AI, Automation & Robotics for Weed Control

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Ontario

Presentation Outline

- What is AI, Automation and Robotics
- Robotic/Autonomous Weeders
  - FarmDroid
  - Naïo Oz, Orio, Ted
- AI and Automation
  - Nexus La Chevre (The Goat)
  - Carbon Robotics LaserWeeder™
  - Weed Scouting/Mowing
  - Sprayers: Ecorobotix
    Weed-IT
  - Herbicide Discovery
- AgRobotics Working Group – Innovation Farms
- Weeding Tech Conclusions

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What is AI, Automation and Robotics?

- **Artificial intelligence** is the science of making machines that can think like humans. It can do things that are considered "smart." AI technology can process large amounts of data in ways, unlike humans. The goal for AI is to be able to do things such as recognize patterns, make decisions, and judge like humans.
- **Automation** is the application of technology, programs, robotics or processes to achieve outcomes with minimal human input.
- **Robotics** is an interdisciplinary sector of science and engineering dedicated to the design, construction and use of mechanical robots.
- **Robots** are any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a humanlike manner.

2022 CROP ROBOTICS LANDSCAPE

The Mixing Bowl | Better Food Ventures

AUTONOMOUS MOVEMENT	CROP MANAGEMENT							HARVEST
	Navigation/ Autonomy	Small Tractor/ Platform	Large Tractor	Scouting	Preparation & Planting	Drone Application	Application	Weeding & Thinning	Specialty Field Harvesting
ROW CROP	AgriRobot, Cognitive Pilot, Trimble, Sabanto, CHCNAV, FJDynamics, Steyr, ASI, Cerea, Topcon, Ag Leader, GPX, Blue White Robotics, Agtonomy, GOtrack, Braun	Salin 247, Kubota, Donkey, AI.Land, The FarmHand Tractor, ELATEC, farm-ng, Sabi Agri, Continental, Korechi, Future Acres, Monarch, exobotic, AGREENCULTURE, Burro, Vinergy, XAG, Exxact Robotics	Nexat, Agxeed, Raven, AgroIntelli, autoagri, Fox, Amos, Tarra, New Holland, Sitia, oxin, Slopehelper, ViTiBOT	EarthSense, Small Robot Company, Meropy, Bosch, Egrobots, Solinftec, sentera, Censys, quantum systems, AgEagle, draganfly, Delair, Atmos UAV, wingtra, aerobots, Event 38, microdrones	Fendt, Horsch, Rowbot, TerraClear	EAVision, Kray, precision.ai, Guardian, Thanos, Forward Robotics, T-A Viation, Joyance, Nileworks, M-Drone, Lahaxx, Asta, Pyka, Drone Volt, Drone4 Agro, Marut Drones, Titan Flying, hylio, DJI, Fly Dragon, X-Drone, HADI, LeadingEdge, BroUAV, LJ Tech, hse, AERO41, Garuda Aerospace	Case IH, Agrifac, Carbon Bee, Resson, Augmenta, DAT, Dammann, Bilberry, Amazone, Blue River, Claas, Plantium, Autonomous Pivot, Greeneye Technology, ecorobotix, Verdant Robotics, Saga Robotics, Tric, XMachines, Mechtronix, Yanmar, Kilter, Guss, edele, Midnight Robotics, Jacto, INESCTEC, Free Green Nature	rootwave, Kongskilde, HayBeeSee, Steketee, Greenfield, Farming Revolution, NUCROP, Vision Robotics, Carbon Robotics, Earth Rover, oddbot, Carre, Dahlia Robotics, Stout, Farmdroid, F. Poulsen Engineering, naïo, Farmhand, KULT, FarmWise, garford, Nexus Robotics, ekobot, Tensorfield, AgriBotX, Weedbot, Aiden, Ferrari, Pixelfarming Robotics	Steketee, Carbon Robotics, Carre, Farmdroid, Farmhand, FarmWise, garford, ekobot, Weedbot, Ferrari, Pixelfarming Robotics
SPECIALTY FIELD									Moody Machines, Lapalme Agtech, Harvest Croo, University of Plymouth, Outback Robotics, Koppert Machines, neupeak, ADEV, advanced.farm, MiFood
ORCHARD-VINEYARD								Orchard-Vineyard Weeding & Pruning: VitiRover, Wall-ye, AIGRO, Insight Trac, BEAGLE, Eleos Robotics, Ladybug Robotics, aigritec	Orchard-Vineyard Harvesting: TEVEL, OMC, Ripe Robotics, RoboticsPlus, UBot, Fine Field

Robotic solutions placed in other task/product categories on this landscape may have scouting capabilities in addition to their primary function.

2024 CROP ROBOTICS LANDSCAPE

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AUTONOMOUS MOVEMENT | CROP MANAGEMENT | HARVEST

ORCHARD-VINEYARD | SPECIALTY FIELD | ROW CROP | INDOOR

Navigation & Autonomy

FieldBee, GOtrack, bonsai, robot makers, FLORY, COBO, AGREENCULTURE, bluewhite, Agtonomy, PROTRAKTOR, Tillett and Hague Technology Ltd, SingularXYZ, e-survey, MOVE ON, Agres, Sveaverken, GPX, PHENIX, MACH, farm(x), Mojow, CHCNAV, PTx Trimble, LAFORGE, ASI, FJDynamics, TOPCON, SABANTO, RAVEN, Cerea, Ag Leader, HEXAGON, AgriRobot, COGNITIVE PILOT, PIAGGIO FAST FORWARD

Orchard-Vineyard Tractor & Platform

SABI AGRI, EXXACT ROBOTICS, Herculano, PELLENC, chasing machines, PeK automotive, Bobcat, YANMAR, VineRobotics, VINERGY, ViTiBOT, Robotics Plus, Black Shire, OXIN, RAUSSENDORF

Tractor

SITIA, Korechi, MONARCH, Kubota, AMOS, HariTech, ZTRACTOR, EOX, autoagri, SOFTiROB, AGOVOR, AGROINTELLI, SIZA ROBOTICS, TARRA, Farmertronics, AGXEED, TRAKTORARVID, NEXAT, NEW HOLLAND, KUHN, BARNSTORM AGTECH, JOHN DEERE, COMBINED POWERS, METALFOR, CLAAS

Platform/Carrier

FIELD ROBOTICS, BURRO, ANTOBOT, ROBO TECH, farm-ng, naïo, agREEos, AI.Land, FOX ROBOTICS, ANT ROBOTICS, XAG, FARMDROID, twisted FIELDS, E-TERRY, AgriBotX, DONKEY, XMACHINES, NATURE ROBOTS, 輝翠, CUBOREX, AGAR, exobotic, Orbiba Robotics, ROBOTRIKS, permarobotics, BOPA, digital workbench, EARTHSENSE, SALIN 247

Scouting

Robotic systems in other product categories may have scouting capabilities in addition to their primary function.

