

Wheat Quality Council
Hard Spring Wheat Technical Committee
2020 Crop



February 16-18, 2021
Virtual Meeting

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Sponsored by the Wheat Quality Council
February 16-18, 2021
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Wheat Quality Council

Hard Spring Wheat Technical Committee

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.

Eight experimental lines of hard spring wheat were grown at up to six locations in 2020 and evaluated for kernel, milling, and bread baking quality against the check varieties Linkert 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 2020 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 2020 Wheat Quality Testing Program

Source of Wheat

Source/Breeding Program	SWQC Code #	Identification
Syngenta	1	AP Murdock
North Dakota State University	2	NDHRS16-14-126
21 st Century Genetics	3	AKF-Snowfire
University of Minnesota	4	MN15005-4
21 st Century Genetics	5	TCG-Wildcat
Montana State University	6	Dagmar
Limagrain	7	LCS Rebel (Western Check)
University of Minnesota	8	MN15119-2
University of Minnesota	9	Linkert (Eastern Check)
North Dakota State University	10	Glenn

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	4/27/2020	5/11/2020	5/5/2020	5/18/2020	5/5/2020	5/7/2020
Harvest Date	8/13/2020	8/19/2020	8/13/2020	8/20/2020	8/26/2020	9/1/2020
Fertilizer (lb/A)						
N	200	120	100	194	120	120
P	*	*	20	5 ppm	28	17 ppm
K	100	*	10	133 ppm	370	350 ppm
Herbicide(rate/A)						
Broadleaf	Wolverine 1.6 pt.	Witness 1 pt./A	Vendetta 16 oz/A	Bromac 1.5 pt/A	Wolverine Adv. 27 oz/A	GoldSky 1 pt/A
Grass	*	Affinity TM 0.4 oz/A	*	Axial XL 16.4 oz/A	OpenSky 16 oz/A	LV6 8 oz/A
Fungicide	*	Axial Star 15 oz/A	Prosaro 5 oz/A	*	Prosaro 8 oz/A	Prosaro 7 oz/A
		Prosaro 6.5 oz/A				(at flowering)

*No application.

CLIMATOLOGICAL DATA						
Average Temperature (°F) / Precipitation (in.)						
Month	Watertown	Casselton	Havre	Crookston	Minot	Williston
April	40.0 / 1.04	37.8 / 1.61	38.3 / 0.56	37.0 / 1.92	37.0 / 0.07	38.0 / 0.07
May	53.0 / 2.26	53.0 / 1.55	53.5 / 1.58	52.9 / 1.00	52.0 / 1.20	55.0 / 0.63
June	70.0 / 2.66	70.2 / 3.39	68.1 / 2.69	67.9 / 4.52	65.0 / 3.93	65.0 / 1.45
July	72.0 / 2.54	72.9 / 6.76	68.0 / 0.72	71.5 / 7.52	68.0 / 1.12	70.0 / 1.87
August	69.0 / 0.60	69.5 / 5.02	71.0 / 0.04	67.9 / 3.02	69.0 / 0.86	72.0 / 0.37

*Data not available.

YIELD DATA						
Yield (bu/acre) / Test Weight (lb/bu) / % Moisture						
SWQC Code #	Watertown	Casselton	Havre	Crookston†	Minot	Williston
1	64.5 / 59.3 / 11.4	71.1 / 60.3 / 12.9	*	86.6 / 58.0 / 13.3	58.0 / 59.8 / 12.4	18.0 / 61.2 / **
2	*	58.8 / 60.2 / 12.8	*	*	48.7 / 59.4 / 12.4	20.0 / 63.2 / **
3	*	*	*	*	65.0 / 59.1 / 12.5	24.0 / 62.4 / **
4	68.2 / 59.2 / 11.4	71.1 / 60.0 / 12.7	46.1 / 59.8 / 8.7	80.3 / 58.0 / 14.0	64.9 / 60.0 / 12.8	
5	*	68.6 / 59.7 / 12.8	*	80.6 / 57.0 / 13.9		
6	*	*	46.3 / 60.3 / 8.6	*	46.5 / 56.7 / 12.7	23.0 / 62.4 / **
7	*	*	36.3 / 62.9 / 9.0	*	50.1 / 58.8 / 12.5	24.0 / 61.8 / **
8	70.1 / 60.3 / 11.4	65.2 / 61.1 / 12.2	*	79.6 / 59.0 / 14.5	66.2 / 60.7 / 12.5	
9	56.4 / 59.7 / 11.3	64.2 / 61.0 / 12.2	*	72.0 / 59.0 / 14.1		
10	58.3 / 60.5 / 11.3	56.9 / 61.2 / 12.3	38.4 / 62.2 / 8.9	76.5 / 60.0 / 14.9	58.4 / 62.3 / 12.8	20.0 / 63.5 / **
Site Totals	5	7	4	6	8	6

†At time of delivery, moisture contents of Crookston samples were, on average, 14.0% and thus had to be dried down prior to analysis.

*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	Planting was done on time for this area with good soil conditions and good seed to soil contact.	Soil moisture was nearly ideal right at planting, but planting date was delayed due to wet conditions prior to planting.		Did not get into the field until May 18 th ; adequate moisture at planting.	Good stored soil moisture going into the growing season.	Seeded 5-7-20 into soybean stubble; adequate soil moisture.
During Growth	There was a hot, dry period from June 15-20 th . Otherwise, ideal conditions during this period.	Plentiful moisture during the growing season. Some heat stress during late May – early June when the wheat was in the boot stage.		Plenty of moisture during the growing season.	Little precipitation until the end of June but crops were able to use soil moisture. No disease pressure noted.	Trial had good emergence, resulting in an excellent stand.
At Flowering	There was another hot, dry period from July 2 nd - 6 th , which limited the top end of yield potential.	Warm conditions with adequate moisture but scab risk was fairly low.		Had flooding problem, which prevented the application of fungicides.	Frequent precipitation with conditions favorable for scab.	Above average temperatures, above average wind speed, and much below average rainfall attributed to a very poor growing season at the WREC.
During Maturation	The grain filling period had dry and mild temperatures. Head scab was minimal.	Excess moisture delayed harvest slightly.		Observed scab during this time period.	Warm and moist conditions were favorable for grain filling.	4.32 inches total precipitation during the growing season. There was very little available moisture during the growing season in the soil profile.
At Harvest	Harvest was dry and mild, which helped in maintaining test weight and color.	Although excess moisture did delay harvest slightly, the grain was able to be harvested at 12-13% moisture under ideal conditions.	Grasshoppers were present late in the season but there was other spring wheat, which was still green that they focused on more. They did not have an effect on seed yield or quality.	No lodging observed at harvest.	Hot and dry conditions favored uniform drydown and uninterrupted harvest.	Extremely dry.

Description of 2020 Hard Spring Wheat Lines

SWQC #1 – AP Murdock

AP Murdock is a hard red spring wheat bred and developed by Syngenta Crop Protection, LLC primarily adapted for the Northern Plains of the USA. It has early heading, similar to SY Rowyn with high test weight. It is a standard semi-dwarf, similar in height to SY Soren. Straw strength is moderate to strong. Disease resistance is intermediate for Foliar Diseases and Fusarium Head Blight. Protein levels are moderate, similar to SY Rowyn. Overall breadmaking characteristics are very good.

SWQC #2 – NDHRS16-14-126

NDHRS16-14-126 is a line derived from the cross ND804/Freyr. ND804 is a re-selection from a sister of Glenn. It is moderately susceptible to leaf rust, but is moderately resistant to Fusarium Head Blight. In testing, it has shown high yield potential across North Dakota. It was approved for pre-release in 2020 and a release decision is pending data collection in 2020.

SWQC #3 – AKF-Snowfire

AKF-Snowfire is a hard white spring wheat (HWS) developed by 21st Century Genetics Corp. from the cross TCG-Spitfire x Alpine. It has exceptional yield and standability, with a good general disease package for the Northern Great Plains (NGP). Protein content is average for a HWS but quality is very good. It handles the diseases stresses of the more humid areas of the NGP quite well. This is rare for a HWS. AKF-Snowfire will be marketed by Arrow K Farms (AKF) of Belfield ND.

SWQC #4 – MN15005-4

MN15005-4 (Prosper/MN08301-6//Norden) has a good combination of yield and protein and has straw strength almost as good as Linkert which is the main reason for its 5-yr. reign as the most popular variety in MN. Disease resistance is acceptable, rated as moderately susceptible (rated 5 on 1-9 scale) to scab and bacterial leaf streak.

SWQC #5 – TCG-Wildcat

TCG-Wildcat (G17C2020) is a hard red spring wheat (HRS) released by 21st Century Genetic Corp. It was developed from the cross WB-Mayville x Linkert. It has an exceptional combination of yield, standability, and protein and test weight, with medium early maturity. It has an MS reaction to most diseases of the Northern Great Plains (NGP) but is MS-S for Scab (Fusarium head blight), so fungicide management is a must; however, it handles scab very well under management. It has good tolerance to preharvest sprouting, maintaining acceptable falling numbers. Bread-making quality is good.

SWQC #6 – Dagmar

Dagmar is hard red spring wheat released by the Montana Agricultural Experiment Station in 2019 due to its excellent yield potential in dryland areas of Montana, solid stems, and superior end-use quality. Dagmar was a selection from the cross MT1133/MT1148. Dagmar has similar grain yield potential to Vida (PI 642366), the most widely grown cultivar in Montana. Stems of Dagmar are more solid than those of Vida, suggesting increased resistance to the wheat stem sawfly. Dagmar has higher grain protein and stronger gluten than Vida.

SWQC #8 – MN15119-2

MN15119-2 (MN02072-7/MN-Washburn) has shown above average grain yield and protein, and high test weight. MN15119-2 is rated as moderately resistant to scab (rated 4 on 1-9 scale) and bacterial leaf streak (3). Straw strength is good, equivalent to MN-Washburn, but not as strong as Linkert.

SWQC #10 – Glenn

Glenn was released in 2005 from North Dakota Agricultural Experiment Station. It was once the most popular variety in ND and was still the fifth most cultivated variety in North Dakota in 2020. Its longevity is due to its reputation for high and consistent end-use quality. Yield of Glenn falls behind current commercial checks, but it can be managed to perform well still. It is moderately susceptible to leaf rust but has a moderate reaction to Bacterial leaf streak, and it is moderately resistant to FHB.

Wheat Production Sites

SWQC Code #	Entry	Source	Production Sites					
			Watertown	Casselton	Havre	Crookston	Minot	Williston
1	AP Murdock	Syngenta	X	X	X	X	X	X
2	NDHRS16-14-126	North Dakota State University		X			X	X
3	AKF-Snowfire	21 st Century Genetics					X	X
4	MN15005-4	University of Minnesota	X	X		X	X	
5	TCG-Wildcat	21 st Century Genetics		X		X		
6	Dagmar	Montana State University			X		X	X
7	LCS Rebel	Limagrain			X		X	X
8	MN15119-2	University of Minnesota	X	X		X	X	
9	Linkert	University of Minnesota	X	X		X		
10	Glenn	North Dakota State University	X	X	X	X	X	X

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^* , a^* , and b^* values);

- 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;
- 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 2020 Hard Spring Wheat Lines

SWQAC #1 – AP Murdock

		Watertown		Casselton		Havre		Crookston		Minot		Williston	
Quality Trait		Linkert B-9	B-1	Linkert C-9	C-1	LCS Rebel H-7	H-1	Linkert K-9	K-1	LCS Rebel M-7	M-1	LCS Rebel W-7	W-1
I. USDA-ARS WQL Data													
1	Wheat Protein (% 12% mb)	15.5	14.5	14.9	13.0	15.6	16.3	15.6	14.5	15.1	15.0	15.6	15.2
2	Flour Protein (% 14% mb)	14.3	13.1	13.4	11.6	14.5	15.1	14.2	12.9	14.1	13.7	14.7	14.4
3	Market Value (Score 1-6)	4.7	4.3	4.3	3.7	5.2	5.0	4.6	4.4	4.8	5.0	5.0	4.6
4	Market Value (Score 1-10)	10.0	9.4	10.0	7.8	10.0	9.2	10.0	8.8	10.0	10.0	10.0	9.4
5	DON (ppm)	0.36	0.20	0.24	0.22	0.02	0.04	0.99	0.72	0.09	0.13	0.01	0.03
6	Test Weight (lb/bu)	61.4	60.8	61.4	59.9	63.3	62.0	61.1	60.4	62.7	61.9	64.0	63.4
7	1000 Kernel Weight (g)	32.4	31.5	32.3	31.8	32.7	30.0	33.6	32.8	36.2	35.3	30.3	28.0
8	Kernel Size, % Large	64	56	69	62	51	26	64	57	76	67	44	27
9	Kernel Size, % Small	8	9	7	9	11	15	8	11	7	7	16	22
10	Wheat Moisture (%)	11.5	11.8	12.6	13.2	9.4	9.0	11.7	12.4	12.3	11.4	9.9	10.3
11	Wheat Ash (% 14% mb)	1.63	1.49	1.74	1.54	1.45	1.48	1.67	1.44	1.65	1.48	1.50	1.65
12	Wheat Falling Number (sec)	437	454	418	435	452	492	415	448	399	494	461	511
13	SKCS Hardness Index	72.6	71.6	69.2	63.8	72.0	83.2	76.5	74.2	68.2	67.9	69.4	72.4
14	Vitreous Kernels (%)	80	61	68	28	98	98	62	56	86	72	99	97
Flour Extraction (%)													
15	Tempered Wheat Basis (%)	70.5	68.7	70.2	67.3	69.5	66.4	70.5	68.6	72.9	69.5	69.1	67.6
16	Total Product Basis (%)	72.5	70.6	72.6	70.2	70.3	67.7	72.1	70.4	74.6	71.3	73.1	69.3
17	Flour/Bu Wheat (lbs)	43.9	42.3	43.5	40.4	44.5	41.3	44.0	41.6	46.1	44.0	44.9	43.0
Flour Quality													
18	Flour Color Brightness (L*)	90.3	89.5	90.5	89.8	90.0	89.1	90.0	89.2	90.3	89.7	90.2	89.6
19	Flour Color Yellowness (b*)	8.3	10.4	8.8	11.5	9.7	11.5	8.8	11.1	9.0	10.8	9.2	10.8
20	Flour Moisture (%)	12.8	13.0	13.4	13.3	13.2	12.6	13.6	12.7	13.0	13.4	13.4	12.8
21	Flour Ash (% 14% mb)	0.47	0.51	0.48	0.53	0.46	0.56	0.50	0.53	0.48	0.51	0.44	0.56
22	Flour Falling Number (Malted) (sec)	247	250	251	258	256	258	253	257	251	259	253	258
Farinograph													
23	Water Absorption (% 500 BU)	63.5	65.1	62.5	62.9	67.5	69.6	62.6	66.5	66.1	66.3	66.6	67.7
24	Water Absorption (% 14% mb)	62.3	64.1	62.1	62.2	66.0	68.3	61.7	65.1	65.1	65.7	66.0	66.3
25	Arrival Time (min)	3.1	3.1	2.2	3.5	4.6	4.3	2.9	2.9	3.8	4.7	5.0	4.0
26	Peak Time (min)	9.8	7.5	8.5	7.0	10.2	8.0	7.2	7.2	8.0	8.2	8.5	9.4
27	Dough Stability (min)	18.0	9.4	14.5	8.1	14.5	11.2	15.6	9.3	9.3	12.2	10.9	12.1
28	Mixing Tolerance Index (MTI) (BU)	18	28	20	32	20	17	11	30	31	15	21	24
29	Time To Breakdown (TTB) (min)	19.9	12.6	15.1	11.6	17.5	14.9	15.8	12.3	13.0	16.1	15.1	15.8

SWQAC #1 – AP Murdock

		Watertown		Casselton		Havre		Crookston		Minot		Williston	
		Linkert		Linkert		LCS Rebel		Linkert		LCS Rebel		LCS Rebel	
Quality Trait		B-9	B-1	C-9	C-1	H-7	H-1	K-9	K-1	M-7	M-1	W-7	W-1
II. Cooperator Results													
30	Bake Absorption (Average %)	66.1	66.0	65.0	64.1	68.7	69.9	65.5	66.9	68.0	67.6	68.5	68.9
31	Loaf Volume (% of Check)		94.9		97.3		98.1		95.3		97.7		95.0
32	Mixing Requirement*	7.5	5.8	7.2	5.1	6.3	5.1	7.6	5.1	6.1	5.8	5.8	5.8
33	Dough Characteristics**	6.7	6.0	6.8	5.4	6.9	6.2	6.9	6.0	6.8	6.2	6.8	7.1
34	Mixing Tolerance†		4.1		3.8		4.4		3.4		4.7		5.5
35	Internal Crumb Color††		4.4		3.4		4.6		3.9		4.3		4.5
36	Internal Crumb Texture‡		4.1		4.6		5.3		4.1		5.0		4.8
III. Cooperator Evaluation‡													
	Quality Traits 1-2: Protein		3.4		2.5		6.4		3.0		5.0		4.7
	Quality Traits 3-22: Milling		3.5		2.8		3.1		3.7		3.4		3.2
	Quality Traits 23-36: Baking		3.9		3.6		4.6		3.6		4.5		4.0
	Quality Traits 1-36: Overall Comparison		3.6		3.3		4.4		3.7		4.5		3.9

*9 = Very long; 7 = Long; 5 = Medium; 3 = Short; 1 = Very short.

**9 = Bucky – Tough; 7 = Strong – Elastic; 5 = Medium – Pliable; 3 = Mellow – Very Pliable; 1 = Weak – Short or Sticky.

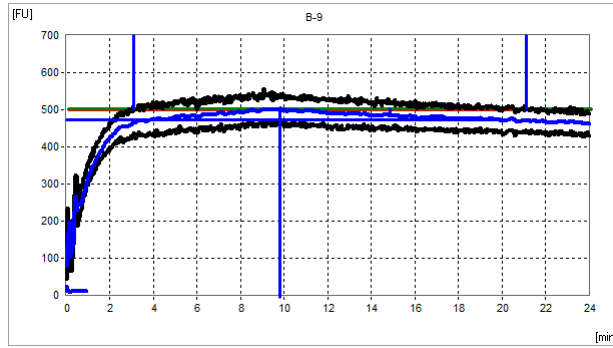
†9 = Much More Tolerance Than Check; 7 = More Tolerance Than Check; 5 = Tolerance Equivalent To Check; 3 = Less Tolerance Than Check; 1 = Much Less Tolerance Than Check.

††9 = Much Brighter Than Check; 7 = Brighter Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.

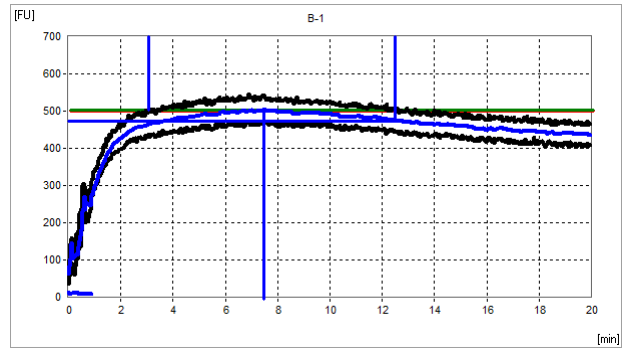
‡9 = Much Better Than Check; 7 = Better Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.

Farinograms

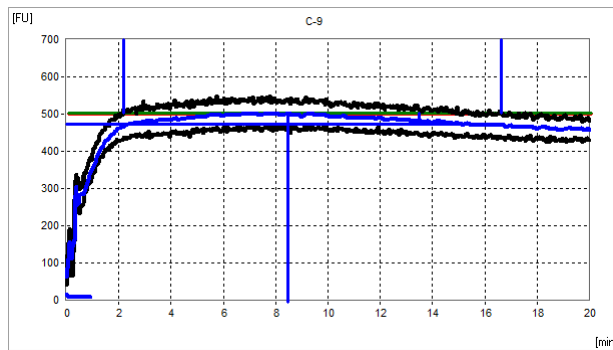
Linkert Check (Watertown, B-9)



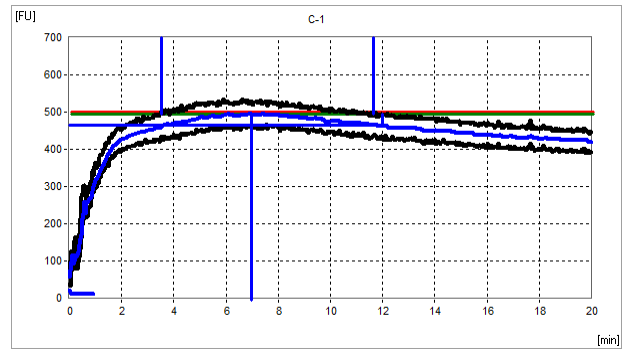
AP Murdock (Watertown, B-1)



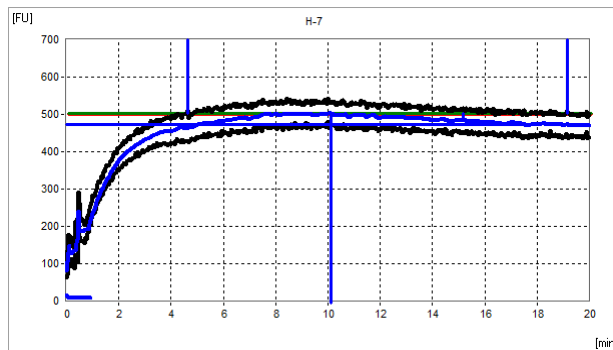
Linkert Check (Casselton, C-9)



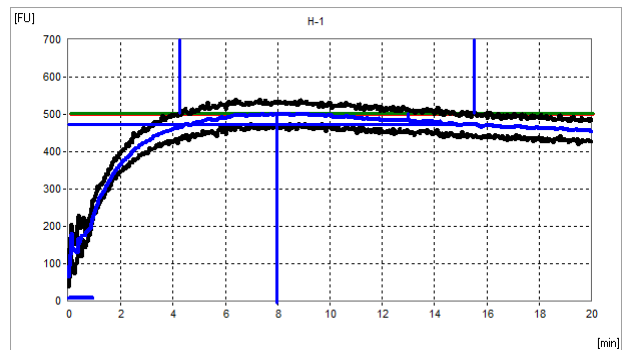
AP Murdock (Casselton, C-1)



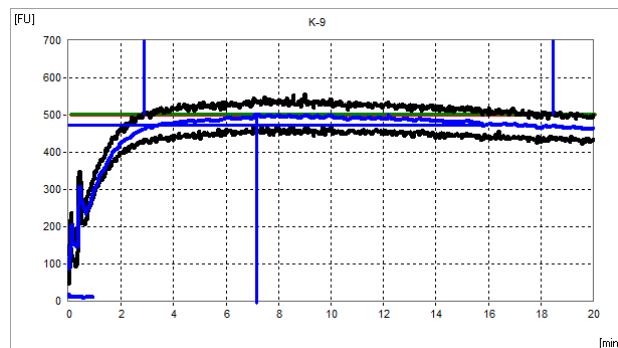
LCS Rebel Check (Havre, H-7)



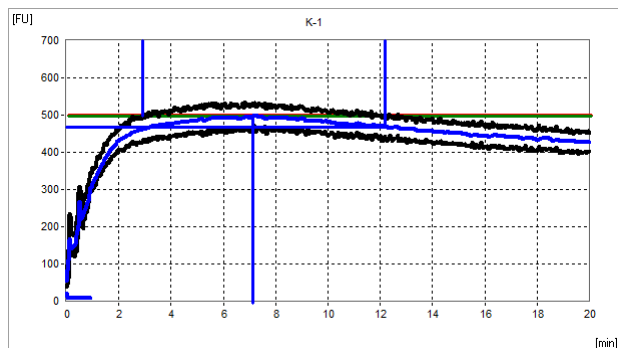
AP Murdock (Havre, H-1)



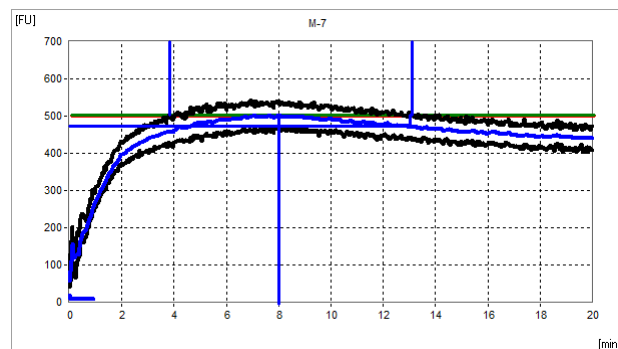
Linkert Check (Crookston, K-9)



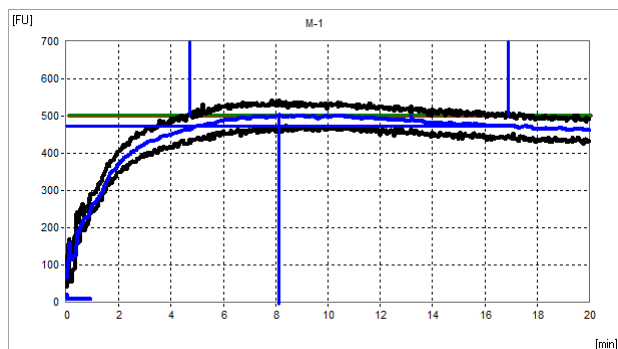
AP Murdock (Crookston, K-1)



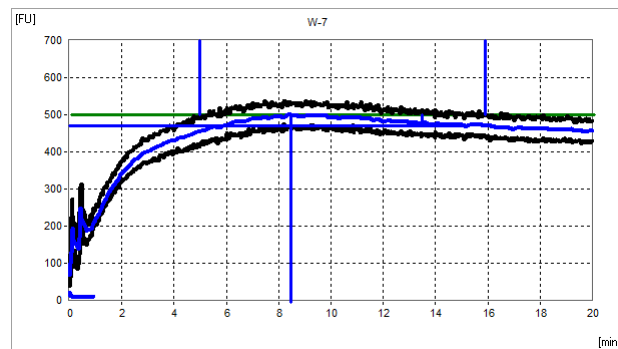
LCS Rebel Check (Minot, M-7)



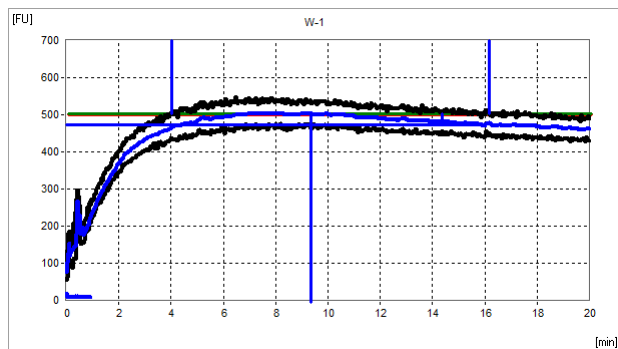
AP Murdock (Minot, M-1)



LCS Rebel Check (Williston, W-7)

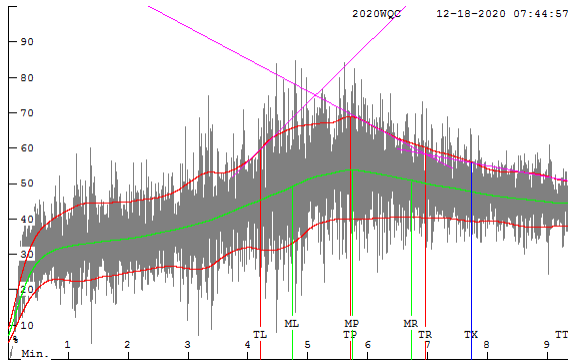


AP Murdock (Williston, W-1)

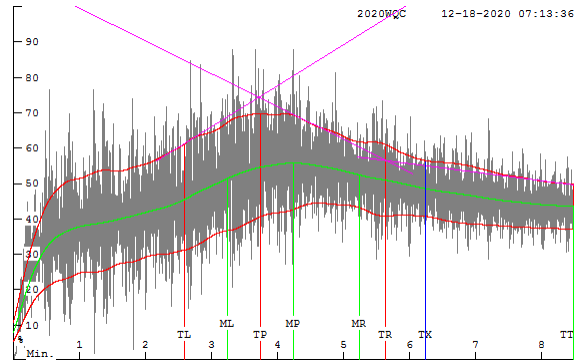


Mixograms

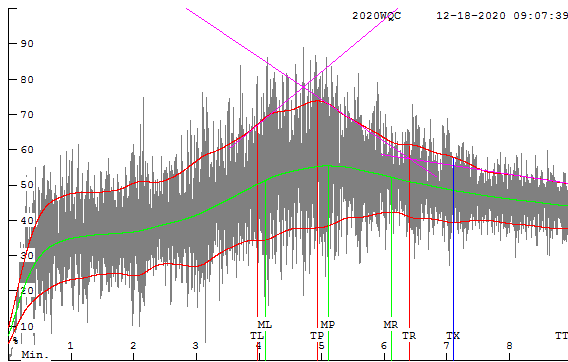
Linkert Check (Watertown, B-9)



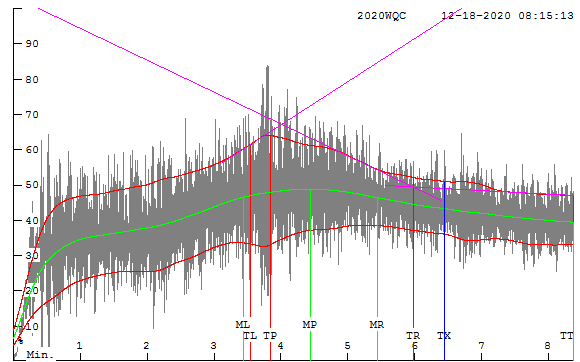
AP Murdock (Watertown, B-1)



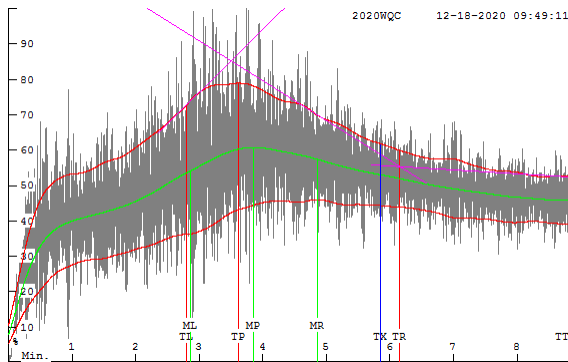
Linkert Check (Casselton, C-9)



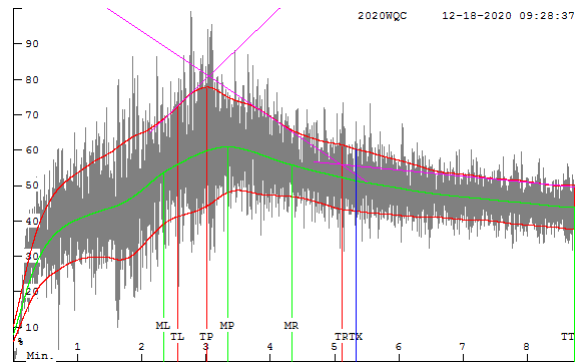
AP Murdock (Casselton, C-1)



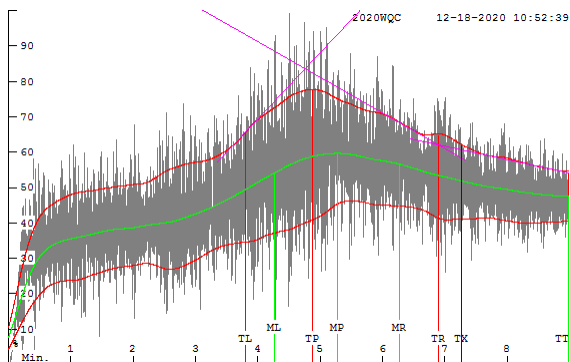
LCS Rebel Check (Havre, H-7)



