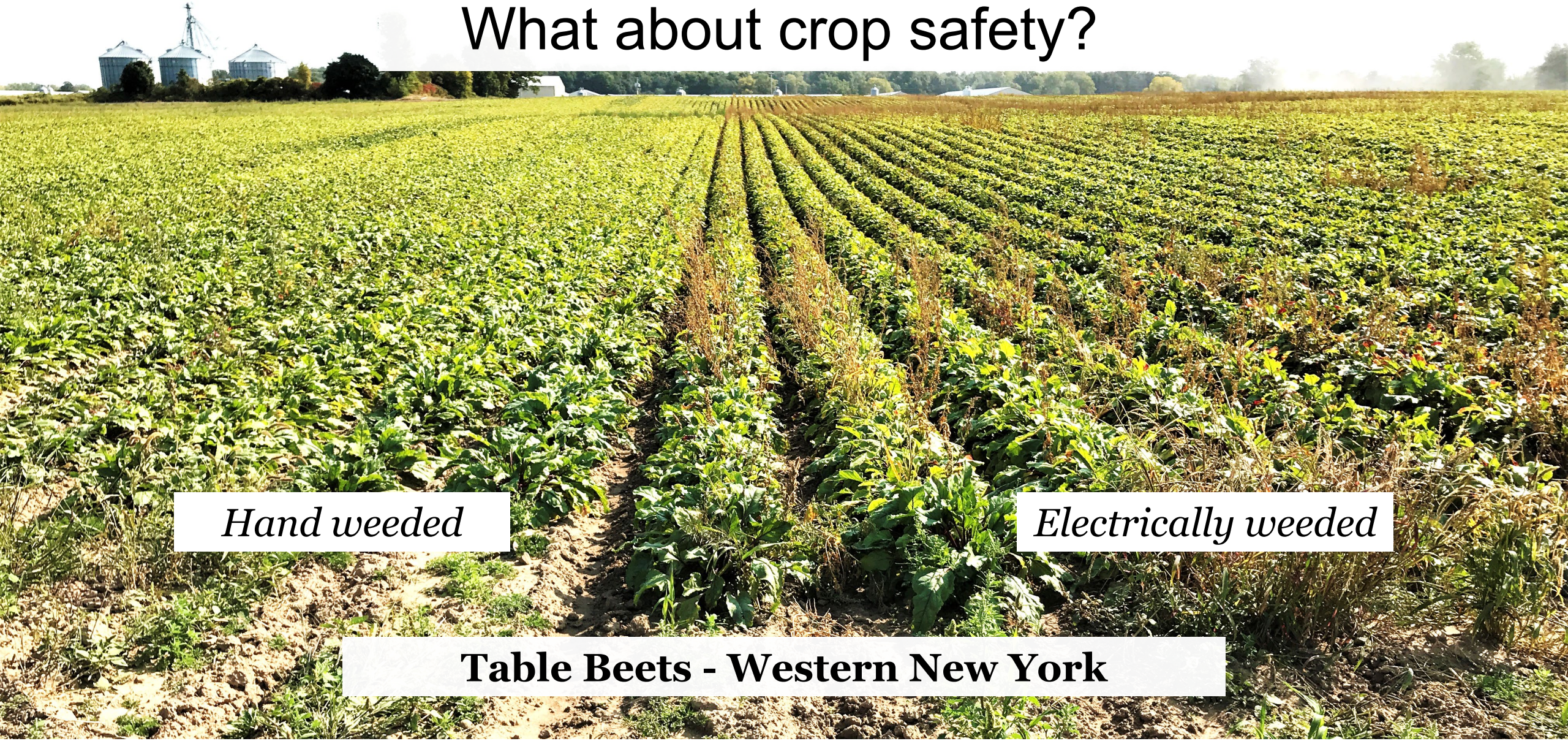
- Early intervention can preserve yields
- Benefit to reducing weed interference at harvest to allow for the unimpeded movement of machinery in the field (i.e., reduce numbers of stoppage, increase efficiency)
- Prevent weed seed production and return to the field (i.e., seedbank management) BUT…will likely be dependent on species

Changes in lambsquarters biomass (g) over time following electric weeding in beets



Some perennials (i.e. hemp dogbane) and weeds below the canopy (i.e. galinsoga) can escape control

What about crop safety?



