

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

WESTERN REGIONAL SPRING BARLEY NURSERY – 2008 Crop
Preliminary Quality Report

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Detailed Data:

Aberdeen, ID
Tetonia, ID
Fairfield, MT

Idaho Falls, ID
Conrad, MT

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 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.

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

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Western Regional Spring Barley Nursery – 2008 Crop

Nursery samples were received for malting quality evaluation from five 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/53660000/2008WRBNREPORT.pdf>)

Thirteen of the twenty seven 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/ni/Guidelines.pdf>) and are listed in Appendix B.

The mean values for fifteen quality factors are listed over the five stations located in the Western Region (Table 2) and over all lines (Table 3). Individual station data are reported in Tables 4 through 8. Evaluations of data from individual locations and overall performance evaluations, derived primarily from Tables 2 and 3, are presented below.

The barleys from Aberdeen, ID (Table 4) were very plump and averaged 11.2% protein. Extract values were very good, with a location average of 81.5%. Soluble protein and α -amylase values were generally good, but most S/T ratios were too high. A quarter of the diastatic power and free amino nitrogen (FAN) values were too low, negatively impacted by the low total protein contents. The best performers were Stander, Harrington, 2B02-2925, MT010160, 2B03-3719, MT010158 and 2ND21867. Stander performed very well, but had an elevated turbidity. Harrington had very good quality values, but an extract value just below AMBA's ideal criteria and a β -glucan level just above the ideal prevented a maximum quality score. 2B02-2925 had a slightly elevated soluble protein value that contributed to an unacceptably high S/T ratio. MT010160 had an elevated S/T ratio. 2B03-3719 appeared to have been overmodified by our standard malting protocol. The S/T value was very high, indicating excessive

protein modification, while the β -glucan level was 52 ppm, indicating possible carbohydrate overmodification. MT010158 was plump, had good extract and soluble protein values, but its S/T and viscosity values were a bit elevated. 2ND21867 performed well, but had a low FAN value, probably influenced by the low total protein contents.

The barleys from Idaho Falls, ID (Table 5) were plump, with wide ranging amounts of total protein, including 13 that were too high. Soluble protein levels also ranged widely with eight that fell below desired limits and two that exceeded the upper limit. Over half of the S/T ratios were too low. Eleven diastatic power values were too low, however, most of these were feed type barleys. Eight α -amylase values were low and all of these were from feed type barleys. All but one of the β -glucan values exceeded desired limits. Thirteen FAN values were too low, with most of these from feed type barleys. Sixteen viscosity and F-C values exceeded desired limits, confirming the β -glucan results, which suggested the barleys from this location did not modify well using our standardized malting protocol. The best performer was 2B02-2925. This line performed well with most quality parameters falling within desired limits, except for a slightly elevated β -glucan value.

Most of the barleys from Tetonia, ID (Table 6) had elevated protein contents. A third of the extract values were too low, while two thirds of the β -glucan levels were too high. Soluble protein levels were generally low, with four lines falling below minimum limits. All S/T values were unacceptably low. Most FAN values fell below desired limits, which combined with the low S/T ratios, suggest very poor protein modification. A third of the viscosity and turbidity values were above the desired limit. The best performer was 2ND22927; however, note the hazy wort.

The plump barleys from Conrad, MT (Table 7) had protein levels that ranged from 11.9 to 14.4%, with eight that exceeded the upper desired limit of 13.5%. Six extract values were too low and two thirds of the F-C differences exceeded the upper limit. Protein modification was poor. Six soluble protein values were too low and most S/T ratios fell below the minimum desired values. Half of the FAN values fell below desired limits. Four feed lines had unacceptably low amyolytic values, while most of the enzymes from those lines designated as "malting" were good. Around half of the β -

glucan, viscosity and turbidity values exceeded the upper desired limits. The best performers were 2B02-2925 and Legacy. Both of these lines showed good, balanced modification.

The barleys from Fairfield, MT (Table 8) were very plump and averaged only 10.5% protein. Total proteins below 11.0% generally result in low diastatic power, soluble protein and free amino nitrogen levels. This appears to be the case with this nursery, where around half of the submissions were deficient in DP, soluble protein and FAN. A dozen α -amylase values were low however, most of these were “feed” lines. About half of the β -glucan, viscosity, F-C and turbidity values were too high, again, mostly “feed” lines. The best performers were Conrad, Stander, Harrington, 2B03-3719, MT010158, MT010160, 2B02-2925 and MT030042. Conrad was an addition to this nursery and performed well and similarly to the Harrington experimental check. Both varieties had acceptable levels of soluble protein and free amino nitrogen. Enzyme activities were similar and sufficient. Extract, viscosity, turbidity and β -glucan values were similar and very good. Stander’s total protein, soluble protein and FAN values were very good. Carbohydrate modification also appeared to be good, with excellent F-C and viscosity values, good turbidity and only slightly elevated β -glucan contents. 2B03-3719 had very low total protein contents, but generated sufficient levels of soluble protein and free amino nitrogen. This line had an excellent extract value of 83.1%, with good low β -glucan contents, excellent viscosity and turbidity values. 2B02-2925 was very similar to 2B03-3719, but with slightly less protein modification. MT010158 and MT010160 were very similar in performance. MT010160 had a slightly better extract and viscosity value, however, its F-C difference was a bit higher. MT030042 had the highest extract value at 83.3%. All measurements for carbohydrate modification were good. This line had sufficient soluble protein and free amino nitrogen levels in spite of its 10.5% total protein value. The diastatic power value was a bit low, though this would no doubt improve with higher protein contents. The acceptable soluble protein with the low total protein resulted in an S/T ratio that exceeded the upper limit.

