UNITED STATES DEPARTMENT OF AGRICULTURE
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CEREAL CROPS RESEARCH UNIT

MISSISSIPPI VALLEY REGIONAL SPRING BARLEY NURSERY
2009 Crop

Preliminary Quality Report

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Detailed Data:

Crookston, MN
Fargo, ND
Aberdeen, ID
Bottineau, ND
Sidney, 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 are interested in the development of improved barleys.

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

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

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Mississippi Valley Regional Spring Barley Nursery – 2009 Crop

Nursery samples were received for malting quality evaluation from four experimental stations located in Minnesota, North Dakota or Montana and from one location (Aberdeen, ID), which is not located within the Mississippi Valley. The parentages of the nursery entries are listed in Table 1. Seventeen of the thirty-four entries were new in this year's nursery.

These samples were germinated for four days in Joe White micro-malters under conditions that should generate malts having modification levels similar to those produced by industry. Detailed descriptions of the malting conditions and analytical methods employed are listed in Appendix A. The criteria and value assignments, based upon AMBA guidelines (http://www.ambainc.org/media/AMBA_PDFs/Press_Releases/GUIDELINES.pdf) used to calculate quality scores are listed in Appendix B.

The mean values for fourteen quality factors are listed over the four stations located in the Mississippi Valley Region (Table 2) and over all lines (Table 3). Data on the nursery lines from an additional station (Aberdeen, ID) located outside the Mississippi Valley Region were generated and those data were combined with the other locations and are presented in Tables 9 and 10. Individual station data are reported in Tables 4 through 8. Evaluations of data from individual locations and overall performance (derived primarily from Tables 2, 3, 9 and 10) are also presented.

The plump barleys from Crookston, MN (Table 4) generally had good protein levels. Most extract values exceeded AMBA's "ideal" values for 2 and 6-rowed malts. Soluble protein levels were generally good, while S/T ratios ranged from seven that were too low to five that were too high. Amylolitic values were generally good; however the presence of the "low protein" gene in some lines may have negatively affected their diastatic power values. Nearly half of the β-glucan values were too high and twenty-two viscosities exceeded the desired limit, suggesting that our standard malting protocol did not yield sufficient

carbohydrate modification. Most free amino nitrogen (FAN) and turbidity values were good. The best performers were M135, 6B05-0881, ND24906, ND20448, M137, 6B03-4304, 6B05-0572, ND23497, 2ND25272, ND22421, SR424 and SR429. M135 showed no deficiencies at this location. 6B05-0881 had excellent quality, except for a slightly elevated viscosity value. The extract value for ND24906 was just below AMBA's "ideal" limit. The soluble protein value for ND20488 was slightly below AMBA's "ideal". M137 had a slightly elevated β-glucan level. 6B03-4304 had slightly elevated β-glucan and viscosity values. 6B05-0572 had a slightly low soluble protein level and an elevated viscosity value. ND23497 had elevated β-glucan and viscosity values. 2ND25752 had a low diastatic power value and slightly elevated β-glucan contents. ND22421 had a slightly depressed soluble protein value and slightly elevated β-glucan and viscosity values. SR424 had low total and soluble protein values. SR429 had a slightly elevated soluble protein value and a very high S/T ratio. Most of the deficiencies described above could be resolved with a malting protocol optimized for each line.

The barleys from Bottineau, ND (Table 5) were very plump and most had good protein contents. The majority of all malt quality parameters analyzed fell within AMBA's "ideal" guidelines. Quality scores were exceptional, with eight lines receiving a maximum score of 65, contributing to a location average of 59. As such, there were few deficiencies of note in these barleys. The most discriminating quality parameter was S/T which ranged between two that were too low to eleven that exceeded desired limits. Sixteen lines scored 60 or better and the line scoring the lowest was still a very respectable 49.

The barleys from Fargo, ND (Table 6) were plump and ranged in protein from two that were a bit low to four that exceeded the desired maximum. Extract values were generally good. A third of the soluble protein and S/T values were too high. Amylolitic and free amino nitrogen values were generally good, while most β-glucan and viscosity values were too high. The best performers were Lacey, 2ND24388, 6B04-0007, SR425, 2ND25272, Tradition, 2ND25276 and Robust. Lacey performed very well, but had a hazy wort, even though its

turbidity value was only 10.5 Hach units. 2ND24388, 6B04-0007 and Tradition had elevated β-glucan and viscosity values. SR425 and 2ND25276 had slightly elevated β-glucan values and slightly low diastatic power activities. Robust had a slightly elevated soluble protein level and a β-glucan value that was too high.

The barleys from Sidney, MT (Table 7) were very plump and generally had very good protein contents. Extract values were excellent, with all lines meeting AMBA's "ideal" criteria. Soluble protein and FAN values were generally good, but half of the S/T ratios were too high, indicating too much protein modification. Amylolitic values were very good and turbidities were excellent, except for that of 2ND24388. Nearly half of the β-glucan values were too high and eleven viscosity values exceeded the desired limits. The best performers were M135, Morex, ND20488, ND23497, 6B05-572, 6B05-0716, Lacey, SR425, and ND24906. M135 had no deficiencies at this location, though its S/T value was nearly out of the "ideal" range. ND23497 had an excellent quality profile, but with a β-glucan value that was just above what would be considered "ideal". ND20448, Morex, 6B05-0572 and 6B05-0716 had excellent quality profiles, but with slightly elevated β-glucan and viscosity values indicating the need for a bit more modification than our standard malting protocol allowed. All quality criteria scores for Lacey, SR425 and ND24906 fell within the "ideal" ranges, except for their elevated S/T values. Many other lines demonstrated very good quality as this location's average quality score was 55.

The plump barleys from Aberdeen, ID (Table 8) had good to slightly low protein contents. Amylolitic and soluble protein values were generally good, while two thirds of the S/T, β-glucan and viscosity values were too high. The best performers were M137, ND24906, 6B05-0717, SR424, ND22241 and Legacy. M137 had no deficiencies in its quality parameters. ND24906 also showed good quality except for an elevated viscosity value. SR424 had an elevated S/T ratio. ND22241 had a slightly hazy wort and a slightly elevated β-glucan level. Legacy had elevated β-glucan contents.

Performance of the Mississippi Valley Nursery (MVN) was best at Bottineau, ND (Tables 2 and 9). All of the barleys grown at this site performed

well, with only isolated instances of any deficiencies, in what must have been a nearly ideal growing environment. The barleys at Sidney, MT also performed very well, having the highest average extract value in the MVN, aided by the lowest average total protein levels. Even though the protein levels were low, the mean diastatic power value was one of the highest. The average S/T and β-glucan values were a bit high, which lowered the average quality scores compared to Bottineau. The experimental lines grown at Crookston, MN performed quite well. Extract values were good and similar to those of Bottineau and Fargo. Soluble protein, S/T, diastatic power, α-amylase and FAN values were very good. Carbohydrate modification was a bit slow resulting in elevated β-glucan and viscosity values. The nursery from Fargo, ND performed well having an average quality score of 47. The slightly elevated protein profile negatively impacted the quality and this location also had the highest β-glucan and viscosity values. The MVN was grown at Aberdeen, ID, which is located outside the Mississippi Valley. The nursery performed very well having an average extract value of 81.4%, assisted by the rather low average grain protein content of 11.6%. The low grain protein contributed to deficiencies in wort protein, FAN and diastatic power values in a few lines. Average β-glucan levels at Aberdeen were similar to those at Crookston and Sidney and a bit high suggesting slightly under-modified malts from our standard malting protocol.

The best performing lines of the MVN (Table 3) were 6B05-0572, M135, Lacey, 6B03-4304, 6B05-0716, 2ND24388, SR425, ND20448, SR420, 2ND25272, 2ND25276, 6B05-0881 and M139. The averaged quality parameter values for 6B05-0572, 6B050716 and 6B03-4304 were excellent. Note that their viscosity values were just above AMBA's "ideal" range. M135 and Lacey also had excellent quality parameter values. M135 had a bit more protein, slightly more enzyme activity and a lower mean extract value than Lacey. 2ND24388 had an excellent average extract value. This line has a low protein profile, with moderate enzyme and FAN levels. Note that its β-glucan levels were elevated in Crookston and Fargo. SR425 appeared to have balanced, but more rapid modification than most of the nursery. This line's S/T ratio was a bit high, while

its mean β-glucan and viscosity values were the lowest in the nursery. ND20448 had a mean extract value above 80%, a good protein profile, moderate enzyme levels and good carbohydrate modification, except at the Fargo location. SR420 performed well, but note an elevated S/T ratio and a rather low average diastatic power value. 2ND25272 and 2ND25276 performed very well. These lines have a low protein profile, with excellent extract values. 2ND25276 performed a bit better than 2ND25272 based on a mean extract value of 82%, a viscosity of 1.48 cPa and a higher average FAN value. 6B05-0881 had an elevated S/T ratio in three of the four MVN locations and the highest average diastatic power value. M139 performed well, but note the elevated β-glucan contents.

