Wheat Quality Council

Hard Spring Wheat Technical Committee

2024 Crop

February 18-20, 2025
Embassy Suites by Hilton Kansas City Olathe
Olathe, KS

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Sponsored by the Wheat Quality Council
February 18-20, 2025

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Wheat Quality Council

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Introduction

Breeders' experimental wheat lines 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.

Nine experimental lines of hard spring wheat were grown at six locations in 2024 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 by the USDA-ARS Western Wheat Quality Laboratory (WWQL), Pullman, WA, and were analyzed by the USDA-ARS Hard Spring & Durum Wheat Quality Laboratory (HSDWQL), 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 2024 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 2024 Wheat Quality Testing Program

Wheat Source

Source/Breeding Program	SWQC Code #	Identification
University of Minnesota	1	Linkert (Eastern Check)
Montana State University	2	Dagmar (alternative western check)
South Dakota State University	3	SD4905
University of Minnesota	4	MN13398-2
Limagrain Cereal Seeds	5	LCS Rebel (Western Check)
University of Minnesota	6	MN19358-1
Montana State University	7	MT 21074
North Dakota State University	8	NDHRS15-0006-C46
Limagrain Cereal Seeds	9	LCS Hammer AX
Montana State University	10	MT 21104
North Dakota State University	11	ND Stampede (alternative check)

Field Plot Locations and Procedures

Coordinator: 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 – Leandro Bortolon;
- 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.

Wheat Production Sites

SWQC Code #	Entry	Production Sites					
		Watertown	Casselton	Havre	Crookston	Minot	Williston
1	Linkert (Eastern Check)	X	X		X		
2	Dagmar (alternative western check)			X		X	X
3	SD4905	X	X		X		
4	MN13398-2	X	X		X	X	
5	LCS Rebel (Western Check)			X		X	X
6	MN19358-1	X	X		X	X	
7	MT 21074			X		X	
8	NDHRS15-0006-C46		X		X	X	X
9	LCS Hammer AX	X	X	X	X	X	X
10	MT 21104			X		X	
11	ND Stampede (alternative check)	X	X	X	X	X	X

Field Production Data

Variable	Watertown	Casselton	Havre	Crookston	Minot	Williston
Planting Date	04/24/2024	04/24/2024	05/01/2024	04/25/2024	05/13/2024	05/17/2024
Harvest Date	09/06/2024	08/13/2024	08/14/2024	08/12/2024	08/27/2024	08/28/2024
Fertilizer (lb/acre)						
N	200	253	50	141.4	150	150
P	*	12 ppm	10	52	50	50
K	50	221 ppm	5	*	*	*
Herbicide(rate/acre)						
Broadleaf	Bronate (1.5 pt)	Huskie Complete (13.7 oz)	Brox-M (24 oz)	Axial Bold (15 oz) Bromac (24 oz) Zidua SC (3 oz)	Huskie FX (18 oz)	GoldSky (16 oz)
Grass	Axial Bold (15 oz)	Huskie Complete (13.7 oz)	OpenSky (16 oz)	Huskie Complete (13.7 oz)	Axial Star (16.4 oz)	GoldSky (16 oz)
Fungicide	*	PropiMax (3 oz) Prosaro (6.5 oz)	Prosaro (5 oz)	*	*	Pydiflumetofen (10 oz) Miravis Ace (10 oz) Propiconazole (10 oz)

*No application.

CLIMATOLOGICAL DATA

Average Temperature (°F) / Precipitation (in)

Month	Watertown	Casselton	Havre	Crookston	Minot	Williston
April	44.0 / 4.68	57.0 / 3.15	45.4 / 0.86	44.6 / 2.12	43.0 / 2.23	56.0 / 0.79
May	57.0 / 4.52	60.0 / 5.42	52.4 / 4.33	56.2 / 4.05	54.0 / 3.65	67.0 / 2.15
June	65.0 / 3.86	78.0 / 3.14	60.0 / 2.47	63.6 / 4.74	61.0 / 3.82	75.0 / 3.29
July	70.0 / 4.96	83.0 / 2.62	72.0 / 0.71	70.1 / 3.09	70.0 / 2.04	81.0 / 1.65
August	67.0 / 2.20	76.0 / 0.45	68.7 / 1.46	*	65.0 / 1.41	77.0 / 0.49

*Data not available.

YIELD DATA

Yield (bu/acre) / Test Weight (lb/bu) / Moisture (%)

SWQC Code #	Watertown	Casselton	Havre	Crookston	Minot	Williston
1	46.2 / 54.8 / 12.3	82.0 / 61.5 / 13.0	*	70.3 / 60.2 / 13.1	*	*
2	*	*	47.3 / 58.0 / 10.7	*	64.2 / 61.1 / 13.4	** / 60.0 / 12.6
3	71.9 / 56.0 / 12.3	96.3 / 59.7 / 12.8	*	91.4 / 61.5 / 13.1	*	*
4	53.8 / 54.4 / 12.5	95.8 / 60.6 / 12.4	*	87.1 / 61.4 / 13.3	55.3 / 60.1 / 10.0	*
5	*	*	36.0 / 58.4 / 10.9	*	72.7 / 60.5 / 9.5	** / 57.0 / 12.6
6	53.2 / 52.9 / 12.3	88.7 / 61.2 / 12.7	*	91.2 / 62.2 / 12.9	70.2 / 62.4 / 12.7	*
7	*	*	45.9 / 55.0 / 10.5	*	62.7 / 59.4 / 8.7	*
8	*	102.4 / 60.0 / 13.0	*	90.2 / 57.8 / 12.9	56.6 / 61.0 / 12.2	** / 54.0 / 12.6
9	47.9 / 53.5 / 12.6	94.3 / 57.3 / 12.7	56.7 / 58.7 / 10.7	53.9 / 58.1 / 13.3	59.5 / 59.4 / 9.4	** / 56.0 / 12.6
10	*	*	52.4 / 59.1 / 10.7	*	56.9 / 57.9 / 8.9	*
11	61.7 / 54.9 / 12.8	96.8 / 59.2 / 12.8	41.6 / 57.2 / 10.7	97.1 / 61.3 / 13.0	74.4 / 58.5 / 8.6	** / 54.0 / 12.6
Site Totals	**6**	**7**	**6**	**7**	**9**	**5**

*Not increased at this site.
** No data available.

Climate, Disease, and Field Conditions

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

	Watertown	Casselton	Havre	Crookston	Minot	Williston
At Planting	Planted in ideal conditions with adequate moisture.	Planted into good moisture and had good rain a couple of days after planting. Emergence date – 05/07/2024.	Seeding conditions were good once the fields were accessible. Seeding was slightly delayed by cool, wet weather. Rain (3.5 in) was received on May 7th and 8th, washing nutrients from the root zone.	Conditions at planting were good.	No comment.	Conditions at planting were excellent. Soil moisture was full in the top 4 feet.
During Growth	Emergence was excellent with a good stand. Good tillering with not much stress and cool temperatures.	Cool, wet, humid season.	Following the early and heavy rain in May, there was only 0.8 in of precipitation for the remainder of the month.	Favorable conditions for wheat this year. Plenty of moisture and cooler temperatures in May and June. An application of Stratego was made at Feekes 5. Because of the way the strips were planted this year, no fungicide application was made at Feekes 9 so as not to drive on the strips with the sprayer.	No comment.	Excellent growing conditions up to flowering then the rain shut off and it got hot. Temperatures recorded up to 111º, which is evident in the low test weights.
At Flowering	Plenty of moisture but no foggy conditions or heavy dews.	Timely application of fungicide.	Dry and hot conditions persisted through flowering and into seed fill with temperatures during the third week of June hitting the high 80's to mid-90s for several consecutive days.	Favorable weather for scab. Plots looked amazing. Prosaro was sprayed onto the strips for scab.	Heat.	Hot and dry.
During Maturation	One heavy rain but plants showed good straw strength.	Couple of rain events.	High temperatures coupled with high winds and low precipitation during seed fill and maturation resulted in decreased seed side and decreased test weights in the spring cereals.	Hot and humid.	No comment.	Hot and dry.
At Harvest	Dry conditions in early August but rains at maturity reduced test weights. Cool weather all season delayed the normal harvest date by two weeks. Heavy DON levels in the area.	Nice dry day to combine; low moisture levels.	Precipitation in August delayed harvest slightly. Wheat stem sawfly was non-existent at the research center in 2024.	The plants did get a little weathered in the field. This was due to them not wanting to dry down on their own. It was pleasantly surprising by how well the strips did. This piece of ground was fertilized for a yield goal of 70 bushels. Majority of the plots passed that target.	No comment.	Hot and dry.

Description of 2024 Hard Spring Wheat Lines

SWQC #2 – Dagmar

Dagmar (MT1133/MT1148) was released in 2019. Moderately sawfly resistant, high yielding, high protein, good test weight, early maturing hard red spring wheat variety adapted to rainfed growing environments in MT. Dagmar has performed well in diverse dryland growing environments and has good end-use quality. Also has good tan spot resistance.

SWQC #3 – SD4905

SD4905 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 F4 population (SD4576/Prevail) that was originally created in fall 2014. During early-generation observation, the population was tested as 32026 and renamed SD4905 with its placement into the 2019 Preliminary Yield Trial. SD4905 was evaluated in Advanced Yield Trials from 2020 through 2024. Beginning in 2021, SD4905 was tested in the Uniform Regional Spring Wheat Nursery for two seasons, and the South Dakota Crop Performance Testing trials for four seasons.

Points of note associated with SD4905 include:

1. High yield potential;
2. Above average test weight;
3. Above average grain protein concentration;
4. Moderate resistance to Fusarium head blight and bacterial leaf streak;
5. Average to above average end-use quality performance.

SWQC #4 – MN13398-2

MN13398-2 (Linkert/Sabin) is short, early maturing, and has a good combination of yield and protein and has straw strength almost as good as Linkert. MN13398-2 is rated as moderately resistant to scab (rated 4 on 1-9 scale).

SWQC #6 – MN19358-1

MN19358-1 (MN-Torgy/MN13398-2) is early maturing and has shown average grain yields, above average protein, and high test weight. MN19358-1 is rated as moderately resistant to scab (rated 4 on 1-9 scale) but moderately susceptible to bacterial leaf streak (6). Straw strength is good, equivalent to MN-Rothsay.

SWQC #7 – MT 21074

MT 21074 (MT1525/MT1348) is a red chaffed, semi-dwarf, medium maturity hard red spring wheat experimental line adapted to rainfed growing environments in MT. Has good yield, high protein content, good test weight, good straw strength and resistance to wheat stem sawfly.

SWQC #8 – NDHRS15-0006-C46

NDHRS15-0006-C46 is a short statured experimental line which is best adapted to the Red River Valley in North Dakota/Minnesota. Relative to ND Stampede, it has shorter plant height, improved straw strength, improved FHB resistance, increased yield potential in rainfed environments, and similar quality.

SWQC #9 – LCS Hammer AX

LCS Hammer AX is the first LCS CoAXium hard red spring wheat available to farmers. This high-yielding, early-maturing CoAXium line has medium plant height and delivers superior grassy weed control with balanced protein and good test weight.

SWQC #10 – MT 21104

MT 2114 (MT1451/MT1866) is a semi-dwarf, medium maturity hard red spring wheat experimental line adapted to rainfed growing environments in MT. Line has good yield potential, protein content, test weight, and straw strength. It is moderately susceptible to wheat stem sawfly.

SWQC #11 – ND Stampede

ND Stampede is a short statured variety with wide adaptation to the Northern Plains. It has high yield potential, good disease resistance, and improved straw strength. It was released in 2024 by the North Dakota Agricultural Experiment Station.

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. Wheat with DON levels above 1.0 ppm were not milled.

Cleaned wheat (90 lb) was tempered to 16.5% moisture content and conditioned for approximately 20-24 h before milling. Milling was performed on the MIAG Multomat mill at the USDA-ARS, Western Wheat Quality Laboratory, Pullman, WA. Feed rate was set at 127 lb/h. Break rollers were adjusted to the following releases through a U.S. 25 S.S. sieve: first break – 43%; second break – 60%.

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

Milling streams blended to long patent flour – 1st Break, 2nd Break, Grader, 3rd Break, 1st Middlings, 2nd Middlings, 3rd Middlings, 1st Middlings Redust, 4th Middlings, and 5th Middlings.

Methods of Analysis

- Wheat Market Value Score;
- DON levels – analyzed by North Dakota Grain Inspection, Fargo, ND;
- Test weight (AACCI Method 55-10);
- Wheat and flour protein (AACCI Method 46-30);
- 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) - analyzed 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 min 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).

- GlutoPeak (Chandi & Seetharaman (2012), J. Food Qual. 35:69-75):

    - Solvent: 0.5 *M* $CaCl_2 \cdot 2H_2O$;

    - Temperature: 34ºC;

    - Speed: 1,900 rpm.

    GlutoPeak parameters:

    - AM: Torque 15 s before peak (GPU);

    - PM: Torque 15 s after peak (GPU);

    - BEM: Peak torque (GPU);

    - PMT: Peak maximum time (s);

    - Aggregation energy: area under the curve between AM and PM (cm^2).

- Extensograph (AACCI Method 54-10 with modifications):
    - Flour (100 g, 14% mb), 2.0% NaCl (ACS grade), 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 min at 30° C and 78% r.h. Dough was then stretched as described in the referenced procedure. 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.

Baking Procedures

Flour samples were shipped to cooperators for evaluation of baking properties. Flour had been uniformly malted to a Falling Number of approximately 250 s. 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 USDA-ARS HSDWQL for compilation of results.

Special thanks to ADM Milling for providing the malt for this project.

Baking Collaborators

- 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;
- North Dakota State University, Department of Plant Sciences – Fargo, ND;
- University of Idaho – Aberdeen, ID;
- 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 2024 Hard Spring Wheat Lines

SWQC #2 – Dagmar

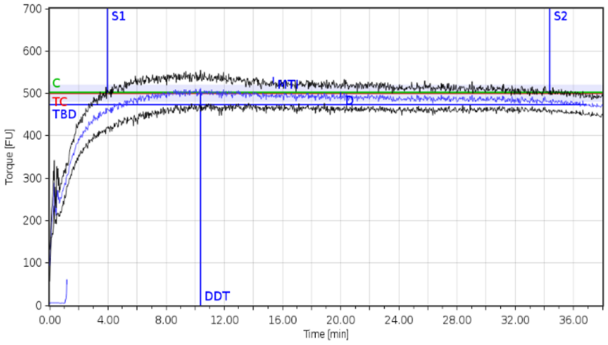
		Havre		Minot		Williston	
		LCS Rebel		LCS Rebel		LCS Rebel	
	Quality Trait	H-5	H-2	M-5	M-2	W-5	W-2
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	16.6	16.8	15.6	16.5	14.6	13.9
2	Flour Protein (%, 14% mb)	15.2	15.2	14.2	14.8	13.3	12.5
3	Market Value (Score 1-6)	4.4	4.5	5.3	5.7	4.4	4.4
4	Market Value (Score 1-10)	10.0	10.0	10.0	9.6	10.0	9.4
5	DON (ppm)	nd	nd	≤ 0.5	≤ 0.5	≤ 0.5	nd
6	Test Weight (lb/bu)	59.6	59.1	63.8	62.3	61.7	62.1
7	1000 Kernel Weight (g)	28.1	30.9	35.7	37.6	30.8	34.7
8	Kernel Size, Large (%)	20	33	72	76	47	62
9	Kernel Size, Small (%)	26	18	6	7	16	9
10	Wheat Moisture (%)	11.5	11.3	11.4	11.9	12.5	12.7
11	Wheat Ash (%, 14% mb)	1.53	1.55	1.37	1.38	1.60	1.68
12	Wheat Falling Number (s)	469	458	396	431	442	420
13	SKCS Hardness Index	72.1	68.5	62.7	63.1	69.5	73.2
14	Vitreous Kernels (%)	99	95	83	83	94	96
	Flour Extraction						
15	Tempered Wheat Basis (%)	73.0	69.5	77.5	75.5	75.2	72.1
16	Total Product Basis (%)	73.3	70.7	77.5	76.2	75.4	72.8
17	Flour/Bu Wheat (lb)	44.4	42.2	50.5	47.9	46.8	44.9
	Flour Quality						
18	Flour Color Brightness (*L**)	90.5	90.3	91.0	90.2	90.9	90.8
19	Flour Color Yellowness (*b**)	9.8	9.8	9.7	9.9	9.8	9.4
20	Flour Moisture (%)	13.2	13.4	13.4	13.4	13.4	13.0
21	Flour Ash (%, 14% mb)	0.46	0.46	0.41	0.42	0.50	0.52
22	Flour Falling Number (malted, s)	252	249	247	251	254	251
	Farinograph						
23	Water Absorption (%, 500 BU)	63.6	62.6	61.2	61.3	60.5	61.1
24	Water Absorption (%, 14% mb)	63.0	62.2	61.0	60.9	60.1	60.1
25	Arrival Time (min)	4.0	3.2	2.8	2.5	2.1	1.4
26	Peak Time (min)	10.4	9.1	7.7	8.5	7.4	5.6
27	Dough Stability (min)	30.4	20.1	15.4	35.8	13.6	10.4
28	Mixing Tolerance Index (MTI, BU)	17	12	21	20	23	32
29	Time To Breakdown (TTB, min)	36.9	24.6	17.7	39.9	14.2	10.9
	II. Cooperator Results						
30	Bake Absorption (Average %)	65.6	64.9	63.9	64.4	63.0	63.0
31	Loaf Volume (% of Check)		100.3		96.7		100.9

SWQC #2 – Dagmar

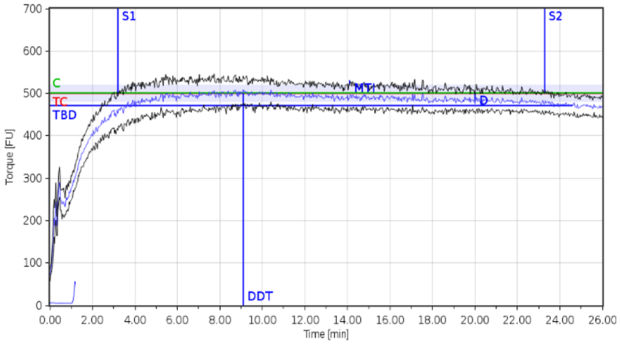
	Quality Trait	Havre LCS Rebel H-5	Havre H-2	Minot LCS Rebel M-5	Minot M-2	Williston LCS Rebel W-5	Williston W-2
	II. Cooperator Results						
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	**6.8**	**5.5**	**6.2**	**6.3**	**7.1**	**6.5**
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	**6.5**	**5.6**	**5.8**	**6.3**	**7.3**	**6.7**
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		**4.4**		**6.2**		**4.5**
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**5.1**		**5.6**		**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		**5.0**		**5.3**		**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		**5.0**		**5.7**		**3.9**
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**3.8**		**4.5**		**4.1**
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**5.3**		**5.2**		**5.3**
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.6**		**5.4**		**4.5**

Farinograms

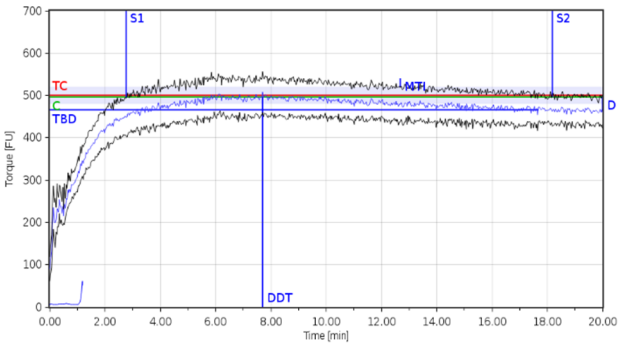
LCS Rebel Check (Havre, H-5)



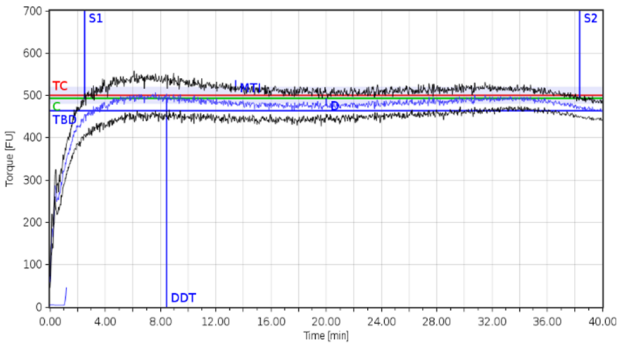
Dagmar (Havre, H-2)



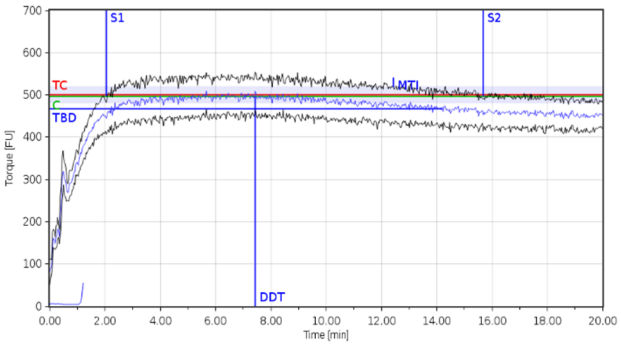
LCS Rebel Check (Minot, M-5)



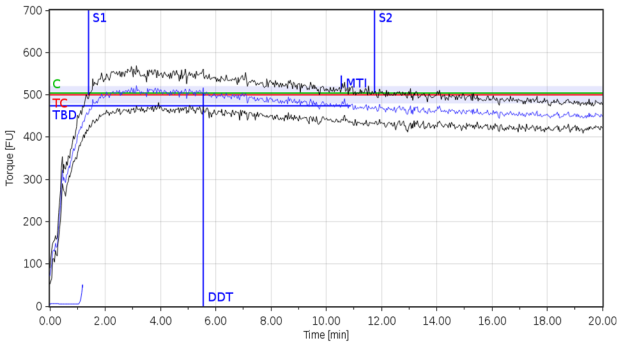
Dagmar (Minot, M-2)



LCS Rebel Check (Williston, W-5)

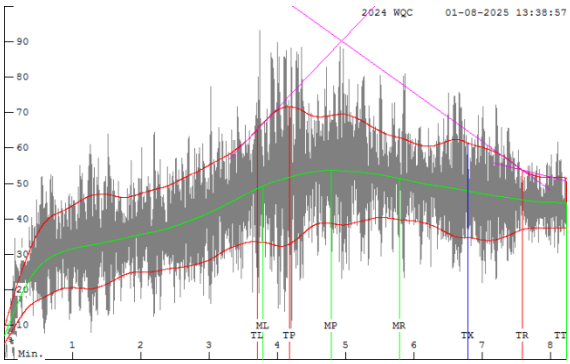


Dagmar (Williston, W-2)

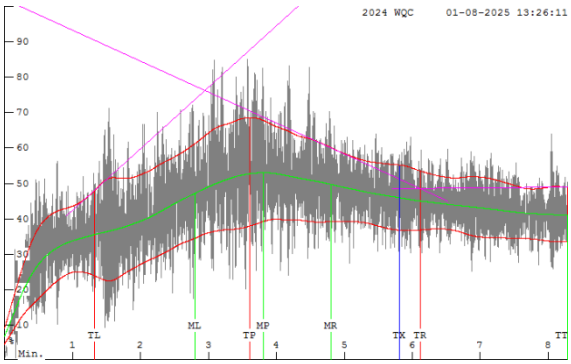


Mixograms

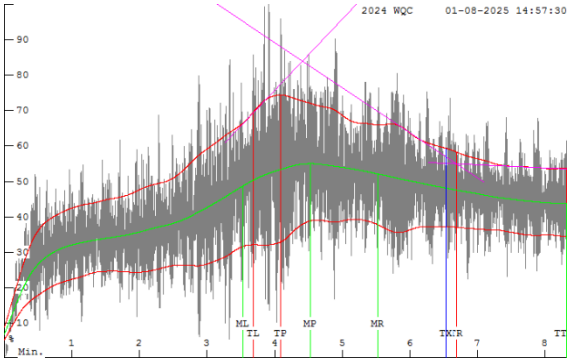
LCS Rebel Check (Havre, H-5)



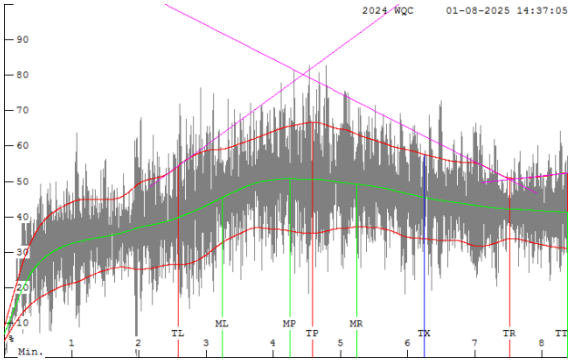
Dagmar (Havre, H-2)



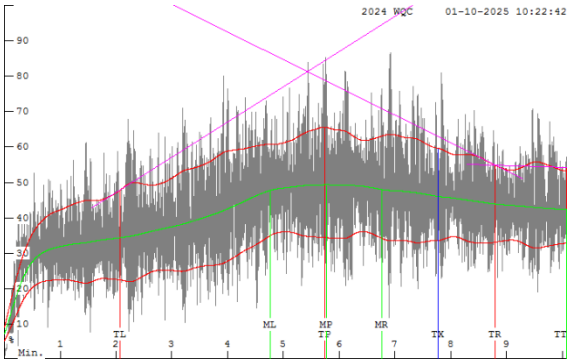
LCS Rebel Check (Minot, M-5)



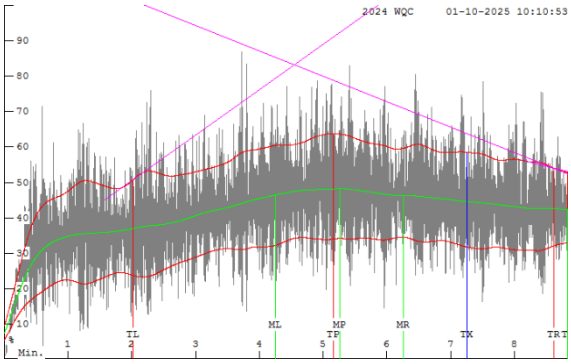
Dagmar (Minot, M-2)



LCS Rebel Check (Williston, W-5)

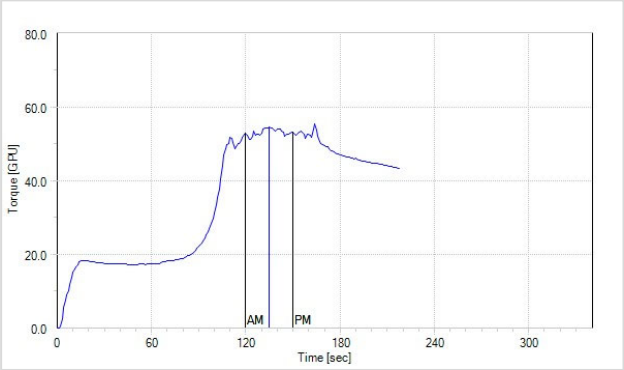


Dagmar (Williston, W-2)

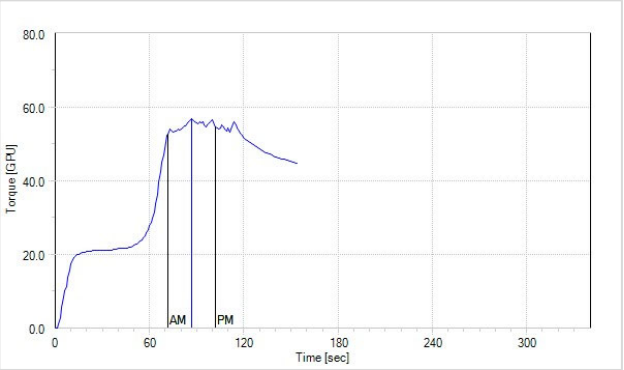


GlutoPeak Curves

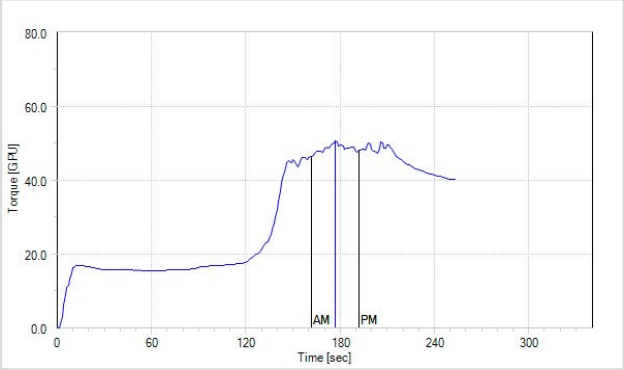
LCS Rebel Check (Havre, H-5)



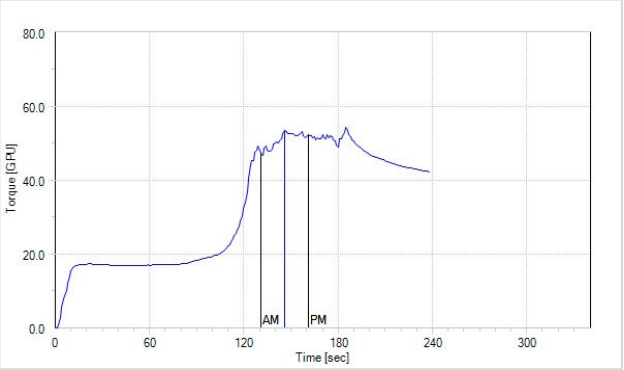
Dagmar (Havre, H-2)



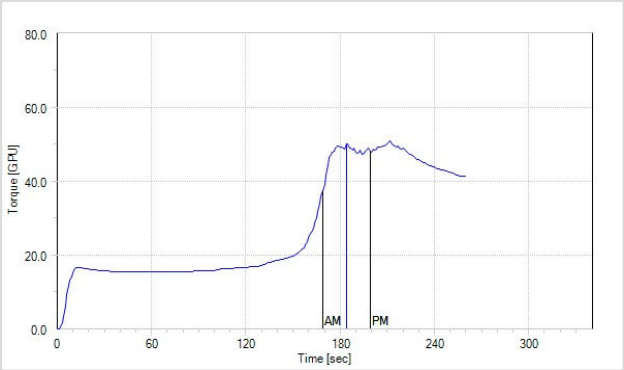
LCS Rebel Check (Minot, M-5)



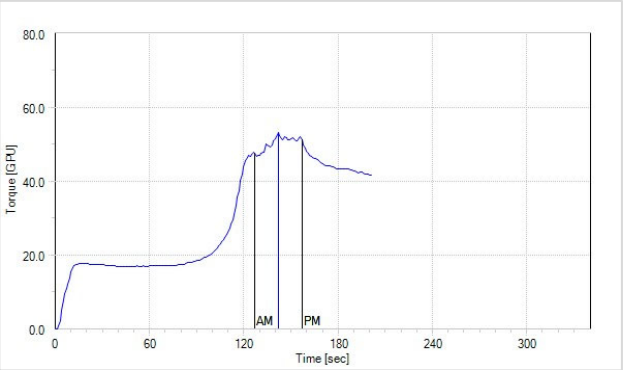
Dagmar (Minot, M-2)



LCS Rebel Check (Williston, W-5)

