

UNITED STATES DEPARTMENT OF AGRICULTURE
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**Western REGIONAL SPRING BARLEY NURSERY
2013 Crop**

Preliminary Quality Report

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Detailed Data:

Aberdeen, ID
Fairfield, MT
Idaho Falls, ID

Appendix:

Methods
Criteria for Quality Score

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 are interested in the development of improved barleys.

This report includes data furnished by the Agricultural Research Service and 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.

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

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Western Regional Spring Barley Nursery – 2013 Crop

The Western Regional Spring Barley Nursery (WRSBN) is an annual agronomic project coordinated by Dr. Charles Erickson of the USDA-ARS National Small Grains Germplasm Research Facility, Aberdeen, ID. Cereal Crops Research Unit, in Madison, Wisconsin, tests barleys, from a subset of the nursery locations, for malting quality. This year we received WRSBN selections from Aberdeen, ID, Fairfield, MT, and Idaho Falls, ID. Fairfield and Idaho Falls each grew 31 selections, while Aberdeen grew 21; we did not receive 2Ab09-X06F058HL-21, UT2170-16, X06G07-T43, X05013-T1, 09WA-231.5, 09WA-203.26, 09WA-228.13 09WA-203.24, or 09WA-249.9 from this site. Table 1 is an entry list, supplied by Dr. Erickson, with parentages for the 2013 WRSBN. These samples were tested for barley characteristics, malted, and analyzed for malt quality.

The malting batches were performed in Joe White (JW) micro-malters, under conditions that should generate malts having modification levels similar to those produced industrially. 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 the traditional “Ideal Commercial Malt Criteria” developed by the American Malting Barley Association (AMBA). The overall quality scores might not reflect the needs of craft brewers. AMBA has recently expanded its guidelines for ideal malt criteria to include these needs, and they are listed in Appendix B.

SAS 9.3 statistical software was used to compare performances at the three locations and between the selections; mean values for fourteen quality factors are listed for the three WRSBN stations (Table 2), and for all lines (Table 3). Individual station data are reported in Tables 4 through 6. Evaluations of data from individual locations and overall performance of each line, derived mostly from Tables 2 and 3, are presented, as well.

The 2013 WRSBN locations exhibited similar average Kernel Weights, with only Fairfield Montana’s average (41.9mg) significantly larger than that of Aberdeen, Idaho (40.9mg). Aberdeen’s average Plumpness (6/64”) was significantly less ($p < 0.05$) than the averages for Fairfield and Idaho Falls. Kernel surface brightness, as measured by an Agtron Colorimeter, was also similar at each location, likely due to the relatively close geographical proximity of these nursery locations. Significant differences in the Barley Protein (dry basis) averages were seen, with Idaho Falls highest at 13.5%, Aberdeen intermediate at 12.8%, and Fairfield the lowest at 11.7% (significant at $p < 0.05$). This low Fairfield Protein average may have helped raise its average Malt Extract level to 80.6%, which was significantly greater than Idaho Falls (79.8%) or Aberdeen (78.8%). Aberdeen’s Malt Extract average was lowest, likely due to the aforementioned Plumpness results.

The malts made from Aberdeen barleys developed significantly more average Color, when mashed, than those from Fairfield or Idaho Falls. The Aberdeen location displayed more vigorous protein modification than the other locations, on average. The Soluble Protein average was higher for Aberdeen (5.05%), than for Idaho Falls (4.76%), which was higher than Fairfield (4.32%) (significant at $p < 0.05$), despite the high Barley Protein average seen with the Idaho Falls barleys. They exhibited the highest average S/T ratio (40.7), which was significantly greater than Fairfield’s (39.2) average, which

was greater than that of Idaho Falls (37.1). Also, the Aberdeen (223.1ppm) and Idaho Falls (217.9) FAN averages were significantly higher than that of Fairfield. All of these averages point to greater availability of amino acids during kilning for the Aberdeen malts, and hence more Maillard reactions and color development.

The Aberdeen location was also notable for significantly better cell wall modification during malting of its barleys. Its Beta-Glucan average of 189.6ppm was significantly lower ($p < 0.05$) than Fairfield (249.4ppm) or Idaho Falls (223.7ppm), which did not differ significantly. This was likely a factor in its low average Relative Viscosity of 1.49. That number was significantly lower than the Fairfield average (1.66) or Idaho Falls (1.64), which again did not differ significantly ($p < 0.05$). Aberdeen's Turbidity average was significantly lower than that of Fairfield ($p < 0.05$), but not significantly different from Idaho Falls ($p > 0.05$).

Idaho Falls, as a WRSBN location, was notable for the development of the highest average amyolytic enzyme activities. Both its Diastatic Power (150.1°) and α -Amylase (70.4° DU) averages were significantly higher than the averages for either of the other locations. Its highest average Barley Protein, as noted earlier, enabled these results.

