Wheat Quality Council

Hard Spring Wheat Technical Committee

2023 Crop

February 21-23, 2024

Olathe, KS

Wheat Quality Council

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Sponsored by the Wheat Quality Council
February 21-23, 2024

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Introduction

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

Eight experimental lines of hard spring wheat were grown at six locations in 2023 and evaluated for kernel, milling, and bread baking quality against the check varieties Linkert and LCS Rebel. To avoid any bias in the test procedures, code numbers were assigned to the experimental lines and maintained throughout the growing and harvesting of the plots and the milling and baking trials. Wheat samples were milled and analyzed at the USDA Hard Red Spring and Durum Wheat Quality Laboratory (WQL), Fargo, ND. Flour samples were shipped to independent laboratories and tested for bread-baking quality.

From this report:

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

The results relate only to test samples that were volunteered for testing in the 2023 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 2023 Wheat Quality Testing Program

Wheat Source

Source/Breeding Program	SWQC Code #	Identification
North Dakota State University	1	NDHRS14-0134-C09
South Dakota State University	2	SD4930
University of Minnesota	3	Linkert (Eastern Check)
Montana State University	4	MT 2063
Limagrain Cereal Seeds	5	LCS Boom
Limagrain Cereal Seeds	6	LCS Cannon
Limagrain Cereal Seeds	7	LCS Buster
North Dakota State University	8	NDHRS14-0134-C03
Montana State University	9	MT 2030
Limagrain Cereal Seeds	10	LCS Rebel (Western Check)

Field Plot Locations and Procedures

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

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

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

Field Production Data

Variable	Watertown	Casselton	Havre	Crookston	Minot
Planting Date	04/27/2023	05/16/2023	05/05/2023	05/05/2023	06/01/2023
Harvest Date	08/17/2023	08/18/2023	08/08/2023	08/24/2023	09/06/2023
Fertilizer (lb/acre)					
N	200	120	100	280	100
P	*	*	20	*	50
K	100	*	10	*	
Herbicide(rate/acre)					
Broadleaf	Bronate (1.5 pt)	Huskie Complete (13.7 oz)	Brox-M (24 oz)	Huskie Complete (13.7 oz)	Huskie FX (18 oz)
Grass	Parity (0.6 pt.)	(Huskie Complete)	OpenSky (16 oz)	*	Axial Star (16 oz) Brox-M (19 oz)
Fungicide	*	Propiconazole (3 oz) Prosaro (6.5 oz)	Prosaro (5 oz)	Tilt (4 oz)	*

*No application.

CLIMATOLOGICAL DATA					
	Average Temperature (°F) / Precipitation (in)				
Month	Watertown	Casselton	Havre	Crookston	Minot
April	37.0 / 1.07	32.5 / 1.55	41.0 / 0.55	33.8 / 1.71	34.6 / 1.06
May	62.0 / 1.12	61.0 / 3.13	59.3 / 2.90	62.8 / 0.87	59.6 / 4.67
June	71.0 / 1.81	72.1 / 3.77	63.5 / 2.28	71.2 / 1.20	69.1 / 1.09
July	68.0 / 1.25	68.0 / 1.09	70.2 / 0.64	65.5 / 2.10	67.2 / 0.97
August	69.0 / 4.33	68.9 / 1.63	70.9 / 0.85	67.3 / 1.42	67.3 / 3.10

YIELD DATA					
	Yield (bu/acre) / Test Weight (lb/bu) / Moisture (%)				
SWQC Code #	Watertown	Casselton	Havre	Crookston	Minot
1	*	104.7 / 59.8 / 13.9	*	75.3 / 58.2 / 14.9	65.2 / 56.1 / 17.1
2	50.3 / 57.7 / 12.0	102.4 / 61.4 / 14.5	*	81.0 / 58.9 / 15.1	*
3	44.8 / 58.5 / 11.5	83.7 / 62.4 / 13.6	*	60.7 / 59.3 / 14.3	*
4	*	*	28.6 / 55.1 / 11.5	*	44.2 / 55.2 / 18.2
5	47.9 / 59.5 / 11.9	82.3 / 64.3 / 12.8	33.7 / 56.4 / 11.3	58.4 / 60.4 / 14.7	66.6 / 58.2 / 16.6
6	50.7 / 57.2 / 11.8	82.3 / 64.1 / 12.7	30.3 / 56.2 / 11.4	59.8 / 60.9 / 13.9	65.9 / 57.9 / 17.1
7	49.7 / 57.3 / 11.8	95.8 / 60.8 / 14.2	25.7 / 54.0 / 11.4	*	68.7 / 55.2 / 18.4
8	50.8 / 57.2 / 11.8	97.7 / 62.5 / 13.6	31.4 / 53.7 / 11.3	70.3 / 59.1 / 14.1	86.1 / 56.8 / 16.8
9	*	*	27.9 / 56.7 / 11.3	*	66.9 / 57.9 / 16.7
10	*	*	27.4 / 56.0 / 11.3	*	62.9 / 59.0 / 16.6
Site Totals	6	7	7	6	8

*Not increased at this site.

Climate, Disease, and Field Conditions

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

	Watertown	Casselton	Havre	Crookston	Minot
At Planting	Spring wheat was planted on time but with the lack of moisture, the final stand counts were less than desired.	Ideal planting conditions. Good soil moisture resulting in very good even emergence.	Fair seeding conditions; however, fallow soil profile was not full for the 2023 crop year. Third year of drought. Timely rain early in the season resulted in good biomass but the plants ran out of water and were unable to produce to their potential and fill the heads.	Planting conditions were good for wheat. Ample amount of soil moisture. Ground was cultivated once.	Late snow and early rain in May made for wet conditions pushing planting back. Planted late (roughly 2 weeks later than usual); conditions dry but moisture present in the soil. Some herbicide damage present at emergence (yellowing of leaves); plants grew out of it quickly.
During Growth	The dry weather limited the amount of tillering. May and June rainfall was at a 4.24 deficit from normal.	Adequate rainfall during the early part of the growing season. Dry in early to mid-June with hot temperatures; 2.5 in of rain on 06/24/2023.	Drought during growth and delayed heading. The majority of the June precipitation occurred in a single rain event on June 2nd and 3rd (1.95 in) with the next significant amount of precipitation occurring on July 11th with 0.50 in.	June was very hot. Average temperature for June was 4º F above average. No disease was noticed; insects were not a concern either.	Dry; very little moisture throughout June and July.
At Flowering	The advantage of the dry weather was the lack of Fusarium head blight. July rainfall was 2.27 in below normal.	Mostly dry during flowering with very little moisture resulting in no scab pressure.	Dry.	Heading was June 21st for most entries. Scab was not a concern, but applications were made anyway.	Dry; some humid mornings.
During Maturation	Grain filling was reduced because of the dry conditions.	Warm and dry during maturation.	Dry.	Some cooler temperatures in August, which caused a slow dry down. Wheat sat in the field for about 2 weeks, waiting to dry down.	Dry; intermittent rain showers.
At Harvest	Rainfall was 1.23 in above normal, which discolored the grain and reduced test weights.	Dry conditions for harvest resulting in very good quality.	Dry.	Grain moisture ranged from low 14s to low 15s at harvest. No other concerns at harvest.	Wet; intermittent rain showers more frequent, pushing things to a later harvest time. Plants were desiccated with paraquat to speed things up for the September 15th deadline.

Description of 2023 Hard Spring Wheat Lines

SWQC #1 – NDHRS14-0134-C09

NDHRS14-0134-C09 is a sister line of NDHRS14-0134-C03. It is slightly taller, slightly later, and has even higher yield potential. It has similar disease resistance and a wide adaptation across the spring wheat growing area.