CENSYS, Avulor, microdrones, EVENT 38, ANZUROBOTICS, DELAIR, asteria aerospace, aerobotics, QUANTUM SYSTEMS, wingtra, skyfront, AgEagle, sentera, EGROBOTS

Prep & Planting

TERRACLEAR, Precision Planting, FENDT, GEOPROSPECTORS, HORSCH

Drone Application

BROUAV, 天途 TTA AVIATION, PARABUG, HUIDA TECH, Aero Systems West, Fly Dragon, DRONE VOLT, ASTA, ABZ INNOVATION, General Aeronautics, M-DRONE, draganFLY, LAHAK, HONGFEI, Nileworks, TopGun, dji, Garuda aerospace, THANOS, KRAY, hylio, LeadingEdge AERIAL TECHNOLOGIES, YAMAHA Precision Agriculture, TITAN FLYING, HEVEN DRONES, PSYCHE AEROSPACE, JOYANCE, AYAAN AUTONOMOUS SYSTEMS, MARUT DRONES, AGRODRONE, HAOYI, FORWARD ROBOTICS, PYKA, NTT e-Drone Technology, spider-i, PRECISION AI, AGROBEE, ROTOR, AEROSEEDER LLC, GUARDIAN AGRICULTURE, TAVISION

Orchard-Vineyard Application

PANTANO, GUSS, TEYME, AGRICOBOTS, Smart Apply, ma, LJ Tech, ede, AGTECH BY DESIGN, FREE GREEN, JACTO, HADA

Orchard-Vineyard Canopy/Floor Mgt

Leger, VITIROVER, AIGRO, probotics, BRAUN, BEAGLE TECH, robotic perception

Orchard-Vineyard Harvesting

FINE FIELD, advanced.farm, TEVEL, Ubot, OMC, nanovel

Smart Spraying & Other Application

fieldin, TRIC, BERTHOUD, MANTIS AG TECHNOLOGY, DAT, VERDANT ROBOTICS, Legmin, THORVALD, OSIRIS, Kilter, ecorobotix, PerPlant, WEED-IT, AGMECHTRONIX, HAYES SPRAYING, bilberry, ONTARGET, Plantium, DAMMANN, ROWBOT, DeepAgro, BBLEAP, BOSCH, Greeneye TECHNOLOGY, YARA, GOLDACRES, Stara, Carbon Bee, CASE IH, Agtecnic, FLUX, agrifac, SOLINFTEC, BLUE RIVER TECHNOLOGY, ISARIA, AMAZONE, 360 YIELD CENTER, Upside Robotics, Elemental, GRUNNER, Autonomous Pivot

Physical Weeding & Thinning

garford, AIGEN, STOUT, EARTH ROVER, FARM-NG, TENSORFIELD, oddbot, KULT, TRABTYX, Feldklasse, FarmWise, GREENTECH ROBOTICS, GREENSHIELD, CARBON ROBOTICS, ferrari GROWTECH, ARVAtec, nexus, Dahlia Robotics, F. POULSEN ENGINEERING, AUWEN, CARRE, PIXELFARMING ROBOTICS, harvested ROBOTICS, Einböck, WEEDBOT, ESCARDA TECHNOLOGIES, OLIVER, Photoheyler, samo, LEMKEN, ANDELA, TERRA ROBOTICS, AgriPass, AGROBOT, CYCLAIR, FARMING REVOLUTION

Field Harvesting

HARVEST CROO ROBOTICS, ADEV AUTOMATION INC., Tortuga, SYLEKTIS, MUDDY MACHINES, KOPPERT MACHINES, MiFood, SAMI, autopickr, Fieldwork ROBOTICS, LOMMERS, Harvest Moon Automation

Indoor Platform

SAIA, metazet, AUTOMATO ROBOTICS, Continental

Indoor Scouting

HortiKey, ecoation, GEARBOX, CORVUS DRONES, MYTHRONICS, ioCrops, IUNU

Indoor Application & Protection

arugga, bogaerts, FTH, Berkvens, HARVESTX, pats, BERG, OCTIVA, Micothon, polybee

Indoor Deleafing

aisprid, VDL, Lenzeel

Indoor Harvesting

Traka, ORGANIFARMS, certhon, neupeak, FOUR GROWERS, Dogtooth, FRAVEBOT, IAV, METOMOTION, MYCIONICS, AGRIST, AGROBOT, nak system, Floating Robotics, ISO, DENSO, CRUX, 4AG ROBOTICS

This landscape focuses on companies offering smart and autonomous robotic solutions used for growing food crops, not mechanization or fixed automation. The landscape is extensive, but not exhaustive. Companies appear on the landscape only once, though some offer solutions in multiple categories. Best effort has been made to place companies appropriately, but logo positions are not necessarily exact. Also, some segments and solutions may be applicable across crop systems.

www.MixingBowlHub.com

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Western Growers

Robotic/Autonomous Weeders

Several weeding robots promise to:

- Reduce soil compaction
- Reduce inputs (seed, herbicide)
- Provide a lower carbon footprint
- Decrease labour requirements

To test these claims, autonomous weeding robots have been trialed in Ontario for several years.

