

UNITED STATES DEPARTMENT OF AGRICULTURE  
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CEREAL CROPS RESEARCH UNIT

**WESTERN REGIONAL SPRING BARLEY NURSERY – 2009 Crop**  
Preliminary Quality Report

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Detailed Data:

Aberdeen, ID  
Conrad, MT

Idaho Falls, ID  
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 – 2009 Crop

Nursery samples were received for malting quality evaluation from four 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/53660000/2009WRBNREPORT.pdf>

Sixteen 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 have generated 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 four stations located in the Western Region (Table 2) and over all lines (Table 3). Individual station data are reported in Tables 4 through 7. Evaluations of data from individual locations and overall performance evaluations, derived primarily from Tables 2 and 3, are presented below.

Most of the barleys from Aberdeen, ID (Table 4) were plump and had good protein contents. Seven soluble protein values were low, with most of these being feed type barleys. Most of the  $\beta$ -glucan and viscosity values were too high. Sixteen turbidity values were over 15 Hach units, with most of these from feed type lines. Half of the free amino nitrogen (FAN) values were below the desired minimum. The best performers were Harrington, 2B04-0175, 2B03-3604, AC Metcalfe, 02Ab17271, 2B02-2925 and MT010158. Harrington and 2B04-0175 performed very well, having only slightly elevated  $\beta$ -glucan values. 2B03-3604 and 2Ab17271 had slightly elevated  $\beta$ -glucan and viscosity values. AC Metcalfe had a deficient FAN value and an elevated  $\beta$ -glucan

level. 2B02-2925 had slightly elevated S/T and viscosity values. MT010158 had slightly elevated viscosity and turbidity values.

The barleys from Idaho Falls, ID (Table 5) were very plump and total protein values tended to be a bit low. Extract values were generally good and soluble protein values were also good, except for 5 feed type lines that were too low. Half of the  $\beta$ -glucan and viscosity values were too high, while half of the FAN values were too low, with most of the deficiencies being present in the feed type lines. The best performers were 2B03-3719, 02Ab17271, 2B05-0672, AC Metcalfe, 2B02-2925, 2B03-3604, MT010158, MT010160, 2ND21867, and 2B04-0175. 2B03-3719, 02Ab17271, 2B05-0672 and AC Metcalfe showed good quality profiles, except for their elevated S/T ratios. 2B02-2925 and 2B03-3604 had elevated S/T ratios and very slightly elevated  $\beta$ -glucan levels. MT010158 had an elevated S/T ratio and an  $\alpha$ -amylase value slightly below the “ideal” criteria. MT010160 had a high S/T ratio along with an elevated soluble protein value. 2ND21867 had an elevated  $\beta$ -glucan level. 2B04-0175 had elevated soluble protein and S/T values and a slightly depressed diastatic power value.

The plump barleys from Conrad, MT (Table 6) had protein levels that were lower than desired, but this contributed to generally good extract values. A third of the soluble protein values were too low, while S/T ratios ranged between eleven that were too low, to 13 that were above the desired maximum limit. Diastatic power values were generally low, with a third falling below the desired minimum limit. Five feed type lines had  $\alpha$ -amylase values that fell below the minimum limit. Most of the  $\beta$ -glucan, viscosity and turbidity values were good, with only a few exceeding upper limits and all of these from feed type lines. The best performers were MT010158, 2B04-0175, 2B03-3604, 2B05-0672 and Harrington. MT010158 had a good quality profile, except for a deficient FAN value. 2B04-0175 had an elevated S/T ratio. 2B03-3604 had a low total protein value, which contributed to an elevated S/T ratio. 2B05-0672 had a low total protein value and a low kernel weight. Harrington had a slightly low diastatic power value, low kernel weight and slightly elevated  $\beta$ -glucan contents.

The barleys from Fairfield, MT (Table 7) were very plump and had rather low total protein contents. Extract values were extremely good averaging over 82%. A third of the soluble protein values were too low. The diastatic power levels were generally low,

with ten that fell below minimum limits. Six feed type lines had  $\alpha$ -amylase values that fell below the desired minimum. S/T ratios varied from three that were too low to eighteen that exceeded the maximum limit. The low protein contents impacted the FAN values, where eighteen were too low. The  $\beta$ -glucan, viscosity and turbidity values were generally good. The best performers were 2B02-2925, 2B03-3719, 2B03-3604, 2B04-0175, MT010158, MT020155, AC Metcalfe, 2B05-0672 and 2B05-0811. These lines had exceptional extract values, but their low total protein contents contributed towards very high S/T ratios.

The nursery was grown under much better environmental conditions this year resulting in substantially lower grain protein overall, with much higher extract values than in several previous years. There were only small differences between the mean quality scores of the locations in this year's nursery (Table 2), perhaps due to the better than normal conditions. The barleys from Fairfield performed well, where the average extract value was 82.2%. Even feed type lines had excellent extract values and a few malting type lines had extract values near 84%. The wort extracts were enhanced by the very low total protein contents, however the low grain protein negatively impacted S/T, FAN and diastatic power values. Carbohydrate modification was excellent in the malting type lines (Table 2B), with desirable low  $\beta$ -glucan levels and the lowest average viscosity value in the nursery. Submissions from Idaho Falls also performed well. This location averaged 80.5% extract, which rose to 81.7% when only the malting lines were included. Protein levels were very good, which contributed to good diastatic power and FAN levels, especially in the malting types. Carbohydrate modification was generally good in the malting type lines, resulting in low  $\beta$ -glucan and viscosity values. The barleys from Aberdeen had higher average grain protein than the other locations. The malting type lines had good extract values. The protein profiles of these lines were good, with sufficient diastatic power, FAN and soluble protein values and a good average S/T ratio. Carbohydrate modification was not as fully developed as at the other locations, but many of the malting types had  $\beta$ -glucan and viscosity values in or near AMBA's "ideal" criteria ranges. The nursery performed well at Conrad, where barleys were plump and bright. The average total protein level was a bit on the low side, which negatively impacted the mean diastatic power level. Carbohydrate modification was

very good, resulting in desirable low  $\beta$ -glucan and viscosity values.

The best performers in the nursery were MT010158, 2B03-3604, 2B04-0175, 2B05-0672, 02Ab17271, AC Metcalfe, 2B02-2925, Harrington and CDC Meredith (Table 3). The barley characteristics of MT010158 were similar to those of the nursery control Harrington, as were malt extract and soluble protein. This line averaged much higher diastatic power values, while  $\alpha$ -amylase and  $\beta$ -glucan levels were lower than those of Harrington. Free amino nitrogen values for MT010158 were too low in worts associated with Conrad and Idaho Falls. 2B03-3604, 2B04-0175 and 2B05-0672 had similar good malting quality. These lines generally produced a half per cent more extract and higher amyolytic activities than Harrington. 02Ab17271 had a higher average extract value than that of Harrington. Diastatic power and FAN levels were generally a bit higher than those of Harrington, while  $\alpha$ -amylase activities were 10 – 15 units lower. AC Metcalfe and Harrington were remarkably similar in this year's nursery. AC Metcalfe averaged a bit less  $\beta$ -glucan and slightly higher FAN values than the nursery control. CDC Meredith had the highest average extract value in the nursery. This line had lower diastatic power values than Harrington, probably due to the lower total grain protein. Average  $\beta$ -glucan and FAN values were very good in AC Metcalfe and CDC Meredith.

