

Barley Coordinated Agricultural Project Work Plan FY06 (3/1/07 – 2/28/08)
Blake Cooper, Busch Agricultural Resources Inc.

1.) Describe the research, education, and outreach activities you are planning for the next year (3/1/07 – 2/28/08)

Research We will soon identify the 96 BARI CAP breeding lines for 2007 per the requirements outlined in the Barley CAP Participants Guide. For 2007, these lines come mostly from our domestic two row, and domestic six row breeding programs, at the new Y4 and Y3 stages; with the remainder coming from the International two row breeding program. We are planning on planting the domestic lines at the following locations as part of our elite variety trials which are typically 3 replicated plots of ~1.5 m x ~5 m in size, laid out in a randomized complete block design that is optimized for nearest neighbor analysis as listed in table 1 below:

Trial Name	Mid Western Locations					
	Sidney, MT	Sidney, MT	Terry, MT	Casselton, ND	Bottineau, ND	Minot, ND
Water type	<i>irrigated</i>	<i>dryland</i>	<i>irrigated</i>	<i>irrigated</i>	<i>dryland</i>	<i>dryland</i>
two row		X				
six row	X	X	X	X	X	X

Trial Name	Intermountain West Locations					
	Twin Falls, ID	Idaho Falls, ID	Rexburg, ID	Brady, MT	Fairfield, MT	Conrad, MT
Water type	<i>irrigated</i>	<i>irrigated</i>	<i>irrigated</i>	<i>dryland</i>	<i>irrigated</i>	<i>dryland</i>
International two row		X			X	
two row	X	X	X	X	X	X
six row		X		X	X	

The new Y4 group will be included in many ‘exchange’ trials with Universities. Additionally, some of these same lines will be included in paid testing at sites in the provinces of Alberta, Saskatchewan, and Manitoba, Canada. The international two row lines may also be tested at several sites in Europe, the Peoples Republic of China and Argentina.

The respective two-row trials will have Harrington as one of the check varieties and Robust as one of the check varieties in the six row trials. Each BARI operated location in the table above will also have a separate single replicate plot of the “Malt-Genes” trial which includes Robust, Harrington and the other CAP check Baronesse. The entire “Malt-Genes” set of 36 varieties will appear on the OPA 2 Illumina SNP Chip test platform and were used previously (by Dr. Pat Hayes) to validate the broader applicability of the SNP technology to a range of germplasm. We have previously sent grain samples of these 36 “Malt-Genes” lines from ~ 10 locations each in 2004, 2005 and 2006 (to Al Budde) at the CCRU, Madison, WI. as a standardized set of malting data over a wide range of geographic and management practices. We do not, however, anticipate sending this “malt-Genes” set for a fourth year of malting data. While all three specified check varieties are not included directly in each of our Y4 (2401 and 6401) trials and Y3 (2301 and 6301) trials, the common access to all three barley CAP spring check varieties from the “Malt-Genes” trial grown at all the same locations should permit a valid check set for the data collected in the elite trials.

We typically collect data on grain yield, plump grain % (assortment), and grain protein concentration from all sites that are taken to harvest. In addition; we will collect data such as plant height, stem length, heading date, lodging, various disease reactions, etc. at all locations where such notes are justified. We normally do not collect data on test weight, but are prepared to record this observation on all locations that are taken to harvest. Additionally; we commit to micro-malting several of these locations in our own malt quality laboratory in Ft. Collins managed by Dr. Jolanta Menert. We reserve the right to abandon any of these locations for yield harvest, and / or malting quality evaluations at our sole discretion, if we feel that the data would be

compromised due to adverse weather conditions (hail storms, other Acts of God and Nature, etc.) or limitations on our laboratory or research resources.

We will also participate in a collaborative FHB trial with the four Midwest breeding programs. Prior to April 1, 2007, we will send seed from our 96 entries to North Dakota (Richard Horsley and Stephen Neate) and Minnesota (Kevin Smith) and we may assist in the collection of data at these sites if time and personnel availability permits. We will send breeders source seed of our 96 CAP lines seed to Brian Steffenson (5 g), and Tom Blake (10 g) for evaluation of spot blotch and backup Breeders Source seed increases respectively.