The top performing lines in the 2013 WRSBN, based on the overall Quality Score, which is derived from the ideal malt parameters for industrial adjunct brewing, were: 2B09-3425, 2ND25276, 2ND27705, AC Metcalfe, and 2B10-4162. 2B09-3425 had an excellent Malt Extract average of 81.5% (dry basis). This was significantly lower than only the average for X06-G07-T43, which is a hull-less line. (The Malt Extract value for 2B09-3425 when grown at Fairfield was 82.0%) It met the ideal criteria for an adjunct, two-rowed malting barley, across the board. Highlights would include a β -Glucan level average of 57.0ppm, Turbidity average of 4.1 Hach units, Relative Viscosity average of 1.45, FAN average of 235.0ppm, and amyolytic averages for DP and α -amylase of 153.7° and 97.9°DU, respectively.

The high performing lines 2ND25276 and 2ND27705 exhibited balanced quality, hitting ideal ranges for many parameters. The Malt Extract average for 2ND25276 of 80.8% did not differ significantly from that for 2ND27705 of 79.7% ($p < 0.05$). Diastatic Power was significantly higher on average for 2ND27705 than 2ND25276 – 160.3° versus 137.0°, but α -Amylase averages did not differ significantly. Neither's averages differed significantly for Relative Viscosity or Turbidity.

AC Metcalfe's average Barley Protein of 13.0% was at the high end of the ideal range, and its Malt Extract average of 80.5% did not hit the ideal threshold for a 2-rowed malting barley. (Its Malt Extract value of 79.1% from the barley grown at Aberdeen pulled down the average). However, all other measured quality parameters were ideal for this type of malting barley. 2B10-4162 scored well on most parameters; the Malt Extract average of 81.3% was ideal, and it had relatively high amyolytic enzyme averages, and low β -Glucan, Relative Viscosity, and Turbidity averages. In fact, its Malt Extract measurement for the Fairfield malt was 82.5% for this hulled barley.

Those barleys which showed the worst overall malting quality in the 2013 WRSBN, when grown at these 3 locations, were: Steptoe, UT2170-16, 2Ab09-X06F058HL-21, and X05013-T1. These results were unsurprising. 2Ab09-X06F058HL-21 and X05013-T1 are hull-less, Food barley lines, and Steptoe and UT2170-16 are classified as Feed barley. Many of the parameter ideals for Food barleys are

diametrically opposed to those for Malting barleys. X05013-T1 had a β -Glucan average of 982.0ppm, a Relative Viscosity average of 2.72, Kohlbach Index average of 25.6, and α -Amylase average of 39.4°DU. 2Ab09-X06F058HL-21 averaged 15.1% Barley Protein, 27.2 for S/T, 47.8°DU for α -Amylase, and 1106.0ppm of β -Glucan. Its Relative Viscosity was 5.25! It yielded similar averages in the 2012 WRSBN.

The Feed barley, Steptoe, had a Malt Extract average of 74.8%, even though it was 2-rowed, and had 96.4% plump (6/64"), with a Kernel Weight average of 42.6mg. Its α -amylase average was lowest in the nursery at 36.6°DU, and it had β -Glucan and Turbidity averages of 823.3ppm and 46.3 Hach units, respectively. UT2170-16 also showed low DP and α -Amylase averages – 81.5° and 42.8°DU. It had an average β -Glucan level of 601.0ppm, and high Relative Viscosity and Turbidity averages of 1.67 and 27.7 Hach units.

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Table 1: 2013 Western Regional Spring Barley Nursery

Seed Source	Entry No.	Entry	Parentage	Type	Grade	Years Tested	Cooperator
WSU	1	Steptoe	CI 15229	6 row	feed		Check, Ulrich, Wood
WPB	2	Baronesse	PI 568246	2 row	feed		Check, Clark, Cook
USDA-ARS	3	Harrington		2 row	malting		Check, Erickson
USDA-ARS	4	AC Metcalfe		2 row	malting		Check, Erickson, Beattie
BARI	5	* 2B09-3425	2B05-0550 / 2B99-2763-10	2 row	malting	0	Askelson
BARI	6	* 2B10-4162	MERIT 57 / 2B05-0712	2 row	malting	0	Askelson
BARI	7	* 2B10-4465	2B04-0291 / 2B05-0615	2 row	malting	0	Askelson
BARI	8	* 2B10-4480	2B04-0294 / 2B05-0676	2 row	malting	0	Askelson
USDA-ARS	9	2Ab07-X031098-31	2B97-4004/Newdale	2 row	malting	1	HU
USDA-ARS	10	2Ab09-X06F058HL-21	02HR-4590/CDC Fibar	2 row	hulless,Food	1	HU
USDA-ARS	11	2Ab07-X04M219-46	95SR316A/2B97-4004	2 row	malting	1	HU
USDA-ARS	12	* 2Ab08-X05M010-82	2B98-5312/98Ab11993	2 row	malting	0	HU
USDA-ARS	13	* 2Ab08-X04M282-48	2B98-5312/97Ab7973	2 row	malting	0	HU
USDA-ARS	14	* 2Ab08-X04M278-35	2B97-4004/97Ab6643	2 row	malting	0	HU
USDA-ARS	15	* 08ID2661	04lpa-10/Tetonia	2 row	feed	1	Bregitzer
MSU	16	* MT090190		2 row	feed	0	Blake
MSU	17	* MT090180		2 row	feed	0	Blake
MSU	18	* MT100126		2 row	feed	0	Blake
MSU	19	* MT100120		2 row	feed	0	Blake
NDSU	20	2ND25276	ND20802/3/ND1922//ND19929/ND20177	2 row	malting	3	Horsley
NDSU	21	* 2ND27705	2ND24393/TR05285	2 row	malting	0	Horsley
NDSU	22	* 2ND28065	2ND21867/2ND24238	2 row	malting	0	Horsley
USU	23	UT6R2120-14		6 row	feed	2	Hole
USU	24	* UT2170-16		6 row	feed	0	Hole
WSU	25	* X06G07-T43	Merlin/Baronesse*2//WA 9820-98/3/03WA-139.4	6 row	Hulless/Food	0	Murphy, Wood
WSU	26	* X05013-T1	Merlin/Baronesse*2//SH 97110	6 row	Hulless/Food	0	Murphy, Wood
WSU	27	* 09WA-231.5	02WZN-1015/YU-501-385N	6 row	Feed	0	Murphy, Wood
WSU	28	* 09WA-203.26	YU501-385/02WZN-1100	6 row	Feed	0	Murphy, Wood
WSU	29	* 09WA-228.13	02WZN-1100/YU501-385	6 row	Feed	0	Murphy, Wood
WSU	30	* 09WA-203.24	YU501-385/02WZN-1100	6 row	Feed	0	Murphy, Wood
WSU	31	* 09WA-249.9	NZDK 00-131/98Ab11993//Baronesse/WA 7478-97	6 row	Feed	0	Murphy, Wood