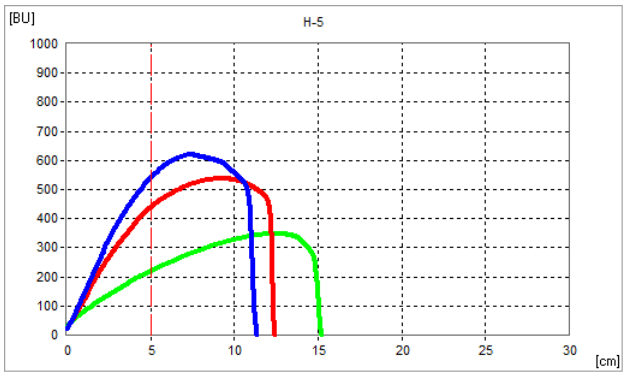


Dagmar (Williston, W-2)

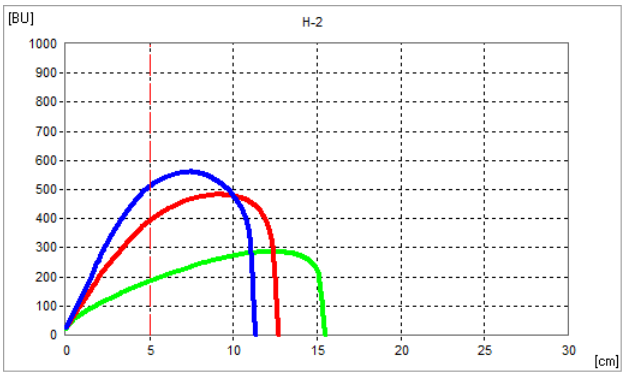


Extensograms

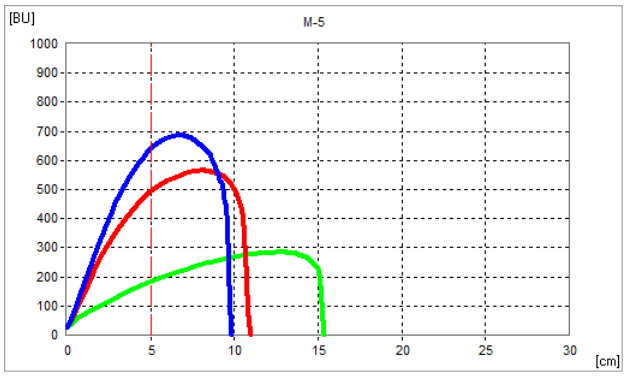
LCS Rebel Check (Havre, H-5)



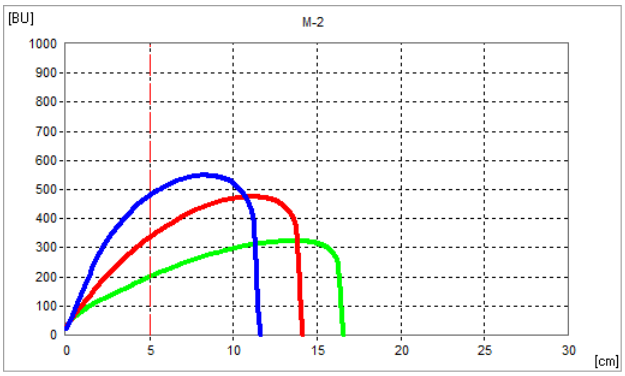
Dagmar (Havre, H-2)



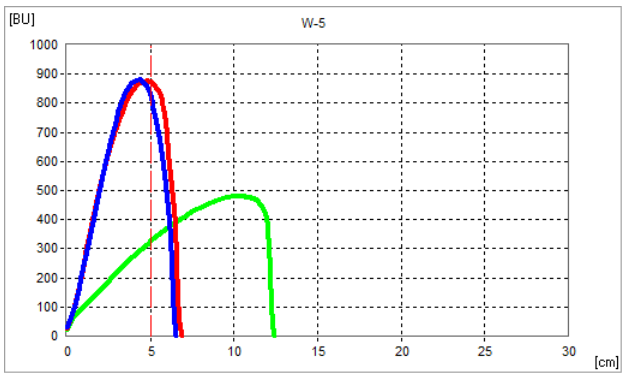
LCS Rebel Check (Minot, M-5)



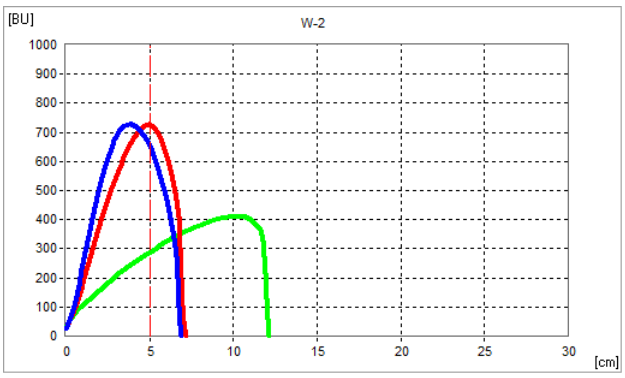
Dagmar (Minot, M-2)



LCS Rebel Check (Williston, W-5)



Dagmar (Williston, W-2)



45 min; 90 min; 135 min

SWQC #3 – SD4905

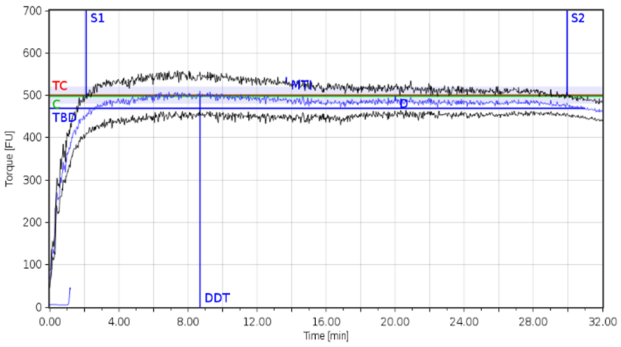
		Watertown		Casselton		Crookston	
		Linkert		Linkert		Linkert	
	Quality Trait	B-1	B-3	C-1	C-3	K-1	K-3
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	17.3	17.4	14.9	14.1	16.0	14.2
2	Flour Protein (%, 14% mb)	n/a	n/a	13.7	12.5	n/a	n/a
3	Market Value (Score 1-6)	3.1	3.4	4.9	4.0	5.4	4.8
4	Market Value (Score 1-10)	10.0	10.0	10.0	8.6	10.0	7.8
5	DON (ppm)	4.3	2.6	1.0	0.8	1.9	1.9
6	Test Weight (lb/bu)	56.7	57.0	62.0	60.4	62.3	62.3
7	1000 Kernel Weight (g)	29.2	29.6	37.3	33.6	36.1	35.7
8	Kernel Size, Large (%)	48	51	82	63	68	65
9	Kernel Size, Small (%)	14	14	5	11	8	11
10	Wheat Moisture (%)	13.2	13.3	13.1	13.1	12.6	12.8
11	Wheat Ash (%, 14% mb)	1.63	1.62	1.63	1.70	1.50	1.49
12	Wheat Falling Number (s)	330	366	438	436	468	431
13	SKCS Hardness Index	75.0	64.0	64.9	57.2	69.7	70.2
14	Vitreous Kernels (%)	60	61	47	31	92	95
	Flour Extraction						
15	Tempered Wheat Basis (%)	n/a	n/a	75.4	76.8	n/a	n/a
16	Total Product Basis (%)	n/a	n/a	76.1	75.6	n/a	n/a
17	Flour/Bu Wheat (lb)	n/a	n/a	47.2	47.0	n/a	n/a
	Flour Quality						
18	Flour Color Brightness (*L**)	n/a	n/a	90.5	90.9	n/a	n/a
19	Flour Color Yellowness (*b**)	n/a	n/a	9.6	11.0	n/a	n/a
20	Flour Moisture (%)	n/a	n/a	13.4	13.0	n/a	n/a
21	Flour Ash (%, 14% mb)	n/a	n/a	0.50	0.48	n/a	n/a
22	Flour Falling Number (malted, s)	n/a	n/a	251	247	n/a	n/a
	Farinograph						
23	Water Absorption (%, 500 BU)	n/a	n/a	60.6	58.3	n/a	n/a
24	Water Absorption (%, 14% mb)	n/a	n/a	59.6	57.5	n/a	n/a
25	Arrival Time (min)	n/a	n/a	2.1	1.9	n/a	n/a
26	Peak Time (min)	n/a	n/a	8.7	5.2	n/a	n/a
27	Dough Stability (min)	n/a	n/a	27.8	10.0	n/a	n/a
28	Mixing Tolerance Index (MTI, BU)	n/a	n/a	15	34	n/a	n/a
29	Time To Breakdown (TTB, min)	n/a	n/a	31.0	11.4	n/a	n/a
	II. Cooperator Results						
30	Bake Absorption (Average %)	n/a	n/a	62.9	60.2	n/a	n/a
31	Loaf Volume (% of Check)		n/a		98.1		n/a

SWQC #3 – SD4905

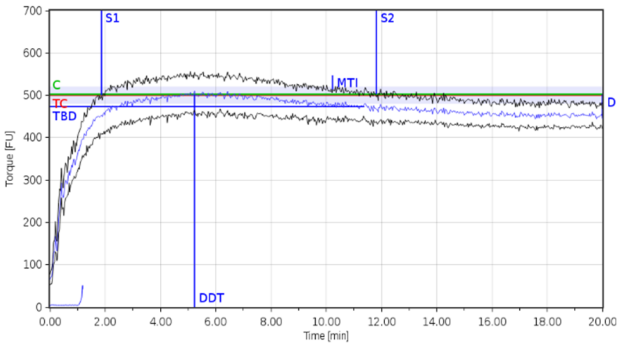
	Quality Trait	Watertown Linkert B-1	Watertown Linkert B-3	Casselton Linkert C-1	Casselton Linkert C-3	Crookston Linkert K-1	Crookston Linkert K-3
	II. Cooperator Results						
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	n/a	n/a	6.5	3.9	n/a	n/a
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	n/a	n/a	6.4	4.6	n/a	n/a
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		n/a		3.4		n/a
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		4.9		n/a
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		4.4		n/a
	III. Cooperator Evaluation						
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		3.4		n/a
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		4.5		n/a
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		3.5		n/a
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		3.5		n/a

Farinograms

Linkert Check (Casselton, C-1)

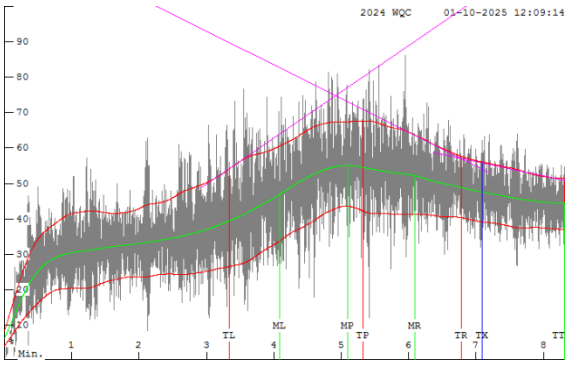


SD4905 (Casselton, C-3)

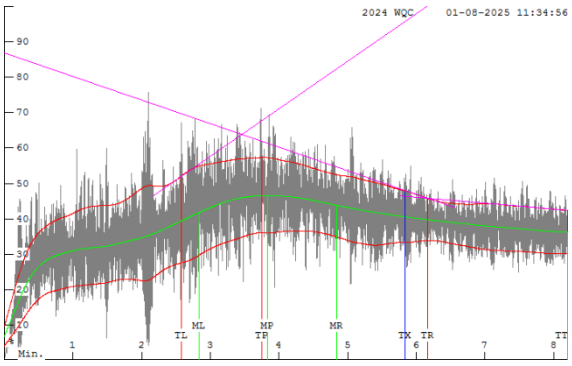


Mixograms

Linkert Check (Casselton, C-1)

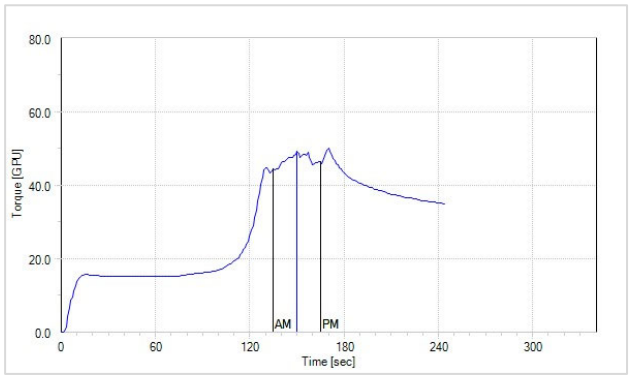


SD4905 (Casselton, C-3)

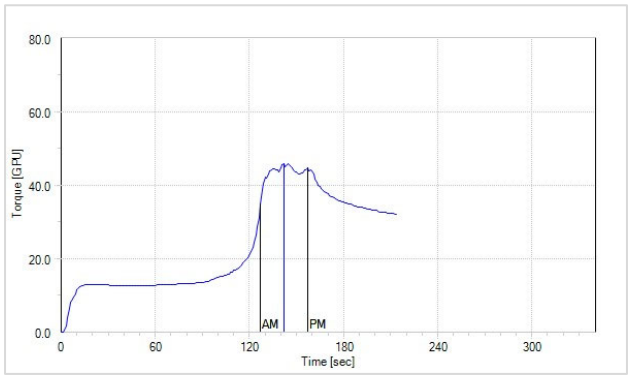


GlutoPeak Curves

Linkert Check (Casselton, C-1)

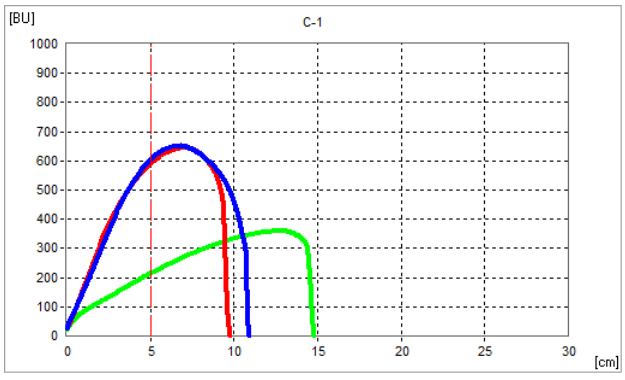


SD4905 (Casselton, C-3)

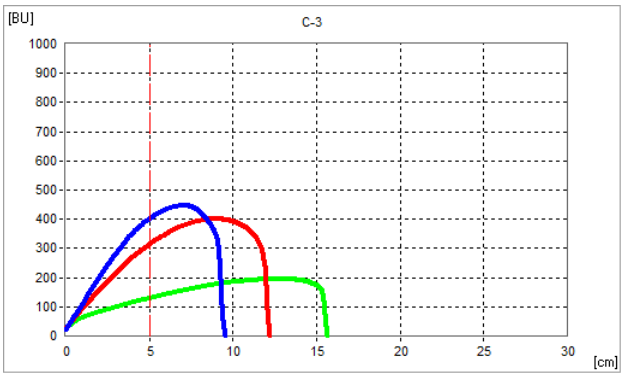


Extensograms

Linkert Check (Casselton, C-1)



SD4905 (Casselton, C-3)



45 min; 90 min; 135 min

SWQC #4 – MN13398-2

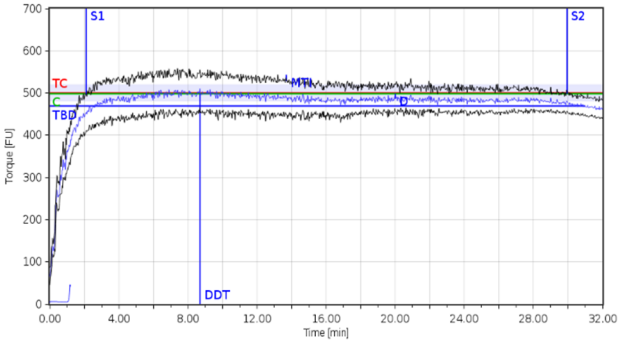
		Watertown		Casselton		Crookston		Minot	
		Linkert		Linkert		Linkert		LCS Rebel	
	Quality Trait	B-1	B-4	C-1	C-4	K-1	K-4	M-5	M-4
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	17.3	17.8	14.9	14.6	16.0	14.7	15.6	14.5
2	Flour Protein (%, 14% mb)	n/a	n/a	13.7	13.4	n/a	n/a	14.2	13.3
3	Market Value (Score 1-6)	3.1	3.3	4.9	4.1	5.4	4.8	5.3	4.6
4	Market Value (Score 1-10)	10.0	9.6	10.0	8.8	10.0	8.0	10.0	7.8
5	DON (ppm)	4.3	1.4	1.0	0.8	1.9	0.7	≤ 0.5	≤ 0.5
6	Test Weight (lb/bu)	56.7	57.1	62.0	61.1	62.3	62.8	63.8	63.2
7	1000 Kernel Weight (g)	29.2	26.6	37.3	30.5	36.1	31.5	35.7	29.9
8	Kernel Size, Large (%)	48	29	82	46	68	43	72	37
9	Kernel Size, Small (%)	14	20	5	15	8	14	6	14
10	Wheat Moisture (%)	13.2	13.3	13.1	12.9	12.6	12.4	11.4	10.0
11	Wheat Ash (%, 14% mb)	1.63	1.65	1.63	1.70	1.50	1.51	1.37	1.52
12	Wheat Falling Number (s)	330	371	438	435	468	475	396	518
13	SKCS Hardness Index	75.0	83.4	64.9	80.7	69.7	85.8	62.7	80.5
14	Vitreous Kernels (%)	60	70	47	72	92	96	83	98
	Flour Extraction								
15	Tempered Wheat Basis (%)	n/a	n/a	75.4	71.7	n/a	n/a	77.5	74.7
16	Total Product Basis (%)	n/a	n/a	76.1	72.3	n/a	n/a	77.5	74.6
17	Flour/Bu Wheat (lb)	n/a	n/a	47.2	44.5	n/a	n/a	50.5	49.0
	Flour Quality								
18	Flour Color Brightness (*L**)	n/a	n/a	90.5	90.4	n/a	n/a	91.0	90.8
19	Flour Color Yellowness (*b**)	n/a	n/a	9.6	10.9	n/a	n/a	9.7	10.2
20	Flour Moisture (%)	n/a	n/a	13.4	12.9	n/a	n/a	13.4	13.7
21	Flour Ash (%, 14% mb)	n/a	n/a	0.50	0.52	n/a	n/a	0.41	0.51
22	Flour Falling Number (malted, s)	n/a	n/a	251	247	n/a	n/a	247	249
	Farinograph								
23	Water Absorption (%, 500 BU)	n/a	n/a	60.6	60.9	n/a	n/a	61.2	59.3
24	Water Absorption (%, 14% mb)	n/a	n/a	59.6	59.9	n/a	n/a	61.0	59.3
25	Arrival Time (min)	n/a	n/a	2.1	2.3	n/a	n/a	2.8	2.1
26	Peak Time (min)	n/a	n/a	8.7	6.2	n/a	n/a	7.7	9.0
27	Dough Stability (min)	n/a	n/a	27.8	16.1	n/a	n/a	15.4	39.3
28	Mixing Tolerance Index (MTI, BU)	n/a	n/a	15	16	n/a	n/a	21	9
29	Time To Breakdown (TTB, min)	n/a	n/a	31.0	15.7	n/a	n/a	17.7	43.2
	II. Cooperator Results								
30	Bake Absorption (Average %)	n/a	n/a	62.9	63.2	n/a	n/a	63.9	62.9
31	Loaf Volume (% of Check)		n/a		98.8		n/a		95.7

SWQC #4 – MN13398-2

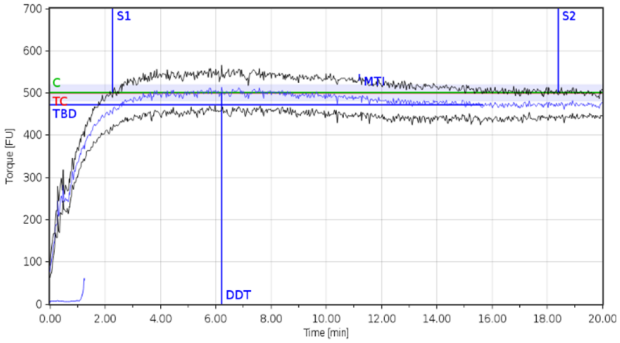
	Quality Trait	Watertown Linkert B-1	Watertown Linkert B-4	Casselton Linkert C-1	Casselton Linkert C-4	Crookston Linkert K-1	Crookston Linkert K-4	Minot LCS Rebel M-5	Minot LCS Rebel M-4
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	n/a	n/a	6.5	5.6	n/a	n/a	6.2	7.1
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	n/a	n/a	6.4	6.5	n/a	n/a	5.8	6.5
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		n/a		4.6		n/a		5.9
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		4.5		n/a		5.3
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		4.5		n/a		5.0
	III. Cooperator Evaluation								
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		4.6		n/a		3.9
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		3.5		n/a		3.6
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		4.8		n/a		4.7
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		4.6		n/a		4.3

Farinograms

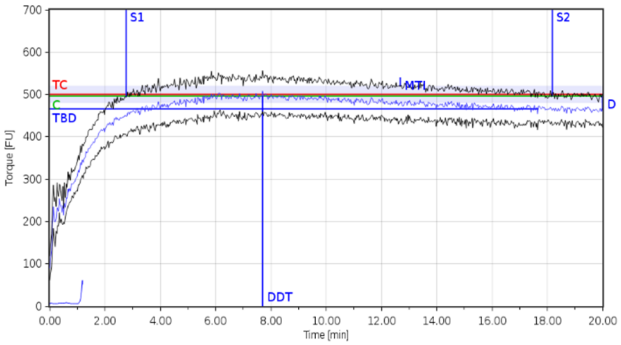
Linkert Check (Casselton, C-1)



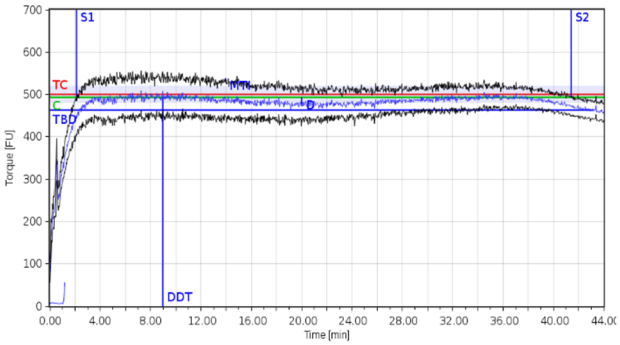
MN13398-2 (Casselton, C-4)



LCS Rebel Check (Minot, M-5)

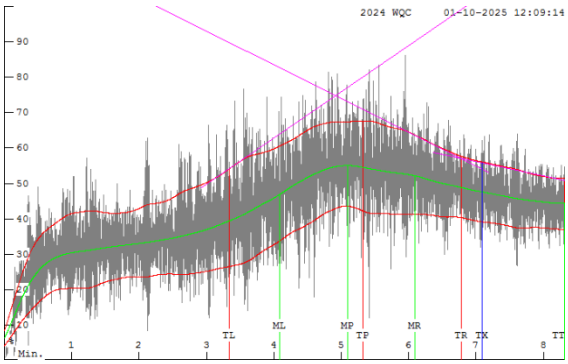


MN13398-2 (Minot, M-4)

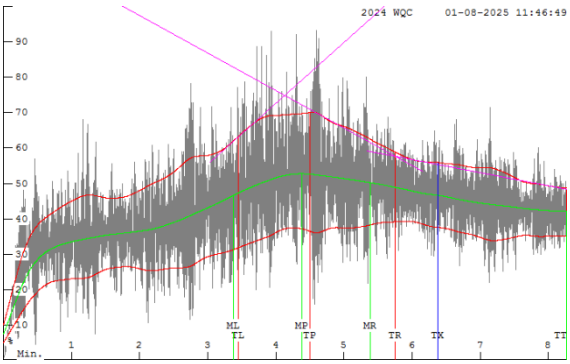


Mixograms

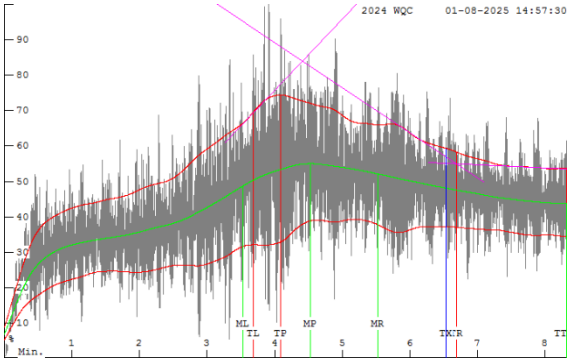
Linkert Check (Casselton, C-1)



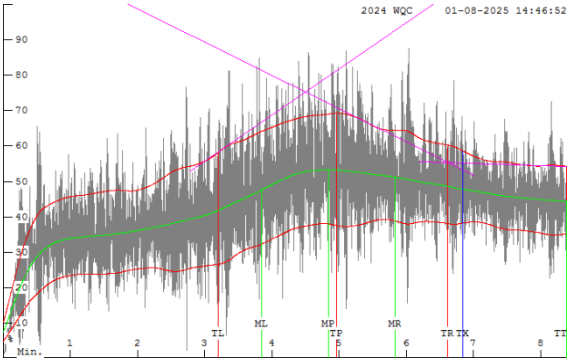
MN13398-2 (Casselton, C-4)



LCS Rebel Check (Minot, M-5)

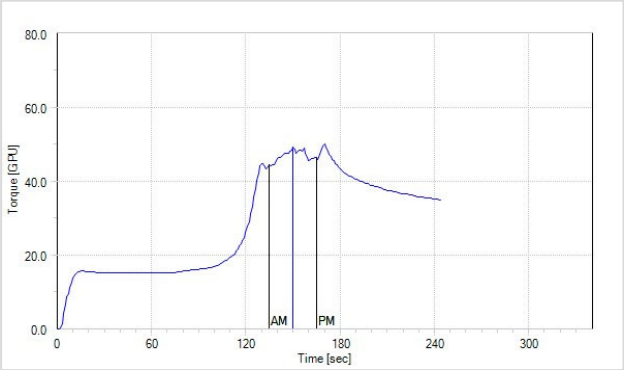


MN13398-2 (Minot, M-4)



GlutoPeak Curves

Linkert Check (Casselton, C-1)



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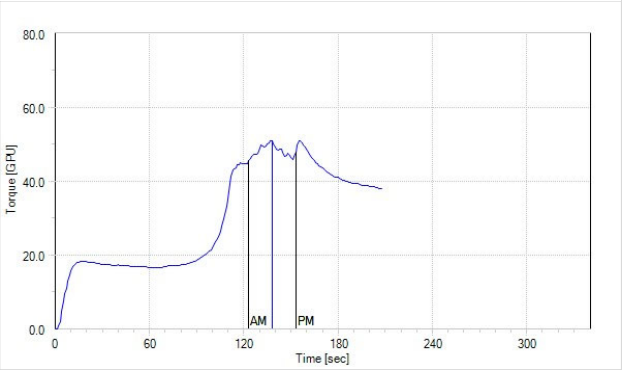
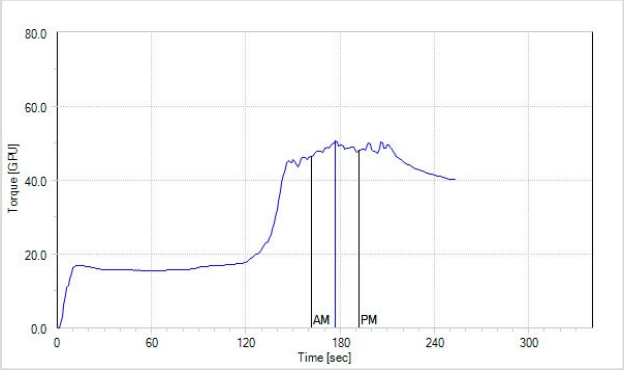
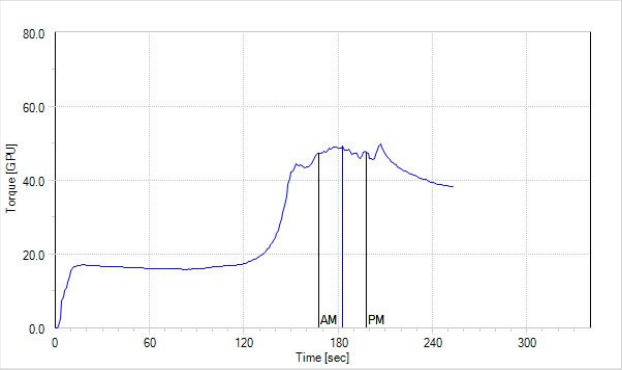


LCS Rebel Check (Minot, M-5)

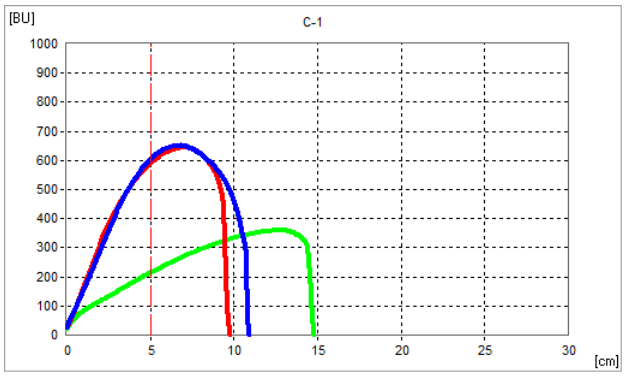


MN13398-2 (Minot, M-4)

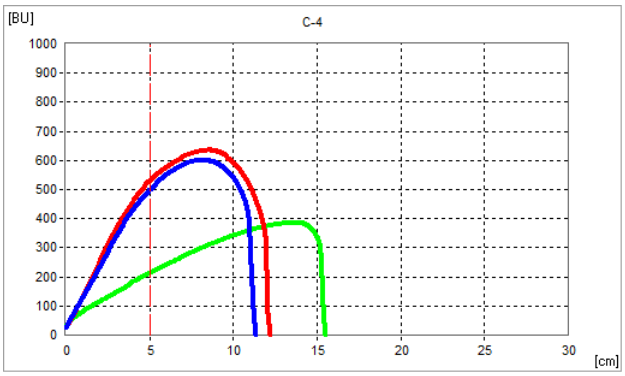


Extensograms

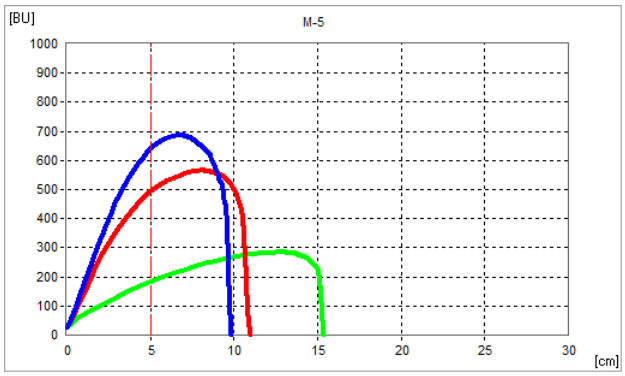
Linkert Check (Casselton, C-1)



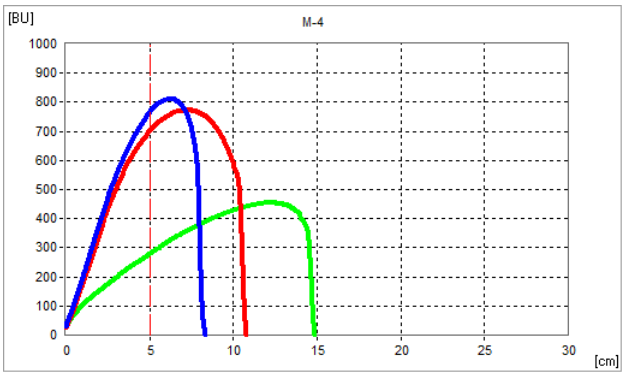
MN13398-2 (Casselton, C-4)