In we will continue to offer planting (~10 g) of the Breeders Seed Source of each of the 96 breeding lines from each of the 8 participating spring barley programs (768 lines total) in the 2007 barley CAP project at Ft. Collins in a single replicate mini-plots (6 rows by ~1.5 m² in length). We will not plant the winter barleys at Ft. Collins in 2007. The spring lines will be planted as soon as practicable after April 1, 2006 at Ft. Collins, CO. We plan to record observations such as plant height, heading date, and other botanical traits as deemed appropriate on these plots and to harvest each of the 768 plots as “combine pure seed” which will subsequently be de-awned, cleaned and ~ 600 grams distributed to other participants as listed in the Barley CAP Participant Guide for testing of the Breeders Seed Source.

(Note: We had previously agreed to plant a single row “hand harvest pure seed” increase in 2007 of the Single Seed Descent DNA Seed Source from 2006 lines for long-term storage at germplasm storage centers. At present we are working under the assumption that the single seed increase currently being done by Dr. Kevin Smith at UM will be sufficient for that purpose and thus we will not be growing single rows of the 2006 source in 2007).

Education We plan to ‘educate’ some of our corporate upper management on the general goals and purposes of the Barley CAP program. This may occur at various field day locations and as we make presentations to management at scheduled company meetings. (i.e. Brewer’s Conclave, Williamsburg, VA in June).

Outreach We typically give tours every year to several school groups from high schools and colleges; trade or association groups (teachers, Master Brewer’s of America, Agronomy Clubs, etc.). We will attempt to include what we are doing and share any Barley CAP publications, promotional materials, etc. as appropriate with each of these groups.

2.) List specific outcomes and deliverables that will be accomplished in the first 6 months (3/1 – 8/31). These will be used as benchmarks for your bi-annual progress report.

- Send seed of our 96 lines to (Smith, Steffenson, Horsley, Neate and Blake) by April 1.
- Plant out ~1.5 m² Breeders Seed Source at Ft. Collins, CO of all 768 spring CAP lines for 2007.
- Plant replicated yield trials of our own 96 lines as listed in table 1. Plant Malt-Genes trial at same sites.
- Collect botanical observations such as plant height, heading date etc. as appropriate on the 768 spring CAP lines and make the plots available to other participants for any other botanical observations or notes they may wish to make at Ft. Collins, CO.
- Make available any desired prior data, including malting quality data on our own 96 lines to the data base coordinator Dr. Jennifer Kling, OSU. Most of these 96 lines will have had 3-4 years of prior data collected from multiple locations and growing conditions. The prior data set will have Merit, Harrington and B1202 checks for two row trials and Morex, Robust and Legacy for six row trials. Because these checks are all included in the planned OPA 2 standard set and are also included in the Y4 and Y3 stage trials there should be enough common check overlap to make this very extensive prior phenotypic data set highly useable for association mapping of our 96 barley CAP lines.

3.) List specific outcomes and deliverables that will be accomplished in the second 6 months (9/1/07 – 2/22/08). These will be used as benchmarks for the bi-annual progress report.

- Record observations for grain yield, plant height, heading date, etc. according to the Barley CAP Participants Guide as we deem appropriate in our own elite trials from the locations listed in table 1.
- Micro-malt and evaluate malting quality traits from our own elite trials from selected locations among those available in table 1. as we deem appropriate. Final malting data may only be available after 02/28/08.
- Supply (only if requested) grain samples of the 2007 “Malt-Genes” trial to CCRU from as many locations as deemed appropriate, to complete malting data to validate malting genes on future OPA chips.

**Barley Coordinated Agricultural Project Biannual Progress Report
 FY06 (4/1/06 – 3/31/07)
 Blake Cooper, Busch- Agricultural Resources Inc.**

1) Describe the research, education, and outreach activities you completed in the first half of the FY06 (4/1/06 – 9/30/06)

Research – We accomplished a small scale pure seed increase of all 960 lines, including 192 winter barley lines and 768 spring barley lines. Each entry was grown in a single 1 meter² mini-plot consisting of six rows of 1 meter in length. The growing conditions in Fort Collins during 2006 were extremely difficult. Temperatures were significantly above normal and this stress resulted in reduced yields in spite of our best efforts to maintain full irrigation, etc. Plant Height and Heading Date notes were recorded for all lines, including the winter barleys which did manage to vernalize and head following spring sowing. Each plot was harvested individually with a Wintersteiger Plot combine with chaff air set low to recover the maximum amount of pure seed. Subsequently, each line was re-cleaned by passing two times through a belt thresher with constant air flow to remove chaff and retain maximum amount of seed. The clean weight of each plot was recorded, a small ~7 gram reference sub-sample was retained for long-term germplasm storage in our facility and the balance of all lines plus the check cultivar pure seed was shipped to St. Paul MN for distribution to participants.