* new entries

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

LOCATION	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	40.9 b	91.2 b	40.9 b	78.8 c	2.4 a	12.8 b	5.05 a	40.7 a	137.0 b	67.8 b	189.6 b	223.1 a	1.49 b	7.8 b	50.6 a
Fairfield, MT	41.9 a	95.1 a	41.9 a	80.6 a	2.2 b	11.7 c	4.32 c	39.2 b	127.5 c	67.1 b	249.4 a	193.4 b	1.66 a	10.7 a	49.0 a
Idaho Falls, ID	41.5 ab	95.7 a	41.5 ab	79.8 b	2.1 b	13.5 a	4.76 b	37.1 c	150.1 a	70.4 a	223.7 a	217.9 a	1.64 a	9.0 ab	45.8 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, 2B09-3425, 2B10-4162, 2B10-4465, 2B10-4480, 2Ab07-X031098-31, 2Ab09-X06F058HL-21, 2Ab07-X04M219-46, 2Ab08-X05M010-82, 2Ab08-X04M282-48, 2Ab08-X04M278-35, 08ID2661, MT090190, MT090180, MT100126, MT100120, 2ND25276, 2ND27705, 2ND28065, UT6R2120-14, UT2170-16, X06G07-T43, X05013-T1, 09WA-231.5, 09WA-203.26, 09WA-228.13, 09WA-203.24, 09WA-249.9

