HarvestEye Technology Assessment for PEI Potato Board

Genesis Crop Systems Inc/Contour Consulting

PROJECT REPORT
February 11th, 2025

Introduction

Genesis Crop Systems Inc and Contour Consulting (Team) were engaged by the PEI Potato Board to implement a series of on farm evaluations to assess the potential value of the HarvestEye (HE) tuber measuring technology for use on Prince Edward Island potato farms. The HE technology was developed in the UK by B-Hive Innovations which HarvestEye Ltd. has commercialized to provide users with real time geospatial tuber dimension measurements based on optical technology mounted on potato harvesters. Note that HarvestEye also promotes use of this technology for collection of other data.

Project objectives could be summarized as follows, but may not be limited to:

- Provision of precise tuber size distribution across various field management zones and capacity to improve overall crop profitability in the mid-long term;
- Provision of precise tuber size distribution as crop is placed in storage to enhance overall management decisions regarding crop shipments during crop shipping stage;
- Provide further qualification to current precision ag strategies including SWAT mapping, variable rate fertilizer and seed spacing strategies; and
- Assess use of handheld imaging mode for assessing size distribution in small tuber samples (ie. ten-foot strip samples).

Methodology

The PEI Potato Board entered into an agreement with HarvestEye Ltd. for the delivery of three HE units to be evaluated during the 2024 harvest season. These units were supplied at 50% cost (total of $6950 CAD/unit) for a one-year rental.

GCS identified three farmers – Howmac Farms (*seed, processing)*, Rollo Bay Holdings – (*seed, tablestock)* and JJ Smallman Farms (*chips)* - to participate in the program. This group was selected due to the diverse nature of their potato markets, thereby providing a cross-section of the various types of potatoes produced in PEI. Upon completion of harvest, one of the units was moved to Smith Farms to determine applicability for installation on bin piling equipment.

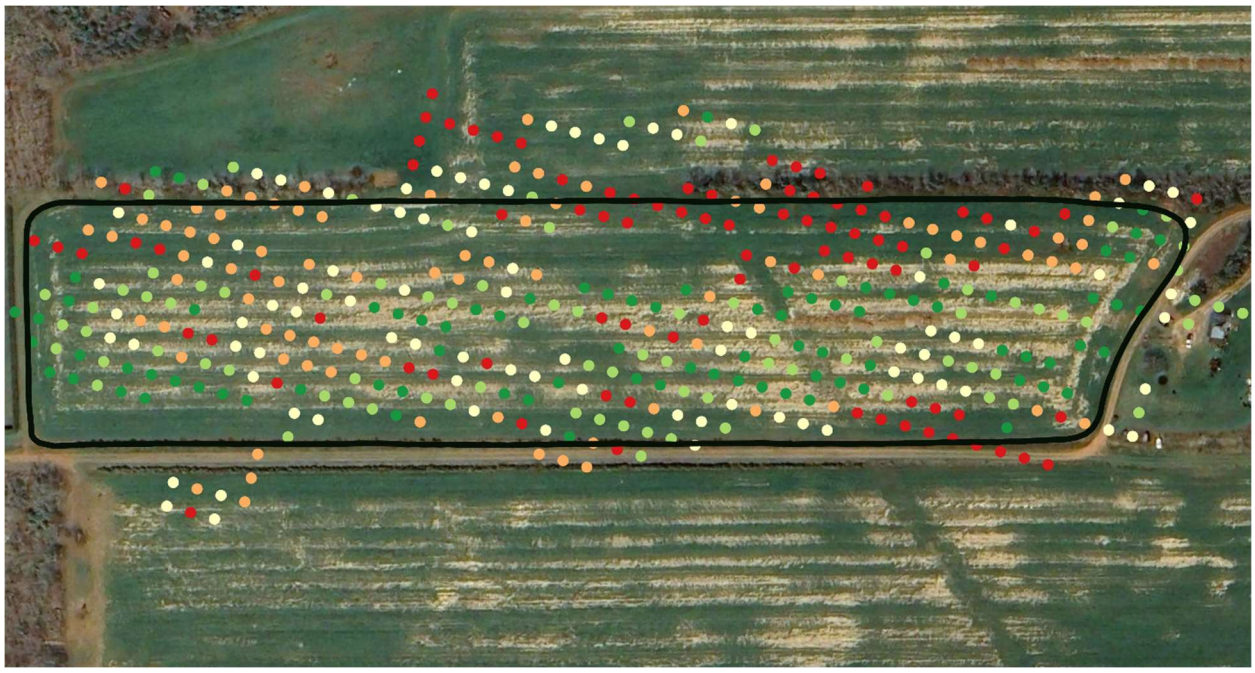
HE units were received at the Board office in mid-August and delivered to cooperating farmers shortly after. All installation instructions were provided via HarvestEye Ltd. and growers were left to install the systems and prepare for operation on their own accord without any assistance from the team.