- FarmDroid FD20
- Naïo Oz
- Naïo Orio
- Naïo Ted

FarmDroid FD20 – https://farmdroid.dk

- 2022 Seeding and Weeding Sugar Beets and Rutabagas
- 2023 & 2024 Seeding and Weeding Onions

- Solar-charged batteries, CO2 neutral
- 24-hours autonomous operation (sleep mode when batteries are low)
- Seeder, and inter- and intra-row mechanical weeder
- Geo-tags each individual seed
- Passive weeder - cultivator

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FarmDroid – Weeding Sugar Beets

- Seeder, and inter- and intra-row mechanical weeder
- The intra-row weeding (weeding between the plants in the row) was important in breaking the soil crust. This action resulted in:
    - Larger and more uniform sugar beets

FarmDroid – Weeding Onions

Operated on 7 acres of a 50 acre commercial onion field, in 2023 and 2024.

Modifications in 2024:

- Seeding configuration to increase speed
- Four wheels vs three wheels
- Cultivator tines/ shovels
  - 2023-large weeds could get caught up in the cultivator tines, get dragged along and damage the seedling onions
  - 2024 –new tines/shovels to do a better job of cultivating
- Still have someone walk behind the FarmDroid, but faster than people weeding

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Naïo Technologies - Oz

- Company based out of France
- Over 160 active units operating in 15 countries
  - Small enough to drive between 30” rows
  - Multiple implements to attach, customize implements
- Guided by RTK GPS
- On-board map creation tool to create guidance lines
  - Can be logged at planting by recording every crop row planted
  - Could also look at creating guidance paths in external software
- Battery powered
  - 7-9 hour charge
  - Implement being used, working depth and soil type will impact battery life
- Speed of 1.4 km/h optimal, 1.8 km/h max.
  - 10-12.5 km of row/day

Could the Future Farm Look Like This?

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Naïo Orio 2023 & 2024
https://www.naio-technologies.com/

- Autonomous tool carrier robot
- Rechargeable lithium batteries
- Up to 10 hours of autonomous operation
- RTK GPS guidance
- Worked in carrots, onions and beets on muck and mineral soils with a camera guided hitch
- In 2023, a band sprayer was also built to use with the Orio controlled by a Raven Industries field computer
- In 2024, cultivator, in row 3D printed hooded sprayer, over the row band sprayer and wick weeders were used.

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2023 & 2024 – Trial Years, Cave Springs – Grapes

Naïo Ted

https://www.naio-technologies.com/

- For grapes/vineyards, potential for trellised fruit
- First in Ontario June 2023
- 55 sold - 33 working in France, Germany, Italy and Spain
- Autonomous 100% electric vehicle – up to 10 hours
- 10 acres/day
- Inter- and intra-row weeder
- Hilling and De-hilling
- Vine hedger
- Yield estimation
- Plans to integrate UV-C lighting to control mildew and small insects (aphids and mites)
- Used as a tourist attraction

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AI and Automation

- Nexus Robotics – The Goat
- Carbon Robotics LaserWeeder™
- Weed Scouting/Mowing
  - 2023 & 2024 Weed Scouting Project
  - Korechi Innovations RoamIO autonomous platform with electric mowers
- Sprayers
  - Ecorobotix
  - Weed-IT
- Herbicide Discovery

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2022 Nexus Goat – Weeding Onions and Carrots

https://nexusrobotics.ca

- Active weeder
- Electric hybrid motor
- 24-hour autonomous operation
- Machine vision inter- and intra-row mechanical weed removal

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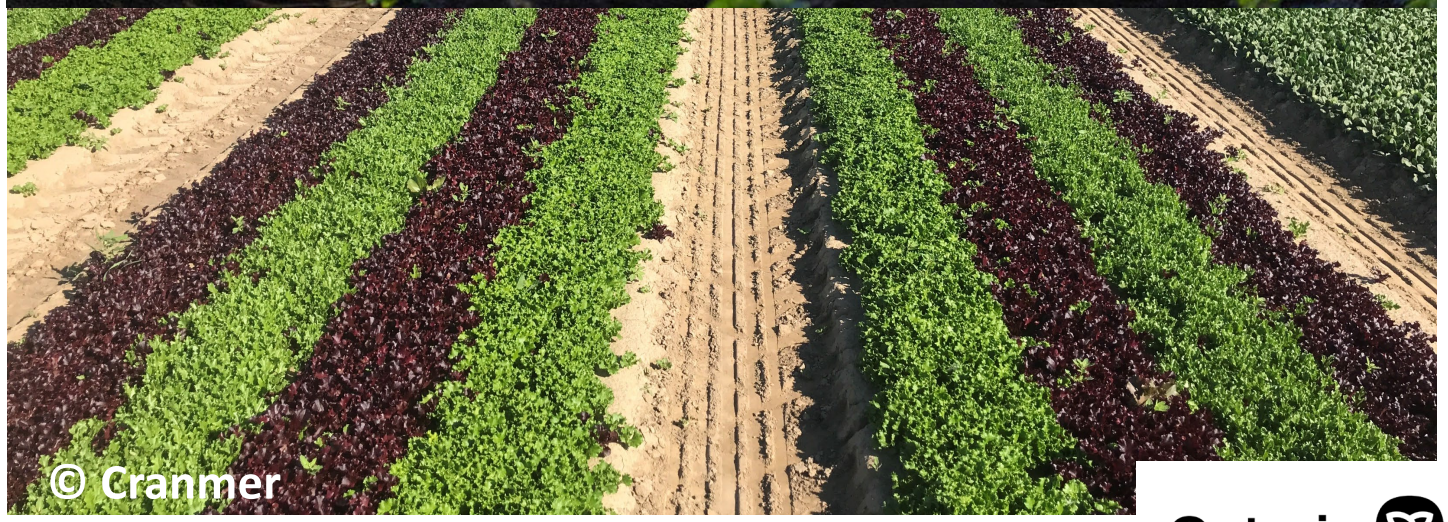
2023 & 2024 Nexus Goat – Leaf Lettuce

- Success in leaf lettuce in 2023 winter in Arizona
- Decided to try in leaf lettuce in Ontario.
  - Removed > 80% of the weeds
  - **Grower pleased**



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Carbon Robotics LaserWeeder™