WESTERN REGIONAL SPRING BARLEY NURSERY - 2013 Crop

Table 3 - Varietal Means* of Barley and Malt Quality Factors for Three 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)	Viscosity (Relative)	Turbidity (HACH)	Quality Score
Step toe	42.6 cdef	96.4 abcd	64.7 fg	74.8 n	3.1 b	11.4 jk	3.46 k	32.0 ij	71.3 i	36.6 l	823.3 c	191.7 defghijk	1.80 c	46.3 a	20.0 l
Baronesse	41.9 defg	95.6 abcd	73.7 abcde	76.6 m	2.7 cd	13.2 bcd	3.92 ij	31.1 ij	120.7 gh	51.2 ij	135.3 kjlm	137.0 jklm	1.49 efg	23.5 cd	31.7 ijk
Harrington	39.6 ghi	93.7 bedefg	70.0 abcdef	79.9 fghijk	2.1 ghijkl	12.8 bcdefgh	5.30 bcde	42.1 bcde	162.3 bcd	84.2 bc	111.7 jklm	238.0 abcdefg	1.45 fg	4.4 e	58.7 abcd
AC Metcalfe	39.8 ghi	94.3 abcdef	75.7 ab	80.5 cdefgh	2.2 efghij	13.0 bcdef	5.32 bcde	43.1 bcd	175.3 ab	93.9 a	55.0 lm	241.7 abcdefg	1.44 g	4.8 e	60.7 ab
2B09-3425	40.5 fgh	95.7 abcd	67.7 cdefg	81.5 bc	2.3 defghi	12.2 fghij	5.08 def	44.7 abc	153.7 cdef	97.9 a	57.0 lm	235.0 abcdefg	1.45 fg	4.1 e	67.3 a
2B10-4162	40.9 fg	95.1 abcde	70.3 abcdef	81.3 bcde	2.6 cde	12.7 cdefgh	5.42 abcd	45.0 abc	148.7 cdef	90.8 ab	61.3 lm	298.3 a	1.45 fg	5.0 e	60.0 abc
2B10-4465	41.3 efg	94.5 abcdef	68.3 bcdefg	81.4 bcd	2.4 cdefg	13.0 bcdef	5.41 abcd	44.1 abc	154.0 cdef	90.3 ab	45.3 lm	292.3 a	1.44 g	3.7 e	59.3 abc
2B10-4480	40.8 fg	94.9 abcde	70.3 abcdef	80.8 cdefg	2.4 defgh	12.6 cdefghi	5.45 abc	45.5 ab	169.0 abc	94.8 a	50.7 lm	256.3 abcd	1.42 g	4.5 e	57.0 abcde
2Ab07-X031098-31	40.8 fg	94.3 abcdef	67.7 cdefg	80.9 cdef	2.4 cdefg	13.5 bc	5.71 a	44.8 abc	186.7 a	83.1 bcd	41.3 lm	260.3 abc	1.44 g	4.6 e	57.7 abcde
2Ab09-X06F058HL-12	39.8 ghi	96.2 abcd	50.5 hi	80.3 efghi	1.4 n	15.1 a	3.92 ij	27.2 k	76.0 i	47.8 jk	1106.0 a	134.0 klm	5.25 a	6.2 e	22.5 kl
2Ab07-X04M219-46	38.5 hij	90.1 fg	74.3 abcd	80.5 cdefgh	2.3 efghi	12.8 bcdefgh	5.02 ef	40.1 def	162.7 bcd	73.9 e	46.0 lm	214.3 bcdefghi	1.45 fg	4.9 e	58.0 abcd
2Ab08-X05M010-82	37.7 ij	90.7 fg	67.3 cdefg	79.0 jkl	2.2 efghij	12.7 cdefgh	4.93 f	39.4 efg	160.3 bcde	86.2 bc	62.3 lm	266.7 abc	1.44 g	3.9 e	53.3 bcdef
2Ab08-X04M282-48	36.8 j	84.8 h	65.0 fg	78.9 kl	2.4 defgh	13.1 bcde	5.14 cdef	41.7 cde	149.3 cdef	94.5 a	111.3 jklm	277.3 ab	1.43 g	3.9 e	47.0 efg
2Ab08-X04M278-35	43.9 bcd	94.7 abcde	71.3 abcdef	81.6 bc	2.8 c	12.4 defghi	5.51 ab	46.8 a	159.3 bcde	80.8 cde	36.7 m	255.3 abcde	1.45 fg	7.2 e	58.0 abcd
08ID2661	43.4 bcde	92.4 defg	76.7 a	78.5 l	2.2 fghijk	13.0 bcdef	4.55 g	36.4 gh	90.3 i	47.6 jk	442.3 e	189.0 efghijk	1.54 ef	5.8 e	36.0 hij
MT090190	44.3 bc	97.2 abc	66.3 efg	79.9 fghijk	2.0 hijklm	12.0 ghij	4.51 g	39.8 def	152.3 cdef	60.7 fgh	152.3 ijkl	188.3 fghijk	1.48 efg	6.1 e	56.0 bcde
MT090180	43.9 bcd	96.5 abcd	70.0 abcdef	79.9 fghijk	2.0 ijklm	12.3 defghi	4.33 gh	37.2 fg	146.7 def	58.5 fghi	207.7 ghijk	202.7 cdefghij	1.51 efg	6.8 e	48.0 defg
MT100126	44.3 bc	97.1 abcd	69.0 abcdefg	79.7 ghijk	2.0 hijkl	12.0 hij	4.50 g	39.6 efg	150.7 cdef	55.5 hij	248.7 ghi	186.7 ghijkl	1.52 efg	6.8 e	49.7 cdefg
MT100120	44.5 bc	97.7 abc	67.7 cdefg	80.1 fghij	2.0 hijkl	11.7 ijk	4.35 gh	39.3 efg	146.7 def	59.7 fgh	189.0 hijk	175.3 ghijklm	1.52 efg	8.1 e	49.7 cdefg
2ND25276	44.7 abc	97.6 abc	62.0 g	80.8 cdefg	2.2 efghij	12.2 fghij	5.11 cdef	44.0 abc	137.0 fg	76.2 de	133.3 jklm	207.0 cdefghi	1.46 efg	6.0 e	63.0 ab
2ND27705	40.4 fgh	93.5 bedefg	75.0 abc	79.7 ghijk	2.3 efghi	12.5 defghi	5.02 ef	42.4 bcde	160.3 bcde	78.4 cde	73.0 lm	251.3 abcdef	1.42 g	4.8 e	62.0 ab
2ND28065	40.3 fgh	93.0 cdefg	66.7 defg	79.4 hijkl	1.7 lmn	12.8 bcdefgh	4.60 g	37.8 fg	123.0 gh	56.2 ghi	196.0 ghijk	184.0 ghijkl	1.47 efg	3.9 e	45.3 fgh
UT6R2120-14	41.4 efg	97.3 abc	55.0 h	77.1 m	2.3 efghi	12.8 bcdefgh	3.68 jk	30.3 j	140.5 efg	41.7 kl	387.5 ef	134.5 klm	1.55 ef	10.4 e	29.0 jkl
UT2170-16	32.4 k	77.5 i	64.0 fg	76.5 m	2.5 cdef	11.1 k	3.44 k	32.3 ij	81.5 i	42.8 kl	601.0 d	121.0 lm	1.67 d	27.7 bc	20.0 l
X06G07-T43	36.8 j	89.8 g	46.5 i	85.7 a	2.2 efghij	13.7 b	4.36 gh	33.8 hi	155.5 bcdef	63.8 fg	122.5 jklm	242.5 abcdefg	1.56 e	19.6 d	48.0 defg
X05013-T1	42.0 defg	95.2 abcde	44.5 i	82.2 b	1.9 jklm	14.7 a	3.62 jk	25.6 k	83.0 i	39.4 l	982.0 b	118.0 m	2.72 b	9.3 e	26.0 jkl
09WA-231.5	41.4 efg	97.3 abc	68.0 bcdefg	79.1 ijkl	1.7 mn	12.3 efghij	3.87 ij	32.8 ij	123.0 gh	48.3 jk	222.0 ghij	138.0 jklm	1.51 efg	5.7 e	39.5 ghi
09WA-203.26	45.5 ab	97.0 abcd	71.5 abcdef	79.4 hijkl	1.8 klm	12.4 defghi	3.97 ij	33.6 hij	109.5 h	52.8 hij	279.0 gh	149.5 ijklm	1.51 efg	7.9 e	36.0 hij
09WA-228.13	46.7 a	98.0 ab	69.5 abcdefg	79.7 ghijk	1.8 klm	12.9 bcdefg	4.15 hi	33.7 hi	124.0 gh	56.5 ghi	303.5 fg	184.5 fghijkl	1.51 efg	7.7 e	40.0 ghi
09WA-203.24	45.1 ab	98.7 a	67.0 defg	79.7 ghijk	1.9 jklm	12.1 fghij	3.92 ij	34.0 hi	113.5 h	57.0 ghi	302.5 fg	156.0 hijklm	1.51 efg	7.3 e	39.5 ghi
09WA-249.9	44.3 bc	98.0 ab	69.5 abcdefg	80.2 efghi	3.5 a	12.0 ghij	4.91 f	43.1 bcd	114.5 h	65.9 f	98.5 klm	218.0 bcdefgh	1.45 fg	32.0 b	53.5 bcdef