Additionally, we trialed our own 96 lines (two row, six row and international) at multiple sites in the upper-Midwest and Western U.S. and in assorted trials in Canada, Europe and Argentina as part of the normal course of testing we would have performed on these lines. Data will be summarized when complete. Some of these sites will also be submitted for micro-malting analysis and these quality data will also be summarized when complete. Furthermore, we will have multiple years (3-5) of prior data (agronomic, pathology and malting quality) already collected on these same lines that will be available for up loading at the appropriate time into the THT database.

Education - No real activity here, other than weekly updates to Ft. Collins staff and management on status of project and coordinating ongoing operations and the goals of the project at large.

Outreach - No real activity here either. Blake did present summaries and updates of project to senior management at several internal meetings during the year. But we did not do much ‘external’ outreach.

2) List specific outcomes and deliverables accomplished in the first half of FY06 (4/1 – 9/30).

- Breeder’s seed was planted in 1 meter² plots in February, 2006.
- Collected plant Height and Heading date from CAP breeders seed plots.
- Harvested and processed and shipped pure seed from each of 960 CAP entries. Retained a ~ 7 gram reference sub-sample of each line for long-term germplasm storage.
- Conducted yield trials and observations on our own 96 entries as part of normal research. Collected data where ever we could.
- Sent pedigrees to Jennifer Kling for inclusion in THT database.
- Spent several hours in assorted email discussions and conference calls relating to line nomenclature, pure seed distribution and database issues.
- Spent about half a day in cursory data analysis of CAP lines comparing seed amounts (yield) from Ft. Collins and Bozeman, MT pure seed plots. {See attachments}.
- We estimate that we ‘invested’ almost 300 man-hours and /or the equivalent of \$9,000 - \$10,000 on the Barley CAP during this period. We did not request or receive any government funds from the project, but are willing to bear this burden privately as a participant.

Estimated Man-Hours of Labor Contributed to CAP Project during 2006 (284)

Planting (32)		Notes (50)	
Land prep	06	Height	12
Seed Prep	10	Heading	36
Planting	16	General appearance	02

Plot Maintenance (60)

Fertilizer & Pesticides	02
Rotary Hoe & Hand	17
Alley Cutting, 2x	06
Extra weed control	20
Irrigation 5x	15

Harvesting (142)

Label Prep / Combine	40
Belt Thresh / Clean	50
Weight and Package	24
UMN Shipment	20
Data Analysis	08

Additionally, we would have expensed fuel, travel and hotel bills incurred during delivery of seed to St. Paul, MN; electricity (irrigation), fuel, fertilizer and insecticide, bags, labels, etc.

A good faith estimate of our total "investment" in the Barley CAP Project for 2006 would be ~ \$9,000 - \$10,000 of in-kind support.

Summary of Breeders Seed Increase at Ft. Collins, CO and Bozeman, MT

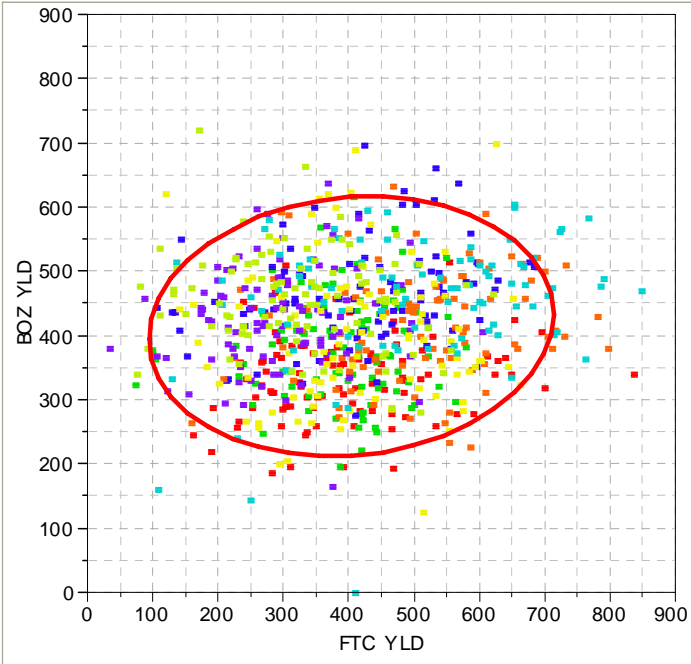
This table contains the mean amount of Pure seed recovered from each plot (line) for each of the 10 individual breeding programs. The winter barley from OSU and UVA were only grown in Ft. Collins. The table also includes the mean Julian heading date and mean plant height in cm for each program.

