Wheat Quality Council

Hard Spring Wheat Technical Committee

2019 Crop



February 18-20, 2020

Kansas City, MO

Wheat Quality Council

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Sponsored by the Wheat Quality Council February 18-20, 2020 Dave Green, Executive Vice President Wheat Quality Council P.O. Box 19539 Lenexa, KS 66285 Phone: 913-634-0248 E-mail: dave.green.wqc@gmail.com



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Introduction

Breeders' experimental lines of wheat are evaluated for overall quality before being released for commercial production. The Hard Spring Wheat Technical Committee provides milling and baking quality data on breeders' experimental lines of wheat that are annually submitted to the Wheat Quality Council (WQC). The impact is the commercialization of high quality wheat for production and processing.

Nine experimental lines of hard spring wheat were grown at up to six locations in 2019 and evaluated for kernel, milling, and bread baking quality against the check varieties Glenn and LCS Rebel. To avoid any bias in the test procedures, code numbers were assigned to the experimental lines and maintained throughout the growing and harvesting of the plots and the milling and baking trials. Wheat samples were milled and analyzed at the USDA Hard Red Spring and Durum Wheat Quality Laboratory (WQL), Fargo, ND. Flour samples were shipped to independent laboratories and tested for bread baking quality.

From this report:

The WQC makes no representation regarding the accuracy or conclusiveness of the data developed by and received from the participating laboratories. The data has been scientifically determined and accurately reported from the perspective of the Hard Spring Wheat Technical Committee.

The results relate only to test samples that were volunteered for testing in the 2019 crop year. Test results from other crop years may differ from those reported herein.

The Hard Spring Wheat Technical Committee, by compilation of data and issuance of this report, does not make or intend any general recommendations or conclusions on its part with respect to the desirability of any wheat included in the tests. Mention of a vendor, product, proprietary product, or procedure does not constitute a guarantee or warranty of the vendor, product, or procedure by the Hard Spring Wheat Technical Committee or by cooperating laboratories, and does not imply its approval to the exclusion of other vendors, products, or procedures that may also be suitable. Data reported herein are not to be used in any publication or literature or for advertising or publicity purposes.

The 2019 Wheat Quality Testing Program

	SWQC	
Source/Breeding Program	Code #	Identification
Limagrain	1	LCS Rebel (Western Check)
North Dakota State University	2	Glenn (Check)
WestBred	3	WB9719
Syngenta	4	SY Longmire
North Dakota State University	5	NDHRS16-13-97
University of Minnesota	6	Linkert (Eastern Check)
University of Minnesota	7	MN14105-7
WestBred	9	WB9479
North Dakota State University	10	ND828
Montana State University	11	Lanning

Source of Wheat

Field Plot Locations and Procedures

Coordinators: Steve Sebesta, Director and Joyana Baumann, Assistant Director, Foundation Seedstocks, Department of Plant Sciences, North Dakota State University.

The experimental lines and check variety were grown at the following locations in the spring wheat region:

- Northeast Research Station (Watertown), South Shore, SD; South Dakota State University, Brookings, SD – Jack Ingemansen;
- Agronomy Seed Farm, Casselton, ND Brian Otteson;
- Northern Agricultural Research Center, Havre, MT Peggy Lamb;
- Northwest Research and Outreach Center, Crookston, MN Mark Hanson;
- North Central Agricultural Experiment Station, Minot, ND Eric Eriksmoen;
- Williston Research Extension Center, Williston, ND Kyle Dragseth.

Wheat was seeded in large-scale plots of ½ acre in size to approximate commercial production. Cultural practices such as tillage and weed control common to each area were used. Consideration was also given to germination, seed size, and planting depth to provide stand uniformity. Based on soil test results from each location, nitrogen fertilizer was applied to the test plots at rates approaching higher levels than used commercially to more fully express the potential of each experimental line. Levels of phosphorus and potassium were applied in sufficient amounts so as not to be limiting factors. Each plot was individually harvested and the grain produced was thoroughly blended to obtain a uniform sample representing the entire plot.

Field Production Data

Variable	Watertown	Casselton	Havre	Crookston	Minot	Williston
Planting Date	04/25/2019	05/15/2019	04/25/2019	05/21/2019	04/23/2019	05/07/2019
Harvest Date	09/05/2019	08/30/2019	08/22/2019	08/31/2019	08/30/2019	09/04/2019
Fertilizer (lb/A)						
N	200	120	100	172	131	100
Р	*	*	20	12 ppm	38 ppm	24
K	*	*	10	146 ppm	210 lbs/A	*
Herbicide(rate/A)						
Broadleaf	Bronate 1 pt/A	Pacer 1 pt/A Affinity TM 0.3 oz/A	Bromac 24 oz/A	Bromac 1.5 pt/A	WideMatch 20 oz/A Huskie 12 oz/A	Bronate 1.5 pt/A
Grass	Puma 0.66 pt/A	Parity 0.66 pt/A	*	Axial XL 16 oz/A	Rimfire Max 3 oz/A	Axial 1.0 pt/A
Fungicide		Prosaro 6.5 oz/A	*	*	Proline 5 oz/A	*

*No application.

CLIMATOLOGICAL DATA										
	Average Temperature (°F) / Precipitation (in.)									
Month	Watertown	Casselton	Havre	Crookston	Minot	Williston				
April	*	41.0 / 1.21	44.6 / 0.92	40.1 / 1.56	41.0 / 0.93	44.0 / 0.85				
May	51.0 / 3.40	50.1 / 3.29	49.4 / 1.53	51.4 / 1.38	50.0 / 0.74	51.0 / 1.37				
June	66.0 / 2.42	66.6 / 3.38	61.4 / 3.24	65.6 / 1.39	64.0 / 3.14	64.0 / 3.65				
July	70.0 / 6.66	71.1 / 5.18	67.4 / 0.64	70.7 / 3.32	69.0 / 1.76	69.0 / 3.38				
August	65.0 / 4.12	65.5 / 2.91	67.2 / 0.73	65.0 / 4.72	64.0 / 2.84	67.0 / 2.22				

*Data not available.

			YIELD DATA			
		Yield	(bu/acre) / Test We	ight (lb/bu) / % Moi	sture [†]	
SWQC						
Code #	Watertown	Casselton	Havre	Crookston	Minot	Williston
1	*	*	40.1 / 59.1 / 11.0	*	60.5 / 61.8 / 16.7	** / 59.7 / 14.5
2	41.5 / 56.1 / 12.0	46.0 / 59.6 / 14.3	29.1 / 57.3 / 10.9	66.5 / 59.0 / 14.2	61.6 / 63.2 / 17.2	** / 60.9 / 14.2
3	*	*	46.9 / 60.0 / 10.6	*	51.4 / 63.8 / 17.3	** / 61.5 / 14.1
4	*	*	40.4 / 59.2 / 11.0	*	66.5 / 61.9 / 16.3	** / 59.7 / 13.8
5	*	54.4 / 58.2 / 13.9	*	*	55.0 / 61.7 / 16.4	** / 59.3 / 14.0
6	48.4 / 55.0 / 12.1	57.7 / 58.7 / 13.6	*	63.1 / ** / 13.4	*	*
7	69.6 / 56.1 / 11.9	68.3 / 59.2 / 13.4	*	75.1 / 58.0 / 14.0	36.6 / 60.9 / 17.4	*
9	73.1 / 56.4 / 11.9	53.5 / 57.8 / 13.4	*	75.3 / ** / 13.5	*	*
10	*	*	*	*	58.5 / 61.8 / 16.5	** / 59.9 / 13.5
11	*	*	37.3 / 57.6 / 10.8	*	*	** / 60.9 / 14.3
Site Totals	4	5	5	4	7	7

[†]At time of delivery, moisture contents of Watertown, Casselton, Havre, Crookston, Minot, and Williston samples were 14.3, 13.9, 11.1, 14.5, 14.0, and 15.4%, respectively. *Not increased at this site. ** Data not available

Climate, Disease, and Field Conditions

Notes on production related to climate condition, diseases (scab, etc.), and field conditions that could affect grain quality.

	Watertown	Casselton	Havre	Crookston	Minot	Williston
At Planting	Cool temperatures with excess moisture, which delayed planting.	Plentiful moisture at planting.	The spring wheat for the area was seeded later than typical due to cold soil conditions and wet ground. SWQC #2 experienced a drill malfunction at time of seeding. It was re- seeded on 05/13/19, but it should not be considered a good comparison to other entries.	We did not get into the field until the third week of May. We then had adequate moisture at planting.	Adequate top soil moisture to get crop started. No subsoil moisture.	We had enough moisture in the top 6 inches of soil to get the crop germinated. However, there was no available moisture from 6-48 inches.
During Growth	Cool May with 5 degree lower than average temperatures.	Wet growing season.	All spring cereals were stressed early on during growth and through the third week of June due to lack of "relevant" rainfall. Rain events that were recorded in early June came as downpours that resulted in severe runoff and did crops very little good. Slow soaking rainfall beginning on June 22 nd followed by much cooler than normal temperatures throughout July resulted in spring crops achieving higher than previously expected yields and quality	Dry weather conditions until July.	Good growing conditions. Dry soil conditions going into reproductive stage. No pest issues observed.	June and July were above average for precipitation. It was one of the best growing seasons at the WREC in years. Started dry and then got wet.
At Flowering	Excess moisture and normal temperatures	Rain several times per week.	No issues observed.	Adequate or slightly above moisture during flowering.	Timely rainfall and good growing conditions. No pest issues observed.	
During Maturation	Normal temperatures. Excess moisture.	Wet conditions	No issues observed.	We did observe scab during this time period.	Good growing conditions. No pest issues observed.	Scab pressure was fairly high although we chose not to fungicide to see the difference between varieties. No scab found in grain.
At Harvest	Excess moisture delayed harvest date by 3 weeks. Five degrees cooler than normal.	Harvested dry but, generally, conditions were wet.	Harvest was later than normal due to late seeding, late rainfall and cooler than normal temperatures in July, resulting in late crop maturity. SWQC #2 was very tough to thresh out, although it was thoroughly ripe and dry.	No lodging present at harvest.	Rainy weather conditions delayed harvest. No pest issues. SWQC #7 had poorer germination/seedling emergence causing a thinner stand and reduced yields.	Excellent yield, poor protein, average test weight. Yield goal was 40 bu/acre and grain yield was much higher, thus creating the lower protein.

Description of 2019 Hard Spring Wheat Lines

SWQC #1 – LCS Rebel

LCS Rebel is a hard red spring wheat marketed by Limagrain Cereal Seeds. LCS Rebel was selected for a consistent combination of top end yield potential and 14%+ levels of protein content. The disease resistance package for this new release is highlighted by resistance to current races of stripe and stem rust. LCS Rebel is adapted to all growing regions in North Dakota, Minnesota, and Montana.

SWQC #3 – WB9719

WB9719 is a hard red spring wheat variety released by WestBred. It is above average yielding and average in grain protein, making it a well-balanced variety. WB9719 is of medium plant height and is a medium-late maturing variety. The straw strength for WB9719 is very good, similar to SY Ingmar and SY Soren. WB9719 is well adapted to high stress environments from moisture or temperature. The disease package for WB9719 is characterized by better scab tolerance than WB-Mayville, moderate resistance to bacterial leaf streak, exceptional yellow rust resistance, and medium-susceptibility to tan spot. WB9719 has very good milling and baking end-use quality.

SWQC #4 – SY Longmire

SY Longmire is a solid stemmed hard red spring wheat bred and developed by Syngenta Crop Protection, LLC adapted primarily for Montana and the Western areas of North Dakota. SY Longmire was selected from the cross of SY Ingmar and Choteau. SY Longmire has shown good tolerance to wheat stem sawfly in field conditions. It has medium heading, similar to SY Ingmar with moderate to high test weight. It is a standard semi-dwarf, taller than SY Soren but shorter than SY Ingmar with average standability. SY Longmire disease resistance indicates moderate resistance to leaf and stem rust, being intermediate for foliar spotting and bacterial leaf streak, and moderately susceptible to Fusarium head blight. Protein levels have been high, similar to SY Ingmar. Overall bread making characteristics are acceptable.

SWQC #5 – NDHRS16-13-97

NDHRS16-13-97 is an experimental hard red spring wheat line selected from the cross ND709-9/ND2902. It has similar height to Faller but with stronger straw, and is about two days earlier than Faller. It has shown a relative advantage in eastern ND production areas. It is moderately resistant to FHB and leaf rust. In statewide testing, its yield has been most similar to Elgin-ND. It is currently being increased for a possible release in 2021.

SWQC #6 – Linkert

Linkert (MN97695-4/Ada sel) was released by the University of Minnesota in 2013 and has been the No. 1 variety in Minnesota since 2016, sown on > 25% of the state's acreage from 2016-2019. Linkert is a mid-maturity hard red spring wheat with excellent straw strength, high grain protein content and good end-use quality characteristics. Linkert is moderately resistant to leaf

rust, resistant to stripe rust, but moderately susceptible to Fusarium head blight and bacterial leaf streak. Linkert is resistant to preharvest sprouting.

SWQC #7 – MN14105-7

MN14105-7 (Sabin/01S0377-6//Linkert) has shown high yields, especially in southern MN along with medium protein levels and good end-use quality. Disease resistance is good, among the best for bacterial leaf streak (rate 3 on 1-9 scale) and moderately resistant to scab (4). Straw strength is moderate, better than Shelly and Lang-MN, but not as strong as MN-Washburn or Linkert.

SWQC #9 – WB9479

WB9479 is a hard red spring wheat variety released by WestBred. It has very similar attributes to the line WB-Mayville. It has well above average grain protein, with average to above average yield, making it a well-balanced variety for yield and protein. It has exceptional straw strength, with standability similar to WB-Mayville, though lower than Linkert. The height of WB9479 is medium-short and maturity is medium to medium-early. WB9479 has better scab tolerance than WB-Mayville, exceptional yellow rust resistance, and is moderately-susceptible to bacterial leaf streak and tan spot. The milling and baking quality for WB9479 is exceptional.

SWQC #10 - ND828

ND828 is an experimental hard red spring wheat line selected from the cross Goldfield/2*Alsen//Steele-ND. It is a late maturing line with taller straw. It has a high level of FHB resistance, is moderately resistant to leaf rust, and resistant to stem rust. It is best adapted to drier climates due to straw strength but yield potential has been strong throughout North Dakota. It was tested statewide and a seed increase was conducted to be considered for release in 2020.

SWQC #11 – Lanning

Lanning hard red spring wheat was released by the Montana Agricultural Experiment Station due to its excellent yield potential in dryland areas of Montana and its superior end-use quality. Lanning was derived from the cross 'Glenn'/MT0747 by single seed descent beginning in the F2 generation. A single plant in the F4 generation was the source of experimental line MT1316, which subsequently was named Lanning. Lanning has grain yield equivalent to Vida, the most widely grown cultivar in Montana from 2010-2018. Lanning has higher grain protein and stronger gluten characteristics than Vida. Lanning is hollow-stemmed, suggesting that it will be susceptible to damage caused by the wheat stem sawfly (*Cephus cinctus* Nort.). Lanning should be of interest to producers of hard red spring on dryland acreage throughout the wheat growing region of Montana.

Wheat Production Sites

SWQC			Production Sites						
Code #	Entry	Source	Watertown	Casselton	Havre	Crookston	Minot	Williston	
1	LCS Rebel	Limagrain			Х		Х	Х	
2	Glenn	NDSU	Х	Х	Х*	Х	Х	Х	
3	WB9719	WestBred			Х		Х	Х	
4	SY Longmire	Syngenta			Х		Х	Х	
5	NDHRS16-13-97	NDSU		Х			Х	Х	
6	Linkert	UMN	Х	Х		Х			
7	MN14105-7	UMN	Х	Х		Х	Х		
9	WB9479	WestBred	Х	Х		Х			
10	ND828	NDSU					Х	Х	
11	Lanning	MSU			Х			Х	

*Not evaluated. See notes on page 7.

Grain Cleaning and Milling Procedures

Wheat with moisture content above 13.5% were placed in a drier (90° F) until moisture decreased to \leq 13%. Wheat (approximately 3 bu/line) was then cleaned in a Carter-Day Bulldog seed cleaner that was equipped with two rotating indent cylinders (#24 – coarse; #16 – fine), a sizer cylinder (#5), vibrator, and air aspiration.

Cleaned wheat (110 lbs) was tempered to 16.5% moisture content and conditioned for approximately 20-24 hours before milling. Milling was performed on the Miag Multomat. Feed rate was set at 180 lbs/hour. Break rollers were adjusted to the following releases through a U.S. 16 S.S. sieve: first break – 30%; second break – 53%; and third break, clean-up – 66%.

Flour blending: Sixteen mill streams were selected among 23 streams based on cumulative ash curves and blended to long patent flour. Cumulative ash content was calculated based on product basis milling yield (14% moisture basis).