**Table 1. 2009 Western Regional Spring Barley Nursery, Entry List**

<b>Seed Source</b>	<b>Entry Number</b>	<b>Entry</b>	<b>Parentage</b>	<b>Rowed</b>	<b>Grade</b>
WSU	1	Steptoe	CI 15229	6 row	feed
WPB	2	Baronesse	PI 568246	2 row	feed
USDA-ARS	3	Harrington		2 row	malting
Ag. Canada	4	AC Metcalfe		2 row	malting
BARI	5	2B02-2925	MERIT/2B97-4527	2 row	malting
BARI	6	2B03-3719	2B96-5038/2B97-4796	2 row	malting
BARI	7*	2B03-3604	MERIT/2B97-4832	2 row	malting
BARI	8*	2B04-0175	2B97-4719/2B97-4004	2 row	malting
BARI	9*	2B05-0672	2B00-0366/2B99-2763	2 row	malting
BARI	10*	2B05-0811	2B99-2763/2B00-0719	2 row	malting
USDA-ARS	11*	2Ab04-X00017-4	97Ab6361/95Ab11469	2 row	feed
USDA-ARS	12*	02Ab17271	85Ab2323/Merit	2 row	malting
WPB	13*	BZ505-172	CDC Trey/Xena	2 row	feed
WPB	14*	BZ505 192	TR 361/Xena	2 row	feed
MSU	15	MT010158	MT920041/Harrington	2 row	feed/malting
MSU	16	MT010160	MT920041/Harrington	2 row	feed/malting
MSU	17	MT020155	MT960225/H1851195	2 row	feed/malting
MSU	18	MT020204	MTLB 32/H1851195	2 row	feed/malting
MSU	19	MT030042	MT910189/MT960099	2 row	feed/malting
MSU	20	MT040073	MT960045/Harrington	2 row	feed/malting
NDSU	21	2ND21867	ND18172/ND19130	2 row	malting
USU	22*	UT99B1670-3530	UT91B706-A-259/DA587-170	6 row	feed
USU	23	UT04B2041-42	Goldeneye/Columbia	6 row	feed
WSU	24	04WA-122.20	85AB2323/Baronesse	2 row	feed
WSU	25*	04WNZ-124	Farmington/Baronesse	2 row	feed
WSU	26*	04WA-113.22	Camas/Baronesse	2 row	feed
WSU	27*	04WNZ-286	85AB2323/Baronesse	2 row	feed
USASK	28*	CDC Meredith		2 row	malting
USASK	29*	CDC Reserve		2 row	malting
USASK	30*	CDC Coalition		2 row	feed
USASK	31*	CDC Austenson (TR06389)		2 row	feed

\* New Entries

## WESTERN REGIONAL SPRING BARLEY NURSERY - 2009 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
Aberdeen, ID	38.6 C	93.6 B	67 C	80.4 B	2.3 A	11.8 A	4.73 A	42.0 C	139 A	59.7 A	235 A	169 A	1.52 A	20.1 A	44
Idaho Falls, ID	41.7 AB	99.6 A	73 B	80.7 B	2.0 B	11.2 B	4.81 A	44.3 B	118 B	56.6 B	196 B	167 A	1.50 B	13.6 B	45
Conrad, MT	41.0 BC	99.1 A	78 A	80.5 B	2.1 B	10.4 C	4.46 B	44.5 B	105 C	58.7 AB	132 C	160 A	1.49 C	15.8 B	42
Fairfield, MT	42.4 A	99.6 A	68 C	82.2 A	2.0 B	9.6 D	4.53 B	50.4 A	110 BC	60.6 A	138 C	162 A	1.48 C	13.7 B	45

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

\*\* Steptoe, Baronesse, Harrington, AC Metcalfe, 2B02-2925, 2B03-3719, 2B03-3604, 2B04-0175, 2B05-0672, 2B05-0811, 2Ab04-X00017-4, 02Ab17271, BZ505-172, BZ505-192, MT010158, MT010160, MT020155, MT020204, MT030042, MT040073, 2ND21867, UT99B1670-3530, UT04B2041-42, 04WA-122.20, 04WZN-124, 04WA-113.22, 04WZN-286, CDC Meredith, CDC Reserve, CDC Coalition, CDC Austenson

**Table 2B. Station Means\* of Barley and Malt Quality Factors for the 18 Malting or Feed/Malting Varieties or Selections\*\*\***

Aberdeen, ID	38.3 C	93.1 B	67 C	81.3 C	2.1 A	12.0 A	5.12 AB	44.7 C	154 A	69.5 AB	156 A	193 A	1.50 A	12.7 A	50
Idaho Falls, ID	41.8 AB	99.6 A	73 B	81.7 B	1.9 A	11.4 B	5.29 A	48.3 B	128 B	66.0 B	111 B	194 A	1.48 B	7.8 C	53
Conrad, MT	41.0 B	99.2 A	78 A	81.7 B	2.1 A	10.5 C	4.94 B	49.1 B	114 C	69.8 AB	89 C	190 A	1.46 C	10.9 B	50
Fairfield, MT	42.3 A	99.7 A	70 C	83.3 A	1.9 A	9.7 D	4.96 B	55.2 A	119 BC	73.2 A	75 C	186 A	1.46 C	7.4 C	52

\* 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, 2B02-2925, 2B03-3719, 2B03-3604, 2B04-0175, 2B05-0672, 2B05-0811, 02Ab17271, MT010158, MT010160, MT020155, MT020204, MT030042, MT040073, 2ND21867, CDC Meredith, CDC Reserve