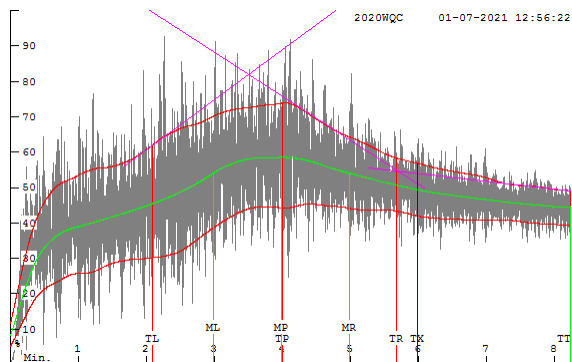
AP Murdock (Havre, H-1)



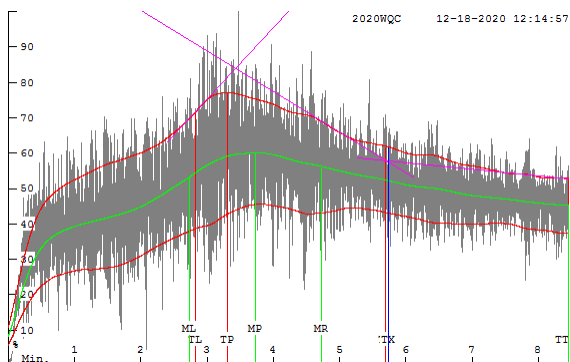
Linkert Check (Crookston, K-9)



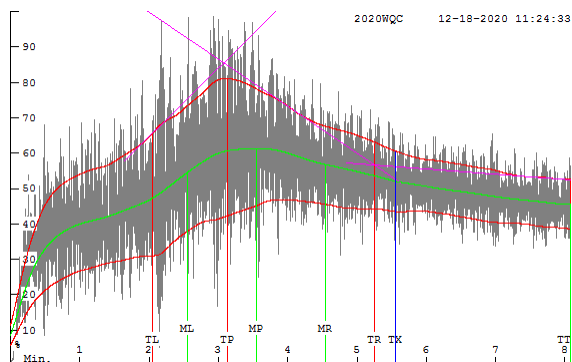
AP Murdock (Crookston, K-1)



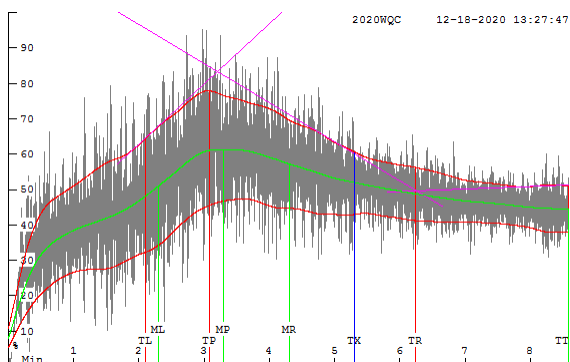
LCS Rebel Check (Minot, M-7)



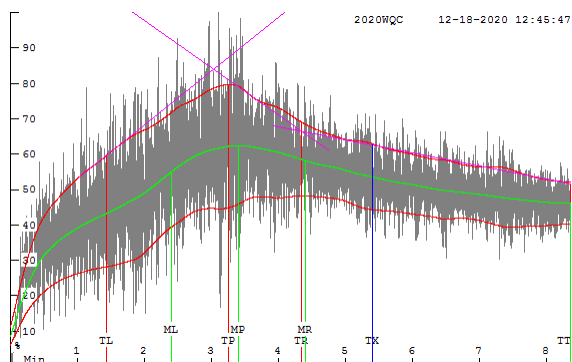
AP Murdock (Minot, M-1)



LCS Rebel Check (Williston, W-7)

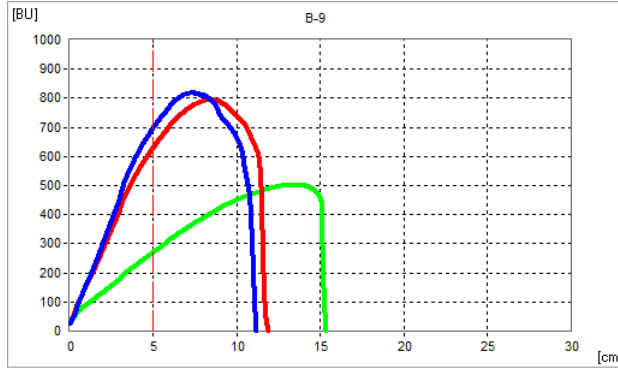


AP Murdock (Williston, W-1)

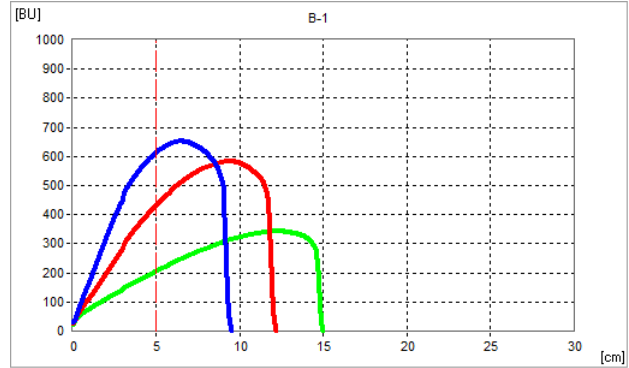


Extensograms

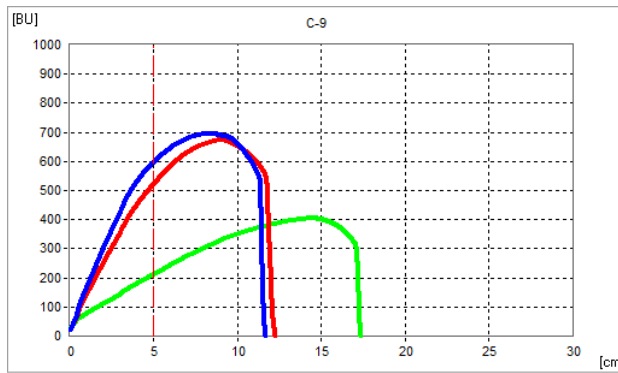
Linkert Check (Watertown, B-9)



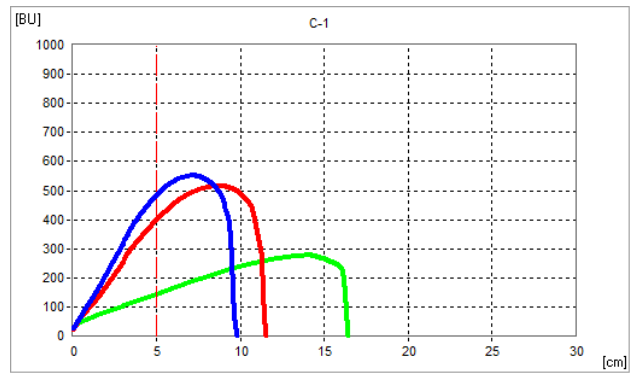
AP Murdock (Watertown, B-1)



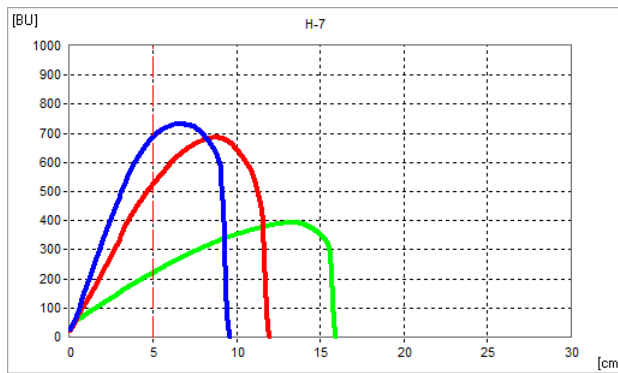
Linkert Check (Casselton, C-9)



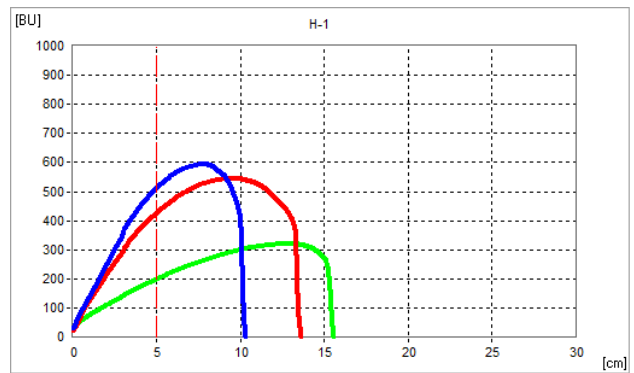
AP Murdock (Casselton, C-1)



LCS Rebel Check (Havre, H-7)

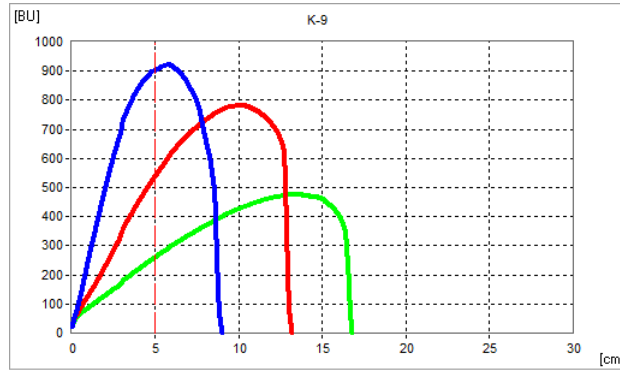


AP Murdock (Havre, H-1)

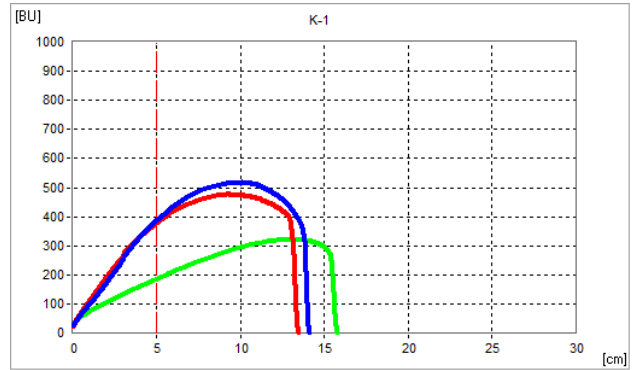


— 45 min; — 90 min; — 135 min

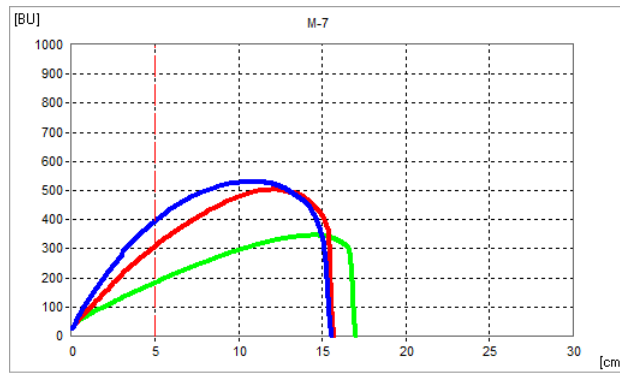
Linkert Check (Crookston, K-9)



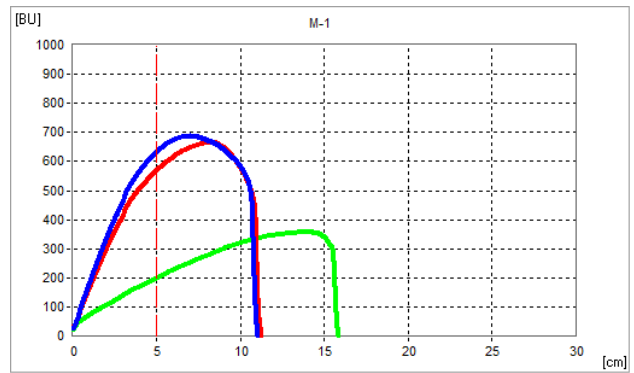
AP Murdock (Crookston, K-1)



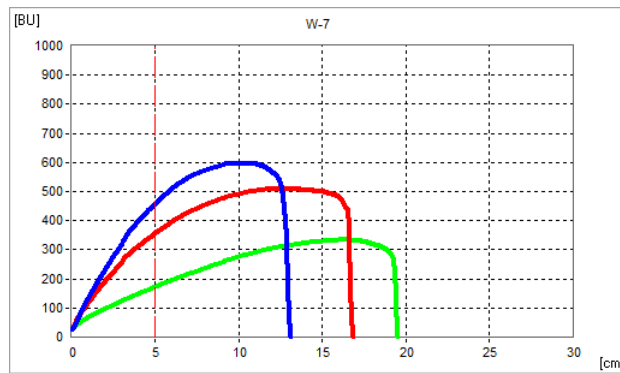
LCS Rebel Check (Minot, M-7)



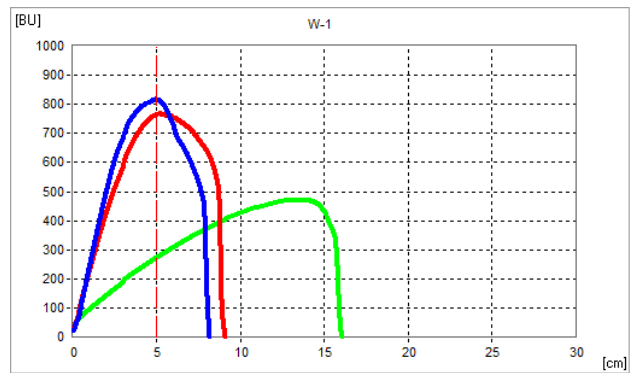
AP Murdock (Minot, M-1)



LCS Rebel Check (Williston, W-7)



AP Murdock (Williston, W-1)



— 45 min; — 90 min; — 135 min

SWQC #2 – NDHRS16-14-126

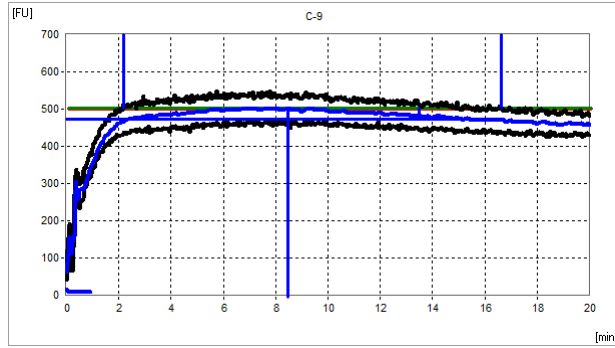
Quality Trait	Casselton		Minot		Williston	
	Linkert		LCS Rebel		LCS Rebel	
	C-9	C-2	M-7	M-2	W-7	W-2
I. USDA-ARS WQL Data						
1 Wheat Protein (% , 12% mb)	14.9	14.5	15.1	15.9	15.6	14.7
2 Flour Protein (% , 14% mb)	13.4	12.6	14.1	14.4	14.7	13.8
3 Market Value (Score 1-6)	4.3	3.5	4.8	5.3	5.0	4.6
4 Market Value (Score 1-10)	10.0	8.8	10.0	10.0	10.0	9.0
5 DON (ppm)	0.24	0.18	0.09	0.06	0.01	0.01
6 Test Weight (lb/bu)	61.4	61.0	62.7	62.9	64.0	64.6
7 1000 Kernel Weight (g)	32.3	32.0	36.2	36.2	30.3	28.9
8 Kernel Size, % Large	69	75	76	84	44	50
9 Kernel Size, % Small	7	5	7	3	16	15
10 Wheat Moisture (%)	12.6	13.0	12.3	11.4	9.9	10.1
11 Wheat Ash (% , 14% mb)	1.74	1.67	1.65	1.59	1.50	1.60
12 Wheat Falling Number (sec)	418	336	399	423	461	424
13 SKCS Hardness Index	69.2	75.2	68.2	79.0	69.4	84.6
14 Vitreous Kernels (%)	68	55	86	80	99	99
Flour Extraction (%)						
15 Tempered Wheat Basis (%)	70.2	62.9	72.9	66.0	69.1	64.4
16 Total Product Basis (%)	72.6	65.0	74.6	67.2	73.1	65.8
17 Flour/Bu Wheat (lbs)	43.5	38.3	46.1	42.2	44.9	42.1
Flour Quality						
18 Flour Color Brightness (L^*)	90.5	89.6	90.3	89.5	90.2	89.8
19 Flour Color Yellowness (b^*)	8.8	9.5	9.0	9.0	9.2	9.1
20 Flour Moisture (%)	13.4	12.8	13.0	13.0	13.4	13.3
21 Flour Ash (% , 14% mb)	0.48	0.56	0.48	0.51	0.44	0.52
22 Flour Falling Number (Malted) (sec)	251	264	251	255	253	263
Farinograph						
23 Water Absorption (% , 500 BU)	62.5	74.2	66.1	75.7	66.6	75.8
24 Water Absorption (% , 14% mb)	62.1	72.8	65.1	74.8	66.0	75.0
25 Arrival Time (min)	2.2	2.8	3.8	4.3	5.0	4.8
26 Peak Time (min)	8.5	7.2	8.0	7.3	8.5	9.9
27 Dough Stability (min)	14.5	8.3	9.3	8.2	10.9	8.8
28 Mixing Tolerance Index (MTI) (BU)	20	34	31	26	21	37
29 Time To Breakdown (TTB) (min)	15.1	11.6	13.0	12.7	15.1	13.8
II. Cooperator Results						
30 Bake Absorption (Average %)	65.0	71.7	68.0	73.6	68.5	74.2
31 Loaf Volume (% of Check)		94.1		99.4		94.9

SWQC #2 – NDHRS16-14-126

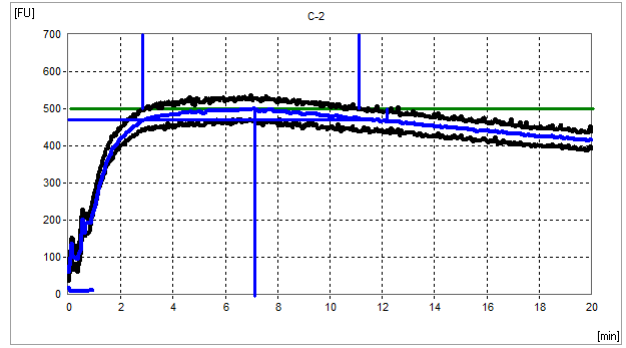
Quality Trait		Casselton		Minot		Williston	
		Linkert		LCS Rebel		LCS Rebel	
		C-9	C-2	M-7	M-2	W-7	W-2
II. Cooperator Results							
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	7.2	4.5	6.1	4.1	5.8	5.1
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.8	4.9	6.8	5.8	6.8	6.1
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		3.5		3.7		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		3.8		4.2		4.4
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		3.9		4.0		4.1
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		3.8		5.9		3.5
	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		1.8		2.2		2.3
	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		3.3		4.0		3.5
	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		2.7		3.6		2.9

Farinograms

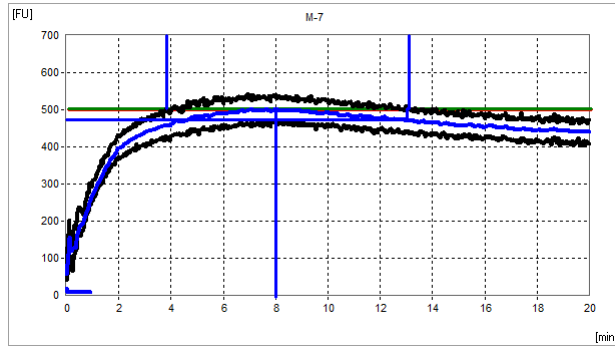
Linkert Check (Casselton, C-9)



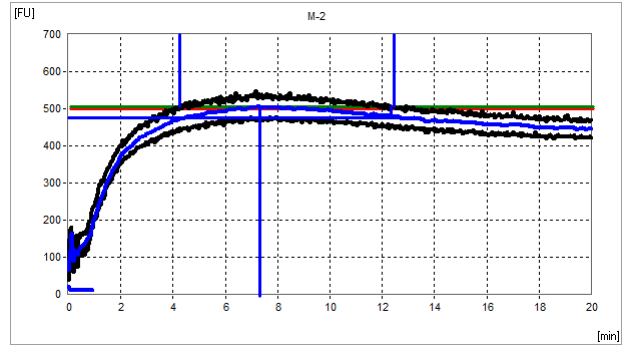
NDHRS16-14-126 (Casselton, C-2)



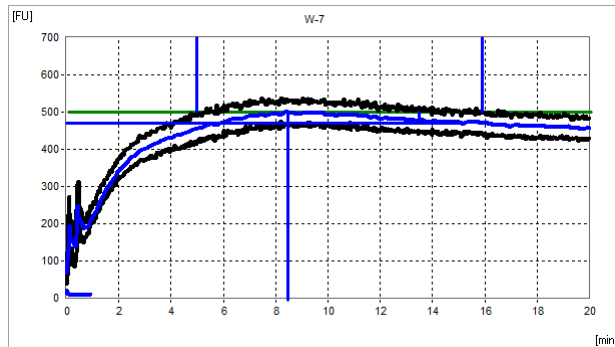
LCS Rebel Check (Minot, M-7)



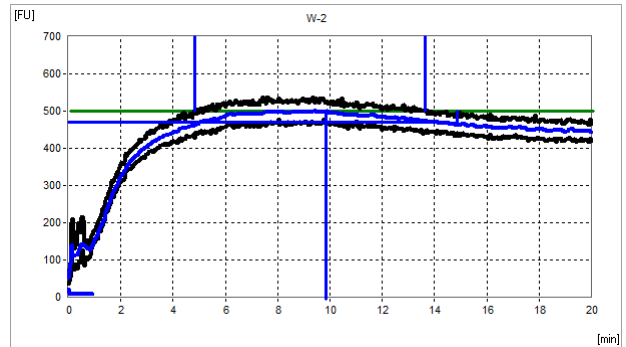
NDHRS16-14-126 (Minot, M-2)



LCS Rebel Check (Williston, W-7)

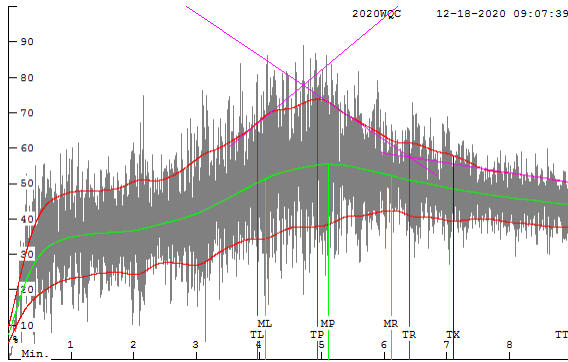


NDHRS16-14-126 (Williston, W-2)

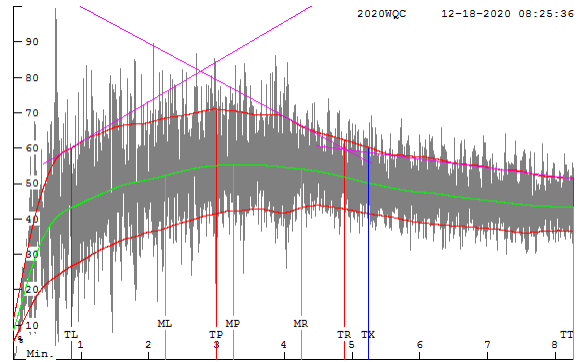


Mixograms

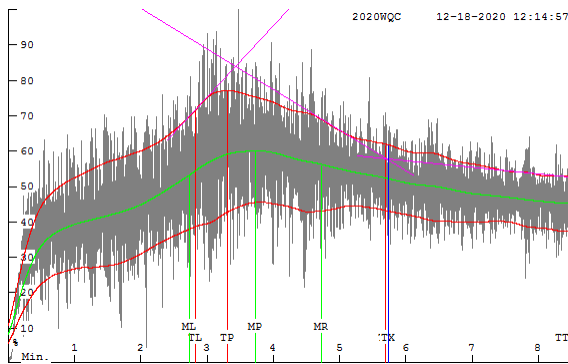
Linkert Check (Casselton, C-9)



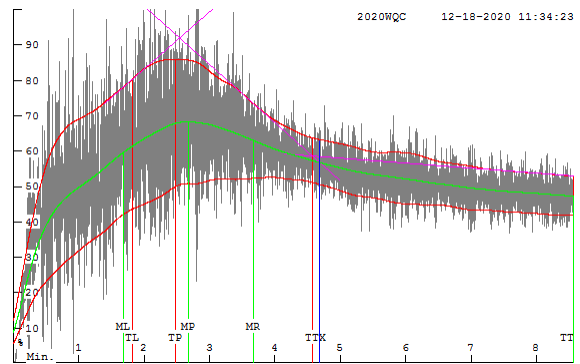
NDHRS16-14-126 (Casselton, C-2)



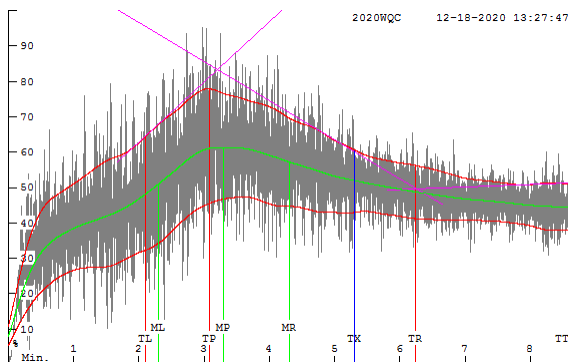
LCS Rebel Check (Minot, M-7)



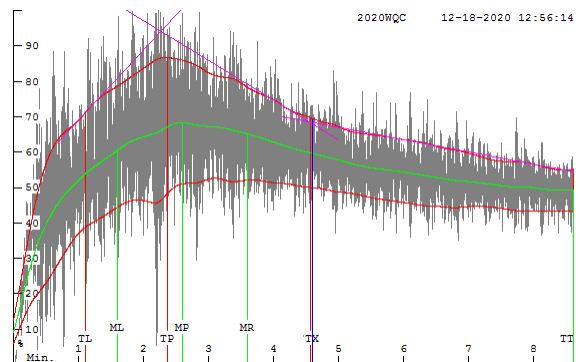
NDHRS16-14-126 (Minot, M-2)



LCS Rebel Check (Williston, W-7)

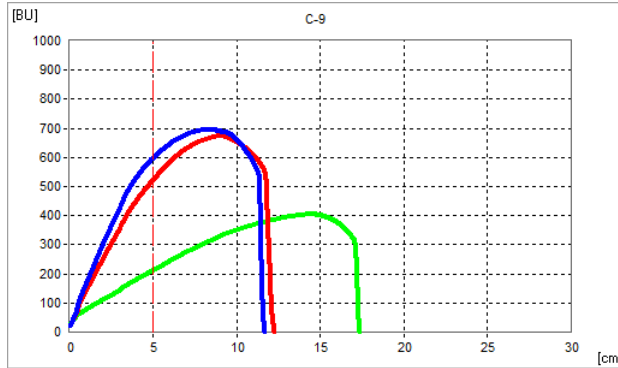


NDHRS16-14-126 (Williston, W-2)

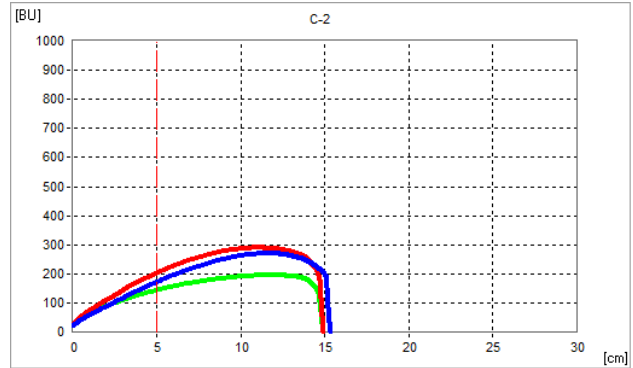


Extensograms

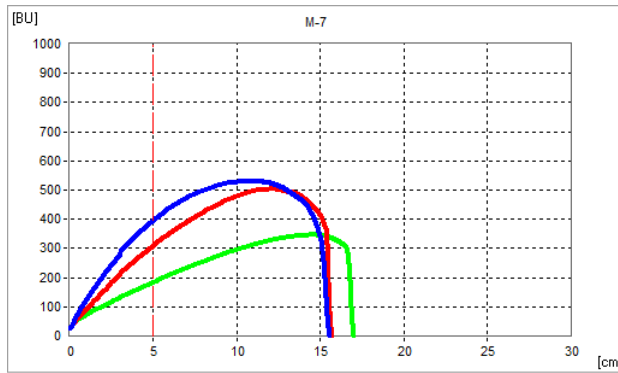
Linkert Check (Casselton, C-9)



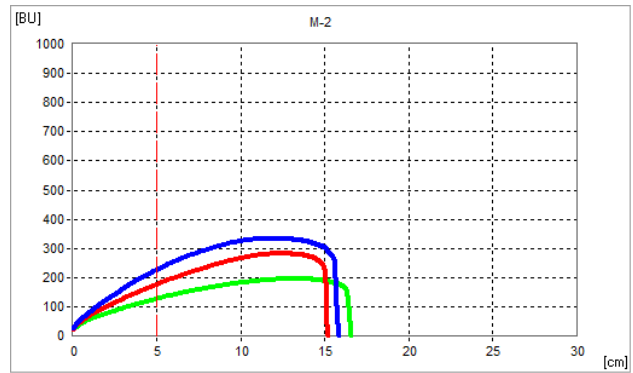
NDHRS16-14-126 (Casselton, C-2)



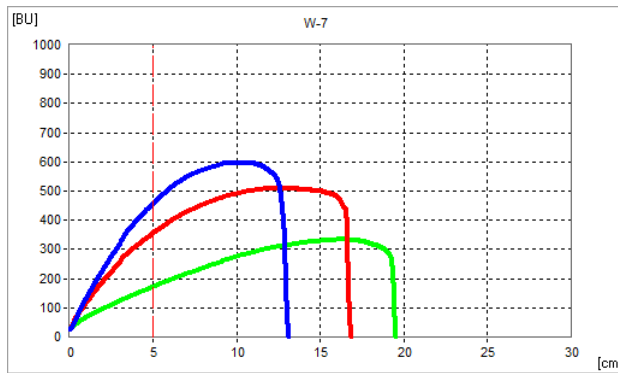
LCS Rebel Check (Minot, M-7)



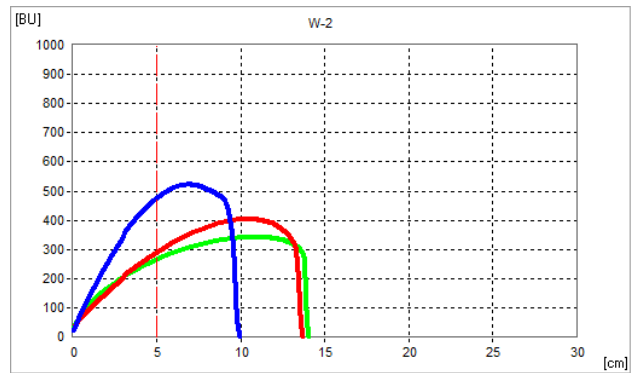
NDHRS16-14-126 (Minot, M-2)



LCS Rebel Check (Williston, W-7)



NDHRS16-14-126 (Williston, W-2)