SWQC #2 – SD4930

SD4930 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 ('Shelly'/SD4624) that was originally created in fall 2015. During early-generation observation, the population was tested as 32405 and renamed as SD4930 with its placement into the 2019 Preliminary Yield Trial. SD4930 was evaluated in Advanced Yield Trials from 2020 through 2023. SD4930 was included in the 2021 – 2023 South Dakota Crop Performance Testing trials, as well as the 2022 and 2023 Uniform Regional Spring Wheat Nurseries.

Points of note associated with SD4930 include:

1. Excellent yield potential;
2. Average test weight;
3. Average grain protein concentration;
4. Later than average heading date;
5. Average plant height;
6. Moderate levels of Fusarium head blight and Bacterial leaf streak resistance;
7. Good Farinograph mixing tolerance (average MTI =12.3 FU, n = 9) and stability (average = 21.3 mins, n = 9).

SWQC #4 – MT 2063

MT 2063 (MT 1572/MT1133//Choteau/Yellowstone) is a hard red spring wheat line under consideration for release by the Montana Agricultural Experiment Station. MT 2063 has good yield potential in Montana's rainfed environments, average grain protein content, and good test weight. MT 2063 is a medium maturity line relative to Vida and has moderate resistance to stripe rust and wheat stem sawfly.

SWQC #5 – LCS Boom

LCS Boom is a hard-red spring wheat variety developed by Limagrain Cereal Seeds. Its adaptation area spans Eastern Montana through the Dakotas to the Red River Valley. Building on the genetics of 'LCS Cannon,' it is one of the earliest maturing spring wheats available. LCS Boom features consistent protein, very good straw strength and test weight, and an excellent grain yield. It also exhibits resistance to stem rust, stripe rust, tan spot, and Fusarium head blight, along with intermediate resistance to leaf rust and bacterial leaf streak. LCS Boom has most desirable overall end-use quality.

SWQC #6 – LCS Cannon

LCS Cannon is a hard-red spring wheat variety developed by Limagrain Cereal Seeds with an adaptation area spanning from Eastern Montana through the Dakotas to the Red River Valley. It is a very early maturing wheat line with consistent protein, excellent straw strength and test weight, and a very good grain yield. Additionally, LCS Cannon exhibits resistance to stem rust, stripe rust, tan spot, and fusarium head blight, along with intermediate resistance to leaf rust and bacterial leaf streak. LCS Cannon has desirable overall end-use quality.

SWQC #7 – LCS Buster

LCS Buster is a hard-red spring wheat variety developed by Limagrain Cereal Seeds. It has an adaptation area from the western Dakotas to the Red River Valley. Similar to 'LCS Trigger' but with improved protein, LCS Buster is notable for its very strong straw strength, good test weight, and excellent grain yield. It also possesses resistance to stem rust, leaf rust, stripe rust, tan spot, and fusarium head blight, with intermediate resistance to bacterial leaf streak. While LCS Buster has acceptable overall end-use quality, it offers improved protein content compared to 'LCS Trigger.'

SWQC #8 – NDHRS14-0134-C03

NDHRS14-0134-C03 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 proposed for release in January 2024 from the North Dakota Agricultural Experiment Station.

SWQC #9 – MT 2030

MT 2030 (Lanning/MT 1338) is a hard red spring wheat line under consideration for release by the Montana Agricultural Experiment Station. MT 2030 has high yield potential in Montana's rainfed environments and has good grain protein content and test weight. MT 2030 is a medium maturity line relative to Vida and is susceptible to wheat stem sawfly.

Wheat Production Sites

SWQC Code #	Entry	Source	Production Sites				
			Watertown	Casselton	Havre	Crookston	Minot
1	NDHRS14-0134-C09	North Dakota State University		X		X	X
2	SD4930	South Dakota State University	X	X		X	
3	Linkert	Eastern Check	X	X		X	
4	MT 2063	Montana State University			X		X
5	LCS Boom	Limagrain Cereal Seeds	X	X	X	X	X
6	LCS Cannon	Limagrain Cereal Seeds	X	X	X	X	X
7	LCS Buster	Limagrain Cereal Seeds	X	X	X		X
8	NDHRS14-0134-C03	North Dakota State University	X	X	X	X	X
9	MT 2030	Montana State University			X		X
10	LCS Rebel	Western Check			X		X

Grain Cleaning and Milling Procedures

Wheat with moisture content above 13.5% were placed in a drier (96º F) until moisture decreased to ≤ 13%. Wheat (approximately 3 bu/line) was cleaned using a Carter-Day Bulldog seed cleaner that was equipped with two rotating indent cylinders (#24 – coarse; #16 – fine), a sizer cylinder (#5), vibrator, and air aspiration.

Cleaned wheat (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. Feed rate was set at 180 lb/h. Break rollers were adjusted to the following releases through a U.S. 16 S.S. sieve: first break – 30%; second break – 53%; and third break, clean-up – 65%.

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

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

Methods of Analysis

- Wheat Market Value Score;
- DON levels (gas chromatography method, J. AOAC Int. 79:472, 1996) - analyzed by NDSU, Department of Plant Sciences, 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).

- Extensograph (AACCI Method 54-10 with modifications):

    - Flour (100 g, 14% mb), 2.0% NaCl (U.S.P.), and water (Farinograph absorption - 2%) were mixed to optimum development in a pin mixer (National Mfg. Co.);

    - Dough was scaled to 150 g, rounded, molded, placed in extensograph holders, and rested for 45, 90, and 135 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 WQL 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;
- USDA-ARS Hard Red Spring & Durum Wheat Quality Laboratory – Fargo, ND;
- USDA-ARS Hard Winter Wheat Quality Laboratory – Manhattan, KS;
- USDA-ARS Western Wheat Quality Laboratory – Pullman, WA;
- Wheat Marketing Center – Portland, OR.

