Results:

(1) Precision Thinning:

The 2015 season brought an excessive bloom to Northern NY state. Bud loads on trees involved in the precision thinning project for Honeycrisp ranged from 1.0 to 2.1 (flower buds per apple). This is much lower and more manageable than in the last three years, which had excessively high bud loads (3.0- 5.0). From our previous studies the optimum level of pruning severity to get the maximum crop value was about 1.5 and 1.8, Gala and Honeycrisp respectively.

The weather in 2015 when entered into the Apple Carbohydrate Model for Clinton County showed a poor supply to demand balance only between the end of bloom and 7mm fruit size. Thereafter, around the regular thinning window (12mm) there was no deficit to aid in thinning (Figure 1), which suggested relatively high doses of chemical thinners for this period. The model for Altamont in the Albany area showed only a short period (3-4 days) of carb supply between bloom to 15mm fruit size (Figure 2). In this case, we would expect much more thinning to result from the chemical thinners.

At each location, after taking the fruit diameter measurements growers sent the data electronically to the project leader who analyzed the data and sent back them a thinning recommendation for their individual orchards within 24 hours, allowing growers to quickly apply an additional thinning spray if needed.

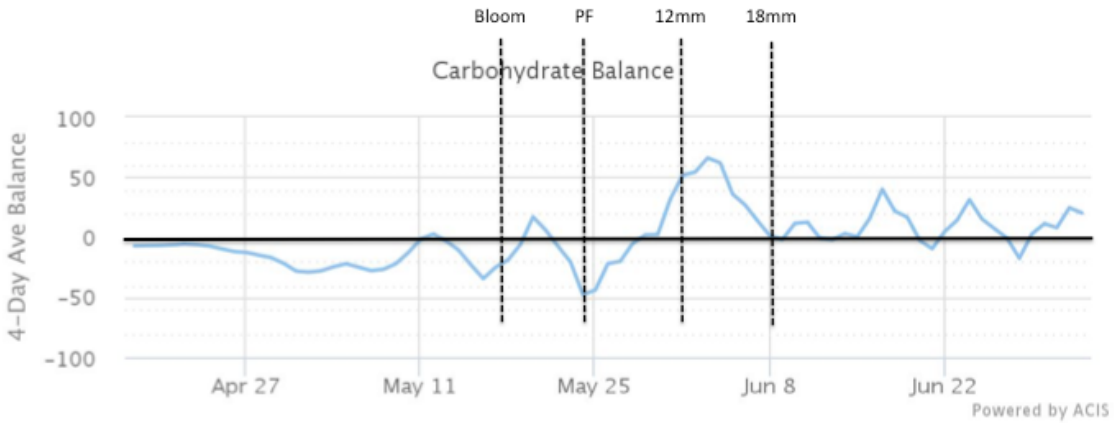

Figure 1. Predicted daily carbohydrate balance during spray applications in Peru, NY, according to weather data and the MalySim model, 2015.

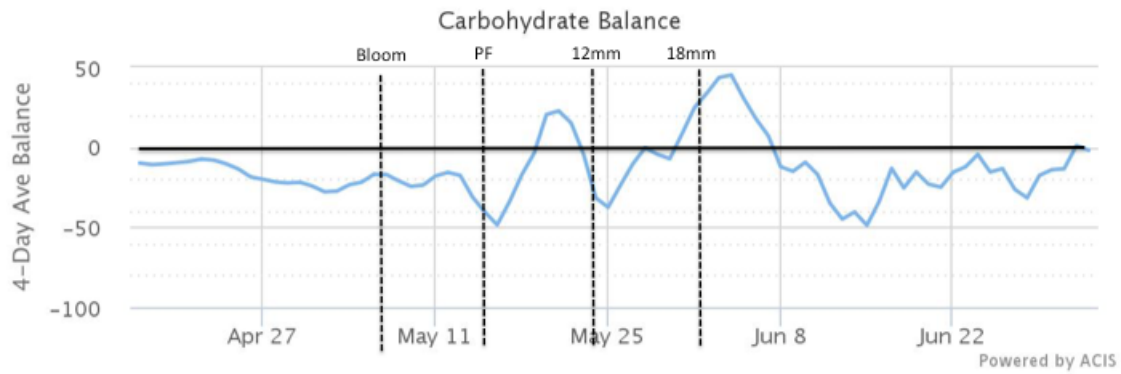

Figure 2. Predicted daily carbohydrate balance during spray applications in Altamont, NY, according to weather data and the MalySim model, 2015.

