Participatory variety trials for flavor, quality and agronomic performance to increase direct-market opportunities and on-farm trialing capacity for organic growers

Graduate Student:

Name and Title: Kitt Healy, MS Agroecology and MS Horticulture Candidate
Organization: University of Wisconsin, Madison
Phone: 630-346-4749
Address: 1575 Linden Dr.
City, State, Zip: Madison, WI 53706
E-mail: gkhealy@wisc.edu

Faculty Advisor:

Name and Title: Julie Dawson
Organization: University of Wisconsin, Madison
Phone: 608-609-6165
Address: 1575 Linden Dr
City, State, Zip: Madison, WI 53706
E-mail: dawson@hort.wisc.edu
ABSTRACT
Sales to local food markets can be a valuable opportunity for organic producers. Access to these markets depends on raising high-quality produce. Given their unique environments, organic farmers benefit from a better understanding of which varieties are likely to perform well on their farms, and meet the quality criteria of their customers. This research evaluates diverse varieties of nine species of common vegetable crops for agronomic performance and culinary quality. Trials were grown on eight organic farms in the Madison, WI region, and on organic land at the West Madison research station. Outcomes include productivity data that is immediately useful to organic farmers and plant breeders, as well as detailed information about how four local chefs perceive the flavor and over-all quality of each variety. This research also laid an important foundation for future collaborative research and plant breeding to develop excellent varieties for organic production in the upper Midwest.

Introduction

Nationwide, the demand for direct-market organic produce is growing. According to the USDA local food sales increased from $1 billion in 2005 to $6.1 billion in 2012; and the market for organic produce has seen double-digit growth over the last 20 years (USDA-ERS, 2015). Nonetheless, Lammerts van Bueren estimates that 95% of crops grown on organic farms are not bred for organic environments (Lammerts van Bueren et al., 2014). Furthermore, relatively few breeding programs focus on adaptation to a “region of intended use,” aiming instead for broad adaptation to a wide range of environments (Hoagland et al., 2015). This puts organic farmers at a disadvantage, since few varieties they rely on are selected for optimal performance in organic systems, and fewer still are selected for adaptation to farmers’ unique local conditions. More regionally-specific research is needed to understand which new and existing varieties of important crops meet the needs of organic farmers in the environment of intended use (Renaud et al., 2010).
Organic farmers are also becoming interested in culinary traits that consumers desire, such as flavor, nutrition and aesthetic appeal (Hoagland et al. 2014). Research indicates that these traits, primarily nutrition, can vary dramatically within species based on how certain cultivars interact with the environment (Meagy 2013). Researchers in Oregon and New York have begun incorporating sensory evaluation into variety trials focused on regional adaptation in organic crops (Navazio 2014, Mazourek 2014). These projects rely on participatory methods to ensure that research priorities reflect the needs of local farmers and other food systems stakeholders. Farmers may collaborate with researchers at any stage in the research process, from defining hypotheses, to collecting data, to publicizing results. These methods not only help create relevant research, they encourage immediate implementation of findings and recommendations, since farmers feel greater ownership of the process and resulting information. Recent initiatives have expanded the scope of participation to include non-farmer stakeholders such as chefs, bakers, brewers, produce buyers, CSA members and the broader public.

Wisconsin is ranked 2nd in the US for total number of organic farms, and 3rd in the US for organic vegetable farms (Silva et al. 2012). In Dane County alone, over 100 farms sell directly to local restaurants, grocers, and food hubs (USDA-ERS, 2014). Identifying varieties that perform well under organic management in Wisconsin’s unique environment, and exhibit the culinary characteristics that customers desire, is essential to supporting these farmers. In a 2012 survey, Wisconsin organic vegetable farmers identified carrots, sweet corn, melon, onions, cucumber, peppers and winter squash as priority crops for variety trialaling and plant breeding (Lyon et al., 2015). For our trials, kale and beets were added to this list based on conversations with participating farmers. The 2012 Lyon et al. survey and farmer conversations were used to identify disease tolerance, yield, germination, season extension and flavor as priority traits that farmers were interested in improving across crop species.

The goals for this project were:

1) Identify high-performing varieties in organic systems

2) Establish a network of farmers, chefs and researchers to enable future participatory variety trials and breeding.
Methods and Materials

Funding from the CERES trust supported the on-farm trials as well as overall project coordination. We include both the research station trials and the on-farm trials in this report, as they are part of the same effort. Variety trials were conducted on organically-managed land at the University of Wisconsin West Madison Agricultural Research Station (WMARS). Trial species and varieties were selected in collaboration with 10 participating farmers and 5 local chefs. Variety submissions were solicited from independent plant breeders and seed companies around the country. Trial varieties were selected based on lack of previous trialing in Wisconsin and purported high quality in organic production systems.