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Table 1

Entry#	CI # or Contributor	Name	Parentage
1.	15773	Morex	Cree/Bonanza
2.	476976	Robust	Morex/Manker
3.	Busch Ag. Res.	Legacy	Bumper/Karl//Bumper/Manker/3/Bumper/Karl/4/Excel
4.	PI 613603	Lacey	M78/M79
5.	North Dakota	Conlon	Bowman*2/Brigitta mutant//ND10232
6.	Busch Ag. Res.	Tradition	6B89-2126/ND10981
7.	North Dakota	ND20448	ND16918/C98-10-155-3
8.	North Dakota	Pinnacle	ND1872/ND19130
9.	North Dakota	ND22421	ND18546/ND19656
10.	Saskatchewan	SR420	SM99748/SM99153
11.	Minnesota	M137	ND20493/Rasmusson
12.	North Dakota	ND23497	Drummond/ND20414
13.	North Dakota	2ND24263	2ND19869/3/2ND18998//2ND16092/2ND17263
14.	North Dakota	2ND24388	2ND17274/Rawson//2ND19854
15.	Busch Ag. Res.	6B04-0007	TRADITION//6B96-3373/DRUMMOND
16.	Saskatchewan	SR424	SM01262/SM01147
17.	Saskatchewan	SR425	SM00207/SM00150
18.	Minnesota	M135	FEG97-44/M118
19.	Minnesota	M138	M00-33/M122 (FEG65-02)
20.	Minnesota	M139	M00-33/M122 (FEG65-02)
21.	Minnesota	M140	M00-33/FEG66-08
22.	Minnesota	M141	M122/M123 MAS
23.	North Dakota	ND24906	ND20508/ND20492
24.	North Dakota	ND25160	ND19557/ND19491
25.	North Dakota	ND25161	ND19557/ND19491
26.	North Dakota	2ND25272	ND20802/3/ND19922//ND19929/ND20177
27.	North Dakota	2ND25276	ND20802/3/ND19922//ND19929/ND20177
28.	Busch Ag. Res.	6B03-4304	6B98-9022//6B94-8253/6B97-2245
29.	Busch Ag. Res.	6B05-0572	6B95-2482-1/6B98-9852
30.	Busch Ag. Res.	6B05-0716	6B98-9814/TRADITION
31.	Busch Ag. Res.	6B05-0717	6B98-9814/TRADITION
32.	Busch Ag. Res.	6B05-0881	6B99-6009/TRADITION
33	Saskatchewan	SR429	SM01764/SM00269
34	Saskatchewan	SR432	SM01778/BT485

*Entries 18-34 are new for 2009.

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Table 2 - Station Means* of Barley and Malt Quality Factors for 38 Varieties or Selections.**

LOCATION	Kernel Weight (mg)		on 6/64" (%)		Barley Color (Agtron)		Malt Extract (%)		Wort Color		Barley Protein (%)		Wort Protein (%)		S/T (%)		DP (°ASBC)		Alpha-amylase (20°DU)		Beta-glucan (ppm)		FAN (ppm)		Viscosity (Relative)		Turbidity (HACH)		Quality Score
Crookston, MN	**39.6**	B	**97.7**	B	**31**	D	**79.8**	B	**1.9**	B	**12.3**	B	**5.22**	C	**44.0**	C	**155**	B	**64.6**	C	**178**	B	**221**	A	**1.52**	A	**11.2**	A	**53**
Bottineau, ND	**42.0**	A	**99.4**	A	**40**	B	**80.0**	B	**1.8**	C	**12.2**	B	**5.35**	B	**45.7**	B	**173**	A	**67.4**	AB	**91**	C	**223**	A	**1.47**	C	**7.2**	B	**59**
Fargo, ND	**38.5**	C	**95.9**	C	**33**	C	**80.1**	B	**2.3**	A	**12.9**	A	**5.77**	A	**46.4**	AB	**153**	B	**69.5**	A	**247**	A	**218**	A	**1.53**	A	**11.0**	A	**47**
Sidney, MT	**36.7**	D	**94.6**	D	**50**	A	**80.7**	A	**1.8**	BC	**11.9**	C	**5.36**	B	**47.0**	A	**172**	A	**66.1**	BC	**177**	B	**221**	A	**1.49**	B	**6.9**	B	**55**

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

** Morex, Robust, Legacy, Lacey, Conlon, Tradition, ND20448, Pinnacle, ND22421, SR420, M137, ND23497, 2ND24263, 2ND24388, 6B04-0007, SR424, SR425, M135, M138, M139, M140, M141, ND24906, ND25160, ND25161, 2ND25272, 2ND25276, 6B03-4304, 6B05-0572, 6B05-0716, 6B05-0717, 6B05-0881, SR429, SR432