Growers then uploaded field names, harvested varieties and other field information to the HE portal. Follow up prior to crop harvest indicated that the systems were field ready at all sites. Size profile protocols for each of the farms were provided to Andre Lourenco via GCS.

Results

A summary of results is provided on a farm-by-farm basis;

Howmac Farms reported no issues with installation of the system and data was collected when harvest commenced. This data is not presented in real time but can be viewed through the HE online portal which provides the data as pictured below. When accessing the results, it was noted that there were issues with GPS drift in approximately one-quarter of the fields at HowMac. An example of this can be seen below.



The field boundary can be seen in black outline, while HarvestEye data is displayed in points. Some fields had issues with points falling far outside a field boundary.

HarvestEye uses a standalone GPS system that is not integrated with tractor's existing GPS system. HarvestEye is aware of issues with GPS drift, and they are working on a solution. Ensuring the grower has the GPS installed in an unobstructed area is important. GPS drift is not a big concern for simply viewing reports in the online portal. It could be a concern if the grower is focused on using this information for variable rate seeding applications in the future.

Rollo Bay Holdings reported no issues with equipment installation and entry of field information. Data was collected when harvest commenced. There were no issues with GPS drift at Rollo Bay Holdings. Some patterns emerged when viewing HarvestEye data in combination with historical satellite imagery.

The image on the left shows what the field looked like in 2012, approximately one year before being cleared. The image on the right shows the field with HarvestEye data from 2024. Green dots indicate there were larger sized tubers coming from the recently cleared section of the field.

JJ Smallman Farms reported no issues with equipment installation and entry of field information. The system operated properly for part of the first day of harvest and then stopped. A brief summary from Morgan below;

- Started harvest of the first field of year where everything worked briefly before going down. Tried connecting with UK help line; no response for +/- 2 days (apparently long weekend)
- Tried trouble shooting without tech support and suspected it might be cable to camera
- Eventually connected with customer support and requested cable; took 10 days for delivery
- Installed new cable; still inoperable
- Connected with tech support. Following diagnostics, identified camera was not functioning properly and arranged for shipment of replacement camera
- Took 10 days for replacement camera to arrive
- Installed replacement camera and captured small amount of data during final day of harvest

Initial data for all farms was reported based on tuber length. A request was sent out requesting conversion of all fields to tuber diameter – the standard measure of potato commerce in PEI.

Evaluation of Handheld Imaging:

With the addition of a smaller mounted camera apparatus, the handheld unit that comes with the standard HarvestEye system can be used to do imaging of smaller samples of potatoes for grading purposes. These could be samples from ten-foot strips prior to harvest or samples going into storage. The operator needs to designate a field that the samples come from, give the sample a

name/identifier, and input a total weight of the potatoes in the sample. Tubers can then be laid out on the floor or other flat surface, with an image then taken from above using the handheld. This gives an immediate report with total tuber number and average tuber size. A more detailed report is then generated and sent by email with breakdown by size band (which can be adjusted by HE IT per customer request) according to length, width, or size, in either imperial or metric units.

While grading samples with UPEI grad students for an AIM supported project, Ryan and Charanpreet Singh used the handheld unit to assess the accuracy and ease-of-use of the HE system. The team had the number of tubers in each of three size bands as well as total weight from conventional grading, so this was a good opportunity to assess accuracy.