Carrots, kale, beets and peppers and winter squash were grown in trial plots on 2-4 local farms. Several school and community gardens participated in a lettuce evaluation but we are unable to include their observations in analyses due to institutional review board (IRB) restrictions on including minors in research. These were excellent outreach opportunities, and students learned about organic horticulture, local food systems, plant breeding, and how to conduct research. Growers selected which species and the number of varieties they wanted to trial, based on capacity and market interests. Farmers managed on-farm trials according to their standard practices. Data were collected from these trials through qualitative evaluation forms. Each farm was sent seed for a core set of four to five varieties of crops they wished to trial, and could choose to add other optional varieties for that crop. The observations we ask farmers to collect on the varieties in their trials are the following:

- Would you grow this again?
- How marketable is it?
- What did you think of the flavor?
- Strongest points and Major flaws
- Productivity compared to others in the trial and your favorite variety
- Susceptibility to insect/disease/stress compared to other varieties
- Best/Worst Variety (choose one best and one worst variety for each crop)
- General Notes (any other observations that don't fit in the previous categories)
Though this data is largely qualitative, it provides good information about the varieties and farmers’ preferences for each species. Researchers visited each on-farm trial at least once during the season to strengthen relationships with farmers, hear feedback and ensure that trials were managed in a way that would yield usable information.

Squash, cucumber, melon, kale, greens, beets, and onion trials were grown in the demonstration garden plots at WMARS, on land that has been managed to certified organic standards for 6 years. The land has not been certified organic because of the occasional use of treated seeds in the ornamental flower displays in the garden (in separate beds from vegetable plots, separated by grass buffers). Treated seeds were not used in the vegetable trials and all management was conducted according to NOP standards. The soil in the demonstration gardens is very fertile, with an organic matter content between 5 and 7%. Fertility is maintained through an annual oat cover crop and applications of alfalfa mulch. No pesticides were used on the variety trials so the researchers could identify varieties displaying some resistance to pathogens and pests. OMRI approved pesticides exist for some of the diseases observed in the demonstration garden but were not applied because to help researchers identify varietal resistance. Hand weeding and mulch were used to control weeds in the trial beds and overhead irrigation was used when necessary. Each crop was planted, managed, and harvested according to recommendations from the seed companies and breeders, as well as the expert wisdom of trial manager Brian Emerson.

Germination, first flowering and first fruit data were taken early in the season at WMARS. For fruiting crops, marketable fruits were weighed to determine an average marketable yield per plant. For kale, harvests were weighed in 10-leaf bunches and average bunch weights were calculated for each variety. Additional data (average height, average leaf weight, disease damage and pest damage) were taken on kale per the request of participating farmers. Additional data collection was pursued for other species in consultation with breeders and farmers. Cucumbers, for example, were subject to a powdery mildew rating, since this is a common pathogen affecting cucurbits.

The number of plants in a “plot” varied across species, but was consistent within species, so that each variety was equally weighted in yield measurements. For some crops,
unmarketable yield was also measured by weight. Fruits or leaves were deemed unmarketable if they were damaged by disease, insects, or physiological deformities to an extent that they could not be sold at a farmers market. For each crop, harvests began as soon as the first fruits were ripe, or leaves mature, and continued at regular intervals throughout the season. Winter squash were harvested in early October and evaluated for marketable and unmarketable fruits after 60 and 100 days of storage. Onions were harvested in mid-August and early September according to maturity, weighed at harvest and evaluated for numbers of marketable and unmarketable bulbs after 90 days of storage. Additional information on planting and first harvest dates for each species can be found in the WMARS Production Summaries on Dr. Dawson’s website: dawson.horticulture.wisc.edu.

In addition to the production data collected, certain crops were selected for a culinary evaluation involving four Madison chefs. Chefs were recruited by PI Dr. Julie Dawson and Madison Chef Tory Miller in 2013, and volunteered their time without compensation. Winter squash, peppers, kale, greens, beets, and melon were subject to culinary evaluation, and carrots will be evaluated in the near future. For crops with many varieties in the trial, such as kale and cucumbers, trained members of the field crew performed a preliminary flavor evaluation to obtain baseline data and in some cases narrow the scope before bringing varieties to the chefs. These screening evaluations employed a quantitative descriptive analysis (QDA) form (see Figure 1. as an example) and were asked to rank 7 elements of flavor and color on a scale from “none” to “too high,” giving the researchers a basic characterization of each variety. Elements evaluated included color, texture, sweetness, acidity, saltiness, bitterness, and intensity. Crew members were also asked to identify favorites and provide comments to elaborate their descriptions. In some cases, on the favorites from crew tastings were selected for evaluation by local chefs, while in other cases chefs requested a complete set of varieties for their flavor evaluations.