2023 – Trial Year

https://carbonrobotics.com

2 Demos (May and July)

- 1 shared unit in C-K Ontario
- Mixed reviews by growers

- Cost an issue $2M Canadian with $50K/yr tech fee
- Credit arrangements are available in the U.S.
- Company exploring options with FCC and OMAFRA funding programs

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Carbon Robotics LaserWeeder™

https://carbonrobotics.com

2023 – Trial Year

Conventional vs. LaserWeeder™

Accuracy of LaserWeeder™

- Sub-millimeter accuracy
- 30 x 150 w CO2 10.6 m lasers with tracking cameras
- 9 x LED bedtop lighting bars & 12 x Hi-Res predict cameras
- 40+ crop AI deep learning models, precision computer vision software
- Liftable weeding implement with 20 ft coverage width
- Pulls behind row tractors with 3-point hitch
- 60-84” adjustable row spacing
- Front-mounted PTO-driven generator
- Overall dimensions 240 “ W x 117” L x 106” H

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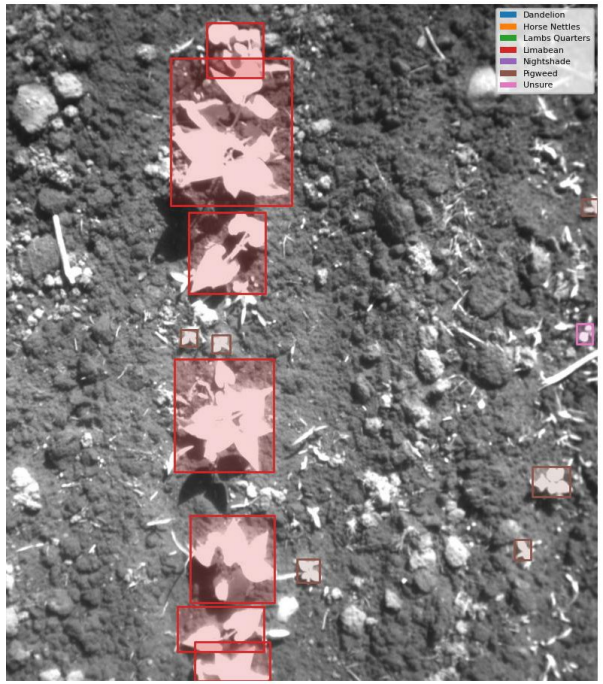
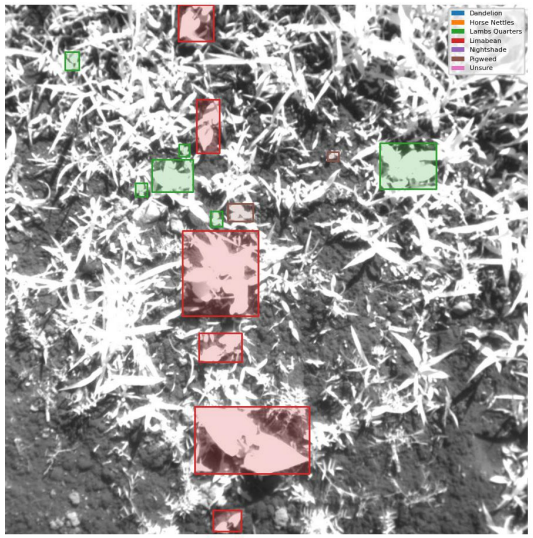
2023 & 2024 – Autonomous Weed Scouting Project



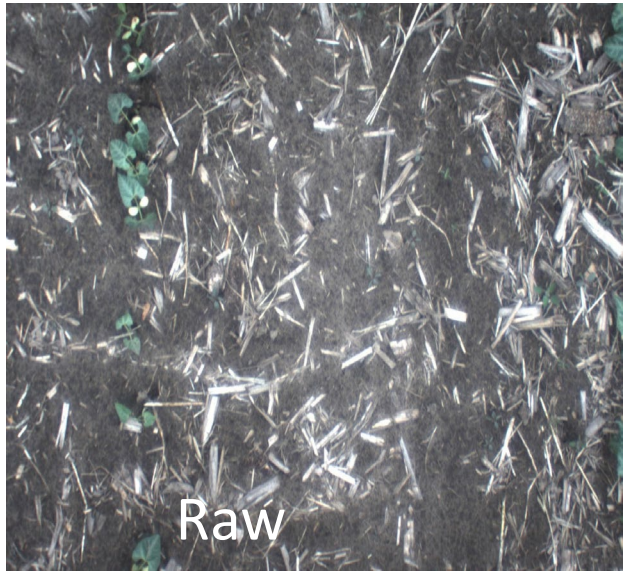


Goal: To autonomously scout lima beans to create weed density maps for herbicide application and harvest avoidance.

