Wheat Quality Council

Hard Spring Wheat Technical Committee

2021 Crop

February 22-24, 2022

Kansas City, MO

Wheat Quality Council

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Sponsored by the Wheat Quality Council
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Introduction

Breeders' experimental lines of wheat are evaluated for overall quality before being released for commercial production. The Hard Spring Wheat Technical Committee provides milling and baking quality data on breeders' experimental wheat lines 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 2021 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 2021 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 2021 Wheat Quality Testing Program

Wheat Source

Source/Breeding Program	SWQC Code #	Identification
Montana State University	1	MT1855
Montana State University	2	MT Sidney
Limagrain	3	LCS Ascent
University of Minnesota	4	MN-Rothsay
Limagrain	5	LCS Rebel (Western Check)
21st Century Genetics	6	G18C2097
South Dakota State University	7	Ascend-SD
University of Minnesota	8	Linkert (Eastern Check)
Syngenta	9	AP Smith
University of Minnesota	10	MN15119-2

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 – Michael Leiseth;
- 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 fully express the potential of each experimental line. Levels of phosphorus and potassium were applied in sufficient amounts so as not to be limiting factors. Each plot was individually harvested and the grain produced was thoroughly blended to obtain a uniform sample representing the entire plot.

Field Production Data

Variable	Watertown	Casselton	Havre	Crookston	Minot	Williston
Planting Date	04/23/2021	04/30/2021	04/24/2021	04/30/2021	05/12/2021	05/15/2021
Harvest Date	08/12/2021	08/13/2021	07/29/2021	07/29/2021	08/25/2021	09/12/2021
Fertilizer (lb/acre)						
N	200	120	100	195	172	100
P	*	*	20	100	33	18
K	50	*	10	*	170	46
Herbicide(rate/acre)						
Broadleaf	Maestro (1.5 pt)	Widematch (1 pt) MCPA (1/2 pt)	Vendetta (16 oz)	Bromac (1.5 pt)	Wolverine Adv. (27 oz)	Bronate (1.5 pt.)
Grass	Parity (0.5 pt)	Axial Bold (15 oz)	*	Axial Bold (15 oz) Zidua (3 oz)	Glyphosate (32 oz, preharvest burndown)	*
Fungicide	*	Propimax (2 oz) Prosaro (6.5 oz)	Prosaro (5 oz)	Tilt (4 oz) Prosaro (6.5 oz)	*	Prosaro (6.5 oz)

*No application.

CLIMATOLOGICAL DATA						
	Average Temperature (°F) / Precipitation (in)					
Month	Watertown	Casselton	Havre	Crookston	Minot	Williston
April	42.0 / 3.17	40.5 / 1.31	42.6 / 0.51	41.0 / 0.67	39.0 / 0.33	n/a
May	56.0 / 1.36	54.9 / 1.22	49.8 / 3.02	55.0 / 0.77	51.0 / 1.00	53.0 / 1.33
June	72.0 / 0.62	71.2 / 2.55	66.9 / 0.23	70.0 / 1.65	68.0 / 1.66	69.0 / 2.75
July	71.0 / 3.30	73.3 / 0.77	74.7 / 0.32	73.0 / 0.32	73.0 / 2.08	76.0 / 0.57
August	70.0 / 3.42	69.3 / 0.00	67.7 / 1.22	n/a	68.0 / 1.77	69.0 / 1.25

YIELD DATA						
	Yield (bu/acre) / Test Weight (lb/bu) / Moisture (%)					
SWQC Code #	Watertown	Casselton	Havre	Crookston†	Minot	Williston
1	*	*	16.5 / 58.6 / 8.9	*	17.9 / 59.4 / 9.2	*
2	*	*	16.8 / 59.8 / 8.8	*	35.8 / 61.1 / 11.2	*
3	53.5 / 59.1 / 12.4	64.0 / 64.9 / 11.0	15.7 / 62.1 / 8.7	49.5 / 63.3 / 12.9	21.8 / 60.5 / 10.6	10.0 / 59.0 / 10.6
4	54.9 / 60.1 / 12.2	77.8 / 64.2 / 11.2	*	48.0 / 61.6 / 12.7	26.6 / 60.4 / 10.5	*
5	*	*	11.3 / 60.6 / 8.9	*	30.0 / 61.0 / 10.4	9.8 / 59.0 / 10.7
6	54.1 / 60.3 / 12.4	73.5 / 64.8 / 10.9	*	50.5 / 61.5 / 12.5	*	*
7	56.3 / 59.8 / 12.2	76.9 / 64.3 / 11.0	*	47.2 / 60.0 / 12.6	13.1 / 58.8 / 10.5	*
8	48.0 / 59.0 / 12.4	75.6 / 63.8 / 10.7	*	47.6 / 62.5 / 12.2	*	*
9	*	82.1 / 64.6 / 10.6	*	51.4 / 60.9 / 12.3	8.7 / 59.8 / 8.8	8.0 / 58.0 / 10.8
10	35.7 / 61.4 / 12.7	75.2 / 64.9 / 11.0	*	44.6 / 60.9 / 12.9	9.1 / 59.5 / 9.1	*
Site Totals	**6**	**7**	**4**	**7**	**8**	**3**

*Not increased at this site.

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	On-time planting conditions with good seed to soil contact and ample moisture.	Very good conditions at planting. Soil was dry enough to plant and had adequate moisture below the soil surface.	Good moisture at seeding.	Field conditions were good given the climate.	Dry soil conditions.	The trial was planted following soybeans on 05/15/2021 with little to no soil moisture in the top 24 inches.
During Growth	June was 6º above normal and very little rain during heading. Canopy was reduced with some weed pressure.	Very warm to hot, dry, windy conditions. Some moisture stress early on, followed by several rain events in mid-June.	June 15th and 16th: during heading, we had 2 days over 100º that were in conjunction with a week of high winds. During June, we only received 0.23 inches of precipitation, coupled with the fact that we did not have more than 0.08 inches of precipitation in any single event – the life was sucked out of our crops.	Dry and hot throughout the growing season. Weed pressure was not an issue.	Dry growing conditions – very little rainfall.	The month of June was favorable; however, July was hot and windy with only 0.57 inches of recorded rainfall.
At Flowering	Low disease pressure with the lack of moisture. Drought stressed. Temperatures above normal.	Very warm conditions at flowering but mostly dry. Conditions were not favorable for scab.	Heat, wind, and continued drought. Sprayed for grasshoppers.	Disease was not an issue this year.	Hot and dry. Very little rainfall. No disease pressure.	Above average temperatures; below average rainfall.
During Maturation	2.16 inches of rain on 07/06/2021.	Hot, dry weather pushed maturity along very quickly.	Drought.	Ground was cracked and extremely dry. We did have a grasshopper issue in the beginning of July. We sprayed it with Warrior 2 to help with this. The grasshoppers at the beginning of July were affecting flag leaves. If I had to say a percentage of flag leaf damage, I would say 20% of the flag leaf was defoliated. This even throughout all entries.	Hot and dry. Very little rainfall.	Hot and dry.
At Harvest	2.24 inches of rain on 08/08/2021 that reduced test weight and color.	Hot, dry conditions allowed for quick harvest with no rain delays. Grain quality was excellent.	Drought.	Grasshoppers were an issue again at harvest time.	Hot and dry.	Hot and dry.

Description of 2021 Hard Spring Wheat Lines

SWQC #1 – MT1855

MT1855 is a hard red spring wheat under consideration for release by the Montana Agricultural Experiment Station. MT1855 has good yield potential, test weight, grain protein content and aluminum tolerance in dryland areas of Montana. MT1855 has a semi-solid stem and is moderately resistant to wheat stem sawfly. MT1855 was selected from the cross MT1053/MO8/3-4.

SWQC #2 – MT Sidney

MT Sidney is a hard red spring wheat released by the Montana Agricultural Experiment Station in 2021. MT Sidney was released for having moderate Fusarium Head Blight resistance, good yield potential, excellent test weight and good grain protein content in dryland areas of Montana. MT Sidney was selected from the cross MT1274/RB07. MT Sidney has similar grain yield potential to Vida (PI 642366), the most widely grown cultivar in Montana, and improved test weight and grain protein content.

SWQC #3 – LCS Ascent

LCS Ascent (LARR19-0046) is a hard red spring wheat variety developed by Limagrain Cereal Seeds that is broadly adapted across the Northern Plains. LCS Ascent is a medium maturing wheat with average plant height and a strong disease package. LCS Ascent has excellent grain quality and above average test weight. PVP (94) applied.

SWQC #4 – MN-Rothsay

MN-Rothsay (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 #6 – G18C2097

G18C2097 is hard red spring wheat (HRS) developed by 21st Century Genetics Corp (TCG). It was developed from the cross Linkert X Brick. It is a medium short, medium early variety with excellent standability under high yields. Protein and test weight are medium high. It has a general MS reaction to the diseases of the Northern Great Plains (NGP). So, fungicide is a must for best results. It is a high yielding management HRS adapted to the Red River Valley (RRV) area of ND and MN. It has good tolerance to preharvest sprouting, maintaining acceptable falling numbers. Bread-making quality is good.

SWQC #7 – Ascend-SD

Ascend-SD (SD4873) is a hard red spring wheat breeding line developed by the South Dakota State University HRS wheat breeding program. It was derived as a single spike from within an F_4 population ('Lang-MN'/SD4389) that was originally created in fall 2013. During early-generation observation, the population was tested as 31421 and renamed SD4873 with its placement into the 2018 Preliminary Yield Trial. Ascend-SD was evaluated in Advanced Yield Trials from 2019 through 2021. During 2020 and 2021, Ascend-SD was tested in both the Uniform Regional Spring Wheat Nursery and the South Dakota Crop Performance Testing trials. Points of note associated with Ascend-SD include:

1. Excellent yield potential;
2. Greater than average test weight;
3. Average level of grain protein concentration;
4. Later than average heading date;
5. Slightly taller than average;
6. Moderate levels of Fusarium head blight and Bacterial leaf streak resistance;
7. Better than average bread loaf volume and mixing tolerance.

SWQC #9 – AP Smith

AP Smith is a hard red spring wheat bred and developed by Syngenta Crop Protection, LLC primarily adapted for the Northern Plains of the USA. AP Smith was selected from the cross between AgriPro line 08S0066-17 and SY Ingmar. It has medium heading, similar to 'Faller' with moderate test weight. It is a standard semidwarf, similar in height to 'SY Ingmar'. Straw strength is very strong. Disease resistance is intermediate for Foliar Diseases and Fusarium Head Blight. Protein levels are moderate to high, between 'AP Murdock' and 'SY Ingmar'. Overall bread-making characteristics are very good

SWQC #10 – 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.

Wheat Production Sites

SWQC Code #	Entry	Source	Production Sites					
			Watertown	Casselton	Havre	Crookston	Minot	Williston
1	MT1855	Montana State University			X		X	
2	MT Sidney	Montana State University			X		X	
3	LCS Ascent	Limagrain	X	X	X	X	X	X
4	MN-Rothsay	University of Minnesota	X	X		X	X	
5	LCS Rebel	Limagrain			X		X	X
6	G18C2097	21st Century Genetics	X	X		X		
7	Ascend-SD	South Dakota State University	X	X		X	X	
8	Linkert	University of Minnesota	X	X		X		
9	AP Smith	Syngenta		X		X	X	X
10	MN15119-2	University of Minnesota	X	X		X	X	

Grain Cleaning and Milling Procedures

Wheat (approximately 3 bu/line) was cleaned using 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 (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 North Dakota Grain Inspection, 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;

- Flour wet gluten and gluten index (AACCI Method 38-12);

- 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, 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 (cm^2): 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

Flour samples were shipped to cooperators for evaluation of baking properties. 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 – Manhattan, KS;
- Great Plains Analytical Laboratory – Kansas City, MO;
- 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 2021 Hard Spring Wheat Lines

SWQC #1 – MT1855

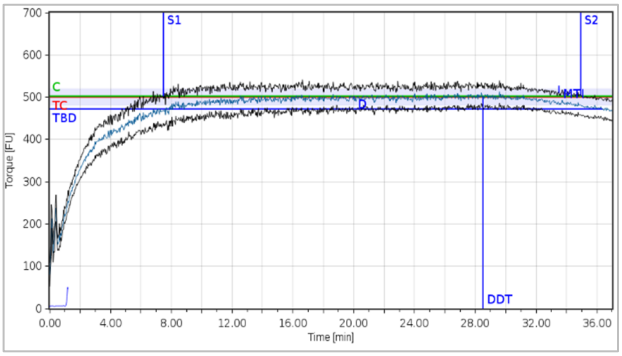
		Havre		Minot	
		LCS Rebel		LCS Rebel	
	Quality Trait	H-5	H-1	M-5	M-1
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	18.3	17.9	18.5	18.2
2	Flour Protein (%, 14% mb)	16.8	16.6	16.9	16.5
3	Market Value (Score 1-6)	5.1	4.7	4.7	4.9
4	Market Value (Score 1-10)	10.0	9.6	10.0	9.6
5	DON (ppm)	nd	nd	nd	nd
6	Test Weight (lb/bu)	62.1	60.1	61.6	60.4
7	1000 Kernel Weight (g)	27.7	27.0	35.0	35.0
8	Kernel Size, Large (%)	7	9	68	59
9	Kernel Size, Small (%)	24	25	5	8
10	Wheat Moisture (%)	9.3	9.6	10.8	10.9
11	Wheat Ash (%, 14% mb)	1.16	1.18	1.46	1.44
12	Wheat Falling Number (s)	458	476	345	394
13	SKCS Hardness Index	76.6	79.1	67.4	74.3
14	Vitreous Kernels (%)	99	98	19	60
	Flour Extraction				
15	Tempered Wheat Basis (%)	71.5	68.6	72.3	68.7
16	Total Product Basis (%)	73.4	71.7	73.6	70.5
17	Flour/Bu Wheat (lb)	44.9	42.9	45.0	41.9
	Flour Quality				
18	Flour Color Brightness (*L**)	90.2	90.1	90.1	89.8
19	Flour Color Yellowness (*b**)	9.0	10.9	8.3	9.6
20	Flour Moisture (%)	13.4	13.1	13.3	13.4
21	Flour Ash (%, 14% mb)	0.39	0.42	0.46	0.53
22	Flour Falling Number (malted, s)	246	255	246	251
	Farinograph				
23	Water Absorption (%, 500 BU)	69.5	72.0	69.7	71.0
24	Water Absorption (%, 14% mb)	69.1	71.4	69.3	70.6
25	Arrival Time (min)	7.5	7.6	8.1	6.3
26	Peak Time (min)	28.5	10.0	20.3	10.6
27	Dough Stability (min)	27.5	11.7	18.1	12.5
28	Mixing Tolerance Index (MTI, BU)	18	10	22	15
29	Time To Breakdown (TTB, min)	36.4	20.7	27.0	20.0
	II. Cooperator Results				
30	Bake Absorption (Average %)	71.1	72.0	71.4	71.8
31	Loaf Volume (% of Check)		94.4		99.3

SWQC #1 – MT1855

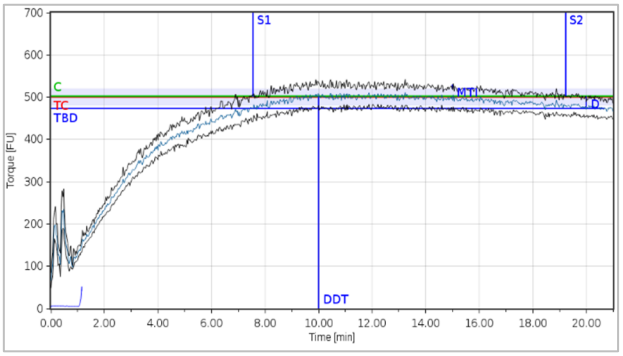
	Quality Trait	Havre LCS Rebel H-5	Havre H-1	Minot LCS Rebel M-5	Minot M-1
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.3	4.6	6.4	4.9
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.3	4.8	6.3	4.7
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		2.5		2.9
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.3		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		4.1		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		4.7		4.8
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.7		3.9
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.4		4.4
	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		3.6		4.2

Farinograms

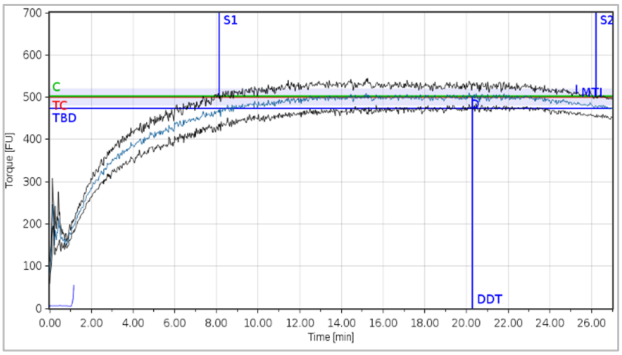
LCS Rebel Check (Havre, H-5)



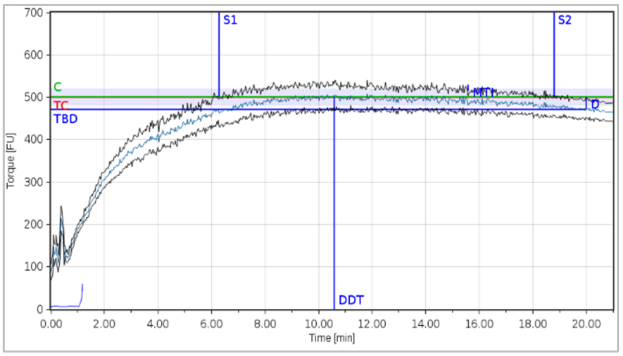
MT1855 (Havre, H-1)



LCS Rebel Check (Minot, M-5)

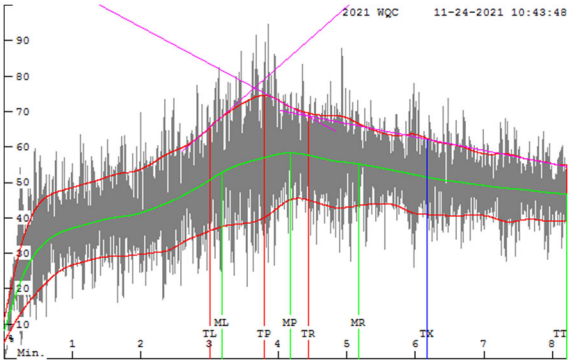


MT1855 (Minot, M-1)

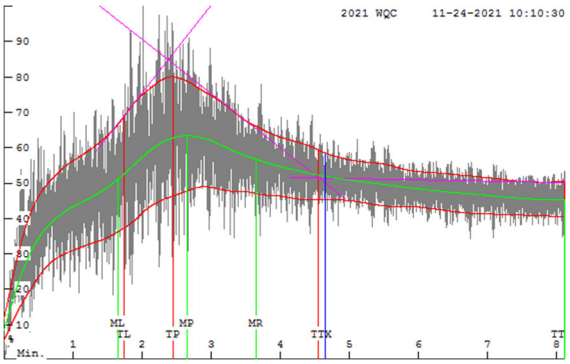


Mixograms

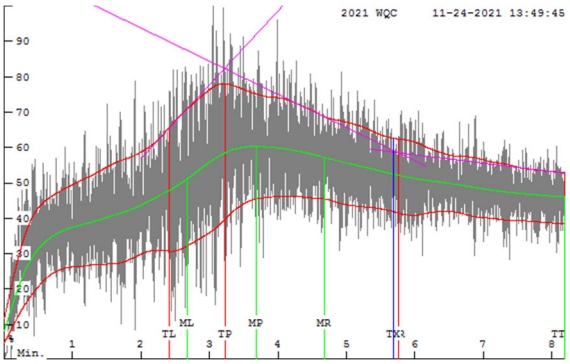
LCS Rebel Check (Havre, H-5)



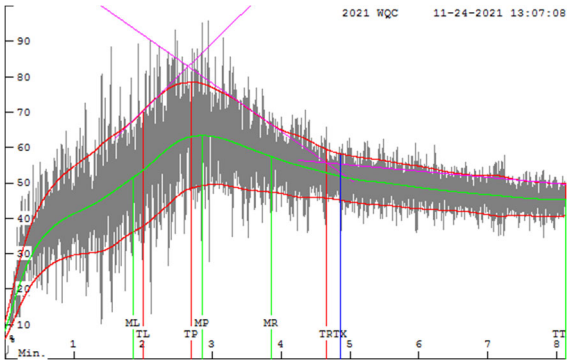
MT1855 (Havre, H-1)



LCS Rebel Check (Minot, M-5)

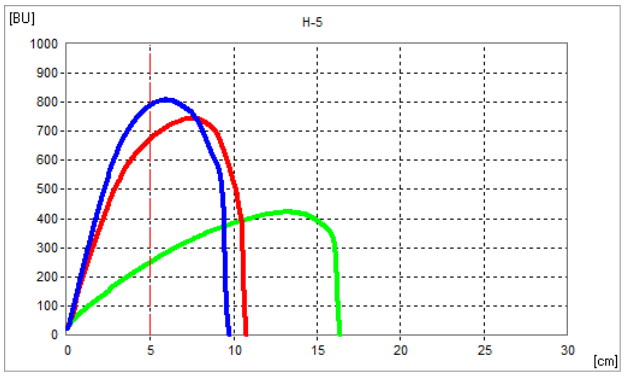


MT1855 (Minot, M-1)

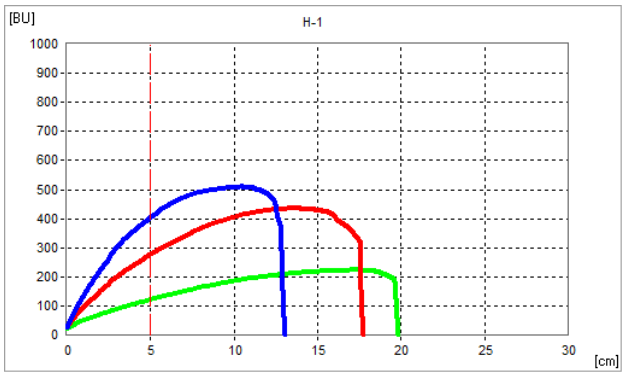


Extensograms

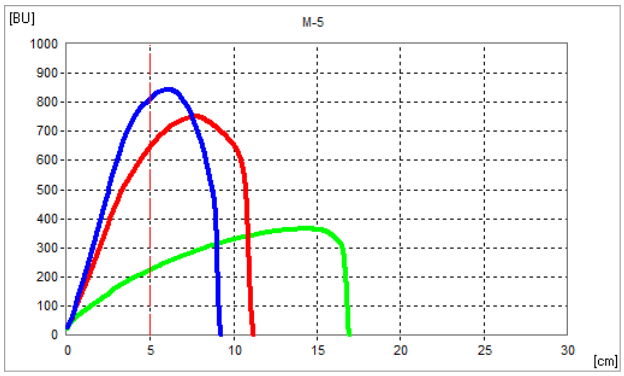
LCS Rebel Check (Havre, H-5)



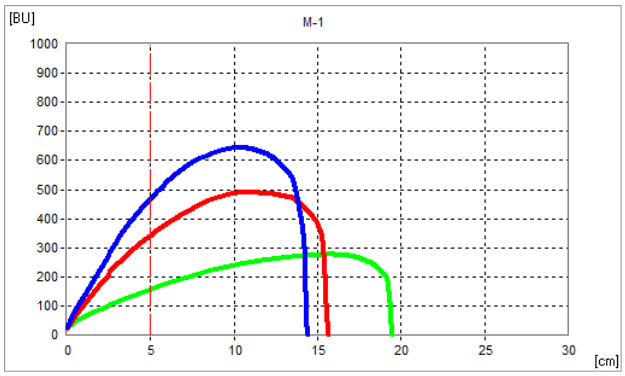
MT1855 (Havre, H-1)



LCS Rebel Check (Minot, M-5)



MT1855 (Minot, M-1)



45 min; 90 min; 135 min

SWQC #2 – MT Sidney

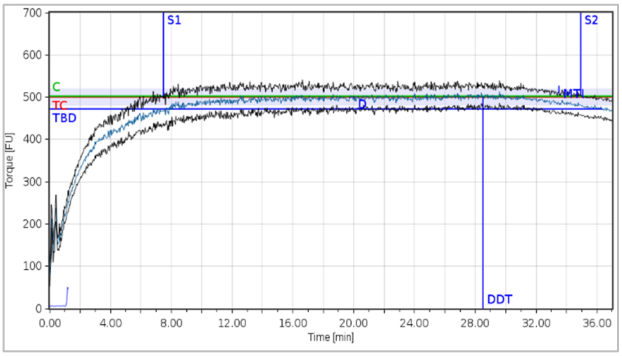
		Havre		Minot	
		LCS Rebel		LCS Rebel	
	Quality Trait	H-5	H-2	M-5	M-2
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	18.3	17.4	18.5	18.0
2	Flour Protein (%, 14% mb)	16.8	16.2	16.9	16.3
3	Market Value (Score 1-6)	5.1	4.8	4.7	4.1
4	Market Value (Score 1-10)	10.0	8.2	10.0	9.2
5	DON (ppm)	nd	nd	nd	nd
6	Test Weight (lb/bu)	62.1	62.1	61.6	60.7
7	1000 Kernel Weight (g)	27.7	21.5	35.0	30.5
8	Kernel Size, Large (%)	7	1	68	37
9	Kernel Size, Small (%)	24	70	5	14
10	Wheat Moisture (%)	9.3	9.5	10.8	11.2
11	Wheat Ash (%, 14% mb)	1.16	1.13	1.46	1.52
12	Wheat Falling Number (s)	458	465	345	339
13	SKCS Hardness Index	76.6	82.1	67.4	64.6
14	Vitreous Kernels (%)	99	100	19	42
	Flour Extraction				
15	Tempered Wheat Basis (%)	71.5	70.9	72.3	73.2
16	Total Product Basis (%)	73.4	72.6	73.6	74.1
17	Flour/Bu Wheat (lb)	44.9	44.4	45.0	45.5
	Flour Quality				
18	Flour Color Brightness (*L**)	90.2	90.2	90.1	90.1
19	Flour Color Yellowness (*b**)	9.0	10.0	8.3	8.6
20	Flour Moisture (%)	13.4	13.1	13.3	13.4
21	Flour Ash (%, 14% mb)	0.39	0.39	0.46	0.47
22	Flour Falling Number (malted, s)	246	249	246	254
	Farinograph				
23	Water Absorption (%, 500 BU)	69.5	68.3	69.7	67.1
24	Water Absorption (%, 14% mb)	69.1	67.7	69.3	66.5
25	Arrival Time (min)	7.5	7.1	8.1	8.1
26	Peak Time (min)	28.5	14.3	20.3	16.6
27	Dough Stability (min)	27.5	16.5	18.1	12.9
28	Mixing Tolerance Index (MTI, BU)	18	7	22	31
29	Time To Breakdown (TTB, min)	36.4	24.6	27.0	22.0
	II. Cooperator Results				
30	Bake Absorption (Average %)	71.1	70.2	71.4	69.2
31	Loaf Volume (% of Check)		96.4		100.9

SWQC #2 – MT Sidney

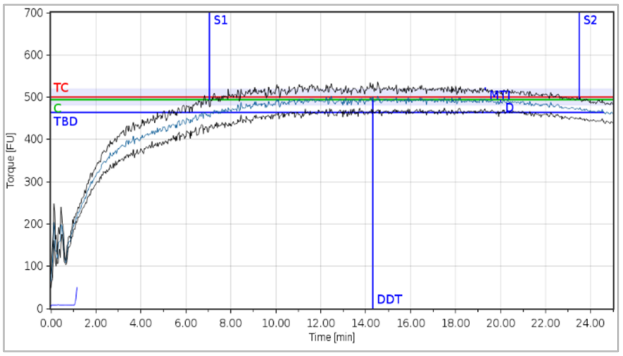
	Quality Trait	Havre LCS Rebel H-5	Havre H-2	Minot LCS Rebel M-5	Minot M-2
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	**6.3**	**5.2**	**6.4**	**5.9**
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	**6.3**	**4.8**	**6.3**	**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		**3.2**		**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		**4.5**		**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		**4.8**		**4.9**
	III. Cooperator Evaluation				
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.3**		**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		**4.0**		**4.8**
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**3.9**		**4.8**
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.1**		**4.6**

Farinograms

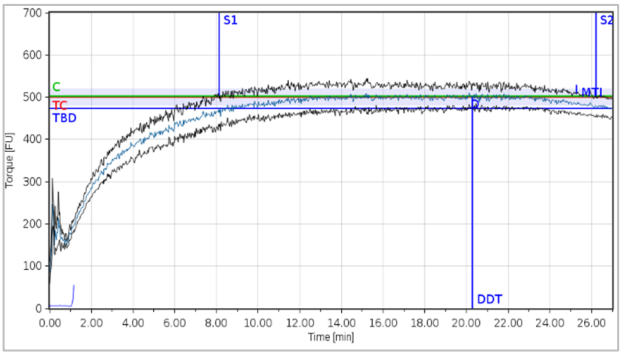
LCS Rebel Check (Havre, H-5)



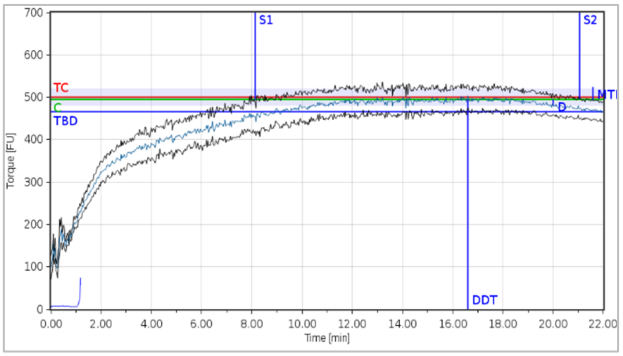
MT Sidney (Havre, H-2)



LCS Rebel Check (Minot, M-5)

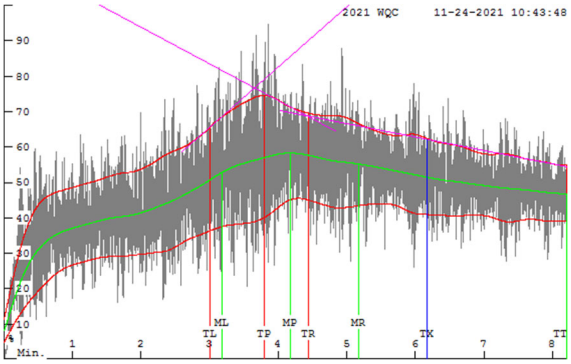


MT Sidney (Minot, M-2)

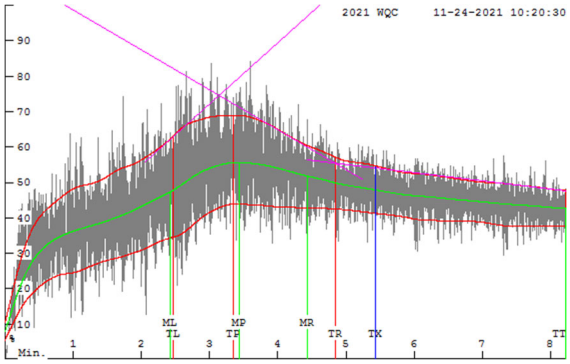


Mixograms

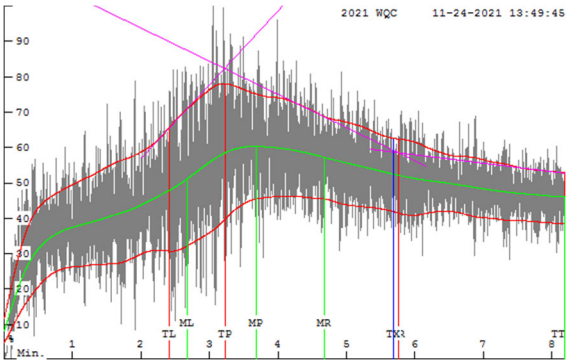
LCS Rebel Check (Havre, H-5)