### WESTERN REGIONAL SPRING BARLEY NURSERY - 2009 Crop

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

Variety or Selection	Kernel Weight (mg)	on 6/64* (%)	Barley Color (Agron)	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>	<b>41.9</b>	BCDEFG	<b>99.1</b>	A	<b>68</b>	BCDE	<b>75.6</b>	M	<b>3.8</b>	A	<b>10.0</b>	G	<b>3.44</b>	J	<b>36.3</b>	J	<b>54</b>	H	<b>30.1</b>	I	<b>947</b>	A	<b>109</b>	F	<b>1.73</b>	A	<b>55.5</b>	A	<b>15</b>
<b>Baronesse</b>	<b>41.5</b>	BCDEFG	<b>99.0</b>	A	<b>73</b>	ABCD	<b>79.1</b>	K	<b>2.5</b>	BCD	<b>10.6</b>	ABCDEFG	<b>3.71</b>	IJ	<b>36.4</b>	J	<b>88</b>	FG	<b>39.6</b>	H	<b>111</b>	GH	<b>108</b>	F	<b>1.51</b>	DEF	<b>33.0</b>	BC	<b>26</b>
<b>Harrington</b>	<b>40.0</b>	FGH	<b>97.9</b>	AB	<b>75</b>	AB	<b>82.0</b>	ABCDEF	<b>1.6</b>	FG	<b>10.9</b>	ABCDEF	<b>5.02</b>	BCDEF	<b>49.5</b>	CD	<b>116</b>	BCDE	<b>73.6</b>	ABC	<b>112</b>	GH	<b>183</b>	BCD	<b>1.47</b>	GHIJ	<b>6.1</b>	DE	<b>53</b>
<b>AC Metcalfe</b>	<b>39.6</b>	FGH	<b>98.8</b>	A	<b>75</b>	AB	<b>82.0</b>	ABCDEF	<b>2.1</b>	CDEF	<b>11.0</b>	ABCDEF	<b>5.13</b>	ABCDE	<b>48.9</b>	CDE	<b>127</b>	ABCD	<b>76.9</b>	A	<b>86</b>	H	<b>198</b>	ABC	<b>1.46</b>	IJ	<b>9.4</b>	DE	<b>54</b>
<b>2B02-2925</b>	<b>42.3</b>	BCDEF	<b>99.0</b>	A	<b>71</b>	ABCD	<b>81.9</b>	ABCDEF	<b>2.0</b>	DEFG	<b>10.8</b>	ABCDEFG	<b>5.22</b>	ABCDE	<b>50.7</b>	ABC	<b>123</b>	BCDE	<b>81.8</b>	A	<b>96</b>	GH	<b>200</b>	AB	<b>1.48</b>	FGHIJ	<b>7.1</b>	DE	<b>54</b>
<b>2B03-3719</b>	<b>43.0</b>	ABCDE	<b>99.6</b>	A	<b>73</b>	ABCD	<b>82.6</b>	AB	<b>2.3</b>	BCDEF	<b>10.4</b>	DEFG	<b>5.36</b>	AB	<b>55.0</b>	A	<b>135</b>	ABC	<b>80.5</b>	A	<b>79</b>	H	<b>216</b>	A	<b>1.46</b>	IJ	<b>8.6</b>	DE	<b>53</b>
<b>2B03-3604</b>	<b>43.0</b>	ABCDE	<b>98.3</b>	AB	<b>73</b>	ABC	<b>82.6</b>	AB	<b>2.2</b>	BCDEF	<b>10.6</b>	ABCDEFG	<b>5.26</b>	ABCD	<b>51.7</b>	ABC	<b>135</b>	ABC	<b>81.3</b>	A	<b>103</b>	GH	<b>207</b>	AB	<b>1.48</b>	FGHI	<b>8.4</b>	DE	<b>56</b>
<b>2B04-0175</b>	<b>41.3</b>	CDEFGH	<b>98.5</b>	AB	<b>75</b>	AB	<b>82.4</b>	ABCD	<b>2.2</b>	BCDEF	<b>11.3</b>	ABC	<b>5.53</b>	A	<b>50.4</b>	BC	<b>135</b>	ABC	<b>75.9</b>	AB	<b>82</b>	H	<b>217</b>	A	<b>1.47</b>	HIJ	<b>7.3</b>	DE	<b>56</b>
<b>2B05-0672</b>	<b>39.5</b>	FGH	<b>99.5</b>	A	<b>73</b>	ABCD	<b>82.5</b>	ABCD	<b>1.9</b>	DEFG	<b>10.5</b>	BCDEFG	<b>4.86</b>	DEFG	<b>48.4</b>	CDE	<b>142</b>	AB	<b>76.9</b>	A	<b>68</b>	H	<b>181</b>	BCD	<b>1.46</b>	IJ	<b>8.1</b>	DE	<b>56</b>
<b>2B05-0811</b>	<b>40.2</b>	EFHG	<b>96.4</b>	AB	<b>71</b>	ABCD	<b>82.6</b>	AB	<b>2.0</b>	DEFG	<b>11.4</b>	AB	<b>5.35</b>	AB	<b>49.9</b>	BCD	<b>131</b>	ABC	<b>79.8</b>	A	<b>123</b>	FGH	<b>196</b>	ABC	<b>1.48</b>	FGHI	<b>8.5</b>	DE	<b>48</b>
<b>2Ab04-X00017-4</b>	<b>44.3</b>	AB	<b>98.7</b>	A	<b>73</b>	ABCD	<b>79.8</b>	JK	<b>1.6</b>	FG	<b>11.0</b>	ABCDEF	<b>4.14</b>	H	<b>40.5</b>	HIJ	<b>130</b>	ABC	<b>44.5</b>	FGH	<b>223</b>	DEF	<b>124</b>	F	<b>1.52</b>	DE	<b>10.1</b>	DE	<b>42</b>
<b>02Ab17271</b>	<b>41.7</b>	BCDEFGH	<b>97.1</b>	AB	<b>74</b>	AB	<b>82.5</b>	ABC	<b>2.0</b>	DEFG	<b>10.6</b>	ABCDEF	<b>5.13</b>	ABCDE	<b>51.1</b>	ABC	<b>132</b>	ABC	<b>64.1</b>	D	<b>98</b>	GH	<b>196</b>	ABC	<b>1.48</b>	GHIJ	<b>8.4</b>	DE	<b>55</b>
<b>BZ505-172</b>	<b>43.7</b>	ABC	<b>97.9</b>	AB	<b>75</b>	AB	<b>80.5</b>	HIJ	<b>1.5</b>	G	<b>11.0</b>	ABCDEF	<b>3.93</b>	HI	<b>37.4</b>	IJ	<b>121</b>	BCDE	<b>39.2</b>	H	<b>151</b>	FGH	<b>122</b>	F	<b>1.50</b>	DEFGH	<b>7.9</b>	DE	<b>37</b>
<b>BZ505-192</b>	<b>40.9</b>	CDEFGH	<b>97.0</b>	AB	<b>71</b>	ABCD	<b>79.7</b>	JK	<b>1.7</b>	EFG	<b>10.7</b>	ABCDEFG	<b>4.58</b>	G	<b>44.7</b>	EFHG	<b>121</b>	BCDE	<b>67.5</b>	CD	<b>136</b>	FGH	<b>183</b>	BCD	<b>1.47</b>	HIJ	<b>8.2</b>	DE	<b>47</b>
<b>MT010158</b>	<b>41.5</b>	BCDEFGH	<b>98.0</b>	AB	<b>63</b>	EF	<b>81.9</b>	ABCDEF	<b>1.8</b>	EFG	<b>11.2</b>	ABC	<b>4.91</b>	CDEFG	<b>47.3</b>	CDE	<b>151</b>	A	<b>51.7</b>	EF	<b>85</b>	H	<b>176</b>	BCD	<b>1.48</b>	GHIJ	<b>7.8</b>	DE	<b>58</b>
