Consumer-Engaged Participatory Plant Breeding Model Comparison and Beet Flavor Breeding

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Abstract

A resilient organic agriculture requires crop varieties bred for the agronomic and market conditions specific to organic food systems. Participatory plant breeding (PPB) has emerged as a cost-effective strategy for creating marketable cultivars that perform well on organic farms. To investigate best practices for PPB in Wisconsin, this project compares two different participatory plant breeding models – a single-farm model and a broad outreach model - to evaluate their cost efficiency and effectiveness. In the process, the project begins to develop novel, locally adapted, flavor-identified beet cultivars suited for organic production. High geosmin (very earthy) and low geosmin (very mild) beet populations served as starting materials for the first year of this three-year recurrent selection breeding project. In both PPB models, farmer input guided selection for agronomic qualities, while input on hedonic liking from core groups and the public guided selection for eating quality. Selected beet families were mass pollinated in four separate greenhouse isolations to make distinct high geosmin and low geosmin populations for each model's 2017 selection cycle. First year cost analysis showed that the most significant cost difference between farm-based and agricultural station-based PPB was that of land rental and farmer engagement.

Introduction

Participatory plant breeding and organic agriculture

Organic agriculture takes a systems approach to farming, understanding that agroecosystems cannot be isolated from the societies or economies in which they exist (Lammerts van Bueren et. al., 2002). That is, a resilient organic agriculture requires a robust organic seed supply; it needs crop varieties bred for the agronomic and market conditions specific to organic food systems (Organic Seed Alliance, 2011).

Organic farms and markets diverge from their conventional counterparts in several ways. First, conventional farms use synthetic inputs to approach homogeneity, but organic farms are more heterogeneous (Dawson et. al., 2008). Second, organic growers have greater need for plant disease resistance, weed competitiveness, and crop resilience during abiotic stress (Brouwer and Colley, 2016; Hultengren et. al., 2016). Finally, many organic markets are local, consumer-direct, and focused on outstanding or unique flavor (Dawson and Healy, 2017).

Despite differing varietal needs, organic vegetable growers rely mostly on cultivars bred by mainstream commercial breeding programs. Crops are selected under elite conventional conditions, and economic incentives drive development of uniform, widely adapted cultivars rather than specialty varieties (Atlin et. al., 2001). For traits controlled by many genes, genetic changes made in elite environments often fail to translate to heterogeneous settings like organic farms (Ceccarelli, 1994).

As mainstream plant breeding is not adequately serving the needs of organic growers, organic plant breeders need cost efficient methods that create marketable cultivars. For several reasons, participatory plant breeding (PPB) has emerged as a promising strategy. First, decentralized PPB offers greater gain from selection for quantitative traits like flavor, yield, and climactic adaptation (Dawson et. al., 2008; Murphy et. al., 2007; Renaud et. al., 2014). Second, farmer involvement in PPB can lead to increased varietal adoption, which in turn increases the program's effectiveness and cost efficiency (Ceccarelli, 2015). Finally, engaging farmers and consumers in the breeding process is both essential to gauging marketability and consistent with organic systems-based thinking (Shelton et. al., 2014).

Participatory plant breeding for beet flavor

At UW-Madison, interest in PPB converges with new research into beet flavor. Historically, beets were not bred deliberately for earthy flavor, as this trait was believed to be environmentally determined. However, new research shows that earthiness, conferred by a volatile terpenoid called geosmin, is under genetic control (Freidig and Goldman, 2014; Maher and Goldman, 2017; Lu et. al., 2003).

While geosmin manipulation might eventually be useful in breeding for commodity beet markets, it could be immediately useful for specialty beet markets. Specialty vegetable cultivars are commonly accepted in local direct markets (Goldman and Navazio, 2003), and a recent survey of West Coast organic growers indicated both color diversity and earthy flavor as breeding priorities (Brouwer and Colley, 2016). A 2015 survey of Wisconsin organic farmers identified beet as the fourth most profitable crop in non-CSA venues, and it identified a trend towards using specialty crops to establish market niches (Lyon et. al., 2015). Thus, a breeding project is proposed to develop flavor identified beet cultivars for Wisconsin organic farms with direct-to-consumer markets.