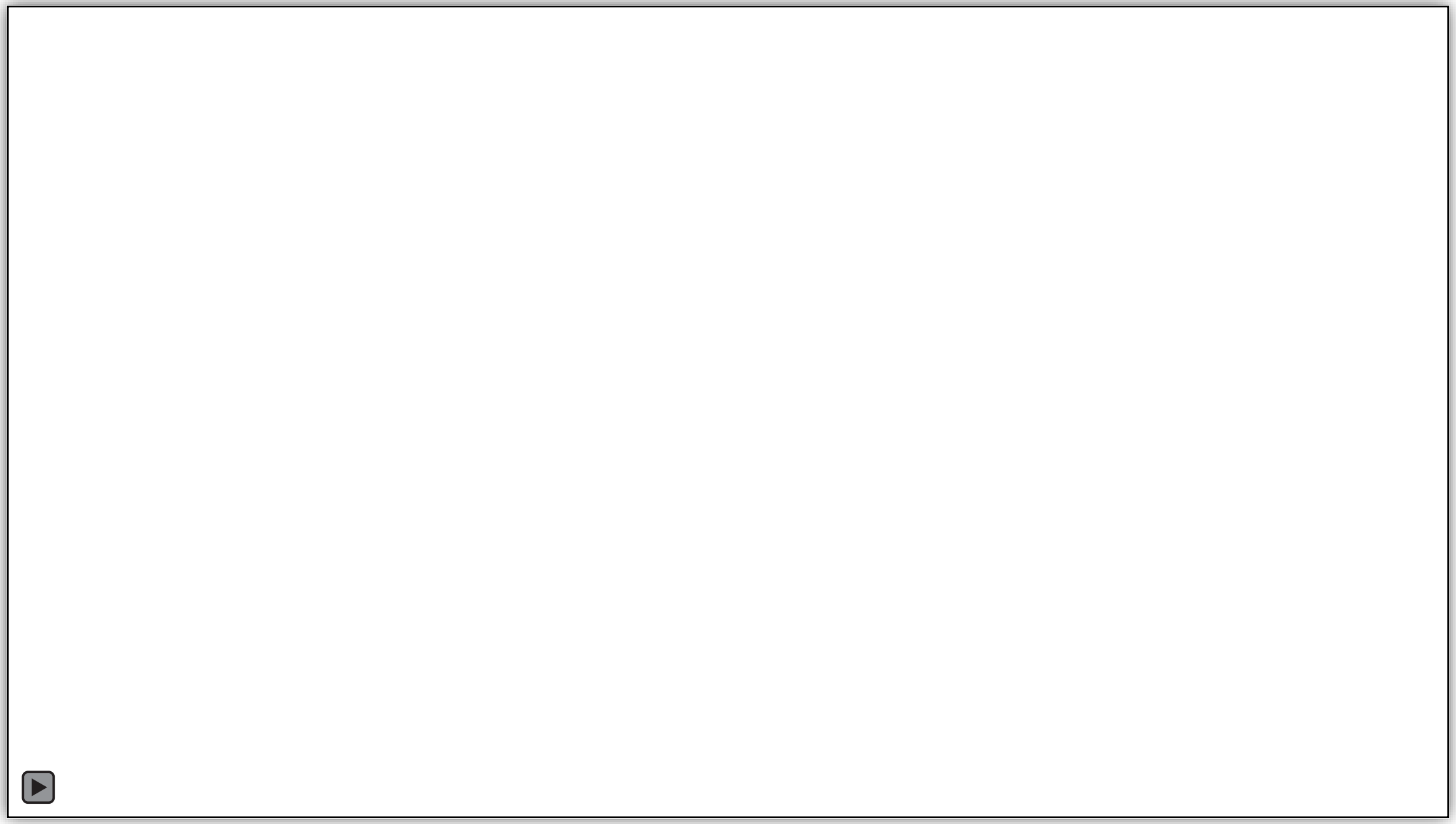

Observed more frequently on dry, sandy soils


Beet adjacent to treated weed
Not adjacent to treated weed

AI-Powered Technology

Weed Detection, Crop Row Detection, Crop-Weed Discrimination

Farmwise Vulcan
Verdant Robotics Sharpshooter
Carbon Robotics Laser Weeder



Difficulties for Weed Control Alternatives


BRAGA
RANCH
LASERWEEDER
CARBON
ROBOTICS


FIRE THE LASER!!!

Beet

NTC S-Met

S-Met + LW LW

Pea

NTC S-Met

S-Met + LW LW

Spinach

NTC S-Met

S-Met + LW LW

Crops planted on June 10, 2024; Image taken July 19, 2024

Relative Aboveground Biomass (g)

