UNITED STATES DEPARTMENT OF AGRICULTURE
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MIDWEST AREA
CEREAL CROPS RESEARCH UNIT

MISSISSIPPI VALLEY REGIONAL SPRING BARLEY NURSERY - 2004 Crop

Preliminary Quality Report

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Detailed Data:
Aberdeen, ID
Crookston, MN
Morris, MN
Sidney, MT
Bottineau, ND

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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Mississippi Valley Regional Spring Barley Nursery – 2004 Crop

Nursery samples were received for malting quality evaluation from five experimental stations located in Idaho, Minnesota, Montana and North Dakota. The parentages of the nursery entries are listed in Table 1. Fourteen of the thirty-two entries were new in this year's nursery.

These samples were germinated for 5 days and rotated for 3 minutes every half hour, which should yield malts having modification levels similar to those produced by industry. The malting conditions and analytical methods employed are listed in Appendix A. The criteria and value assignments used to calculate quality scores are listed in Appendix B.

The mean values for 16 quality factors are listed over the four stations located in the Mississippi Valley Region (Table 2) and over all varieties (Table 3). Tables 9 and 10 include the station data used for Tables 2 and 3, in addition to data from the Aberdeen, ID location, which lies outside of the Mississippi Valley. 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, 3, 9 and 10) are presented below.

The plump barleys from Aberdeen, ID (Table 4) had good low protein contents. The extract values were very good, averaging over 80%. Most of the soluble protein levels were good, but over half of the S/T ratios exceeded desired limits. A third of the diastatic power values fell below desired limits, while α-amylase levels were good. Nearly three quarters of the β-glucan values exceeded the maximum limit, while free amino nitrogen levels were generally good. Nearly half of the viscosities slightly exceeded desired limits, while a quarter of the turbidities were too high. The best performers were 6B001328, 6B00-1361, ND16301, 6B98-9022, Tradition and ND19620. 6B00-1328 had excellent malt quality values, balanced modification, with low viscosity and turbidity. 6B00-1361 and 6B98-9022 performed well, except for elevated S/T ratios. ND16301 had a slightly elevated viscosity and S/T ratio. Tradition had elevated β-glucan and turbidity levels. ND19620 had slightly elevated viscosity, S/T and β-glucan values.

The barleys from Crookston, MN (Table 5) had varied plumpness ranging from 65 – 95%. A third of the protein contents were unacceptably high. Malt extract values were generally

good, while seven soluble protein values exceeded the acceptable limit. The S/T ratios varied widely between 15 that were too low and seven that were too high. Most of the enzyme and free amino nitrogen levels were good, while all but one β-glucan value was unacceptably high. Over half of the viscosities exceeded the desired limit, although most by only a small amount. Three quarters of the turbidities exceeded the desired limit. The best performers were ND19522, BT490, ND19742, M118, Tradition, M115, M112 and ND16301. Nearly all of these lines had issues of elevated turbidity, viscosity and β-glucan values.

The plump barleys from Morris, MN (Table 6) had good protein levels. Extract values were good, except for those of Barbless and Morex. Just under half of the soluble protein values were too high and over half of the S/T ratios exceeded desired limits. Enzyme and free amino nitrogen levels were generally good, while most β-glucan contents were too high. The viscosities and turbidities were generally good. The best performers were Tradition, Lacey, Conlon, 6B00-1328, Drummond, ND19522, 6B98-9022 and Robust. The quality parameters of these lines looked good, except for elevated β-glucan levels ranging on the high side of acceptable (Conlon and ND19522) to unacceptably high (Robust).

The barleys from Sidney, MT (Table 7) were plump and generally had good protein contents. The extract values were very good, with the experiment averaging over 80%. Soluble protein values ranged from very good, to five that exceeded the maximum limit. Half of the S/T ratios exceeded the desired limit. The amylolitic and free amino nitrogen values were good. Over half of the β-glucan levels were too high. Most of the viscosity and turbidity values were good. The best performers were Drummond, Lacey, ND19742, M109, M112, ND19620, 6B00-1328, Newdale, 2ND19854, ND16301, Robust, 6B98-9022 and 6B99-6639. Drummond and Lacey scored very well, with acceptable values for all of the quality parameters assessed. ND19742 also scored high, but its turbidity value was slightly above the desired limit. M109 and M112 had slightly elevated viscosities and unacceptably high β-glucan contents. ND19620 had high, but acceptable amylolitic levels and an elevated turbidity value. ND16301 and 6B001328 had unacceptably high S/T ratios. Newdale performed well and would have scored even higher had it been plumper. 2ND19854 and 6B98-9022 had slightly elevated viscosity and turbidity values and high β-glucan levels. Robust had a slightly elevated viscosity and an unacceptably high β-glucan level. 6B99-6639 had elevated viscosity and β-glucan values.

Most of the barleys from Bottineau, ND (Table 8) were plump and had good protein contents. Only four extract values fell below the minimum limits and F-C differences were generally good. A third of the soluble protein levels were too low, while most free amino nitrogen values were sufficient. Seven diastatic power levels exceeded 200 degrees ASBC, while α-amylase values were generally good. Half of the β-glucan levels, a third of the viscosities and two thirds of the turbidities were too high. The best performers were 6B00-1361, 6B00-1323, BT493, M118, BT490, M115, 6B98-9022, 6B00-1328, and M109. All quality parameters assessed for 6B001361, 6B00-1323 and BT493 fell within desired limits. M118, M115 and BT490 had elevated β-glucan levels when malted using our standard malt protocol, but these were lower than the Morex and Robust experimental controls. 6B98-9022 had a low S/T ratio and an elevated turbidity value. 6B00-1328 had low soluble protein and S/T values. M109 had an elevated β-glucan level and slightly elevated viscosity and turbidity values.

Overall, the barleys grown at the Sidney location performed extremely well. At this location, the averaged values (Tables 2 and 9) for kernel weight, plumpness, barley color, extract, F-C, wort color, clarity, diastatic power, α-amylase, and turbidity were superior to those of the other locations. As a result, the experiment averaged a quality score of 50. These lines also performed well at Aberdeen and Morris, yielding an average score of 46, followed by Bottineau at 44. At Crookston barley protein levels were a bit high and the lines did not modify well.

The best performing lines throughout this nursery were ND19522, 6B00-1328, 6B00-1361, Lacey and M109, although many other lines also showed commercial promise. ND19522 had the highest average quality score of this nursery. This line showed consistent performance at all locations. ND19522 was very plump, and its malt yielded good extract, soluble protein, free amino nitrogen and amylolitic values. ND19522 modified more readily than most lines and much better than the experimental controls. Note the borderline high viscosities. 6B00-1328 performed better in the western portion of the nursery. This was a plump barley, with good protein contents. Malt from this line had good extract, color, soluble protein, free amino nitrogen, viscosity, turbidity and α-amylase values. 6B00-1361 performed well at all locations. This line had good plumpness and protein contents. Its average extract was the highest amongst the 6 rowed lines. Carbohydrate modification was good with our standard malting protocol, but protein modification was too rapid resulting in very high average S/T and free amino nitrogen values.

Lacey was generally plump, had adequate extract, good viscosity, soluble protein, free amino nitrogen and amylolitic values. Carbohydrate modification was a bit slow with our malting protocol, especially in the submission from Crookston, although still better than the Morex and Robust experimental controls. M109 was plump and had good protein contents, except that from Crookston. The extract, soluble protein, free amino nitrogen and amylolitic values were generally good. With our malting protocol, the β-glucan level was too high, although similar to Morex and Robust. Note the borderline high viscosity and turbidity levels.

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Table 1

Entry#	CI # or Contributor	Name	Parentage
1.	5105	Barbless	Oderbrucker/Lion
2.	15773	Morex	Cree/Bonanza
3.	476976	Robust	Morex/Manker
4.	Busch Ag. Res.	Legacy(6B93-2978)	Bumper/Karl//Bumper/Manker/3/Bumper/Karl/4/Excel
5.	PI 615584	Drummond (ND15477)	ND9712//Stander/ND12200
6.	PI 613603	Lacey (M98)	M78/M79
7.	North Dakota	Conlon	Bowman*2/Brigitta mutant//ND10232
8.	Busch Ag.	Tradition(6B95-2482)	6B89-2126/ND10981
9.	Minnesota	M109	Lacey/M95
10.	Minnesota	M112	M93-121/M81
11.	Minnesota	M115	M94-33/M94-111
12.	Minnesota	M116	M104/M81
13.	North Dakota	ND18579	ND15483/ND15614
14.	North Dakota	2ND19119	ND15403-3/ND15368//ND16453
15.	Busch Ag. Res.	6B99-6639	B1614//6B92-7166/B1614
16.	Busch Ag. Res.	6B99-6774	Legacy/6B94-7862
17.	Manitoba	Newdale	CDC Stratus//TR236/WM862-6
18.	Saskatchewan	BT490	SM95096/SM94043
19.	North Dakota	ND19552	ND15483/ND16301
20.	North Dakota	ND19620	ND15483/ND16258
21.	North Dakota	ND19728	ND15483//Azure/ND5377
22.	North Dakota	ND19742	ND15483//ND9712/ND5377
23.	North Dakota	ND16301	Foster//ND12200/6B88-3213
24.	North Dakota	2ND19854	ND15403-3/ND1642
25.	Minnesota	M118	M104/M103
26.	Minnesota	M119	M104/M81
27.	Busch Ag. Res.	6B98-9022	6B92-7098/6b92-7166
28.	Busch Ag. Res.	6B00-1323	6B94-8126 // LEGACY / 6B95-6311
29.	Busch Ag. Res.	6B00-1328	6B94-8126 // LEGACY / 6B95-6311
30.	Busch Ag. Res.	6B00-1361	6B94-8126 // LEGACY / 6B95-6311
31.	Saskatchewan	BT493	SM95001 / SM95098
32.	Saskatchewan	BT495	SM95043 / SM95428

*Entries 19-32 are new for 2004.