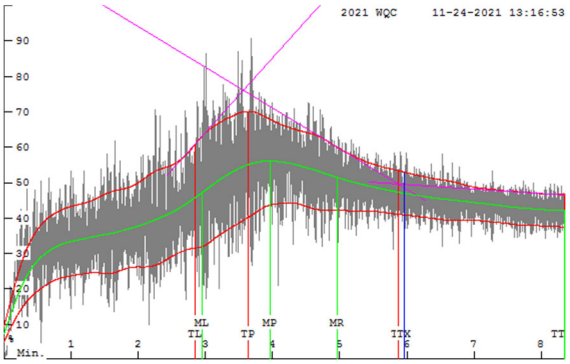
MT Sidney (Havre, H-2)



LCS Rebel Check (Minot, M-5)

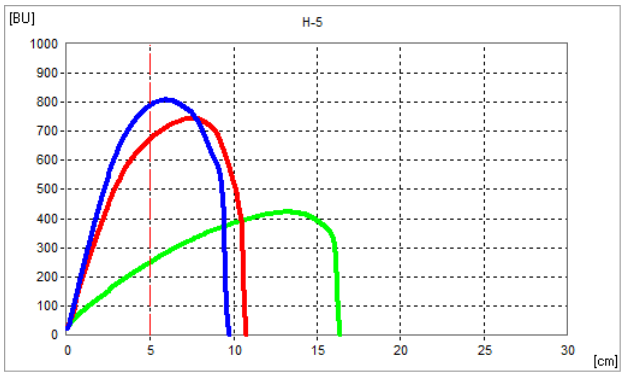


MT Sidney (Minot, M-2)

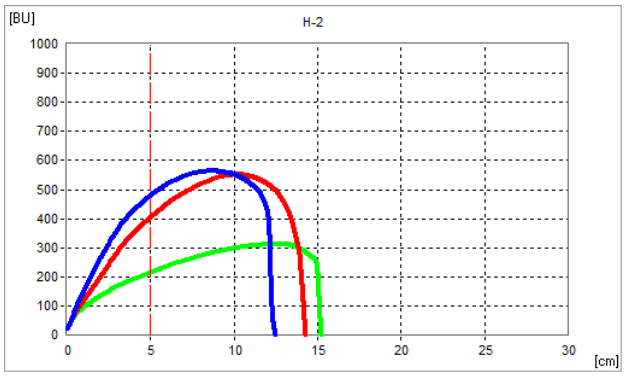


Extensograms

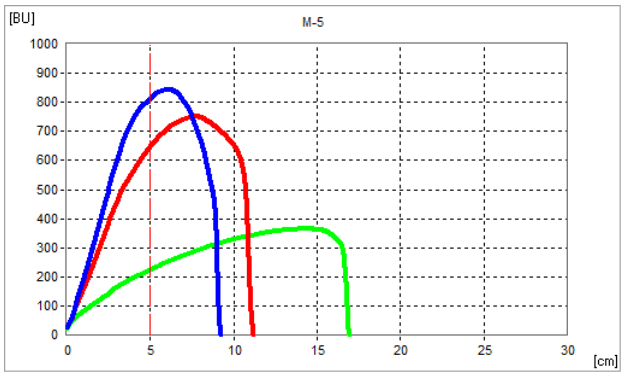
LCS Rebel Check (Havre, H-5)



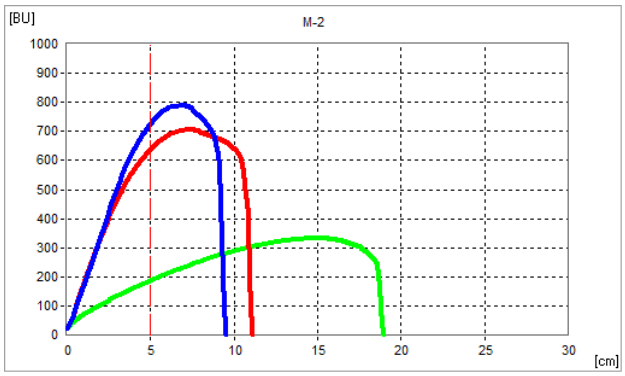
MT Sidney (Havre, H-2)



LCS Rebel Check (Minot, M-5)



MT Sidney (Minot, M-2)



45 min; 90 min; 135 min

SWQC #3 – LCS Ascent

		Watertown		Casselton		Havre		Crookston		Minot		Williston	
		Linkert		Linkert		LCS Rebel		Linkert		LCS Rebel		LCS Rebel	
	Quality Trait	B-8	B-3	C-8	C-3	H-5	H-3	K-8	K-3	M-5	M-3	W-5	W-3
	I. USDA-ARS WQL Data												
1	Wheat Protein (%, 12% mb)	17.3	15.6	14.5	13.3	18.3	16.6	15.3	14.8	18.5	17.7	17.4	16.0
2	Flour Protein (%, 14% mb)	16.2	14.2	13.2	12.3	16.8	14.9	14.4	13.5	16.9	15.9	16.5	15.1
3	Market Value (Score 1-6)	5.2	4.7	4.9	4.3	5.1	5.2	5.3	4.9	4.7	4.5	3.6	3.3
4	Market Value (Score 1-10)	10.0	7.0	10.0	7.6	10.0	7.8	10.0	9.2	10.0	9.0	10.0	8.4
5	DON (ppm)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
6	Test Weight (lb/bu)	61.4	61.8	64.3	65.4	62.1	63.2	63.8	64.4	61.6	61.3	60.7	60.5
7	1000 Kernel Weight (g)	34.9	31.5	33.2	34.8	27.7	25.3	34.1	30.7	35.0	32.2	29.2	25.2
8	Kernel Size, Large (%)	63	63	56	63	7	2	44	42	68	58	34	19
9	Kernel Size, Small (%)	8	9	9	9	24	35	7	12	5	7	15	26
10	Wheat Moisture (%)	12.0	12.2	10.9	11.2	9.3	9.1	11.4	11.9	10.8	9.9	10.8	10.9
11	Wheat Ash (%, 14% mb)	1.52	1.40	1.45	1.49	1.16	1.13	1.39	1.22	1.46	1.49	1.41	1.44
12	Wheat Falling Number (s)	475	400	474	379	458	445	465	432	345	357	202	280
13	SKCS Hardness Index	76.7	68.4	86.1	71.0	76.6	87.6	78.3	84.7	67.4	66.0	67.6	77.7
14	Vitreous Kernels (%)	42	33	87	93	99	99	90	84	19	18	27	22
	Flour Extraction												
15	Tempered Wheat Basis (%)	70.5	73.1	71.7	74.0	71.5	68.5	72.6	72.3	72.3	73.0	73.5	72.2
16	Total Product Basis (%)	72.2	74.7	73.3	75.8	73.4	70.3	73.7	73.3	73.6	74.1	75.0	74.1
17	Flour/Bu Wheat (lb)	44.1	46.0	46.8	49.7	44.9	44.0	47.2	47.2	45.0	45.1	45.1	44.2
	Flour Quality												
18	Flour Color Brightness (*L**)	90.3	90.2	90.6	90.8	90.2	90.3	91.1	90.7	90.1	90.4	90.3	90.4
19	Flour Color Yellowness (*b**)	8.0	7.9	10.0	9.7	9.0	8.8	8.1	8.4	8.3	7.8	8.3	7.8
20	Flour Moisture (%)	13.6	13.9	13.7	13.5	13.4	13.8	13.1	13.1	13.3	13.1	13.3	13.4
21	Flour Ash (%, 14% mb)	0.52	0.50	0.51	0.44	0.39	0.40	0.48	0.44	0.46	0.46	0.43	0.46
22	Flour Falling Number (malted, s)	254	258	247	255	246	258	257	251	246	253	266*	260
	Farinograph												
23	Water Absorption (%, 500 BU)	68.4	64.6	62.7	58.4	69.5	67.4	64.7	65.6	69.7	68.0	66.4	65.6
24	Water Absorption (%, 14% mb)	68.4	64.8	62.5	58.0	69.1	67.2	63.9	64.8	69.3	67.0	65.8	65.0
25	Arrival Time (min)	22.1	6.5	2.8	2.6	7.5	7.0	7.6	5.9	8.1	9.6	12.2	25.0
26	Peak Time (min)	28.0	21.8	7.9	6.9	28.5	17.8	36.4	12.5	20.3	17.8	38.0	31.2
27	Dough Stability (min)	11.9	19.5	26.2	17.7	27.5	15.0	39.7	18.7	18.1	12.3	33.4	17.7
28	Mixing Tolerance Index (MTI, BU)	19	32	15	21	18	31	5	10	22	34	11	3
29	Time To Breakdown (TTB, min)	34.8	26.8	30.6	19.4	36.4	23.2	48.9	25.8	27.0	22.8	46.7	43.8

*Not malted.

SWQC #3 – LCS Ascent

		Watertown		Casselton		Havre		Crookston		Minot		Williston	
		Linkert		Linkert		LCS Rebel		Linkert		LCS Rebel		LCS Rebel	
	Quality Trait	B-8	B-3	C-8	C-3	H-5	H-3	K-8	K-3	M-5	M-3	W-5	W-3
	II. Cooperator Results												
30	Bake Absorption (Average %)	70.3	66.5	65.2	61.8	71.1	69.3	67.0	67.3	71.4	69.6	69.1	68.1
31	Loaf Volume (% of Check)		99.2		97.6		94.9		99.4		101.6		101.6
32	Mixing Requirement*	6.8	6.6	7.0	6.6	6.3	4.8	8.0	5.5	6.4	5.3	8.5	8.3
33	Dough Characteristics**	6.4	6.2	6.7	6.1	6.3	5.2	6.8	5.8	6.3	5.7	7.4	7.6
34	Mixing Tolerance†		4.4		4.3		3.1		3.3		3.8		4.6
35	Internal Crumb Color††		5.2		5.3		5.0		4.8		5.3		5.3
36	Internal Crumb Texture‡		4.7		4.6		5.3		4.4		5.4		4.9
	III. Cooperator Evaluation‡												
	Quality Traits 1-2: Protein		3.1		3.6		2.9		3.9		3.8		3.7
	Quality Traits 3-22: Milling		6.0		6.3		3.3		5.0		5.0		3.8
	Quality Traits 23-36: Baking		4.3		3.7		3.6		4.3		5.0		5.1
	Quality Traits 1-36: Overall Comparison		4.5		4.1		3.7		3.8		4.8		4.3

*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.

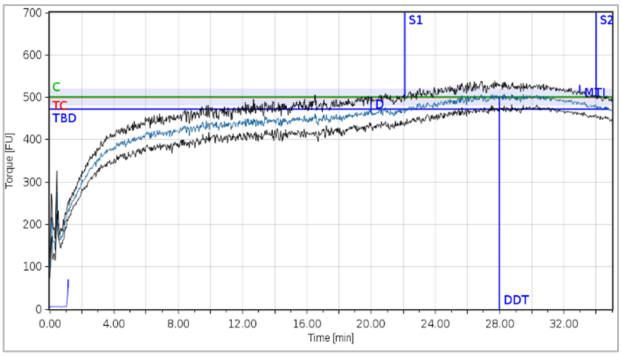
†9 = Much More Tolerance Than Check; 7 = More Tolerance Than Check; 5 = Tolerance Equivalent To Check; 3 = Less Tolerance Than Check; 1 = Much Less Tolerance Than Check.

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

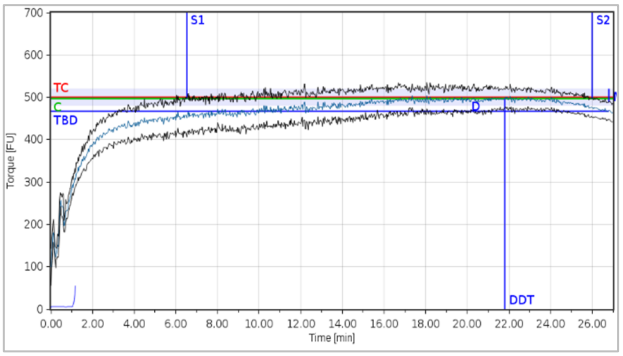
‡9 = Much Better Than Check; 7 = Better Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.

Farinograms

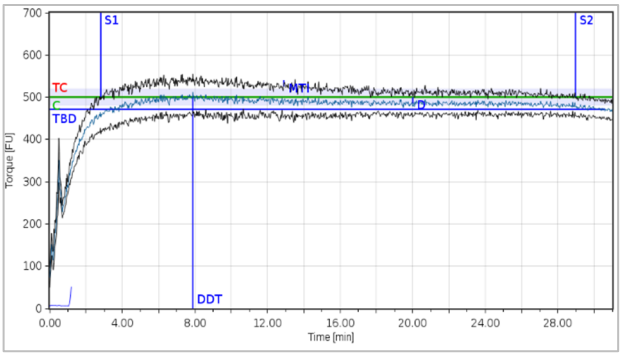
Linkert Check (Watertown, B-8)



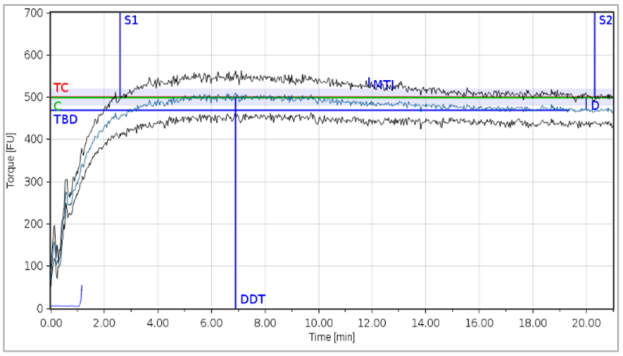
LCS Ascent (Watertown, B-3)



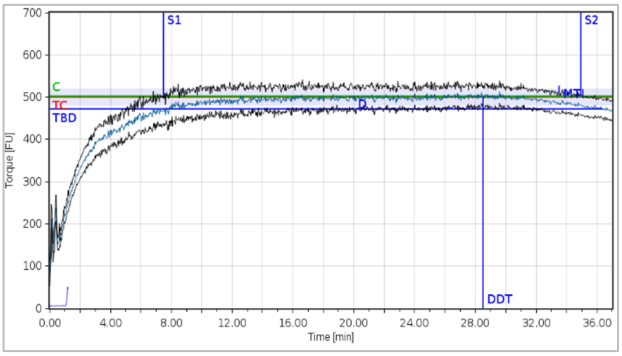
Linkert Check (Casselton, C-8)



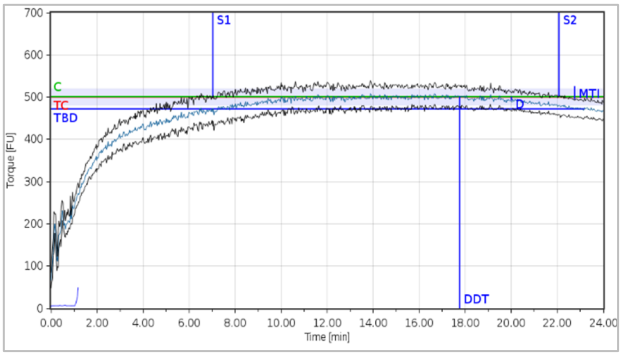
LCS Ascent (Casselton, C-3)



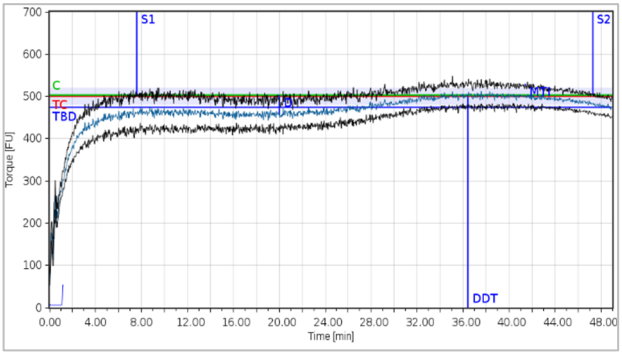
LCS Rebel Check (Havre, H-5)



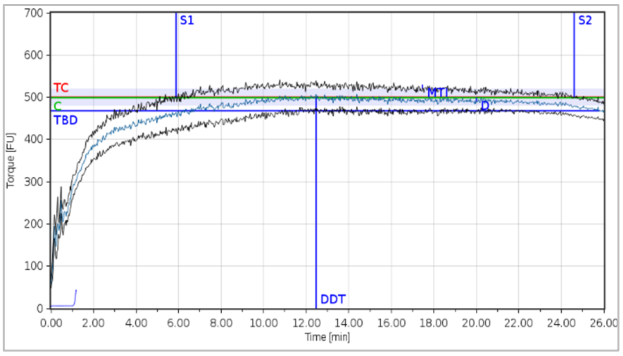
LCS Ascent (Havre, H-3)



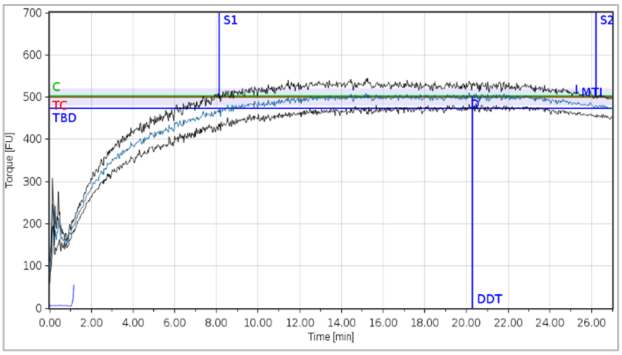
Linkert Check (Crookston, K-8)



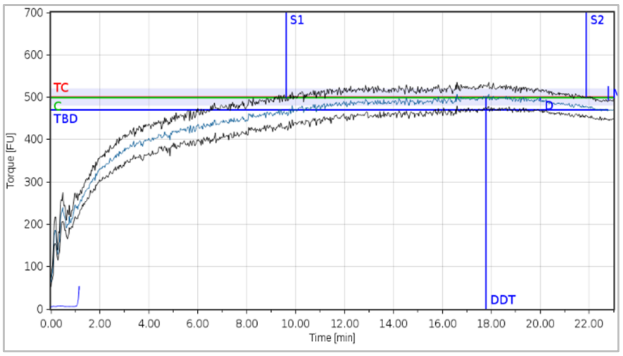
LCS Ascent (Crookston, K-3)



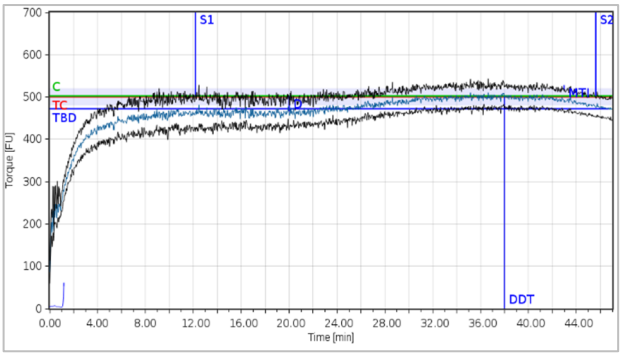
LCS Rebel Check (Minot, M-5)



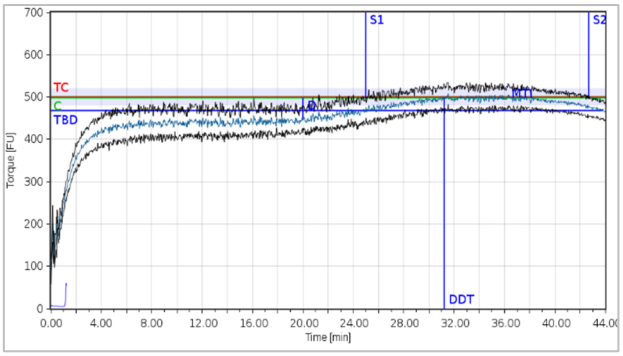
LCS Ascent (Minot, M-3)



LCS Rebel Check (Williston, W-5)

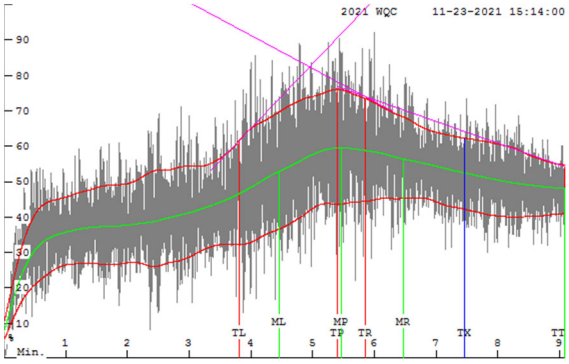


LCS Ascent (Williston, W-3)

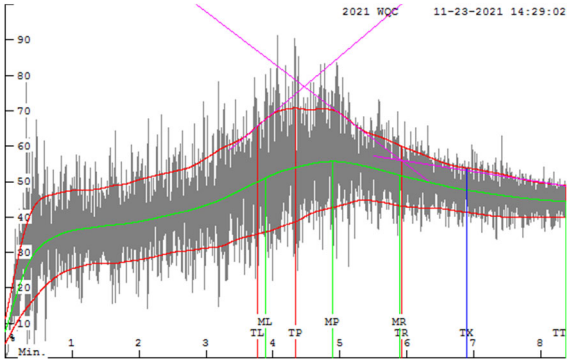


Mixograms

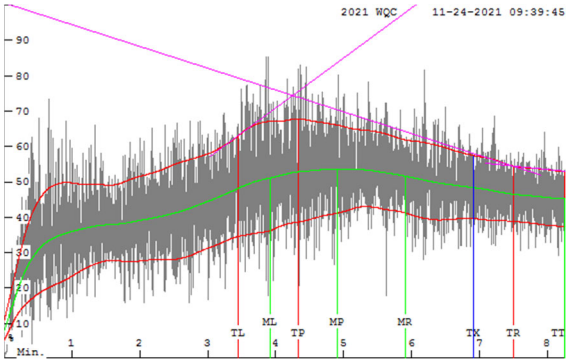
Linkert Check (Watertown, B-8)



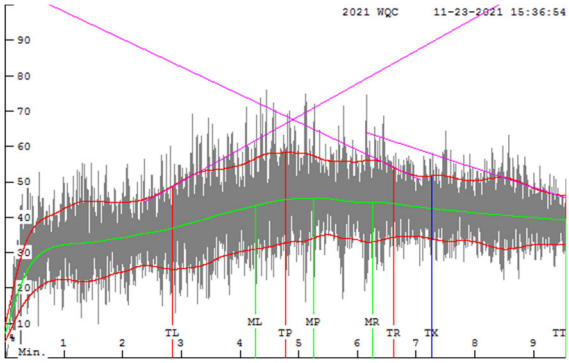
LCS Ascent (Watertown, B-3)



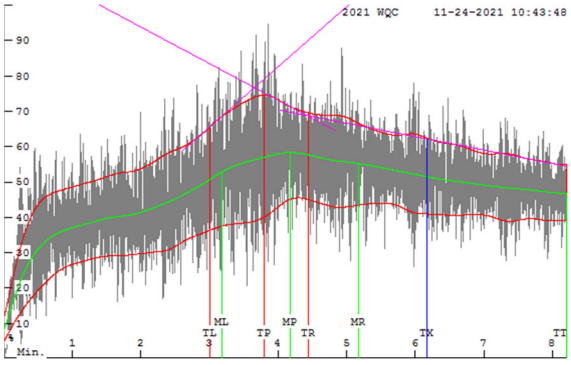
Linkert Check (Casselton, C-8)



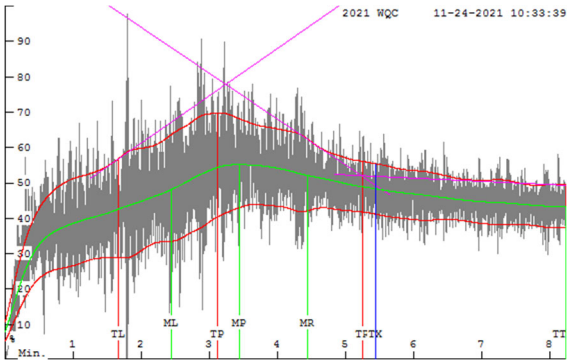
LCS Ascent (Casselton, C-3)



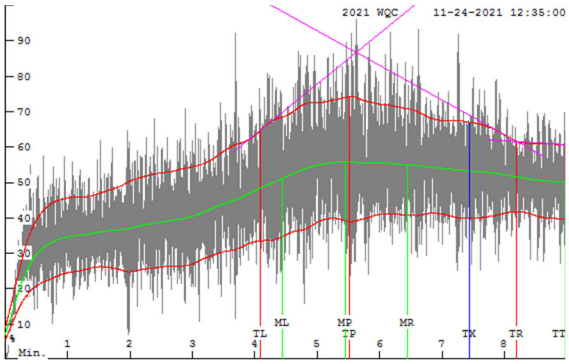
LCS Rebel Check (Havre, H-5)



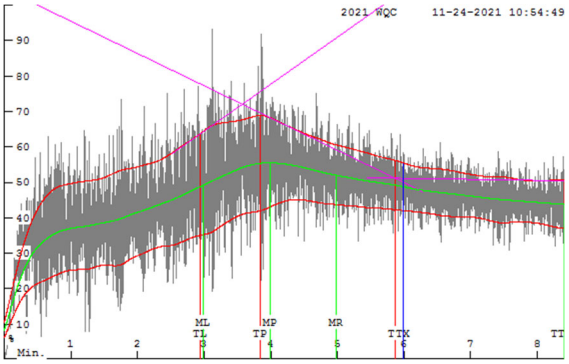
LCS Ascent (Havre, H-3)



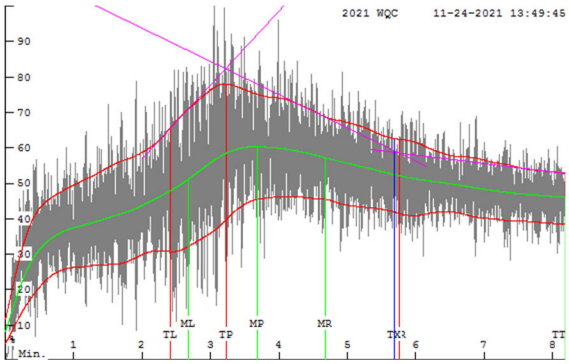
Linkert Check (Crookston, K-8)



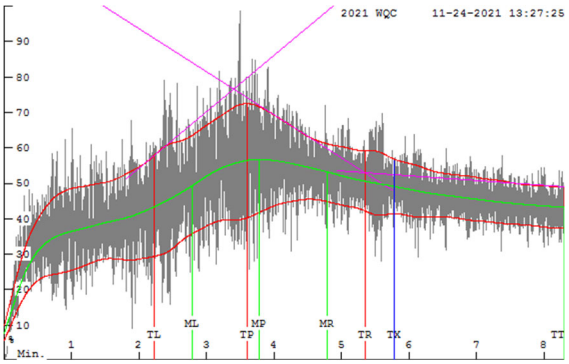
LCS Ascent (Crookston, K-3)



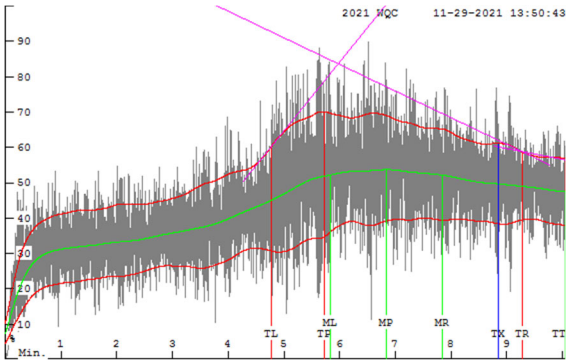
LCS Rebel Check (Minot, M-5)



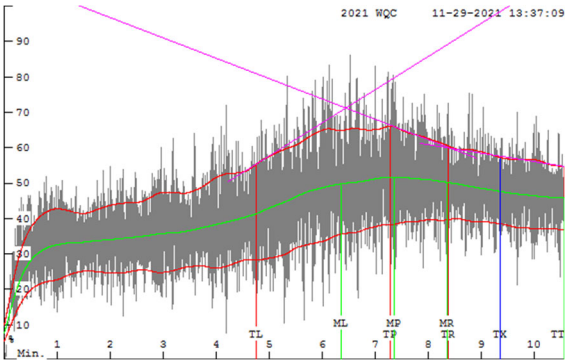
LCS Ascent (Minot, M-3)



LCS Rebel Check (Williston, W-5)

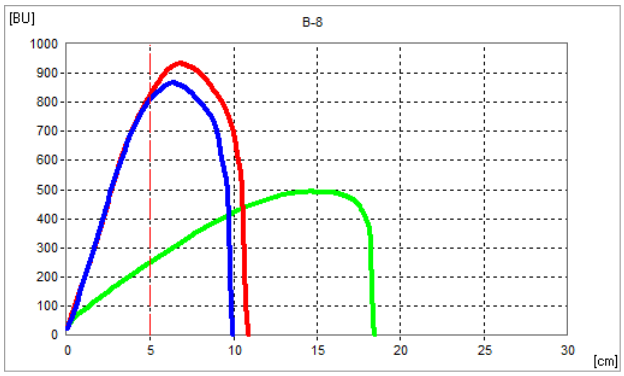


LCS Ascent (Williston, W-3)

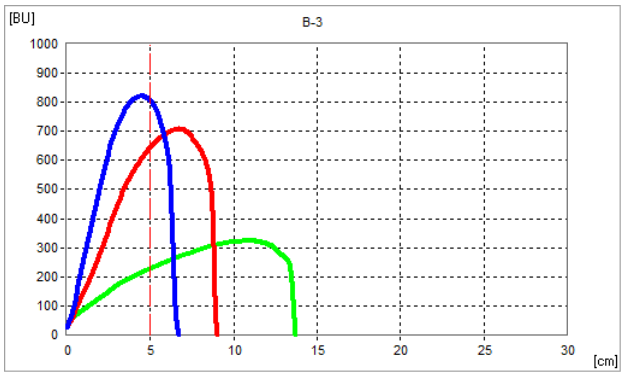


Extensograms

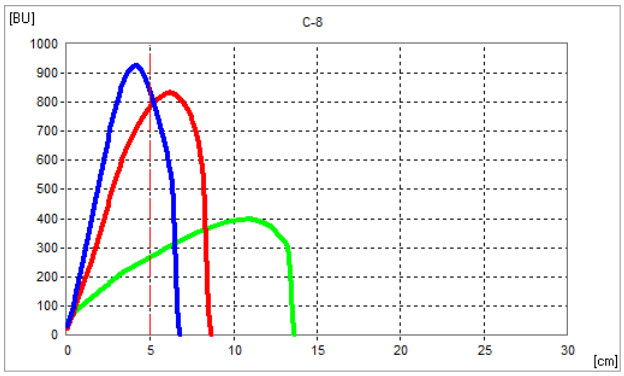
Linkert Check (Watertown, B-8)