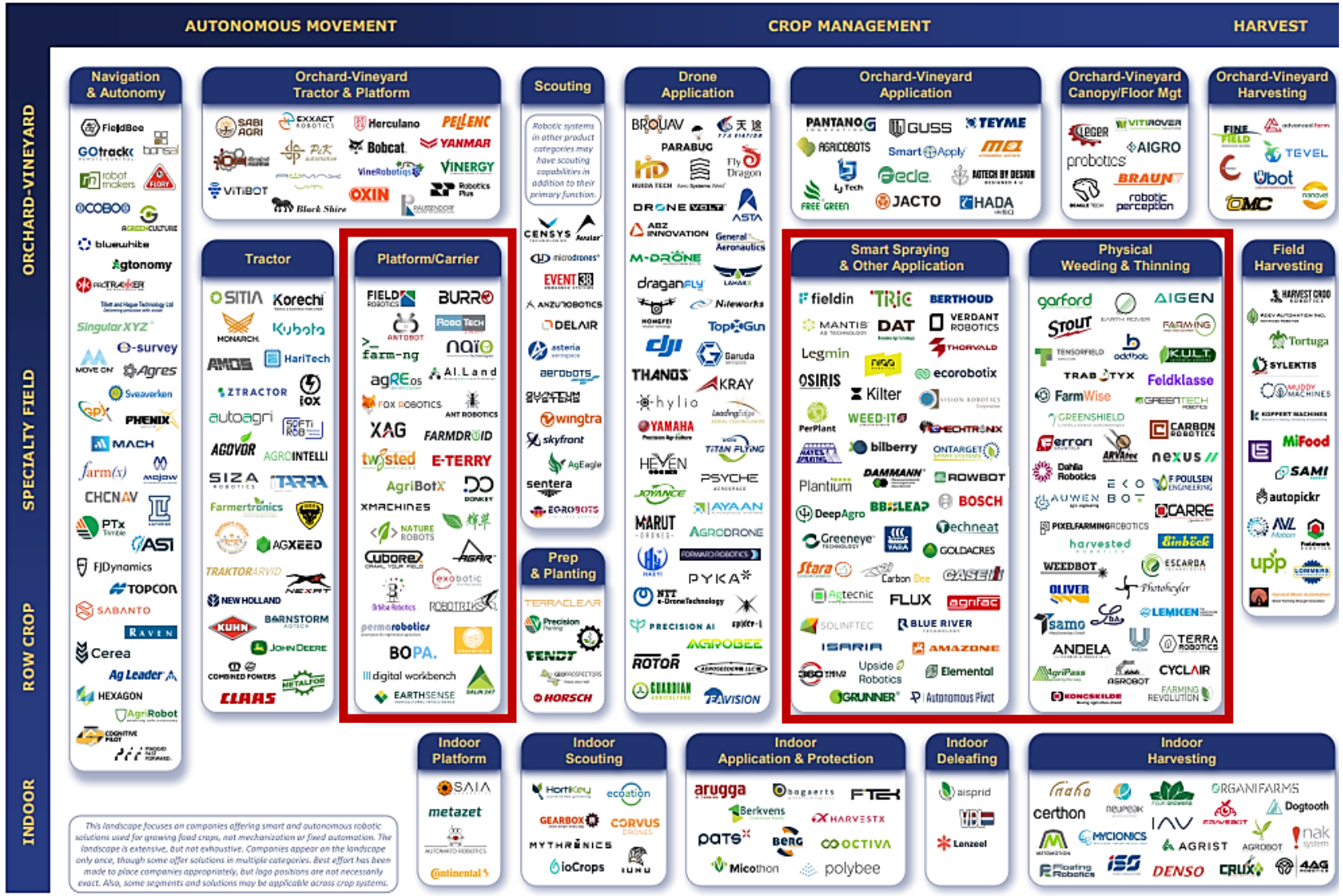
	Beet	Spinach
	(Approx.) Percent (%) of Nontreated Check	
S-Metolachlor	- 60%	- 80%
S-Metolachlor + Laserweeder™	- 40%	- 50%
Laserweeder™	+ 40%	+ 80%

What else?

- 2025 CALS Moonshots Grant (with B. Nault)
- Can we kill many birds with one stone?
- Laser weeding impacts on weed control, crop vigor, thrips damage, SLB incidence and severity

2024 CROP ROBOTICS LANDSCAPE

The Mixing Bowl | Better Food Ventures



www.MixingBowlHub.com

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Western Growers

Cornell CALS College of Agriculture and Life Sciences

www.MixingBowlHub.com

Choose Your Fighter!

Significant Investment in Ag Robotics

- AgFunder has reported that companies in the sector have raised approximately $399 million in the first half of 2024. Notable recent investment:

- Swarm Farm Robotics secured $8.3 million Series A funding
- Farm-ng secured $10 million Series A funding
- Verdant Robotics secured $46.5 million Series A funding
- Burro secured $24 million Series B funding
- Naïo Technologies secured $33 million Series C funding
- Carbon Robotics recently raised a $70 million Series D, which included ongoing investment from NVIDIA‘s venture capital arm, NVentures.

Questions We Need to Ask About Technology

COST – Units themselves, but also parts and services (money as well as time…if service providers are not local), cost of associated equipment, fuel expenditures, etc…

ADAPTABILITY – Western vs Eastern US, soils, farm sizes (e.g., acreage needed for adoption), field shapes, production conditions, etc…

INFRASTRUCTURE AND REGULATORY READINESS – Cellular and internet service, base stations (personal, public?), safety and transportation, etc…

CHANGING NATURE OF LABOR – Who will build, operate and service new technology, are we training them properly, what about recruiting from the people who know the job best, what about communities that have provided the labor that is being replaced

NYS Research Trials Underway to Evaluate New Technology

Funding and Support

- Interregional 4 Project
- New York State Ag and Markets
- New York Wine and Grape Foundation
- New York Vegetable Research Council and Association
- Genesee Valley Regional Market Authority
- New York Farm Viability Institute
- Cornell College of Agriculture and Life Sciences
- USDA Federal Capacity Funds
- USDA Organic Research and Extension Initiative
- USDA Specialty Crop Research Initiative
- USDA Crop Protection and Pest Management

Thank You!

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