Milling streams blended to long patent flour – 1st Break, 2nd Break I, Break Dust, Sizing I, 2nd Break II, 3rd Break, Sizing II, 5th Break, 4th Break, 1st Middlings, 2nd Middlings, 3rd Middlings, 4th Middlings, 6th Middlings, Tail Flour, and Tail Cyclone Flour.

Methods of Analysis

- Wheat Market Value Score;
- DON levels analyzed by NDSU, Department of Plant Sciences (gas chromatography method, J. AOAC Int. 79:472, 1996);
- Test weight (AACCI Method 55-10);
- Wheat and flour protein (AACCI Method 46-30 combustion method);
- Wheat and flour ash (AACCI Method 08-01);
- Kernel Size (Sieving according to USDA-ARS WQL);
- Wheat and flour Falling Number (Perten Falling Number System, AACCI Method 56-81);
- Single kernel characteristics (Perten Single Kernel Characterization System SKCS, AACCI Method 55-31):
 - Mean and standard deviation values were calculated from 300 kernels.
- Vitreous kernel content (DHV analysis by FGIS Grain Testing Service, Fargo, ND);
- Flour color (Minolta Colorimeter, *L** and *b** values);

- Polymeric to monomeric protein ratio (TPP/TMP) and high-molecular weight glutenin composition (HMW-GS) – analyzed by Michael Tilley/Sushma Prakash, USDA-ARS-CGAHR, Manhattan, KS (Cereal Chem. 75:374, 1998; J. Cereal Sci. 18:23, 1993; J. Cereal Sci. 46:157, 2007);
- Flour extraction: % Total product basis (TPB), % tempered wheat basis (TWB), and estimated pounds patent flour/bushel wheat;
- Farinograph (AACCI Method 54-21, Brabender Computerized Farinograph system with 50 g mixing bowl):
 - Water absorption: 500 BU and 14% mb;
 - Arrival time: time required for the top of the curve to reach the 500 BU line after addition of water;
 - Peak time: time between addition of water and development of the maximum consistency of the dough;
 - Stability: difference in time between the point at which the top of the curve first intercepts the 500 BU line (arrival time) and the point at which the top of the curve leaves the 500 BU line (departure time);
 - Mechanical Tolerance Index (MTI): difference in BU between the top of the curve at the peak and the top of the curve measured 5 minutes after the peak is reached;
 - Time to Breakdown (TTB): time from the start of mixing to the time at which consistency has decreased 30 BU from the peak point.
- Mixograph (AACCI Method 54-40A, mixograph with 35 g mixing bowl):
 - Water absorption (14% mb) = Protein (14% mb) x 1.5 + 43.6 (The Mixograph Handbook, 1997).
- Extensograph (AACCI Method 54-10 with modifications):
 - Flour (100 g, 14% mb), 2.0% NaCl (U.S.P.), and water (farinograph absorption 2%) were mixed to optimum development in a pin mixer (National Mfg. Co.);
 - Dough was scaled to 150 g, rounded, molded, placed in extensograph holders, and rested for 45, 90, and 135 minutes at 30°C and 78% relative humidity. The dough was then stretched as described in the procedure referenced above. For conversion purposes, 500 g = 400 BU;
 - Extensograph parameters:
 - Energy (cm²): area under the curve;

- Resistance to extension (BU): height of the curve 50 mm after the beginning of torque increase;
- Extensibility (cm): total length of the curve at the baseline;
- Maximum resistance (BU): maximum curve height;
- Ratio number: quotient of resistance to extension and extensibility;
- Ratio number (max.): quotient of maximum resistance and extensibility.

Test Bake Procedures

Samples of flour were shipped to cooperators for evaluation of baking properties. The flour had been uniformly malted to a falling number of approximately 250 seconds. Bleach was not added to the flour. Each cooperator test baked the flour according to their standard method using straight dough, sponge and dough, or other test bake methods. Cooperator data were returned to the WQL for compilation of results.

Bake Cooperators

- ADM Milling Overland Park, KS;
- Ardent Mills Denver, CO;
- Bay State Milling, Quincy, MA;
- General Mills Minneapolis, MN;
- Grain Craft Wichita, KS;
- Limagrain Cereal Seeds LLC Fort Collins, CO;
- North Dakota State University, Department of Plant Sciences Fargo, ND;
- Syngenta Berthoud, CO;
- USDA-ARS Hard Red Spring & Durum Wheat Quality Laboratory Fargo, ND;
- USDA-ARS Hard Winter Wheat Quality Laboratory Manhattan, KS;
- USDA-ARS Western Wheat Quality Laboratory Pullman, WA;
- Wheat Marketing Center Portland, OR.

The Wheat Quality Council acknowledges the dedication and sacrifice of time by those individuals who are involved in test baking hard spring wheat samples. Your efforts are well appreciated by wheat breeders, commercial flour millers and bakers, and wheat marketing personnel who inspire the overall industry to improve the quality of U.S. wheat.

Quality Data of 2019 Hard Spring Wheat Lines

SWQC #1 – LCS Rebel

		Havre* Minot		not	Williston	
			Glenn		Glenn	
		H-1	M-2	M-1	W-2	W-1
	I. USDA-ARS WQL Data					
1	Wheat Protein (%, 12% mb)	16.7	16.8	15.8	14.0	14.6
2	Flour Protein (%, 14% mb)	15.6	16.0	14.6	13.1	13.6
3	Market Value (Score 1-6)	4.8	4.8	5.0	4.2	4.9
4	Market Value (Score 1-10)	10.0	10.0	9.0	10.0	9.2
5	DON (ppm)	0.02	1.14	1.34	0.01	0.01
6	Test Weight (lb/bu)	60.6	64.0	63.7	64.3	62.5
7	1000 Kernel Weight (g)	29.6	34.6	38.9	33.0	38.7
8	Kernel Size, % Large	44	75	83	70	83
9	Kernel Size, % Small	14	5	5	7	4
10	Wheat Moisture (%)	11.3	12.9	12.4	12.1	12.8
11	Wheat Ash (%, 14% mb)	1.48	1.70	1.57	1.65	1.58
12	Wheat Falling Number (sec)	426	352	354	374	404
13	SKCS Hardness Index	73.9	74.6	66.7	81.1	67.5
14	Vitreous Kernels (%)	95.4	83.4	62.7	55.4	60.2
	(,,)	••••			••••	
	Flour Extraction (%)					
15	Tempered Wheat Basis (%)	69.1	70.2	71.8	65.7	69.0
16	Total Product Basis (%)	70.9	71.8	74.3	67.4	71.1
17	Flour/Bu Wheat (lbs)	42.6	45.1	46.3	43.0	43.4
••						
	Flour Quality					
18	Flour Color Brightness (L*)	90.2	90.2	90.4	90.8	90.5
19	Flour Color Yellowness (b*)	10.1	8.5	8.6	8.7	8.8
20	Flour Moisture (%)	12.9	13.1	13.7	13.6	13.1
21	Flour Ash (%, 14% mb)	0.44	0.46	0.43	0.45	0.43
22	Flour Falling Number (Malted) (sec)	255	245	249	245	254
	Farinograph					
23	Water Absorption (%, 500 BU)	68.8	68.7	67.4	65.0	64.0
24	Water Absorption (%, 14% mb)	67.6	67.8	67.2	64.4	62.8
25	Arrival Time (min)	6.3	5.2	4.9	2.5	3.0
26	Peak Time (min)	10.3	11.2	9.5	8.4	9.0
27	Dough Stability (min)	14.9	15.7	10.1	12.3	12.8
28	Mixing Tolerance Index (MTI) (BU)	14	12	29	22	30
29	Time To Breakdown (TTB) (min)	20.1	21.1	15.0	14.9	14.0
	II. Cooperator Results					
30	Bake Absorption (Average %)	69.8	70.6	69.2	67.4	66.8
31	Loaf Volume (% of Check)	n/a		96.9		101.8

*Glenn check (H-2) was not evaluated. See notes on page 7.

SWQC #1 – LCS Rebel

		Havre	Min	Minot		Williston	
	Quality Trait	H-1	Glenn M-2	M-1	Glenn W-2	W-1	
32	II. Cooperator Results Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	5.2	6.2	5.4	6.5	6.4	
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.2	7.1	7.3	6.9	6.9	
34	Mixing Tolerance 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check	n/a		4.5		5.3	
35	Internal Crumb Color 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check	n/a		4.9		5.3	
36	Internal Grain and Texture 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check	n/a		4.8		5.7	
	III. Cooperator Evaluation Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check	n/a		3.5		5.6	
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check	n/a		6.2		6.4	
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check	n/a		4.4		5.4	
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check	n/a		4.9		5.8	

Farinograms



Glenn Check (Minot, M-2)



Glenn Check (Williston, W-2)



LCS Rebel (Minot, M-1)





Mixograms



Glenn Check (Minot, M-2)



LCS Rebel (Minot, M-1)



Extensograms



Glenn Check (Minot, M-2) LCS Rebel (Minot, M-1) [BU] M-2 [BU] M-1 600· 500-500-400· 400· 300· 100-100-[cm] [cm]



SWQC #3 - WB9719

		Havre		Min	ot	Willis	ston
		LCS Rebel		Glenn		Glenn	
	Quality Trait	H-1	H-3	M-2	M-3	W-2	W-3
	I. USDA-ARS WOL Data						
1	Wheat Protein (%, 12% mb)	16.7	15.8	16.8	16.5	14.0	12.5
2	Flour Protein (%, 14% mb)	15.6	14.9	16.0	15.3	13.1	11.4
3	Market Value (Score 1-6)	4.8	4.6	4.8	5.2	4.2	4.1
4	Market Value (Score 1-10)	10.0	9.4	10.0	9.6	10.0	8.2
5	DON (ppm)	0.02	0.01	1.14	nd	0.01	0.02
6	Test Weight (lb/bu)	60.6	61.5	64.0	64.6	64.3	64.7
7	1000 Kernel Weight (g)	29.6	29.2	34.6	40.5	33.0	35.5
8	Kernel Size, % Large	44	60	75	90	70	88
9	Kernel Size, % Small	14	10	5	3	7	4
10	Wheat Moisture (%)	11.3	11.0	12.9	12.0	12.1	12.9
11	Wheat Ash (%, 14% mb)	1.48	1.47	1.70	1.55	1.65	1.58
12	Wheat Falling Number (sec)	426	403	352	357	374	392
13	SKCS Hardness Index	73.9	75.2	74.6	65.0	81.1	75.6
14	Vitreous Kernels (%)	95.4	98.3	83.4	56.7	55.4	45.8
	Flour Extraction (%)						
15	Tempered Wheat Basis (%)	69.1	68.7	70.2	70.8	65.7	63.7
16	Total Product Basis (%)	70.9	70.4	71.8	71.6	67.4	65.4
17	Flour/Bu Wheat (Ibs)	42.6	43.4	45.1	46.2	43.0	41.4
	Flour Quality						
18	Flour Color Brightness (<i>L</i> *)	90.2	90.1	90.2	90.2	90.8	90.9
19	Flour Color Yellowness (b*)	10.1	10.4	8.5	8.6	8.7	9.0
20	Flour Moisture (%)	12.9	13.4	13.1	12.7	13.6	13.2
21	Flour Ash (%, 14% mb)	0.44	0.45	0.46	0.41	0.45	0.42
22	Flour Falling Number (Malted) (sec)	255	260	245	243	245	258
	Farinograph		A7 5	~~ =	00 F		
23	Water Absorption (%, 500 BU)	68.8	67.5	68.7	68.5	65.0	63.6
24	water Absorption (%, 14% mb)	67.6	66.8	67.8	67.1	64.4	62.7
25	Arrival Time (min)	6.3	5.6	5.2	4.8	2.5	1.9
20	Peak Time (min)	10.3	10.2	11.2	9.3	0.4 40.0	3.3
21	Dough Stability (Min)	14.9	13.5	15.7	12.4	12.3	9.1
2ŏ 20	Time To Breakdown (TTP) (BU)	14	15	12	23	14.0	13
29	mine to breakdown (TTB) (min)	20.1	19.4	21.1	17.0	14.9	11.1
	II Cooperator Results						
30	Bake Absorption (Average %)	69.8	68 1	70.6	69 3	67.4	65.4
31	L oaf Volume (% of Check)	00.0	95.6	10.0	95.8		93.9
31	Loat volume (% of Check)		95.6		95.8		93.9

SWQC #3 – WB9719

		Havre		Minot		Willis	ston
		LCS Rebel	<u> </u>	Glenn		Glenn	
	Quality Trait	H-1	H-3	M-2	M-3	W-2	W-3
	II. Cooperator Results						
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	5.2	4.6	6.2	5.2	6.5	6.1
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.2	5.8	7.1	7.2	6.9	5.5
34	Mixing Tolerance 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		3.7		4.4		4.5
35	Internal Crumb Color 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.6		5.0		4.8
36	Internal Grain and Texture 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.0		5.1		5.3
	III. Cooperator Evaluation Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.5		4.4		2.8
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.1		5.5		3.9
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.2		4.1		4.1
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.7		4.7		3.7

Farinograms



WB9719 (Havre, H-3)



Glenn Check (Minot, M-2)



Glenn Check (Williston, W-2)



WB9719 (Minot, M-3)





Mixograms



Glenn Check (Minot, M-2)

Glenn Check (Williston, W-2)



WB9719 (Minot, M-3)



Extensograms



SWQC #4 – SY Longmire

		Havre	e	Mir	ot	Willi	ston
		LCS Rebel		Glenn		Glenn	
	Quality Trait	H-1	H-4	M-2	M-4	W-2	W-4
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	16.7	17.0	16.8	17.1	14.0	12.8
2	Flour Protein (%, 14% mb)	15.6	16.2	16.0	16.0	13.1	11.7
3	Market Value (Score 1-6)	4.8	4.6	4.8	5.3	4.2	4.2
4	Market Value (Score 1-10)	10.0	10.0	10.0	10.0	10.0	8.4
5	DON (ppm)	0.02	nd	1.14	nd	0.01	0.02
6	Test Weight (lb/bu)	60.6	60.1	64.0	63.2	64.3	63.1
7	1000 Kernel Weight (g)	29.6	29.5	34.6	37.7	33.0	34.5
8	Kernel Size, % Large	44	34	75	84	70	73
9	Kernel Size, % Small	14	15	5	4	7	6
10	Wheat Moisture (%)	11.3	11.2	12.9	12.5	12.1	12.3
11	Wheat Ash (%, 14% mb)	1.48	1.52	1.70	1.65	1.65	1.61
12	Wheat Falling Number (sec)	426	482	352	384	374	411
13	SKCS Hardness Index	73.9	71.8	74.6	61.8	81.1	68.7
14	Vitreous Kernels (%)	95.4	96.1	83.4	41.6	55.4	20.8
	Flour Extraction (%)						
15	Tempered Wheat Basis (%)	69.1	70.9	70.2	69.0	65.7	66.9
16	Total Product Basis (%)	70.9	72.0	71.8	72.1	67.4	68.5
17	Flour/Bu Wheat (lbs)	42.6	43.6	45.1	44.3	43.0	42.7
	Flour Quality						
18	Flour Color Brightness (L*)	90.2	89.9	90.2	90.3	90.8	90.8
19	Flour Color Yellowness (b*)	10.1	10.7	8.5	8.8	8.7	9.4
20	Flour Moisture (%)	12.9	13.1	13.1	13.7	13.6	13.1
21	Flour Ash (%, 14% mb)	0.44	0.47	0.46	0.43	0.45	0.44
22	Flour Falling Number (Malted) (sec)	255	252	245	241	245	244
	Farinograph						
23	Water Absorption (%, 500 BU)	68.8	68.6	68.7	69.4	65.0	62.8
24	Water Absorption (%, 14% mb)	67.6	67.7	67.8	69.3	64.4	61.6
25	Arrival Time (min)	6.3	5.0	5.2	5.4	2.5	2.0
26	Peak Time (min)	10.3	10.3	11.2	10.0	8.4	4.5
27	Dough Stability (min)	14.9	19.3	15.7	10.1	12.3	8.5
28	Mixing Tolerance Index (MTI) (BU)	14	13	12	23	22	22
29	Time To Breakdown (TTB) (min)	20.1	22.7	21.1	16.4	14.9	10.7
	II. Cooperator Results						
30	Bake Absorption (Average %)	69.8	69.8	70.6	70.5	67.4	64.9
31	Loaf Volume (% of Check)		103.4		101.8		100.3