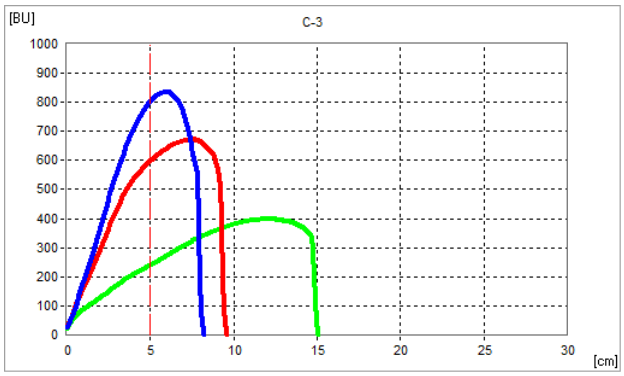
LCS Ascent (Watertown, B-3)



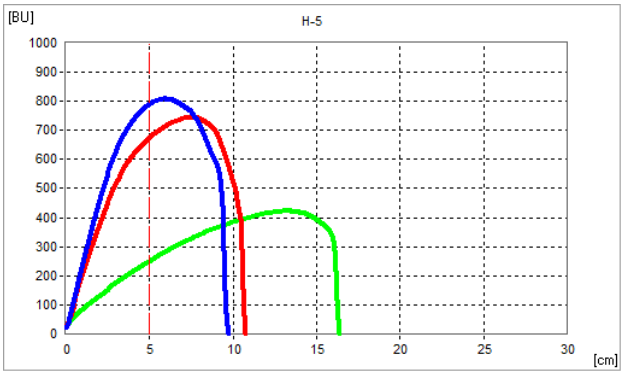
Linkert Check (Casselton, C-8)



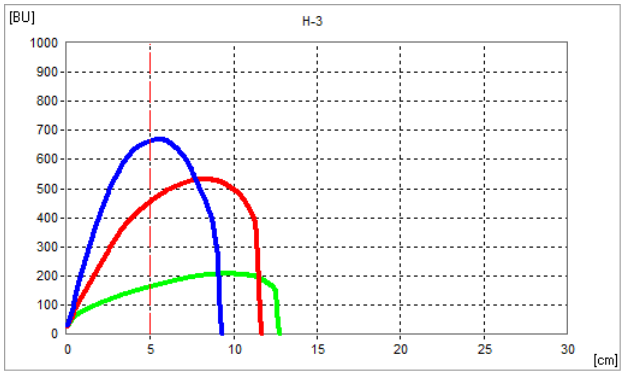
LCS Ascent (Casselton, C-3)



LCS Rebel Check (Havre, H-5)

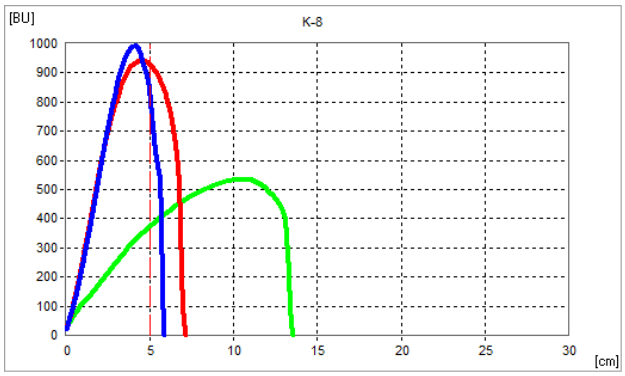


LCS Ascent (Havre, H-3)

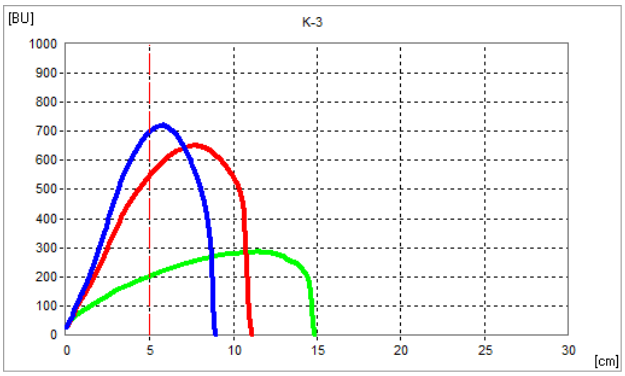


45 min; 90 min; 135 min

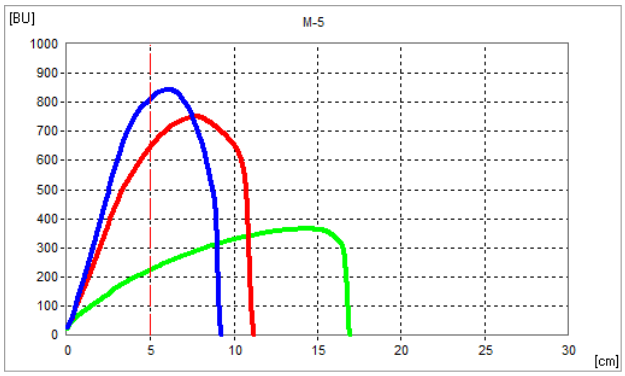
Linkert Check (Crookston, K-8)



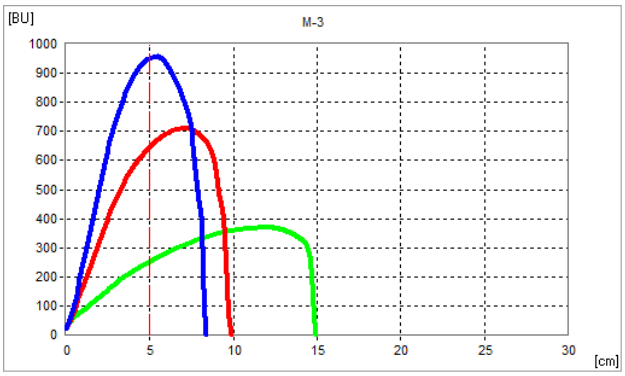
LCS Ascent (Crookston, K-3)



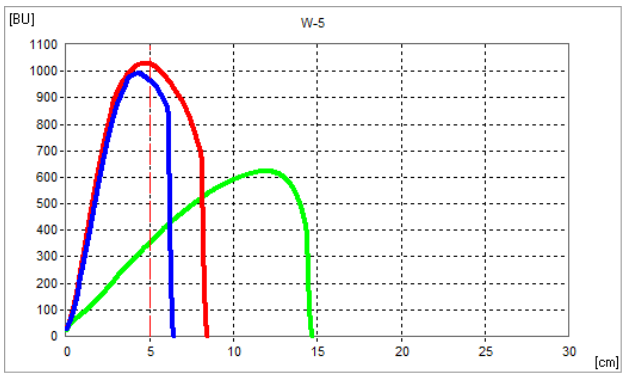
LCS Rebel Check (Minot, M-5)



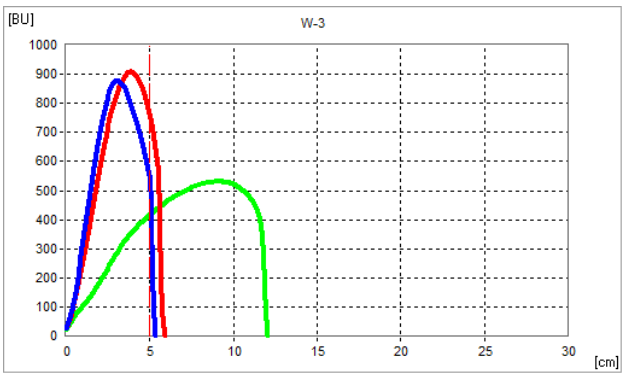
LCS Ascent (Minot, M-3)



LCS Rebel Check (Williston, W-5)



LCS Ascent (Williston, W-3)



45 min; 90 min; 135 min

SWQC #4 – MN-Rothsay

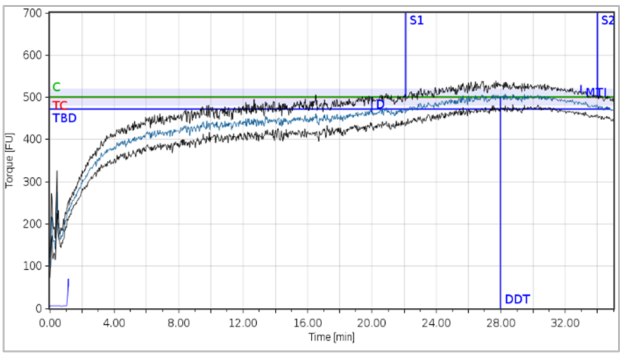
		Watertown		Casselton		Crookston		Minot	
		Linkert		Linkert		Linkert		LCS Rebel	
	Quality Trait	B-8	B-4	C-8	C-4	K-8	K-4	M-5	M-4
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	17.3	16.4	14.5	14.6	15.3	14.4	18.5	18.4
2	Flour Protein (%, 14% mb)	16.2	15.0	13.2	13.5	14.4	13.3	16.9	16.9
3	Market Value (Score 1-6)	5.2	5.4	4.9	4.8	5.3	4.9	4.7	4.8
4	Market Value (Score 1-10)	10.0	9.0	10.0	9.4	10.0	9.0	10.0	9.2
5	DON (ppm)	nd	nd	nd	nd	nd	nd	nd	nd
6	Test Weight (lb/bu)	61.4	62.1	64.3	64.5	63.8	63.8	61.6	61.3
7	1000 Kernel Weight (g)	34.9	35.2	33.2	32.6	34.1	31.4	35.0	30.1
8	Kernel Size, Large (%)	63	59	56	67	44	29	68	33
9	Kernel Size, Small (%)	8	11	9	7	7	18	5	16
10	Wheat Moisture (%)	12.0	12.0	10.9	11.2	11.4	11.9	10.8	10.8
11	Wheat Ash (%, 14% mb)	1.52	1.50	1.45	1.58	1.39	1.24	1.46	1.40
12	Wheat Falling Number (s)	475	446	474	429	465	462	345	400
13	SKCS Hardness Index	76.7	69.8	86.1	78.1	78.3	84.9	67.4	73.4
14	Vitreous Kernels (%)	42	35	87	89	90	85	19	21
	Flour Extraction								
15	Tempered Wheat Basis (%)	70.5	72.2	71.7	72.7	72.6	72.5	72.3	72.0
16	Total Product Basis (%)	72.2	73.9	73.3	74.9	73.7	74.1	73.6	73.6
17	Flour/Bu Wheat (lb)	44.1	45.7	46.8	48.1	47.2	46.9	45.0	44.8
	Flour Quality								
18	Flour Color Brightness (*L**)	90.3	90.4	90.6	90.5	91.1	90.8	90.1	90.4
19	Flour Color Yellowness (*b**)	8.0	8.1	10.0	9.9	8.1	9.0	8.3	8.4
20	Flour Moisture (%)	13.6	13.6	13.7	13.1	13.1	13.1	13.3	13.6
21	Flour Ash (%, 14% mb)	0.52	0.48	0.51	0.51	0.48	0.44	0.46	0.48
22	Flour Falling Number (malted, s)	254	245	247	251	257	251	246	251
	Farinograph								
23	Water Absorption (%, 500 BU)	68.4	65.0	62.7	65.0	64.7	63.1	69.7	68.2
24	Water Absorption (%, 14% mb)	68.4	64.8	62.5	64.0	63.9	62.5	69.3	68.2
25	Arrival Time (min)	22.1	6.3	2.8	3.2	7.6	4.8	8.1	9.6
26	Peak Time (min)	28.0	15.3	7.9	8.3	36.4	16.7	20.3	19.0
27	Dough Stability (min)	11.9	13.6	26.2	12.1	39.7	23.2	18.1	12.8
28	Mixing Tolerance Index (MTI, BU)	19	32	15	27	5	5	22	43
29	Time To Breakdown (TTB, min)	34.8	20.5	30.6	16.3	48.9	29.0	27.0	23.1
	II. Cooperator Results								
30	Bake Absorption (Average %)	70.3	67.4	65.2	66.5	67.0	65.5	71.4	70.5
31	Loaf Volume (% of Check)		97.8		99.0		99.6		99.9

SWQC #4 – MN-Rothsay

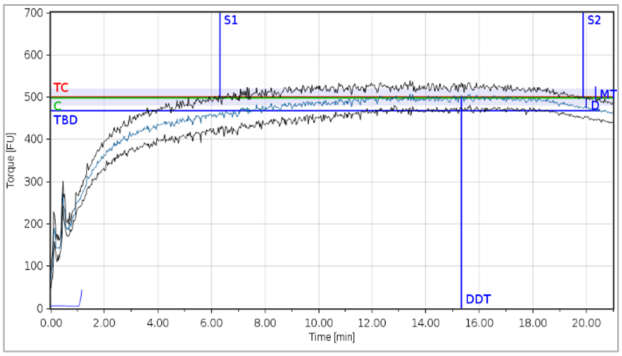
	Quality Trait	Watertown Linkert B-8	Watertown Linkert B-4	Casselton Linkert C-8	Casselton Linkert C-4	Crookston Linkert K-8	Crookston Linkert K-4	Minot LCS Rebel M-5	Minot LCS Rebel M-4
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.8	5.8	7.0	5.9	8.0	6.5	6.4	5.7
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.4	5.9	6.7	6.3	6.8	5.9	6.3	5.5
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		3.9		4.4		3.7		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		4.8		5.4		4.8		5.3
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.8		5.2		5.2		5.3
	III. Cooperator Evaluation								
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.9		5.3		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		5.8		5.8		5.0		4.4
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.3		4.6		4.3		4.8
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.7		5.0		4.3		4.8

Farinograms

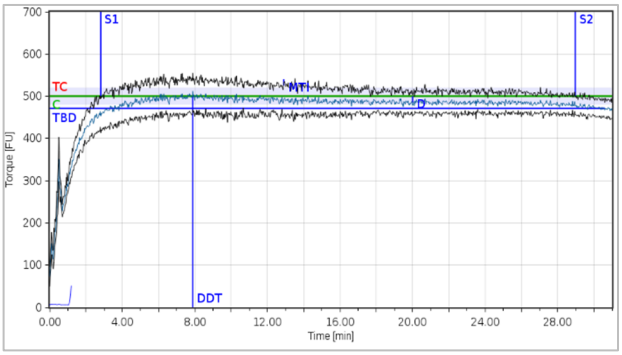
Linkert Check (Watertown, B-8)



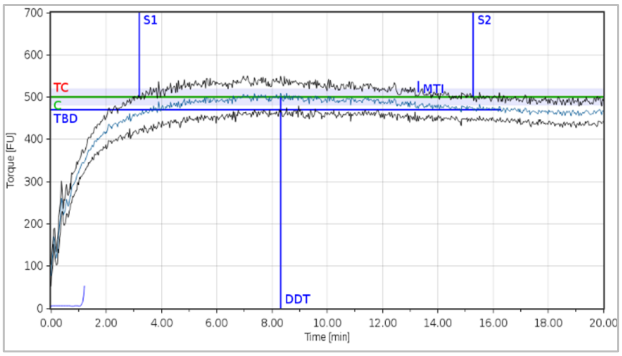
MN-Rothsay (Watertown, B-4)



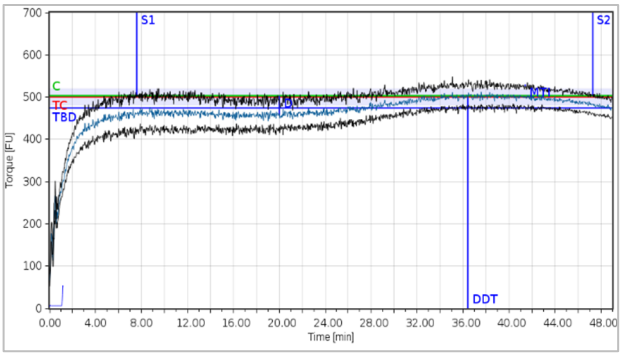
Linkert Check (Casselton, C-8)



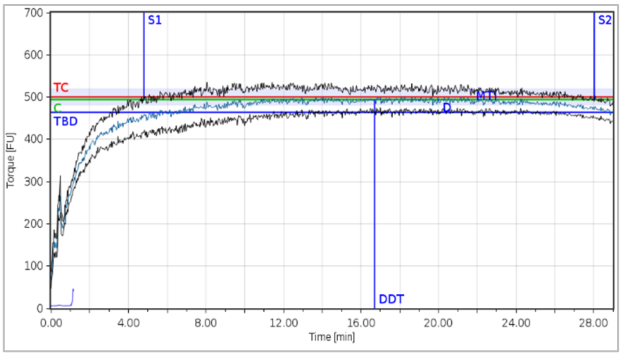
MN-Rothsay (Casselton, C-4)



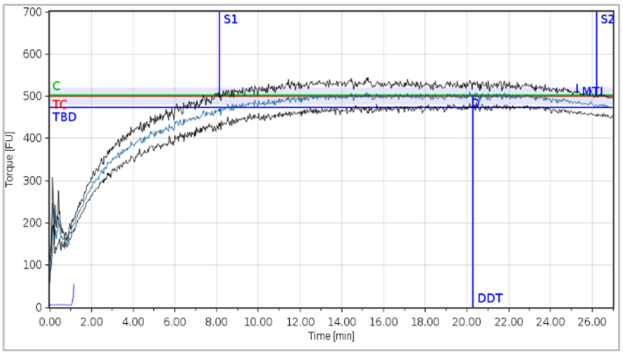
Linkert Check (Crookston, K-8)



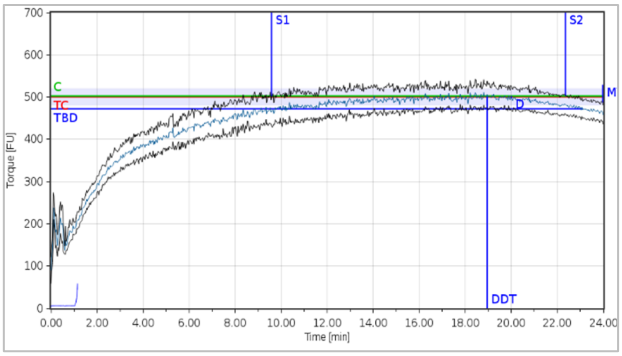
MN-Rothsay (Crookston, K-4)



LCS Rebel Check (Minot, M-5)

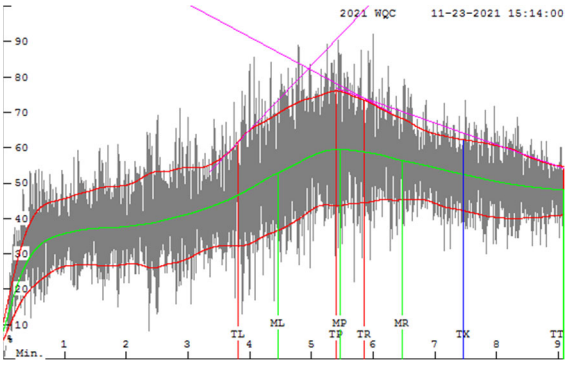


MN-Rothsay (Minot, M-4)

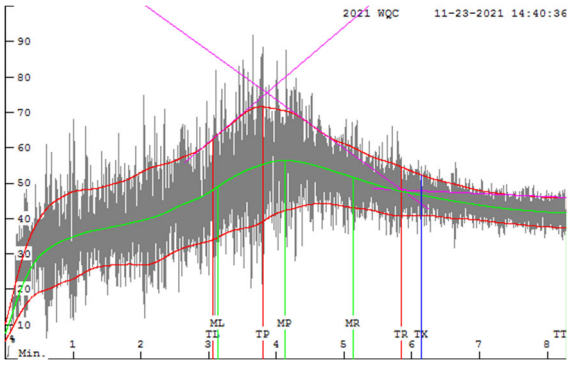


Mixograms

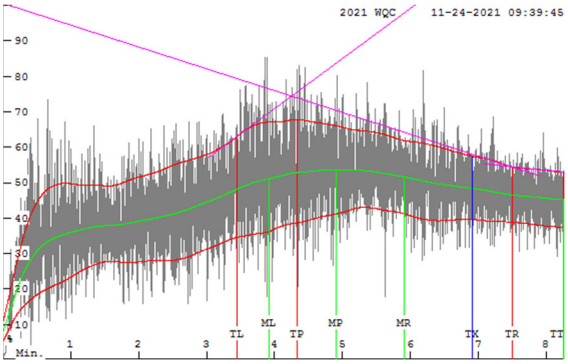
Linkert Check (Watertown, B-8)



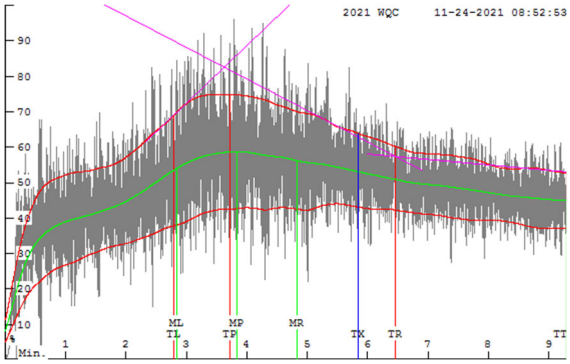
MN-Rothsay (Watertown, B-4)



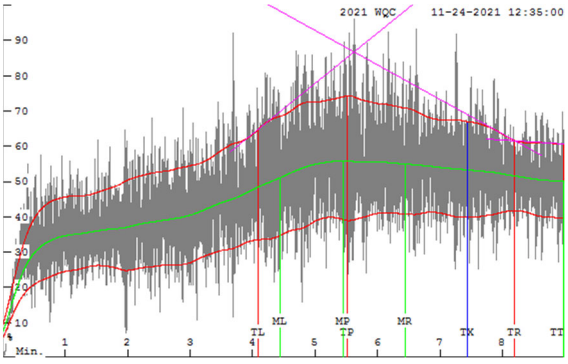
Linkert Check (Casselton, C-8)



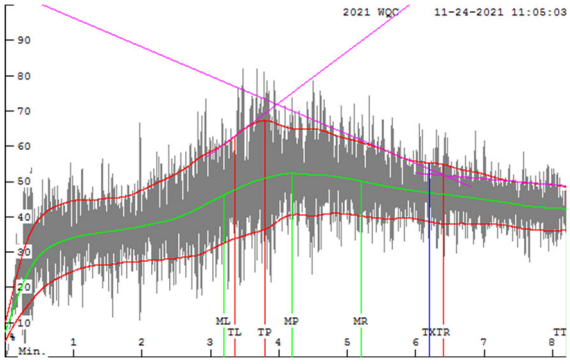
MN-Rothsay (Casselton, C-4)



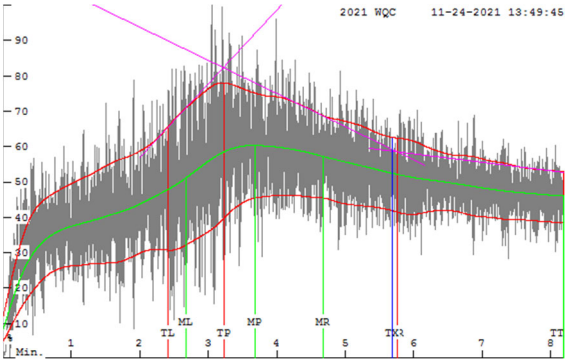
Linkert Check (Crookston, K-8)



MN-Rothsay (Crookston, K-4)



LCS Rebel Check (Minot, M-5)



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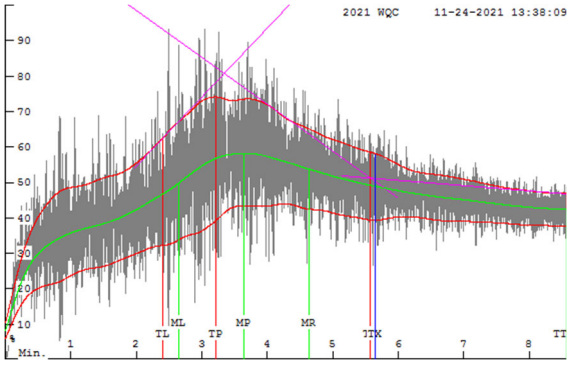
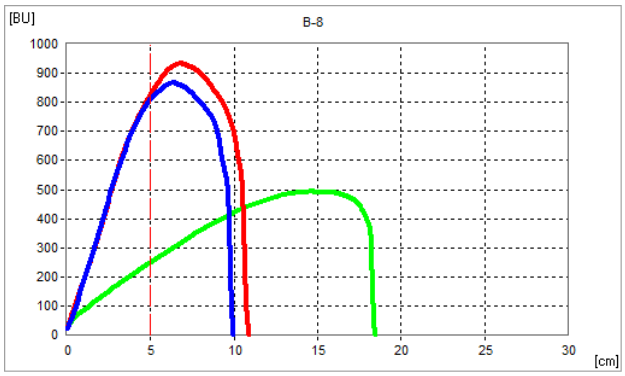


Extensograms

Linkert Check (Watertown, B-8)



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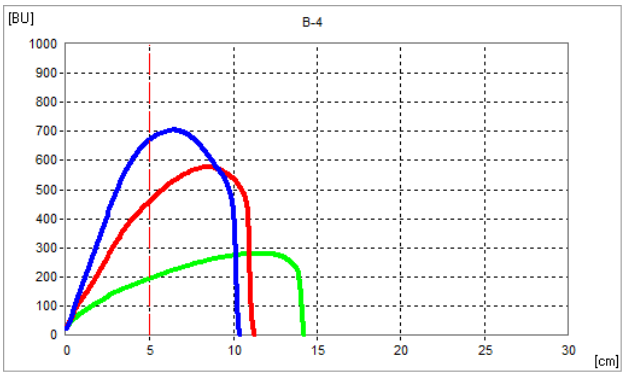
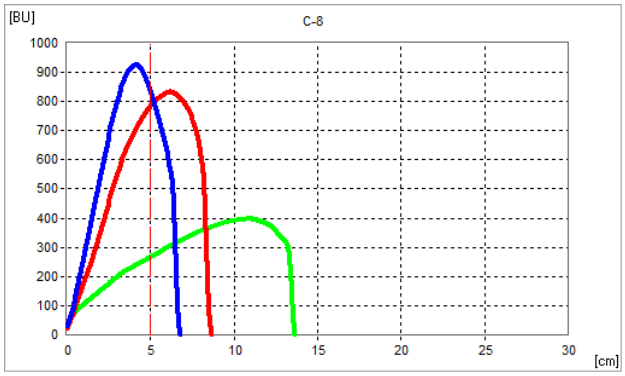


Linkert Check (Casselton, C-8)



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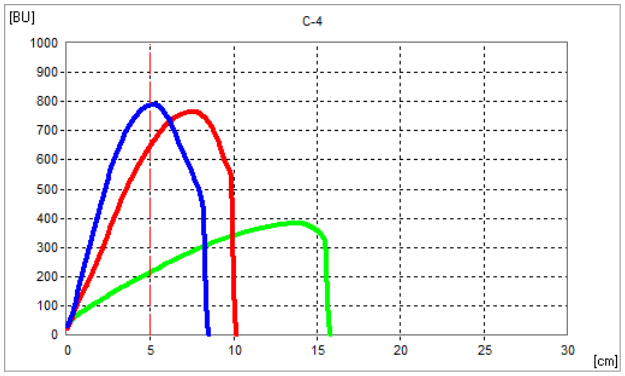
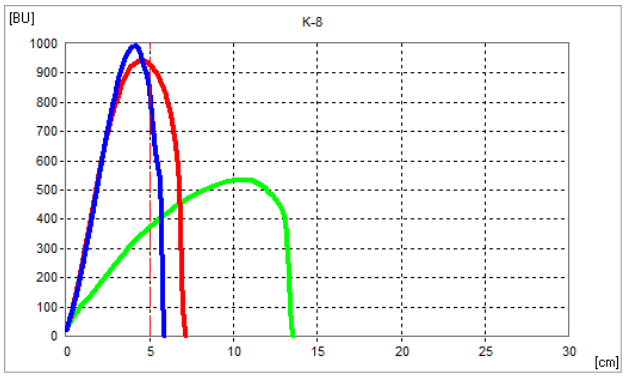


Linkert Check (Crookston, K-8)



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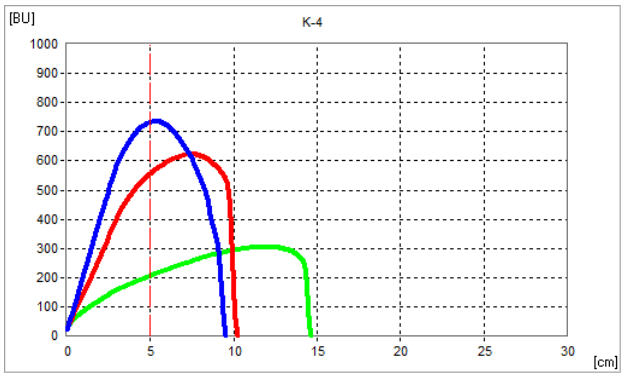
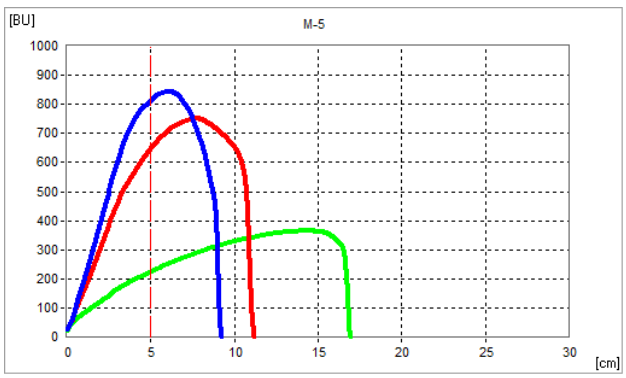
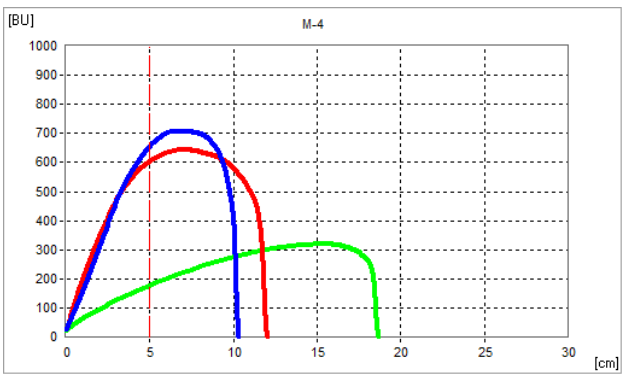


LCS Rebel Check (Minot, M-5)



MN-Rothsay (Minot, M-4)