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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 (%)		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
Morex	**36.8**	GHIJK	**94.8**	CDE	**39**	CDEFGHIJ	**79.2**	JKLM	**1.8**	DE	**13.3**	AB	**5.44**	GHIJK	**42.8**	KLMN	**171**	CDEF	**63.9**	BCDE	**165**	EFGHIJ	**238**	ABCD	**1.49**	CDEFGH	**6.2**	C	**54**
Robust	**38.0**	DEFGHI	**95.9**	ABCD	**36**	HIJK	**79.7**	GHIJKLM	**1.7**	E	**12.9**	ABCDEF	**5.46**	GHIJK	**43.5**	IJKLM	**164**	EFG	**51.3**	G	**243**	BCDE	**221**	CDEFGHI	**1.49**	CDEFGH	**5.3**	C	**54**
Legacy	**36.7**	GHIJK	**96.7**	ABCD	**40**	BCDEFG	**80.0**	FGHIJKL	**2.4**	ABC	**13.0**	ABCDE	**6.08**	A	**48.4**	BCD	**166**	DEFG	**72.7**	AB	**212**	BCDEF	**260**	A	**1.49**	CDEFGH	**8.1**	BC	**48**
Lacey	**39.1**	DE	**97.3**	ABC	**38**	DEFGHIJ	**80.2**	FGHIJ	**2.0**	DE	**12.3**	EFGHIJK	**5.32**	IJKL	**44.8**	FGHIJKL	**162**	EFGH	**64.1**	BCDE	**119**	GHIJ	**218**	CDEFGHI	**1.46**	FGH	**7.7**	BC	**59**
Conlon	**47.6**	A	**98.4**	AB	**36**	GHIJK	**81.3**	ABCD	**1.8**	DE	**12.4**	DEFGHIJK	**4.77**	NO	**40.4**	N	**132**	IJK	**61.6**	DE	**283**	B	**191**	IJK	**1.52**	BCDE	**16.1**	AB	**55**
Tradition	**38.0**	DEFGHI	**98.6**	A	**41**	ABCDE	**79.9**	FGHIJKLM	**1.7**	E	**12.7**	BCDEFGH	**5.19**	KLM	**41.6**	MN	**193**	ABC	**64.2**	BCDE	**177**	DEFGH	**217**	CDEFGHI	**1.52**	ABCD	**9.1**	BC	**54**
ND20448	**38.7**	DEF	**97.7**	ABC	**44**	AB	**80.1**	FGHIJ	**1.8**	DE	**12.4**	CDEFGHIJK	**5.58**	DEFGHIJ	**46.4**	CDEFGHI	**158**	EFGHI	**67.3**	ABCDE	**135**	FGHIJ	**237**	ABCDE	**1.50**	CDEFG	**7.0**	BC	**56**
Pinnacle	**47.1**	A	**98.0**	AB	**34**	K	**81.8**	A	**1.9**	DE	**11.0**	NO	**4.82**	NO	**45.7**	DEFGHIJK	**105**	L	**53.6**	FG	**247**	BCD	**184**	JK	**1.53**	ABC	**12.3**	ABC	**50**
ND22421	**39.2**	DE	**97.9**	AB	**40**	BCDEFGH	**79.9**	FGHIJKLM	**1.9**	DE	**11.9**	IJKL	**5.28**	JKLM	**45.8**	DEFGHIJ	**143**	GHIJK	**62.9**	CDE	**166**	EFGHIJ	**203**	FGHIJ	**1.51**	BCDE	**10.1**	BC	**54**
SR420	**38.3**	DEFGH	**95.7**	ABCDE	**45**	A	**80.6**	BCDEFGH	**2.2**	ABCD	**12.1**	GHIJKL	**5.66**	CDEFGH	**49.0**	ABC	**136**	HIJK	**68.4**	ABCDE	**155**	FGHIJ	**231**	ABCDEF	**1.48**	DEFGH	**6.2**	C	**56**
M137	**37.3**	FGHIJK	**97.9**	AB	**41**	BCDEF	**79.5**	IJKLM	**1.8**	DE	**13.0**	ABCDE	**5.87**	ABCD	**46.5**	CDEFGH	**199**	AB	**65.6**	BCDE	**134**	FGHIJ	**225**	BCDEFGH	**1.47**	EFGH	**6.7**	C	**54**
ND23497	**38.2**	DEFGH	**98.3**	AB	**42**	ABC	**79.6**	HIJKLM	**1.7**	DE	**13.1**	ABCD	**5.77**	BCDEF	**45.8**	DEFGHIJ	**202**	AB	**60.9**	EF	**153**	FGHIJ	**229**	ABCDEF	**1.51**	BCDE	**7.3**	BC	**54**
2ND24263	**42.9**	C	**98.0**	AB	**36**	GHIJK	**81.3**	ABCDE	**1.8**	DE	**12.6**	CDEFGHIJ	**5.42**	HIJK	**44.0**	HIJKLM	**161**	EFGH	**69.8**	ABCDE	**376**	A	**207**	EFGHIJ	**1.56**	A	**6.9**	BC	**53**
2ND24388	**46.7**	A	**97.8**	ABC	**36**	IJK	**81.4**	ABC	**2.1**	BCDE	**11.8**	KLM	**4.80**	NO	**41.9**	LMN	**151**	EFGHIJK	**62.7**	CDE	**180**	DEFGH	**193**	IJK	**1.51**	BCDEF	**19.5**	A	**57**
6B04-0007	**38.0**	DEFGHI	**97.6**	ABC	**42**	ABC	**80.6**	BCDEFGH	**1.8**	DE	**12.2**	FGHIJKL	**4.91**	NO	**41.9**	LMN	**176**	BCDE	**64.9**	BCDE	**135**	FGHIJ	**197**	HIJK	**1.50**	CDEFG	**14.3**	ABC	**53**
SR424	**36.7**	HIJK	**95.6**	ABCDE	**37**	GHIJK	**80.1**	FGHIJK	**2.4**	ABC	**11.5**	LMN	**5.27**	JKLM	**47.5**	CDEF	**151**	EFGHIJK	**70.6**	ABCD	**133**	FGHIJ	**235**	ABCDE	**1.49**	CDEFGH	**11.5**	ABC	**53**
SR425	**36.3**	IJK	**94.0**	DEF	**42**	ABCD	**80.6**	BCDEFG	**2.1**	BCDE	**11.9**	JKL	**5.52**	FGHIJ	**48.0**	BCDE	**159**	EFGHI	**69.5**	ABCDE	**86**	J	**234**	ABCDEF	**1.45**	H	**8.0**	BC	**57**
M135	**38.4**	DEFG	**97.2**	ABC	**40**	CDEFGHI	**79.4**	IJKLM	**2.1**	ABCDE	**12.7**	BCDEFGH	**5.66**	CDEFGH	**45.7**	DEFGHIJK	**176**	BCDE	**71.5**	ABC	**128**	GHIJ	**253**	AB	**1.46**	GH	**8.7**	BC	**59**
M138	**36.7**	GHIJK	**93.1**	EF	**38**	DEFGHIJ	**79.1**	JKLM	**1.8**	DE	**13.2**	ABC	**5.63**	DEFGHI	**44.7**	FGHIJKL	**164**	EFG	**68.1**	ABCDE	**241**	BCDE	**234**	ABCDEF	**1.49**	CDEFGH	**7.3**	BC	**53**
M139	**35.9**	K	**92.1**	F	**37**	FGHIJK	**79.1**	KLM	**1.7**	DE	**13.2**	ABC	**5.46**	GHIJK	**43.3**	JKLM	**152**	EFGHIJ	**66.4**	ABCDE	**193**	CDEFGH	**225**	BCDEFGH	**1.48**	DEFGH	**6.9**	BC	**55**
M140	**38.3**	DEFGH	**95.5**	BCDE	**37**	EFGHIJK	**79.1**	LM	**1.8**	DE	**12.9**	ABCDEF	**5.47**	GHIJK	**43.9**	HIJKLM	**163**	EFG	**62.9**	CDE	**237**	BCDE	**210**	DEFGHIJ	**1.48**	DEFGH	**7.3**	BC	**53**
M141	**38.1**	DEFGH	**96.1**	ABCD	**40**	BCDEFG	**78.9**	M	**2.0**	DE	**13.5**	A	**5.85**	ABCDE	**45.0**	EFGHIJK	**191**	ABCD	**70.7**	ABC	**169**	DEFGHI	**232**	ABCDEF	**1.49**	CDEFGH	**7.6**	BC	**48**
ND24906	**36.2**	JK	**97.5**	ABC	**42**	ABC	**79.0**	LM	**2.0**	DE	**12.7**	BCDEFGHI	**5.79**	BCDEF	**47.8**	CDE	**198**	AB	**68.3**	ABCDE	**91**	IJ	**238**	ABCD	**1.49**	CDEFGH	**8.2**	BC	**54**
ND25160	**38.0**	DEFGHI	**97.9**	AB	**38**	DEFGHIJ	**80.5**	CDEFGH	**2.0**	DE	**10.7**	O	**4.89**	NO	**48.9**	ABC	**133**	IJK	**65.6**	BCDE	**201**	CDEFG	**195**	HIJK	**1.52**	ABCD	**10.6**	BC	**44**
ND25161	**37.9**	EFGHIJ	**97.3**	ABC	**39**	CDEFGHIJ	**80.8**	BCDEF	**1.9**	DE	**10.8**	NO	**5.01**	MN	**49.2**	ABC	**134**	IJK	**65.7**	BCDE	**270**	BC	**200**	GHIJ	**1.55**	AB	**10.2**	BC	**44**
2ND25272	**45.1**	B	**96.9**	ABC	**37**	EFGHIJK	**81.5**	AB	**1.7**	DE	**11.1**	MNO	**4.69**	O	**44.4**	GHIJKLM	**125**	KL	**70.8**	ABC	**174**	DEFGHI	**170**	K	**1.51**	BCDEFG	**7.4**	BC	**56**
2ND25276	**44.5**	B	**97.7**	ABC	**35**	JK	**82.0**	A	**2.0**	CDE	**11.1**	MNO	**5.05**	LMN	**47.4**	CDEFG	**128**	JKL	**75.3**	A	**129**	FGHIJ	**193**	IJK	**1.48**	DEFGH	**7.4**	BC	**56**
6B03-4304	**37.7**	EFGHIJ	**97.4**	ABC	**39**	CDEFGHIJ	**79.7**	GHIJKLM	**1.8**	DE	**12.8**	ABCDEFG	**5.56**	EFGHIJ	**45.7**	DEFGHIJK	**178**	BCDE	**71.1**	ABC	**133**	FGHIJ	**228**	BCDEFG	**1.51**	BCDE	**7.5**	BC	**58**
6B05-0572	**37.7**	EFGHIJ	**97.4**	ABC	**38**	CDEFGHIJ	**80.1**	FGHIJ	**1.9**	DE	**12.4**	CDEFGHIJK	**5.44**	GHIJK	**45.8**	DEFGHIJ	**193**	ABC	**72.2**	AB	**125**	GHIJ	**237**	ABCDE	**1.51**	BCDE	**8.5**	BC	**60**
6B05-0716	**37.8**	EFGHIJ	**97.0**	ABC	**39**	CDEFGHIJ	**80.4**	DEFGHI	**1.7**	DE	**12.5**	CDEFGHIJK	**5.37**	HIJK	**44.4**	GHIJKLM	**201**	AB	**66.4**	ABCDE	**144**	FGHIJ	**214**	CDEFGHIJ	**1.51**	BCDE	**8.7**	BC	**58**
6B05-0717	**37.6**	EFGHIJ	**98.1**	AB	**37**	FGHIJK	**80.3**	EFGHI	**2.2**	ABCD	**12.4**	DEFGHIJK	**5.81**	ABCDEF	**48.6**	ABCD	**169**	CDEFG	**69.8**	ABCDE	**129**	FGHIJ	**240**	ABCD	**1.52**	ABCD	**13.4**	ABC	**54**
6B05-0881	**37.8**	EFGHIJ	**97.7**	ABC	**39**	CDEFGHIJ	**80.1**	FGHIJK	**2.0**	DE	**12.7**	BCDEFGH	**5.73**	CDEFG	**47.2**	CDEFG	**206**	A	**72.3**	AB	**117**	HIJ	**233**	ABCDEF	**1.50**	BCDEFG	**7.5**	BC	**55**
SR429	**39.6**	D	**97.0**	ABC	**38**	DEFGHIJK	**80.3**	FGHI	**2.5**	A	**12.0**	HIJKL	**5.93**	ABC	**51.2**	A	**144**	FGHIJK	**71.5**	ABC	**122**	GHIJ	**255**	AB	**1.49**	CDEFGH	**8.4**	BC	**51**
SR432	**39.3**	DE	**97.8**	AB	**37**	GHIJK	**79.9**	FGHIJKLM	**2.5**	AB	**12.2**	FGHIJKL	**6.00**	AB	**50.8**	AB	**148**	FGHIJK	**72.6**	AB	**170**	DEFGHI	**243**	ABC	**1.48**	CDEFGH	**8.6**	BC	**49**