* 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; Fairfield, MT; Idaho Falls, ID

***n.d.: Sample's clarity reported as hazy, hence the wort color was not defined.

2013 WRSBN

Table 4 -- Aberdeen, ID

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)	Rel. Visco	Turbid (Hach)	Quality Score	Overall Rank
5471	Steptoe	6	42.0	95.9	70	*74.5	3.1	2	12.0	3.80	32.8	76	41.1	*818	154	*1.76	*32.0	25	21
5472	Baronesse	2	42.0	96.5	75	76.8	2.9	2	12.5	4.10	34.3	101	51.7	129	155	1.50	*24.0	37	19
5473	Harrington	2	39.7	90.9	69	79.6	2.1	1	12.8	5.47	42.2	158	78.6	114	252	1.45	3.6	60	5
5474	ACMetcalfe	2	38.8	91.2	72	79.1	2.2	1	13.2	5.55	42.9	175	85.8	71	255	1.44	4.9	56	9
5475	2B09-3425	2	39.4	91.8	71	80.2	2.2	1	12.3	5.06	42.5	159	87.1	73	230	1.46	4.5	64	1
5476	2B10-4162	2	40.7	91.7	74	79.7	2.5	1	13.1	5.40	42.9	142	76.6	72	259	1.46	5.1	61	3
5477	2B10-4465	2	42.2	93.9	71	80.6	2.7	1	13.5	6.01	46.3	148	83.8	39	282	1.43	3.8	50	13
5478	2B10-4480	2	40.1	91.8	69	79.6	2.4	1	13.3	5.49	43.6	162	83.8	69	254	1.46	5.0	61	3
5479	2Ab07-X031098-31	2	40.1	92.9	72	79.8	2.6	1	13.7	5.67	44.1	171	74.5	65	264	1.45	5.9	52	11
5480	2Ab07-X04M219-46	2	38.9	86.6	74	79.6	2.5	1	13.2	5.17	40.1	158	66.1	37	227	1.44	4.7	57	8
5481	2Ab08-X05M010-82	2	38.4	85.6	63	78.5	2.4	1	13.1	5.41	42.2	134	76.7	71	237	1.44	4.2	54	10
5482	2Ab08-X04M282-48	2	35.9	*74.4	66	77.5	2.5	1	13.5	5.32	41.9	142	88.3	114	252	1.43	4.8	41	18
5483	2Ab08-X04M278-35	2	42.9	91.4	67	80.2	2.9	1	13.5	5.90	45.0	166	73.6	53	272	1.45	7.0	58	7
5484	08ID2661	2	42.0	87.2	79	77.5	2.0	1	12.9	4.58	35.8	89	45.7	472	198	1.57	6.1	36	20
5485	MT090190	2	43.0	95.1	68	78.8	2.1	1	11.9	4.66	39.9	127	56.4	281	200	1.52	7.1	52	11
5486	MT090180	2	42.5	93.7	73	78.6	2.0	1	12.6	4.37	36.5	127	53.0	336	177	1.56	7.9	43	15
5487	MT100126	2	43.0	95.0	70	78.6	2.2	1	12.0	4.62	39.8	127	49.6	416	194	1.60	9.7	49	14
5488	MT100120	2	44.0	96.8	70	79.3	2.1	1	11.6	4.33	39.2	118	52.9	332	182	1.60	9.7	43	15
5489	2ND25276	2	45.4	96.9	66	80.5	2.1	1	12.0	5.20	45.0	124	72.2	113	218	1.46	4.8	63	2
5490	2ND27705	2	39.8	89.3	78	78.4	2.3	1	12.8	5.26	42.4	149	74.4	77	231	1.42	5.3	59	6
5491	2ND28065	2	38.6	86.4	71	78.1	1.7	1	13.5	4.76	35.4	123	51.8	230	193	1.47	4.0	42	17
Minima			35.9	85.6	63	76.8	1.7		11.6	3.80	32.8	76	41.1	37	154	1.42	3.6		
Maxima			45.4	96.9	79	80.6	3.1		13.7	6.01	46.3	175	88.3	472	282	1.60	9.7		
Means			40.9	92.0	71	79.0	2.4		12.8	5.05	40.7	137	67.8	158	223	1.48	5.7		
Standard Deviations			2.3	3.6	4	1.1	0.3		0.6	0.60	3.8	27	15.3	135	38	0.06	1.8		
Coefficients of Variation			5.5	3.9	5	1.3	14.7		5.0	11.82	9.3	19	22.5	85	17	3.89	32.0		