The malting lines grown at Aberdeen, ID performed best (Table 2), followed closely by those grown at Fairfield, MT. These barleys were very plump and extract

values were excellent, enhanced by the low average total protein values. Soluble protein levels at Fairfield averaged a little low, but the low soluble then divided by the low total protein contents resulted in an acceptable averaged S/T ratio. The average wort protein value from Aberdeen was quite good in spite of the low total protein contents, however the S/T ratio was unacceptably high because of that good average soluble protein level. The diastatic power values were a little low at both sites, again reflective of the low total protein, while the average α -amylase levels at both sites were good. Both sites had similar averaged β -glucan contents that were encouraging at 154 and 156 ppm. The average FAN, viscosity and turbidity values from these sites were not statistically different, however, the Aberdeen site's average values were closer to AMBA's "ideal" range than those from Fairfield. Idaho Falls, and Conrad followed in overall performance. These sites also produced plump barleys; however, the total protein contents averaged around 13.5%. The elevated protein impacted average extract values, which were significantly lower than those of Fairfield and Aberdeen. The average soluble protein values from Idaho Falls and Conrad were good, however protein modification was reduced at these sites and resulted in unacceptably low average S/T ratio at Conrad. Enzyme activities were good and FAN levels were satisfactory. Average β -glucan levels in wort derived from the Idaho Falls submissions were high suggesting reduced carbohydrate modification. The nursery grown at Tetonia was a bit thin and had elevated protein levels. This location had the lowest average extract, as might be expected with the highest average total protein contents. Average enzyme activities were good, but protein modification was poor resulting in low soluble protein and FAN values and a very low S/T ratio. The average β -glucan levels were a bit high, but some lines modified well, while others did not, and the same type of situation was observed with viscosity measurements.

The lines that performed best overall (Table 3) were 2B02-2925, 2B03-3719, Harrington, MT030042 and 2ND22927. 2B02-2925 had averaged quality parameters that were equal to or better than the Harrington experimental standard and would fall within most of AMBA's "ideal" malt criteria ranges. The averaged extract was below the "ideal", however this was greatly affected by a very poor value from the malt generated from Tetonia. Extract values of malts generated from Aberdeen, Idaho Falls and

Fairfield show this line capable of very high extracts. 2B03-3719 modified more readily than the Harrington standard. Average extract, soluble protein, S/T, FAN, diastatic power and α -amylase values were higher than those of the Harrington experimental standard, while β -glucan, and F-C values were lower. This line was capable of adequate nitrogen modification even when its total protein contents were low (Tables 4 and 8). The Harrington Standard was generally plump, with a modest average extract value. Its F-C value was a bit high, however the average β -glucan contents were good. Other quality parameters generally fell within the range of AMBA's "ideal malt" criteria. MT30042 averaged a per cent lower total protein than Harrington. This line had a very good average extract value, but slightly elevated β -glucan contents. The average diastatic power value was lower than that of Harrington, probably due to the low total protein. 2ND22927 had the highest average extract in the nursery. Elevated β -glucan, viscosity and turbidity values should be noted.

Table 1: 2008 Western Regional Spring Barley Nursery, Entry List

Seed Source	Entry Number	Entry	Parentage	TYPE	Grade
WSU	1	Steptoe	CI 15229	6 row	feed
WPB	2	Baronesse	PI 568246	2 row	feed
USDA-ARS	3	Morex	CI 15773	6 row	malting
USDA-ARS	4	Stander	PI 564743	6 row	malting
USDA-ARS	5	Harrington		2 row	malting
BARI	6 *	2B02-2925	MERIT/2B97-4527	2 row	malting
BARI	7 *	2B03-3719	2B96-5038/2B97-4796	2 row	malting
USDA-ARS	8 *	02Ab17060	91Ab3148/90Ab321	2-Row	feed
PB1	9 *	PB1 04-2R-4263	PB1 96-2R-6123 X PB1 97-2R-7090	2 row	feed
WPB	10	BZ503-097	Xena/Dolly	2 row	feed
WPB	11 *	BZ504-093	Salute/Boulder	2 row	feed
WPB	12 *	BZ505-187	CDC Trey/Salute	2 row	feed
MSU	13	MT010158	MT920041/Harrington	2 row	feed/malting
MSU	14	MT010160	MT920041/Harrington	2 row	feed/malting
MSU	15	MT020155	MT960225/H1851195	2 row	feed/malting
MSU	16	MT020204	MTLB 32/H1851195	2 row	feed/malting
MSU	17	MT030042	MT910189/MT960099	2 row	feed/malting
MSU	18 *	MT040073	MT960045/Harrington	2 row	feed/malting
NDSU	19	2ND21867	ND18172/ND19130	2 row	malting
NDSU	20	2ND22182	ND18413/ND19134//ND19164	2 row	malting
NDSU	21	2ND22927	ND19119-1/ND19931	2 row	malting
USU	22 *	UT03B1960-483	OR741209//ID633019/Woodvale/3/short2//ID633019/Woodvale/4/Brigham	6 row	feed
USU	23 *	UT04B2041-42	Goldeneye/Columbia	6 row	feed
WSU	24 *	02WNZ-1095	Camas/Baronesse	2 row	feed
WSU	25 *	02WA-7028.9	Camas/Baronesse	2 row	feed
WSU	26 *	04WA-101.45	WA8608-97/Baronesse	2 row	feed
WSU	27 *	04WA-122.20	85AB2323/Baronesse	2 row	feed