45 min; 90 min; 135 min

SWQC #6 – G18C2097

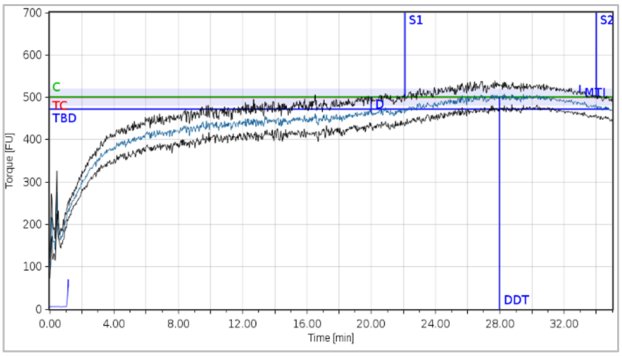
		Watertown		Casselton		Crookston	
		Linkert		Linkert		Linkert	
	Quality Trait	B-8	B-6	C-8	C-6	K-8	K-6
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	17.3	16.2	14.5	15.3	15.3	14.7
2	Flour Protein (%, 14% mb)	16.2	15.0	13.2	14.1	14.4	13.5
3	Market Value (Score 1-6)	5.2	5.3	4.9	5.5	5.3	4.9
4	Market Value (Score 1-10)	10.0	8.8	10.0	9.4	10.0	9.0
5	DON (ppm)	nd	nd	nd	nd	nd	nd
6	Test Weight (lb/bu)	61.4	61.8	64.3	64.8	63.8	62.6
7	1000 Kernel Weight (g)	34.9	35.8	33.2	40.4	34.1	33.3
8	Kernel Size, Large (%)	63	71	56	80	44	37
9	Kernel Size, Small (%)	8	7	9	4	7	10
10	Wheat Moisture (%)	12.0	12.0	10.9	10.9	11.4	11.7
11	Wheat Ash (%, 14% mb)	1.52	1.52	1.45	1.57	1.39	1.41
12	Wheat Falling Number (s)	475	480	474	457	465	502
13	SKCS Hardness Index	76.7	77.7	86.1	71.5	78.3	92.0
14	Vitreous Kernels (%)	42	41	87	92	90	88
	Flour Extraction						
15	Tempered Wheat Basis (%)	70.5	70.2	71.7	70.5	72.6	71.4
16	Total Product Basis (%)	72.2	72.3	73.3	72.8	73.7	72.9
17	Flour/Bu Wheat (lb)	44.1	44.2	46.8	46.9	47.2	45.7
	Flour Quality						
18	Flour Color Brightness (*L**)	90.3	90.2	90.6	90.8	91.1	90.8
19	Flour Color Yellowness (*b**)	8.0	8.8	10.0	8.5	8.1	9.4
20	Flour Moisture (%)	13.6	13.4	13.7	13.2	13.1	13.7
21	Flour Ash (%, 14% mb)	0.52	0.52	0.51	0.48	0.48	0.50
22	Flour Falling Number (malted, s)	254	254	247	253	257	249
	Farinograph						
23	Water Absorption (%, 500 BU)	68.4	67.0	62.7	64.3	64.7	63.4
24	Water Absorption (%, 14% mb)	68.4	66.8	62.5	63.7	63.9	63.0
25	Arrival Time (min)	22.1	15.7	2.8	3.5	7.6	3.6
26	Peak Time (min)	28.0	26.1	7.9	9.5	36.4	36.3
27	Dough Stability (min)	11.9	14.2	26.2	26.6	39.7	39.8
28	Mixing Tolerance Index (MTI, BU)	19	35	15	12	5	13
29	Time To Breakdown (TTB, min)	34.8	30.7	30.6	31.1	48.9	45.2
	II. Cooperator Results						
30	Bake Absorption (Average %)	70.3	68.9	65.2	66.4	67.0	66.2
31	Loaf Volume (% of Check)		99.2		100.4		99.7

SWQC #6 – G18C2097

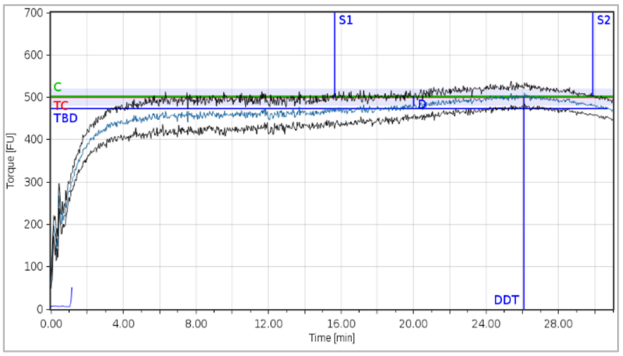
	Quality Trait	Watertown Linkert B-8	Watertown Linkert B-6	Casselton Linkert C-8	Casselton Linkert C-6	Crookston Linkert K-8	Crookston Linkert K-6
	II. Cooperator Results						
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	**6.8**	**7.1**	**7.0**	**6.8**	**8.0**	**7.9**
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	**6.4**	**6.7**	**6.7**	**6.8**	**6.8**	**7.3**
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		**5.2**		**4.9**		**5.1**
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**		**6.0**		**4.2**
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		**4.3**		**4.7**		**4.4**
	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		**3.9**		**6.3**		**3.8**
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.9**		**5.2**		**4.4**
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.3**		**5.0**		**4.6**
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.3**		**5.3**		**4.2**

Farinograms

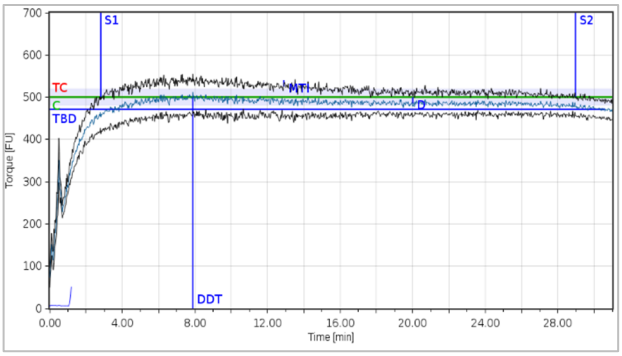
Linkert Check (Watertown, B-8)



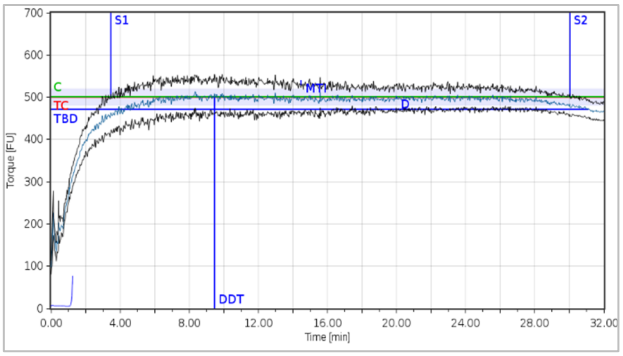
G18C2097 (Watertown, B-6)



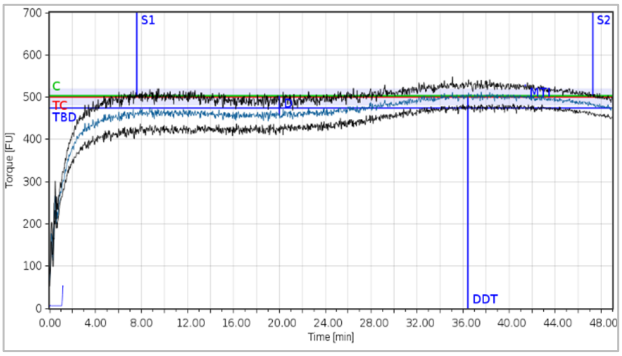
Linkert Check (Casselton, C-8)



G18C2097 (Casselton, C-6)



Linkert Check (Crookston, K-8)



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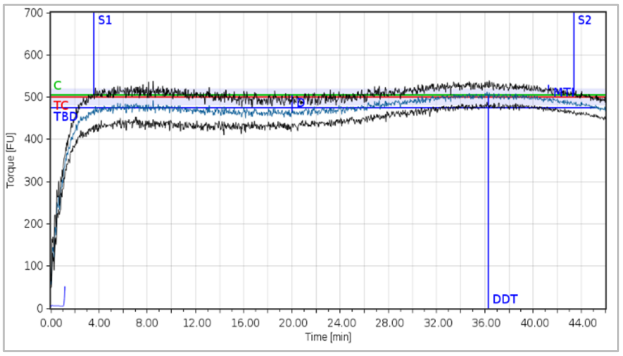
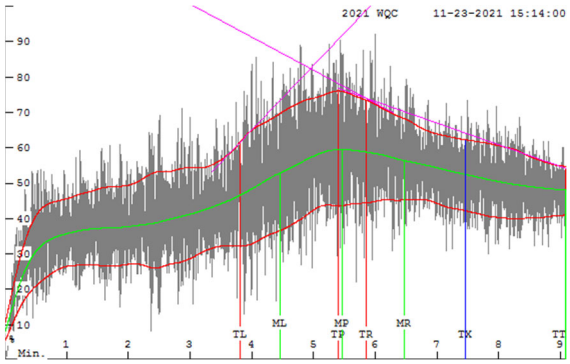
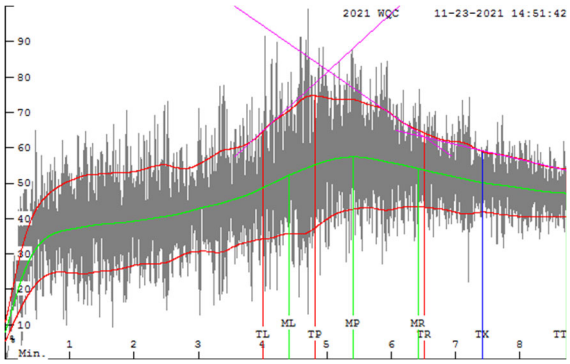


Mixograms

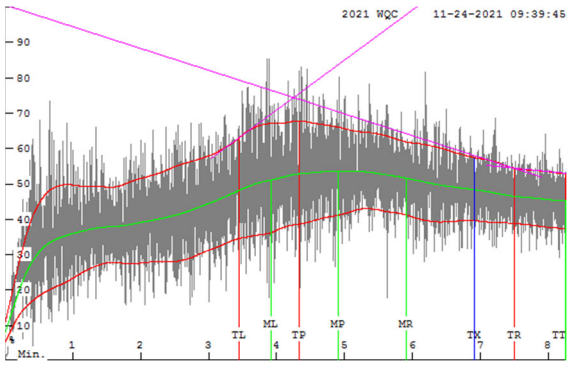
Linkert Check (Watertown, B-8)



G18C2097 (Watertown, B-6)



Linkert Check (Casselton, C-8)



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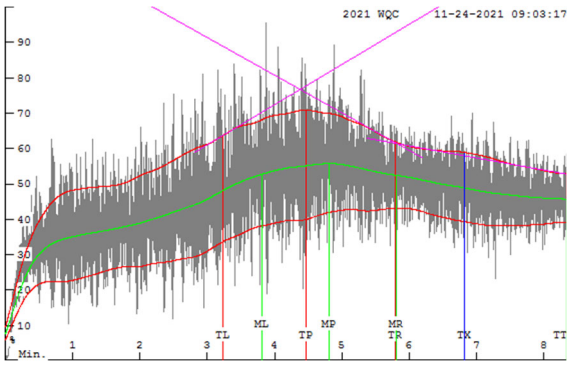

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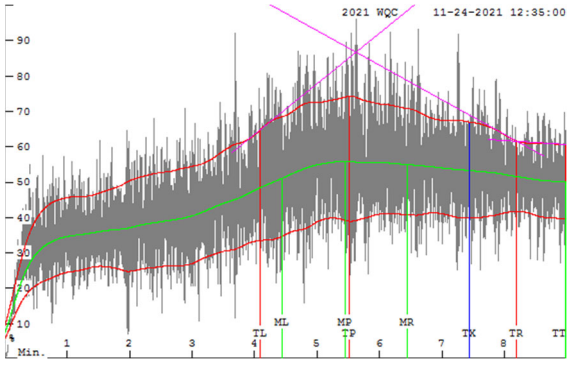

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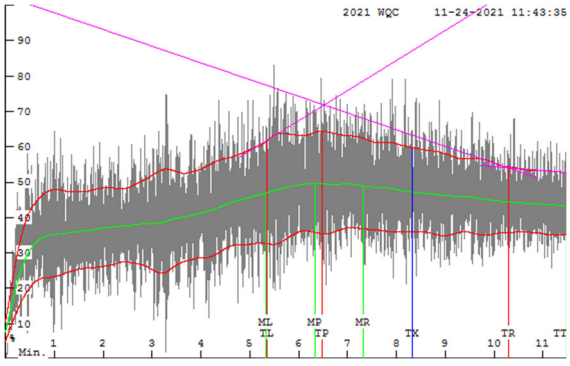
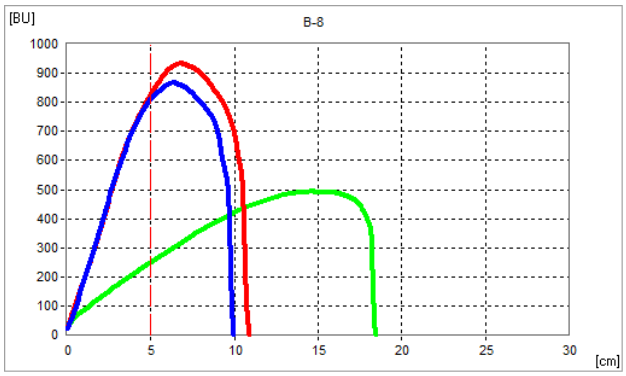
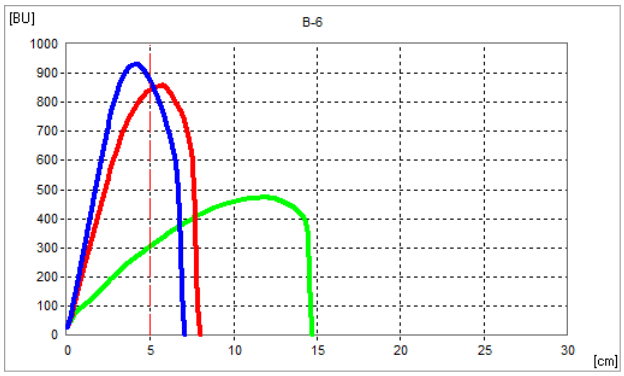


Extensograms

Linkert Check (Watertown, B-8)



G18C2097 (Watertown, B-6)



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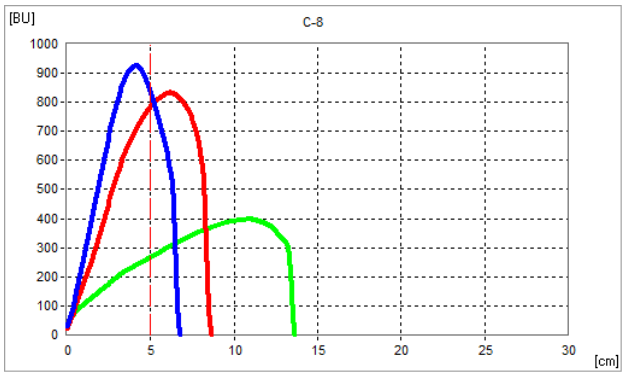

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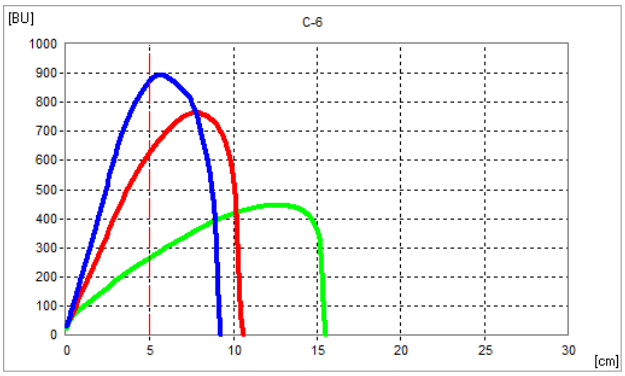
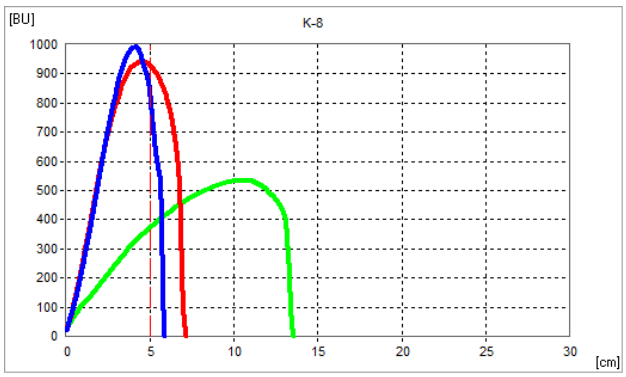
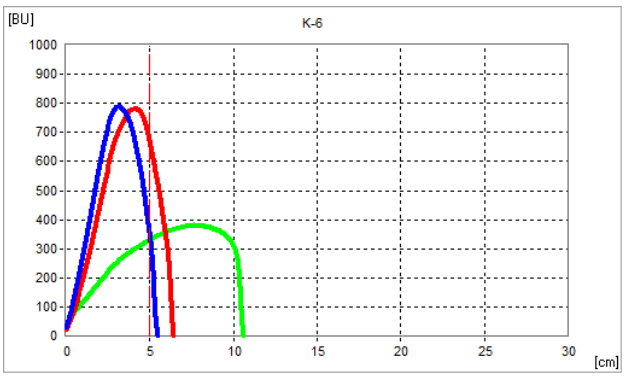


Linkert Check (Crookston, K-8)



G18C2097 (Crookston, K-6)



45 min; 90 min; 135 min

SWQC #7 – Ascend-SD

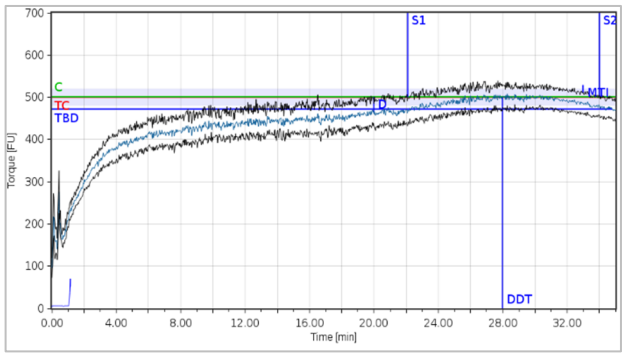
		Watertown		Casselton		Crookston		Minot	
		Linkert		Linkert		Linkert		LCS Rebel	
	Quality Trait	B-8	B-7	C-8	C-7	K-8	K-7	M-5	M-7
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	17.3	15.9	14.5	13.9	15.3	15.0	18.5	18.0
2	Flour Protein (%, 14% mb)	16.2	14.8	13.2	12.8	14.4	13.8	16.9	16.6
3	Market Value (Score 1-6)	5.2	4.7	4.9	4.5	5.3	4.3	4.7	4.2
4	Market Value (Score 1-10)	10.0	7.6	10.0	8.6	10.0	7.2	10.0	8.8
5	DON (ppm)	nd	nd	nd	nd	nd	nd	nd	nd
6	Test Weight (lb/bu)	61.4	61.3	64.3	64.5	63.8	61.5	61.6	60.7
7	1000 Kernel Weight (g)	34.9	28.5	33.2	29.9	34.1	23.0	35.0	28.7
8	Kernel Size, Large (%)	63	35	56	29	44	2	68	31
9	Kernel Size, Small (%)	8	16	9	16	7	42	5	15
10	Wheat Moisture (%)	12.0	12.1	10.9	11.0	11.4	11.5	10.8	11.3
11	Wheat Ash (%, 14% mb)	1.52	1.40	1.45	1.42	1.39	1.33	1.46	1.45
12	Wheat Falling Number (s)	475	463	474	424	465	454	345	357
13	SKCS Hardness Index	76.7	92.3	86.1	91.4	78.3	93.2	67.4	82.5
14	Vitreous Kernels (%)	42	56	87	88	90	91	19	23
	Flour Extraction								
15	Tempered Wheat Basis (%)	70.5	67.6	71.7	70.2	72.6	67.7	72.3	67.6
16	Total Product Basis (%)	72.2	68.9	73.3	72.3	73.7	69.3	73.6	68.4
17	Flour/Bu Wheat (lb)	44.1	41.9	46.8	46.2	47.2	42.5	45.0	41.8
	Flour Quality								
18	Flour Color Brightness (*L**)	90.3	89.9	90.6	90.5	91.1	90.3	90.1	89.7
19	Flour Color Yellowness (*b**)	8.0	9.0	10.0	10.1	8.1	10.0	8.3	9.3
20	Flour Moisture (%)	13.6	13.0	13.7	12.8	13.1	13.3	13.3	13.0
21	Flour Ash (%, 14% mb)	0.52	0.54	0.51	0.52	0.48	0.53	0.46	0.55
22	Flour Falling Number (malted, s)	254	253	247	252	257	256	246	248
	Farinograph								
23	Water Absorption (%, 500 BU)	68.4	67.1	62.7	64.4	64.7	63.4	69.7	70.2
24	Water Absorption (%, 14% mb)	68.4	66.3	62.5	63.2	63.9	62.8	69.3	69.2
25	Arrival Time (min)	22.1	3.7	2.8	2.3	7.6	2.4	8.1	5.2
26	Peak Time (min)	28.0	34.6	7.9	7.2	36.4	7.7	20.3	12.9
27	Dough Stability (min)	11.9	35.4	26.2	11.1	39.7	15.9	18.1	21.2
28	Mixing Tolerance Index (MTI, BU)	19	26	15	33	5	17	22	8
29	Time To Breakdown (TTB, min)	34.8	40.7	30.6	14.0	48.9	18.2	27.0	27.8
	II. Cooperator Results								
30	Bake Absorption (Average %)	70.3	69.1	65.2	65.6	67.0	66.3	71.4	71.5
31	Loaf Volume (% of Check)		97.5		99.7		102.7		100.9

SWQC #7 – Ascend-SD

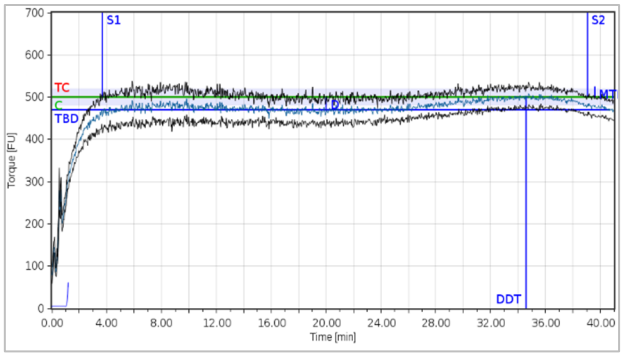
	Quality Trait	Watertown Linkert B-8	Watertown Linkert B-7	Casselton Linkert C-8	Casselton Linkert C-7	Crookston Linkert K-8	Crookston Linkert K-7	Minot LCS Rebel M-5	Minot LCS Rebel M-7
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.8	7.6	7.0	5.1	8.0	7.7	6.4	6.6
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.4	7.2	6.7	5.7	6.8	7.0	6.3	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		6.8		3.6		4.3		5.7
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.8		5.4		4.5		4.5
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		4.6		4.8		4.8		4.8
	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		3.6		4.2		4.5		4.8
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.2		3.9		2.6		2.7
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.7		4.3		4.8		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		4.3		4.2		3.8		3.8

Farinograms

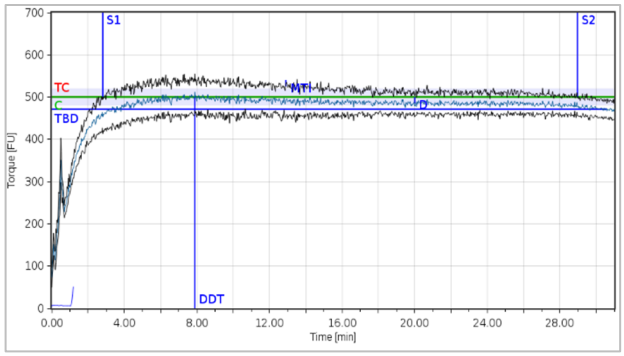
Linkert Check (Watertown, B-8)



Ascend-SD (Watertown, B-7)



Linkert Check (Casselton, C-8)



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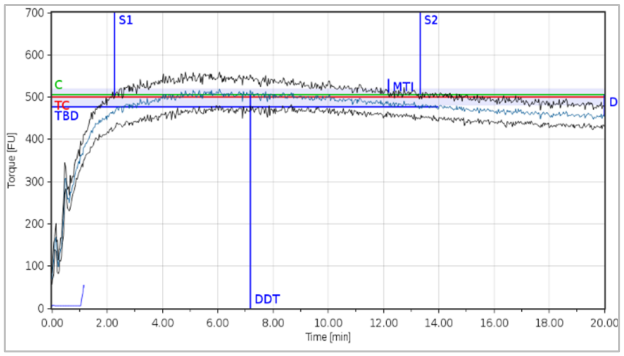
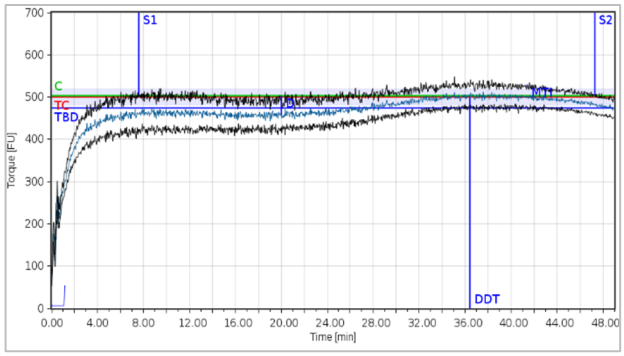


Linkert Check (Crookston, K-8)



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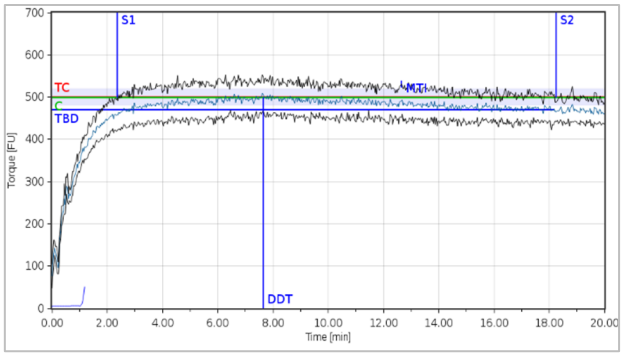
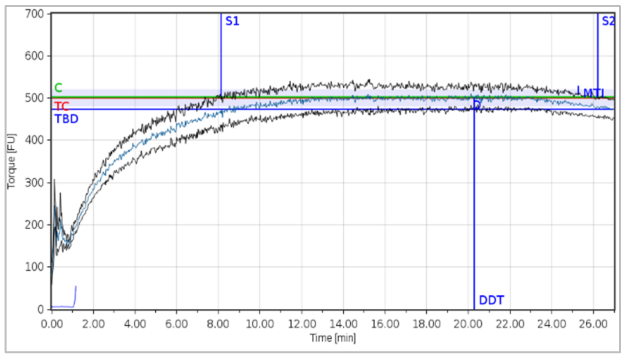


LCS Rebel Check (Minot, M-5)



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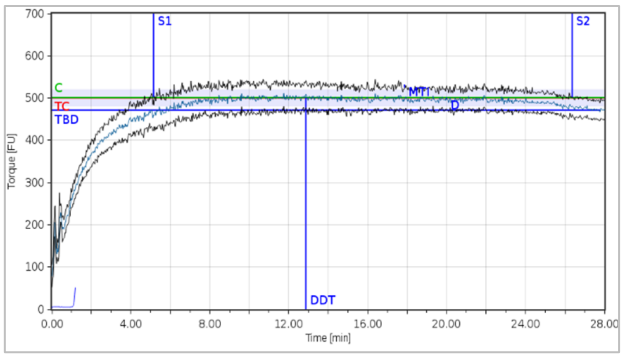
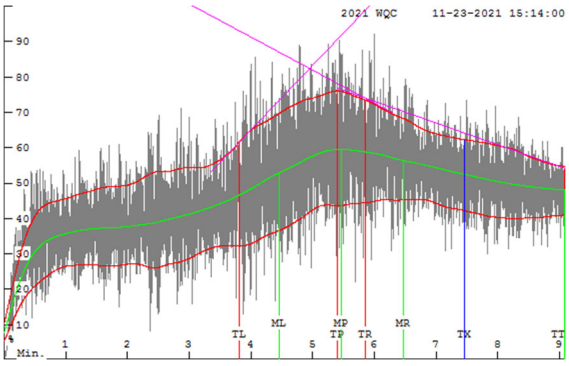


Mixograms

Linkert Check (Watertown, B-8)



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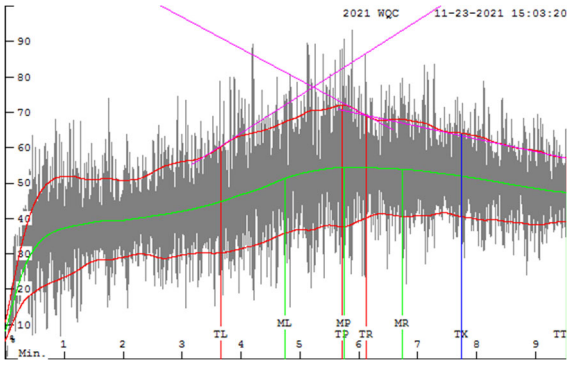
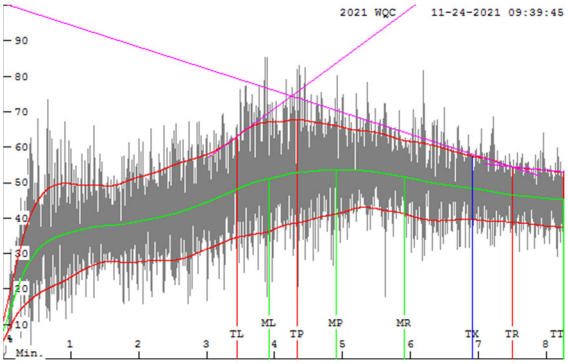


Linkert Check (Casselton, C-8)



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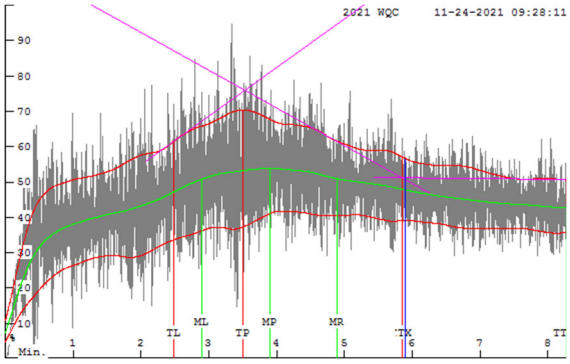
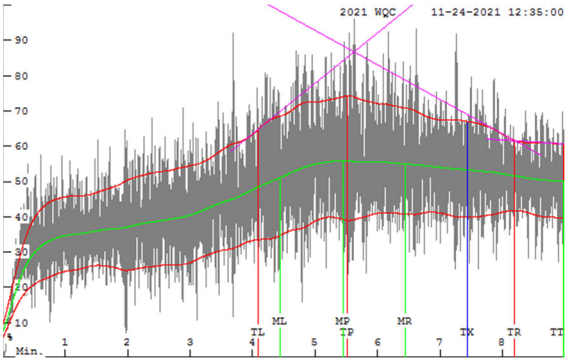


Linkert Check (Crookston, K-8)



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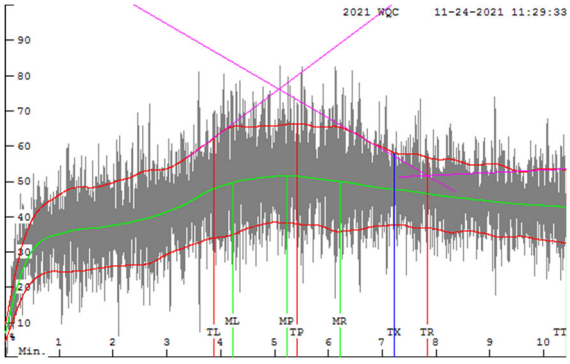
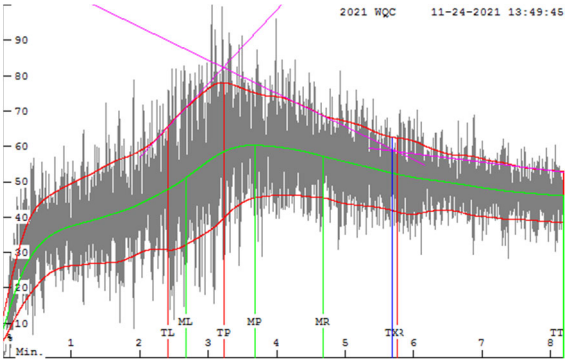
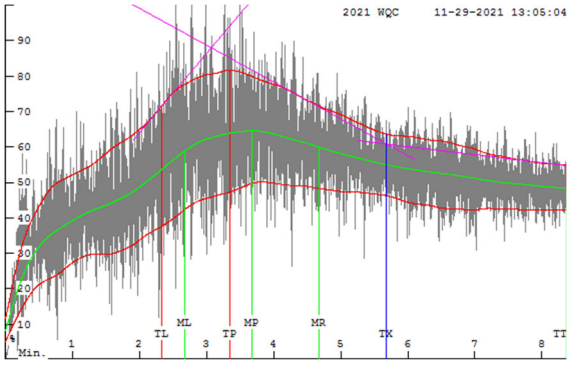