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

Quality Data of 2023 Hard Spring Wheat Lines

SWQC #1 – NDHRS14-0134-C09

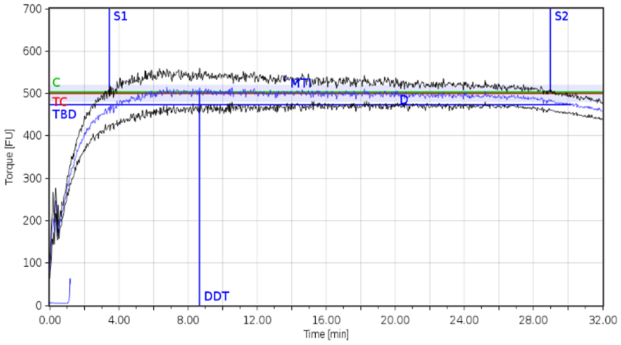
		Casselton		Crookston		Minot	
		Linkert		Linkert		LCS Rebel	
	Quality Trait	C-3	C-1	K-3	K-1	M-10	M-1
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	15.9	14.1	16.9	14.9	16.2	14.6
2	Flour Protein (%, 14% mb)	14.7	12.8	16.2	13.9	15.2	13.8
3	Market Value (Score 1-6)	5.6	4.6	5.2	4.0	5.6	4.5
4	Market Value (Score 1-10)	10.0	7.0	10.0	6.2	10.0	6.2
5	DON (ppm)	0.03	0.07	0.02	0.06	0.02	0.01
6	Test Weight (lb/bu)	63.3	61.7	60.9	60.6	63.6	61.4
7	1000 Kernel Weight (g)	39.7	34.2	37.6	31.7	38.9	32.8
8	Kernel Size, Large (%)	85	67	79	65	83	59
9	Kernel Size, Small (%)	5	10	5	9	5	10
10	Wheat Moisture (%)	12.4	12.6	12.3	12.5	12.9	12.7
11	Wheat Ash (%, 14% mb)	1.60	1.46	1.68	1.45	1.40	1.20
12	Wheat Falling Number (s)	460	435	454	366	388	397
13	SKCS Hardness Index	68.6	78.4	68.1	77.9	61.1	71.3
14	Vitreous Kernels (%)	84	78	71	69	75	76
	Flour Extraction						
15	Tempered Wheat Basis (%)	70.5	70.0	68.3	67.8	72.9	70.4
16	Total Product Basis (%)	71.7	72.0	69.7	68.7	73.5	71.6
17	Flour/Bu Wheat (lb)	45.1	44.2	42.2	41.4	46.6	43.8
	Flour Quality						
18	Flour Color Brightness (*L**)	90.7	90.7	90.5	90.1	90.4	91.1
19	Flour Color Yellowness (*b**)	8.9	8.4	8.4	8.4	8.1	7.7
20	Flour Moisture (%)	12.9	13.6	13.6	13.2	13.3	13.8
21	Flour Ash (%, 14% mb)	0.51	0.49	0.47	0.47	0.42	0.40
22	Flour Falling Number (malted, s)	249	248	255	255	260	251
	Farinograph						
23	Water Absorption (%, 500 BU)	64.6	64.2	68.1	66.9	65.9	63.1
24	Water Absorption (%, 14% mb)	63.6	63.8	67.7	66.1	65.1	62.9
25	Arrival Time (min)	3.5	2.4	20.3	2.0	3.6	2.4
26	Peak Time (min)	8.7	6.3	28.4	7.7	8.8	8.0
27	Dough Stability (min)	25.5	8.9	12.9	14.0	31.1	17.0
28	Mixing Tolerance Index (MTI, BU)	8	36	26	21	14	22
29	Time To Breakdown (TTB, min)	30.2	11.8	33.8	17.3	36.2	39.3
	II. Cooperator Results						
30	Bake Absorption (Average %)	66.8	66.2	69.5	68.5	68.5	66.0
31	Loaf Volume (% of Check)		94.2		91.1		95.7

SWQC #1 – NDHRS14-0134-C09

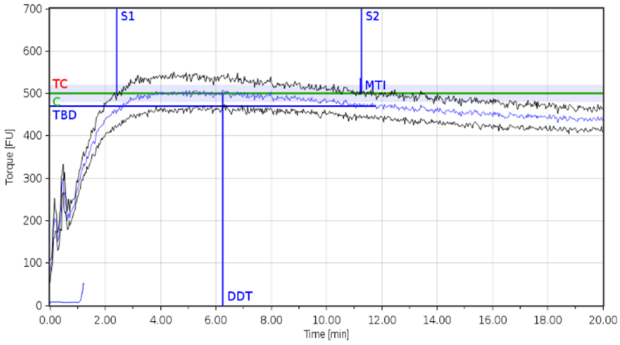
	Quality Trait	Casselton Linkert C-3	Casselton Linkert C-1	Crookston Linkert K-3	Crookston Linkert K-1	Minot LCS Rebel M-10	Minot LCS Rebel M-1
	II. Cooperator Results						
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.8	5.1	7.2	6.1	6.5	6.6
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.9	5.7	6.9	5.6	6.5	6.2
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		3.3		4.2		5.4
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.4		4.7		5.3
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.6		5.4		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		2.6		3.0		3.5
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.5		4.4		3.5
	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		3.9		3.7		4.4
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.7		3.6		4.1

Farinograms

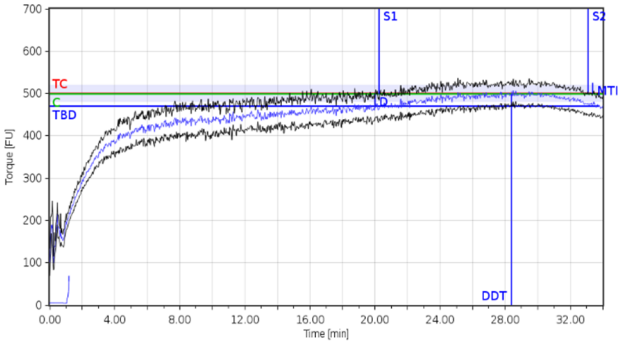
Linkert Check (Casselton, C-3)



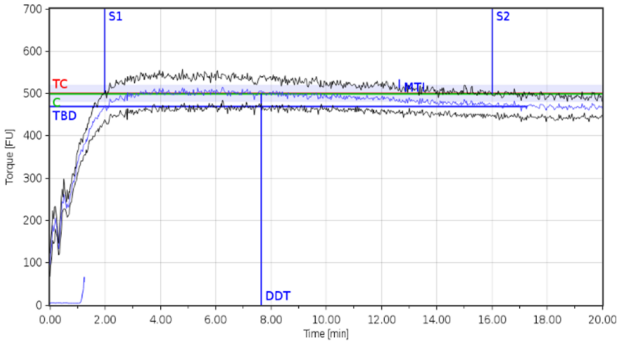
NDHRS14-0134-C09 (Casselton, C-1)



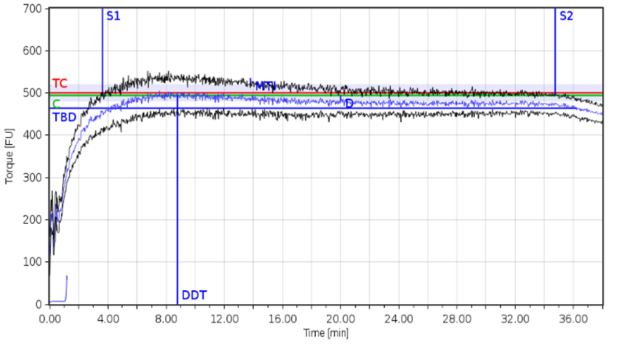
Linkert Check (Crookston, K-3)



NDHRS14-0134-C09 (Crookston, K-1)



LCS Rebel Check (Minot, M-10)



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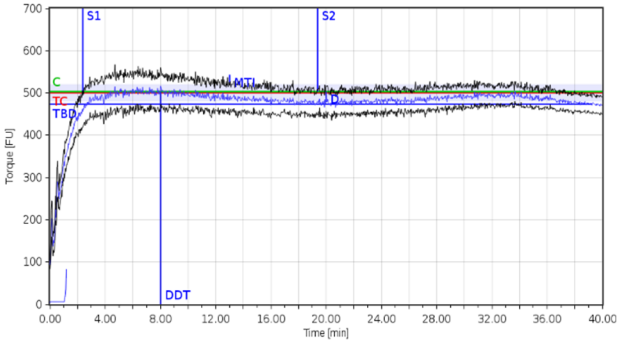
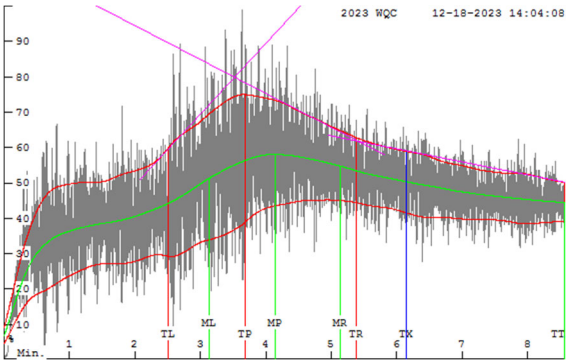


