





# DEVELOPING NEW BARLEY VARIETIES: A WORK IN PROGRESS

BY ADRIENNE SO

CONSIDER TOAST. BY THE TIME CEREAL GRAINS BECOME BREAD, THEY'VE BEEN GROWN IN FIELDS, HARVESTED, THRESHED, AND GROUND INTO FLOUR. THE FLOUR IS LEAVENED, KNEADED, BAKED INTO LOAVES, AND DRIVEN TO YOUR LOCAL MARKET.

In your kitchen, it's sliced and browned in your toaster, its surface possibly smeared with butter and jam before you eat it for breakfast. The finished product has gone through so many different processes that the quality of the grain, where it came from, and how it was grown doesn't seem to matter.

But obviously, it does. Many people take the time and attention to source bread made locally, from grain that's grown sustainably, not only for the taste but because doing so has implications that resound far beyond just what you choose to eat first thing in the morning. A brewer's choice of malted barley has those same implications. But while many craft brewers carefully source their hops and analyze the mineral content of their water, many don't pay attention to their barley malt beyond determining whether it's two-row or six-row, North American or European.

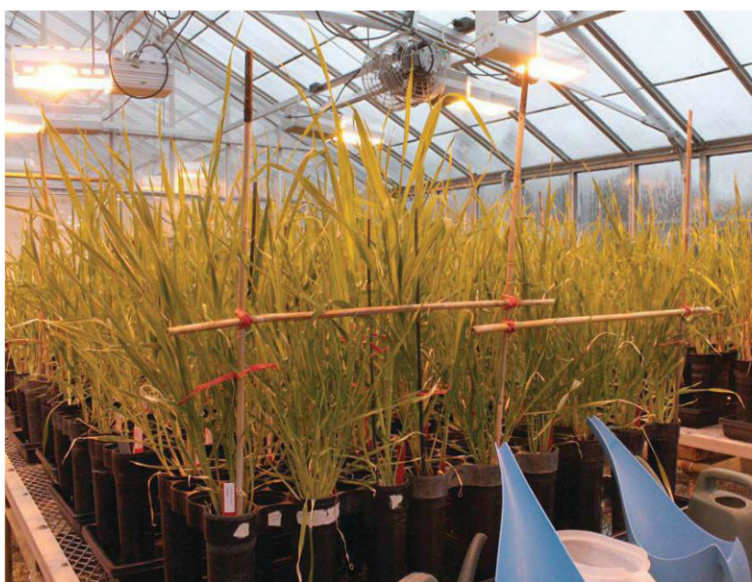
A multi-institutional chain of researchers, farmers, maltsters, and brewers is starting to change that, slowly piecing together the links in a supply chain that would provide American craft brewers with a vibrant array of flavorful, interesting, and locally grown grains. But while similar advances were made in leaps and bounds with hop research over the past 30



Researchers, farmers, maltsters, and brewers are hoping to provide craft brewers with flavorful, interesting, and locally grown barley.



Barley samples in the Crop and Soil Science facility at Oregon State University.



or 40 years, matters have been going much more slowly with barley—not just because researchers have to gather data, but because they also have to develop the processes by which we gather that data, quantify it, and then persuade people to take it into account.

“Intuitively, I know from eating apples and tomatoes that breeds and varieties make a huge difference,” said Daniel Carey, brewmaster at New Glarus Brewing. “I just can’t prove it yet.”

## ARTISANAL MALTING

It’s easy to discount how barley variety impacts flavor because of the considerable contributions of the maltster’s art. Malting is the process of germinating grain to

convert the grain’s starch into usable sugars, then heating, or “kilning,” the grain to achieve particular textures or flavors. So many variables go into this process—time, temperature, and grain moisture to name a few—that to perfect their recipes, most maltsters want and need barley with relatively consistent attributes.