The results from the sequential thinning sprays using the precision thinning protocol showed that the bloom and petal fall sprays were quite effective in 2015 but in some blocks an additional thinning was still needed. The 12mm spray gave significant thinning in Albany County due to a low carbohydrate balance (Figures 3 and 4). The model predicted over-thinning in 2 of the 4 blocks (Figure 3). Whereas in Clinton County thinning seemed to be greater at between bloom to past petal fall and less thinning from the 12mm spray (Figures 5 and 6). None of the blocks received the 18mm spray and hand thinning was performed. Figures 3, 4, 5 and 6 show the results provided by the Fruit Growth Rate Model and how much thinning each grower had in each of their blocks.

The fruit diameter measurements and fruit growth rate model gave good estimates of the thinning effect of the previous thinning spray. The real-time recommendations allowed cooperating growers to make real-time decisions about the next spray. That information combined with the results of the carbohydrate model gave much greater confidence concerning the timing and dosage of thinning sprays in 2015 and an excellent outcome.

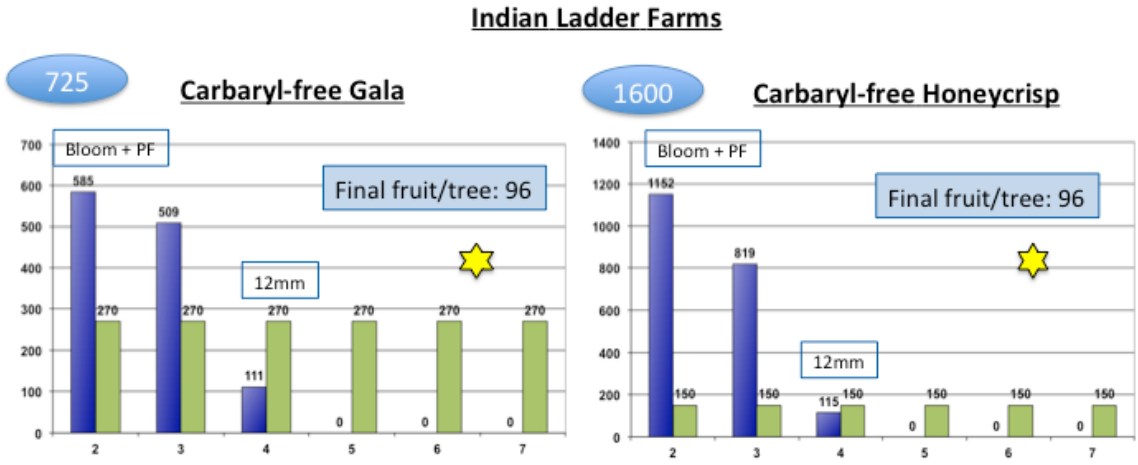

Figure 3. Number of fruit/tree (blue bars) predicted by the Fruit Growth Rate Model and target fruit number (green bars) of precision-thinned carbaryl-free Gala and Honeycrisp apple trees after 3 thinning sprays (bloom, petal fall and 12mm

fruit size) at Indian Ladder Farms, Albany, NY, 2015. Blue circle = initial number of fruit per tree.