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 Dr. Gongshe Hu, Aberdeen, ID

Neg Std Dev	34.1	81.3	59	75.9	1.3		10.9	3.26	29.4	57	22.0	-247	109	1.31	0.2				
Pos Std Dev	47.7	102.7	83	82.2	3.4		14.7	6.85	52.1	217	113.6	564	337	1.65	11.1				

2013 WRSBN
Table 05 - Fairfield, MT

Lab #	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)	Rel. Visco.	Turbidity (Hach)	FAN (ppm)	Quality Score	Overall Rank
5260	Stephoe	6	42.3	96.2	55	74.1	n.d.	3	10.6	3.05	31.1	59	31.6	879	1.87	65.0	162	15	31
5261	Baronesse	2	42.3	94.1	66	76.9	n.d.	3	12.3	3.57	30.2	120	47.1	172	1.50	27.0	126	28	27
5262	Harrington	2	38.2	94.3	69	80.4	2.1	1	11.4	4.91	43.4	148	83.2	129	1.45	5.8	220	60	9
5263	AC Metcalfe	2	39.6	94.1	77	81.2	2.2	1	12.1	4.99	43.3	159	92.2	44	1.42	4.2	213	67	4
5264	2B09-3425	2	40.9	97.3	66	82.0	2.3	1	11.5	4.80	45.6	141	97.7	52	1.45	4.6	219	69	1
5265	2B10-4162	2	40.9	96.5	68	82.5	2.5	1	11.4	5.12	47.2	138	97.1	50	1.44	4.0	352	64	6
5266	2B10-4465	2	41.1	93.8	64	82.2	2.3	1	11.6	4.86	45.0	145	93.6	50	1.44	3.5	224	69	1
5267	2B10-4480	2	40.0	94.8	70	82.0	2.4	1	10.8	5.05	48.2	154	98.5	41	1.43	5.1	237	57	13
5268	2Ab07-X031098-31	2	40.9	93.6	63	81.9	2.4	1	12.4	5.45	45.4	178	87.5	33	1.41	4.1	239	69	1
5269	2Ab09-X06F058HL-21	2	39.5	96.2	54	80.5	1.2	1	14.2	3.84	28.4	71	46.7	1102	5.22	5.7	128	20	29
5270	2Ab07-X04M219-46	2	37.3	89.6	70	80.7	2.3	1	11.9	4.74	40.4	149	78.0	50	1.43	5.5	200	60	9
5271	2Ab08-X05M010-82	2	37.2	94.0	63	79.5	2.0	1	11.8	4.55	39.6	163	87.6	54	1.42	3.8	243	57	13
5272	2Ab08-X04M282-48	2	37.7	89.2	59	80.4	2.5	1	11.8	4.93	45.3	143	100.4	86	1.41	3.6	217	60	9
5273	2Ab08-X04M278-35	2	44.1	96.0	72	83.0	2.7	1	10.6	4.83	48.3	136	86.8	28	1.43	6.9	215	60	9
5274	08ID2661	2	43.1	92.7	71	79.5	2.3	1	11.9	4.34	38.6	79	48.0	455	1.54	6.3	176	36	23
5275	MT090190	2	46.8	99.0	60	81.4	1.9	1	11.2	4.33	42.4	154	62.8	92	1.47	5.5	178	61	8
5276	MT090180	2	45.6	98.6	63	81.2	2.0	1	11.3	4.23	39.4	149	61.6	139	1.48	7.4	257	57	13
5277	MT100126	2	45.7	98.5	66	81.2	2.0	1	10.5	4.29	42.1	154	60.2	114	1.47	5.7	180	55	17
5278	MT100120	2	46.4	98.8	61	81.5	2.0	1	11.1	4.33	42.2	156	62.8	107	1.49	7.4	169	57	13
5279	2ND25276	2	44.0	97.3	56	81.0	2.4	1	11.6	4.95	43.7	145	76.4	152	1.46	7.5	194	63	7
5280	2ND27705	2	41.5	96.1	66	80.8	2.3	1	11.5	4.68	43.3	151	82.0	75	1.42	3.9	305	66	5
5281	2ND28065	2	41.7	96.4	61	80.4	1.8	1	11.7	4.31	39.4	106	56.7	229	1.47	4.4	168	42	20
5282	UT6R2120-14	6	41.7	97.8	50	77.7	2.1	1	11.7	3.24	29.1	133	40.2	370	1.55	10.5	117	30	26
5283	UT2170-16	6	32.5	79.1	58	76.5	n.d.	3	10.4	3.26	33.2	74	40.9	626	1.66	37.0	111	17	30
5284	X06G07-T43	6	36.6	88.1	40	86.1	2.2	2	12.9	4.13	33.9	144	61.6	123	1.56	23.0	217	53	18
5285	X05013-T1	6	42.8	95.6	40	82.6	1.4	1	13.9	3.43	25.9	70	35.9	987	2.91	7.0	111	27	28
5286	09WA-231.5	6	42.6	97.9	60	79.6	1.7	1	11.5	3.70	33.6	114	43.9	275	1.52	5.9	128	36	23
5287	09WA-203.26	6	46.9	97.7	65	79.8	1.9	1	11.9	3.78	34.1	103	48.5	328	1.52	9.3	137	36	23
5289	09WA-228.13	6	48.3	97.9	64	79.9	1.8	1	12.1	3.83	33.5	110	51.3	373	1.53	7.2	196	42	20
5291	09WA-203.24	2	45.4	98.6	62	80.2	1.9	1	11.5	3.80	35.6	110	55.4	386	1.53	6.6	144	40	22
5292	09WA-249.9	6	44.3	98.4	64	81.0	3.5	2	11.0	4.63	44.0	96	63.7	131	1.45	29.0	213	46	19