To investigate best practices for PPB in Wisconsin, this project compares two different participatory plant breeding models – a single-farm model (hereafter, *farm*) and a broad outreach (hereafter, *outreach*) model - to evaluate their cost efficiency and effectiveness. In the process, the project begins to develop novel, locally adapted, flavor-identified beet cultivars suited for organic production. High geosmin (very earthy) and low geosmin (very mild) beet populations were developed at UW-Madison and served as starting materials for this three-year recurrent selection breeding project.

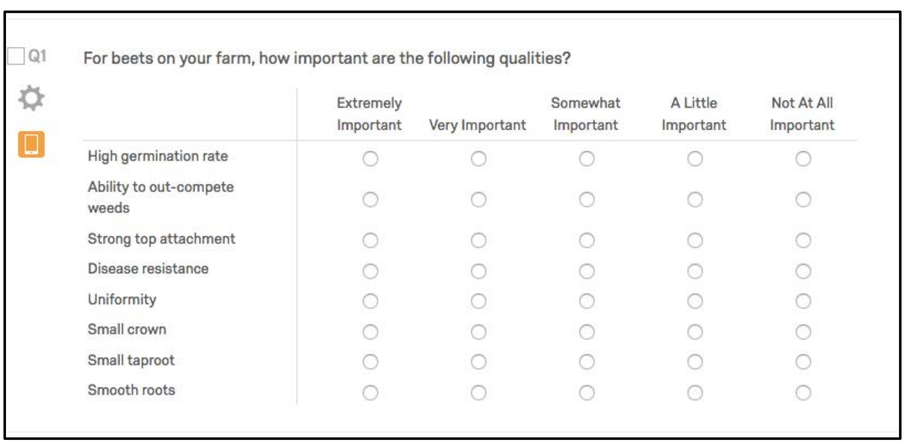
Methods and materials

Plot establishment

In early June 2016, beet plots containing 144 – 12’ rows of identical starting materials were established at Tipi Produce in Evansville, WI and the West Madison Agricultural Research Facility in Verona, WI for the *farm* and *outreach* models, respectively. Each plot contained two repetitions of 30 half-sib families of each flavor group (high and low geosmin), for a total of 120 breeding rows. Bull’s Blood and Touchstone Gold beet cultivars were included as high and low geosmin checks, respectively; fields were surrounded by buffer rows of commercial beet cultivars. Rows were planted, weeded, thinned, and harvested by Goldman Lab staff; field preparation was carried out by Tipi Produce and WMARS staff.

Breeding priority determination

To select for field performance and market appearance, farmer input was gathered. Farmers were asked to rate the importance of field performance and aesthetic characteristics (Figure 1) on a 5-point scale of Not At All Important (0) to Extremely Important (4). This information was gathered in an interview with Steve Pincus, Tipi Produce owner for the *farm* model, and via a UW Qualtrics survey from five Wisconsin vegetable farmers for the *outreach* model.


Q1 For beets on your farm, how important are the following qualities?

	Extremely Important	Very Important	Somewhat Important	A Little Important	Not At All Important
High germination rate	○	○	○	○	○
Ability to out-compete weeds	○	○	○	○	○
Strong top attachment	○	○	○	○	○
Disease resistance	○	○	○	○	○
Uniformity	○	○	○	○	○
Small crown	○	○	○	○	○
Small taproot	○	○	○	○	○
Smooth roots	○	○	○	○	○

Figure 1: Farmer breeding priority survey, shown in the *outreach* model’s online survey platform.

Phenotyping and field selection

Stand counts, leaf height, and canopy habit were recorded during the growing season to gauge germination rate and weed competitiveness. One week before harvest, five representative roots from each row were taken to the UW-Madison Carrot and Beet Lab for photography and evaluation of disease symptoms, uniformity, and aesthetic qualities (Figure 2). A 1-5 numerical rating for each performance criterion was multiplied by the 0-4 farmer breeding priority for that criterion; these values were summed to create a Selection Index (SI).

Figure 2: Phenotyping for quality characteristics, using five representative roots from each half sib family.

Considering both reps of each half-sib family, ten families with low root abundance and/or poor SI were eliminated from each flavor group at each farm. All viable roots of the remaining families were harvested, packed, and stored in late August 2016.