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

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

2009 MISSISSIPPI VALLEY REGIONAL SPRING BARLEY NURSERY - CROOKSTON, MN

Table 4

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5392	Morex	6	36.5	96.1	33	78.3	1.7	1	13.9	5.19	39.5	163	60.7	218	276	1.51	6.8	41	31
5393	Robust	6	38.9	97.2	28	78.7	1.6	1	13.0	5.12	40.3	152	45.6	388	241	1.53	5.5	43	30
5394	Legacy	6	38.1	97.5	32	79.0	2.2	1	13.7	5.91	44.7	164	69.0	303	295	1.52	6.2	49	25
5395	Lacey	6	40.8	98.7	29	79.2	1.7	1	12.8	5.13	41.3	174	62.1	169	241	1.48	7.8	52	18
5396	Conlon	2	50.0	99.5	30	81.7	n.d.	3	12.1	4.72	40.4	128	59.6	239	234	1.60	*46	56	12
5397	Tradition	6	37.6	98.7	33	79.6	1.7	1	13.1	4.95	39.2	188	58.8	195	242	1.55	11.4	49	25
5398	ND20448	6	39.6	99.1	*41	80.1	1.8	1	11.9	5.09	44.8	181	67.5	69	269	1.49	6.6	61	4
5399	Pinnacle	2	46.6	98.3	28	80.9	2.0	1	11.2	5.07	46.0	91	52.7	212	213	1.51	10.2	48	27
5400	ND22421	6	39.9	98.5	35	80.2	1.9	1	11.5	5.14	45.0	148	62.8	139	197	1.54	9.7	57	9
5401	M137	6	38.2	98.8	32	79.4	1.7	1	12.2	5.56	45.5	200	65.5	130	210	1.48	6.2	61	4
5402	ND23497	6	38.5	99.4	33	79.2	1.9	1	12.6	5.66	46.7	174	59.3	194	222	1.56	9.7	58	8
5403	2ND24263	2	44.0	97.5	28	81.3	2.1	1	12.5	5.63	45.5	146	67.9	351	215	1.63	13.9	54	17
5404	2ND24388	2	48.4	98.7	28	78.9	1.6	1	11.9	4.81	42.2	169	61.9	177	218	1.55	8.3	52	18
5405	6B04-0007	6	36.7	97.6	34	83.0	2.4	2	12.6	4.66	38.4	136	59.3	123	169	1.50	*32	45	29
5406	SR424	6	34.7	*93.5	28	80.0	1.9	1	10.7	4.86	46.1	141	69.6	116	213	1.49	6.3	56	12
5407	SR425	6	36.6	96.4	37	80.0	1.9	1	11.4	5.15	47.6	161	69.8	81	214	1.46	6.1	51	21
5408	M135	6	38.8	98.5	32	79.6	2.1	1	12.4	5.53	45.7	164	76.0	104	266	1.47	8.1	65	1
5409	M138	6	37.1	96.0	32	79.0	1.7	1	12.6	5.30	43.9	162	64.1	222	221	1.52	8.6	55	16
5410	M139	6	36.4	*91.8	32	78.6	1.7	1	13.3	5.27	41.8	144	61.9	183	208	1.49	8.4	50	23
5411	M140	6	39.0	96.6	29	78.3	1.6	1	13.1	5.26	40.5	160	59.7	280	190	1.49	6.5	50	23
5412	M141	6	38.5	98.4	33	78.6	1.7	1	13.6	5.77	43.9	174	68.1	214	238	1.53	7.8	46	28
5413	ND24906	6	36.4	98.2	32	79.0	1.9	1	12.3	5.44	44.9	182	65.1	73	252	1.49	9.9	62	3
5414	ND25160	6	38.2	98.4	26	80.0	2.0	1	10.7	4.66	44.2	109	59.4	284	179	1.57	14.9	39	32
5415	ND25161	6	37.0	97.5	30	80.0	2.1	1	10.9	4.79	47.0	112	61.9	300	177	1.61	15.7	34	33
5416	2ND25272	2	44.7	97.5	33	81.2	1.9	2	11.3	4.52	41.2	105	65.3	136	163	1.56	12.9	57	9
5418	2ND25276	2	43.1	97.9	26	82.3	2.0	2	10.8	4.76	44.2	107	74.3	93	179	1.52	10.6	56	12
5419	6B03-4304	6	38.1	98.2	31	79.3	1.8	1	13.2	5.49	43.7	159	65.8	148	217	1.55	10	61	4
5420	6B05-0572	6	37.5	98.6	31	80.0	2.0	2	12.1	5.10	44.3	172	66.3	114	217	1.56	12.7	60	7
5421	6B05-0716	6	38.7	98.6	30	80.5	1.8	1	12.1	5.12	42.5	194	64.1	138	196	1.52	10.1	57	9
5422	6B05-0717	6	39.2	99.1	29	79.8	2.3	2	13.0	5.75	47.8	160	68.1	145	232	1.55	15.3	51	21

Table 4

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5423	6B05-0881	6	38.9	98.1	31	79.9	1.9	1	12.5	5.31	43.5	202	67.0	108	207	1.51	8.4	65	1
5424	SR429	6	40.1	98.3	30	79.4	2.5	1	12.3	5.71	48.9	145	71.3	101	244	1.47	10.2	56	12
5425	SR432	6	39.7	98.3	28	79.8	2.3	1	12.3	5.96	50.7	157	80.7	141	245	1.44	6.7	52	18
5386	LACEY MALT CHECK	6	35.9	95.2	51	79.5	2.0	1	12.8	5.64	47.4	155	61.5	83	202	1.47	10.3	60	
5417	HARRINGTON MALT CHECK	2	34.6	86.2	80	79.1	1.7	2	12.5	5.34	44.2	110	63.7	88	215	1.45	7.6	48	
Minima			34.7	96.0	26	78.3	1.6		10.7	4.52	38.4	91	45.6	69	163	1.44	5.5	34	
Maxima			50.0	99.5	37	83.0	2.5		13.9	5.96	50.7	202	80.7	388	295	1.63	15.7	65	
Means			39.6	98.1	31	79.8	1.9		12.3	5.22	44.0	155	64.6	178	221	1.52	9.4	53	
Standard Deviations			3.5	0.9	3	1.1	0.2		0.9	0.39	2.9	28	6.5	82	31	0.04	2.9	7	
Coefficients of Variation			9.0	0.9	8	1.4	12.4		7.0	7.41	6.6	18	10.1	46	14	2.88	30.9	14	

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

2009 MISSISSIPPI VALLEY REGIONAL SPRING BARLEY NURSERY - BOTTINEAU, ND

Table 5

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5256	Morex	6	40.5	99.2	40	79.2	1.6	1	13.0	5.50	44.8	178	60.9	98	232	1.47	5	65	1
5258	Robust	6	41.5	99.7	35	79.5	1.5	1	13.1	5.50	43.1	174	50.6	139	214	1.47	4.3	61	10
5259	Legacy	6	39.7	99.6	41	79.9	2.3	1	12.9	6.19	50.3	169	72.2	69	260	1.45	4.6	53	32
5260	Lacey	6	41.6	99.9	41	80.6	1.6	1	11.8	5.26	46.0	155	63.8	56	214	1.44	5.6	65	1
5261	Conlon	2	50.7	99.8	37	81.5	1.3	1	12.0	4.59	40.6	134	56.9	*204	174	1.48	5	58	17
5262	Tradition	6	40.2	99.8	42	79.9	1.5	1	12.2	4.95	41.5	197	61.7	83	203	1.48	8.3	56	20
5263	ND20448	6	40.9	99.5	48	79.8	1.8	1	12.3	5.75	48.3	142	65.7	69	236	1.48	6.6	56	20
5264	Pinnacle	2	50.7	99.7	37	82.0	1.6	2	10.6	4.49	45.2	101	49.8	146	165	1.50	12.4	49	34
5265	ND22421	6	40.9	99.4	41	79.4	1.7	1	11.7	4.92	43.5	145	60.7	76	193	1.48	10.2	61	10
5266	M137	6	39.7	99.3	44	79.1	1.6	1	13.0	5.72	47.2	193	63.0	75	220	1.44	5.3	56	20
5267	ND23497	6	40.4	99.5	46	79.0	1.7	1	12.6	5.72	47.0	203	60.9	73	221	1.47	5.1	56	20
5268	2ND24263	2	46.0	99.9	35	81.0	1.6	1	12.4	5.17	42.6	162	66.5	*304	187	*1.54	3.7	55	30
5269	2ND24388	2	48.9	99.7	32	82.1	2.2	2	11.6	4.54	40.0	143	58.8	143	172	1.49	*25	60	12
5270	6B04-0007	6	40.8	99.1	42	79.4	1.7	1	12.3	4.86	41.4	206	65.5	76	197	1.48	9.5	56	20
5271	SR424	6	40.6	99.3	36	79.7	2.3	1	11.9	5.26	46.1	157	67.1	76	234	1.47	9.9	65	1
5272	SR425	6	39.4	98.9	43	80.6	2.1	1	12.1	5.68	48.4	160	69.6	45	244	1.44	8.3	60	12
5273	M135	6	41.2	99.3	42	79.0	2.1	1	12.9	5.76	45.3	192	67.2	72	251	1.45	8.4	58	17
5274	M138	6	39.0	98.4	38	78.9	1.7	1	13.5	5.67	44.2	178	67.5	135	244	1.46	6.0	58	17
5275	M139	6	38.6	98.4	35	78.9	1.7	1	13.4	5.58	43.1	176	72.7	106	259	1.46	6.2	62	9
5276	M140	6	41.5	99.0	37	79.2	1.7	1	12.4	5.33	44.6	174	64.1	111	231	1.45	7.2	65	1
5277	M141	6	41.1	98.9	41	79.1	1.7	1	13.6	5.86	45.0	212	73.1	85	230	1.45	5.6	56	20
5278	ND24906	6	37.9	98.7	46	78.2	1.9	1	12.7	5.85	48.9	227	73.4	48	231	1.45	7.0	53	32
5279	ND25160	6	39.7	99.6	40	79.9	1.6	1	11.2	4.90	46.3	165	69.2	58	223	1.45	4.8	56	20
5280	ND25161	6	40.0	98.9	42	80.7	1.6	1	11.0	4.96	46.6	164	70.4	89	228	1.48	5.9	56	20
5281	2ND25272	2	49.0	99.6	36	81.5	1.5	1	10.8	4.53	44.6	149	73.4	84	166	1.46	5.4	60	12
5282	2ND25276	2	48.6	99.6	35	81.3	1.8	1	11.1	5.11	47.9	161	77.4	60	198	1.43	5.8	60	12
5283	6B03-4304	6	40.4	99.4	40	79.9	1.6	1	12.4	5.38	45.5	195	77.2	50	246	1.47	5.4	65	1
5284	6B05-0572	6	40.5	99.3	43	80.0	1.6	1	11.6	5.28	46.6	217	77.4	52	266	1.44	4.5	65	1
5285	6B05-0716	6	40.9	99.3	42	80.0	1.6	1	12.1	5.25	45.4	211	68.7	73	216	1.47	8.1	65	1
5286	6B05-0717	6	40.7	99.5	40	80.2	1.9	1	11.9	5.60	47.7	170	72.8	62	252	1.45	7.3	60	12

