Robots for Weeding Vegetable Crops

Project Update

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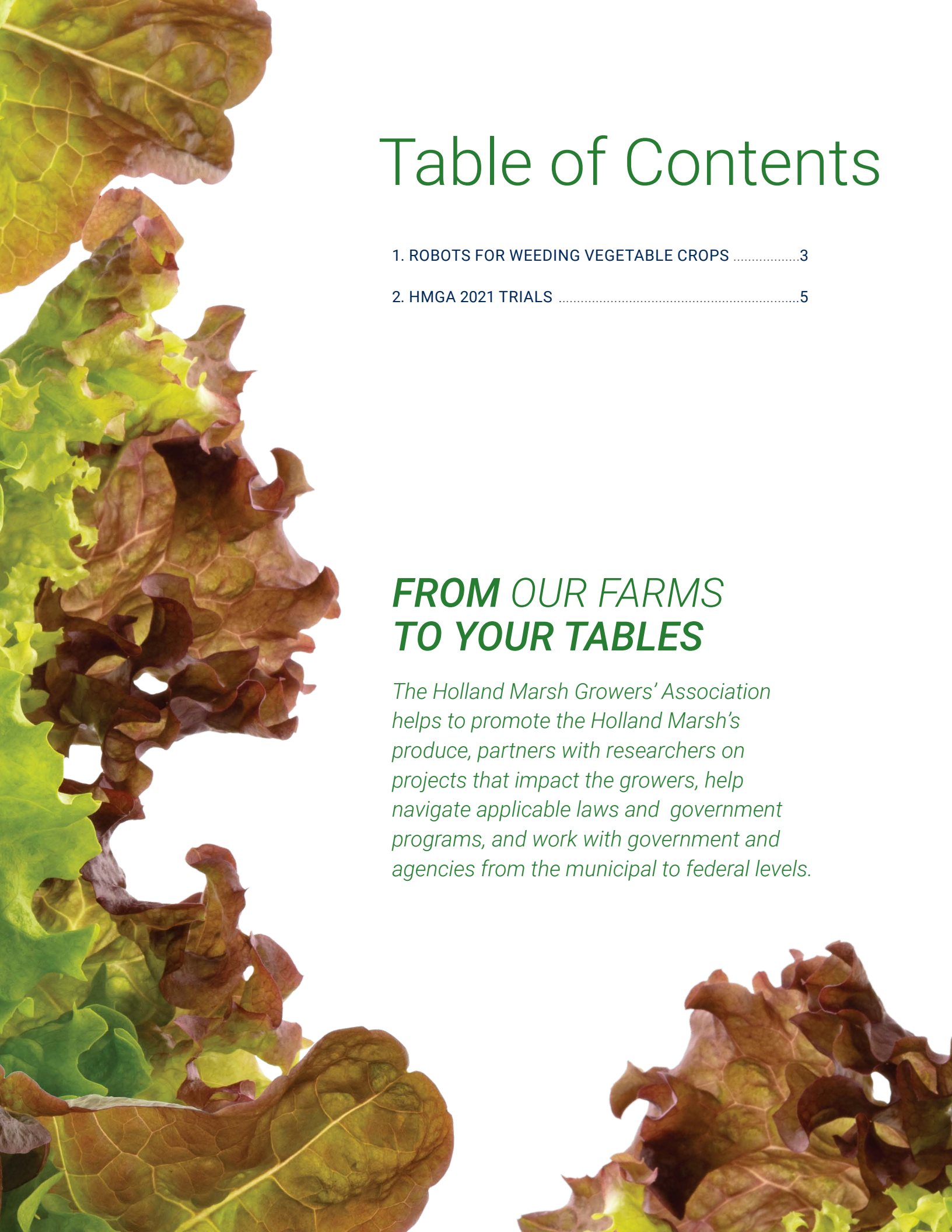

Table of Contents

***FROM** OUR FARMS*
TO YOUR TABLES

The Holland Marsh Growers' Association helps to promote the Holland Marsh's produce, partners with researchers on projects that impact the growers, help navigate applicable laws and government programs, and work with government and agencies from the municipal to federal levels.

ROBOTS FOR WEEDING VEGETABLE CROPS

The use of robots in agriculture is not new to farmers and it takes many forms, from robotic milkers to self-driving equipment. Recently there have been worldwide efforts to introduce robotics to the very diverse horticulture systems. While many approaches have now been commercialized, many more are in development stages combining mechanical functions with Artificial Intelligence (AI).

The Holland Marsh Growers' Association (HMGA) has had a vision of the future based on the introduction and use of autonomous robots for weeding vegetable crops such as carrots, onions, celery and many more. Partially funded by the Ministry of Agriculture Food and Rural Affairs, and growers sharing this vision for the future, several companies were invited to conduct field trials during the 2021 crop year to learn and determine the feasibility of using commercial robots for weeding purposes. Interest was driven by savings in herbicide use and ultimately boost in production.