SWQC #4 – SY Longmire

		Havre		Minot		Willis	ston
		LCS Rebel		Glenn		Glenn	
	Quality Trait	H-1	H-4	M-2	M-4	W-2	W-4
	II. Cooperator Results			-			
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	5.2	5.5	6.2	3.4	6.5	5.4
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.2	6.6	7.1	5.0	6.9	5.5
34	Mixing Tolerance 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		5.0		2.9		3.9
35	Internal Crumb Color 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.2		5.2		5.1
36	Internal Grain and Texture 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.1		5.1		5.9
	III. Cooperator Evaluation Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.7		4.8		2.9
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.6		4.5		5.0
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.6		4.5		4.6
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.6		4.2		4.4

Farinograms



SY Longmire (Havre, H-4)



Glenn Check (Minot, M-2)



Glenn Check (Williston, W-2)



SY Longmire (Minot, M-4)





Mixograms



Glenn Check (Minot, M-2)

Glenn Check (Williston, W-2)



SY Longmire (Minot, M-4)



Extensograms



SWQC #5 - NDHRS16-13-97

		Casselton		Minot		Willi	ston
		Glenn		Glenn		Glenn	
	Quality Trait	C-2	C-5	M-2	M-5	W-2	W-5
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	15.7	14.7	16.8	16.8	14.0	12.3
2	Flour Protein (%, 14% mb)	14.5	13.4	16.0	15.6	13.1	11.3
3	Market Value (Score 1-6)	3.5	2.7	4.8	5.4	4.2	4.0
4	Market Value (Score 1-10)	10.0	7.4	10.0	9.2	10.0	7.0
5	DON (ppm)	0.46	nd	1.14	0.53	0.01	0.06
6	Test Weight (lb/bu)	62.6	60.4	64.0	62.3	64.3	62.2
7	1000 Kernel Weight (g)	27.4	28.4	34.6	39.9	33.0	38.3
8	Kernel Size, % Large	44	55	75	87	70	84
9	Kernel Size, % Small	11	10	5	4	7	4
10	Wheat Moisture (%)	12.4	12.6	12.9	12.7	12.1	13.0
11	Wheat Ash (%, 14% mb)	1.71	1.71	1.70	1.58	1.65	1.58
12	Wheat Falling Number (sec)	285	191	352	393	374	390
13	SKCS Hardness Index	81.7	81.9	74.6	66.7	81.1	67.2
14	Vitreous Kernels (%)	85.5	61.7	83.4	18.7	55.4	38.7
	Flour Extraction (%)						
15	Tempered Wheat Basis (%)	68.3	69.3	70.2	69.9	65.7	67.7
16	Total Product Basis (%)	70.9	71.5	71.8	71.8	67.4	69.5
17	Flour/Bu Wheat (lbs)	43.4	42.3	45.1	44.0	43.0	42.4
	Flour Quality						
18	Flour Color Brightness (L*)	90.3	90.3	90.2	90.4	90.8	90.9
19	Flour Color Yellowness (b*)	9.4	8.2	8.5	7.2	8.7	7.3
20	Flour Moisture (%)	13.8	13.5	13.1	13.5	13.6	13.5
21	Flour Ash (%, 14% mb)	0.45	0.46	0.46	0.45	0.45	0.44
22	Flour Falling Number (Malted) (sec)	246	248*	245	248	245	257
	Farinograph						
23	Water Absorption (%. 500 BU)	62.9	62.8	68.7	71.0	65.0	63.1
24	Water Absorption (%, 14% mb)	62.7	62.4	67.8	70.3	64.4	62.5
25	Arrival Time (min)	2.6	2.7	5.2	5.6	2.5	2.2
26	Peak Time (min)	8.4	6.5	11.2	9.4	8.4	3.3
27	Dough Stability (min)	11.9	11.6	15.7	10.2	12.3	7.5
28	Mixing Tolerance Index (MTI) (BU)	28	14	12	20	22	21
29	Time To Breakdown (TTB) (min)	14.0	14.4	21.1	16.6	14.9	9.3
	II. Cooperator Results						
30	Bake Absorption (Average %)	66.6	65.6	70.6	71.4	67.4	65.0
31	Loaf Volume (% of Check)		96.8		100.5		96.3

*Not malted.

SWQC #5 – NDHRS16-13-97

		Casselton		Minot		Williston	
		Glenn		Glenn		Glenn	
	Quality Trait	C-2	C-5	M-2	M-5	W-2	W-5
	II. Cooperator Results			• •			
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	5.9	6.1	6.2	4.4	6.5	6.5
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	5.9	6.5	7.1	6.2	6.9	6.2
34	Mixing Tolerance 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		5.8		3.6		4.6
35	Internal Crumb Color 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.7		5.7		6.2
36	Internal Grain and Texture 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check		5.6		4.9		5.6
	1 = Much Poorer Than Check						
	III Cooperator Evaluation						
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.7		4.6		2.8
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.7		4.4		4.7
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.5		4.5		4.8
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.8		4.6		4.7

Farinograms



Glenn Check (Minot, M-2)



Glenn Check (Williston, W-2)



NDHRS16-13-97 (Casselton, C-5) [FU] C-5 100 -[min]





Mixograms



Glenn Check (Minot, M-2)

Glenn Check (Williston, W-2)

NDHRS16-13-97 (Casselton, C-5)





Extensograms



SWQC #6 – Linkert

		Watertown		Casselton		Croo	ston
		Glenn		Glenn		Glenn	
	Quality Trait	B-2	B-6	C-2	C-6	K-2	K-6
	I. USDA-ARS WOL Data						
1	Wheat Protein (%, 12% mb)	17.0	16.7	15.7	15.6	14.7	15.1
2	Flour Protein (%, 14% mb)	15.5	15.4	14.5	14.5	13.5	14.1
3	Market Value (Score 1-6)	3.3	3.4	3.5	3.6	3.4	3.2
4	Market Value (Score 1-10)	10.0	10.0	10.0	9.2	10.0	8.8
5	DON (ppm)	0.65	0.84	0.46	0.15	0.03	0.06
6	Test Weight (lb/bu)	59.3	58.4	62.6	60.4	62.4	59.3
7	1000 Kernel Weight (g)	25.9	28.3	27.4	29.0	31.9	32.1
8	Kernel Size, % Large	40	49	44	55	66	65
9	Kernel Size, % Small	14	12	11	9	7	6
10	Wheat Moisture (%)	13.2	13.1	12.4	12.0	13.4	12.5
11	Wheat Ash (%, 14% mb)	1.97	1.83	1.71	1.64	1.65	1.59
12	Wheat Falling Number (sec)	354	360	285	340	274	314
13	SKCS Hardness Index	77.3	73.8	81.7	78.7	79.7	73.0
14	Vitreous Kernels (%)	50.7	48.1	85.5	68.2	53.1	21.7
	Flour Extraction (%)	00.4					00.4
15	Tempered Wheat Basis (%)	62.1	66.7	68.3	69.9	68.2	69.4
16	I otal Product Basis (%)	65.6	68.7	/0.9	/2.6	/0.5	/2.0
17	Flour/Bu wheat (lbs)	37.1	39.2	43.4	42.8	42.8	41.5
	Elour Quality						
18	Flour Color Brightness (/*)	89.0	9 98	90.3	90.6	90.1	90.2
19	Flour Color Yellowness (b*)	8.8	89	94	9 1	91	86
20	Flour Moisture (%)	13.6	13.3	13.8	13.2	13.5	13.3
21	Flour Ash (%, 14% mb)	0.55	0.51	0.45	0.47	0.45	0.46
22	Flour Falling Number (Malted) (sec)	249	246	246	257	250	251
	······································						
	Farinograph						
23	Water Absorption (%, 500 BU)	63.3	62.0	62.9	61.9	64.8	62.5
24	Water Absorption (%, 14% mb)	62.8	61.1	62.7	61.1	64.2	61.8
25	Arrival Time (min)	2.8	2.7	2.6	3.6	2.0	2.2
26	Peak Time (min)	10.0	8.4	8.4	10.5	7.4	8.2
27	Dough Stability (min)	15.1	19.0	11.9	18.8	11.5	16.7
28	Mixing Tolerance Index (MTI) (BU)	22	13	28	19	30	20
29	Time To Breakdown (TTB) (min)	15.9	20.8	14.0	19.0	12.5	15.1
	II. Cooperator Desults						
20	II. Cooperator Results	66.9	66.0	66.6	CE O	67.0	CE O
3U 24	Dake Absorption (Average %)	00.0	00.2	00.0	101 2	07.2	00.00
31	Loai volume (% of Check)		33.0		101.3		101.0

SWQC #6 – Linkert

		Watertown		Casselton		Crookston	
		Glenn		Glenn		Glenn	
	Quality Trait	B-2	B-6	C-2	C-6	K-2	K-6
	II. Cooperator Results						
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.4	7.2	5.9	6.8	6.1	6.6
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.2	6.9	5.9	6.6	6.7	7.1
34	Mixing Tolerance 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		5.8		5.9		5.9
35	Internal Crumb Color 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.5		5.5		5.5
36	Internal Grain and Texture 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.3		5.6		6.0
	III. Cooperator Evaluation Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.0		5.2		5.9
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		6.5		5.3		4.6
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.4		6.2		5.9
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.6		5.7		5.6
Farinograms



Linkert (Watertown, B-6)



Glenn Check (Casselton, C-2)



Glenn Check (Crookston, K-2)



Linkert (Casselton, C-6)





Mixograms



Glenn Check (Casselton, C-2)

Glenn Check (Crookston, K-2)

Linkert (Watertown, B-6)





Extensograms





SWQC #7 – MN14105-7

		Wate	rtown	Casselton		Crookston		Minot	
		Glenn		Glenn		Glenn		Glenn	
	Quality Trait	B-2	B-7	C-2	C-7	K-2	K-7	M-2	M-7
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	17.0	15.9	15.7	14.8	14.7	13.8	16.8	15.7
2	Flour Protein (%, 14% mb)	15.5	14.6	14.5	13.8	13.5	12.6	16.0	14.6
	(11)								-
3	Market Value (Score 1-6)	3.3	3.3	3.5	3.8	3.4	3.1	4.8	4.8
4	Market Value (Score 1-10)	10.0	8.4	10.0	9.0	10.0	8.6	10.0	8.4
5	DON (ppm)	0.65	1.57	0.46	0.55	0.03	0.20	1.14	0.91
6	Test Weight (lb/bu)	59.3	58.1	62.6	60.7	62.4	59.9	64.0	62.0
7	1000 Kernel Weight (g)	25.9	27.6	27.4	29.3	31.9	30.1	34.6	35.9
8	Kernel Size, % Large	40	53	44	63	66	65	75	79
9	Kernel Size, % Small	14	11	11	7	7	7	5	5
10	Wheat Moisture (%)	13.2	13.1	12.4	12.0	13.4	12.9	12.9	12.5
11	Wheat Ash (%, 14% mb)	1.97	1.69	1.71	1.58	1.65	1.46	1.70	1.58
12	Wheat Falling Number (sec)	354	369	285	385	274	326	352	386
13	SKCS Hardness Index	77.3	67.8	81.7	72.1	79.7	65.6	74.6	62.2
14	Vitreous Kernels (%)	50.7	44.6	85.5	64.9	53.1	34.5	83.4	24.0
	()								
	Flour Extraction (%)								
15	Tempered Wheat Basis (%)	62.1	68.5	68.3	70.6	68.2	70.9	70.2	69.7
16	Total Product Basis (%)	65.6	70.9	70.9	74.2	70.5	74.3	71.8	71.7
17	Flour/Bu Wheat (lbs)	37.1	39.9	43.4	43.7	42.8	42.8	45.1	43.5
	Flour Quality								
18	Flour Color Brightness (L*)	89.0	89.7	90.3	90.2	90.1	90.2	90.2	90.5
19	Flour Color Yellowness (b*)	8.8	8.7	9.4	9.1	9.1	9.1	8.5	8.1
20	Flour Moisture (%)	13.6	13.2	13.8	13.7	13.5	13.7	13.1	13.1
21	Flour Ash (%, 14% mb)	0.55	0.47	0.45	0.46	0.45	0.45	0.46	0.43
22	Flour Falling Number (Malted) (sec)	249	262	246	253	250	258	245	248
	Farinograph								
23	Water Absorption (%, 500 BU)	63.3	60.5	62.9	61.2	64.8	60.2	68.7	65.1
24	Water Absorption (%, 14% mb)	62.8	59.5	62.7	60.8	64.2	60.0	67.8	63.9
25	Arrival Time (min)	2.8	2.3	2.6	2.8	2.0	2.2	5.2	4.0
26	Peak Time (min)	10.0	7.0	8.4	7.9	7.4	5.5	11.2	8.2
27	Dough Stability (min)	15.1	13.8	11.9	11.3	11.5	8.3	15.7	11.4
28	Mixing Tolerance Index (MTI) (BU)	22	20	28	33	30	33	12	20
29	Time To Breakdown (TTB) (min)	15.9	15.3	14.0	12.7	12.5	10.3	21.1	15.4
	II. Cooperator Results						~~ -		
30	Bake Absorption (Average %)	66.8	65.0	66.6	65.0	67.2	63.7	70.6	67.5
31	Loaf Volume (% of Check)		96.0		96.3		96.4		99.3

SWQC #7 – MN14105-7

		Water	town	Casselton		Crookston		Minot	
		Glenn		Glenn		Glenn		Glenn	
	Quality Trait	B-2	B-7	C-2	C-7	K-2	K-7	M-2	M-7
	II. Cooperator Results								
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.4	6.8	5.9	5.9	6.1	5.8	6.2	5.5
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.2	6.6	5.9	6.0	6.7	6.4	7.1	7.3
34	Mixing Tolerance 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		5.0		4.5		4.6		4.4
35	Internal Crumb Color 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.8		5.4		5.1		5.3
36	Internal Grain and Texture 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		6.3		6.3		5.4		5.9
	III. Cooperator Evaluation								
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.3		3.7		3.5		3.4
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		6.8		6.4		5.5		4.1
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.9		5.2		4.5		4.9
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.3		5.2		4.4		4.5

Farinograms



Glenn Check (Casselton, C-2)



Glenn Check (Crookston, K-2)



Glenn Check (Minot, M-2)





MN14105-7 (Casselton, C-7)



MN14105-7 (Crookston, K-7)



MN14105-7 (Minot, M-7)



Mixograms



Extensograms



44

SWQC #9 – WB9479

		Water	town	Casse	elton	Crool	ston	
		Glenn		Glenn		Glenn		
	Quality Trait	B-2	B-9	C-2	C-9	K-2	K-9	
	I. USDA-ARS WQL Data							
1	Wheat Protein (%, 12% mb)	17.0	16.5	15.7	14.5	14.7	15.0	
2	Flour Protein (%, 14% mb)	15.5	15.1	14.5	13.7	13.5	13.8	
•		• •			• •			
3	Market Value (Score 1-6)	3.3	3.7	3.5	2.8	3.4	3.2	
4	Market Value (Score 1-10)	10.0	10.0	10.0	7.6	10.0	9.2	
5	DON (ppm)	0.65	1.12	0.46	0.56	0.03	1.00	
6	lest Weight (lb/bu)	59.3	59.0	62.6	59.4	62.4	60.2	
7	1000 Kernel Weight (g)	25.9	29.6	27.4	26.3	31.9	30.9	
8	Kernel Size, % Large	40	66	44	47	66	72	
9	Kernel Size, % Small	14	8	11	13	7	5	
10	Wheat Moisture (%)	13.2	13.2	12.4	11.9	13.4	12.5	
11	Wheat Ash (%, 14% mb)	1.97	1.66	1.71	1.72	1.65	1.56	
12	Wheat Falling Number (sec)	354	357	285	339	274	296	
13	SKCS Hardness Index	77.3	67.7	81.7	73.2	79.7	67.8	
14	Vitreous Kernels (%)	50.7	42.4	85.5	55.6	53.1	44.9	
	Flour Extraction (%)							
15	Tempered Wheat Basis (%)	62 1	69 5	68 3	71 1	68.2	73 2	i
16	Total Product Basis (%)	65.6	71 0	70.9	73.6	70.5	74 9	
17	Flour/Bu Wheat (lbs)	37.1	41.4	43.4	42.9	42.8	44.5	
		••••						Ì
	Flour Quality							
18	Flour Color Brightness (L*)	89.0	89.6	90.3	90.2	90.1	89.7	
19	Flour Color Yellowness (b*)	8.8	9.2	9.4	9.8	9.1	9.6	
20	Flour Moisture (%)	13.6	13.7	13.8	13.4	13.5	13.5	
21	Flour Ash (%, 14% mb)	0.55	0.45	0.45	0.46	0.45	0.43	
22	Flour Falling Number (Malted) (sec)	249	248	246	256	250	261	
	Earinggraph							
23	Water Absorption (% 500 BU)	63 3	60.0	62.9	59 9	64.8	61 1	ļ
24	Water Absorption (% 14% mb)	62.8	59.5	62.7	59 1	64.2	60.5	
25	Arrival Time (min)	2.8	24	2.6	23	2.0	2 1	
26	Peak Time (min)	10.0	9.5	8.4	7.5	74	55	
20	Dough Stability (min)	15.0	18.5	11 0	1/ 2	11.5	17.5	
20	Mixing Tolerance Index (MTI) (PU)	22	15	28	24	30	12	
20	Time To Breakdown (TTB) (min)	15.9	18.8	14.0	13.7	12.5	14.8	
								1
~~	II. Cooperator Results	00.0	647		60 0	07.0	04 7	
30	Bake Absorption (Average %)	66.8	64.7	66.6	63.8	67.2	64.7	
31	Loaf Volume (% of Check)		97.4		94.7		101.6	