The interest in artisanal malting has grown concurrently with craft brewing’s popularity. Still, even as small, creative maltsters are beginning to push malt’s boundaries, they tend to be limited by available barley varieties. The vast majority of the malting barley grown in the United States—over 70 percent—is bought and used by major companies like Anheuser-Busch and MillerCoors. This is not necessarily a bad thing.

“Up until the past five or 10 years, craft brewers have traveled in the wake of some really large ships,” said Chris Swersey, technical brewing projects manager for the Brewers Association. “The largest brewers have been able to communicate their needs very effectively for 50 years or more. That means our domestic malted barley supply is of extremely high quality and tailored to brewing adjunct beer styles.”

As the market share for craft beer grows, craft brewers have demonstrated their buying power as well. The Brewers Association recently released a white paper, “Malting Barley Characteristics for Craft Brewers,” that elucidates some of the gaps in research and infrastructure—such as the hurdles in custom contracting—that need to be addressed before we begin to see more flavorful, interesting barleys on the market. The white paper is available on [BrewersAssociation.org](http://BrewersAssociation.org) under the Business Tools/Publications dropdown menu.

According to Dr. Patrick Hayes, professor of barley breeding and genetics at Oregon State University, the prevalent varieties of malting barley currently grown have been selected mostly for their production capacity, resistance to disease, and absence of off-flavors rather than for interesting or novel characteristics.

Big brewers have traditionally preferred six-row to two-row varieties (the terminology refers to the barley’s floral structure and whether the head has six or two rows of grain) because six-row barleys easily adapted to a North American climate, unlike the two-row varieties traditionally favored by European maltsters and breweries.

For craft brewers, two-row varieties have the force of tradition behind them, but other attributes provide positive qualities that are more apparent in smaller, all-barley malt beers. According to Scott Heisel, vice president and technical director for the American



Malting Barley Association (AMBA), popular two-row malting barleys like AC Metcalfe, Harrington, and Hockett have kernels that tend to be plumper and more uniform in size. “The ratio of husk to kernel is lower and the husk has compounds that have astringent flavors,” said Heisel. “Two-rows might be a little more mellow.”

As more influential, innovative craft brewers like Dogfish Head and Sierra Nevada have joined AMBA’s ranks, the organization has devoted more time and money to speed up the research and development process on barley variety characteristics that cater to craft brewers’ needs, such as lower protein levels and lower enzymatic action. “We’re seeing some of those [varieties] being recommended and used, like Pinnacle, which is being released out of North Dakota State [University],” Heisel said.

AMBA’s recently released barley breeding guidelines for all-malt brewers is a significant step toward pinpointing desirable characteristics for barley destined for all-malt brew. While these guidelines cover crucial traits like the level of soluble protein, AMBA agrees with brewers that flavor is the most important quality. Unfortunately, it’s also the hardest one to define and measure. “Most of the flavor testing is being done at our member breweries,” said Heisel. “We don’t know what all the flavor compounds are. There are so many variables in growing conditions and crop years that it’s very difficult to carry out that research.”

## FOCUS ON FLAVOR

One of those member breweries is the pioneering California brewery Sierra Nevada Brewing Co. Tom Nielsen, technical lead on all things related to beer flavor science and materials, has a theory on why hop research has been carried out with relative ease compared to barley research. Hops impart much of their aroma and flavor from essential oils, which are relatively easy to isolate, evaluate, and measure. “We’ve been working on this [barley] project for more than a year now, and the impact flavors aren’t so readily available,” he said. “With barley, you need to tease the flavors out a little more.”

Along with Dr. Hayes, Nielsen is part of a core group of professionals and academics who are trying to release the secrets of barley flavor. Putting together processes that would help evaluate flavor is difficult enough, but it’s the project’s sheer scope that makes the research so intimidating.

In order to figure out what barleys produce different flavors, first you must select and grow hundreds of different varieties. Then you must harvest, malt, and brew with them, then measure different chemical com-

pounds in the congress wort, and draw links between those compounds and different aromas and flavors that may arise in the finished product. Once you’ve compiled results, you must continue to test and re-test because so many other factors may have contributed to flavor—when and where the barley was grown, what kind of fertilizer the farmer used, where it was malted. The number of variables to control seems almost infinite.