* new entries

WESTERN REGIONAL SPRING BARLEY NURSERY - 2008 Crop

Table 2 - Station Means* of Barley and Malt Quality Factors for 13 Varieties or Selections**

	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C (%)	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	43.8	A	98.3	A	71	C	81.4	B	0.9	B	2.2	A	11.3	C	5.29	A	48.4	A	123	C	62.7	A	154	B	195	AB	1.49	B	13.6	A	49.8
Idaho Falls, ID	44.5	A	99.0	A	67	D	80.4	C	1.3	A	2.2	AB	13.5	B	5.40	A	41.3	C	135	BC	57.9	B	295	A	208	A	1.53	A	20.1	A	41.4
Tetonia, ID	34.9	C	86.5	B	81	A	78.5	E	1.3	A	1.9	B	14.5	A	4.58	C	32.4	E	169	A	58.4	B	213	B	165	D	1.52	AB	15.7	A	28.5
Conrad, MT	42.1	B	98.4	A	79	AB	79.2	D	1.4	A	2.1	AB	13.4	B	4.85	B	36.7	D	144	B	51.5	C	159	B	180	C	1.52	A	15.3	A	38.2
Fairfield, MT	44.5	A	99.3	A	76	B	82.2	A	1.3	A	2.0	AB	10.7	D	4.67	BC	46.1	B	106	D	53.7	C	156	B	182	BC	1.51	AB	17.1	A	46.1

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

** Morex, Harrington, 2B02-2925, 2B03-3719, MT010158, MT010160, MT020155, MT020204, MT030042, MT040073, 2ND21867, 2ND22182, 2ND22927

WESTERN REGIONAL SPRING BARLEY NURSERY - 2008 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 (Agtron)	Malt Extract (%)	F-C (%)	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														
Morex	35.9	F	93.7	C	80	A	79.3	FG	1.4	BC	1.9	B	13.5	A	4.77	DE	36.8	F	174	AB	51.6	E	154	BCDE	175	D	1.51	BC	12.2	B	42.2
Harrington	39.1	E	96.1	ABC	77	AB	80.2	CDE	1.2	BCD	1.6	BC	13.1	AB	5.13	BCD	40.9	DE	161	ABC	65.7	CD	118	CDE	194	BCD	1.47	CD	6.1	B	45.2
2B02-2925	41.8	C	96.5	ABC	76	AB	80.4	CD	0.9	BCD	1.9	BC	12.7	AB	5.29	ABC	43.9	BC	155	BCD	73.2	AB	98	DE	202	ABC	1.49	CD	6.8	B	48.8
2B03-3719	42.3	C	97.7	ABC	77	AB	80.9	BC	0.7	D	2.1	B	12.4	AB	5.60	A	47.9	A	182	A	76.2	A	49	E	217	AB	1.46	D	6.8	B	46.4
MT010158	42.4	C	95.8	ABC	70	C	80.5	CD	1.4	BC	1.9	BC	12.4	AB	4.85	D	40.8	DE	142	CDE	42.5	FG	225	BC	184	CD	1.55	AB	10.6	B	42.0
MT010160	42.0	CD	95.8	ABC	76	AB	81.0	BC	1.4	BC	1.6	BC	12.8	AB	4.98	CD	40.6	DE	154	BCD	51.1	E	207	BCD	185	CD	1.50	CD	6.5	B	42.0
MT020155	40.5	CE	93.7	C	72	BC	79.8	DEF	1.2	BCD	1.7	BC	12.8	AB	5.08	BCD	42.0	CDE	131	DE	61.2	D	206	BCD	194	BCD	1.50	CD	5.8	B	41.2
MT020204	40.4	CE	96.0	ABC	74	BC	79.5	EFG	1.5	B	1.8	BC	13.0	AB	5.39	AB	43.1	BCD	164	ABC	68.4	BC	197	BCD	221	A	1.49	CD	5.8	B	38.6
MT030042	40.8	CE	94.8	BC	73	BC	81.6	AB	1.1	BCD	1.9	BC	12.0	B	4.85	D	43.1	BCD	124	E	70.8	ABC	166	BCD	194	BCD	1.50	CD	8.2	B	44.0
MT040073	40.0	E	96.0	ABC	69	C	78.6	G	2.0	A	2.8	A	13.0	AB	4.04	F	31.9	G	73	F	38.6	G	272	B	117	F	1.55	AB	43.2	A	19.6
2ND21867	44.5	B	98.1	ABC	77	AB	80.3	CDE	1.2	BCD	1.4	C	12.7	AB	4.47	E	36.7	F	123	E	42.0	FG	203	BCD	152	E	1.50	CD	7.3	B	36.6
2ND22182	48.4	A	99.3	A	70	C	80.5	CD	1.1	BCD	3.1	A	12.3	B	4.76	DE	39.8	E	83	F	47.3	EF	402	A	175	D	1.58	A	46.6	A	39.8
2ND22927	47.2	A	98.6	AB	81	A	81.9	A	0.9	CD	3.2	A	12.1	B	5.22	BC	45.1	B	95	F	50.6	E	244	B	212	AB	1.57	A	47.0	A	44.0