Table 05 - Fairfield, MT

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)	Rel. Viscosity	Turbidity (Hach)	FAN (ppm)	Quality Score	Overall Rank
5288	LACEY MALT CHECK	6	32.6	88.8	44	79.0	2.6	1	13.6	5.56	43.2	186	85.1	35	1.40	5.9	270	65	
5290	HARRINGTON MALT CHECK	6	39.4	95.9	74	81.9	2.1	1	11.6	4.63	42.9	130	88.2	71	1.48	6.1	195	58	
Minima			32.5	79.1	40	74.1	1.2		10.4	3.05	25.9	59	31.6	28	1.41	3.5	111		
Maxima			48.3	99.0	77	86.1	3.5		14.2	5.45	48.3	178	100.4	1102	5.22	65.0	352		
Means			41.9	95.1	62	80.6	2.1		11.7	4.32	39.2	127	67.1	249	1.66	10.7	193		
Standard Deviations			3.6	4.1	8	2.2	0.4		0.9	0.63	6.4	32	21.2	287	0.71	13.0	56		
Coefficients of Variation			8.5	4.3	13	2.7	19.8		7.3	14.62	16.2	25	31.7	115	43.15	121.5	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 B.A.R.I.

Neg Std Dev	31.2	82.8	38	74.1	0.9	9.1	2.43	20.1	32	3.4	-613	-0.49	-28.3	25
Pos Std Dev	52.5	107.4	87	87.0	3.4	14.3	6.22	58.3	223	130.8	1112	3.80	49.8	361