Miscellaneous Pedigree Information:

ND9712 = Hazen*2/WPG821
ND12200 = Bumper/Hazen//Azure
ND15246 = ND9668/ND9712
ND9668 = Azure*2/M34
ND15377 = ND9712//ND10883/6B86-3016
ND10883 = Azure/BT358
ND15483 = ND9712//Stander/ND12231
ND12231 = ND9319/Azure
ND9319 = Hazen/BT456
ND15614 = ND9712*2/ND10521
ND10521 = Glenn/M46
ND16301 = Foster//ND12200/6B88-3213
ND16258 = ND12738*2/PC249
ND5377 = Glenn/Karl

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Table 2 - Station Means* of Barley and Malt Quality Factors for 32 Varieties or Selections.**

LOCATION	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
Crookston, MN	34.8	C	83.0	D	40	BC	78.9	C	1.4	A	2.6	A	1.5	A	13.7	A	5.64	B	43.2	C	135	C	60.8	D	409	A	259	B	1.51	A	17.7	A	39
Morris, MN	36.4	B	90.0	B	39	C	79.5	B	1.0	B	2.3	B	1.2	B	12.7	B	5.83	A	48.2	A	132	C	63.5	C	285	B	286	A	1.50	A	10.7	B	46
Sidney, MT	38.8	A	92.6	A	64	A	80.2	A	0.8	C	1.8	C	1.2	B	12.7	B	5.68	B	46.5	B	166	B	69.2	A	250	C	243	B	1.50	A	8.0	B	50
Bottineau, ND	35.3	C	86.4	C	43	B	78.6	D	1.1	B	1.8	C	1.4	A	12.6	B	5.01	C	41.4	D	179	A	65.9	B	208	D	208	C	1.49	B	15.6	A	44

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

** Barbless, Morex, Robust, Legacy, Drummond, Lacey, Conlon, Tradition, M109, M112, M115, M116, ND18579, 2ND19119, 6B99-6639, 6B99-6774, Newdale, BT490, ND19552, ND19620, ND19728, ND19742, ND16301, 2ND19854, M118, M119, 6B98-9022, 6B00-1323, 6B00-1328, 6B00-1361, BT493, BT495

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Table 3 - Varietal Means* of Barley and Malt Quality Factor for Four Stations**

Variety or Selection	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
Barbless	34.6	FGH	77.7	GH	41	I	75.9	H	1.0	AB	1.98	ABCD	1.5	BCD	14.3	A	5.17	EFGHI	37.4	I	163	CDEF	52.7	KL	382	ABC	189	DE	1.51	CDEEFG	18.2	BCDEF	28.8
Morex	33.2	GH	76.4	H	47	BCDEFGH	77.5	G	1.2	AB	2.25	ABCD	1.0	D	14.0	AB	5.41	BCDEFGHI	40.7	GHI	170	BCD	63.3	EFGH	314	ABCDE	224	BCDE	1.50	DEEFGHI	8.7	DEF	33.8
Robust	35.1	FGH	85.6	BCDEFGH	44	GHI	78.3	FG	1.4	A	2.50	AB	1.0	D	13.6	ABCD	5.36	CDEFGHI	41.2	FGHI	160	DEFG	49.8	L	385	AB	228	BCDE	1.51	BCDEEFG	6.7	EF	44.0
Legacy	33.0	H	81.7	FGH	48	ABCDEFG	79.0	CDEF	1.1	AB	2.10	ABCD	1.0	D	13.0	BCDEF	5.78	ABCDEFG	46.5	ABCDEFG	161	DEFG	78.1	AB	383	AB	247	ABCDE	1.51	CDEEFG	6.6	EF	45.0
Drummond	34.3	FGH	86.1	BCDEFG	50	ABC	78.5	EFG	1.0	AB	2.05	ABCD	1.3	CD	13.8	AB	5.58	ABCDEFGHI	42.0	EFGHI	182	AB	66.7	DEFG	251	BCDE	236	ABCDE	1.50	CDEEFG	9.6	CDEF	47.0
Lacey	35.8	DEFGH	88.5	ABCDEF	44	EFGHI	78.9	DEFG	1.0	AB	2.08	ABCD	1.5	BCD	13.2	BCDE	5.22	EFGHI	41.6	FGHI	159	DEFGH	60.3	GHIJ	247	BCDE	206	CDE	1.48	GHIJ	17.2	BCDEF	50.0
Conlon	44.4	B	94.9	AB	44	FGHI	79.8	ABCDEF	1.0	AB	2.05	ABCD	1.0	D	12.8	BCDEF	4.89	IJ	39.7	HI	130	JKL	64.3	EFGH	288	BCDE	182	E	1.47	JK	6.7	EF	44.3
Tradition	35.4	EFGH	89.4	ABCDEF	48	ABCDEFG	78.9	DEFG	1.4	A	2.65	A	1.5	BCD	13.2	BCDE	5.13	GHI	40.5	GHI	193	A	62.0	FGHIJ	258	BCDE	206	CDE	1.51	CDEEFG	25.2	B	46.8
M109	35.8	DEFGH	86.2	BCDEFG	44	GHI	79.8	ABCDE	1.1	AB	2.10	ABCD	1.8	ABC	12.9	BCDEF	5.41	BCDEFGHI	44.9	BCDEFGH	166	BCDE	62.5	FGHI	321	ABCDE	222	BCDE	1.51	BCDEEF	19.1	BCDE	50.0
M112	36.9	DEF	93.1	ABCD	42	HI	78.7	DEFG	1.1	AB	2.13	ABCD	1.8	ABC	12.7	CDEFG	5.14	FGHI	42.0	EFGHI	153	DEFGH	55.6	JK	384	AB	217	BCDE	1.50	CDEEFG	21.8	BCD	46.0
M115	36.9	DEF	88.7	ABCDEF	45	DEFGHI	79.9	ABCDE	1.1	AB	2.18	ABCD	1.3	CD	12.6	CDEFG	5.84	ABCDEFG	48.7	ABCD	155	DEFGH	67.4	DEF	270	BCDE	257	ABCDE	1.49	FGHIJ	10.0	CDEF	47.8
M116	34.3	FGH	82.8	EFGH	45	DEFGHI	78.8	DEFG	1.1	AB	2.18	ABCD	1.0	D	12.9	BCDEF	5.87	ABCDEF	46.2	ABCDEFG	159	DEFGH	67.4	DEF	272	BCDE	250	ABCDE	1.47	IJ	8.7	DEF	39.0
ND18579	34.4	FGH	86.2	BCDEFG	45	CDEFGHI	78.9	DEFG	1.3	AB	2.25	ABCD	1.0	D	13.0	BCDE	5.68	ABCDEFGH	45.3	BCDEFGH	171	BCD	64.1	EFGH	306	ABCDE	258	ABCDE	1.50	DEEFGHI	9.6	CDEF	44.3
2ND19119	48.3	A	96.2	A	49	ABCDE	81.0	A	0.6	B	1.65	D	1.3	CD	12.4	FEFG	6.01	ABC	50.4	ABC	102	N	66.1	DEFG	194	CDE	295	AB	1.49	EEFGHIJ	13.3	BCDEF	43.8
6B99-6639	38.6	CDE	92.2	ABCDE	44	FGHI	78.7	EFG	0.9	AB	1.88	ABCD	1.0	D	13.7	ABC	5.73	ABCDEFGH	43.3	DEFGHI	187	A	58.4	HIJK	277	BCDE	275	ABCD	1.53	ABC	7.7	EF	42.3
6B99-6774	34.0	FGH	85.2	BCDEFGH	49	ABCDEF	79.9	ABCDE	0.9	AB	1.93	ABCD	1.0	D	13.1	BCDE	6.21	A	48.9	ABCD	161	DEFG	81.6	A	308	ABCDE	280	ABC	1.51	BCDEEFG	7.0	EF	43.0
Newdale	39.0	CD	83.9	DEFGH	45	DEFGHI	80.7	AB	1.4	A	2.48	ABC	1.0	D	12.9	BCDEF	5.67	ABCDEFGH	45.7	BCDEFGH	128	KL	83.5	A	150	E	228	BCDE	1.45	K	4.6	F	40.8
BT490	34.4	FGH	85.7	BCDEFGH	51	AB	80.2	ABCD	1.0	AB	2.00	ABCD	1.0	D	12.5	DEFG	5.70	ABCDEFGH	47.5	ABCDEF	142	HIJK	69.2	CDE	322	ABCDE	316	A	1.52	BCDEE	9.6	CDEF	48.5
ND19552	35.9	DEFGH	94.3	ABC	49	ABCDEF	79.7	ABCDEF	1.3	AB	2.30	ABCD	1.0	D	13.1	BCDE	5.56	ABCDEFGHI	44.6	BCDEFGH	182	AB	66.7	DEFG	209	BCDE	268	ABCDE	1.51	BCDEEF	10.8	CDEF	52.0
ND19620	36.6	DEFG	90.2	ABCDEF	48	ABCDEFG	79.3	BCDEF	1.3	AB	2.30	ABCD	1.8	ABC	13.2	BCDE	5.50	ABCDEFGHI	43.5	DEFGHI	179	ABC	63.2	EFGH	216	BCDE	243	ABCDE	1.51	BCDEEF	19.6	BCDE	48.0
ND19728	32.8	H	84.0	DEFGH	48	ABCDEFG	78.7	DEFG	1.3	AB	2.33	ABCD	1.5	BCD	12.9	BCDEF	5.45	BCDEFGHI	44.4	BCDEFGH	162	CDEF	58.6	HIJK	255	BCDE	244	ABCDE	1.51	BCDEEFG	14.4	BCDEF	43.8
ND19742	34.3	FGH	88.4	ABCDEF	46	BCDEFGHI	79.9	ABCDE	1.3	AB	2.40	ABCD	2.0	AB	11.9	FFG	5.02	HIJ	44.7	BCDEFGH	122	LM	59.1	HIJ	365	ABCD	266	ABCDE	1.53	AB	22.4	BC	48.3
ND16301	36.7	DEFG	93.1	ABCD	50	AB	79.4	BCDEF	1.3	AB	2.25	ABCD	1.3	CD	12.9	BCDEF	5.48	ABCDEFGHI	44.3	CDEFGH	168	BCD	61.9	FGHIJ	220	BCDE	264	ABCDE	1.51	BCDEEFG	13.0	BCDEF	46.3
2ND19854	41.1	C	90.3	ABCDEF	45	CDEFGHI	80.5	AB	0.7	AB	1.68	CD	2.3	A	11.6	G	4.69	J	42.1	EFGHI	110	MN	56.3	IJK	303	ABCDE	205	CDE	1.50	CDEEFG	38.2	A	38.0
M118	35.8	DEFGH	90.8	ABCDEF	45	DEFGHI	79.5	BCDEF	1.1	AB	2.20	ABCD	1.3	CD	12.6	DEFG	5.76	ABCDEFG	48.1	ABCDE	144	GHIJK	66.7	DEFG	374	ABC	267	ABCDE	1.50	DEEFGHI	10.7	CDEF	47.3
M119	37.4	DEF	92.5	ABCDE	44	FGHI	79.4	BCDEF	1.2	AB	2.23	ABCD	1.3	CD	12.9	BCDEF	5.97	ABCD	47.3	ABCDEF	132	IJKL	66.2	DEFG	272	BCDE	295	AB	1.48	HIJ	11.2	CDEF	41.8
6B98-9022	35.8	DEFGH	93.7	ABCD	49	ABCDE	78.3	FG	0.9	AB	1.88	ABCD	1.5	BCD	13.3	ABCDE	5.35	CDEFGHI	42.2	EFGHI	156	DEFGH	59.0	HIJ	264	BCDE	236	ABCDE	1.50	CDEEFGH	14.6	BCDEF	48.0
6B00-1323	35.1	EFGH	81.8	FGH	44	FGHI	80.0	ABCDE	0.8	AB	1.83	BCD	1.0	D	12.5	DEFG	5.90	ABCDE	48.8	ABCD	146	FGHIJ	69.5	CDE	285	BCDE	297	AB	1.48	GHIJ	7.1	EF	48.5
6B00-1328	35.5	DEFGH	92.4	ABCDE	48	ABCDEFG	79.3	BCDEF	0.8	AB	1.83	BCD	1.3	CD	12.5	FEFG	5.24	DEFGHI	43.4	DEFGHI	147	FGHI	57.7	HIJK	234	BCDE	217	BCDE	1.50	DEEFGHI	10.9	CDEF	50.8
6B00-1361	36.8	DEF	90.4	ABCDEF	49	ABCD	80.4	ABC	0.9	AB	1.83	BCD	1.0	D	12.4	FEFG	6.14	AB	52.2	A	148	EFGHI	71.7	CD	182	DE	317	A	1.49	FGHIJ	7.3	EF	50.8
BT493	35.1	EFGH	89.6	ABCDEF	52	A	80.4	ABC	1.0	AB	2.00	ABCD	1.0	D	12.3	FEFG	5.90	ABCDE	50.7	AB	124	LM	74.7	BC	257	BCDE	292	ABC	1.52	BCD	8.5	DEF	44.5
BT495	35.3	EFGH	84.6	CDEFGH	59	ABCDEFG	79.3	BCDEF	1.0	AB	2.03	ABCD	1.8	ABC	12.3	FEFG	5.44	BCDEFGHI	46.5	ABCDEFG	127	KL	71.2	CD	476	A	240	ABCDE	1.55	A	16.4	BCDEF	43.0

