

Beer Here

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(PhysOrg.com) -- Drinking beer is a simple act, but making beer is not. It starts out with genetics and tens of thousands of barley varieties and ends with a clear ambrosia that belies the time, effort and technology that went into its making.

At Montana State University, scientists have worked for more than a century to advance one of the state's most important [crops](#) and helped improve a product beloved by millions. The trail from research bench, to barley field, to microbrewery is long and circuitous. But, as [beer](#) lovers will tell you, the end result is worth the long wait.

Montana State University barley breeder Tom Blake stood calf-deep in a trial field of barley at the Arthur H. Post [Agronomy](#) Farm near Bozeman. Clipboard in hand, he walked down the rows scratching notes about the barley's height and flower progression.

Each year Blake develops 10,000-15,000 new lines of barley in the hope of getting one variety that brewers like.

"We do tedious work really, really well," he joked.

Blake studied genetics at the University of California Davis. After doing research on humans and animals, he knew he wanted to work with plants -- specifically, plants that had good [genetic](#) resources and interesting biochemistry. Barley fit the bill.

"Barley is one of the most biochemically interesting plants because of

what you have to achieve during the malting process; it's fascinating stuff.

"Plus, I love beer. That helps," Blake said.

According to MSU Extension, Montana is the second largest barley producer in the U.S. (second to North Dakota), growing 900,000 acres of barley in 2007. Barley is grown for two general uses: for cattle feed and for malt. Malted barley is used in beer, but it is also an ingredient in distilled alcohol, malt syrup, malted milk and breakfast foods. In the same way that ice cream makes a milkshake, and chocolate syrup adds the flavor, barley is the base and the body of beer.

High protein barleys are valued for animal feed and starchy barley for malting. Montana farmers will often grow a malt variety hoping for malt quality and use the feed grain market as a safety net.

Currently, there are about 15 students, staff and researchers at MSU and throughout the Agricultural Research Centers working to find the best barley for Montana conditions that brewers will like. It is work that requires patience.

At the end of eight or nine years of field trials, those 10,000-15,000 varieties of barley that Blake started with have been whittled down to a few that are kept for further study. By then Blake knows which varieties grow best in Montana and are likely to be of high malting quality. He provides about 100 potential varieties each year to the U.S. Department of Agriculture in Madison, Wis., which malts the grain in small batches and then tests them for quality.

"Maybe one (in 100) will look good enough in malting quality and be agronomically better," Blake said.

With a thumbs-up from the USDA, the barley moves on to the brewing industry. Big brewers such as Miller-Coors and Anheuser-Busch then grow the new MSU variety for three years in their own trials.

In 1986 Blake developed a barley cross called Hockett. After eight years of field trials, Blake deemed it worthy of recommending to brewers for their own trials. In 2006 and 2007, Miller-Coors grew it in trials, and then recommended it to their own growers. According to Blake, Anheuser-Busch plans to contract 1.8 million bushels of Hockett for next year. From the time Blake made the Hockett cross to getting it accepted by the brewing industry and planted by Montana farmers, 20 years had elapsed. In that time 200,000-300,000 new crosses were tested.

"Breeding is a very slow process over ridiculously long periods of time," Blake added.

The Farm

About 35 miles east of Conrad, Paul Lindberg is in his third year of growing the MSU-bred Hockett for Anheuser-Busch. It is the last year of the testing phase for Anheuser-Busch. While his crop didn't meet malting qualifications the first year (no timely rain), Lindberg has since had good results.

Brewers require barley with a plump, meaty kernel and a low percentage of skinned or broken kernels. It must be less than 13.5 percent protein. Last year Lindberg's crop far exceeded Anheuser-Busch's expectations.

"I am very proud of that," Lindberg said.

All of Lindberg's malt will be sold to Anheuser-Busch. While the mega-brewer malts some barley at its own plants, Lindberg's barley will likely

be malted in Great Falls at the MaltEurop malting plant and shipped to Anheuser-Busch's brewing facilities in Fort Collins, Colo., St. Louis, Mo., or Columbus, Ohio.

Lindberg got 72 bushels per acre this year, which he considers a very good yield for his 300 acres of Hockett barley.

"This is the best barley I've seen," Lindberg said.

The Malt Plant

Heading out of Great Falls, gas stations, industrial complexes and mini marts are quickly replaced with wide-open space. Just a couple miles from the city limits, the MaltEurop malting plant looms like a monolith in the middle of a field.

The steel and concrete facility is the largest building, by volume, in Montana. It is 109 feet tall and the floor space would be big enough to grow almost three and a half acres of barley, if it weren't filled with stainless steel vessels that reach 72 feet from the floor.

The Great Falls MaltEurop plant processes 11 million bushels of barley per year. The plant runs 24 hours a day, seven days a week, 365 days a year with 48 employees.

Yet, despite the company's massive statistics, barley procurement is personal business, company officials say. Mark Black, barley program manager, works with barley researchers and growers at all stages of the growing and malting process.

"In our plant breeding and trial plots we share data between ourselves and MSU (as well as other institutions), and identify traits in varieties that can be brought forward for better brewing and agronomic

characteristics," Black said. "Agronomics includes better yielding varieties as well as disease resistance."