— 45 min; — 90 min; — 135 min

SWQC #3 – AKF-Snowfire

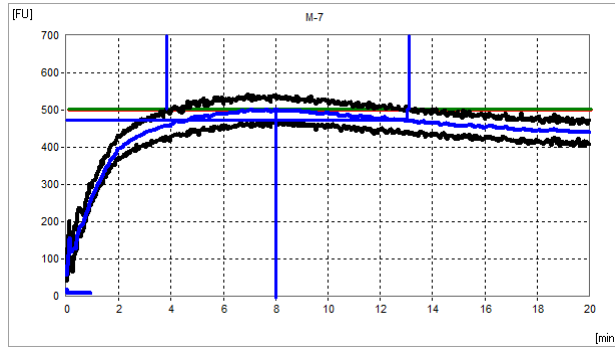
Quality Trait		Minot		Williston	
		LCS Rebel	M-3	LCS Rebel	W-3
		M-7		W-7	
I. USDA-ARS WQL Data					
1	Wheat Protein (% , 12% mb)	15.1	14.7	15.6	14.8
2	Flour Protein (% , 14% mb)	14.1	13.8	14.7	14.0
3	Market Value (Score 1-6)	4.8	5.0	5.0	4.8
4	Market Value (Score 1-10)	10.0	10.0	10.0	9.4
5	DON (ppm)	0.09	0.10	0.01	0.01
6	Test Weight (lb/bu)	62.7	62.9	64.0	64.4
7	1000 Kernel Weight (g)	36.2	35.8	30.3	30.8
8	Kernel Size, % Large	76	64	44	30
9	Kernel Size, % Small	7	8	16	19
10	Wheat Moisture (%)	12.3	11.9	9.9	10.3
11	Wheat Ash (% , 14% mb)	1.65	1.55	1.50	1.50
12	Wheat Falling Number (sec)	399	447	461	590
13	SKCS Hardness Index	68.2	69.9	69.4	72.0
14	Vitreous Kernels (%)	86	87	99	99
Flour Extraction (%)					
15	Tempered Wheat Basis (%)	72.9	70.7	69.1	69.1
16	Total Product Basis (%)	74.6	73.0	73.1	71.3
17	Flour/Bu Wheat (lbs)	46.1	45.0	44.9	45.0
Flour Quality					
18	Flour Color Brightness (L*)	90.3	90.2	90.2	90.2
19	Flour Color Yellowness (b*)	9.0	9.9	9.2	10.0
20	Flour Moisture (%)	13.0	13.0	13.4	13.1
21	Flour Ash (% , 14% mb)	0.48	0.47	0.44	0.47
22	Flour Falling Number (Malted) (sec)	251	249	253	255
Farinograph					
23	Water Absorption (% , 500 BU)	66.1	70.6	66.6	71.6
24	Water Absorption (% , 14% mb)	65.1	69.4	66.0	70.6
25	Arrival Time (min)	3.8	2.7	5.0	3.8
26	Peak Time (min)	8.0	5.3	8.5	8.4
27	Dough Stability (min)	9.3	9.6	10.9	11.7
28	Mixing Tolerance Index (MTI) (BU)	31	20	21	25
29	Time To Breakdown (TTB) (min)	13.0	12.0	15.1	13.7
II. Cooperator Results					
30	Bake Absorption (Average %)	68.0	70.6	68.5	71.6
31	Loaf Volume (% of Check)		98.7		100.5

SWQC #3 – AKF-Snowfire

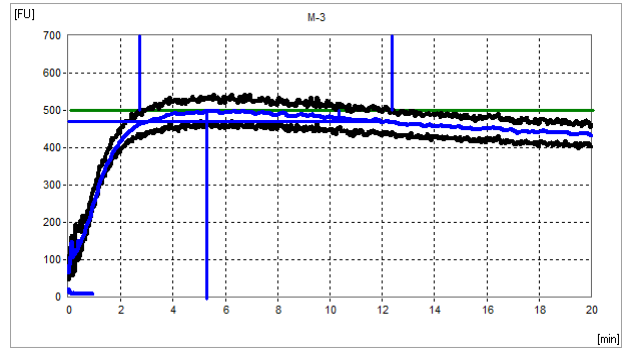
Quality Trait		Minot		Williston	
		LCS Rebel M-7	M-3	Glenn W-7	W-3
II. Cooperator Results					
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.1	6.5	5.8	6.0
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.8	6.8	6.8	6.5
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		5.6		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		4.7		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		4.9		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		4.4		3.5
	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		4.5		4.5
	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		4.7		5.3
	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		4.5		4.7

Farinograms

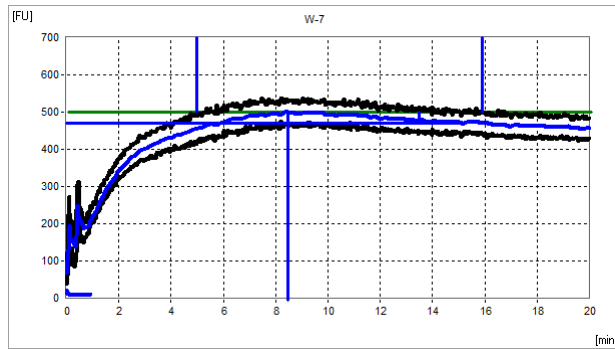
LCS Rebel Check (Minot, M-7)



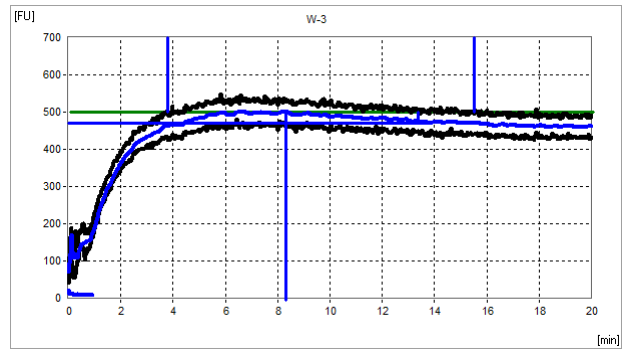
AKF-Snowfire (Minot, M-3)



LCS Rebel Check (Williston, W-7)

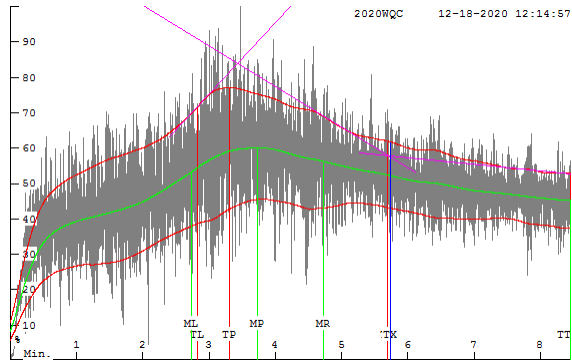


AKF-Snowfire (Williston, W-3)

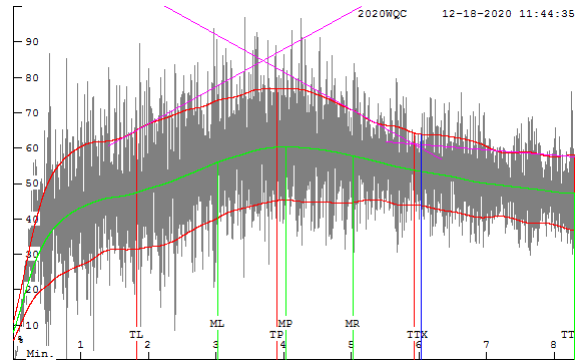


Mixograms

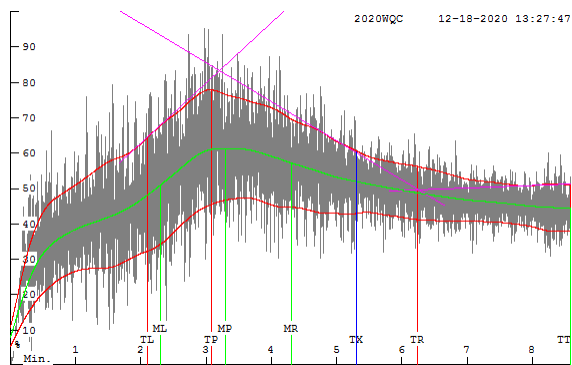
LCS Rebel Check (Minot, M-7)



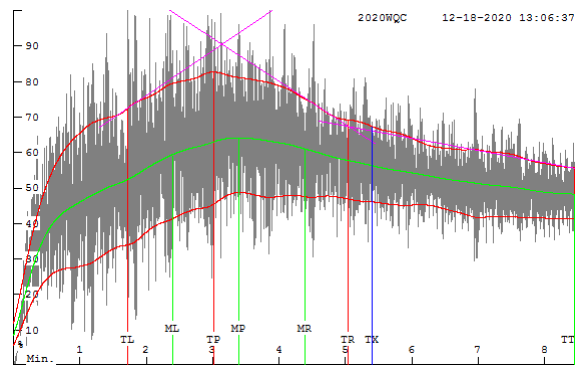
AKF-Snowfire (Minot, M-3)



LCS Rebel Check (Williston, W-7)

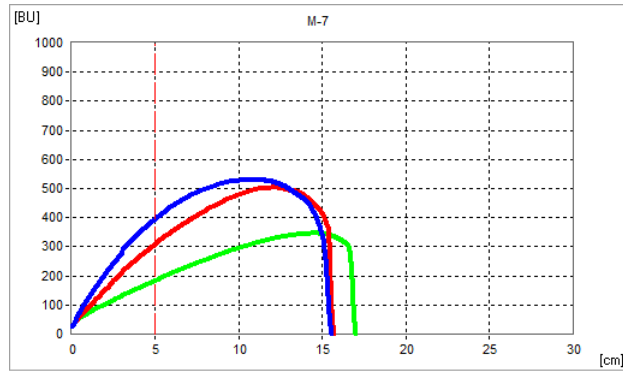


AKF-Snowfire (Williston, W-3)

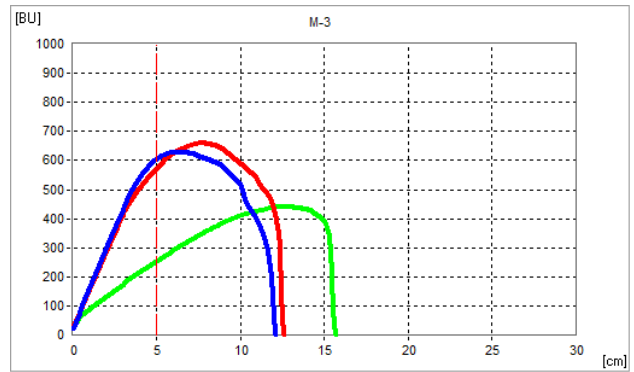


Extensograms

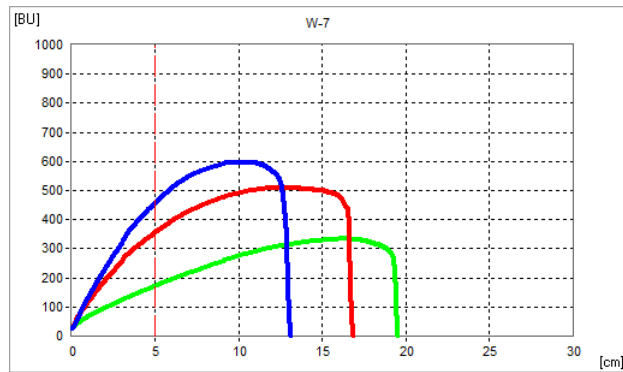
LCS Rebel Check (Minot, M-7)



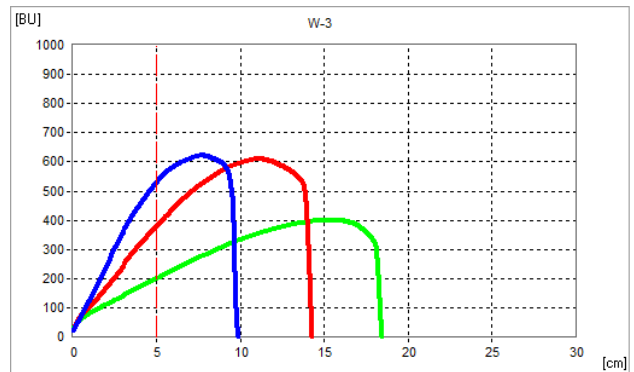
AKF-Snowfire (Minot, M-3)



LCS Rebel Check (Williston, W-7)



AKF-Snowfire (Williston, W-3)



— 45 min; — 90 min; — 135 min

SWQC #4 – MN15005-4

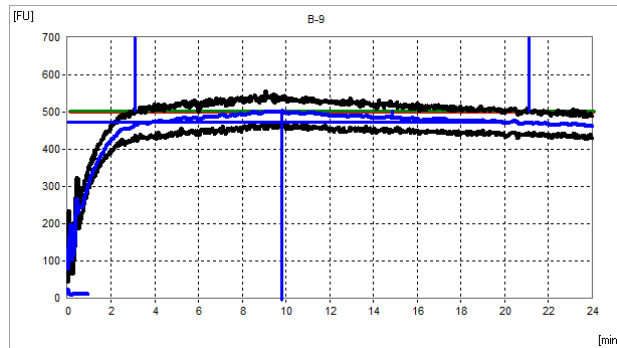
Quality Trait		Watertown		Casselton		Crookston		Minot	
		Linkert B-9	B-4	Linkert C-9	C-4	Linkert K-9	K-4	LCS Rebel M-7	M-4
I. USDA-ARS WQL Data									
1	Wheat Protein (% , 12% mb)	15.5	14.6	14.9	13.9	15.6	14.9	15.1	14.9
2	Flour Protein (% , 14% mb)	14.3	13.2	13.4	12.3	14.2	13.3	14.1	13.8
3	Market Value (Score 1-6)	4.7	4.4	4.3	3.4	4.6	4.1	4.8	4.6
4	Market Value (Score 1-10)	10.0	9.0	10.0	8.2	10.0	8.6	10.0	9.6
5	DON (ppm)	0.36	0.24	0.24	0.25	0.99	0.37	0.09	0.09
6	Test Weight (lb/bu)	61.4	61.7	61.4	60.1	61.1	61.1	62.7	61.8
7	1000 Kernel Weight (g)	32.4	29.9	32.3	27.0	33.6	28.3	36.2	33.0
8	Kernel Size, % Large	64	52	69	43	64	36	76	56
9	Kernel Size, % Small	8	12	7	17	8	19	7	13
10	Wheat Moisture (%)	11.5	11.8	12.6	12.8	11.7	12.4	12.3	11.9
11	Wheat Ash (% , 14% mb)	1.63	1.53	1.74	1.67	1.67	1.63	1.65	1.62
12	Wheat Falling Number (sec)	437	437	418	405	415	420	399	441
13	SKCS Hardness Index	72.6	69.3	69.2	63.8	76.5	74.9	68.2	67.6
14	Vitreous Kernels (%)	80	68	68	46	62	60	86	50
Flour Extraction (%)									
15	Tempered Wheat Basis (%)	70.5	70.7	70.2	70.3	70.5	71.0	72.9	73.1
16	Total Product Basis (%)	72.5	72.9	72.6	73.0	72.1	73.2	74.6	75.2
17	Flour/Bu Wheat (lbs)	43.9	44.3	43.5	42.3	44.0	43.7	46.1	46.0
Flour Quality									
18	Flour Color Brightness (L*)	90.3	90.2	90.5	90.4	90.0	89.9	90.3	90.4
19	Flour Color Yellowness (b*)	8.3	8.9	8.8	9.3	8.8	9.6	9.0	9.5
20	Flour Moisture (%)	12.8	13.0	13.4	12.8	13.6	13.1	13.0	13.6
21	Flour Ash (% , 14% mb)	0.47	0.46	0.48	0.51	0.50	0.49	0.48	0.47
22	Flour Falling Number (Malted) (sec)	247	251	251	251	253	246	251	254
Farinograph									
23	Water Absorption (% , 500 BU)	63.5	63.9	62.5	64.2	62.6	62.0	66.1	63.5
24	Water Absorption (% , 14% mb)	62.3	63.0	62.1	63.0	61.7	61.0	65.1	63.1
25	Arrival Time (min)	3.1	3.5	2.2	2.7	2.9	3.1	3.8	4.0
26	Peak Time (min)	9.8	7.3	8.5	8.0	7.2	7.4	8.0	8.8
27	Dough Stability (min)	18.0	9.7	14.5	9.8	15.6	8.5	9.3	10.0
28	Mixing Tolerance Index (MTI) (BU)	18	28	20	36	11	37	31	27
29	Time To Breakdown (TTB) (min)	19.9	12.8	15.1	12.3	15.8	11.3	13.0	13.6
II. Cooperator Results									
30	Bake Absorption (Average %)	66.1	65.8	65.0	65.1	65.5	64.2	68.0	65.8
31	Loaf Volume (% of Check)		97.5		98.1		99.9		101.0

SWQC #4 – MN15005-4

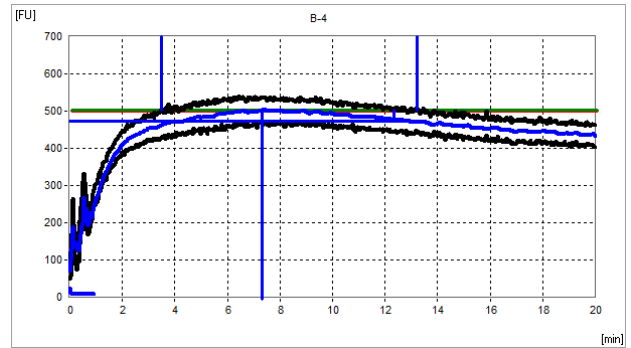
Quality Trait		Watertown		Casselton		Crookston		Minot	
		Linkert B-9	B-4	Linkert C-9	C-4	Linkert K-9	K-4	LCS Rebel M-7	M-4
II. Cooperator Results									
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	7.5	5.4	7.2	6.2	7.6	5.7	6.1	5.8
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.7	5.9	6.8	5.3	6.9	6.0	6.8	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		3.9		4.5		3.6		4.8
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		4.0		4.9		4.9
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		4.7		5.7		5.2		5.8
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		3.2		3.5		5.0
	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		4.6		4.4		4.9		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		4.3		4.4		4.9		5.0
	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		3.9		4.3		4.6		5.2

Farinograms

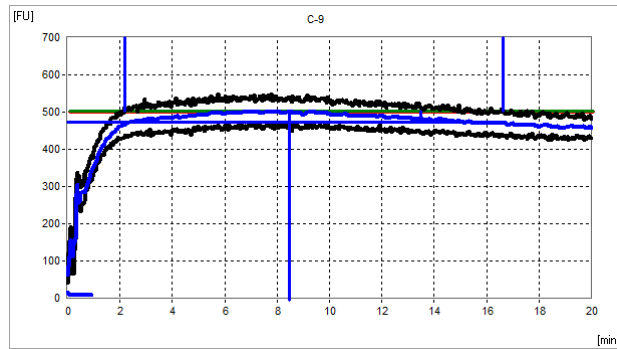
Linkert Check (Watertown, B-9)



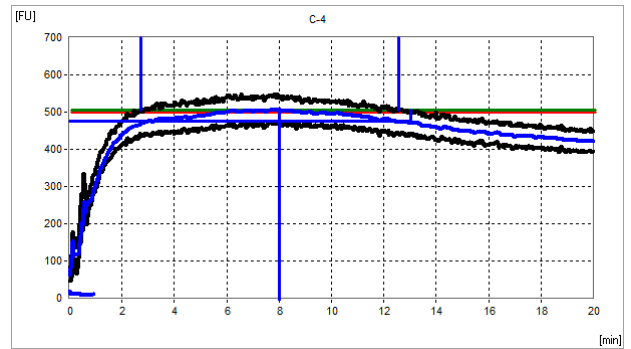
MN15005-4 (Watertown, B-4)



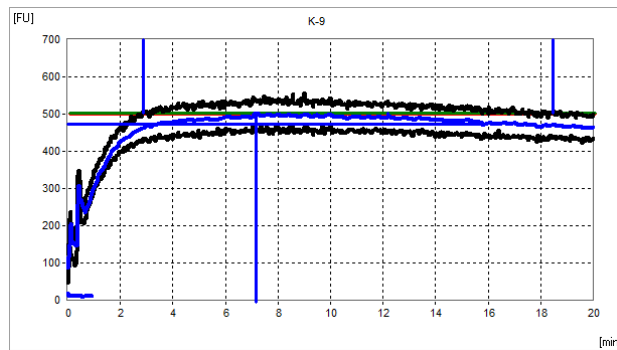
Linkert Check (Casselton, C-9)



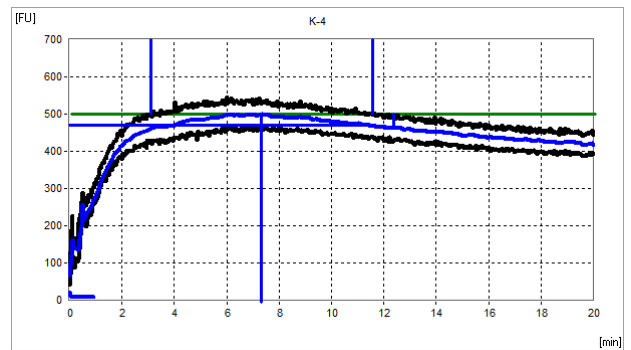
MN15005-4 (Casselton, C-4)



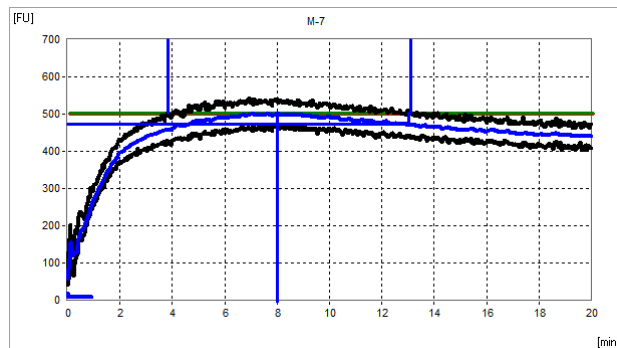
Linkert Check (Crookston, K-9)



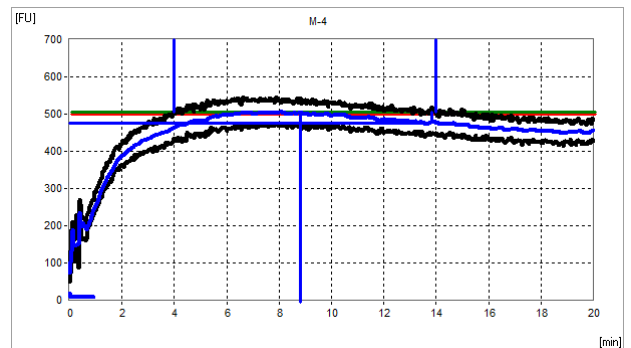
MN15005-4 (Crookston, K-4)



LCS Rebel Check (Minot, M-7)

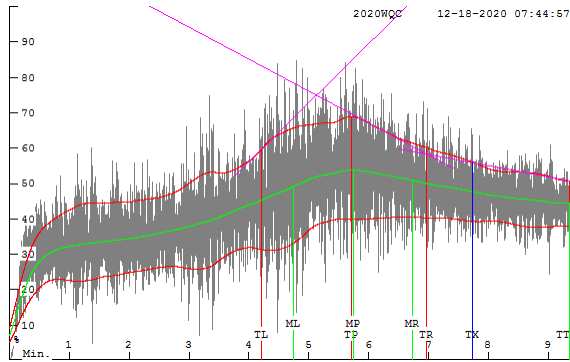


MN15005-4 (Minot, M-4)

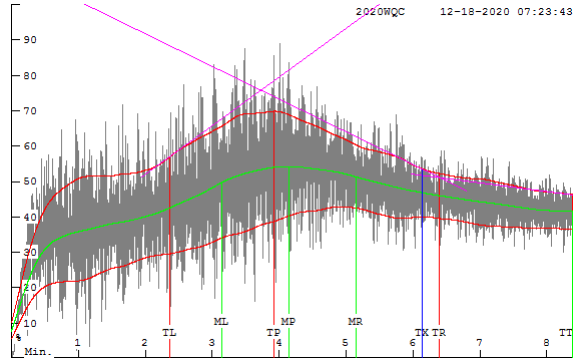


Mixograms

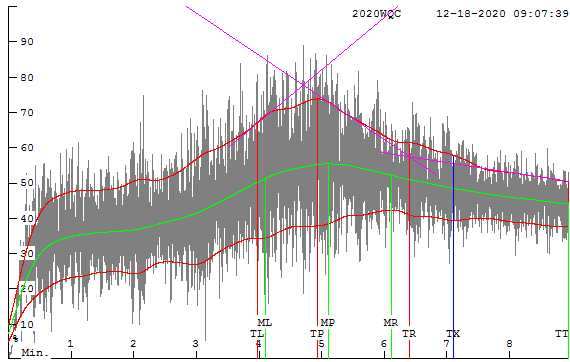
Linkert Check (Watertown, B-9)



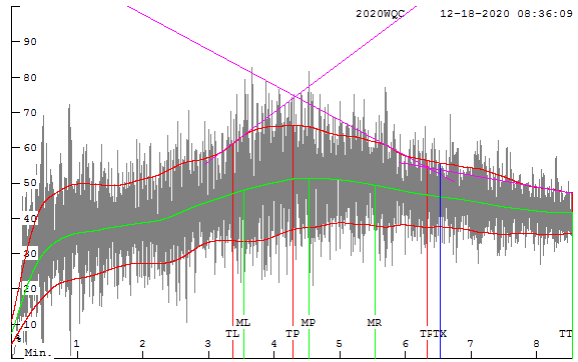
MN15005-4 (Watertown, B-4)



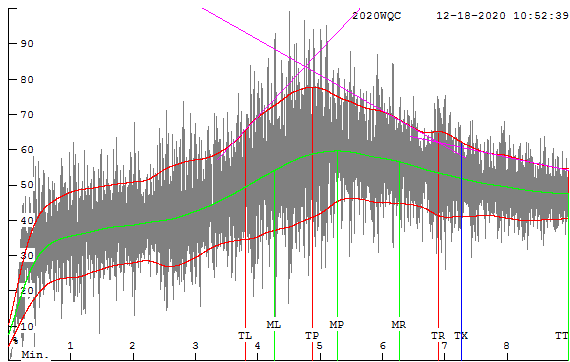
Linkert Check (Casselton, C-9)



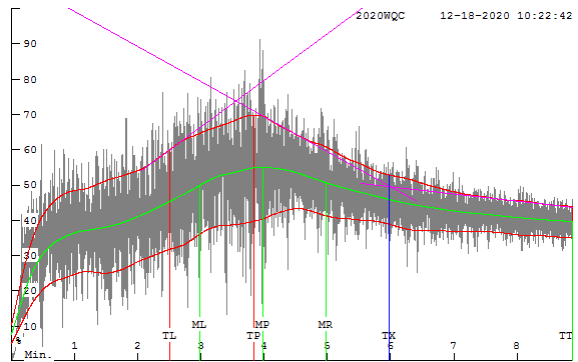
MN15005-4 (Casselton, C-4)



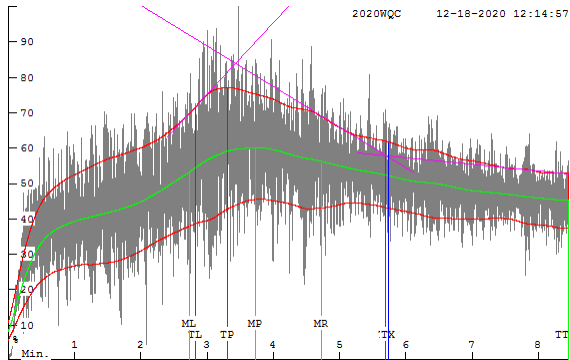
Linkert Check (Crookston, K-9)



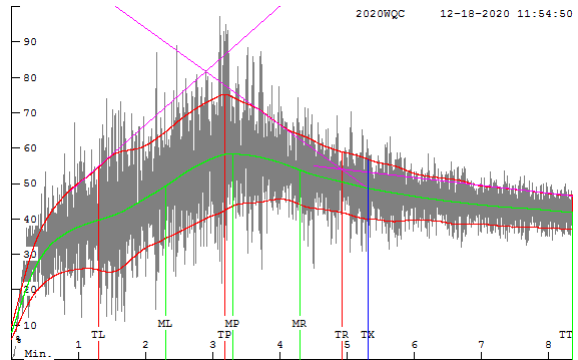
MN15005-4 (Crookston, K-4)



LCS Rebel Check (Minot, M-7)

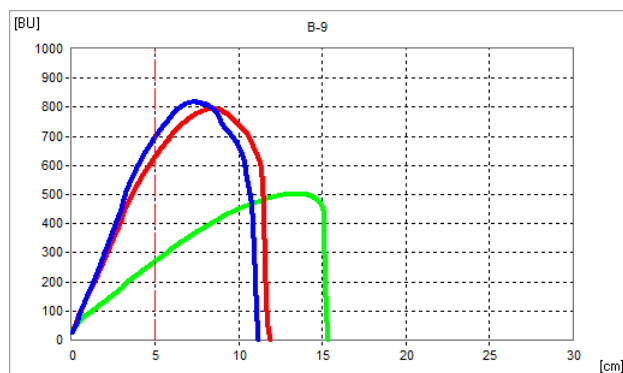


MN15005-4 (Minot, M-4)

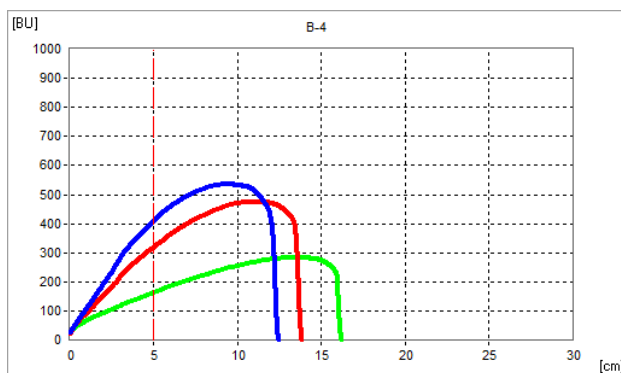


Extensograms

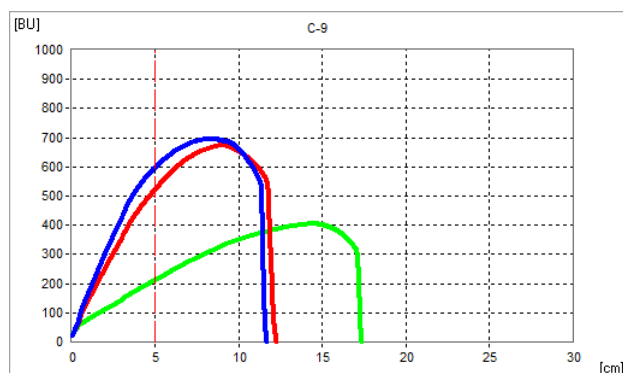
Linkert Check (Watertown, B-9)



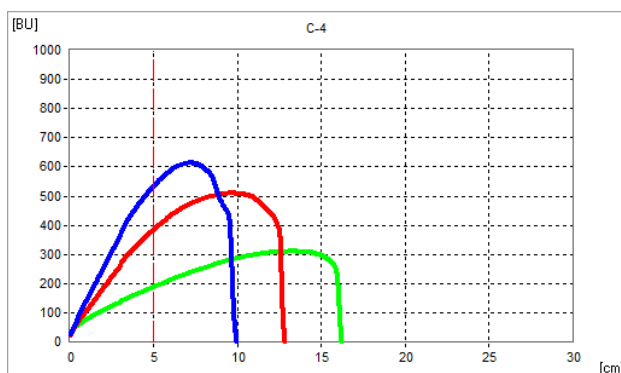
MN15005-4 (Watertown, B-4)



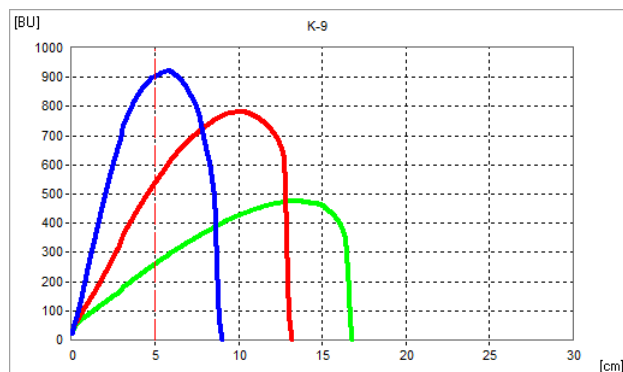
Linkert Check (Casselton, C-9)