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

** Crookston and Morris MN, Sidney MT and Bottineau ND

2004 MISSISSIPPI VALLEY UNIFORM REGIONAL 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 (%)	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
5066	Barbless	6	32.3	*67.6	59	*73.7	*2.5	2.1	2	13.0	4.18	33.4	78	32.0	*638	190	1.56	18.4	16	40
5067	Morex	6	35.8	87.0	55	79.4	1.3	1.7	1	12.1	5.14	45.7	120	52.7	311	286	1.51	6.7	51	7
5068	Robust	6	37.3	89.7	58	79.6	1.4	1.5	1	12.1	5.25	44.9	120	45.8	323	265	1.49	5.0	51	7
5069	Legacy	6	35.9	88.5	64	79.1	0.7	1.8	1	12.3	5.66	48.7	126	58.9	467	258	1.52	5.2	50	9
5070	Drummond	6	37.3	93.4	63	80.5	0.7	1.7	1	10.7	5.05	50.5	108	57.1	167	239	1.52	5.7	40	32
5071	Lacey	6	38.3	89.8	56	80.3	0.8	1.8	1	11.9	5.15	45.5	115	51.0	187	256	1.48	8.0	50	9
5072	Conlon	2	46.3	99.1	56	80.2	0.4	1.8	1	11.3	4.93	45.3	92	53.2	369	177	1.48	8.2	43	25
5073	Tradition	6	38.6	93.0	57	79.6	0.8	2.2	2	12.8	5.29	42.5	139	50.7	329	200	1.51	20.0	54	5
5074	M109	6	39.0	90.9	54	80.1	1.0	2.4	2	12.4	5.86	49.4	136	53.4	215	246	1.49	18.1	45	20
5076	M112	6	38.0	96.0	54	79.7	0.7	2.1	2	11.3	5.43	49.2	118	50.7	261	179	1.47	14.2	40	32
5077	M115	6	37.7	92.2	59	80.4	0.5	2.0	1	11.7	5.74	53.1	123	54.9	222	259	1.48	7.4	46	15
5078	M116	6	36.5	87.6	57	79.2	0.7	2.2	2	11.8	5.77	51.2	124	55.2	334	254	1.48	11.9	45	20
5079	ND18579	6	37.6	93.0	63	80.3	0.5	2.1	1	12.1	5.86	51.7	136	65.1	218	231	1.48	8.3	46	15
5080	2ND19119	2	*53.6	98.9	58	81.3	0.7	2.7	1	11.5	6.48	57.8	96	69.4	155	296	1.52	12.1	42	29
5081	6B99-6639	6	40.0	94.9	52	80.0	1.0	2.0	1	11.8	5.56	47.9	124	65.2	240	240	1.53	8.1	50	9
5082	6B99-6774	6	37.8	95.6	61	80.8	1.1	2.1	1	11.7	6.07	55.2	126	73.2	270	246	1.51	8.0	43	25
5083	Newdale	2	42.3	94.3	57	80.7	0.9	1.8	1	12.1	5.60	47.9	113	76.3	126	200	1.44	5.9	50	9
5084	BT490	6	36.4	92.2	58	81.1	1.0	1.9	1	11.6	5.70	52.9	111	73.8	274	237	1.50	8.3	46	15
5085	ND18579	6	37.3	94.4	61	80.7	0.6	2.0	1	11.8	5.85	54.2	124	67.9	217	254	1.49	7.5	46	15
5086	ND19552	6	37.5	96.6	63	80.8	0.6	1.9	1	10.9	5.45	53.1	134	68.9	141	224	1.51	7.9	48	14
5087	ND19620	6	39.3	97.0	58	80.6	1.0	1.8	1	12.1	5.59	48.8	141	63.8	216	224	1.52	7.1	53	6
5088	ND19728	6	36.2	95.8	61	80.1	0.9	1.7	1	11.0	5.11	48.3	122	62.2	238	221	1.52	9.9	41	30
5089	ND19742	6	36.2	93.6	61	81.2	1.4	2.0	2	10.8	4.92	49.5	117	59.9	325	177	1.54	20.0	36	37
5090	ND16301	6	37.3	92.8	59	80.0	0.5	1.8	1	11.6	5.35	49.7	149	64.5	151	185	1.52	10.1	56	3
5091	2ND19854	2	42.7	92.3	55	80.4	1.5	n.d.	3	11.2	4.57	42.8	106	54.0	405	173	1.51	*33.0	41	30
5092	M118	6	38.6	94.9	54	79.8	1.2	1.8	1	11.9	5.84	50.1	156	70.6	220	260	1.46	6.4	49	13
5093	M119	6	37.1	90.9	59	79.8	0.8	1.9	1	11.5	5.64	53.0	119	66.6	185	225	1.46	8.0	44	23
5094	6B98-9022	6	37.9	96.9	60	79.7	1.0	1.8	1	11.4	5.22	48.6	145	61.2	110	186	1.49	8.5	55	4
5095	6B00-1323	6	38.0	85.2	51	81.1	0.9	2.1	1	11.9	6.07	54.1	135	68.5	212	268	1.49	8.2	43	25
5096	6B00-1328	6	38.8	96.1	59	80.4	0.4	1.8	1	11.8	5.01	45.6	148	67.3	129	285	1.47	7.6	61	1