* 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, Tetonia, ID, Conrad, MT and Fairfield, MT

2008 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 (Agron)	Malt Extract (%)	F-C (%)	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
5086	Morex	6	36.1	96.5	80	79.4	1.9	2.0	1	12.5	4.98	41.3	161	53.9	133	167	1.48	11.6	52	8
5087	Stander	6	37.2	98.4	82	79.7	0.7	2.7	2	13.1	5.27	42.6	170	57.4	122	186	1.47	24.0	60	1
5088	Harrington	2	43.4	99.1	74	80.6	0.7	1.6	1	12.3	5.34	45.2	147	70.7	112	202	1.45	6.5	58	2
5089	2B02-2925	2	43.8	97.9	75	81.8	0.4	2.2	1	11.0	5.61	51.4	139	78.4	94	213	1.49	7.8	56	3
5090	2B03-3719	2	42.1	98.4	79	82.4	0.2	2.0	1	10.2	5.29	56.3	145	76.5	53	193	1.46	4.2	55	5
5091	02Ab17060	2	45.6	97.7	71	80.4	0.6	1.7	1	10.6	4.47	43.4	119	52.8	154	153	1.48	5.4	47	14
5092	MT010158	2	44.9	98.2	60	81.4	1.0	2.2	1	11.6	5.36	48.3	133	49.1	147	192	1.56	12.3	53	6
5093	MT010160	2	44.0	98.7	64	82.5	0.6	1.8	1	11.2	5.41	49.1	150	58.9	102	205	1.47	6.1	56	3
5096	MT020155	2	41.9	98.9	64	80.2	0.4	1.9	1	12.1	5.60	49.8	126	71.2	146	214	1.45	4.4	48	11
5097	MT020204	2	44.3	99.1	68	80.8	0.7	2.0	1	11.5	5.83	51.9	157	79.0	104	230	1.44	4.6	49	10
5098	MT030042	2	42.7	95.1	58	83.1	1.3	2.1	1	10.4	5.26	53.2	111	82.4	101	202	1.44	5.2	48	11
5099	MT040073	2	41.4	98.4	68	80.2	1.3	n.d.	3	10.8	4.43	41.0	64	44.8	155	130	1.50	65.0	37	17
5100	2ND21867	2	46.5	98.9	79	81.4	1.0	1.3	1	10.8	4.68	43.4	122	47.3	122	167	1.47	7.7	53	6
5101	2ND22182	2	50.4	99.4	68	81.2	1.0	2.8	2	11.1	5.27	47.7	68	49.4	383	200	1.58	20.0	42	15
5102	2ND22927	2	47.6	99.3	80	83.4	1.3	3.1	2	11.4	5.67	51.0	79	53.9	354	222	1.59	22.0	41	16
5103	02Ab17271	2	42.8	96.2	80	82.8	0.4	1.7	1	9.9	4.48	50.1	100	58.4	93	177	1.51	8.0	48	11
5104	02Ab17373	2	44.9	98.3	76	83.4	1.4	2.0	1	10.2	5.20	51.6	117	77.6	82	198	1.46	5.4	52	8
5094	HARRINGTON MALT CHECK	2	35.9	88.6	84	79.4	0.7	1.7	1	12.8	5.62	47.5	147	73.4	61	210	1.43	4.5	46	
5095	MOREX MALT CHECK	6	35.3	95.0	79	80.4	0.7	2.3	1	11.7	6.03	53.2	147	75.8	62	242	1.47	8.3	53	
Minima			36.1	95.1	58	79.4	0.2	1.3		9.9	4.43	41.0	64	44.8	53	130	1.44	4.2	37	
Maxima			50.4	99.4	82	83.4	1.9	4.0		13.1	5.83	56.3	170	82.4	383	230	1.59	65.0	60	
Means			43.5	98.1	72	81.5	0.9	2.2		11.2	5.18	48.1	124	62.4	144	191	1.49	13.0	50	
Standard Deviations			3.4	1.2	8	1.3	0.4	0.7		0.9	0.43	4.5	32	12.9	89	26	0.05	14.8	6	
Coefficients of Variation			7.9	1.2	11	1.6	51.1	30.2		7.9	8.38	9.4	26	20.7	62	13	3.16	114.6	12	

