

Gary's Update



The research progress of the barley CAP is going well. The breeding programs and phenotypers are working well together and an enormous amount of phenotypic data has been collected. Julie Dickerson has adopted the Germinate schema for The Hordeum Toolbox (THT) (www.hordeumtoolbox.org) database.

Jennifer Kling (Oregon State University) is in the process of curating the phenotypic data and pedigrees before they are uploaded to THT. Shiaoman Chao (USDA-ARS, Fargo, ND) has isolated DNA from 960 lines from the first year. In the next month the first set of SNP data from these lines will be obtained. Thus, as the phenotype and genotype data come together this fall it will be an exciting time.

The extension and education team has developed a variety of extension materials for growers and end users including: posters, powerpoint presentation, business card, and brochure. These materials have been used at many field days and grower meetings. More recently, the extension/education team developed fact sheets for growers and end users that provide information on malting and breeding (see page 2). To enhance the extension/education efforts of the barley CAP, USDA-CSREES is providing supplemental funding. To obtain the funding, USDA-CREES requested an extension/education proposal. The objectives of the proposal were (1) to develop a long-range plan for extension to growers; and (2) develop and implement a teaching module for graduate student plant breeding courses. The proposal was submitted at the end of July and we are waiting for the USDA-CSREES response.

The third annual barley CAP meeting will be held on January 10, 2008 at the La Hacienda Hotel in San Diego, CA. The agenda for the meeting is in the article on the right side of this page. All barley CAP participants are expected to attend.

Finally, don't forget that the six month progress reports are due on October 1, 2007.

Barley CAP Annual Meeting Information

by Gary Muehlbauer

The 3rd Annual Barley CAP meeting will be January 10, 2008, at La Hacienda Hotel, San Diego. This will be a full day meeting 8 am to 6 pm. Hotel reservations are by individual call in (619) 298-4707. Make reservations by December 10, 2007.

Tentative agenda

- | | |
|------------------|---|
| 8:00 – 8:30 am | Continental breakfast |
| 8:30 – 8:50 am | CAP overview, budgets, renewal proposal
Gary Muehlbauer, U Minnesota |
| 8:50 – 9:40 am | Extension and education
Peggy Lemaux, U California-Berkeley
Brian Steffenson, U Minnesota |
| 9:40 – 10:15 am | SNP mapping & genotyping update
Tim Close, U California-Riverside
Shiaoman Chao, USDA-ARS |
| 10:15 – 10:30 am | Break |
| 10:30 – 10:50 | Phenotypes and traits
Kevin Smith, U Minnesota |
| 10:50 – 11:30 | THT
Julie Dickerson, Iowa State U |
| 11:30 – 1:30 pm | Lunch (on your own) |
| 11:30 – noon | QTL miner demo
Rex Bernardo, U Minnesota |
| 1:00 – 1:30 pm | QTL miner demo
Rex Bernardo, U Minnesota |
| 1:30 – 3:30 pm | Break Out Sessions |
| | • Data, databases and bioinformatics
Jennifer Kling, Oregon State U
Julie Dickerson, Iowa State U
Shiaoman Chao, USDA-ARS
Tim Close, U California-Riverside
Rex Bernardo, U Minnesota |
| | • Breeding lines, phenotyping, MAS
Pat Hayes, Oregon State U
Kevin Smith, U Minnesota |
| | • Extension and education
Peggy Lemaux, U California-Berkeley
Brian Steffenson, U Minnesota |
| 3:30 – 3:45 pm | Break |
| 3:45 – 4:30 pm | Summary from breakout groups |
| 4:30 – 6:00 pm | Scientific and Stakeholder Advisory Board meetings |

New Informational Fact Sheets Available for Barley CAP Outreach

by Karen Hertsgaard and Peggy G. Lemaux

Several new informational fact sheets are or soon will be available for Barley CAP participants to distribute to interested groups. The fact sheets are available for download in the outreach section of the Barley CAP website (barleycap.org) or from Barley CAP participants.