Consumer selection

To ensure adequate genetic diversity for intermating and to make flavor evaluation manageable, breeding groups (hereafter, groups) of 5 families were created. For each model, 4 high geosmin and 4 low geosmin groups with somewhat distinct color palettes were created. These groups were evaluated for appearance and flavor based on hedonic liking, or the overall feeling of pleasure associated with viewing and tasting each beet group. In addition, tasters were asked whether they perceived “signature beet flavor,” typically interpreted as geosmin, in the beet group. Finally, tasters ranked the groups on the basis of their willingness to buy or eat the beet sample again (Figure 3).

Low Geosmin Breeding Group	**Appearance**	**Overall Flavor** *Would you happily eat this again?*		**Signature Beet Flavor** *Does this taste "beet like" to you?*	**Flavor & Appearance Description** *What **strikes you** about the flavor or appearance?* *Does it **remind you** of other tastes, aromas, colors, or patterns?*	**Ranking** ***1 = Most** willing to buy or eat* ***4 = Least** willing to buy or eat* *Do not include check in your ranking.* *If you don't like any of the breeding groups, please skip the ranking.*
		Steamed	**Raw**			
L1	Like Dislike Neutral	Yes No	Yes No	Yes No		

Figure 3: Consumer ballot for evaluation of color and flavor of beet groups.

An initial flavor evaluation was carried out by core tasters for each model: 14 Tipi Produce staff (*farm*) and 3 chefs participating in the Seed to Kitchen Collaborative (*outreach).* These tasters eliminated two groups from each flavor class (Figure 4). Because core group tastings were not public, samples were prepared in UW-Madison's Food Application Lab, a commercial-grade educational kitchen that does not maintain the state certification necessary for public foodservice. Both raw and steamed samples of all half sib families were prepared and refrigerated in separate plastic bins overnight.

Figure 4: Tipi Produce staff (left) and Seed to Kitchen Collaborative chefs (right) each selected two favorite high geosmin groups and two favorite low geosmin groups for the *farm* and *outreach* models, respectively.

Finally, consumers – 75 farm customers at Tipi Produce's Fall Open House (*farm*) and 60 attendees at UW-Madison's Horticulture Showcase (*outreach*) – selected a preferred group from each flavor class (Figure 5). For these public tasting events, samples were prepared in The Crossing's certified commercial kitchen. Raw and steamed samples of all candidate half sib families were prepared, but samples were bulked in breeding groups for tasting. Appendices 1 and 2 show dates and locations of all field, food preparation, and tasting activities for this project's *farm* and *outreach* models, respectively.

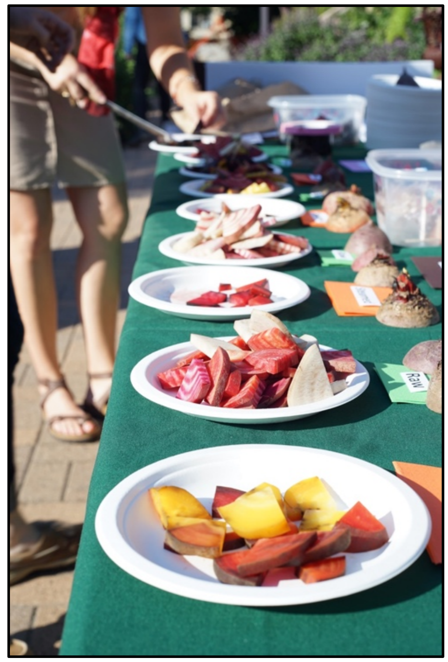


Figure 5: Tipi Produce CSA members (left) and attendees at UW-Madison's Horticulture Showcase (right) each selected the final high and low geosmin groups for the *farm* and *outreach* models, respectively.

Seed production

This farmer- and consumer-engaged selection process resulted in four selected groups – one high geosmin and one low geosmin from each model – to constitute the starting populations for 2017 field selection. Roots were vernalized from late August 2016 until late November 2016 so that flowering would be induced upon re-planting. On November 30, 2016, sixty roots from each breeding group were planted in separate 6" pots, and greenhouse seed production was initiated. Four separate greenhouse isolations were established – one for each selected breeding group – in which mass pollination was allowed to occur. That is, all plants in each isolation were allowed to disperse airborne pollen to all other plants in the isolation. After pollination and seed development, dried seed was harvested from each plant. The seed from one plant constitutes a half sib family, and approximately 30 half sib families from each breeding group were selected to comprise 2017 high geosmin and low geosmin populations (Figure 6).