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

2008 WESTERN REGIONAL SPRING BARLEY NURSERY AND ADDITIONS - IDAHO FALLS, ID

Table 5																					
Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C (%)	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	
5327	Step toe	6	42.7	98.8	64	76.1	3.4	n.d.	3	11.8	3.51	31.1	42	26.8	1207	113	1.94	44.0	20	22	
5328	Baronesse	2	44.4	99.0	66	77.4	2.3	n.d.	3	13.9	3.87	28.1	100	38.2	300	126	1.57	30.0	14	26	
5329	Morex	6	36.1	98.2	73	80.0	2.1	1.6	1	14.1	5.26	38.3	179	55.8	291	226	1.54	9.5	43	9	
5330	Stander	6	38.1	99.3	73	80.5	1.1	2.2	1	13.7	6.06	46.1	152	65.7	250	251	1.52	7.2	46	6	
5331	Harrington	2	41.8	98.1	67	80.2	1.3	1.5	1	13.6	5.62	41.9	158	67.3	169	241	1.49	6.9	40	12	
5332	2B02-2925	2	46.4	99.5	68	81.5	1.4	2.0	1	13.2	5.76	44.6	141	70.3	167	224	1.50	6.9	49	3	
5333	2B03-3719	2	45.9	99.5	70	80.7	1.0	2.2	1	13.3	6.21	47.8	189	73.9	76	233	1.49	8.8	45	8	
5334	02Ab17060	2	46.6	99.4	70	79.5	1.7	1.5	1	12.8	4.54	35.6	123	45.8	336	184	1.53	7.7	47	5	
5335	PB1 04-2R-4263	2	47.4	99.6	72	81.6	1.4	1.8	1	12.6	4.95	41.0	109	49.7	240	226	1.50	7.2	52	1	
5336	BZ503-097	2	49.6	99.7	67	78.4	2.9	n.d.	3	13.7	3.76	28.1	54	28.1	1314	117	1.78	38.0	14	26	
5337	BZ504-093	2	44.3	99.5	64	76.9	2.2	n.d.	3	13.9	4.13	29.8	67	46.9	1436	128	1.98	15.4	17	25	
5338	BZ505-187	2	39.8	99.1	67	77.0	4.1	2.5	2	14.0	3.91	28.8	46	29.7	1743	117	2.22	14.2	8	28	
5339	MT010158	2	44.7	98.5	64	79.9	1.3	1.7	1	14.2	5.59	41.3	167	45.0	256	229	1.53	7.4	42	10	
5340	MT010160	2	44.0	98.3	68	80.8	1.4	1.9	1	13.9	5.61	42.4	142	54.4	244	203	1.50	8.3	41	11	
5341	MT020155	2	43.1	98.9	66	80.3	0.9	1.7	1	13.2	5.40	42.3	126	63.7	392	199	1.55	7.0	50	2	
5342	MT020204	2	41.6	98.7	63	79.2	2.0	2.2	1	14.2	5.87	41.7	164	68.9	329	243	1.50	7.0	37	14	
5343	MT030042	2	42.1	98.3	62	81.3	1.0	2.6	2	13.1	5.50	44.1	115	71.5	238	244	1.51	18.0	49	3	
5344	MT040073	2	42.7	99.3	65	78.6	1.8	n.d.	3	14.3	4.26	30.0	84	42.4	282	123	1.52	46.0	21	21	
5345	2ND21867	2	48.7	99.7	66	80.3	1.0	1.6	1	13.6	4.84	37.7	122	44.6	347	149	1.51	7.8	37	14	
5346	2ND22182	2	51.5	99.9	61	80.3	0.9	n.d.	3	12.7	4.82	38.2	76	46.1	657	174	1.59	69.0	38	13	
5347	2ND22927	2	49.5	99.7	73	82.4	0.7	n.d.	3	11.9	5.47	46.0	86	48.8	380	223	1.59	59.0	46	6	
5348	UT03B1960-483	6	42.0	99.4	60	77.2	3.3	n.d.	3	12.5	4.22	36.4	110	35.6	1064	143	1.66	39.0	20	22	
5351	UT04B2041-42	6	38.8	99.7	60	78.4	2.3	1.8	2	13.3	3.78	30.4	69	41.0	715	137	1.56	13.1	32	17	
5352	02WVZ-1095	2	45.2	99.2	67	79.9	1.6	n.d.	3	11.8	3.85	33.7	95	41.9	205	126	1.51	27.0	31	18	
5353	02WA-7028.9	2	46.1	99.3	74	79.9	2.3	1.3	1	13.0	4.05	31.7	81	36.7	492	128	1.56	9.7	27	19	
5354	04WA-101.45	2	51.4	99.7	67	79.1	2.1	n.d.	3	13.6	3.93	29.5	101	34.4	516	115	1.59	36.0	18	24	
5355	04WA-122.20	2	47.4	99.2	71	78.9	2.5	1.6	2	13.2	4.08	31.0	104	32.2	625	123	1.57	16.5	27	19	
5356	Conrad	2	42.0	99.2	63	79.1	1.6	1.5	1	14.7	5.39	37.0	160	67.0	254	199	1.49	4.8	36	16	
5349	HARRINGTON MALT CHECK	2	35.8	91.6	80	79.4	1.1	1.6	1	13.4	5.22	41.9	125	66.4	97	198	1.46	6.0	52		
5350	MOREX MALT CHECK	6	35.1	95.5	78	80.6	0.6	2.3	1	12.4	6.03	50.9	134	71.6	107	244	1.49	8.1	50		
Minima			36.1	98.1	60	76.1	0.7	1.3		11.8	3.51	28.1	42	26.8	76	113	1.49	4.8	8		
Maxima			51.5	99.9	74	82.4	4.1	3.3		14.7	6.21	47.8	189	73.9	1743	251	2.22	69.0	52		
Means			44.4	99.2	67	79.5	1.8	2.1		13.4	4.79	36.9	113	49.0	519	177	1.60	20.4	34		
Standard Deviations			3.9	0.5	4	1.6	0.8	0.5		0.8	0.83	6.3	41	14.5	434	51	0.17	17.8	13		
Coefficients of Variation			8.7	0.5	6	2.0	46.1	25.6		5.7	17.40	17.0	36	29.6	84	29	10.82	87.2	38		