Mixograms

Linkert Check (Casselton, C-3)



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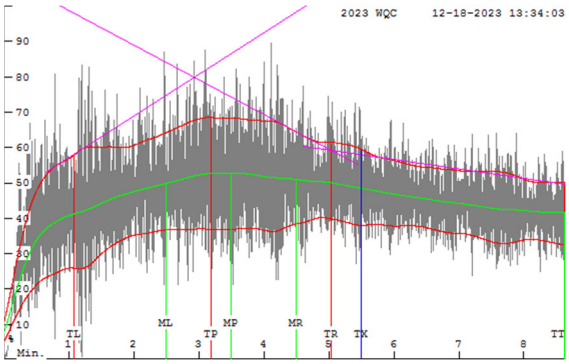

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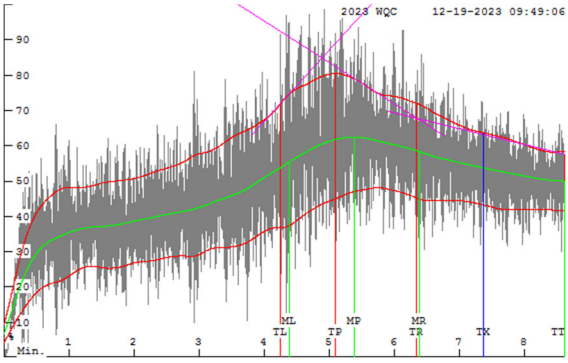
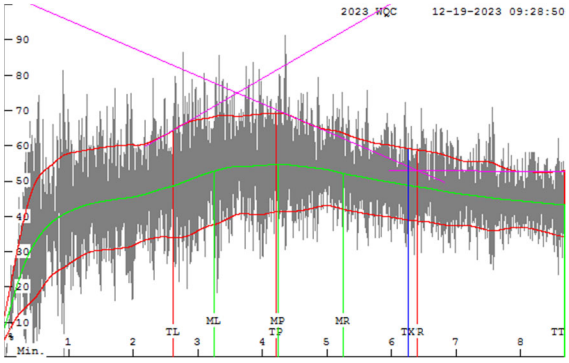
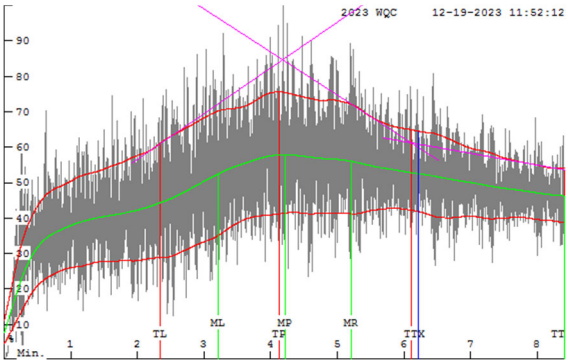


NDHRS14-01340-C09 (Crookston, K-1)



LCS Rebel (Minot, M-10)



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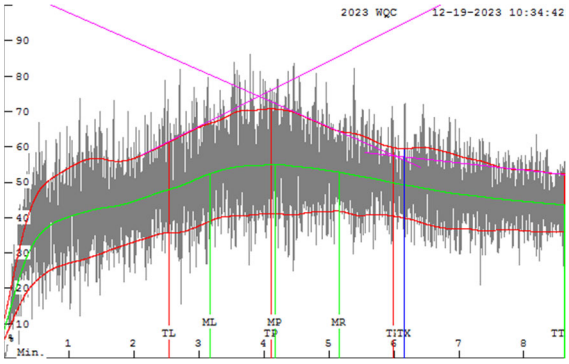
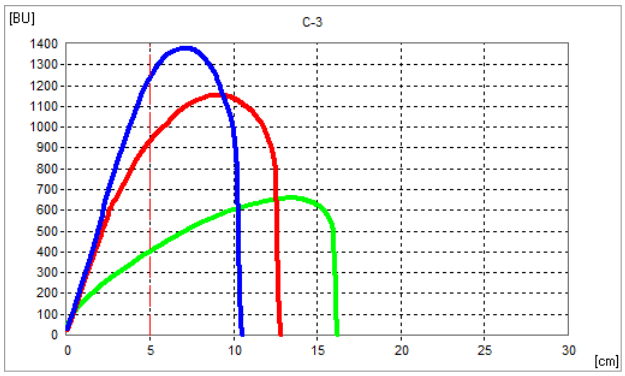
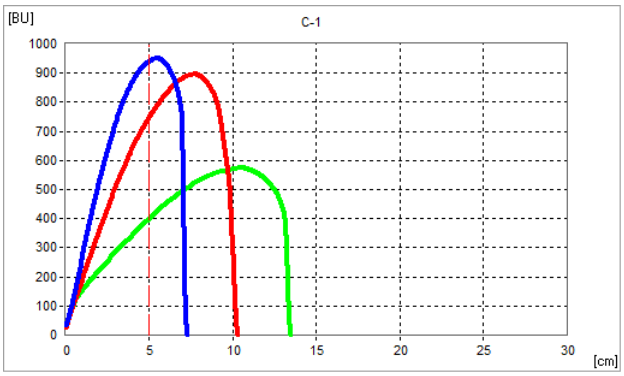


Extensograms

Linkert Check (Casselton, C-3)



NDHRS14-0134-C09 (Casselton, C-1)



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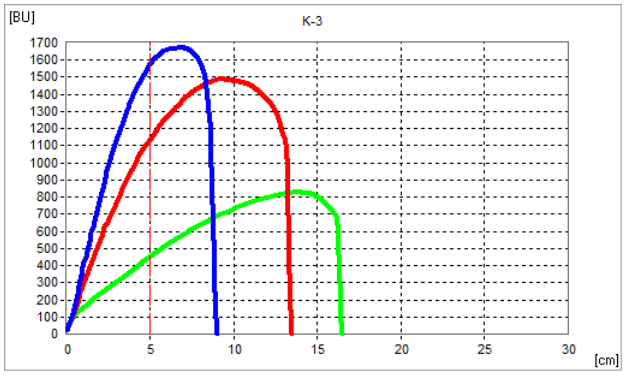
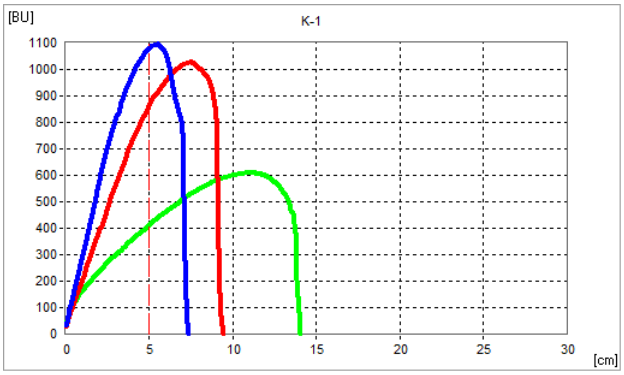
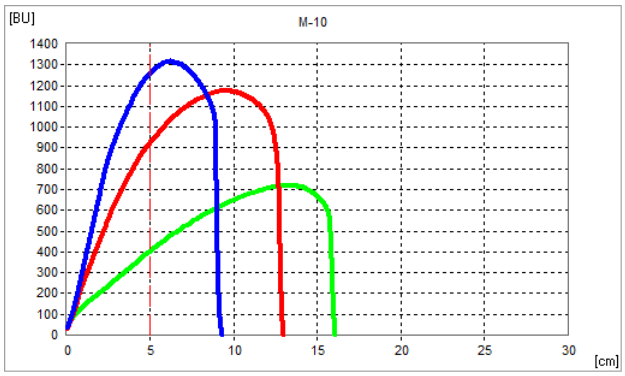


