

UNITED STATES DEPARTMENT OF AGRICULTURE  
AGRICULTURAL RESEARCH SERVICE  
MIDWEST AREA  
CEREAL CROPS RESEARCH UNIT

**WESTERN REGIONAL SPRING BARLEY NURSERY – 2010 Crop**  
Preliminary Quality Report

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Detailed Data:

Idaho Falls, ID      Conrad, MT      Fairfield, MT

Appendix:

Methods

Criteria for Quality Score

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This is a joint progress report of cooperative investigations being conducted in the Agricultural Research Service of the U.S. Department of Agriculture and State Agricultural Experiment Stations. It contains preliminary data that have not been sufficiently confirmed to justify general release; interpretations may be modified with additional experimentation. Confirmed results will be published through established channels. The report is primarily a tool available to cooperators and their official staffs and for those persons who have a direct and special interest in the development of improved barleys.

This report includes data furnished by the Agricultural Research Service as well as by the State Agricultural Experiment Stations. The report is not intended for publication and should not be referred to in literature citations nor quoted in publicity or advertising. Use of the data may be granted for certain purposes upon written request to the agency or agencies involved.

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Samples malted and analyzed by the Cereal Crops Research Unit, Madison, WI

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## Western Regional Spring Barley Nursery – 2010 Crop

Nursery samples were received for malting quality evaluation from three experimental stations located in Idaho and Montana. The parentages of the nursery entries are listed in Table 1. The agronomics of this nursery are presented in a separate report at:

<http://www.ars.usda.gov/SP2UserFiles/Place/53660000/2010WRBNREPORT.pdf>

Ten of the thirty-one entries were new in this year's nursery.

These samples were germinated for four days in Joe White micro-malters under conditions that should generate malts having modification levels similar to those produced by industry. Detailed descriptions of the malting conditions and analytical methods employed are listed in Appendix A. The criteria and value assignments used to calculate quality scores are based upon "Ideal Commercial Malt Criteria" developed by the American Malting Barley Association (AMBA)

([http://www.ambainc.org/media/AMBA\\_PDFs/Press\\_Releases/GUIDELINES.pdf](http://www.ambainc.org/media/AMBA_PDFs/Press_Releases/GUIDELINES.pdf)) and are listed in Appendix B.

The mean values for fourteen quality factors are listed over the three stations located in the Western Region (Table 2) and over all lines (Table 3). Individual station data are reported in Tables 4 through 6. Evaluations of data from individual locations and overall performance evaluations, derived primarily from Tables 2 and 3, are presented below.

The barleys from Idaho Falls, ID (Table 4) were plump, but many had elevated total protein values. Extract values ranged from 73.2 to 80.9%, with many of the lower values derived from "feed" type lines. Soluble protein values ranged from four that were too low to five that exceeded the upper limit. Half of the S/T ratios were too low, with most of these having the "feed type" designation. Most enzyme profiles were good. Thirteen viscosities and two thirds of the  $\beta$ -glucan contents were unacceptably high, indicating rather poor modification of these lines by our standardized malting protocol. Thirteen free amino nitrogen values (FAN) fell below desired amounts, but most were derived from the "feed type" barleys. Six turbidity values exceeded 15 Hach units. The

best performers were ND22421, 2ND25276, BZ505-172, 2ND26238, 2B06-0933 and CDC Austenson. ND22421 was very plump and had an extract value about 1% higher than the two-rowed Harrington experimental control, driven mostly by the lower total protein content. Most other quality parameters were within AMBA's "ideal" range, except for slightly elevated viscosity and turbidity values. 2ND25276 had an extract value over 2% higher than the experimental check, also driven by lower total protein. The diastatic power value was a bit low, due to the lower protein contents, but soluble protein and FAN levels were good. The  $\beta$ -glucan level was a bit high, but wort viscosity was good. BZ505-172 was submitted as a "feed type" barley, but showed some malting quality. Nitrogen modification was good, with a mid range S/T ratio and sufficient soluble protein and FAN levels. Carbohydrate modification proceeded a bit more slowly and resulted in elevated  $\beta$ -glucan and viscosity values. 2ND26328 had balanced modification, but was slightly under-modified by our standardized malting protocol. As a result, the S/T ratio and FAN values were a bit low, while the  $\beta$ -glucan contents were a bit high. 2B06-0933 had an extract value about 2% higher than Harrington, with a protein level about 1% lower. Other quality values were good, indicating a balanced, well modified malt. CDC Austenson was submitted as a "feed type" barley, but showed some malting quality. This line was slightly under-modified by our malting protocol and as a result, had rather low S/T and FAN values, with elevated  $\beta$ -glucan contents. Note that 2B04-0175, 2B05-0811, 2B06-0929, 2B07-1562 and 2B07-1590 had quality profiles that were very similar to the Harrington control, however all of these lines had superior extract values.

The barleys from Conrad (Table 5) were extremely plump and had rather low total protein levels. Extract values were very good, due in part to the low total protein levels. Most soluble protein values fell within AMBA's "ideal" range, but when combined with the low total protein values, over half of the S/T ratios exceeded the upper limit. Half of the diastatic power and FAN values were too low, while most  $\alpha$ -amylase,  $\beta$ -glucan and viscosity values were good. Eight lines had elevated turbidity values. The best performers were 2ND26328, MT020204, 2B04-0175, 2B06-0929, 2B07-1562, 2B06-0933 and Harrington. 2ND26238 was plump, with adequate malt extract and soluble protein. The S/T ratio was too high, but FAN contents were good. The enzyme

profile for 2ND26238 was on the lower side of AMBA's "ideal" guidelines. Beta-glucan, viscosity and turbidity values were very good. MT020204 was plump and its extract value was adequate, though lower than the control, which had similar protein levels. This line had excellent soluble protein and FAN values, but its S/T ratio was too high. Beta-glucan, viscosity and turbidity values were good, indicating good carbohydrate modification. 2B04-0175, 2B07-1562, 2B06-0933 had similar quality profiles to the Harrington control, except for extract values that were about 1% higher. The quality parameters of 2B06-0929 were also similar to those of Harrington, but this line's extract value was 1.9% higher. Harrington, the experimental control, performed well at this location, but had a rather low total protein value that contributed to an unacceptably high S/T ratio and low diastatic power value.

The barleys from Fairfield (Table 6) were very plump and most had good total protein levels. Most of the extract values were good. Seven diastatic power values were too low, but most of these were derived from "feed type" barleys. Alpha-amylase levels were generally good. Fourteen FAN values were low, mostly from "feed type" lines. A dozen  $\beta$ -glucan and viscosity values were too high, with nearly all derived from "feed type" barleys. Eight turbidities exceeded 15 Hach units and all were from the "feed type" barleys. The best performers were 2ND26328, ND22421, 2ND25276, 2B04-0175, 2B05-0811, 2B06-0933, 2B07-01590, 02Ab17271, CDC Meredith and 2B07-1562. 2ND26328 had an excellent quality profile, with only a slightly depressed FAN value falling outside of AMBA's "ideal" malt criteria. ND22421 also showed an excellent quality profile, but had a slightly depressed FAN value and slightly elevated  $\beta$ -glucan contents. 2ND25276 performed very well, but had an elevated S/T ratio and a slightly depressed diastatic power level. 02Ab17271, 2B04-0175, 2B05-0811, 2B06-0933, 2B07-1590 and 2B07-1562 had similar good profiles. All had slightly elevated soluble protein values that contributed to unacceptably high S/T ratios. Note that 2B05-0811 did not generate as much diastatic power as the other Busch Ag. Res. submissions. All yielded higher extract values than the experimental control. CDC Meredith had a very good extract value, but its S/T and turbidity values were elevated.