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. B. Cooper and A. Meisner, BAR, LLC - Fort Collins

2008 WESTERN REGIONAL SPRING BARLEY NURSERY AND ADDITIONS - TETONIA, ID

Table 6

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C (%)	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
5105	Morex	6	29.6	77.4	83	77.9	1.0	1.9	2	15.0	4.34	29.7	205	51.2	116	134	1.51	2.1	31	6
5106	Harrington	2	32.4	85.9	78	78.5	1.5	1.4	1	15.2	4.95	32.8	212	67.8	112	152	1.46	4.4	33	4
5107	Legacy	6	28.9	75.3	89	77.4	1.4	1.6	1	14.4	4.79	33.9	224	63.9	68	152	1.47	5.7	28	8
5108	Conlon	2	36.6	94.1	89	78.7	1.6	1.8	2	14.1	4.23	30.3	151	48.4	385	120	1.56	19.7	24	11
5109	2B02-2925	2	32.8	87.2	81	76.7	1.3	1.3	1	16.3	5.07	31.3	237	85.9	98	185	1.46	5.5	33	4
5110	2B03-3719	2	34.9	92.0	80	79.1	0.6	1.9	1	15.1	5.61	37.6	253	87.7	47	226	1.43	6.9	35	3
5111	01Ab7163	2	33.0	81.4	82	78.5	1.2	1.4	1	14.7	4.55	31.2	142	44.5	151	150	1.48	5.5	24	11
5112	MT010158	2	35.1	85.2	81	79.5	1.3	2.2	2	11.6	3.82	33.3	116	35.8	474	138	1.65	17.5	25	9
5113	MT010160	2	35.4	85.2	88	79.2	1.9	1.3	1	14.4	4.33	30.8	180	46.0	318	161	1.54	5.4	23	13
5114	MT020155	2	32.2	73.7	80	77.5	1.2	1.3	1	14.6	4.56	32.4	153	55.0	193	167	1.50	5.0	23	13
5115	MT020204	2	33.7	84.3	81	77.2	1.6	1.5	1	15.3	5.14	33.7	205	68.5	255	213	1.51	5.0	23	13
5116	MT030042	2	34.5	83.3	86	79.5	1.3	1.4	1	14.2	4.45	32.0	165	69.9	243	166	1.53	4.7	30	7
5117	MT040073	2	33.4	83.2	73	76.5	2.5	n.d.	3	15.3	3.95	26.0	93	37.2	407	114	1.58	41.0	0	16
5118	2ND21867	2	36.7	93.4	79	78.9	1.5	1.2	1	14.5	4.10	28.6	140	42.1	224	144	1.52	6.0	25	9
5119	2ND22182	2	42.6	98.3	74	79.8	0.6	n.d.	3	13.2	4.48	35.3	110	53.3	208	160	1.55	54.0	40	2
5120	2ND22927	2	41.2	94.9	84	80.6	0.9	n.d.	3	13.2	4.69	37.0	134	59.4	76	187	1.47	47.0	49	1
5094	HARRINGTON MALT CHECK	2	35.9	88.6	84	79.4	0.7	1.7	1	12.8	5.62	47.5	147	73.4	61	210	1.43	4.5	46	
5095	MOREX MALT CHECK	6	35.3	95.0	79	80.4	0.7	2.3	1	11.7	6.03	53.2	147	75.8	62	242	1.47	8.3	53	
Minima			28.9	73.7	73	76.5	0.6	1.2		11.6	3.82	26.0	93	35.8	47	114	1.43	2.1	0	
Maxima			42.6	98.3	89	80.6	2.5	3.7		16.3	5.61	37.6	253	87.7	474	226	1.65	54.0	49	
Means			34.5	85.9	82	78.5	1.3	1.9		14.4	4.56	32.2	170	57.3	211	161	1.51	14.7	28	
Standard Deviations			3.6	7.2	5	1.2	0.5	0.7		1.1	0.47	3.0	48	15.7	130	30	0.06	17.0	10	
Coefficients of Variation			10.4	8.3	6	1.5	34.8	37.8		7.4	10.25	9.2	28	27.4	62	19	3.64	115.6	37	