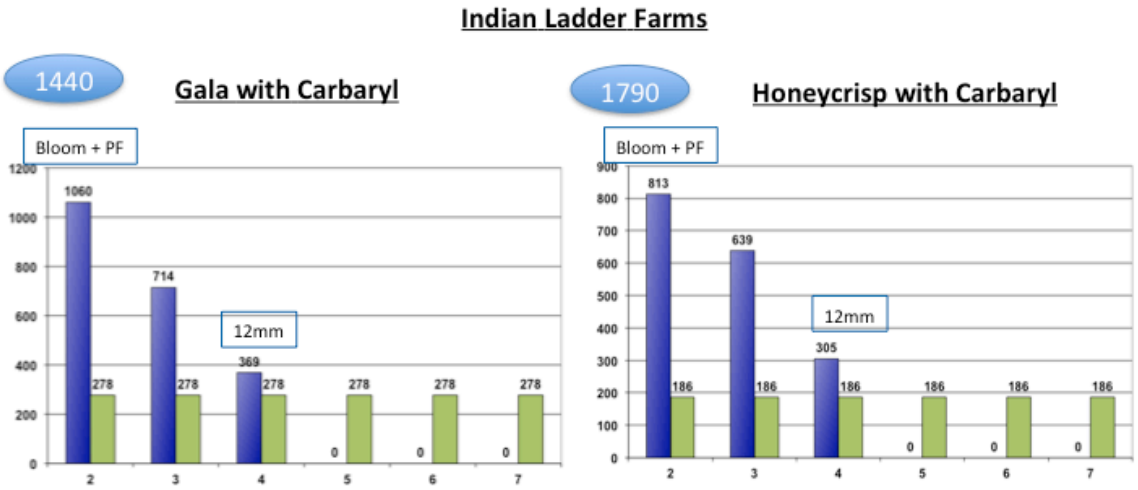

Figure 4. Number of fruit/tree (blue bars) predicted by Fruit Growth Rate Model and target fruit number (green bars) of precision-thinned Gala and Honeycrisp apple trees after 2 thinning sprays (petal fall and 12mm fruit size) at Indian Ladder Farms, Albany, NY, 2015. Blue circle = initial number of fruit per tree. After the third thinner application hand thinning was suggested for both blocks.

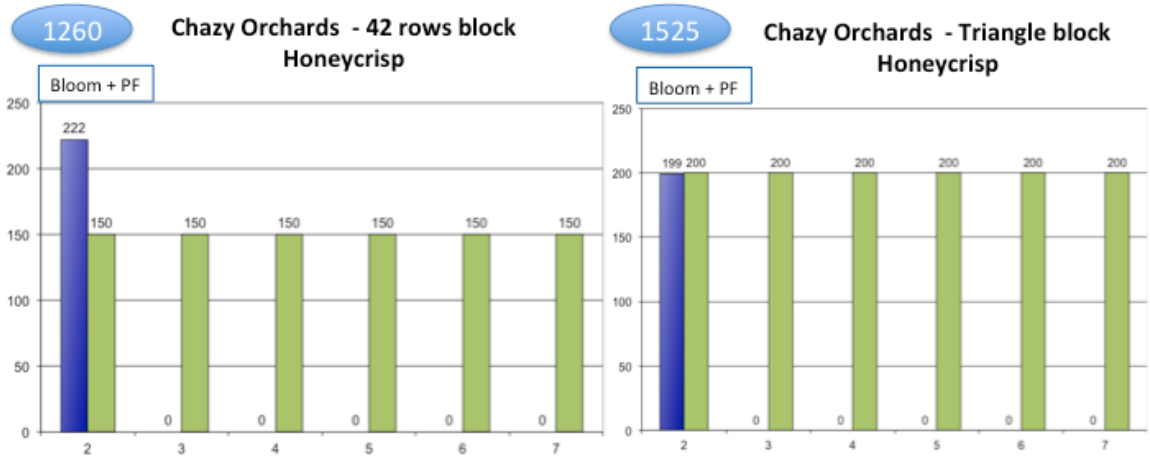

Figure 5. Number of fruit/tree (blue bars) predicted by the Fruit Growth Rate Model and target fruit number (green bars) of precision-thinned Honeycrisp apple trees after 2 thinning sprays (bloom and petal fall) at Chazy Orchards, Chazy, NY, 2015. Blue circle = initial number of fruit per tree. Hand thinning was recommended for 42 rows block. Thinning in the Triangle block was about right, no

extra thinning was necessary.