The lines in this nursery performed best overall (Table 2) at the Fairfield, MT site. The total protein levels averaged an excellent 12.2%. The averaged extract value of all

selections was a bit low, however the “malting” and “feed/malting” lines averaged 81.3%, which was quite good. Most other quality parameters were very good for the malting lines, however the mean soluble protein level was a bit high and this contributed to a mean S/T ratio that was unacceptably high. The Conrad, MT location averaged just over 10% total protein. The low protein levels contributed to excellent extract values for the malting lines. The mean soluble protein level was good, but the S/T ratio exceeded the upper desired limit. The lower total protein values negatively impacted the diastatic power values, which averaged below the desired level. Turbidity values were a bit high, while all other quality parameter fell within AMBA’s “ideal” guidelines.

The averaged total protein values from the selections grown in the Idaho Falls nursery were high at 13.6% and at 13.9% for those designated as malting lines. Extract values were lowest of the nursery locations, while the diastatic power and FAN values were highest as would be expected, with the elevated protein. Carbohydrate modification was poor compared to the other locations resulting in higher  $\beta$ -glucan and viscosity values.

The best performers in this nursery were 2B06-0933, 2B07-1590, 2ND25276, 2ND26328, ND22421, 2B05-0811 and 2B04-0176. Note that all lines designated as malting or feed/malting types performed equal to or better than the Harrington control, with the exception of MT040073. 2B06-0933 and 2B07-1590 were plump, had good total protein contents and excellent extract values. These lines had balanced modification that yielded low  $\beta$ -glucan and viscosity values, with good soluble protein and FAN levels. The S/T ratios were a bit high indicating slight overmodification by our standardized malting protocol. Enzyme and turbidity levels were excellent. 2ND25276 was plump, had 1% less protein and over 1% more extract than the Harrington control. Other quality parameters were good and similar to Harrington. 2ND26328 was the plumpest line in the nursery. This line had a total protein level similar to that of the Harrington control, with an extract value that was a half percent higher. Diastatic power,  $\alpha$ -amylase and FAN values were a bit lower than the control, while the  $\beta$ -glucan value was a bit higher, though not significantly different. Viscosity and turbidity values were good. 2B05-0811 had the highest averaged extract value in this nursery. Enzyme levels fell into AMBA’s “ideal” range. The averaged S/T and FAN values were high,

indicating excessive protein modification with our standardized malting protocol, but the  $\beta$ -glucan and viscosity values were low showing that overall modification was balanced.

The mean quality values of 2B04-0175 and 2B06-0933 were very similar. These lines had total protein contents that were similar to the Harrington control. Both lines yielded over 1% more extract than Harrington. Enzyme and FAN levels were higher than that of Harrington, while  $\beta$ -glucan and viscosity values were lower. ND22421 was the only six row malting line in the nursery. This line was very plump averaging 97.7% and its total protein value was similar to the two row check. The mean extract value for ND22421 was a little lower than that of Harrington, while most of the other quality parameters were similar to the experimental control.

**Table 1. 2010 Western Regional Spring Barley Nursery, Entry List**

Seed Source	Entry Number	Entry	Parentage	Rowed	Grade
WSU	1	Steptoe	CI 15229	6	feed
WPB	2	Baronesse	PI 568246	2	feed
USDA-ARS	3	Harrington		2	malting
USDA-ARS	4	AC Metcalfe		2	malting
BAR LLC	5	2B04-0175	2B97-4719/2B97-4004	2	malting
BAR LLC	6	2B05-0811	2B99-2763/2B00-0719	2	malting
BAR LLC	7*	2B06-0929	2B97-4004//2B00-0784/2B99-2771	2	malting
BAR LLC	8*	2B06-0933	2B97-4004//2B97-4299/2B99-2763	2	malting
BAR LLC	9*	2B07-1562	MERIT 16/2B00-0251	2	malting
BAR LLC	10*	2B07-1590	MERIT 16/2B01-2005	2	malting
USDA-ARS	11	2Ab04-X00017-4	97Ab6361/95Ab11469	2	feed
USDA-ARS	12	02Ab17271	85Ab2323/Merit	2	malting
WPB	13	BZ505-172	CDC Trey/Xena	2	feed
WPB	14	BZ505 192	TR 361/Xena	2	feed
MSU	15	MT020155	MT960225/H1851195	2	feed/malting
MSU	16	MT020204	MTLB 32/H1851195	2	feed/malting
MSU	17	MT030042	MT910189/MT960099	2	feed/malting
MSU	18	MT040073	MT960045/Harrington	2	feed/malting
NDSU	19*	2ND25276	ND20802/3/ND1922//ND19929/ND20177	2	malting
NDSU	20*	2ND26328	ND22032-2/ND21972	2	malting
NDSU	21*	ND22421	ND18546/ND19656	6	malting
USU	22	UT99B1670-3530	UT91B706-A-259/DA587-170	6	feed
USU	23	UT04B2041-42	Goldeneye/Columbia	6	feed
WSU	24	04WA-113.22	Camas/Baronesse	2	feed
WSU	25	04WZN-124	Farmington/Baronesse	2	feed
WSU	26*	05WA-316K	Baronesse/PB1-95-2R-522	2	feed
WSU	27*	05WA-316.99	Baronesse/PB1-95-2R-522	2	feed
WSU	28*	05WA-329.49	Bob/Baronesse//85Ab2323	2	feed
USASK	29	CDC Meredith		2	malting
USASK	30	CDC Coalition		2	feed
USASK	31	CDC Austenson		2	feed

\* New Entries

## WESTERN REGIONAL SPRING BARLEY NURSERY - 2010 Crop

**Table 2A. Station Means\* of Barley and Malt Quality Factors for 31 Varieties or Selections\*\***

	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha- amylase (20°DU)	Beta- glucan (ppm)	FAN (ppm)	Viscosity (Relative)	Turbidity (Hach)	Quality Score
Idaho Falls, ID	<b>42.2</b> b	<b>94.0</b> c	<b>55.0</b> c	<b>78.4</b> c	<b>2.0</b> b	<b>13.6</b> a	<b>5.14</b> a	<b>38.8</b> c	<b>140</b> a	<b>57.4</b> b	<b>279</b> a	<b>198</b> a	<b>1.52</b> a	<b>12.0</b> b	<b>40.4</b>
Conrad, MT	<b>42.0</b> b	<b>98.2</b> a	<b>61.5</b> a	<b>81.4</b> a	<b>2.3</b> a	<b>10.1</b> c	<b>4.64</b> b	<b>47.5</b> a	<b>99</b> c	<b>58.5</b> b	<b>153</b> c	<b>170</b> c	<b>1.49</b> b	<b>17.0</b> a	<b>45.4</b>
Fairfield, MT	<b>44.3</b> a	<b>97.1</b> b	<b>56.5</b> b	<b>79.9</b> b	<b>2.2</b> a	<b>12.2</b> b	<b>5.04</b> a	<b>43.4</b> b	<b>125</b> b	<b>63.9</b> a	<b>203</b> b	<b>184</b> b	<b>1.50</b> a	<b>10.9</b> b	<b>46.3</b>