LCS Rebel Check (Minot, M-5)

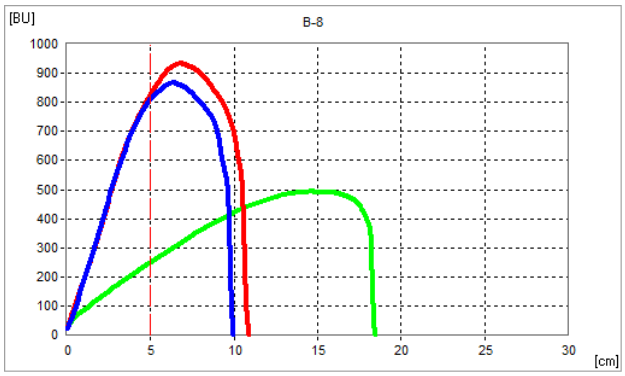


Ascend-SD (Minot, M-7)



Extensograms

Linkert Check (Watertown, B-8)



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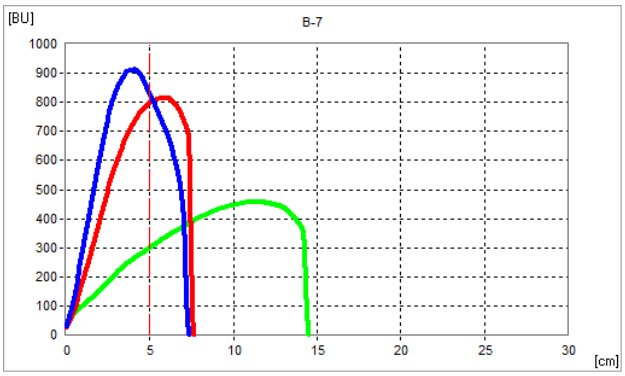
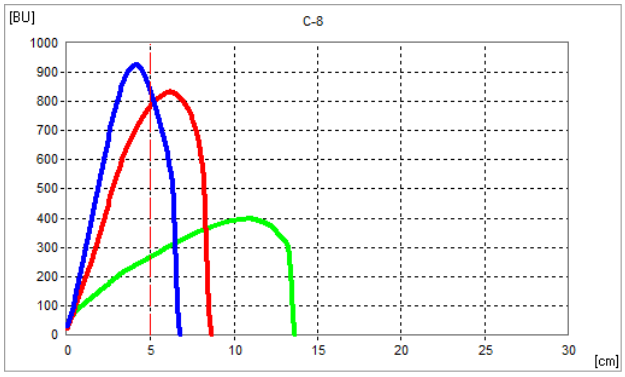


Linkert Check (Casselton, C-8)



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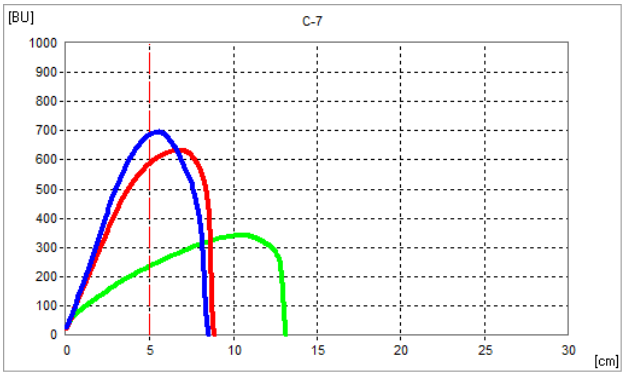

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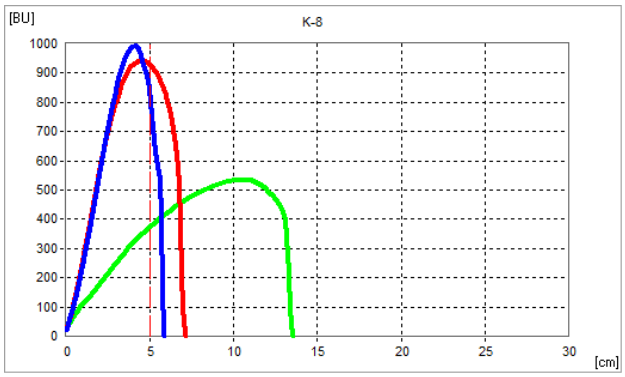

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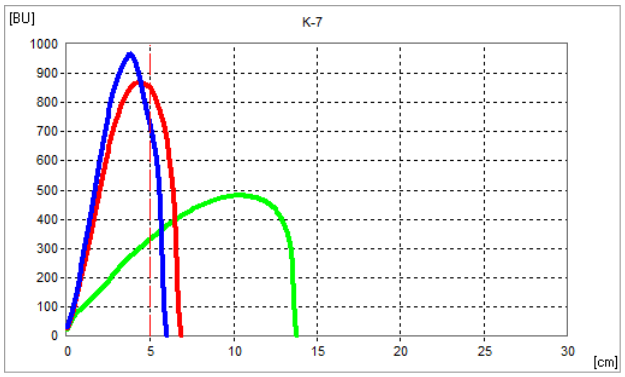
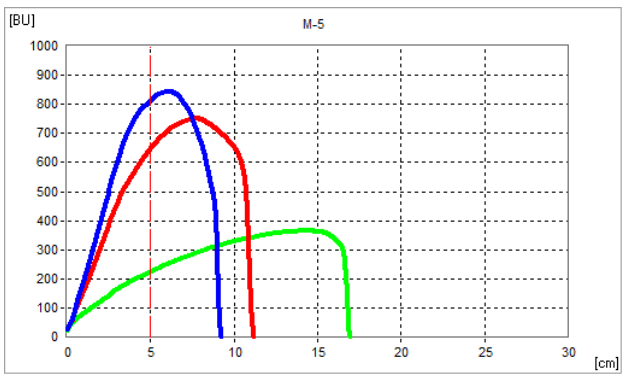
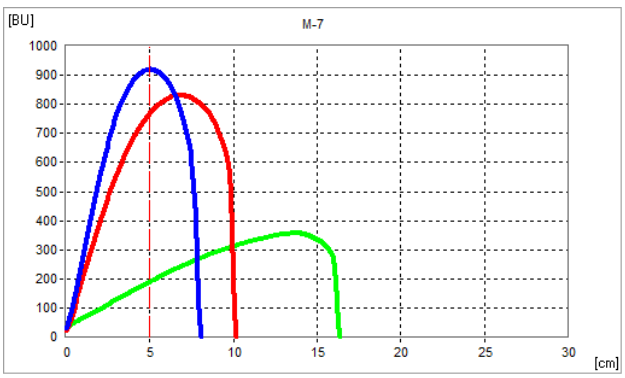


LCS Rebel Check (Minot, M-5)



Ascend-SD (Minot, M-7)



45 min; 90 min; 135 min

SWQC #9 – AP Smith

		Casselton		Crookston		Minot		Williston	
		Linkert		Linkert		LCS Rebel		LCS Rebel	
	Quality Trait	C-8	C-9	K-8	K-9	M-5	M-9	W-5	W-9
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	14.5	14.1	15.3	14.6	18.5	17.9	17.4	16.0
2	Flour Protein (%, 14% mb)	13.2	12.7	14.4	13.6	16.9	16.8	16.5	15.4
3	Market Value (Score 1-6)	4.9	4.9	5.3	4.6	4.7	4.8	3.6	3.0
4	Market Value (Score 1-10)	10.0	9.6	10.0	7.8	10.0	9.4	10.0	7.8
5	DON (ppm)	nd	nd	nd	nd	nd	nd	nd	nd
6	Test Weight (lb/bu)	64.3	65.0	63.8	62.5	61.6	61.4	60.7	60.0
7	1000 Kernel Weight (g)	33.2	32.6	34.1	28.4	35.0	33.1	29.2	23.7
8	Kernel Size, Large (%)	56	49	44	22	68	66	34	13
9	Kernel Size, Small (%)	9	12	7	18	5	6	15	32
10	Wheat Moisture (%)	10.9	11.0	11.4	11.4	10.8	10.9	10.8	10.8
11	Wheat Ash (%, 14% mb)	1.45	1.29	1.39	1.43	1.46	1.56	1.41	1.57
12	Wheat Falling Number (s)	474	431	465	439	345	386	202	285
13	SKCS Hardness Index	86.1	78.0	78.3	86.2	67.4	68.1	67.6	78.9
14	Vitreous Kernels (%)	87	85	90	91	19	17	27	40
	Flour Extraction								
15	Tempered Wheat Basis (%)	71.7	74.0	72.6	71.8	72.3	70.2	73.5	71.8
16	Total Product Basis (%)	73.3	76.1	73.7	74.0	73.6	72.6	75.0	73.4
17	Flour/Bu Wheat (lb)	46.8	49.2	47.2	45.8	45.0	44.2	45.1	43.4
	Flour Quality								
18	Flour Color Brightness (*L**)	90.6	90.8	91.1	90.7	90.1	89.9	90.3	89.9
19	Flour Color Yellowness (*b**)	10.0	9.5	8.1	9.8	8.3	9.1	8.3	9.8
20	Flour Moisture (%)	13.7	13.0	13.1	13.2	13.3	12.9	13.3	13.1
21	Flour Ash (%, 14% mb)	0.51	0.42	0.48	0.51	0.46	0.49	0.43	0.50
22	Flour Falling Number (malted, s)	247	250	257	258	246	264	266*	254
	Farinograph								
23	Water Absorption (%, 500 BU)	62.7	62.2	64.7	63.7	69.7	69.0	66.4	64.9
24	Water Absorption (%, 14% mb)	62.5	61.4	63.9	62.9	69.3	67.8	65.8	63.9
25	Arrival Time (min)	2.8	3.1	7.6	4.4	8.1	15.9	12.2	26.7
26	Peak Time (min)	7.9	8.8	36.4	30.4	20.3	25.3	38.0	37.6
27	Dough Stability (min)	26.2	16.3	39.7	33.4	18.1	13.8	33.4	17.3
28	Mixing Tolerance Index (MTI, BU)	15	23	5	10	22	34	11	18
29	Time To Breakdown (TTB, min)	30.6	21.3	48.9	39.4	27.0	30.3	46.7	45.0
	II. Cooperator Results								
30	Bake Absorption (Average %)	65.2	64.2	67.0	66.1	71.4	70.7	69.1	66.9
31	Loaf Volume (% of Check)		100.0		101.2		98.3		95.9

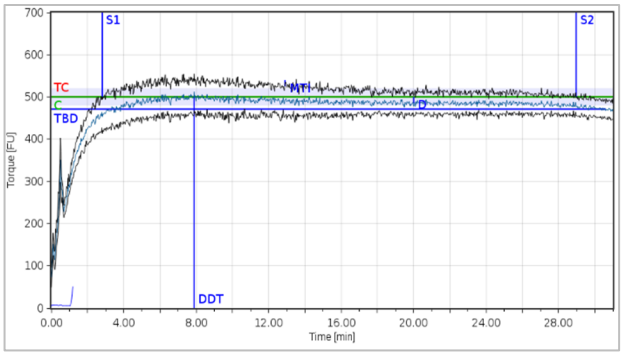
*Not malted.

SWQC #9 – AP Smith

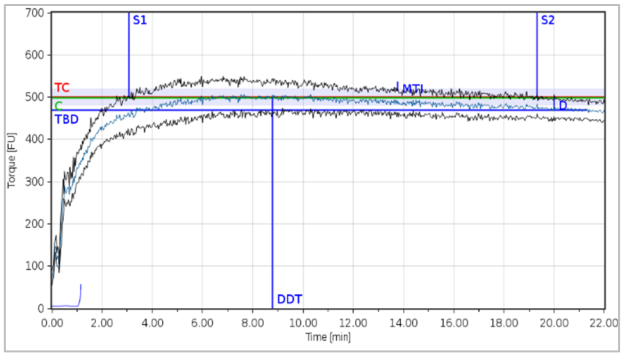
	Quality Trait	Casselton Linkert C-8	Casselton Linkert C-9	Crookston Linkert K-8	Crookston Linkert K-9	Minot LCS Rebel M-5	Minot LCS Rebel M-9	Williston LCS Rebel W-5	Williston LCS Rebel W-9
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	7.0	6.0	8.0	7.8	6.4	7.3	8.5	8.3
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	7.1	6.3	6.6	7.4	7.0
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		4.2		4.7		5.3		5.0
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.5		4.0		4.8		4.3
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.0		4.5		4.9		4.5
	III. Cooperator Evaluation								
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.6		3.9		4.8		3.7
	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		6.7		4.6		4.1		3.2
	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		4.9		4.6		4.0
	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		4.5		4.4		4.4		3.8

Farinograms

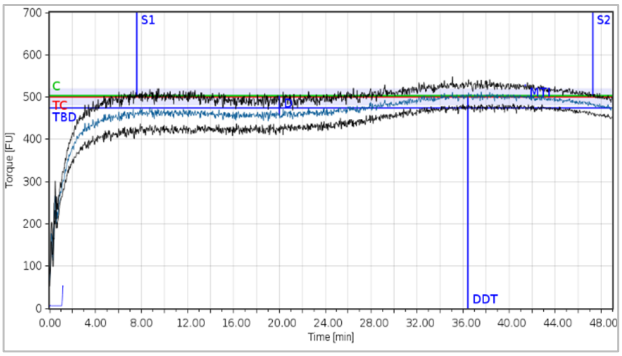
Linkert Check (Casselton, C-8)



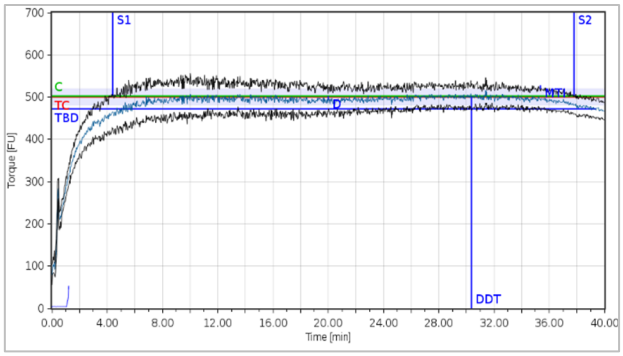
AP Smith (Casselton, C-9)



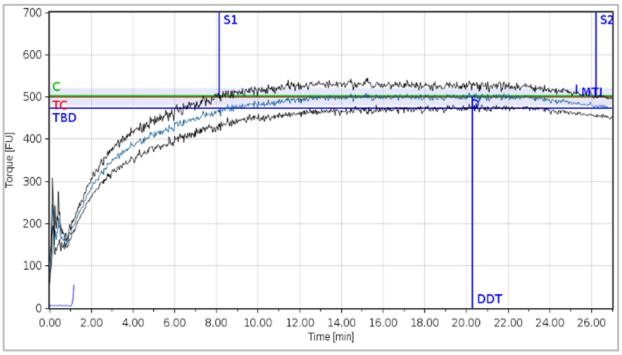
Linkert Check (Crookston, K-8)



AP Smith (Crookston, K-9)



LCS Rebel Check (Minot, M-5)



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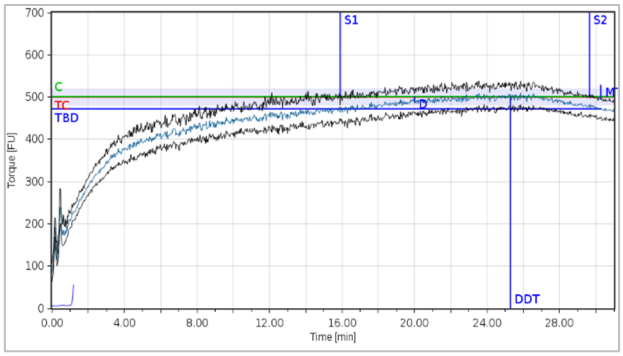
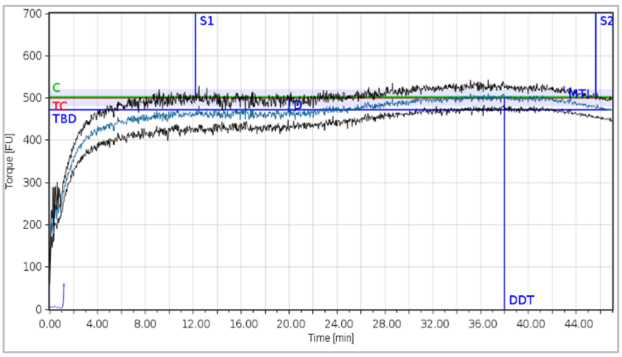
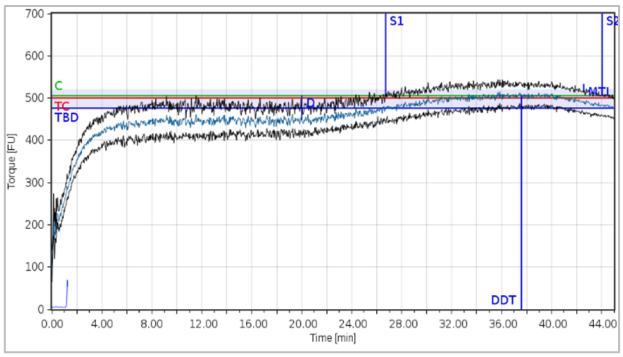


LCS Rebel Check (Williston, W-5)

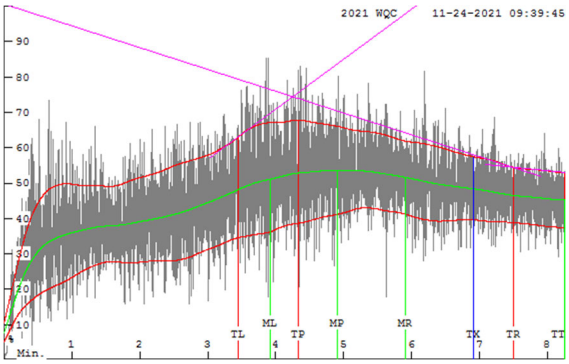


AP Smith (Williston, W-9)

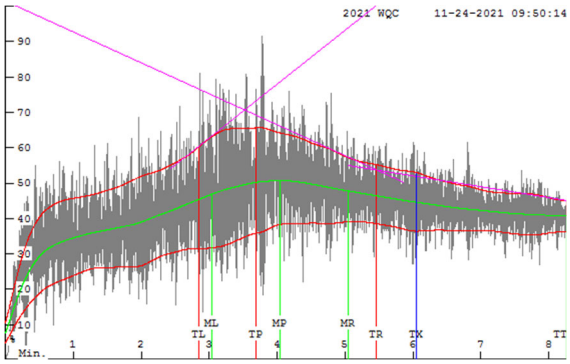


Mixograms

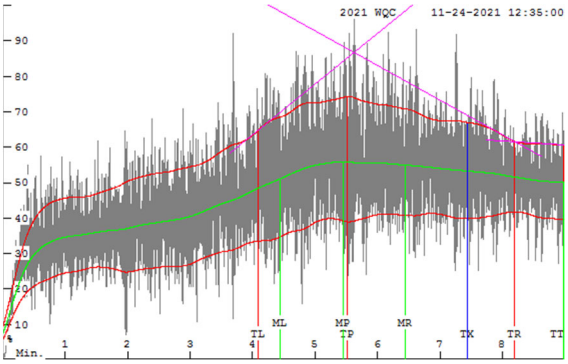
Linkert Check (Casselton, C-8)



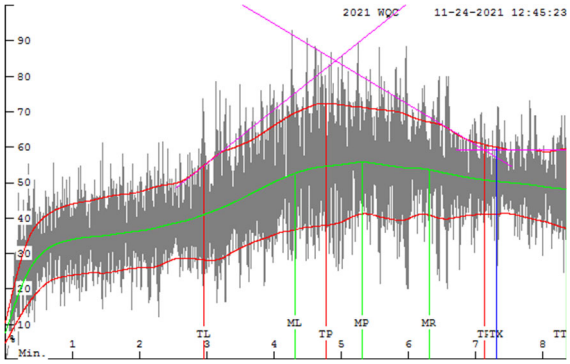
AP Smith (Casselton, C-9)



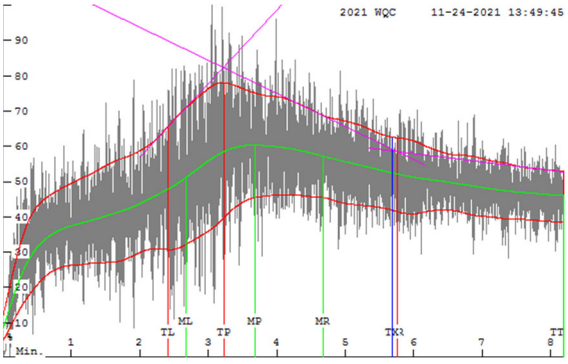
Linkert Check (Crookston, K-8)



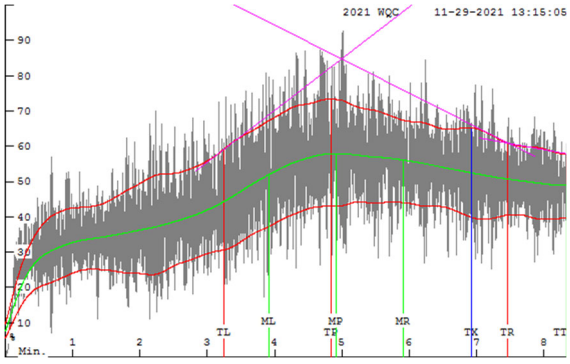
AP Smith (Crookston, K-9)



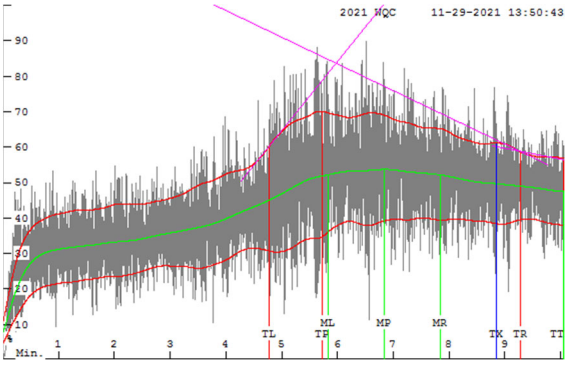
LCS Rebel Check (Minot, M-5)



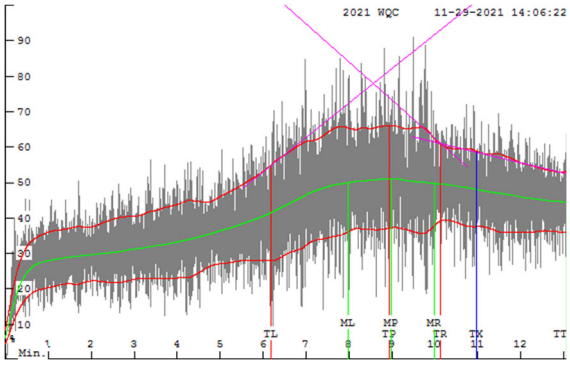
AP Smith (Minot, M-9)



LCS Rebel Check (Williston, W-5)

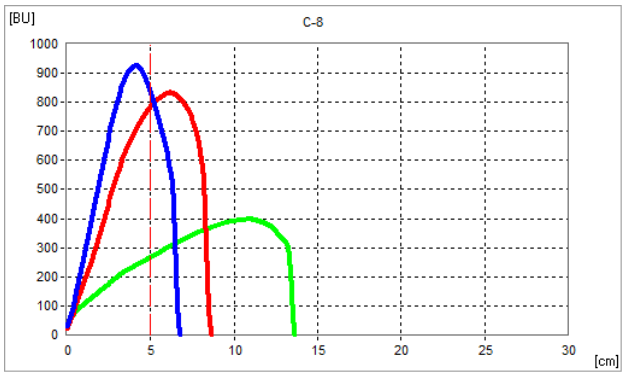


AP Smith (Williston, W-9)



Extensograms

Linkert Check (Casselton, C-8)



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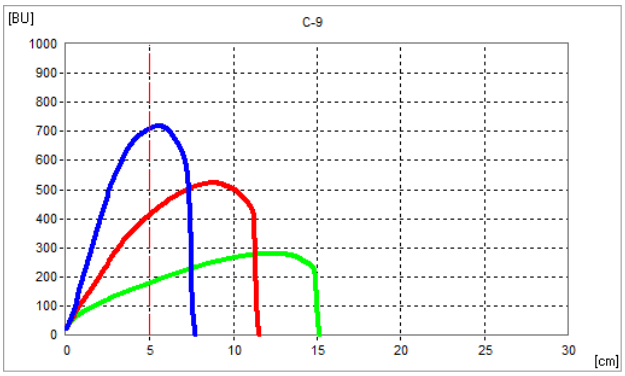

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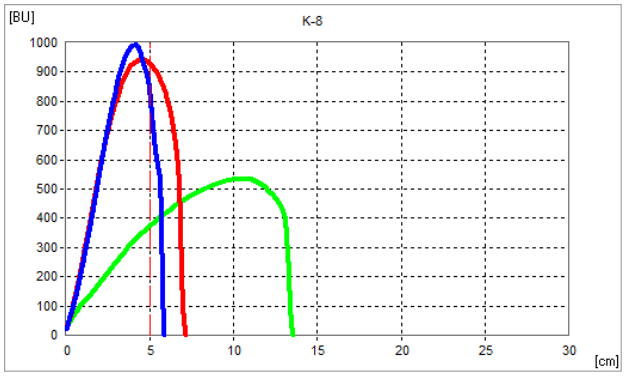

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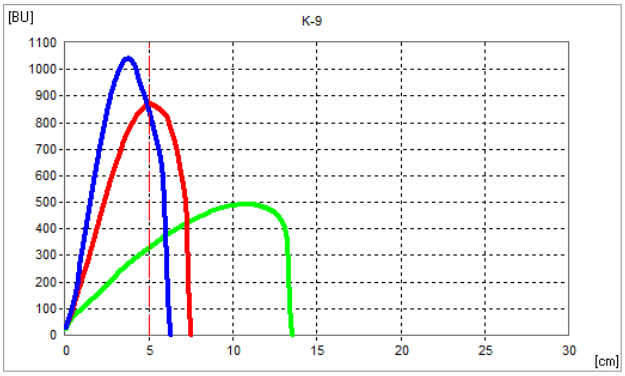
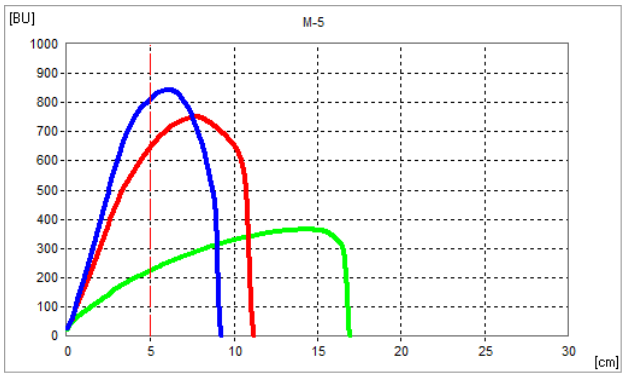


LCS Rebel (Minot, M-5)



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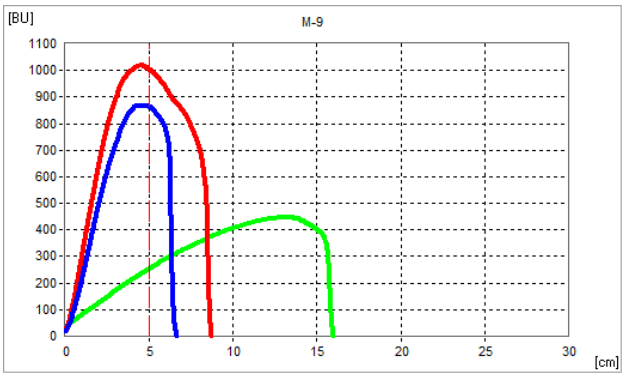
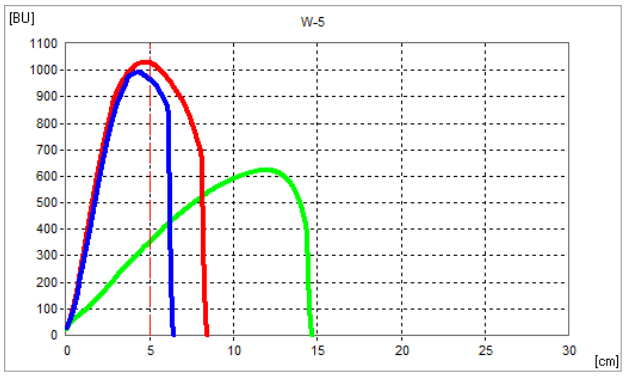


LCS Rebel Check (Williston, W-5)



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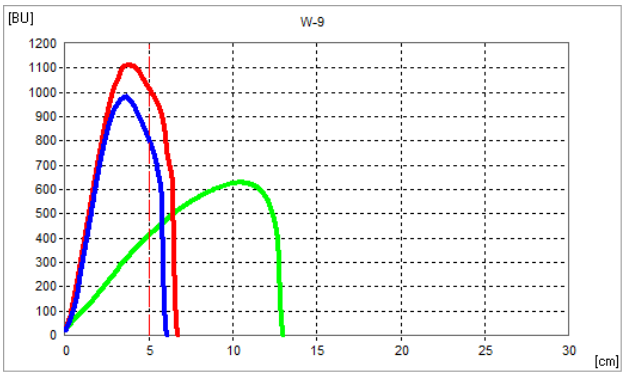