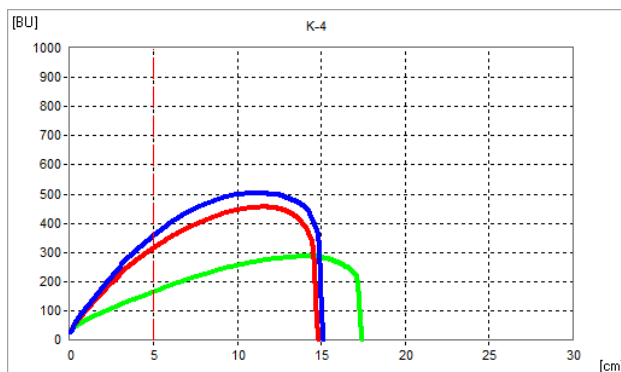
MN15005-4 (Casselton, C-4)



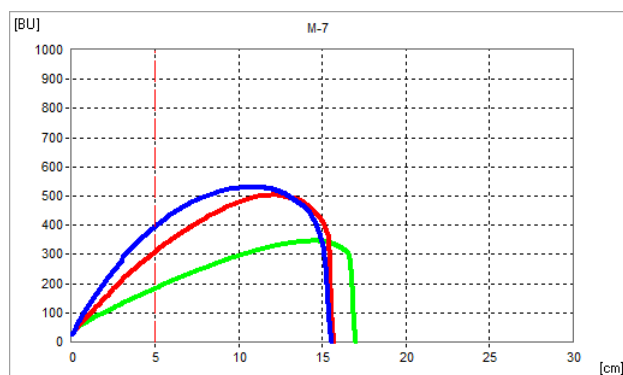
Linkert Check (Crookston, K-9)



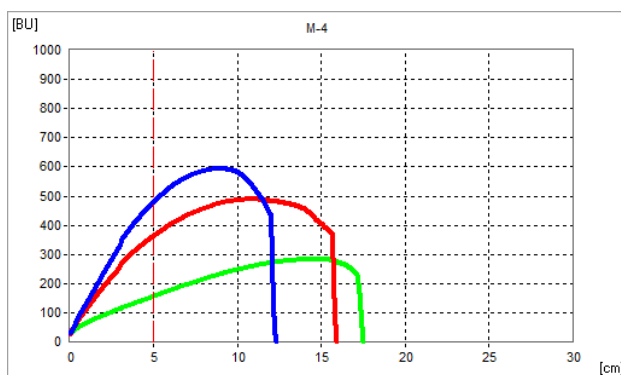
MN15005-4 (Crookston, K-4)



LCS Rebel Check (Minot, M-7)



MN15005-4 (Minot, M-4)



— 45 min; — 90 min; — 135 min

SWQC #5 – TCG-Wildcat

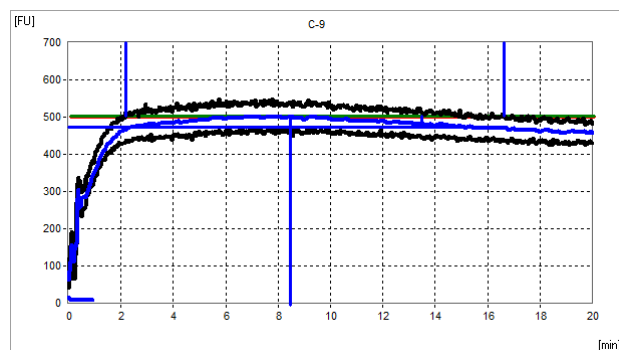
Quality Trait		Casselton		Crookston	
		Linkert C-9	C-5	Linkert K-9	K-5
I. USDA-ARS WQL Data					
1	Wheat Protein (% , 12% mb)	14.9	15.3	15.6	15.0
2	Flour Protein (% , 14% mb)	13.4	13.5	14.2	13.2
3	Market Value (Score 1-6)	4.3	4.5	4.6	3.9
4	Market Value (Score 1-10)	10.0	10.0	10.0	8.6
5	DON (ppm)	0.24	0.58	0.99	0.54
6	Test Weight (lb/bu)	61.4	61.5	61.1	60.2
7	1000 Kernel Weight (g)	32.3	31.8	33.6	29.7
8	Kernel Size, % Large	69	71	64	60
9	Kernel Size, % Small	7	7	8	11
10	Wheat Moisture (%)	12.6	12.9	11.7	12.3
11	Wheat Ash (% , 14% mb)	1.74	1.61	1.67	1.52
12	Wheat Falling Number (sec)	418	412	415	384
13	SKCS Hardness Index	69.2	69.1	76.5	77.3
14	Vitreous Kernels (%)	68	52	62	57
Flour Extraction (%)					
15	Tempered Wheat Basis (%)	70.2	67.4	70.5	69.2
16	Total Product Basis (%)	72.6	70.2	72.1	71.2
17	Flour/Bu Wheat (lbs)	43.5	41.6	44.0	41.9
Flour Quality					
18	Flour Color Brightness (<i>L</i> *)	90.5	89.6	90.0	89.0
19	Flour Color Yellowness (<i>b</i> *)	8.8	9.9	8.8	10.8
20	Flour Moisture (%)	13.4	13.2	13.6	12.8
21	Flour Ash (% , 14% mb)	0.48	0.51	0.50	0.50
22	Flour Falling Number (Malted) (sec)	251	253	253	253
Farinograph					
23	Water Absorption (% , 500 BU)	62.5	66.5	62.6	64.3
24	Water Absorption (% , 14% mb)	62.1	65.6	61.7	62.2
25	Arrival Time (min)	2.2	2.7	2.9	2.4
26	Peak Time (min)	8.5	6.3	7.2	5.5
27	Dough Stability (min)	14.5	8.0	15.6	7.1
28	Mixing Tolerance Index (MTI) (BU)	20	32	11	41
29	Time To Breakdown (TTB) (min)	15.1	10.8	15.8	9.2
II. Cooperator Results					
30	Bake Absorption (Average %)	65.0	67.6	65.5	65.6
31	Loaf Volume (% of Check)		96.4		96.0

SWQC #5 – TCG-Wildcat

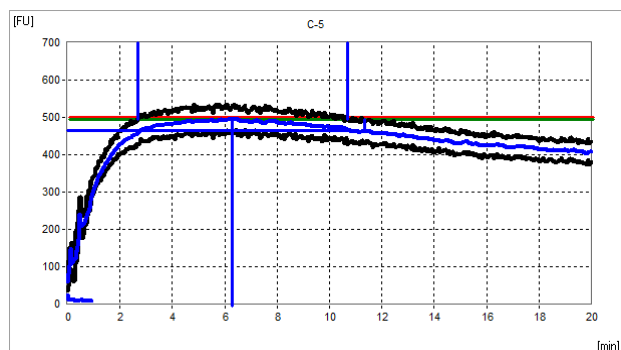
Quality Trait		Casselton		Crookston	
		Linkert		Linkert	
		C-9	C-5	K-9	K-5
II. Cooperator Results					
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	7.2	5.8	7.6	5.7
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.8	5.5	6.9	5.6
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		4.1		3.2
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		4.3		4.6
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		5.5		5.0
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		5.3		3.6
	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		3.3		4.3
	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		4.1		3.7
	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		4.1		3.9

Farinograms

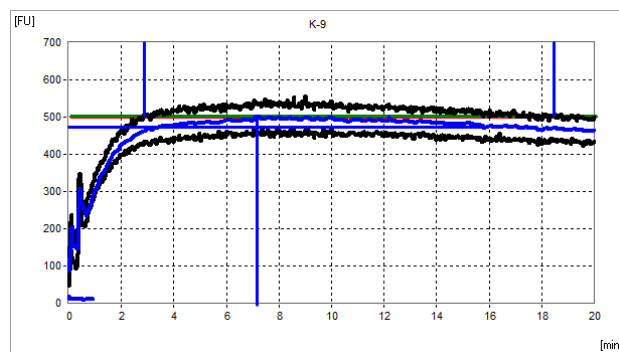
Linkert Check (Casselton, C-9)



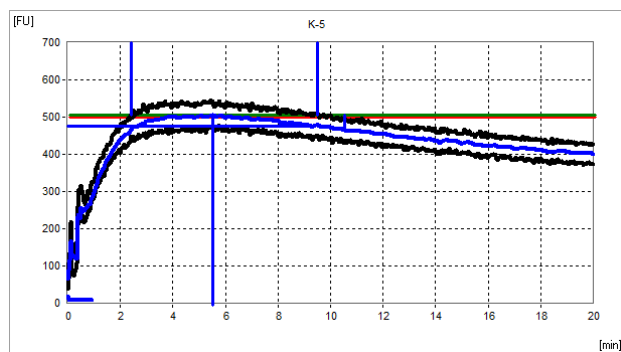
TCG-Wildcat (Casselton, C-5)



Linkert Check (Crookston, K-9)

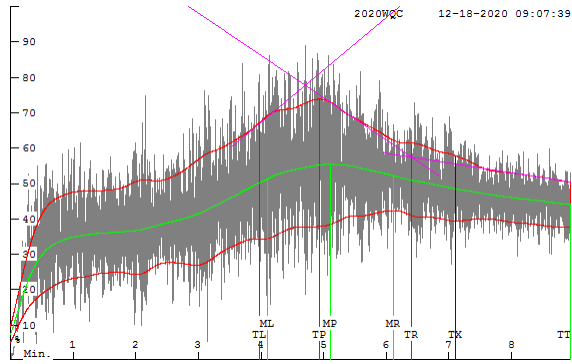


TCG-Wildcat (Crookston, K-5)

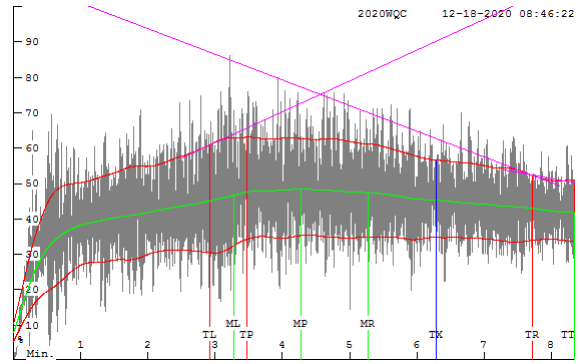


Mixograms

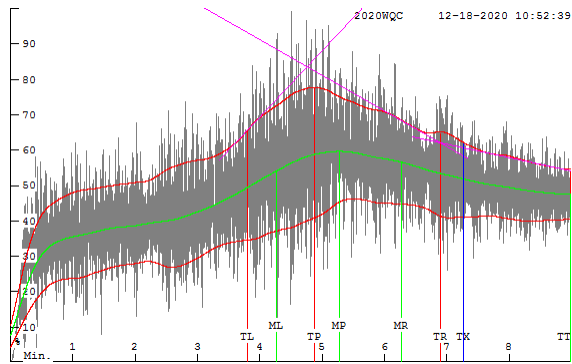
Linkert Check (Casselton, C-9)



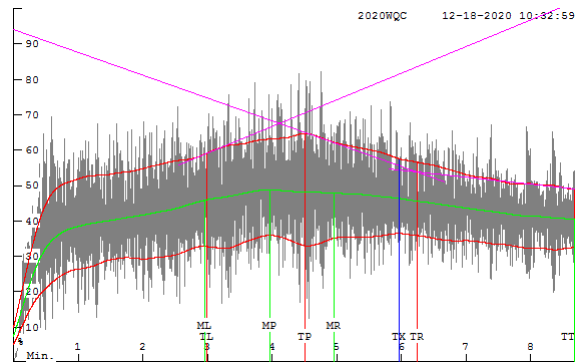
TCG-Wildcat (Casselton, C-5)



Linkert Check (Crookston, K-9)

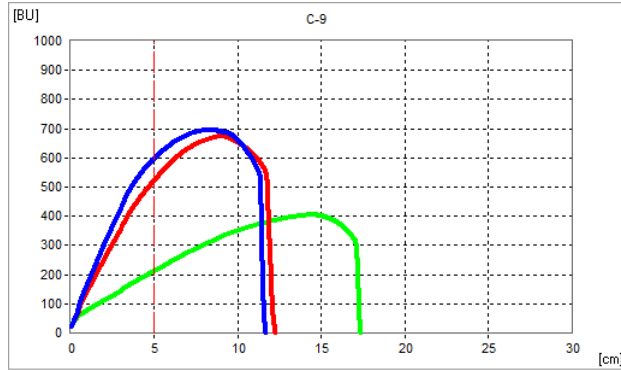


TCG-Wildcat (Crookston, K-5)

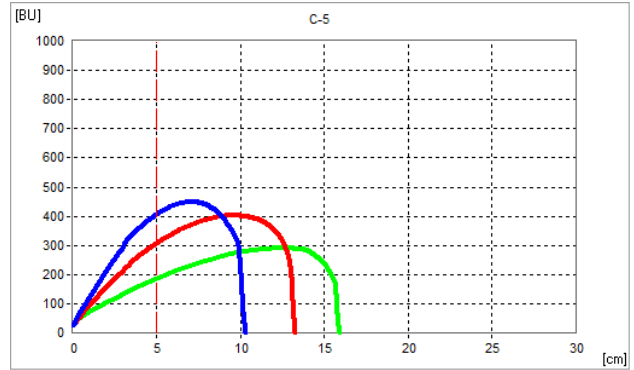


Extensograms

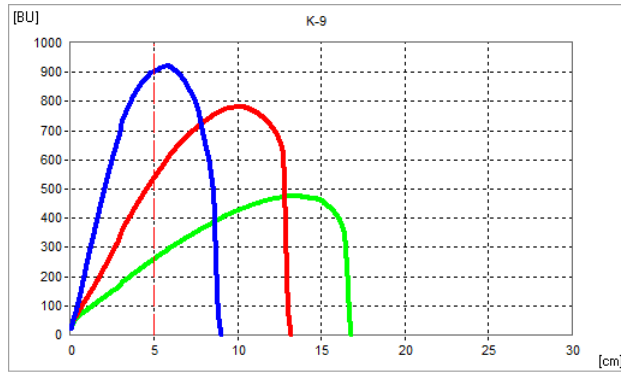
Linkert Check (Casselton, C-9)



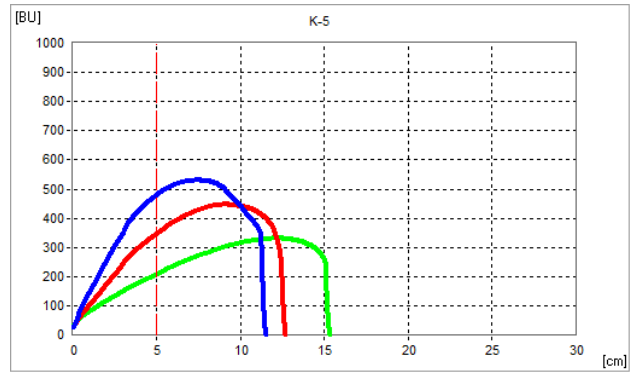
TCG-Wildcat (Casselton, C-5)



Linkert Check (Crookston, K-9)



TCG-Wildcat (Crookston, K-5)



— 45 min; — 90 min; — 135 min

SWQC #6 – Dagmar

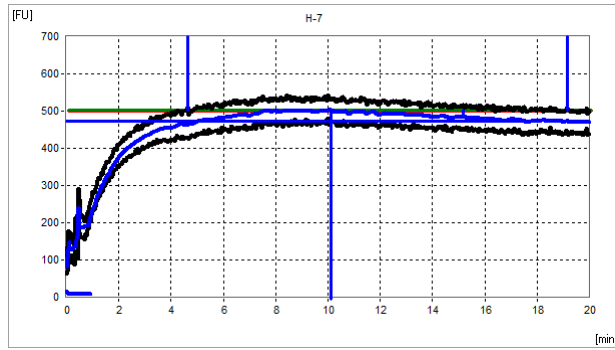
Quality Trait		Havre		Minot		Williston	
		LCS Rebel	H-6	LCS Rebel	M-6	LCS Rebel	W-6
		H-7		M-7		W-7	
I. USDA-ARS WQL Data							
1	Wheat Protein (% , 12% mb)	15.6	15.6	15.1	15.2	15.6	15.2
2	Flour Protein (% , 14% mb)	14.5	14.4	14.1	14.4	14.7	14.3
3	Market Value (Score 1-6)	5.2	5.2	4.8	4.5	5.0	4.8
4	Market Value (Score 1-10)	10.0	10.0	10.0	9.6	10.0	9.8
5	DON (ppm)	0.02	0.02	0.09	0.22	0.01	0.02
6	Test Weight (lb/bu)	63.3	62.5	62.7	60.6	64.0	63.4
7	1000 Kernel Weight (g)	32.7	34.3	36.2	34.7	30.3	32.1
8	Kernel Size, % Large	51	63	76	71	44	50
9	Kernel Size, % Small	11	7	7	8	16	15
10	Wheat Moisture (%)	9.4	9.1	12.3	12.0	9.9	10.0
11	Wheat Ash (% , 14% mb)	1.45	1.43	1.65	1.72	1.50	1.65
12	Wheat Falling Number (sec)	452	456	399	460	461	436
13	SKCS Hardness Index	72.0	73.1	68.2	69.0	69.4	70.5
14	Vitreous Kernels (%)	98	99	86	63	99	96
Flour Extraction (%)							
15	Tempered Wheat Basis (%)	69.5	70.0	72.9	69.0	69.1	70.7
16	Total Product Basis (%)	70.3	72.1	74.6	71.1	73.1	71.7
17	Flour/Bu Wheat (lbs)	44.5	44.3	46.1	42.3	44.9	45.4
Flour Quality							
18	Flour Color Brightness (L*)	90.0	89.6	90.3	89.7	90.2	89.8
19	Flour Color Yellowness (b*)	9.7	9.9	9.0	9.2	9.2	9.2
20	Flour Moisture (%)	13.2	13.4	13.0	13.1	13.4	13.1
21	Flour Ash (% , 14% mb)	0.46	0.44	0.48	0.50	0.44	0.49
22	Flour Falling Number (Malted) (sec)	256	252	251	255	253	252
Farinograph							
23	Water Absorption (% , 500 BU)	67.5	66.9	66.1	66.5	66.6	67.6
24	Water Absorption (% , 14% mb)	66.0	65.7	65.1	65.5	66.0	66.6
25	Arrival Time (min)	4.6	3.4	3.8	3.7	5.0	3.6
26	Peak Time (min)	10.2	7.7	8.0	7.0	8.5	8.4
27	Dough Stability (min)	14.5	23.5	9.3	11.2	10.9	13.2
28	Mixing Tolerance Index (MTI) (BU)	20	18	31	20	21	24
29	Time To Breakdown (TTB) (min)	17.5	18.4	13.0	14.3	15.1	13.9
II. Cooperator Results							
30	Bake Absorption (Average %)	68.7	68.5	68.0	68.2	68.5	69.3
31	Loaf Volume (% of Check)		99.7		98.5		98.2

SWQC #6 – Dagmar

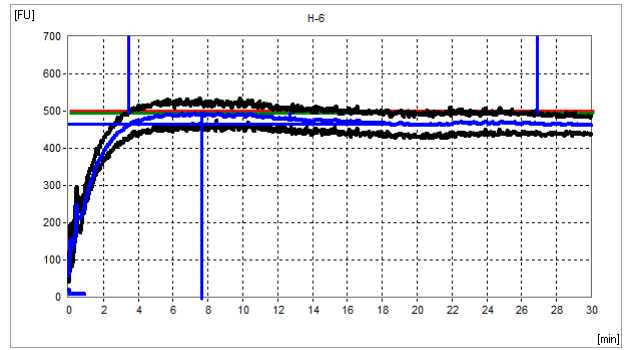
Quality Trait		Havre		Minot		Williston	
		LCS Rebel		LCS Rebel		LCS Rebel	
		H-7	H-6	M-7	M-6	W-7	W-6
II. Cooperator Results							
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.3	6.1	6.1	5.8	5.8	5.7
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.9	7.0	6.8	6.7	6.8	6.7
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		5.4	
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	5.0		4.9		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	5.2		4.4		5.8	
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		5.4		4.6	
	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	5.3		3.3		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	4.4		4.1		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	5.0		4.5		5.4	

Farinograms

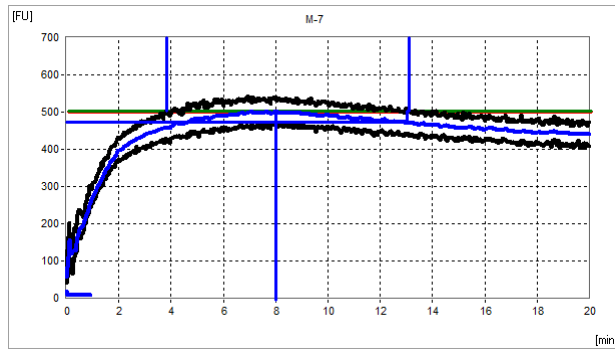
LCS Rebel Check (Havre, H-7)



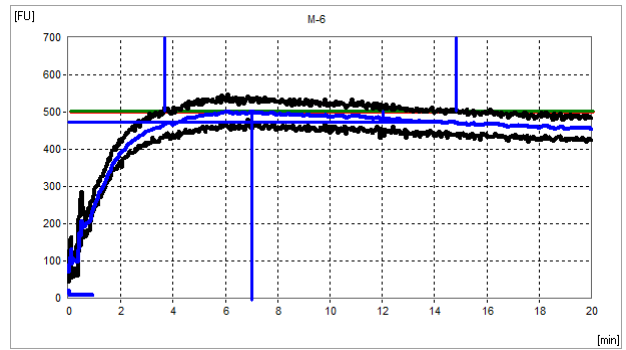
Dagmar (Havre, H-6)



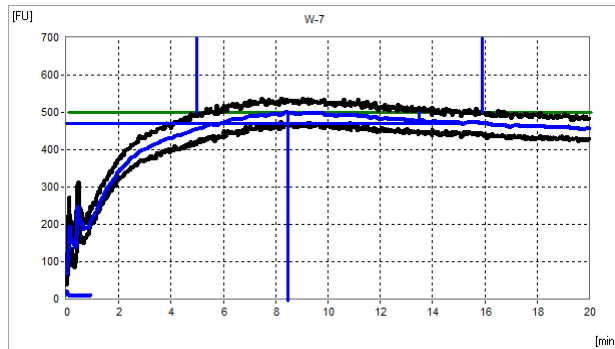
LCS Rebel Check (Minot, M-7)



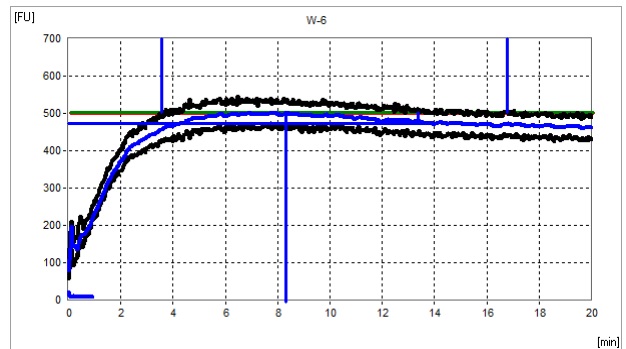
Dagmar (Minot, M-6)



LCS Rebel Check (Williston, W-7)

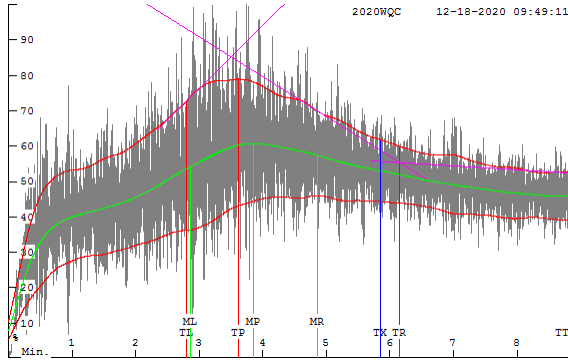


Dagmar (Williston, W-6)

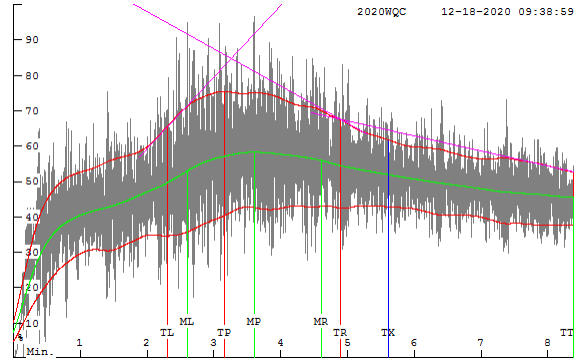


Mixograms

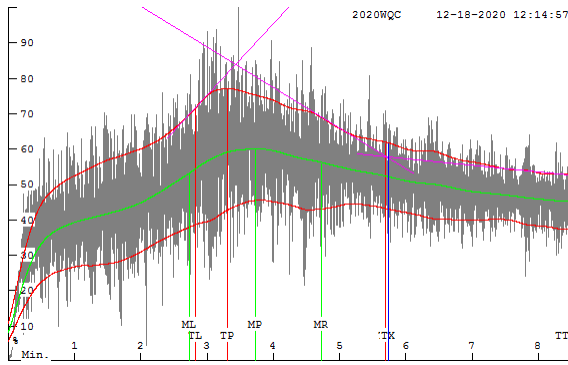
LCS Rebel Check (Havre, H-7)



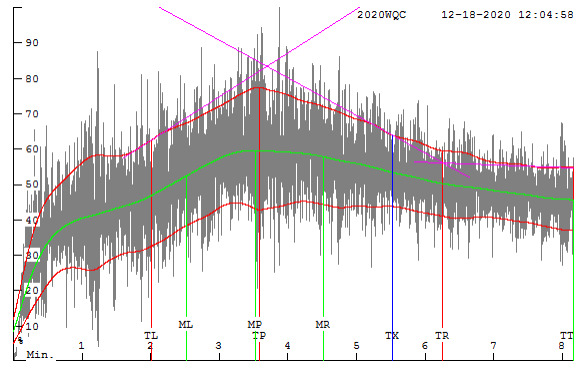
Dagmar (Havre, H-6)



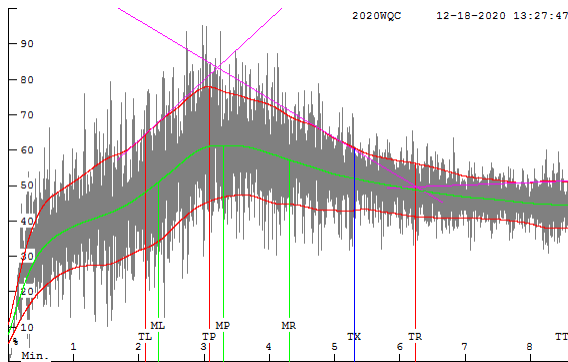
LCS Rebel Check (Minot, M-7)



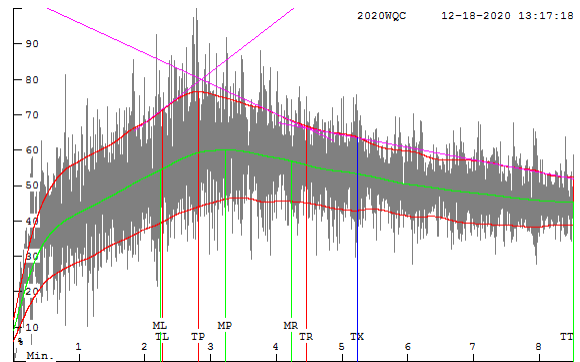
Dagmar (Minot, M-6)



LCS Rebel Check (Williston, W-7)

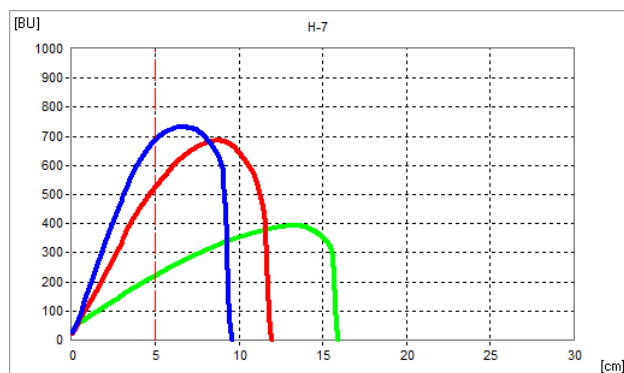


Dagmar (Williston, W-6)

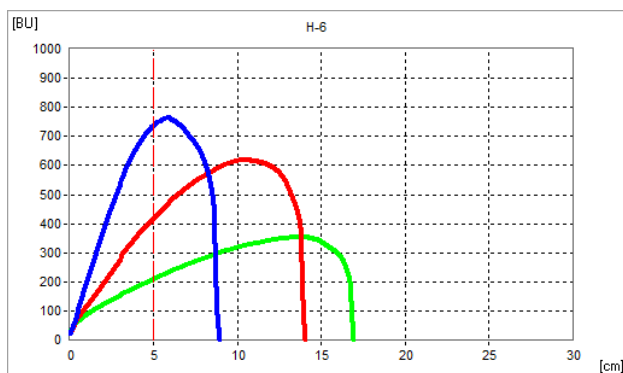


Extensograms

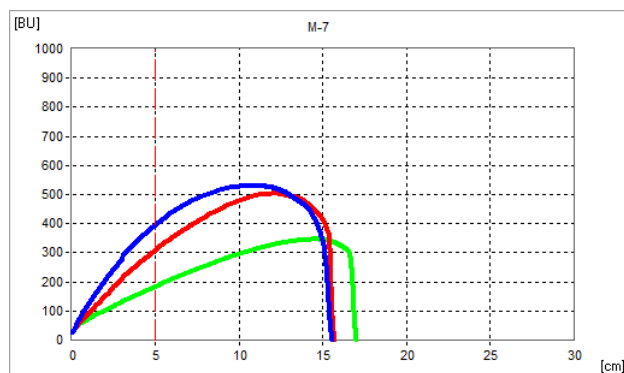
LCS Rebel Check (Havre, H-7)



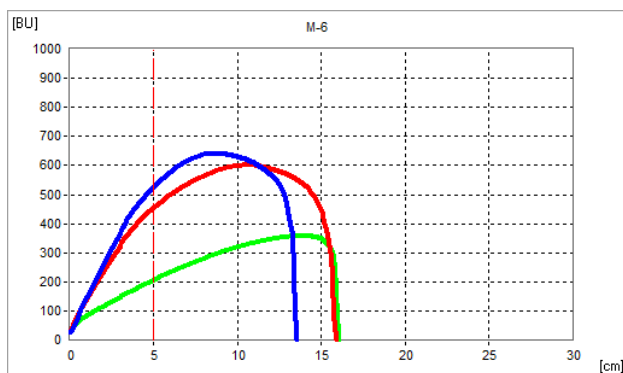
Dagmar (Havre, H-6)



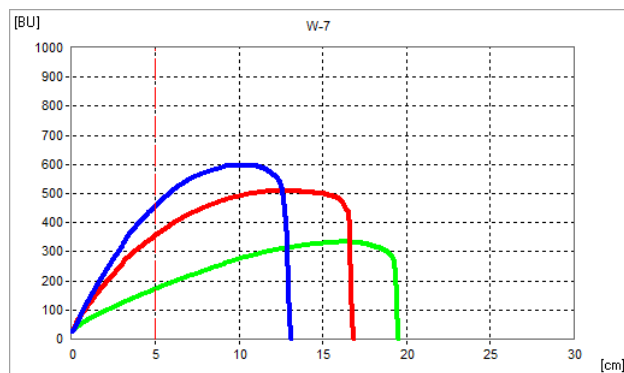
LCS Rebel Check (Minot, M-7)