In general, the total tuber counts from the HE was within 1 or 2 tubers of the actual and were often correct. Though a size definition was requested for smalls of 1.875 inches for width, this change was not implemented by HE in time to be reflected in the reports received, which defined smalls as less than 1.6 in. This led to some discrepancy in the number of small tubers, but this could be corrected in the future. Getting count and average weight of > 10 oz tubers is available in a secondary output in the same report, with total raw weight estimations per size band illustrated on a bar graph. Currently, HE is considering the implementation of technology that allows the input of true total weight of the sample to re-estimate the weight per size band.

Besides the PDF report, images of the sample (both original and with counts) are included in the email, as well as an Excel spreadsheet with length, width, size (minimum size hole in mm that the tuber would fit through) and weight for each tuber. This spreadsheet could be used to do additional statistics but requires additional time. HE also has data services available on-demand to provide insights and data that may not be available to obtain from the portal and reports under normal circumstances.

Extensive testing was not possible due to time constraints, particularly because the Potato Board team did not have access to the HE units until they were uninstalled at the three cooperating farms. Getting an individual handheld unit just for imaging of grading samples was more expensive than could be justified for the purposes of this project. It did not take long to setup the handheld unit for direct imaging and the user interface is relatively user-friendly.

To be successful in using the HE handheld unit for the purposes of rapid grading in the field or at the storage, it is recommended to:

- Ensure that the desired size/width/length bands are established and confirmed with HE IT in advance of imaging;
- Have a flat, clean surface with good light to do the imaging;
- Ensure potatoes are not lying on top of each other (does take some manual effort) and preferably not too many potatoes touching;
- A possible option for quick throughput would be having a box or tray that can be easily shaken to move the potatoes into a single layer as well as allow soil to fall through the bottom. This would be particularly useful for field operations;
- Have a scale in the field/storage to get a total sample weight to compare with weights provided by the HE handheld.

A copy of a complete PDF report is included as an appendix to this report. The image below shows the output in the report detailing bands according to tuber width.

HarvestEye Handheld Report

HarvestEye

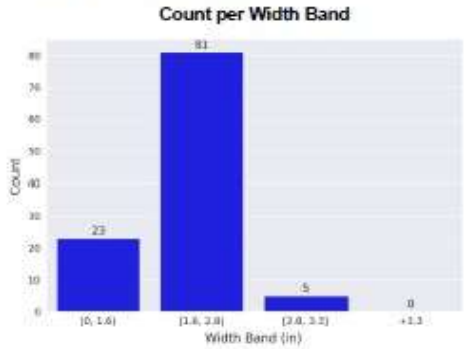
Sample Information

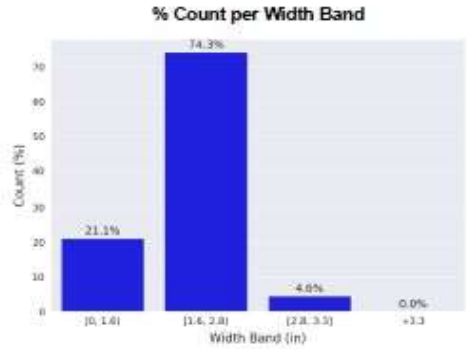
Farm: PEI Potato Board 1	**Field**: QA	**Dig Sample**:	**Timestamp**: 2024-10-24 10:45:44
Crop: Potato	**Variety**: Test	**Count**: 109	**Input Weight (Lbs)**: 25.44

Summary Statistics

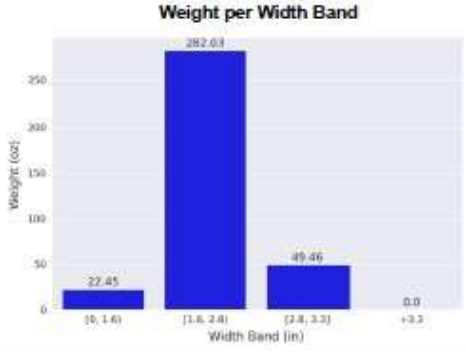
Metric	mean	std	min	max
Length (in)	2.7	0.7	1.3	4.6
Width (in)	1.9	0.5	0.7	3.2
Size (mm)	46.3	10.4	20.0	73.0
Weight (oz)	3.2	2.2	0.3	11.8