Figure 6: A greenhouse isolation of beet plants (left) is allowed to mass pollinate by airborne dispersal of pollen borne on fertile flowers (center). Dried seed is then harvested (right).

Results: Participatory beet breeding program establishment

Ceres Trust grant funds were used to accomplish two major objectives: establishment of a four-year participatory beet breeding program and comparison of initial effectiveness parameters for *farm* and *outreach* PPB models.

Collaborative crop selection

This project's first year resulted in the selection of four distinct beet groups by two different farmer and consumer populations. Farmer breeding priorities from both models (Table 1) show a consistent high priority for high germination and disease resistance, plus a significant priority on weed competitiveness, top attachment, uniformity, and root smoothness. Steve Pincus (*farm*) placed higher priority on crown and taproot size than did surveyed farmers (*outreach*).

	Farmer Survey (Outreach model)	Steve Pincus (Farm model)
High germination	3.8	3.5
Out compete weeds	2.8	3.5
Strong top attachment	2.8	3.5
Disease resistance	3	3.5
Uniformity	3	2.5
Small crown	1.2	2.5
Small taproot	1.4	2.5
Smooth roots	2.8	2.5

Table 1: Farmer selection priorities for table beet

Although half-sib families were evaluated independently in each model, 8 of 60 families were eliminated from both models for unacceptable field performance (very low germination and/or disease susceptibility). While average selection indices were exactly equal between the models at 76, the farm model's index showed a much higher standard deviation (14.2) than that of the outreach model (7.8). Stated simply, bad rows at Tipi produce were rated worse than bad rows at WMARS, and good rows at Tipi were rated better than good rows at WMARS. The higher variability the farm model index reflects: 1.) a higher incidence of rhizoctonia at Tipi Produce than WMARS, resulting in poorer ratings for disease resistance, 2.) a higher priority on root aesthetic characteristics in the *farm* model, magnifying the significance of crown and taproot refinement, and 3.) a higher incidence of low stand count at Tipi Produce resulting from mechanical cultivation of hand-planted rows (i.e. "iron blight").

Consumer selection yielded notably similar results between the two models. For the low geosmin flavor class, both the *farm* and *outreach* models selected groups with a palette of red, yellow, and pure white beets. However, the red roots in the *outreach* model are deeply pigmented, while those in the *farm* model are heavily zoned (Figure 7). There was strong preference toward the "winning" group in the *outreach* model, but preference was almost exactly split between the two "finalist" low geosmin groups in the *farm* model. However, most respondents in both models indicated a strong willingness to buy their less-favorite group, so it seems that there remains market potential even for narrowly-chosen beet families.

Figure 7: Low geosmin groups selected by the 2016 farm (left) and outreach (right) models. One representative half-sib family from each selected group is shown.

In the high geosmin flavor class, preference was quite evenly split in both models. Both core taster groups selected similar "finalist" groups: a pink-purple-white group with moderate to heavy zoning, and a yellow-red-coral group with moderate zoning (Figure 8). In the *farm* model, the two groups tied in the core tasting, and the pink-purple-white group won by a single vote among farm consumers. In the *outreach* model, the chefs narrowly preferred the pink-purple-white group, and the two groups tied vote-for-vote among public tasters. Thus, both models will advance high geosmin breeding groups with a similar palette of colors; it remains to be seen whether successive color and flavor selections diverge or remain consistent.

Figure 8: High geosmin groups selected by the 2016 farm (left) and outreach (right) models. One representative half-sib family from each selected group is shown.

Beet flavor components

Core group and public selection was based on overall hedonic liking in order to most closely reflect consumers' real-life experience with food. While tasters were asked to rate appearance and flavor separately, the act of eating is an inherently multisensory experience in which sight, smell, taste, sound, and touch interact. Thus, participants ranked beet groups based on overall willingness to buy or eat again.

While tasters were not asked explicitly to detect beet flavor components like geosmin or sugar, it is possible that they intuitively selected for desirable levels of these compounds. Thus, a post-hoc analysis of geosmin and sugars has been undertaken. Geosmin data has been fully collected, and descriptive data is available for the high and low geosmin populations. Measurement of soluble solids, a generally accepted measure of sucrose in table beet, is almost complete.