LCS Rebel Check (Minot, M-5)



MN13398-2 (Minot, M-4)



45 min; 90 min; 135 min

SWQC #6 – MN19358-1

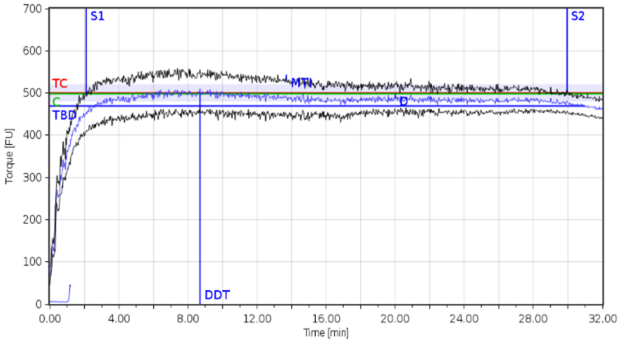
		Watertown		Casselton		Crookston		Minot	
		Linkert		Linkert		Linkert		LCS Rebel	
	Quality Trait	B-1	B-6	C-1	C-6	K-1	K-6	M-5	M-6
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	17.3	17.6	14.9	14.8	16.0	14.1	15.6	15.3
2	Flour Protein (%, 14% mb)	n/a	n/a	13.7	13.2	n/a	n/a	14.2	14.0
3	Market Value (Score 1-6)	3.1	3.1	4.9	4.5	5.4	4.9	5.3	5.2
4	Market Value (Score 1-10)	10.0	9.6	10.0	9.2	10.0	7.8	10.0	9.6
5	DON (ppm)	4.3	2.2	1.0	≤ 0.5	1.9	1.0	≤ 0.5	≤ 0.5
6	Test Weight (lb/bu)	56.7	57.4	62.0	61.4	62.3	63.7	63.8	63.3
7	1000 Kernel Weight (g)	29.2	25.7	37.3	32.4	36.1	34.0	35.7	32.8
8	Kernel Size, Large (%)	48	37	82	64	68	69	72	61
9	Kernel Size, Small (%)	14	19	5	10	8	8	6	9
10	Wheat Moisture (%)	13.2	13.3	13.1	12.8	12.6	12.6	11.4	11.7
11	Wheat Ash (%, 14% mb)	1.63	1.61	1.63	1.63	1.50	1.41	1.37	1.37
12	Wheat Falling Number (s)	330	341	438	458	468	470	396	495
13	SKCS Hardness Index	75.0	81.1	64.9	70.9	69.7	79.9	62.7	69.9
14	Vitreous Kernels (%)	60	82	47	65	92	82	83	75
	Flour Extraction								
15	Tempered Wheat Basis (%)	n/a	n/a	75.4	72.1	n/a	n/a	77.5	74.6
16	Total Product Basis (%)	n/a	n/a	76.1	72.2	n/a	n/a	77.5	75.6
17	Flour/Bu Wheat (lb)	n/a	n/a	47.2	44.8	n/a	n/a	50.5	48.6
	Flour Quality								
18	Flour Color Brightness (*L**)	n/a	n/a	90.5	90.5	n/a	n/a	91.0	90.7
19	Flour Color Yellowness (*b**)	n/a	n/a	9.6	10.4	n/a	n/a	9.7	9.9
20	Flour Moisture (%)	n/a	n/a	13.4	12.5	n/a	n/a	13.4	13.2
21	Flour Ash (%, 14% mb)	n/a	n/a	0.50	0.49	n/a	n/a	0.41	0.46
22	Flour Falling Number (malted, s)	n/a	n/a	251	241	n/a	n/a	247	252
	Farinograph								
23	Water Absorption (%, 500 BU)	n/a	n/a	60.6	61.4	n/a	n/a	61.2	60.8
24	Water Absorption (%, 14% mb)	n/a	n/a	59.6	60.0	n/a	n/a	61.0	60.2
25	Arrival Time (min)	n/a	n/a	2.1	1.9	n/a	n/a	2.8	2.5
26	Peak Time (min)	n/a	n/a	8.7	6.3	n/a	n/a	7.7	7.8
27	Dough Stability (min)	n/a	n/a	27.8	11.6	n/a	n/a	15.4	15.7
28	Mixing Tolerance Index (MTI, BU)	n/a	n/a	15	30	n/a	n/a	21	20
29	Time To Breakdown (TTB, min)	n/a	n/a	31.0	13.5	n/a	n/a	17.7	17.1
	II. Cooperator Results								
30	Bake Absorption (Average %)	n/a	n/a	62.9	63.1	n/a	n/a	63.9	63.6
31	Loaf Volume (% of Check)		n/a		99.8		n/a		96.8

SWQC #6 – MN19358-1

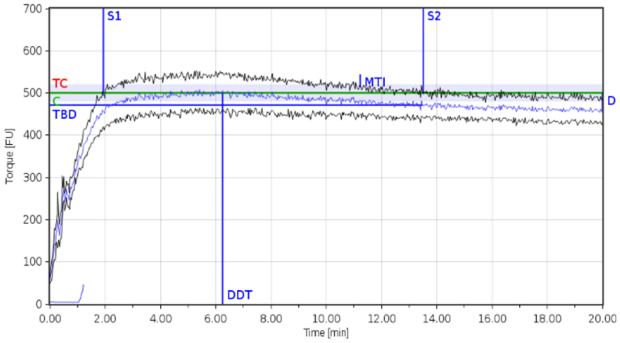
	Quality Trait	Watertown Linkert B-1	Watertown Linkert B-6	Casselton Linkert C-1	Casselton Linkert C-6	Crookston Linkert K-1	Crookston Linkert K-6	Minot LCS Rebel M-5	Minot LCS Rebel M-6
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	n/a	n/a	6.5	5.0	n/a	n/a	6.2	5.9
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	n/a	n/a	6.4	5.8	n/a	n/a	5.8	6.6
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		n/a		4.3		n/a		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		n/a		5.4		n/a		5.3
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		4.6		n/a		5.4
	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		n/a		4.5		n/a		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		n/a		3.5		n/a		4.1
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		4.5		n/a		4.7
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		n/a		4.1		n/a		4.4

Farinograms

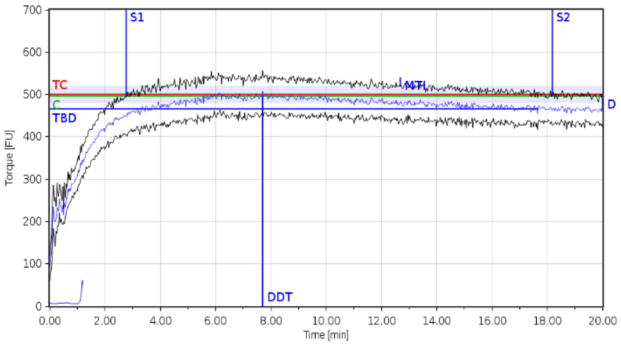
Linkert Check (Casselton, C-1)



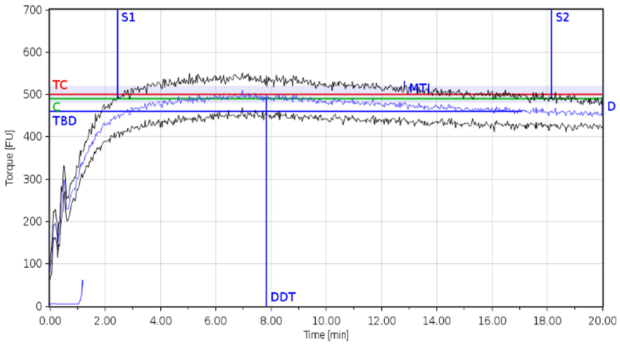
MN19358-1 (Casselton, C-6)



LCS Rebel Check (Minot, M-5)

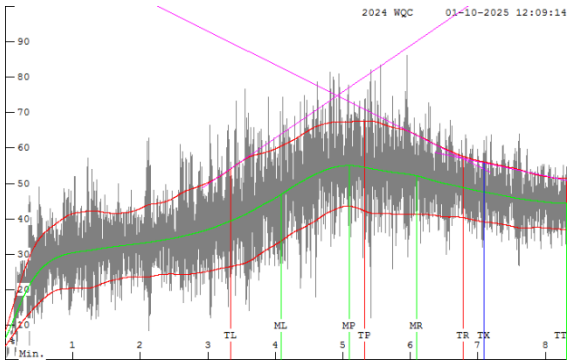


MN19358-1 (Minot, M-6)

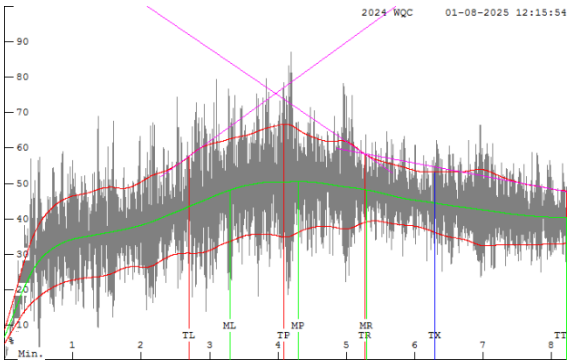


Mixograms

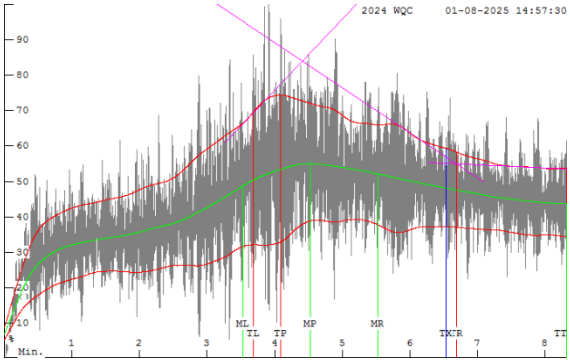
Linkert Check (Casselton, C-1)



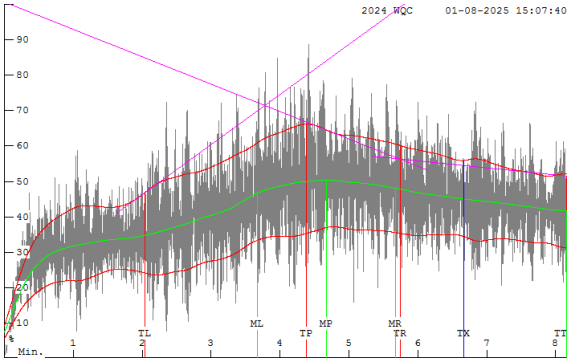
MN19358-1 (Casselton, C-6)



LCS Rebel Check (Minot, M-5)

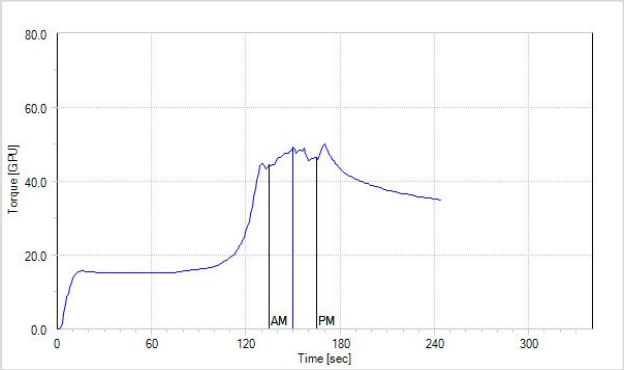


MN19358-1 (Minot, M-6)

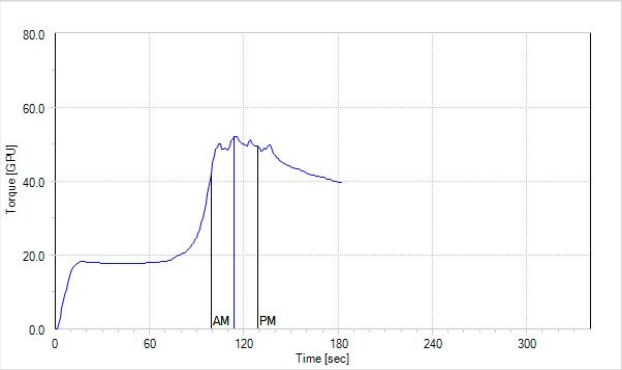


GlutoPeak Curves

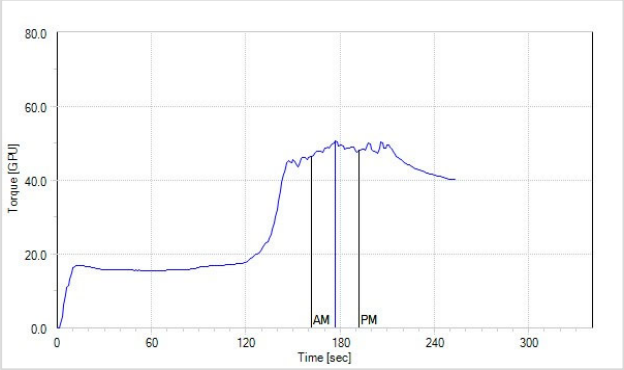
Linkert Check (Casselton, C-1)



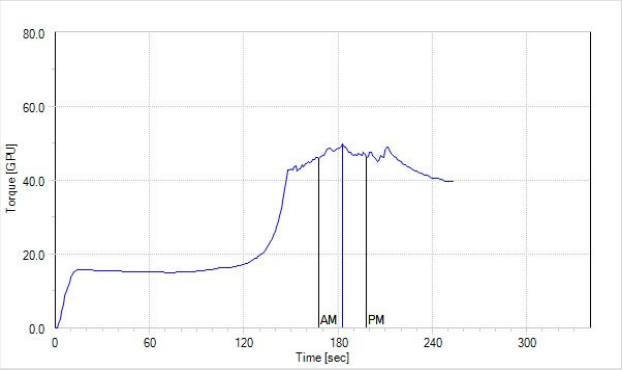
MN19358-1 (Casselton, C-6)



LCS Rebel Check (Minot, M-5)

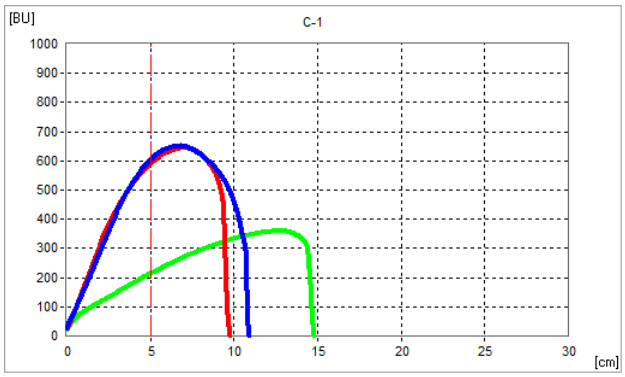


MN19358-1 (Minot, M-6)

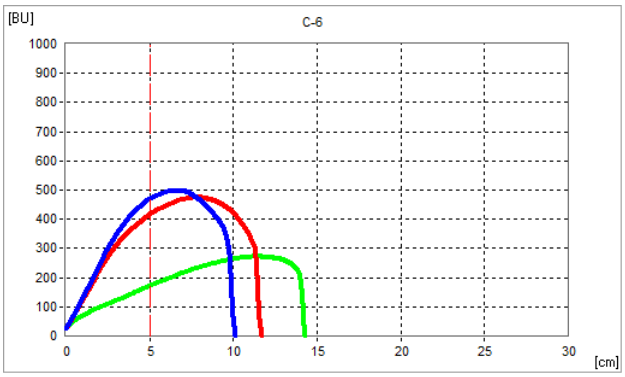


Extensograms

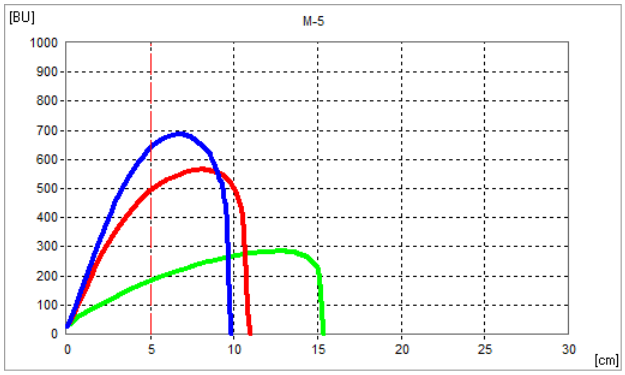
Linkert Check (Casselton, C-1)



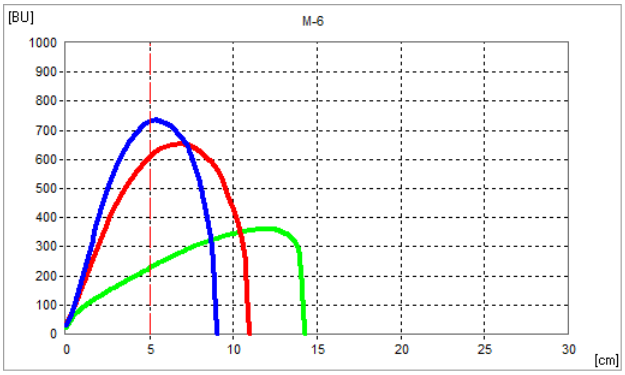
MN19358-1 (Casselton, C-6)



LCS Rebel Check (Minot, M-5)



MN19358-1 (Minot, M-6)



45 min; 90 min; 135 min

SWQC #7 – MT 21074

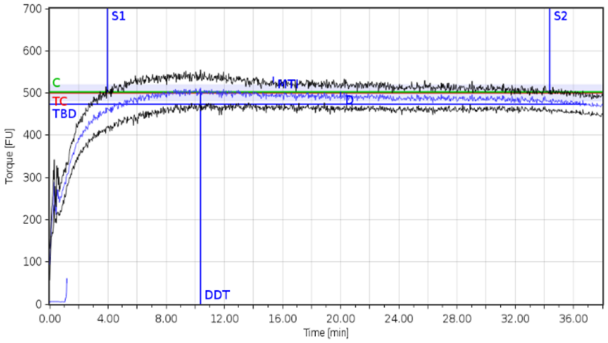
		Havre		Minot	
		LCS Rebel		LCS Rebel	
	Quality Trait	H-5	H-7	M-5	M-7
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	16.6	16.9	15.6	15.7
2	Flour Protein (%, 14% mb)	15.2	15.4	14.2	14.3
3	Market Value (Score 1-6)	4.4	3.9	5.3	5.1
4	Market Value (Score 1-10)	10.0	9.2	10.0	9.4
5	DON (ppm)	nd	nd	≤ 0.5	≤ 0.5
6	Test Weight (lb/bu)	59.6	57.6	63.8	62.7
7	1000 Kernel Weight (g)	28.1	25.9	35.7	34.2
8	Kernel Size, Large (%)	20	11	72	68
9	Kernel Size, Small (%)	26	28	6	9
10	Wheat Moisture (%)	11.5	11.2	11.4	9.7
11	Wheat Ash (%, 14% mb)	1.53	1.61	1.37	1.51
12	Wheat Falling Number (s)	469	458	396	416
13	SKCS Hardness Index	72.1	68.0	62.7	66.9
14	Vitreous Kernels (%)	99	98	83	93
	Flour Extraction				
15	Tempered Wheat Basis (%)	73.0	72.3	77.5	73.6
16	Total Product Basis (%)	73.3	72.3	77.5	73.7
17	Flour/Bu Wheat (lb)	44.4	42.4	50.5	47.9
	Flour Quality				
18	Flour Color Brightness (*L**)	90.5	90.4	91.0	90.6
19	Flour Color Yellowness (*b**)	9.8	11.4	9.7	9.0
20	Flour Moisture (%)	13.2	12.8	13.4	13.5
21	Flour Ash (%, 14% mb)	0.46	0.50	0.41	0.47
22	Flour Falling Number (malted, s)	252	253	247	254
	Farinograph				
23	Water Absorption (%, 500 BU)	63.6	59.1	61.2	60.8
24	Water Absorption (%, 14% mb)	63.0	58.1	61.0	60.6
25	Arrival Time (min)	4.0	3.7	2.8	3.1
26	Peak Time (min)	10.4	11.6	7.7	8.4
27	Dough Stability (min)	30.4	42.0	15.4	16.1
28	Mixing Tolerance Index (MTI, BU)	17	23	21	20
29	Time To Breakdown (TTB, min)	36.9	47.1	17.7	20.4
	II. Cooperator Results				
30	Bake Absorption (Average %)	65.6	62.9	63.9	63.6
31	Loaf Volume (% of Check)		104.4		97.1

SWQC #7 – MT 21074

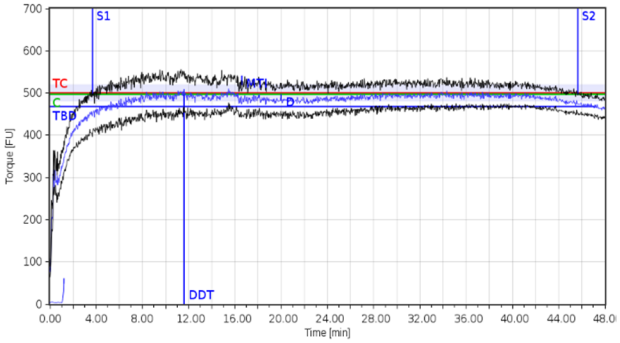
	Quality Trait	Havre LCS Rebel H-5	Havre LCS Rebel H-7	Minot LCS Rebel M-5	Minot LCS Rebel M-7
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.8	7.7	6.2	5.0
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.5	7.1	5.8	5.0
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		5.5		4.1
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		4.5		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		5.1		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		5.1		5.0
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.3		3.6
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.1		4.5
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.5		4.0

Farinograms

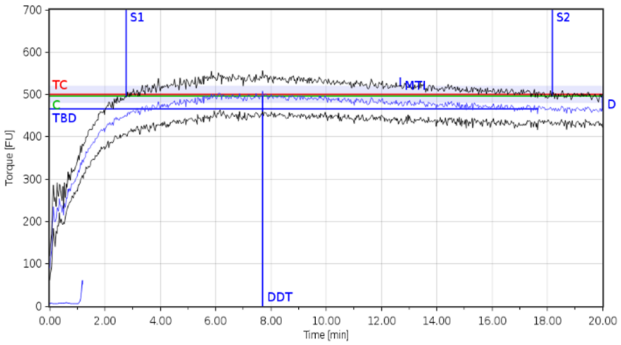
LCS Rebel Check (Havre, H-5)



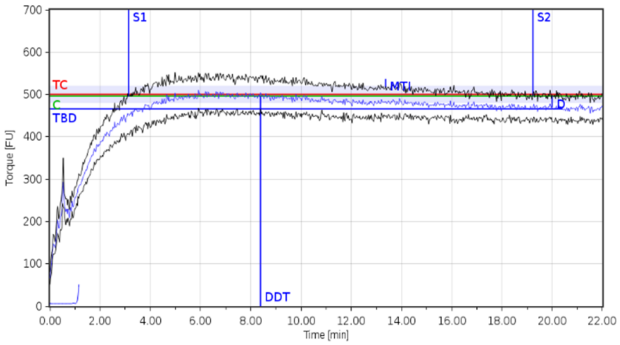
MT 21074 (Havre, H-7)



LCS Rebel Check (Minot, M-5)

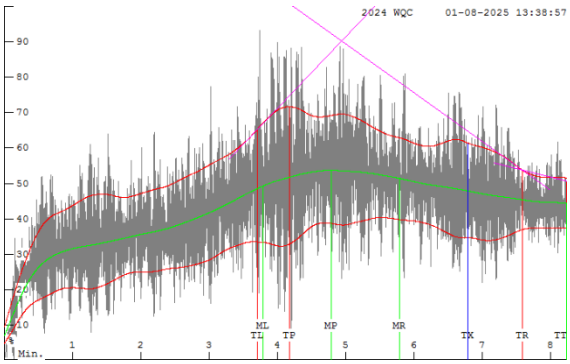


MT 21074 (Minot, M-7)

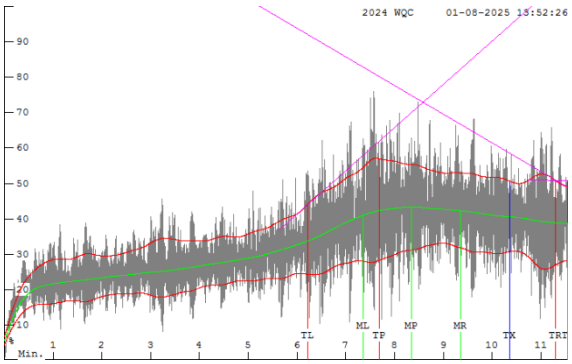


Mixograms

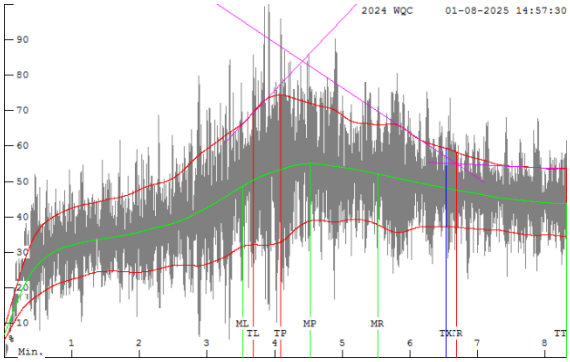
LCS Rebel Check (Havre, H-5)



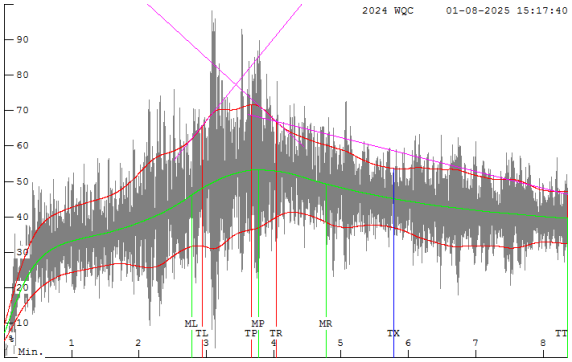
MT 21074 (Havre, H-7)



LCS Rebel Check (Minot, M-5)

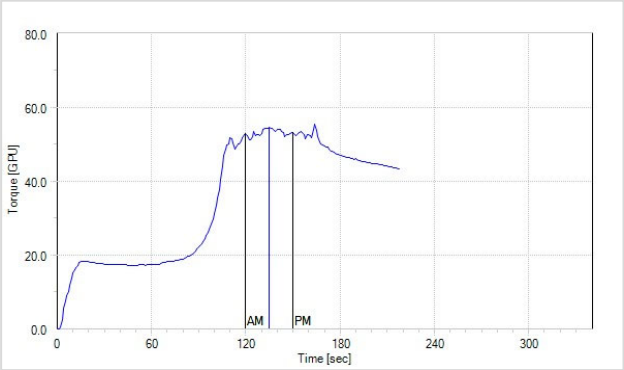


MT 21074 (Minot, M-7)

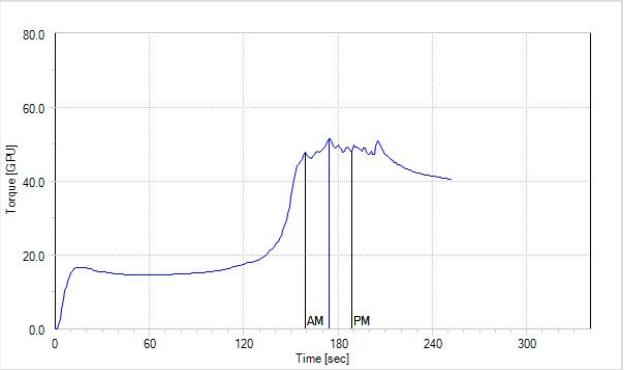


GlutoPeak Curves

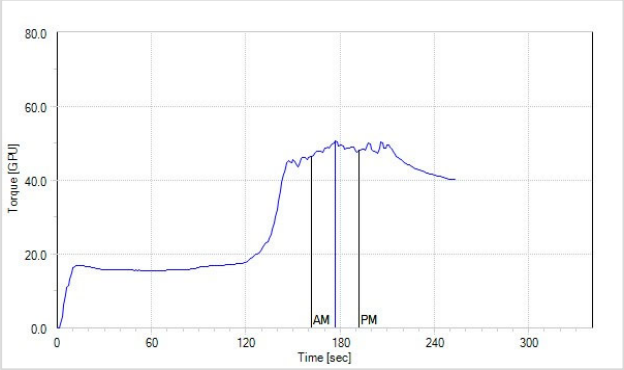
LCS Rebel Check (Havre, H-5)



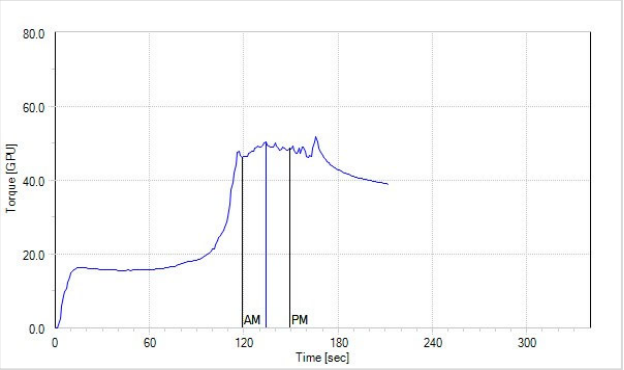
MT 21074 (Havre, H-7)



LCS Rebel Check (Minot, M-5)

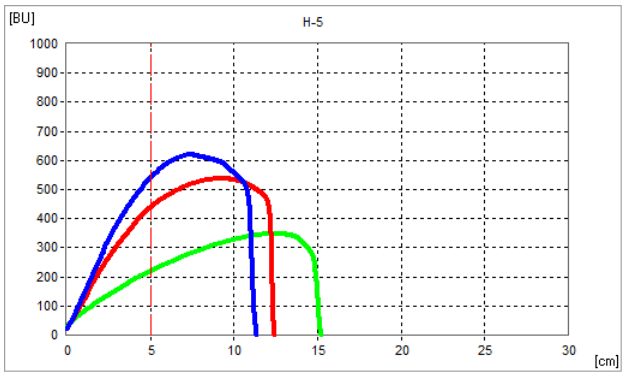


MT 21074 (Minot, M-7)

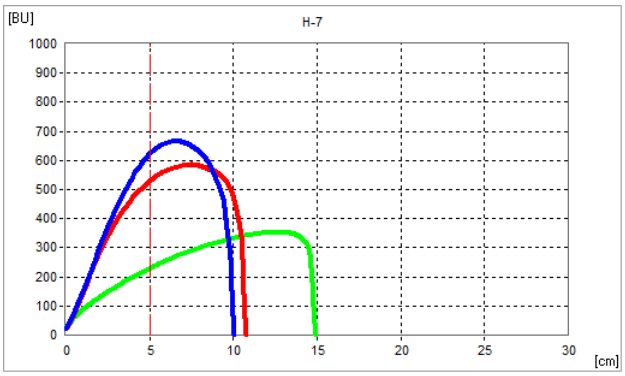


Extensograms

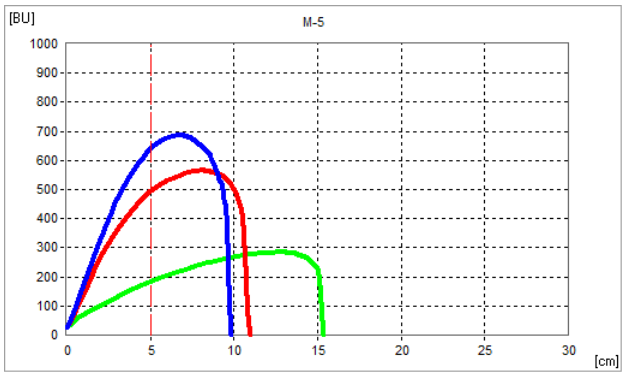
LCS Rebel Check (Havre, H-5)