45 min; 90 min; 135 min

SWQC #10 – MN15119-2

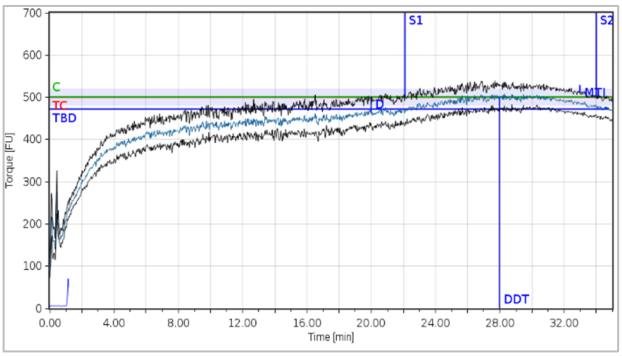
		Watertown		Casselton		Crookston		Minot	
		Linkert		Linkert		Linkert		LCS Rebel	
	Quality Trait	B-8	B-10	C-8	C-10	K-8	K-10	M-5	M-10
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	17.3	16.2	14.5	14.2	15.3	14.3	18.5	17.8
2	Flour Protein (%, 14% mb)	16.2	15.6	13.2	12.7	14.4	13.4	16.9	17.2
3	Market Value (Score 1-6)	5.2	5.0	4.9	4.6	5.3	4.6	4.7	4.3
4	Market Value (Score 1-10)	10.0	7.6	10.0	8.8	10.0	7.6	10.0	8.6
5	DON (ppm)	nd	nd	nd	nd	nd	nd	nd	nd
6	Test Weight (lb/bu)	61.4	61.7	64.3	65.3	63.8	62.8	61.6	59.8
7	1000 Kernel Weight (g)	34.9	31.2	33.2	29.9	34.1	28.9	35.0	33.0
8	Kernel Size, Large (%)	63	57	56	53	44	20	68	53
9	Kernel Size, Small (%)	8	12	9	10	7	21	5	8
10	Wheat Moisture (%)	12.0	12.2	10.9	11.0	11.4	11.8	10.8	10.8
11	Wheat Ash (%, 14% mb)	1.52	1.48	1.45	1.34	1.39	1.31	1.46	1.49
12	Wheat Falling Number (s)	475	424	474	409	465	417	345	357
13	SKCS Hardness Index	76.7	66.7	86.1	83.1	78.3	74.6	67.4	56.5
14	Vitreous Kernels (%)	42	37	87	80	90	93	19	13
	Flour Extraction								
15	Tempered Wheat Basis (%)	70.5	74.5	71.7	71.7	72.6	73.9	72.3	74.3
16	Total Product Basis (%)	72.2	76.1	73.3	73.6	73.7	75.1	73.6	75.9
17	Flour/Bu Wheat (lb)	44.1	46.7	46.8	47.9	47.2	47.4	45.0	46.0
	Flour Quality								
18	Flour Color Brightness (*L**)	90.3	90.1	90.6	90.7	91.1	91.2	90.1	90.3
19	Flour Color Yellowness (*b**)	8.0	8.8	10.0	8.9	8.1	8.9	8.3	8.7
20	Flour Moisture (%)	13.6	13.6	13.7	12.9	13.1	13.7	13.3	13.7
21	Flour Ash (%, 14% mb)	0.52	0.46	0.51	0.43	0.48	0.44	0.46	0.47
22	Flour Falling Number (malted, s)	254	253	247	252	257	249	246	257
	Farinograph								
23	Water Absorption (%, 500 BU)	68.4	63.9	62.7	64.5	64.7	58.8	69.7	65.6
24	Water Absorption (%, 14% mb)	68.4	63.7	62.5	63.5	63.9	58.6	69.3	65.6
25	Arrival Time (min)	22.1	12.9	2.8	2.2	7.6	3.5	8.1	14.3
26	Peak Time (min)	28.0	33.5	7.9	9.6	36.4	45.3	20.3	29.0
27	Dough Stability (min)	11.9	24.5	26.2	18.6	39.7	49.5	18.1	19.8
28	Mixing Tolerance Index (MTI, BU)	19	31	15	14	5	14	22	26
29	Time To Breakdown (TTB, min)	34.8	38.6	30.6	22.7	48.9	54.5	27.0	35.6
	II. Cooperator Results								
30	Bake Absorption (Average %)	70.3	67.0	65.2	66.1	67.0	62.6	71.4	68.8
31	Loaf Volume (% of Check)		101.7		100.5		102.9		100.8

SWQC #10 – MN15119-2

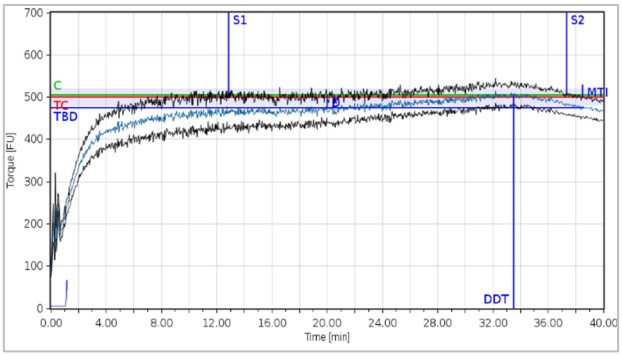
	Quality Trait	Watertown Linkert B-8	Watertown Linkert B-10	Casselton Linkert C-8	Casselton Linkert C-10	Crookston Linkert K-8	Crookston Linkert K-10	Minot LCS Rebel M-5	Minot LCS Rebel M-10
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.8	7.2	7.0	5.6	8.0	8.2	6.4	7.2
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.4	6.8	6.7	5.9	6.8	7.2	6.3	6.2
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		5.8		4.2		5.1		5.1
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		4.1		5.3		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		4.7		4.7		4.6		5.2
	III. Cooperator Evaluation								
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.3		4.6		3.3		5.2
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		6.3		4.9		5.5		5.8
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.2		4.6		4.6		4.9
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.7		4.5		4.3		4.9

Farinograms

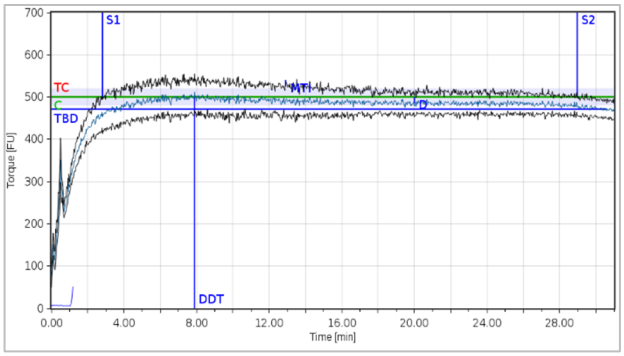
Linkert Check (Watertown, B-8)



MN15119-2 (Watertown, B-10)



Linkert Check (Casselton, C-8)



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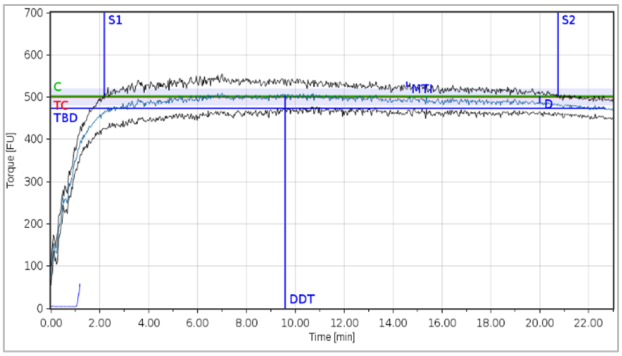
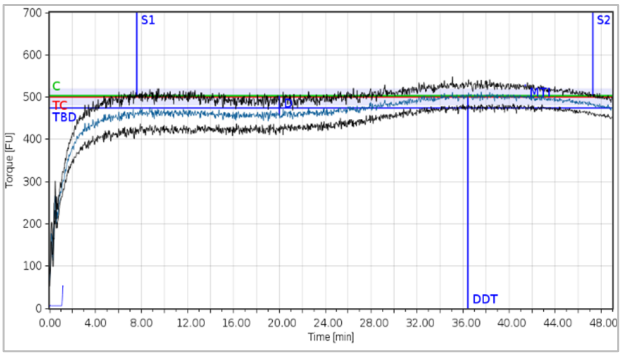


Linkert Check (Crookston, K-8)



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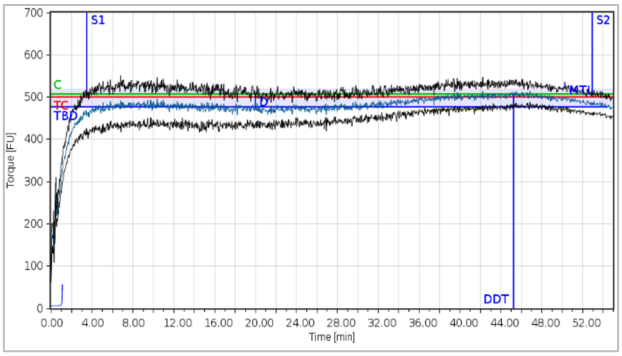
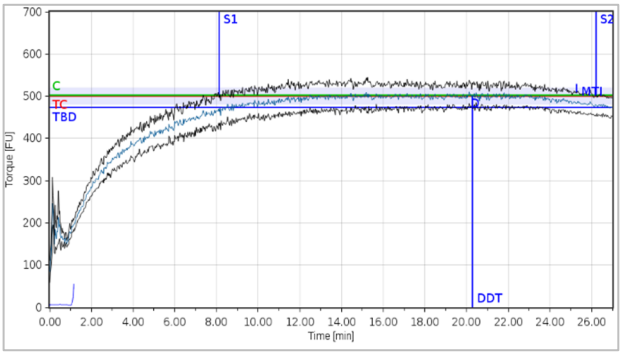


LCS Rebel Check (Minot, M-5)



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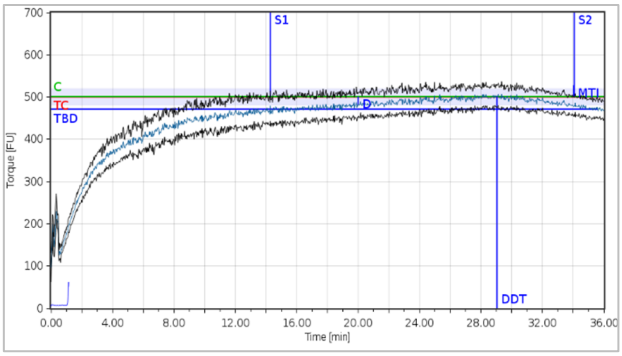
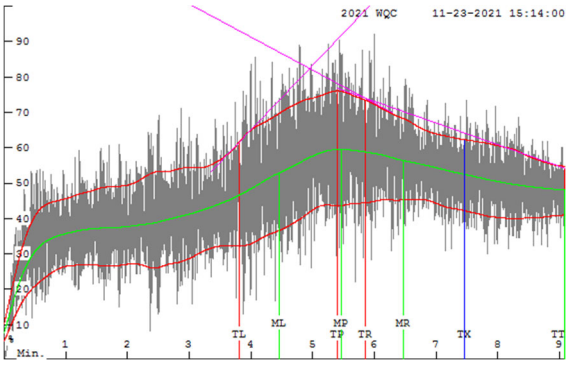


Mixograms

Linkert Check (Watertown, B-8)



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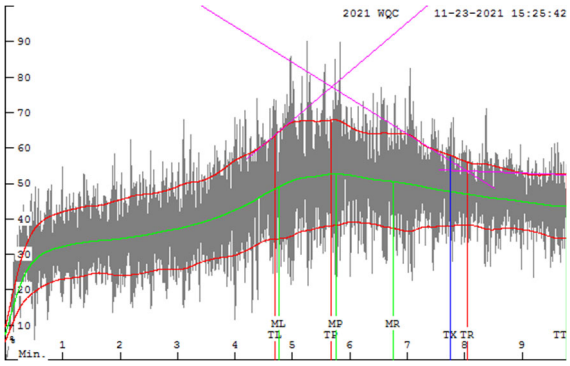

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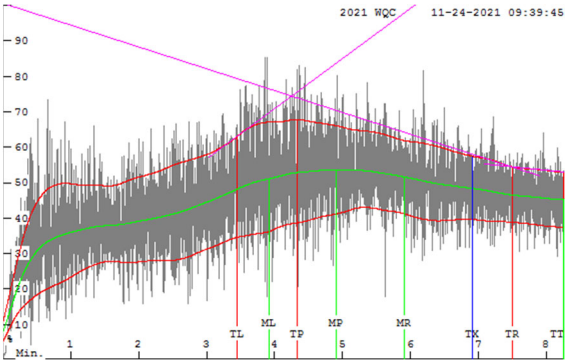

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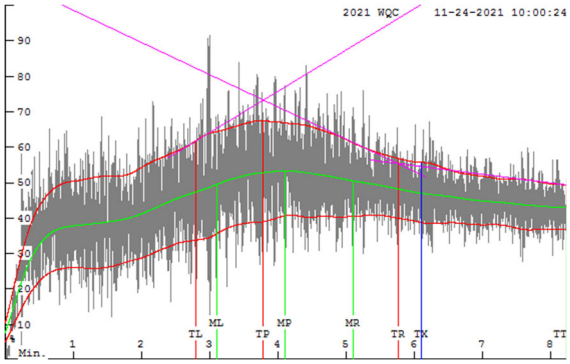

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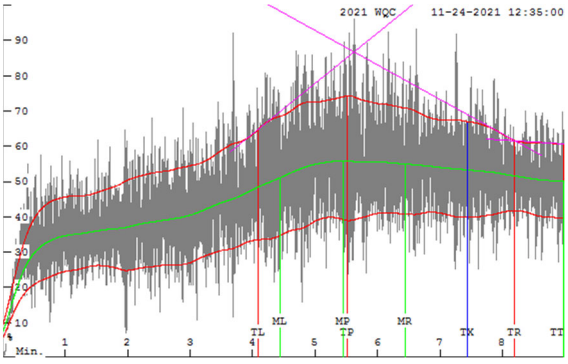

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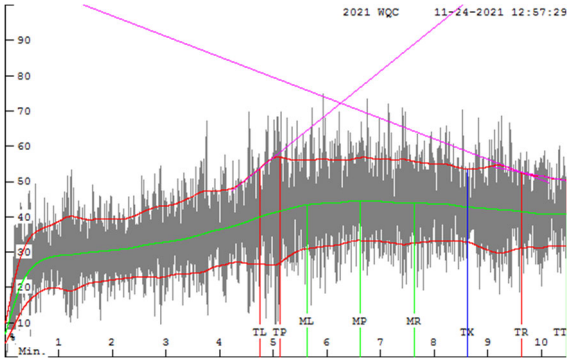
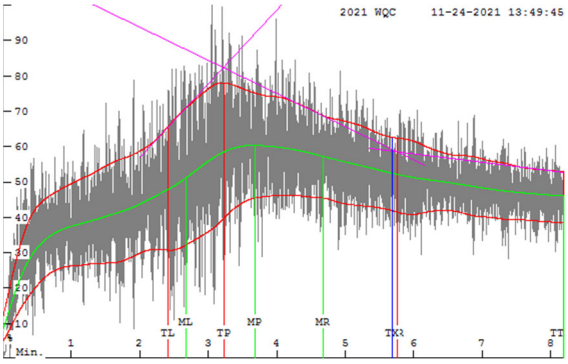


LCS Rebel Check (Minot, M-5)



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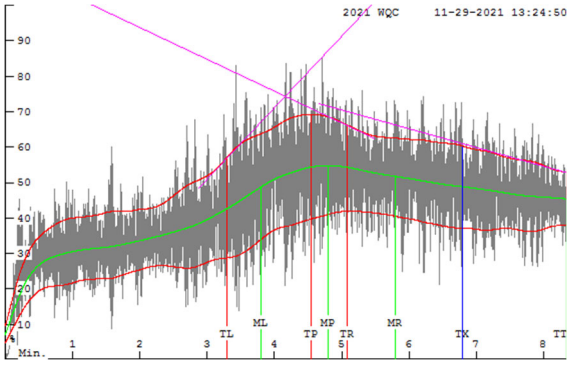
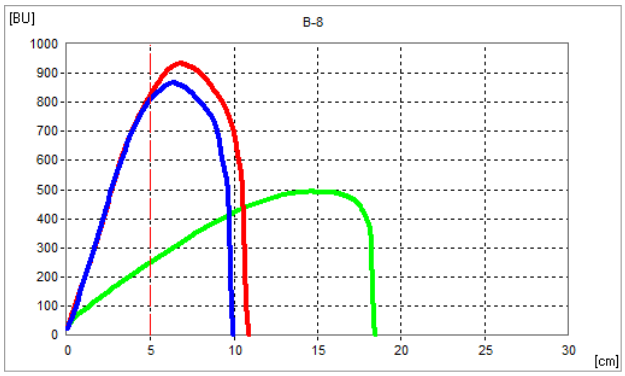


Extensograms

Linkert Check (Watertown, B-8)



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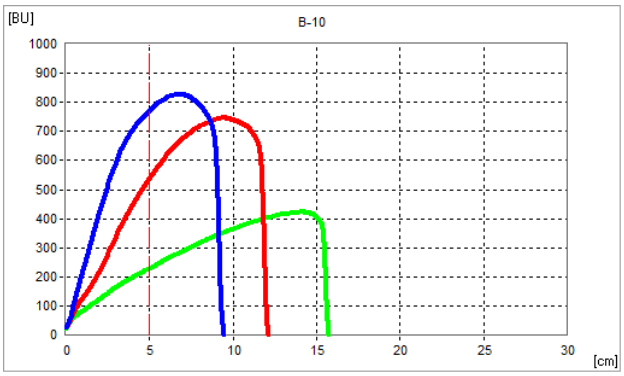
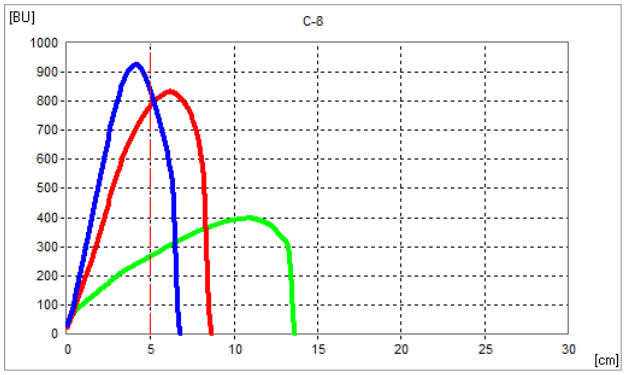


Linkert Check (Casselton, C-8)



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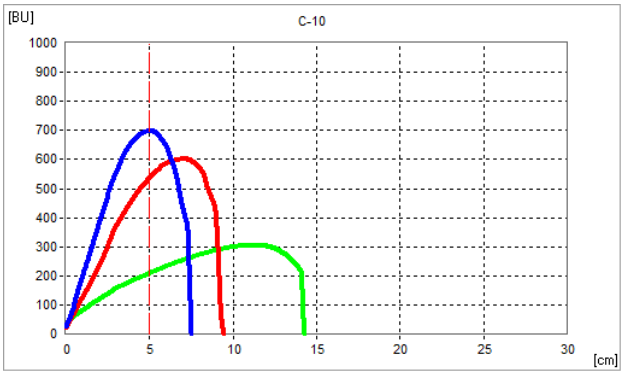
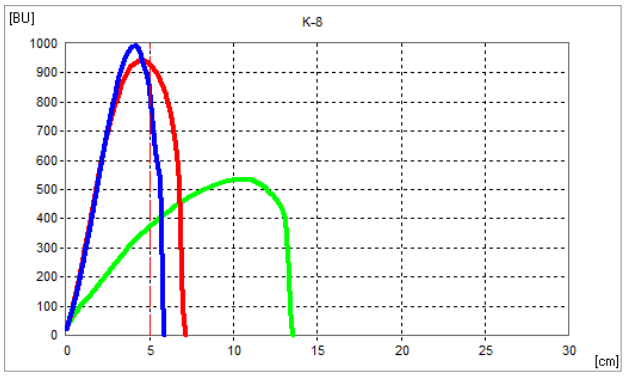


Linkert Check (Crookston, K-8)



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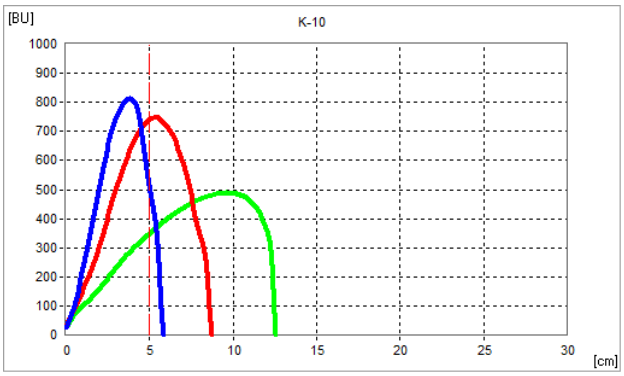
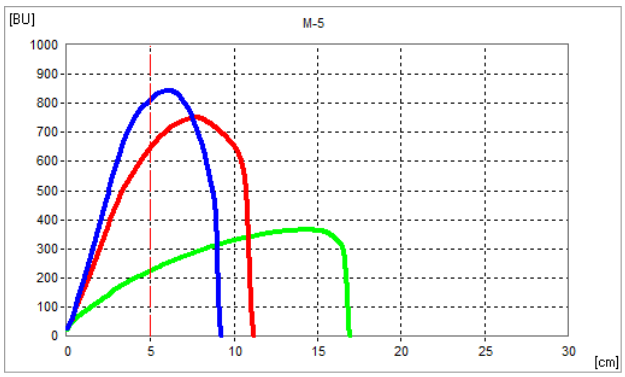


LCS Rebel Check (Minot, M-5)



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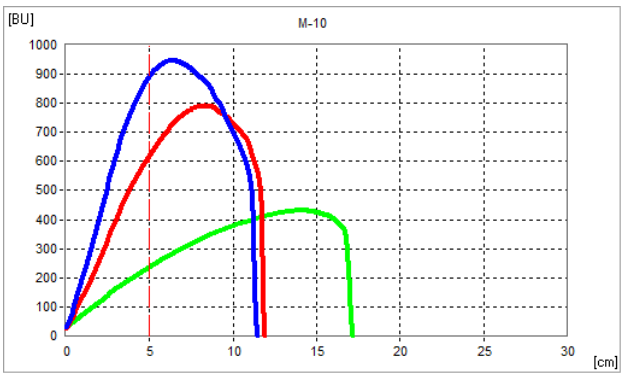


45 min; 90 min; 135 min

Appendix

Wheat Market Value Score

The development of a Wheat Market Value Score (WMS) or Export Market Value 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 the Check (i.e. Linkert, LCS Rebel) is evaluated along with the experimental lines for each growing location. Method #2 was developed on a scale of 0 to 10 where the experimental lines is evaluated against the Check for each growing location.

Wheat Market Value Score – Method #1

	Score	Test Weight (lb/bu)	1000 Kernel Weight (g)	Falling Number (s)	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 Market Value Score = [(TW*2) + (1000 KWT*2) + (FN*2) + (WP *3) + WA] / 10

Wheat Market Value Score – Method #2

Component Score	Wheat Protein (%, 12% mb)	Test Weight (lb/bu)	Falling Number (s)	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 Market Value 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			
Tail Cyclone Flour*	TC	22			
5th Middlings	5 M	14	**Clear Flour**		
Low Grade	LG	17			
Low Quality	LQ	18			
Tail Shorts	Tail Sh	19	**Short & Bran**		
Head Shorts	Head Sh	20			
Bran	Bran	21			
Tail Cyclone Shorts*	TC Sh	23			

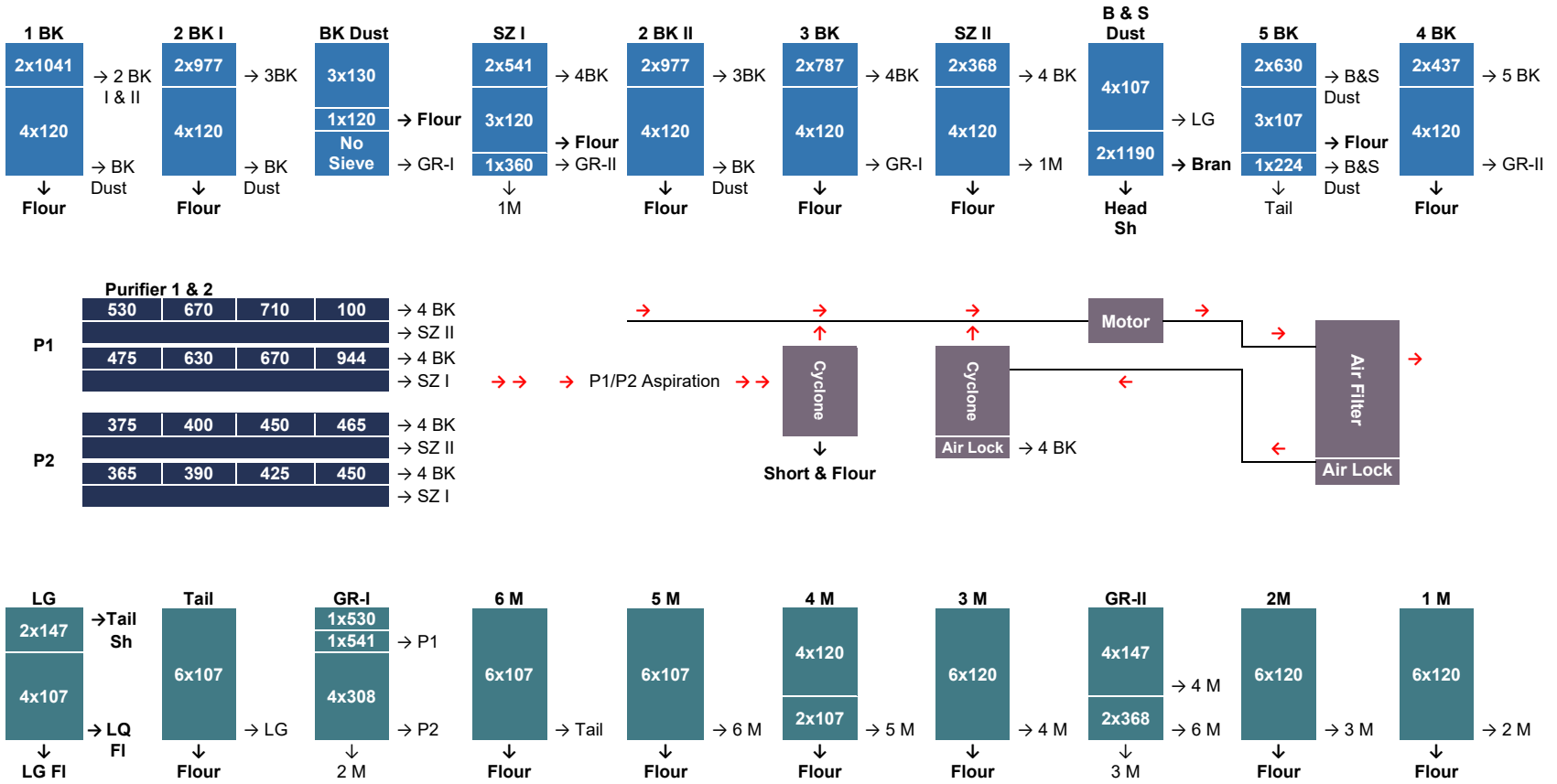
*Tail Cyclone fraction was separated into flour and shorts by rebolting.

Calculation of flour extraction:

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

Miag Multomat Mill Flow Chart

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



Sieve Opening Size - µm

Wheat Kernel Characteristics by Location

Location	ID	Entry	Wheat Market Value Score 1-6	Wheat Market Value Score 1-10	Test Weight (lb/bu)	1000 Kernel Weight (g)	Kernel Size Large (%)	Kernel Size Small (%)	Vitreous Kernels (%)	SKC Hardness Index	Moisture (%)	Protein (%, 12% mb)	Ash (%, 14% mb)	Falling Number (s)	DON (ppm)
Watertown	B-3	LCS Ascent	4.7	7.0	61.8	31.5	63	9	33	68.4	12.2	15.6	1.40	400	nd
	B-4	MN-Rothsay	5.4	9.0	62.1	35.2	59	11	35	69.8	12.0	16.4	1.50	446	nd
	B-6	G18C2097	5.3	8.8	61.8	35.8	71	7	41	77.7	12.0	16.2	1.52	480	nd
	B-7	Ascend-SD	4.7	7.6	61.3	28.5	35	16	56	92.3	12.1	15.9	1.40	463	nd
	B-8	**Linkert**	**5.2**	**10.0**	**61.4**	**34.9**	**63**	**8**	**42**	**76.7**	**12.0**	**17.3**	**1.52**	**475**	**nd**
	B-10	MN15119-2	5.0	7.6	61.7	31.2	57	12	37	66.7	12.2	16.2	1.48	424	nd
Casselton	C-3	LCS Ascent	4.3	7.6	65.4	34.8	63	9	93	71.0	11.2	13.3	1.49	379	nd
	C-4	MN-Rothsay	4.8	9.4	64.5	32.6	67	7	89	78.1	11.2	14.6	1.58	429	nd
	C-6	G18C2097	5.5	9.4	64.8	40.4	80	4	92	71.5	10.9	15.3	1.57	457	nd
	C-7	Ascend-SD	4.5	8.6	64.5	29.9	29	16	88	91.4	11.0	13.9	1.42	424	nd
	C-8	**Linkert**	**4.9**	**10.0**	**64.3**	**33.2**	**56**	**9**	**87**	**86.1**	**10.9**	**14.5**	**1.45**	**474**	**nd**
	C-9	AP Smith	4.9	9.6	65.0	32.6	49	12	85	78.0	11.0	14.1	1.29	431	nd
	C-10	MN15119-2	4.6	8.8	65.3	29.9	53	10	80	83.1	11.0	14.2	1.34	409	nd
Havre	H-1	MT1855	4.7	9.6	60.1	27.0	9	25	98	79.1	9.6	17.9	1.18	476	nd
	H-2	MT Sidney	4.8	8.2	62.1	21.5	1	70	100	82.1	9.5	17.4	1.13	465	nd
	H-3	LCS Ascent	5.2	7.8	63.2	25.3	2	35	99	87.6	9.1	16.6	1.13	445	nd
	H-5	**LCS Rebel**	**5.1**	**10.0**	**62.1**	**27.7**	**7**	**24**	**99**	**76.6**	**9.3**	**18.3**	**1.16**	**458**	**nd**
Crookston	K-3	LCS Ascent	4.9	9.2	64.4	30.7	42	12	84	84.7	11.9	14.8	1.22	432	nd
	K-4	MN-Rothsay	4.9	9.0	63.8	31.4	29	18	85	84.9	11.9	14.4	1.24	462	nd
	K-6	G18C2097	4.9	9.0	62.6	33.3	37	10	88	92.0	11.7	14.7	1.41	502	nd
	K-7	Ascend-SD	4.3	7.2	61.5	23.0	2	42	91	93.2	11.5	15.0	1.33	454	nd
	K-8	**Linkert**	**5.3**	**10.0**	**63.8**	**34.1**	**44**	**7**	**90**	**78.3**	**11.4**	**15.3**	**1.39**	**465**	**nd**
	K-9	AP Smith	4.6	7.8	62.5	28.4	22	18	91	86.2	11.4	14.6	1.43	439	nd
	K-10	MN15119-2	4.6	7.6	62.8	28.9	20	21	93	74.6	11.8	14.3	1.31	417	nd
Minot	M-1	MT1855	4.9	9.6	60.4	35.0	59	8	60	74.3	10.9	18.2	1.44	394	nd
	M-2	MT Sidney	4.1	9.2	60.7	30.5	37	14	42	64.6	11.2	18.0	1.52	339	nd
	M-3	LCS Ascent	4.5	9.0	61.3	32.2	58	7	18	66.0	9.9	17.7	1.49	357	nd
	M-4	MN-Rothsay	4.8	9.2	61.3	30.1	33	16	21	73.4	10.8	18.4	1.40	400	nd
	M-5	**LCS Rebel**	**4.7**	**10.0**	**61.6**	**35.0**	**68**	**5**	**19**	**67.4**	**10.8**	**18.5**	**1.46**	**345**	**nd**
	M-7	Ascend-SD	4.2	8.8	60.7	28.7	31	15	23	82.5	11.3	18.0	1.45	357	nd
	M-9	AP Smith	4.8	9.4	61.4	33.1	66	6	17	68.1	10.9	17.9	1.56	386	nd
	M-10	MN15119-2	4.3	8.6	59.8	33.0	53	8	13	56.5	10.8	17.8	1.49	357	nd
Williston	W-3	LCS Ascent	3.3	8.4	60.5	25.2	19	26	22	77.7	10.9	16.0	1.44	280	nd
	W-5	**LCS Rebel**	**3.6**	**10.0**	**60.7**	**29.2**	**34**	**15**	**27**	**67.6**	**10.8**	**17.4**	**1.41**	**202**	**nd**
	W-9	AP Smith	3.0	7.8	60.0	23.7	13	32	40	78.9	10.8	16.0	1.57	285	nd