As expected, high geosmin and low geosmin populations show substantially different mean geosmin concentrations (Table 3). Notably, the high geosmin population shows a much broader spread in geosmin concentration than the low geosmin population (Figure 9). Statistical analysis is in progress that will confirm the significance of the difference between initial population means.

Over the three-year course of collaborative selection, tasters may select beet groups with geosmin concentration that diverges from that of the starting populations. In the first generation of selection, mean geosmin concentration in selected groups diverged numerically from that of the relevant populations (Table 2). For example, mean geosmin concentration in the low geosmin population is 7.86 μg geosmin / g beet tissue, while the *farm* and *outreach* models selected groups with 5.34 and 9.03 μg geosmin / g beet tissue, respectively. Statistical analysis will reveal whether these differences in geosmin concentration are significant in context of the variation in geosmin concentration among all half sib families.

	Geosmin Concentration (μg geosmin / g beet tissue)			
	Population mean	Population standard deviation	Farm Model Selected Group mean	Outreach Model Selected Group mean
Low Geosmin	7.86	3.58	5.34	9.03
High Geosmin	41.75	12.81	45.25	36.30

Table 2: Geosmin concentration of high and low geosmin populations and selected high and low geosmin groups.

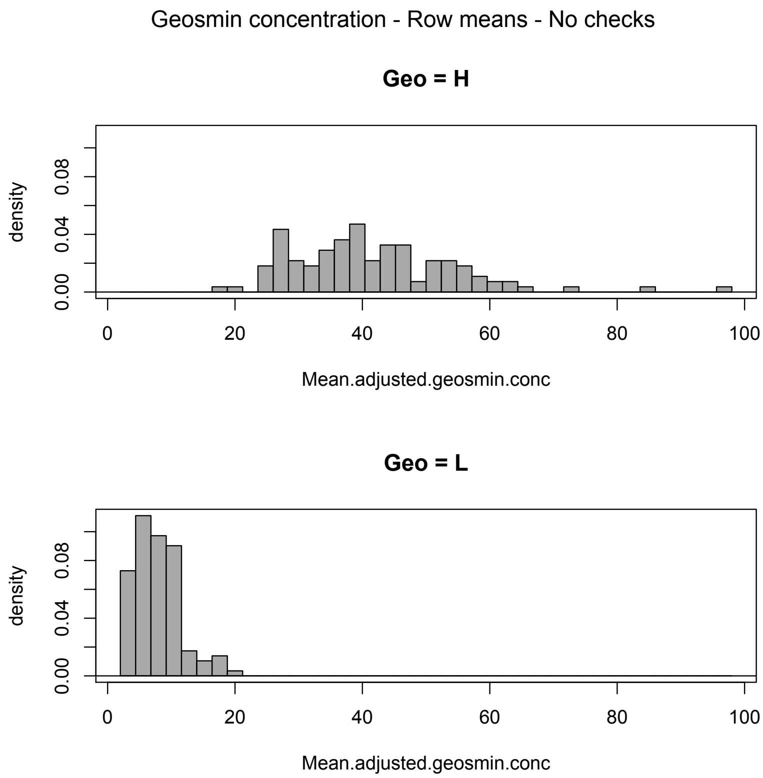


Figure 9: Geosmin concentration of high and low geosmin populations in μg geosmin / g beet tissue.

Farmer and community involvement

Farmers Steve Pincus and Beth Kazmar of Tipi Produce participated at several levels in this collaborative breeding project. In exchange for a $4,500 stipend, they provided a 0.15 acre plot, prepared it for planting, and mechanically cultivated it as feasible. Steve communicated his beet breeding priorities via an in-person interview, and both Steve and Beth helped to coordinate two on-farm tasting events: one for their staff, and one for consumers. With their cooperation, 14 staff and 75 consumers participated in collaborative beet selection at via this project's *farm* model.

In the project's *outreach* model, 5 farmers communicated breeding priorities via an online survey, 3 Madison chefs acted as core tasters, and 60 consumers participated in the public tasting event. In sum, 6 farmers and 152 tasters took part in selecting specialty beets according to their agronomic needs and hedonic liking, respectively.

Results: Cost efficiency of participatory breeding models

Both participatory breeding models facilitated selection of breeding material from a highly variable population, and both were met with enthusiastic engagement from both farmers and consumers. While it's not possible to evaluate the eventual marketability of the beets selected, we can compare single-season costs for each model. Since plot sizes and selection volume were equal between models, costs for seed, field stakes, kitchen rental, and sampling supplies were also equal. The major cost differences came from labor, mileage, and farmer compensation (Table 3).

