Vegetable breeders turn to chefs for flavor boost

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Last August, four chefs sat around a table in a Madison, WI, restaurant, each with small samples of 10 tomato varieties. With nary a word spoken, the chefs tasted each morsel, then rated the flavor along dimensions represented by axes drawn on paper. Tomatoes high in sweetness and acidity fell on the right. Those high in umami, a savory flavor, were grouped in the bottom left.

Tomato flights aren't the latest food trend, and Julie Dawson, the woman overseeing this event, was not administering a culinary exam. Dawson, a plant breeder at the University of Wisconsin–Madison, is one of a small but growing number of breeders who are harnessing the power of the chef's palate to produce more flavorful vegetables.

Most of the tomatoes the chefs tasted that day were varieties in the making. The chefs' input helped determine which varieties hit the seed catalogues, which were bred with others to improve flavor, and which were

dropped from production altogether. "Chefs can articulate what tastes good and what needs to be fixed in ways that others can't," says Dawson.

Breeder–chef partnerships vary in approach from quantitative analyses to informal conversation, but all are centered on the basic idea that when breeders and chefs unite they can revolutionize the quality of produce.

Flavor Lost and Found

People have crossed plants and selected the most productive, disease-resistant, attractive, and flavorful offspring for millennia. But as we came to rely on food grown at a distance, taste dropped out of the equation. "People have been breeding for durability during shipping and shelf life, so they haven't put the effort into consideration for flavor," says plant breeder and geneticist Jim Myers of Oregon State University.

Many breeders care about flavor but can't afford the time and money necessary to select for it. A single

Fig. 1. Chefs with expert palates are helping plant breeders revolutionize the flavor of produce. The owners of the Oregon-based, organic seed company, Adaptive Seeds—Andrew Still (*Second from Right*) and Sarah Kleeger (*Left*)—walk their fields with Oregon State University agricultural researcher Lane Selman (*Right*) and local chef Timothy Wastell as the team develops new varieties of kale. Image courtesy of Shawn Linehan (photographer).

breeder may need to taste hundreds of different lines of a particular crop each year. Or a breeder may rely on sensory panels, groups of 10 or more people who learn a common vocabulary to provide precise descriptions of flavor components, such as acidity, sugar, and umami, a process that can last weeks or months.

Chefs can make the selection process easier for breeders because they have experience assessing flavor. "Chefs have highly trained palates," says Myers. "They're used to tasting foods and deconstructing them so they understand flavors and nuances." And chefs have much to gain from getting involved. "I want better tasting, better performing vegetables to use," says Timothy Wastell, chef at Antica Terra winery in Oregon. "Food is only as good as the ingredients you are using, so it's a no brainer that the food will get better when the produce gets better." Food also tastes better when it is fresh from the farm, says Wisconsin-based chef Tory Miller, who works with local breeders, in part to help them develop a greater variety of crops suited to the local climate.

Chefs and Breeders Unite

Chef Dan Barber was one of the first to recognize the power of the chef-breeder partnership. In 2013, he invited Dawson, Myers, and about a dozen other breeders to attend a summit along with about 60 chefs at the Stone Barns Center for Food and Agriculture in Pocantico Hills, NY, a nonprofit education center that is partnered with Barber's onsite restaurant, Blue Hill at Stone Barns. There, Barber laid out a vision for how chefs, breeders, and farmers could work together to produce vegetable varieties that are both highly productive and flavorful. And maybe, if vegetables tasted better, people would eat more of them.

Vegetable breeder Michael Mazourek of Cornell University helped organize the event. He and Barber started collaborating in 2009 after Barber hosted a dinner for Cornell plant breeders and served one of Mazourek's squash varieties. The dish's flavor and preparation so impressed Mazourek—Barber cooked the squash hotter and longer than cookbooks often advise—that Mazourek decided to start selecting for a variety that best fit this culinary technique. Mazourek says he valued working with someone who appreciated the more creative aspects of plant breeding—selecting for unusual colors and textures, flavors, and shapes. He wanted that experience for other breeders as well. "I had all these peers that were working on all their coolest projects, but they weren't showing others because the [produce] wasn't mainstream enough," Mazourek says.

Dawson returned from New York and teamed up with Tory Miller of L'Etoile Restaurant, who also attended the summit, and a handful of other local chefs. Together the group started the Seed to Kitchen Collaborative, now in its fourth summer. Each year, breeders from across the country give Dawson seeds for as many as 40 different candidate varieties each of about a dozen different crops. The varieties are all developed through traditional plant crosses, because

Fig. 2. By offering feedback at vegetable tastings hosted by University of Wisconsin–Madison plant breeder Julie Dawson, chefs in Madison, WI, influence the flavor profiles of vegetable varieties in the making. Pictured *Left to Right*: Jonny Hunter, Julie Dawson, Tory Miller, and Dan Bonanno. Image courtesy of Gerhard Fischer (University of Wisconsin–Madison, Madison, WI).

many will be grown on organic farms that don't allow genetically modified seed.