Table 5

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5288	6B05-0881	6	40.2	99.7	42	79.9	1.7	1	12.4	5.73	47.5	232	77.2	55	236	1.47	5.3	56	20
5290	SR429	6	43.9	99.6	40	80.6	2.3	1	11.5	5.62	51.0	146	76.9	54	283	1.46	7.0	55	30
5291	SR432	6	41.7	99.6	37	80.4	2.4	1	12.1	5.97	50.5	151	73.5	67	247	1.46	7.2	56	20
5292	SR420	6	41.4	99.3	40	80.0	2.1	1	12.2	5.42	45.9	141	65.5	103	223	1.48	8.1	65	1
5255	LACEY MALT CHECK	6	35.9	95.6	51	79.7	1.9	1	12.8	5.49	44.5	152	63.7	61	213	1.45	9.6	65	
5257	HARRINGTON MALT CHECK	2	35.8	88.7	79	79.1	1.7	1	12.7	5.35	43.1	109	62.4	91	212	1.47	8.8	49	
5287	LACEY MALT CHECK	6	35.9	95.0	51	79.6	1.7	1	12.6	5.54	45.0	169	67.9	60	208	1.46	8.8	65	
5289	HARRINGTON MALT CHECK	2	35.3	88.6	80	79.0	1.7	1	13.2	5.41	43.4	125	71.7	86	244	1.47	7.5	47	
Minima			37.9	98.4	32	78.2	1.3		10.6	4.49	40.0	101	49.8	45	165	1.43	3.7	49	
Maxima			50.7	99.9	48	82.1	2.4		13.6	6.19	51.0	232	77.4	146	283	1.50	12.4	65	
Means			42.0	99.4	40	80.0	1.8		12.2	5.35	45.7	173	67.4	81	223	1.46	6.6	59	
Standard Deviations			3.5	0.4	4	0.9	0.3		0.8	0.44	2.7	29	7.2	28	29	0.02	2.0	4	
Coefficients of Variation			8.3	0.4	9	1.2	15.4		6.3	8.31	6.0	17	10.7	35	13	1.13	29.6	7	

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 C. Sellmer, Busch Ag Resources, LLC - Fort Collins, CO

2009 MISSISSIPPI VALLEY REGIONAL SPRING BARLEY NURSERY - FARGO, ND
Table 6

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5184	Morex	6	36.9	95.0	34	79.6	2.1	1	13.6	5.79	43.5	160	67.0	207	227	1.51	8	49	13
5185	Robust	6	37.2	95.9	31	80.2	1.8	1	12.9	5.91	46.5	147	55.6	237	218	1.50	5.7	54	8
5186	Legacy	6	35.7	96.3	34	80.3	3.4	2	13.3	6.43	48.8	133	63.6	251	247	1.53	17.1	42	23
5187	Lacey	6	38.4	96.3	31	79.9	n.d.	3	13.0	5.63	44.3	149	67.4	146	211	1.48	10.5	59	1
5188	Conlon	2	46.2	96.5	34	81.0	1.7	1	12.7	5.03	41.8	119	67.9	*461	176	1.53	7.9	52	10
5189	Tradition	6	37.8	97.5	37	80.1	1.7	2	13.3	5.70	43.8	181	69.6	231	217	1.54	10	57	6
5191	ND20448	6	38.3	95.8	34	80.3	1.9	1	12.9	5.88	48.0	133	68.9	241	223	1.52	8.2	46	17
5193	Pinnacle	2	46.2	96.0	31	81.7	2.1	1	11.6	5.08	46.8	95	58.7	338	190	1.55	13.1	51	12
5194	ND22421	6	39.6	97.4	30	80.3	2.2	1	12.7	6.04	50.2	110	65.8	294	229	1.52	12.4	39	31
5195	M137	6	35.9	95.9	35	79.2	2.0	1	14.1	6.45	46.5	181	69.9	208	240	1.51	9.8	41	24
5196	ND23497	6	37.5	96.5	34	79.9	1.7	1	14.3	6.07	45.6	184	64.9	222	225	1.50	7.8	41	24
5197	2ND24263	2	40.6	96.3	33	81.1	2.0	1	13.3	5.67	44.4	156	76.0	*570	204	1.58	6	48	15
5198	2ND24388	2	43.5	94.1	32	82.1	2.2	1	12.5	5.19	43.1	145	73.9	277	186	1.52	12.7	58	2
5199	6B04-0007	6	37.0	95.8	36	79.5	1.9	1	12.2	5.34	45.0	166	70.4	185	207	1.52	8.7	58	2
5200	SR424	6	36.2	95.4	33	80.3	n.d.	3	11.9	5.73	48.5	119	63.6	185	236	1.56	22	40	28
5201	SR425	6	36.3	93.8	36	80.9	2.5	1	12.2	5.63	46.9	127	61.3	128	219	1.47	10.8	58	2
5202	M135	6	38.0	96.0	31	78.4	2.5	1	13.8	5.95	44.7	153	65.1	251	238	1.50	11.8	46	17
5203	M138	6	37.1	93.6	30	79.1	2.0	1	14.1	6.02	45.4	158	76.5	304	233	1.52	8.7	41	24
5204	M139	6	35.5	92.5	31	79.1	1.8	2	13.8	5.75	43.6	145	69.9	278	217	1.50	7.1	48	15
5205	M140	6	37.8	94.0	31	78.8	2.2	2	13.9	5.79	42.4	157	68.7	315	209	1.50	9.1	45	19
5206	M141	6	37.1	95.4	31	78.4	2.9	2	14.7	6.23	43.3	207	78.6	195	238	1.52	12.3	37	32
5207	ND24906	6	36.3	96.5	35	78.7	2.2	2	13.6	6.23	48.2	201	73.6	145	242	1.52	10.6	40	28
5208	ND25160	6	36.9	96.0	33	81.1	2.2	2	10.5	5.04	52.0	134	74.6	224	191	1.54	11.4	40	28
5209	ND25161	6	37.5	96.1	33	81.3	1.8	1	10.7	5.07	51.2	133	72.9	283	190	1.52	9.8	41	24
5210	2ND25272	2	43.9	93.7	32	81.6	1.9	1	11.3	4.80	43.9	125	78.8	319	169	1.53	6.4	58	2
5211	2ND25276	2	43.0	96.2	32	81.8	2.2	1	11.3	5.07	46.9	116	75.0	211	182	1.50	8.4	55	7
5212	6B03-4304	6	37.4	97.0	32	79.5	2.2	1	13.5	5.88	46.2	184	75.9	149	229	1.53	9.8	52	10
5213	6B05-0572	6	37.4	96.8	32	80.1	2.1	1	13.2	5.88	46.1	184	77.4	196	238	1.55	12.9	54	8
5214	6B05-0716	6	36.9	96.1	33	80.2	1.9	1	13.6	5.77	44.9	207	71.3	197	218	1.53	10.3	49	13
5215	6B05-0717	6	35.8	97.4	29	80.3	2.6	2	12.9	6.24	48.9	169	71.0	215	247	1.59	*25	45	19

Table 6

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5216	6B05-0881	6	37.5	97.6	35	80.1	2.5	2	13.2	6.11	48.9	187	75.8	174	233	1.54	11.9	45	19
5217	SR429	6	39.4	96.2	34	80.5	3.0	1	12.5	6.37	51.3	130	61.5	210	242	1.55	11.6	43	22
5218	SR432	6	39.0	97.7	31	78.0	3.0	1	13.5	6.46	49.1	140	64.2	304	243	1.55	15.9	35	33
5190	HARRINGTON MALT CHECK	2	34.4	87.4	79	79.4	1.9	2	13.1	5.41	42.2	113	66.0	119	205	1.47	8.1	42	
5192	LACEY MALT CHECK	6	37.3	94.7	50	80.0	n.d.	3	12.9	5.68	46.2	153	64.4	90	207	1.45	11.1	63	
Minima			35.5	92.5	29	78.0	1.7		10.5	4.80	41.8	95	55.6	128	169	1.47	5.7	35	
Maxima			46.2	97.7	37	82.1	3.4		14.7	6.46	52.0	207	78.8	338	247	1.59	22.0	59	
Means			38.5	95.9	33	80.1	2.2		12.9	5.77	46.4	153	69.5	230	218	1.53	10.6	47	
Standard Deviations			2.9	1.3	2	1.0	0.4		1.0	0.46	2.7	29	5.9	56	22	0.03	3.3	7	
Coefficients of Variation			7.5	1.3	6	1.3	19.3		7.9	8.02	5.8	19	8.5	24	10	1.70	31.6	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 R. Horsley, North Dakota State University - Fargo