	Farm	**Outreach**	**Difference** (Farm - Outreach)
Total labor time	**272.25 person-hours**	**216.5 person-hours**	**55.75 person-hours**
Weeding time	61.125 person-hours	29.5 person-hours	31.625 person-hours
Transit time	60.25 person-hours	28.9 person-hours	31.35 person-hours
Mileage	**580.8 miles**	**133.2 miles**	
Farmer participation / Land rental	**$4,500**	**$200***	

Table 3: Cost differences between participatory breeding models

*Additional expenses for WMARS farm needs are shared among land users.

The increased mileage and transit time for the *farm* model is simply an artifact of Tipi Produce's location 52.8 miles from UW-Madison campus; these values would change with the relative locations of any farm and agricultural station pairing. The additional labor time required by the farm model is fully accounted for by the aforementioned transit time and additional weeding time needed to manage a tenacious galinsoga population at Tipi Produce. Again, it cannot be generalized that on-farm participatory breeding requires more labor than ag station-based PPB; this result was a function of Tipi Produce's location and weed population.

The most significant cost difference between farm-based and ag station-based PPB is the land rental cost. However, the payment to cooperating farmers is not simply for land rental and field preparation. In a participatory model like this, the farmers also provide selection priorities, facilitate tastings with their staff and customers, and help to communicate the project's goals to a wider audience. Because we value Steve and Beth's enthusiastic participation with this project and hope to cultivate a long-term farmer-researcher collaboration, we did not try to negotiate a low payment rate with them. However, even if we had, a fair payment would have been considerably more than the university-subsidized $200/acre rental rate for ag station land.

Results: Program assessment and adjustment

The structure of this participatory plant breeding program allowed for successful collaborative beet selection in both *farm* and *outreach* models. However, a few adjustments to the sample preparation protocol, tasting procedure, and farmer survey will increase workflow efficiency and data quality for future selection cycles. Specifically, in 2016 I kept all half sib families separate for the core tasting, in case chefs or staff members wanted to re-assort families into modified breeding groups. I learned, however, that tasting eight beet groups (four high geosmin and four low geosmin) demanded enough time and concentration that the core tasters were not interested in revisiting the composition of beet groups. Thus, for future core tastings, half sib families will be bulked into breeding groups, reducing the volume of roots prepared and the complexity of sample organization.

For both core group and public tasting events, we will also ask tasters to evaluate beet groups using only steamed samples. This will allow for more consistent flavor perception among tasters and more straightforward interpretation of preference data. While raw samples will still be available, tasters will be asked to try them only after evaluating the steamed samples. This will decrease the chance that their flavor perception is altered by harsh or bitter flavor compounds (likely oxalate and saponins, respectively) that are more pronounced in raw beet.

Finally, for the *outreach* model to effectively select for the agronomic and quality priorities of Wisconsin organic and direct-market farmers, it is desirable to collect input from as many farmers as possible. The 2016 survey was opened in August, a difficult time for farmers to attend to non-essential tasks. While it gleaned only five responses, the 2017 survey request was sent in March and gleaned responses from 24 farmers. These additional responses will be incorporated into the *outreach* model's Selection Index, making it more accurately reflect the needs of Wisconsin's organic and direct market farmers.

Outreach

The results of the first year of this participatory beet breeding project were shared in a poster presentation, in several demonstration plots, and in two interactive workshops.

- Poster presentation
  - February 2017 - Organicology – Portland, OR
- Demonstration Plots
  - August 2016 – Student Organic Seed Symposium – Waterville, ME
  - Summer 2017 – Allen Centennial Gardens – Madison, WI
  - August 2017 – Student Organic Seed Symposium – Davis, CA
- Workshops
  - January 28, 2017 – Allen Centennial Gardens Winter Class Series – Madison, WI

- June 24, 2017 - Aldo Leopold Foundation – Building a Land Ethic Conference – Baraboo, WI

Conclusion

In the first year of this three-year participatory beet breeding project, foundational steps were made towards both of the project's two goals. First, the project seeks to begin development of marketable, flavor-identified specialty beet cultivars that perform well on Wisconsin organic farms. Second, it seeks to evaluate two participatory breeding models for cost efficiency and effectiveness. To that end, a farmer- and consumer-engaged beet selection protocol was carried out in two PPB models, evaluated for cost efficiency, and assessed for procedural effectiveness.