Flour Characteristics by Location

Location	ID	Entry	Extraction			Color			Moisture	Protein	Ash	Wet Gluten	Gluten	Falling Number
			TWB* (%)	TPB* (%)	Flour/bu Wheat (lb)	*L**	*a**	*b**	(%)	(%, 14% mb)	(%, 14% mb)	(%)	Index	(Malted, s)
Watertown	B-3	LCS Ascent	73.1	74.7	46.0	90.2	-0.76	7.9	13.9	14.2	0.50	36.6	99	258
	B-4	MN-Rothsay	72.2	73.9	45.7	90.4	-0.77	8.1	13.6	15.0	0.48	42.3	93	245
	B-6	G18C2097	70.2	72.3	44.2	90.2	-0.90	8.8	13.4	15.0	0.52	40.1	98	254
	B-7	Ascend-SD	67.6	68.9	41.9	89.9	-0.92	9.0	13.0	14.8	0.54	38.6	97	253
	B-8	**Linkert**	**70.5**	**72.2**	**44.1**	**90.3**	**-0.76**	**8.0**	**13.6**	**16.2**	**0.52**	**41.2**	**98**	**254**
	B-10	MN15119-2	74.5	76.1	46.7	90.1	-0.79	8.8	13.6	15.6	0.46	41.5	97	253
Casselton	C-3	LCS Ascent	74.0	75.8	49.7	90.8	-1.07	9.7	13.5	12.3	0.44	31.5	99	255
	C-4	MN-Rothsay	72.7	74.9	48.1	90.5	-1.17	9.9	13.1	13.5	0.51	34.3	97	251
	C-6	G18C2097	70.5	72.8	46.9	90.8	-0.83	8.5	13.2	14.1	0.48	36.9	98	253
	C-7	Ascend-SD	70.2	72.3	46.2	90.5	-1.20	10.1	12.8	12.8	0.52	34.2	97	252
	C-8	**Linkert**	**71.7**	**73.3**	**46.8**	**90.6**	**-1.23**	**10.0**	**13.7**	**13.2**	**0.51**	**32.9**	**99**	**247**
	C-9	AP Smith	74.0	76.1	49.2	90.8	-1.11	9.5	13.0	12.7	0.42	34.0	97	250
	C-10	MN15119-2	71.7	73.6	47.9	90.7	-1.01	8.9	12.9	12.7	0.43	33.1	98	252
Havre	H-1	MT1855	68.6	71.7	42.9	90.1	-1.26	10.9	13.1	16.6	0.42	45.8	91	255
	H-2	MT Sidney	70.9	72.6	44.4	90.2	-1.01	10.0	13.1	16.2	0.39	45.1	88	249
	H-3	LCS Ascent	68.5	70.3	44.0	90.3	-0.78	8.8	13.8	14.9	0.40	39.7	90	258
	H-5	**LCS Rebel**	**71.5**	**73.4**	**44.9**	**90.2**	**-0.70**	**9.0**	**13.4**	**16.8**	**0.39**	**44.9**	**93**	**246**
Crookston	K-3	LCS Ascent	72.3	73.3	47.2	90.7	-0.84	8.4	13.1	13.5	0.44	34.2	97	251
	K-4	MN-Rothsay	72.5	74.1	46.9	90.8	-0.96	9.0	13.1	13.3	0.44	34.0	98	251
	K-6	G18C2097	71.4	72.9	45.7	90.8	-1.10	9.4	13.7	13.5	0.50	30.7	99	249
	K-7	Ascend-SD	67.7	69.3	42.5	90.3	-1.05	10.0	13.3	13.8	0.53	31.5	99	256
	K-8	**Linkert**	**72.6**	**73.7**	**47.2**	**91.1**	**-0.81**	**8.1**	**13.1**	**14.4**	**0.48**	**34.2**	**100**	**257**
	K-9	AP Smith	71.8	74.0	45.8	90.7	-1.13	9.8	13.2	13.6	0.51	29.9	100	258
	K-10	MN15119-2	73.9	75.1	47.4	91.2	-1.01	8.9	13.7	13.4	0.44	31.2	99	249
Minot	M-1	MT1855	68.7	70.5	41.9	89.8	-0.96	9.6	13.4	16.5	0.53	45.2	92	251
	M-2	MT Sidney	73.2	74.1	45.5	90.1	-0.77	8.6	13.4	16.3	0.47	44.6	92	254
	M-3	LCS Ascent	73.0	74.1	45.1	90.4	-0.71	7.8	13.1	15.9	0.46	42.6	92	253
	M-4	MN-Rothsay	72.0	73.6	44.8	90.4	-0.75	8.4	13.6	16.9	0.48	46.4	92	251
	M-5	**LCS Rebel**	**72.3**	**73.6**	**45.0**	**90.1**	**-0.72**	**8.3**	**13.3**	**16.9**	**0.46**	**45.9**	**93**	**246**
	M-7	Ascend-SD	67.6	68.4	41.8	89.7	-0.88	9.3	13.0	16.6	0.55	44.5	95	248
	M-9	AP Smith	70.2	72.6	44.2	89.9	-0.94	9.1	12.9	16.8	0.49	42.0	96	264
	M-10	MN15119-2	74.3	75.9	46.0	90.3	-0.75	8.7	13.7	17.2	0.47	44.6	95	257
Williston	W-3	LCS Ascent	72.2	74.1	44.2	90.4	-0.65	7.8	13.4	15.1	0.46	35.7	98	260
	W-5	**LCS Rebel**	**73.5**	**75.0**	**45.1**	**90.3**	**-0.66**	**8.3**	**13.3**	**16.5**	**0.43**	**40.9**	**99**	**266†**
	W-9	AP Smith	71.8	73.4	43.4	89.9	-0.99	9.8	13.1	15.4	0.50	35.0	99	254

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

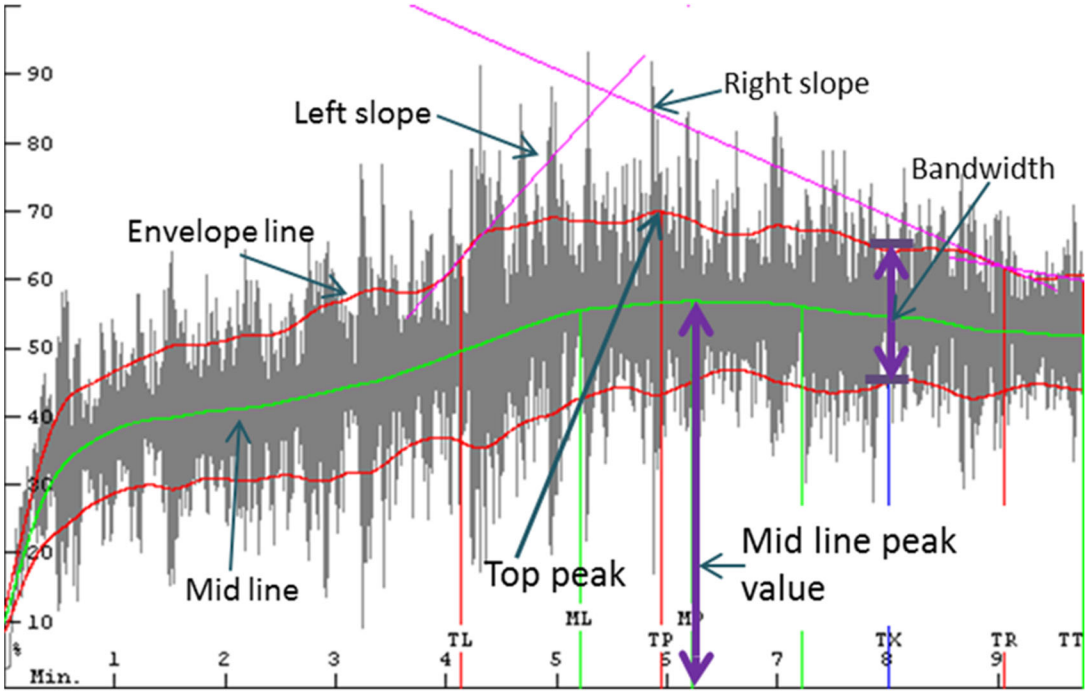
Farinograph Characteristics by Location

Location	ID	Entry	Water Absorption (%, 500 BU)	Water Absorption (%, 14% mb)	Arrival Time (min)	Peak Time (min)	Dough Stability (min)	MTI (BU)	TTB (min)
Watertown	B-3	LCS Ascent	64.6	64.8	6.5	21.8	19.5	32	26.8
	B-4	MN-Rothsay	65.0	64.8	6.3	15.3	13.6	32	20.5
	B-6	G18C2097	67.0	66.8	15.7	26.1	14.2	35	30.7
	B-7	Ascend-SD	67.1	66.3	3.7	34.6	35.4	26	40.7
	B-8	**Linkert**	**68.4**	**68.4**	**22.1**	**28.0**	**11.9**	**19**	**34.8**
	B-10	MN15119-2	63.9	63.7	12.9	33.5	24.5	31	38.6
Casselton	C-3	LCS Ascent	58.4	58.0	2.6	6.9	17.7	21	19.4
	C-4	MN-Rothsay	65.0	64.0	3.2	8.3	12.1	27	16.3
	C-6	G18C2097	64.3	63.7	3.5	9.5	26.6	12	31.1
	C-7	Ascend-SD	64.4	63.2	2.3	7.2	11.1	33	14.0
	C-8	**Linkert**	**62.7**	**62.5**	**2.8**	**7.9**	**26.2**	**15**	**30.6**
	C-9	AP Smith	62.2	61.4	3.1	8.8	16.3	23	21.3
	C-10	MN15119-2	64.5	63.5	2.2	9.6	18.6	14	22.7
Havre	H-1	MT1855	72.0	71.4	7.6	10.0	11.7	10	20.7
	H-2	MT Sidney	68.3	67.7	7.1	14.3	16.5	7	24.6
	H-3	LCS Ascent	67.4	67.2	7.0	17.8	15.0	31	23.2
	H-5	**LCS Rebel**	**69.5**	**69.1**	**7.5**	**28.5**	**27.5**	**18**	**36.4**
Crookston	K-3	LCS Ascent	65.6	64.8	5.9	12.5	18.7	10	25.8
	K-4	MN-Rothsay	63.1	62.5	4.8	16.7	23.2	5	29.0
	K-6	G18C2097	63.4	63.0	3.6	36.3	39.8	13	45.2
	K-7	Ascend-SD	63.4	62.8	2.4	7.7	15.9	17	18.2
	K-8	**Linkert**	**64.7**	**63.9**	**7.6**	**36.4**	**39.7**	**5**	**48.9**
	K-9	AP Smith	63.7	62.9	4.4	30.4	33.4	10	39.4
	K-10	MN15119-2	58.8	58.6	3.5	45.3	49.5	14	54.5
Minot	M-1	MT1855	71.0	70.6	6.3	10.6	12.5	15	20.0
	M-2	MT Sidney	67.1	66.5	8.1	16.6	12.9	31	22.0
	M-3	LCS Ascent	68.0	67.0	9.6	17.8	12.3	34	22.8
	M-4	MN-Rothsay	68.2	68.2	9.6	19.0	12.8	43	23.1
	M-5	**LCS Rebel**	**69.7**	**69.3**	**8.1**	**20.3**	**18.1**	**22**	**27.0**
	M-7	Ascend-SD	70.2	69.2	5.2	12.9	21.2	8	27.8
	M-9	AP Smith	69.0	67.8	15.9	25.3	13.8	34	30.3
	M-10	MN15119-2	65.6	65.6	14.3	29.0	19.8	26	35.6
Williston	W-3	LCS Ascent	65.6	65.0	25.0	31.2	17.7	3	43.8
	W-5	**LCS Rebel**	**66.4**	**65.8**	**12.2**	**38.0**	**33.4**	**11**	**46.7**
	W-9	AP Smith	64.9	63.9	26.7	37.6	17.3	18	45.0

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-3	LCS Ascent	4.3	70.7	32.1	4.9	55.7	27.5	202.3
	B-4	MN-Rothsay	3.8	71.6	32.4	4.1	56.4	28.1	166.7
	B-6	G18C2097	4.8	74.7	37.2	5.4	57.4	30.9	229.1
	B-7	Ascend-SD	5.7	72.0	34.4	5.7	54.3	34.4	241.6
	B-8	**Linkert**	5.4	76.0	32.4	5.5	59.5	32.3	228.5
	B-10	MN15119-2	5.7	67.9	29.8	5.8	52.7	29.7	219.9
Casselton	C-3	LCS Ascent	4.8	58.3	25.5	5.3	45.4	23.2	189.5
	C-4	MN-Rothsay	3.7	74.9	32.4	3.8	58.7	32.2	169.3
	C-6	G18C2097	4.5	70.8	31.0	4.8	55.7	27.9	200.8
	C-7	Ascend-SD	3.5	70.3	33.0	3.9	53.8	26.7	163.8
	C-8	**Linkert**	4.3	67.8	29.2	4.9	53.6	24.8	203.1
	C-9	AP Smith	3.7	65.7	29.8	4.0	50.7	25.9	157.2
	C-10	MN15119-2	3.8	67.4	28.5	4.1	53.3	26.1	170.6
Havre	H-1	MT1855	2.4	80.0	33.7	2.7	63.4	30.9	120.9
	H-2	MT Sidney	3.4	69.0	25.1	3.4	55.6	25.1	138.9
	H-3	LCS Ascent	3.1	69.7	29.3	3.5	55.2	25.0	144.1
	H-5	**LCS Rebel**	3.8	74.5	34.5	4.2	58.3	26.2	178.2
Crookston	K-3	LCS Ascent	3.8	68.8	26.9	4.0	55.5	25.2	164.9
	K-4	MN-Rothsay	3.8	67.3	30.9	4.2	52.3	24.4	160.8
	K-6	G18C2097	6.5	64.3	29.0	6.3	49.7	28.3	248.2
	K-7	Ascend-SD	5.4	66.4	28.3	5.2	51.6	28.0	209.7
	K-8	**Linkert**	5.5	74.2	35.3	5.4	55.8	34.8	221.2
	K-9	AP Smith	4.8	72.3	34.3	5.3	55.7	30.0	216.0
	K-10	MN15119-2	5.1	56.9	29.9	6.6	44.6	23.5	227.6
Minot	M-1	MT1855	2.7	78.4	29.9	2.9	63.4	28.8	128.9
	M-2	MT Sidney	3.6	70.1	29.9	4.0	56.1	24.3	153.6
	M-3	LCS Ascent	3.6	72.5	32.2	3.8	56.7	29.8	156.1
	M-4	MN-Rothsay	3.2	74.1	35.0	3.6	58.2	30.1	150.7
	M-5	**LCS Rebel**	3.2	78.0	38.3	3.7	60.3	29.7	157.9
	M-7	Ascend-SD	3.4	81.6	34.3	3.7	64.5	30.2	171.6
	M-9	AP Smith	4.9	73.3	30.1	4.9	57.9	30.1	197.3
	M-10	MN15119-2	4.6	69.2	29.4	4.8	54.7	27.5	179.7
Williston	W-3	LCS Ascent	7.3	66.0	27.8	7.4	51.7	27.7	284.8
	W-5	**LCS Rebel**	5.7	70.0	35.4	6.8	53.7	29.8	266.9
	W-9	AP Smith	9.0	66.0	28.8	9.0	51.1	28.7	328.0

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 min) 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 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

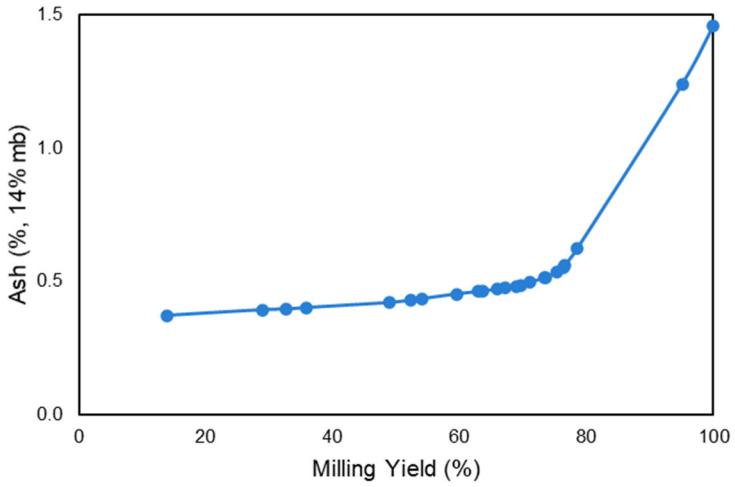
45 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-3	LCS Ascent	57	229	137	323	1.7	2.4
	B-4	MN-Rothsay	52	195	142	279	1.4	2.0
	B-6	G18C2097	88	305	147	471	2.1	3.2
	B-7	Ascend-SD	84	301	145	458	2.1	3.2
	B-8	**Linkert**	112	251	185	492	1.4	2.7
	B-10	MN15119-2	79	230	157	422	1.5	2.7
Casselton	C-3	LCS Ascent	75	241	151	399	1.6	2.6
	C-4	MN-Rothsay	73	215	158	382	1.4	2.4
	C-6	G18C2097	86	266	155	446	1.7	2.9
	C-7	Ascend-SD	56	237	132	341	1.8	2.6
	C-8	**Linkert**	68	268	137	398	2.0	2.9
	C-9	AP Smith	54	180	152	280	1.2	1.9
	C-10	MN15119-2	56	210	143	304	1.5	2.1
Havre	H-1	MT1855	57	123	199	222	0.6	1.1
	H-2	MT Sidney	63	215	152	312	1.4	2.1
	H-3	LCS Ascent	36	163	128	206	1.3	1.6
	H-5	**LCS Rebel**	86	251	164	422	1.5	2.6
Crookston	K-3	LCS Ascent	56	203	149	285	1.4	1.9
	K-4	MN-Rothsay	58	206	147	304	1.4	2.1
	K-6	G18C2097	53	332	106	380	3.1	3.6
	K-7	Ascend-SD	83	333	138	481	2.4	3.5
	K-8	**Linkert**	90	376	135	535	2.8	4.0
	K-9	AP Smith	82	331	135	492	2.5	3.6
	K-10	MN15119-2	75	350	126	488	2.8	3.9
Minot	M-1	MT1855	70	157	195	276	0.8	1.4
	M-2	MT Sidney	80	187	190	331	1.0	1.7
	M-3	LCS Ascent	71	253	149	369	1.7	2.5
	M-4	MN-Rothsay	75	177	187	319	1.0	1.7
	M-5	**LCS Rebel**	79	225	169	365	1.3	2.2
	M-7	Ascend-SD	69	190	164	356	1.2	2.2
	M-9	AP Smith	87	256	160	447	1.6	2.8
	M-10	MN15119-2	91	238	171	431	1.4	2.5
Williston	W-3	LCS Ascent	80	418	120	531	3.5	4.4
	W-5	**LCS Rebel**	106	358	147	622	2.4	4.2
	W-9	AP Smith	96	417	130	629	3.2	4.9

90 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-3	LCS Ascent	77	647	90	708	7.2	7.8
	B-4	MN-Rothsay	80	462	112	578	4.1	5.1
	B-6	G18C2097	83	844	80	857	10.5	10.7
	B-7	Ascend-SD	75	801	77	815	10.4	10.6
	B-8	**Linkert**	124	832	109	932	7.6	8.6
	B-10	MN15119-2	108	542	121	746	4.5	6.2
Casselton	C-3	LCS Ascent	80	600	96	672	6.2	7.0
	C-4	MN-Rothsay	93	653	102	765	6.4	7.5
	C-6	G18C2097	97	630	106	766	5.9	7.2
	C-7	Ascend-SD	69	590	89	632	6.6	7.1
	C-8	**Linkert**	85	787	87	833	9.1	9.6
	C-9	AP Smith	76	416	115	522	3.6	4.5
	C-10	MN15119-2	68	538	95	601	5.7	6.3
Havre	H-1	MT1855	102	279	178	434	1.6	2.4
	H-2	MT Sidney	100	407	143	550	2.9	3.9
	H-3	LCS Ascent	81	457	117	532	3.9	4.6
	H-5	**LCS Rebel**	104	676	108	744	6.3	6.9
Crookston	K-3	LCS Ascent	88	551	111	651	5.0	5.9
	K-4	MN-Rothsay	81	558	103	624	5.5	6.1
	K-6	G18C2097	55	653	64	781	10.2	12.2
	K-7	Ascend-SD	69	847	68	870	12.4	12.7
	K-8	**Linkert**	81	926	71	941	13.0	13.2
	K-9	AP Smith	76	869	75	869	11.6	11.6
	K-10	MN15119-2	72	742	88	748	8.5	8.6
Minot	M-1	MT1855	100	342	157	491	2.2	3.1
	M-2	MT Sidney	103	639	111	705	5.8	6.4
	M-3	LCS Ascent	87	648	99	711	6.6	7.2
	M-4	MN-Rothsay	105	605	120	645	5.0	5.4
	M-5	**LCS Rebel**	106	651	112	751	5.8	6.7
	M-7	Ascend-SD	108	771	102	831	7.6	8.2
	M-9	AP Smith	113	1002	87	1020	11.5	11.7
	M-10	MN15119-2	115	624	119	791	5.3	6.7
Williston	W-3	LCS Ascent	61	747	59	908	12.6	15.4
	W-5	**LCS Rebel**	112	1026	84	1030	12.2	12.3
	W-9	AP Smith	90	1009	67	1113	15.1	16.6

135 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-3	LCS Ascent	65	803	67	822	12.0	12.3
	B-4	MN-Rothsay	94	674	104	704	6.5	6.8
	B-6	G18C2097	79	867	71	932	12.3	13.2
	B-7	Ascend-SD	80	823	73	911	11.2	12.4
	B-8	**Linkert**	107	812	100	869	8.2	8.7
	B-10	MN15119-2	100	772	95	826	8.2	8.7
Casselton	C-3	LCS Ascent	80	806	83	834	9.8	10.1
	C-4	MN-Rothsay	82	790	85	790	9.3	9.3
	C-6	G18C2097	101	875	93	894	9.5	9.7
	C-7	Ascend-SD	70	687	85	696	8.0	8.2
	C-8	**Linkert**	71	826	68	929	12.2	13.7
	C-9	AP Smith	68	711	78	719	9.2	9.3
	C-10	MN15119-2	63	698	76	698	9.3	9.3
Havre	H-1	MT1855	89	405	131	509	3.1	3.9
	H-2	MT Sidney	94	482	125	564	3.9	4.5
	H-3	LCS Ascent	80	664	93	668	7.1	7.2
	H-5	**LCS Rebel**	102	791	98	809	8.1	8.3
Crookston	K-3	LCS Ascent	75	700	90	720	7.8	8.0
	K-4	MN-Rothsay	86	733	95	735	7.7	7.7
	K-6	G18C2097	48	323	55	790	5.9	14.4
	K-7	Ascend-SD	63	707	60	965	11.8	16.1
	K-8	**Linkert**	63	779	58	992	13.3	17.0
	K-9	AP Smith	74	826	63	1042	13.2	16.6
	K-10	MN15119-2	51	490	58	812	8.4	13.9
Minot	M-1	MT1855	120	470	144	645	3.3	4.5
	M-2	MT Sidney	93	727	95	789	7.6	8.3
	M-3	LCS Ascent	97	952	84	957	11.3	11.4
	M-4	MN-Rothsay	93	658	103	706	6.4	6.9
	M-5	**LCS Rebel**	95	812	93	844	8.8	9.1
	M-7	Ascend-SD	93	920	81	920	11.3	11.3
	M-9	AP Smith	68	862	66	868	13.0	13.1
	M-10	MN15119-2	136	897	115	947	7.8	8.3
Williston	W-3	LCS Ascent	55	497	53	878	9.3	16.4
	W-5	**LCS Rebel**	77	963	64	993	15.0	15.5
	W-9	AP Smith	69	790	61	984	13.1	16.3

Ash Content in Mill Streams

Linkert Check - Casselton



Mill Stream	Stream (%, 14% mb) Yield	Ash	Cumulative (%, 14% mb) Yield	Ash
Patent:				
1 M	13.8	0.37	13.8	0.37
2 M	15.1	0.41	28.9	0.39
Sz I	3.7	0.41	32.6	0.39
Sz II	3.2	0.46	35.8	0.40
3 M	13.1	0.47	48.9	0.42
6 M	3.5	0.55	52.3	0.43
1 Bk	1.7	0.61	54.1	0.43
4 M	5.4	0.62	59.5	0.45
4 Bk	3.5	0.62	63.0	0.46
2 Bk I	0.7	0.65	63.7	0.46
Bk Dust	2.2	0.65	65.9	0.47
2 Bk II	1.2	0.68	67.2	0.47
3 Bk	1.7	0.68	68.9	0.48
TC	0.7	0.94	69.6	0.48
5 Bk	1.5	1.03	71.1	0.49
Tail	2.2	1.05	73.3	0.51
Clear Flour:				
LQ	0.2	1.21	73.6	0.51
LG	1.7	1.39	75.3	0.53
5 M	1.0	1.76	76.3	0.55
Bran & Shorts:				
TC Sh	0.2	2.72	76.5	0.56
Tail Sh	2.0	3.10	78.5	0.62
Head Sh	16.5	4.17	95.1	1.24
Bran	4.9	5.69	100.0	1.46
Patent (Rebolted)		**0.51**		
Wheat		**1.45**		

Cooperators' Bake Data

Linkert Checks

WATERTOWN (B-8)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	64.0	2825	9	9
B	73.0	1070	7	5
C	72.5	942	6	7
D	74.2	1210	9	5
E	73.3	964	7	7
F	69.0	998	7	6
G	73.7	825	5	5
H	68.0	2633	9	9
I	70.4	2500	9	9
J	68.8	2368	7	9
K	68.4	1904	1	1
L	68.4	2079	6	5
Avg.	70.3		6.8	6.4
S.D.	3.1		2.3	2.4

CASSSELTON (C-8)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	61.0	2825	9	7
B	69.0	900	5	5
C	69.5	902	6	5
D	69.2	960	7	6
E	67.7	884	6	7
F	64.0	798	7	6
G	66.9	885	5	6
H	62.0	2736	9	7
I	64.5	2575	9	7
J	63.1	2347	7	9
K	62.7	2114	7	7
L	62.7	2139	7	8
Avg.	65.2		7.0	6.7
S.D.	3.1		1.4	1.2

CROOKSTON (K-8)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	62.0	2875	9	7
B	70.0	950	9	5
C	74.9	947	9	4
D	71.6	940	9	5
E	68.7	926	6	8
F	64.9	893	9	5
G	68.4	890	6	7
H	64.0	2809	9	9
I	65.9	2475	9	9
J	64.6	2164	7	9
K	64.7	1961	7	7
L	64.7	2128	7	7
Avg.	67.0		8.0	6.8
S.D.	3.7		1.3	1.7

LCS Rebel Checks

HAVRE (H-5)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	65.0	2550	7	8
B	72.0	1020	5	5
C	76.3	998	5	8
D	72.3	1170	7	6
E	74.0	982	6	7
F	69.4	1043	5	5
G	75.0	1010	5	7
H	69.0	2809	9	7
I	71.1	2475	9	7
J	70.0	2370	7	7
K	69.5	2018	3	3
L	69.5	2176	7	5
Avg.	71.1		6.3	6.3
S.D.	3.1		1.8	1.5

MINOT (M-5)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	65.0	2850	9	9
B	74.0	1120	3	5
C	74.8	964	4	7
D	73.9	1225	7	4
E	74.1	928	5	7
F	69.7	927	5	6
G	75.3	925	5	5
H	69.0	2706	9	7
I	71.3	2750	9	7
J	70.0	2483	9	9
K	69.7	1991	5	5
L	69.7	2255	7	5
Avg.	71.4		6.4	6.3
S.D.	3.1		2.2	1.6

WILLISTON (W-5)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	64.0	2775	9	9
B	74.0	1045	9	5
C	77.0	996	9	8
D	73.8	1020	9	5
E	70.6	926	7	8
F	66.3	904	8	6
G	71.0	1015	8	8
H	65.0	2868	9	7
I	67.8	2350	9	9
J	66.6	2225	9	9
K	66.4	2132	7	7
L	66.4	2118	9	8
Avg.	69.1		8.5	7.4
S.D.	4.1		0.8	1.4

SWQC #1 – MT1855

HAVRE (H-1)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	64.0	2425	95.1	6	7	5	5	5	5	5	5	5
B	72.0	890	87.3	1	1	1	3	3	5	3	3	1
C	72.5	985	98.7	3	4	1	4	4	5	2	5	4
D	72.7	1150	98.3	5	5	1	3	4	5	4	4	4
E	76.3	902	91.9	5	7	5	4	5	5	4	2	4
F	71.4	1082	103.7	3	5	2	4	5	5	4	4	4
G	74.8	945	93.6	5	6	2	2	4	4	3	3	3
H	71.0	2332	83.0	5	5	1	1	1	3	4	1	1
I	73.4	2500	101.0	9	7	3	5	5	5	5	5	5
J	72.0	2280	96.2	7	5	5	3	5	5	3	3	3
K	72.0	1687	83.6	1	1	1	3	4	5	3	2	5
L	72.0	2176	100.0	5	5	3	3	4	4	4	4	4
Avg.	72.0		94.4	4.6	4.8	2.5	3.3	4.1	4.7	3.7	3.4	3.6
S.D.	2.9		6.8	2.3	2.0	1.7	1.2	1.2	0.7	0.9	1.3	1.4

MINOT (M-1)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	64.0	2800	98.2	9	8	5	5	5	5	5	5	5
B	73.0	945	84.4	3	1	3	3	3	3	3	1	1
C	74.2	994	103.1	3	4	3	4	4	5	3	5	5
D	72.9	1140	93.1	5	6	1	3	4	4	5	4	4
E	75.5	924	99.6	5	5	5	5	4	5	5	4	5
F	70.6	1093	117.9	3	5	3	7	5	5	4	6	5
G	75.5	985	106.5	5	4	3	4	4	5	4	5	5
H	70.0	2545	94.1	3	5	1	3	3	5	4	3	3
I	72.6	2675	97.3	9	5	3	5	3	5	5	5	5
J	71.3	2549	102.7	5	7	3	5	5	5	1	5	3
K	71.0	1931	97.0	3	1	1	5	5	5	3	4	4
L	71.0	2200	97.6	6	5	4	4	4	5	5	6	5
Avg.	71.8		99.3	4.9	4.7	2.9	4.4	4.1	4.8	3.9	4.4	4.2
S.D.	3.1		8.1	2.2	2.1	1.4	1.2	0.8	0.6	1.2	1.4	1.3

SWQC #2 – MT Sidney

HAVRE (H-2)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	64.0	2500	98.0	5	5	4	5	5	5	5	5	5
B	72.0	925	90.7	3	3	1	5	3	3	5	3	3
C	74.0	1014	101.6	4	5	3	5	5	5	4	5	5
D	73.7	1120	95.7	5	5	1	7	4	4	5	5	5
E	72.8	952	96.9	6	7	6	6	5	5	2	3	3
F	68.7	1009	96.7	5	4	3	4	6	6	4	4	4
G	74.1	995	98.5	5	5	3	4	6	3	4	4	4
H	68.0	2427	86.4	7	5	3	3	3	3	3	1	1
I	69.7	2675	108.1	9	7	5	5	7	5	3	7	7
J	68.2	2316	97.7	7	5	5	3	5	5	5	3	5
K	68.3	1905	94.4	1	1	1	4	5	3	4	3	3
L	68.3	2012	92.5	5	5	3	3	4	4	4	4	4
Avg.	70.2		96.4	5.2	4.8	3.2	4.5	4.8	4.3	4.0	3.9	4.1
S.D.	3.1		5.4	2.0	1.6	1.6	1.2	1.2	1.1	1.0	1.5	1.5