2009 MISSISSIPPI VALLEY REGIONAL SPRING BARLEY NURSERY - SIDNEY, MT

Table 7

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5219	Morex	6	33.4	88.8	49	79.6	1.7	1	12.7	5.27	43.2	184	67.0	139	218	1.47	5.1	61	2
5220	Robust	6	34.3	90.7	49	80.3	1.8	1	12.7	5.33	44.0	184	53.3	210	209	1.48	5.8	58	12
5221	Legacy	6	33.3	93.2	53	80.7	1.9	1	12.1	5.81	49.8	199	86.0	225	237	1.48	4.6	49	29
5223	Lacey	6	35.7	94.2	50	80.9	1.9	1	11.6	5.27	47.5	170	63.1	107	207	1.46	6.8	60	7
5225	Conlon	2	43.6	97.7	44	81.1	1.7	1	12.7	4.76	38.6	148	61.8	228	181	1.46	5.3	53	20
5226	Tradition	6	36.6	98.2	53	80.3	1.7	1	12.4	5.17	42.0	207	66.8	201	207	1.52	6.8	54	18
5227	ND20448	6	35.8	96.3	52	80.3	1.9	1	12.6	5.58	44.7	177	66.9	158	222	1.51	6.4	61	2
5228	Pinnacle	2	44.9	97.8	*38	82.7	2.0	1	10.7	4.63	44.8	134	53.0	292	170	1.55	*13.4	53	20
5229	ND22421	6	36.5	96.1	53	80.0	1.8	1	11.8	5.03	44.4	168	62.5	152	194	1.50	7.9	57	15
5230	M137	6	35.5	97.5	52	80.3	1.8	1	12.8	5.76	46.9	223	64.1	122	228	1.46	5.5	57	15
5231	ND23497	6	36.6	97.9	55	80.1	1.6	1	12.9	5.65	44.0	248	58.6	122	249	1.50	6.6	61	2
5232	2ND24263	2	41.2	98.2	48	81.7	1.5	1	12.1	5.21	43.4	182	68.6	277	221	1.49	4.1	57	15
5233	2ND24388	2	45.8	98.5	50	82.5	n.d.	3	11.1	4.67	42.3	147	56.4	122	197	1.46	*32	59	11
5234	6B04-0007	6	37.3	97.8	56	80.5	1.5	1	11.7	4.77	42.7	198	64.3	158	216	1.50	7.1	54	18
5235	SR424	6	35.2	94.3	49	80.3	1.9	1	11.5	5.24	49.4	187	82.1	154	259	1.46	7.9	51	27
5236	SR425	6	32.9	86.9	50	81.1	1.8	1	11.9	5.60	49.0	188	77.2	89	260	1.43	6.9	60	7
5237	M135	6	35.7	95.1	53	80.7	1.8	1	11.8	5.40	47.0	196	77.9	86	257	1.43	6.4	65	1
5238	M138	6	33.8	84.2	51	79.5	1.7	1	12.5	5.51	45.1	158	64.3	303	239	1.48	6	58	12
5239	M139	6	33.1	85.8	50	79.8	1.7	1	12.2	5.26	44.6	144	61.0	206	218	1.47	6	58	12
5240	M140	6	35.0	92.3	52	79.9	1.6	1	12.2	5.50	48.0	163	59.0	242	211	1.47	6.5	53	20
5241	M141	6	35.6	91.6	55	79.7	1.6	1	12.2	5.52	48.0	171	63.1	185	221	1.48	4.8	53	20
5242	ND24906	6	34.4	96.7	55	80.1	1.9	1	12.3	5.63	49.0	184	61.0	100	228	1.49	5.2	60	7
5243	ND25160	6	37.2	97.4	52	81.2	2.1	1	10.3	4.97	53.1	126	59.3	237	189	1.53	*11.1	41	34
5244	ND25161	6	37.0	96.8	50	81.3	2.1	1	10.6	5.21	52.1	127	57.6	*407	207	1.57	9.3	45	33
5245	2ND25272	2	42.7	96.6	48	81.9	1.7	1	10.9	4.89	47.9	123	65.7	156	181	1.48	4.8	48	31
5246	2ND25276	2	43.4	97.1	48	82.4	2.0	1	11.2	5.26	50.5	128	74.6	150	212	1.48	4.9	53	20
5247	6B03-4304	6	34.8	94.9	51	80.1	1.7	1	12.2	5.49	47.3	174	65.7	184	220	1.52	4.7	53	20
5248	6B05-0572	6	35.2	95.0	47	80.4	1.7	1	12.8	5.48	46.2	198	67.7	136	225	1.49	4	61	2
5249	6B05-0716	6	34.7	94.1	52	81.0	1.7	1	12.1	5.34	44.9	193	61.6	167	226	1.51	6.4	61	2
5250	6B05-0717	6	34.6	96.3	48	81.1	1.9	1	11.8	5.63	50.1	175	67.1	94	229	1.48	5.8	60	7

Table 7

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5251	6B05-0881	6	34.8	95.3	47	80.5	1.9	1	12.8	5.78	48.8	202	69.4	130	259	1.50	4.4	52	26
5252	SR429	6	35.1	93.8	46	80.7	2.3	1	11.6	6.01	53.7	154	76.5	122	250	1.46	4.8	49	29
5253	SR432	6	36.7	95.6	50	81.2	2.1	1	10.8	5.60	52.7	142	71.8	166	238	1.49	4.7	51	27
5254	SR420	6	35.1	92.1	50	81.1	2.3	1	12.0	5.89	52.2	131	71.3	207	239	1.47	4.2	46	32
5222	LACEY MALT CHECK	6	35.3	96.1	50	77.0	1.9	1	12.6	5.21	42.4	163	64.8	85	189	1.45	9.5	55	
5224	HARRINGTON MALT CHECK	2	36.3	89.5	80	79.0	1.7	1	12.9	5.28	41.8	116	66.1	113	198	1.48	8.4	45	
Minima			32.9	84.2	44	79.5	1.5		10.3	4.63	38.6	123	53.0	86	170	1.43	4.0	41	
Maxima			45.8	98.5	56	82.7	2.3		12.9	6.01	53.7	248	86.0	303	260	1.57	9.3	65	
Means			36.7	94.6	51	80.7	1.8		11.9	5.36	47.0	172	66.1	171	221	1.49	5.8	55	
Standard Deviations			3.5	3.7	3	0.8	0.2		0.7	0.35	3.6	30	7.7	58	23	0.03	1.3	6	
Coefficients of Variation			9.5	3.9	6	1.0	11.1		5.9	6.58	7.7	18	11.7	34	11	2.01	21.8	10	

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 C. Sellmer, Busch Ag Resources, LLC - Fort Collins, CO

2009 MISSISSIPPI VALLEY REGIONAL SPRING BARLEY NURSERY - ABERDEEN, ID

Table 8

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5000	Morex	6	32.9	92.8	64	81.2	1.6	1	11.3	4.68	44.6	162	57.4	103	183	1.48	8.8	53	12
5001	Robust	6	36.2	95.9	70	81.9	1.9	1	10.9	5.02	49.8	151	50.6	163	193	1.48	7.3	47	25
5002	Legacy	6	37.6	88.9	64	81.5	1.8	1	13.4	5.36	43.2	192	53.9	175	194	1.50	11.5	58	6
5003	Lacey	6	39.8	96.2	60	81.6	1.8	1	11.4	5.35	51.0	158	74.9	149	202	1.48	7.1	51	19
5004	Conlon	2	43.8	98.3	60	81.4	1.7	1	10.5	4.58	46.3	122	53.7	201	168	1.48	10.3	53	12
5005	Tradition	6	40.4	95.8	56	79.1	1.8	2	12.5	4.52	38.4	124	39.1	205	145	1.51	9.5	35	35
5006	ND20448	6	40.8	97.9	76	81.4	n.d.	3	11.2	5.15	48.9	122	56.8	171	194	1.56	*29	39	33
5007	Pinnacle	2	45.8	98.5	60	82.4	n.d.	3	11.1	4.85	44.9	120	48.1	222	148	1.54	18.4	53	12
5008	ND22421	6	39.0	97.8	64	80.3	2.0	2	12.8	5.61	46.4	154	57.5	164	205	1.54	12.7	60	4
5009	SR420	6	36.4	94.7	62	82.0	1.9	1	11.1	5.39	50.4	124	66.7	198	221	1.52	9.6	45	26
5010	M137	6	34.2	96.6	74	79.4	1.6	1	13.1	5.47	43.2	216	61.2	117	203	1.47	6.3	65	1
5011	ND23497	6	33.5	96.0	79	81.4	1.7	2	12.7	5.11	42.8	180	52.0	202	156	1.55	13.2	53	12
5012	2ND24263	2	40.8	99.2	66	82.2	1.5	1	11.8	4.98	43.4	163	59.6	275	151	1.51	5.8	57	7
5013	2ND24388	2	44.7	98.4	62	82.9	n.d.	3	11.3	5.04	46.4	143	54.3	234	184	1.51	*44	56	10
5014	6B04-0007	6	38.1	98.6	75	78.9	n.d.	3	13.9	5.22	38.5	207	59.3	209	192	1.53	*32	43	30
5015	SR424	6	36.1	93.3	66	80.8	1.7	1	11.6	5.26	47.9	150	73.1	104	194	1.47	6.4	60	4
5016	SR425	6	32.9	86.0	67	82.5	1.7	1	10.2	5.00	49.7	121	62.6	76	171	1.49	6.9	48	23
5017	M135	6	36.7	97.3	71	82.3	1.9	1	11.7	5.57	48.7	158	66.5	149	195	1.49	7.0	56	10
5018	M138	6	34.0	92.4	72	81.4	1.8	1	10.7	4.96	48.3	130	62.4	148	190	1.47	6.8	44	28
5019	M139	6	35.0	92.9	64	81.8	1.8	1	11.9	5.39	49.1	132	64.8	152	188	1.52	8.9	53	12
5020	M140	6	34.9	94.9	68	81.4	1.9	2	11.6	5.29	48.5	133	56.5	196	205	1.48	11.8	49	22
5021	M141	6	35.5	92.7	73	80.1	1.9	1	12.0	5.13	44.8	159	57.9	131	183	1.50	8.0	57	7
5022	ND24906	6	34.2	96.4	64	80.0	1.8	1	12.5	5.52	44.1	186	60.3	111	178	1.54	11.0	65	1
5023	ND25160	6	33.9	96.1	71	83.1	2.2	2	9.8	4.42	47.4	116	56.1	293	136	1.55	21	33	36
5024	ND25161	6	34.7	98.0	79	81.2	1.7	1	11.4	5.10	45.7	142	58.7	168	173	1.51	8.1	52	18
5025	2ND25272	2	40.1	97.8	65	82.2	1.5	1	10.4	4.26	41.5	121	58.0	197	153	1.49	6.7	48	23
5026	2ND25276	2	39.4	97.6	69	82.3	1.7	1	10.8	4.71	46.6	119	68.3	122	162	1.49	9.2	50	21
5027	6B05-0572	6	35.0	96.8	72	81.3	1.6	1	11.8	5.01	42.8	167	60.8	141	187	1.50	7.0	57	7
5028	6B05-0716	6	39.0	92.3	58	82.2	2.0	1	11.3	5.28	48.0	142	77.1	132	190	1.48	8.8	51	19
5030	6B05-0717	6	34.7	93.6	66	79.8	2.1	2	13.1	5.60	43.5	178	61.3	112	237	1.50	10.5	64	3