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

2008 WESTERN REGIONAL SPRING BARLEY NURSERY AND ADDITONS - CONRAD, MT

Table 7

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C (%)	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
5357	Steptoe	6	40.9	98.9	86	74.7	3.4	n.d.	3	12.5	3.44	28.4	63	26.2	*1221	93	1.92	40.0	20	18
5358	Baronesse	2	36.0	98.0	84	75.4	2.2	n.d.	3	14.4	3.73	26.8	100	31.0	286	95	1.57	45.0	5	21
5359	Morex	6	39.0	96.9	85	78.6	1.0	n.d.	3	13.9	4.50	33.0	184	47.5	65	163	1.52	22.0	40	6
5360	Harrington	2	34.9	97.7	84	79.1	1.4	1.8	1	13.2	4.82	36.8	160	58.4	111	176	1.47	7.2	40	6
5361	Legacy	6	46.7	97.1	90	78.8	0.7	2.0	1	13.3	5.06	40.0	197	61.6	48	194	1.46	9.6	53	2
5362	Conlon	2	42.1	99.7	82	78.7	1.1	n.d.	3	13.2	4.53	34.3	132	48.5	315	146	1.54	30.0	37	10
5363	2B02-2925	2	42.1	98.7	80	79.2	0.9	2.0	1	13.2	5.29	40.2	154	64.0	73	208	1.49	8.5	54	1
5364	2B03-3719	2	42.6	99.1	77	79.0	1.1	2.5	1	13.8	6.04	44.2	200	72.4	37	243	1.46	9.0	42	5
5365	01Ab7163	2	40.9	97.5	81	78.9	2.1	1.5	1	13.1	4.32	34.7	104	41.4	251	155	1.54	6.3	31	15
5366	02Ab17060	2	43.0	98.2	80	77.3	1.8	1.6	1	13.9	4.15	31.0	127	40.5	286	149	1.55	9.5	26	16
5367	MT010158	2	42.8	97.8	72	79.1	1.9	1.6	1	14.1	4.87	35.7	169	42.0	116	176	1.50	8.8	37	10
5368	MT010160	2	43.1	98.0	82	79.4	1.6	1.6	1	13.9	4.79	35.3	170	46.5	234	172	1.51	7.3	37	10
5369	MT020155	2	42.8	97.8	75	78.3	1.8	1.6	1	13.5	4.88	36.3	141	56.9	146	191	1.50	6.5	40	6
5370	MT020204	2	40.3	98.4	80	78.2	1.6	1.6	1	13.7	5.20	38.2	179	62.0	129	213	1.50	6.6	39	9
5371	MT030042	2	41.3	98.4	85	80.6	1.1	1.5	1	11.9	4.32	37.7	131	61.8	157	154	1.51	5.8	45	3
5372	MT040073	2	41.0	99.5	71	77.4	1.9	n.d.	3	13.4	3.82	28.4	67	31.4	306	111	1.62	35.0	14	20
5373	2ND21867	2	44.4	99.1	79	79.3	1.3	1.5	1	13.8	4.48	32.8	130	37.0	147	158	1.50	7.6	33	13
5374	2ND22182	2	46.1	99.3	74	79.8	1.6	n.d.	3	13.3	4.66	35.6	86	42.5	386	171	1.61	33.0	33	13
5375	2ND22927	2	47.1	99.1	85	80.9	0.7	n.d.	3	12.8	5.37	43.2	97	47.2	163	210	1.58	41.0	43	4
5376	UT03B1960-483	6	39.9	99.3	75	76.0	3.6	n.d.	3	12.1	3.73	31.3	108	29.1	783	103	1.98	29.0	20	18
5377	UT04B2041-42	6	33.7	95.9	88	77.0	2.9	1.6	2	12.1	3.25	27.4	63	31.1	415	102	1.62	17.2	21	17
5349	HARRINGTON MALT CHECK	2	35.8	91.6	80	79.4	1.1	1.6	1	13.4	5.57	44.7	125	66.4	97	198	1.46	6.0	52	
5350	MOREX MALT CHECK	6	35.1	95.5	78	80.6	0.6	2.3	1	12.4	6.44	54.4	134	71.6	107	244	1.49	8.1	50	
Minima			33.7	95.9	71	74.7	0.7	1.5		11.9	3.25	26.8	63	26.2	37	93	1.46	5.8	5	
Maxima			47.1	99.7	90	80.9	3.6	3.7		14.4	6.04	44.2	200	72.4	783	243	1.98	45.0	54	
Means			41.5	98.3	81	78.4	1.7	2.1		13.3	4.53	34.8	131	46.6	223	161	1.57	18.3	34	
Standard Deviations			3.5	1.0	5	1.6	0.8	0.7		0.7	0.69	4.9	43	13.3	275	42	0.13	13.8	12	
Coefficients of Variation			8.4	1.0	6	2.0	47.6	31.3		5.2	15.24	14.0	33	28.5	102	26	8.60	75.4	37	

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. B. Cooper and A. Meisner, BAR, LLC - Fort Collins