Of course, it’s possible to skip the measuring part and simply grow, malt, and brew

“WITH BARLEY, YOU NEED TO TEASE THE FLAVORS OUT A LITTLE MORE.”



top: Malting barley variety test plots at Dickinson, N.D.

bottom: Paul Ogg (left, Declaration Brewing Co.) and Ryan Brooks (right, Coronado Brewing Co.) inspecting malting barley test plots at Bismarck, N.D.



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with different varieties. But without the measurements, “[the differences have] the status of urban legend, almost. It’s never been quantified,” said Hayes.

Hayes decided that the first step to finding different chemical compounds was to look at barley varieties that hadn’t been bred intensively to fit the mainstream flavor profile. That meant rounding up a list of more than 2,062 exotic and ancient barleys from as far away as Kazakhstan, North Korea, Yemen, Brazil, and Egypt, a collection that he compiled with the help of Dr. Harold Bockelman, curator of the National Small Grains Collection.

Once those were grown and the field narrowed (pun intended) to 114 final contestants, the most promising varieties were malted by Rahr Malting Co. in Minnesota. Nielsen then brewed with the malted grains and analyzed the wort via a human sensory panel and a gas chromatograph-mass spectrometer, or GC-MS.

The gas chromatograph separates out the molecules while the mass spectrometer captures and measures them; it’s a relatively common analysis in the food science industries, but that doesn’t mean that the results are easy to interpret. “Defining

### Inspecting early season two-row malting barley.

flavor has some of the best chemists in the world racking their brains,” said Hayes. “The idea is to identify specific chemical compounds that can be related to a specific sensory parameter.”

The most important part of the analysis, however, might be the sensory one that Nielsen refers to as “olfactometry”—sniffing of the gas chromatography. While the numbers provide quantitative proof that different chemical compounds do exist, the most sophisticated instrument is still the human nose, and how it integrates those compounds to particular effect—whether they make the beer sweet or bready, grassy, fruity or floral.

Of the 114 samples that Hayes sent, Nielsen has analyzed about 40. The lab has already put together some interesting hypotheses as to how different amino acid interactions drive the Maillard reaction—which is to say that different levels of amino acids and soluble proteins affect how the barley reacts during the malting process and results in different, potent flavors.

One of those compounds is free amino nitrogen, or FAN, which is the sum of ami-



no acids, ammonium ions, and small peptides in the wort. While big brewers who use adjuncts require high levels of FAN, Nielsen is one of a number of brewers who espouses the idea that all-barley malts in craft beer require lower levels of FAN. This idea could become an important marker for the barley required for different beer styles.

However, Nielsen cautions that this is just the tip of the iceberg. The lab has generated a tremendous amount of data, but analyzing it will take some time. "Let's look at them for the next couple of years and see if any of this is reproducible," said Nielsen. "It's been interesting to find all this information, and it's certainly driving another wave of analysis and trialing."

Hayes imagines several ways to streamline that process. "There's a huge bottleneck for making malts for research purposes, then you've got another bottleneck where once you've made malt, you need to analyze it for quality parameters," he said.

"Our dream is to develop a system for making hundreds or thousands of malts at a time. I envision a mini-malter, a mothership... We're also working with the Canadian Malting Barley Technical Centre. They've developed this near-infrared reflectant technology that's currently used to predict the moisture and protein of grain. They've calibrated the machine to analyze malt and in two minutes, predict all of its malt parameters. The calibrations are still being refined. When you couple that with the mothership concept, suddenly you have the ability to put malt analysis at the same level of intensity as DNA sequencing."

#### FIELD WORK

Hayes admits that his ideas will take some time to materialize—he refers to his mothership as "the moonshot of malt." In the meantime, Nielsen is also tackling the barley flavor problem from a few different angles. Nielsen and Sierra Nevada are part of a project spearheaded by the Brewers Association, in conjunction with the National Small Grains Collection, University of Idaho, and North Dakota State University. "We're trying to see if there's something on the shelf right now that we could use," said Swersey. "If yes, great. If not, we'll learn what we can about future direction and change gears."