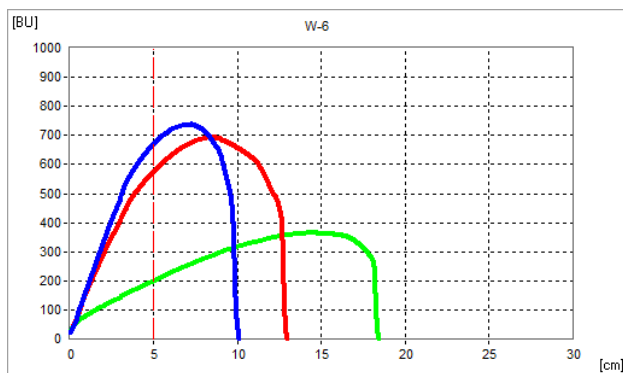
Dagmar (Minot, M-6)



LCS Rebel Check (Williston, W-7)



Dagmar (Williston, W-6)



— 45 min; — 90 min; — 135 min

SWQC #8 – MN15119-2

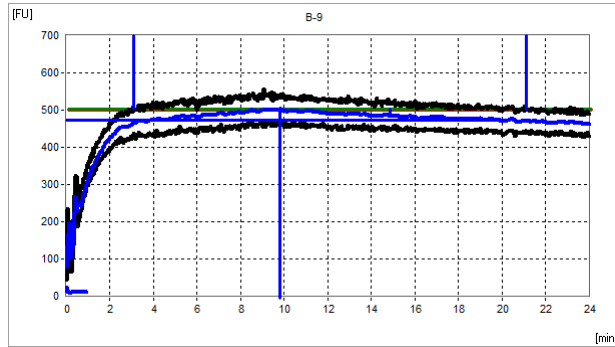
Quality Trait		Watertown		Casselton		Crookston		Minot	
		Linkert B-9	B-8	Linkert C-9	C-8	Linkert K-9	K-8	LCS Rebel M-7	M-8
I. USDA-ARS WQL Data									
1	Wheat Protein (% , 12% mb)	15.5	14.7	14.9	15.5	15.6	14.7	15.1	14.6
2	Flour Protein (% , 14% mb)	14.3	13.5	13.4	14.2	14.2	13.5	14.1	13.8
3	Market Value (Score 1-6)	4.7	4.4	4.3	3.9	4.6	3.8	4.8	4.8
4	Market Value (Score 1-10)	10.0	9.0	10.0	8.8	10.0	8.6	10.0	9.4
5	DON (ppm)	0.36	0.73	0.24	0.41	0.99	0.87	0.09	0.10
6	Test Weight (lb/bu)	61.4	62.4	61.4	61.1	61.1	61.6	62.7	62.6
7	1000 Kernel Weight (g)	32.4	31.7	32.3	29.9	33.6	32.0	36.2	34.9
8	Kernel Size, % Large	64	64	69	60	64	58	76	69
9	Kernel Size, % Small	8	9	7	10	8	11	7	8
10	Wheat Moisture (%)	11.5	11.9	12.6	12.7	11.7	12.5	12.3	11.9
11	Wheat Ash (% , 14% mb)	1.63	1.54	1.74	1.65	1.67	1.66	1.65	1.46
12	Wheat Falling Number (sec)	437	390	418	359	415	344	399	405
13	SKCS Hardness Index	72.6	64.6	69.2	61.0	76.5	65.5	68.2	57.8
14	Vitreous Kernels (%)	80	75	68	80	62	81	86	91
Flour Extraction (%)									
15	Tempered Wheat Basis (%)	70.5	73.7	70.2	71.9	70.5	71.2	72.9	73.8
16	Total Product Basis (%)	72.5	75.5	72.6	74.1	72.1	74.4	74.6	75.8
17	Flour/Bu Wheat (lbs)	43.9	46.6	43.5	44.0	44.0	43.9	46.1	47.1
Flour Quality									
18	Flour Color Brightness (L*)	90.3	90.3	90.5	90.0	90.0	89.8	90.3	90.5
19	Flour Color Yellowness (b*)	8.3	9.2	8.8	9.5	8.8	9.9	9.0	9.6
20	Flour Moisture (%)	12.8	13.2	13.4	12.9	13.6	12.7	13.0	13.6
21	Flour Ash (% , 14% mb)	0.47	0.43	0.48	0.47	0.50	0.46	0.48	0.43
22	Flour Falling Number (Malted) (sec)	247	248	251	248	253	253	251	248
Farinograph									
23	Water Absorption (% , 500 BU)	63.5	60.5	62.5	62.6	62.6	60.3	66.1	60.7
24	Water Absorption (% , 14% mb)	62.3	59.8	62.1	61.6	61.7	58.4	65.1	60.2
25	Arrival Time (min)	3.1	3.7	2.2	3.3	2.9	2.7	3.8	4.2
26	Peak Time (min)	9.8	8.4	8.5	8.2	7.2	7.0	8.0	9.0
27	Dough Stability (min)	18.0	11.4	14.5	9.9	15.6	10.7	9.3	12.5
28	Mixing Tolerance Index (MTI) (BU)	18	24	20	30	11	27	31	21
29	Time To Breakdown (TTB) (min)	19.9	14.6	15.1	13.3	15.8	12.8	13.0	16.6
II. Cooperator Results									
30	Bake Absorption (Average %)	66.1	63.5	65.0	65.2	65.5	63.0	68.0	64.0
31	Loaf Volume (% of Check)		100.1		102.6		101.2		101.3

SWQC #8 – MN15119-2

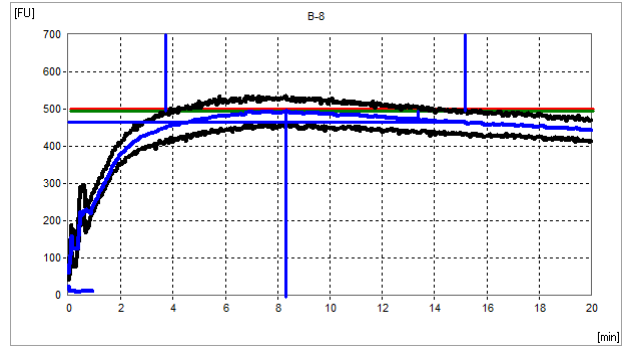
Quality Trait		Watertown		Casselton		Crookston		Minot	
		Linkert B-9	B-8	Linkert C-9	C-8	Linkert K-9	K-8	LCS Rebel M-7	M-8
II. Cooperator Results									
32	Mixing Requirement 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	7.5	6.6	7.2	6.0	7.6	6.1	6.1	6.3
33	Dough Characteristics 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.7	6.0	6.8	6.3	6.9	6.5	6.8	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		4.7		5.3		4.6		5.2
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		5.0		4.0		4.6		5.0
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		5.4		4.6		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		3.8		6.1		3.7		4.5
	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		6.6		5.9		6.1		6.1
	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		4.5		4.6		4.5		5.1
	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		4.8		5.4		4.9		5.0

Farinograms

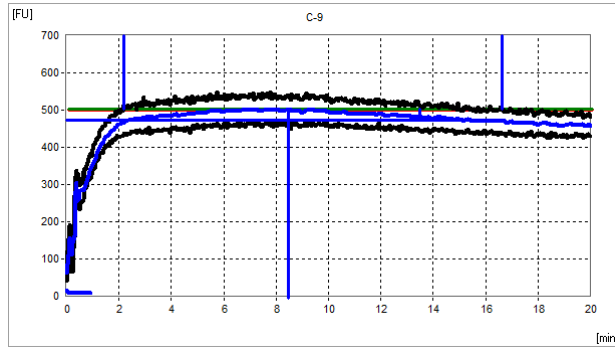
Linkert Check (Watertown, B-9)



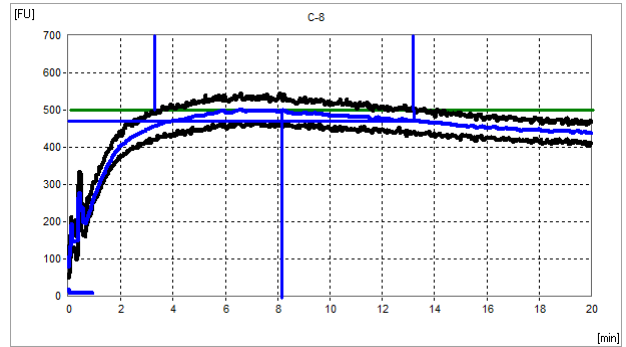
MN15119-2 (Watertown, B-8)



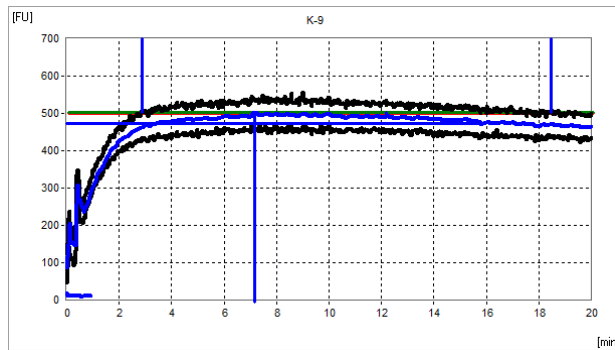
Linkert Check (Casselton, C-9)



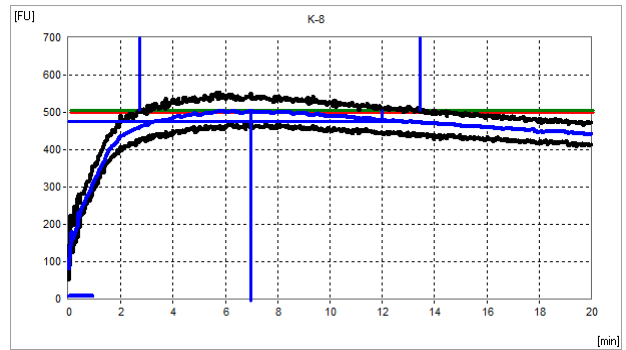
MN15119-2 (Casselton, C-8)



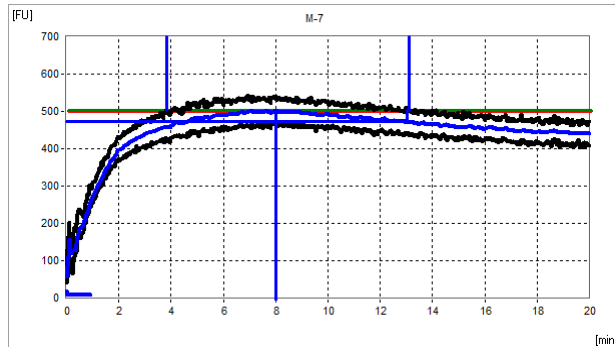
Linkert Check (Crookston, K-9)



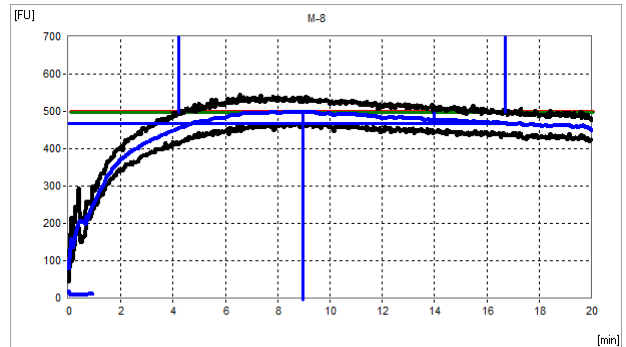
MN15119-2 (Crookston, K-8)



LCS Rebel Check (Minot, M-7)

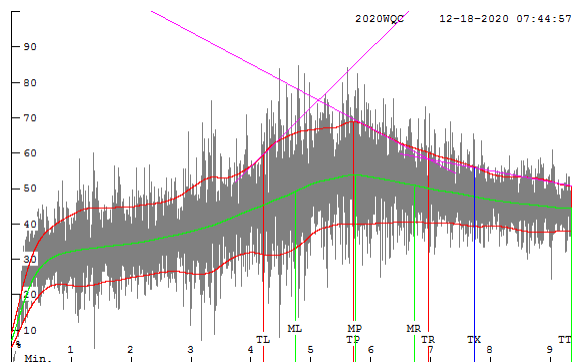


MN15119-2 (Minot, M-8)

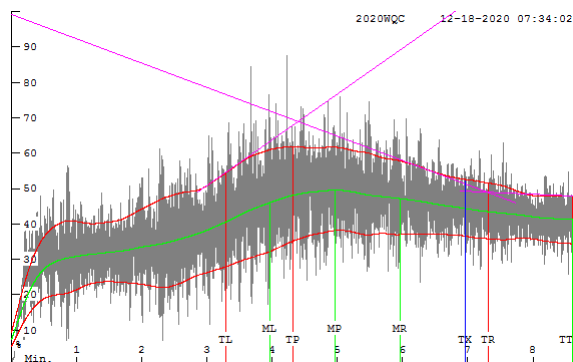


Mixograms

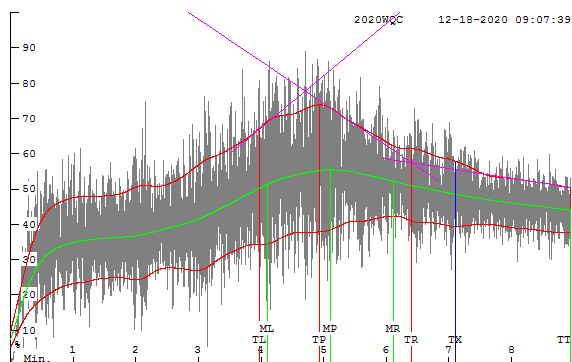
Linkert Check (Watertown, B-9)



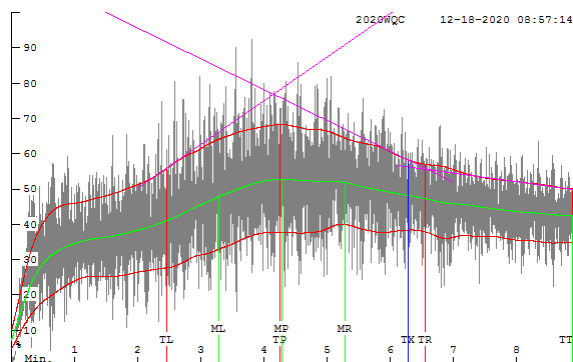
MN15119-2 (Watertown, B-8)



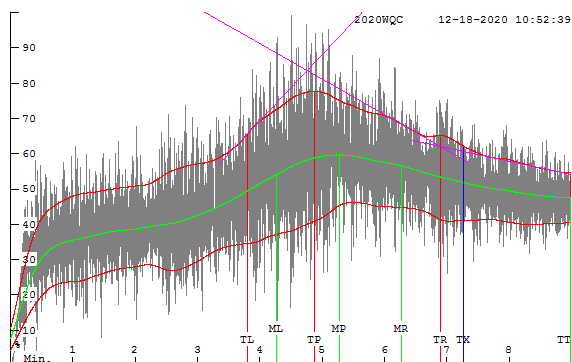
Linkert Check (Casselton, C-9)



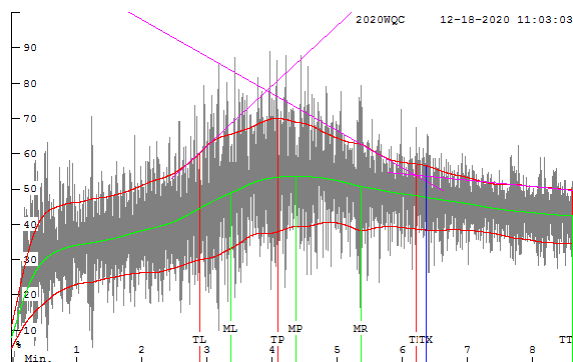
MN15119-2 (Casselton, C-8)



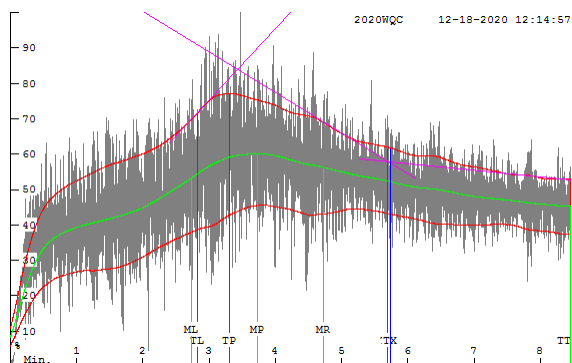
Linkert Check (Crookston, K-9)



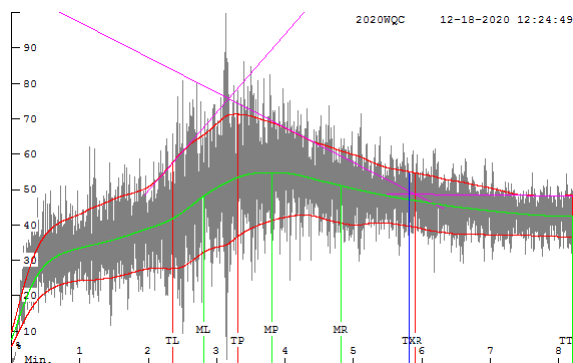
MN15119-2 (Crookston, K-8)



LCS Rebel Check (Minot, M-7)

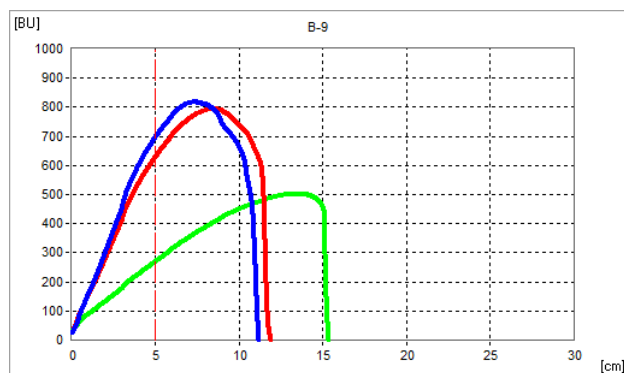


MN15119-2 (Minot, M-8)

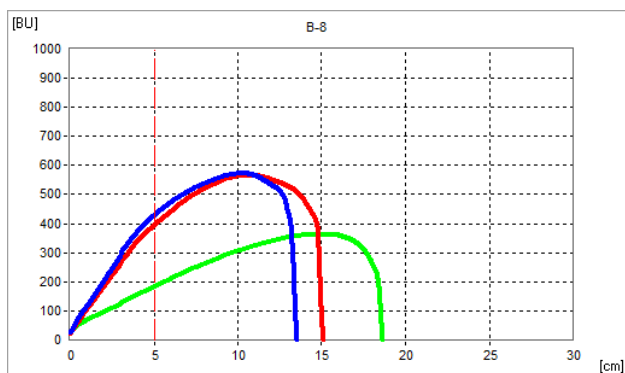


Extensograms

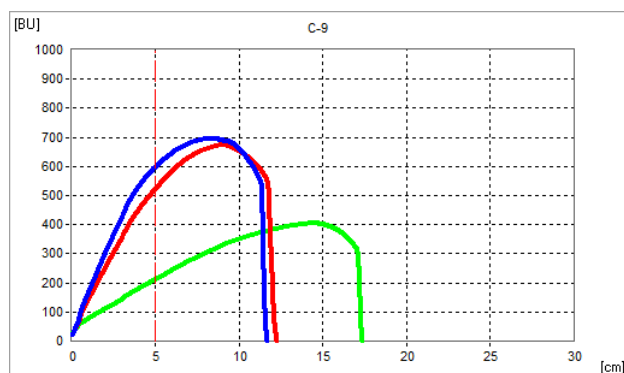
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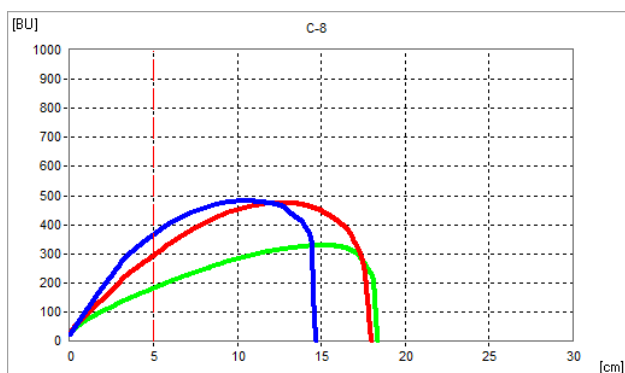
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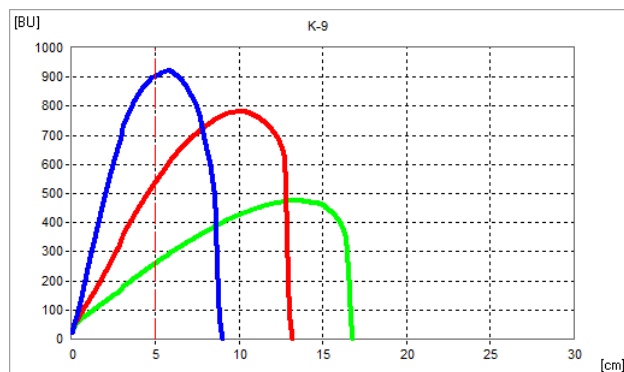
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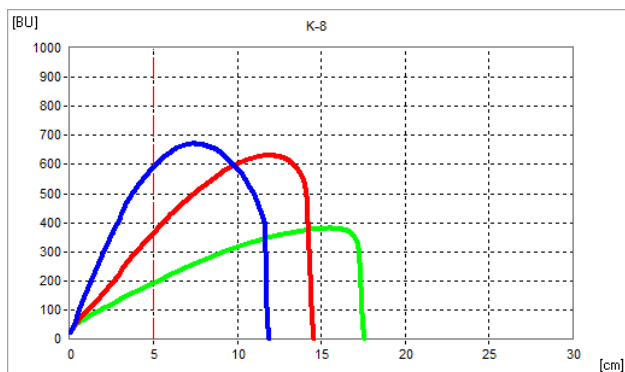
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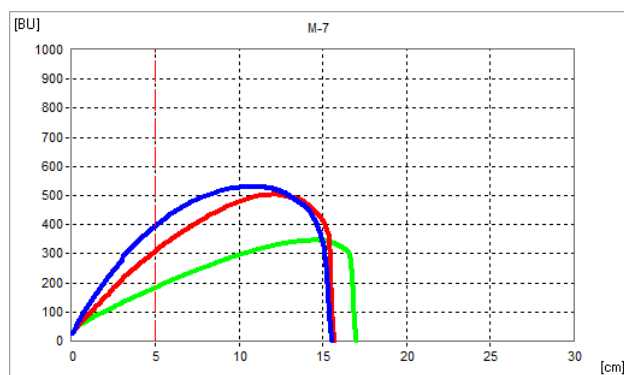
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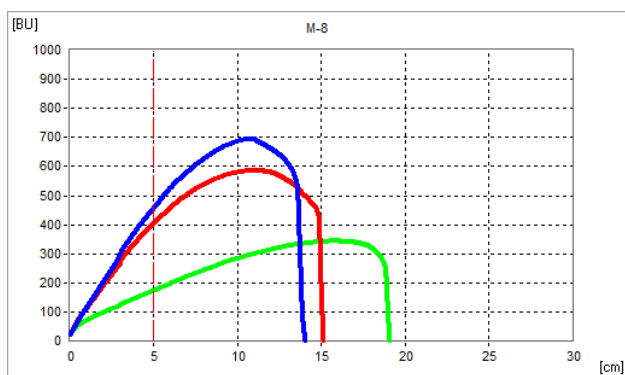
MN15119-2 (Crookston, K-8)



LCS Rebel Check (Minot, M-7)



MN15119-2 (Minot, M-8)



— 45 min; — 90 min; — 135 min

SWQAC #10 – Glenn

		Watertown		Casselton		Havre		Crookston		Minot		Williston	
		Linkert		Linkert		LCS Rebel		Linkert		LCS Rebel		LCS Rebel	
Quality Trait		B-9	B-10	C-9	C-10	H-7	H-10	K-9	K-10	M-7	M-10	W-7	W-10
I. USDA-ARS WQL Data													
1	Wheat Protein (% , 12% mb)	15.5	15.5	14.9	14.4	15.6	16.4	15.6	15.0	15.1	15.4	15.6	15.4
2	Flour Protein (% , 14% mb)	14.3	14.1	13.4	12.9	14.5	15.3	14.2	13.5	14.1	14.5	14.7	14.7
3	Market Value (Score 1-6)	4.7	4.5	4.3	3.9	5.2	5.0	4.6	3.9	4.8	4.7	5.0	4.5
4	Market Value (Score 1-10)	10.0	9.2	10.0	9.2	10.0	9.2	10.0	7.8	10.0	8.8	10.0	8.6
5	DON (ppm)	0.36	0.13	0.24	0.19	0.02	0.02	0.99	0.46	0.09	0.06	0.01	0.02
6	Test Weight (lb/bu)	61.4	63.4	61.4	62.6	63.3	63.8	61.1	62.7	62.7	65.0	64.0	65.2
7	1000 Kernel Weight (g)	32.4	30.1	32.3	29.2	32.7	30.7	33.6	28.8	36.2	34.1	30.3	27.5
8	Kernel Size, % Large	64	53	69	56	51	35	64	52	76	77	44	28
9	Kernel Size, % Small	8	11	7	10	11	13	8	12	7	5	16	20
10	Wheat Moisture (%)	11.5	11.7	12.6	13.0	9.4	9.2	11.7	11.7	12.3	12.1	9.9	9.7
11	Wheat Ash (% , 14% mb)	1.63	1.63	1.74	1.71	1.45	1.51	1.67	1.72	1.65	1.63	1.50	1.62
12	Wheat Falling Number (sec)	437	387	418	380	452	399	415	354	399	373	461	399
13	SKCS Hardness Index	72.6	81.5	69.2	76.9	72.0	76.5	76.5	79.6	68.2	77.3	69.4	75.7
14	Vitreous Kernels (%)	80	95	68	78	98	98	62	86	86	95	99	98
Flour Extraction (%)													
15	Tempered Wheat Basis (%)	70.5	69.9	70.2	68.3	69.5	68.7	70.5	69.8	72.9	71.9	69.1	68.2
16	Total Product Basis (%)	72.5	71.5	72.6	70.8	70.3	69.8	72.1	71.3	74.6	73.5	73.1	71.1
17	Flour/Bu Wheat (lbs)	43.9	44.9	43.5	42.5	44.5	44.1	44.0	44.6	46.1	47.3	44.9	44.7
Flour Quality													
18	Flour Color Brightness (L*)	90.3	90.0	90.5	90.0	90.0	89.7	90.0	89.7	90.3	90.1	90.2	90.2
19	Flour Color Yellowness (b*)	8.3	8.7	8.8	8.8	9.7	9.8	8.8	9.2	9.0	8.9	9.2	9.0
20	Flour Moisture (%)	12.8	12.9	13.4	12.4	13.2	12.9	13.6	13.3	13.0	13.2	13.4	12.8
21	Flour Ash (% , 14% mb)	0.47	0.47	0.48	0.50	0.46	0.52	0.50	0.49	0.48	0.48	0.44	0.47
22	Flour Falling Number (Malted) (sec)	247	247	251	250	256	253	253	253	251	248	253	248
Farinograph													
23	Water Absorption (% , 500 BU)	63.5	64.1	62.5	66.5	67.5	69.9	62.6	64.3	66.1	66.9	66.6	67.9
24	Water Absorption (% , 14% mb)	62.3	63.1	62.1	64.8	66.0	68.7	61.7	63.0	65.1	66.0	66.0	66.6
25	Arrival Time (min)	3.1	3.2	2.2	1.6	4.6	5.6	2.9	2.4	3.8	4.5	5.0	5.2
26	Peak Time (min)	9.8	8.4	8.5	3.0	10.2	9.9	7.2	6.3	8.0	8.5	8.5	9.5
27	Dough Stability (min)	18.0	14.4	14.5	8.0	14.5	10.8	15.6	11.0	9.3	10.7	10.9	12.5
28	Mixing Tolerance Index (MTI) (BU)	18	17	20	22	20	28	11	25	31	20	21	23
29	Time To Breakdown (TTB) (min)	19.9	16.1	15.1	9.7	17.5	17.0	15.8	12.7	13.0	14.1	15.1	15.9

SWQAC #10 – Glenn

		Watertown		Casselton		Havre		Crookston		Minot		Williston	
Quality Trait		Linkert B-9	B-10	Linkert C-9	C-10	LCS Rebel H-7	H-10	Linkert K-9	K-10	LCS Rebel M-7	M-10	LCS Rebel W-7	W-10
II. Cooperator Results													
30	Bake Absorption (Average %)	66.1	66.5	65.0	67.3	68.7	70.3	65.5	66.2	68.0	68.4	68.5	69.2
31	Loaf Volume (% of Check)		100.5		97.6		101.2		97.9		98.8		98.2
32	Mixing Requirement*	7.5	7.1	7.2	6.3	6.3	6.0	7.6	6.9	6.1	6.4	5.8	6.2
33	Dough Characteristics**	6.7	7.2	6.8	6.8	6.9	7.0	6.9	7.3	6.8	7.1	6.8	6.6
34	Mixing Tolerance†		5.1		5.1		4.9		4.8		5.4		5.6
35	Internal Crumb Color††		4.8		4.4		4.8		5.2		5.2		5.3
36	Internal Crumb Texture‡		4.7		4.7		4.5		4.6		5.2		5.7
III. Cooperator Evaluation‡													
	Quality Traits 1-2: Protein		5.2		4.5		6.5		4.1		5.6		5.0
	Quality Traits 3-22: Milling		4.7		4.1		4.4		4.6		4.9		4.2
	Quality Traits 23-36: Baking		5.1		4.7		4.7		4.1		5.0		5.0
	Quality Traits 1-36: Overall Comparison		5.3		4.3		4.7		4.3		4.9		5.2

*9 = Very long; 7 = Long; 5 = Medium; 3 = Short; 1 = Very short.

**9 = Bucky – Tough; 7 = Strong – Elastic; 5 = Medium – Pliable; 3 = Mellow – Very Pliable; 1 = Weak – Short or Sticky.

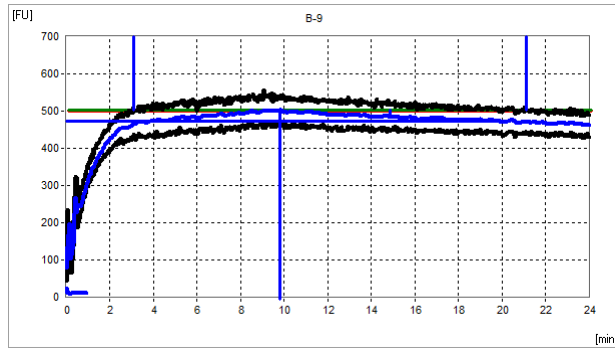
†9 = Much More Tolerance Than Check; 7 = More Tolerance Than Check; 5 = Tolerance Equivalent To Check; 3 = Less Tolerance Than Check; 1 = Much Less Tolerance Than Check.

††9 = Much Brighter Than Check; 7 = Brighter Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.

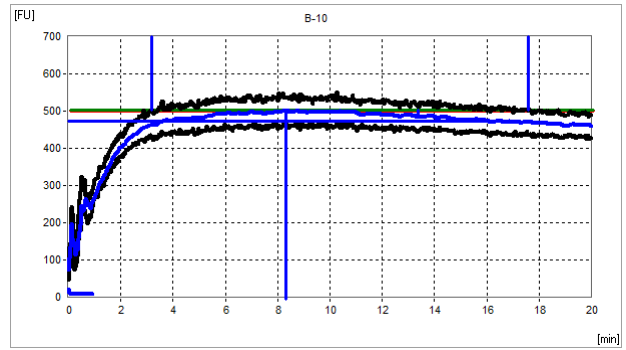
‡9 = Much Better Than Check; 7 = Better Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.