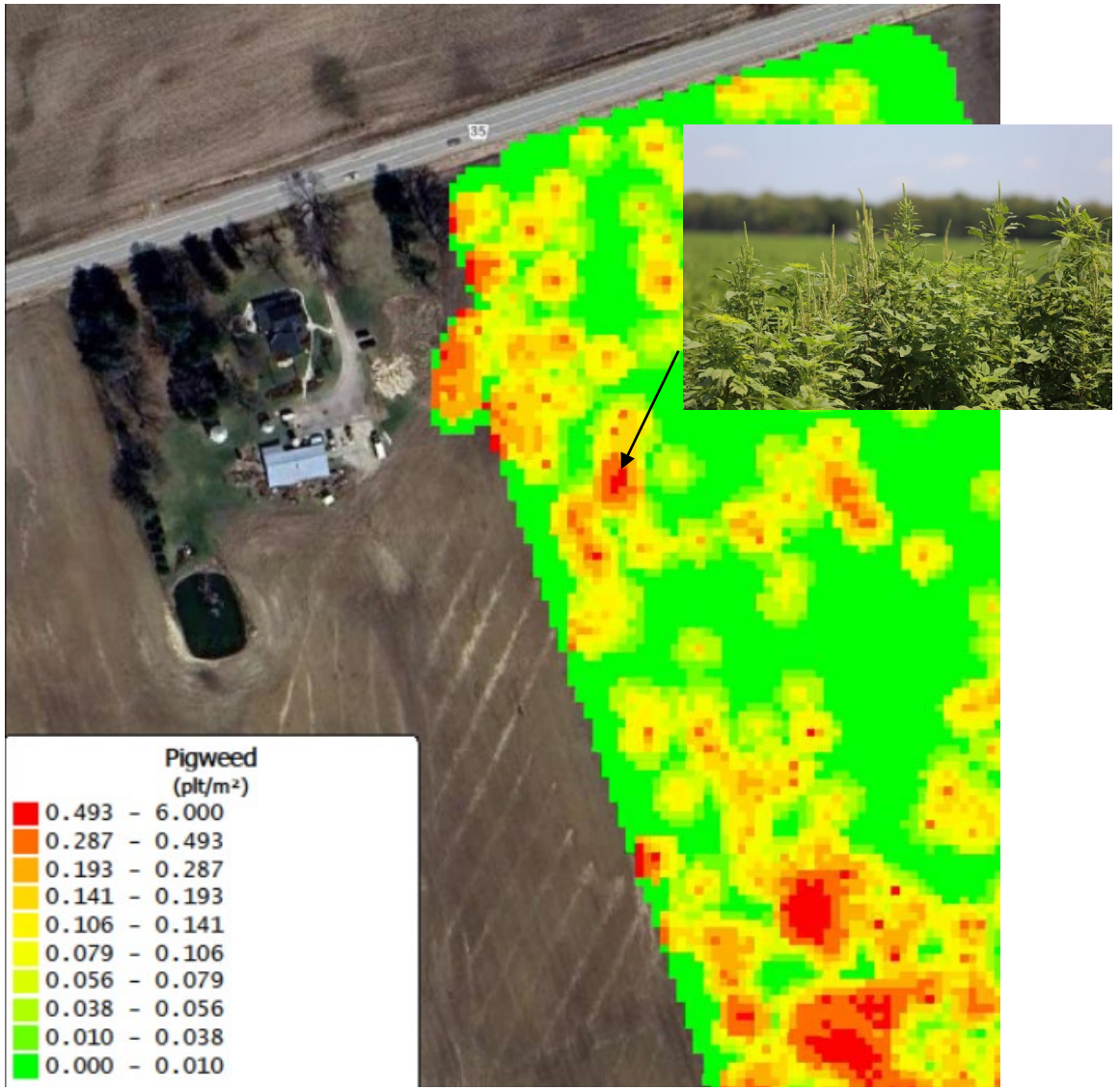
Determine the maximum height the cameras can be positioned and the maximum speed the autonomous carrier can reach to collect accurate images of the crop and 3 weed species.

AAC Agricultural Adaptation Council · University of Guelph · BioTalent Canada – Igniting the bio-economy's brainpower · Ontario Processing Vegetable Growers · Ontario · OCI – Where Next Happens · NORTERA · AgRoboticsWG

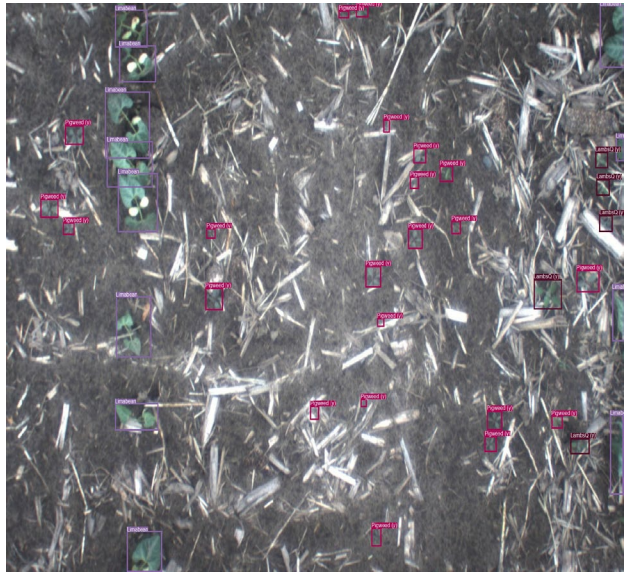
Scouting – 25’ Swath of Overhead Images



Digital Weed Density Map



Weed Detection Algorithm



Jason Gharibo. October 21, 2024. Haggerty AgRobotics Company, Ltd.

Korechi Innovations RoamIO HCW & Haggerty AgRobotics Electric Mower

https://korechi.com
www.haggertyagrobotics.com

- Used for mowing, weeding, seeding, collecting data etc.
- 32 in. ground clearance and adjustable width (47.5” – 75.5”)
- 1300 lb (590 kg)
- Maximum 4 mph (6.5 kph)
- Collision avoidance – dual cameras with AI
- Multi-band GNSS RTK with dual antenna for cm level accuracy
- Many optional accessories

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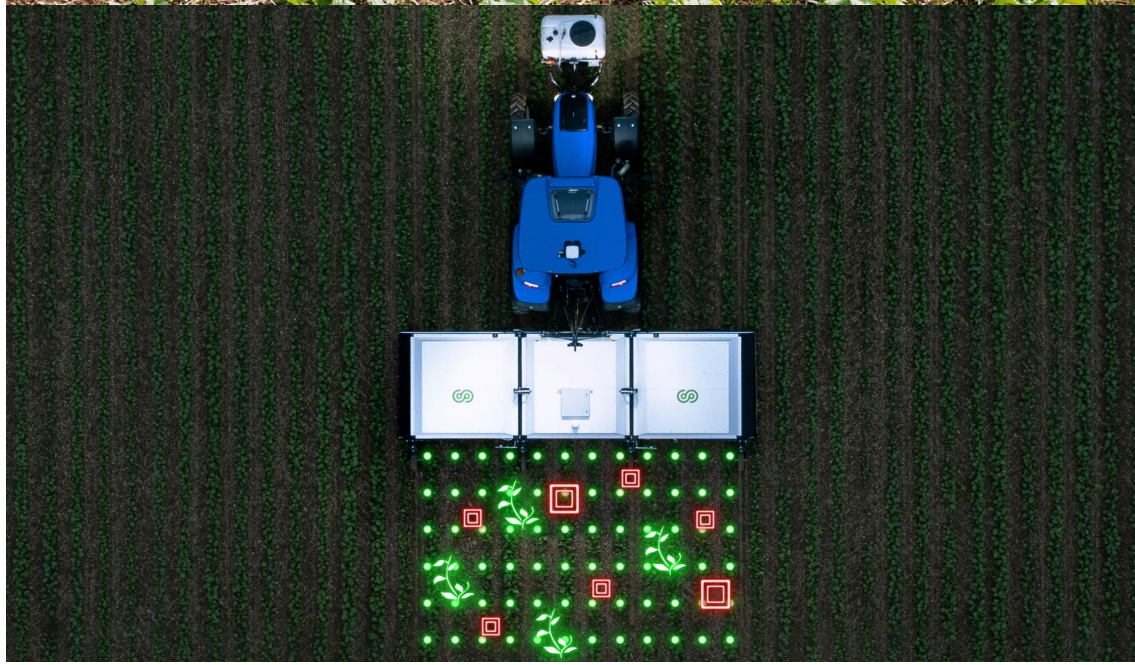
Ecorobotix