\* Within each column, means followed by the same letter are not significantly different (alpha=0.05), according to Duncan's Multiple Range Test

\*\*Step toe, Baronesse, Harrington, AC Metcalfe, 2B04-0175, 2B05-0811, 2B06-0929, 2B06-0933, 2B07-1562, 2B07-1590, 2Ab04-X00017-4, 02Ab17271, BZ505-172, BZ505 192, MT020155, MT020204, MT030042, MT040073, 2ND25276, 2ND26328, ND22421, UT99B1670-3530, UT04B2041-42, 04WA-113.22, 04WNZ-124, 05WA-316K, 05WA-316.99, 05WA-329.49, CDC Meredith, CDC Coalition, CDC Austenson

**Table 2B. Station Means\* of Barley and Malt Quality Factors for the 17 Malting or Feed/Malting Varieties or Selections\*\*\***

	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha- amylase (20°DU)	Beta- glucan (ppm)	FAN (ppm)	Viscosity (Relative)	Turbidity (Hach)	Quality Score
Idaho Falls, ID	<b>41.6</b> b	<b>94.0</b> b	<b>54.4</b> c	<b>79.4</b> c	<b>1.8</b> b	<b>13.9</b> a	<b>5.67</b> a	<b>41.9</b> c	<b>161</b> a	<b>67.4</b> b	<b>161</b> a	<b>230</b> a	<b>1.49</b> a	<b>7.6</b> ab	<b>49.2</b>
Conrad, MT	<b>41.6</b> b	<b>98.4</b> a	<b>62.5</b> a	<b>82.6</b> a	<b>2.1</b> a	<b>10.2</b> c	<b>5.07</b> b	<b>51.4</b> a	<b>106</b> c	<b>69.9</b> b	<b>94</b> b	<b>200</b> b	<b>1.46</b> b	<b>10.5</b> a	<b>52.4</b>
Fairfield, MT	<b>44.1</b> a	<b>97.4</b> a	<b>57.4</b> b	<b>81.3</b> b	<b>2.3</b> a	<b>12.2</b> b	<b>5.70</b> a	<b>49.1</b> b	<b>140</b> b	<b>77.6</b> a	<b>104</b> b	<b>218</b> a	<b>1.47</b> b	<b>5.9</b> b	<b>57.0</b>

\* Within each column, means followed by the same letter are not significantly different (alpha=0.05), according to Duncan's Multiple Range Test

\*\*\*Harrington, AC Metcalfe, 2B04-0175, 2B05-0811, 2B06-0929, 2B06-0933, 2B07-1562, 2B07-1590, 02Ab17271, MT020155, MT020204, MT030042, MT040073, 2ND25276, 2ND26328, ND22421, CDC Meredith



**WESTERN REGIONAL SPRING BARLEY NURSERY - 2010 Crop**

Table 3A. Varietal Means\* of Barley and Malt Quality Factors for all Stations\*\*