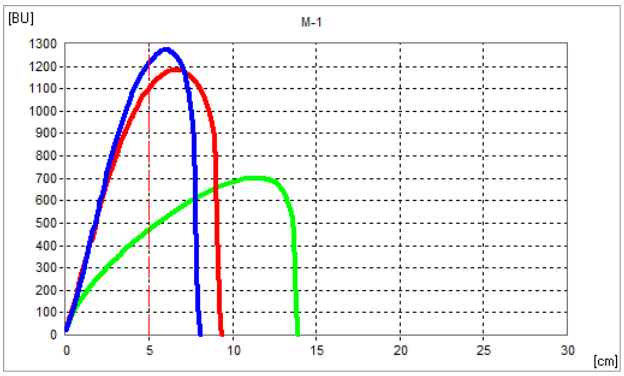
NDHRS14-0134-C09 (Crookston, K-1)



LCS Rebel Check (Minot, M-10)



NDHRS14-0134-C09 (Minot, M-1)



45 min; 90 min; 135 min

SWQC #2 – SD4930

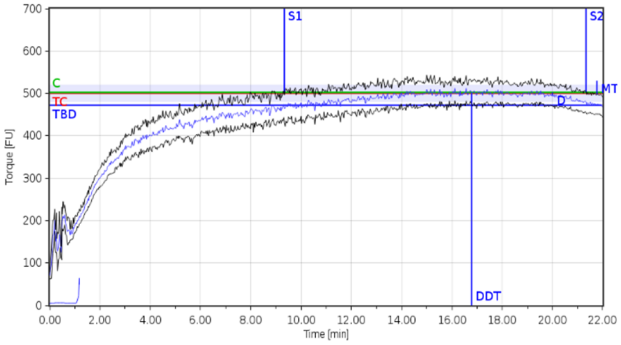
		Watertown		Casselton		Crookston	
		Linkert		Linkert		Linkert	
	Quality Trait	B-3	B-2	C-3	C-2	K-3	K-2
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	16.5	14.7	15.9	13.6	16.9	14.2
2	Flour Protein (%, 14% mb)	15.5	13.6	14.7	12.4	16.2	13.3
3	Market Value (Score 1-6)	5.6	4.9	5.6	4.1	5.2	4.1
4	Market Value (Score 1-10)	10.0	7.0	10.0	5.2	10.0	5.8
5	DON (ppm)	nd	nd	0.03	0.09	0.02	nd
6	Test Weight (lb/bu)	62.0	61.2	63.3	62.4	60.9	61.1
7	1000 Kernel Weight (g)	43.0	38.6	39.7	33.3	37.6	33.9
8	Kernel Size, Large (%)	95	86	85	72	79	76
9	Kernel Size, Small (%)	2	4	5	10	5	8
10	Wheat Moisture (%)	12.4	12.5	12.4	13.0	12.3	12.5
11	Wheat Ash (%, 14% mb)	1.53	1.42	1.60	1.54	1.68	1.51
12	Wheat Falling Number (s)	456	407	460	383	454	384
13	SKCS Hardness Index	62.0	58.5	68.6	66.9	68.1	62.8
14	Vitreous Kernels (%)	43	37	84	77	71	48
	Flour Extraction						
15	Tempered Wheat Basis (%)	68.0	72.8	70.5	70.3	68.3	72.4
16	Total Product Basis (%)	69.5	74.6	71.7	72.0	69.7	73.7
17	Flour/Bu Wheat (lb)	43.3	45.0	45.1	44.0	42.2	44.9
	Flour Quality						
18	Flour Color Brightness (*L**)	90.9	90.8	90.7	90.9	90.5	90.8
19	Flour Color Yellowness (*b**)	8.3	9.6	8.9	11.0	8.4	11.0
20	Flour Moisture (%)	13.7	13.3	12.9	13.3	13.6	13.8
21	Flour Ash (%, 14% mb)	0.50	0.48	0.51	0.46	0.47	0.41
22	Flour Falling Number (malted, s)	251	250	249	262	255	249
	Farinograph						
23	Water Absorption (%, 500 BU)	67.6	61.1	64.6	58.5	68.1	59.2
24	Water Absorption (%, 14% mb)	67.4	60.3	63.6	57.9	67.7	59.0
25	Arrival Time (min)	9.3	2.6	3.5	1.9	20.3	2.5
26	Peak Time (min)	16.8	13.7	8.7	6.1	28.4	7.8
27	Dough Stability (min)	12.0	19.4	25.5	13.9	12.9	19.4
28	Mixing Tolerance Index (MTI, BU)	33	16	8	27	26	14
29	Time To Breakdown (TTB, min)	22.0	22.6	30.2	13.7	33.8	22.4
	II. Cooperator Results						
30	Bake Absorption (Average %)	69.2	64.2	66.8	62.0	69.5	62.7
31	Loaf Volume (% of Check)		95.7		96.4		95.6

SWQC #2 – SD4930

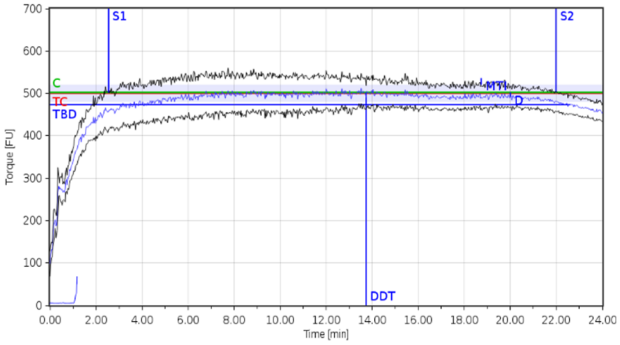
	Quality Trait	Watertown Linkert B-3	Watertown Linkert B-2	Casselton Linkert C-3	Casselton Linkert C-2	Crookston Linkert K-3	Crookston Linkert K-2
	II. Cooperator Results						
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.7	6.5	6.8	4.9	7.2	6.5
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.5	6.4	6.9	4.9	6.9	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		4.6		3.9		4.7
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.7		3.6		4.3
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.4		5.1		4.7
	III. Cooperator Evaluation						
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.5		2.5		3.0
	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		6.5		4.5		6.8
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.2		3.4		4.1
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.6		3.5		4.6

Farinograms

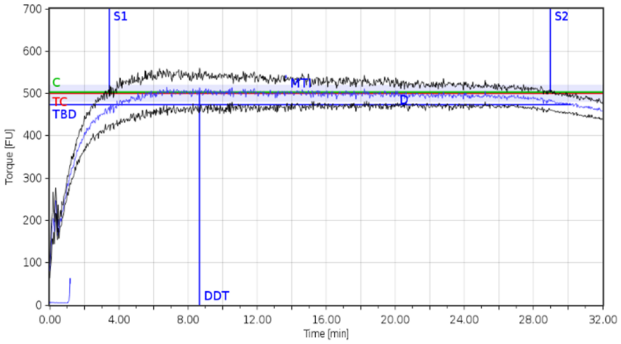
Linkert Check (Watertown, B-3)