https://ecorobotix.com

AI Powered Ultra-High Precision Spraying for Vegetable Crops

- Use of algorithms to detect and treat an extensive array of crops and weeds.
- In 2021, Ecorobotix launched the ARA ultra-high precision sprayer:
  - The ARA, features a 6-meter foldable frame and a front tank, a more versatile and transportable solution.
  - Targeted application of herbicides, fungicides, insecticides or fertilizers.
  - One nozzle every four cms to apply chemicals in a six-by-six cm (2.4 square inches) area of weeds.
  - Current crops: sugar beets, string beans, spinach, onions, salad, chicory, volunteer potatoes in onions and sugar beets, carrots (beta version).
  - 4 ha per hour.
- By mid-2023, a US subsidiary was established.
- Canadian dealer in Quebec – Univerco – info@univerco.net



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Weed-IT Sprayer

- Visic
  -
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Targeted Herbicide Applications for Weed Control in Grapes

Lynn M. Sosnoskie[1] Elizabeth C. Maloney[1] and Thierry E. Besançon[2]

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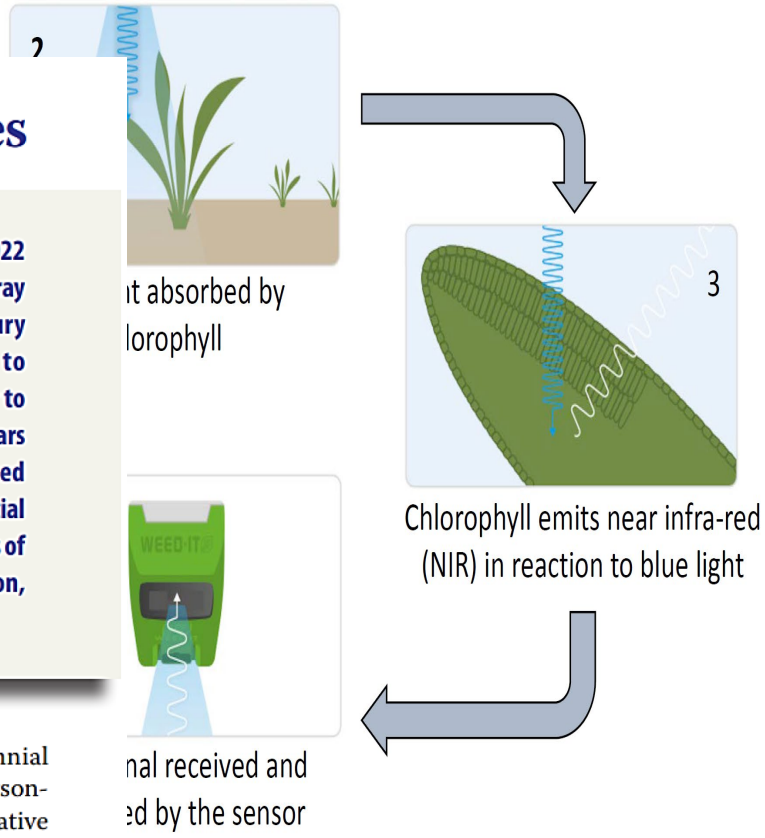
Keywords: weeds, weed control, herbicide resistance, herbicide injury, novel technology, precision spraying, targeted spraying, vision-guided spraying

Results from our work in 2021 and 2022 show that precision, vision-guided spray technology resulted in less vine injury and reduced weed cover relative to untreated check plots but was inferior to conventional banded treatments appears especially when weed cover approached 50%. The reduced vine injury and potential to reduce herbicide use will be the focus of our future research trials with precision, vision-guided spray technology.

Fruit crops are important contributors to the agricultural economy of the United States (US); in 2017, fruit, tree nut, and berry sales amounted to $28.6 billion (USDA-NASS, 2023). Despite a historic cultural association with California's Napa Valley, substantial grape production regions also occur in the Eastern US. The grape industry in New York (NY), primarily juice and wine, is valued at $340 million.

Weeds are a significant threat to fruit crop production; in addition to competitive interactions, weeds can provide a habitat for vertebrate and insect pests, physically interfere with crop management operations, and reduce harvest efficiency (Mia et al., 2020). To preserve yields and profits, fruit growers invest significant amounts of time and money managing unwanted vegetation. Across all cropping systems in the US, herbicides are the most frequently used pesticides (USDA-NASS, 2023), although there is growing interest in reducing chemical loads. In addition to growing concerns about evolved resistance across weed species, herbicide use may be unwanted because of the potential for crop injury; environmental impact and worker safety concerns, changing public perceptions about pesticide use, and potential systems because they possess crop canopies that are frequently higher than the naturally occurring floor vegetation and are often highly sensitive to many active ingredients. In 2020, 617 perennial crop stakeholders (growers, consultants, other industry personnel) completed an online survey to gauge interest in alternative weed management tools and practices. Seventy-four percent of respondents had a positive opinion about the potential of novel technology, including vision sprayers, for the management of unwanted vegetation (Sosnoskie, unpublished data). In 2020, the Interregional 4 (IR-4) Project funded an Integrated Solutions (IS) trial to describe the effects of 1) conventional banded and 2) vision-guided spray applications of novel herbicides on weed control, crop injury, and yield responses in grape.