SWQC #9 – WB9479

		Water	town	Casselton		Crookston	
		Glenn		Glenn		Glenn	
	Quality Trait	B-2	B-9	C-2	C-9	K-2	K-9
	II. Cooperator Results						
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.4	7.2	5.9	6.6	6.1	6.8
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.2	6.1	5.9	6.5	6.7	6.8
34	Mixing Tolerance 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		5.4		5.5		5.6
35	Internal Crumb Color 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.8		5.2		5.4
36	Internal Grain and Texture 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		6.3		5.3		5.5
	III. Cooperator Evaluation Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.1		3.8		5.5
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		7.5		5.4		6.5
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.5		5.3		5.5
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check		6.1		5.0		5.9

Farinograms

Glenn Check (Casselton, C-2)

Glenn Check (Crookston, K-2)

WB9479 (Watertown, B-9)

WB9479 (Casselton, C-9)

Mixograms

Glenn Check (Crookston, K-2)

WB9479 (Casselton, C-9)

Extensograms

SWQC #10 - ND828

		Minot		Williston		
		Glenn		Glenn		
	Quality Trait	M-2	M-10	W-2	W-10	
	I. USDA-ARS WQL Data					
1	Wheat Protein (%, 12% mb)	16.8	15.9	14.0	11.7	
2	Flour Protein (%, 14% mb)	16.0	14.9	13.1	10.6	
3	Market Value (Score 1-6)	4.8	5.3	4.2	3.5	
4	Market Value (Score 1-10)	10.0	9.0	10.0	6.4	
5	DON (ppm)	1.14	1.41	0.01	0.03	
6	Test Weight (lb/bu)	64.0	63.3	64.3	62.0	
7	1000 Kernel Weight (g)	34.6	39.2	33.0	37.6	
8	Kernel Size, % Large	75	84	70	84	
9	Kernel Size, % Small	5	4	7	5	
10	Wheat Moisture (%)	12.9	12.3	12.1	12.8	
11	Wheat Ash (%, 14% mb)	1.70	1.57	1.65	1.66	
12	Wheat Falling Number (sec)	352	388	374	375	
13	SKCS Hardness Index	74.6	70.6	81.1	74.3	
14	Vitreous Kernels (%)	83.4	48.7	55.4	55.6	
	Flour Extraction (%)					
15	Tempered Wheat Basis (%)	70.2	70.7	65.7	64.7	
16	Total Product Basis (%)	71.8	72.6	67.4	66.3	
17	Flour/Bu Wheat (lbs)	45.1	45.6	43.0	40.3	
40	Flour Quality	00.0	00.0	00.0	04.0	
18	Flour Color Brightness (L [*])	90.2	90.2	90.8	91.0	
19	Flour Color Yellowness (D^)	8.5	9.3	ð./	9.4	
20	Flour Moisture (%)	13.1	13.7	13.6	13.2	
21	Flour Asn (%, 14% mb)	0.46	0.45	0.45	0.50	
22	Flour Failing Number (Maited) (sec)	245	245	245	266	
	Earinograph					
22	Water Absorption (% 500 BU)	69.7	67.6	65.0	62.1	
23	Water Absorption (%, 500 BO)	67.8	67.0	64.4	62.2	
24	Arrival Time (min)	52	107.2	25	1 02.2	
20	Poak Time (min)	11 2	4.0	2.5	3.2	
20	Dough Stability (min)	15.7	12 3	12 3	6.8	
21	Mixing Toloranco Index (MTI) (BII)	12.7	2.5	2.5	27	
20	Time To Breakdown (TTB) (min)	21.1	15.6	14 9	87	
23		4 1.1	10.0	14.5	0.7	
	II. Cooperator Results					
30	Bake Absorption (Average %)	70.6	68.9	67.4	64.4	
31	Loaf Volume (% of Check)		101.8		92.9	

SWQC #10 - ND828

		Min	ot	Williston	
	Quality Trait	Glenn M-2	M-10	Glenn W-2	W-10
32	II. Cooperator Results Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.2	5.4	6.5	5.1
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	7.1	7.2	6.9	4.9
34	Mixing Tolerance 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		4.3		3.9
35	Internal Crumb Color 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.9		3.9
36	Internal Grain and Texture 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.9		4.5
	III. Cooperator Evaluation Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.5		1.6
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.5		3.8
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.8		3.3
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.1		2.9

Farinograms

Glenn Check (Williston, W-2)

ND828 (Minot, M-10) [FU] M-10 700 600 500 400-300-200 100 10 12 14 16 18 20 0 [min]

ND828 (Williston, W-10)

Mixograms

ND828 (Minot, M-10)

Glenn Check (Williston, W-2)

ND828 (Williston, W-10)

Extensograms

[BU] M-10 900· [cm]

ND828 (Minot, M-10)

Glenn Check (Williston, W-2)

ND828 (Williston, W-10)

SWQC #11 – Lanning

		Havre		Williston		
		LCS Rebel		Glenn		
	Quality Trait	H-1	H-11	W-2	W-11	
	I. USDA-ARS WQL Data					
1	Wheat Protein (%, 12% mb)	16.7	16.5	14.0	13.0	
2	Flour Protein (%, 14% mb)	15.6	15.6	13.1	11.9	
					-	
3	Market Value (Score 1-6)	4.8	4.5	4.2	4.2	
4	Market Value (Score 1-10)	10.0	9.6	10.0	9.0	
5	DON (ppm)	0.02	0.01	0.01	nd	
6	Test Weight (lb/bu)	60.6	60.1	64.3	63.1	
7	1000 Kernel Weight (g)	29.6	31.9	33.0	35.9	
8	Kernel Size, % Large	44	65	70	76	
9	Kernel Size, % Small	14	8	7	6	
10	Wheat Moisture (%)	11.3	10.9	12.1	12.5	
11	Wheat Ash (%, 14% mb)	1.48	1.57	1.65	1.56	
12	Wheat Falling Number (sec)	426	396	374	386	
13	SKCS Hardness Index	73.9	73.4	81.1	78.5	
14	Vitreous Kernels (%)	95.4	77.9	55.4	62.9	
	Flour Extraction (%)					
15	Tempered Wheat Basis (%)	69.1	69.7	65.7	66.4	
16	Total Product Basis (%)	70.9	71.3	67.4	67.6	
17	Flour/Bu Wheat (lbs)	42.6	42.7	43.0	42.2	
	Flour Quality					
18	Flour Color Brightness (<i>L</i> *)	90.2	90.1	90.8	90.7	
19	Flour Color Yellowness (b*)	10.1	10.3	8.7	9.8	
20	Flour Moisture (%)	12.9	12.8	13.6	13.1	
21	Flour Ash (%, 14% mb)	0.44	0.46	0.45	0.44	
22	Flour Falling Number (Malted) (sec)	255	257	245	253	
	Farinograph					
23	Water Absorption (%, 500 BU)	68.8	68.4	65.0	65.1	
24	Water Absorption (%, 14% mb)	67.6	67.1	64.4	64.1	
25	Arrival Time (min)	6.3	6.0	2.5	2.2	
26	Peak Lime (min)	10.3	11.0	8.4	5.0	
27	Dough Stability (min)	14.9	11.8	12.3	9.5	
28	WIXING LOIERANCE INDEX (MII) (BU)	14	21	22	21	
29	Time To Breakdown (TTB) (min)	20.1	17.5	14.9	11.3	
	II. Cooperator Posults					
20	Bake Absorption (Average %)	69.8	69 7	67.4	66.8	
31	L oaf Volume (% of Check)	03.0	98.9	07.4	96.0	

SWQC #11 – Lanning

		Havre		Williston	
		LCS Rebel		Glenn	
	Quality Trait	H-1	H-11	W-2	W-11
	IL Cooperator Results				
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	5.2	5.0	6.5	6.6
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.2	6.5	6.9	6.2
34	Mixing Tolerance 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		4.6		4.7
35	Internal Crumb Color 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.5		4.3
36	Internal Grain and Texture 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.7		5.1
	III. Cooperator Evaluation Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.3		3.2
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.1		4.7
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.7		4.5
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.7		4.1

Farinograms

Glenn Check (Williston, W-2)

Lanning (Havre, H-11) [FU] H-11 [min]

Lanning (Williston, W-11)

Mixograms

Lanning (Havre, H-11)

Glenn Check (Williston, W-2)

Lanning (Williston, W-11)

Extensograms

Lanning (Havre, H-11) [BU] H-11 [cm]

Glenn Check (Williston, W-2)

Lanning (Williston, W-11)

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Wheat Marketing Score

The development of a Wheat Marketing Score (WMS) or Export Marketing Score was discussed at the Hard Spring Wheat Planning Meeting in March, 2004. The purpose for developing a WMS was to facilitate a better understanding of wheat quality in marketing systems. Two WMS methods were developed and tested. For each method, the quality variables of Test Weight (TW), 1000 Kernel Weight (KWT), Falling Number (FN), Wheat Protein (WP), and Wheat Ash (WA) were incorporated for calculating the WMS. Method #1 was developed on a scale of 0 to 6 where Glenn Check was evaluated along with the experimental lines for each growing locations. Method #2 was developed on a scale of 0 to 10 where the experimental lines were evaluated against the Glenn Check for each growing locations.

Wheat Marketing Score or Export Marketing Score								
	Score	Test Weight (Ib/bu)	1000 KWT (g)	Falling Number (sec)	Wheat Protein (%, 12% mb)	Wheat Ash (%, 14% mb)		
	6	63	39	425	16.5	1.35		
	5	62	36	400	15.5	1.45		
	4	61	33	375	14.5	1.55		
Target Value	3	60	30	350	13.5	1.65		
	2	59	26	325	12.5	1.75		
	1	58	22	300	11.5	1.85		
	0	57	18	275	10.5	1.95		
Variation (+/-) fro	m Target Value	1	3 g up, 4 g down	25	1.0	0.10		

Wheat Marketing Score – Method #1

Wheat Marketing Score = [(TW*2) + (1000 KWT*2) + (FN*2) + (WP *3) + WA] / 10

Wheat Marketing Score – Method #2

Component Score	Wheat Protein (%, 12% mb)	Test Weight (Ib/bu)	Falling Number (sec)	1000 Kernel Weight (g)	Wheat Ash (%, 14% mb)
0	Diff > 6.0	Diff > 10	Diff < -125	Diff > 20	Diff > 0.5
2	5.0 < Diff ≤ 6.0	8 < Diff ≤ 10	-125 ≤ Diff < -100	16 < Diff ≤ 20	0.4 < Diff ≤ 0.5
4	4.0 < Diff ≤ 5.0	6 < Diff ≤ 8	-100 ≤ Diff < -75	12 < Diff ≤ 16	0.3 < Diff ≤ 0.4
6	3.0 < Diff ≤ 4.0	4 < Diff ≤ 6	-75 ≤ Diff < -50	8 < Diff ≤ 12	0.2 < Diff ≤ 0.3
8	2.0 < Diff ≤ 3.0	2 < Diff ≤ 4	-50 ≤ Diff < -25	4 < Diff ≤ 8	0.1 < Diff ≤ 0.2
10	-0.5 ≤ Diff ≤ 2.0	-1 ≤ Diff ≤ 2	Diff ≥ -25	-2 ≤ Diff ≤ 4	Diff ≤ 0.1
8	-1.0 ≤ Diff < -0.5	-2 ≤ Diff < -1		-4 ≤ Diff < -2	
6	-1.5 ≤ Diff < -1.0	-3 ≤ Diff < -2		-6 ≤ Diff < -4	
4	-2.0 ≤ Diff ≤ -1.5	-4 ≤ Diff < -3		-8 ≤ Diff < -6	
2	-2.5 ≤ Diff < -2.0	-5 ≤ Diff < -4		-10 ≤ Diff < -8	
0	Diff < -2.5	Diff < -5		Diff < -10	
Weight of each factor	0.3	0.2	0.2	0.2	0.1

Wheat Marketing Score = (WP*0.3) + (TW*0.2) + (FN*0.2) + (1000 TKW*0.2) + (WA*0.1)

Miag Mill Streams

		Mill			
Mill Stream	Abbreviation	Stream #		Product	
1 st Break	1 Bk	1			
2 nd Break I	2 Bk I	2			
Break Dust	Bk Dust	3			
Sizing I	Sz I	4			
2 nd Break II	2 Bk II	5			
3 rd Break	3 Bk	6			
Sizing II	Sz II	7	Lana		
5 th Break	5 Bk	8	Long	Straight Grade Flour	
4 th Break	4 Bk	9	Flour		
1 st Middlings	1 M	10	i ioui		Whole
2 nd Middlings	2 M	11			
3 rd Middlings	3 M	12			Wheat
4 th Middlings	4 M	13			Flour
6 th Middlings	6 M	15			
Tail Flour	Tail	16			
Tail Cyclone Flour*	TC	22			
5 th Middlings	5 M	14	Clear		
Low Grade	LG	17	Flour		
Low Quality	LQ	18	Tiour		
Tail Shorts	Tail Sh	19			
Head Shorts	Head Sh	20	sn sn	ort	
Bran	Bran	21	C Rr	x an	
Tail Cyclone Shorts*	TC Sh	23	Bran		

*Tail Cyclone fraction was separated into flour and short by rebolting.

Calculation of flour extraction:

- Tempered wheat basis (TWB, %): long patent flour extraction percentage of tempered wheat (14% mb);
- Total product basis (TPB, %): long patent flour percentage of the total mill product (14% mb);
- Pounds of long patent flour / bushel wheat (FWB): estimated pounds of long patent flour (14% mb) per bushel of wheat sample.

Miag Multomat Mill Flow Chart

Hard Red Spring & Durum Wheat Quality Laboratory, Cereal Crops Research Unit, USDA-ARS-ETSARC, Fargo, ND