<b>MT010160</b>	<b>38.8</b>	HI	<b>96.8</b>	AB	<b>75</b>	AB	<b>82.2</b>	ABCDE	<b>1.7</b>	FG	<b>11.0</b>	ABCDEF	<b>5.28</b>	ABC	<b>51.1</b>	ABC	<b>151</b>	A	<b>65.5</b>	D	<b>120</b>	FGH	<b>195</b>	ABC	<b>1.47</b>	HIJ	<b>5.0</b>	E	<b>50</b>
<b>MT020155</b>	<b>39.8</b>	FGH	<b>96.0</b>	AB	<b>67</b>	CDE	<b>81.5</b>	DEFG	<b>1.9</b>	DEFG	<b>10.8</b>	ABCDEFG	<b>5.15</b>	ABCDE	<b>50.4</b>	BC	<b>124</b>	BCDE	<b>68.2</b>	BCD	<b>148</b>	FGH	<b>190</b>	ABC	<b>1.48</b>	GHIJ	<b>6.7</b>	DE	<b>49</b>
<b>MT020204</b>	<b>38.8</b>	HI	<b>97.9</b>	AB	<b>72</b>	ABCD	<b>81.2</b>	FGHI	<b>1.8</b>	EFG	<b>11.1</b>	ABCDE	<b>5.25</b>	ABCD	<b>50.0</b>	BCD	<b>151</b>	A	<b>73.6</b>	ABC	<b>109</b>	GH	<b>200</b>	AB	<b>1.47</b>	HIJ	<b>7.1</b>	DE	<b>51</b>
<b>MT030042</b>	<b>39.8</b>	FGH	<b>98.1</b>	AB	<b>75</b>	AB	<b>82.7</b>	AB	<b>2.0</b>	DEFG	<b>10.5</b>	CDEFG	<b>5.17</b>	ABCDE	<b>50.8</b>	ABC	<b>131</b>	ABC	<b>78.7</b>	A	<b>105</b>	GH	<b>197</b>	ABC	<b>1.47</b>	GHIJ	<b>7.7</b>	DE	<b>50</b>
<b>MT040073</b>	<b>40.6</b>	DEFGH	<b>99.3</b>	A	<b>66</b>	DE	<b>79.8</b>	JK	<b>2.8</b>	B	<b>10.9</b>	ABCDEF	<b>4.00</b>	HI	<b>38.2</b>	IJ	<b>71</b>	GH	<b>41.6</b>	GH	<b>147</b>	FGH	<b>119</b>	F	<b>1.51</b>	DEFG	<b>39.8</b>	B	<b>30</b>
<b>2ND21867</b>	<b>45.3</b>	A	<b>99.3</b>	A	<b>71</b>	ABCD	<b>81.7</b>	BCDEF	<b>1.6</b>	FG	<b>11.4</b>	A	<b>4.84</b>	EFG	<b>45.1</b>	EFG	<b>120</b>	BCDE	<b>49.5</b>	EFG	<b>150</b>	FGH	<b>167</b>	CD	<b>1.49</b>	FGHI	<b>6.2</b>	DE	<b>49</b>
<b>UT99B1670-3530</b>	<b>36.7</b>	IJ	<b>96.3</b>	AB	<b>59</b>	F	<b>77.6</b>	L	<b>4.0</b>	A	<b>10.6</b>	ABCDEFG	<b>3.97</b>	HI	<b>38.9</b>	IJ	<b>109</b>	CDEF	<b>40.3</b>	H	<b>409</b>	B	<b>122</b>	F	<b>1.58</b>	B	<b>61.3</b>	A	<b>23</b>
<b>UT04B2041-42</b>	<b>34.7</b>	J	<b>96.5</b>	AB	<b>64</b>	EF	<b>79.1</b>	K	<b>2.0</b>	DEFG	<b>10.0</b>	G	<b>3.67</b>	IJ	<b>38.9</b>	IJ	<b>68</b>	GH	<b>44.0</b>	FGH	<b>337</b>	BC	<b>119</b>	F	<b>1.56</b>	C	<b>17.5</b>	D	<b>26</b>
<b>04WA-122.20</b>	<b>43.2</b>	ABCDE	<b>98.2</b>	AB	<b>75</b>	AB	<b>79.9</b>	JK	<b>1.8</b>	EFG	<b>10.2</b>	FG	<b>3.88</b>	HI	<b>39.9</b>	IJ	<b>98</b>	EF	<b>37.8</b>	H	<b>172</b>	EFGH	<b>121</b>	F	<b>1.50</b>	DEFG	<b>15.7</b>	DE	<b>30</b>
<b>04WENZ-124</b>	<b>40.5</b>	DEFGH	<b>98.9</b>	A	<b>67</b>	CDE	<b>80.0</b>	JK	<b>2.3</b>	BCDE	<b>10.5</b>	BCDEFG	<b>4.13</b>	H	<b>41.4</b>	GHI	<b>117</b>	BCDE	<b>40.7</b>	H	<b>134</b>	FGH	<b>130</b>	EF	<b>1.49</b>	FGHI	<b>28.9</b>	C	<b>38</b>
<b>04WA-113.22</b>	<b>40.6</b>	DEFGH	<b>98.5</b>	AB	<b>77</b>	A	<b>80.7</b>	GHIJ	<b>1.8</b>	EFG	<b>10.5</b>	BCDEFG	<b>4.15</b>	H	<b>41.3</b>	GHI	<b>100</b>	DEF	<b>42.7</b>	GH	<b>289</b>	CD	<b>128</b>	EF	<b>1.52</b>	D	<b>12.7</b>	DE	<b>36</b>
<b>04WENZ-286</b>	<b>40.8</b>	CDEFGH	<b>97.8</b>	AB	<b>72</b>	ABCD	<b>80.3</b>	HIJ	<b>1.8</b>	EFG	<b>11.0</b>	ABCDEF	<b>4.20</b>	H	<b>40.5</b>	HIJ	<b>127</b>	ABCD	<b>45.5</b>	EFGH	<b>136</b>	FGH	<b>130</b>	EF	<b>1.50</b>	DEFG	<b>15.8</b>	DE	<b>41</b>
<b>CDC Meredith</b>	<b>41.0</b>	CDEFGH	<b>98.7</b>	A	<b>74</b>	AB	<b>82.9</b>	A	<b>2.2</b>	BCDEF	<b>10.3</b>	EFG	<b>5.15</b>	ABCDE	<b>54.3</b>	AB	<b>110</b>	CDEF	<b>74.5</b>	ABC	<b>73</b>	H	<b>203</b>	AB	<b>1.45</b>	J	<b>9.1</b>	DE	<b>51</b>
<b>CDC Reserve</b>	<b>39.1</b>	GHI	<b>94.8</b>	B	<b>76</b>	A	<b>81.5</b>	BCDEFG	<b>2.1</b>	DEFG	<b>10.7</b>	ABCDEFG	<b>4.73</b>	FG	<b>45.8</b>	DEF	<b>129</b>	ABC	<b>61.1</b>	D	<b>137</b>	FGH	<b>188</b>	ABC	<b>1.49</b>	EFGHI	<b>12.9</b>	DE	<b>51</b>
<b>CDC Coalition</b>	<b>41.9</b>	BCDEFG	<b>98.8</b>	A	<b>77</b>	A	<b>81.2</b>	EFGH	<b>2.7</b>	BC	<b>10.5</b>	BCDEFG	<b>3.92</b>	HI	<b>39.0</b>	IJ	<b>98</b>	EF	<b>50.0</b>	EFG	<b>192</b>	EFG	<b>123</b>	F	<b>1.52</b>	D	<b>39.7</b>	B	<b>34</b>
<b>CDC Austenson</b>	<b>43.5</b>	ABCD	<b>98.9</b>	A	<b>73</b>	ABCD	<b>80.2</b>	IJ	<b>1.7</b>	EFG	<b>11.3</b>	ABCD	<b>4.57</b>	G	<b>41.8</b>	FGHI	<b>114</b>	BCDE	<b>52.9</b>	E	<b>247</b>	CDE	<b>156</b>	DE	<b>1.50</b>	DEFGH	<b>7.3</b>	DE	<b>50</b>