MINOT (M-2)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	64.0	2700	94.7	9	9	5	5	5	5	5	5	5
B	72.0	1090	97.3	5	5	1	5	5	3	5	3	3
C	73.3	980	101.7	4	7	2	4	3	5	6	5	5
D	72.8	1210	98.8	7	6	1	5	4	4	4	5	4
E	71.5	978	105.4	5	7	5	5	5	5	4	4	4
F	67.5	999	107.8	4	4	3	7	6	5	5	6	6
G	71.6	980	105.9	5	6	3	5	6	4	5	5	5
H	67.0	2560	94.6	5	5	3	3	3	5	5	3	3
I	68.5	2750	100.0	9	7	3	5	5	5	3	5	5
J	68.1	2545	102.5	7	7	3	5	5	5	5	5	5
K	67.1	2075	104.2	5	5	5	5	7	5	6	6	6
L	67.1	2219	98.4	6	5	4	5	5	4	4	6	4
Avg.	69.2		100.9	5.9	6.1	3.2	4.9	4.9	4.6	4.8	4.8	4.6
S.D.	2.9		4.4	1.7	1.4	1.4	0.9	1.2	0.7	0.9	1.0	1.0

SWQC #3 – LCS Ascent

WATERTOWN (B-3)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	62.0	2825	100.0	9	9	5	5	4	4	5	5	5
B	68.0	920	86.0	5	5	3	5	3	1	7	3	5
C	63.9	931	98.8	6	7	3	5	4	3	7	5	5
D	70.5	1090	90.1	9	5	3	7	5	1	5	5	4
E	69.6	959	99.5	6	7	4	5	7	3	5	3	4
F	65.5	942	94.4	7	5	4	7	8	7	6	4	4
G	70.7	910	110.3	6	5	7	5	4	3	6	5	4
H	64.0	2839	107.8	9	9	5	5	5	3	7	6	5
I	66.8	2550	102.0	9	7	5	5	7	3	5	5	5
J	68.1	2393	101.1	5	7	3	3	1	3	7	3	3
K	64.6	1870	98.2	3	3	7	5	4	2	7	3	5
L	64.6	2136	102.7	5	5	4	5	4	4	5	5	5
Avg.	66.5		99.2	6.6	6.2	4.4	5.2	4.7	3.1	6.0	4.3	4.5
S.D.	2.9		6.8	2.0	1.8	1.4	1.0	1.9	1.6	1.0	1.1	0.7

CASSELTON (C-3)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2750	97.3	8	7	5	5	5	4	5	5	5
B	65.0	790	87.8	5	3	3	5	3	5	7	1	1
C	67.9	890	98.7	6	5	5	6	5	4	7	4	5
D	65.9	920	95.8	9	5	5	3	2	3	5	3	3
E	62.9	882	99.8	5	7	5	6	5	4	6	2	4
F	59.0	836	104.8	6	5	4	7	6	3	7	6	6
G	62.8	855	96.6	5	8	3	4	4	4	5	4	4
H	58.0	2863	104.6	7	7	3	7	5	3	7	5	5
I	60.0	2500	97.1	9	7	5	5	5	3	5	3	3
J	63.1	2285	97.4	5	7	3	5	5	3	9	3	3
K	58.4	1915	90.6	5	5	3	5	4	3	7	3	4
L	58.4	2166	101.3	9	7	7	5	6	4	5	5	6
Avg.	61.8		97.6	6.6	6.1	4.3	5.3	4.6	3.6	6.3	3.7	4.1
S.D.	3.3		5.0	1.7	1.4	1.3	1.1	1.2	0.7	1.3	1.4	1.4

HAVRE (H-3)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	63.0	2425	95.1	3	5	3	5	5	4	5	3	3
B	69.0	890	87.3	3	5	1	5	3	1	1	3	1
C	75.6	960	96.2	4	5	4	5	5	3	2	5	4
D	71.3	1075	91.9	5	3	3	7	5	1	4	3	3
E	72.2	977	99.5	6	7	4	6	7	3	3	2	3
F	68.1	1047	100.4	4	5	3	5	7	7	4	5	5
G	72.6	840	83.2	5	5	3	5	6	2	3	3	3
H	67.0	2618	93.2	5	5	1	3	3	3	4	1	3
I	69.2	2775	112.1	9	7	3	5	9	3	3	7	7
J	68.2	2265	95.6	5	5	3	3	5	3	3	3	3
K	67.4	1922	95.2	5	5	7	6	5	2	3	4	5
L	67.4	1948	89.5	4	5	2	5	4	3	4	4	4
Avg.	69.3		94.9	4.8	5.2	3.1	5.0	5.3	2.9	3.3	3.6	3.7
S.D.	3.3		7.3	1.6	1.0	1.6	1.1	1.7	1.6	1.1	1.6	1.5

CROOKSTON (K-3)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2775	96.5	5	5	4	5	5	5	5	4	4
B	67.0	945	99.5	3	7	3	3	3	3	5	5	1
C	73.8	934	98.6	5	4	3	4	3	4	5	5	4
D	70.6	975	103.7	7	5	3	3	4	3	5	4	4
E	69.7	926	100.0	4	7	5	5	5	4	5	3	4
F	65.8	890	99.7	5	5	3	5	5	4	5	5	5
G	70.3	885	99.4	5	6	2	5	5	4	5	6	5
H	65.0	2604	92.7	5	7	1	5	5	3	5	3	3
I	66.8	2575	104.0	9	7	3	5	5	5	5	5	5
J	66.0	2190	101.2	5	5	3	5	3	5	5	3	3
K	65.6	1946	99.2	7	7	5	7	5	3	5	5	4
L	65.6	2096	98.5	6	5	4	5	5	4	5	4	4
Avg.	67.3		99.4	5.5	5.8	3.3	4.8	4.4	3.9	5.0	4.3	3.8
S.D.	3.3		3.0	1.6	1.1	1.1	1.1	0.9	0.8	0.0	1.0	1.1

MINOT (M-3)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	64.0	2900	101.8	9	9	5	5	5	5	5	5	5
B	71.0	1020	91.1	3	5	3	5	3	3	5	3	3
C	72.9	990	102.7	4	5	7	5	5	4	6	5	6
D	72.5	1145	93.5	5	5	3	5	6	3	4	4	4
E	72.3	974	105.0	5	7	4	5	6	4	4	4	4
F	67.8	1056	113.9	5	5	4	8	7	6	5	6	6
G	73.8	985	106.5	5	5	3	6	6	4	5	6	5
H	67.0	2604	96.2	5	5	3	3	5	3	5	3	3
I	69.0	2725	99.1	9	7	3	5	5	3	5	5	5
J	69.3	2627	105.8	7	7	3	5	5	3	5	7	5
K	68.0	2137	107.3	1	2	3	6	7	3	6	7	7
L	68.0	2163	95.9	6	6	4	5	5	4	5	5	5
Avg.	**69.6**		**101.6**	**5.3**	**5.7**	**3.8**	**5.3**	**5.4**	**3.8**	**5.0**	**5.0**	**4.8**
S.D.	**2.9**		**6.6**	**2.3**	**1.7**	**1.2**	**1.1**	**1.1**	**1.0**	**0.6**	**1.3**	**1.2**

WILLISTON (W-3)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	63.0	2900	104.5	9	9	5	5	5	5	5	5	5
B	70.0	1035	99.0	9	9	5	3	3	5	3	5	3
C	75.7	1020	102.4	9	5	4	5	6	3	4	5	5
D	70.9	920	90.2	9	7	5	7	5	2	4	5	4
E	70.0	884	95.5	6	8	6	6	5	4	4	4	4
F	66.2	961	106.3	8	6	4	7	6	6	4	6	5
G	71.1	910	89.7	8	8	2	5	3	2	4	3	3
H	65.0	2986	104.1	9	7	5	5	5	3	4	7	5
I	67.0	2500	106.4	9	9	5	5	7	5	3	5	5
J	66.6	2549	114.6	9	9	3	5	3	3	3	7	3
K	65.6	2065	96.9	7	7	7	6	7	3	3	5	5
L	65.6	2314	109.3	8	7	4	5	4	3	4	4	4
Avg.	**68.1**		**101.6**	**8.3**	**7.6**	**4.6**	**5.3**	**4.9**	**3.7**	**3.8**	**5.1**	**4.3**
S.D.	**3.5**		**7.5**	**1.0**	**1.3**	**1.3**	**1.1**	**1.4**	**1.3**	**0.6**	**1.2**	**0.9**

SWQC #4 – MN-Rothsay

WATERTOWN (B-4)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	63.0	2700	95.6	9	8	5	4	4	5	5	5	4
B	70.0	935	87.4	3	5	3	5	3	3	7	3	5
C	72.1	901	95.6	4	6	2	6	6	4	6	5	5
D	72.2	1080	89.3	5	5	1	3	4	3	5	3	3
E	69.8	920	95.4	5	7	4	5	8	4	5	2	4
F	65.7	1041	104.3	4	5	2	7	6	6	5	6	5
G	69.3	840	101.8	6	5	6	5	6	4	6	6	5
H	65.0	2736	103.9	7	9	3	5	5	3	7	5	5
I	66.8	2425	97.0	9	7	5	5	5	3	5	3	5
J	65.2	2489	105.1	5	7	3	3	1	5	7	3	5
K	65.0	1897	99.6	7	3	9	5	5	3	7	5	5
L	65.0	2057	98.9	5	4	4	5	4	4	5	5	5
Avg.	67.4		97.8	5.8	5.9	3.9	4.8	4.8	3.9	5.8	4.3	4.7
S.D.	3.1		5.7	1.9	1.7	2.2	1.1	1.8	1.0	0.9	1.4	0.7

CASSELTON (C-4)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2800	99.1	9	7	5	5	5	5	5	5	5
B	69.0	855	95.0	3	3	5	5	5	7	7	3	5
C	69.4	866	96.0	3	8	7	5	7	5	6	4	5
D	69.5	970	101.0	7	6	5	7	5	6	5	6	6
E	69.2	908	102.7	6	7	4	5	5	5	6	5	5
F	64.6	830	104.0	5	6	4	7	5	5	6	5	5
G	69.7	865	97.7	5	6	2	4	5	5	5	4	4
H	64.0	2883	105.4	5	7	3	7	5	5	5	5	5
I	66.0	2575	100.0	9	7	3	5	5	5	5	5	5
J	65.0	2303	98.1	7	9	5	5	5	5	7	5	5
K	65.0	1874	88.6	3	3	3	5	5	6	7	3	5
L	65.0	2145	100.3	9	7	7	5	5	5	5	5	5
Avg.	66.5		99.0	5.9	6.3	4.4	5.4	5.2	5.3	5.8	4.6	5.0
S.D.	2.8		4.5	2.3	1.8	1.6	1.0	0.6	0.7	0.9	0.9	0.4

CROOKSTON (K-4)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2850	99.1	9	7	5	5	5	5	5	5	5
B	67.0	910	95.8	5	7	3	5	5	1	5	3	3
C	72.0	790	83.4	5	5	1	5	3	4	5	3	3
D	68.7	995	105.9	7	5	3	3	5	3	5	5	5
E	67.7	906	97.8	5	6	5	5	6	4	4	3	4
F	63.4	930	104.1	6	5	4	4	7	4	5	6	6
G	67.8	900	101.1	5	5	3	6	6	3	5	5	4
H	63.0	2795	99.5	9	7	3	5	7	3	5	5	5
I	64.5	2525	102.0	9	7	5	5	5	3	5	5	5
J	64.6	2234	103.2	7	7	5	3	3	5	5	3	3
K	63.1	1983	101.1	5	5	3	6	5	3	6	5	5
L	63.1	2163	101.6	6	5	4	5	5	4	5	4	4
Avg.	**65.5**		**99.6**	**6.5**	**5.9**	**3.7**	**4.8**	**5.2**	**3.5**	**5.0**	**4.3**	**4.3**
S.D.	**3.1**		**5.8**	**1.7**	**1.0**	**1.2**	**1.0**	**1.3**	**1.1**	**0.4**	**1.1**	**1.0**

MINOT (M-4)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	65.0	2750	96.5	9	8	5	5	5	5	5	5	5
B	73.0	1030	92.0	3	3	3	5	5	5	5	3	3
C	75.5	971	100.7	4	6	3	5	6	5	5	5	5
D	74.2	1100	89.8	5	3	1	5	6	5	4	5	5
E	73.3	935	100.8	5	6	3	5	6	5	3	3	4
F	68.7	1089	117.5	4	5	3	7	7	5	5	6	6
G	73.5	895	96.8	5	5	3	3	6	5	5	4	4
H	68.0	2765	102.2	7	7	3	5	5	5	4	5	5
I	70.2	2600	94.5	9	7	3	5	3	5	3	3	3
J	68.2	2580	103.9	9	9	5	5	3	5	5	7	7
K	68.2	2031	102.0	1	1	1	7	5	5	5	7	5
L	68.2	2308	102.4	7	6	5	6	6	5	4	4	5
Avg.	**70.5**		**99.9**	**5.7**	**5.5**	**3.2**	**5.3**	**5.3**	**5.0**	**4.4**	**4.8**	**4.8**
S.D.	**3.3**		**7.1**	**2.6**	**2.3**	**1.3**	**1.1**	**1.2**	**0.0**	**0.8**	**1.4**	**1.1**

SWQC #6 – G18C2097

WATERTOWN (B-6)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	63.0	2850	100.9	9	9	5	5	4	5	5	5	5
B	70.0	925	86.4	7	3	5	5	3	3	5	3	3
C	73.9	955	101.4	6	7	3	4	3	4	5	5	5
D	72.4	1125	93.0	9	5	5	5	5	3	5	5	5
E	72.0	932	96.7	6	7	4	5	5	4	5	3	4
F	68.1	939	94.1	7	5	4	3	3	6	5	3	4
G	70.5	890	107.9	6	6	6	4	3	4	5	4	4
H	67.0	2809	106.7	7	9	3	5	5	3	5	5	5
I	68.8	2450	98.0	9	9	5	5	5	3	5	5	5
J	67.0	2362	99.7	7	9	5	3	5	5	5	5	3
K	67.0	1923	101.0	5	5	9	3	5	3	5	6	5
L	67.0	2172	104.5	7	6	8	5	5	4	4	3	3
Avg.	68.9		99.2	7.1	6.7	5.2	4.3	4.3	3.9	4.9	4.3	4.3
S.D.	3.0		6.1	1.3	2.0	1.8	0.9	1.0	1.0	0.3	1.1	0.9

CASSELTON (C-6)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	62.0	2925	103.5	9	7	5	5	4	6	5	5	5
B	69.0	900	100.0	5	3	3	7	5	7	5	5	5
C	71.4	949	105.2	5	8	7	4	5	6	4	6	6
D	70.6	1055	109.9	7	5	5	9	8	7	5	8	7
E	68.6	924	104.5	5	7	5	6	4	6	9	6	7
F	64.5	817	102.4	5	7	4	7	5	6	5	5	5
G	68.9	860	97.2	6	6	5	6	5	6	4	4	4
H	63.0	2780	101.6	9	9	5	7	5	7	6	5	7
I	65.7	2425	94.2	9	7	5	5	3	7	5	3	3
J	64.6	2327	99.1	7	9	5	5	3	5	5	5	5
K	64.3	1924	91.0	7	7	5	6	5	7	3	3	5
L	64.3	2059	96.3	7	6	5	5	4	6	6	5	5
Avg.	66.4		100.4	6.8	6.8	4.9	6.0	4.7	6.3	5.2	5.0	5.3
S.D.	3.1		5.2	1.6	1.7	0.9	1.3	1.3	0.7	1.5	1.3	1.2

CROOKSTON (K-6)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	3000	104.3	9	7	5	5	5	5	5	5	5
B	69.0	905	95.3	9	5	9	3	3	3	5	3	3
C	73.0	932	98.4	8	8	3	5	4	4	4	5	4
D	71.2	865	92.0	9	5	5	1	4	3	5	3	3
E	68.2	918	99.1	6	8	5	4	5	4	5	4	4
F	64.7	798	89.4	9	7	5	4	4	4	4	4	4
G	67.6	905	101.7	7	8	5	4	4	4	4	4	4
H	63.0	2795	99.5	9	9	5	5	5	3	4	5	5
I	65.0	2425	98.0	9	9	5	5	3	5	5	5	5
J	64.6	2222	102.7	7	9	5	3	5	3	3	5	3
K	63.4	2109	107.5	5	5	3	6	6	3	4	7	6
L	63.4	2301	108.1	8	8	6	5	5	4	5	5	4
Avg.	**66.2**		**99.7**	**7.9**	**7.3**	**5.1**	**4.2**	**4.4**	**3.8**	**4.4**	**4.6**	**4.2**
S.D.	**3.6**		**5.7**	**1.4**	**1.6**	**1.5**	**1.3**	**0.9**	**0.8**	**0.7**	**1.1**	**0.9**

SWQC #7 – Ascend-SD

WATERTOWN (B-7)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	63.0	2825	100.0	9	9	5	5	4	5	4	5	5
B	71.0	885	82.7	7	1	5	5	3	3	3	3	1
C	74.8	953	101.2	6	9	5	4	5	3	2	5	4
D	73.5	1055	87.2	9	6	7	7	7	3	3	7	5
E	71.3	896	92.9	6	8	5	5	5	4	3	4	4
F	67.8	890	89.2	8	6	7	3	4	6	4	3	4
G	71.9	945	114.5	7	7	9	5	3	4	3	4	4
H	66.0	2775	105.4	9	9	9	5	5	3	3	7	7
I	68.3	2425	97.0	9	9	7	5	5	3	3	5	3
J	67.2	2383	100.6	7	9	5	5	5	3	3	5	5
K	67.1	1858	97.6	5	5	9	3	3	2	3	5	5
L	67.1	2122	102.1	9	8	9	5	6	4	4	3	4
Avg.	69.1		97.5	7.6	7.2	6.8	4.8	4.6	3.6	3.2	4.7	4.3
S.D.	3.4		8.6	1.4	2.4	1.8	1.1	1.2	1.1	0.6	1.4	1.4

CASSELTON (C-7)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2950	104.4	8	7	5	5	4	5	5	5	5
B	66.0	785	87.2	3	1	3	5	3	5	3	1	1
C	67.5	873	96.8	4	9	5	5	5	4	4	4	4
D	68.2	945	98.4	5	5	5	5	5	4	5	5	5
E	68.5	884	100.0	4	8	4	5	5	5	2	4	4
F	64.5	920	115.3	5	5	4	7	6	4	4	6	5
G	70.4	895	101.1	5	5	2	5	6	4	4	6	5
H	63.0	2825	103.3	5	7	1	7	5	3	4	5	5
I	65.2	2550	99.0	9	7	3	5	5	3	5	5	5
J	64.6	2434	103.7	5	7	3	5	5	5	3	3	3
K	64.4	1772	83.8	3	1	1	6	4	3	3	2	3
L	64.4	2220	103.8	5	6	7	5	5	5	5	5	5
Avg.	65.6		99.7	5.1	5.7	3.6	5.4	4.8	4.2	3.9	4.3	4.2
S.D.	2.6		8.2	1.8	2.5	1.8	0.8	0.8	0.8	1.0	1.5	1.3

CROOKSTON (K-7)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	62.0	3025	105.2	9	7	5	5	5	5	4	5	5
B	69.0	945	99.5	9	5	5	3	5	3	3	5	1
C	74.4	991	104.6	6	7	3	4	6	4	2	6	4
D	69.8	990	105.3	9	5	3	3	5	4	3	5	4
E	68.0	948	102.4	6	7	4	5	5	5	1	2	3
F	64.1	919	102.9	8	6	5	4	4	5	3	5	3
G	69.0	930	104.5	6	7	2	5	5	5	3	6	5
H	63.0	2809	100.0	7	7	3	5	5	5	2	5	5
I	64.8	2425	98.0	9	9	3	5	3	5	3	3	3
J	64.6	2226	102.9	7	9	5	5	5	5	1	5	3
K	63.4	2027	103.4	7	7	5	5	5	4	2	7	5
L	63.4	2202	103.5	9	8	9	5	4	4	4	4	4
Avg.	66.3		102.7	7.7	7.0	4.3	4.5	4.8	4.5	2.6	4.8	3.8
S.D.	3.7		2.4	1.3	1.3	1.8	0.8	0.8	0.7	1.0	1.3	1.2

MINOT (M-7)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	64.0	3075	107.9	9	9	5	5	5	5	5	5	5
B	73.0	1035	92.4	3	3	5	5	3	5	1	3	1
C	75.7	989	102.6	4	7	7	4	5	5	2	5	5
D	74.4	1215	99.2	7	6	5	1	3	4	3	3	3
E	74.4	958	103.2	5	8	6	5	6	5	1	7	4
F	70.4	935	100.9	5	6	5	4	5	5	3	5	4
G	75.1	920	99.5	5	7	6	4	7	4	4	6	4
H	69.0	2780	102.7	7	5	3	5	5	5	3	7	5
I	71.2	2600	94.5	9	7	5	5	3	5	3	3	3
J	70.0	2602	104.8	9	9	5	5	5	5	1	7	3
K	70.2	1972	99.0	7	7	7	5	5	5	2	5	5
L	70.2	2355	104.4	9	7	9	6	6	4	4	4	4
Avg.	71.5		100.9	6.6	6.8	5.7	4.5	4.8	4.8	2.7	5.0	3.8
S.D.	3.3		4.4	2.2	1.7	1.5	1.2	1.3	0.5	1.3	1.5	1.2

SWQC #9 – AP Smith

CASSELTON (C-9)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2950	104.4	5	5	4	5	4	5	5	4	4
B	66.0	875	97.2	3	5	1	5	5	5	7	3	3
C	69.3	918	101.8	4	7	6	5	5	4	7	5	5
D	67.5	960	100.0	7	5	5	5	6	4	5	5	5
E	66.3	874	98.9	4	7	5	6	5	5	6	5	5
F	61.8	810	101.5	5	5	3	8	4	4	7	4	6
G	67.0	830	93.8	5	5	3	5	6	4	6	5	4
H	61.0	2725	99.6	7	7	3	7	5	5	8	3	3
I	63.4	2525	98.1	9	7	5	5	5	5	7	5	5
J	62.2	2488	106.0	7	7	3	5	5	5	9	5	5
K	62.2	2023	95.7	7	7	5	5	5	4	8	4	4
L	62.2	2193	102.5	9	5	7	5	5	5	5	5	5
Avg.	64.2		100.0	6.0	6.0	4.2	5.5	5.0	4.6	6.7	4.4	4.5
S.D.	2.9		3.5	2.0	1.0	1.6	1.0	0.6	0.5	1.3	0.8	0.9

CROOKSTON (K-9)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	62.0	3100	107.8	9	7	5	5	5	5	5	5	5
B	67.0	995	104.7	7	9	3	3	5	3	5	9	5
C	74.3	948	100.1	9	4	4	4	3	4	4	5	4
D	69.6	970	103.2	9	5	3	3	6	3	5	5	5
E	68.1	943	101.8	6	7	5	4	5	4	3	4	4
F	63.7	833	93.3	7	6	5	3	4	4	4	4	4
G	68.3	950	106.7	6	7	4	4	4	4	4	5	4
H	63.0	2883	102.6	9	7	3	5	5	3	4	5	5
I	64.9	2225	89.9	9	9	5	5	1	5	5	1	1
J	64.6	2162	99.9	7	9	5	3	5	5	5	5	5
K	63.7	2061	105.1	7	7	5	4	5	3	6	6	6
L	63.7	2109	99.1	9	8	9	5	6	4	5	5	5
Avg.	66.1		101.2	7.8	7.1	4.7	4.0	4.5	3.9	4.6	4.9	4.4
S.D.	3.5		5.3	1.3	1.6	1.6	0.9	1.4	0.8	0.8	1.8	1.2

MINOT (M-9)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Quality Score Compared to Check (LCS Rebel): Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	65.0	2925	102.6	9	9	5	5	5	5	5	5	5
B	73.0	1100	98.2	7	5	7	3	5	5	5	5	5
C	74.7	988	102.5	7	5	8	4	5	5	3	5	5
D	74.4	930	75.9	9	7	9	3	4	5	4	3	4
E	72.9	930	100.2	5	6	4	5	6	5	4	3	4
F	68.5	870	93.9	7	5	6	6	3	5	4	3	3
G	74.9	930	100.5	7	8	4	5	5	4	4	5	5
H	68.0	2853	105.4	7	7	3	5	7	5	5	7	7
I	69.8	2375	86.4	9	9	3	5	1	5	5	3	3
J	69.0	2419	97.4	9	9	5	5	7	5	3	5	3
K	69.0	2136	107.3	3	2	3	6	5	5	3	7	5
L	69.0	2461	109.1	8	7	7	6	6	4	4	4	4
Avg.	**70.7**		**98.3**	**7.3**	**6.6**	**5.3**	**4.8**	**4.9**	**4.8**	**4.1**	**4.6**	**4.4**
S.D.	**3.2**		**9.3**	**1.8**	**2.1**	**2.1**	**1.0**	**1.7**	**0.4**	**0.8**	**1.4**	**1.2**

WILLISTON (W-9)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Quality Score Compared to Check (LCS Rebel): Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	63.0	2975	107.2	9	9	5	5	5	5	5	5	5
B	69.0	1075	102.9	9	9	9	3	3	3	1	7	5
C	72.3	994	99.8	9	5	8	4	4	4	2	5	4
D	71.6	910	89.2	9	6	5	5	4	3	4	4	4
E	68.7	887	95.8	8	7	4	4	5	4	2	1	2
F	64.4	991	109.6	9	5	4	4	5	6	4	5	4
G	68.6	725	71.4	7	7	2	4	5	2	4	2	2
H	64.0	2868	100.0	9	9	5	5	5	3	3	5	5
I	65.9	2125	90.4	9	9	5	5	3	5	3	3	3
J	65.6	2146	96.4	9	9	5	3	5	3	3	3	3
K	64.9	2044	95.9	3	1	3	5	5	3	3	4	5
L	64.9	1947	91.9	9	8	5	5	5	3	4	4	4
Avg.	**66.9**		**95.9**	**8.3**	**7.0**	**5.0**	**4.3**	**4.5**	**3.7**	**3.2**	**4.0**	**3.8**
S.D.	**3.1**		**9.9**	**1.8**	**2.4**	**1.9**	**0.8**	**0.8**	**1.2**	**1.1**	**1.6**	**1.1**

SWQC #10 – MN15119-2

WATERTOWN (B-10)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	64.0	2700	95.6	9	9	5	5	6	5	5	5	5
B	71.0	960	89.7	7	3	3	5	3	5	9	1	3
C	74.5	977	103.7	7	7	4	4	6	4	7	5	6
D	72.1	1140	94.2	9	5	7	5	3	4	5	4	4
E	68.8	976	101.2	6	7	4	5	5	5	6	1	4
F	65.3	1071	107.3	6	6	5	3	6	5	6	6	6
G	67.2	945	114.5	5	8	9	3	3	4	6	2	3
H	63.0	2839	107.8	9	9	7	5	5	3	7	7	7
I	65.7	2400	96.0	9	9	7	5	5	5	5	5	5
J	64.6	2378	100.4	7	9	5	1	3	5	7	3	3
K	63.9	1963	103.1	3	1	5	3	5	3	8	7	5
L	63.9	2215	106.5	9	8	9	5	6	4	4	4	5
Avg.	67.0		101.7	7.2	6.8	5.8	4.1	4.7	4.3	6.3	4.2	4.7
S.D.	3.8		7.0	1.9	2.6	1.9	1.3	1.3	0.8	1.4	2.1	1.3

CASSELTON (C-10)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2875	101.8	5	5	4	5	4	5	5	4	4
B	68.0	885	98.3	5	5	3	5	5	5	5	3	3
C	68.3	893	99.0	4	6	3	4	4	4	5	4	4
D	68.5	985	102.6	7	5	5	5	4	4	5	5	5
E	68.4	916	103.6	4	8	5	5	4	5	4	5	5
F	65.5	877	109.9	5	6	3	7	6	4	5	6	5
G	70.4	850	96.0	5	4	4	6	6	4	5	5	4
H	63.0	2839	103.8	7	7	3	7	5	5	5	5	5
I	65.5	2500	97.1	9	7	5	5	5	5	5	5	5
J	66.0	2414	102.9	5	7	3	5	3	5	5	5	3
K	64.5	1860	88.0	6	6	5	6	5	4	5	3	6
L	64.5	2198	102.8	5	5	7	4	5	5	5	5	5
Avg.	66.1		100.5	5.6	5.9	4.2	5.3	4.7	4.6	4.9	4.6	4.5
S.D.	2.7		5.4	1.4	1.2	1.3	1.0	0.9	0.5	0.3	0.9	0.9

CROOKSTON (K-10)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	3000	104.3	9	7	5	5	5	5	5	5	5
B	67.0	970	102.1	9	9	5	3	5	1	7	7	7
C	70.5	955	100.8	9	5	3	4	4	4	6	5	4
D	68.2	1010	107.4	9	6	5	3	3	3	5	3	3
E	63.7	980	105.8	6	7	4	5	5	4	4	1	3
F	60.6	885	99.1	8	6	4	4	6	4	6	5	6
G	63.0	945	106.2	5	7	6	5	4	3	5	5	4
H	59.0	2897	103.1	9	7	5	5	5	3	4	5	5
I	60.6	2375	96.0	9	9	5	5	3	3	5	3	1
J	60.3	2311	106.8	7	9	5	3	5	3	7	5	5
K	58.8	2089	106.5	9	7	7	4	4	3	7	7	5
L	58.8	2062	96.9	9	7	7	5	6	4	5	4	4
Avg.	62.6		102.9	8.2	7.2	5.1	4.3	4.6	3.3	5.5	4.6	4.3
S.D.	4.0		4.0	1.4	1.3	1.2	0.9	1.0	1.0	1.1	1.7	1.6

MINOT (M-10)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	65.0	2750	96.5	9	9	5	5	5	5	5	5	5
B	73.0	1035	92.4	7	3	5	3	5	5	7	3	5
C	76.1	1052	109.1	8	6	7	5	5	6	6	7	6
D	73.7	1085	88.6	9	4	5	3	4	6	4	3	4
E	70.7	984	106.0	6	6	5	5	6	5	5	5	5
F	66.1	1084	116.9	5	6	5	5	5	4	6	6	6
G	68.8	985	106.5	5	7	5	4	7	4	5	4	4
H	65.0	2839	104.9	7	5	3	5	5	5	5	7	5
I	67.6	2525	91.8	9	9	5	5	3	5	7	3	3
J	68.0	2524	101.7	9	9	5	5	5	7	9	5	7
K	65.6	2121	106.5	3	3	3	5	6	6	7	7	5
L	65.6	1992	88.3	9	7	8	5	6	4	4	4	4
Avg.	68.8		100.8	7.2	6.2	5.1	4.6	5.2	5.2	5.8	4.9	4.9
S.D.	3.8		9.1	2.0	2.2	1.4	0.8	1.0	0.9	1.5	1.6	1.1

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
Farinograph (50 g bowl)	Absorption (%)	64
	Peak Time (min)	6-8
	Stability (min)	15-17
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.