Sieve Opening Size - µm

Wheat Kernel Characteristics by Location

				W	neat			1000							
			Wheat	Mark	ceting	DON	Test	Kernel	Kerne	el Size	Wheat	Wheat	Falling	SKCS	Vitreous
Location	п	Entry	(% 42% mb)	SC	ore	DON (nnm)	weight	weight	Large	Small	MOISTURE	ASN (% 14% mb)	Number	Hardness	Kernels
Location	B-2	Glenn	(%, 12% IIID) 17.0	33	10 0	0.65	(IDS/DU) 59 3	25.9	(%)	(%)	(70)	(/0, 14 /0 IIID) 1 97	354	77.3	(⁷ 0) 50 7
Watertown	B-6	Linkert	16.7	3.4	10.0	0.84	58.4	28.3	10	12	13.1	1.83	360	73.8	48.1
	B-7	MN14105_7	15.9	33	8.4	1 57	58.1	20.5	53	11	13.1	1.00	369	67.8	44.6
	B-0	W/B0/170	16.5	3.7	10.4	1.07	59.0	20.6	66	8	13.2	1.65	357	67.7	42.0
	C-2	Glenn	15.7	3.5	10.0	0.46	62.6	20.0	44	11	12.4	1.00	285	81 7	85.5
	C-5	NDHRS16-13-97	14 7	27	74	nd	60.4	28.4	55	10	12.6	1 71	191	81.9	61.7
Casselton	C-6	Linkert	15.6	3.6	9.7	0.15	60.4	20.4	55	9	12.0	1.64	340	78.7	68.2
easement	C-7	MN14105-7	14.8	3.8	9.0	0.55	60.7	29.3	63	7	12.0	1.58	385	72.1	64.9
	C-9	WB9479	14.5	2.8	7.6	0.56	59.4	26.3	47	13	11.0	1 72	339	73.2	55.6
	H-1	LCS Rebel	16.7	4.8	10.0	0.02	60.6	29.6	44	14	11.3	1.48	426	73.9	95.4
	H-3	WB9719	15.8	4.6	94	0.01	61.5	29.2	60	10	11.0	1 47	403	75.2	98.3
Havre	H-4	SY Longmire	17.0	4.6	10.0	nd	60.1	29.5	34	15	11.2	1.52	482	71.8	96.1
	H-11	Lanning	16.5	4.5	9.6	0.01	60.1	31.9	65	8	10.9	1.57	396	73.4	77.9
	K-2	Glenn	14.7	3.4	10.0	0.03	62.4	31.9	66	7	13.4	1.65	274	79.7	53.1
	K-6	Linkert	15.1	3.2	8.8	0.06	59.3	32.1	65	6	12.5	1.59	314	73.0	21.7
Crookston	K-7	MN14105-7	13.8	3.1	8.6	0.20	59.9	30.1	65	7	12.9	1.46	326	65.6	34.5
	K-9	WB9479	15.0	3.2	9.2	1.00	60.2	30.9	72	5	12.5	1.56	296	67.8	44.9
	M-1	LCS Rebel	15.8	5.0	9.0	1.34	63.7	38.9	83	5	12.4	1.57	354	66.7	62.7
	M-2	Glenn	16.8	4.8	10.0	1.14	64.0	34.6	75	5	12.9	1.70	352	74.6	83.4
	M-3	WB9719	16.5	5.2	9.6	nd	64.6	40.5	90	3	12.0	1.55	357	65.0	56.7
Minot	M-4	SY Lonamire	17.1	5.3	10.0	nd	63.2	37.7	84	4	12.5	1.65	384	61.8	41.6
	M-5	NDHRS16-13-97	16.8	5.4	9.2	0.53	62.3	39.9	87	4	12.7	1.58	393	66.7	18.7
	M-7	MN14105-7	15.7	4.8	8.4	0.91	62.0	35.9	79	5	12.5	1.58	386	62.2	24.0
	M-10	ND828	15.9	5.3	9.0	1.41	63.3	39.2	84	4	12.3	1.57	388	70.6	48.7
	W-1	LCS Rebel	14.6	4.9	9.2	0.01	62.5	38.7	83	4	12.8	1.58	404	67.5	60.2
	W-2	Glenn	14.0	4.2	10.0	0.01	64.3	33.0	70	7	12.1	1.65	374	81.1	55.4
	W-3	WB9719	12.5	4.1	8.2	0.02	64.7	35.5	88	4	12.9	1.58	392	75.6	45.8
Williston	W-4	SY Longmire	12.8	4.2	8.4	0.02	63.1	34.5	73	6	12.3	1.61	411	68.7	20.8
	W-5	NDHRS16-13-97	12.3	4.0	7.0	0.06	62.2	38.3	84	4	13.0	1.58	390	67.2	38.7
	W-10	ND828	11.7	3.5	6.4	0.03	62.0	37.6	84	5	12.8	1.66	375	74.3	55.6
	W-11	Lanning	13.0	4.2	9.0	nd	63.1	35.9	76	6	12.5	1.56	386	78.5	62.9

Flour Characteristics by Location

			Flour Extraction						Flour	Flour		
			TWB*	TPB*	Flour/bu	Flour Color		r	Moisture	Protein	Flour Ash	Flour FN
Location	ID	Entry	(%)	(%)	Wheat (lbs)	L*	а*	b*	(%)	(%, 14% mb)	(%, 14% mb)	Malted (sec)
	B-2	Glenn	62.1	65.6	37.1	89.0	-0.9	8.8	13.6	15.5	0.55	249
Watertown	B-6	Linkert	66.7	68.7	39.2	89.6	-0.9	8.9	13.3	15.4	0.51	246
Watertown	B-7	MN14105-7	68.5	70.9	39.9	89.7	-0.8	8.7	13.2	14.6	0.47	262
	B-9	WB9479	69.5	71.9	41.4	89.6	-0.8	9.2	13.7	15.1	0.45	248
	C-2	Glenn	68.3	70.9	43.4	90.3	-0.9	9.4	13.8	14.5	0.45	246
	C-5	NDHRS16-13-97	69.3	71.5	42.3	90.3	-0.6	8.2	13.5	13.4	0.46	248 [†]
Casselton	C-6	Linkert	69.9	72.6	42.8	90.6	-0.9	9.1	13.2	14.5	0.47	257
	C-7	MN14105-7	70.6	74.2	43.7	90.2	-0.8	9.1	13.7	13.8	0.46	253
	C-9	WB9479	71.1	73.6	42.9	90.2	-1.0	9.8	13.4	13.7	0.46	256
	H-1	LCS Rebel	69.1	70.9	42.6	90.2	-1.0	10.1	12.9	15.6	0.44	255
Havre	H-3	WB9719	68.7	70.4	43.4	90.1	-1.1	10.4	13.4	14.9	0.45	260
TIAVIC	H-4	SY Longmire	70.9	72.0	43.6	89.9	-1.1	10.7	13.1	16.2	0.47	252
	H-11	Lanning	69.7	71.3	42.7	90.1	-1.1	10.3	12.8	15.6	0.46	257
	K-2	Glenn	68.2	70.5	42.8	90.1	-0.9	9.1	13.5	13.5	0.45	250
Crookston	K-6	Linkert	69.4	72.0	41.5	90.2	-0.9	8.6	13.3	14.1	0.46	251
orookston	K-7	MN14105-7	70.9	74.3	42.8	90.2	-0.9	9.1	13.7	12.6	0.45	258
	K-9	WB9479	73.2	74.9	44.5	89.7	-0.9	9.6	13.5	13.8	0.43	261
	M-1	LCS Rebel	71.8	74.3	46.3	90.4	-0.8	8.6	13.7	14.6	0.43	249
	M-2	Glenn	70.2	71.8	45.1	90.2	-0.7	8.5	13.1	16.0	0.46	245
	M-3	WB9719	70.8	71.6	46.2	90.2	-0.8	8.6	12.7	15.3	0.41	243
Minot	M-4	SY Longmire	69.0	72.1	44.3	90.3	-0.8	8.8	13.7	16.0	0.43	241
	M-5	NDHRS16-13-97	69.9	71.8	44.0	90.4	-0.3	7.2	13.5	15.6	0.45	248
	M-7	MN14105-7	69.7	71.7	43.5	90.5	-0.6	8.1	13.1	14.6	0.43	248
	M-10	ND828	70.7	72.6	45.6	90.2	-0.9	9.3	13.7	14.9	0.45	245
	W-1	LCS Rebel	69.0	71.1	43.4	90.5	-0.9	8.8	13.1	13.6	0.43	254
	W-2	Glenn	65.7	67.4	43.0	90.8	-1.0	8.7	13.6	13.1	0.45	245
	W-3	WB9719	63.7	65.4	41.4	90.9	-1.1	9.0	13.2	11.4	0.42	258
Williston	W-4	SY Longmire	66.9	68.5	42.7	90.8	-1.2	9.4	13.1	11.7	0.44	244
	W-5	NDHRS16-13-97	67.7	69.5	42.4	90.9	-0.6	7.3	13.5	11.3	0.44	257
	W-10	ND828	64.7	66.3	40.3	91.0	-1.2	9.4	13.2	10.6	0.50	266
	W-11	Lanning	66.4	67.6	42.2	90.7	-1.2	9.8	13.1	11.9	0.44	253

*TWB = Tempered wheat basis; TPB = Total product basis. [†] Not malted.

Flour Protein Characteristics by Location

				HMW Glutenin Subunits				
Location	ID	Entry	TPP/TMP*	GLU-A1	GLU-B1	GLU-D1		
	B-2	Glenn	0.82	2*	7+9	5+10		
Watertown	B-6	Linkert	0.92	1,2*	7 ^{oe} +8	5+10		
watertown	B-7	MN14105-7	0.88	1	7+8	5+10		
	B-9	WB9479	0.86	1,2*	7 ^{oe} +8	5+10		
	C-2	Glenn	0.92	2*	7+9	5+10		
	C-5	NDHRS16-13-97	0.95	2*	7+9	5+10		
Casselton	C-6	Linkert	0.99	1,2*	7 ^{oe} +8	5+10		
	C-7	MN14105-7	0.98	1	7+8	5+10		
	C-9	WB9479	0.94	1,2*	7 ^{oe} +8	5+10		
	H-1	LCS Rebel	0.89	2*	7+9	5+10		
Havre	H-3	WB9719	0.83	2*	7+9	5+10		
navio	H-4	SY Longmire	0.73	2*	7+9	5+10		
	H-11	Lanning	0.84	2*	7+9	5+10		
	K-2	Glenn	0.92	2*	7+9	5+10		
Crookston	K-6	Linkert	0.88	1,2*	7 ^{oe} +8	5+10		
	K-7	MN14105-7	0.91	1	7+8	5+10		
	K-9	WB9479	0.88	1,2*	7 ^{oe} +8	5+10		
	M-1	LCS Rebel	0.98	2*	7+9	5+10		
	M-2	Glenn	0.91	2*	7+9	5+10		
	M-3	WB9719	0.89	2*	7+9	5+10		
Minot	M-4	SY Longmire	0.85	2*	7+9	5+10		
	M-5	NDHRS16-13-97	0.92	2*	7+9	5+10		
	M-7	MN14105-7	0.92	1	7+8	5+10		
	M-10	ND828	0.92	2*	7+9	5+10		
	VV-1	LCS Rebei	0.90	2*	7+9	5+10		
	VV-2	Glenn	1.00	2^	7+9	5+10		
	VV-3	WB9719	0.97	2*	7+9	5+10		
Williston	VV-4	SY Longmire	0.92	2^	7+9	5+10		
	VV-5	NDHKS16-13-97	1.00	2*	7+9	5+10		
	VV-10	ND828	1.01	2^	7+9	5+10		
	VV-11	Lanning	1.05	2*	7+9	5+10		

TPP/TMP = Total polymeric protein / total monomeric protein.

Farinograph Characteristics by Location

					Arrival	Peak	Dough		
Location	п	Entry	Water Abs.	Water Abs.	Time (min)	Time	Stability	MTI	TTB
Location		Clonn	(%, 500 BC)	(70, 1470 IIID)	(11111)	10.0	(1111)	(60)	15.0
	B-6	Linkert	62.0	61 1	2.0	8.4	10.0	13	20.8
Watertown	B-7	MN1/105_7	60.5	59.5	2.7	7.0	13.0	20	15.3
	B-9	WR9479	60.0	59.5	2.5	9.5	18.5	15	18.8
	C-2	Glenn	62.9	62.7	2.6	8.4	11.9	28	14.0
	C-5	NDHRS16-13-97	62.8	62.4	27	6.5	11.6	14	14 4
Casselton	C-6	Linkert	61.9	61.1	3.6	10.5	18.8	19	19.0
	C-7	MN14105-7	61.2	60.8	2.8	7.9	11.3	33	12.7
	C-9	WB9479	59.9	59.1	2.3	7.5	14.2	24	13.7
	H-1	LCS Rebel	68.8	67.6	6.3	10.3	14.9	14	20.1
Hayma	H-3	WB9719	67.5	66.8	5.6	10.2	13.5	15	19.4
navre	H-4	SY Longmire	68.6	67.7	5.0	10.3	19.3	13	22.7
	H-11	Lanning	68.4	67.1	6.0	11.0	11.8	21	17.5
	K-2	Glenn	64.8	64.2	2.0	7.4	11.5	30	12.5
Crookston	K-6	Linkert	62.5	61.8	2.2	8.2	16.7	20	15.1
CIOOKSION	K-7	MN14105-7	60.2	60.0	2.2	5.5	8.3	33	10.3
	K-9	WB9479	61.1	60.5	2.1	5.5	17.5	12	14.8
	M-1	LCS Rebel	67.4	67.2	4.9	9.5	10.1	29	15.0
	M-2	Glenn	68.7	67.8	5.2	11.2	15.7	12	21.1
	M-3	WB9719	68.5	67.1	4.8	9.3	12.4	23	17.0
Minot	M-4	SY Longmire	69.4	69.3	5.4	10.0	10.1	23	16.4
	M-5	NDHRS16-13-97	71.0	70.3	5.6	9.4	10.2	20	16.6
	M-7	MN14105-7	65.1	63.9	4.0	8.2	11.4	20	15.4
	M-10	ND828	67.6	67.2	4.8	9.2	12.3	22	15.6
	VV-1	LCS Rebel	64.0	62.8	3.0	9.0	12.8	30	14.0
	W-2	Glenn	65.0	64.4	2.5	8.4	12.3	22	14.9
	VV-3	WB9/19	63.6	62.7	1.9	3.3	9.1	13	11.1
williston	VV-4	ST LONGMIRE	02.8	01.0	2.0	4.5	ö.5	22	10.7
	VV-5	NUHK516-13-9/	03.1 62.1	62.5	2.2	3.3 2.2	1.5	21	9.3
	VV-10	ND828	63.1	62.2	1.8	3.2	6.ð	27	ŏ./
	VV-11	Lanning	65.1	64.1	2.2	5.0	9.5	21	11.3

Mixograph Characteristics by Location

			Envelope Peak	Envelope Peak	Envelope Peak	Midline Peak	Midline Peak	Midline Peak	Midline Peak
			Time	Value	Width	Time	Value	Width	Integral
Location	ID	Entry	(min)	(%)	(%)	(min)	(%)	(%)	(% TQ*min)
	B-2	Glenn	5.6	68.6	29.6	6.0	53.5	25.8	229.0
Watertown	B-6	Linkert	6.1	65.7	31.2	6.6	51.6	23.7	230.0
	B-7	MN14105-7	7.3	59.4	27.3	7.5	45.3	26.4	251.7
	B-9	WB9479	7.6	63.0	30.7	7.8	47.4	27.3	252.6
	C-2	Glenn	4.7	73.3	35.3	4.9	54.8	33.9	198.5
	C-5	NDHRS16-13-97	4.9	68.5	31.1	5.2	52.4	30.2	207.9
Casselton	C-6	Linkert	5.6	70.9	31.0	5.7	55.2	30.5	213.3
	C-7	MN14105-7	4.5	64.3	29.9	4.7	49.1	28.6	173.1
	C-9	WB9479	5.9	65.0	32.7	6.6	49.7	27.5	237.4
	H-1	LCS Rebel	3.7	77.9	32.9	3.6	61.4	31.5	155.4
Havro	H-3	WB9719	3.4	70.8	27.9	3.5	56.6	27.9	143.4
TIAVIE	H-4	SY Longmire	3.6	71.7	30.5	3.8	56.5	29.1	158.6
	H-11	Lanning	2.9	71.6	29.0	3.2	58.0	25.2	135.5
	K-2	Glenn	4.4	69.8	29.7	4.7	54.6	26.9	196.6
Crookston	K-6	Linkert	6.1	67.6	30.9	6.6	52.7	26.9	255.6
Orookston	K-7	MN14105-7	4.8	61.0	29.5	5.2	45.2	26.6	189.3
	K-9	WB9479	6.5	65.6	27.8	6.5	50.8	27.8	238.4
	M-1	LCS Rebel	3.3	78.9	36.4	3.7	60.9	31.9	163.3
	M-2	Glenn	4.0	79.0	33.3	4.3	62.5	31.4	187.1
	M-3	WB9719	3.9	76.1	33.6	3.7	58.5	30.9	160.8
Minot	M-4	SY Longmire	2.4	73.0	29.3	2.6	58.2	27.9	112.0
	M-5	NDHRS16-13-97	2.6	82.9	40.7	2.9	62.9	36.8	134.8
	M-7	MN14105-7	3.7	67.7	31.5	4.3	52.6	26.1	169.8
	M-10	ND828	3.6	75.1	31.4	3.7	59.4	30.3	164.1
	W-1	LCS Rebel	5.8	67.3	28.4	5.6	53.0	26.5	228.0
	W-2	Glenn	4.8	72.0	32.6	4.8	55.1	32.5	200.9
	W-3	WB9719	6.5	60.7	29.5	5.2	45.8	27.7	196.4
Williston	W-4	SY Longmire	5.0	63.6	32.3	4.4	47.2	23.9	174.4
	W-5	NDHRS16-13-97	5.4	62.9	30.4	5.5	47.3	29.0	221.1
	W-10	ND828	3.5	55.5	27.0	5.0	43.4	22.1	189.5
	W-11	Lanning	5.5	64.9	31.4	5.9	48.8	28.5	238.8

Interpreting Mixogram Results

Among the numbers on the previous page, the time to peak (maximum mixing resistance) for both the top of the envelope and midline is shown, including envelope and midline % of full value. These values are traditionally the most meaningful. A midline peak time around 3-5 minutes and 60% scale are usually about right for bread flour. Very steep slopes for left-of-peak and right-of-peak are undesirable, which indicate a flour sample with low tolerance and high sensitivity to mixing time.

Delayed peaks and narrow widths (especially at about 8 minutes) are often taken as indicating "weakness."

Integral values for the midline section are for the areas beneath the midline from time 0 to the peak. Units are the vertical axis (% torque) multiplied by the horizontal axis (minutes). These values represent the work put into the flour and water in order to develop the dough.