With the new beet populations produced during winter 2016-17, the second cycle of participatory beet selection has begun. While both *farm* and *outreach* PPB models started the 2016 season with identical high and low geosmin populations, the 2017 populations for each model are distinct. Over the next two years of selection, it will be interesting to see whether collaboratively-selected beets will have convergent or divergent color characteristics, geosmin concentration, and sugar concentration.

Regardless of their color and flavor composition, the beet cultivars that emerge from this participatory breeding program will have unique stories. They will have been selected by and for Wisconsin growers and eaters; they will be adapted not only to Wisconsin's biological ecosystem but also to its human ecosystem.

Measuring the impact of participatory plant breeding – presented as status or story - on consumer acceptance of these beet cultivars is the subject of another study, planned for 2019. However, this PPB project will both produce novel beet cultivars with unique stories and lay the groundwork for future collaborative beet breeding efforts in Wisconsin.

Appendix 1
Participatory Beet Breeding Activity Log: Farm Model

Date	Activity	Location
6/2/16	Plant	Tipi Produce, Evansville, WI
6/10/16	Field check, soil test	Tipi Produce, Evansville, WI
6/17/16	Mechanical cultivation	Tipi Produce, Evansville, WI
6/20/16	Hand weeding	Tipi Produce, Evansville, WI
7/1/16	Hand weeding, stand counts, thinning	Tipi Produce, Evansville, WI
7/21/16	Weeding	Tipi Produce, Evansville, WI
7/26/16	Weeding	Tipi Produce, Evansville, WI
8/11/16	Canopy height measurement, habit evaluation, weeding	Tipi Produce, Evansville, WI
8/17/16	Sample harvest	Tipi Produce, Evansville, WI
8/17/16	Phenotyping	UW-Madison Carrot and Beet Lab
8/18/16	Phenotyping	UW-Madison Carrot and Beet Lab
8/26/16	Harvest	Tipi Produce, Evansville, WI
8/30/16	Packing	UW-Madison Carrot and Beet Lab
9/17/16	Create breeding groups	UW-Madison Carrot and Beet Lab
9/21/16	Sort roots	UW-Madison Carrot and Beet Lab
9/22/16	Wash roots	UW-Madison Food Applications Lab
9/22/16	Wash roots, cut & steam	UW-Madison Food Applications Lab
9/23/16	Core tasting	Tipi Produce, Evansville, WI
9/29/16	Sort roots	UW-Madison Carrot and Beet Lab
9/30/16	Wash, cut & steam roots	The Crossing, Madison, WI

Appendix 2
Participatory Beet Breeding Activity Log: Outreach Model

Date	Activity	Location
6/7/16	Plant	West Madison Agricultural Research Station
6/10/16	Field check, soil test	West Madison Agricultural Research Station
6/21/16	Weed	West Madison Agricultural Research Station
6/30/16	Weed, stand counts	West Madison Agricultural Research Station
7/5/16	Thin	West Madison Agricultural Research Station
7/20/16	Weed	West Madison Agricultural Research Station
8/3/16	Weed	West Madison Agricultural Research Station
8/15/16	Top heights & habits, sample harvest	West Madison Agricultural Research Station
8/15/16	Phenotyping	UW-Madison Carrot and Beet Lab
8/16/16	Phenotyping	UW-Madison Carrot and Beet Lab
8/26/16	Harvest & Packing	West Madison Agricultural Research Station
9/9/16	Create breeding groups	UW-Madison Carrot and Beet Lab
9/10/16	Finalize breeding groups & sort roots	UW-Madison Carrot and Beet Lab
9/11/16	Sort roots	UW-Madison Carrot and Beet Lab
9/12/16	Chef tasting prep	UW-Madison Food Applications Lab
9/13/16	Chef tasting	A Pig in a Fur Coat restaurant, Madison, WI
9/14/16	Pull roots for public tasting	UW-Madison Carrot and Beet Lab
9/15/16	Public tasting prep	The Crossing, Madison, WI
9/15/16	Public tasting	Allen Centennial Gardens, Madison, WI

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