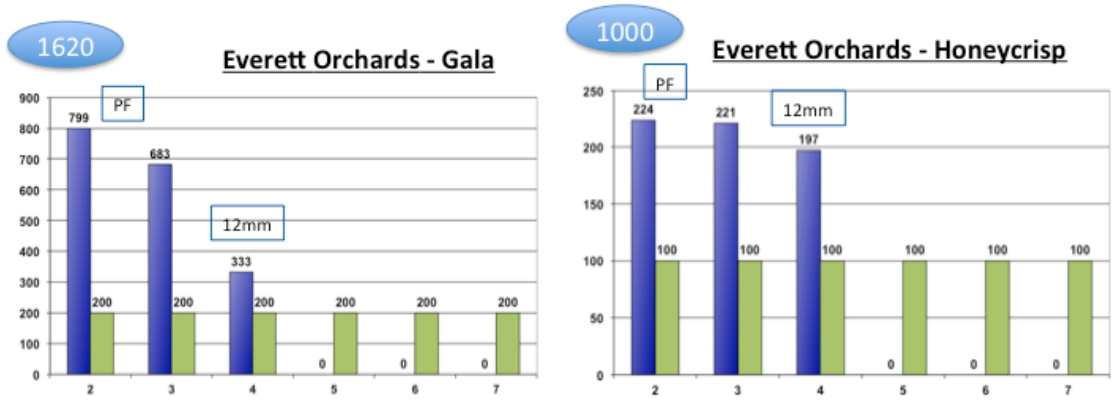

Figure 6. Number of fruit/tree (blue bars) predicted by the Fruit Growth Rate Model and target fruit number (green bars) of precision-thinned Gala and Honeycrisp apple trees after 2 thinning sprays (petal fall and 12 mm fruit size) at Everett Orchards, Plattsburgh, NY, 2015. Blue circle = initial number of fruit per tree. Fruit were getting too large to be chemically thinned, hand thinning was recommended for both varieties.

(2) Precision Irrigation:

No tree stress was observed in the Geneva, Wayne, Orleans, or Champlain Valley region orchards, with only slight differences between irrigated and non-irrigated trees. On the other hand, significant tree water stress was observed during all three summer measurements at the Ulster County orchard for non-irrigated trees, with values lower than -1.6 MPa (MegaPascals) (Figure 7).