Table 8

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (mPa)	Turbidity (Hach)	Quality Score	Overall Rank
5032	6B05-0881	6	34.4	96.8	69	81.6	2.3	1	11.6	5.44	49.0	148	63.4	180	210	1.50	10.3	53	12
5033	SR429	6	35.9	95.9	62	82.4	2.0	2	10.2	5.21	54.3	113	58.8	181	201	1.51	13.2	40	32
5034	SR432	6	34.8	92.7	66	81.6	2.0	1	10.8	5.57	55.3	124	71.7	171	223	1.48	6.9	45	26
5035	04Ab060-66	6	36.0	93.0	59	81.0	1.9	1	11.4	4.78	42.6	137	53.0	180	180	1.50	9.9	43	30
5036	04Ab034-62	6	36.2	96.2	66	80.1	n.d.	3	10.1	4.48	47.7	104	57.5	*372	172	1.57	*53	32	39
5037	04Ab041-79	6	32.3	85.1	64	80.9	n.d.	3	10.3	4.76	49.7	135	47.9	264	167	1.56	*43	33	36
5038	01AB7833	6	37.0	92.3	62	83.3	*3.2	2	8.6	4.41	56.0	66	63.8	221	175	1.51	11.9	33	36
5039	01AB7841	6	35.7	96.0	71	79.9	2.1	1	10.5	4.98	51.0	90	58.8	170	196	1.49	6.4	37	34
5040	04Ab023-11	6	36.3	90.0	58	81.2	2.3	1	11.2	4.89	47.3	141	56.5	223	184	1.51	10.8	44	28
5029	HARRINGTON MALT CHECK	2	35.7	88.5	79	79.1	1.6	1	12.9	5.27	41.9	127	62.6	81	210	1.47	6.9	52	
5031	LACEY MALT CHECK	6	35.9	95.0	55	79.4	1.6	1	13.1	5.10	42.3	172	60.0	73	173	1.45	8.9	61	
Minima			32.3	85.1	56	78.9	1.5		8.6	4.26	38.4	66	39.1	76	136	1.47	5.8	32	
Maxima			45.8	99.2	79	83.3	2.3		13.9	5.61	56.0	216	77.1	293	237	1.57	21.0	65	
Means			36.9	94.9	67	81.3	1.8		11.4	5.06	46.9	142	59.5	174	184	1.51	9.6	49	
Standard Deviations			3.2	3.3	6	1.1	0.2		1.1	0.37	4.0	30	7.5	49	22	0.03	3.3	9	
Coefficients of Variation			8.8	3.5	9	1.3	11.2		9.4	7.25	8.5	21	12.6	28	12	1.83	34.7	19	

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

MISSISSIPPI VALLEY UNIFORM REGIONAL BARLEY NURSERY - 2009 Crop

Table 9 - Station Means* of Barley and Malt Quality Factors for 34 Varieties or Selections.**

LOCATION	Kernel Weight (mg)		on 6/64" (%)		Barley Color (Agtron)		Malt Extract (%)		Wort Color		Barley Protein (%)		Wort Protein (%)		S/T (%)		DP (°ASBC)		Alpha-amylase (20°DU)		Beta-glucan (ppm)		FAN (ppm)		Viscosity (Relative)		Turbidity (HACH)		Quality Score	
Aberdeen, ID	**37.1**	D	**95.4**	CD	**67**	A	**81.4**	A	**1.8**	BC	**11.6**	D	**5.12**	D	**46.5**	AB	**148**	B	**60.1**	D	**168**	B	**185**	B	**1.50**	B	**11.9**	A	**51**	
Crookston, MN	**39.6**	B	**97.7**	B	**31**	E	**79.8**	C	**1.9**	B	**12.3**	B	**5.22**	C	**44.0**	C	**155**	B	**64.6**	C	**178**	B	**221**	A	**1.52**	A	**11.2**	A	**53**	
Bottineau, ND	**42.0**	A	**99.4**	A	**40**	C	**80.0**	C	**1.8**	C	**12.2**	BC	**5.35**	B	**45.7**	B	**173**	A	**67.4**	AB	**91**	C	**223**	A	**1.47**	D	**7.2**	B	**59**	
Fargo, ND	**38.5**	C	**95.9**	C	**33**	D	**80.1**	C	**2.3**	A	**12.9**	A	**5.77**	A	**46.4**	AB	**153**	B	**69.5**	A	**247**	A	**218**	A	**1.53**	A	**11.0**	A	**47**	
Sidney, MT	**36.7**	D	**94.6**	D	**50**	B	**80.7**	B	**1.8**	BC	**11.9**	C	**5.36**	B	**47.0**	A	**172**	A	**66.1**	BC	**177**	B	**221**	A	**1.49**	C	**6.9**	B	**55**	

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

** Morex, Robust, Legacy, Lacey, Conlon, Tradition, ND20448, Pinnacle, ND22421, SR420, M137, ND23497, 2ND24263, 2ND24388, 6B04-0007, SR424, SR425, M135, M138, M139, M140, M141, ND24906, ND25160, ND25161, 2ND25272, 2ND25276, 6B03-4304, 6B05-0572, 6B05-0716, 6B05-0717, 6B05-0881, SR429, SR432