Materials and Methods



CornellCALS College of Agriculture and Life Sciences

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AI for Herbicide Discovery

- Most Crop Protection Companies have struggled with new herbicide discovery with patents expiring.
- Costs have steadily increased.
- Average lead time between the first synthesis of a new crop protection molecule and its subsequent commercial introduction has also increased to over 15 years.
  - Greater complexity in the data requirements.
  - Regulatory bodies not granting conditional approvals.

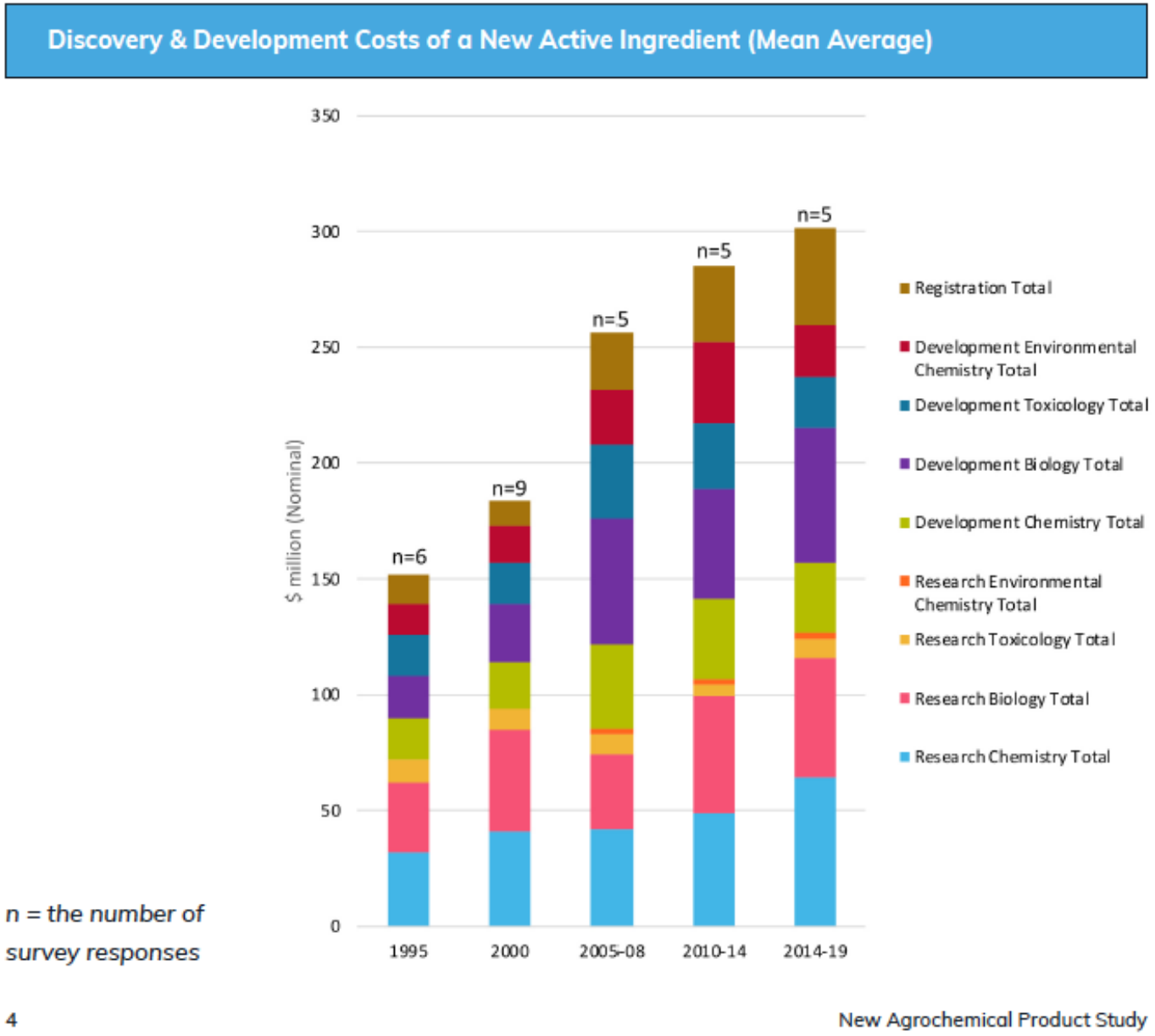

Image from "Time and Cost of New Agrochemical Product Discovery, Development and Registration A Study on Behalf of Crop Life International, February 2024 (Ag Bio Investor)"

AI for Herbicide Discovery

Major agricultural companies like Bayer, Corteva, NuFarm and Syngenta are betting on AI to speed up the development of new herbicides, fungicides and insecticides.

Bayer's AI system, internally known as 'CropKey', can rapidly search data for chemical molecules capable of breaking down the protein structure of weeds, potentially yielding better results in field tests than traditional methods.

The technology has enabled Bayer to develop a new herbicide, Icafolin, slated for a 2028 launch in Brazil – marking the first introduction of a new herbicide in over thirty years.

MoA Technologies has discovered 60 promising novel modes of action areas, with multiple candidates infield trials post laboratory validation and glasshouse testing. MoA has signed an exclusive deal with NuFarm for one of these novel modes of action.

Syngenta estimates that AI could reduce the time from discovery to commercialization of a pesticide from 15 to 10 years and cut laboratory and field tests by 30%.

AI's role in agriculture extends beyond just speeding up chemical development; it also allows for early toxicity screenings crucial for pesticides used on crops for human consumption. This helps in ensuring environmental safety and cost-efficiency.

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AI for Herbicide Discovery

- AI tools are helping **identify novel modes of action (MoA) at a faster rate**, due to high-throughput screens for new modes of action, mode of action elucidation & chemotype discovery. Only a handful of new MoA have been found in the last 30 years, but AI has helped identify more than 50 novel MoAs in the last few years.