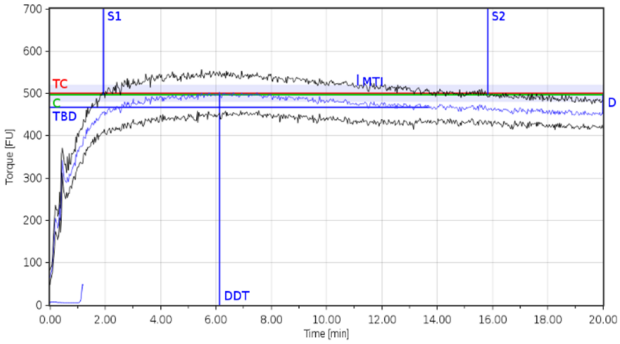
SD4930 (Watertown, B-2)



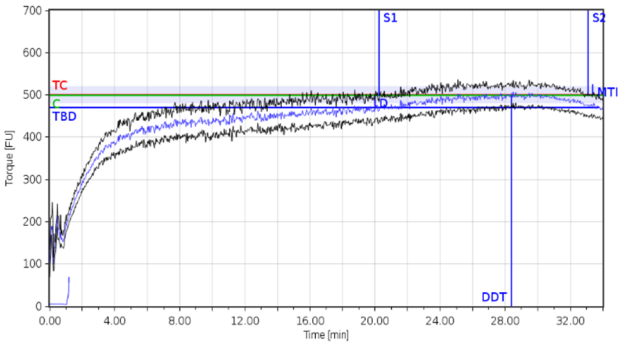
Linkert Check (Casselton, C-3)



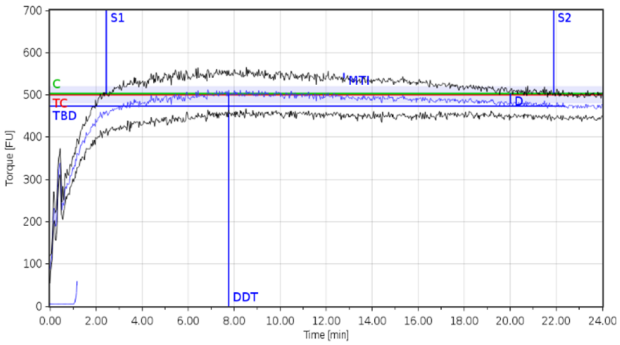
SD4930 (Casselton, C-2)



Linkert Check (Crookston, K-3)

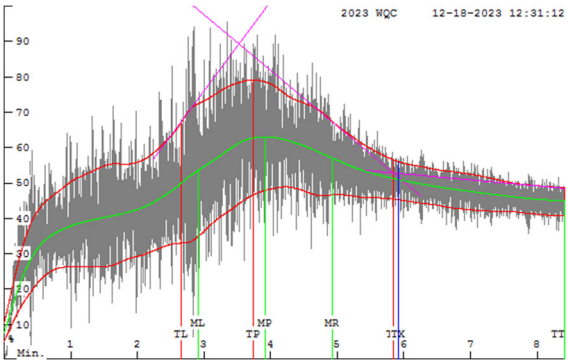


SD4930 (Crookston, K-2)

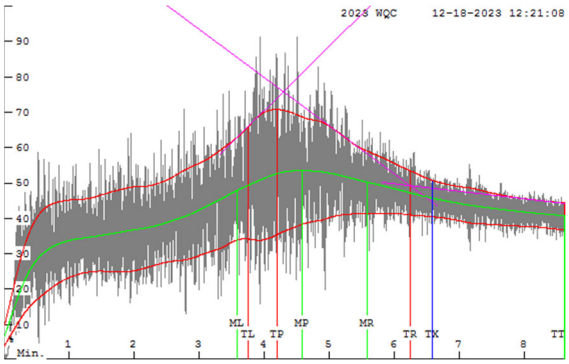


Mixograms

Linkert Check (Watertown, B-3)



SD4930 (Watertown, B-2)



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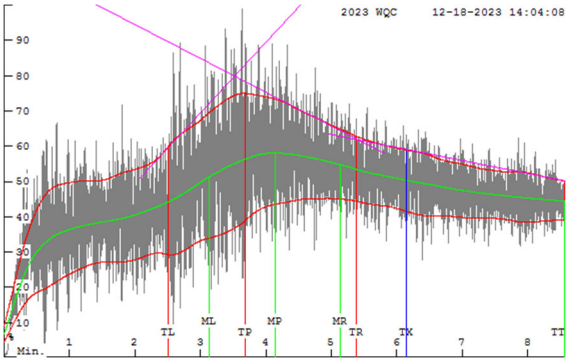

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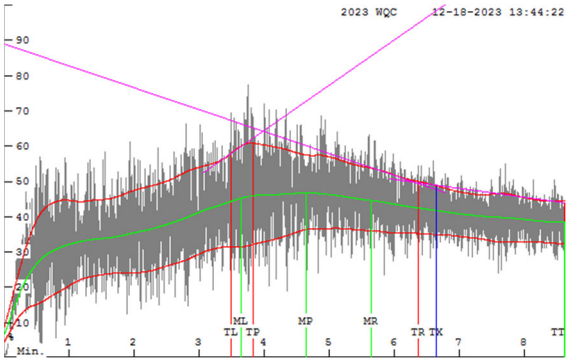
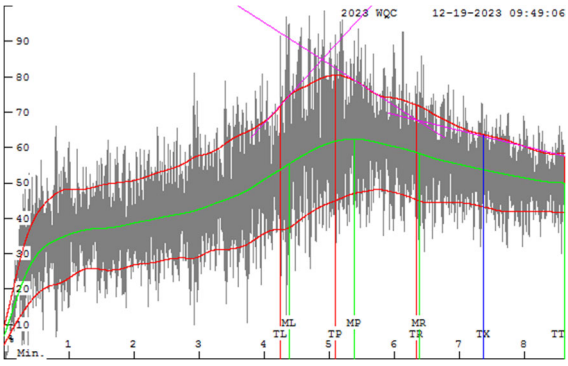


Linkert Check (Crookston, K-3)



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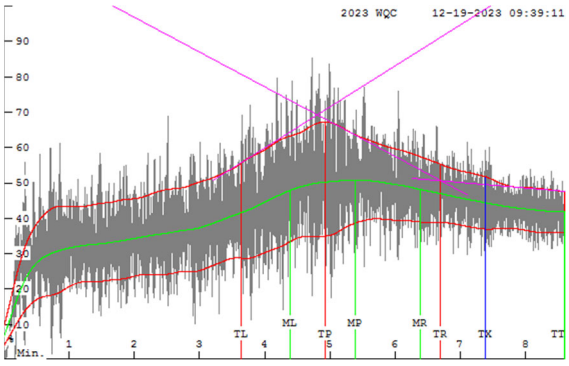
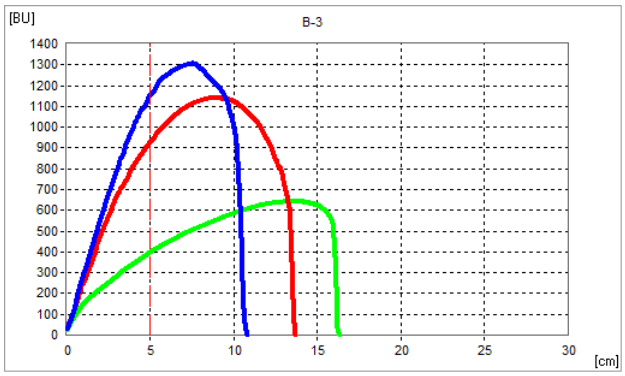
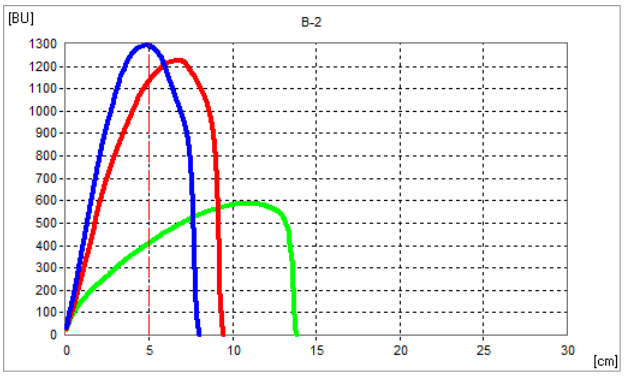