Initially, the chefs used a similar QDA form to the one used in the crew screenings. While this yielded useful information about how the chefs perceive flavor, participants felt than a detailed description of each variety was not immediately relevant to them or the farmers they purchase from. Accordingly, we replaced the QDA method with a more qualitative evaluation.
Peppers

<table>
<thead>
<tr>
<th>Variety</th>
<th>notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>poor</td>
</tr>
<tr>
<td>Texture</td>
<td>poor</td>
</tr>
<tr>
<td>Sweetness</td>
<td>low</td>
</tr>
<tr>
<td>Acidity</td>
<td>none</td>
</tr>
<tr>
<td>Saltiness</td>
<td>none</td>
</tr>
<tr>
<td>Bitterness</td>
<td>none</td>
</tr>
<tr>
<td>Flavor intensity</td>
<td>low</td>
</tr>
<tr>
<td>off flavors</td>
<td>present</td>
</tr>
</tbody>
</table>

Figure 1. Sample Quantitative Descriptive Analysis for Vegetable Flavor Evaluations

that included chef-developed questions like: “Would you buy this for your restaurant?” and “How would you use this?” Chefs were also asked to select favorites and least favorites for each species and to give a 1-10 ranking of flavor intensity.

The focus on flavor intensity came out of conversations with chefs about their broad preferences in vegetable crops, which generally include intense flavors and novel colors, shapes, and stories. Tailoring the evaluation to reflect chef’s priorities helped maintain their enthusiasm throughout the trial. The results of the quantitative descriptive analysis were distributed to participating chefs, farmers, breeders, and seed companies in early February 2016.

Results

Detailed results for all crops can be downloaded from [dawson.horticulture.wisc.edu](http://dawson.horticulture.wisc.edu).

The winter squash summary is provided in full at the end of this document as an example.

Beets

Beets were included in the on-farm trials, and in the WMARS trial plots, though productivity data was not recorded for the trial plots. Three farms grew two varieties of purple
beets: Boro and Rhonda, both from High Mowing Seed Company. All the farmers reported they would buy both varieties again, though they had a slight preference for Boro despite one report of poor germination. Both of these varieties will be included in future trials. In the culinary evaluations, neither Boro nor Rhonda was outstanding. 7 varieties of beets were evaluated in total, all grown at WMARS in trial plots or breeder Irwin Goldman’s nearby field. Goldman’s Badger series (Flame, Torch and Sunset), as well as his high and low geosmin breeding lines outperformed both Boro and Rhonda in the chefs’ culinary evaluations. No clear leaders emerged in flavor intensity rankings.

Carrots

7 varieties of carrots were grown on three farms, and at WMARS on certified organic land as part of a winter trial. Productivity data has not yet been collected for the winter trial, and a flavor evaluation of the winter carrots is forthcoming. Of the 7 varieties trialed, Miami and Yaya emerged as favorites among the farmers, for their high yield of marketable roots and good flavor. Nectar and Negovia were generally not preferred.

Cucumber

14 varieties and breeding lines of cucumber were grown at WMARS, and were evaluated for flavor by the field crew and breeder Yiqun Weng, but were not included in the chef evaluations due to time restraints. Two of Dr. Weng’s breeding lines, WI7440 and WI7552, excelled with high average numbers of marketable fruits per plant and low incidence of powdery mildew, which commonly afflicts cucumbers. WI7440 also ranked well in the flavor evaluations, exhibiting a good balance of sweetness and acid as well as a color that tasters preferred.

Kale and Greens

20 varieties of kale were grown at WMARS, and Madison chefs evaluated 18 varieties. In the research station trials,
Galega de Folhas Lisas from Seeds of Italy and Kale Coalition from Adaptive Seeds had the highest average bunch weight, while Curly Roja, Ripbor and Meadowlark had the lowest insect damage scores, and Darkibor, Curly Roja, Galega de Folhas Lisas and Old Growth Palm had the lowest disease scores. Neither pest nor disease pressure were very high at the research station, so more information is needed to make stronger judgments about how varieties perform in more challenging environments. From the on-farm trials, Darkibor emerged as a strong favorite for yield, color and flavor over Redbor. In the chefs’ evaluation, participants unanimously agreed they would buy Sutherland, Ripbor, Meadowlark and Redbor for their restaurants, though Darkibor, Hudson Valley Dino and Black Magic were all rated highly for flavor intensity. In addition to the kale, five varieties of greens (chicory, radicchio and endive) were grown in the on-farm trials and evaluated for production characteristics. Leonardo Radicchio was the most consistent favorite among farmers, for its color, flavor and high marketable yield.