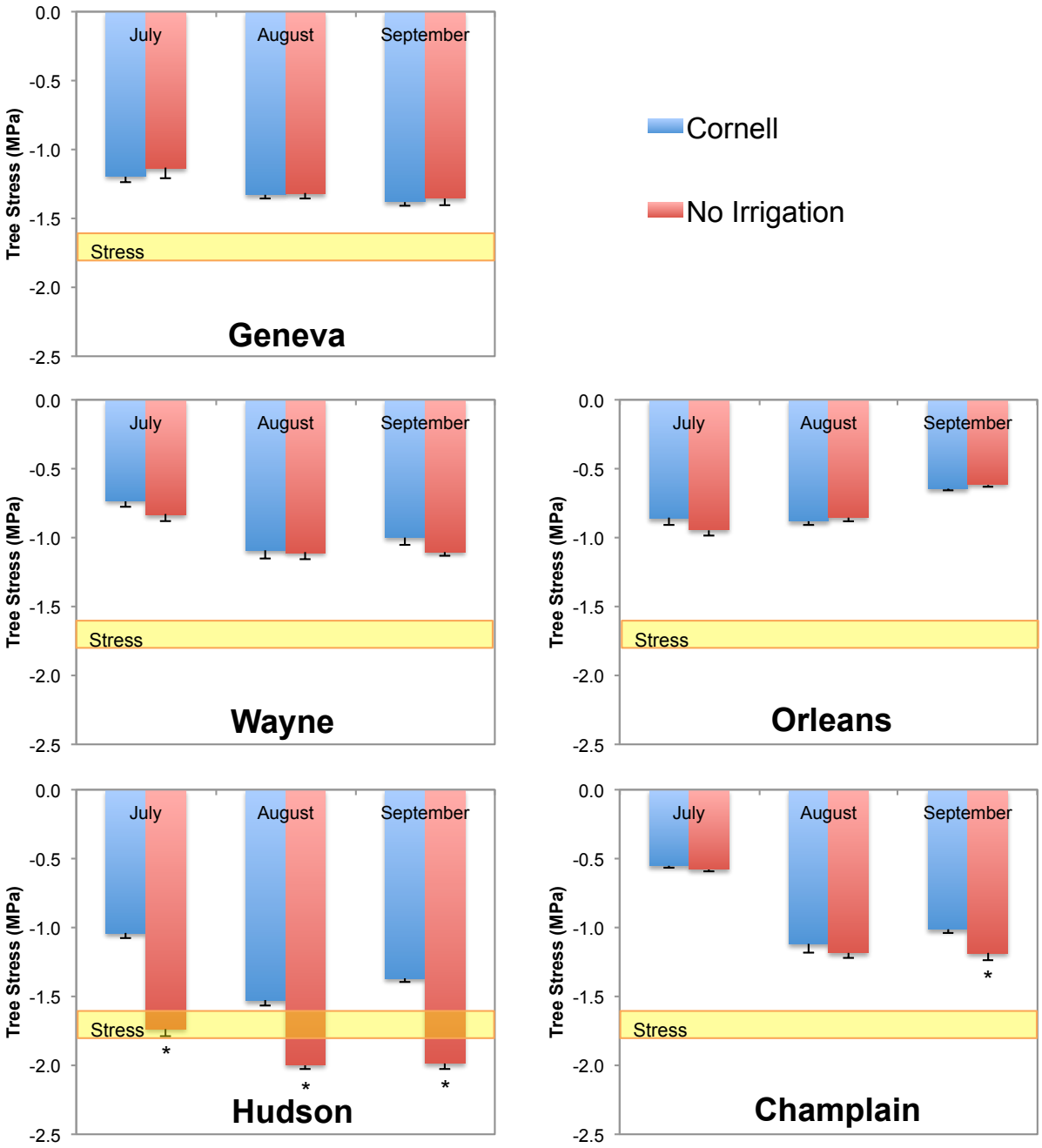

Figure 7. Tree stress during summer at orchards in Geneva, Wayne and Orleans counties, and Hudson and Champlain valleys, 2015. Asterisks indicate significant differences. Blue bars (Cornell) represent trees that were irrigated according to the Cornell Apple Irrigation Model, while red bars represent trees that were left unirrigated (No irrigation).

Regarding the number of harvested fruits, yield, and fruit size, no differences were observed at Geneva and Wayne County sites), where no tree stress was observed.

Conversely, yield and fruit size at the Hudson Valley orchards site were significantly much smaller for non-irrigated trees even though no differences were observed for the number of fruits which were set early. Irrigated trees had an average of 1.5 kg more per

tree, with bigger apples about 140 g for the irrigated trees vs 110 g for the non-irrigated) trees (Figure 8).