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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 (%)		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
2ND24263	**42.5**	B	**98.2**	AB	**42**	FGH	**81.5**	ABCD	**1.7**	FG	**12.4**	ABCDEFGHJ	**5.33**	FGH	**43.9**	GHIJK	**162**	EFGHIJ	**67.7**	ABCDEF	**355**	A	**196**	DEFG	**1.55**	A	**6.7**	CD	**54**
ND25161	**37.3**	DEFGHIJKL	**97.5**	ABCD	**47**	ABCDEF	**80.9**	BCDEFG	**1.9**	DEFG	**10.9**	LM	**5.03**	IJK	**48.5**	BCD	**136**	JKLM	**64.3**	BCDEFG	**249**	BC	**195**	DEFG	**1.54**	AB	**9.8**	CD	**46**
Pinnacle	**46.8**	A	**98.1**	AB	**39**	H	**81.9**	AB	**2.0**	BCDEFG	**11.0**	LM	**4.82**	JKL	**45.5**	CDEFGHI	**108**	N	**52.5**	HI	**242**	BC	**177**	GH	**1.53**	ABC	**13.5**	BCD	**51**
ND25160	**37.2**	EFGHIJKL	**97.5**	ABCD	**44**	DEFG	**81.0**	ABCDEF	**2.0**	ABCDEFG	**10.5**	M	**4.80**	JKL	**48.6**	BC	**130**	LMN	**63.7**	CDEFG	**219**	BCDEF	**184**	FGH	**1.53**	ABC	**12.6**	BCD	**42**
Tradition	**38.5**	CDEFG	**98.0**	ABC	**44**	DEFG	**79.8**	HIJKL	**1.7**	G	**12.7**	ABCDEF	**5.06**	HIJ	**41.0**	K	**179**	ABCDEF	**59.2**	GH	**183**	CDEFGH	**203**	DEFG	**1.52**	ABCD	**9.2**	CD	**50**
ND23497	**37.3**	DEFGHIJKL	**97.9**	ABCD	**49**	ABC	**79.9**	GHIJKL	**1.7**	FG	**13.0**	ABCD	**5.64**	ABCDEF	**45.2**	CDEFGHI	**198**	AB	**59.1**	GH	**163**	DEFGHI	**215**	BCDE	**1.52**	ABCDE	**8.5**	CD	**54**
6B05-0717	**37.0**	FGHIJKL	**97.2**	ABCD	**42**	EFGH	**80.2**	FGHIJKL	**2.2**	ABCDEF	**12.5**	ABCDEFGH	**5.76**	AB	**47.6**	BCDEF	**171**	CDEFGH	**68.1**	ABCDEF	**125**	HIJ	**239**	AB	**1.52**	ABCDE	**12.8**	BCD	**56**
ND22421	**39.2**	CD	**97.8**	ABCD	**45**	CDEFG	**80.0**	FGHIJKL	**1.9**	BCDEFG	**12.1**	DEFGHIJK	**5.35**	FGH	**45.9**	CDEFGHI	**145**	HIJKLM	**61.9**	DEFG	**165**	DEFGHI	**203**	CDEFG	**1.52**	ABCDE	**10.6**	BCD	**55**
6B03-4304	**37.7**	CDEFGHIJ	**97.4**	ABCD	**39**	H	**79.7**	IJKL	**1.8**	EFG	**12.8**	ABCDE	**5.56**	BCDEFG	**45.7**	CDEFGHI	**178**	ABCDEF	**71.1**	ABC	**133**	GHIJ	**228**	ABC	**1.51**	ABCDE	**7.5**	CD	**58**
ND20448	**39.1**	CDE	**97.7**	ABCD	**50**	AB	**80.4**	EFGHIJ	**2.0**	ABCDEFG	**12.2**	CDEFGHIJK	**5.49**	BCDEFG	**46.9**	BCDEFG	**151**	GHIJKLM	**65.2**	BCDEFG	**142**	GHIJ	**229**	ABC	**1.51**	BCDE	**11.4**	BCD	**53**
Conlon	**46.9**	A	**98.4**	A	**41**	GH	**81.3**	ABCDE	**1.8**	EFG	**12.0**	EFGHIJK	**4.74**	KL	**41.5**	JK	**130**	LMN	**60.0**	FG	**266**	B	**186**	FGH	**1.51**	BCDEF	**14.9**	BC	**54**
6B05-0572	**37.1**	FGHIJKL	**97.3**	ABCD	**45**	CDEFG	**80.4**	EFGHIJ	**1.8**	EFG	**12.3**	BCDEFGHIJK	**5.35**	FGH	**45.2**	DEFGHI	**188**	ABCD	**69.9**	ABCD	**128**	HIJ	**227**	ABC	**1.51**	BCDEF	**8.2**	CD	**59**
2ND24388	**46.3**	A	**97.9**	ABCD	**41**	GH	**81.7**	ABC	**2.2**	ABCDE	**11.7**	HIJKL	**4.85**	JKL	**42.8**	IJK	**149**	GHIJKLM	**61.0**	EFG	**191**	CDEFGH	**191**	EFGH	**1.51**	BCDEFG	**24.4**	A	**57**
6B04-0007	**38.0**	CDEFGHI	**97.8**	ABCD	**49**	ABCD	**80.3**	FGHIJK	**1.9**	BCDEFG	**12.5**	ABCDEFGH	**4.97**	JK	**41.2**	K	**182**	ABCDEF	**63.8**	CDEFG	**150**	FGHIJ	**196**	DEFG	**1.51**	BCDEFGH	**17.9**	AB	**51**
6B05-0881	**37.2**	FGHIJKL	**97.5**	ABCD	**45**	CDEFG	**80.4**	EFGHIJ	**2.0**	ABCDEFG	**12.5**	ABCDEFGH	**5.68**	ABCDE	**47.5**	BCDEF	**194**	ABCD	**70.5**	ABC	**129**	HIJ	**229**	ABC	**1.50**	BCDEFGH	**8.1**	CD	**54**
6B05-0716	**38.0**	CDEFGHI	**96.1**	ABCDE	**43**	EFGH	**80.8**	CDEFGH	**1.8**	EFG	**12.2**	BCDEFGHIJK	**5.35**	FGH	**45.1**	EFGHI	**189**	ABCD	**68.5**	ABCDE	**141**	GHIJ	**209**	CDEF	**1.50**	BCDEFGH	**8.7**	CD	**57**
2ND25272	**44.1**	B	**97.0**	ABCDE	**43**	EFGH	**81.7**	ABC	**1.7**	G	**11.0**	LM	**4.60**	L	**43.8**	GHIJK	**125**	MN	**68.2**	ABCDEF	**178**	CDEFGH	**167**	H	**1.50**	BCDEFGH	**7.2**	CD	**54**
ND24906	**35.8**	JKL	**97.3**	ABCD	**46**	ABCDEF	**79.2**	KL	**1.9**	CDEFG	**12.7**	ABCDEF	**5.73**	ABC	**47.0**	BCDEFG	**196**	ABC	**66.7**	ABCDEFG	**95**	IJ	**226**	ABC	**1.50**	CDEFGH	**8.7**	CD	**56**
Legacy	**36.9**	GHIJKL	**95.1**	DEF	**45**	CDEFG	**80.3**	FGHIJ	**2.3**	ABC	**13.1**	AB	**5.94**	A	**47.3**	BCDEF	**171**	CDEFGH	**68.9**	ABCDE	**205**	BCDEFG	**246**	A	**1.49**	CDEFGHI	**8.8**	CD	**50**
M141	**37.5**	CDEFGHIJKL	**95.4**	BCDEF	**47**	ABCDEF	**79.2**	L	**2.0**	BCDEFG	**13.2**	A	**5.70**	ABCD	**45.0**	EFGHI	**185**	ABCDE	**68.2**	ABCDEF	**162**	DEFGHI	**222**	ABCD	**1.49**	CDEFGHI	**7.7**	CD	**50**
SR420	**37.6**	CDEFGHIJK	**95.4**	BCDEF	**51**	A	**81.1**	ABCDEF	**2.1**	ABCDEFG	**11.8**	GHIJKL	**5.57**	BCDEFG	**49.5**	AB	**132**	KLMN	**67.8**	ABCDEF	**169**	DEFGH	**228**	ABC	**1.49**	CDEFGHI	**7.3**	CD	**52**
Robust	**37.6**	CDEFGHIJK	**95.9**	ABCDE	**43**	EFGH	**80.1**	FGHIJKL	**1.7**	FG	**12.5**	ABCDEFGH	**5.38**	EFG	**44.8**	FGHI	**162**	EFGHIJ	**51.1**	I	**227**	BCD	**215**	BCDE	**1.49**	CDEFGHI	**5.7**	D	**53**
SR429	**38.9**	CDEF	**96.8**	ABCDE	**42**	EFGH	**80.7**	CDEFGHI	**2.4**	A	**11.6**	IJKL	**5.79**	AB	**51.8**	A	**138**	JKLM	**69.0**	ABCDE	**134**	GHIJ	**244**	A	**1.49**	CDEFGHI	**9.4**	CD	**49**
SR424	**36.6**	HIJKL	**95.2**	CDEF	**42**	EFGH	**80.2**	FGHIJKL	**2.3**	ABCD	**11.5**	KL	**5.27**	GHI	**47.6**	BCDEF	**151**	GHIJKLM	**71.1**	ABC	**127**	HIJ	**227**	ABC	**1.49**	CDEFGHI	**10.5**	BCD	**54**
M138	**36.2**	IJKL	**92.9**	FG	**45**	CDEFG	**79.6**	JKL	**1.8**	FG	**12.7**	ABCDEF	**5.49**	BCDEFG	**45.4**	CDEFGHI	**157**	FGHIJK	**67.0**	ABCDEFG	**223**	BCDE	**225**	ABC	**1.49**	CDEFGHI	**7.2**	CD	**51**
Morex	**36.0**	JKL	**94.4**	EFG	**44**	DEFG	**79.6**	JKL	**1.8**	FG	**12.9**	ABCD	**5.29**	GHI	**43.1**	HIJK	**169**	DEFGHI	**62.6**	CDEFG	**153**	EFGHIJ	**227**	ABC	**1.49**	DEFGHI	**6.7**	CD	**54**
M139	**35.7**	KL	**92.3**	G	**42**	EFGH	**79.6**	JKL	**1.7**	FG	**12.9**	ABCD	**5.45**	CDEFG	**44.5**	FGHIJ	**148**	GHIJKLM	**66.0**	ABCDEFG	**185**	CDEFGH	**218**	ABCDE	**1.49**	DEFGHI	**7.3**	CD	**54**
2ND25276	**43.5**	B	**97.7**	ABCD	**42**	FGH	**82.0**	A	**1.9**	BCDEFG	**11.0**	LM	**4.98**	JK	**47.2**	BCDEFG	**126**	LMN	**73.9**	A	**127**	HIJ	**187**	FGH	**1.48**	DEFGHI	**7.8**	CD	**55**
SR432	**38.4**	CDEFGH	**96.8**	ABCDE	**42**	EFGH	**80.2**	FGHIJKL	**2.4**	AB	**11.9**	FGHIJK	**5.91**	A	**51.7**	A	**143**	IJKLM	**72.4**	AB	**170**	DEFGH	**239**	AB	**1.48**	DEFGHI	**8.3**	CD	**48**
M140	**37.7**	CDEFGHIJK	**95.4**	BCDEF	**43**	EFGH	**79.5**	JKL	**1.8**	EFG	**12.6**	ABCDEFG	**5.43**	CDEFG	**44.8**	FGHI	**157**	FGHIJK	**61.6**	DEFG	**229**	BCD	**209**	CDEF	**1.48**	EFGHI	**8.2**	CD	**52**
M137	**36.7**	GHIJKL	**97.6**	ABCD	**47**	ABCDE	**79.5**	JKL	**1.7**	FG	**13.1**	ABC	**5.79**	AB	**45.9**	CDEFGHI	**203**	A	**64.7**	BCDEFG	**131**	HIJ	**220**	ABCD	**1.47**	FGHI	**6.6**	CD	**56**
M135	**38.1**	CDEFGHI	**97.2**	ABCD	**46**	BCDEFG	**80.0**	FGHIJKL	**2.1**	ABCDEFG	**12.5**	ABCDEFGH	**5.64**	ABCDEF	**46.3**	BCDEFGH	**173**	BCDEFG	**70.5**	ABC	**132**	GHIJ	**241**	AB	**1.47**	GHI	**8.3**	CD	**58**
Lacey	**39.2**	C	**97.1**	ABCDE	**42**	FGH	**80.5**	DEFGHIJ	**1.9**	CDEFG	**12.1**	DEFGHIJK	**5.33**	FGH	**46.0**	CDEFGHI	**161**	EFGHIJ	**66.2**	ABCDEFG	**125**	HIJ	**215**	BCDE	**1.47**	HI	**7.6**	CD	**57**
SR425	**35.6**	L	**92.4**	G	**47**	ABCDEF	**81.0**	ABCDEF	**2.0**	BCDEFG	**11.6**	JKL	**5.41**	DEFG	**48.3**	BCDE	**151**	GHIJKL	**68.1**	ABCDEF	**84**	J	**222**	ABCD	**1.46**	I	**7.8**	CD	**55**

* 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, MN, Bottineau, ND, Fargo, ND and Sidney, MT

Appendix A: METHODS

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

Barley Mill Ground barley was prepared with a Labconco Burr mill that was adjusted so that only 35% of the grist remained on a 525 μm sieve after 3 min of shaking and tapping.

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

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

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

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

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

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

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

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

Malt Protein Content See Barley Protein Content.

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

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

Wort Clarity was assessed by visual inspection.

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

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

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

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

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

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

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

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

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

Appendix B 2009 Crop Year

Quality Score Parameters for 2- and 6-rowed barleys

	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=hazy	= 3	0	= 3	0
2=slightly hazy	= 2	1	= 2	1
1=clear	= 1	2	= 1	2
Barley Protein	≥ 13.5	0	≥ 14.0	0
(% db)	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	> 6.0	0	> 6.0	0
(% db)	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	>47	0	>47	0
Protein, % db)	40–47	5	42–47	5
	< 40	0	< 42	0
DP (Diastatic	>120	7	>140	7
Power, ° ASBC)	100–120	4	120–140	4
	< 100	0	< 120	0
Alpha-amylase	>45	7	>45	7
(20° DU)	40–45	4	40–45	4
Beta-glucan	< 100	7	<120	7
(ppm)	100–150	3	120 – 170	3
	> 150	0	> 170	0