**Melon**

17 varieties and breeding lines of melon were grown at the West Madison Agricultural Research Station (WMARS). 16 of these varieties were evaluated for flavor, with one variety excluded due to under-ripe fruit. Iroquois Cantaloupe from Hudson Valley Seed Library, Artemis from Vitalis and three breeding lines from Vitalis offered early harvests, a trait, which farmers prefer in the short season of the upper Midwest. Serenade from Johnny’s Selected Seeds had the highest number of marketable fruits, and Iroquois Cantaloupe had the highest percentage of marketable fruit, as well as uniform ripening and an easy “slip” which growers use to determine ripeness. In the flavor evaluations, Artemis and E25G.00109 were unanimously identified as varieties chefs would buy for their restaurant. Melemelon ranked the highest for flavor intensity and was a strong favorite for at least one of the chefs.

**Onion**

19 varieties of onion were trialed at WMARS. Onions were not included in the 2015 flavor evaluations due to time constraints. All varieties except Newburg, Pink Hybrid and Red Hybrid had good or excellent germination. The highest per row yields by weight came from Bejo Seeds.
varieties Red Carpet, Sedona and Yankee, though some of the breeding lines from Cornell were also high yielding.

**Peppers**

19 varieties of sweet and 14 varieties of hot peppers were trialed at WMARS. 12 varieties of sweet and 3 varieties of hot peppers were grown on 2 organic farms. Hot peppers Aji 14 from UW-Madison, Bastan from Vitalis and Wisconsin Wroaster from UW-Madison had particularly high yields. Bastan was also a favorite for its chocolate color, and Wisconsin Wroaster had desirable growth habit for easy picking. Sweet peppers JPRS3829, JPRC985 and JPRC999, all breeding lines from Johnny’s Selected Seeds, had the highest per plant yields. While Vitalis variety E20B.52005 had the highest average fruit weight, it also experiences high soft rot incidence. Farmers growing pepper trials generally agreed that they would grow all the trial varieties again, though some of the breeding lines from Johnny’s were identified as ripening later than the farmers would like, though they were still highly marketable. The chefs did not prefer many of the sweet peppers, except for Carmen. The Aji peppers stood out as favorites, as did a novel variety called “Habanada.” This is a habanero pepper that’s been selected for low capsaicin, making its spiciness nearly undetectable. Chefs enjoyed the flavor of this pepper as well as the novelty and excitement of bringing something brand new to market.

**Winter Squash**

25 varieties of winter squash were grown at WMARS and 9 were included in the chefs’ flavor evaluations. Lower Salmon River, a variety from Adaptive Seeds, Butterscotch and Sweet Dumpling from Johnny’s Selected Seeds, Tiana from Vitalis and NY13-9914, a breeding line from Cornell, all produced 100% marketable fruits at harvest time. Tiana and Oregon Sweet Homestead from Adaptive tied for highest total harvest weight. Pests were not a problem in the
trial gardens, but powdery mildew was prevalent. After 100 days of storage, Nutterbutter, Honeynut and Havana had the highest number of marketable fruits. In the flavor evaluations, chefs unanimously said they would buy E30R.00013, a breeding line from Vitalis Seeds, and Butterscotch from Johnny’s for their restaurants. Those varieties also had the highest flavor intensity ratings of the group. Two farmers trialed butternut squash, and preferred the larger squash Havana and Tiana for their markets. Chefs are interested in both larger squash and single-serving sized butternuts, and we are looking for early maturing larger squash for this year’s trial. Both chefs and farmers liked the flavor of Nutterbutter.

Conclusion
These varieties trials laid an important foundation for future participatory projects aimed at increasing the number of high-performing and regionally adapted vegetable varieties available to organic farmers. All the farmers who participated in the 2015 trials have agreed to participate again, and the number of chefs involved in flavor evaluations will likely increase in the 2016 season. In response to chef feedback, one important modification will be made to the flavor evaluations moving forward. When asked to identify a “favorite” variety, the chefs found it difficult to single out one variety over other “good” options. In the future we will get better preference information from the chefs by asking them whether and how much they like each variety, rather than asking them to select a single favorite. The farmer evaluations will remain much the same in 2016, as we build a body of consistent data that local farmers can consult when selecting varieties. The full results from these trials are available to the public on Dr. Dawson’s website (dawson.horticulture.wisc.edu), and will be presented at three conferences and circulated widely through the FairShare CSA Coalition list-serve, which reaches over 50 local farmers. Thanks to the generous support of the Ceres Trust, this research will reach a broad
range of local food system stakeholders committed to supporting Wisconsin’s direct-market organic farming community.