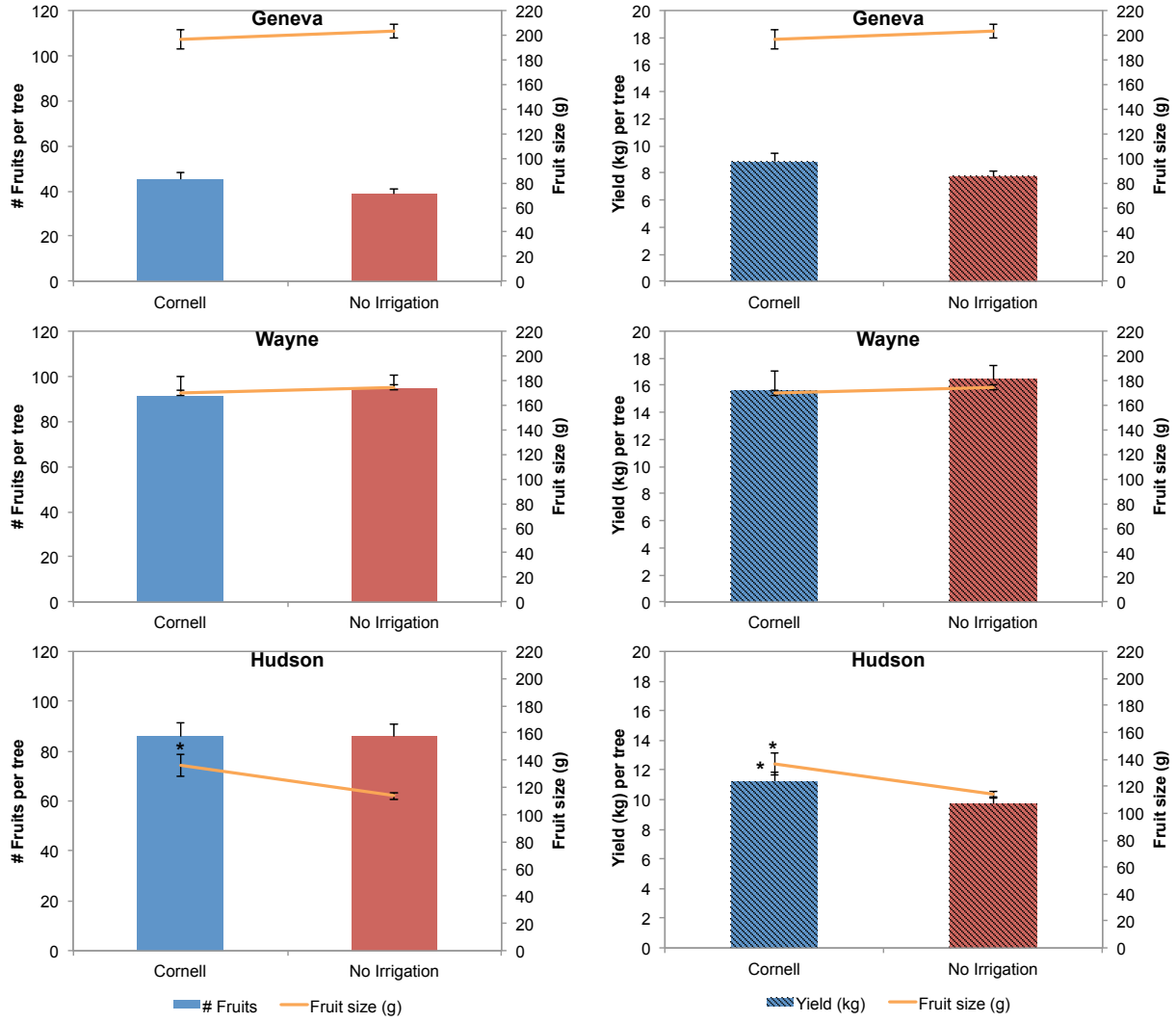

Figure 8. Number of fruits, fruit size, and yield in Geneva, Wayne County and Hudson Valley area orchards, 2015. Asterisks indicate significant differences. There was no harvest in NNY as crop was removed to enhance tree growth in the recently-planted orchards.

(3) Precision Harvest:

Precision harvest management includes assessing the quality of the fruit by measuring fruit dry matter content and fruit mineral concentration, identifying the optimum fruit maturity for each variety and each block by using traditional fruit maturity indices or the new DA meter, and having the labor resources to harvest the fruit at the optimum moment. This is not easy, but precision harvest management can help growers capture the

high crop values possible from a season-long effort of precision orchard management designed to not leave “money on the table.”