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

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



## 2009 WESTERN REGIONAL SPRING BARLEY NURSERY AND ADDITIONS - ABERDEEN, 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 (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5051	Steptoe	6	42.3	97.6	67	*75.6	n.d.	3	10.6	3.45	33.0	54	29.9	*1254	115	*1.76	63	15	39
5052	Baronesse	2	40.4	97.3	73	79.1	n.d.	3	11.2	3.79	35.8	85	43.8	140	117	1.52	38	30	33
5053	Harrington	2	38.6	93.5	70	81.8	1.5	1	11.9	4.84	42.9	128	71.9	140	187	1.49	6.3	58	1
5054	AC Metcalfe	2	39.2	97.3	72	81.4	1.9	1	12.0	4.64	40.2	137	75.5	168	172	1.50	10.1	55	6
5055	2B02-2925	2	41.0	97.6	66	81.9	2.2	1	11.3	5.07	47.1	140	81.4	141	197	1.51	9.4	55	6
5056	2B03-3719	2	41.8	99.0	71	82.6	1.9	1	10.7	5.25	51.6	144	79.1	130	203	1.50	8.0	50	16
5057	2B03-3604	2	41.8	94.6	65	82.3	2.2	1	11.3	5.20	46.9	149	81.9	178	209	1.52	11.8	57	4
5058	2B04-0175	2	38.8	95.1	73	81.1	2.3	1	12.3	5.43	44.3	155	76.0	126	212	1.48	7.3	58	1
5059	2B05-0811	2	38.5	86.9	64	81.0	1.9	1	13.8	5.62	42.8	169	84.7	163	218	1.50	7.4	36	29
5060	2Ab04-X00017-4	2	41.8	95.7	68	79.8	1.7	1	12.6	4.18	35.8	146	45.3	348	124	1.53	10.3	42	25
5061	02Ab17271	2	39.7	91.2	64	81.9	2.0	1	12.1	5.47	46.0	167	63.5	166	212	1.51	9.5	55	6
5063	BZ505-172	2	41.3	92.9	73	78.9	1.4	1	13.1	4.03	31.2	143	40.6	269	125	1.51	7.9	34	32
5065	BZ505-192	2	34.0	89.6	63	77.1	1.7	1	11.7	4.91	43.1	149	65.9	119	180	1.47	8.2	44	23
5066	MT010158	2	39.7	93.3	56	80.8	1.9	1	12.7	5.04	41.4	174	52.2	111	186	1.51	12.8	55	6
5067	MT010160	2	30.7	89.4	80	80.8	1.6	1	11.6	5.41	48.6	194	84.9	122	207	1.49	6.8	46	20
5068	MT020155	2	35.8	86.0	59	81.1	1.9	1	11.4	5.24	46.9	156	71.8	173	192	1.49	9.3	51	15
5069	MT020204	2	34.2	92.9	72	80.9	2.1	1	11.8	4.94	44.3	166	62.2	104	176	1.50	12.9	53	11
5070	MT030042	2	32.5	93.8	75	81.2	2.4	2	12.5	5.56	45.4	210	67.2	163	201	1.53	14.9	52	13
5071	MT040073	2	40.3	97.9	66	79.6	n.d.	3	11.4	3.93	35.9	75	39.7	226	133	1.52	48	26	36
5072	2ND21867	2	43.9	97.7	62	81.0	1.8	1	12.5	4.80	39.7	141	48.3	215	169	1.51	7.6	47	18
5073	UT99B1670-3530	6	30.7	87.0	53	77.3	n.d.	3	11.4	4.23	39.9	120	40.9	457	125	1.59	*93	18	37
5074	UT04B2041-42	6	33.8	89.3	53	79.7	2.6	2	10.6	4.04	39.8	82	47.1	306	142	1.55	26	30	33
5075	04WA-122.20	2	42.7	95.9	71	79.4	2.4	2	10.7	3.97	40.0	112	38.1	172	139	1.52	27	27	35
5076	04WZN-124	2	40.3	97.8	56	80.7	n.d.	3	10.8	4.10	39.2	124	42.4	127	133	1.49	37	38	28
5077	04WA-113.22	2	40.0	95.8	69	81.1	n.d.	3	10.5	4.21	43.0	96	43.6	343	126	1.52	25	36	29
5078	04WZN-286	2	34.6	92.5	77	80.5	2.2	2	12.8	4.99	41.5	200	63.6	181	165	1.54	20	49	17
5079	CDC Meredith	2	39.4	96.1	66	82.4	2.3	1	11.2	5.39	52.3	140	76.8	106	187	1.50	14.8	53	11
5080	CDC Reserve	2	35.0	80.8	61	80.3	2.5	1	12.9	5.24	43.1	170	64.5	218	221	1.51	19.6	45	21
5081	CDC Coalition	2	41.7	96.5	71	80.5	2.3	2	12.0	4.29	37.6	122	56.0	360	144	1.55	19.6	44	23
5082	CDC Austenson	2	42.9	97.6	69	80.2	2.3	1	12.0	4.71	41.4	123	51.5	337	153	1.52	11.4	55	6