**Literature Cited**


### Winter Squash and Pumpkin

#### 2015 Vegetable Variety Screening Trials

**University of Wisconsin**

**Urban and Regional Food Systems**

<table>
<thead>
<tr>
<th>Cultivar Type</th>
<th>Company</th>
<th>First Flower Date</th>
<th>Harvest Date</th>
<th>Percent Mature</th>
<th>Fruit Sample Size (g)</th>
<th>Weight (g)</th>
<th>AVG Fruit Size (g)</th>
<th>Storability</th>
<th>Fruity Harvested</th>
<th>Total Harvested</th>
<th>Total Fruits Harvested</th>
<th>Storage % M/W</th>
<th>Storage % U/M</th>
<th>Storage % D/W</th>
<th>Storage % C/W</th>
<th>Storage % M/W</th>
<th>Storage % U/M</th>
<th>Storage % D/W</th>
<th>Storage % C/W</th>
<th>Storage % M/W</th>
<th>Storage % U/M</th>
<th>Storage % D/W</th>
<th>Storage % C/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discus</td>
<td>C. discus</td>
<td>10-7-2015</td>
<td>12-24-2015</td>
<td>90%</td>
<td>4.2</td>
<td>220</td>
<td>2.8</td>
<td>90%</td>
<td>20</td>
<td>100</td>
<td>1</td>
<td>30</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Honeynut</td>
<td>C. moschata</td>
<td>7-24-2015</td>
<td>9-24-2015</td>
<td>80%</td>
<td>2.6</td>
<td>220</td>
<td>2.8</td>
<td>90%</td>
<td>20</td>
<td>100</td>
<td>1</td>
<td>30</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>NY-1349028</td>
<td>C. moschata</td>
<td>7-24-2015</td>
<td>9-24-2015</td>
<td>80%</td>
<td>2.6</td>
<td>220</td>
<td>2.8</td>
<td>90%</td>
<td>20</td>
<td>100</td>
<td>1</td>
<td>30</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>NY-1349912</td>
<td>C. moschata</td>
<td>7-24-2015</td>
<td>9-24-2015</td>
<td>80%</td>
<td>2.6</td>
<td>220</td>
<td>2.8</td>
<td>90%</td>
<td>20</td>
<td>100</td>
<td>1</td>
<td>30</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Violina-Rugosa</td>
<td>C. moschata</td>
<td>7-24-2015</td>
<td>9-24-2015</td>
<td>80%</td>
<td>2.6</td>
<td>220</td>
<td>2.8</td>
<td>90%</td>
<td>20</td>
<td>100</td>
<td>1</td>
<td>30</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>NY-1349914</td>
<td>C. moschata</td>
<td>7-24-2015</td>
<td>9-24-2015</td>
<td>80%</td>
<td>2.6</td>
<td>220</td>
<td>2.8</td>
<td>90%</td>
<td>20</td>
<td>100</td>
<td>1</td>
<td>30</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Potimarron</td>
<td>C. moschata</td>
<td>7-24-2015</td>
<td>9-24-2015</td>
<td>80%</td>
<td>2.6</td>
<td>220</td>
<td>2.8</td>
<td>90%</td>
<td>20</td>
<td>100</td>
<td>1</td>
<td>30</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Doran-Round</td>
<td>C. moschata</td>
<td>7-24-2015</td>
<td>9-24-2015</td>
<td>80%</td>
<td>2.6</td>
<td>220</td>
<td>2.8</td>
<td>90%</td>
<td>20</td>
<td>100</td>
<td>1</td>
<td>30</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