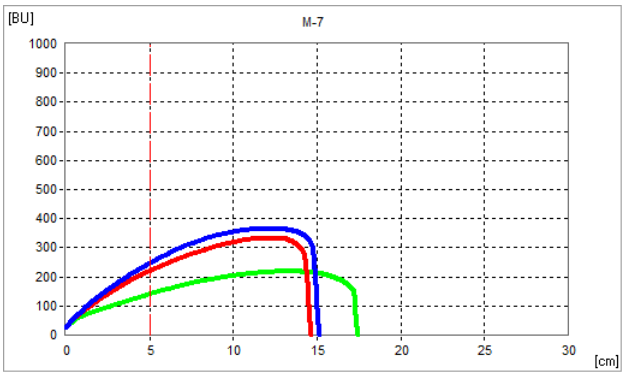
MT 21074 (Havre, H-7)



LCS Rebel Check (Minot, M-5)



MT 21074 (Minot, M-7)



45 min; 90 min; 135 min

SWQC #8 – NDHRS15-0006-C46

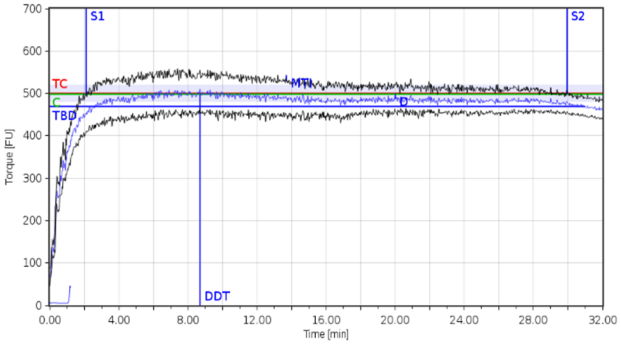
		Casselton		Crookston		Minot		Williston	
		Linkert		Linkert		LCS Rebel		LCS Rebel	
	Quality Trait	C-1	C-8	K-1	K-8	M-5	M-8	W-5	W-8
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	14.9	14.4	16.0	13.8	15.6	14.9	14.6	15.3
2	Flour Protein (%, 14% mb)	13.7	13.2	n/a	n/a	14.2	13.6	13.3	14.2
3	Market Value (Score 1-6)	4.9	4.5	5.4	4.8	5.3	5.0	4.4	3.4
4	Market Value (Score 1-10)	10.0	9.6	10.0	6.8	10.0	9.4	10.0	7.4
5	DON (ppm)	1.0	1.0	1.9	2.1	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5
6	Test Weight (lb/bu)	62.0	61.7	62.3	63.4	63.8	63.5	61.7	58.6
7	1000 Kernel Weight (g)	37.3	35.6	36.1	37.3	35.7	34.3	30.8	26.1
8	Kernel Size, Large (%)	82	75	68	75	72	73	47	26
9	Kernel Size, Small (%)	5	7	8	6	6	7	16	26
10	Wheat Moisture (%)	13.1	13.0	12.6	12.8	11.4	11.4	12.5	12.3
11	Wheat Ash (%, 14% mb)	1.63	1.59	1.50	1.43	1.37	1.44	1.60	1.71
12	Wheat Falling Number (s)	438	406	468	402	396	412	442	401
13	SKCS Hardness Index	64.9	71.5	69.7	79.5	62.7	70.3	69.5	79.4
14	Vitreous Kernels (%)	47	55	92	95	83	99	94	95
	Flour Extraction								
15	Tempered Wheat Basis (%)	75.4	74.0	n/a	n/a	77.5	71.2	75.2	73.6
16	Total Product Basis (%)	76.1	74.5	n/a	n/a	77.5	75.1	75.4	72.7
17	Flour/Bu Wheat (lb)	47.2	46.3	n/a	n/a	50.5	45.8	46.8	42.8
	Flour Quality								
18	Flour Color Brightness (*L**)	90.5	90.6	n/a	n/a	91.0	91.0	90.9	90.6
19	Flour Color Yellowness (*b**)	9.6	9.1	n/a	n/a	9.7	8.5	9.8	8.9
20	Flour Moisture (%)	13.4	12.6	n/a	n/a	13.4	13.0	13.4	13.1
21	Flour Ash (%, 14% mb)	0.50	0.46	n/a	n/a	0.41	0.43	0.50	0.53
22	Flour Falling Number (malted, s)	251	249	n/a	n/a	247	251	254	254
	Farinograph								
23	Water Absorption (%, 500 BU)	60.6	63.4	n/a	n/a	61.2	62.4	60.5	62.3
24	Water Absorption (%, 14% mb)	59.6	62.2	n/a	n/a	61.0	61.8	60.1	61.7
25	Arrival Time (min)	2.1	2.5	n/a	n/a	2.8	3.3	2.1	3.4
26	Peak Time (min)	8.7	7.5	n/a	n/a	7.7	8.3	7.4	8.1
27	Dough Stability (min)	27.8	10.7	n/a	n/a	15.4	16.9	13.6	12.9
28	Mixing Tolerance Index (MTI, BU)	15	31	n/a	n/a	21	26	23	28
29	Time To Breakdown (TTB, min)	31.0	13.8	n/a	n/a	17.7	22.3	14.2	16.2
	II. Cooperator Results								
30	Bake Absorption (Average %)	62.9	64.5	n/a	n/a	63.9	64.5	63.0	64.5
31	Loaf Volume (% of Check)		100.1		n/a		98.1		110.4

SWQC #8 – NDHRS15-0006-C46

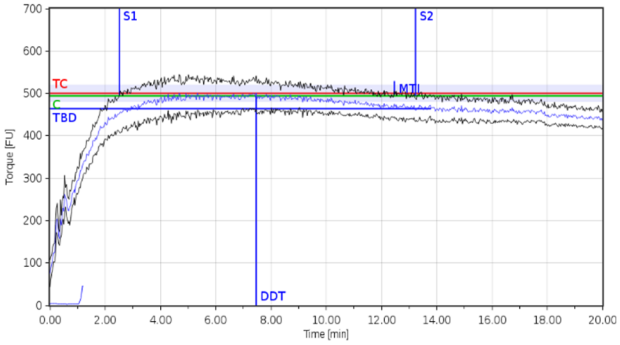
	Quality Trait	Casselton Linkert C-1	Casselton Linkert C-8	Crookston Linkert K-1	Crookston Linkert K-8	Minot LCS Rebel M-5	Minot LCS Rebel M-8	Williston LCS Rebel W-5	Williston LCS Rebel W-8
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.5	4.3	n/a	n/a	6.2	5.9	7.1	6.8
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.4	4.5	n/a	n/a	5.8	6.4	7.3	7.2
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		3.7		n/a		5.3		4.8
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.8		n/a		5.6		5.2
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		4.8		n/a		4.8		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		4.5		n/a		4.1		6.1
	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		4.4		n/a		3.7		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		4.7		n/a		4.8		6.5
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.5		n/a		4.4		5.6

Farinograms

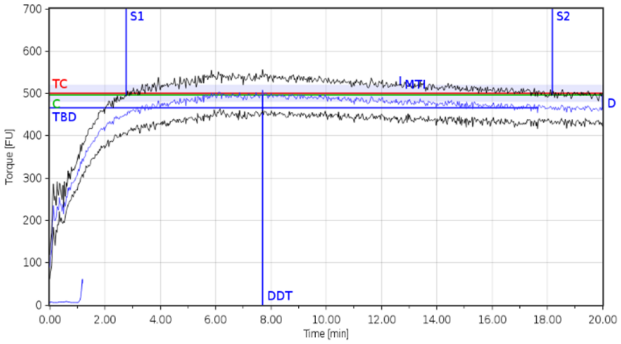
Linkert Check (Casselton, C-1)



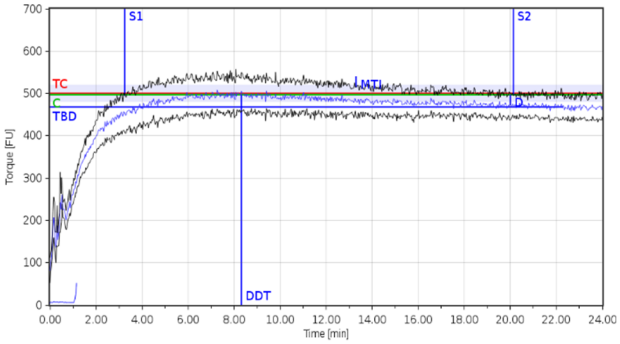
NDHRS15-0006-C46 (Casselton, C-8)



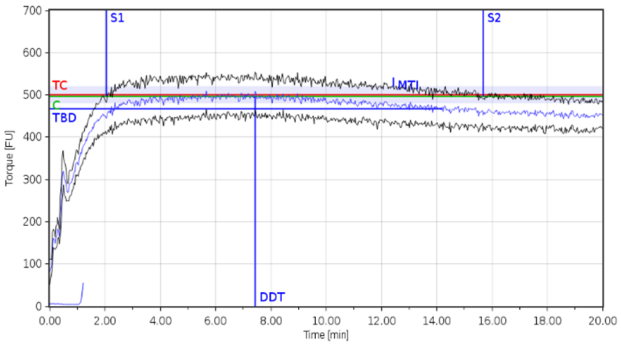
LCS Rebel Check (Minot, M-5)



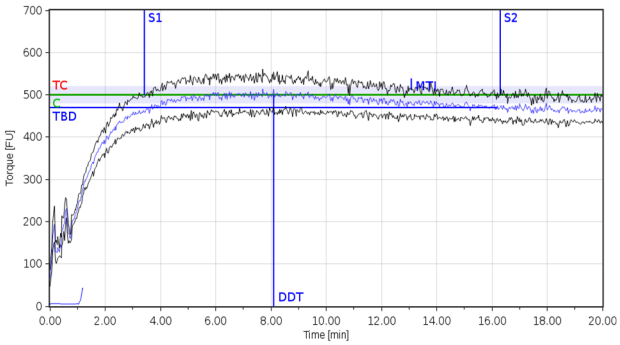
NDHRS15-0006-C46 (Minot, M-8)



LCS Rebel Check (Williston, W-5)

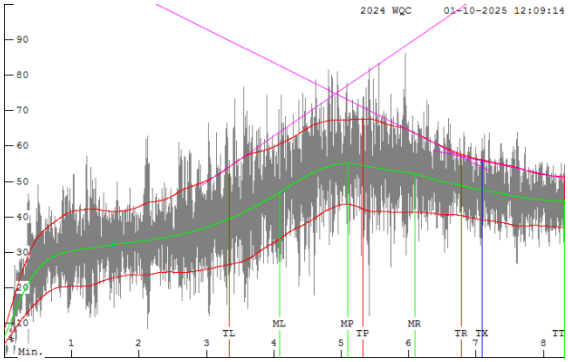


NDHRS15-0006-C46 (Williston, W-8)



Mixograms

Linkert Check (Casselton, C-1)



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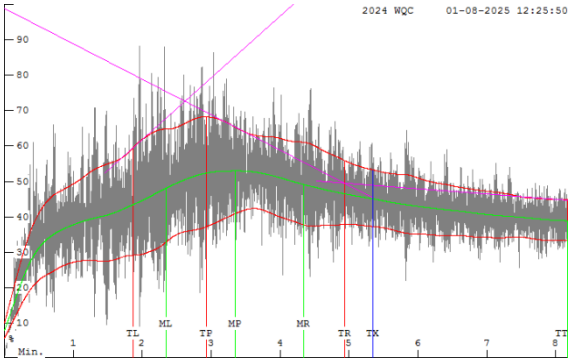

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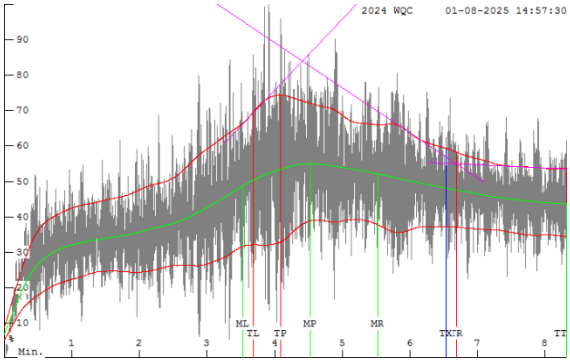

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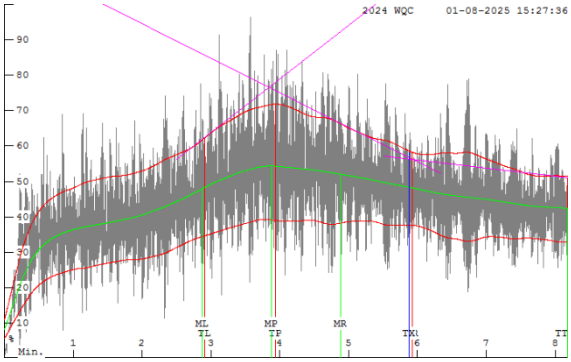
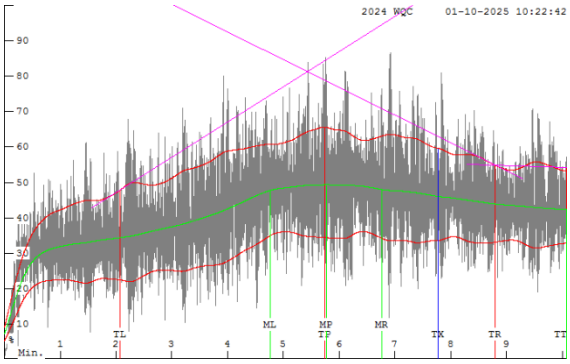


LCS Rebel Check (Williston, W-5)



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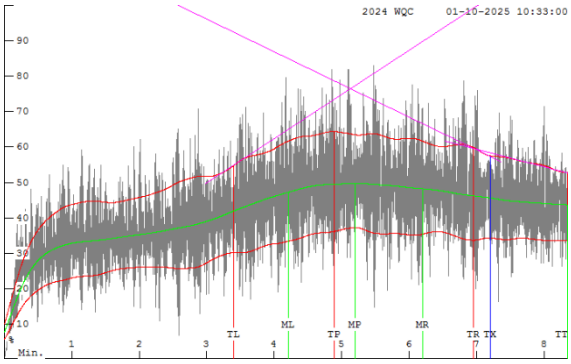
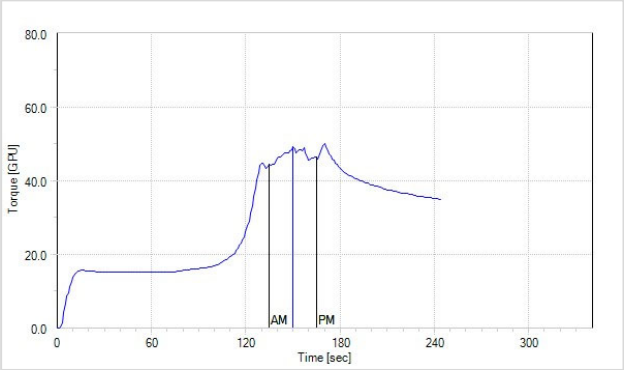
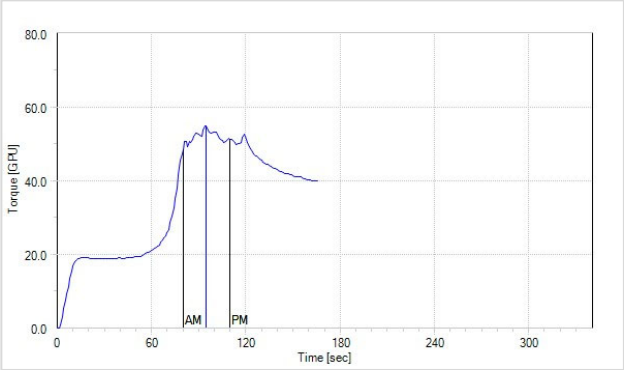


GlutoPeak Curves

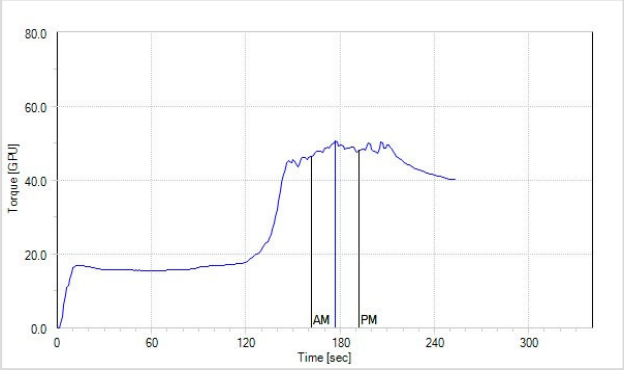
Linkert Check (Casselton, C-1)



NDHRS15-0006-C46 (Casselton, C-8)



LCS Rebel Check (Minot, M-5)



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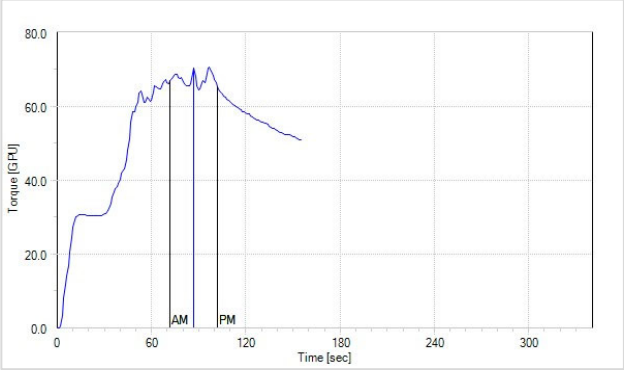
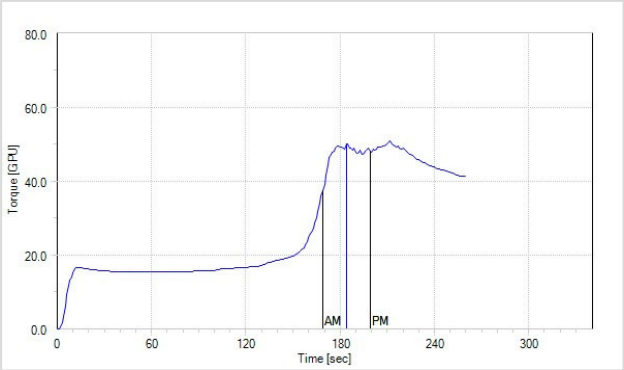


LCS Rebel Check (Williston, W-5)



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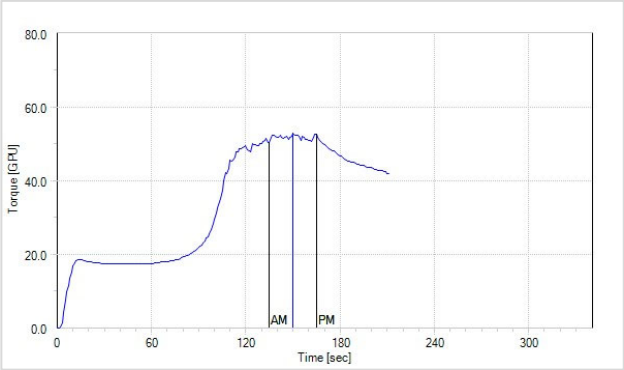
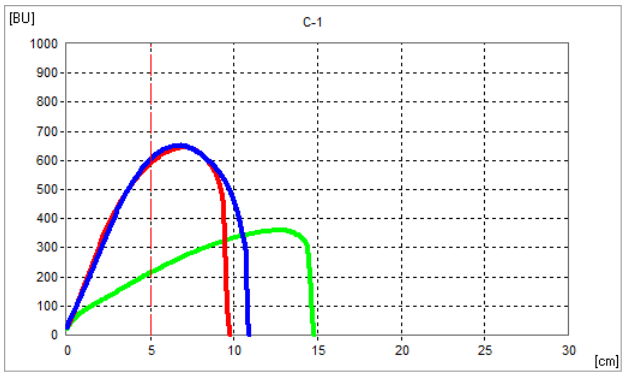
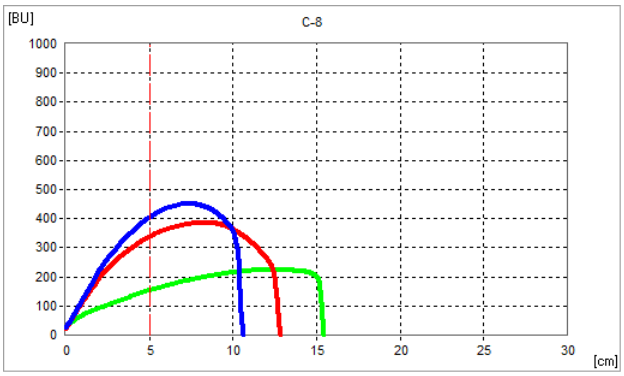


Extensograms

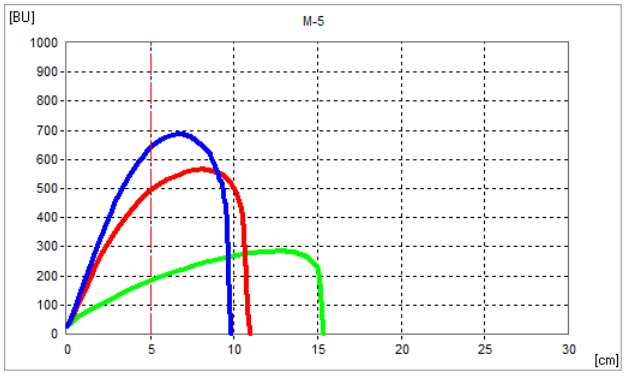
Linkert Check (Casselton, C-1)



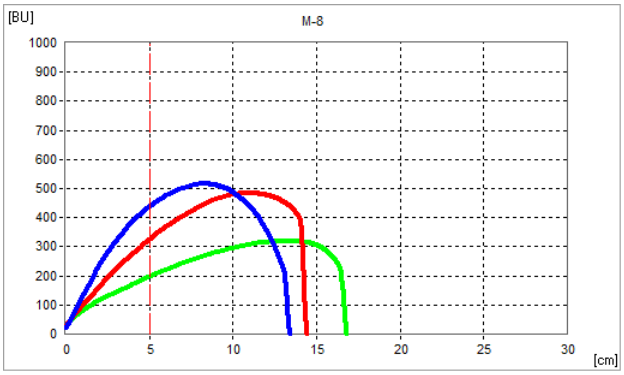
NDHRS15-0006-C46 (Casselton, C-8)



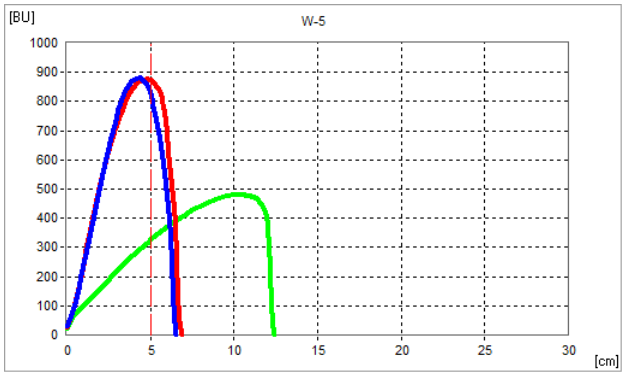
LCS Rebel Check (Minot, M-5)



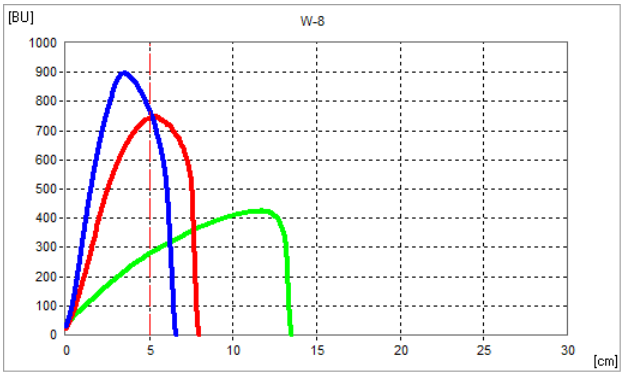
NDHRS15-0006-C46 (Minot, M-8)



LCS Rebel Check (Williston, W-5)



NDHRS15-0006-C46 (Williston, W-8)



45 min; 90 min; 135 min

SWQC #9 – LCS Hammer AX

		Watertown		Casselton		Havre		Crookston		Minot		Williston	
		Linkert		Linkert		LCS Rebel		Linkert		LCS Rebel		LCS Rebel	
	Quality Trait	B-1	B-9	C-1	C-9	H-5	H-9	K-1	K-9	M-5	M-9	W-5	W-9
	I. USDA-ARS WQL Data												
1	Wheat Protein (%, 12% mb)	17.3	17.0	14.9	13.8	16.6	14.8	16.0	13.8	15.6	14.0	14.6	14.6
2	Flour Protein (%, 14% mb)	n/a	n/a	13.7	n/a	15.2	13.2	n/a	n/a	14.2	12.6	13.3	13.3
3	Market Value (Score 1-6)	3.1	3.3	4.9	3.8	4.4	4.4	5.4	4.0	5.3	4.7	4.4	3.7
4	Market Value (Score 1-10)	10.0	9.6	10.0	7.6	10.0	8.2	10.0	6.4	10.0	7.4	10.0	8.4
5	DON (ppm)	4.3	2.5	1.0	1.7	nd	nd	1.9	2.5	≤ 0.5	≤ 0.5	≤ 0.5	nd
6	Test Weight (lb/bu)	56.7	57.1	62.0	60.3	59.6	60.9	62.3	60.9	63.8	63.0	61.7	59.5
7	1000 Kernel Weight (g)	29.2	25.9	37.3	31.6	28.1	29.9	36.1	31.2	35.7	31.6	30.8	26.4
8	Kernel Size, Large (%)	48	35	82	50	20	28	68	41	72	52	47	21
9	Kernel Size, Small (%)	14	21	5	16	26	20	8	19	6	13	16	32
10	Wheat Moisture (%)	13.2	13.5	13.1	13.0	11.5	11.6	12.6	12.8	11.4	10.4	12.5	12.7
11	Wheat Ash (%, 14% mb)	1.63	1.67	1.63	1.66	1.53	1.46	1.50	1.56	1.37	1.44	1.60	1.59
12	Wheat Falling Number (s)	330	382	438	473	469	525	468	500	396	551	442	493
13	SKCS Hardness Index	75.0	73.5	64.9	68.1	72.1	68.9	69.7	78.2	62.7	66.6	69.5	72.2
14	Vitreous Kernels (%)	60	72	47	21	99	97	92	72	83	54	94	96
	Flour Extraction												
15	Tempered Wheat Basis (%)	n/a	n/a	75.4	n/a	73.0	73.1	n/a	n/a	77.5	75.2	75.2	73.7
16	Total Product Basis (%)	n/a	n/a	76.1	n/a	73.3	72.8	n/a	n/a	77.5	76.2	75.4	73.6
17	Flour/Bu Wheat (lb)	n/a	n/a	47.2	n/a	44.4	45.1	n/a	n/a	50.5	48.9	46.8	43.5
	Flour Quality												
18	Flour Color Brightness (*L**)	n/a	n/a	90.5	n/a	90.5	91.4	n/a	n/a	91.0	91.0	90.9	91.1
19	Flour Color Yellowness (*b**)	n/a	n/a	9.6	n/a	9.8	9.0	n/a	n/a	9.7	9.5	9.8	9.7
20	Flour Moisture (%)	n/a	n/a	13.4	n/a	13.2	12.9	n/a	n/a	13.4	13.3	13.4	13.1
21	Flour Ash (%, 14% mb)	n/a	n/a	0.50	n/a	0.46	0.45	n/a	n/a	0.41	0.45	0.50	0.49
22	Flour Falling Number (malted, s)	n/a	n/a	251	n/a	252	250	n/a	n/a	247	241	254	247
	Farinograph												
23	Water Absorption (%, 500 BU)	n/a	n/a	60.6	n/a	63.6	58.9	n/a	n/a	61.2	58.0	60.5	58.7
24	Water Absorption (%, 14% mb)	n/a	n/a	59.6	n/a	63.0	57.9	n/a	n/a	61.0	57.6	60.1	57.9
25	Arrival Time (min)	n/a	n/a	2.1	n/a	4.0	1.5	n/a	n/a	2.8	1.6	2.1	1.5
26	Peak Time (min)	n/a	n/a	8.7	n/a	10.4	6.0	n/a	n/a	7.7	5.4	7.4	6.8
27	Dough Stability (min)	n/a	n/a	27.8	n/a	30.4	15.6	n/a	n/a	15.4	17.4	13.6	17.5
28	Mixing Tolerance Index (MTI, BU)	n/a	n/a	15	n/a	17	21	n/a	n/a	21	22	23	22
29	Time To Breakdown (TTB, min)	n/a	n/a	31.0	n/a	36.9	14.5	n/a	n/a	17.7	14.2	14.2	15.7

SWQC #9 – LCS Hammer AX

		Watertown		Casselton		Havre		Crookston		Minot		Williston	
		Linkert		Linkert		LCS Rebel		Linkert		LCS Rebel		LCS Rebel	
	Quality Trait	B-1	B-9	C-1	C-9	H-5	H-9	K-1	K-9	M-5	M-9	W-5	W-9
	II. Cooperator Results												
30	Bake Absorption (Average %)	n/a	n/a	62.9	n/a	65.6	61.3	n/a	n/a	63.9	61.5	63.0	62.1
31	Loaf Volume (% of Check)		n/a		n/a		99.9		n/a		91.6		100.7
32	Mixing Requirement*	n/a	n/a	6.5	n/a	6.8	6.5	n/a	n/a	6.2	6.5	7.1	7.5
33	Dough Characteristics**	n/a	n/a	6.4	n/a	6.5	6.9	n/a	n/a	5.8	5.8	7.3	6.7
34	Mixing Tolerance†		n/a		n/a		5.1		n/a		5.6		5.4
35	Internal Crumb Color††		n/a		n/a		4.9		n/a		4.9		4.8
36	Internal Crumb Texture‡		n/a		n/a		4.5		n/a		4.6		5.2
	III. Cooperator Evaluation‡												
	Quality Traits 1-2: Protein		n/a		n/a		3.0		n/a		3.2		5.0
	Quality Traits 3-22: Milling		n/a		n/a		4.8		n/a		4.0		3.5
	Quality Traits 23-36: Baking		n/a		n/a		4.4		n/a		3.4		5.0
	Quality Traits 1-36: Overall Comparison		n/a		n/a		4.1		n/a		3.5		4.5

*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.

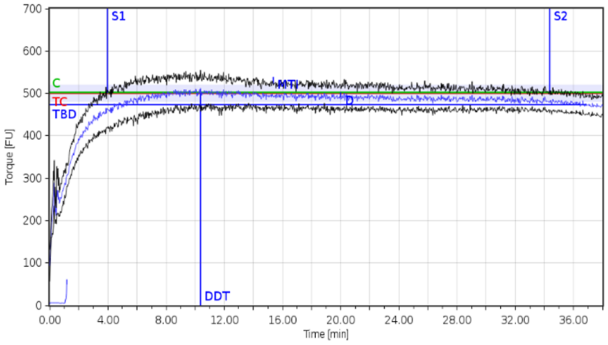
†9 = Much More Tolerance Than Check; 7 = More Tolerance Than Check; 5 = Tolerance Equivalent To Check; 3 = Less Tolerance Than Check; 1 = Much Less Tolerance Than Check.