- The crop protection industry is applying AI techniques like protein folding, multi-parameter optimization, protein-to-protein interaction models, etc. used in the pharmaceutical industry.

- The crop protection industry has realized about **20% of the benefits of AI tools** used in the pharmaceutical industry, for the herbicide discovery process.
  - There are still significant learning opportunities

- As the agricultural sector grapples with these challenges, AI emerges not just as a tool for innovation, but as a crucial ally in safeguarding future food supplies against the growing threat of resistant weeds.

2024 Wall Street Journal www.wsj.com/science/environment/super-weed-killer-ai-8105de6a

AgRoboticsWG.com

An industry + government + academia + technology collaboration success story

After OMAFA identified "Robotics and Automation" as a solution focus for critical challenges in agriculture:

- Formed the **AgRobotics Working Group**, bringing together stakeholders from government, research, technology companies, agri-business, grower associations and innovative growers.
- The group has **secured over $8 million** in funding since 2021, including $2 M from Farm Credit Canada for the Innovation Farms Initiative and $2.4 M through an S-CAP TPA for the Western Fair District to administer the WG and provide project funding and new technology company mentorships.
- With **180 members**, 150 meetings, and 100 presentations, the group has gained access to **30 robots** from **8 technology companies**, aiming to influence the adoption of robotics and automation in the agriculture sector.
- [RoboCrop: Ontario Farms Experiment with the Future | ONsite (youtube.com)]

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New Agricultural Robotics Centre

Posted: October 16, 2024 **Category:** District News

New Agricultural Robotics Centre to Be Established at The Grove at Western Fair.
Innovative Partnership Aims to Drive Agricultural Robotics, Automation and Commercialization.

London, Ontario – October 16, 2024 – The Grove at Western Fair is set to become home to the Agricultural Robotics Research and Training Centre, (ARTC), a groundbreaking initiative designed to advance agricultural robotics and automation through a unique partnership. The new ARTC will be the physical ecosystem hub of cutting-edge agricultural robotics innovation, research, training, and commercialization, designed to foster collaboration and support the innovation ecosystem of companies, agri-food industry and government stakeholders.

The ARTC will serve as the headquarters for the AgRobotics Working Group (www.AgRoboticsWG.com), with Haggerty AgRobotics Company Inc. spearheading the operations centre and research infrastructure. It will feature a state-of-the-art farm research sandbox, where innovators can test, prototype, and develop the next generation

- The ARTC will not only support agricultural innovators and businesses from across Canada but will also engage leaders in the agri-food automation sector from around the world. By facilitating collaboration among industry experts, entrepreneurs, and academic institutions, the ARTC aims to accelerate the development and practical adoption of innovative, efficient, and scalable robotics solutions for the agricultural sector.
- RHA Ventures Inc. will lead the commercialization efforts through the ARTC's dedicated commercialization hub, providing strategic guidance and support for startups and emerging technologies that have the potential to transform agriculture.
- The new initiative will also provide opportunities for hands-on education and workforce development, ensuring the next generation of Canadian farmers, agri-tech professionals and students are well-equipped to embrace and lead the shift toward automation and robotics in agriculture.

AI, Automation & Robotics - Conclusions

Drivers for adoption of new technologies

- **Labor** — the lack of it — is the number one factor driving farmers' adoption of automation and robotics solutions, according to panelists, demonstrators and attendees at the 2024 FIRA USA show. But it's not the only driver.
  - Resistant weeds
  - Evolving regulatory landscape
  - Climate change

Barriers to adoption of new technologies

- **Trust** – the lack of it – is still the number one factor preventing adoption on a large scale
  - According to a new Rabobank report on the state of autonomy in agricultural equipment, "87% of commercialized agricultural robots are owned by their developers (startups and scaleups)." Translation: Most autonomous solutions available to farmers right now are from startups farmers have never heard of, nor trust. And what machines they do have are available only in very limited numbers.
  - It will be important to leverage trusted brands and existing dealer networks, ensuring farmers receive reliable, autonomous solutions that seamlessly integrate into their operations.

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Barriers to adoption of new technologies

Technical

Efficiency: Speed and time savings are not always guaranteed compared to older techniques

Complexity of Use: Equipment that is too complex can discourage producers

Uncertainty about Performance: Growers seek guarantees on the effectiveness of technologies before adopting them

Adaptability Issues: Some technologies do not always fit specific production models

AI, Automation & Robotics - Conclusions

Barriers to adoption of new technologies

Economic

High Purchase Price: The initial cost of equipment remains a barrier, especially for small farms.

Uncertain Return on Investment: Uncertainty about the time needed to recover the investment is a major obstacle.

Limited Access to Subsidies: Current subsidies often only cover part of the costs or are not available for untested technologies.

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Barriers to adoption of new technologies

Human

Lack of Qualified Workforce: Difficulty in recruiting trained personnel to operate new technologies slows their adoption.

Lack of Time for Training: Growers have limited time for training on these new tools.

Lack of Awareness of Technologies: Lack of information about available new technologies limits their adoption

AI, Automation & Robotics - Conclusions

Barriers to adoption of new technologies

Implementation

Limited Technical Support: The lack of support after purchase makes adoption riskier.

Dependency on Suppliers: Producers fear becoming too dependent on suppliers for the management of tools and data.

Compatibility with Existing Systems: Integrating new technologies withc urrent systems can be complicated and costly.

Since 2022, growers across all sectors have indicated that the lack of validation of the technologies is a significant barrier to their adoption

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AI, Automation & Robotics - Conclusions

- AgRobotics technology for weed management has dramatically improved over the last two years, with new models and tools available to growers.
  - There is still room to improve these systems and third-party research collaborations are the best way to accomplish this.
    - The work being completed with the FarmDroid and Naio Orio at the Ontario Crops Research Station – Bradford, by Dr. Mary Ruth McDonald and her team is an excellent example of this.
    - Both of these robots will contribute to future farm profitability and environmental stewardship by utilizing sustainable weed management techniques.

- AI is having a positive impact on the herbicide discovery process and subsequently for management of resistant weeds.

Thank-you for your attention

Questions?

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