**Trial Notes:** All varieties planted June 3, 2015. Planted in mounds and mulched with chopped alfalfa hay. High incidence of Angular Leaf Spot in early season. No significant varietal difference in disease resistance. Four plants per mound and 12 ft between mounds.
<table>
<thead>
<tr>
<th>Culture</th>
<th>Type</th>
<th>Maturity</th>
<th>FG %</th>
<th>Weight (kg)</th>
<th>Total # Fruit</th>
<th>Fruit size (gm)</th>
<th>Total sample fruit weight (kg)</th>
<th>AVG Fruit weight (gm)</th>
<th>Total fruit</th>
<th>Total fruit yield (gm)</th>
<th>Total fruit yield (gm)</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honey-Boat</td>
<td>C. pepo</td>
<td>28 Apr</td>
<td>0.75</td>
<td>3.0</td>
<td>0.26</td>
<td>113</td>
<td>0.26</td>
<td>113</td>
<td>30.4</td>
<td>4.3</td>
<td>28.4</td>
<td>4.3</td>
</tr>
<tr>
<td>Buttermilk</td>
<td>C. pepo</td>
<td>28 Apr</td>
<td>1.00</td>
<td>3.0</td>
<td>0.41</td>
<td>128</td>
<td>0.41</td>
<td>128</td>
<td>31.2</td>
<td>4.0</td>
<td>28.2</td>
<td>4.0</td>
</tr>
<tr>
<td>Butterscotch</td>
<td>C. pepo</td>
<td>28 Apr</td>
<td>0.75</td>
<td>3.0</td>
<td>0.28</td>
<td>76</td>
<td>0.28</td>
<td>76</td>
<td>19.8</td>
<td>2.6</td>
<td>17.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Havana</td>
<td>C. pepo</td>
<td>28 Apr</td>
<td>1.00</td>
<td>3.0</td>
<td>0.35</td>
<td>71</td>
<td>0.35</td>
<td>71</td>
<td>21.3</td>
<td>2.9</td>
<td>18.4</td>
<td>2.9</td>
</tr>
<tr>
<td>Tiana</td>
<td>C. pepo</td>
<td>28 Apr</td>
<td>0.75</td>
<td>3.0</td>
<td>0.23</td>
<td>60</td>
<td>0.23</td>
<td>60</td>
<td>18.0</td>
<td>2.4</td>
<td>15.6</td>
<td>2.4</td>
</tr>
<tr>
<td>Ayote</td>
<td>C. pepo</td>
<td>28 Apr</td>
<td>1.00</td>
<td>3.0</td>
<td>1.12</td>
<td>100</td>
<td>1.12</td>
<td>100</td>
<td>30.0</td>
<td>4.0</td>
<td>26.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Cruzan</td>
<td>C. pepo</td>
<td>28 Apr</td>
<td>1.00</td>
<td>3.0</td>
<td>0.87</td>
<td>107</td>
<td>0.87</td>
<td>107</td>
<td>26.1</td>
<td>3.5</td>
<td>22.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Invincible-</td>
<td>C. pepo</td>
<td>28 Apr</td>
<td>1.00</td>
<td>3.0</td>
<td>3.11</td>
<td>207</td>
<td>3.11</td>
<td>207</td>
<td>62.1</td>
<td>8.3</td>
<td>53.8</td>
<td>8.3</td>
</tr>
<tr>
<td>Candystick-Dessert</td>
<td>C. pepo</td>
<td>28 Apr</td>
<td>1.00</td>
<td>3.0</td>
<td>0.15</td>
<td>52</td>
<td>0.15</td>
<td>52</td>
<td>15.6</td>
<td>2.1</td>
<td>13.5</td>
<td>2.1</td>
</tr>
<tr>
<td>Honey-Boat</td>
<td>C. pepo</td>
<td>28 Apr</td>
<td>0.75</td>
<td>3.0</td>
<td>0.12</td>
<td>36</td>
<td>0.12</td>
<td>36</td>
<td>10.8</td>
<td>1.5</td>
<td>9.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Sweet-Dumpling</td>
<td>C. pepo</td>
<td>28 Apr</td>
<td>0.75</td>
<td>3.0</td>
<td>0.15</td>
<td>53</td>
<td>0.15</td>
<td>53</td>
<td>15.9</td>
<td>2.2</td>
<td>13.7</td>
<td>2.2</td>
</tr>
<tr>
<td>Farm</td>
<td>Farmer</td>
<td>Species</td>
<td>Variety</td>
<td>Notes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>---------</td>
<td>---------</td>
<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild Ridge</td>
<td>Anna Metscher</td>
<td>Squash</td>
<td>Honeynut</td>
<td>Best - very good size for CSA.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pesticides: none.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Trial management: soil prep - fall tillage, fall cover crop.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fertilizer: compost 2 buckets 1 t row at 2'.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Irrigation: drip 1 row/bed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pest or pathogen treatments: none.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tested as best for our markets.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Size was needed for our markets.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The color did not like.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Beefy flavor was the best.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**General Notes:**