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 (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5083	Tetonia	2	36.1	86.1	71	78.0	n.d.	3	12.6	3.93	32.7	98	37.1	447	100	1.57	34	17	38
5084	Lenetah	2	33.7	82.7	56	79.4	1.9	1	12.5	5.04	40.3	125	49.6	265	170	1.49	9.6	39	27
5085	Merit	2	39.5	96.9	70	83.5	2.3	1	10.2	4.75	49.2	134	82.0	178	192	1.56	17.6	45	21
5086	2Ab04-X00017-1	2	42.9	93.6	69	79.7	1.7	1	12.0	4.41	38.5	144	43.4	307	142	1.53	9.3	47	18
5087	04Ab074-7	2	40.6	95.2	71	81.4	n.d.	3	10.3	4.02	41.9	92	42.6	307	116	1.53	46	36	29
5088	04Ab045-22	2	40.9	96.6	61	79.5	n.d.	3	12.0	4.41	38.7	116	47.5	255	122	1.54	55	41	26
5089	2Ab04-X01084-27	2	38.7	90.6	55	80.3	2.1	1	12.3	4.85	41.4	129	64.4	171	159	1.51	8.2	52	13
5090	04Ab029-15	2	44.3	97.2	72	81.7	2.3	1	12.6	5.34	44.6	133	71.9	473	188	1.56	13.0	58	1
5091	04Ab029-22	2	44.4	98.8	72	82.6	n.d.	3	12.1	5.29	45.2	142	66.8	410	183	1.60	34	56	5
5062	HARRINGTON MALT CHECK	2	34.9	88.6	81	79.1	1.7	1	12.9	5.25	42.3	117	68.0	117	203	1.49	8	45	
5064	LACEY MALT CHECK	6	35.7	95.0	47	79.5	1.8	1	12.2	5.24	43.4	184	68.4	61	192	1.46	9.5	65	
Minima			30.7	80.8	53	77.1	1.4		10.2	3.45	31.2	54	29.9	104	100	1.47	6.3	15	
Maxima			44.4	99.0	80	83.5	2.6		13.8	5.62	52.3	210	84.9	473	221	1.60	63.0	58	
Means			38.9	93.5	67	80.6	2.0		11.8	4.72	41.9	135	58.9	227	165	1.52	19.4	44	
Standard Deviations			3.7	4.6	7	1.4	0.3		0.9	0.59	4.9	34	16.0	107	35	0.03	14.8	12	
Coefficients of Variation			9.6	4.9	10	1.8	15.4		7.2	12.43	11.6	25	27.3	47	21	1.93	76.5	28	

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 D. Obert, USDA/ARS - Aberdeen

## 2009 WESTERN REGIONAL SPRING BARLEY NURSERY - IDAHO FALLS, ID

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 (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5377	Steptoe	6	41.9	99.7	71	75.8	n.d.	3	9.9	3.69	37.9	56	30.9	*961	121	*1.73	57	15	31
5362	Baronesse	2	41.0	99.7	72	78.9	n.d.	3	11.0	3.89	35.8	103	38.2	103	109	1.49	27	25	27
5374	Harrington	2	40.6	99.4	74	82.0	1.7	1	11.0	5.42	52.9	112	67.7	106	174	1.47	6.7	47	19
5383	AC Metcalfe	2	39.4	99.5	76	81.5	2.0	1	12.1	5.48	47.5	134	76.4	69	211	1.45	6.2	57	4
5380	2B02-2925	2	43.6	99.5	70	81.3	2.0	1	11.8	5.46	48.6	123	76.2	109	206	1.50	4.8	56	5
5390	2B03-3719	2	43.7	99.7	72	82.3	2.0	1	11.2	5.12	48.0	141	78.7	74	237	1.47	4.8	60	1
5379	2B03-3604	2	43.2	99.5	75	82.3	2.1	1	11.2	5.41	48.6	124	75.3	103	209	1.49	6.0	56	5
5371	2B04-0175	2	43.2	99.8	71	82.4	2.2	1	11.4	5.93	51.9	113	65.6	84	194	1.48	7.5	53	10
5370	2B05-0672	2	40.1	99.8	72	82.2	1.9	1	11.2	5.15	47.0	133	66.7	80	160	1.49	9.7	59	3
5373	2B05-0811	2	41.3	99.7	75	82.6	1.9	1	11.6	5.57	49.9	122	71.7	157	183	1.50	10.0	52	11
5382	2Ab04-X00017-4	2	45.2	99.8	76	79.3	1.6	1	11.2	4.27	39.2	122	45.4	258	137	1.53	8.7	40	21
5384	02Ab17271	2	42.8	99.2	73	81.9	2.0	1	11.5	5.46	48.4	133	61.6	97	209	1.48	7.4	60	1
5375	BZ505-172	2	43.2	99.8	77	80.8	1.5	1	10.9	4.08	38.7	113	41.6	127	118	1.49	6.2	38	23
5391	BZ505-192	2	43.2	99.8	75	80.2	1.8	1	11.1	4.59	41.8	114	69.2	177	236	1.48	8.5	52	11
5363	MT010158	2	41.9	99.9	63	82.2	1.6	1	11.2	4.98	47.6	164	47.0	74	157	1.47	6.3	56	5
5359	MT010160	2	41.1	99.5	75	82.0	1.6	1	12.0	5.73	50.6	174	56.0	99	197	1.44	4.2	55	8
5378	MT020155	2	40.9	99.1	72	80.7	1.9	1	11.2	5.34	48.5	118	64.1	198	201	1.49	4.2	46	20
5364	MT020204	2	40.1	99.6	73	80.9	1.5	1	12.0	5.58	50.6	165	71.0	125	191	1.47	3.5	52	11
5361	MT030042	2	41.5	99.6	72	82.9	1.8	1	10.4	5.39	52.4	110	79.6	65	189	1.43	4.7	51	17
5376	MT040073	2	40.0	99.8	70	79.4	n.d.	3	11.3	4.22	37.3	72	42.1	156	117	1.51	33	33	25
5385	2ND21867	2	45.5	99.8	75	81.0	1.6	1	12.5	5.12	43.8	130	51.9	179	181	1.48	5.4	55	8
5381	UT99B1670-3530	6	39.1	99.6	59	77.3	n.d.	3	11.2	4.08	37.0	115	40.1	519	135	1.59	57	19	30
5372	UT04B2041-42	6	*35.1	*98.9	61	78.0	1.5	1	11.1	3.90	35.9	75	43.7	500	118	1.55	11.5	25	27
5368	04WA-122.20	2	44.4	99.3	77	79.5	1.6	2	11.1	4.05	37.1	109	36.7	283	108	1.52	15.5	35	24
5369	04WNZ-124	2	41.5	99.8	73	80.0	1.3	1	11.0	4.07	39.7	102	37.9	222	115	1.54	7.7	30	26
5365	04WA-113.22	2	40.2	99.5	82	79.8	1.5	1	11.1	4.17	39.2	107	41.0	318	111	1.54	10.6	39	22
5367	04WNZ-286	2	41.7	99.6	72	80.3	n.d.	3	11.2	4.49	42.9	125	44.0	148	124	1.48	27	52	11
5388	CDC Meredith	2	41.9	99.6	78	82.4	2.1	1	10.9	5.02	49.9	108	72.0	63	259	1.43	5.7	51	17
5387	CDC Reserve	2	40.8	99.6	80	81.4	2.1	1	10.6	4.76	45.5	124	65.2	162	217	1.52	10.5	52	11
5360	CDC Coalition	2	41.8	99.6	80	81.0	n.d.	3	10.8	3.90	38.1	92	47.6	171	104	1.51	40	25	27