2006 CAP Breeder's Seed Increase

TRIAL_NM	FTC	BOZ	2 Loc	FTC HDJD	FTC HTCM
	Ave. grams	Ave. grams	Ave. grams	Ave. Julian	Ave. cm
2NDSU	396.8	334.0	365.4	161.4	58.9
6NDSU	388.5	379.1	383.8	170.0	63.7
BARI	421.2	463.3	442.2	169.8	57.3
MSU	505.8	413.9	459.8	169.4	58.6
OSU	352.9			160.7	58.2
UMN	296.0	424.9	360.5	168.7	59.2
USDA	409.5	397.4	403.4	169.8	59.0
USU	494.0	454.5	474.2	168.9	59.9
UVA	293.0			158.1	41.7
WSU	332.9	459.3	396.1	166.7	58.1
Grand Average	389.2	415.5	402.4	166.9	57.4

See next page for bi-variate fit Bozeman vs. Ft. Collins pure seed amounts. Overall there was only a very slight positive correlation (0.096) between the amount of pure seed harvested (yield) at Ft. Collins and Bozeman. The BARI and Utah State University individual programs had moderate correlations between Ft. Collins and Bozeman (0.25 and 0.26 respectively). Effectively the two environments did not behave alike.

Bivariate Fit of BOZ YLD By FTC YLD



— Bivariate Normal Ellipse P=0.900

Correlation					
Variable	Mean	Std Dev	Correlator	Signif. Prot	Number
FTC YLD	404.8162	144.3065	0.095911	0.0082	759
BOZ YLD	415.1274	94.33056			

Correlation TRIAL NAME=="FTC CAP 2NDSU"					
Variable	Mean	Std Dev	Correlator	Signif. Prot	Number
FTC YLD	396.8333	128.8934	0.151852	0.1397	96
BOZ YLD	333.9906	66.11687			

Correlation TRIAL NAME=="FTC CAP 6NDSU"					
Variable	Mean	Std Dev	Correlator	Signif. Prot	Number
FTC YLD	388.4635	99.62766	0.059945	0.5618	96
BOZ YLD	379.0531	79.81042			

Correlation TRIAL NAME=="FTC CAP BARI"					
Variable	Mean	Std Dev	Correlator	Signif. Prot	Number
FTC YLD	419.0978	134.7877	0.253323	0.0148	92
BOZ YLD	463.2815	78.91186			

Correlation TRIAL NAME=="FTC CAP MSU"					
Variable	Mean	Std Dev	Correlator	Signif. Prot	Number
FTC YLD	505.8073	131.8975	0.143579	0.1628	96
BOZ YLD	413.8635	84.45347			

Correlation TRIAL NAME=="FTC CAP UMN"					
Variable	Mean	Std Dev	Correlator	Signif. Prot	Number
FTC YLD	296.0474	100.9363	0.097212	0.3487	95
BOZ YLD	424.9168	79.15425			

Correlation TRIAL NAME=="FTC CAP USDA"					
Variable	Mean	Std Dev	Correlator	Signif. Prot	Number
FTC YLD	409.484	125.5513	-0.02095	0.8412	94
BOZ YLD	397.4138	111.2624			

Correlation TRIAL NAME=="FTC CAP USU"					
Variable	Mean	Std Dev	Correlator	Signif. Prot	Number
FTC YLD	495.0105	168.6049	0.260763	0.0107	95
BOZ YLD	454.4926	98.2288			

Correlation TRIAL NAME=="FTC CAP WSU"					
Variable	Mean	Std Dev	Correlator	Signif. Prot	Number
FTC YLD	327.4789	120.5108	-0.14459	0.1621	95
BOZ YLD	456.5884	73.90973			