In summary, the midline time to peak and % peak values, the top line ascending and descending slopes, and the bandwidth at 8 minutes are the values most used. "Best" values are typically determined by the breeder, miller, and baker. (MixSmart Documentation and Instructions, A.E. Walker and C.E. Walker, 2004, National Manufacturing Company)

Extensograph Characteristics by Location

45 Minutes Resting												
Location	ID	Entry	Energy (cm²)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)				
Watertown	B-2	Glenn	85	247	160	444	1.5	2.8				
	B-6	Linkert	100	280	164	513	1.7	3.1				
	B-7	MN14105-7	80	276	147	442	1.9	3.0				
	B-9	WB9479	102	312	157	530	2.0	3.4				
Casselton	C-2	Glenn	79	202	171	381	1.2	2.2				
	C-5	NDHRS16-13-97	83	239	159	436	1.5	2.8				
	C-6	Linkert	98	241	179	442	1.4	2.5				
	C-7	MN14105-7	76	244	149	416	1.6	2.8				
	C-9	WB9479	98	325	149	545	2.2	3.7				
Havre	H-1	LCS Rebel	72	189	174	327	1.1	1.9				
	H-3	WB9719	56	193	148	299	1.3	2.0				
	H-4	SY Longmire	78	202	170	374	1.2	2.2				
	H-11	Lanning	73	165	187	313	0.9	1.7				
Crookston	<mark>K-2</mark>	Glenn	75	222	158	394	1.4	2.5				
	K-6	Linkert	106	264	169	529	1.6	3.1				
	K-7	MN14105-7	72	271	139	422	2.0	3.0				
	K-9	WB9479	89	208	173	439	1.2	2.5				
Minot	M-1	LCS Rebel	67	154	182	301	0.9	1.7				
	M-2	Glenn	112	224	191	496	1.2	2.6				
	M-3	WB9719	77	177	186	332	1.0	1.8				
	M-4	SY Longmire	54	111	218	182	0.5	0.8				
	M-5	NDHRS16-13-97	68	155	197	263	0.8	1.3				
	M-7	MN14105-7	76	234	155	399	1.5	2.6				
	M-10	ND828	64	196	159	321	1.2	2.0				
Williston	W-1	LCS Rebel	85	262	154	460	1.7	3.0				
	W-2	Glenn	89	290	151	486	1.9	3.2				
	W-3	WB9719	84	436	122	533	3.6	4.4				
	W-4	SY Longmire	61	225	140	347	1.6	2.5				
	W-5	NDHRS16-13-97	93	304	152	505	2.0	3.3				
	W-10	ND828	49	206	129	304	1.6	2.4				
	W-11	Lanning	91	282	156	472	1.8	3.0				

90 Minutes Resting												
								Ratio				
	15	E sa fue a	Energy	Resistance	Extensibility	Maximum	Ratio	Number				
Location		Entry	(Cm ⁻)	(BU)	(mm)	(BU)	Number	(max)				
	D-2	Gienn	121	404	149	705	3.1	4.3				
Watertown	D-0 D 7	MNI14105 7	107	409	102	705	3.2	4.0				
	D-/ B-0	W/R0/70	107	404 5/3	135	678	3.0	4.5				
	C-2	Glenn	120	429	146	545	29	3.0				
	C-5	NDHRS16-13-07	105	530	130	605	4 1	47				
Casselton	C-6	Linkert	116	512	131	712	30	5.4				
Cassellon	C-7	MN14105-7	96	387	138	550	2.8	4.0				
	C-9	WB9479	97	439	128	611	3.4	4.8				
	H-1	LCS Rebel	90	307	150	474	2.1	3.2				
	H-3	WB9719	91	416	135	517	3.1	3.8				
Havre	H-4	SY Lonamire	101	346	157	492	2.2	3.1				
	H-11	Lanning	91	279	159	458	1.8	2.9				
	K-2	Glenn	91	475	119	616	4.0	5.2				
Creekster	K-6	Linkert	135	572	137	792	4.2	5.8				
CIOOKSION	K-7	MN14105-7	85	620	103	678	6.0	6.6				
	K-9	WB9479	116	669	117	770	5.7	6.6				
	M-1	LCS Rebel	113	382	159	539	2.4	3.4				
	M-2	Glenn	122	518	139	692	3.7	5.0				
	M-3	WB9719	101	479	131	577	3.7	4.4				
Minot	M-4	SY Longmire	60	122	213	212	0.6	1.0				
	M-5	NDHRS16-13-97	72	240	159	345	1.5	2.2				
	M-7	MN14105-7	103	464	129	640	3.6	5.0				
	M-10	ND828	103	375	151	526	2.5	3.5				
	W-1	LCS Rebel	88	631	101	700	6.2	6.9				
	W-2	Glenn	87	754	90	818	8.4	9.1				
	VV-3	WB9719	68	620	87	676	7.1	7.8				
Williston	W-4	SY Longmire	70	536	95	592	5.6	6.2				
	VV-5	NDHRS16-13-97	101	585	115	/10	5.1	6.2				
	VV-10	ND828	55	447	93	494	4.8	5.3				
	VV-11	Lanning	93	501	119	667	4.2	5.6				
	135 Minutes Resting											
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Location	ID	Entry	Energy (cm²)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)				
	B-2	Glenn	121	564	134	712	4.2	5.3				
Watertown	В-6	Linkert	121	611	125	777	4.9	6.2				
	В-7	MN14105-7	115	485	140	635	3.5	4.5				
	В-9	WB9479	116	623	122	734	5.1	6.0				
Casselton	C-2	Glenn	100	525	123	636	4.3	5.2				
	C-5	NDHRS16-13-97	78	573	98	622	5.8	6.3				
	C-6	Linkert	134	607	138	751	4.4	5.4				
	C-7	MN14105-7	117	542	139	669	3.9	4.8				
	C-9	WB9479	102	539	118	720	4.6	6.1				
Havre	H-1	LCS Rebel	<mark>93</mark>	468	125	565	3.8	4.5				
	H-3	WB9719	76	460	111	540	4.1	4.9				
	H-4	SY Longmire	103	437	139	571	3.1	4.1				
	H-11	Lanning	89	378	136	522	2.8	3.8				
Crookston	<mark>K-2</mark>	Glenn	<mark>84</mark>	641	100	690	6.4	6.9				
	K-6	Linkert	115	577	121	797	4.8	6.6				
	K-7	MN14105-7	76	700	88	711	8.0	8.1				
	K-9	WB9479	106	680	112	784	6.1	7.0				
Minot	M-1	LCS Rebel	108	499	135	594	3.7	4.4				
	M-2	Glenn	114	625	119	782	5.3	6.6				
	M-3	WB9719	74	520	100	616	5.2	6.1				
	M-4	SY Longmire	67	153	196	258	0.8	1.3				
	M-5	NDHRS16-13-97	92	262	178	396	1.5	2.2				
	M-7	MN14105-7	105	550	124	680	4.4	5.5				
	M-10	ND828	81	464	115	556	4.1	4.9				
Williston	W-1	LCS Rebel	78	717	87	754	8.3	8.7				
	W-2	Glenn	84	863	80	896	10.8	11.2				
	W-3	WB9719	73	725	86	725	8.4	8.4				
	W-4	SY Longmire	70	682	85	685	8.1	8.1				
	W-5	NDHRS16-13-97	84	792	86	797	9.2	9.3				
	W-10	ND828	45	542	68	567	8.0	8.4				
	W-11	Lanning	86	660	100	721	6.6	7.2				

Ash Content in Mill Streams

Glenn Check - Casselton



	<u>Stre</u> (%, 14	eam % mb)	<u>Cumulative</u> (%, 14% mb)			
Mill Stream	Yield	Ash	Yield	Ash		
Patent:						
1 M	13.8	0.31	13.8	0.31		
2 M	14.8	0.31	28.6	0.31		
Sz I	3.8	0.33	32.3	0.31		
3 M	10.0	0.37	42.4	0.33		
Sz II	3.0	0.41	45.4	0.33		
4 M	7.0	0.57	52.4	0.36		
Bk Dust	3.3	0.58	55.6	0.38		
1 Bk	1.8	0.62	57.4	0.38		
3 Bk	1.8	0.66	59.1	0.39		
4 Bk	3.8	0.67	62.9	0.41		
2 Bk II	1.3	0.70	64.2	0.42		
2 Bk I	0.8	0.71	64.9	0.42		
6 M	3.0	0.89	67.9	0.44		
TC	0.5	0.94	68.4	0.44		
5 Bk	1.3	1.10	69.7	0.46		
Tail	1.3	1.41	70.9	0.47		
Clear Flour:						
5 M	1.8	1.56	72.7	0.50		
LG	1.0	1.57	73.7	0.51		
LQ	0.3	1.83	73.9	0.52		
Bran & Shorts:						
TC Sh	0.3	1.97	74.2	0.52		
Tail Sh	1.5	3.55	75.7	0.58		
Head Sh	15.5	4.30	91.2	1.22		
Bran	8.8	7.27	100.0	1.75		
Patent (Rebolted)		0.45				
Wheat		1 71				

Cooperators' Bake Data

Glenn Checks

WATERTOWN (B-2)										
		Loaf								
	Bake	Volume	Mixing	Dough						
Cooperator	Absorption (%)	(cc)	Requirement	Characteristics						
Α	68.0	1000	5	7						
В	62.0	3000	5	5						
С	72.0	1150	7	7						
D	67.8	1061	6	6						
E	64.8	1123	6	6						
F	72.1	1085	7	5						
G	63.3	2546	5	7						
н	65.6	1125	5	6						
I	62.0	2956	7	5						
J	72.2	1063	8	7						
K	64.8	2650	9	7						
Avg.	66.8		6.4	6.2						
S.D.	3.9		1.4	0.9						

CASSSELTON (C-2)											
		Loaf									
	Bake	Volume	Mixing	Dough							
Cooperator	Absorption (%)	(cc)	Requirement	Characteristics							
Α	68.0	1110	5	7							
В	61.0	2975	5	5							
С	71.0	1005	5	7							
D	67.7	1007	5	7							
E	65.0	1066	5	6							
F	72.5	1060	7	5							
G	62.9	2368	5	5							
н	66.1	1180	5	6							
I	62.0	3015	7	5							
J	72.0	1050	7	7							
κ	64.7	2525	9	5							
Avg.	66.6		5.9	5.9							
SD	40		14	0 9							

	CR	OOKSION ((K-2)								
		Loaf									
	Bake	Volume	Mixing	Dough							
Cooperator	Absorption (%)	(cc)	Requirement	Characteristics							
Α	66.5	1110	5	7							
В	60.0	2950	7	7							
С	70.0	965	5	7							
D	69.4	900	5	6							
E	67.3	930	5	6							
F	72.1	925	7	7							
G	64.8	2296	5	6							
н	68.2	1025	5	6							
I	64.0	2927	8	7							
J	70.6	960	6	8							
K	66.2	2825	9	7							
Avg.	67.2		6.1	6.7							
S.D.	3.4		1.4	0.6							

		MINOT (M-2)								
		Loaf									
	Bake	Volume	Mixing	Dough							
Cooperator	Absorption (%)	(cc)	Requirement	Characteristics							
Α	70.5	1060	5	7							
В	62.0	2925	7	7							
С	73.0	1180	5	7							
D	72.8	986	5	7							
E	71.4	1078	4	6							
F	74.7	945	7	7							
G	68.7	2433	5	6							
н	72.5	1175	5	8							
I	66.0	3045	9	9							
J	75.2	988	7	7							
ĸ	69.8	2725	9	7							
Avg.	70.6		6.2	7.1							
S.D.	3.9		1.7	0.8							

	WILLISTON (W-2)											
		Loaf										
	Bake	Volume	Mixing	Dough								
Cooperator	Absorption (%)	(cc)	Requirement	Characteristics								
Α	67.0	1040	5	7								
В	60.0	2900	7	7								
С	69.0	940	5	5								
D	69.3	864	5	7								
E	68.7	912	6	5								
F	70.8	830	7	9								
G	65.0	2467	5	6								
н	68.3	1025	5	6								
I	64.0	2868	9	9								
J	73.2	944	9	8								
κ	66.4	2650	9	7								
Avg.	67.4		6.5	6.9								
S.D.	3.6		1.8	1.4								

LCS Rebel Check

		HAVRE (H-1)								
		Loaf									
	Bake	Volume	Mixing	Dough							
Cooperator	Absorption (%)	(cc)	Requirement	Characteristics							
A	70.0	1095	3	7							
В	62.0	3050	7	7							
С	71.0	950	3	5							
D	72.4	986	5	5							
E	73.3	969	4	5							
F	73.5	1130	5	7							
G	68.8	2526	3	2							
н	69.7	1100	4	6							
I	66.0	3015	9	9							
J	71.9	1080	5	8							
K	69.6	2700	9	7							
Avg.	69.8		5.2	6.2							
S.D.	3.4		2.2	1.9							

LCS Rebel

	MINOT (M-1)												
		Lo	oaf Volume			Quality Score Compared to Check (Glenn)							
	Bake						Internal	Internal					
	Absorption			Mixing	Dough	Mixing	Crumb	Grain &					
Cooperator	(%)	_ (cc) _	(% of Check) _	Requirement _	Characteristics _	Tolerance	_ Color _	Texture_	_Protein_	Milling _	Baking _	Overall	
Α	67.5	925	87.3	3	7	3	5	5	3	7	5	4	
В	61.0	2900	99.1	7	7	5	5	5	5	5	5	5	
С	71.0	1040	88.1	3	7	5	5	5	3	7	3	5	
D	72.3	918	93.1	5	7	3	4	6	3	7	2	4	
E	69.1	955	88.6	4	6	6	6	5	3	7	5	5	
F	73.3	1095	115.9	5	9	5	5	5	3	5	3	5	
G	67.4	2562	105.3	5	6	5	5	5	4	6	5	5	
н	69.6	1075	91.5	4	6	2	4	5	3	6	4	4	
I	66.0	3045	100.0	8	8	5	5	4	5	6	5	5	
J	74.4	1028	104.0	6	8	4	5	5	3	5	6	5	
K	69.2	2525	92.7	9	9	7	5	3	3	7	5	7	
Avg.	69.2		96.9	5.4	7.3	4.5	4.9	4.8	3.5	6.2	4.4	4.9	
S.D.	3.7		8.9	2.0	1.1	1.4	0.5	0.8	0.8	0.9	1.2	0.8	

					WILLISTON (W	/-1)							
		Lo	oaf Volume			Quality Score Compared to Check (Glenn)							
	Bake						Internal	Internal					
	Absorption			Mixina	Dough	Mixina	Crumb	Grain &					
Cooperator	(%)	(cc)	(% of Check)	Requirement	Characteristics	Tolerance	Color	Texture	Protein	Milling	Baking	Overall	
Α	68.0	1050	101.0	5	9	5	5	7	6	9	5	7	
В	60.0	2850	98.3	5	5	7	5	5	5	5	7	7	
С	70.0	970	103.2	5	5	5	5	7	5	5	5	5	
D	67.7	846	97.9	5	7	4	5	5	6	6	4	5	
E	65.7	897	98.4	6	6	5	5	5	5	7	5	5	
F	71.2	900	108.4	9	9	5	7	7	5	7	7	7	
G	64.0	2402	97.4	5	5	5	5	5	6	6	5	5	
н	67.7	1080	105.4	5	6	5	6	6	6	6	6	6	
I	63.0	3015	105.1	8	8	5	5	6	5	6	5	5	
J	72.7	1010	107.0	8	7	5	5	5	6	6	5	5	
K	64.8	2600	98.1	9	9	7	5	5	7	7	5	7	
Avg.	66.8		101.8	6.4	6.9	5.3	5.3	5.7	5.6	6.4	5.4	5.8	
S.D.	3.8		4.1	1.7	1.6	0.9	0.6	0.9	0.7	1.1	0.9	1.0	

	HAVRE (H-3)												
		Lo	oaf Volume				Quality S	Score Comp	ared to Ch	eck (LCS I	Rebel)		
	Bake				Dt		Internal	Internal					
	Absorption			Mixing	Dough	Mixing	Crumb	Grain &					
Cooperator	(%)	(cc)	_ (% of Check) _	Requirement	Characteristics	Tolerance	Color	Texture	Protein	Milling	Baking	Overall	
Α	68.0	950	86.8	3	7	3	3	7	3	5	5	3	
В	61.0	2975	97.5	5	5	3	5	5	5	5	3	3	
С	70.0	900	94.7	3	5	1	3	3	3	5	3	3	
D	72.0	911	92.4	5	5	5	5	6	4	5	4	4	
E	69.5	933	96.3	4	6	5	3	7	4	5	5	5	
F	70.9	1030	91.2	5	7	3	7	5	3	5	7	5	
G	67.5	2691	106.5	4	4	6	5	5	4	5	5	4	
н	68.0	1010	91.8	5	7	4	5	3	3	5	4	4	
I	65.0	3015	100.0	5	5	3	5	4	3	6	3	3	
J	68.0	995	92.1	5	8	5	5	5	4	5	4	4	
ĸ	68.8	2775	102.8	7	5	3	5	5	3	5	3	3	
Avg.	68.1		95.6	4.6	5.8	3.7	4.6	5.0	3.5	5.1	4.2	3.7	
S.D.	3.0		5.7	1.1	1.3	1.4	1.2	1.3	0.7	0.3	1.3	0.8	