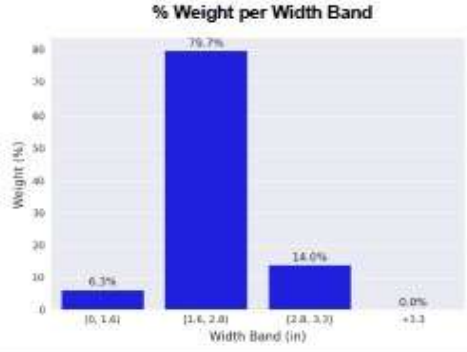
Count Distributions





Weight Distributions

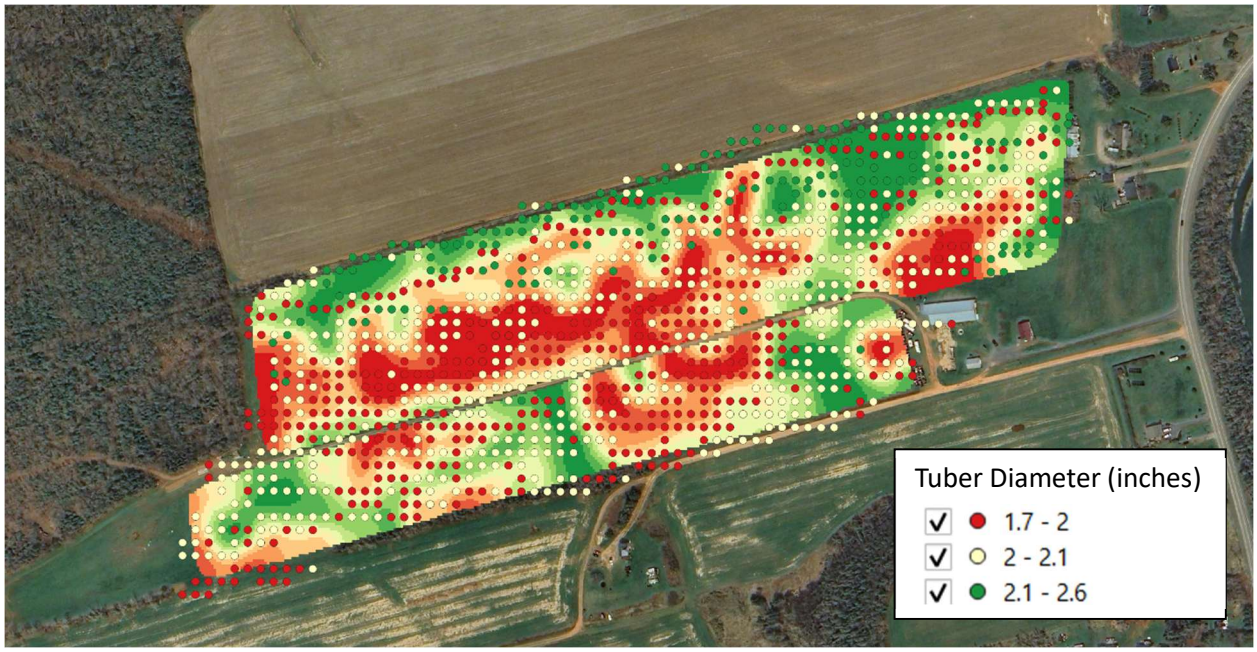




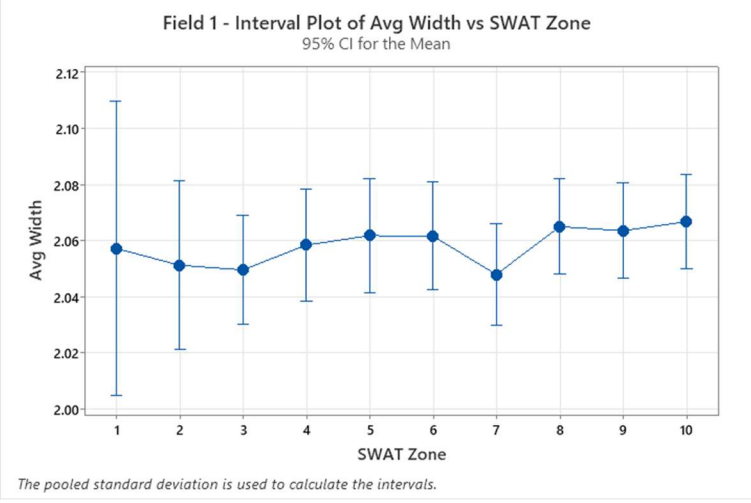
HarvestEye and SWAT Zones:

HowMac Farms had SWAT MAPS for some fields harvested in 2024. Considering there were some issues with GPS drift and missing points in some locations, we chose to analyze only two fields which had higher quality data. By importing HarvestEye points into freely available QGIS software, a join between SWAT Zones could be used to assess size profile differences across zones. Previous research has shown that there are significant differences in size profile between SWAT Zones, with upper landscape areas (Zones 1-3) often yielding a higher percentage of smalls. Lower landscape areas (Zones 7-10) showed less smalls and a higher percentage of >10 oz.

Field 1



HarvestEye points are labeled red, yellow, or green, according to their width (diameter). Some patterns are visible when viewing points over top of SWAT Zones, but it is difficult to get an accurate idea visually. GIS software was used to automatically identify what Zone every HarvestEye point was in and this information was imported into Minitab statistical software for further analysis.

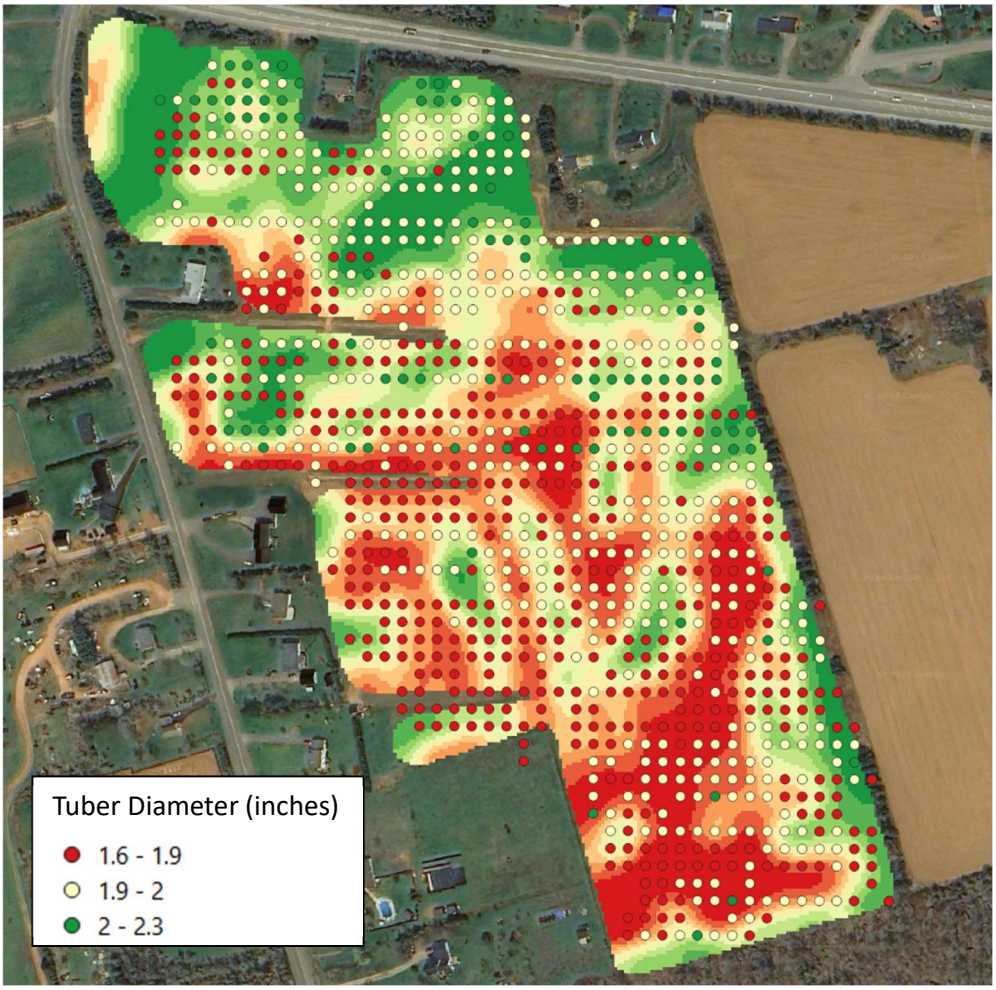


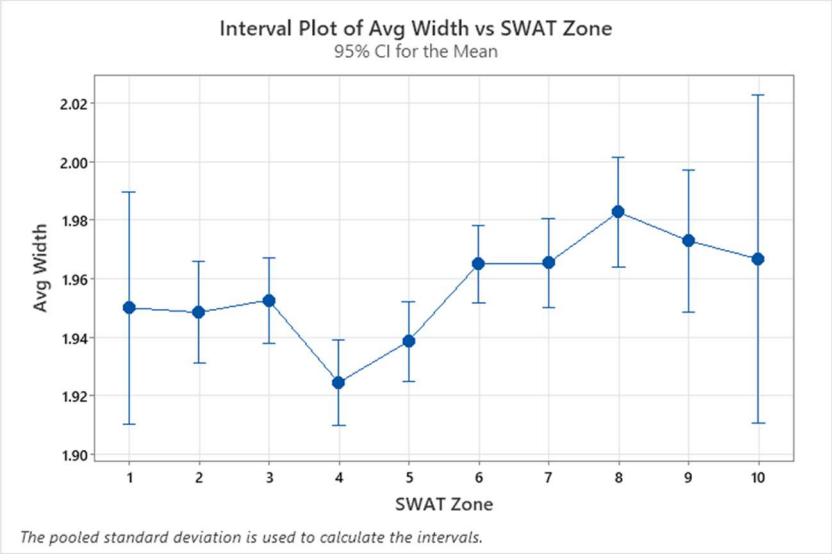