Extensograms

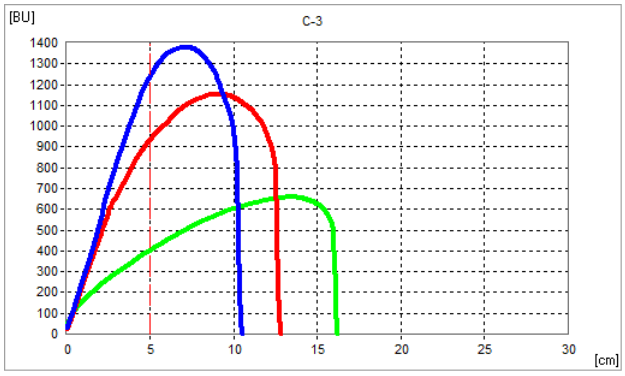
Linkert Check (Watertown, B-3)



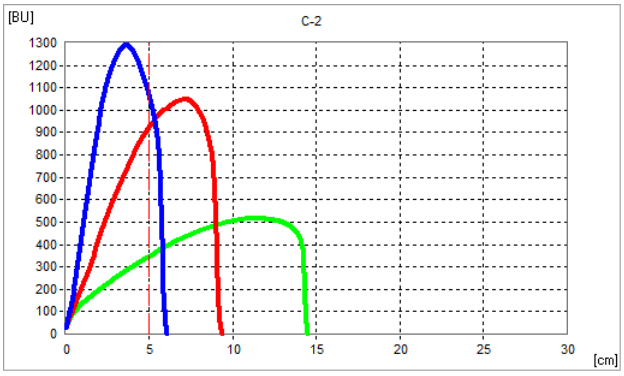
SD4930 (Watertown, B-2)



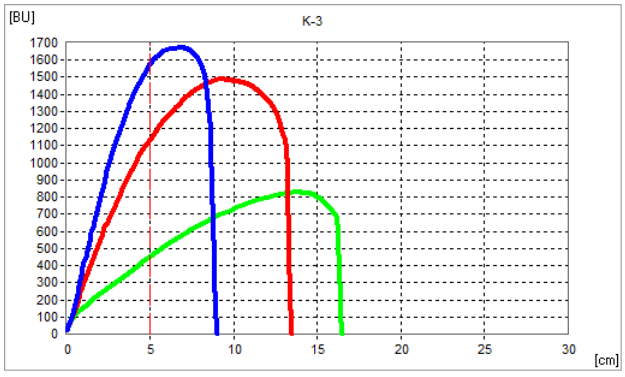
Linkert Check (Casselton, C-3)



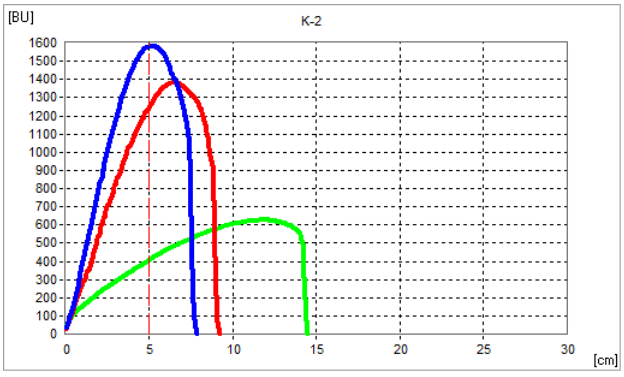
SD4930 (Casselton, C-2)



Linkert (Crookston, K-3)



SD4930 (Crookston, K-2)



45 min; 90 min; 135 min

SWQC #4 – MT 2063

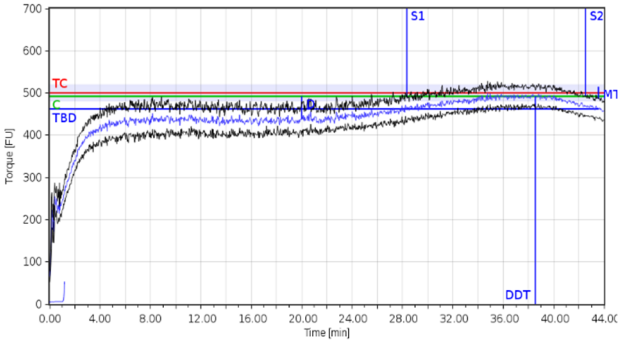
		Havre		Minot	
		LCS Rebel		LCS Rebel	
	Quality Trait	H-10	H-4	M-10	M-4
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	16.4	17.2	16.2	15.0
2	Flour Protein (%, 14% mb)	15.8	16.8	15.2	14.1
3	Market Value (Score 1-6)	3.5	3.4	5.6	4.6
4	Market Value (Score 1-10)	10.0	9.4	10.0	7.2
5	DON (ppm)	0.01	0.01	0.02	0.06
6	Test Weight (lb/bu)	55.8	55.2	63.6	60.9
7	1000 Kernel Weight (g)	19.1	20.6	38.9	34.2
8	Kernel Size, Large (%)	5	9	83	68
9	Kernel Size, Small (%)	61	50	5	6
10	Wheat Moisture (%)	11.0	10.9	12.9	12.4
11	Wheat Ash (%, 14% mb)	1.47	1.65	1.40	1.39
12	Wheat Falling Number (s)	473	426	388	399
13	SKCS Hardness Index	76.2	66.1	61.1	60.7
14	Vitreous Kernels (%)	98	95	75	74
	Flour Extraction				
15	Tempered Wheat Basis (%)	64.4	66.5	72.9	70.3
16	Total Product Basis (%)	66.1	67.2	73.5	71.8
17	Flour/Bu Wheat (lb)	36.2	36.9	46.6	43.4
	Flour Quality				
18	Flour Color Brightness (*L**)	90.4	90.2	90.4	90.9
19	Flour Color Yellowness (*b**)	10.7	11.0	8.1	8.8
20	Flour Moisture (%)	13.1	13.1	13.3	13.6
21	Flour Ash (%, 14% mb)	0.47	0.47	0.42	0.43
22	Flour Falling Number (malted, s)	254	254	260	256
	Farinograph				
23	Water Absorption (%, 500 BU)	65.7	66.5	65.9	62.4
24	Water Absorption (%, 14% mb)	64.7	65.5	65.1	62.2
25	Arrival Time (min)	28.4	30.4	3.6	6.0
26	Peak Time (min)	38.6	34.6	8.8	42.8
27	Dough Stability (min)	14.2	10.5	31.1	43.6
28	Mixing Tolerance Index (MTI, BU)	29	18	14	16
29	Time To Breakdown (TTB, min)	43.6	41.8	36.2	53.7
	II. Cooperator Results				
30	Bake Absorption (Average %)	67.9	68.2	68.5	65.1
31	Loaf Volume (% of Check)		103.0		102.8