					MINOT (M-3)						
		Lo	oaf Volume				Qualit	y Score Co	mpared to	Check (Gle	enn)	
Cooperator	Bake Absorption (%)	(cc)	(% of Check)	- Mixing Requirement	Dough Characteristics	Mixing	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
Α	68.0	950	89.6	3	9	3	5	5	4	5	5	4
В	61.0	2900	99.1	7	7	5	5	5	5	5	5	5
С	72.0	1040	88.1	3	7	3	5	5	3	7	3	5
D	72.1	925	93.8	4	7	4	5	5	5	7	2	5
E	70.5	966	89.6	4	6	6	5	6	4	5	4	4
F	72.3	1020	107.9	5	9	5	5	5	5	5	3	5
G	68.5	2240	92.1	5	6	5	5	5	5	5	4	5
н	72.6	1090	92.8	4	6	3	5	6	5	5	4	4
I	66.0	3015	99.0	8	8	5	5	4	5	6	5	5
J	69.7	1000	101.2	5	7	4	5	5	4	5	5	5
ĸ	69.1	2725	100.0	9	7	5	5	5	3	5	5	5
Avg.	69.3		95.8	5.2	7.2	4.4	5.0	5.1	4.4	5.5	4.1	4.7
S.D.	3.4		6.1	2.0	1.1	1.0	0.0	0.5	0.8	0.8	1.0	0.5

					WILLISTON (W	/-3)						
		Lo	oaf Volume				Quality	y Score Co	npared to	Check (Gle	enn)	
Cooperator	Bake Absorption (%)	(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
Α	65.0	900	86.5	5	5	5	3	5	2	1	5	2
В	57.0	2750	94.8	3	3	3	5	5	3	5	3	3
С	67.0	855	91.0	5	3	5	5	5	1	3	3	3
D	67.6	776	89.8	5	7	6	5	6	3	5	3	4
E	68.1	817	89.6	6	6	5	5	6	3	4	4	4
F	66.8	800	96.4	7	5	3	5	5	3	3	5	5
G	63.6	2243	90.9	5	4	5	5	6	3	4	3	4
н	67.2	950	92.7	6	7	3	5	4	3	4	4	3
I	63.0	2897	101.0	8	8	5	5	7	5	4	5	5
J	69.8	933	98.8	8	7	5	5	4	2	5	5	5
ĸ	64.7	2700	101.9	9	5	5	5	5	3	5	5	3
Avg.	65.4		93.9	6.1	5.5	4.5	4.8	5.3	2.8	3.9	4.1	3.7
S.D.	3.5		5.0	1.8	1.7	1.0	0.6	0.9	1.0	1.2	0.9	1.0

SY Longmire

					HAVRE (H-4	·)						
		Lo	oaf Volume				Quality S	Score Comp	bared to Ch	eck (LCS I	Rebel)	
	Bake Absorption			Mixing	Dough	Mixing	Internal Crumb	Internal Grain &				
Cooperator	(%)	(cc)	(% of Check)	Requirement	Characteristics	Tolerance	Color	Texture	Protein	Milling	Baking	Overall
Α	70.0	1000	91.3	5	9	3	3	5	7	7	5	5
В	62.0	3100	101.6	7	7	5	5	5	5	5	5	5
С	72.0	910	95.8	3	5	3	5	5	5	7	3	5
D	72.8	1004	101.8	5	5	5	6	5	5	5	5	5
E	70.6	1027	106.0	4	6	6	5	6	5	6	6	6
F	72.7	1150	101.8	5	7	4	7	3	7	5	5	5
G	68.6	2855	113.0	5	5	6	5	5	6	6	7	6
н	71.3	1200	109.1	3	5	6	6	5	5	5	6	6
I	66.0	3045	101.0	9	9	7	5	5	7	6	7	6
J	72.2	1150	106.5	5	8	5	5	5	6	5	6	6
ĸ	69.7	2950	109.3	9	7	5	5	7	5	5	7	7
Avg.	69.8		103.4	5.5	6.6	5.0	5.2	5.1	5.7	5.6	5.6	5.6
S.D.	3.3		6.3	2.1	1.6	1.3	1.0	0.9	0.9	0.8	1.2	0.7

MINOT (M-4) Quality Score Compared to Check (Glenn) Loaf Volume Mixing Dough Mixing (% of Check) Requirement Characteristics Tolerance 83.0 3 3 Internal Internal Bake Absorption (%) Grain & Crumb Protein 5 5 Cooperator (cc) Color Texture Milling Baking Overall Α 70.0 880 3 3 3 3 2 в 62.0 2900 99.1 3 3 3 5 5 5 3 3 7 С 71.0 96.6 5 5 3 3 1140 1 1 5 5 D 74.3 988 100.2 3 4 4 5 6 5 5 2 4 3 3 5 Е 69.9 1098 101.9 6 4 7 5 5 5 5 5 5 5 7 F 73.3 1145 121.2 3 7 7 5 5 5 69.4 2432 100.0 6 5 6 G 5 5 5 5 н 71.6 1200 102.1 4 5 2 7 5 5 5 4 5 2 3 67.0 2986 98.1 4 5 2 5 4 4 3 5 5 7 5 75.4 1103 111.6 3 4 6 6 5 6 J 71.3 5 5 κ 2900 106.4 5 3 5 3 7 3 3.4 1.1 2.9 1.3 5.2 1.2 5.1 1.4 Avg. S.D. 70.5 101.8 5.0 4.5 4.2 4.8 4.5 3.7 9.5 1.3 1.0 0.8 1.5 1.5

					WILLISTON (W	/-4)						
		Lc	oaf Volume		· · ·		Quality	y Score Coi	npared to	Check (Gle	enn)	
0	Bake Absorption			Mixing	Dough	Mixing	Internal Crumb	Internal Grain &	Duratala	5.8°111	Delling	0
Cooperator	(%)	(CC)	(% of Check)	Requirement	Characteristics	Tolerance	Color	Texture	Protein	Milling	вакіпд	Overall
Α	64.5	975	93.8	5	5	3	3	5	2	5	5	3
В	58.0	2800	96.6	3	3	3	5	5	3	5	3	3
С	67.0	890	94.7	5	3	3	5	5	1	5	3	3
D	66.7	820	94.9	5	6	5	5	6	4	5	3	4
E	67.5	904	99.1	5	6	5	5	7	3	5	5	5
F	65.6	875	105.4	5	7	3	7	9	3	5	9	7
G	62.8	2493	101.1	5	4	4	6	5	3	5	4	5
н	66.5	1090	106.3	5	7	3	4	5	4	5	5	4
1	62.0	3015	105.1	7	5	4	5	5	4	5	4	4
J	70.0	913	96.7	5	7	5	6	6	2	5	5	5
K	63.6	2900	109.4	9	7	5	5	7	3	5	5	5
Avg.	64.9		100.3	5.4	5.5	3.9	5.1	5.9	2.9	5.0	4.6	4.4
S.D.	3.3		5.5	1.5	1.6	0.9	1.0	1.3	0.9	0.0	1.7	1.2

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					CASSELTON (C-5)						
		Lo	oaf Volume				Qualit	y Score Co	mpared to	Check (Gle	enn)	
	Bake						Internal	Internal				
	Absorption			Mixing	Dough	Mixing	Crumb	Grain &				
Cooperator	(%)	_ (cc) _	(% of Check) _	Requirement _	_ Characteristics _	Tolerance	_ Color _	Texture	_Protein_	Milling _	Baking _	Overall
Α	66.5	1010	91.0	5	7	7	7	7	3	5	7	5
В	60.0	3000	100.8	5	5	5	5	5	5	5	5	5
С	69.0	950	94.5	5	7	7	5	3	3	3	3	3
D	67.4	998	99.1	6	7	7	5	5	3	4	6	4
E	65.3	1009	94.7	5	6	6	5	5	4	6	6	6
F	69.2	990	93.4	7	7	5	7	7	3	5	7	5
G	62.8	2215	93.5	5	5	5	5	5	4	5	4	5
н	65.2	1090	92.4	5	5	5	5	5	4	5	4	4
I	62.0	3089	102.5	8	8	6	7	7	6	4	6	6
J	69.6	1035	98.6	7	7	4	7	6	3	5	6	5
ĸ	64.4	2625	104.0	9	7	7	5	7	3	5	7	5
Avg.	65.6		96.8	6.1	6.5	5.8	5.7	5.6	3.7	4.7	5.5	4.8
S.D.	3.1		4.4	1.4	1.0	1.1	1.0	1.3	1.0	0.8	1.4	0.9

					MINOT (M-5)						
		Lo	oaf Volume				Qualit	y Score Co	mpared to	Check (Gle	enn)	
	Bake						Internal	Internal				
	Absorption			Mixing	Dough	Mixing	Crumb	Grain &				
Cooperator	(%)	(cc)	(% of Check)	Requirement	Characteristics	Tolerance	Color	Texture	Protein	Milling	Baking	Overall
Α	69.0	1025	96.7	3	9	3	7	7	5	5	7	6
В	62.0	2850	97.4	5	5	3	5	5	5	5	3	3
С	72.0	1070	90.7	1	7	3	5	3	3	3	3	3
D	75.5	974	98.8	3	5	4	6	4	5	3	3	4
E	72.7	1057	98.1	4	6	4	7	5	4	5	5	5
F	73.0	1100	116.4	3	5	3	7	5	5	3	3	5
G	71.0	2347	96.5	5	5	5	5	5	5	5	5	5
н	73.4	1110	94.5	3	5	2	5	5	5	5	4	5
1	67.0	2897	95.1	8	7	4	5	4	4	4	4	4
J	77.6	1198	121.3	4	7	4	6	6	5	5	7	6
κ	72.3	2725	100.0	9	7	5	5	5	5	5	5	5
Avg.	71.4		100.5	4.4	6.2	3.6	5.7	4.9	4.6	4.4	4.5	4.6
<u>sn</u>	12		9.5	23	1 3	0 0	0 0	10	07	0 0	15	10

					WILLISTON (W	/-5)						
		Lc	oaf Volume				Quality	y Score Co	mpared to	Check (Gle	enn)	
	Bake Absorption			Mixing	Dough	Mixing	Internal Crumb	Internal Grain &				
Cooperator	(%)	(cc)	(% of Check)	Requirement	Characteristics	Tolerance	Color	Texture	Protein	Milling	Baking	Overall
Α	64.0	1000	96.2	5	9	7	7	7	2	3	7	4
В	57.0	2875	99.1	5	5	3	5	5	3	5	5	5
С	66.0	840	89.4	7	3	5	7	3	1	3	3	3
D	67.4	762	88.2	6	7	5	6	5	3	6	2	4
E	65.1	838	91.9	6	7	5	7	5	3	6	4	5
F	66.2	850	102.4	7	5	3	7	7	3	5	7	7
G	63.1	2440	98.9	5	6	5	7	6	3	5	5	5
Н	67.5	980	95.6	6	5	3	6	6	3	5	5	4
1	62.0	2927	102.1	8	6	5	5	7	5	4	5	5
J	72.6	905	95.9	8	8	5	6	6	2	5	5	5
K	64.5	2650	100.0	9	7	5	5	5	3	5	5	5
Avg.	65.0		96.3	6.5	6.2	4.6	6.2	5.6	2.8	4.7	4.8	4.7
S.D.	3.9		4.8	1.4	1.7	1.2	0.9	1.2	1.0	1.0	1.5	1.0

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					WATERTOWN ((B-6)						
		Lo	oaf Volume				Quality	y Score Co	mpared to	Check (Gle	enn)	
	Bake						Internal	Internal				
	Absorption			Mixing	Dough	Mixing	Crumb	Grain &				
Cooperator	(%)	_ (cc) _	(% of Check) _	Requirement	_ Characteristics _	Tolerance_	_ Color _	Texture	_Protein_	Milling _	Baking_	Overall
Α	68.0	1100	110.0	7	7	9	9	5	5	7	7	6
В	62.0	2950	98.3	7	7	7	5	5	5	7	7	7
С	72.0	1100	95.7	7	7	5	5	7	5	9	5	7
D	66.0	1030	97.1	6	7	6	5	5	5	5	5	5
E	64.0	1057	94.1	6	5	4	7	5	5	7	6	6
F	71.9	1095	100.9	9	5	5	5	5	5	5	5	5
G	62.0	2847	111.8	5	7	5	5	4	5	6	6	6
н	65.5	1090	96.9	6	9	7	5	6	4	6	4	5
I	61.0	2986	101.0	8	8	6	5	7	6	6	6	6
J	72.4	1053	99.1	9	7	5	5	6	5	6	5	6
K	63.1	2450	92.5	9	7	5	5	3	5	7	3	3
Avg.	66.2		99.8	7.2	6.9	5.8	5.5	5.3	5.0	6.5	5.4	5.6
S.D.	4.3		6.1	1.4	1.1	1.4	1.3	1.2	0.4	1.1	1.2	1.1

					CASSELTON (C-6)						
		Lo	oaf Volume				Quality	y Score Co	mpared to	Check (Gle	enn)	
	Bake						Internal	Internal				
	Absorption			Mixina	Dough	Mixina	Crumb	Grain &				
Cooperator	(%)	(cc)	(% of Check)	Requirement	Characteristics	Tolerance	Color	Texture	Protein	Milling	Baking	Overall
Α	68.0	1055	95.0	5	7	7	5	7	5	7	7	6
В	61.0	3050	102.5	7	7	7	5	5	5	5	7	7
С	71.0	905	90.0	5	5	3	5	3	5	5	1	3
D	66.1	1066	105.9	6	8	6	5	6	5	6	8	6
E	64.2	1019	95.6	6	6	5	7	7	5	6	7	7
F	71.4	1075	101.4	9	5	5	7	7	5	3	7	5
G	61.9	2567	108.4	7	7	5	5	5	5	6	6	6
н	64.5	1160	98.3	5	6	8	4	4	5	6	5	5
I	61.0	3104	103.0	8	8	7	7	7	7	4	7	6
J	72.3	1130	107.6	8	7	5	5	4	5	5	6	5
K	63.1	2700	106.9	9	7	7	5	7	5	5	7	7
Avg.	65.9		101.3	6.8	6.6	5.9	5.5	5.6	5.2	5.3	6.2	5.7
S.D.	4.2		6.0	1.5	1.0	1.4	1.0	1.5	0.6	1.1	1.9	1.2

					CROOKSTON (K-6)						
		Lc	oaf Volume				Quality	y Score Co	npared to	Check (Gle	enn)	
Cooperator	Bake Absorption (%)	(cc)	(% of Check)	- Mixing Requirement	Dough Characteristics	Mixing	Internal Crumb Color	Internal Grain &	Protein	Milling	Baking	Overall
Δ	67.0	1055	95 0	5	7	5	5	7	6	5	7	6
B	60.0	2900	98.3	7	7	5	5	5	7	5	5	5
С	70.0	1035	107.3	7	7	5	5	7	5	3	7	5
D	67.0	910	101.1	6	7	6	6	7	5	5	7	6
E	65.0	950	102.2	6	6	5	7	7	6	6	7	7
F	71.6	995	107.6	9	7	7	5	9	7	3	7	7
G	62.5	2474	107.8	5	7	5	6	6	7	5	6	6
н	66.0	1065	103.9	5	5	7	5	4	5	5	5	5
I	62.0	2986	102.0	8	8	6	5	5	6	4	6	5
J	68.9	930	96.9	6	8	5	6	6	6	5	5	5
К	63.8	2525	89.4	9	9	9	5	3	5	5	3	5
Avg.	65.8		101.0	6.6	7.1	5.9	5.5	6.0	5.9	4.6	5.9	5.6
S.D.	3.6		5.8	1.5	1.0	1.3	0.7	1.7	0.8	0.9	1.3	0.8