SWATZone	N	Mean	Grouping
10	138	2.0667	A
8	134	2.06493	A
9	134	2.0634	A
5	94	2.06170	A
6	104	2.06154	A
4	96	2.05833	A
1	14	2.0571	A
2	43	2.05116	A
3	101	2.04950	A
7	117	2.04786	A

Means that do not share a letter are significantly different.

Results from Field 1 show that Zones 8, 9, and 10 had the highest average tuber width, but there was no significant difference in average tuber width between zones. Zone 1 only had 14 points within it, so sample size is too small to draw any conclusions.

Field 2:



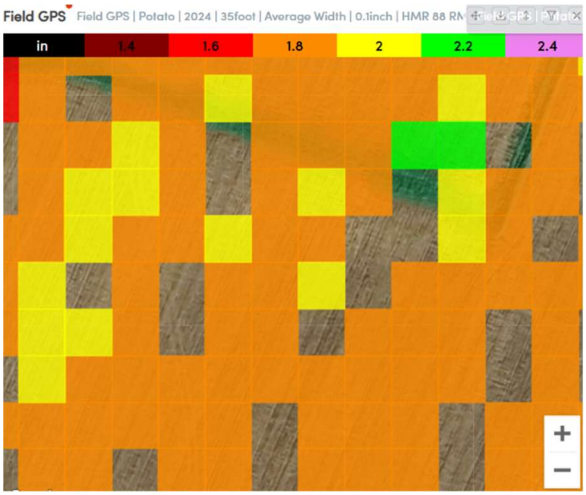


SWATZone	N	Mean	Grouping		
8	81	1.98272	A		
9	48	1.9729	A	B	
10	9	1.9667	A	B	C
7	121	1.96529	A	B	
6	163	1.96503	A	B	
3	133	1.95263	A	B	C
1	18	1.9500	A	B	C
2	95	1.94842	A	B	C
5	153	1.93856		B	C
4	131	1.92443			C

Means that do not share a letter are significantly different.

In Field 2, Zones 8, 9, and 10 had the largest average tuber width again, but they were not significantly different than all zones except 4 and 5. Zone 10 had a small sample size of only nine points. There were small differences of 0.06 inches between the zone with the lowest average tuber width and the highest.