Variety or Selection	Kernel Weight (mg)	on 6/64* (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Visc. (Rel.)	Turb. (Hach)	Quality Score														
<b>Steptoe</b>	42.6	efghi	96.2	abcd	51.3	j	74.8	n	3.8	a	11.4	ef	3.68	k	34.5	i	57	k	30.6	o	997	a	128	h	1.73	a	35.6	bc	17.3
<b>Harrington</b>	43.2	defghi	96.7	abcd	56.3	defghij	77.6	lm	2.7	bc	11.8	bcdef	3.94	jk	35.5	hi	92	hij	42.2	lmn	168	defgh	128	h	1.52	bcdef	32.0	bc	27.0
<b>AC Metcalfe</b>	41.5	ghij	95.2	abcd	60.0	abcde	80.5	bcdefg	1.7	defghi	12.3	abcde	5.50	abcd	47.3	abcd	138	abcde	73.6	bcdef	139	efgh	219	abcde	1.48	fgh	5.0	e	50.3
<b>2B04-0175</b>	39.8	jk	95.7	abcd	60.0	abcde	80.5	bcdef	2.1	cdefghi	12.8	ab	5.90	a	47.8	abcd	159	ab	82.2	abc	61	h	225	abcd	1.46	gh	7.4	e	52.7
<b>2B05-0811</b>	43.5	defgh	97.3	abc	61.7	abc	81.8	ab	2.3	bcdefg	12.2	abcdef	5.77	ab	49.3	abc	143	abcde	76.2	abcdef	71	gh	231	abc	1.47	gh	5.8	e	56.7
<b>2B06-0929</b>	43.2	defghi	96.9	abcd	58.7	abcdefg	82.5	a	2.2	bcdefgh	11.7	bcdef	5.73	abc	50.2	ab	132	bcde	82.8	ab	88	gh	241	a	1.47	gh	5.7	e	57.3
<b>2B06-0933</b>	44.4	cdef	97.2	abcd	57.7	bcdefgh	82.2	a	2.4	bcdef	12.5	abcde	5.82	a	48.4	abc	141	abcde	71.0	ef	101	gh	251	a	1.48	efgh	6.4	e	51.3
<b>2B07-1562</b>	41.0	ef	96.4	abcd	62.0	abc	82.0	a	2.1	cdefghi	12.1	abcdef	5.65	abc	48.9	abc	144	abcd	81.5	abcd	71	gh	232	abc	1.47	fgh	5.8	e	58.7
<b>2B07-1590</b>	42.8	defghi	97.2	abcd	58.0	abcdefg	81.6	abcde	2.1	cdefghi	12.3	abcde	5.69	abc	48.4	abc	167	a	84.8	a	103	gh	234	ab	1.47	fgh	5.2	e	55.3
<b>2Ab04-X00017-4</b>	44.5	cde	97.7	ab	57.0	cdefghi	81.7	ab	2.4	bcd	12.2	abcde	5.57	abc	47.9	abc	160	ab	79.6	abcde	94	gh	221	abcde	1.47	gh	7.3	e	58.7
<b>02Ab17271</b>	46.3	abc	96.6	abcd	63.0	a	78.8	hijkl	1.5	hi	11.9	bcdef	4.20	hijk	36.8	ghi	126	cdef	47.0	ijklm	247	cde	128	h	1.51	cdefg	6.4	e	39.0
<b>BZ505-172</b>	44.3	cdef	95.3	abcd	61.0	abcd	81.4	abcd	2.1	cdefghi	11.5	def	4.93	defg	45.6	bcde	127	cdef	55.1	hij	137	efgh	180	fg	1.48	efgh	7.4	e	50.0
<b>BZ505 192</b>	46.6	ab	97.8	ab	61.0	abcd	80.3	cdefg	1.7	defghi	11.6	cdef	4.69	efghi	41.5	efgh	138	abcde	49.1	ijkl	176	defgh	174	fg	1.50	cdefgh	7.9	e	49.7
<b>MT020155</b>	43.6	cdef	97.0	abcd	59.7	abcdefg	79.8	fghi	1.8	defghi	12.1	bcdef	5.12	cdef	43.5	cdef	128	cdef	74.5	bcdef	186	defg	200	cdef	1.47	fgh	6.7	e	51.3
<b>MT020204</b>	42.7	defghi	94.9	bcd	54.7	fghij	80.2	defg	2.0	defghi	12.6	abcd	5.73	abc	48.0	abc	134	bcde	73.4	cdef	184	defgh	236	ab	1.47	fgh	5.3	e	49.7
<b>MT030042</b>	42.2	fghi	96.4	abcd	55.7	efghij	80.0	efgh	1.9	defghi	12.4	abcde	5.75	abc	49.7	ab	153	abc	74.2	bcdef	159	defgh	240	a	1.46	h	5.7	e	51.0
<b>MT040073</b>	42.7	defghi	95.6	abcd	55.7	efghij	81.8	ab	2.1	cdefghi	11.7	bcdef	5.44	abcd	49.0	abc	112	efgh	77.7	abcdef	148	efgh	218	abcde	1.47	fgh	7.5	e	50.7
<b>2ND25276</b>	41.6	ghij	97.0	abcd	52.7	hij	78.5	ijkl	2.3	bcdefg	12.4	abcde	4.30	hijk	36.4	ghi	74	ijk	44.6	klm	166	defgh	134	h	1.50	cdefgh	26.6	cd	28.7
<b>2ND26328</b>	44.1	cdef	97.7	ab	54.3	ghij	81.6	abc	2.0	defghi	11.4	ef	5.30	abcde	48.6	abc	123	cdefg	69.3	fg	133	efgh	202	bcdef	1.47	gh	7.4	e	58.3
<b>ND22421</b>	43.5	defgh	98.1	a	57.7	bcdefgh	81.2	abcde	1.6	ghi	12.1	bcdef	5.14	bcdef	43.4	cdef	129	cdef	57.5	hi	152	efgh	190	ef	1.46	h	6.7	e	58.3
<b>UT99B1670-3530</b>	38.2	k	97.7	ab	60.3	abcde	79.8	fghi	2.0	defghi	12.1	bcdef	5.28	abcde	45.6	bcde	142	abcde	61.9	gh	122	fgh	196	def	1.49	defgh	8.1	e	58.0
<b>UT04B2041-42</b>	39.8	jk	97.1	abcd	47.0	k	78.0	kl	3.4	a	11.4	ef	4.19	hijk	38.2	fghi	117	defgh	42.4	lmn	443	b	133	h	1.57	b	50.7	a	23.0
<b>04WA-113.22</b>	36.0	l	95.0	abcd	52.0	ij	78.7	hijkl	1.7	efghi	11.1	f	3.89	jk	36.4	ghi	70	jk	42.2	lmn	324	c	136	h	1.53	bcde	10.0	e	29.3
<b>04WNZ-124</b>	42.6	defghi	94.1	d	60.3	abcde	77.9	kl	1.7	fghi	13.2	a	4.63	fghi	36.5	ghi	116	defgh	43.5	klmn	431	b	157	gh	1.53	bcde	8.8	e	31.7
<b>05WA-316.K</b>	41.2	hij	95.4	abcd	56.0	defghij	78.3	jkl	2.4	bcde	12.0	bcdef	4.40	ghij	38.3	fghi	128	cdef	44.8	klm	158	efgh	151	gh	1.48	efgh	27.4	cd	37.0
<b>05WA-316.99</b>	44.2	cdef	95.7	abcd	56.0	defghij	78.5	ijkl	1.4	i	11.3	ef	4.13	ijk	39.2	fghi	91	hij	39.0	mn	278	cd	135	h	1.55	bc	6.8	e	26.3
<b>05WA-329.49</b>	44.9	bcd	94.5	cd	56.3	defghij	76.6	m	1.9	defghi	11.7	bcdef	3.96	jk	35.7	hi	80	ijk	35.4	no	313	c	128	h	1.53	bcde	17.6	de	23.3
<b>CDC Meredith</b>	47.8	a	97.5	abc	58.7	abcdefg	79.1	ghijk	1.9	defghi	12.7	abc	4.47	ghij	38.0	fghi	99	fghi	45.3	klm	325	c	151	gh	1.56	b	18.0	de	30.3
<b>CDC Coalition</b>	41.1	ij	95.8	abcd	60.7	abcde	81.2	abcde	2.0	defghi	11.4	ef	5.62	abc	52.4	a	127	cdef	72.7	def	108	gh	219	abcde	1.46	h	12.9	e	53.0
<b>CDC Austenson</b>	43.4	defgh	97.6	abc	60.3	abcde	80.2	defg	2.8	b	11.6	cdef	4.07	ijk	36.7	ghi	95	ghij	51.0	ijkl	252	cde	125	h	1.54	bcd	42.0	ab	36.3

Table 3B. Varietal Means\* of Barley and Malt Quality Factors for only the Malting Barleys from all Stations\*\*

Variety or Selection	Kernel Weight (mg)	on 6/64* (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Visc. (Rel.)	Turb. (Hach)	Quality Score														
<b>Harrington</b>	41.5	bcd	95.2	b	60.0	ab	80.5	cde	1.7	bc	12.3	abcd	5.50	abc	47.3	bc	138	bcde	73.6	cdef	139	abcd	219	abcd	1.48	bcde	5.0	b	50.3
<b>AC Metcalfe</b>	39.8	de	95.7	ab	60.0	ab	80.5	cde	2.1	abc	12.8	a	5.90	a	47.8	b	159	ab	82.2	abc	61	f	225	abcd	1.46	cde	7.4	b	52.7
<b>2B04-0175</b>	43.5	ab	97.3	ab	61.7	a	81.8	ab	2.3	ab	12.2	abcd	5.77	ab	49.3	ab	143	abcd	76.2	abcdef	71	ef	231	abc	1.47	cde	5.8	b	56.7
<b>2B05-0811</b>	43.2	abc	96.9	ab	58.7	abc	82.5	a	2.2	abc	11.7	bcd	5.73	ab	50.2	ab	132	bcde	82.8	ab	88	def	241	a	1.47	cde	5.7	b	57.3
<b>2B06-0929</b>	44.4	a	97.2	ab	57.7	abcd	82.2	ab	2.4	a	12.5	abc	5.82	a	48.4	ab	141	abcd	71.0	ef	101	bcdef	251	a	1.48	abc	6.4	b	51.3
<b>2B06-0933</b>	41.0	cd	96.4	ab	62.0	a	82.0	ab	2.1	abc	12.1	abcd	5.65	ab	48.9	ab	144	abcd	81.5	abcd	71	ef	232	abc	1.47	bcde	5.8	b	58.7
<b>2B07-1562</b>	42.8	abc	97.2	ab	58.0	abc	81.6	abc	2.1	abc	12.3	abcd	5.69	ab	48.4	ab	167	a	84.8	a	103	bcdef	234	ab	1.47	bcde	5.2	b	55.3
<b>2B07-1590</b>	44.5	a	97.7	ab	57.0	abcd	81.7	abc	2.4	a	12.2	abcd	5.57	abc	47.9	ab	160	ab	79.6	abcde	94	cdef	221	abcd	1.47	cde	7.3	b	58.7
<b>02Ab17271</b>	44.3	a	95.3	ab	61.0	a	81.4	abcd	2.1	abc	11.5	cd	4.93	c	45.6	bc	127	cde	55.1	h	137	abcde	180	e	1.48	abcd	7.4	b	50.0
<b>MT020155</b>	42.7	abc	94.9	b	54.7	cd	80.2	de	2.0	abc	12.6	ab	5.73	ab	48.0	ab	134	bcde	73.4	cdef	184	a	236	ab	1.47	cde	5.3	b	49.7
<b>MT020204</b>	42.2	abc	96.4	ab	55.7	bcd	80.0	e	1.9	abc	12.4	abcd	5.75	ab	49.7	ab	153	abc	74.2	bcdef	159	abc	240	a	1.46	de	5.7	b	51.0
<b>MT030042</b>	42.7	abc	95.6	ab	55.7	bcd	81.8	ab	2.1	abc	11.7	bcd	5.44	abc	49.0	ab	112	e	77.7	abcdef	148	abcd	218	abcd	1.47	bcde	7.5	b	50.7
<b>MT040073</b>	41.6	bcd	97.0	ab	52.7	d	78.5	f	2.3	ab	12.4	abc	4.30	d	36.4	d	74	f	44.6	i	166	ab	134	f	1.50	a	26.6	a	28.7
<b>2ND25276</b>	44.1	a	97.7	ab	54.3	cd	81.6	abc	2.0	abc	11.4	cd	5.30	abc	48.6	ab	123	de	69.3	fg	133	abcde	202	bcde	1.47	cde	7.4	b	58.3
<b>2ND26328</b>	43.5	ab	98.1	a	57.7	abcd	81.2	abcd	1.6	c	12.1	abcd	5.14	bc	43.4	c	129	cde	57.5	h	152	abcd	190	de	1.46	e	6.7	b	58.3
<b>ND22421</b>	38.2	e	97.7	ab	60.3	ab	79.8	e	2.0	abc	12.1	abcd	5.28	abc	45.6	bc	142	abcd	61.9	gh	122	abcdef	196	cde	1.49	ab	8.1	b	58.0
<b>CDC Meredith</b>	41.1	cd	95.8	ab	60.7	ab	81.2	bcd	2.0	abc	11.4	d	5.62	ab	52.4	a	127	cde	72.7	def	108	bcdef	219	abcd	1.46	de	12.9	b	53.0

