Autonomous Weed Scouting Project Report – Year 2

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- Shaun Sharpe, AAFC Weed Scientist, Saskatoon, Saskatchewan
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Overall Research Summary

The multifaceted challenge to address weed escapes in lima bean production fields continues to be tackled by an interdisciplinary team from academia (University of Guelph), government/regulatory (OMAFRA), growers (Nortera Foods), and industry (Haggerty AgRobotics). Building on the foundational work in 2023, the team has continued refining the imaging system, dataset, and pattern recognition model to optimize weed identification in processing vegetables. Though still not perfect, the combination of data from 2023 and 2024 has enhanced our ability to scout for pigweed, nightshade and horsenettle in lima bean fields, with a resolution not previously possible for practical field applications.

The following methodology was followed:

1. Designed and fabricated the next iteration scouting system towards commercial scale. A camera-boom system was made to collect 20-30 acres of in-field images of lima bean fields at early-season, mid-season, and pre-harvest stages. This was conducted across five distinct commercial lima bean production fields in SW Ontario.
2. Process the scouting images by utilizing the model from 2023 to identify pigweed, nightshade, and horsenettle from these images. Use identified weed locations to digitize weed zones in the field – weed density map.
3. Utilize images collected in 2024 to update, and optimize the model, with the hypothesis that adding more images from different scenarios will improve model performance in

diverse field conditions. Test different dataset combinations.

4. Ground-truth weed density maps with in-field observations to establish the accuracy of the model and the weed density mapping program.

Following the foundational work in 2023, the team has updated the imaging system, dataset, and pattern recognition model to optimize weed identification in processing vegetables.

This year commercial sites were scanned at a greater scale towards making the system commercially applicable (20-30 acres, compared to last year's ~1 acre). Six cameras simultaneously took overhead images, allowing the rover to cover a 25' swath at the optimal height and speed determined in 2023. This adjustment allowed the system to cover approximately five times more area with each pass of the scouting system.

Scans were conducted across five different commercial sites, contributing to a database that reflects more of the variability found in real-life, commercial applications. The crop management schedule was made in accordance with industry standards set by OMAFRA and followed by Nortera Foods. Imaging took place after first planting in May until the first week of October—just before lima bean harvest.

After each scan, the data was transported to Dr. Moussa's data science team, who processed the images and geolocations into a weed density map.

The combination of data from 2023 and 2024 has enhanced the ability to identify and map the weeds of interest, improving both precision and recall for practical field applications when compared to last year. The field-tested weed density mapping process has allowed for weed detection and classification to be proven at a commercial scale. This experience and dataset will inform further analysis and model adjustments to distinguish between real weed presence and application errors for 2025.

Next Steps

- Ensure sufficient accuracy in differentiating pigweed from nightshade.
- Dr. Moussa's team will continue to process and optimize machine learning models and dataset features and test outputs in preparation for the 2025 growing season.
- Apply latest scouting system to 2025 lima bean production fields in SW Ontario.
- Perform post-scan, in-field validation of Scans 1 and 3 weed density maps to verify their accuracy.