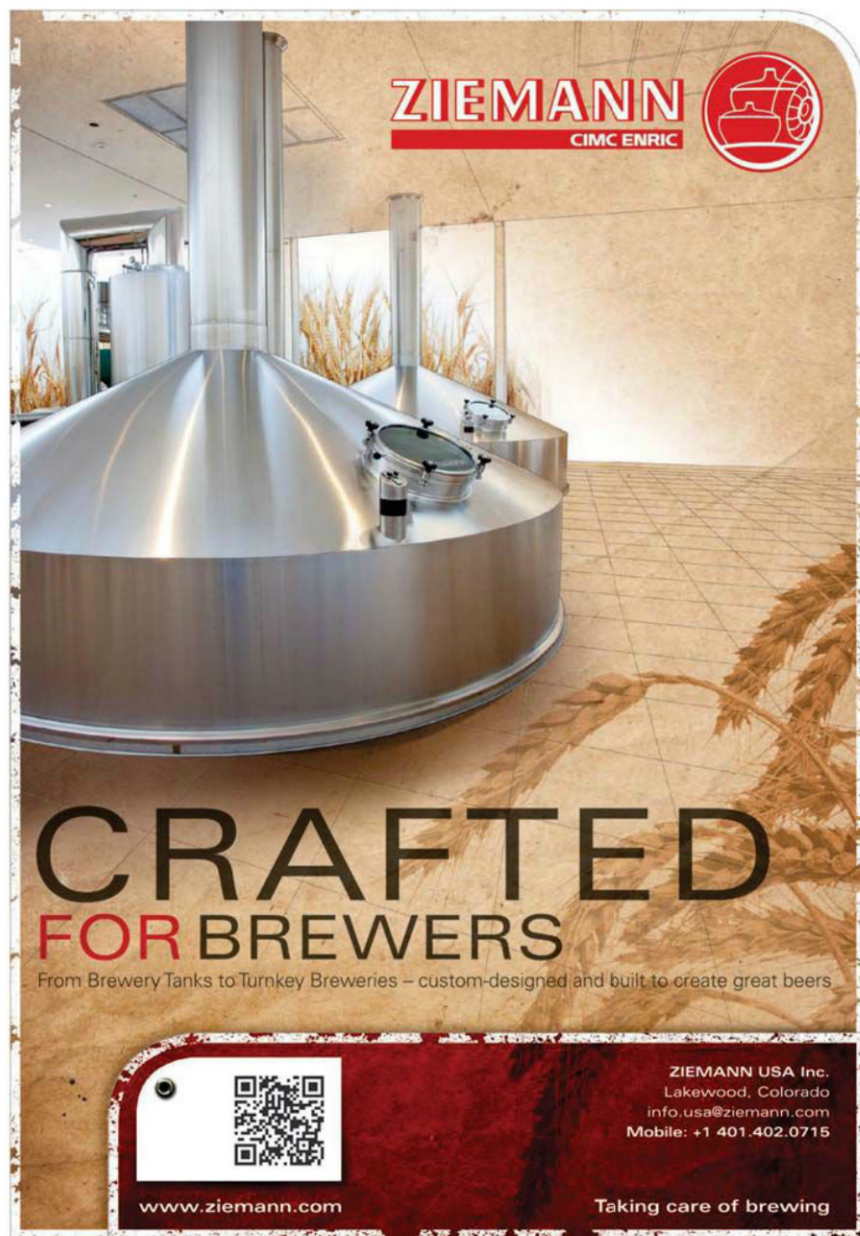
Dr. Juliet Marshall, a cereals agronomy and pathology professor at the University of Idaho, helped the BA select and grow 10 lines of winter and spring barleys that met craft brewer specifications in terms of FAN and protein levels by coordinating with Dr. Gongshe Hu at the Agricultural Research Service's Aberdeen facility.