- Best/Worst:
  - Best: Honeynut
  - Worst: one of the same variety.
- Major Flaws:
  - One of the same variety.
- Strengths:
  - Beefy flavor.
- What did you think of the flavor?
  - Beefy flavor.
- How do you feel about this variety?
  - Like it.
- Would you grow it again?
  - Yes.
- How marketable is it?
  - Very marketable.
- What did you think of the flavor?
  - Beefy flavor.
- How do you feel about this variety?
  - Like it.
- Would you grow it again?
  - Yes.
- How marketable is it?
  - Very marketable.
<table>
<thead>
<tr>
<th>Variety</th>
<th>Type</th>
<th>Date</th>
<th>Description</th>
<th>Unique Flavor Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butterscotch</td>
<td>butternut</td>
<td>12.8.15</td>
<td>blend</td>
<td>0 to 0 make soup; dessert; roasted or sautéed to showcase natural sweetness; very simply not a huge fan of the texture. Nutty oaky flavor I like; very rich, great for dessert; great density and depth of flavor! Sweet and rich and earthy; buttery good crust when cooked, that was delicious; sweetness; great sweet and rich taste and firm texture made this a favorite; buttery.</td>
</tr>
<tr>
<td>Tiana</td>
<td>butternut</td>
<td>12.8.15</td>
<td>cold in a ketchup for our polenta fries; slightly denser texture than previous, richer body. Serve roasted or mashed; roasted or candied citrus, kind of sweet and sour in a good way; nutty and buttery flavor, would be highlighted by simple proportions; slightly bitter, firmer texture.</td>
<td></td>
</tr>
<tr>
<td>NYS9028</td>
<td>butternut</td>
<td>12.8.15</td>
<td>roasted, blended, very versatile; roasted or soup; soup carrot and rutabaga. Good texture; dense and carrot like in flavor and sweetness; nutty yummy new flavors, love the flavor not really &quot;squashy&quot; more caroity/rutagegga; flavor.</td>
<td></td>
</tr>
<tr>
<td>Honeynut</td>
<td>butternut</td>
<td>12.8.15</td>
<td>roasted as a side; mild, very soft texture and slightly sweet. Good for soup puree, pie; soup good texture almost rutabaga. Mild flavor and little nutty and buttery; sweet and nutty, though not as rich as the previous one; slightly grainy root veggie flavor.</td>
<td></td>
</tr>
<tr>
<td>Nutterbutter</td>
<td>butternut</td>
<td>12.8.15</td>
<td>with butter and salt and pepper. So good by itself; soup with other things great texture, buttery; mild flavor good alone, really liked this one, makes a great holiday side; dry; too mild.</td>
<td></td>
</tr>
<tr>
<td>NYS9912</td>
<td>butternut</td>
<td>12.8.15</td>
<td>in a soup; stringy, soft texture. Good for puree or soup; puree buttery and nutty, but not overpowering; mild and some light hay or straw earthiness; slightly stringy smooth and creamy, yum.</td>
<td></td>
</tr>
<tr>
<td>E30R.00013</td>
<td>red kuri</td>
<td>12.8.15</td>
<td>roasted; roasted or braised, great flavor and natural sweetness, good body; puree bright and summery; earthy rick flavor and nice firm texture. Slightly smoky finish; slight sweet, pumpkin, smooth texture doesn't taste like anter?; appearance; smooth texture.</td>
<td></td>
</tr>
<tr>
<td>Orange/Summer</td>
<td>red kuri</td>
<td>12.8.15</td>
<td>blended as a sauce, for something very versatile though; fine texture and mild flavor, would be good for puree or pie. Also good roasted and sautéed; puree citrus undertones, smokey; mild earthy flavor, slightly mineral finish would be good for curry or stew; strong flavor, soft texture, slight pumpkin flavor.</td>
<td></td>
</tr>
<tr>
<td>Potimarron</td>
<td>red kuri</td>
<td>12.8.15</td>
<td>for a holiday special as a side; roasted, sautéed, soup, puree. Great rich texture has many applications; soup strong flavor, right away, then it dies; rich, dense earthy, sweet and caroity in flavor; smooth strong squash flavor. Good sometimes; creamy; appearance; NA.</td>
<td></td>
</tr>
</tbody>
</table>