Table 4

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
5097	6B00-1361	6	39.4	93.2	61	80.7	0.8	2.3	1	11.9	5.55	50.6	143	76.7	99	304	1.51	9.1	60	2
5098	BT493	6	37.9	93.7	63	81.2	0.3	2.2	1	11.2	5.12	48.9	125	83.7	95	298	1.49	6.6	45	20
5099	BT495	6	36.7	87.5	63	80.0	1.0	n.d.	3	11.5	4.68	42.8	127	70.9	241	260	1.51	*40.0	46	15
5101	94AB13449	6	37.5	88.9	48	80.4	0.5	n.d.	3	10.9	4.57	43.2	117	59.7	108	233	1.50	*76.0	44	23
5102	98AB11993	2	44.9	96.1	46	80.9	0.9	1.7	1	11.0	4.19	40.5	97	71.9	76	199	1.50	4.9	38	34
5103	95AB11469	2	*48.7	97.1	62	79.8	1.2	1.6	1	11.1	3.81	35.5	118	45.5	287	159	1.50	6.8	35	38
5104	98AB12904	6	37.1	89.7	53	79.7	1.1	n.d.	3	10.3	4.14	43.4	113	54.8	221	202	1.53	*74.0	37	35
5105	COLTER	6	37.9	84.5	55	80.1	0.7	1.8	1	10.7	3.85	39.0	105	52.9	189	169	1.53	9.6	37	35
5106	CREEL	6	38.4	86.7	55	79.1	1.3	2.1	2	9.6	3.54	37.6	108	50.0	254	150	1.50	14.4	33	39
5107	CRYSTAL	2	44.5	96.3	62	80.8	1.3	1.9	1	11.8	4.66	41.5	102	69.9	283	198	1.51	6.5	43	25
5075	MOREX MALT CHECK	6	34.9	85.5	77	80.4	0.9	2.2	1	12.8	6.46	52.7	116	58.3	246	241	1.54	8.5	39	
5100	MOREX MALT CHECK	6	34.1	86.9	78	80.1	0.4	1.9	1	12.0	5.36	46.2	138	75.0	164	288	1.51	7.2	58	
Minima			32.3	84.5	46	79.1	0.3	1.5		9.6	3.54	33.4	78	32.0	76	150	1.44	4.9	16	
Maxima			46.3	99.1	64	81.3	1.5	2.7		13.0	6.48	57.8	156	83.7	467	304	1.56	20.0	61	
Means			38.4	92.7	58	80.2	0.9	1.9		11.6	5.19	47.3	121	61.3	227	228	1.50	9.4	45	
Standard Deviations			2.7	3.8	4	0.6	0.3	0.2		0.6	0.68	5.5	17	10.4	89	41	0.02	4.1	8	
Coefficients of Variation			7.0	4.1	7	0.8	35.1	12.4		5.6	13.15	11.6	14	17.0	39	18	1.59	44.0	18	

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

2004 MISSISSIPPI VALLEY UNIFORM REGIONAL BARLEY NURSERY - CROOKSTON, MN

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
5000	Barbless	6	32.6	64.9	37	*74.7	1.8	2.0	1	15.2	5.12	35.3	152	53.3	537	215	1.50	8.9	24	32
5001	Morex	6	31.7	66.3	40	77.0	1.3	2.2	1	14.5	5.42	39.8	155	61.7	417	245	1.50	12.8	27	29
5002	Robust	6	32.9	78.0	37	77.2	2.3	1.9	1	14.8	5.52	38.8	148	45.8	538	245	1.51	6.0	31	25
5003	Legacy	6	32.0	80.4	36	78.5	1.0	2.4	1	13.7	5.93	45.0	137	71.0	492	268	1.51	10.6	42	13
5004	Drummond	6	31.6	74.8	45	77.6	1.5	2.3	2	15.1	5.55	38.3	162	63.0	449	258	1.53	20.0	29	28
5005	Lacey	6	34.2	84.9	36	78.3	1.7	2.7	2	14.5	5.38	39.1	144	58.2	445	221	1.50	31.0	39	18
5006	Conlon	2	41.1	89.7	39	79.5	1.4	1.9	1	13.1	4.93	38.7	118	66.6	325	201	1.46	6.1	39	18
5007	Tradition	6	34.5	82.5	44	78.5	1.7	3.0	2	13.5	5.08	40.4	161	57.9	388	222	1.51	*54.0	45	5
5008	M109	6	36.1	85.2	33	79.1	1.1	2.8	2	14.3	5.87	43.6	149	61.5	482	276	1.52	25.0	43	9
5009	M112	6	37.1	95.2	29	78.3	2.2	2.6	2	13.8	5.42	40.0	144	56.3	518	243	1.50	28.0	44	7
5010	M115	6	35.2	84.5	38	79.3	0.9	2.9	2	13.3	5.97	47.9	127	63.0	397	274	1.49	18.4	45	5
5011	M116	6	32.7	71.6	41	78.2	1.3	3.3	1	14.2	6.84	48.6	137	62.7	254	351	1.46	12.2	25	30
5012	ND18579	6	31.7	77.2	38	78.1	1.9	2.4	1	14.1	5.72	41.0	157	58.9	516	281	1.51	14.2	30	26
5013	2ND19119	2	*45.2	94.1	48	81.1	0.8	2.9	2	12.3	6.03	50.4	88	57.4	195	308	1.47	20.0	41	17
5014	6B99-6639	6	35.8	86.1	37	77.9	1.5	2.1	1	14.1	5.51	41.4	163	51.4	370	274	1.52	8.9	37	21
5015	6B99-6774	6	31.4	67.6	41	79.7	1.3	2.7	1	13.5	6.27	47.4	139	78.1	407	319	1.51	8.6	37	21
5016	Newdale	2	37.3	80.5	40	80.9	1.3	2.1	1	13.7	5.60	43.2	107	83.0	257	275	1.46	5.5	25	30
5017	BT490	6	32.9	81.2	49	80.1	1.3	2.7	1	12.8	5.86	46.6	132	65.8	379	299	1.51	16.0	51	2
5018	ND19552	6	34.7	93.2	43	79.7	1.5	2.4	1	13.4	5.43	43.2	176	61.8	323	265	1.51	16.5	58	1
5019	ND19620	6	33.5	82.8	41	79.2	1.3	2.9	2	13.6	5.19	40.6	147	57.4	343	248	1.51	30.0	43	9
5020	ND19728	6	29.8	75.2	40	77.9	1.5	2.4	1	14.0	5.58	42.6	164	56.3	391	290	1.51	13.4	42	13
5021	ND19742	6	33.3	86.2	36	79.9	1.8	3.2	2	12.0	5.06	43.9	97	53.5	552	271	1.56	28.0	46	3
5022	ND16301	6	36.4	91.2	39	79.0	1.2	2.6	2	13.8	5.22	38.0	156	56.0	458	253	1.54	24.0	44	7
5023	2ND19854	2	39.4	84.7	37	81.2	1.7	3.4	2	12.5	4.83	41.8	97	50.6	397	208	1.50	42.0	33	24
5024	M118	6	34.9	89.0	34	79.6	1.9	2.8	2	13.3	5.94	45.8	107	58.9	524	252	1.52	14.5	46	3
5026	M119	6	36.4	91.4	36	78.9	1.4	3.2	2	14.1	6.11	44.8	102	59.2	433	268	1.49	19.6	30	26
5027	6B98-9022	6	33.8	90.4	43	77.8	1.2	2.1	2	14.3	5.54	40.8	141	56.2	373	198	1.51	13.3	36	23
5028	6B00-1323	6	35.9	84.4	38	80.1	0.8	2.4	1	13.0	6.09	48.4	128	65.9	364	269	1.49	7.5	43	9
5029	6B00-1328	6	35.2	91.3	43	78.5	1.2	2.2	2	13.4	5.19	40.2	129	53.0	384	189	1.51	15.8	42	13
5030	6B00-1361	6	36.5	90.7	42	80.3	0.7	3.0	1	12.7	6.45	51.8	124	61.7	250	312	1.49	9.4	43	9