The four main benefits of using commercial robots are:

- A reduction of pesticide uses by 50% or more
- Greater weed control efficacy
- Increased productivity, and
- Greater flexibility on crop harvest timing.

There is a variety of technologies deployed with applicability to vegetable production. These are mainly:

- Mechanical approaches
- Infrared technology
- Combination of mechanical and AI to create smart equipment.

Mechanical approaches have been in place for centuries and are known as interrow cultivation. A Real Time Kinematics (RTK) positioning unit is used to map each row to then guide the robot when an operation is needed. These systems that combine a RTK input and a mechanical approach work well for certain applications. Another mechanical approach is based on electricity, whereby weeds have overtaken an emerging crop. An electrical bar zaps the taller weeds without affecting the crop. This can be effective in situations where growers start vegetable crops from seeds.

Infrared technology has been used on field sensors for many years and the quality of sensor can vary from early applications to high resolution multi-spectral sensors. These sensors are used to detect and distinguish weeds from the desired crop. The technology is useful on drones for yield mapping and delivering an herbicide spray directly on weeds. At this time, the herbicide application is limited until product registration catches up. Infrared technology is also useful on equipment performing mechanical functions.

Integrating AI on machines represents the area where further development and growth is expected. Equipment receives, “just in time” signals to perform either a mechanical function such as pulling a weed, or applying a herbicide spray to a weed. It functions on recognition of the crop and/or weeds as the equipment is deployed. Many companies in horticulture are working on the use of AI with a mechanical function while others are focusing on sprayer systems to reduce overall herbicide use. Some companies are also testing laser technology to destroy weeds closest to the vegetable crop.

HMGA 2021 TRIALS

During the 2021 crop year, three autonomous robot types were tested in the vegetable crops. The first arriving on the scene was the Oz, manufactured by NaIO. It was a small robot operating mechanically using RTK information and capable of working in a celery field in combination with an annual herbicide program. Its use was limited to the June - late July period starting when the pre-planting herbicide application wears out. Mechanical weeding occurs on a bi-weekly period eliminating the need for an herbicide. The OZ is capable of weeding 7 acres per day.

A Weed Zapper was also used on a vegetable farm in the spring to control weeds effectively.

In late July, a Canadian company, NEXUS brought its robot to the Holland Marsh for field work. The robot is much larger than the Oz and relies on an AI system to reach into crop rows to pluck weeds. The use of raised beds and hills for onion and carrot production presented unique challenges with respect to wheelbase spacing and equipment clearance. Nevertheless, the operator was able to gather useful information for future trials.

In late July and in September, the RoamIO robot, manufactured by Korechi, Oshawa, Ontario was deployed to test its wheel tracking system and settings on muck soils. The robot was equipped with both mechanical implements as well as a Soil Optix sensor to scan the soil and ultimately create a soil map. The robot performed very well and development continues to add multi-functionality to include opportunities to apply herbicides based on AI capabilities.

In November, a new autonomous robot, DINO, manufactured by NaIO arrived in Canada and was demonstrated in the Holland Marsh as both a dry presentation as well as a field test on several rows of ready to harvest carrots. The possibility to use this robot on either raised beds and hilled crops will be further explored in 2022.

Also in November, a DJI Drone use was demonstrated using water as a replacement for herbicides. The drone can carry a large volume of product and can apply as a broadcast or targeted to specific weeds. Further applications for cover crop seeding and soil mapping are also in development as these drones can be equipped with multi-spectral cameras.

Each company offers considerable information on their websites, and readers are encouraged to access this information.

With all this technology arriving at growers' farm gates, what is the business case for its use and is it cost effective to replace an existing piece of farm machinery and manual labour? The following factors have been identified when assessing feasibility:

- Labour tradeoff
- Herbicide use reduction
- Biosecurity
- Fuel versus electricity use
- Soil health and early detection of plant disease
- Multi-functionality
- Human health
- Serviceability

Several constraints were identified during the year starting with the weather, production methods, row spacing and eventually a closed crop canopy preventing field access. Nevertheless, there were both lessons learned for growers and tech developers. From a cost benefit basis, the average cost of weed control is $1,500 per acre with the chemicals itself representing two thirds of those costs. Eliminating the possibly of two in-season applications, the grower herbicide cost reduction is estimated at $200. There is opportunity for more herbicide reduction earlier at pre and post planting once growers are convinced and trust the technology. As technology providers add more functionality and greater surface coverage per day, a business case will tip in favour of autonomous robots.

For the 2022 crop year, researchers working with a few growers will continue with the development and testing phases on several equipment. If funding permits, the HMGA will continue to support these projects to bring the latest production technologies to local growers.

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