This year MSU researchers are testing 800 varieties of barley for MaltEurop. They will identify which, if any, are well adapted to Montana's dry, cold environment and meet malting barley guidelines.

"We'll ship the data from our trials to MaltEurop and point them in the direction of varieties that will work well for their buyers, the brewers," Blake said.

Black takes his cues from his customers: brewers such as Anheuser-Busch, Miller-Coors and many Montana microbreweries. MaltEurop has processed mostly Metcalfe and Harrington varieties of barley, both developed in Canada. This year he'll be malting Hockett, too.

Black procures barley primarily from Montana's Golden Triangle, in north central Montana.

Black said, "This is the newest, brightest plant out there and, I may be biased, but it is adjacent to the best malting barley in America."

The point of the malting process is to break down proteins in the barley, making starch available to the plant's own enzymes and yeast that will break down sugars in the beer brewing process. To do that, water, air and heat are used in different combinations in four steps.

"It's the same thing that happens in nature," said Treg Reutiman, process manager and maltster. "We're just controlling it."

The grain is cleaned and then steeped to raise the kernel moisture as quickly as possible. Coming into the steep tank, the barley is about 12 percent moisture. Leaving the tank a day and a half later, the moisture is

between 43-46 percent.

Next, the grain is left to germinate for four days. Plump kernels fill the round tank to five feet deep and a row of helices, or turn screws, moves through the bed mixing the grain. At this point the kernels are starting to grow little roots -- rootlets -- and it is imperative to keep mixing so the rootlets don't grow together forming an impenetrable mass.

The kiln is where the barley gains its color, character, aroma and taste. Warm air is pumped through the grain, reaching 185 degrees at the end of a day and a half. The Great Falls MaltEurop plant solely malts barley for light beers such as pale ales, ambers and Indian pale ales. Darker malts require more time in the kiln.

When it is finished, the 380-metric ton batch of malted barley is loaded into five-and-a-half railcars or 15 semi-trucks. It is enough malt to make 3.5 million 12-ounce beers.

Annually, the plant produces enough malt to make 1.9 billion 12-ounce beers, around 35 percent of the U.S. beer market.

"This place is a barley monster," said Reutiman. "It devours so much barley."

The Brewery

As a physics major at MSU, Tim O'Leary learned to solve problems.

"One thing I learned from my professors at MSU is that problems don't seem unsolvable when you break them down into little pieces," said O'Leary. "Whether it's math or building a brewery, problem solving is at the heart of it."

O'Leary is the owner of Kettlehouse Brewing in Missoula. In 2008 the brewery produced over 4,000 barrels of beer. O'Leary anticipates crafting 6,000 barrels this year and reaching capacity next year with 10,000 barrels.

The barley from MaltEurop makes the bulk of Kettlehouse beers with specialty barley and wheat malt added to some for a richer, fuller beer.

"My mom instilled a 'support the local guy' ethic in me," said O'Leary. "I knew Montana was one of the top barley producing states in the country, so I wanted to get our malt from in-state."

Unlike wine, beer cannot have vintages; drinkers will not tolerate swings in flavor.

"Having barley with consistent parameters is the key to consistent flavor," O'Leary said.

To begin the brewing process, enzymes break down the starch that was accessed during the malting process and turn it into simple sugars. The result is called wort, which is then moved to the lauter tun vessel where it is separated from the grain. It is there that the barley leaves the beer. Its work has been done.

The clear, sweet wort is boiled, caramelized and sterilized. Hops are added at different times throughout the hour and a half boil to give each beer its particular flavor. The boiled wort is spun and twirled to coagulate proteins, which, along with the hops, collect in the center of the vessel and are drawn off.

The wort comes to life in the fermenter as yeast eats the sugars produced in the brewing process. The ultimate steps are carbonating the brew and transferring it to kegs or bottles, just steps from where it was made.

Cold Smoke Scotch Ale is Kettlehouse's biggest seller. It's a dark beer that doesn't taste bitter, according to O'Leary. Its name is a reference to the powdery snow found at Bridger Bowl ski area, the place that drew O'Leary back to Montana after starting school in Minnesota. O'Leary grew up in Helena and his mom promised to buy him a season pass to Bridger Bowl if he returned to Montana and went to school at MSU.

"When I saw how excited and interested professors in the physics department were, I decided (physics) was a worthwhile challenge," O'Leary recalled. "Professors like John Carlsten, Bob Swenson, Hugo Schmidt, John Hermanson and Dick Smith made it interesting, and I could see they had a passion for the subject matter."

The chemistry, biology, engineering and thermodynamics he learned at MSU are the background O'Leary needs to turn barley into beer. It helps him when he is talking to engineers about his heating and cooling system, deciding what size pumps to buy and understanding how the process of enzymes breaking down the starches in barley lead to a better brew.

"When I'm talking to bar owners in Bozeman, the first thing I tell them is that I went to school at MSU, it helps sell my beer," O'Leary said. "Then I tell them -- and bar owners all over the state -- that we use barley grown and malted in Montana; that helps, too."

Provided by Montana State University ([news](#) : [web](#))

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