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 (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5366	CDC Austenson	2	43.7	99.7	74	80.1	1.5	1	11.9	4.83	42.0	118	50.9	302	148	1.51	5.7	52	11
5386	LACEY MALT CHECK	6	35.9	95.2	51	79.5	2.0	1	12.8	5.64	47.4	155	61.5	83	202	1.47	10.3	60	
5389	HARRINGTON MALT CHECK	2	35.9	89.1	82	79.2	1.8	1	12.3	4.98	41.4	115	66.1	93	246	1.48	9.2	49	
Minima			39.1	99.1	59	75.8	1.3		9.9	3.69	35.8	56	30.9	63	104	1.43	3.5	15	
Maxima			45.5	99.9	82	82.9	2.2		12.5	5.93	52.9	174	79.6	519	259	1.59	57.0	60	
Means			41.9	99.6	73	80.7	1.8		11.2	4.81	44.3	118	56.6	171	167	1.49	13.6	45	
Standard Deviations			1.7	0.2	5	1.7	0.3		0.5	0.67	5.6	25	15.1	116	46	0.03	14.6	13	
Coefficients of Variation			4.0	0.2	7	2.1	14.3		4.6	13.93	12.7	21	26.6	68	27	2.28	106.9	29	

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 Ag Resources, LLC - Fort Collins, CO

## 2009 WESTERN REGIONAL SPRING BARLEY NURSERY - CONRAD, 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 (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5311	Steptoe	6	41.8	99.7	78	75.2	n.d.	3	10.1	3.37	35.8	50	30.1	*609	103	*1.70	43	15	31
5296	Baronesse	2	40.4	99.1	83	78.0	n.d.	3	10.4	3.53	34.3	86	39.7	89	95	1.51	38	25	28
5308	Harrington	2	38.4	98.8	80	81.0	1.6	1	11.1	4.92	46.9	115	77.7	117	190	1.47	5.8	55	3
5317	AC Metcalfe	2	38.3	98.8	80	82.1	2.8	2	10.5	5.50	53.9	107	71.6	54	229	1.45	16.1	48	11
5314	2B02-2925	2	41.0	99.3	78	81.4	2.1	1	10.3	5.18	50.8	109	80.8	64	204	1.45	8.2	51	7
5324	2B03-3719	2	42.6	99.8	76	82.1	3.3	2	10.1	5.88	61.3	107	76.8	62	237	1.45	17.0	47	13
5313	2B03-3604	2	42.2	99.4	83	82.0	2.3	1	10.1	5.22	53.3	123	80.0	63	221	1.46	9.9	55	3
5305	2B04-0175	2	40.6	99.1	82	82.0	2.1	1	11.4	5.46	49.6	143	81.3	60	226	1.45	8.3	59	2
5304	2B05-0672	2	37.7	98.8	81	81.9	1.8	1	10.6	4.76	44.8	146	83.0	65	188	1.44	7.9	55	3
5307	2B05-0811	2	40.5	99.3	79	82.4	2.3	1	10.9	5.22	49.8	105	82.6	78	192	1.46	10.7	51	7
5316	2Ab04-X00017-4	2	44.1	99.2	76	78.8	1.6	1	10.8	4.14	40.9	123	44.7	121	121	1.49	9.8	43	17
5318	02Ab17271	2	41.9	98.5	79	82.2	2.2	1	10.3	4.82	50.7	110	62.3	76	193	1.47	10.4	51	7
5309	BZ505-172	2	43.4	99.1	79	80.0	1.5	1	10.4	3.78	37.4	110	37.5	114	126	1.50	8.4	31	22
5325	BZ505-192	2	41.3	99.0	76	79.2	1.8	1	10.5	4.35	42.9	109	62.3	127	162	1.46	10.8	42	19
5297	MT010158	2	42.2	98.9	71	81.2	1.6	1	11.2	4.54	42.5	144	53.2	99	162	1.47	6.6	65	1
5293	MT010160	2	41.6	98.8	76	82.3	1.5	1	10.8	4.75	47.2	126	59.6	176	170	1.49	5.1	47	13
5312	MT020155	2	40.5	99.4	74	81.0	2.0	1	10.4	4.83	49.2	96	64.4	123	177	1.48	8.0	43	17
5298	MT020204	2	39.0	99.5	79	80.4	1.6	1	10.4	4.98	48.5	151	81.9	92	202	1.44	6.7	49	10
5295	MT030042	2	43.3	99.4	82	83.0	1.6	1	9.6	4.53	47.7	115	85.5	102	188	1.47	5.0	48	11
5310	MT040073	2	40.8	99.6	65	79.6	n.d.	3	10.7	3.95	38.2	62	40.6	102	114	1.50	41	28	24
5319	2ND21867	2	46.0	99.7	77	81.6	1.7	1	10.8	4.83	48.0	101	48.1	110	164	1.48	6.9	45	16
5315	UT99B1670-3530	6	39.2	99.6	69	77.0	n.d.	3	10.2	3.69	37.4	92	40.5	*324	108	*1.61	45	19	30
5306	UT04B2041-42	6	*34.0	98.4	82	78.7	1.8	2	9.3	3.29	37.9	53	42.4	224	104	1.57	14.7	27	26
5302	04WA-122.20	2	42.6	97.9	79	79.9	1.6	1	9.6	3.64	38.5	81	38.3	126	111	1.49	11.8	27	26
5303	04WNZ-124	2	39.9	98.8	70	78.4	n.d.	3	10.7	4.19	40.6	120	41.7	102	126	1.46	31	38	21
5299	04WA-113.22	2	40.0	99.3	83	80.6	1.5	1	10.4	3.98	39.2	106	44.7	204	132	1.52	9.3	29	23
5301	04WNZ-286	2	42.5	99.1	74	79.2	1.4	1	10.2	3.46	34.2	89	36.8	98	102	1.50	10.6	28	24
5322	CDC Meredith	2	41.6	99.3	76	82.8	2.3	1	9.7	5.17	55.4	89	70.6	73	190	1.45	9.7	47	13
5321	CDC Reserve	2	40.0	99.0	85	81.7	2.1	1	9.9	4.43	46.1	101	56.1	89	166	1.47	12.2	54	6
5294	CDC Coalition	2	41.7	99.4	85	80.8	n.d.	3	9.9	3.58	37.6	88	49.2	154	116	1.54	54	25	28

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 (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5300	CDC Austenson	2	42.4	98.5	78	79.2	1.5	1	11.2	4.20	37.9	112	54.5	206	150	1.49	7.6	40	20
5320	LACEY MALT CHECK	6	35.6	94.0	50	79.5	2.1	2	12.6	5.72	46.6	153	60.2	65	204	1.47	11.9	60	
5323	HARRINGTON MALT CHECK	2	36.6	88.5	80	78.8	2.0	2	12.5	5.75	46.3	113	66.3	91	224	1.47	11.4	44	
Minima			37.7	97.9	65	75.2	1.4		9.3	3.29	34.2	50	30.1	54	95	1.44	5.0	15	
Maxima			46.0	99.8	85	83.0	3.3		11.4	5.88	61.3	151	85.5	224	237	1.57	54.0	65	
Means			41.2	99.1	78	80.5	1.9		10.4	4.46	44.5	105	58.7	109	160	1.48	15.8	42	
Standard Deviations			1.8	0.4	5	1.8	0.5		0.5	0.71	6.9	24	17.6	45	43	0.03	13.7	13	
Coefficients of Variation			4.4	0.4	6	2.3	24.4		4.8	15.87	15.5	23	30.0	41	27	2.08	86.8	31	