\* Within each column, means followed by the same letter are not significantly different (alpha=0.05), according to Duncan's Multiple Range Test

\*\* Idaho Falls, ID, Conrad, MT and Fairfield, MT

## 2010 WESTERN REGIONAL SPRING BARLEY NURSERY - IDAHO FALLS, ID

Table 4

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (Relative)	Turbidity (Hach)	Quality Score	Overall Rank
5103	Steptoe	6	41.1	93.2	48	73.2	*3.8	1	12.1	3.68	32.0	63	28.9	*1088	126	1.82	5.7	22	26
5104	Baronesse	2	43.1	94.6	53	74.8	n.d.	3	13.7	3.97	29.3	106	38.7	283	126	1.55	28.0	14	31
5105	Harrington	2	39.7	91.3	59	78.2	1.6	1	14.6	5.77	41.9	174	69.8	185	240	1.48	6.0	40	17
5106	AC Metcalfe	2	38.7	90.6	53	78.4	2.1	1	14.9	6.31	42.9	200	78.5	70	263	1.49	9.8	44	13
5107	2B04-0175	2	41.5	94.2	57	79.5	1.9	1	14.7	6.31	43.6	180	77.0	87	268	1.48	4.7	49	7
5108	2B05-0811	2	40.9	93.8	57	80.9	1.8	1	13.7	6.14	45.0	173	83.1	87	268	1.47	4.5	49	7
5109	2B06-0929	2	44.5	95.0	52	80.3	2.0	1	14.3	6.08	43.6	165	69.1	125	262	1.50	5.8	46	11
5110	2B06-0933	2	40.8	93.9	58	80.3	1.8	1	13.8	5.84	43.5	164	76.1	89	245	1.49	4.4	52	5
5111	2B07-1562	2	41.4	94.6	52	79.6	1.7	1	14.0	5.84	42.2	213	85.4	131	249	1.48	3.0	48	10
5112	2B07-1590	2	43.8	95.3	53	80.0	1.8	1	14.0	5.77	42.5	184	78.6	108	249	1.47	4.5	49	7
5113	2Ab04-X00017-4	2	45.2	93.5	64	77.5	1.3	1	13.2	4.11	31.3	135	43.2	337	138	1.53	5.9	31	21
5114	02Ab17271	2	43.9	94.0	57	79.2	1.3	1	13.2	4.06	32.7	141	36.3	249	142	1.52	5.3	31	21
5115	BZ505-172	2	47.0	97.0	62	79.8	2.2	1	12.8	5.67	45.5	174	61.3	204	242	1.51	10.4	56	3
5116	BZ505 192	2	43.2	95.2	60	78.0	1.7	1	14.0	5.39	38.5	162	72.3	239	205	1.49	5.7	42	15
5117	MT020155	2	41.2	90.2	50	78.0	1.7	1	15.0	5.70	39.7	167	66.2	289	233	1.49	4.3	33	19
5118	MT020204	2	42.7	93.0	55	78.0	1.7	1	14.7	6.00	43.1	182	69.7	234	248	1.48	4.8	39	18
5119	MT030042	2	40.7	91.2	48	79.9	2.1	1	13.9	5.83	43.2	139	70.1	203	239	1.49	8.8	45	12
5120	MT040073	2	41.2	95.3	52	76.7	n.d.	3	14.5	4.39	31.1	92	40.0	240	138	1.52	29.0	16	30
5121	2ND25276	2	44.2	96.4	52	80.7	2.0	1	12.5	5.48	45.5	133	63.6	177	214	1.48	9.3	60	2
5122	2ND26328	2	43.9	97.5	56	80.8	1.5	1	12.7	4.99	39.6	136	52.4	217	185	1.47	5.9	53	4
5123	ND22421	6	38.8	98.2	60	79.4	1.8	1	13.3	5.46	42.8	156	60.1	123	205	1.52	10.5	66	1
5124	UT99B1670-3530	6	40.0	96.8	45	77.0	n.d.	3	12.3	4.16	34.9	116	36.4	633	133	1.63	51.0	20	27
5126	UT04B2041-42	6	37.1	94.1	49	78.0	1.9	1	11.9	4.06	34.8	77	40.0	503	147	1.55	12.8	30	23
5128	04WA-113.22	2	40.9	87.0	57	76.1	1.7	1	14.7	4.86	33.7	129	43.9	575	175	1.50	10.4	27	24
5129	04WZN-124	2	40.5	94.1	54	77.2	2.2	2	13.4	4.50	34.1	130	43.8	241	164	1.49	21.0	33	19
5130	05WA-316.K	2	43.7	93.3	54	76.9	1.4	1	13.1	4.25	33.5	95	36.7	400	142	1.54	6.3	20	27
5131	05WA-316.99	2	44.3	90.4	54	75.0	1.9	2	13.5	4.20	32.4	83	35.8	440	148	1.53	17.7	19	29
5132	05WA-329.49	2	47.2	95.2	56	77.3	1.8	1	14.9	4.83	33.2	98	42.3	436	176	1.55	13.7	23	25
5133	CDC Meredith	2	38.9	92.7	54	79.7	2.4	1	13.2	6.36	48.7	139	70.5	132	253	1.47	9.3	43	14
5134	CDC Coalition	2	43.3	96.5	61	79.7	n.d.	3	12.4	4.41	36.7	99	52.5	295	149	1.51	50.0	41	16