**Taste Notes:**

- **Strongest Point:**
  - Butterscotch: Nutty oaky flavor
  - Tiana: Nutty and buttery flavor
  - NYS9028: Nutty
  - Honeynut: Nutty and buttery flavor
  - Nutterbutter: Nutty
  - NYS9912: Nutty
  - E30R.00013: Nutty
  - Orange/Summer: Nutty
  - Potimarron: Nutty

- **Major Flaws:**
  - Butterscotch: Not a huge fan of the texture
  - Tiana: Slightly bitter, firmer texture
  - NYS9028: Slightlystringy smooth and creamy
  - Honeynut: Slightly grainy root veggie flavor
  - Nutterbutter: Too mild
  - NYS9912: Slightly stringy smooth and creamy
  - E30R.00013: Appearance; smooth texture
  - Orange/Summer: Astringent finish; soft texture; grainy
  - Potimarron: Slightly chewy; flavor; appearance; smooth texture; bitter

**Buy for Yourself vs. Buy for Your Restaurant:**

- Butterscotch: Buy for yourself
- Tiana: Buy for yourself
- NYS9028: Buy for restaurant
- Honeynut: Buy for yourself
- Nutterbutter: Buy for yourself
- NYS9912: Buy for restaurant
- E30R.00013: Buy for restaurant
- Orange/Summer: Buy for restaurant
- Potimarron: Buy for restaurant

**Variety:**

- Butterscotch
- Tiana
- NYS9028
- Honeynut
- Nutterbutter
- NYS9912
- E30R.00013
- Orange/Summer
- Potimarron
<table>
<thead>
<tr>
<th>Variety</th>
<th>Intensity</th>
<th>Color</th>
<th>Texture</th>
<th>Bitter</th>
<th>Sweet</th>
<th>Saltiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Kuri</td>
<td>2.7</td>
<td>3.2</td>
<td>3.0</td>
<td>2.7</td>
<td>2.7</td>
<td>2.9</td>
</tr>
<tr>
<td>Orange Summer</td>
<td>2.5</td>
<td>3.0</td>
<td>3.0</td>
<td>2.5</td>
<td>2.5</td>
<td>2.9</td>
</tr>
<tr>
<td>Potimarron</td>
<td>2.8</td>
<td>3.0</td>
<td>3.1</td>
<td>2.8</td>
<td>2.8</td>
<td>3.1</td>
</tr>
<tr>
<td>Butterscotch</td>
<td>2.9</td>
<td>3.0</td>
<td>3.0</td>
<td>2.9</td>
<td>2.9</td>
<td>3.0</td>
</tr>
<tr>
<td>Butterscotch Dori</td>
<td>2.7</td>
<td>3.0</td>
<td>3.0</td>
<td>2.7</td>
<td>2.7</td>
<td>3.0</td>
</tr>
<tr>
<td>Tiana</td>
<td>2.7</td>
<td>3.0</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td>Havana</td>
<td>2.8</td>
<td>3.0</td>
<td>2.9</td>
<td>2.8</td>
<td>2.8</td>
<td>3.0</td>
</tr>
<tr>
<td>Nutterbutter</td>
<td>2.2</td>
<td>2.6</td>
<td>2.5</td>
<td>2.2</td>
<td>2.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Nutterbutter 012</td>
<td>2.0</td>
<td>2.4</td>
<td>1.8</td>
<td>2.0</td>
<td>2.0</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Significant differences among varieties: **p < 0.0001, *p < 0.01, *p < 0.05**
These quality components graph of variables. The individual (variety) factor map on the next page plots where each variety lands relative to the factor map with the length of the arrow for each characteristic proportional to the contribution of that characteristic to the variation among varieties. The length of the arrow for each characteristic is proportional to its contribution to the variation among varieties, and the direction of the arrow is in the direction of increasing scores for that characteristic. The length of the arrow for each characteristic is proportional to its contribution to the variation among varieties, and the direction of the arrow is in the direction of increasing scores for that characteristic.

The individual (variety) factor map on the next page plots where each variety lands relative to the factor map with the length of the arrow for each characteristic proportional to the contribution of that characteristic to the variation among varieties. The length of the arrow for each characteristic is proportional to its contribution to the variation among varieties, and the direction of the arrow is in the direction of increasing scores for that characteristic. This shows how related the characteristics are to each other and is also used to read the following graph of variables. The graph of variables shows how related the characteristics are to each other, and is also used to read the following factor map.
Individuals factor map (PCA)

Dim 1 (77.03%)
Dim 2 (16.10%)

Representation of varieties, based on crew evaluation, resulting from a principal component analysis of all crew quality evaluation data. The graph helps us select which varieties to send to the group of chefs we are working with for further quality evaluation.

This graph helps us select which varieties to send to the group of chefs we are working with for further quality evaluation. The position of each variety shows how it was evaluated for the different quality characteristics on the previous page. For example, a variety that plots near or beyond the end of the color arrow would show particularly intense color, and a variety on the opposite side of the graph than the direction in which the color arrow points would have poor color. This can be done for each of the quality characteristics. This graph also shows how varieties are related to each other for the complete set of quality characteristics, and characteristics that contributed more to the variation among varieties have greater weight in determining where varieties are positioned on the graph. This can be helpful in making selections based on multiple characteristics at once.