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 Ag Resources, LLC - Fort Collins, CO

## 2009 WESTERN REGIONAL SPRING BARLEY NURSERY - FAIRFIELD, MT

Table 7

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5344	Steptoe	6	41.7	99.4	56	*75.6	n.d.	3	9.4	3.27	38.6	57	29.6	*965	97	*1.73	59	15	31
5329	Baronesse	2	44.2	99.8	64	80.5	n.d.	3	9.8	3.61	39.7	78	36.7	112	112	1.52	29	25	29
5341	Harrington	2	42.4	99.8	74	83.2	1.7	1	9.7	4.91	55.5	110	77.2	86	181	1.46	5.5	52	12
5350	AC Metcalfe	2	41.4	99.5	72	83.1	1.8	1	9.6	4.91	54.0	128	84.0	52	181	1.44	5.3	54	6
5347	2B02-2925	2	43.5	99.7	69	83.1	1.9	1	10.0	5.19	56.1	120	88.9	70	192	1.48	5.8	55	1
5357	2B03-3719	2	43.9	99.8	71	83.4	1.9	1	9.5	5.19	59.0	147	87.4	49	188	1.44	4.4	55	1
5346	2B03-3604	2	44.7	99.7	70	83.9	2.1	1	9.8	5.20	58.0	142	87.9	66	190	1.47	5.7	55	1
5338	2B04-0175	2	42.6	99.9	75	84.0	2.3	1	10.2	5.29	55.9	128	80.6	59	236	1.47	6.0	55	1
5337	2B05-0672	2	40.7	99.8	65	83.3	1.9	1	9.7	4.68	53.5	146	81.1	58	195	1.45	6.8	54	6
5340	2B05-0811	2	40.7	99.6	67	84.5	1.9	1	9.2	5.00	57.2	127	80.3	95	190	1.47	5.7	54	6
5349	2Ab04-X00017-4	2	46.3	99.9	72	81.4	1.7	2	9.3	3.99	45.9	129	42.7	164	115	1.53	11.4	42	22
5351	02Ab17271	2	42.4	99.3	81	84.2	1.8	1	8.6	4.78	59.5	118	68.9	52	169	1.45	6.1	52	12
5342	BZ505-172	2	46.8	99.8	72	82.5	1.5	1	9.6	3.83	42.4	119	37.1	95	118	1.49	9.1	43	21
5358	BZ505-192	2	44.9	99.7	68	82.4	1.6	1	9.3	4.45	51.1	112	72.6	121	153	1.47	5.4	48	18
5330	MT010158	2	42.3	99.8	61	83.5	2.0	1	9.7	5.08	57.6	124	54.4	57	200	1.46	5.4	55	1
5326	MT010160	2	41.7	99.5	70	83.7	2.0	1	9.7	5.22	57.9	111	61.4	85	206	1.45	3.8	51	14
5345	MT020155	2	42.0	99.6	62	83.2	1.8	1	10.0	5.19	57.1	125	72.6	96	191	1.45	5.1	54	6
5331	MT020204	2	42.1	99.7	65	82.4	2.1	1	10.4	5.48	56.5	124	79.1	115	231	1.46	5.1	51	14
5328	MT030042	2	41.8	99.6	69	83.9	2.3	1	9.3	5.21	57.7	90	82.4	90	212	1.46	6.0	47	19
5343	MT040073	2	41.2	99.7	63	80.7	n.d.	3	10.3	3.91	41.3	75	44.1	104	111	1.49	37	33	27
5352	2ND21867	2	45.7	99.8	70	83.3	1.4	1	9.8	4.59	49.0	110	49.5	94	153	1.47	4.9	49	17
5348	UT99B1670-3530	6	37.9	*99.0	54	78.6	n.d.	3	9.6	3.89	41.2	111	39.5	*334	120	1.54	50	22	30
5339	UT04B2041-42	6	36.1	99.5	59	80.2	2.1	2	9.0	3.44	42.1	63	42.9	*316	112	1.55	17.8	35	25
5335	04WA-122.20	2	43.2	99.6	73	80.6	1.6	1	9.3	3.86	43.9	89	38.2	107	128	1.49	8.6	32	28
5336	04WZN-124	2	40.3	99.2	68	80.9	n.d.	3	9.6	4.16	46.3	124	40.9	84	144	1.46	40	47	19
5332	04WA-113.22	2	42.1	99.4	73	81.2	1.5	1	10.1	4.24	43.9	92	41.6	290	142	1.51	5.8	39	24
5334	04WZN-286	2	44.2	99.8	65	81.1	1.4	1	9.8	3.86	43.5	95	37.4	116	130	1.50	5.4	35	25
5355	CDC Meredith	2	41.0	99.7	77	84.0	2.0	1	9.3	5.03	59.6	102	78.6	50	175	1.44	6.2	51	14
5354	CDC Reserve	2	40.6	99.8	76	82.7	1.7	1	9.4	4.48	48.7	120	58.5	78	148	1.46	9.1	54	6
5327	CDC Coalition	2	42.4	99.6	73	82.6	n.d.	3	9.3	3.93	42.9	89	47.1	83	128	1.48	45	41	23

Table 7

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 (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5333	CDC Austenson	2	44.9	99.8	69	81.4	1.7	1	10.0	4.54	46.1	104	54.6	142	171	1.46	4.5	53	11
5353	LACEY MALT CHECK	6	36.3	94.0	49	79.6	1.7	1	12.3	5.65	48.5	175	62.2	63	191	1.44	8.6	60	
5356	HARRINGTON MALT CHECK	2	34.9	88.8	80	79.2	1.7	1	12.6	5.61	47.5	127	64.0	65	194	1.45	9.4	43	
Minima			36.1	99.2	54	78.6	1.4		8.6	3.27	38.6	57	29.6	49	97	1.44	3.8	15	
Maxima			46.8	99.9	81	84.5	2.3		10.4	5.48	59.6	147	88.9	290	236	1.55	59.0	55	
Means			42.4	99.7	68	82.5	1.8		9.6	4.53	50.4	110	60.6	95	162	1.48	13.7	45	
Standard Deviations			2.3	0.2	6	1.5	0.2		0.4	0.63	7.1	23	19.5	48	38	0.03	15.6	11	
Coefficients of Variation			5.3	0.2	9	1.8	13.3		4.1	13.96	14.1	21	32.2	50	24	2.04	113.7	24	

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 Ag Resources, LLC - Fort 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

## 2009 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	0	= 3	0	
	3=hazy	= 2	1	= 2	1
	2=slightly hazy	= 1	2	= 1	2
	1=clear				
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	