Dawson plants the seeds and monitors them for disease resistance, yield, and cold tolerance. After harvest, about 10 to 20 university students rate the varieties on a scale from 1 to 5 for characteristics such as sweetness, bitterness, and acidity. Dawson then incorporates the students' responses into a principal component analysis (PCA), a statistical technique that allows her to group varieties with similar combinations of flavor components while determining which components are most important for setting varieties apart. She chooses

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a sampling of varieties that span the flavor spectrum and presents these to chefs during a monthly tasting.

The chefs sometimes create flavor maps as they did for tomatoes last year. They also fill out questionnaires with open-ended questions, such as "What is the best trait of this variety?" The chefs then discuss which varieties they're excited about. During last year's tomato tasting, Miller was wowed by the "incredible amount of umami" in some varieties.

The results give those tired of bland tomatoes reason for hope. In each tasting, Dawson adds an existing modern variety and an heirloom variety as controls. Some of the new lines developed by breeders who select for both flavor and productivity are beating the heirlooms in the flavor category. "There might not be as much of a tradeoff as we

thought between production and flavor," Dawson says. "We just have to select for both."

Getting to Market

Already, Dawson's group has helped convince breeders to move forward with commercial varieties. One success, 'Garden Gem,' is a cross between a modern, high-yielding tomato and an heirloom. Tomato breeder and molecular biologist Harry Klee of the University of Florida developed the tomato and formed a 100-person consumer taste panel. He found that its flavor rivals the heirloom parent but with two to three times the yield. When Klee trialed the 'Garden Gem' in Dawson's program, the chefs rated it highly. Citing the chefs' approval helped Klee win over online grocer Fresh Direct, which contracted with a Pennsylvania farmer to grow the tomato. "What we are trying to do in a nutshell is to force the growers to grow more good-flavored stuff because the consumers are demanding it, and that's where the chefs become really powerful," says Klee.

In another chef-breeder collaboration, Mazourek worked with Barber to create the 'Honeynut' squash, a cross between butternut and buttercup squash varieties. Barber promoted the hybrid at his restaurant; it then spread to farmer's markets, Trader Joe's, and Blue Apron. Mazourek likes to cut a squash in half, taste one side, and ship the other to Barber. They then chat about what qualities work well and what could be improved.

Myers, after collaborating with Oregon State agricultural researcher Lane Selman and garnering chef input, is nearly ready to release a habañero pepper that boasts flavor without heat. "While we have worked closely with farmers to make sure that we get their input into the breeding process, we did not originally have much effort on evaluating taste and quality," says Myers, who is the project director of the Northern Organic Vegetable Improvement Collaborative, a program to breed vegetables for organic farmers.

Selman now runs the Culinary Breeding Network (CBN), a group of plant breeders, seed growers, farmers, chefs, and produce buyers. Since 2014, she's hosted the annual CBN Variety Showcase, a tasting event where chefs pair with breeders to

present novel varieties and preparations to food enthusiasts. "The breeder will get more feedback in that evening than they will for the rest of the year," says Selman. At last year's event, chefs from Tom Douglas' restaurant group impressed guests by flavoring soda with Myers' mild habañero peppers. This year, Selman expects 500 attendees and 25 breeder-chef teams.

Selman also works with the organic seed company Adaptive Seeds to select new varieties of kale that have attractive leaves and unique flavors and do well on organic farms. Chef Wastell walks the fields with the company's owners, tasting the leafy greens as he goes and noting which are sweet, tangy, or pleasantly bitter.

The Human Element

But Klee is more interested in catering to the public than to chefs. To make the perfect supermarket tomato, he's taking a molecular approach, identifying 13 key flavor chemicals and the underlying genes that modern tomato varieties lack (1). He is now systematically crossing plants to breed those genes back in while maintaining the traits that make the tomato profitable for farmers. Klee says he practices traditional plant crossing, as opposed to genetic engineering, in part because he doesn't feel he could recover the expense associated with getting government approval to release a genetically modified crop.

Dawson also wants to incorporate genetic analyses into her breeding process. But instead of homing in on each precise gene that contributes to a flavor profile, she's attempting to correlate collections of genes with information about flavor taken from surveys. Matching groups of genes with particular flavor profiles could, for example, yield a sort of genetic fingerprint for a delicious carrot; that signature could then, Dawson says, help weed out some obviously unpalatable varieties early in the breeding process.

But Dawson doesn't think this molecular approach could ever replace her chef collaborators. "I think that a lot of good flavor can be in some surprising places and I'm not sure if an algorithm or even genetic predictions could actually capture what tastes good," she says. "You'll always need that human element."

1 Tieman D, et al. (2017) A chemical genetic roadmap to improved tomato flavor. *Science* 355:391–394.