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					WATERTOWN ((B-7)						
		Lo	oaf Volume				Quality	y Score Co	mpared to	Check (Gle	enn)	
	Bake Absorption			Mixing	Dough	Mixing	Internal Crumb	Internal Grain &				
Cooperator	(%)	_ (cc) _	(% of Check) _	Requirement	Characteristics		Color	Texture	_Protein_	Milling	Baking	Overall
Α	66.5	1090	109.0	5	7	5	7	7	3	7	5	5
В	61.0	3000	100.0	7	7	7	5	5	5	7	7	7
С	71.0	1030	89.6	7	5	3	5	7	5	9	3	5
D	64.6	1007	94.9	6	7	5	6	6	4	6	5	5
E	62.7	947	84.3	6	6	4	7	7	5	7	6	6
F	70.8	1080	99.5	9	5	5	7	7	5	5	7	7
G	60.5	2507	98.5	5	7	5	6	5	3	7	5	5
н	65.1	1070	95.1	5	6	4	5	7	3	7	4	4
I	60.0	2897	98.0	9	9	7	5	7	7	6	5	6
J	71.3	995	93.6	7	7	5	6	6	4	7	4	5
κ	61.5	2475	93.4	9	7	5	5	5	3	7	3	3
Avg.	65.0		96.0	6.8	6.6	5.0	5.8	6.3	4.3	6.8	4.9	5.3
S.D.	4.4		6.3	1.6	1.1	1.2	0.9	0.9	1.3	1.0	1.4	1.2

					CASSELTON (^_7)						
		Lc	af Volume		CASSELION (5-1)	Quality	v Score Co	npared to (Check (Gle	nn)	
Cooperator	Bake Absorption (%)		(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	66.5	1030	92.8	5	7	3	5	9	3	9	5	5
В	60.0	2950	99.2	5	5	5	5	5	5	5	5	5
С	70.0	865	86.1	5	5	1	5	3	3	7	1	3
D	65.7	1010	100.3	5	7	4	5	6	3	8	4	5
E	63.8	950	89.1	5	6	5	5	7	4	7	7	7
F	70.2	1010	95.3	7	5	5	7	9	3	7	9	7
G	61.2	2359	99.6	5	7	5	5	6	4	6	5	5
н	64.4	1080	91.5	5	5	4	5	6	4	6	4	4
I	61.0	3104	103.0	7	5	5	7	6	5	5	5	6
J	69.4	1005	95.7	7	7	5	5	5	4	5	5	5
К	62.8	2700	106.9	9	7	7	5	7	3	5	7	5
Avg.	65.0		96.3	5.9	6.0	4.5	5.4	6.3	3.7	6.4	5.2	5.2
S.D.	3.7		6.2	1.4	1.0	1.5	0.8	1.7	0.8	1.4	2.0	1.2

					CROOKSTON (K-7)						
		Lc	oaf Volume				Quality	y Score Coi	npared to	Check (Gle	nn)	
Cooperator	Bake Absorption	(cc)	(% of Chock)	Mixing	Dough Charactoristics	Mixing	Internal Crumb	Internal Grain &	Protoin	Milling	Baking	Ovorall
Δ	64.0	Q10	82 0	5	5	3	3	3	3	7	2 Saking	3
B	59.0	2900	98.3	5	5	3	5	5	3	5	3	3
Ċ	67.0	890	92.2	5	5	3	5	5	3	5	3	3
D	65.2	942	104.7	5	7	5	6	6	4	6	6	5
E	63.0	891	95.8	5	6	5	7	7	3	7	6	6
F	68.4	980	105.9	7	7	7	5	9	3	3	7	7
G	60.2	2209	96.2	5	7	5	6	4	4	6	5	5
Н	63.4	950	92.7	5	6	4	4	6	3	6	4	4
I	60.0	2897	99.0	8	8	6	5	4	6	5	5	4
J	68.7	953	99.3	5	7	5	5	5	4	5	5	5
K	62.0	2675	94.7	9	7	5	5	5	3	5	3	3
Avg.	63.7		96.4	5.8	6.4	4.6	5.1	5.4	3.5	5.5	4.5	4.4
S.D.	3.3		6.5	1.5	1.0	1.3	1.0	1.6	0.9	1.1	1.4	1.4

					MINOT (M-7)								
		Lc	oaf Volume			Quality Score Compared to Check (Glenn)								
	Bake						Internal	Internal						
	Absorption			Mixing	Dough	Mixing	Crumb	Grain &						
Cooperator	(%)	(cc)	(% of Check)	Requirement	Characteristics	Tolerance	Color	Texture	Protein	Milling	Baking	Overall		
Α	67.0	990	93.4	3	9	3	5	7	3	3	5	3		
В	61.0	2900	99.1	7	7	5	5	5	5	5	5	5		
С	71.0	1060	89.8	3	7	3	5	5	3	3	3	3		
D	69.1	987	100.1	5	8	4	6	5	3	3	3	3		
E	66.6	922	85.5	4	6	6	7	7	3	5	6	6		
F	70.7	1105	116.9	5	7	5	7	9	3	3	9	9		
G	65.1	2523	103.7	5	7	5	5	5	4	5	5	5		
н	68.8	1110	94.5	4	6	3	5	8	3	5	5	4		
I	64.0	3015	99.0	9	9	5	3	3	5	3	4	4		
J	73.7	1098	111.1	7	7	4	5	6	2	5	6	5		
ĸ	65.9	2700	99.1	9	7	5	5	5	3	5	3	3		
Avg.	67.5		99.3	5.5	7.3	4.4	5.3	5.9	3.4	4.1	4.9	4.5		
SD	36		9.0	22	10	10	11	17	0 9	10	18	18		

W	B 9	47	'9
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WATERTOWN (B-9)												
		L¢	oaf Volume				Qualit	y Score Co	mpared to	Check (Gle	enn)	
	Bake						Internal	Internal				
	Absorption			Mixing	Dough	Mixing	Crumb	Grain &				
Cooperator	(%)	(cc)	(% of Check)	Requirement	Characteristics	Tolerance	Color	Texture	Protein	Milling	Baking	Overall
Α	66.0	1090	109.0	7	7	7	7	7	5	9	7	7
В	61.0	3000	100.0	5	5	5	5	5	5	7	5	5
С	72.0	1070	93.0	9	5	5	3	7	5	9	5	7
D	64.7	974	91.8	6	7	6	6	6	5	7	5	6
E	62.6	971	86.5	6	6	4	7	6	5	8	6	6
F	71.4	1100	101.4	9	5	5	7	9	5	5	7	7
G	60.0	2619	102.9	5	3	4	7	7	5	8	5	6
н	62.2	1075	95.6	5	6	6	7	7	4	7	5	5
I	60.0	2927	99.0	9	9	7	5	5	7	7	6	7
J	69.9	1035	97.4	9	7	5	5	5	5	8	5	6
ĸ	61.5	2525	95.3	9	7	5	5	5	5	7	5	5
Avg.	64.7		97.4	7.2	6.1	5.4	5.8	6.3	5.1	7.5	5.5	6.1
S.D.	4.5		6.1	1.8	1.6	1.0	1.3	1.3	0.7	1.1	0.8	0.8

					CASSELTON (C-9)						
		Lo	oaf Volume	_			Qualit	y Score Co	mpared to	Check (Gle	enn)	
Cooperator	Bake Absorption (%)	(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
Α	66.0	925	83.3	5	7	5	5	3	3	7	3	3
В	60.0	2900	97.5	7	7	7	5	5	5	5	7	5
С	70.0	940	93.5	7	7	5	5	3	3	5	3	5
D	63.9	970	96.3	6	8	5	5	6	3	3	5	4
E	62.9	927	87.0	6	6	6	7	8	4	7	7	7
F	68.9	1025	96.7	9	5	5	5	7	3	5	7	7
G	59.9	2386	100.8	3	4	3	5	6	4	7	4	5
н	63.3	1000	84.7	5	5	6	5	5	3	6	4	4
I	59.0	3118	103.4	8	8	7	5	4	7	4	6	5
J	67.0	998	95.0	8	7	5	5	4	4	5	5	5
к	61.1	2600	103.0	9	7	7	5	7	3	5	7	5
Avg.	63.8		94.7	6.6	6.5	5.5	5.2	5.3	3.8	5.4	5.3	5.0
SD	37		7 0	19	13	12	0 6	17	13	13	16	12

					CROOKSTON (K-9)							
		Lc	oaf Volume			Quality Score Compared to Check (Glenn)							
Cooperator	Bake Absorption (%)	(cc)	(% of Check)	- Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall	
Α	66.5	1030	92.8	5	7	5	5	5	5	9	5	7	
В	60.0	2975	100.8	7	7	5	5	5	7	5	5	5	
С	70.0	970	100.5	7	7	3	5	5	5	9	5	5	
D	65.4	954	106.0	6	7	6	5	6	5	6	6	6	
E	64.0	949	102.0	6	6	6	7	7	5	7	7	7	
F	70.1	1015	109.7	9	7	9	5	9	7	3	7	7	
G	61.1	2489	108.4	4	6	4	6	6	5	7	6	6	
Н	64.5	1075	104.9	5	5	7	6	7	5	6	6	6	
1	60.0	3015	103.0	9	9	7	5	4	7	7	6	6	
J	67.6	940	97.9	8	7	5	5	4	5	6	5	5	
K	62.5	2575	91.2	9	7	5	5	3	5	7	3	5	
Avg.	64.7		101.6	6.8	6.8	5.6	5.4	5.5	5.5	6.5	5.5	5.9	
S.D.	3.6		5.9	1.8	1.0	1.6	0.7	1.7	0.9	1.7	1.1	0.8	

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MINOT (M-10)												
		L¢	oaf Volume				Qualit	y Score Co	mpared to	Check (Gle	enn)	
	Bake						Internal	Internal				
	Absorption			Mixing	Dough	Mixing	Crumb	Grain &				
Cooperator	(%)	(cc)	(% of Check)	Requirement	Characteristics	Tolerance	Color	Texture	Protein	Milling	Baking	Overall
Α	67.0	1180	111.3	3	7	5	5	5	3	5	5	5
В	61.0	2925	100.0	7	7	5	5	5	5	5	5	5
С	72.0	1180	100.0	3	7	3	5	3	3	7	5	5
D	72.3	976	99.0	5	7	4	5	6	3	6	5	5
E	69.0	951	88.2	4	6	5	7	6	3	6	4	5
F	71.3	1140	120.6	5	9	3	1	3	3	5	3	5
G	67.6	2448	100.6	5	7	5	5	6	4	5	5	6
н	67.8	1010	86.0	4	6	3	4	6	4	5	4	4
1	66.0	3015	99.0	9	9	5	5	3	5	6	5	5
J	74.9	1133	114.7	5	7	4	7	6	3	5	7	6
K	69.2	2750	100.9	9	7	5	5	5	3	5	5	5
Avg.	68.9		101.8	5.4	7.2	4.3	4.9	4.9	3.5	5.5	4.8	5.1
S.D.	3.7		10.3	2.1	1.0	0.9	1.6	1.3	0.8	0.7	1.0	0.5

					WILLISTON (W	-10)						
		Lo	oaf Volume				Quality	/ Score Coi	npared to	Check (Gle	nn)	
	Bake						Internal	Internal				
	Absorption			Mixing	Dough	Mixing	Crumb	Grain &				
Cooperator	(%)	(cc)	(% of Check)	Requirement	Characteristics	Tolerance	Color	Texture	Protein	Milling	Baking	Overall
Α	63.0	880	84.6	5	5	7	3	5	1	1	3	1
В	57.0	2800	96.6	3	3	3	5	5	3	5	3	3
С	66.0	775	82.4	5	1	3	3	3	1	1	1	1
D	67.1	751	86.9	5	7	5	4	5	1	6	1	3
E	65.3	805	88.3	5	6	5	3	4	2	4	4	3
F	64.7	865	104.2	5	5	3	3	7	3	5	7	7
G	63.1	2355	95.5	5	3	4	5	4	2	4	4	4
Н	67.7	940	91.7	7	5	2	2	4	2	5	3	2
1	62.0	2868	100.0	1	5	1	4	4	1	2	1	1
J	68.3	883	93.5	6	7	5	6	4	1	4	4	4
K	64.2	2600	98.1	9	7	5	5	5	1	5	5	3
Avg.	64.4		92.9	5.1	4.9	3.9	3.9	4.5	1.6	3.8	3.3	2.9
S.D.	3.2		6.8	2.0	1.9	1.7	1.2	1.0	0.8	1.7	1.8	1.8

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					HAVRE (H-1'	1)						
		Lo	oaf Volume				Quality S	Score Comp	ared to Ch	eck (LCS I	Rebel)	
	Bake						Internal	Internal				
	Absorption			Mixing	Dough	Mixing	Crumb	Grain &				
Cooperator	(%)	_ (cc) _	_ (% of Check) _	Requirement	_ Characteristics _	Tolerance	_ Color _	Texture	_Protein_	_ Milling _	Baking _	Overall
Α	69.7	1040	95.0	3	7	3	1	5	5	5	3	4
В	62.0	3000	98.4	7	7	5	5	5	5	5	5	5
С	72.0	935	98.4	3	5	3	3	7	5	5	5	5
D	72.0	932	94.5	4	6	5	5	5	5	6	5	5
E	70.4	942	97.2	3	6	5	5	5	5	5	5	5
F	72.3	1145	101.3	5	7	4	5	1	7	5	3	3
G	68.4	2389	94.6	5	7	7	5	6	5	5	5	5
н	71.4	1175	106.8	3	6	3	5	5	5	5	6	6
I	66.0	3015	100.0	8	8	6	5	3	6	5	5	4
J	73.8	1073	99.4	5	8	5	5	5	5	5	5	5
ĸ	69.1	2750	101.9	9	5	5	5	5	5	5	5	5
Avg.	69.7		98.9	5.0	6.5	4.6	4.5	4.7	5.3	5.1	4.7	4.7
S.D.	3.4		3.7	2.1	1.0	1.3	1.3	1.6	0.6	0.3	0.9	0.8

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					WILLISTON (W	-11)						
		Lo	oaf Volume	_			Quality	y Score Co	mpared to	Check (Gle	enn)	
Cooperator	Bake Absorption (%)	(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
Α	65.5	940	90.4	7	9	7	3	5	3	5	7	4
В	58.0	2825	97.4	5	5	3	5	5	3	5	3	3
С	67.0	895	95.2	5	3	5	5	5	1	3	3	3
D	69.2	790	91.4	6	7	5	5	6	4	5	4	4
E	69.8	889	97.5	7	6	5	3	5	4	5	4	5
F	70.6	820	98.8	7	5	3	3	5	3	5	5	3
G	65.1	2417	98.0	5	6	5	5	4	3	5	5	4
Н	68.8	950	92.7	7	5	4	3	5	4	5	4	4
1	64.0	2897	101.0	8	8	5	5	5	5	4	5	5
J	70.2	935	99.0	7	7	5	5	6	2	5	5	5
ĸ	66.1	2500	94.3	9	7	5	5	5	3	5	5	5
Avg.	66.8		96.0	6.6	6.2	4.7	4.3	5.1	3.2	4.7	4.5	4.1
S.D.	3.7		3.4	1.3	1.7	1.1	1.0	0.5	1.1	0.6	1.1	0.8

Hard Red Spring Wheat Breeding Quality Target Values

	Quality Parameter	Target Value*
Wheat	Test Weight (lb/bu, Grading Factor) Protein (%, 12% mb) Ash (%, 14% mb) Vitreousness (% dark, hard & vitreous, DHV) 1000 Kernel Weight (g) Falling Number (sec) Wheat Hardness (SKCS) Wheat Hardness (NIR)	60 14.5 < 1.65 80 > 31 400 80 70
Milling	Flour Extraction: Buhler Lab Mill (%, 0.48% ash) Quadrumat Senior (%, 0.48% ash) Protein Loss (%)	70 70 < 1.0
Flour	Ash (%, 14% mb) Color (<i>L</i> * value) Wet Gluten (%, 14% mb, 13.5% protein)	0.48 90 36
Farinograph (50 g bowl)	Absorption (%) Peak Time (min) Stability (min)	64 6-8 15-17
Mixograph	Peak time (min)	5
Bread Baking [‡]	Loaf Volume (cc) Grain & Texture (1 = poor, 10 = excellent) [†]	1050 8.5

*HRS Wheat Breeding Quality Targets were developed by a committee of HRS wheat breeders and quality personnel. Contact Senay Simsek, North Dakota State University, Department of Plant Sciences, for more information.

[†]Subjective ratings and classifications are from North Dakota State University, Hard Red Spring Wheat Quality Laboratory.

‡Bread quality based on 100 g pup loaf, straight dough method (North Dakota State University, Hard Red Spring Wheat Quality Laboratory).

Important points for use:

- 1. <u>Breeding target values are a tool.</u> The values shown are targets and should be seen as a tool to help breeders meet the market needs for end-use quality.
- 2. They reflect the surveyed quality needs of our export markets and they also meet the needs of the domestic markets.
- 3. Standard or check varieties and different locations are still needed due to location and yearly weather variations.
- 4. Target values should be compared to actual quality data on experimental lines after several years of testing at multiple locations to help determine if the line would meet the industry needs for quality before being released as a named variety.
- 5. These targets will be reviewed periodically and updated as needed.
- 6. Utilization of these breeding targets by all HRS wheat breeders is essential to provide better uniformity and consistency and meeting the needs of our domestic and export markets.