The first fact sheet, written by Karen Hertsgaard and Paul Schwarz from the Institute of Barley and Malt Sciences (IBMS) at North Dakota State University, is titled *Barley, Malt and Beer*. It was designed by Barbara Alonso at UC Berkeley. It is a two-sided document describing the malting and brewing processes, and explaining how Barley CAP research will lead to identification of markers that can speed the release of new varieties with improved malting quality characteristics. This fact sheet is especially useful for growers and end-users of barley and malt. It was distributed to more than 300 growers, researchers and Extension staff at Regional Extension Center Field Days in North Dakota in July.



WHAT IS BARLEY CAP?
Coordinated Agricultural Project for Barley
The Barley Coordinated Agricultural Project (CAP) is a community effort of 30 scientists from 10 institutions focused on identifying molecular markers that will dramatically speed up breeding efforts to improve barley for food, feed and brewing.

Although most cereal grains can be used in brewing, brewers discovered hundreds of years ago that barley is really the grain of choice for making malt and beer. In fact to make beer, malted barley is the major ingredient in beer, contributing sugars for fermentation and most of the color, flavor and foam.

US brewers produce over 6 billion gallons of beer each year, requiring over 4 billion lbs of malted barley. The production by U.S. barley growers is essential to supply this industry.

WHAT GOES INTO MY BEER?
On average a single 12 oz serving requires:
72 oz water
0.8902 lb malted barley
0.2890 lb unmalted rice or corn
0.0003 lb hops

QUALITY FACTORS USED IN MALTING BARLEY PURCHASE
Malting barley probably undergoes more quality tests than any other field crop. However, for purchase only a few tests can predict malting and brewing quality.

Kernel Ploppiness: Barley kernels are ~65% starch, which is converted during brewing to fermentable sugars and finally alcohol. Plump kernels have more starch and thus more fermentable extract needed to brew beer.

Protein Content: Barley kernels are typically 10-13% protein – some of which is important for yeast nutrition during fermentation and some for beer color, flavor and foam. Malsters and brewers generally have upper limits on protein content depending on their process. As protein content increases, the properties of starch/fermentable extract decreases, causing economic losses to brewers. High protein can also cause processing problems, like formation of too much color.

Germination: Malting depends on controlled germination. If grain does not germinate, necessary biochemical changes do not take place, reducing the amount of fermentable extract. Poor germination also causes problems in brewing, like poor beer filtration.

Variety: Barley varieties are developed specifically for malting and brewing – each with its own characteristics. Different brewers prefer different varieties or blends of varieties for their products.

Damaged Kernels: Many types of kernel damage can occur, often greatly influenced by environment. Damage can reduce germination in cause production of undesirable tastes and off-flavors that end up in beer. Examples include mold, ventosa, immature kernels, sprouted, or skinned and broken kernels.

WHAT IS BARLEY CAP DOING?
Malting quality is a complex trait. The genetic complexity and the expensive laboratory procedures required to measure malting quality make it an excellent target for Marker-Assisted Selection (MAS). With MAS, genetic markers close to malting traits act like biochemical flags providing fast and easy identification of traits important to barley breeders. Identification of markers for malting quality will speed release of new varieties bred for specific malt attributes.



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The impact is being felt in land grant universities, which are a major force in public sector breeding efforts. Losses in breeding programs rise profoundly impact their ability to develop improved varieties.

Recently, USDA CSREES initiated Coordinated Agricultural Programs or CAPs, to foster collaborative efforts that gather and utilize new genetic information to speed up breeding.

Barley CAP involves 10 breeding programs and 11 researchers from 13 states (www.barleycap.org), who will focus their efforts on biologically and economically important problems in barley.

Availability of CAP funding creates a means to combine long term breeding efforts by leveraging the physical and intellectual resources from all participating programs.

The CAP structure provides a new model for breeding programs that is regionally, rather than state-oriented, leveraging efforts of a diverse group of individuals and institutions. CAP programs lead the way in fostering the new, streamlined approach to crop breeding.

WHAT IS BARLEY CAP DOING?
Improvements through classical breeding require many years. Efforts of Barley CAP are aimed at simplifying and streamlining the process. This will be accomplished through the identification of genetic markers linked to traits of interest that can be used in a Marker Assisted Selection approach. This technology speeds breeding efforts to identify plants with desired traits. Barley CAP leverages the multidisciplinary efforts of many researchers at diverse institutions focused on improving barley.