Table 4

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (Relative)	Turbidity (Hach)	Quality Score	Overall Rank
5135	CDC Austenson	2	44.0	96.9	62	79.0	1.5	1	12.7	5.01	40.5	123	55.6	240	180	1.48	3.8	52	5
5125	LACEY MALT CHECK	6	36.8	96.2	50	80.0	1.9	1	12.7	5.45	45.3	165	61.9	86	211	1.49	14.5	70	
5127	HARRINGTON MALT CHECK	2	40.2	96.3	75	82.4	1.3	1	11.6	5.08	45.5	156	82.4	57	208	1.46	3.4	69	
Minima			37.1	87.0	45	73.2	1.3		11.9	3.68	29.3	63	28.9	70	126	1.47	3.0		
Maxima			47.2	98.2	64	80.9	2.4		15.0	6.36	48.7	213	85.4	633	268	1.82	51.0		
Means			42.2	94.0	55	78.4	1.8		13.6	5.14	38.8	140	57.4	252	198	1.52	12.0		
Standard Deviations			2.4	2.5	5	1.9	0.3		0.9	0.84	5.4	38	16.9	147	50	0.07	12.2		
Coefficients of Variation			5.7	2.6	8	2.4	15.2		6.7	16.34	14.0	27	29.5	58	25	4.30	101.4		

Malt Check Data are Excluded from Rank Sorting and Statistics

Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics

For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by A. Meisner, Busch Agricultural Resources, LLC., Ft. Collins, CO

## 2010 WESTERN REGIONAL SPRING BARLEY NURSERY - CONRAD, MT

Table 5

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (Relative)	Turbidity (Hach)	Quality Score	Overall Rank
5136	Step toe	6	41.6	97.6	57	*75.6	n.d.	3	10.5	3.65	36.9	55	30.0	*939	127	1.71	52.0	15	31
5137	Baronesse	2	42.0	98.6	61	80.4	n.d.	3	9.2	3.86	44.5	74	40.9	72	118	1.50	46.0	38	24
5138	Harrington	2	41.6	98.2	63	82.4	1.7	1	10.1	5.13	50.9	103	74.0	97	205	1.47	5.2	56	3
5139	AC Metcalfe	2	39.0	99.9	64	82.7	2.0	1	10.4	5.33	52.3	117	81.4	55	192	1.46	7.3	54	8
5140	2B04-0175	2	41.5	98.9	67	83.5	2.2	1	10.1	5.12	51.5	102	71.9	48	204	1.46	6.5	56	3
5141	2B05-0811	2	42.1	98.4	63	83.4	2.2	1	9.9	5.12	52.1	93	75.4	92	224	1.48	8.0	53	11
5142	2B06-0929	2	41.6	98.3	66	84.3	2.2	1	9.9	5.13	51.9	108	68.1	74	234	1.48	8.1	56	3
5143	2B06-0933	2	39.5	98.1	67	83.3	2.1	1	10.6	5.31	51.7	115	75.1	55	225	1.47	8.0	54	8
5144	2B07-1562	2	41.5	98.2	64	83.5	1.7	1	10.0	5.02	52.8	115	77.9	78	214	1.47	7.0	56	3
5145	2B07-1590	2	42.9	98.7	62	83.2	2.9	2	10.2	5.04	52.8	117	75.2	96	183	1.47	11.7	54	8
5146	2Ab04-X00017-4	2	44.8	98.2	62	79.9	1.7	1	10.4	4.09	41.2	112	46.6	200	123	1.50	8.5	40	23
5147	02Ab17271	2	43.8	97.8	66	83.2	2.6	2	9.7	4.92	52.3	92	62.0	81	183	1.45	11.5	50	14
5148	BZ505-172	2	44.7	98.4	63	80.6	1.4	1	10.3	4.05	40.5	112	40.7	144	140	1.48	7.3	43	20
5149	BZ505 192	2	42.0	98.0	63	81.1	1.8	1	10.2	4.61	46.5	103	70.1	143	188	1.47	10.0	55	7
5150	MT020155	2	42.3	97.9	58	81.9	2.1	1	10.4	5.52	54.0	102	69.9	129	235	1.46	7.4	53	11
5151	MT020204	2	40.7	98.2	61	81.8	2.0	1	10.1	5.32	54.7	129	77.9	91	222	1.44	8.8	59	2
5152	MT030042	2	43.4	98.0	64	82.9	2.0	1	9.8	4.87	50.7	94	78.3	123	189	1.45	7.7	47	16
5153	MT040073	2	41.5	98.4	54	80.8	n.d.	3	10.4	4.26	42.4	64	45.4	117	142	1.47	46.0	36	26
5154	2ND25276	2	43.5	98.3	56	82.6	2.0	1	10.1	4.96	51.3	119	70.1	144	192	1.46	9.0	53	11
5155	2ND26328	2	42.7	98.8	58	81.6	1.8	1	11.5	5.25	47.5	124	57.7	142	200	1.45	9.1	61	1
5156	ND22421	6	37.0	97.5	64	80.7	2.3	1	10.5	4.96	48.8	113	60.1	103	189	1.48	8.7	44	19
5158	UT99B1670-3530	6	39.4	97.5	51	78.9	n.d.	3	10.5	4.15	41.1	119	43.9	358	128	1.53	52.0	26	30
5160	UT04B2041-42	6	*34.6	*96.2	58	79.2	1.6	2	9.7	3.54	37.2	64	43.5	229	118	1.53	10.6	30	28
5161	04WA-113.22	2	42.3	98.2	65	79.9	1.6	1	11.1	4.36	40.9	103	42.2	262	142	1.53	8.7	45	17
5162	04WNZ-124	2	42.6	98.8	60	80.1	n.d.	3	10.4	4.35	44.1	115	44.1	91	142	1.47	45.0	45	17
5163	05WA-316.K	2	43.7	98.1	59	80.0	1.7	1	9.4	4.15	48.1	85	40.8	158	126	1.52	9.2	31	27
5164	05WA-316.99	2	45.5	97.7	57	78.7	2.1	2	9.6	3.94	41.5	68	36.4	127	118	1.50	17.8	28	29
5165	05WA-329.49	2	46.4	98.8	62	81.4	2.1	2	10.0	4.32	46.3	85	46.1	120	138	1.51	18.2	41	22
5166	CDC Meredith	2	42.2	98.6	65	82.0	2.1	1	9.3	4.94	56.8	92	67.9	73	172	1.45	8.5	48	15
5167	CDC Coalition	2	42.4	98.6	65	82.0	n.d.	3	9.7	3.94	42.3	84	48.6	114	105	1.50	52.0	37	25