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

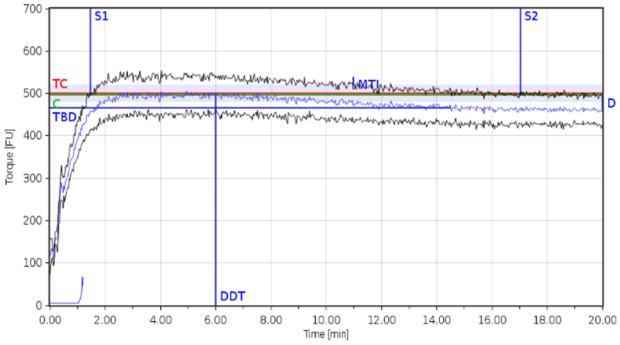
‡9 = Much Better Than Check; 7 = Better Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.

Farinograms

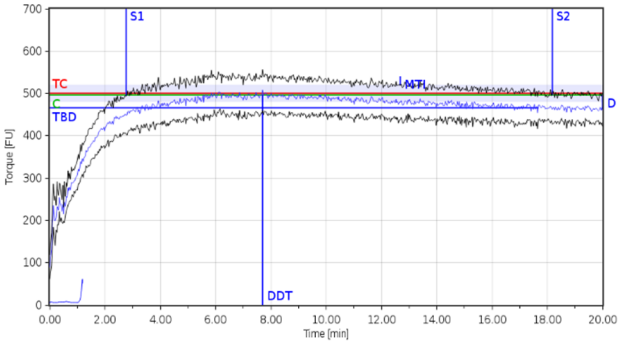
LCS Rebel Check (Havre, H-5)



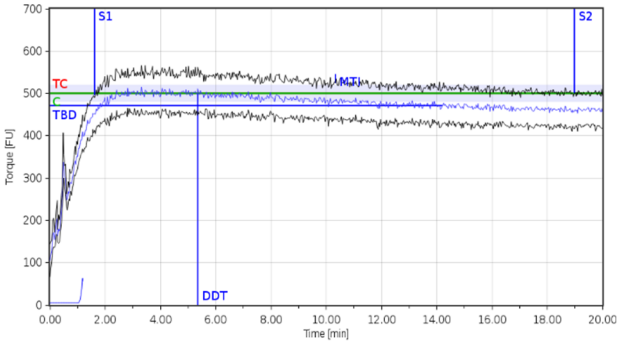
LCS Hammer AX (Havre, H-9)



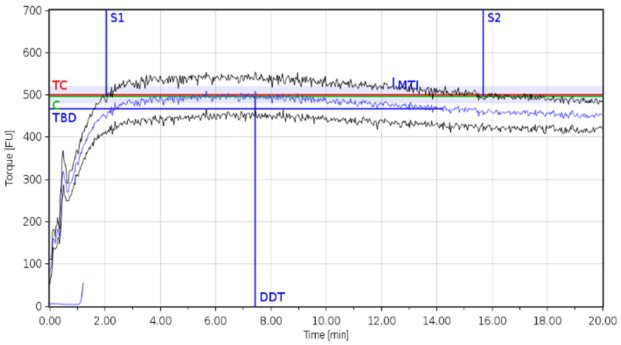
LCS Rebel Check (Minot, M-5)



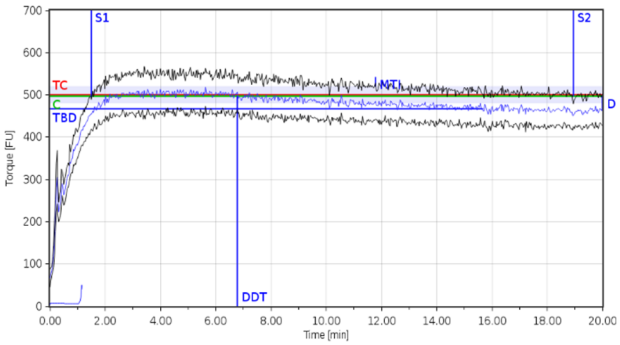
LCS Hammer AX (Minot, M-9)



LCS Rebel Check (Williston, W-5)

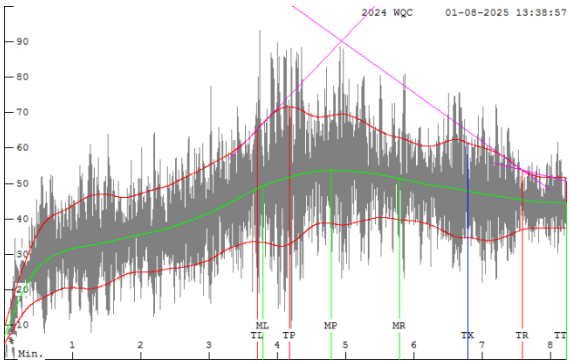


LCS Hammer AX (Williston, W-9)

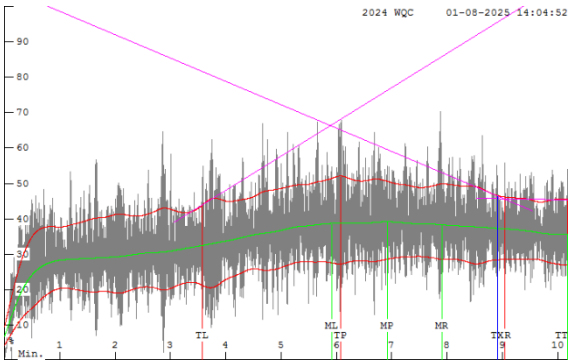


Mixograms

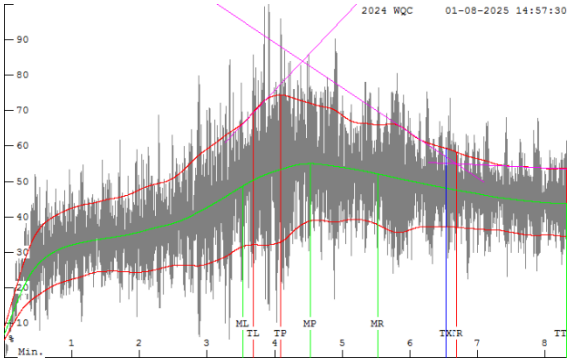
LCS Rebel Check (Havre, H-5)



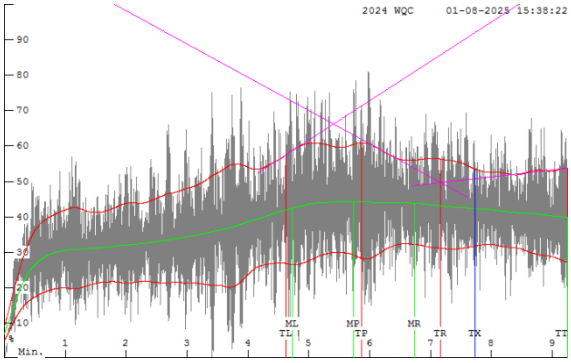
LCS Hammer AX (Havre, H-9)



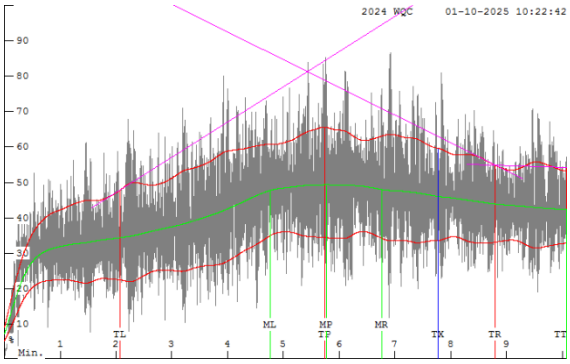
LCS Rebel Check (Minot, M-5)



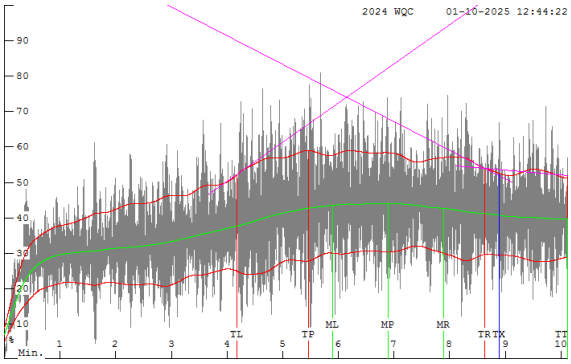
LCS Hammer AX (Minot, M-9)



LCS Rebel Check (Williston, W-5)

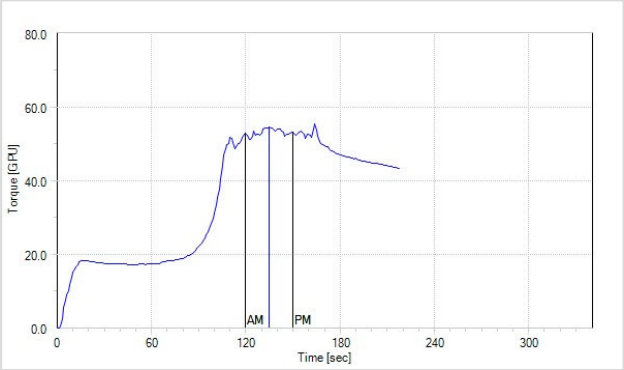


LCS Hammer AX (Williston, W-9)

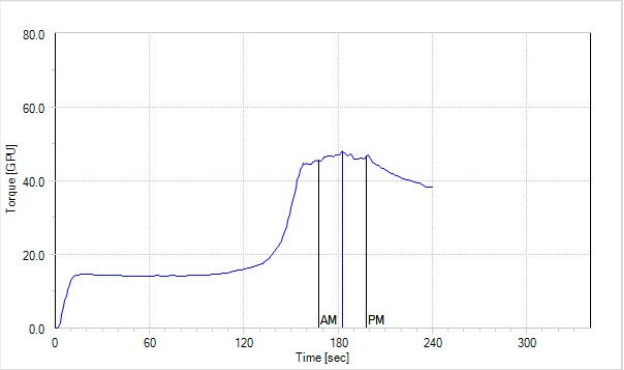


GlutoPeak Curves

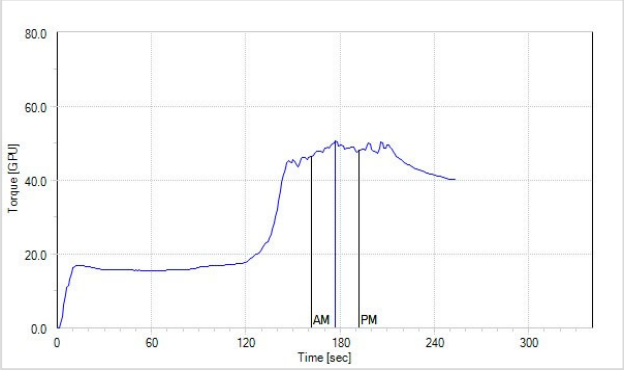
LCS Rebel Check (Havre, H-5)



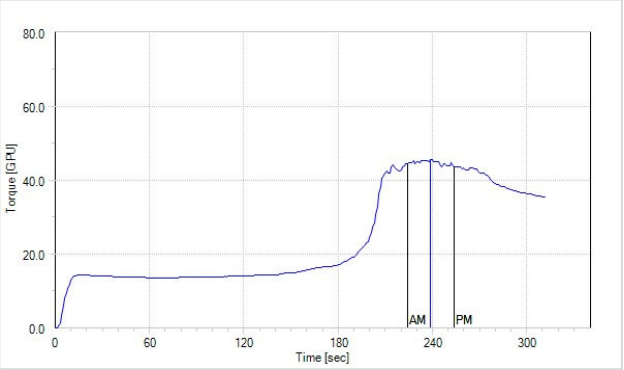
LCS Hammer AX (Havre, H-9)



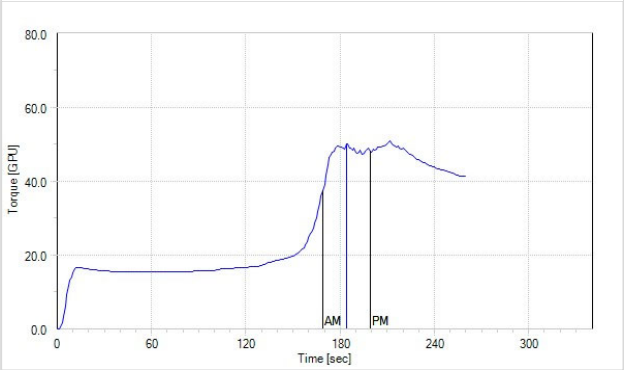
LCS Rebel Check (Minot, M-5)



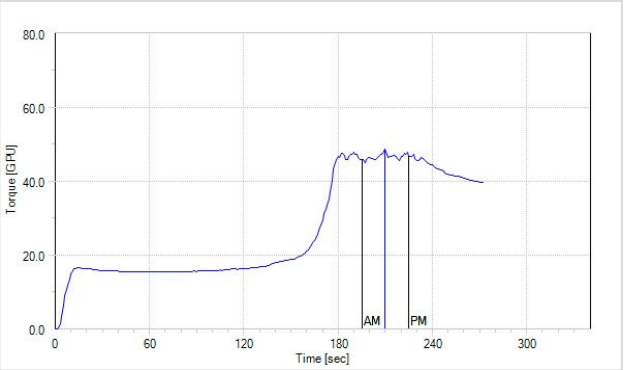
LCS Hammer AX (Minot, M-9)



LCS Rebel Check (Williston, W-5)

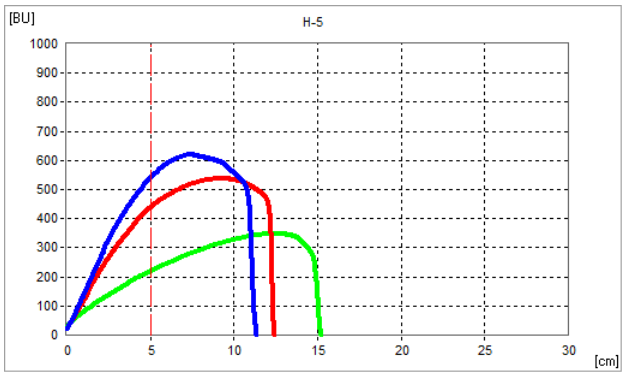


LCS Hammer AX (Williston, W-9)

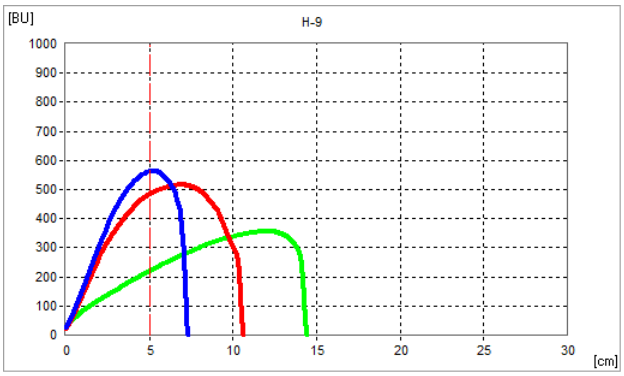


Extensograms

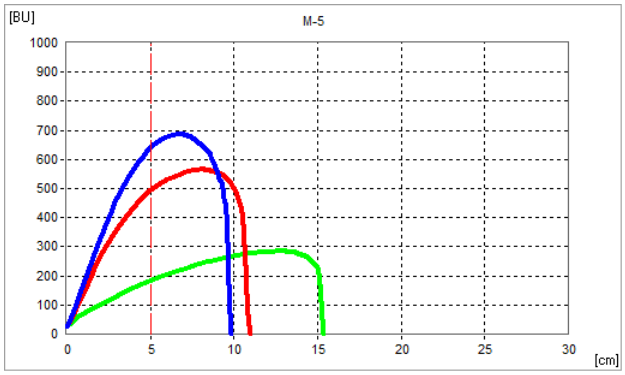
LCS Rebel Check (Havre, H-5)



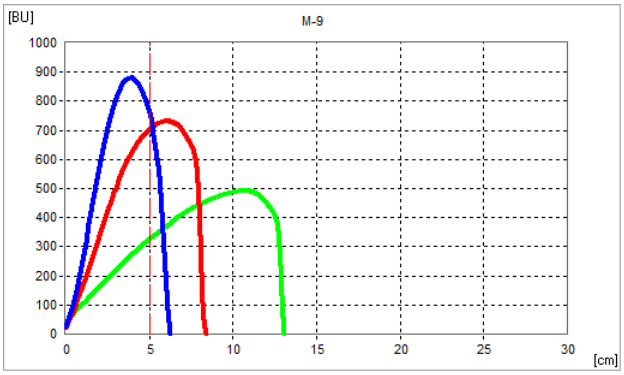
LCS Hammer AX (Havre, H-9)



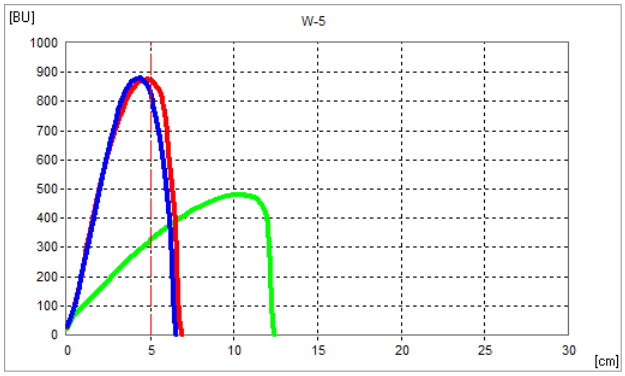
LCS Rebel Check (Minot, M-5)



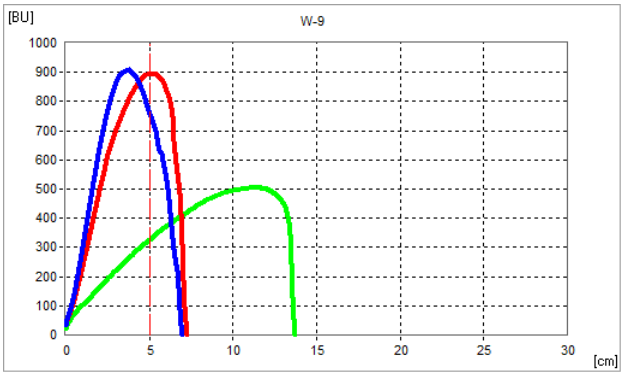
LCS Hammer AX (Minot, M-9)



LCS Rebel Check (Williston, W-5)



LCS Hammer AX (Williston, W-9)



45 min; 90 min; 135 min

SWQC #10 – MT 21104

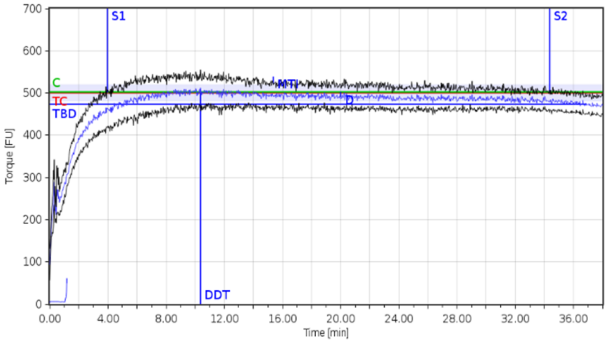
		Havre		Minot	
		LCS Rebel		LCS Rebel	
	Quality Trait	H-5	H-10	M-5	M-10
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	16.6	16.2	15.6	14.8
2	Flour Protein (%, 14% mb)	15.2	14.8	14.2	13.4
3	Market Value (Score 1-6)	4.4	4.5	5.3	4.7
4	Market Value (Score 1-10)	10.0	9.6	10.0	8.2
5	DON (ppm)	nd	nd	≤ 0.5	≤ 0.5
6	Test Weight (lb/bu)	59.6	60.4	63.8	62.4
7	1000 Kernel Weight (g)	28.1	29.8	35.7	30.7
8	Kernel Size, Large (%)	20	28	72	53
9	Kernel Size, Small (%)	26	19	6	13
10	Wheat Moisture (%)	11.5	11.3	11.4	10.1
11	Wheat Ash (%, 14% mb)	1.53	1.59	1.37	1.42
12	Wheat Falling Number (s)	469	440	396	424
13	SKCS Hardness Index	72.1	71.6	62.7	65.1
14	Vitreous Kernels (%)	99	99	83	89
	Flour Extraction				
15	Tempered Wheat Basis (%)	73.0	71.9	77.5	76.0
16	Total Product Basis (%)	73.3	71.4	77.5	76.9
17	Flour/Bu Wheat (lb)	44.4	44.1	50.5	49.2
	Flour Quality				
18	Flour Color Brightness (*L**)	90.5	90.3	91.0	90.7
19	Flour Color Yellowness (*b**)	9.8	9.6	9.7	11.1
20	Flour Moisture (%)	13.2	13.2	13.4	13.1
21	Flour Ash (%, 14% mb)	0.46	0.51	0.41	0.47
22	Flour Falling Number (malted, s)	252	250	247	254
	Farinograph				
23	Water Absorption (%, 500 BU)	63.6	62.1	61.2	56.5
24	Water Absorption (%, 14% mb)	63.0	61.5	61.0	55.9
25	Arrival Time (min)	4.0	2.9	2.8	2.1
26	Peak Time (min)	10.4	8.0	7.7	7.2
27	Dough Stability (min)	30.4	16.4	15.4	48.4
28	Mixing Tolerance Index (MTI, BU)	17	12	21	10
29	Time To Breakdown (TTB, min)	36.9	21.9	17.7	24.6
	II. Cooperator Results				
30	Bake Absorption (Average %)	65.6	64.3	63.9	60.7
31	Loaf Volume (% of Check)		100.3		97.7

SWQC #10 – MT 21104

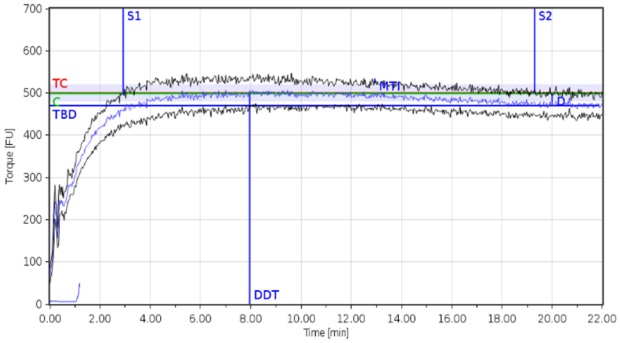
	Quality Trait	Havre LCS Rebel H-5	Havre LCS Rebel H-10	Minot LCS Rebel M-5	Minot LCS Rebel M-10
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	**6.8**	**5.7**	**6.2**	**7.2**
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	**6.5**	**5.3**	**5.8**	**6.1**
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		**4.0**		**6.1**
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		**4.8**		**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		**4.6**		**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		**4.5**		**4.0**
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.5**		**4.5**
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.4**		**5.4**
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.4**		**4.4**

Farinograms

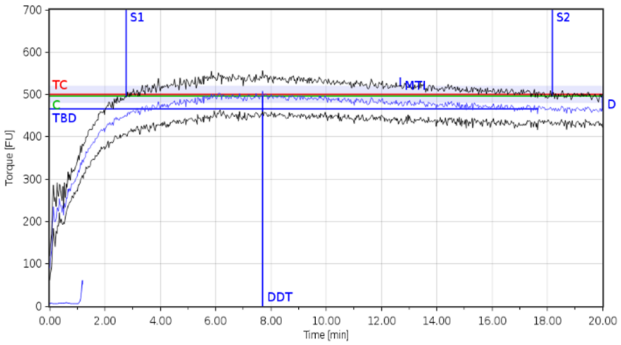
LCS Rebel Check (Havre, H-5)



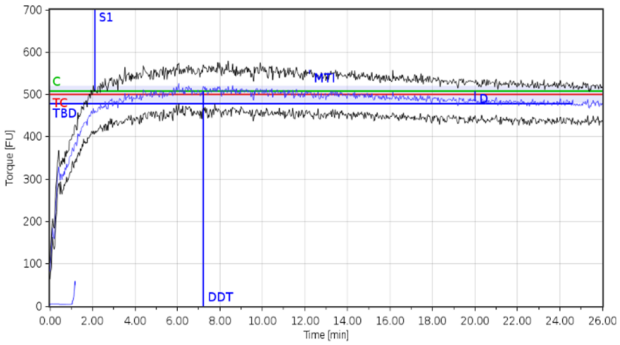
MT 21104 (Havre, H-10)



LCS Rebel Check (Minot, M-5)

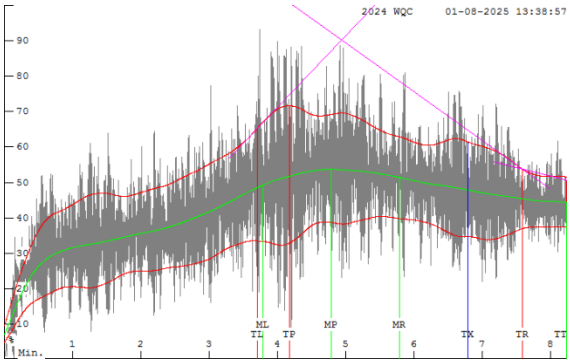


MT 21104 (Minot, M-10)

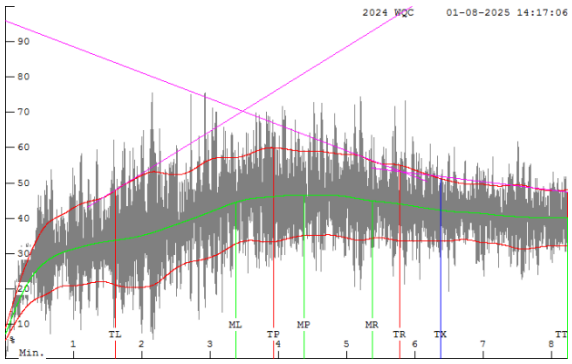


Mixograms

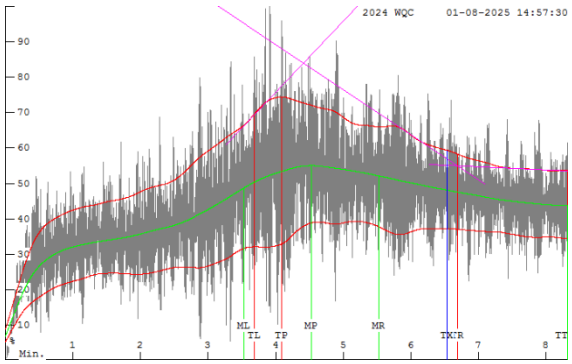
LCS Rebel Check (Havre, H-5)



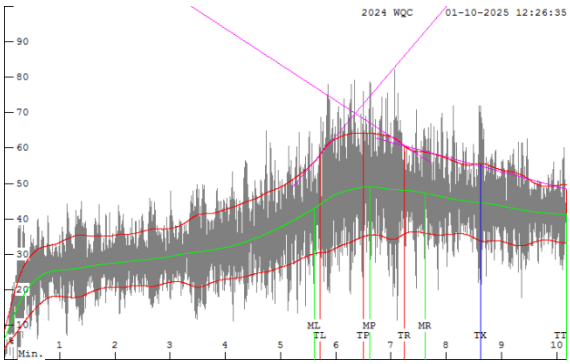
MT 21104 (Havre, H-10)



LCS Rebel Check (Minot, M-5)

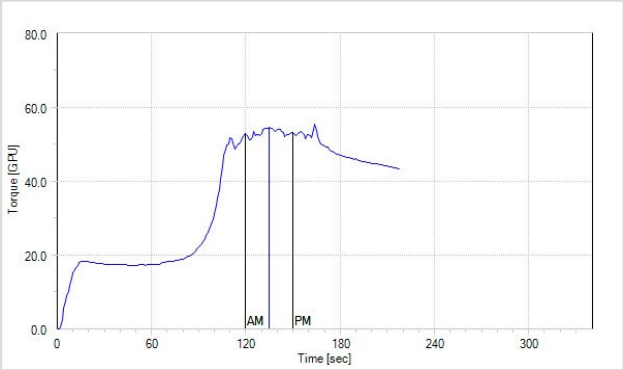


MT 21104 (Minot, M-10)



GlutoPeak Curves

LCS Rebel Check (Havre, H-5)



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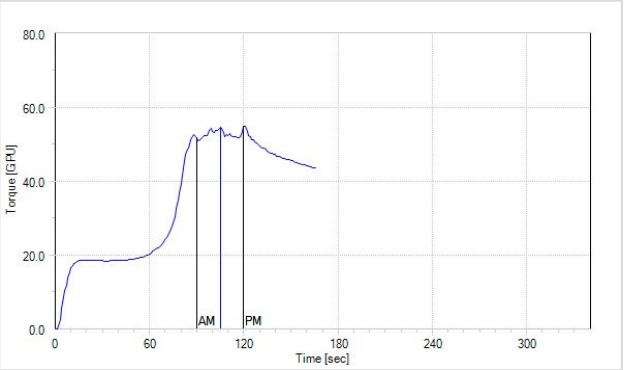

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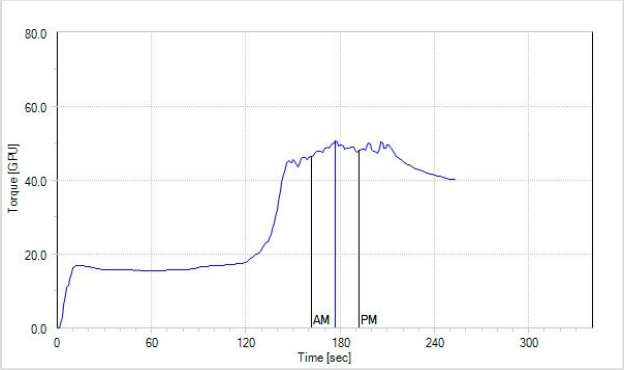

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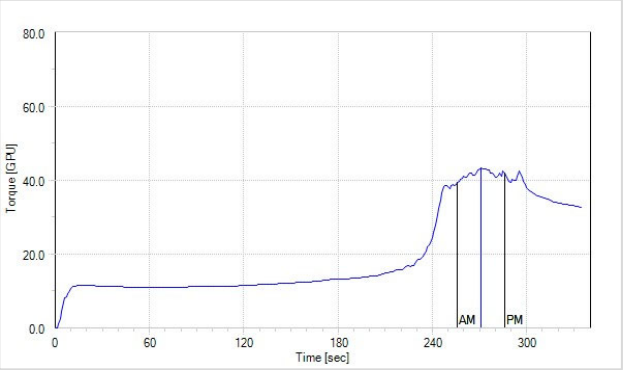
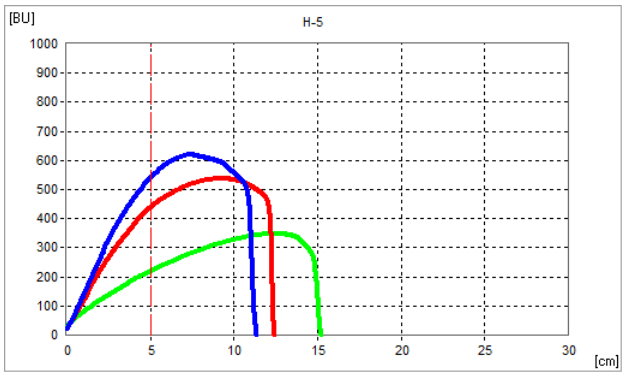


Extensograms

LCS Rebel Check (Havre, H-5)