Plant breeding is an inexpensive way to develop new crop varieties. Historically nearly every U.S. crop has been improved through classical breeding.

U.S. consumers only spend less than 10% of their income on food today; it was 22% in 1925. This was due in large part to increases in farm productivity due to breeding. But are breeding efforts important in the 21st century?

To address issues, like the ability of crops to survive drought and floods the use of crops for biofuels and feeding crop levels due to urbanization, breeding for improved crops is critical.

Today, breeding of crops, like corn, cotton and soybeans, is largely done by the private sector. But breeding of barley, wheat and many small acreage crops, is still primarily done in the public sector.

Because breeding improvements need many generations to achieve goals, long term commitments of personnel and resources are needed. But government investments in breeding have declined dramatically in recent years – much government funding goes to more basic rather than applied research.

Another fact sheet available for download is entitled, *Plant Breeding – The Way Forward*. This addresses the need for investment in breeding efforts for barley and how Barley CAP is a step in the right direction in developing those resources.

The next fact sheet under development is entitled: *Barley: It's What's for Dinner* and focuses on the use of barley in foods. So, check the website often and use these fact sheets to enlighten your target audiences!!

If you have comments about the fact sheets or ideas for future versions, please contact Peggy Lemaux at lemauxpg@nature.berkeley.edu or Barbara Alonso at balonso@nature.berkeley.edu.

Prototype of Hordeum Toolbox Available

by Julie Dickerson

The first prototype of The Hordeum Toolbox (THT) database is available at www.hordeumtoolbox.org. The current data in the database consists of trait data from the first year of the study, pedigrees from the first year and the CAP Core lines, and the marker data from the CAP Core barley lines. The web portal offers features such as graphical views of pedigrees, displays of markers on genetic maps, and searches through the pedigree data. The Germinate database, developed by scientists at the Scottish Crop Research Institute and the University of Dundee, was used to develop THT. The prototype was developed at Iowa State University by a PhD bioinformatics student, Huang Yong, and an undergraduate senior in computer engineering, Ethan Wilder, under the direction of Julie A. Dickerson.

Barley CAP Website Update

Patrick Hayes and Peter Szucs have added material to the Research Progress section of the Barley CAP website (www.barleycap.org). One new link is for the 1933 locus (ppt) file. The remaining files have been updated.

CAP Core Germplasm screening:

- CAP Core Pedigrees (Excel file)
- Pilot OPA data
 - Pilot OPA 1: data analysis in process
 - Pilot OPA 2: SNP Data (Excel file 2.5 mb)
 - * Pilot OPA 3: OPA synthesis in process
- UPGMA Cluster Analysis of the CAP Core Germplasm based on Pilot OPA 2 SNPs

CAP Maps:

- An Explanatory Note on CAP Maps
- Oregon Wolfe Barley
 - 1993 loci: Pre-CAP data, Pilot OPA 1, Pilot OPA 2, DArT
- Steptoe x Morex (in process)
- Morex x Barke (in process)

Students and Faculty Visit U of M

by Gary Muehlbauer

A group of six Ph.D. graduate students from two universities in India [Indian Institute of Technology at Roorkee (IITR), and the Ch. Charan Singh University at Meerut (CCSU)] are in Shahryar Kianian's lab at North Dakota State University for a five month training experience as part of a NSF-Developing Country Collaboration grant. Five of these students, Shahryar and Dr. Ghavami (a postdoctoral scientist at NDSU) visited the St. Paul campus of University of Minnesota to learn more about the Barley and Wheat CAP projects. All of these students are involved in research projects related to crop improvement (QTL mapping and gene introgression) and were very interested in how various genomic techniques are being applied at U. of Minnesota.



Gary Muehlbauer and Shahryar Kianian with a group of Indian scientists. Gary discussed the barley CAP with them during a visit to St. Paul, MN, on August 17, 2007. The group consisted of scientists and students in breeding and genetics from India.



Utah State University Small Grains Team

by David Hole

The Utah State University small grains improvement team is responsible for development and technology transfer of spring barley, spring wheat, fall barley, fall wheat, and fall triticale cultivars. Cultivar development is divided between dryland (crop-fallow) and irrigated production environments in the state of Utah and the Intermountain West. The program has a long history of direct involvement with producers and industry.