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
5031	BT493	6	34.4	86.4	49	80.3	1.1	2.7	1	13.0	6.13	49.9	110	73.1	323	271	1.52	9.5	39	18
5032	BT495	6	33.0	74.9	42	78.2	1.3	2.9	2	13.1	5.53	44.4	105	66.6	603	219	1.56	15.9	42	13
5025	MOREX MALT CHECK	6	35.1	86.4	77	80.3	0.4	2.3	1	12.2	6.44	55.5	121	70.5	211	304	1.54	7.2	43	
Minima			29.8	64.9	29	77.0	0.7	1.9		12.0	4.83	35.3	88	45.8	195	189	1.46	5.5	24	
Maxima			41.1	95.2	49	81.2	2.3	3.4		15.2	6.84	51.8	176	83.0	603	351	1.56	42.0	58	
Means			34.5	83.0	40	79.0	1.4	2.6		13.7	5.64	43.2	135	60.8	409	259	1.51	16.5	39	
Standard Deviations			2.4	8.2	4	1.1	0.4	0.4		0.8	0.46	4.1	23	7.8	98	38	0.02	8.7	8	
Coefficients of Variation			7.1	9.8	11	1.4	27.6	15.8		5.7	8.21	9.5	17	12.9	24	14	1.57	52.7	21	

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 K. Smith, University of Minnesota - St. Paul

2004 MISSISSIPPI VALLEY UNIFORM REGIONAL BARLEY NURSERY - MORRIS, MN

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
5033	Barbless	6	35.6	81.3	35	*75.6	1.5	1.9	1	13.8	5.26	39.2	122	50.7	425	190	1.51	6.9	35	32
5034	Morex	6	32.6	78.7	35	77.4	1.0	2.0	1	13.8	5.73	43.8	147	67.0	246	253	1.49	5.0	37	28
5035	Robust	6	35.6	92.0	37	78.9	1.0	1.9	1	13.2	5.62	44.5	137	51.9	364	238	1.50	5.3	52	6
5036	Legacy	6	33.2	83.9	41	79.5	1.0	2.2	1	12.5	6.14	52.2	139	77.5	335	278	1.48	5.5	43	18
5037	Drummond	6	35.2	91.2	44	79.1	1.2	2.0	1	13.3	5.85	46.0	161	66.5	263	237	1.50	6.6	54	5
5038	Lacey	6	35.6	88.8	36	79.2	0.9	2.3	2	12.8	5.26	44.2	141	60.8	209	195	1.47	*18.6	57	2
5039	Conlon	2	*43.8	95.5	40	80.7	1.0	1.7	1	12.1	5.04	45.1	110	64.9	191	192	1.45	5.5	55	3
5040	Tradition	6	34.5	91.6	41	79.1	0.7	1.9	1	13.0	5.21	43.4	171	64.4	243	202	1.50	10.8	58	1
5041	M109	6	35.9	89.7	38	80.2	1.5	2.6	2	12.2	5.37	48.0	138	61.1	245	201	1.50	*29.0	49	12
5042	M112	6	36.7	94.9	37	79.2	1.4	2.4	2	11.9	4.96	44.5	124	54.5	391	190	1.51	*28.0	50	10
5043	M115	6	37.0	92.0	39	80.6	1.3	2.3	1	12.1	6.37	54.7	133	72.6	208	292	1.48	6.8	43	18
5044	M116	6	34.4	88.0	38	79.4	1.4	2.3	1	12.5	5.83	48.3	122	68.1	327	263	1.48	9.4	46	15
5045	ND18579	6	34.7	89.9	39	78.9	1.1	2.2	1	12.4	5.62	47.2	143	63.3	376	251	1.51	9.0	50	10
5046	2ND19119	2	*48.4	96.4	36	80.6	0.9	2.6	1	12.5	6.11	51.4	87	67.5	294	257	1.48	8.6	36	30
5047	6B99-6639	6	39.7	94.1	38	79.1	1.3	2.2	1	13.7	6.10	47.0	175	61.0	213	270	1.52	8.0	46	15
5048	6B99-6774	6	33.5	90.2	42	79.9	0.8	2.6	1	12.9	6.60	52.9	148	85.5	298	355	1.50	7.5	43	18
5049	Newdale	2	38.9	90.4	38	81.0	0.6	2.1	1	12.7	6.15	50.2	107	78.4	134	263	1.45	4.3	40	24
5051	BT490	6	34.1	87.5	42	80.3	0.8	2.2	1	12.2	6.21	52.5	125	66.9	295	426	1.51	5.5	43	18
5052	ND19552	6	35.6	92.8	40	79.1	0.6	2.2	1	13.6	5.82	45.9	154	59.3	185	349	1.51	9.2	52	6
5053	ND19620	6	37.3	91.1	39	79.0	0.6	2.2	1	13.4	5.93	46.9	169	60.1	240	320	1.52	9.4	51	9
5054	ND19728	6	33.4	85.1	43	78.9	0.6	2.2	1	12.7	5.76	47.0	126	51.1	291	261	1.52	9.6	43	18
5055	ND19742	6	34.1	84.2	35	79.6	0.8	2.6	2	12.0	5.33	48.5	104	54.1	400	329	1.53	*18.4	45	17
5056	ND16301	6	37.9	94.7	46	80.0	0.3	2.0	1	12.6	6.03	50.5	146	57.4	164	324	1.51	7.0	49	12
5057	2ND19854	2	40.6	93.2	40	80.2	1.0	2.7	2	11.2	4.85	44.9	100	52.1	253	261	1.50	*39.0	37	28
5058	M118	6	35.4	91.1	38	79.3	1.2	2.5	1	12.4	6.02	52.5	112	58.8	413	347	1.50	10.6	39	25
5059	M119	6	38.8	94.7	38	79.6	0.5	2.5	1	12.7	6.63	52.5	114	62.9	283	394	1.49	8.6	39	25
5060	6B98-9022	6	35.5	93.7	40	78.4	1.4	2.0	1	13.0	5.59	44.6	125	53.0	308	285	1.51	8.8	52	6
5061	6B00-1323	6	34.9	83.5	37	80.0	1.3	2.5	1	12.7	6.39	51.4	123	66.1	310	335	1.50	7.0	43	18
5062	6B00-1328	6	36.2	95.7	39	79.6	0.9	1.9	1	12.3	5.44	45.3	128	52.9	268	207	1.50	9.3	55	3
5063	6B00-1361	6	37.4	92.0	40	80.8	0.6	2.6	1	12.9	6.65	54.3	158	77.0	166	440	1.48	7.4	49	12

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
5064	BT493	6	34.8	89.2	42	80.4	1.2	2.7	1	12.9	6.43	53.7	110	71.7	255	418	1.54	8.7	39	25
5065	BT495	6	35.0	82.7	43	79.0	1.7	2.6	1	12.4	6.10	50.8	117	72.3	529	322	1.54	7.6	36	30
5050	MOREX MALT CHECK	6	34.3	87.1	77	80.2	0.7	2.1	1	12.8	6.22	52.2	121	59.0	243	325	1.56	7.5	43	
Minima			32.6	78.7	35	77.4	0.3	1.7		11.2	4.85	39.2	87	50.7	134	190	1.45	4.3	35	
Maxima			40.6	96.4	46	81.0	1.7	2.7		13.8	6.65	54.7	175	85.5	529	440	1.54	10.8	58	
Means			35.8	90.0	39	79.6	1.0	2.3		12.7	5.83	48.2	132	63.5	285	286	1.50	7.7	46	
Standard Deviations			2.0	4.6	3	0.8	0.3	0.3		0.6	0.50	3.9	22	8.9	88	72	0.02	1.8	7	
Coefficients of Variation			5.5	5.1	7	1.0	34.4	12.2		4.6	8.54	8.0	16	14.1	31	25	1.42	22.9	15	

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 K. Smith, University of Minnesota - St. Paul