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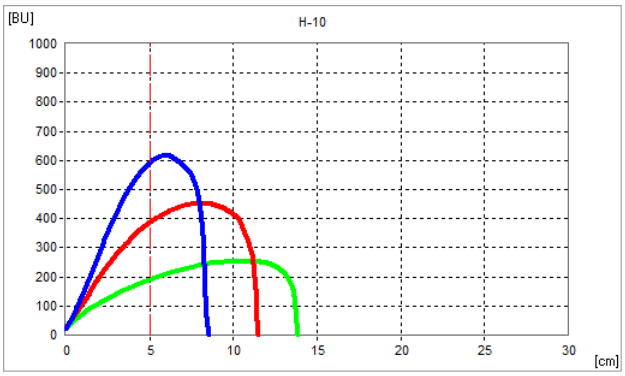
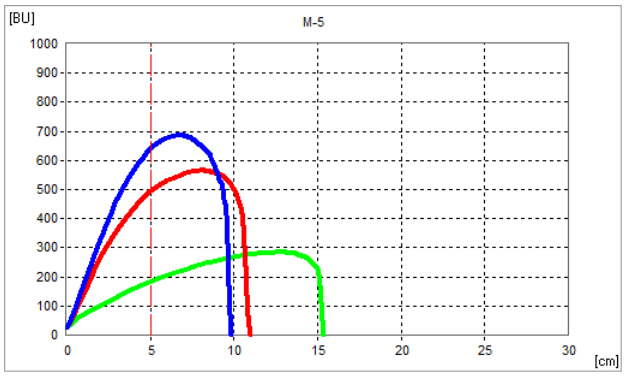
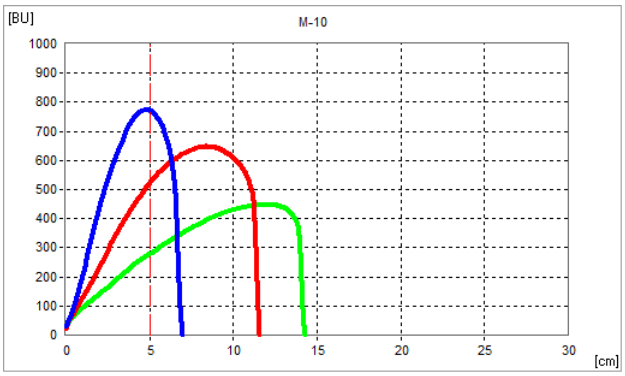


LCS Rebel Check (Minot, M-5)



MT 21104 (Minot, M-10)



45 min; 90 min; 135 min

SWQC #11 – ND Stampede

		Watertown		Casselton		Havre		Crookston		Minot		Williston	
		Linkert		Linkert		LCS Rebel		Linkert		LCS Rebel		LCS Rebel	
	Quality Trait	B-1	B-11	C-1	C-11	H-5	H-11	K-1	K-11	M-5	M-11	W-5	W-11
	I. USDA-ARS WQL Data												
1	Wheat Protein (%, 12% mb)	17.3	16.9	14.9	14.5	16.6	16.7	16.0	14.8	15.6	14.9	14.6	16.4
2	Flour Protein (%, 14% mb)	n/a	n/a	13.7	13.1	15.2	15.4	n/a	n/a	14.2	13.6	13.3	15.0
3	Market Value (Score 1-6)	3.1	2.7	4.9	4.1	4.4	4.0	5.4	5.2	5.3	5.1	4.4	3.6
4	Market Value (Score 1-10)	10.0	9.6	10.0	8.4	10.0	9.6	10.0	8.8	10.0	9.0	10.0	7.2
5	DON (ppm)	4.3	3.9	1.0	1.0	nd	≤ 0.5	1.9	1.6	≤ 0.5	≤ 0.5	≤ 0.5	nd
6	Test Weight (lb/bu)	56.7	56.7	62.0	60.6	59.6	57.7	62.3	62.6	63.8	63.0	61.7	56.9
7	1000 Kernel Weight (g)	29.2	27.6	37.3	32.5	28.1	26.4	36.1	36.3	35.7	32.2	30.8	23.9
8	Kernel Size, Large (%)	48	43	82	57	20	14	68	68	72	56	47	11
9	Kernel Size, Small (%)	14	17	5	14	26	28	8	9	6	14	16	37
10	Wheat Moisture (%)	13.2	13.3	13.1	13.1	11.5	11.6	12.6	12.9	11.4	10.8	12.5	12.4
11	Wheat Ash (%, 14% mb)	1.63	1.58	1.63	1.60	1.53	1.53	1.50	1.35	1.37	1.34	1.60	1.65
12	Wheat Falling Number (s)	330	283	438	412	469	470	468	448	396	441	442	449
13	SKCS Hardness Index	75.0	75.7	64.9	73.9	72.1	70.3	69.7	80.4	62.7	72.7	69.5	74.4
14	Vitreous Kernels (%)	60	64	47	69	99	96	92	93	83	96	94	96
	Flour Extraction												
15	Tempered Wheat Basis (%)	n/a	n/a	75.4	73.1	73.0	71.3	n/a	n/a	77.5	70.6	75.2	72.6
16	Total Product Basis (%)	n/a	n/a	76.1	73.4	73.3	71.4	n/a	n/a	77.5	73.9	75.4	71.4
17	Flour/Bu Wheat (lb)	n/a	n/a	47.2	45.1	44.4	41.5	n/a	n/a	50.5	45.6	46.8	41.3
	Flour Quality												
18	Flour Color Brightness (*L**)	n/a	n/a	90.5	90.6	90.5	90.2	n/a	n/a	91.0	91.0	90.9	90.6
19	Flour Color Yellowness (*b**)	n/a	n/a	9.6	9.0	9.8	8.5	n/a	n/a	9.7	8.4	9.8	8.7
20	Flour Moisture (%)	n/a	n/a	13.4	12.8	13.2	12.6	n/a	n/a	13.4	12.7	13.4	12.7
21	Flour Ash (%, 14% mb)	n/a	n/a	0.50	0.48	0.46	0.54	n/a	n/a	0.41	0.44	0.50	0.51
22	Flour Falling Number (malted, s)	n/a	n/a	251	250	252	260	n/a	n/a	247	255	254	253
	Farinograph												
23	Water Absorption (%, 500 BU)	n/a	n/a	60.6	62.3	63.6	66.1	n/a	n/a	61.2	62.7	60.5	64.7
24	Water Absorption (%, 14% mb)	n/a	n/a	59.6	61.1	63.0	64.7	n/a	n/a	61.0	61.7	60.1	63.7
25	Arrival Time (min)	n/a	n/a	2.1	1.8	4.0	3.7	n/a	n/a	2.8	3.2	2.1	40.2
26	Peak Time (min)	n/a	n/a	8.7	5.2	10.4	11.0	n/a	n/a	7.7	40.7	7.4	52.2
27	Dough Stability (min)	n/a	n/a	27.8	13.3	30.4	26.2	n/a	n/a	15.4	44.7	13.6	30.3
28	Mixing Tolerance Index (MTI, BU)	n/a	n/a	15	20	17	15	n/a	n/a	21	16	23	3
29	Time To Breakdown (TTB, min)	n/a	n/a	31.0	14.7	36.9	32.5	n/a	n/a	17.7	49.3	14.2	73.3

SWQC #11 – ND Stampede

	Quality Trait	Watertown Linkert B-1	Watertown Linkert B-11	Casselton Linkert C-1	Casselton Linkert C-11	Havre LCS Rebel H-5	Havre LCS Rebel H-11	Crookston Linkert K-1	Crookston Linkert K-11	Minot LCS Rebel M-5	Minot LCS Rebel M-11	Williston LCS Rebel W-5	Williston LCS Rebel W-11
	II. Cooperator Results												
30	Bake Absorption (Average %)	n/a	n/a	62.9	63.8	65.6	67.0	n/a	n/a	63.9	64.6	63.0	66.2
31	Loaf Volume (% of Check)		n/a		98.1		102.1		n/a		97.1		105.9
32	Mixing Requirement*	n/a	n/a	6.5	4.9	6.8	7.1	n/a	n/a	6.2	7.3	7.1	7.7
33	Dough Characteristics**	n/a	n/a	6.4	5.5	6.5	8.1	n/a	n/a	5.8	7.1	7.3	7.5
34	Mixing Tolerance†		n/a		4.4		5.5		n/a		6.5		6.1
35	Internal Crumb Color††		n/a		5.1		5.6		n/a		5.7		4.6
36	Internal Crumb Texture‡		n/a		5.1		5.2		n/a		5.5		4.9
	III. Cooperator Evaluation‡												
	Quality Traits 1-2: Protein		n/a		4.5		5.3		n/a		4.1		6.9
	Quality Traits 3-22: Milling		n/a		4.1		3.8		n/a		3.2		2.8
	Quality Traits 23-36: Baking		n/a		5.0		5.6		n/a		5.3		6.4
	Quality Traits 1-36: Overall Comparison		n/a		4.5		4.9		n/a		4.3		5.6

*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.

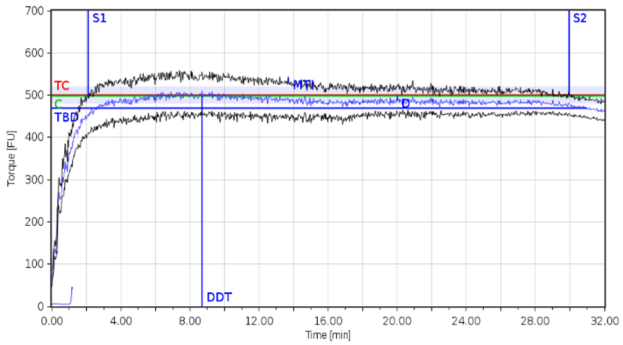
†9 = Much More Tolerance Than Check; 7 = More Tolerance Than Check; 5 = Tolerance Equivalent To Check; 3 = Less Tolerance Than Check; 1 = Much Less Tolerance Than Check.

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

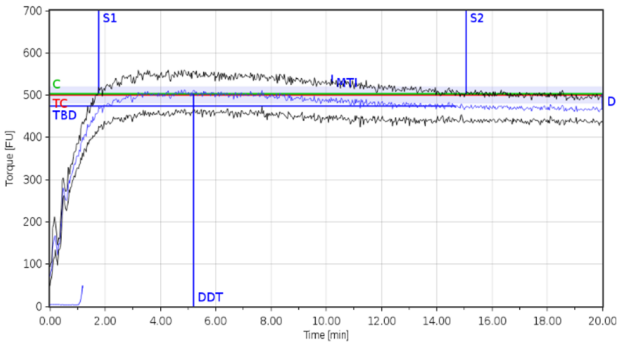
‡9 = Much Better Than Check; 7 = Better Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.

Farinograms

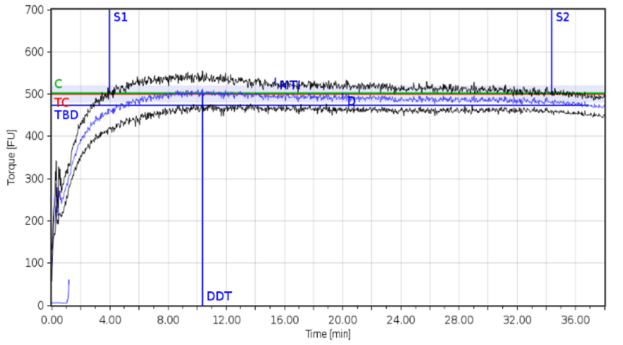
Linkert Check (Casselton, C-1)



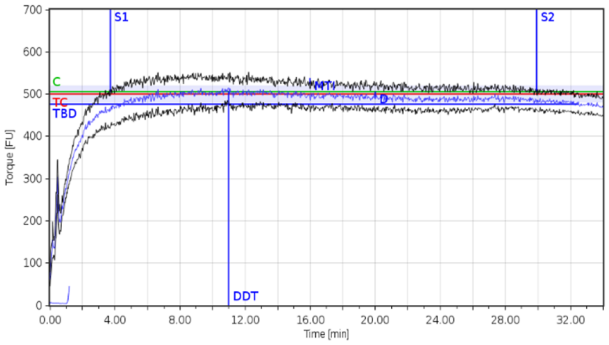
ND Stampede (Casselton, C-11)



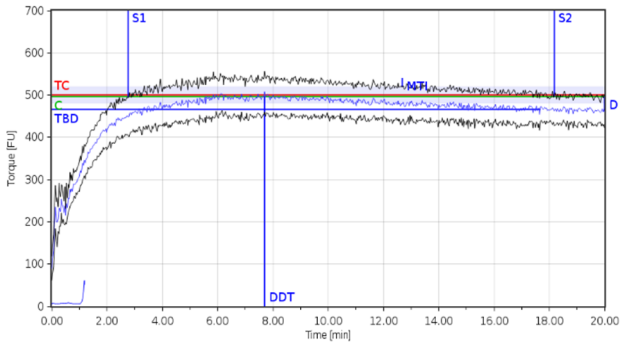
LCS Rebel Check (Havre, H-5)



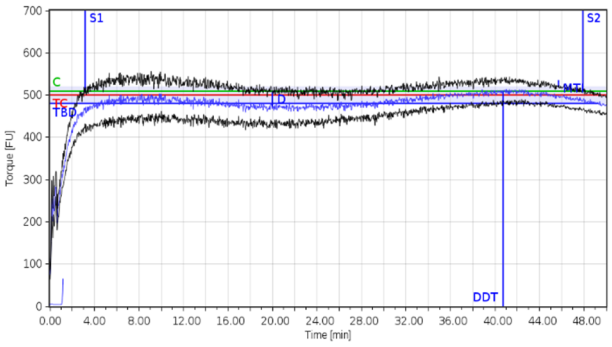
ND Stampede (Havre, H-11)



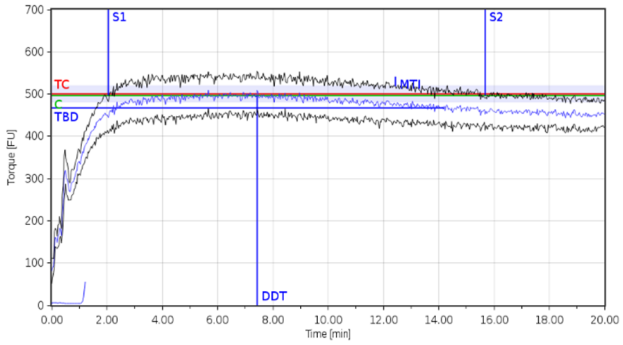
LCS Rebel Check (Minot, M-5)



ND Stampede (Minot, M-11)



LCS Rebel Check (Williston, W-5)



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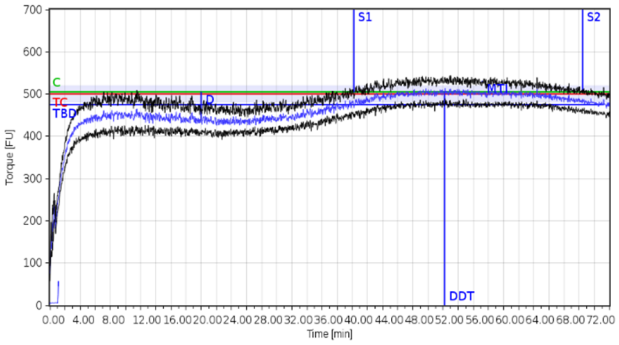
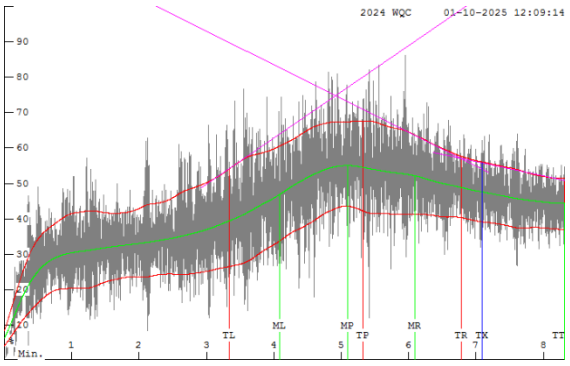


Mixograms

Linkert Check (Casselton, C-1)



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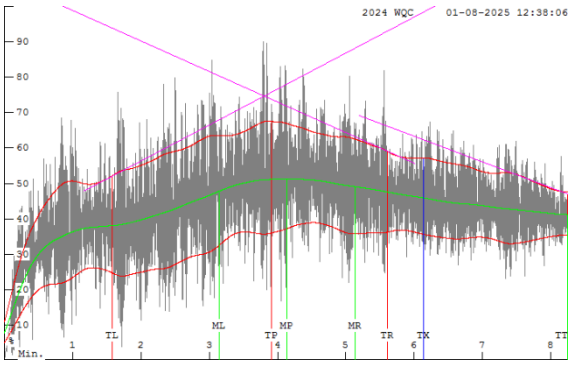
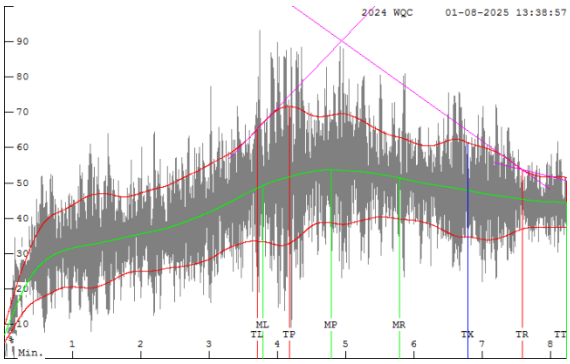


LCS Rebel Check (Havre, H-5)



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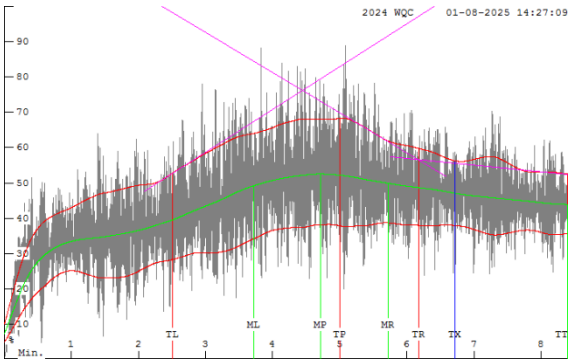
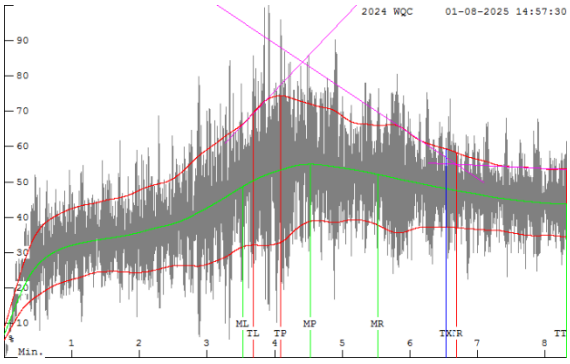
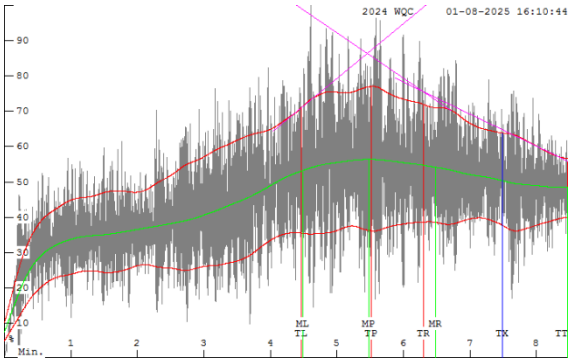


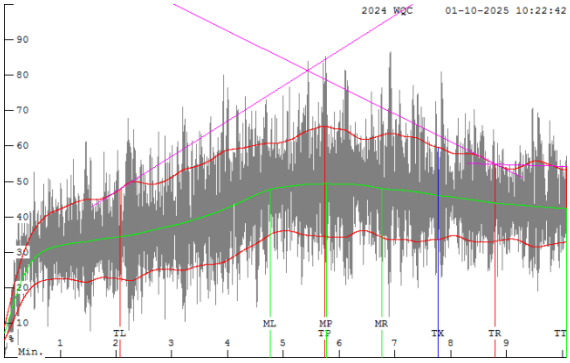
LCS Rebel Check (Minot, M-5)



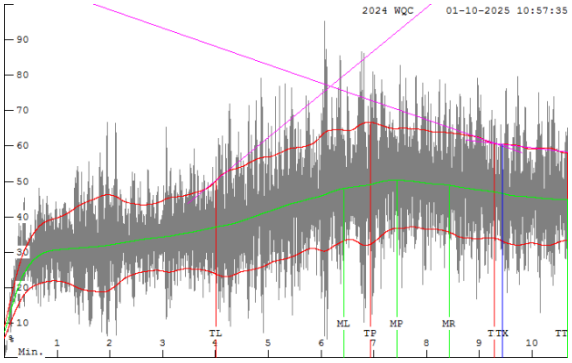
ND Stampede (Minot, M-11)



LCS Rebel Check (Williston, W-5)

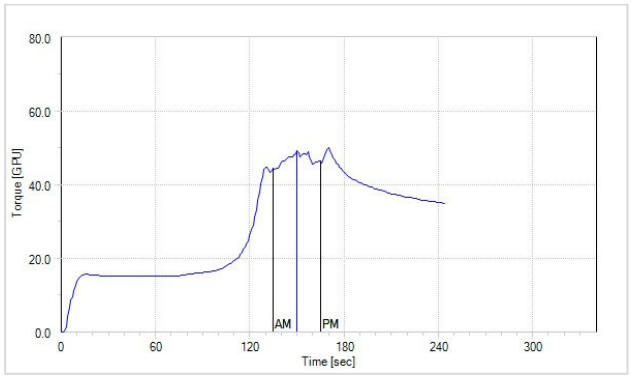


ND Stampede (Williston, W-11)

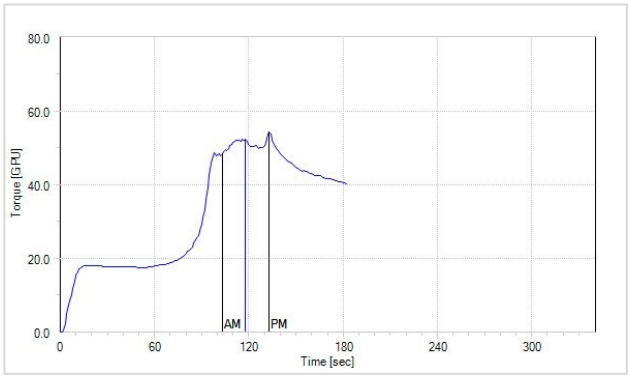


GlutoPeak Curves

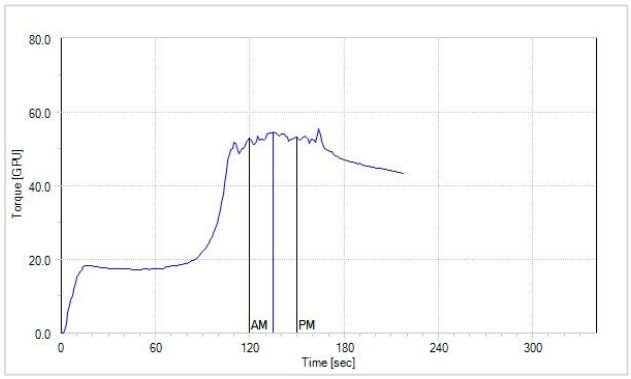
Linkert Check (Casselton, C-1)



ND Stampede (Casselton, C-11)



LCS Rebel Check (Havre, H-5)



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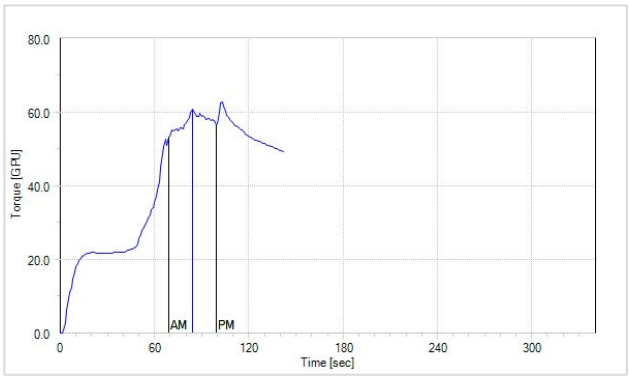
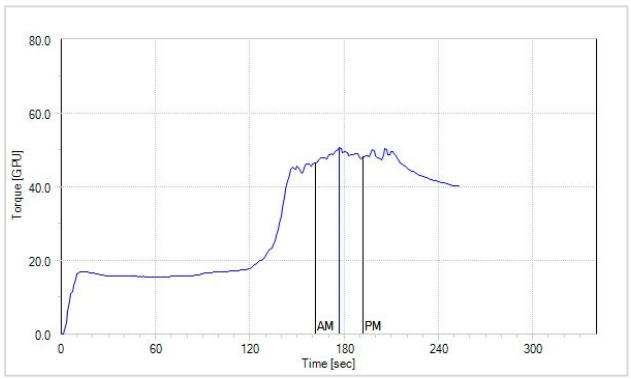
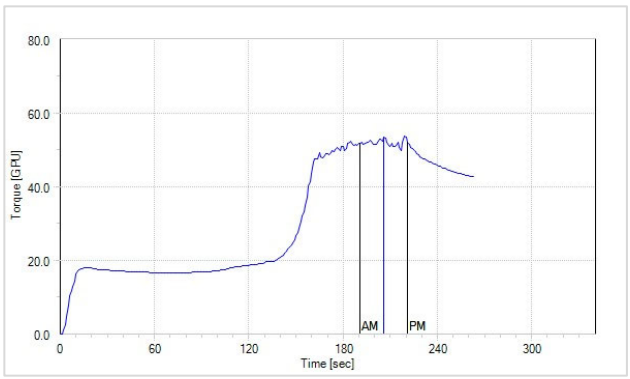


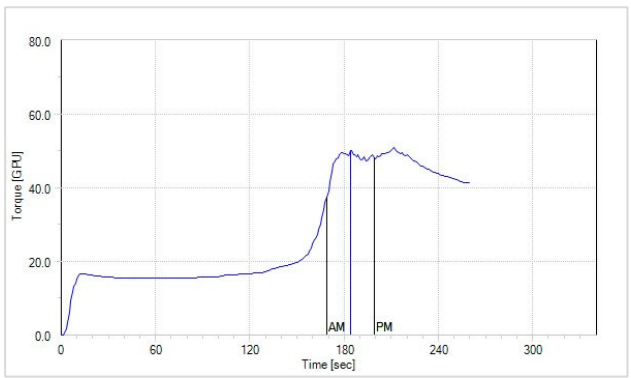
LCS Rebel Check (Minot, M-5)



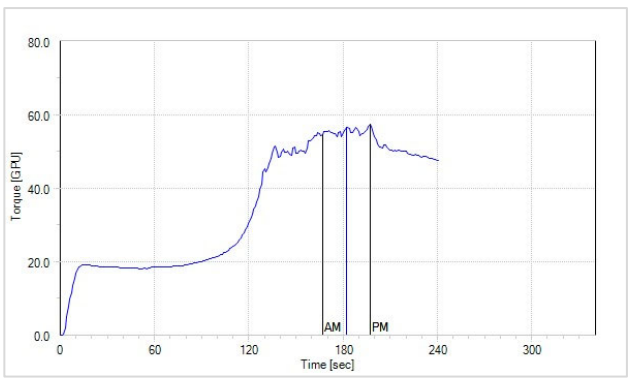
ND Stampede (Minot, M-11)



LCS Rebel Check (Williston, W-5)

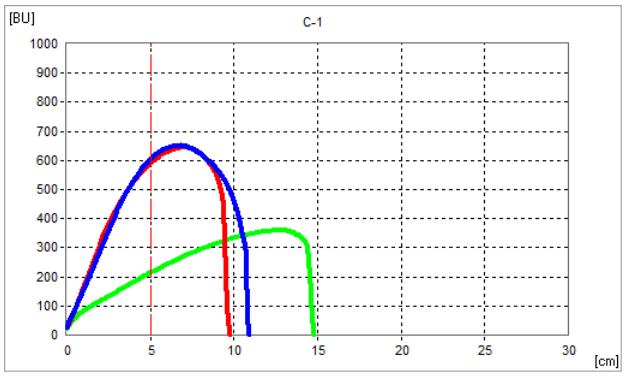


ND Stampede (Williston, W-11)

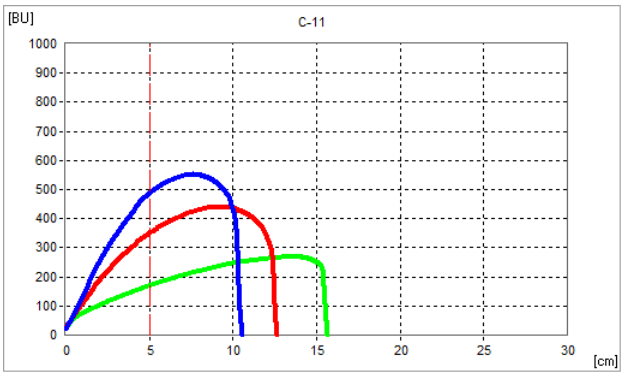


Extensograms

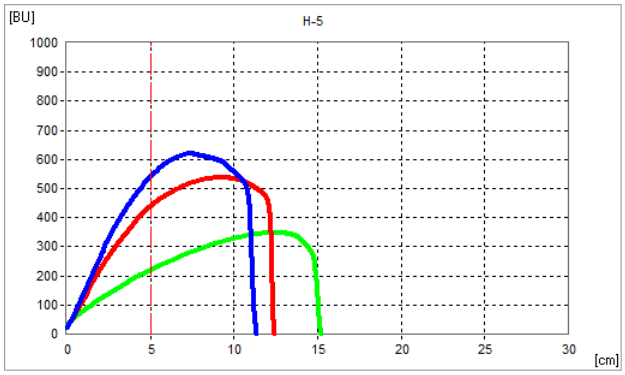
Linkert Check (Casselton, C-1)



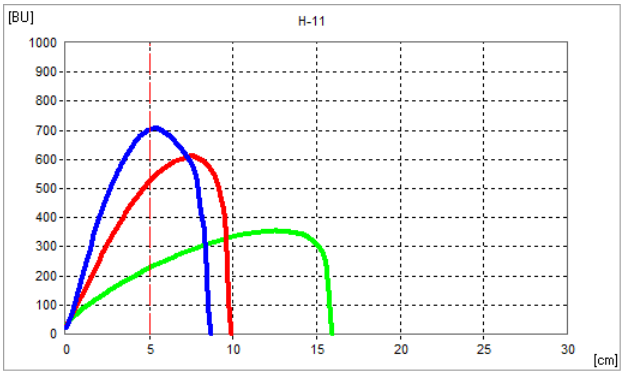
ND Stampede (Casselton, C-11)



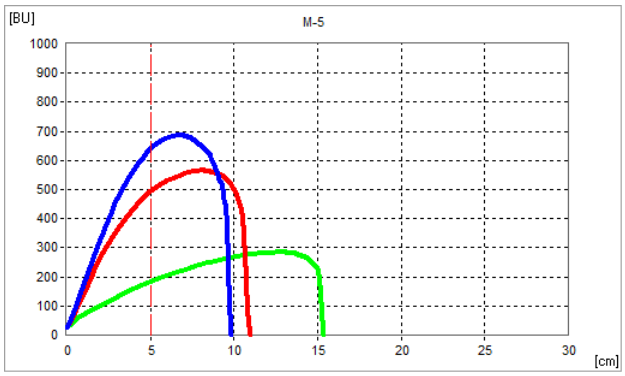
LCS Rebel Check (Havre, H-5)



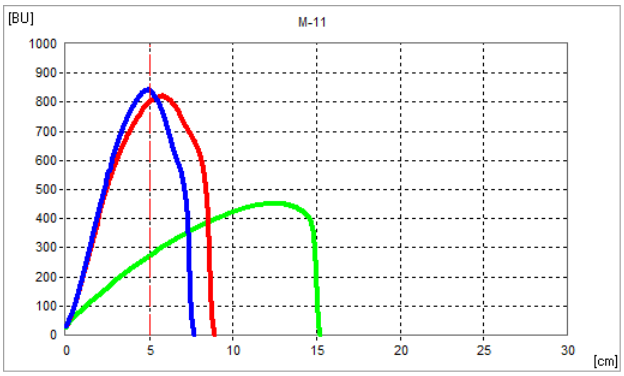
ND Stampede (Havre, H-11)