Each HarvestEye point on the map represents a larger area, approx. 35 ft X 35 ft, from which measurements are taken and represented as an average. This, in combination with displaying an average measurement per zone partly explains why large differences in size profile between zones could not be observed. It could be possible to get a more accurate picture of size profile across zones with access to raw point data from HarvestEye, and ensuring each point is accurately georeferenced by integrating the system with the tractor's RTK GPS. Yield monitor data from systems such as Greentronics display yield data in continuous points that represent the path of the harvester. Users have access to raw yield data and can manipulate it in their own GIS software, or systems such as John Deere Operations Center / Climate Fieldview.



An example of a HarvestEye report with a zoomed in section of a field. Each square is 35 ft x 35 ft, displaying the average tuber width per square.

Possible Future Applications:

Multiple years of HarvestEye data could be used to influence seeding decisions if a farm is equipped with variable rate planting technology. Assuming the data collected is of a high quality, it could be used to generate prescriptions that can be loaded onto a controller and automatically adjust seed spacing on the fly. For example, if there are consistent areas of a field that produce smaller than desirable tubers, within-row seed spacing could be increased (ie. 10" to 11.5") to try and achieve a larger tuber size. Small datasets of only a few years may have reliability limitations due to variance in weather conditions and other impacts. It would be advisable to combine HarvestEye data with other management zone layers such as SWAT MAPS to better understand trends throughout the field.

HarvestEye data could be used to generate profitability maps for a farm. By understanding size profile distribution across a field, an estimate of marketable yield value can be calculated. HarvestEye produces a weight metric based on the size of a tuber. If a grower also has a Greentronics load-cell based yield monitoring system, these data sets could be combined to get a clearer picture. The limitation of a load-cell based system is it does not distinguish potatoes from trash, rocks, clods etc. Profitability maps can be useful in future decision making. If an area of a field is consistently underperforming, ie. too wet, too dry, erosion issues, etc., this could be quantified in a dollar value. A farm could decide whether it is worth it to remedy the problem area or avoid planting it altogether.

Conclusions

- HarvestEye technology can provide a reliable indication of size profile differences across a field, but it may be less reliable in some varieties. The system was built based on European table varieties and desired specifications in that market. As more locally prominent varieties are integrated into the system, it will become more accurate in its size estimation.

- Differences between harvest practices should also be considered. Local harvester typically digs 10-16 rows (including rows lifted by windrowers) through a two-four row harvester, resulting in high tuber flow over the boom, possibly preventing accurate tuber measurements. Placement of cameras may be more effective on windrowers or certain areas of the bin piler where tubers would be passing at a lower rate.

- GPS drift can be an issue in some areas, but we only found this to be a problem in approximately ¼ of the fields at HowMac Farms. There were no issues with drift at Rollo Bay Farms. Positioning the GPS so that it has a constant view of the sky is important. To use HarvestEye for precision agriculture purposes and future decisions, accurate GPS data is necessary. Improvement in accuracy may require a more advanced GPS or adapting the HE technology to utilize the pre-existing GPS used in the harvest equipment.

- HarvestEye has potential to be a valuable tool for assessing trials within a field. If a grower would like to compare treatments using HarvestEye mounted on a harvester, care must be

taken to ensure treatments are of a significant width to get meaningful size profile data. With a HarvestEye grid size of 35ft x 35ft, treatments should be at least 3X wider - approximately 100 feet wide, or 30 to 36 rows wide. Data will be mixed and inaccurate if treatment widths are not adequate. Having access to raw point data that matches the path of the harvester would make this information more reliable.

- Like any AgTech solution, good customer service is critical. HarvestEye is a young start-up with their home base located in a different continent. The company expects to have North American representative(s) in 2025 and this should help growers in this market, specifically in trouble shooting technology and modifying data to be presented in preferred units that are most informative to the grower. Having access to reliable technical support at all hours of the harvesting operation is important in creating more consistent data results.

Acknowledgements:

The research team would like to thank:

- The team at HarvestEye in the United Kingdom for providing their technology at a reduced rate for one year as part of this evaluation project.
- The SIGI program at the PEI Department of Agriculture for providing funding for this project.
- The three participating farms (Howmac Farms, J&J Smallman Farms, and Rollo Bay Holdings) for partnering with us on this project.