2004 MISSISSIPPI VALLEY UNIFORM REGIONAL BARLEY NURSERY - SIDNEY, 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
5150	Barbless	6	38.2	90.5	57	77.3	0.7	1.9	1	14.7	5.41	37.9	181	57.1	262	175	1.50	11.9	30	32
5151	Morex	6	35.7	82.0	66	78.1	1.1	1.7	1	13.7	5.39	40.3	177	61.1	338	200	1.51	6.7	42	30
5152	Robust	6	38.0	91.6	62	79.2	0.7	1.5	1	13.7	5.55	42.5	175	53.0	318	255	1.52	4.4	53	10
5153	Legacy	6	34.7	84.8	66	79.3	1.0	1.8	1	12.9	5.78	46.9	167	85.2	487	225	1.56	4.1	51	14
5154	Drummond	6	37.0	91.4	67	79.2	0.5	1.6	1	13.4	5.64	43.4	187	70.3	127	236	1.50	5.0	62	1
5155	Lacey	6	39.1	94.9	62	79.7	0.1	1.7	1	12.9	5.45	43.1	172	64.4	147	231	1.48	8.2	61	2
5156	Conlon	2	*49.1	98.1	57	79.3	0.6	1.5	1	13.7	5.02	37.0	137	62.1	413	177	1.49	5.5	37	31
5157	Tradition	6	37.1	92.0	62	79.4	0.7	1.6	1	13.3	5.45	41.0	213	67.2	183	231	1.50	7.9	49	16
5158	M109	6	37.3	89.1	61	80.5	0.9	1.8	1	12.7	5.43	45.5	177	64.2	280	210	1.52	9.3	58	4
5159	M112	6	38.8	95.9	62	79.5	1.2	1.6	1	12.5	5.41	44.3	162	57.0	369	224	1.51	8.1	58	4
5160	M115	6	40.3	94.2	60	80.7	0.6	1.9	1	12.7	5.88	47.6	168	69.8	286	235	1.50	5.1	49	16
5161	M116	6	37.1	91.6	55	79.7	0.7	1.8	1	12.3	5.82	47.5	166	68.9	289	213	1.48	4.8	49	16
5162	ND18579	6	37.4	95.3	64	80.2	0.6	1.9	1	12.3	6.04	50.5	178	67.3	177	308	1.49	6.3	49	16
5163	2ND19119	2	*50.5	97.8	66	81.3	0.3	2.2	1	12.5	6.00	49.5	102	69.1	151	287	1.50	11.1	49	16
5164	6B99-6639	6	40.3	94.6	61	79.7	0.7	1.7	1	13.4	5.94	45.7	192	62.5	228	291	1.53	5.0	51	14
5165	6B99-6774	6	36.4	92.9	67	80.4	0.8	1.8	1	12.9	6.13	48.0	172	78.7	330	231	1.51	5.1	46	26
5166	Newdale	2	40.9	85.0	56	80.9	0.7	1.5	1	12.7	5.63	45.9	145	79.0	92	204	1.44	3.8	55	8
5167	BT490	6	36.6	88.6	67	81.2	1.0	1.8	1	12.5	5.71	47.9	138	73.6	409	280	1.54	6.0	46	26
5168	ND19552	6	38.0	96.2	68	80.7	0.8	1.8	1	12.4	5.79	48.4	192	77.4	161	256	1.52	7.1	49	16
5169	ND19620	6	39.3	96.5	67	80.2	0.5	2.0	2	13.0	5.79	45.0	197	70.1	123	244	1.50	*18.1	57	6
5170	ND19728	6	36.4	93.0	66	80.0	0.2	1.9	2	12.9	5.79	48.0	185	68.2	244	256	1.52	11.7	45	28
5171	ND19742	6	37.1	96.6	67	81.2	0.7	1.8	2	11.6	5.26	45.9	151	68.0	168	241	1.50	11.2	60	3
5172	ND16301	6	39.4	97.2	71	81.1	0.3	1.7	1	12.2	5.72	50.3	188	73.5	109	257	1.50	7.4	53	10
5173	2ND19854	2	*45.1	94.9	59	80.8	1.4	1.8	2	12.1	4.96	42.2	126	65.0	337	200	1.52	14.9	54	9
5175	M118	6	37.9	95.0	63	80.4	0.7	1.8	1	11.7	5.83	51.5	177	76.5	281	273	1.48	7.0	49	16
5176	M119	6	39.2	95.9	60	80.6	0.7	1.8	1	11.8	6.05	51.2	154	75.4	187	278	1.47	5.7	49	16
5177	6B98-9022	6	38.5	97.4	67	78.8	1.1	1.6	1	13.3	5.48	43.1	182	62.7	242	224	1.51	10.3	52	12
5178	6B00-1323	6	35.6	80.7	58	80.8	0.9	1.9	1	12.1	5.89	51.1	158	73.9	292	285	1.49	5.4	49	16
5179	6B00-1328	6	37.2	95.2	67	80.6	0.6	1.7	1	12.0	5.68	49.0	172	65.0	152	243	1.49	5.4	56	7
5180	6B00-1361	6	38.2	93.1	69	81.7	0.9	2.0	1	11.8	6.25	56.0	154	76.5	179	301	1.49	5.2	49	16

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
5181	BT493	6	36.6	91.9	69	81.8	1.1	2.0	1	11.6	6.00	53.3	131	79.3	301	270	1.53	7.2	43	29
5182	BT495	6	37.6	90.1	63	81.2	1.2	2.3	2	11.6	5.48	50.0	143	73.3	351	237	1.53	*20.0	52	12
5174	MOREX MALT CHECK	6	34.8	87.3	74	80.2	0.4	2.1	2	12.4	5.98	49.9	150	72.0	155	272	1.51	11.7	51	
Minima			34.7	80.7	55	77.3	0.1	1.5		11.6	4.96	37.0	102	53.0	92	175	1.44	3.8	30	
Maxima			40.9	98.1	71	81.8	1.4	2.3		14.7	6.25	56.0	213	85.2	487	308	1.56	14.9	62	
Means			37.8	92.6	64	80.2	0.8	1.8		12.7	5.68	46.5	166	69.2	250	243	1.50	7.2	50	
Standard Deviations			1.5	4.5	4	1.0	0.3	0.2		0.7	0.30	4.3	24	7.4	100	34	0.02	2.8	7	
Coefficients of Variation			3.9	4.8	7	1.3	39.2	10.6		5.8	5.36	9.3	14	10.7	40	14	1.51	38.2	13	

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. Cooper, BARI - Ft. Collins

2004 MISSISSIPPI VALLEY UNIFORM REGIONAL BARLEY NURSERY - BOTTINEAU, ND

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
5183	Barbless	6	32.0	74.1	*36	*75.9	1.6	n.d.	3	13.6	4.87	37.0	196	49.6	303	174	1.51	*45.0	26	32
5184	Morex	6	32.7	78.6	45	77.6	1.0	1.6	1	13.8	5.10	38.8	199	63.2	254	197	1.49	10.3	29	30
5185	Robust	6	33.8	80.9	39	78.0	1.5	1.4	1	12.7	4.76	39.1	180	48.5	318	172	1.51	10.9	40	24
5186	Legacy	6	32.0	77.6	48	78.6	0.9	1.6	1	12.8	5.28	41.8	199	78.6	218	215	1.47	6.2	44	17
5187	Drummond	6	33.5	86.8	44	78.2	1.1	1.4	1	13.5	5.27	40.3	219	67.2	166	212	1.48	6.8	43	18
5188	Lacey	6	34.1	85.3	43	78.5	1.1	1.5	1	12.4	4.77	40.1	180	57.9	185	177	1.48	10.8	43	18
5189	Conlon	2	*43.6	96.3	40	79.5	1.4	1.5	1	12.4	4.57	37.8	156	63.5	223	159	1.46	9.8	46	14
5190	Tradition	6	35.4	91.6	45	78.4	1.3	2.2	2	13.1	4.76	37.0	227	58.4	217	170	1.51	28.0	35	27
5191	M109	6	33.9	80.6	43	79.4	1.5	1.8	2	12.3	4.95	42.3	199	63.3	275	202	1.51	13.1	50	8
5192	M112	6	34.8	86.3	41	77.7	0.7	1.9	2	12.5	4.76	39.2	182	54.7	256	212	1.49	23.0	32	29
5193	M115	6	34.9	83.9	43	79.1	0.7	1.6	1	12.3	5.14	44.6	190	64.2	188	227	1.47	9.7	54	5
5194	M116	6	32.8	80.0	44	78.0	0.4	1.6	1	12.4	4.99	40.3	211	69.8	218	173	1.47	8.3	36	26
5195	ND18579	6	33.7	82.4	40	78.2	1.1	1.6	1	13.2	5.35	42.4	204	66.8	156	192	1.48	8.8	48	13
5196	2ND19119	2	*49.0	96.5	46	80.9	0.4	2.2	1	12.1	5.91	50.3	131	70.5	135	328	1.51	13.6	49	10
5197	6B99-6639	6	38.6	94.0	40	77.9	1.5	1.7	1	13.7	5.37	39.2	219	58.6	295	265	1.54	8.9	35	27
5198	6B99-6774	6	34.6	90.0	45	79.6	0.6	1.8	1	13.0	5.84	47.1	186	84.1	197	214	1.51	6.8	46	14
5199	Newdale	2	38.7	79.5	44	79.8	0.7	1.6	1	12.6	5.28	43.6	152	93.6	118	168	1.44	4.6	43	18
5201	BT490	6	33.8	85.5	44	79.0	0.3	1.6	1	12.4	5.01	42.8	174	70.4	205	260	1.51	10.9	54	5
5202	ND19552	6	35.3	95.0	44	79.3	1.4	1.6	1	13.1	5.20	40.9	208	68.5	165	202	1.51	10.4	49	10
5203	ND19620	6	36.1	90.5	43	78.8	0.8	1.9	2	12.6	5.10	41.6	203	65.0	159	160	1.52	21.0	41	23
5204	ND19728	6	31.7	82.6	43	78.0	1.3	1.9	2	12.1	4.68	40.1	173	58.7	94	168	1.49	23.0	45	16
5205	ND19742	6	32.8	86.4	45	79.0	1.3	2.0	2	11.8	4.43	40.3	137	60.7	339	224	1.54	32.0	42	21
5206	ND16301	6	33.2	89.4	45	77.3	1.0	1.6	1	13.1	4.93	38.4	180	60.8	148	222	1.49	13.4	39	25
5207	2ND19854	2	39.2	88.2	45	79.6	0.9	n.d.	3	10.7	4.10	39.4	119	57.6	224	152	1.49	*57.0	28	31
5208	M118	6	35.1	88.2	43	78.7	1.2	1.7	1	12.8	5.26	42.5	179	72.5	277	195	1.48	10.8	55	4
5209	M119	6	35.2	87.8	42	78.3	1.5	1.7	1	13.0	5.10	40.7	159	67.3	183	240	1.45	11.0	49	10
5210	6B98-9022	6	35.5	93.3	46	78.3	1.6	1.8	2	12.6	4.80	40.3	176	64.2	131	238	1.47	26.0	52	7
5211	6B00-1323	6	34.0	78.6	43	79.1	1.0	1.6	1	12.3	5.22	44.2	176	72.3	173	300	1.45	8.3	59	2
5212	6B00-1328	6	33.4	87.2	44	78.3	1.2	1.5	1	12.1	4.64	39.0	160	60.1	133	229	1.48	13.1	50	8
5213	6B00-1361	6	35.1	85.7	46	78.9	1.6	1.7	1	12.0	5.21	46.8	155	71.6	134	214	1.49	7.3	62	1