The USU team will be performing a phenotypic assessment of harvest index traits for two years of the full multi-program nursery spring entries. The first of those years is in the field and the data collection is currently ongoing. In addition, the program will perform the normal CAP phenotypic yield and quality assessments for the 96 lines that we have provided in 2005 and 2006. In addition, we have enjoyed presenting the nurseries and the goals of the CAP program to producers and industry representatives at field days and growers' meetings.

The small grains breeding programs have traditionally been tightly integrated acting as a single team and, over time, this integration has become even more comprehensive. It is not unusual to harvest dryland winter wheat yield plots at one location one day and an irrigated spring barley yield nursery down the road the next day. To accomplish this, we boast a great lab and field crew. The crew consists of PhD and MS scientists working alongside graduate students, undergraduate students, and high school students. At least one high school student working for the small grains program at USU went on to obtain their BS and MS degrees in plant science. Currently there are two high school students working on the barley CAP nurseries. Amelia will be beginning her senior year at Sky View High School this fall and is very interested in working toward a BS in plant genetics when she graduates in a year. Ryan will also be a senior and this is his second season in the crew. Corey started in the small grains team while in high school but will now be beginning his junior year this fall at USU as a fellow in the Utah State University honors program. Corey is majoring in Political Science (can't win them all). Corey and Amelia have taken the leadership for data collection for harvest index traits for the plots representing the full set of CAP entries from 2006.

The experience that these high school and undergraduates receive in taking ownership and responsibility for various aspects of the program is very useful to them. It is also a great source of satisfaction to watch their growth over the years. Many former high school and undergraduate student workers keep in touch long after their tenure with the breeding crew.

The permanent technical support is a father and son team, Shyrl and Justin Clawson. Currently, Shyrl takes the lead role for managing the fall small grains and Justin looks after the spring grains. Both Shyrl and Justin received their BS and MS degrees from USU and between them have over 40 years of experience with the program. The only dispensable person in the team appears to be the PI, Dave Hole.



Growers and representatives of the seed industry learn about the goals of the barley CAP program with the help of the non-technical poster in front of the nursery with all 958 CAP lines from 2006.

Continued from page 4.



The USU barley team Left to Right; Amelia, Shyrl Clawson, Ryan, David Hole, Corey, Justin



The Utah CAP yield trials at the 2007 Utah State University field day in Logan, UT.



Amelia collects samples for harvest index evaluation.



Happy workers make happy barley.

Students Participate in Barley CAP Sponsored Tour

by Karen Hertsgaard

Students and interns at NDSU followed processing of barley from the field to finished malt as part of the “Combine to Kitchen Tour” on July 18. This tour, organized by the Barley and Wheat Coordinated Agricultural Projects (CAP), included stops at research labs on the campus of North Dakota State University, the Cargill Malt Plant at Spiritwood, ND and the farm of Jim Slag near Wimbledon, ND. Fourteen students, Dr. Bill Berzonsky (NDSU Specialty Spring Wheat Breeder and a Co-Investigator for the Wheat CAP) and Karen Hertsgaard (Information Specialist for Barley CAP) organized the tours. The tour, sponsored by the barley CAP, was free to students who attended.

The first stop of the tour was the Barley and Malt Quality lab at NDSU. James Gillespie showed how barley samples are analyzed for deoxynivalenol (DON). DON testing is an integral part of breeding for Fusarium Head Blight resistance, and the lab tests about 18,000 samples each year. John Barr and Paul Schwarz explained the biochemistry of the malting and brewing processes, and gave a tour of the lab’s pilot-malting and brewing equipment. Paul Schwarz is in charge of the NDSU Barley and Malt Quality Program, and also directs the Institute of Barley and Malts Sciences.

The second stop on the tour was the Cargill Malt facility where agronomist, Ray Albrecht, and, control

center Operator, Jeremy Alonge introduced the facility and explained the malting process by showing the group actual malt production activities.

