MWFPA Annual report: On-harvester and in-hand NIRS for managing vegetable quality

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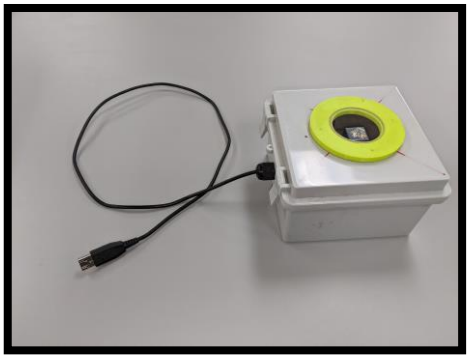
Research objectives: The goals of this work were to (1) continue to build a calibration database for a commercially available diode array NIRS to predict tenderometer reading, (2) compare the accuracy to a low-cost handheld instrument, and (3) evaluate the utility of NIRS to predict ripeness of peas in the pod and on the vine.

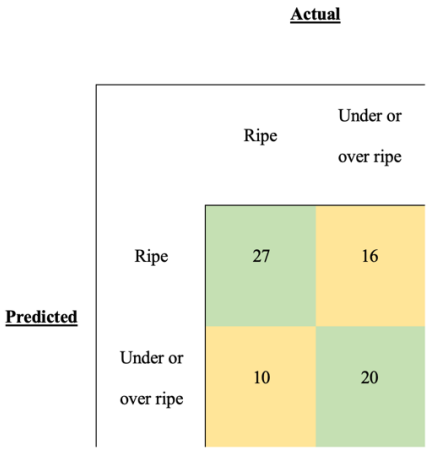
Progress:

Objective 1 – A research paper was published summarizing our progress to-date: M.F. Digman and W.M. Runge. The utility of a near-infrared spectrometer to predict the maturity of green peas (Pisum sativum), *Computers and Electronics in Agriculture*, 193, 2022.

Objective 2 - NIR spectra, RGB image and pea size, moisture and tenderometer reference data were collected over the 2022 harvest season. A NeoSpectra NIR module was used to collect NIR spectra (Figure 1a). From four field visits a total of three hundred spectra were collected along with corresponding tenderometer readings. The average tenderometer reading was 95 with a standard deviation of 16.9 and values ranged from 69 to 156. This compared to a range of moisture contents from 73 – 83, average 79, standard deviation 2.2 %w.b. The size range, average, and standard deviation were 4.3 – 9.1, 6.3, and 1.2 mm, respectively.

A calibration model was developed using partial least squares regression model, which yielded a root mean standard error of prediction of 6.6 TR units. This performance was lower than observed with the benchtop instrument utilized in objective one. Therefore, another approach was explored using partial least squares discriminate analysis (PLSDA) to classify peas into two categories: ripe or under ripe. It was assumed that peas were ripe at a tenderometer value between 80 and 100. The PLSDA model achieved an accuracy of 65% (Figure 1b).





(a) **(b)**

Figure 1. (a) NeoSpectra module prototype and (b) PLS-DA classification model confusion matrix.

Objective 3 – Work has not yet begun on this objective.

Budget: The project is currently under budget as the summer student was shared between two projects and we did not travel to Waseca, MN as planned. We do have a plan to spend the remaining funds supporting a 10% graduate RA who will be working on improving the spectrometer design and explore additional prediction models.

FY 2022 Plans: In 2022 we plan to expand the calibration dataset for objective 2 and make improvements to the spectrometer's optical pathway to improve the signal to noise and resulting prediction model performance. We also plan to travel to Waseca, MN to collect pea data from an additional region as well as begin investigating in-pod ripeness prediction. The team will leverage this progress to submit a research proposal to the NSF National Robotics Initiative to expand the project to UAV and on-harvester pea yield and quality prediction.