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
5214	BT493	6	34.7	90.8	46	79.2	0.8	1.8	1	11.5	5.03	45.9	144	74.9	149	208	1.49	8.5	57	3
5215	BT495	6	35.6	90.7	43	78.7	0.8	2.2	2	12.0	4.65	40.7	143	72.4	421	182	1.56	22.0	42	21
5200	MOREX MALT CHECK	6	35.1	86.6	77	80.4	1.0	1.8	1	12.1	5.89	52.6	161	78.0	99	246	1.48	9.0	56	
Minima			31.7	74.1	39	77.3	0.3	1.4		10.7	4.10	37.0	119	48.5	94	152	1.44	4.6	26	
Maxima			39.2	96.5	48	80.9	1.6	2.2		13.8	5.91	50.3	227	93.6	421	328	1.56	32.0	62	
Means			34.5	86.4	44	78.7	1.1	1.7		12.6	5.01	41.4	179	65.9	208	208	1.49	13.2	44	
Standard Deviations			1.9	5.8	2	0.8	0.4	0.2		0.6	0.37	3.1	27	9.3	74	40	0.03	7.1	9	
Coefficients of Variation			5.4	6.7	5	1.0	35.9	13.1		5.1	7.38	7.4	15	14.1	35	19	1.81	54.0	20	

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. Cooper, BARI - Ft. Collins

MISSISSIPPI VALLEY UNIFORM REGIONAL BARLEY NURSERY - 2004 Crop

Table 9 - Station Means* of Barley and Malt Quality Factors for 32 Varieties or Selections.**

LOCATION	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
Aberdeen, ID	38.6 A	92.2 A	58 B	80.1 A	0.9 BC	2.0 C	1.3 AB	11.7 C	5.40 C	48.7 A	124 D	61.8 CD	246 C	236 C	1.50 AB	11.3 B	46
Crookston, MN	34.8 C	83.0 D	40 D	78.9 C	1.4 A	2.6 A	1.5 A	13.7 A	5.64 B	43.2 C	135 C	60.8 D	409 A	259 B	1.51 A	17.7 A	39
Morris, MN	36.4 B	90.0 B	39 D	79.5 B	1.0 B	2.3 B	1.2 B	12.7 B	5.83 A	48.2 A	132 C	63.5 C	285 B	286 A	1.50 AB	10.7 BC	46
Sidney, MT	38.8 A	92.6 A	64 A	80.2 A	0.8 C	1.8 D	1.2 B	12.7 B	5.68 B	46.5 B	166 B	69.2 A	250 BC	243 BC	1.50 A	8.0 C	50
Bottineau, ND	35.3 C	86.4 C	43 C	78.6 D	1.1 B	1.8 D	1.4 A	12.6 B	5.01 D	41.4 D	179 A	65.9 B	208 D	208 D	1.49 B	15.6 A	44

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

** Barbless, Morex, Robust, Legacy, Drummond, Lacey, Conlon, Tradition, M109, M112, M115, M116, ND18579, 2ND19119, 6B99-6639, 6B99-6774, Newdale, BT490, ND19552, ND19620, ND19728, ND19742, ND16301, 2ND19854, M118, M119, 6B98-9022, 6B00-1323, 6B00-1328, 6B00-1361, BT493, BT495

MISSISSIPPI VALLEY UNIFORM REGIONAL BARLEY NURSERY - 2004 CROP

Table 10 - Varietal Means of Barley and Malt Quality Factor for all Stations including Aberdeen, ID**