Farinograms

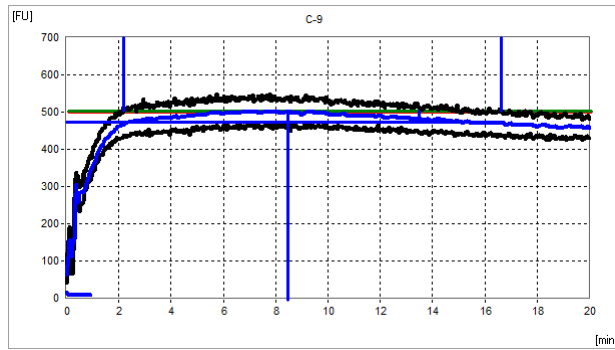
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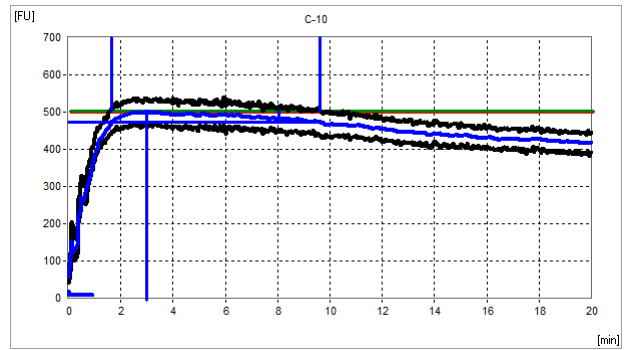
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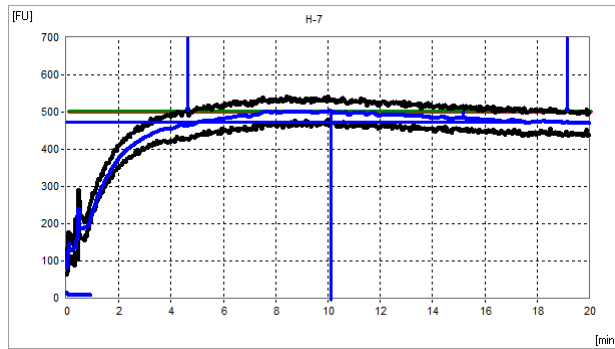
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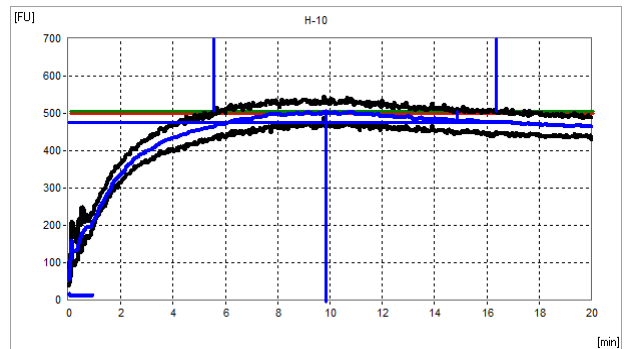
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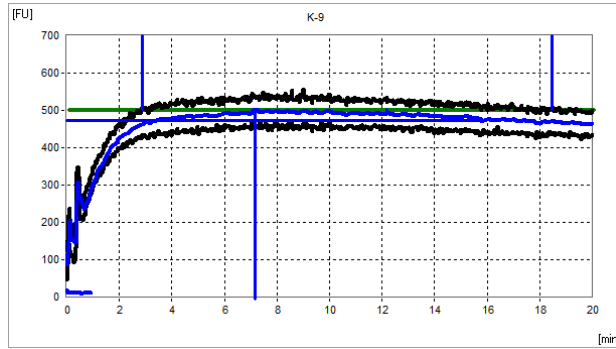
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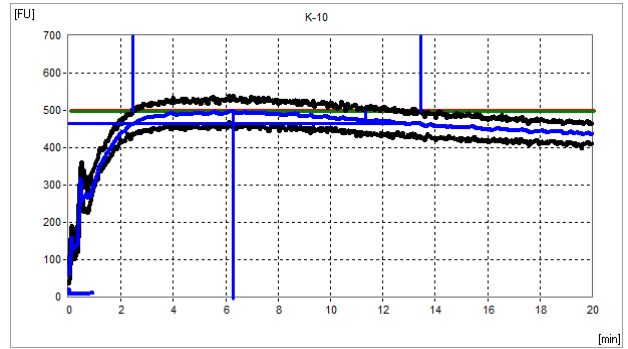
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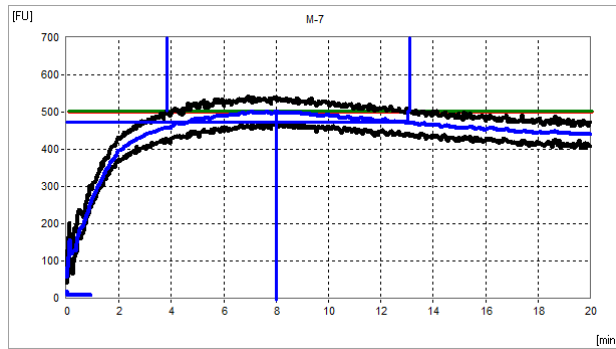
Linkert Check (Crookston, K-9)



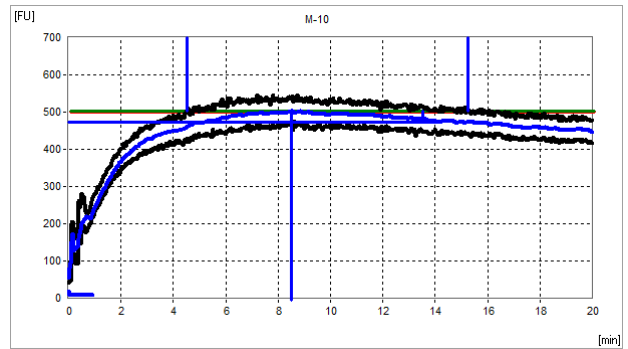
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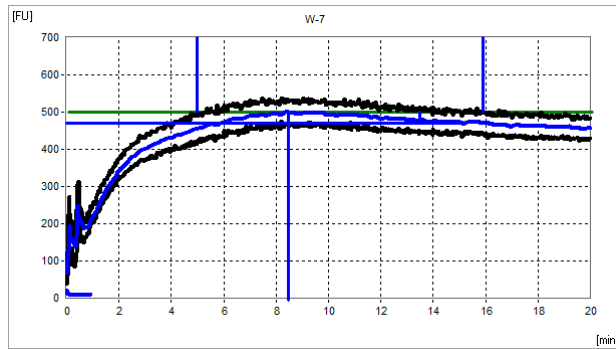
LCS Rebel Check (Minot, M-7)



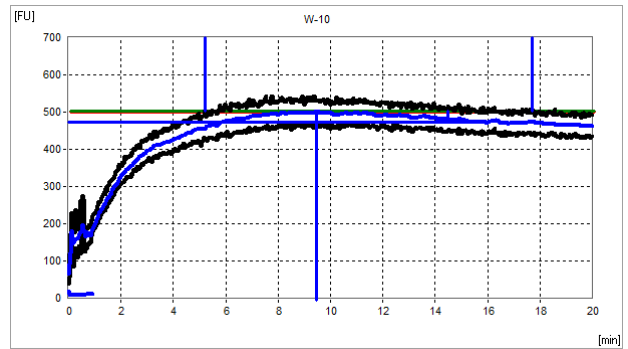
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LCS Rebel Check (Williston, W-7)

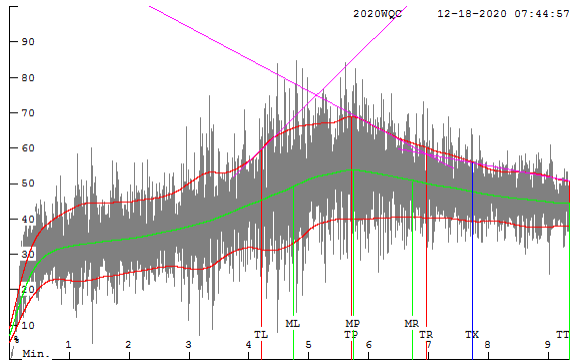


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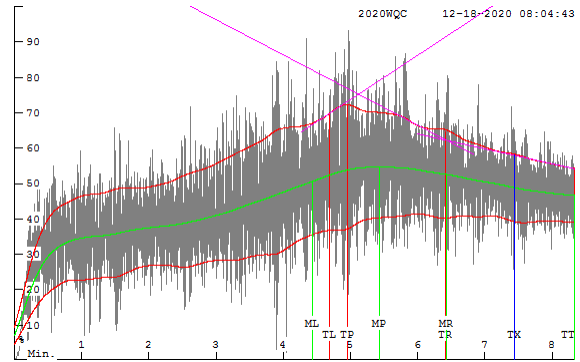


Mixograms

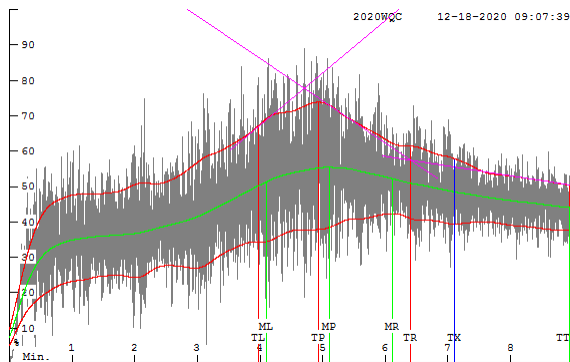
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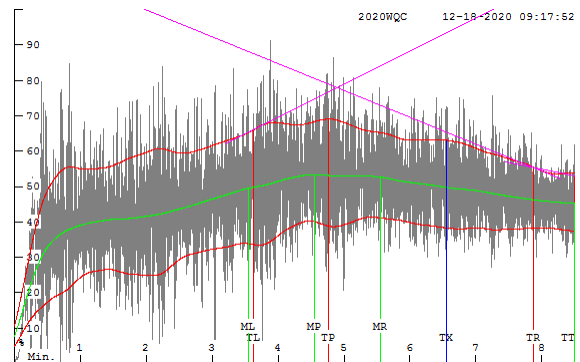
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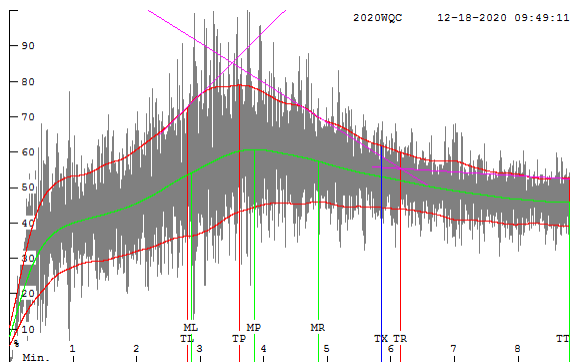
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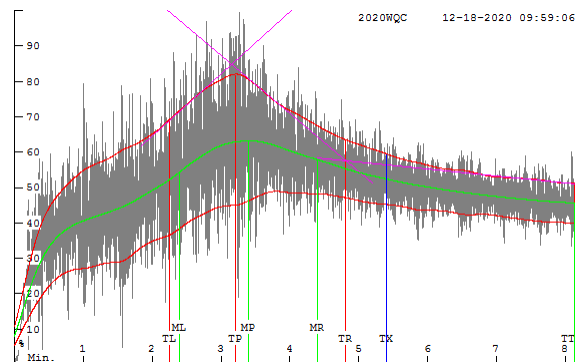
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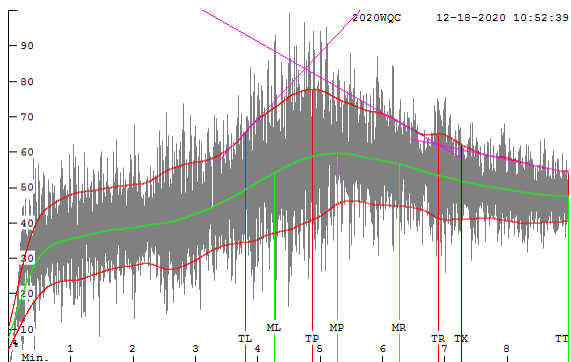
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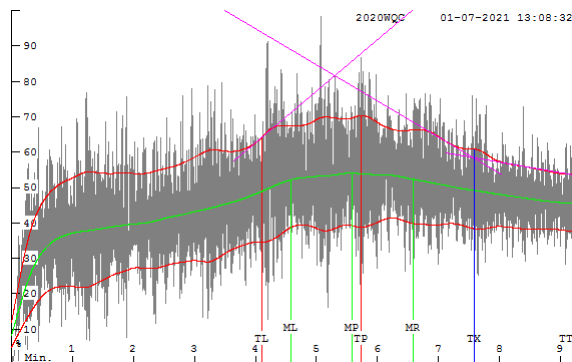
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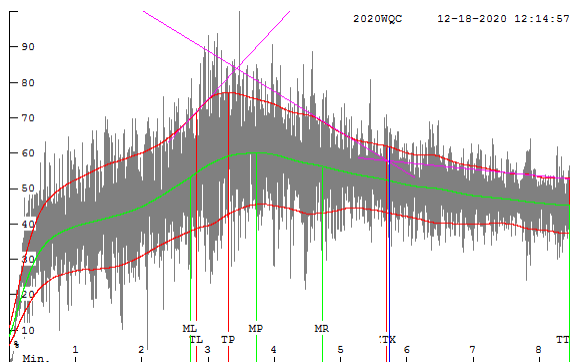
Linkert Check (Crookston, K-9)



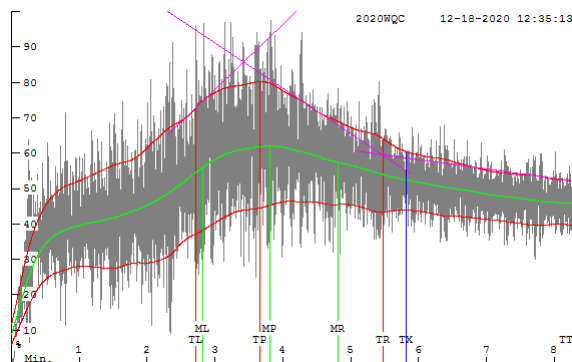
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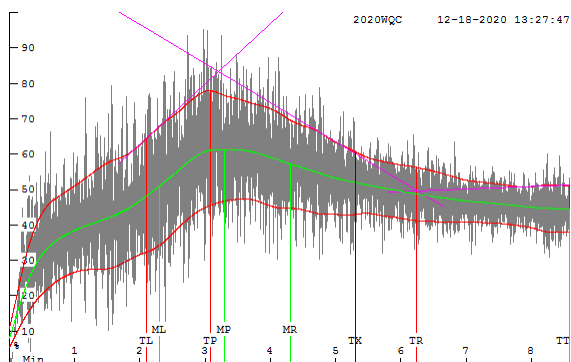
LCS Rebel Check (Minot, M-7)



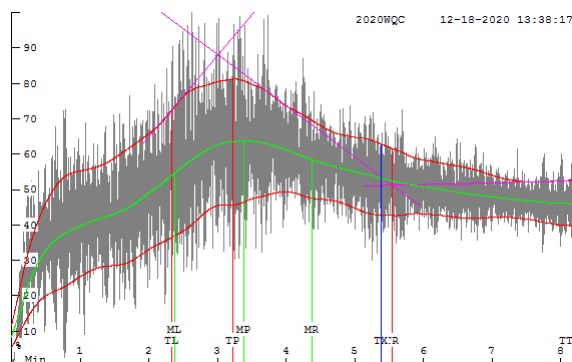
Glenn (Minot, M-10)



LCS Rebel Check (Williston, W-7)

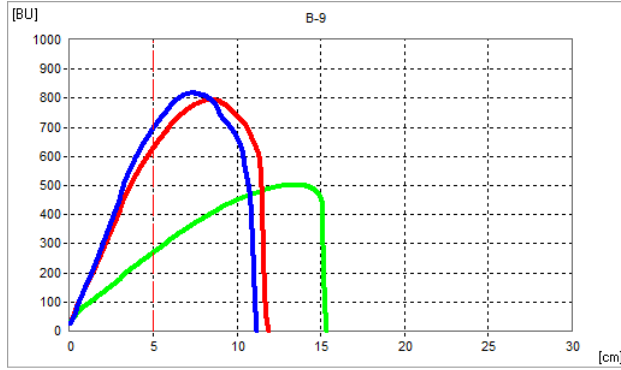


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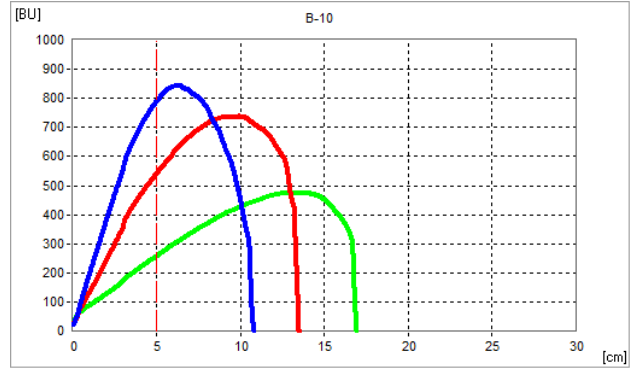


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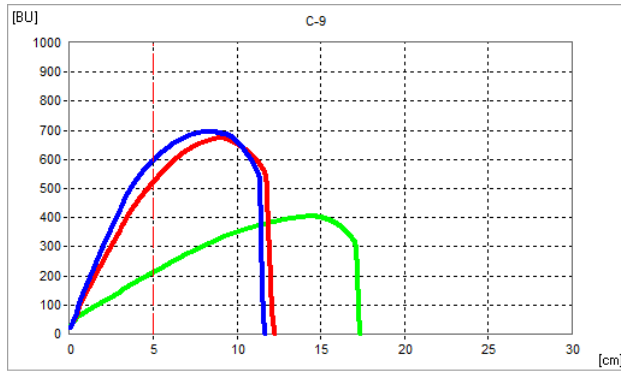
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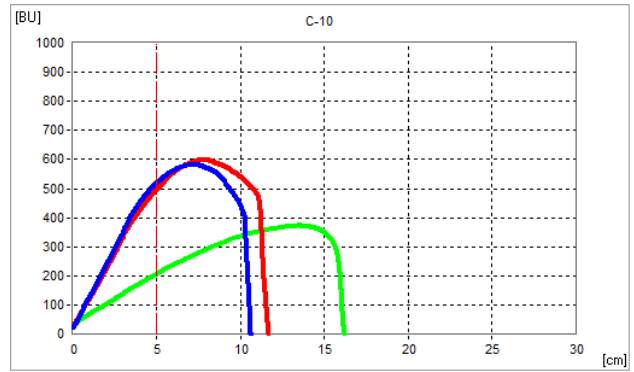
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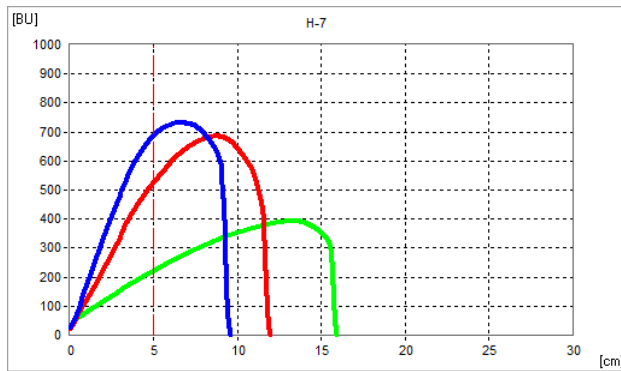
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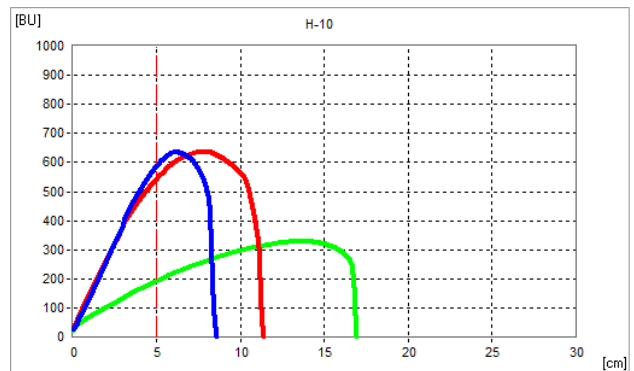
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LCS Rebel Check (Havre, H-7)

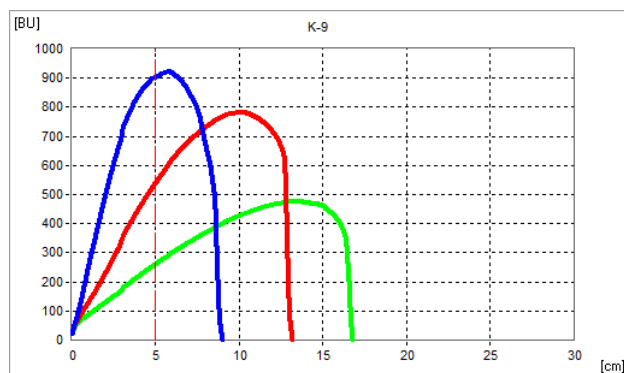


Glenn (Havre, H-10)

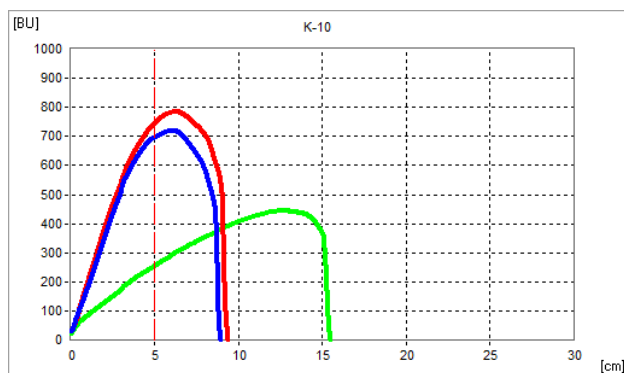


— 45 min; — 90 min; — 135 min

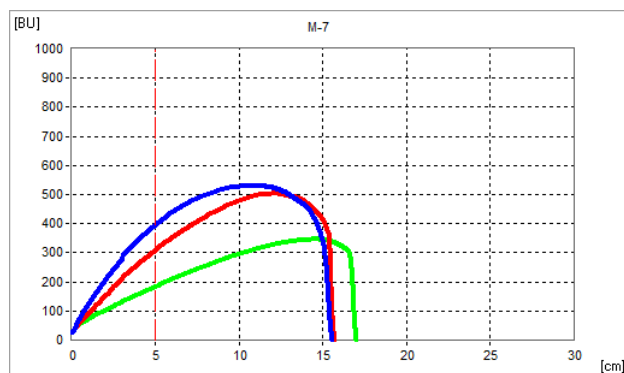
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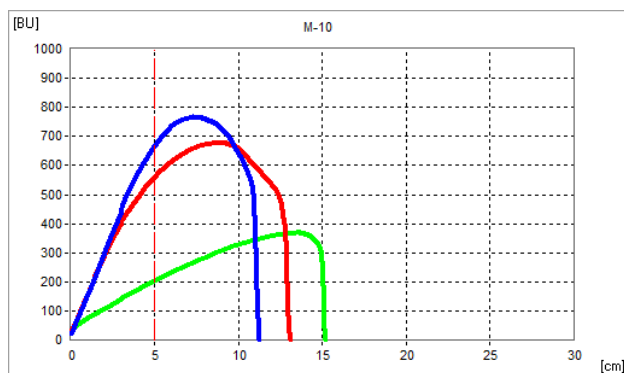
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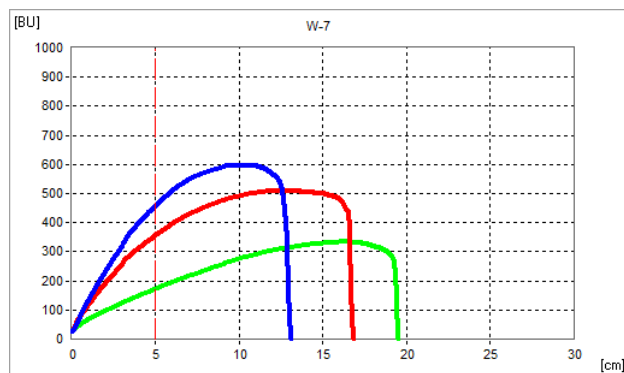
LCS Rebel Check (Minot, M-7)



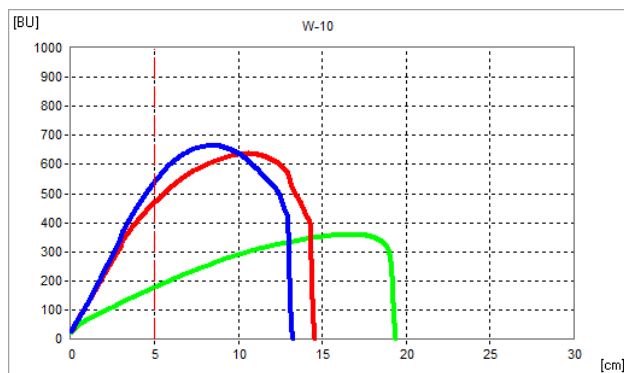
Glenn (Minot, M-10)



LCS Rebel Check (Williston, W-7)



Glenn (Williston, W-10)



— 45 min; — 90 min; — 135 min

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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 – Method #1

Wheat Marketing Score or Export Marketing Score						
	Score	Test Weight (lb/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 (+/-) from Target Value		1	3 g up, 4 g down	25	1.0	0.10

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 (lb/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 Stream	Abbreviation	Mill Stream #	Product		
1st Break	1 Bk	1	Long Patent Flour	Straight Grade Flour	Whole Wheat Flour
2nd Break I	2 Bk I	2			
Break Dust	Bk Dust	3			
Sizing I	Sz I	4			
2nd Break II	2 Bk II	5			
3rd Break	3 Bk	6			
Sizing II	Sz II	7			
5th Break	5 Bk	8			
4th Break	4 Bk	9			
1st Middlings	1 M	10			
2nd Middlings	2 M	11			
3rd Middlings	3 M	12			
4th Middlings	4 M	13			
6th Middlings	6 M	15			
Tail Flour	Tail	16	Clear Flour		
Tail Cyclone Flour*	TC	22			
5th Middlings	5 M	14			
Low Grade	LG	17	Short & Bran		
Low Quality	LQ	18			
Tail Shorts	Tail Sh	19			
Head Shorts	Head Sh	20			
Bran	Bran	21			
Tail Cyclone Shorts*	TC Sh	23			

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

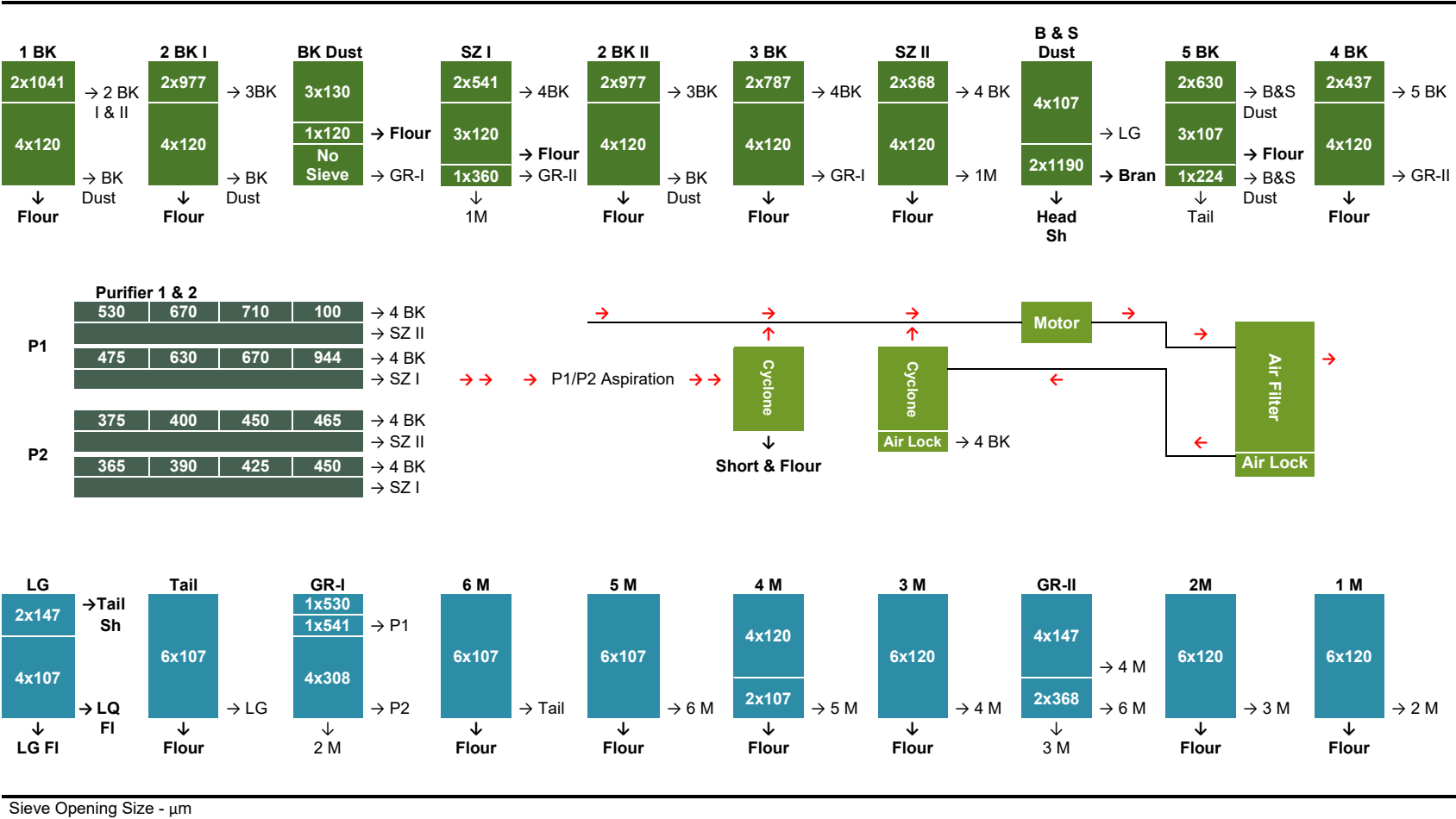
Calculation of flour extraction:

- 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

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Wheat Kernel Characteristics by Location