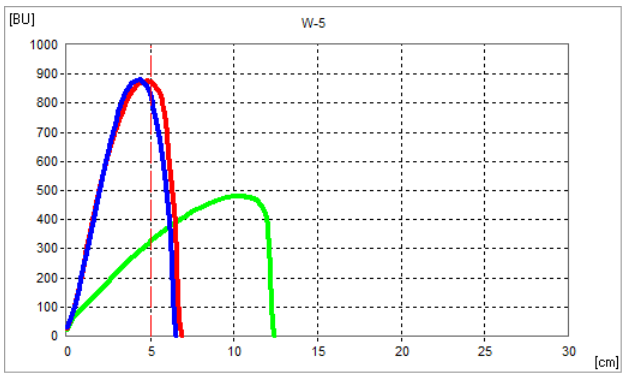
LCS Rebel Check (Minot, M-5)



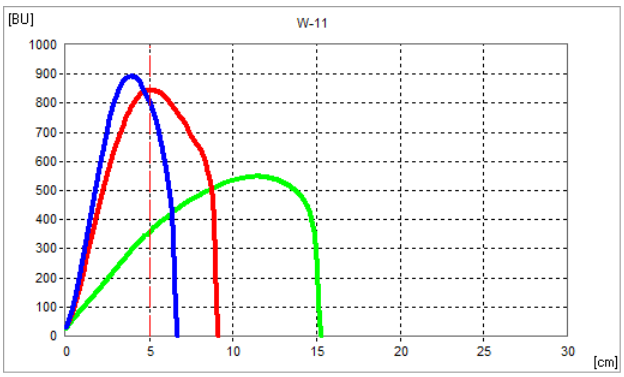
ND Stampede (Minot, M-11)



LCS Rebel Check (Williston, W-5)



ND Stampede (Williston, W-11)



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

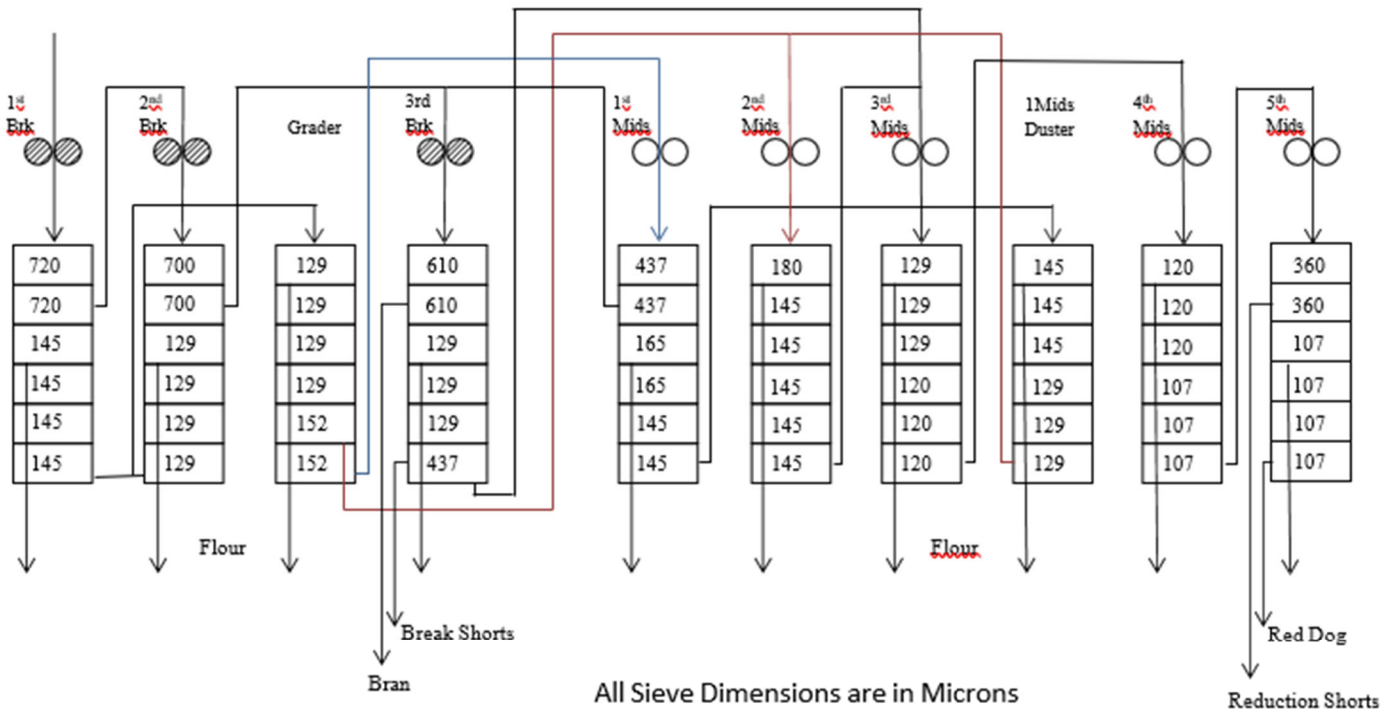
Wheat Market Value Score – Method #2

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 Multomat Mill Flow Chart

USDA-ARS Western Wheat Quality Laboratory, Pullman, WA



	# of Teeth	α	β	Land	Radius	Spiral	Break Setting Targets
1st Break	14	40	70	0.004"	0.024"	8% = 1"	43% Through 707 micron
2nd Break	20	40	75	0.002"	0.012"	10% = 1¼"	64% Through 707 micron
3rd Break	24	35	75	0.002"	0.008"	10% = 1¼"	Bran Appearance

Western Wheat Quality Laboratory,
MIAG MULTOMAT
Break Roll Speed Temper
Fast Rolls: 340rpm 14% Soft Wheat
Slow Rolls: 145rpm 16% Hard Wheat
Differential: 2.34 : 1 0.5% Pre-Temper

Reduction Roll Speed
Fast Rolls: 340rpm
Slow Rolls: 250rpm
Differential: 1.36 : 1

Wheat Kernel Characteristics by Location

Location	ID	Entry	Wheat Market Value Score		Test Weight	1000 Kernel Weight	Kernel Size		Vitreous Kernels	SKCS Hardness Index	Moisture	Protein	Ash	Falling Number	DON
			1-6	1-10	(lb/bu)	(g)	Large (%)	Small (%)	(%)		(%)	(%, 12% mb)	(%, 14% mb)	(s)	(ppm)
Watertown	**B-1**	**Linkert**	**3.1**	**10.0**	**56.7**	**29.2**	**48**	**14**	**60**	**75.0**	**13.2**	**17.3**	**1.63**	**330**	**4.3**
	B-3	SD4905	3.4	10.0	57.0	29.6	51	14	61	64.0	13.3	17.4	1.62	366	2.6
	B-4	MN13398-2	3.3	9.6	57.1	26.6	29	20	70	83.4	13.3	17.8	1.65	371	1.4
	B-6	MN19358-1	3.1	9.6	57.4	25.7	37	19	82	81.1	13.3	17.6	1.61	341	2.2
	B-9	LCS Hammer AX	3.3	9.6	57.1	25.9	35	21	72	73.5	13.5	17.0	1.67	382	2.5
	B-11	ND Stampede	2.7	9.6	56.7	27.6	43	17	64	75.7	13.3	16.9	1.58	283	3.9
Casselton	**C-1**	**Linkert**	**4.9**	**10.0**	**62.0**	**37.3**	**82**	**5**	**47**	**64.9**	**13.1**	**14.9**	**1.63**	**438**	**1.0**
	C-3	SD4905	4.0	8.6	60.4	33.6	63	11	31	57.2	13.1	14.1	1.70	436	0.8
	C-4	MN13398-2	4.1	8.8	61.1	30.5	46	15	72	80.7	12.9	14.6	1.70	435	0.8
	C-6	MN19358-1	4.5	9.2	61.4	32.4	64	10	65	70.9	12.8	14.8	1.63	458	≤ 0.5
	C-8	NDHRS15-0006-C46	4.5	9.6	61.7	35.6	75	7	55	71.5	13.0	14.4	1.59	406	1.0
	C-9	LCS Hammer AX	3.8	7.6	60.3	31.6	50	16	21	68.1	13.0	13.8	1.66	473	1.7
	C-11	ND Stampede	4.1	8.4	60.6	32.5	57	14	69	73.9	13.1	14.5	1.60	412	1.0
Havre	H-2	Dagmar	4.5	10.0	59.1	30.9	33	18	95	68.5	11.3	16.8	1.55	458	nd
	H-5	**LCS Rebel**	**4.4**	**10.0**	**59.6**	**28.1**	**20**	**26**	**99**	**72.1**	**11.5**	**16.6**	**1.53**	**469**	**nd**
	H-7	MT 21074	3.9	9.2	57.6	25.9	11	28	98	68.0	11.2	16.9	1.61	458	nd
	H-9	LCS Hammer AX	4.4	8.2	60.9	29.9	28	20	97	68.9	11.6	14.8	1.46	525	nd
	H-10	MT 21104	4.5	9.6	60.4	29.8	28	19	99	71.6	11.3	16.2	1.59	440	nd
	H-11	ND Stampede	4.0	9.6	57.7	26.4	14	28	96	70.3	11.6	16.7	1.53	470	≤ 0.5
Crookston	**K-1**	**Linkert**	**5.4**	**10.0**	**62.3**	**36.1**	**68**	**8**	**92**	**69.7**	**12.6**	**16.0**	**1.50**	**468**	**1.9**
	K-3	SD4905	4.8	7.8	62.3	35.7	65	11	95	70.2	12.8	14.2	1.49	431	1.9
	K-4	MN13398-2	4.8	8.0	62.8	31.5	43	14	96	85.8	12.4	14.7	1.51	475	0.7
	K-6	MN19358-1	4.9	7.8	63.7	34.0	69	8	82	79.9	12.6	14.1	1.41	470	1.0
	K-8	NDHRS15-0006-C46	4.8	6.8	63.4	37.3	75	6	95	79.5	12.8	13.8	1.43	402	2.1
	K-9	LCS Hammer AX	4.0	6.4	60.9	31.2	41	19	72	78.2	12.8	13.8	1.56	500	2.5
	K-11	ND Stampede	5.2	8.8	62.6	36.3	68	9	93	80.4	12.9	14.8	1.35	448	1.6
Minot	M-2	Dagmar	5.7	9.6	62.3	37.6	76	7	83	63.1	11.9	16.5	1.38	431	≤ 0.5
	M-4	MN13398-2	4.6	7.8	63.2	29.9	37	14	98	80.5	10.0	14.5	1.52	518	≤ 0.5
	M-5	**LCS Rebel**	**5.3**	**10.0**	**63.8**	**35.7**	**72**	**6**	**83**	**62.7**	**11.4**	**15.6**	**1.37**	**396**	**≤ 0.5**
	M-6	MN19358-1	5.2	9.6	63.3	32.8	61	9	75	69.9	11.7	15.3	1.37	495	≤ 0.5
	M-7	MT 21074	5.1	9.4	62.7	34.2	68	9	93	66.9	9.7	15.7	1.51	416	≤ 0.5
	M-8	NDHRS15-0006-C46	5.0	9.4	63.5	34.3	73	7	99	70.3	11.4	14.9	1.44	412	≤ 0.5
	M-9	LCS Hammer AX	4.7	7.4	63.0	31.6	52	13	54	66.6	10.4	14.0	1.44	551	≤ 0.5
	M-10	MT 21104	4.7	8.2	62.4	30.7	53	13	89	65.1	10.1	14.8	1.42	424	≤ 0.5
	M-11	ND Stampede	5.1	9.0	63.0	32.2	56	14	96	72.7	10.8	14.9	1.34	441	≤ 0.5
Williston	W-2	Dagmar	4.4	9.4	62.1	34.7	62	9	96	73.2	12.7	13.9	1.68	420	nd
	W-5	**LCS Rebel**	**4.4**	**10.0**	**61.7**	**30.8**	**47**	**16**	**94**	**69.5**	**12.5**	**14.6**	**1.60**	**442**	**≤ 0.5**
	W-8	NDHRS15-0006-C46	3.4	7.4	58.6	26.1	26	26	95	79.4	12.3	15.3	1.71	401	≤ 0.5
	W-9	LCS Hammer AX	3.7	8.4	59.5	26.4	21	32	96	72.2	12.7	14.6	1.59	493	nd
	W-11	ND Stampede	3.6	7.2	56.9	23.9	11	37	96	74.4	12.4	16.4	1.65	449	nd

Flour Characteristics by Location

Location	ID	Entry	Extraction*			Color			Moisture	Protein	Ash	Wet Gluten	Gluten Index	Falling Number
			TWB (%)	TPB (%)	Flour/bu Wheat (lb)	*L**	*a**	*b**	(%)	(%, 14% mb)	(%, 14% mb)	(%)		(Malted, s)
Casselton	**C-1**	**Linkert**	**75.4**	**76.1**	**47.2**	**90.5**	**-0.83**	**9.6**	**13.4**	**13.7**	**0.50**	**33.8**	**98**	**251**
	C-3	SD4905	76.8	75.6	47.0	90.9	-1.24	11.0	13.0	12.5	0.48	32.3	94	247
	C-4	MN13398-2	71.7	72.3	44.5	90.4	-0.93	10.9	12.9	13.4	0.52	33.1	98	247
	C-6	MN19358-1	72.1	72.2	44.8	90.5	-0.86	10.4	12.5	13.2	0.49	33.4	98	241
	C-8	NDHRS15-0006-C46	74.0	74.5	46.3	90.6	-0.50	9.1	12.6	13.2	0.46	35.8	95	249
	C-11	ND Stampede	73.1	73.4	45.1	90.6	-0.64	9.0	12.8	13.1	0.48	34.1	98	250
Havre	H-2	Dagmar	69.5	70.7	42.2	90.3	-0.48	9.8	13.4	15.2	0.46	40.3	88	249
	H-5	**LCS Rebel**	**73.0**	**73.3**	**44.4**	**90.5**	**-0.62**	**9.8**	**13.2**	**15.2**	**0.46**	**38.6**	**92**	**252**
	H-7	MT 21074	72.3	72.3	42.4	90.4	-0.91	11.4	12.8	15.4	0.50	36.6	96	253
	H-9	LCS Hammer AX	73.1	72.8	45.1	91.4	-0.73	9.0	12.9	13.2	0.45	32.5	97	250
	H-10	MT 21104	71.9	71.4	44.1	90.3	-0.43	9.6	13.2	14.8	0.51	39.8	89	250
	H-11	ND Stampede	71.3	71.4	41.5	90.2	-0.19	8.5	12.6	15.4	0.54	39.4	92	260
Minot	M-2	Dagmar	75.5	76.2	47.9	90.2	-0.51	9.9	13.4	14.8	0.42	39.0	97	251
	M-4	MN13398-2	74.7	74.6	49.0	90.8	-0.83	10.2	13.7	13.3	0.51	31.5	100	249
	M-5	**LCS Rebel**	**77.5**	**77.5**	**50.5**	**91.0**	**-0.81**	**9.7**	**13.4**	**14.2**	**0.41**	**36.7**	**98**	**247**
	M-6	MN19358-1	74.6	75.6	48.6	90.7	-0.76	9.9	13.2	14.0	0.46	34.4	99	252
	M-7	MT 21074	73.6	73.7	47.9	90.6	-0.48	9.0	13.5	14.3	0.47	38.6	97	254
	M-8	NDHRS15-0006-C46	71.2	75.1	45.8	91.0	-0.44	8.5	13.0	13.6	0.43	35.3	98	251
	M-9	LCS Hammer AX	75.2	76.2	48.9	91.0	-0.81	9.5	13.3	12.6	0.45	30.5	100	241
	M-10	MT 21104	76.0	76.9	49.2	90.7	-0.99	11.1	13.1	13.4	0.47	31.6	99	254
	M-11	ND Stampede	70.6	73.9	45.6	91.0	-0.59	8.4	12.7	13.6	0.44	33.3	99	255
Williston	W-2	Dagmar	72.1	72.8	44.9	90.8	-0.61	9.4	13.0	12.5	0.52	30.9	98	251
	W-5	**LCS Rebel**	**75.2**	**75.4**	**46.8**	**90.9**	**-0.77**	**9.8**	**13.4**	**13.3**	**0.50**	**31.3**	**99**	**254**
	W-8	NDHRS15-0006-C46	73.6	72.7	42.8	90.6	-0.40	8.9	13.1	14.2	0.53	34.3	98	254
	W-9	LCS Hammer AX	73.7	73.6	43.5	91.1	-0.81	9.7	13.1	13.3	0.49	31.1	99	247
	W-11	ND Stampede	72.6	71.4	41.3	90.6	-0.40	8.7	12.7	15.0	0.51	35.2	100	253

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

Farinograph Characteristics by Location

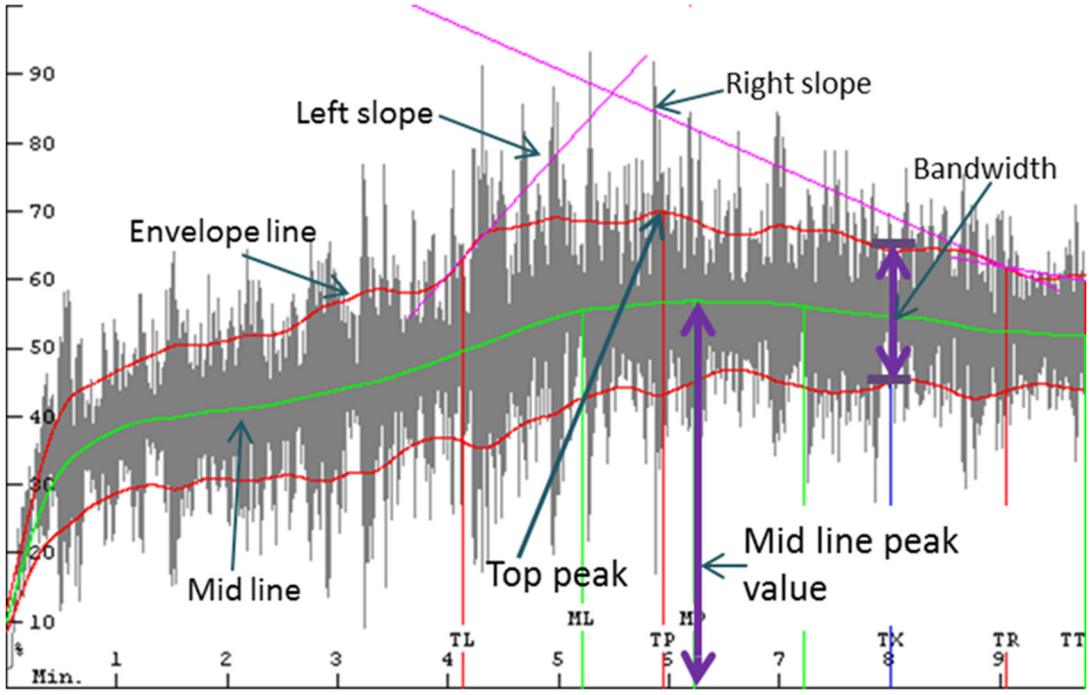
Location	ID	Entry	Water Absorption (%, 500 BU)	Water Absorption (%, 14% mb)	Arrival Time (min)	Peak Time (min)	Dough Stability (min)	MTI* (BU)	TTB* (min)
Casselton	**C-1**	**Linkert**	**60.6**	**59.6**	**2.1**	**8.7**	**27.8**	**15**	**31.0**
	C-3	SD4905	58.3	57.5	1.9	5.2	10.0	34	11.4
	C-4	MN13398-2	60.9	59.9	2.3	6.2	16.1	16	15.7
	C-6	MN19358-1	61.4	60.0	1.9	6.3	11.6	30	13.5
	C-8	NDHRS15-0006-C46	63.4	62.2	2.5	7.5	10.7	31	13.8
	C-11	ND Stampede	62.3	61.1	1.8	5.2	13.3	20	14.7
Havre	H-2	Dagmar	62.6	62.2	3.2	9.1	20.1	12	24.6
	H-5	**LCS Rebel**	**63.6**	**63.0**	**4.0**	**10.4**	**30.4**	**17**	**36.9**
	H-7	MT 21074	59.1	58.1	3.7	11.6	42.0	23	47.1
	H-9	LCS Hammer AX	58.9	57.9	1.5	6.0	15.6	21	14.5
	H-10	MT 21104	62.1	61.5	2.9	8.0	16.4	12	21.9
	H-11	ND Stampede	66.1	64.7	3.7	11.0	26.2	15	32.5
Minot	M-2	Dagmar	61.3	60.9	2.5	8.5	35.8	20	39.9
	M-4	MN13398-2	59.3	59.3	2.1	9.0	39.3	9	43.2
	M-5	**LCS Rebel**	**61.2**	**61.0**	**2.8**	**7.7**	**15.4**	**21**	**17.7**
	M-6	MN19358-1	60.8	60.2	2.5	7.8	15.7	20	17.1
	M-7	MT 21074	60.8	60.6	3.1	8.4	16.1	20	20.4
	M-8	NDHRS15-0006-C46	62.4	61.8	3.3	8.3	16.9	26	22.3
	M-9	LCS Hammer AX	58.0	57.6	1.6	5.4	17.4	22	14.2
	M-10	MT 21104	56.5	55.9	2.1	7.2	48.4	10	24.6
	M-11	ND Stampede	62.7	61.7	3.2	40.7	44.7	16	49.3
Williston	W-2	Dagmar	61.1	60.1	1.4	5.6	10.4	32	10.9
	W-5	**LCS Rebel**	**60.5**	**60.1**	**2.1**	**7.4**	**13.6**	**23**	**14.2**
	W-8	NDHRS15-0006-C46	62.3	61.7	3.4	8.1	12.9	28	16.2
	W-9	LCS Hammer AX	58.7	57.9	1.5	6.8	17.5	22	15.7
	W-11	ND Stampede	64.7	63.7	40.2	52.2	30.3	3	73.3

MTI = Mixing tolerance index; TTB = Time to breakdown.

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)
Casselton	**C-1**	**Linkert**	**5.3**	**67.7**	**25.4**	**5.1**	**55.0**	**23.8**	**186.2**
	C-3	SD4905	3.8	57.3	21.2	3.8	46.6	21.2	133.0
	C-4	MN13398-2	4.5	70.1	33.5	4.4	52.7	32.5	167.4
	C-6	MN19358-1	4.1	66.7	31.9	4.3	50.5	29.1	166.7
	C-8	NDHRS15-0006-C46	2.9	68.2	31.0	3.4	53.0	24.5	136.3
	C-11	ND Stampede	3.9	67.6	31.5	4.1	51.2	29.7	164.8
Havre	H-2	Dagmar	3.6	68.6	30.6	3.8	53.0	28.5	147.0
	H-5	**LCS Rebel**	**4.2**	**71.6**	**38.8**	**4.8**	**53.7**	**30.5**	**183.2**
	H-7	MT 21074	7.7	57.1	28.7	8.4	43.3	24.2	240.1
	H-9	LCS Hammer AX	6.1	52.0	24.9	6.9	39.2	22.0	221.9
	H-10	MT 21104	3.9	60.0	26.7	4.4	46.6	23.8	157.3
	H-11	ND Stampede	5.0	68.3	30.4	4.7	52.5	29.8	184.3
Minot	M-2	Dagmar	4.6	66.7	31.4	4.2	50.8	29.6	158.1
	M-4	MN13398-2	5.0	69.3	31.8	4.8	53.3	31.0	187.0
	M-5	**LCS Rebel**	**4.1**	**74.4**	**41.5**	**4.5**	**55.0**	**33.2**	**173.4**
	M-6	MN19358-1	4.4	66.2	30.9	4.7	50.3	27.6	173.0
	M-7	MT 21074	3.7	71.7	35.3	3.8	53.3	34.3	143.7
	M-8	NDHRS15-0006-C46	3.9	71.8	32.9	3.9	54.4	32.6	156.6
	M-9	LCS Hammer AX	5.9	60.9	32.6	5.7	44.3	31.2	197.7
	M-10	MT 21104	6.5	64.3	29.3	6.6	49.0	28.9	211.5
	M-11	ND Stampede	5.5	77.1	40.9	5.5	56.4	40.7	223.2
Williston	W-2	Dagmar	5.2	63.8	29.8	5.3	48.2	29.5	202.9
	W-5	**LCS Rebel**	**5.7**	**65.5**	**31.2**	**5.8**	**49.3**	**31.2**	**216.8**
	W-8	NDHRS15-0006-C46	4.9	64.4	28.3	5.2	49.7	26.2	197.2
	W-9	LCS Hammer AX	5.5	59.0	31.2	6.9	44.0	28.0	241.5
	W-11	ND Stampede	6.9	66.7	34.4	7.4	50.3	28.2	276.7

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).

GlutoPeak Characteristics by Location

Location	ID	Entry	AM (GPU)	PM (GPU)	BEM (GPU)	PMT (s)	Aggregation Energy (cm^2)
Casselton	**C-1**	**Linkert**	**44**	**46**	**49**	**150**	**1422**
	C-3	SD4905	35	45	46	142	1331
	C-4	MN13398-2	46	48	51	138	1463
	C-6	MN19358-1	42	50	52	114	1511
	C-8	NDHRS15-0006-C46	48	51	55	95	1580
	C-11	ND Stampede	48	54	52	118	1546
Havre	H-2	Dagmar	53	55	57	87	1668
	H-5	**LCS Rebel**	**53**	**53**	**55**	**135**	**1611**
	H-7	MT 21074	48	48	52	174	1477
	H-9	LCS Hammer AX	46	47	48	183	1408
	H-10	MT 21104	52	55	55	105	1599
	H-11	ND Stampede	53	57	61	84	1741
Minot	M-2	Dagmar	47	52	53	146	1546
	M-4	MN13398-2	47	48	49	183	1450
	M-5	**LCS Rebel**	**46**	**48**	**51**	**177**	**1472**
	M-6	MN19358-1	46	46	50	183	1447
	M-7	MT 21074	46	49	50	134	1469
	M-8	NDHRS15-0006-C46	67	65	70	87	2050
	M-9	LCS Hammer AX	45	44	46	239	1354
	M-10	MT 21104	39	42	43	271	1264
	M-11	ND Stampede	52	52	53	206	1579
Williston	W-2	Dagmar	48	51	53	142	1528
	W-5	**LCS Rebel**	**37**	**48**	**50**	**184**	**1454**
	W-8	NDHRS15-0006-C46	50	53	53	150	1569
	W-9	LCS Hammer AX	46	47	49	210	1416
	W-11	ND Stampede	55	58	57	182	1681

AM = Torque 15 s before peak; PM = Torque 15 s after peak; BEM = Peak torque; PMT = Peak maximum time; Aggregation Energy = area under the curve between AM and PM.