Table 5

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (Relative)	Turbidity (Hach)	Quality Score	Overall Rank
5168	CDC Austenson	2	43.8	98.5	63	80.7	2.1	2	10.5	4.75	46.3	97	51.1	185	164	1.50	10.8	42	21
5157	LACEY MALT CHECK	6	36.0	96.3	48	80.1	1.9	2	12.3	5.77	48.0	142	61.9	78	211	1.47	10.2	60	
5159	HARRINGTON MALT CHECK	2	40.4	97.6	75	82.7	1.7	1	11.0	5.37	49.4	149	84.7	61	209	1.45	5.8	59	
Minima			37.0	97.5	51	78.7	1.4		9.2	3.54	36.9	55	30.0	48	105	1.44	5.2		
Maxima			46.4	99.9	67	84.3	2.9		11.5	5.52	56.8	129	81.4	358	235	1.71	52.0		
Means			42.3	98.3	62	81.6	2.0		10.1	4.64	47.5	99	58.5	127	170	1.49	17.0		
Standard Deviations			2.0	0.5	4	1.5	0.3		0.5	0.56	5.5	19	15.6	67	40	0.05	16.1		
Coefficients of Variation			4.6	0.5	6	1.9	16.3		4.8	12.13	11.5	20	26.7	53	24	3.29	95.1		

Malt Check Data are Excluded from Rank Sorting and Statistics

Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics

For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by A. Meisner, Busch Agricultural Resources, LLC., Ft. Collins, CO

## 2010 WESTERN REGIONAL SPRING BARLEY NURSERY - FAIRFIELD, MT

Table 6

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (Relative)	Turbidity (Hach)	Quality Score	Overall Rank
5070	Step toe	6	45.0	97.7	49	75.7	n.d.	3	11.4	3.70	34.5	54	32.8	*965	132	1.66	49.0	15	31
5071	Baronesse	2	44.5	97.0	55	77.7	2.4	2	12.4	3.99	32.8	96	47.0	149	139	1.52	22.0	28	25
5072	Harrington	2	43.1	96.1	58	80.8	1.9	1	12.2	5.62	49.2	137	77.1	135	212	1.48	3.8	54	12
5073	AC Metcalfe	2	41.6	96.6	63	80.5	2.3	1	13.0	6.05	48.1	161	86.7	58	221	1.44	5.2	54	12
5074	2B04-0175	2	47.4	98.8	61	82.5	2.9	1	11.9	5.89	52.8	145	79.7	78	222	1.46	6.1	61	4
5075	2B05-0811	2	46.5	98.5	56	83.1	2.6	1	11.5	5.94	53.4	129	89.8	83	230	1.46	4.5	61	4
5076	2B06-0929	2	46.9	98.2	55	82.0	3.0	1	13.1	6.25	49.6	148	75.7	103	258	1.47	5.2	49	17
5077	2B06-0933	2	42.6	97.1	61	82.3	2.5	1	12.0	5.81	51.4	153	93.2	69	225	1.46	5.1	61	4
5078	2B07-1562	2	45.5	98.8	58	81.6	2.7	1	12.9	6.20	50.3	172	91.2	99	240	1.47	5.6	58	10
5079	2B07-1590	2	46.9	99.0	56	81.8	2.5	1	12.5	5.91	48.4	180	85.0	78	229	1.46	5.6	61	4
5080	2Ab04-X00017-4	2	48.8	98.2	63	79.2	1.6	1	12.0	4.40	37.9	133	51.0	204	125	1.51	4.9	47	18
5081	02Ab17271	2	45.1	94.1	60	81.6	2.4	1	11.7	5.83	51.8	147	67.0	79	216	1.47	5.4	61	4
5082	BZ505-172	2	48.1	98.1	58	80.3	1.6	1	11.7	4.34	38.4	127	45.3	179	139	1.51	5.9	43	20
5083	BZ505 192	2	45.7	97.8	56	80.3	2.0	1	11.9	5.36	45.5	118	81.1	175	207	1.47	4.4	57	11
5084	MT020155	2	44.7	96.6	56	80.7	2.2	1	12.4	5.99	50.2	134	84.1	135	239	1.47	4.2	54	12
5085	MT020204	2	43.2	98.0	51	80.1	2.1	1	12.3	5.93	51.4	147	74.8	152	251	1.47	3.6	51	16
5086	MT030042	2	44.1	97.6	55	82.7	2.3	1	11.5	5.61	53.1	104	84.7	119	225	1.48	5.9	54	12
5087	MT040073	2	42.1	97.2	52	78.1	2.1	1	12.4	4.23	35.7	68	48.3	142	121	1.50	4.8	36	22
5088	2ND25276	2	44.7	98.3	55	81.7	1.9	1	11.7	5.44	49.0	118	74.1	76	200	1.46	4.0	62	3
5089	2ND26328	2	43.9	98.0	59	81.3	1.6	1	12.0	5.17	43.0	126	62.5	97	185	1.45	5.0	68	1
5090	ND22421	6	38.7	97.4	57	79.1	1.9	1	12.4	5.43	45.3	156	65.5	140	194	1.49	5.1	64	2
5091	UT99B1670-3530	6	40.1	97.0	45	78.2	n.d.	3	11.3	4.27	38.6	117	46.9	339	137	1.54	49.0	23	29
5092	UT04B2041-42	6	36.5	94.7	49	78.8	1.6	1	11.5	4.05	37.2	70	42.9	238	144	1.51	6.5	28	25
5094	04WA-113.22	2	44.7	97.0	59	77.7	1.7	1	13.9	4.67	34.8	116	44.6	454	153	1.56	7.2	27	27
5096	04WVNZ-124	2	40.6	93.2	54	77.5	1.8	2	12.4	4.35	36.7	140	46.5	141	148	1.49	16.1	37	21
5097	05WA-316.K	2	45.2	95.6	55	78.6	1.2	1	11.5	3.98	35.9	93	39.5	275	136	1.58	4.9	26	28
5098	05WA-316.99	2	44.8	95.3	58	76.0	1.7	2	11.9	3.73	33.1	89	34.1	371	118	1.56	17.4	21	30
5099	05WA-329.49	2	49.9	98.6	58	78.5	1.8	2	13.2	4.26	34.3	115	47.5	418	140	1.63	22.0	31	24
5100	CDC Meredith	2	42.0	96.2	63	81.9	1.7	2	11.6	5.56	51.6	149	79.7	119	233	1.46	21.0	60	9
5101	CDC Coalition	2	44.4	97.8	55	78.9	n.d.	3	12.6	3.85	31.2	102	52.0	345	122	1.59	24.0	35	23

Table 6

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (Relative)	Turbidity (Hach)	Quality Score	Overall Rank
5102	CDC Austenson	2	45.0	95.7	63	79.0	1.3	1	12.4	4.61	39.2	133	51.2	283	174	1.54	3.9	47	18
5093	LACEY MALT CHECK	6	36.3	96.1	52	80.1	2.3	2	12.7	5.77	47.9	129	63.9	73	211	1.47	10.9	57	
5095	HARRINGTON MALT CHECK	2	39.7	96.4	78	82.2	1.9	1	11.7	5.34	47.2	127	87.5	56	210	1.46	6.1	62	
Minima			36.5	93.2	45	75.7	1.2		11.3	3.70	31.2	54	32.8	58	118	1.44	3.6		
Maxima			49.9	99.0	63	83.1	3.0		13.9	6.25	53.4	180	93.2	454	258	1.66	49.0		
Means			44.3	97.1	57	79.9	2.0		12.2	5.04	43.4	125	63.9	178	184	1.50	10.9		
Standard Deviations			2.9	1.4	4	2.0	0.5		0.6	0.86	7.5	30	19.1	111	46	0.05	12.0		
Coefficients of Variation			6.5	1.5	8	2.5	22.9		5.1	16.99	17.4	24	29.8	63	25	3.59	109.9		

Malt Check Data are Excluded from Rank Sorting and Statistics

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For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by A. Meisner, Busch Agricultural Resources, LLC., Ft. Collins, CO

# Appendix A:

# METHODS

**Cleaning** All samples were cleaned on a Carter Dockage Tester and only grain between 5 and 7/64" was used.

**Barley Mill** Ground barley was prepared with a Labconco Burr mill that was adjusted so that only 35% of the grist remained on a 525  $\mu\text{m}$  sieve after 3 min of shaking and tapping.