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Location	ID	Entry	Wheat Protein (%, 12% mb)	Wheat Marketing Score		DON (ppm)	Test Weight (lbs/bu)	1000 Kernel Weight (g)	Kernel Size		Wheat Moisture (%)	Wheat Ash (%, 14% mb)	Falling Number (sec)	SKCS Hardness Index	Vitreous Kernels (%)
				1-6	1-10				Large (%)	Small (%)					
Watertown	B-1	AP Murdock	14.5	4.3	9.4	0.20	60.8	31.5	56	9	11.8	1.49	454	71.6	61
	B-4	MN15005-4	14.6	4.4	9.0	0.24	61.7	29.9	52	12	11.8	1.53	437	69.3	68
	B-8	MN15119-2	14.7	4.4	9.0	0.73	62.4	31.7	64	9	11.9	1.54	390	64.6	75
	B-9	Linkert	15.5	4.7	10.0	0.36	61.4	32.4	64	8	11.5	1.63	437	72.6	80
	B-10	Glenn	15.5	4.5	9.2	0.13	63.4	30.1	53	11	11.7	1.63	387	81.5	95
Casselton	C-1	AP Murdock	13.0	3.7	7.8	0.22	59.9	31.8	62	9	13.2	1.54	435	63.8	28
	C-2	NDHRS16-14-126	14.5	3.5	8.8	0.18	61.0	32.0	75	5	13.0	1.67	336	75.2	55
	C-4	MN15005-4	13.9	3.4	8.2	0.25	60.1	27.0	43	17	12.8	1.67	405	63.8	46
	C-5	TCG-Wildcat	15.3	4.5	10.0	0.58	61.5	31.8	71	7	12.9	1.61	412	69.1	52
	C-8	MN15119-2	15.5	3.9	8.8	0.41	61.1	29.9	60	10	12.7	1.65	359	61.0	80
	C-9	Linkert	14.9	4.3	10.0	0.24	61.4	32.3	69	7	12.6	1.74	418	69.2	68
Havre	C-10	Glenn	14.4	3.9	9.2	0.19	62.6	29.2	56	10	13.0	1.71	380	76.9	78
	H-1	AP Murdock	16.3	5.0	9.2	0.04	62.0	30.0	26	15	9.0	1.48	492	83.2	98
	H-6	Dagmar	15.6	5.2	10.0	0.02	62.5	34.3	63	7	9.1	1.43	456	73.1	99
	H-7	LCS Rebel	15.6	5.2	10.0	0.02	63.3	32.7	51	11	9.4	1.45	452	72.0	98
Crookston	H-10	Glenn	16.4	5.0	9.2	0.02	63.8	30.7	35	13	9.2	1.51	399	76.5	98
	K-1	AP Murdock	14.5	4.4	8.8	0.72	60.4	32.8	57	11	12.4	1.44	448	74.2	56
	K-4	MN15005-4	14.9	4.1	8.6	0.37	61.1	28.3	36	19	12.4	1.63	420	74.9	60
	K-5	TCG-Wildcat	15.0	3.9	8.6	0.54	60.2	29.7	60	11	12.3	1.52	384	77.3	57
	K-8	MN15119-2	14.7	3.8	8.6	0.87	61.6	32.0	58	11	12.5	1.66	344	65.5	81
	K-9	Linkert	15.6	4.6	10.0	0.99	61.1	33.6	64	8	11.7	1.67	415	76.5	62
	K-10	Glenn	15.0	3.9	7.8	0.46	62.7	28.8	52	12	11.7	1.72	354	79.6	86
Minot	M-1	AP Murdock	15.0	5.0	10.0	0.13	61.9	35.3	67	7	11.4	1.48	494	67.9	72
	M-2	NDHRS16-14-126	15.9	5.3	10.0	0.06	62.9	36.2	84	3	11.4	1.59	423	79.0	80
	M-3	AKF-Snowfire	14.7	5.0	10.0	0.10	62.9	35.8	64	8	11.9	1.55	447	69.9	87
	M-4	MN15005-4	14.9	4.6	9.6	0.09	61.8	33.0	56	13	11.9	1.62	441	67.6	50
	M-6	Dagmar	15.2	4.5	9.6	0.22	60.6	34.7	71	8	12.0	1.72	460	69.0	63
	M-7	LCS Rebel	15.1	4.8	10.0	0.09	62.7	36.2	76	7	12.3	1.65	399	68.2	86
	M-8	MN15119-2	14.6	4.8	9.4	0.10	62.6	34.9	69	8	11.9	1.46	405	57.8	91
Williston	M-10	Glenn	15.4	4.7	8.8	0.06	65.0	34.1	77	5	12.1	1.63	373	77.3	95
	W-1	AP Murdock	15.2	4.6	9.4	0.03	63.4	28.0	27	22	10.3	1.65	511	72.4	97
	W-2	NDHRS16-14-126	14.7	4.6	9.0	0.01	64.6	28.9	50	15	10.1	1.60	424	84.6	99
	W-3	AKF-Snowfire	14.8	4.8	9.4	0.01	64.4	30.8	30	19	10.3	1.50	590	72.0	99
	W-6	Dagmar	15.2	4.8	9.8	0.02	63.4	32.1	50	15	10.0	1.65	436	70.5	96
	W-7	LCS Rebel	15.6	5.0	10.0	0.01	64.0	30.3	44	16	9.9	1.50	461	69.4	99
	W-10	Glenn	15.4	4.5	8.6	0.02	65.2	27.5	28	20	9.7	1.62	399	75.7	98

Flour Characteristics by Location

Location	ID	Entry	Flour Extraction			Flour Color			Flour Moisture (%)	Flour Protein (% , 14% mb)	Flour Ash (% , 14% mb)	Flour FN Malted (sec)
			TWB* (%)	TPB* (%)	Flour/bu Wheat (lbs)	L*	a*	b*				
Watertown	B-1	AP Murdock	68.7	70.6	42.3	89.5	-1.1	10.4	13.0	13.1	0.51	250
	B-4	MN15005-4	70.7	72.9	44.3	90.2	-0.9	8.9	13.0	13.2	0.46	251
	B-8	MN15119-2	73.7	75.5	46.6	90.3	-0.9	9.2	13.2	13.5	0.43	248
	B-9	Linkert	70.5	72.5	43.9	90.3	-0.7	8.3	12.8	14.3	0.47	247
	B-10	Glenn	69.9	71.5	44.9	90.0	-0.8	8.7	12.9	14.1	0.47	247
Casselton	C-1	AP Murdock	67.3	70.2	40.4	89.8	-1.5	11.5	13.3	11.6	0.53	258
	C-2	NDHRS16-14-126	62.9	65.0	38.3	89.6	-0.9	9.5	12.8	12.6	0.56	264
	C-4	MN15005-4	70.3	73.0	42.3	90.4	-1.1	9.3	12.8	12.3	0.51	251
	C-5	TCG-Wildcat	67.4	70.2	41.6	89.6	-0.9	9.9	13.2	13.5	0.51	253
	C-8	MN15119-2	71.9	74.1	44.0	90.0	-0.9	9.5	12.9	14.2	0.47	248
	C-9	Linkert	70.2	72.6	43.5	90.5	-0.9	8.8	13.4	13.4	0.48	251
Havre	C-10	Glenn	68.3	70.8	42.5	90.0	-0.9	8.8	12.4	12.9	0.50	250
	H-1	AP Murdock	66.4	67.7	41.3	89.1	-1.1	11.5	12.6	15.1	0.56	258
	H-6	Dagmar	70.0	72.1	44.3	89.6	-0.7	9.9	13.4	14.4	0.44	252
	H-7	LCS Rebel	69.5	70.3	44.5	90.0	-0.9	9.7	13.2	14.5	0.46	256
Crookston	H-10	Glenn	68.7	69.8	44.1	89.7	-0.8	9.8	12.9	15.3	0.52	253
	K-1	AP Murdock	68.6	70.4	41.6	89.2	-1.3	11.1	12.7	12.9	0.53	257
	K-4	MN15005-4	71.0	73.2	43.7	89.9	-1.0	9.6	13.1	13.3	0.49	246
	K-5	TCG-Wildcat	69.2	71.2	41.9	89.0	-1.0	10.8	12.8	13.2	0.50	253
	K-8	MN15119-2	71.2	74.4	43.9	89.8	-0.9	9.9	12.7	13.5	0.46	253
	K-9	Linkert	70.5	72.1	44.0	90.0	-0.8	8.8	13.6	14.2	0.50	253
Minot	K-10	Glenn	69.8	71.3	44.6	89.7	-0.9	9.2	13.3	13.5	0.49	253
	M-1	AP Murdock	69.5	71.3	44.0	89.7	-1.2	10.8	13.4	13.7	0.51	259
	M-2	NDHRS16-14-126	66.0	67.2	42.2	89.5	-0.7	9.0	13.0	14.4	0.51	255
	M-3	AKF-Snowfire	70.7	73.0	45.0	90.2	-1.1	9.9	13.0	13.8	0.47	249
	M-4	MN15005-4	73.1	75.2	46.0	90.4	-1.0	9.5	13.6	13.8	0.47	254
	M-6	Dagmar	69.0	71.1	42.3	89.7	-0.7	9.2	13.1	14.4	0.50	255
	M-7	LCS Rebel	72.9	74.6	46.1	90.3	-0.9	9.0	13.0	14.1	0.48	251
	M-8	MN15119-2	73.8	75.8	47.1	90.5	-1.0	9.6	13.6	13.8	0.43	248
Williston	M-10	Glenn	71.9	73.5	47.3	90.1	-0.8	8.9	13.2	14.5	0.48	248
	W-1	AP Murdock	67.6	69.3	43.0	89.6	-1.1	10.8	12.8	14.4	0.56	258
	W-2	NDHRS16-14-126	64.4	65.8	42.1	89.8	-0.8	9.1	13.3	13.8	0.52	263
	W-3	AKF-Snowfire	69.1	71.3	45.0	90.2	-1.2	10.0	13.1	14.0	0.47	255
	W-6	Dagmar	70.7	71.7	45.4	89.8	-0.7	9.2	13.1	14.3	0.49	252
	W-7	LCS Rebel	69.1	73.1	44.9	90.2	-0.9	9.2	13.4	14.7	0.44	253
Williston	W-10	Glenn	68.2	71.1	44.7	90.2	-0.9	9.0	12.8	14.7	0.47	248

*TWB = Tempered wheat basis; TPB = Total product basis.

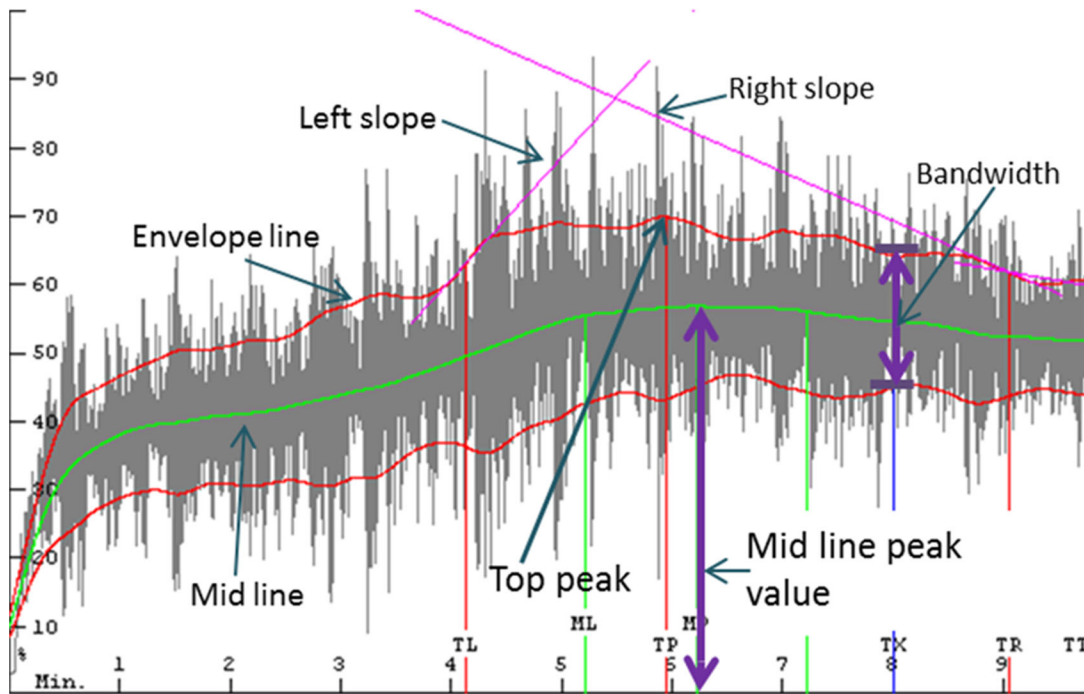
Farinograph Characteristics by Location

Location	ID	Entry	Water Abs. (%, 500 BU)	Water Abs. (%, 14% mb)	Arrival Time (min)	Peak Time (min)	Dough Stability (min)	MTI (BU)	TTB (min)
Watertown	B-1	AP Murdock	65.1	64.1	3.1	7.5	9.4	28	12.6
	B-4	MN15005-4	63.9	63.0	3.5	7.3	9.7	28	12.8
	B-8	MN15119-2	60.5	59.8	3.7	8.4	11.4	24	14.6
	B-9	Linkert	63.5	62.3	3.1	9.8	18.0	18	19.9
	B-10	Glenn	64.1	63.1	3.2	8.4	14.4	17	16.1
Casselton	C-1	AP Murdock	62.9	62.2	3.5	7.0	8.1	32	11.6
	C-2	NDHRS16-14-126	74.2	72.8	2.8	7.2	8.3	34	11.6
	C-4	MN15005-4	64.2	63.0	2.7	8.0	9.8	36	12.3
	C-5	TCG-Wildcat	66.5	65.6	2.7	6.3	8.0	32	10.8
	C-8	MN15119-2	62.6	61.6	3.3	8.2	9.9	30	13.3
	C-9	Linkert	62.5	62.1	2.2	8.5	14.5	20	15.1
	C-10	Glenn	66.5	64.8	1.6	3.0	8.0	22	9.7
Havre	H-1	AP Murdock	69.6	68.3	4.3	8.0	11.2	17	14.9
	H-6	Dagmar	66.9	65.7	3.4	7.7	23.5	18	18.4
	H-7	LCS Rebel	67.5	66.0	4.6	10.2	14.5	20	17.5
	H-10	Glenn	69.9	68.7	5.6	9.9	10.8	28	17.0
Crookston	K-1	AP Murdock	66.5	65.1	2.9	7.2	9.3	30	12.3
	K-4	MN15005-4	62.0	61.0	3.1	7.4	8.5	37	11.3
	K-5	TCG-Wildcat	64.3	62.2	2.4	5.5	7.1	41	9.2
	K-8	MN15119-2	60.3	58.4	2.7	7.0	10.7	27	12.8
	K-9	Linkert	62.6	61.7	2.9	7.2	15.6	11	15.8
	K-10	Glenn	64.3	63.0	2.4	6.3	11.0	25	12.7
Minot	M-1	AP Murdock	66.3	65.7	4.7	8.2	12.2	15	16.1
	M-2	NDHRS16-14-126	75.7	74.8	4.3	7.3	8.2	26	12.7
	M-3	AKF-Snowfire	70.6	69.4	2.7	5.3	9.6	20	12.0
	M-4	MN15005-4	63.5	63.1	4.0	8.8	10.0	27	13.6
	M-6	Dagmar	66.5	65.5	3.7	7.0	11.2	20	14.3
	M-7	LCS Rebel	66.1	65.1	3.8	8.0	9.3	31	13.0
	M-8	MN15119-2	60.7	60.2	4.2	9.0	12.5	21	16.6
	M-10	Glenn	66.9	66.0	4.5	8.5	10.7	20	14.1
Williston	W-1	AP Murdock	67.7	66.3	4.0	9.4	12.1	24	15.8
	W-2	NDHRS16-14-126	75.8	75.0	4.8	9.9	8.8	37	13.8
	W-3	AKF-Snowfire	71.6	70.6	3.8	8.4	11.7	25	13.7
	W-6	Dagmar	67.6	66.6	3.6	8.4	13.2	24	13.9
	W-7	LCS Rebel	66.6	66.0	5.0	8.5	10.9	21	15.1
	W-10	Glenn	67.9	66.6	5.2	9.5	12.5	23	15.9

Mixograph Characteristics by Location

Location	ID	Entry	Envelope Peak Time (min)	Envelope Peak Value (%)	Envelope Peak Width (%)	Midline Peak Time (min)	Midline Peak Value (%)	Midline Peak Width (%)	Midline Peak Integral (% TQ*min)
Watertown	B-1	AP Murdock	3.8	69.7	29.1	4.2	55.8	26.7	179.6
	B-4	MN15005-4	3.9	69.8	31.2	4.2	54.2	28.7	168.9
	B-8	MN15119-2	4.3	61.7	26.6	5.0	49.5	23.5	180.8
	B-9	Linkert	5.7	68.8	28.9	5.7	53.8	28.9	221.2
	B-10	Glenn	5.0	72.2	35.2	5.4	54.7	29.8	219.7
Casselton	C-1	AP Murdock	3.8	64.1	31.0	4.5	48.8	24.0	170.3
	C-2	NDHRS16-14-126	3.0	71.0	29.5	3.3	55.3	28.2	148.1
	C-4	MN15005-4	4.3	66.3	29.5	4.5	51.4	28.6	180.5
	C-5	TCG-Wildcat	3.5	63.1	28.8	4.3	48.4	27.4	173.0
	C-8	MN15119-2	4.3	68.2	30.5	4.3	52.8	30.5	168.3
	C-9	Linkert	4.9	73.8	36.0	5.1	55.4	34.5	206.6
	C-10	Glenn	4.8	69.0	30.3	4.6	53.4	28.3	191.7
Havre	H-1	AP Murdock	3.0	77.8	33.6	3.3	60.9	27.0	148.8
	H-6	Dagmar	3.2	75.4	35.1	3.6	58.3	32.5	159.7
	H-7	LCS Rebel	3.6	78.9	35.8	3.9	60.7	33.6	173.0
	H-10	Glenn	3.2	82.0	37.0	3.4	63.2	34.4	154.9
Crookston	K-1	AP Murdock	4.0	73.9	29.7	4.0	58.5	29.5	176.8
	K-4	MN15005-4	3.8	69.9	30.0	4.0	55.0	29.2	163.2
	K-5	TCG-Wildcat	4.5	64.6	31.7	4.0	48.8	27.2	158.2
	K-8	MN15119-2	4.1	70.0	32.1	4.4	53.6	29.5	173.1
	K-9	Linkert	4.9	77.6	36.8	5.3	59.6	29.8	223.1
	K-10	Glenn	5.7	70.3	31.6	5.6	54.0	30.4	236.2
Minot	M-1	AP Murdock	3.1	81.1	38.7	3.6	61.3	33.0	159.9
	M-2	NDHRS16-14-126	2.5	86.0	36.0	2.7	68.3	34.8	137.2
	M-3	AKF-Snowfire	3.9	76.7	31.6	4.0	60.4	31.3	189.9
	M-4	MN15005-4	3.2	75.0	32.8	3.3	58.4	30.6	138.5
	M-6	Dagmar	3.6	77.4	34.6	3.5	59.5	34.2	156.6
	M-7	LCS Rebel	3.3	77.0	34.2	3.7	60.1	29.8	165.1
	M-8	MN15119-2	3.3	71.3	34.5	3.8	54.8	27.6	149.3
	M-10	Glenn	3.7	80.2	35.6	3.8	62.0	34.6	173.3
Williston	W-1	AP Murdock	3.3	79.7	34.8	3.4	62.5	33.2	153.8
	W-2	NDHRS16-14-126	2.4	86.7	38.4	2.6	68.3	34.9	135.5
	W-3	AKF-Snowfire	3.0	82.7	37.1	3.4	64.1	32.4	169.2
	W-6	Dagmar	2.8	76.5	32.5	3.2	60.1	28.6	149.2
	W-7	LCS Rebel	3.1	77.8	32.4	3.3	61.3	29.8	143.2
	W-10	Glenn	3.2	81.2	35.5	3.4	63.7	34.3	153.5

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

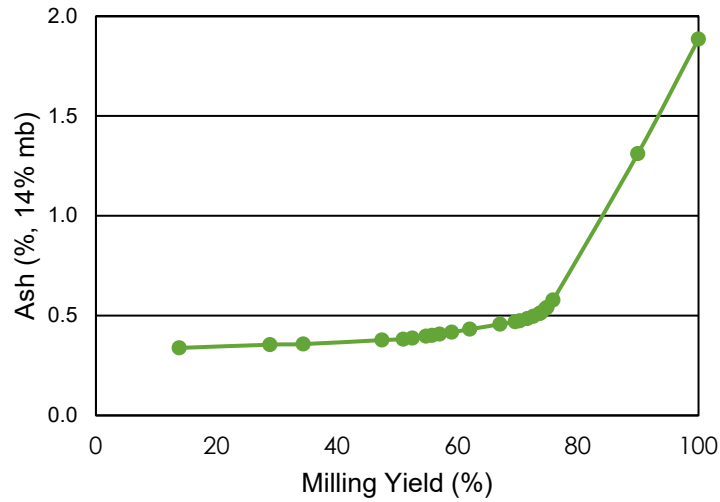
45 Minutes Resting								
Location	ID	Entry	Energy (cm ²)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-1	AP Murdock	63	207	149	341	1.4	2.3
	B-4	MN15005-4	57	164	162	284	1.0	1.8
	B-8	MN15119-2	83	184	186	364	1.0	2.0
	B-9	Linkert	91	272	154	501	1.8	3.3
	B-10	Glenn	98	259	169	475	1.5	2.8
Casselton	C-1	AP Murdock	54	144	164	276	0.9	1.7
	C-2	NDHRS16-14-126	39	145	149	194	1.0	1.3
	C-4	MN15005-4	64	190	162	310	1.2	1.9
	C-5	TCG-Wildcat	59	186	159	290	1.2	1.8
	C-8	MN15119-2	76	182	184	327	1.0	1.8
	C-9	Linkert	86	214	174	404	1.2	2.3
	C-10	Glenn	73	207	162	372	1.3	2.3
Havre	H-1	AP Murdock	63	200	156	320	1.3	2.1
	H-6	Dagmar	76	210	169	353	1.2	2.1
	H-7	LCS Rebel	76	223	159	393	1.4	2.5
	H-10	Glenn	70	193	169	328	1.1	1.9
Crookston	K-1	AP Murdock	63	186	158	321	1.2	2.0
	K-4	MN15005-4	64	165	174	286	1.0	1.6
	K-5	TCG-Wildcat	65	209	154	330	1.4	2.2
	K-8	MN15119-2	80	193	176	380	1.1	2.2
	K-9	Linkert	97	262	168	475	1.6	2.8
	K-10	Glenn	83	257	155	443	1.7	2.9
Minot	M-1	AP Murdock	69	200	159	356	1.3	2.2
	M-2	NDHRS16-14-126	43	128	166	194	0.8	1.2
	M-3	AKF-Snowfire	85	254	157	440	1.6	2.8
	M-4	MN15005-4	62	157	175	284	0.9	1.6
	M-6	Dagmar	71	207	161	357	1.3	2.2
	M-7	LCS Rebel	72	185	170	346	1.1	2.0
	M-8	MN15119-2	82	175	191	343	0.9	1.8
	M-10	Glenn	66	204	152	368	1.3	2.4
Williston	W-1	AP Murdock	93	275	161	470	1.7	2.9
	W-2	NDHRS16-14-126	66	266	140	342	1.9	2.4
	W-3	AKF-Snowfire	90	202	184	400	1.1	2.2
	W-6	Dagmar	85	201	184	364	1.1	2.0
	W-7	LCS Rebel	82	173	195	333	0.9	1.7
	W-10	Glenn	85	178	194	358	0.9	1.9

90 Minutes Resting								
Location	ID	Entry	Energy (cm ²)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-1	AP Murdock	87	434	122	583	3.6	4.8
	B-4	MN15005-4	82	320	138	475	2.3	3.4
	B-8	MN15119-2	109	395	151	566	2.6	3.8
	B-9	Linkert	116	634	119	794	5.3	6.7
	B-10	Glenn	125	545	136	737	4.0	5.4
Casselton	C-1	AP Murdock	72	401	115	516	3.5	4.5
	C-2	NDHRS16-14-126	56	204	149	289	1.4	1.9
	C-4	MN15005-4	83	387	128	509	3.0	4.0
	C-5	TCG-Wildcat	69	309	132	404	2.3	3.1
	C-8	MN15119-2	109	295	180	474	1.6	2.6
	C-9	Linkert	103	526	122	675	4.3	5.5
	C-10	Glenn	87	499	117	598	4.3	5.1
Havre	H-1	AP Murdock	96	428	136	544	3.2	4.0
	H-6	Dagmar	107	421	140	620	3.0	4.4
	H-7	LCS Rebel	99	529	120	685	4.4	5.7
	H-10	Glenn	92	546	114	637	4.8	5.6
Crookston	K-1	AP Murdock	85	379	135	476	2.8	3.5
	K-4	MN15005-4	87	316	148	455	2.1	3.1
	K-5	TCG-Wildcat	73	348	127	448	2.8	3.5
	K-8	MN15119-2	108	367	145	631	2.5	4.4
	K-9	Linkert	125	543	132	781	4.1	5.9
	K-10	Glenn	92	747	94	787	8.0	8.4
Minot	M-1	AP Murdock	96	571	112	665	5.1	5.9
	M-2	NDHRS16-14-126	55	177	152	282	1.2	1.9
	M-3	AKF-Snowfire	108	573	126	659	4.6	5.2
	M-4	MN15005-4	105	365	159	489	2.3	3.1
	M-6	Dagmar	127	455	159	601	2.9	3.8
	M-7	LCS Rebel	98	310	157	504	2.0	3.2
	M-8	MN15119-2	114	406	152	587	2.7	3.9
	M-10	Glenn	115	562	131	677	4.3	5.2
Williston	W-1	AP Murdock	89	766	90	767	8.5	8.5
	W-2	NDHRS16-14-126	70	290	137	404	2.1	3.0
	W-3	AKF-Snowfire	106	382	142	609	2.7	4.3
	W-6	Dagmar	116	578	130	692	4.5	5.3
	W-7	LCS Rebel	117	358	169	510	2.1	3.0
	W-10	Glenn	119	472	145	637	3.3	4.4

135 Minutes Resting								
Location	ID	Entry	Energy (cm ²)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-1	AP Murdock	79	615	95	651	6.5	6.8
	B-4	MN15005-4	84	411	125	536	3.3	4.3
	B-8	MN15119-2	99	429	135	572	3.2	4.2
	B-9	Linkert	112	702	112	818	6.3	7.3
	B-10	Glenn	111	793	108	845	7.3	7.8
Casselton	C-1	AP Murdock	65	487	98	551	5.0	5.6
	C-2	NDHRS16-14-126	52	173	154	270	1.1	1.8
	C-4	MN15005-4	74	537	100	614	5.4	6.2
	C-5	TCG-Wildcat	59	408	103	449	4.0	4.4
	C-8	MN15119-2	94	367	147	481	2.5	3.3
	C-9	Linkert	106	601	117	695	5.2	6.0
	C-10	Glenn	78	521	107	582	4.9	5.4
Havre	H-1	AP Murdock	77	514	103	594	5.0	5.8
	H-6	Dagmar	84	740	89	764	8.3	8.6
	H-7	LCS Rebel	88	690	96	732	7.2	7.6
	H-10	Glenn	63	590	85	635	6.9	7.4
Crookston	K-1	AP Murdock	93	388	141	517	2.8	3.7
	K-4	MN15005-4	100	359	151	503	2.4	3.3
	K-5	TCG-Wildcat	80	482	115	530	4.2	4.6
	K-8	MN15119-2	103	594	119	671	5.0	5.7
	K-9	Linkert	102	903	90	924	10.1	10.3
	K-10	Glenn	80	699	89	719	7.9	8.1
Minot	M-1	AP Murdock	100	635	110	687	5.8	6.2
	M-2	NDHRS16-14-126	70	228	159	333	1.4	2.1
	M-3	AKF-Snowfire	98	606	121	628	5.0	5.2
	M-4	MN15005-4	94	482	123	596	3.9	4.8
	M-6	Dagmar	115	527	135	640	3.9	4.7
	M-7	LCS Rebel	109	397	156	530	2.6	3.4
	M-8	MN15119-2	118	460	140	693	3.3	5.0
	M-10	Glenn	108	670	112	766	6.0	6.8
Williston	W-1	AP Murdock	82	815	81	816	10.0	10.1
	W-2	NDHRS16-14-126	66	477	100	521	4.8	5.2
	W-3	AKF-Snowfire	75	536	99	622	5.4	6.3
	W-6	Dagmar	93	673	101	737	6.7	7.3
	W-7	LCS Rebel	102	460	131	597	3.5	4.6
	W-10	Glenn	112	543	132	665	4.1	5.0

Ash Content in Mill Streams

Linkert Check - Casselton



Mill Stream	Stream (%, 14% mb)		Cumulative (%, 14% mb)	
	Yield	Ash	Yield	Ash
Patent:				
1 M	13.8	0.34	13.8	0.34
2 M	15.1	0.37	28.9	0.35
Sz I	5.5	0.37	34.4	0.36
3 M	13.1	0.43	47.5	0.38
Sz II	3.5	0.44	51.0	0.38
1 Bk	1.5	0.58	52.5	0.39
Bk Dust	2.3	0.61	54.8	0.40
2 Bk I	1.0	0.66	55.8	0.40
2 Bk II	1.3	0.66	57.0	0.41
3 Bk	2.0	0.69	59.0	0.42
4 Bk	3.0	0.73	62.1	0.43
4 M	5.0	0.77	67.1	0.46
6 M	2.5	0.80	69.6	0.47
TC	0.8	0.94	70.4	0.47
5 Bk	1.3	1.11	71.6	0.49
Tail	1.0	1.28	72.6	0.50
Clear Flour:				
LG	1.0	1.50	73.6	0.51
LQ	0.3	1.70	73.9	0.51
5 M	0.8	2.47	74.6	0.53
Bran & Shorts:				
TC Sh	0.3	2.66	74.9	0.54
Tail Sh	1.0	3.31	75.9	0.58
Head Sh	14.1	5.27	89.9	1.31
Bran	10.1	7.02	100.0	1.88
Patent (Rebolted)		0.48		
Wheat		1.74		

Cooperators' Bake Data

Linkert Checks

WATERTOWN (B-9)				
Cooperator	Bake Absorption (%)	Loaf Volume (cc)	Mixing Requirement	Dough Characteristics
A	60.0	2825	9	9
B	67.4	974	6	8
C	73.3	995	9	7
D	64.4	1100	6	6
E	71.4	1025	9	5
F	63.7	1004	7	7
G	64.3	2475	9	7
H	69.0	1040	5	5
I	n/a	n/a	n/a	n/a
J	63.5	2791	6	6
K	63.5	2222	9	7
Avg.	66.1		7.5	6.7
S.D.	4.1		1.6	1.3

CASSELTON (C-9)				
Cooperator	Bake Absorption (%)	Loaf Volume (cc)	Mixing Requirement	Dough Characteristics
A	59.0	2800	9	9
B	67.0	948	6	7
C	71.5	965	7	7
D	62.9	1040	5	6
E	70.0	1000	9	5
F	62.9	974	6	7
G	64.1	2650	9	9
H	68.0	1115	7	5
I	n/a	n/a	n/a	n/a
J	62.5	2646	5	6
K	62.5	2157	9	7
Avg.	65.0		7.2	6.8
S.D.	3.9		1.7	1.4

CROOKSTON (K-9)				
Cooperator	Bake Absorption (%)	Loaf Volume (cc)	Mixing Requirement	Dough Characteristics
A	60.0	2900	9	9
B	66.8	977	7	7
C	73.7	980	8	7
D	62.9	1075	6	6
E	72.2	940	9	5
F	62.7	907	7	7
G	63.7	2775	9	9
H	69.0	1110	7	5
I	n/a	n/a	n/a	n/a
J	61.7	2654	5	7
K	62.6	2115	9	7
Avg.	65.5		7.6	6.9
S.D.	4.7		1.4	1.4

LCS Rebel Checks

HAVRE (H-7)				
Cooperator	Bake Absorption (%)	Loaf Volume (cc)	Mixing Requirement	Dough Characteristics
A	61.0	2900	9	9
B	71.1	881	5	7
C	75.3	940	5	7
D	68.1	970	4	6
E	72.8	965	7	7
F	67.0	889	5	7
G	68.0	2975	9	9
H	69.0	1100	3	5
I	n/a	n/a	n/a	n/a
J	67.5	2640	7	7
K	67.5	2198	9	5
Avg.	68.7		6.3	6.9
S.D.	3.8		2.2	1.4

MINOT (M-7)				
Cooperator	Bake Absorption (%)	Loaf Volume (cc)	Mixing Requirement	Dough Characteristics
A	60.0	2800	9	9
B	70.3	902	5	7
C	77.0	1050	5	7
D	66.9	1080	4	6
E	72.0	1065	7	7
F	65.7	1015	5	7
G	67.1	2725	9	7
H	69.0	1110	3	5
I	n/a	n/a	n/a	n/a
J	66.1	2635	5	6
K	66.1	2118	9	7
Avg.	68.0		6.1	6.8
S.D.	4.5		2.2	1.0