2008 WESTERN REGIONAL SPRING BARLEY NURSERY AND ADDITION - FAIRFIELD, MT

Table 8

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C (%)	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
5297	Steptoe	6	45.5	99.4	68	76.6	3.4	n.d.	3	10.6	3.33	34.5	50	27.5	1116	107	1.86	42.0	15	28
5298	Baronesse	2	43.7	99.2	82	79.4	1.1	n.d.	3	9.6	3.22	35.6	63	31.6	237	87	1.58	32.0	22	24
5299	Morex	6	38.6	99.5	81	80.6	1.1	1.8	2	11.8	4.76	41.7	141	49.6	165	184	1.51	16.0	45	10
5300	Stander	6	39.1	99.4	77	80.7	0.7	2.0	1	12.4	5.62	49.0	142	66.6	153	233	1.48	3.7	56	2
5301	Harrington	2	43.3	99.8	82	82.7	0.9	1.6	1	10.9	4.90	48.1	126	64.3	86	199	1.48	5.5	55	3
5302	2B02-2925	2	43.9	99.0	76	83.0	0.7	1.8	1	9.6	4.74	52.0	103	67.7	57	182	1.50	5.3	52	7
5303	2B03-3719	2	45.9	99.4	81	83.1	0.5	1.8	1	9.5	4.84	53.4	124	70.4	31	189	1.47	5.0	55	3
5304	02Ab17060	2	46.0	99.0	80	80.7	1.1	1.6	1	10.5	4.03	40.0	93	43.0	216	147	1.54	9.2	31	16
5305	PB1 04-2R-4263	2	45.5	99.6	79	82.7	0.9	1.7	1	10.3	4.34	45.2	88	47.6	137	174	1.50	5.6	42	13
5306	BZ503-097	2	48.1	99.7	76	80.2	2.4	n.d.	3	10.7	3.20	32.0	62	27.6	631	85	1.67	46.0	22	24
5307	BZ504-093	2	44.4	99.7	66	80.0	1.8	n.d.	3	10.9	3.87	36.8	57	42.8	782	118	1.82	19.4	26	17
5308	BZ505-187	2	39.6	99.8	74	79.0	4.4	1.9	2	10.9	3.39	32.0	38	27.6	*1634	88	2.79	11.0	17	27
5309	MT010158	2	44.9	99.3	72	82.8	1.3	1.6	1	10.7	4.61	45.2	126	40.6	130	186	1.52	6.8	53	5
5310	MT010160	2	43.4	98.7	78	83.2	1.7	1.6	1	10.7	4.79	45.2	128	49.6	136	183	1.48	5.2	53	5
5311	MT020155	2	42.8	99.1	74	82.7	1.5	1.9	1	10.7	4.96	49.2	111	59.4	155	198	1.50	6.1	45	10
5312	MT020204	2	42.1	99.4	76	82.0	1.6	1.9	1	10.2	4.90	50.1	116	63.5	170	204	1.50	5.6	45	10
5313	MT030042	2	43.3	98.7	73	83.3	1.0	1.9	1	10.5	4.72	48.3	96	68.2	90	205	1.48	7.2	48	8
5314	MT040073	2	41.4	99.5	68	80.4	2.5	n.d.	3	11.2	3.75	33.8	57	37.2	212	108	1.51	29.0	26	17
5315	2ND21867	2	46.4	99.4	80	81.6	1.1	1.4	1	10.6	4.24	41.2	99	39.1	177	142	1.49	7.2	35	15
5316	2ND22182	2	51.5	99.7	71	81.2	1.5	n.d.	3	11.2	4.59	42.2	74	45.2	375	171	1.56	57.0	46	9
5319	2ND22927	2	50.6	99.8	82	82.4	1.0	n.d.	3	11.1	4.88	48.2	81	43.5	247	218	1.59	66.0	41	14
5320	UT03B1960-483	6	43.5	99.6	73	78.0	2.2	n.d.	3	10.8	3.74	35.4	113	37.6	759	119	1.75	26.0	19	26
5321	UT04B2041-42	6	37.2	99.0	79	79.8	2.0	n.d.	3	9.5	3.13	35.8	58	35.0	523	100	1.59	26.0	25	20
5322	02WNZ-1095	2	42.9	98.6	78	80.8	1.0	n.d.	3	9.5	3.35	37.2	82	35.0	104	105	1.51	33.0	25	20
5323	02WA-7028.9	2	44.5	99.1	78	81.7	1.5	1.5	2	10.1	3.54	36.3	71	33.7	224	118	1.56	12.9	26	17
5324	04WA-101.45	2	47.7	99.6	78	81.5	1.4	n.d.	3	9.7	3.44	36.3	77	33.5	208	102	1.60	42.0	25	20
5325	04WA-122.20	2	47.1	98.5	84	80.8	1.8	1.8	2	9.7	3.56	37.1	72	32.8	218	121	1.54	15.9	23	23
5326	Conrad	2	41.7	99.7	83	82.4	1.1	1.5	1	10.3	4.47	44.0	130	63.9	80	180	1.48	6.0	59	1
5317	HARRINGTON MALT CHECK	2	36.2	91.3	81	80.1	1.9	1.6	1	13.1	5.34	40.8	129	67.3	83	215	1.45	4.7	52	
5318	MOREX MALT CHECK	6	34.9	94.9	79	80.6	1.1	2.3	1	12.5	6.17	51.1	124	67.1	78	293	1.47	7.6	50	
Minima			37.2	98.5	66	76.6	0.5	1.4		9.5	3.13	32.0	38	27.5	80	85	1.47	3.7	15	
Maxima			51.5	99.8	84	83.3	4.4	3.5		12.4	5.62	53.4	142	70.4	782	233	2.79	66.0	59	
Means			44.1	99.3	77	81.2	1.5	2.1		10.5	4.17	41.6	92	45.9	279	152	1.60	19.7	37	
Standard Deviations			3.3	0.4	5	1.7	0.8	0.6		0.7	0.70	6.5	30	14.1	275	46	0.25	17.6	14	
Coefficients of Variation			7.5	0.4	6	2.0	54.6	28.7		6.8	16.79	15.6	33	30.7	102	30	15.86	88.9	38	

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. B. Cooper and A. Meisner, BAR, LLC - Fort Collins

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 31 h steep at 19°C: 8 h wet, 8 h air, 4 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 2 and 7 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. Coarse-grind malts were prepared with a corrugated roller mill that was adjusted so that 75% of the grist remained on a 525 µm sieve. Malts to be used for moisture, protein and amyolytic 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. **F-C** represents the difference in extract % between the finely ground malts and the coarsely ground malts.

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.

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

2008 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	