## WHILE THE NUMBERS PROVIDE QUANTITATIVE PROOF THAT DIFFERENT CHEMICAL COMPOUNDS DO EXIST, THE MOST SOPHISTICATED INSTRUMENT IS STILL THE HUMAN NOSE

The lines were malted at North Dakota State University under the supervision of Dr. Paul Schwartz, a professor of malting barley quality, and currently await sensory testing by Nielsen and brewers at Schlafly, Bell's, New Belgium, New Glarus, and Odell to evaluate flavor profiles. "You can meet all

the numbers and they can pass any test, but you still have to taste them," said Marshall.


To a brewer, that's a far-from-onerous project. To spark interest in the varying flavor profiles of different styles of malt, Nielsen and Hayes gave a presentation on barley flavor at last year's Master Brewers



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Association of the Americas conference, for which Nielsen brewed 10-gallon batches with four different barley varieties.

They intended to compare the flavor attributes of heritage barleys like Maris Otter against Canadian barleys like Copeland. There was a demonstrable difference between the distinctive “biscuity” and “honey” flavors of Maris Otter and the “bread,” “fruity” flavors of Copeland. At this year’s Craft Brewers Conference, the new Craft Maltsters Guild gave a similar demonstration, with similar results. Each malthouse from across North America—from Malterie Frontenac in Canada to Colorado Malting

Company—submitted a base malt to New Belgium.

“Each beer was definitely different—color-wise, flavor-wise, aroma-wise. Even the body and mouthfeel of each of the beers were unique,” said Andrea Stanley of Valley Malt in Massachusetts.

#### A COMMON GOAL

While Nielsen and others continue toiling in the trenches, the future does, at times, seem tantalizingly close. I catch a glimpse of it at a bar in Portland, Ore., where I meet a farmer and a brewer having a drink after working together to produce great beer.

Four years ago, Scott Sayer went to Barley Day at Hyslop Farm, an OSU research facility. Sayer owns and operates a small family farm in the Willamette Valley. When he began examining the alternatives to growing grass seed, he finagled 100 pounds of a variety then known as BCD47 (now known as Full Pint) from Hayes at OSU, a variety that was well-adapted to the local climate and disease-resistant.

Sayer planted the grain on 120 acres, a gamble that amounted to about 8 percent of his annual production. This past December, Sayer contacted Hayes once again, who put him in touch with Tim Matthews, head brewer for Oskar Blues. Together, they coordinated a malting and brewing session during the height of the holiday season. Sayer found a shipper to haul his grain to Colorado, where Colorado Malting Company malted it and sent it by truck to Oskar Blues. There, farmer, maltster, and brewer collaborated on a batch of single-barley beer.

For most small craft brewers, putting together a similar supply chain seems like an expensive mess of logistical hurdles. Large malting companies like Great Western and those owned by Anheuser-Busch and Miller-Coors contract for the grain they need, with the rest going on the open market. That limits the amount and the varieties of grain available for purchase. “One hundred acres out here is miniscule,” said Marshall, “but small acreage like that would fit very well into the craft brewer’s target, where a grower can be more flexible with the number of varieties they can grow.”

But the benefits are tremendous. By working directly with the brewer, Sayer is able to tailor his barley directly to a craft brewer’s needs. “Next year, we’ll cut the fertilizer rate,” said Sayer, which will result in lower protein levels and more stable beer. “We need fewer resources, and it’s more environmentally friendly.” Full Pint doesn’t even require fungicides or insecticides to thrive in the Willamette Valley.

Matthews describes his single-barley strong ale as expressing a distinct salted popcorn flavor, with a fruity sweetness. It’s such a hit that by the time I meet them at the bar, Matthews has completely run out. A growler arrives from him several weeks later, and it appears that the future of malting barley in the craft brewing industry has literally arrived at my doorstep, a system wherein the human relationships that bring beer to the table are brought into full relief.

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