**Kernel Weight** The number of kernels in a 20 g aliquot of each sample was counted electronically and the '1000 kernel weight' was calculated.

**Plumpness** Samples were sized on a Eureka-Niagra Barley Grader and the percentage of the seeds retained on a 6/64" screen was determined.

**Barley Color** The brightness of the grains was measured using an Agtron M45-D analyzer.

**Barley Moisture Content** (Barley 5B) Five g of ground sample was dried for 3 h at 104°C. The percentage of weight loss that occurred during this drying was calculated.

**Barley Protein Content** Total nitrogen values were obtained using an automated Dumas combustion procedure with a LECO FP-528 analyzer. Nitrogen values were converted to protein percentages by multiplication by 6.25.

**Malting Conditions** 170 g (db) aliquots of barley were processed in Joe White micro-malters. Samples were hydrated to 47% moisture via a 32 h steep at 19°C: 8 h wet, 8 h air, 5 h wet, 5 h air, 2 h wet, 2 h air, 2 h wet. (Larger barleys, > 42 mg/kernel, received a continuous, wet pre-steep (16°C) of between 1 and 3 h). The samples were germinated for 48 h (18°C), 24 h (17°C), and 24 h (16°C), with moisture adjustment to 47% at 0, 24, and 48 h. The samples received 4 full turns every 2 h. The germinated grain was kilned for 24h as follows: 49°C, 10 h; 54°C, 4 h; 60°C, 3 h; 68°C, 2 h; and 85°C, 3 h, with 30 min. ramps between stages. All stages received 40% total flow, with 0% recirculation for stages 1-3, 50% for stage 4, and 75% for stage 5.

**Malt Mill** Fine-grind malts were prepared with a Miag laboratory cone mill that was adjusted so that 10% of the grist remained on a 525  $\mu\text{m}$  sieve after 3 min of shaking, with tapping. Malts to be used for moisture, protein and amylolytic activity analyses were ground in a Labconco Burr mill (see Barley Mill).

**Malt Moisture Content** Determined by Malt 3 (Methods of Analysis of the ASBC, 8th ed, 1992) See Barley Moisture Content.

**Malt Protein Content** See Barley Protein Content.

**Malt Extract** Samples were extracted using the Malt-4 procedure (Methods of Analysis of the ASBC, 8th ed, 1992), except that all weights and volumes specified for the method were halved. The specific gravity of the filtrate was measured with an Anton/Parr DMA5000 density meter. The density data were used to calculate the amount of soluble material present in the filtrate, and thus the percentage that was extracted from the malt.

**Wort Color** was determined on a Skalar SAN plus analyzer by measuring the absorbance at 430nm and dividing by a factor determined by collaborative testing.

**Wort Clarity** was assessed by visual inspection.

**$\beta$ -Glucan Levels** were determined on a Skalar SAN plus analyzer by using the Wort-18 fluorescence flow injection analysis method with calcofluor as the fluorescent agent (Methods of Analysis of the ASBC, 8th ed, 1992).

**Free Amino Nitrogen Levels** were determined on a Skalar SAN plus analyzer using an automated version of the Wort-12 protocol (Methods of Analysis of the ASBC, 8th ed, 1992).

**Soluble (Wort) Protein Levels** were determined on a Skalar SAN plus analyzer using the Wort-17 UV-spectrophotometric method (Methods of Analysis of the ASBC, 8th ed, 1992).

**S/T Ratio** was calculated as Soluble Protein / Total Malt Protein

**Diastatic Power Values** were determined on a Skalar SAN plus analyzer by the automated ferricyanide procedure Malt-6C (Methods of Analysis of the ASBC, 8th ed, 1992).

**$\alpha$ -Amylase activities** were measured on a Skalar SAN plus analyzer by heating the extract to 73°C to inactivate any  $\beta$ -amylase present. The remaining ( $\alpha$ -amylase) activity was measured as described for Diastatic Power Values.

**Turbidities** were determined in Nephelometric Turbidity Units (NTU) on a Hach Model 18900 Ratio Turbidimeter.

**Quality Scores** were calculated by using a modification of the method of Clancy and Ullrich (Cereal Chem. 65:428-430, 1988). The criteria used to quantify individual quality factors are listed in Table A1.

**Overall Rank Values** were ordered from low to high based on their Quality Scores. A rank of '1' was assigned to the sample with the best quality score.



## Appendix B

## 2010 Crop Year

### Quality Score Parameters for 2- and 6-rowed barleys

Quality parameter	2-rowed		6-rowed	
	condition	score	condition	score
Kernel Weight (mg)	> 42.0	5	> 32.0	5
	40.1–42.0	4	30.1–32.0	4
	38.1–40.0	2	28.1–30.0	2
	≤ 38.0	0	≤ 28.0	0
on 6/64 " (%)	≥ 90.0	5	≥ 80.0	5
	85.0–89.9	3	73.0–79.9	3
	< 85.0	0	< 73.0	0
Malt Extract (% db)	≥ 81.0	10	≥ 79.0	10
	79.4–81.0	7	78.2–78.9	7
	78.0–79.4	4	77.7–78.2	4
	< 78.0	0	< 77.7	0
Wort Clarity 3=hazy 2=slightly hazy 1=clear	= 3	0	= 3	0
	= 2	1	= 2	1
	= 1	2	= 1	2
Barley Protein (% db)	≥ 13.5	0	≥ 14.0	0
	13.0–13.5	5	13.5–13.9	5
	11.0–13.0	10	11.5–13.5	10
	≤ 11.0	5	≤ 11.5	5
Wort Protein (% db)	> 6.0	0	> 6.0	0
	5.6–6.0	3	5.7–6.0	3
	4.4–5.6	7	5.2–5.7	7
	4.0–4.4	3	4.8–5.2	3
	< 4.0	0	< 4.8	0
S/T (Soluble/Total Protein, % db)	> 47	0	> 47	0
	40–47	5	42–47	5
	< 40	0	< 42	0
DP (Diastatic Power, ° ASBC)	> 120	7	> 140	7
	100–120	4	120–140	4
	< 100	0	< 120	0
Alpha-amylase (20° DU)	> 50	7	> 50	7
	40–50	4	40–50	4
	< 40	0	< 40	0
Beta-glucan (ppm)	< 100	7	< 120	7
	100–150	3	120 – 170	3
	> 150	0	> 170	0
Free Amino Nitrogen	> 190	5	> 200	5
	180 – 190	3	190 – 200	3