Extensograph Characteristics by Location

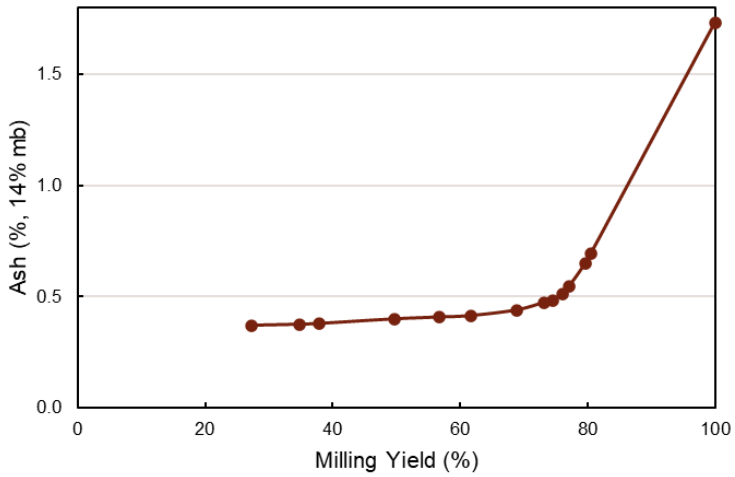
45 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Casselton	**C-1**	**Linkert**	**65**	**215**	**148**	**359**	**1.5**	**2.4**
	C-3	SD4905	41	130	157	195	0.8	1.2
	C-4	MN13398-2	72	214	155	386	1.4	2.5
	C-6	MN19358-1	49	172	143	271	1.2	1.9
	C-8	NDHRS15-0006-C46	46	154	154	225	1.0	1.5
	C-11	ND Stampede	54	171	156	268	1.1	1.7
Havre	H-2	Dagmar	57	185	155	287	1.2	1.9
	H-5	**LCS Rebel**	**66**	**221**	**152**	**349**	**1.5**	**2.3**
	H-7	MT 21074	67	230	149	353	1.5	2.4
	H-9	LCS Hammer AX	63	220	145	356	1.5	2.5
	H-10	MT 21104	47	190	139	254	1.4	1.8
	H-11	ND Stampede	72	228	160	354	1.4	2.2
Minot	M-2	Dagmar	69	201	166	324	1.2	2.0
	M-4	MN13398-2	84	281	149	454	1.9	3.1
	M-5	**LCS Rebel**	**56**	**183**	**154**	**284**	**1.2**	**1.9**
	M-6	MN19358-1	64	228	143	361	1.6	2.5
	M-7	MT 21074	51	142	174	218	0.8	1.3
	M-8	NDHRS15-0006-C46	69	198	168	320	1.2	1.9
	M-9	LCS Hammer AX	78	325	131	492	2.5	3.8
	M-10	MT 21104	78	279	143	448	2.0	3.1
	M-11	ND Stampede	84	271	152	452	1.8	3.0
Williston	W-2	Dagmar	61	289	121	411	2.4	3.4
	W-5	**LCS Rebel**	**72**	**326**	**125**	**479**	**2.6**	**3.8**
	W-8	NDHRS15-0006-C46	70	279	135	424	2.1	3.1
	W-9	LCS Hammer AX	85	325	138	504	2.4	3.7
	W-11	ND Stampede	105	360	153	548	2.4	3.6

90 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Casselton	**C-1**	**Linkert**	**80**	**595**	**98**	**645**	**6.1**	**6.6**
	C-3	SD4905	62	316	122	401	2.6	3.3
	C-4	MN13398-2	98	530	122	635	4.4	5.2
	C-6	MN19358-1	73	420	117	474	3.6	4.0
	C-8	NDHRS15-0006-C46	66	340	128	386	2.7	3.0
	C-11	ND Stampede	72	352	127	440	2.8	3.5
Havre	H-2	Dagmar	80	393	127	482	3.1	3.8
	H-5	**LCS Rebel**	**88**	**440**	**124**	**537**	**3.6**	**4.3**
	H-7	MT 21074	82	531	108	585	4.9	5.4
	H-9	LCS Hammer AX	70	484	107	515	4.5	4.8
	H-10	MT 21104	67	390	115	452	3.4	3.9
	H-11	ND Stampede	73	525	99	612	5.3	6.2
Minot	M-2	Dagmar	86	336	141	475	2.4	3.4
	M-4	MN13398-2	106	703	108	772	6.5	7.2
	M-5	**LCS Rebel**	**80**	**494**	**110**	**565**	**4.5**	**5.2**
	M-6	MN19358-1	91	609	110	652	5.6	5.9
	M-7	MT 21074	62	220	147	332	1.5	2.3
	M-8	NDHRS15-0006-C46	89	325	145	485	2.3	3.4
	M-9	LCS Hammer AX	74	706	84	731	8.4	8.7
	M-10	MT 21104	93	523	116	647	4.5	5.6
	M-11	ND Stampede	89	804	89	822	9.0	9.2
Williston	W-2	Dagmar	59	726	72	727	10.1	10.1
	W-5	**LCS Rebel**	**70**	**870**	**69**	**874**	**12.6**	**12.6**
	W-8	NDHRS15-0006-C46	73	743	80	747	9.3	9.3
	W-9	LCS Hammer AX	77	895	73	895	12.3	12.3
	W-11	ND Stampede	97	843	92	844	9.2	9.2

135 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Casselton	**C-1**	**Linkert**	**90**	**605**	**109**	**651**	**5.6**	**6.0**
	C-3	SD4905	53	404	96	448	4.2	4.7
	C-4	MN13398-2	85	498	113	602	4.4	5.3
	C-6	MN19358-1	64	472	101	497	4.7	4.9
	C-8	NDHRS15-0006-C46	62	407	106	452	3.8	4.3
	C-11	ND Stampede	74	488	105	552	4.6	5.2
Havre	H-2	Dagmar	83	511	114	560	4.5	4.9
	H-5	**LCS Rebel**	**90**	**545**	**113**	**619**	**4.8**	**5.5**
	H-7	MT 21074	83	623	101	665	6.2	6.6
	H-9	LCS Hammer AX	50	563	74	564	7.7	7.7
	H-10	MT 21104	63	591	86	616	6.9	7.2
	H-11	ND Stampede	76	703	87	706	8.1	8.1
Minot	M-2	Dagmar	86	480	117	548	4.1	4.7
	M-4	MN13398-2	81	767	84	811	9.2	9.7
	M-5	**LCS Rebel**	**86**	**640**	**99**	**685**	**6.5**	**7.0**
	M-6	MN19358-1	83	731	91	734	8.1	8.1
	M-7	MT 21074	72	249	152	366	1.6	2.4
	M-8	NDHRS15-0006-C46	89	438	134	516	3.3	3.8
	M-9	LCS Hammer AX	62	760	63	881	12.1	14.1
	M-10	MT 21104	63	771	70	773	11.1	11.1
	M-11	ND Stampede	74	837	77	842	10.9	10.9
Williston	W-2	Dagmar	60	654	69	727	9.5	10.6
	W-5	**LCS Rebel**	**65**	**828**	**65**	**880**	**12.7**	**13.5**
	W-8	NDHRS15-0006-C46	71	767	66	897	11.6	13.5
	W-9	LCS Hammer AX	73	758	70	909	10.9	13.0
	W-11	ND Stampede	71	807	67	894	12.0	13.3

Ash Content in Mill Streams

Linkert Check – Casselton (C-1)



Mill Stream	Stream (%, 14% mb) Yield	Stream (%, 14% mb) Ash	Cumulative (%, 14% mb) Yield	Cumulative (%, 14% mb) Ash
Patent:				
2 M	27.2	0.37	27.2	0.37
1 M	7.5	0.39	34.7	0.37
1 M Dust	3.2	0.42	37.9	0.38
2 Bk	11.8	0.46	49.7	0.40
1 Bk	7.1	0.47	56.8	0.41
Grader	4.9	0.49	61.7	0.41
3 M	7.2	0.66	68.9	0.44
4 M	4.3	1.02	73.2	0.47
3 Bk	1.3	1.05	74.5	0.48
5 M	1.6	1.96	76.1	0.51
Bran, Shorts & Red Dog:				
Red Dog	1.0	2.88	77.1	0.55
BK Short	2.5	3.78	79.6	0.65
Red Short	0.9	4.66	80.5	0.69
Bran	19.5	6.04	100.0	1.73
Patent (Rebolted)		**0.50**		
Wheat		**1.63**		

Cooperators' Bake Data

Linkert Check

CASSELTON (C-1)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	60.0	3000	9	7
B	61.6	2700	9	7
C	61.0	3162	9	7
D	64.6	925	5	5
E	63.0	2442	6	8
F	60.6	2061	5	5
G	67.8	1030	7	6
H	62.2	990	5	6
I	66.8	875	5	7
J	60.6	2722	6	7
K	64.0	1075	5	5
Avg.	62.9		6.5	6.4
S.D.	2.6		1.8	1.0

LCS Rebel Checks

HAVRE (H-5)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	61.0	3050	9	7
B	65.0	2800	9	9
C	64.0	3133	9	7
D	68.0	829	5	5
E	66.6	2552	7	7
F	63.6	2108	7	5
G	69.0	905	6	9
H	65.4	905	6	4
I	69.3	854	5	7
J	63.6	2687	7	6
K	66.0	925	5	5
Avg.	65.6		6.8	6.5
S.D.	2.5		1.6	1.6

MINOT (M-5)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	60.0	2825	7	5
B	63.0	2775	9	9
C	61.0	2956	9	7
D	66.0	956	5	3
E	64.0	2355	6	8
F	61.2	2102	6	5
G	70.3	985	7	4
H	62.8	1000	4	8
I	67.9	883	5	5
J	61.2	2605	5	5
K	65.0	1075	5	5
Avg.	63.9		6.2	5.8
S.D.	3.2		1.7	1.9

WILLISTON (W-5)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	59.0	2925	9	7
B	62.1	2475	9	9
C	61.0	2809	9	9
D	65.1	833	5	5
E	63.2	2366	6	7
F	60.5	2117	7	7
G	69.2	775	9	8
H	61.1	860	6	8
I	67.8	843	7	8
J	60.5	2556	5	6
K	64.0	975	6	6
Avg.	63.0		7.1	7.3
S.D.	3.2		1.6	1.3

SWQC #2 – Dagmar

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	61.0	2800	91.8	3	3	3	5	5	5	5	4	3
B	64.2	2700	96.4	9	9	5	5	3	3	5	5	5
C	63.0	3015	96.2	9	7	5	5	5	5	3	7	5
D	67.2	888	107.1	4	5	5	7	9	5	6	7	6
E	65.6	2413	94.6	6	7	4	5	5	5	1	4	3
F	62.6	1797	85.2	7	6	5	5	4	5	5	4	4
G	68.2	935	103.3	5	5	5	3	5	5	3	5	4
H	64.2	1005	111.0	3	6	3	6	4	5	3	5	5
I	69.4	913	106.9	4	4	4	5	6	5	3	6	5
J	62.6	2678	99.7	6	6	4	6	6	5	3	5	5
K	66.0	1025	110.8	5	4	5	4	3	7	5	6	6
Avg.	**64.9**		**100.3**	**5.5**	**5.6**	**4.4**	**5.1**	**5.0**	**5.0**	**3.8**	**5.3**	**4.6**
S.D.	**2.6**		**8.3**	**2.1**	**1.7**	**0.8**	**1.0**	**1.7**	**0.9**	**1.5**	**1.1**	**1.0**

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	61.0	2825	100.0	5	5	5	4	5	5	5	5	5
B	62.9	2625	94.6	9	9	5	5	5	3	5	5	5
C	62.0	2971	100.5	9	9	7	3	5	7	5	7	7
D	65.9	944	98.7	5	5	5	7	7	5	5	7	6
E	64.0	2426	103.0	8	7	9	7	5	7	4	7	6
F	61.3	1821	86.6	8	6	6	6	5	6	4	3	4
G	70.3	975	99.0	6	4	4	7	5	7	5	5	6
H	63.9	1010	101.0	4	9	8	6	6	6	4	6	6
I	68.5	849	96.1	4	5	5	5	5	5	4	5	5
J	61.3	2374	91.1	6	5	8	5	4	6	4	3	4
K	67.0	1000	93.0	5	5	6	7	6	6	4	4	5
Avg.	**64.4**		**96.7**	**6.3**	**6.3**	**6.2**	**5.6**	**5.3**	**5.7**	**4.5**	**5.2**	**5.4**
S.D.	**3.2**		**4.9**	**1.9**	**1.9**	**1.6**	**1.4**	**0.8**	**1.2**	**0.5**	**1.5**	**0.9**

WILLISTON (W-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	59.0	2725	93.2	5	5	4	5	5	4	5	4	4
B	62.1	2900	117.2	9	7	3	5	3	5	5	5	5
C	61.0	2853	101.6	9	9	5	5	5	3	5	7	5
D	65.1	853	102.4	5	7	6	5	7	5	7	8	7
E	63.2	2249	95.1	7	7	7	5	7	4	2	5	4
F	61.1	1892	89.4	7	6	4	5	5	4	4	4	4
G	66.8	850	109.7	7	7	3	7	7	3	3	7	4
H	65.0	880	102.3	6	8	3	5	4	4	3	4	4
I	66.7	840	99.6	6	7	6	5	5	4	3	5	5
J	61.1	2484	97.2	4	5	4	5	5	4	4	4	4
K	62.0	1000	102.6	6	6	5	6	4	3	4	5	4
Avg.	**63.0**		**100.9**	**6.5**	**6.7**	**4.5**	**5.3**	**5.2**	**3.9**	**4.1**	**5.3**	**4.5**
S.D.	**2.6**		**7.7**	**1.6**	**1.2**	**1.4**	**0.6**	**1.3**	**0.7**	**1.4**	**1.4**	**0.9**

SWQC #3 – SD4905

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	59.0	2825	94.2	3	3	1	5	5	3	3	3	3
B	59.5	2700	100.0	5	5	3	5	7	3	3	3	3
C	58.0	2780	87.9	5	5	3	3	1	3	5	1	1
D	62.5	915	98.9	3	5	4	5	7	5	3	2	3
E	60.5	2456	100.6	4	3	2	6	4	3	7	4	5
F	58.3	2324	112.8	4	5	4	5	4	3	5	5	5
G	65.0	950	92.2	5	5	3	5	4	3	5	4	4
H	60.2	1010	102.0	3	6	2	4	2	3	5	4	4
I	59.0	863	98.6	3	5	8	7	4	4	5	5	5
J	58.3	2616	96.1	3	5	3	4	6	4	6	4	3
K	62.0	1025	95.3	5	4	4	5	4	3	3	4	3
Avg.	**60.2**		**98.1**	**3.9**	**4.6**	**3.4**	**4.9**	**4.4**	**3.4**	**4.5**	**3.5**	**3.5**
S.D.	**2.2**		**6.4**	**0.9**	**0.9**	**1.8**	**1.0**	**1.9**	**0.7**	**1.4**	**1.2**	**1.2**

SWQC #4 – MN13398-2

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	59.0	3100	103.3	5	5	5	5	5	5	5	5	5
B	61.9	2750	101.9	9	7	5	5	5	5	7	7	7
C	61.0	3015	95.4	7	9	5	3	1	5	3	5	5
D	64.9	936	101.2	4	7	5	5	7	5	1	6	4
E	63.0	2435	99.7	7	7	5	5	3	5	2	5	4
F	60.9	2143	104.0	6	7	6	6	5	4	3	3	4
G	69.2	960	93.2	6	6	4	3	5	4	3	4	4
H	63.9	970	98.0	4	6	3	4	4	4	3	4	4
I	66.8	879	100.5	4	7	5	5	5	5	4	5	5
J	60.9	2559	94.0	5	7	4	5	5	4	3	5	5
K	64.0	1025	95.3	5	4	4	4	5	5	4	4	4
Avg.	**63.2**		**98.8**	**5.6**	**6.5**	**4.6**	**4.5**	**4.5**	**4.6**	**3.5**	**4.8**	**4.6**
S.D.	**3.0**		**3.8**	**1.6**	**1.3**	**0.8**	**0.9**	**1.5**	**0.5**	**1.6**	**1.1**	**0.9**

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	59.0	3000	106.2	7	5	5	5	5	5	5	5	5
B	61.3	2550	91.9	9	9	5	5	5	5	3	5	5
C	62.0	3030	102.5	9	7	5	5	5	3	5	7	7
D	64.3	796	83.3	7	5	6	5	7	4	1	5	3
E	62.3	2427	103.1	8	7	9	7	2	3	3	6	4
F	59.3	1952	92.9	8	7	6	6	5	4	5	3	4
G	70.6	930	94.4	9	6	5	7	6	3	3	6	4
H	61.7	935	93.5	5	6	8	4	5	4	4	3	3
I	67.6	805	91.2	5	6	2	3	4	4	4	3	4
J	59.3	2502	96.0	6	7	8	5	4	4	4	4	4
K	64.0	1050	97.7	5	6	6	6	7	4	3	5	4
Avg.	**62.9**		**95.7**	**7.1**	**6.5**	**5.9**	**5.3**	**5.0**	**3.9**	**3.6**	**4.7**	**4.3**
S.D.	**3.6**		**6.5**	**1.6**	**1.1**	**1.9**	**1.2**	**1.4**	**0.7**	**1.2**	**1.3**	**1.1**

SWQC #6 – MN19358-1

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	59.0	3125	104.2	3	3	3	5	5	5	5	3	3
B	62.0	2825	104.6	9	7	5	5	5	3	5	5	5
C	61.0	3074	97.2	7	7	5	3	3	5	5	5	5
D	65.0	952	102.9	4	7	5	5	5	5	1	4	3
E	63.0	2485	101.8	4	7	4	6	6	4	2	5	4
F	61.4	2053	99.6	5	7	5	6	4	4	3	5	4
G	66.2	950	92.2	5	6	4	8	4	5	4	4	4
H	65.7	1010	102.0	4	6	2	5	4	5	3	5	5
I	66.3	914	104.5	4	5	7	6	5	5	4	6	5
J	61.4	2621	96.3	5	4	3	5	4	4	3	5	3
K	63.0	1000	93.0	5	5	4	5	6	4	4	3	4
Avg.	**63.1**		**99.8**	**5.0**	**5.8**	**4.3**	**5.4**	**4.6**	**4.5**	**3.5**	**4.5**	**4.1**
S.D.	**2.4**		**4.5**	**1.7**	**1.4**	**1.3**	**1.2**	**0.9**	**0.7**	**1.3**	**0.9**	**0.8**

MINOT (M-6)												
		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	60.0	2900	102.7	3	3	3	5	5	5	5	5	3
B	62.2	2700	97.3	9	9	5	5	5	5	5	5	5
C	61.0	3030	102.5	9	9	5	3	5	5	5	7	7
D	65.2	886	92.7	5	5	5	5	9	5	3	4	4
E	63.2	2383	101.2	7	7	8	9	4	5	3	5	4
F	60.8	1917	91.2	5	7	3	5	4	5	4	3	5
G	71.1	905	91.9	8	6	5	7	6	4	4	5	4
H	63.6	975	97.5	5	9	5	5	5	4	4	5	4
I	67.0	799	90.5	4	7	5	2	3	5	4	3	3
J	60.8	2712	104.1	5	5	5	6	5	5	4	6	5
K	65.0	1000	93.0	5	6	7	6	8	5	4	4	4
Avg.	**63.6**		**96.8**	**5.9**	**6.6**	**5.1**	**5.3**	**5.4**	**4.8**	**4.1**	**4.7**	**4.4**
S.D.	**3.3**		**5.2**	**2.0**	**1.9**	**1.4**	**1.8**	**1.7**	**0.4**	**0.7**	**1.2**	**1.1**

SWQC #7 – MT 21074

HAVRE (H-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	61.0	3050	100.0	9	7	5	5	5	5	5	5	5
B	60.1	2775	99.1	9	9	5	5	3	5	3	3	3
C	60.0	3104	99.1	9	9	5	3	5	5	5	7	5
D	63.1	965	116.4	6	7	6	5	5	4	3	7	5
E	62.1	2539	99.5	6	7	4	7	9	5	4	6	5
F	59.1	2065	98.0	7	7	5	5	5	5	5	5	5
G	69.7	975	107.7	9	7	7	3	3	5	4	4	4
H	62.2	925	102.2	7	9	6	2	4	5	5	3	4
I	68.7	855	100.1	9	4	6	6	7	5	4	5	5
J	59.1	3017	112.3	8	7	5	4	6	5	5	4	4
K	67.0	1050	113.5	6	5	6	5	4	7	4	7	5
Avg.	**62.9**		**104.4**	**7.7**	**7.1**	**5.5**	**4.5**	**5.1**	**5.1**	**4.3**	**5.1**	**4.5**
S.D.	**3.8**		**6.8**	**1.3**	**1.6**	**0.8**	**1.4**	**1.8**	**0.7**	**0.8**	**1.5**	**0.7**

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	60.0	2700	95.6	3	3	3	4	4	5	5	3	3
B	62.6	2525	91.0	7	5	3	5	5	5	3	3	3
C	61.0	3000	101.5	7	7	3	3	5	5	5	5	5
D	65.6	917	95.9	3	5	4	7	9	5	3	5	4
E	63.6	2452	104.1	6	3	3	7	5	5	3	5	4
F	60.8	2175	103.5	5	5	3	6	4	5	4	5	4
G	69.3	920	93.4	5	4	4	5	4	5	3	4	4
H	63.4	990	99.0	4	9	5	6	6	5	4	6	6
I	68.0	811	91.8	4	3	5	4	3	5	3	4	3
J	60.8	2357	90.5	6	7	6	5	5	5	3	3	3
K	65.0	1100	102.3	5	4	6	6	4	5	4	7	5
Avg.	**63.6**		**97.1**	**5.0**	**5.0**	**4.1**	**5.3**	**4.9**	**5.0**	**3.6**	**4.5**	**4.0**
S.D.	**3.1**		**5.2**	**1.4**	**1.9**	**1.2**	**1.3**	**1.6**	**0.0**	**0.8**	**1.3**	**1.0**

SWQC #8 – NDHRS15-0006-C46

CASSELTON (C-8)												
		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	59.0	2950	98.3	5	5	5	5	5	5	5	5	5
B	64.2	2675	99.1	7	5	3	5	5	5	5	3	5
C	63.0	2809	88.8	5	5	3	3	3	5	5	3	3
D	67.4	954	103.1	3	3	3	5	9	5	3	3	4
E	65.2	2585	105.9	3	6	3	6	6	4	4	6	5
F	63.4	2204	106.9	4	5	4	5	5	4	4	5	4
G	67.3	995	96.6	5	5	4	5	5	4	4	5	4
H	66.7	1045	105.6	3	3	2	6	3	4	4	6	6
I	66.7	924	105.6	3	4	7	5	4	5	5	6	5
J	63.4	2544	93.5	5	5	2	5	5	4	4	6	5
K	63.0	1050	97.7	4	4	5	3	3	4	5	4	4
Avg.	**64.5**		**100.1**	**4.3**	**4.5**	**3.7**	**4.8**	**4.8**	**4.5**	**4.4**	**4.7**	**4.5**
S.D.	**2.5**		**5.9**	**1.3**	**0.9**	**1.5**	**1.0**	**1.7**	**0.5**	**0.7**	**1.3**	**0.8**

MINOT (M-8)												
		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	60.0	2800	99.1	7	5	5	5	4	5	5	5	5
B	63.8	2750	99.1	9	9	5	5	5	5	5	5	5
C	63.0	2956	100.0	7	7	3	3	5	3	5	5	5
D	66.8	902	94.4	4	7	5	7	7	5	3	4	4
E	65.0	2302	97.7	8	8	9	7	5	4	1	5	3
F	62.4	2083	99.1	5	6	3	5	3	4	3	4	4
G	68.9	965	98.0	6	6	5	7	4	3	4	5	4
H	65.4	935	93.5	4	5	5	6	5	4	3	4	4
I	68.0	858	97.2	4	5	6	5	5	4	4	4	4
J	62.4	2580	99.0	6	6	6	6	5	4	4	5	5
K	64.0	1100	102.3	5	6	6	6	5	4	4	7	5
Avg.	**64.5**		**98.1**	**5.9**	**6.4**	**5.3**	**5.6**	**4.8**	**4.1**	**3.7**	**4.8**	**4.4**
S.D.	**2.6**		**2.5**	**1.7**	**1.3**	**1.6**	**1.2**	**1.0**	**0.7**	**1.2**	**0.9**	**0.7**

WILLISTON (W-8)												
		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	60.0	2900	99.1	9	7	5	5	4	5	5	5	5
B	63.7	2975	120.2	9	9	5	5	3	5	3	5	5
C	62.0	2941	104.7	9	7	5	5	5	7	3	7	7
D	66.7	943	113.2	5	7	6	3	9	5	1	8	5
E	64.8	2458	103.9	6	7	5	7	6	7	3	7	6
F	62.3	2144	101.3	9	7	4	4	5	6	3	5	5
G	69.4	950	122.6	7	8	4	7	7	7	3	8	6
H	65.2	1025	119.2	5	8	4	6	3	6	4	6	6
I	68.2	917	108.8	5	7	5	6	7	6	3	6	6
J	62.3	2652	103.8	6	6	4	5	5	6	4	6	5
K	65.0	1150	117.9	5	6	6	4	3	7	3	8	6
Avg.	**64.5**		**110.4**	**6.8**	**7.2**	**4.8**	**5.2**	**5.2**	**6.1**	**3.2**	**6.5**	**5.6**
S.D.	**2.8**		**8.5**	**1.8**	**0.9**	**0.8**	**1.3**	**1.9**	**0.8**	**1.0**	**1.2**	**0.7**

SWQC #9 – LCS Hammer AX

HAVRE (H-9)												
		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	59.0	2875	94.3	7	7	5	5	5	4	5	5	5
B	59.9	2675	95.5	9	9	5	5	3	3	5	3	3
C	59.0	2986	95.3	9	9	5	3	3	3	5	3	3
D	62.9	873	105.3	6	7	6	5	5	5	6	3	5
E	62.0	2438	95.5	6	9	7	7	7	1	5	5	4
F	58.9	2230	105.8	7	6	5	5	5	3	6	6	5
G	65.7	850	93.9	7	4	6	3	5	2	5	4	3
H	61.9	940	103.9	6	6	2	5	5	3	5	5	5
I	63.3	852	99.8	5	7	6	4	3	3	4	4	4
J	58.9	2586	96.2	5	6	3	6	3	3	4	3	4
K	63.0	1050	113.5	5	6	6	6	6	3	3	7	4
Avg.	**61.3**		**99.9**	**6.5**	**6.9**	**5.1**	**4.9**	**4.5**	**3.0**	**4.8**	**4.4**	**4.1**
S.D.	**2.3**		**6.4**	**1.4**	**1.6**	**1.4**	**1.2**	**1.4**	**1.0**	**0.9**	**1.4**	**0.8**

MINOT (M-9)												
		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	59.0	2750	97.3	3	3	3	5	4	4	5	4	4
B	59.6	2650	95.5	9	9	5	5	7	5	5	5	5
C	61.0	2868	97.0	7	7	3	3	5	3	5	3	3
D	62.6	833	87.1	6	7	6	5	5	4	1	3	3
E	61.0	2264	96.1	7	9	9	5	2	2	3	4	3
F	58.0	1877	89.3	8	6	7	6	5	3	5	3	3
G	68.2	820	83.2	9	3	5	5	3	2	5	3	3
H	58.7	840	84.0	6	5	6	4	4	3	4	2	3
I	67.3	778	88.1	6	4	5	3	2	3	4	2	3
J	58.0	2524	96.9	5	6	6	6	5	3	4	4	4
K	63.0	1000	93.0	6	5	7	7	9	3	3	4	4
Avg.	**61.5**		**91.6**	**6.5**	**5.8**	**5.6**	**4.9**	**4.6**	**3.2**	**4.0**	**3.4**	**3.5**
S.D.	**3.5**		**5.4**	**1.8**	**2.1**	**1.7**	**1.2**	**2.1**	**0.9**	**1.3**	**0.9**	**0.7**

WILLISTON (W-9)												
		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	59.0	2900	99.1	9	7	5	5	5	5	5	5	5
B	59.9	2675	108.1	9	9	5	5	3	5	3	5	5
C	59.0	2809	100.0	9	7	5	5	5	5	3	5	5
D	62.9	870	104.4	7	5	6	3	7	5	2	6	4
E	62.0	2342	99.0	7	7	7	7	4	5	3	5	4
F	58.7	1885	89.0	7	7	5	4	5	5	3	4	3
G	67.9	840	108.4	9	5	5	5	9	5	3	6	5
H	62.5	840	97.7	6	8	6	4	5	5	4	4	4
I	68.0	801	95.0	8	7	5	5	5	5	4	4	4
J	58.7	2528	98.9	5	7	6	5	4	5	4	5	5
K	64.0	1050	107.7	6	5	4	5	5	5	4	6	5
Avg.	**62.1**		**100.7**	**7.5**	**6.7**	**5.4**	**4.8**	**5.2**	**5.0**	**3.5**	**5.0**	**4.5**
S.D.	**3.5**		**6.0**	**1.4**	**1.3**	**0.8**	**1.0**	**1.6**	**0.0**	**0.8**	**0.8**	**0.7**

SWQC #10 – MT 21104

HAVRE (H-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	61.0	2725	89.3	3	5	3	5	5	5	5	4	4
B	63.5	2750	98.2	7	5	3	5	3	5	5	5	5
C	62.0	3104	99.1	9	9	5	3	5	5	5	5	5
D	66.5	889	107.2	4	5	4	5	7	5	6	4	5
E	65.1	2485	97.4	6	3	3	7	3	5	4	3	4
F	62.1	1923	91.2	9	5	7	4	4	4	5	4	4
G	68.0	950	105.0	5	5	5	3	4	4	4	5	4
H	62.9	935	103.3	4	8	2	4	3	4	4	3	3
I	68.2	890	104.2	5	3	4	5	6	4	3	4	4
J	62.1	2635	98.1	6	5	3	5	6	4	4	5	5
K	66.0	1025	110.8	5	5	5	7	5	4	5	6	5
Avg.	**64.3**		**100.3**	**5.7**	**5.3**	**4.0**	**4.8**	**4.6**	**4.5**	**4.5**	**4.4**	**4.4**
S.D.	**2.6**		**6.5**	**2.0**	**1.8**	**1.4**	**1.3**	**1.4**	**0.5**	**0.8**	**0.9**	**0.7**

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	59.0	2825	100.0	5	5	5	5	4	5	5	5	5
B	57.9	2725	98.2	9	9	5	5	7	5	5	7	5
C	60.0	3104	105.0	7	7	3	3	5	3	5	7	7
D	60.9	920	96.2	6	5	5	5	7	5	2	6	4
E	59.0	2409	102.3	8	7	9	5	2	3	4	6	4
F	56.5	1831	87.1	9	7	8	6	5	4	4	4	4
G	67.0	915	92.9	9	5	6	5	6	3	5	5	4
H	59.3	920	92.0	6	9	9	3	4	4	5	3	3
I	68.0	863	97.7	9	3	2	3	5	4	5	4	4
J	56.5	2555	98.1	5	5	8	4	4	4	5	4	3
K	64.0	1125	104.7	6	5	7	4	4	4	4	8	5
Avg.	**60.7**		**97.7**	**7.2**	**6.1**	**6.1**	**4.4**	**4.8**	**4.0**	**4.5**	**5.4**	**4.4**
S.D.	**3.9**		**5.5**	**1.7**	**1.9**	**2.3**	**1.0**	**1.5**	**0.8**	**0.9**	**1.6**	**1.1**

SWQC #11 – ND Stampede

CASSELTON (C-11)												
		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	59.0	2925	97.5	5	5	5	5	5	5	5	5	5
B	63.1	2775	102.8	9	7	5	5	7	5	7	7	7
C	63.0	2868	90.7	5	5	3	3	3	5	5	3	3
D	66.1	906	97.9	4	7	5	5	7	5	1	6	4
E	64.2	2483	101.7	5	7	4	7	6	4	3	7	5
F	62.3	2145	104.1	5	5	5	5	5	4	4	5	5
G	68.6	945	91.7	5	5	4	7	5	4	4	4	4
H	64.4	1010	102.0	4	4	2	5	4	4	4	5	4
I	66.3	885	101.1	4	5	6	5	5	5	4	5	5
J	62.3	2498	91.8	3	5	4	5	5	4	5	4	4
K	63.0	1050	97.7	5	5	5	4	4	4	3	4	4
Avg.	**63.8**		**98.1**	**4.9**	**5.5**	**4.4**	**5.1**	**5.1**	**4.5**	**4.1**	**5.0**	**4.5**
S.D.	**2.5**		**4.8**	**1.5**	**1.0**	**1.1**	**1.1**	**1.2**	**0.5**	**1.5**	**1.3**	**1.0**

HAVRE (H-11)												
		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	61.0	2925	95.9	9	9	5	5	5	5	5	5	5
B	66.7	2800	100.0	9	9	5	5	3	5	5	5	5
C	66.0	3104	99.1	9	9	5	3	5	5	3	5	5
D	69.7	872	105.2	5	7	6	5	9	5	3	8	5
E	69.1	2354	92.2	9	9	7	9	9	5	3	4	3
F	66.1	1905	90.4	9	7	7	4	4	5	4	4	4
G	69.4	975	107.7	6	9	6	8	5	5	3	6	5
H	68.4	950	105.0	5	9	4	6	3	5	4	6	5
I	68.0	941	110.2	4	8	5	5	5	5	3	6	5
J	66.1	2872	106.9	8	7	4	5	5	6	4	7	6
K	67.0	1025	110.8	5	6	6	7	4	7	5	6	6
Avg.	**67.0**		**102.1**	**7.1**	**8.1**	**5.5**	**5.6**	**5.2**	**5.3**	**3.8**	**5.6**	**4.9**
S.D.	**2.4**		**7.1**	**2.1**	**1.1**	**1.0**	**1.7**	**2.0**	**0.6**	**0.9**	**1.2**	**0.8**

MINOT (M-11)

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	60.0	2875	101.8	5	5	5	6	6	5	5	5	5
B	63.7	2600	93.7	9	7	5	5	5	5	5	7	5
C	63.0	2897	98.0	9	9	7	5	5	3	5	5	5
D	66.7	886	92.7	6	5	5	7	7	5	1	7	4
E	65.0	2368	100.6	8	7	9	5	9	4	1	6	4
F	62.7	1798	85.5	9	5	8	5	5	4	3	4	4
G	69.7	940	95.4	8	8	5	9	4	3	3	4	3
H	64.9	960	96.0	6	9	9	5	3	4	2	4	4
I	67.7	905	102.5	6	8	3	4	6	4	3	4	4
J	62.7	2589	99.4	9	9	9	6	5	4	3	5	4
K	65.0	1100	102.3	5	6	7	6	6	4	4	7	5
Avg.	**64.6**		**97.1**	**7.3**	**7.1**	**6.5**	**5.7**	**5.5**	**4.1**	**3.2**	**5.3**	**4.3**
S.D.	**2.7**		**5.1**	**1.7**	**1.6**	**2.1**	**1.3**	**1.6**	**0.7**	**1.5**	**1.3**	**0.6**

WILLISTON (W-11)

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	61.0	2900	99.1	9	7	5	5	4	7	5	5	5
B	65.7	2575	104.0	9	9	5	5	5	5	3	7	5
C	65.0	3044	108.4	9	7	5	5	7	7	3	9	9
D	68.7	949	113.9	7	5	6	3	5	6	1	9	5
E	66.8	2334	98.6	8	7	8	7	8	9	2	7	6
F	64.7	2018	95.3	5	7	9	3	4	7	2	4	4
G	71.0	890	114.8	9	8	5	7	8	8	3	8	7
H	66.9	1090	126.7	7	9	8	5	2	7	4	6	6
I	67.6	826	98.0	6	8	2	3	3	6	2	4	4
J	64.7	2520	98.6	9	9	9	5	3	7	3	5	5
K	66.0	1050	107.7	7	6	5	3	5	7	3	6	6
Avg.	**66.2**		**105.9**	**7.7**	**7.5**	**6.1**	**4.6**	**4.9**	**6.9**	**2.8**	**6.4**	**5.6**
S.D.	**2.6**		**9.6**	**1.4**	**1.3**	**2.2**	**1.5**	**2.0**	**1.0**	**1.1**	**1.8**	**1.4**

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)	5.0
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.