Variety or Selection	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
Barbless	34.1	FGH	75.7	J	44.8	KL	75.4	H	1.6	A	2.1	ABCD	1.6	BCD	14.1	A	4.97	HIJ	36.6	H	146	FGHI	48.5	O	433	A	189	FG	1.52	BCD	18.2	BCDEFG	26.2
Morex	33.7	GH	78.5	IJ	48.2	CDEFGHIJKL	77.9	G	1.1	ABCD	1.8	CD	1.0	D	13.6	AB	5.36	DEFGHI	41.7	FGH	160	BCDEF	61.1	HIJKLM	313	ABCDEFGH	236	BCDEFG	1.50	DEFGH	8.3	FGHI	37.2
Robust	35.5	FGH	86.4	CDEFGHI	46.6	GHIJKL	78.6	FG	1.4	AB	1.6	D	1.0	D	13.3	ABCD	5.34	DEFGHI	42.0	FG	152	DEFG	49.0	O	372	ABCD	235	BCDEFG	1.51	CDEFGH	6.3	HI	45.4
Legacy	33.6	GH	83.0	GHIJ	51.0	ABCDEF	79.0	DEFG	0.9	BCD	2.0	BCD	1.0	D	12.8	BCDE	5.76	ABCDEFG	46.9	ABCDEF	154	CDEFG	74.2	BCD	400	ABC	249	ABCDEFG	1.51	CDEFG	6.3	HI	46.0
Drummond	34.9	FGH	87.5	BCDEFGH	52.6	AB	78.9	EFG	1.0	BCD	1.8	CD	1.2	CD	13.2	ABCD	5.47	CDEFGHI	43.7	DEFG	168	ABCDE	64.8	FGHIJKL	234	DEFGHI	236	BCDEFG	1.51	CDEFGH	8.8	FGHI	45.6
Lacey	36.3	EFGH	88.7	ABCDEFGH	46.6	GHIJKL	79.2	CDEFG	0.9	BCD	2.0	BCD	1.4	CD	12.9	ABCDE	5.20	FGHIJ	42.4	FG	151	EFG	58.5	LMN	235	DEFGHI	216	DEFG	1.48	HIJK	15.3	BCDEFGH	50.0
Conlon	44.8	B	95.7	AB	46.4	HIJKL	79.8	ABCDEF	1.0	BCD	1.7	CD	1.0	D	12.5	BCDEF	4.90	IJ	40.8	GH	122	JK	62.1	HIJKLM	304	ABCDEFGHI	181	G	1.47	K	7.0	GHI	44.0
Tradition	36.0	EFGH	90.1	ABCDEFGH	49.8	ABCDEFGHI	79.0	DEFG	1.0	ABCD	2.2	ABCD	1.6	BCD	13.1	ABCD	5.16	GHIJ	40.9	GH	182	A	59.7	JKLMN	272	BCDEFGHI	205	EFG	1.51	CDEFGH	24.1	B	48.2
M109	36.4	EFGH	87.1	CDEFGH	45.8	IJKL	79.9	ABCDEF	1.2	ABCD	2.3	ABCD	1.8	BC	12.8	BCDEF	5.50	BCDEFGHI	45.8	BCDEFG	160	BCDEF	60.7	HIJKLM	299	ABCDEFGHI	227	BCDEFG	1.51	CDEFG	18.9	BCDEF	49.0
M112	37.1	DEF	93.7	ABCDE	44.6	L	78.9	EFG	1.2	ABCD	2.1	ABCD	1.8	BC	12.4	BCDEF	5.20	GHIJ	43.4	EFG	146	FGHI	54.6	NO	359	ABCDE	210	EFG	1.50	DEFGHIJ	20.3	BCDE	44.8
M115	37.0	DEF	89.4	ABCDEFGH	47.8	DEFGHIJKL	80.0	ABCDE	0.8	BCD	2.1	ABCD	1.2	CD	12.4	BCDEF	5.82	ABCDEF	49.6	ABCD	148	EFGH	64.9	FGHIJKL	260	CDEFGHI	257	ABCDEF	1.48	GHIJK	9.5	EFGHI	47.4
M116	34.7	FGH	83.8	FGHI	47.0	FGHIJKL	78.9	EFG	0.9	BCD	2.2	ABCD	1.2	CD	12.6	BCDEF	5.85	ABCDE	47.2	ABCDEF	152	DEFG	64.9	FGHIJKL	284	ABCDEFGHI	251	ABCDEFG	1.47	IJK	9.3	EFGHI	40.2
ND18579	35.0	FGH	87.6	BCDEFGH	48.8	BCDEFGHIJK	79.1	CDEFG	1.0	ABCD	2.0	ABCD	1.0	D	12.8	BCDEF	5.72	ABCDEFG	46.6	ABCDEFG	164	ABCDEF	64.3	FGHIJKL	289	ABCDEFGHI	253	ABCDEFG	1.49	DEFGHIJ	9.3	EFGHI	44.6
2ND19119	49.3	A	96.7	A	50.8	ABCDEF	81.0	A	0.6	D	2.5	AB	1.2	CD	12.2	CDEF	6.11	AB	51.9	A	101	L	66.8	EFGHIJ	186	GHI	295	ABC	1.50	DEFGHIJ	13.1	CDEFGHI	43.4
6B99-6639	38.9	CDE	92.7	ABCDE	45.6	JKL	78.9	EFG	1.2	ABCD	1.9	BCD	1.0	D	13.3	ABC	5.70	ABCDEFG	44.2	CDEFG	175	AB	59.7	JKLMN	269	CDEFGHI	268	ABCDE	1.53	ABC	7.8	FGHI	43.8
6B99-6774	34.7	FGH	87.3	BCDEFGH	51.2	ABCDE	80.1	ABCDE	0.9	BCD	2.2	ABCD	1.0	D	12.8	BCDEF	6.18	A	50.1	ABC	154	CDEFG	79.9	AB	300	ABCDEFGHI	273	ABCDE	1.51	CDEFG	7.2	GHI	43.0
Newdale	39.6	CD	85.9	DEFGHI	47.0	FGHIJKL	80.7	AB	0.8	BCD	1.8	CD	1.0	D	12.8	BCDEF	5.65	ABCDEFG	46.2	ABCDEFG	125	JK	82.1	A	145	I	222	CDEFG	1.45	L	4.8	I	42.6
BT490	34.8	FGH	87.0	CDEFGH	52.0	ABC	80.3	ABCD	0.9	BCD	2.0	ABCD	1.0	D	12.3	BCDEF	5.70	ABCDEFG	48.5	ABCDE	136	GHIJ	70.1	CDEFG	312	ABCDEFGH	300	AB	1.51	BCDE	9.3	EFGHI	48.0
ND19552	36.2	EFGH	94.8	ABC	51.6	ABCD	79.9	ABCDEF	1.0	BCD	2.0	BCD	1.0	D	12.7	BCDEF	5.54	BCDEFGH	46.3	ABCDEFG	171	ABC	67.0	EFGHI	195	FGHI	259	ABCDEF	1.51	BCDEF	10.2	DEFGHI	50.8
ND19620	37.1	DEF	91.6	ABCDEFG	49.6	BCDEFGHIJ	79.6	BCDEF	0.8	BCD	2.2	ABCD	1.6	BCD	12.9	ABCD	5.52	BCDEFGH	44.6	BCDEFG	170	ABCD	64.3	GHIJKL	216	DEFGHI	239	BCDEFG	1.51	BCDE	17.1	BCDEFGH	48.0
ND19728	33.5	H	86.3	CDEFGHI	50.6	ABCDEFG	79.0	EFG	0.9	BCD	2.0	ABCD	1.4	CD	12.5	BCDEF	5.38	DEFGHI	45.2	BCDEFG	158	CDEFG	59.6	KLMN	252	CDEFGHI	230	BCDEFG	1.51	BCDEF	13.5	BCDEFGH	45.6
ND19742	34.7	FGH	89.4	ABCDEFGH	48.8	BCDEFGHIJK	80.2	ABCDE	1.2	ABCD	2.3	ABC	2.0	AB	11.6	EF	5.00	HIJ	45.6	BCDEFG	122	JK	59.7	KLMN	357	ABCDEF	250	ABCDEFG	1.53	AB	21.9	BC	46.8
ND16301	36.8	DEFG	93.1	ABCDE	52.0	ABC	79.5	BCDEF	0.7	CD	1.9	BCD	1.2	CD	12.7	BCDEF	5.45	CDEFGHI	45.4	BCDEFG	158	ABCDEF	61.5	HIJKLM	206	EFGHI	246	ABCDEFG	1.51	BCDEF	12.4	CDEFGHI	44.2
2ND19854	41.4	C	90.7	ABCDEFGH	47.2	EFGHIJKL	80.4	ABC	1.3	ABC	2.6	AB	2.4	A	11.5	F	4.66	J	42.2	FG	118	KL	57.9	MN	323	ABCDEFGH	216	DEFG	1.50	CDEFGH	37.2	A	41.6
M118	36.4	EFGH	91.6	ABCDEF	46.4	HIJKL	79.6	BCDEF	1.2	ABCD	2.1	ABCD	1.2	CD	12.4	BCDEF	5.78	ABCDEFG	48.5	ABCDE	136	FGHI	64.1	DEFGHI	343	ABCDEFG	258	ABCDEF	1.49	FGHIJK	9.9	EFGHI	46.0
M119	37.3	DEF	92.1	ABCDEF	47.0	FGHIJKL	79.4	BCDEF	1.0	BCD	2.2	ABCD	1.2	CD	12.6	BCDEF	5.91	ABCDE	48.4	ABCDE	137	HIJ	67.1	EFGHIJK	254	CDEFGHI	273	ABCDE	1.47	JK	10.6	DEFGHI	43.2
6B98-9022	36.2	EFGH	94.3	ABCD	51.2	ABCDE	78.6	FG	1.3	ABCD	1.9	CD	1.4	CD	12.9	ABCDE	5.33	DEFGHI	43.5	EFG	149	CDEFG	60.5	JKLMN	233	DEFGHI	243	ABCDEFG	1.50	DEFGHI	13.4	BCDEFGH	47.2
6B00-1323	35.7	EFGH	82.5	HIJ	45.4	KL	80.2	ABCDE	1.0	BCD	2.1	ABCD	1.0	D	12.4	BCDEF	5.93	ABCD	49.8	ABC	146	FGHI	67.9	DEFGH	270	CDEFGHI	295	ABC	1.48	GHIJK	7.3	GHI	49.8
6B00-1328	36.2	EFGH	93.1	ABCDE	50.4	ABCDEFGH	79.5	BCDEF	0.9	BCD	1.8	CD	1.2	CD	12.3	BCDEF	5.19	GHIJ	43.8	DEFG	145	EFGH	59.9	JKLMN	213	DEFGHI	234	BCDEFG	1.49	EFGHIJK	10.2	DEFGHI	49.2
6B00-1361	37.3	DEF	90.9	ABCDEFGH	51.6	ABCD	80.5	ABC	0.9	BCD	2.3	ABC	1.0	D	12.3	CDEF	6.02	ABC	51.9	A	148	EFGH	70.8	CDE	166	HI	313	A	1.49	DEFGHIJK	7.7	FGHI	52.8
BT493	35.7	EFGH	90.4	ABCDEFGH	53.8	A	80.6	AB	0.9	BCD	2.3	ABCD	1.0	D	12.0	DEF	5.74	ABCDEFG	50.3	AB	128	JK	75.1	ABC	225	DEFGHI	285	ABCD	1.51	BCDE	8.1	FGHI	47.6
BT495	35.6	FGH	85.2	EFGHI	50.8	ABCDEF	79.4	BCDEF	1.2	ABCD	2.6	A	2.0	AB	12.1	CDEF	5.29	EFGHI	45.7	BCDEFG	127	IJK	73.7	CDEF	429	AB	227	BCDEFG	1.54	A	21.1	BCD	43.4

* 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, Crookston and Morris MN, Sidney MT and Bottineau ND

Appendix A: METHODS

Cleaning All samples were cleaned on a Carter Dockage Tester and any material not retained on a 5/64" screen was discarded.

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 Five g of ground sample was dried for 3 h at 106°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) barley samples were steeped at 16°C for 32-48 h, to 45% moisture, by alternating 4 h of wet steep with 4 h of air rest. The steeped samples were placed in a chamber for 5 d at 17°C and near 100% R.H., in cans that were rotated for 3.0 min every 30 min. The germinated grain (green malt) was kilned for 24 h as follows: 0.5 h from 25°C to 49°C, 9.5 h at 49°C, 0.5 h from 49°C to 54°C, 4.0 h at 54°C, 0.5 h from 54°C to 60°C, 3.0 h at 60°C, 0.5 h from 60°C to 68°C, 2.0 h at 68°C, 0.5h from 68°C to 85°C, and 3.0 h at 85°C.

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. Ground malts for moisture, protein and amylolytic activity analyses were ground in a Labconco Burr mill (see Barley Mill).

Malt Moisture Content 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 that was determined by comparison with values obtained in a collaborative test.

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-6A (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 2004 Crop Year

Quality Score Parameters for 2- and 6-rowed barleys

	2-rowed		6-rowed	
Quality parameter	condition	score	condition	score
Kernel Weight	> 42.0	5	> 32.0	5
(mg)	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	≥ 81.0	10	≥ 79.0	10
(% db)	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	≥ 13.5	0	≥ 14.0	0
(% db)	13.0–13.5	5	13.5–13.9	5
	11.5–13.0	10	11.5–13.5	10
	≤ 11.5	5	≤ 11.5	5
Wort Protein	> 6.0	0	> 6.0	0
(% db)	5.6–6.0	3	5.7–6.0	3
	4.9–5.6	7	5.2–5.7	7
	4.5–4.9	3	4.8–5.2	3
	< 4.5	0	< 4.8	0
S/T (Soluble/Total	>47	0	>47	0
Protein, % db)	42–47	5	42–47	5
	< 42	0	< 42	0
DP (Diastatic	> 180	0	> 200	0
Power, ° ASBC)	160–180	4	180–200	4
	120–160	7	140–180	7
	100–120	4	120–140	4
	< 100	0	< 120	0
Alpha-amylase	> 90	0	> 90	0
(20° DU)	80–90	4	80–90	4
	45–80	7	45–80	7
	35–45	4	35–40	4
	< 35	0	< 35	0
Beta-glucan	< 40	0	< 40	0
(ppm)	40 –60	3	40 –80	3
	60 – 115	7	80 – 140	7
	115–200	3	140 – 200	3
	> 200	0	> 200	0