WILLISTON (W-7)				
Cooperator	Bake Absorption (%)	Loaf Volume (cc)	Mixing Requirement	Dough Characteristics
A	61.0	2850	9	9
B	71.0	944	4	6
C	75.0	1020	5	7
D	67.1	1120	4	8
E	73.4	945	7	7
F	66.4	946	5	7
G	68.0	2925	9	7
H	70.0	1135	3	5
I	n/a	n/a	n/a	n/a
J	66.6	2645	5	5
K	66.6	2324	7	7
Avg.	68.5		5.8	6.8
S.D.	4.0		2.1	1.2

SWQC #1 – AP Murdock

WATERTOWN (B-1)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2825	100.0	9	9	5	5	6	5	5	5	5
B	67.3	900	92.4	5	8	4	4	4	3	4	2	2
C	71.0	950	95.5	5	7	3	4	5	3	3	5	4
D	65.9	995	90.5	7	5	2	4	4	2	3	3	3
E	68.6	995	97.1	7	5	5	5	5	3	5	5	5
F	65.1	929	92.5	5	7	4	3	3	3	3	4	3
G	66.1	2600	105.1	5	5	3	7	5	3	3	5	3
H	67.0	970	93.3	5	3	5	3	1	3	1	1	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3	3	n/a	3
J	65.1	2525	90.5	5	6	5	4	5	4	5	4	4
K	65.1	2049	92.2	5	5	5	5	3	5	3	5	5
Avg.	66.0		94.9	5.8	6.0	4.1	4.4	4.1	3.4	3.5	3.9	3.6
S.D.	3.1		4.7	1.4	1.8	1.1	1.2	1.4	0.9	1.2	1.4	1.0

CASSELTON (C-1)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	58.0	2800	100.0	5	5	4	5	5	3	5	4	4
B	67.0	906	95.6	5	7	4	4	5	3	2	3	2
C	68.4	920	95.3	5	6	5	4	4	2	3	5	4
D	63.4	1040	100.0	5	4	3	2	5	2	3	4	3
E	66.8	900	90.0	5	5	3	1	5	1	1	3	1
F	63.0	859	88.2	5	6	5	2	3	2	3	3	3
G	64.2	2750	103.8	3	7	3	5	5	3	3	3	3
H	64.0	1000	89.7	5	3	3	3	3	1	1	1	5
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2	3	n/a	2
J	62.9	2667	100.8	4	4	3	3	4	3	4	5	4
K	62.9	2360	109.4	9	7	5	5	7	5	3	5	5
Avg.	64.1		97.3	5.1	5.4	3.8	3.4	4.6	2.5	2.8	3.6	3.3
S.D.	2.9		6.8	1.5	1.4	0.9	1.4	1.2	1.1	1.2	1.3	1.3

HAVRE (H-1)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2800	96.6	7	7	5	5	5	5	5	5	5
B	73.2	874	99.2	4	8	5	5	4	6	4	6	5
C	73.6	960	102.1	5	7	4	5	6	6	2	5	4
D	70.7	980	101.0	3	5	4	4	6	6	4	5	5
E	71.1	960	99.5	5	7	5	7	3	9	3	3	3
F	68.7	893	100.4	5	6	4	4	5	6	3	4	3
G	70.3	2725	91.6	5	7	3	3	5	5	3	3	3
H	71.0	995	90.5	3	5	5	5	7	7	1	1	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7	3	n/a	5
J	69.6	2608	98.8	5	3	4	3	5	6	3	5	5
K	69.6	2232	101.5	9	7	5	5	7	7	3	9	7
Avg.	69.9		98.1	5.1	6.2	4.4	4.6	5.3	6.4	3.1	4.6	4.4
S.D.	3.5		4.1	1.8	1.5	0.7	1.2	1.3	1.1	1.0	2.1	1.3

CROOKSTON (K-1)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2850	98.3	7	7	5	5	5	4	5	5	5
B	70.1	882	90.3	5	7	4	4	6	3	5	3	3
C	71.7	910	92.9	4	8	5	4	4	3	3	5	4
D	67.5	960	89.3	5	5	3	2	1	3	3	2	3
E	69.1	915	97.3	5	5	3	5	3	1	3	3	3
F	65.9	925	102.0	5	6	3	4	5	3	4	4	4
G	67.1	2675	96.4	5	5	3	5	5	3	5	3	3
H	67.0	990	89.2	3	5	1	1	3	1	3	1	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2	3	n/a	3
J	65.1	2452	92.4	5	7	4	4	4	3	4	3	3
K	66.5	2214	104.7	7	5	3	5	5	7	3	7	7
Avg.	66.9		95.3	5.1	6.0	3.4	3.9	4.1	3.0	3.7	3.6	3.7
S.D.	3.4		5.4	1.2	1.2	1.2	1.4	1.4	1.6	0.9	1.7	1.3

MINOT (M-1)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2875	102.7	8	8	5	5	5	5	5	5	5
B	70.5	884	98.0	5	6	6	5	5	5	4	5	5
C	72.5	895	85.2	6	8	5	5	5	5	3	3	3
D	66.8	1035	95.8	4	5	6	4	7	5	4	4	4
E	72.1	1035	97.2	7	5	5	3	5	5	3	3	3
F	65.7	941	92.7	5	7	5	4	4	5	3	4	3
G	67.7	2975	109.2	7	5	3	5	5	5	3	7	5
H	68.0	1110	100.0	3	5	5	3	3	3	3	5	5
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5	3	n/a	5
J	66.3	2492	94.6	4	6	4	4	6	5	3	4	5
K	66.3	2146	101.3	9	7	3	5	5	7	3	5	7
Avg.	67.6		97.7	5.8	6.2	4.7	4.3	5.0	5.0	3.4	4.5	4.5
S.D.	3.6		6.4	1.9	1.2	1.1	0.8	1.1	0.9	0.7	1.2	1.2

WILLISTON (W-1)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2875	100.9	9	9	5	5	5	5	5	5	5
B	70.5	874	92.6	4	8	5	5	6	5	3	5	4
C	77.3	915	89.7	5	7	7	4	5	5	1	3	2
D	68.6	1025	91.5	4	5	6	4	3	4	4	3	3
E	72.8	890	94.2	5	9	5	5	1	3	3	1	3
F	66.7	874	92.4	4	7	5	5	7	5	3	4	3
G	68.3	2825	96.6	9	9	7	5	5	5	3	5	5
H	69.0	1075	94.7	3	5	3	3	5	5	3	5	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4	3	n/a	5
J	67.7	2546	96.3	6	5	5	4	6	4	4	4	5
K	67.7	2357	101.4	9	7	7	5	5	7	3	5	5
Avg.	68.9		95.0	5.8	7.1	5.5	4.5	4.8	4.7	3.2	4.0	3.9
S.D.	4.4		3.8	2.3	1.7	1.3	0.7	1.7	1.0	1.0	1.3	1.1

SWQC #2 – NDHRS16-14-126

CASSELTON (C-2)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2825	100.9	5	5	4	5	4	4	5	4	4
B	77.6	870	91.8	5	7	4	3	4	4	1	6	3
C	72.3	845	87.6	5	5	5	3	3	4	1	3	2
D	75.2	985	94.7	4	3	3	3	5	4	1	3	3
E	70.3	915	91.5	5	7	3	3	1	3	3	1	1
F	73.5	936	96.1	7	6	4	4	4	4	2	4	2
G	74.8	2800	105.7	3	3	3	5	5	5	1	5	3
H	66.0	865	77.6	3	5	3	3	3	3	1	1	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4	2	n/a	3
J	74.2	2337	88.3	3	3	3	4	5	4	2	3	3
K	74.2	2308	107.0	5	5	3	5	5	3	1	3	3
Avg.	71.7		94.1	4.5	4.9	3.5	3.8	3.9	3.8	1.8	3.3	2.7
S.D.	5.5		8.9	1.3	1.5	0.7	0.9	1.3	0.6	1.3	1.6	0.8

MINOT (M-2)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2850	101.8	5	4	3	5	5	5	5	3	3
B	79.9	874	96.9	4	6	5	4	4	5	2	7	5
C	75.5	1100	104.8	4	7	4	4	5	5	1	5	3
D	76.6	1140	105.6	4	6	4	4	6	6	3	5	6
E	71.5	1050	98.6	5	9	3	5	1	9	1	3	3
F	75.2	1105	108.9	4	6	3	5	3	6	2	3	2
G	76.8	2900	106.4	5	5	3	3	5	5	3	7	5
H	69.0	1005	90.5	1	5	3	3	3	7	1	1	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7	2	n/a	4
J	75.7	2308	87.6	4	5	4	4	5	7	3	3	3
K	75.7	1969	93.0	5	5	5	5	3	3	1	3	3
Avg.	73.6		99.4	4.1	5.8	3.7	4.2	4.0	5.9	2.2	4.0	3.6
S.D.	5.6		7.3	1.2	1.4	0.8	0.8	1.5	1.6	1.3	1.9	1.2

WILLISTON (W-2)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2875	100.9	9	9	5	5	5	5	5	5	5
B	80.1	854	90.5	5	6	3	4	4	4	2	6	3
C	79.9	915	89.7	4	7	7	3	4	4	1	3	2
D	76.4	1090	97.3	4	5	4	4	4	3	2	4	3
E	73.8	965	102.1	5	9	5	7	1	1	1	3	1
F	75.4	957	101.2	5	6	4	5	4	3	2	4	2
G	77.0	2775	94.9	7	5	5	3	3	5	3	3	3
H	68.0	960	84.6	1	5	3	3	5	3	3	1	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3	2	n/a	3
J	75.8	2454	92.8	6	4	4	5	4	4	3	3	4
K	75.8	2202	94.8	5	5	5	5	7	3	1	3	3
Avg.	74.2		94.9	5.1	6.1	4.5	4.4	4.1	3.5	2.3	3.5	2.9
S.D.	6.0		5.7	2.1	1.7	1.2	1.3	1.5	1.1	1.2	1.4	1.0

SWQC #3 – AKF-Snowfire

MINOT (M-3)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2850	101.8	9	9	5	5	5	5	5	5	5
B	74.4	906	100.4	6	8	6	5	4	5	5	8	6
C	78.0	1010	96.2	8	7	4	5	6	5	5	5	5
D	71.4	1070	99.1	5	6	5	4	5	4	4	5	4
E	72.4	1040	97.7	7	7	9	3	3	3	5	3	3
F	69.6	1012	99.7	7	6	5	5	5	5	4	5	4
G	71.4	2825	103.7	9	7	5	5	5	5	3	5	5
H	68.0	1000	90.1	3	5	5	5	3	3	5	1	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4	4	n/a	4
J	70.6	2619	99.4	4	6	5	5	6	4	4	5	5
K	70.6	2087	98.5	7	7	7	5	7	5	5	5	5
Avg.	70.6		98.7	6.5	6.8	5.6	4.7	4.9	4.4	4.5	4.7	4.5
S.D.	4.6		3.7	2.0	1.1	1.4	0.7	1.3	0.8	0.7	1.8	0.9

WILLISTON (W-3)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2900	101.8	9	9	5	5	5	5	5	5	5
B	75.8	914	96.8	5	7	5	5	5	4	5	7	5
C	78.7	1010	99.0	6	8	7	5	7	4	3	5	4
D	72.3	1125	100.4	4	5	5	5	7	3	5	6	6
E	73.1	985	104.2	5	9	7	5	5	1	5	5	5
F	70.8	984	104.0	5	6	5	5	6	3	5	6	6
G	72.6	2975	101.7	9	7	5	5	5	3	5	5	5
H	69.0	1035	91.2	3	5	5	3	5	3	5	3	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3	4	n/a	4
J	71.6	2944	111.3	5	4	5	5	5	4	5	6	6
K	71.6	2191	94.3	9	5	7	5	3	5	3	5	3
Avg.	71.6		100.5	6.0	6.5	5.6	4.8	5.3	3.5	4.5	5.3	4.7
S.D.	4.9		5.6	2.2	1.8	1.0	0.6	1.2	1.1	0.8	1.1	1.1

SWQC #4 – MN15005-4

WATERTOWN (B-4)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2700	95.6	9	9	5	5	5	5	5	5	5
B	67.8	902	92.6	5	7	4	5	4	3	5	2	3
C	73.0	1000	100.5	6	7	5	5	6	3	5	5	5
D	64.6	1060	96.4	4	5	2	4	5	2	5	4	3
E	69.6	1025	100.0	5	5	5	3	5	3	5	5	5
F	64.0	1002	99.8	5	6	4	4	4	3	5	4	4
G	65.0	2600	105.1	5	5	3	5	5	3	3	5	3
H	67.0	980	94.2	3	5	3	5	3	3	5	1	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3	5	n/a	4
J	63.9	2725	97.6	5	7	5	5	5	5	5	5	5
K	63.9	2080	93.6	7	3	3	5	5	5	3	7	3
Avg.	65.8		97.5	5.4	5.9	3.9	4.6	4.7	3.5	4.6	4.3	3.9
S.D.	3.8		3.8	1.6	1.7	1.1	0.7	0.8	1.0	0.8	1.7	0.9

CASSELTON (C-4)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	58.0	2800	100.0	6	6	4	5	5	4	4	4	4
B	68.0	886	93.5	5	8	4	3	5	3	3	3	2
C	67.8	935	96.9	6	6	4	4	5	3	5	5	5
D	65.1	1065	102.4	5	5	4	3	7	3	5	5	4
E	68.4	955	95.5	7	5	5	3	9	3	5	7	7
F	64.0	960	98.6	6	5	6	4	5	3	5	4	4
G	65.0	2625	99.1	9	5	5	5	5	3	3	5	5
H	66.0	1035	92.8	5	5	3	3	3	3	3	3	5
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3	5	n/a	4
J	64.2	2536	95.8	4	5	3	5	6	4	5	5	4
K	64.2	2293	106.3	9	3	7	5	7	3	5	3	3
Avg.	65.1		98.1	6.2	5.3	4.5	4.0	5.7	3.2	4.4	4.4	4.3
S.D.	3.0		4.1	1.7	1.3	1.3	0.9	1.6	0.4	0.9	1.3	1.3

CROOKSTON (K-4)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2800	96.6	8	7	5	5	5	4	4	5	5
B	66.2	902	92.3	4	6	3	6	6	4	5	2	3
C	70.2	970	99.0	5	7	4	5	7	4	5	6	6
D	62.6	1090	101.4	4	5	2	3	3	4	5	4	4
E	69.1	1030	109.6	5	5	3	7	7	3	5	7	5
F	61.7	1040	114.7	5	6	3	4	7	4	6	6	6
G	63.0	2450	88.3	9	5	5	5	3	3	3	5	3
H	67.0	1050	94.6	3	5	1	5	3	1	5	3	5
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3	5	n/a	3
J	61.0	2609	98.3	5	7	5	4	4	4	6	4	4
K	62.0	2198	103.9	9	7	5	5	7	5	5	7	7
Avg.	64.2		99.9	5.7	6.0	3.6	4.9	5.2	3.5	4.9	4.9	4.6
S.D.	3.7		7.9	2.2	0.9	1.4	1.1	1.8	1.0	0.8	1.7	1.4

MINOT (M-4)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2825	100.9	9	9	5	5	5	5	5	5	5
B	68.3	907	100.6	4	7	5	5	5	5	5	5	5
C	72.7	1060	101.0	5	7	2	5	6	5	5	5	5
D	63.8	1045	96.8	4	7	5	4	6	5	5	5	5
E	69.1	1070	100.5	5	5	3	5	7	5	5	5	5
F	64.1	1067	105.1	4	6	4	5	5	5	5	5	5
G	65.1	2650	97.2	9	9	7	5	5	5	5	5	5
H	68.0	1125	101.4	3	5	5	5	5	3	5	5	5
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5	5	n/a	5
J	63.5	2588	98.2	6	6	5	5	5	5	5	5	5
K	63.5	2299	108.5	9	7	7	5	9	7	5	5	7
Avg.	65.8		101.0	5.8	6.8	4.8	4.9	5.8	5.0	5.0	5.0	5.2
S.D.	3.7		3.6	2.3	1.4	1.5	0.3	1.3	0.9	0.0	0.0	0.6

SWQC #5 – TCG-Wildcat

CASSETON (C-5)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2800	100.0	4	4	4	5	4	5	5	4	4
B	70.6	907	95.7	5	8	4	3	4	5	3	3	3
C	73.3	780	80.8	6	8	3	3	4	5	3	1	2
D	67.1	1020	98.1	5	5	3	4	6	6	3	4	4
E	70.7	920	92.0	7	5	5	5	7	5	3	7	7
F	66.3	914	93.8	6	6	5	4	6	6	3	4	3
G	67.6	2850	107.5	9	5	5	5	5	5	3	7	5
H	68.0	1010	90.6	3	3	1	5	5	5	3	1	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	6	3	n/a	4
J	66.5	2551	96.4	4	4	4	4	7	5	4	5	5
K	66.5	2360	109.4	9	7	7	5	7	5	3	5	5
Avg.	67.6		96.4	5.8	5.5	4.1	4.3	5.5	5.3	3.3	4.1	4.1
S.D.	3.8		8.2	2.0	1.7	1.6	0.8	1.3	0.5	0.6	2.1	1.4

CROOKSTON (K-5)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2800	96.6	5	5	3	5	5	4	5	3	3
B	67.4	833	85.3	5	8	3	6	5	3	5	1	2
C	72.3	955	97.4	6	7	5	5	6	3	5	5	5
D	65.2	990	92.1	5	5	1	4	4	4	4	3	3
E	69.3	940	100.0	7	5	3	5	5	3	3	5	5
F	63.7	973	107.3	6	6	4	4	7	4	5	5	5
G	64.2	2700	97.3	7	7	5	7	7	3	5	5	5
H	68.0	960	86.5	5	3	1	1	3	3	3	1	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4	4	n/a	3
J	62.2	2525	95.1	4	5	4	4	5	4	5	4	4
K	64.3	2169	102.6	7	5	3	5	3	5	3	5	5
Avg.	65.6		96.0	5.7	5.6	3.2	4.6	5.0	3.6	4.3	3.7	3.9
S.D.	3.8		6.8	1.1	1.4	1.4	1.6	1.4	0.7	0.9	1.6	1.1

SWQC #6 - Dagmar

HAVRE (H-6)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2800	96.6	9	9	5	5	5	5	5	5	5
B	70.5	840	95.3	5	8	5	5	5	5	5	5	5
C	76.5	990	105.3	6	6	4	6	5	5	6	4	5
D	67.4	1000	103.1	5	5	7	5	5	5	5	5	5
E	70.8	910	94.3	5	7	7	7	1	5	5	1	3
F	66.8	1014	114.1	5	7	6	4	4	5	6	5	6
G	67.7	2675	89.9	9	9	5	3	5	5	5	3	3
H	70.0	1030	93.6	3	5	5	5	9	5	5	3	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5	6	n/a	7
J	66.9	2741	103.8	5	7	5	5	6	5	5	6	6
K	66.9	2217	100.9	9	7	5	5	7	5	5	7	7
Avg.	68.5		99.7	6.1	7.0	5.4	5.0	5.2	5.0	5.3	4.4	5.0
S.D.	4.0		7.1	2.1	1.4	1.0	1.1	2.0	0.0	0.5	1.7	1.5

MINOT (M-6)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2800	100.0	9	9	5	5	5	5	5	5	5
B	70.7	895	99.2	4	8	6	5	4	5	4	5	5
C	76.7	1075	102.4	6	7	4	5	6	5	4	5	5
D	67.2	1055	97.7	4	5	6	5	6	5	4	5	5
E	71.6	1050	98.6	7	5	7	5	3	7	3	3	5
F	66.4	1113	109.7	4	7	5	6	5	5	3	5	4
G	67.5	2475	90.8	9	7	5	5	3	5	3	3	3
H	69.0	965	86.9	3	5	5	3	3	7	1	1	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5	3	n/a	5
J	66.5	2535	96.2	5	7	5	5	6	5	3	4	4
K	66.5	2196	103.7	7	7	7	5	3	5	3	5	5
Avg.	68.2		98.5	5.8	6.7	5.5	4.9	4.4	5.4	3.3	4.1	4.5
S.D.	4.3		6.4	2.1	1.3	1.0	0.7	1.3	0.8	1.0	1.4	0.8

WILLISTON (W-6)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2850	100.0	9	9	5	5	5	5	5	5	5
B	71.8	867	91.8	4	7	5	5	5	5	5	4	5
C	79.7	990	97.1	5	7	5	5	5	5	4	4	4
D	68.3	1050	93.8	4	6	6	6	6	4	5	6	6
E	73.0	975	103.2	5	7	5	9	5	3	5	7	5
F	67.2	1058	111.8	4	7	5	7	8	4	5	7	7
G	68.6	2750	94.0	9	7	5	5	5	5	5	5	5
H	69.0	1050	92.5	3	5	5	3	7	5	5	3	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4	4	n/a	6
J	67.6	2609	98.6	5	5	6	5	5	4	6	6	6
K	67.6	2310	99.4	9	7	7	5	7	7	3	7	7
Avg.	69.3		98.2	5.7	6.7	5.4	5.5	5.8	4.6	4.7	5.4	5.4
S.D.	5.0		6.0	2.4	1.2	0.7	1.6	1.1	1.0	0.8	1.4	1.2

SWQC #8 – MN15119-2

WATERTOWN (B-8)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2850	100.9	9	9	5	5	5	5	5	5	5
B	64.6	995	102.2	5	7	5	5	4	4	6	3	4
C	70.3	950	95.5	7	6	5	5	6	4	7	5	6
D	61.1	1050	95.5	5	5	3	4	4	3	7	4	4
E	68.8	1020	99.5	9	5	7	5	5	3	7	5	5
F	60.8	1047	104.3	5	6	4	4	5	4	7	5	6
G	61.8	2675	108.1	9	7	5	7	7	3	5	5	5
H	68.0	990	95.2	5	1	5	5	5	3	9	3	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3	7	n/a	4
J	60.5	2674	95.8	5	7	5	5	5	5	6	5	6
K	60.5	2308	103.9	7	7	3	5	5	5	7	5	5
Avg.	63.5		100.1	6.6	6.0	4.7	5.0	5.1	3.8	6.6	4.5	4.8
S.D.	4.1		4.5	1.8	2.1	1.2	0.8	0.9	0.9	1.1	0.8	1.0

CASSELTON (C-8)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2800	100.0	7	7	5	5	4	7	5	5	5
B	66.8	985	103.9	4	8	4	3	4	6	6	3	5
C	70.9	1000	103.6	6	7	5	4	7	6	6	5	5
D	63.4	1080	103.8	5	6	4	4	6	6	6	5	6
E	70.5	1095	109.5	7	5	7	3	5	9	7	5	9
F	62.8	1098	112.7	5	6	5	4	6	7	7	5	7
G	63.6	2750	103.8	9	7	5	5	5	5	5	5	5
H	69.0	1030	92.4	3	3	5	3	7	7	5	3	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4	6	n/a	4
J	62.6	2509	94.8	5	7	6	4	5	5	5	5	5
K	62.6	2198	101.9	9	7	7	5	5	5	7	5	5
Avg.	65.2		102.6	6.0	6.3	5.3	4.0	5.4	6.1	5.9	4.6	5.4
S.D.	3.8		6.0	2.0	1.4	1.1	0.8	1.1	1.4	0.8	0.8	1.6

CROOKSTON (K-8)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2825	97.4	9	9	5	5	5	5	5	5	5
B	63.5	912	93.3	4	7	4	5	5	4	6	1	3
C	69.7	1005	102.6	6	7	5	5	8	4	7	8	8
D	61.2	1070	99.5	4	6	4	4	4	4	6	4	4
E	69.2	1030	109.6	7	5	5	3	3	3	7	3	3
F	60.0	1104	121.7	5	6	5	4	7	4	7	6	7
G	60.4	2400	86.5	9	7	5	5	3	3	5	3	5
H	68.0	1080	97.3	3	3	3	5	3	3	5	5	5
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2	6	n/a	4
J	58.4	2655	100.0	5	8	5	5	5	4	6	5	5
K	60.3	2203	104.2	9	7	5	5	3	5	7	5	5
Avg.	63.0		101.2	6.1	6.5	4.6	4.6	4.6	3.7	6.1	4.5	4.9
S.D.	4.4		9.5	2.3	1.6	0.7	0.7	1.8	0.9	0.8	1.9	1.5

MINOT (M-8)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2850	101.8	9	9	5	5	5	5	5	5	5
B	65.3	918	101.8	5	7	6	5	5	5	5	3	4
C	70.7	1015	96.7	7	7	3	5	7	5	7	5	6
D	61.0	1090	100.9	4	6	6	5	8	4	6	6	5
E	69.6	1050	98.6	7	5	5	3	9	3	7	7	5
F	61.4	1097	108.1	5	6	5	5	5	4	6	5	6
G	62.2	2950	108.3	9	5	5	5	5	5	5	5	5
H	68.0	1055	95.0	3	3	5	5	3	3	7	3	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4	6	n/a	5
J	60.7	2635	100.0	5	7	5	7	6	4	6	5	6
K	60.7	2168	102.4	9	7	7	5	7	7	7	7	5
Avg.	64.0		101.3	6.3	6.2	5.2	5.0	6.0	4.5	6.1	5.1	5.0
S.D.	4.1		4.3	2.2	1.6	1.0	0.9	1.8	1.1	0.8	1.4	0.9

SWQC #10 – Glenn

WATERTOWN (B-10)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2800	99.1	9	9	5	5	5	5	5	5	5
B	67.8	1020	104.7	5	8	5	5	4	5	5	5	5
C	74.4	1000	100.5	9	7	5	3	3	5	5	4	4
D	64.9	1125	102.3	5	6	4	5	6	5	4	5	5
E	72.5	1005	98.0	9	7	7	5	5	5	5	5	5
F	63.5	974	97.0	6	8	5	4	3	5	4	3	4
G	65.1	2500	101.0	9	9	5	7	5	5	5	7	7
H	69.0	1100	105.8	5	5	5	5	5	5	5	7	7
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5	4	n/a	4
J	64.1	2658	95.2	5	6	5	4	6	5	5	5	5
K	64.1	2242	100.9	9	7	5	5	5	7	5	5	7
Avg.	66.5		100.5	7.1	7.2	5.1	4.8	4.7	5.2	4.7	5.1	5.3
S.D.	4.4		3.3	2.0	1.3	0.7	1.0	1.1	0.6	0.5	1.2	1.2

CASSELTON (C-10)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2825	100.9	6	6	4	5	4	5	5	4	5
B	69.8	940	99.2	5	9	5	3	4	4	4	5	4
C	70.8	955	99.0	5	7	5	3	4	4	4	4	4
D	67.7	1025	98.6	4	5	3	5	7	4	4	4	4
E	72.0	950	95.0	7	9	7	5	5	5	5	5	5
F	65.8	899	92.3	6	8	6	5	4	4	4	3	3
G	66.8	2700	101.9	9	7	5	5	5	5	3	7	5
H	68.0	1040	93.3	7	3	5	3	3	5	5	3	5
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4	4	n/a	3
J	66.5	2510	94.9	5	7	6	5	6	4	4	5	4
K	66.5	2175	100.8	9	7	5	5	5	5	3	7	5
Avg.	67.3		97.6	6.3	6.8	5.1	4.4	4.7	4.5	4.1	4.7	4.3
S.D.	3.6		3.4	1.7	1.8	1.1	1.0	1.2	0.5	0.7	1.4	0.8

HAVRE (H-10)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2800	96.6	9	9	5	5	5	5	5	5	5
B	73.9	898	101.9	5	6	4	5	5	6	5	5	5
C	75.4	970	103.2	4	7	5	5	4	6	4	3	3
D	70.8	1030	106.2	4	6	4	6	5	6	4	6	6
E	71.3	990	102.6	5	7	5	5	1	9	5	3	5
F	69.2	895	100.7	5	8	4	4	4	6	4	4	4
G	70.7	2875	96.6	9	9	5	3	5	7	5	5	5
H	71.0	1075	97.7	5	5	5	5	5	7	5	5	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7	4	n/a	5
J	69.9	2809	106.4	5	6	5	5	6	6	4	6	6
K	69.6	2207	100.4	9	7	7	5	5	7	3	5	5
Avg.	70.3		101.2	6.0	7.0	4.9	4.8	4.5	6.5	4.4	4.7	4.7
S.D.	3.8		3.6	2.1	1.3	0.9	0.8	1.4	1.0	0.7	1.1	1.0

CROOKSTON (K-10)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (Linkert)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2850	98.3	9	9	5	5	5	5	4	5	5
B	68.0	886	90.7	6	9	4	6	5	4	4	4	4
C	72.9	875	89.3	6	8	6	4	3	4	5	2	3
D	64.8	995	92.6	6	6	4	5	2	4	4	3	3
E	71.9	910	96.8	9	9	5	7	3	3	5	3	3
F	64.8	962	106.1	6	8	5	5	5	4	5	5	5
G	65.0	2875	103.6	9	7	5	5	7	3	5	5	5
H	68.0	1030	92.8	5	5	5	5	5	3	5	3	3
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4	4	n/a	4
J	63.0	2708	102.0	4	5	4	5	6	4	5	6	5
K	64.3	2267	107.2	9	7	5	5	5	7	5	5	7
Avg.	66.2		97.9	6.9	7.3	4.8	5.2	4.6	4.1	4.6	4.1	4.3
S.D.	4.1		6.5	1.9	1.6	0.6	0.8	1.5	1.1	0.5	1.3	1.3

MINOT (M-10)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2800	100.0	9	9	5	5	5	5	5	5	5
B	71.1	897	99.4	5	8	6	4	4	5	4	5	5
C	74.3	1005	95.7	6	7	5	5	8	6	5	5	5
D	67.5	1070	99.1	4	8	5	5	5	5	4	5	5
E	72.6	980	92.0	7	7	7	5	5	7	5	5	5
F	66.8	1019	100.4	5	8	5	6	5	5	5	5	5
G	68.0	2850	104.6	9	7	5	5	5	5	5	5	5
H	69.0	1110	100.0	5	5	7	5	5	7	7	5	5
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	6	4	n/a	5
J	66.9	2672	101.4	5	7	4	7	5	6	5	5	6
K	66.9	2030	95.8	9	5	5	5	5	5	5	5	3
Avg.	68.4		98.8	6.4	7.1	5.4	5.2	5.2	5.6	4.9	5.0	4.9
S.D.	3.7		3.5	2.0	1.3	1.0	0.8	1.0	0.8	0.8	0.0	0.7

WILLISTON (W-10)												
Cooperator	Bake Absorption (%)	Loaf Volume		Mixing Requirement	Dough Characteristics	Mixing Tolerance	Quality Score Compared to Check (LCS Rebel)					
		(cc)	(% of Check)				Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2950	103.5	9	9	5	5	5	5	4	5	5
B	71.5	926	98.1	4	7	5	5	5	5	4	5	5
C	75.8	1000	98.0	7	7	5	4	5	5	3	4	4
D	68.8	1080	96.4	4	6	6	5	5	5	4	5	5
E	73.3	920	97.4	7	5	5	7	3	5	5	3	5
F	67.6	897	94.8	4	8	5	5	7	5	4	5	5
G	68.6	2750	94.0	9	7	5	5	5	5	5	5	5
H	70.0	1125	99.1	3	5	5	5	7	5	5	5	5
I	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5	4	n/a	5
J	67.9	2714	102.6	6	5	6	7	6	5	5	6	6
K	67.9	2267	97.5	9	7	9	5	9	5	3	7	7
Avg.	69.2		98.2	6.2	6.6	5.6	5.3	5.7	5.0	4.2	5.0	5.2
S.D.	3.9		3.0	2.3	1.3	1.3	0.9	1.6	0.0	0.8	1.1	0.8

Hard Red Spring Wheat Breeding Quality Target Values

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