At the third and final stop Jim, Doris and Sherri Slag welcomed the group to their farm near Wimbledon, ND. Jim grows certified barley seed, wheat and various other crops. He explained the process of producing certified barley seed and allowed tour participants to examine his wheat and barley crops, as well as some of his farm equipment.

The tour was well received and helped students understand the processes that produce quality barley and malt.



At NDSU John Barr and Paul Schwarz explain the malting and brewing processes to tour participants.

Recently Published Barley CAP Related Papers by Close and Lonardi

by Stefano Lonardi

“Efficient and accurate construction of genetic linkage maps from noisy and missing genotyping data,” by Y. Wu, P. Bhat, T. J. Close, S. Lonardi Proceedings of Workshop on Algorithms in Bioinformatics (WABI'07), LNBI 4645, pp.395-406, Philadelphia PA, 2007.

Abstract: We introduce a novel algorithm to cluster and order markers on a genetic linkage map, which is based on several theoretical observations. In most cases, the true order of the markers in a linkage group can be efficiently computed from the minimum spanning tree of a graph. Our empirical studies confirm our theoretical observations, and show that our algorithm consistently outperforms the best available tool in the literature, in particular when the genotyping data is noisy or in case of missing observations.

“A Compartmentalized Approach to the Assembly of Physical Maps,” by S. Bozdog, T.J. Close and S. Lonardi, to appear in Proceedings of IEEE International Symposium on Bioinformatics & Bioengineering (BIBE'07), Boston, MA, 2007.

Abstract: We propose a novel compartmentalized method for the assembly of physical maps from fingerprinted clones. Our assembler exploits the presence of genetic markers at the global level to improve the accuracy of the assembly. Experimental results on the genome of rice and barley demonstrate that the compartmentalized assembler produces significantly more accurate maps, and that it can detect and isolate clones that induce chimeric contigs.

Seedsmen Field Day in Warsaw, Virginia

by Bob Pitman

The seedsmen's tour in May was attended by 57 persons involved in the seed industry in Virginia. This included producers of seed, seed processors/conditioners, and representatives of companies that sell seed in Virginia and surrounding states. Both the wheat and barley CAP programs were discussed.

According to Bruce Beahm, VCIA Foundation Seed Farm Manager, the quality of this year's barley crop was excellent and yields were good, except for a few areas that suffered late freeze damage. His take on barley acreage is that it is steady to increasing slightly.



Wynse Brooks (right) gave a presentation at the seedsmen's tour in Virginia.



Carl Griffey



Calendar

- October 1, 2007** 6 month, Year 2 barley CAP progress reports due
- October 26–28, 2007** 120th Anniversary Convention, the Master Brewers Association of the Americas, Nashville, TN
- Nov 4-8, 2007** ASA-CSSA-SSSA International Annual Meetings in New Orleans, LA.
- Nov. 5-9, 2007** 11th International Symposium on Pre-harvest Sprouting in Cereals, Mendoza, Argentina; <http://www.agro.uba.ar/epg/sprout2007/index.htm> or sprout07@agro.uba.ar
- Nov. 27-30, 2007** 5th Canadian Workshop on Fusarium Head Blight
- December 2-4, 2007** 2007 National Fusarium Head Blight Forum, The Westin Crown Center, Kansas City, MO
- January 10, 2008** Barley CAP annual meeting, La Hacienda Hotel, San Diego, CA. Reservations: (619) 298-4707.
- January 12-16, 2008** International Plant and Animal Genome Conference, Plant & Animal Genome XVI, San Diego, CA
- August 24-29, 2008** **9th International Congress of Plant Pathology**, Torino, Italy. Italian Society for Plant Pathology (SIPaV), Italian Association for Plant Protection (AIPP) and International Society for Plant Pathology (ISPP).
- Aug. 30-Sept 2, 2008** 10th International Fusarium Workshop and Fusarium Genomics Workshop, Alghero, Sardinia (Italy)



BarleyCAP

The Barley Coordinated Agricultural Project (CAP), funded by the National Research Initiative (NRI) of the USDA Cooperative State Research, Education and Extension Service (CSREES), involves government and public- and private-sector laboratories. The project links laboratory and field research with education and outreach. It uses modern tools of genomics to facilitate classical plant breeding efforts to develop superior barley varieties.