Our previous research indicates that crop load is an important variable in determining Honeycrisp apple fruit quality, both at harvest and after storage. When crop load is too high, the tree cannot supply sufficient carbon and other nutrients to give optimum fruit quality (taste, appearance, and storability). Similarly, if weather conditions are cloudy, tree carbon supply for fruit growth is limited, resulting in less than adequate resources for optimum fruit growth and quality.

Our current research is attempting to identify measurable fruit characteristics at harvest that integrate the effect of crop load and climate to predict fruit quality after storage. Based on the work of Dr. John Palmer in New Zealand in 2013, we have begun a study to determine if Honeycrisp orchards can be evaluated at harvest for storage potential using fruit dry matter content, fruit mineral content, and the DA meter.

We have sampled 90–120 Honeycrisp orchards from the main apple-growing regions in New York State, including Northern New York. Fruit were sampled weekly until the end of harvest.

Fruits sampled right before harvest were evaluated for dry matter content and fruit mineral content of macro- and micro-nutrients. Apples from each orchard were harvested, and fruit red color, flesh firmness, starch index, sugar content, and DA meter readings were evaluated. Half of the fruits from each sample were treated with MCP, or were left untreated and stored until early February at 0°C in air and evaluated for fruit quality: flesh firmness and sugar content, external and internal apple disorders. An informal panel evaluated appearance and taste (Photos 1 and 2 in Appendix A). An assessment of potential fruit storability for each block was made based on fruit dry matter content and fruit N, Ca and N/Ca ratio. The results after storage were correlated to pre-harvest measures to determine if we could predict fruit quality and storability at harvest to assist farmers in segregating fruit for long and short-term storage.

Fruit dry matter concentrations among orchards ranged from 12.1% to 18.7% but most of the orchards had dry matter concentrations in a narrow range between 16 and 17%.

Fruit nitrogen concentration varied from 0.10-0.28%, fruit calcium concentration varied from 0.01-0.03%, fruit N/Ca ratio varied from 4.7-18 and fruit K+Mg/Ca ratio varied from 16-45.

Fruits were harvested in five picks: first in the last week of August when fruit firmness was 17 lb., soluble solids: 10.5 and DA meter readings: 0.96-1.71. The last pick was in the first week of October when fruit firmness was 13 lb., soluble solids: 13% and DA meter readings: 0.32-1.0.

After a 4.5 month storage period Fruit Liking Score (measured by an untrained panel of 14 persons) varied considerably between orchards but was not related to fruit dry matter content or any fruit mineral concentration.

No other measure of fruit quality after storage (crunchiness, level of disagreeable flavors, soluble solids, or storage disorders) was related to fruit dry matter content or any fruit mineral concentration.

Fruits treated with MCP had slightly increased acidity but there was little difference in fruit firmness or taste. Fruits from earlier harvest dates had poorer taste. The best taste was achieved at the next-to-last harvest date (late September). The best harvest date coincided with a DA meter reading of 0.3-0.5.

The precision harvest project is still ongoing; in 2016 with support from the New York Farm Viability Institute. The 2015 project funded by the Northern New York Agricultural Development Program prompted new ideas as well as the need for adjustments in the protocol. It also set the basis for the new research projects. The data from this NNYADP research will be used to develop guidelines for precision harvest management of Honeycrisp apples.

Target Goals:

1. One week before harvest, take a fruit sample from each block and assess fruit quality by measuring fruit dry matter concentration and fruit mineral concentration.
2. Use the results of fruit quality assessment to segregate fruit for long-term or short-term storage, immediate sales, or juice.
3. Identify the optimum fruit maturity for harvest of each block with the DA meter and firmness and starch ratings.
4. Manage labor resources to pick the fruit at the optimum maturity.