2013 WRSBN
Table 6 -- Idaho Falls, ID

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)	Rel. Visco.	Turbidity (Hach)	Quality Score	Overall Rank
5227	Steptoe	6	43.4	97.0	69	75.8	n.d.	3	11.5	3.53	32.2	79	37.2	*773	259	1.77	42	20	31
5228	Baronesse	2	41.5	96.1	80	76.1	2.5	2	14.8	4.08	28.9	141	54.7	105	130	1.48	19.4	30	26
5229	Harrington	2	41.0	95.8	72	79.8	2.0	1	14.2	5.51	40.8	181	90.9	92	242	1.44	3.8	56	8
5230	AC Metcalfe	2	41.1	97.6	78	81.2	2.3	1	13.6	5.41	43.1	192	103.8	50	257	1.44	5.3	59	5
5231	2B09-3425	2	41.3	97.9	66	82.2	2.5	1	12.6	5.39	45.9	161	109.0	46	256	1.44	3.3	69	1
5232	2B10-4162	2	41.1	97.2	69	81.7	2.7	1	13.7	5.73	44.9	166	98.7	62	284	1.45	5.8	55	10
5233	2B10-4465	2	40.5	95.9	70	81.3	2.3	1	13.9	5.35	40.9	169	93.6	47	371	1.44	3.7	59	5
5234	2B10-4480	2	42.2	98.0	72	80.8	2.3	1	13.7	5.81	44.6	191	102.2	42	278	1.44	3.4	53	12
5235	2Ab07-X031098-31	2	41.5	96.3	68	81.1	2.3	1	14.3	6.00	44.9	211	87.4	26	278	1.41	3.7	52	13
5236	2Ab09-X06F058HL-21	2	40.1	96.1	47	80.0	1.6	1	15.9	4.00	25.9	81	48.8	*1110	140	5.27	6.7	25	28
5237	2Ab07-X04M219-46	2	39.2	94.1	79	81.2	2.0	1	13.2	5.14	39.8	181	77.6	51	216	1.48	4.4	57	7
5238	2Ab08-X05M010-82	2	37.6	92.4	76	79.1	2.1	1	13.3	4.83	36.4	184	94.3	62	320	1.45	3.6	49	15
5239	2Ab08-X04M282-48	2	36.9	90.8	70	78.9	2.1	1	14.0	5.18	37.9	163	94.7	134	363	1.44	3.4	40	21
5240	2Ab08-X04M278-35	2	44.6	96.8	75	81.7	2.7	1	13.2	5.80	47.2	176	82.1	29	279	1.47	7.8	56	8
5241	08ID2661	2	45.2	97.4	80	78.4	2.2	1	14.1	4.74	34.9	103	49.0	400	193	1.52	5	36	24
5242	MT090190	2	43.1	97.6	71	79.4	2.0	1	13.0	4.55	37.2	176	62.8	84	187	1.46	5.6	55	10
5243	MT090180	2	43.7	97.3	74	79.8	1.9	1	13.1	4.38	35.8	164	61.0	148	174	1.50	5.2	44	18
5244	MT100126	2	44.1	97.8	71	79.2	1.9	1	13.4	4.59	36.9	171	56.6	216	186	1.48	5	45	17
5245	MT100120	2	43.0	97.5	72	79.6	2.0	1	12.5	4.39	36.4	166	63.3	128	175	1.48	7.2	49	15
5246	2ND25276	2	44.7	98.6	64	80.8	2.2	1	12.9	5.18	43.3	142	79.9	135	209	1.46	5.6	63	2
5247	2ND27705	2	40.0	95.0	81	79.8	2.2	1	13.1	5.13	41.5	181	78.8	67	218	1.43	5.1	61	3
5248	2ND28065	2	40.7	96.3	68	79.6	1.7	1	13.2	4.72	38.5	139	60.0	129	191	1.46	3.4	52	13
5249	UT6R2120-14	6	41.0	96.8	60	76.4	2.4	1	14.0	4.11	31.4	148	43.2	405	152	1.54	10.3	28	27
5250	UT2170-16	6	*32.2	*75.8	70	76.4	2.5	2	11.7	3.61	31.4	89	44.7	576	131	1.67	18.4	23	30
5251	X06G07-T43	6	36.9	91.4	53	85.2	2.2	2	14.4	4.58	33.6	167	65.9	122	268	1.55	16.1	43	19
5252	X05013-T1	6	41.1	94.8	49	81.7	2.3	2	15.5	3.81	25.2	96	42.8	*977	125	2.53	11.6	25	28
5253	09WA-231.5	6	40.2	96.7	76	78.6	1.6	1	13.0	4.03	31.9	132	52.6	169	148	1.49	5.5	43	19
5254	09WA-203.26	6	44.1	96.2	78	78.9	1.7	1	12.8	4.16	33.0	116	57.1	230	162	1.47	6.5	36	24
5255	09WA-228.13	6	45.1	98.0	75	79.4	1.8	1	13.7	4.46	33.9	138	61.6	234	173	1.47	8.1	38	23
5257	09WA-203.24	6	44.8	98.7	72	79.2	1.8	1	12.7	4.03	32.3	117	58.6	219	168	1.48	7.9	39	22
5259	09WA-249.9	6	44.3	97.5	75	79.4	n.d.	3	13.0	5.19	42.1	133	68.0	66	223	1.45	35	61	3

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 µm 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 µm 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.

β-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).

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

Viscosities were measured on an Anton Paar AMVn rolling ball viscometer. Relative viscosities were reported: flow time of mash extract over the flow time of distilled water.

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.



American Malting Barley Association, Inc.

MALTING BARLEY BREEDING GUIDELINES IDEAL COMMERCIAL MALT CRITERIA

	Six-Row	Adjunct Two-Row	All Malt Two-Row
Barley Factors			
Plump Kernels (on 6/64)	> 80%	> 90%	> 90%
Thin Kernels (thru 5/64)	< 3%	< 3%	< 3%
Germination (4ml 72 hr. GE)	> 98%	> 98%	> 98%
Protein	≤ 13.0%	≤ 13.0%	≤ 12.0%
Skinned & Broken Kernels	< 5%	< 5%	< 5%
Malt Factors			
Total Protein	≤ 12.8%	≤ 12.8%	≤ 11.8%
on 7/64 screen	> 60%	> 70%	> 75%
Measures of Malt Modification			
Beta-Glucan (ppm)	< 120	< 100	< 100
F/C Difference	< 1.2	< 1.2	< 1.2
Soluble/Total Protein*	42-47%	40-47%	38-45%
Turbidity (NTU)	< 10	< 10	< 10
Viscosity (absolute cp)	< 1.50	< 1.50	< 1.50
Congress Wort			
Soluble Protein*	5.2-5.7%	4.8-5.6%	< 5.3%
Extract (FG db)	> 79.0%	> 81.0%	> 81.0%
Color (°ASBC)	1.8-2.5	1.6-2.5	1.6-2.8
FAN	> 210	> 210	140-190
Malt Enzymes			
Diastatic Power (°ASBC)*	> 150	> 120	110-150
Alpha Amylase (DU)*	> 50	> 50	40-70

General Comments

Barley should mature rapidly, break dormancy quickly without pregermination and germinate uniformly.

The hull should be thin, bright and adhere tightly during harvesting, cleaning and malting.

Malted barley should exhibit a well-balanced, modification in a conventional malting schedule with four day germination.

Malted barley must provide desired beer flavor.

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