SWQC #4 – MT 2063

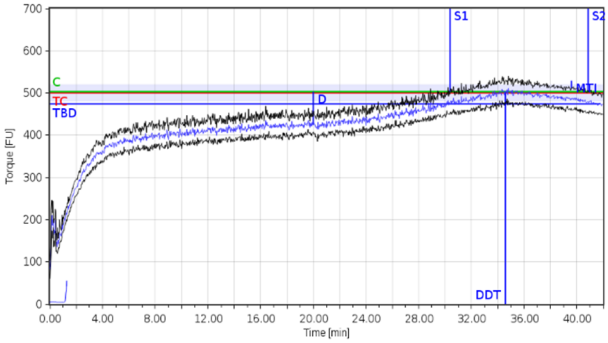
	Quality Trait	Havre LCS Rebel H-10	Havre LCS Rebel H-4	Minot LCS Rebel M-10	Minot LCS Rebel M-4
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	**8.0**	**8.0**	**6.5**	**7.5**
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	**7.5**	**7.2**	**6.5**	**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		**4.8**		**6.5**
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		**5.0**		**4.5**
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.7**		**5.1**
	III. Cooperator Evaluation				
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**5.9**		**4.1**
	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		**5.7**		**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**		**5.7**
	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		**5.5**		**4.8**

Farinograms

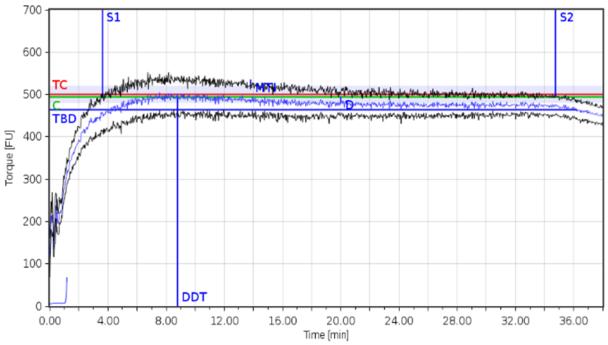
LCS Rebel Check (Havre, H-10)



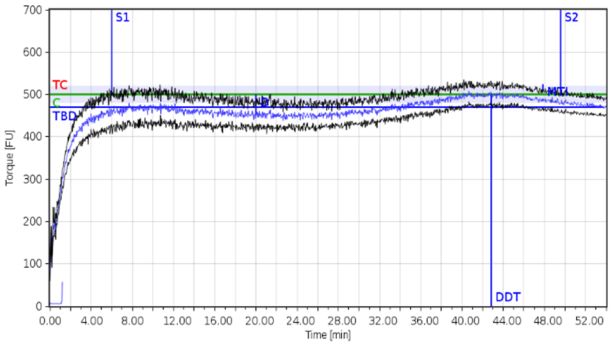
MT 2063 (Havre, H-4)



LCS Rebel Check (Minot, M-10)

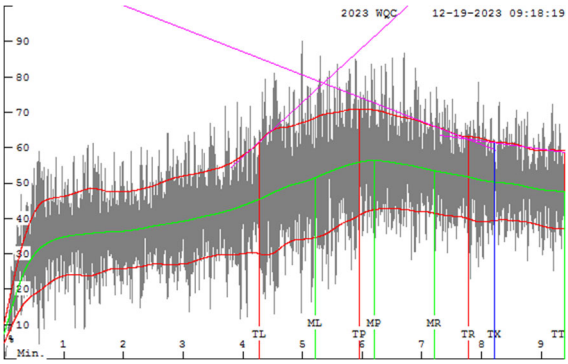


MT 2063 (Minot, M-4)

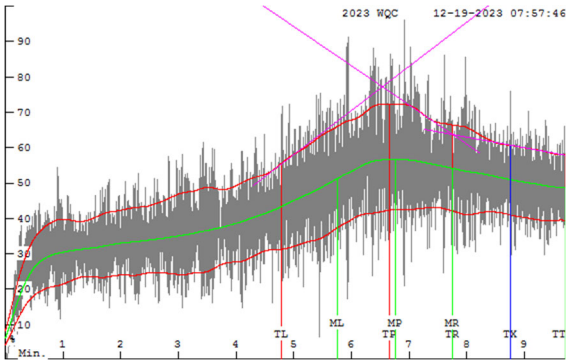


Mixograms

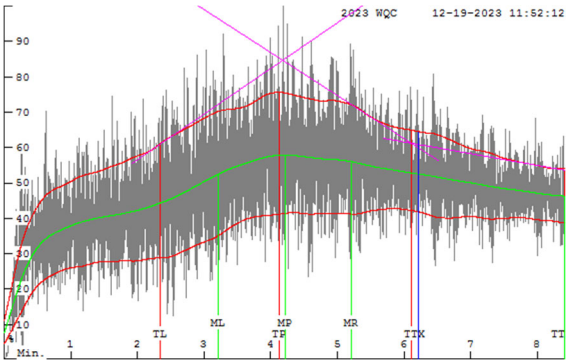
LCS Rebel Check (Havre, H-10)



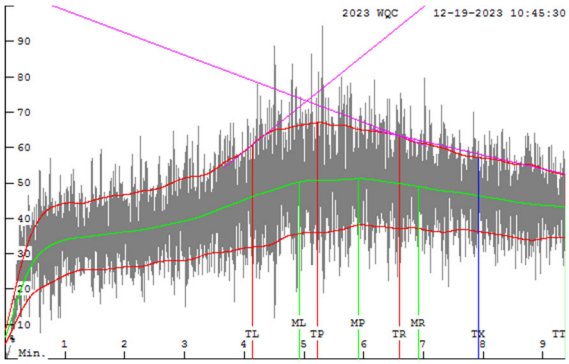
MT 2063 (Havre, H-4)



LCS Rebel Check (Minot, M-10)

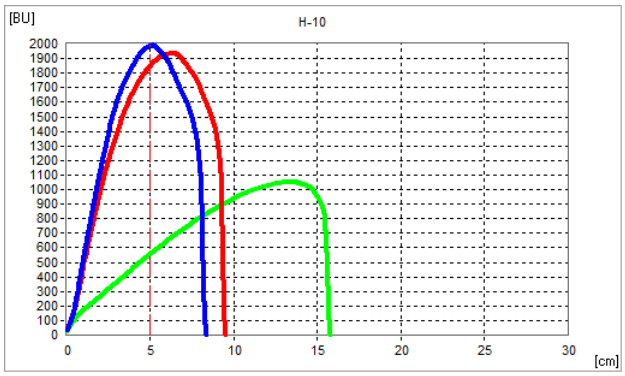


MT 2063 (Minot, M-4)

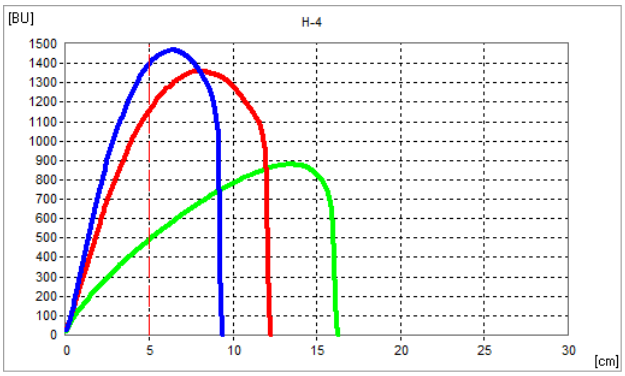


Extensograms

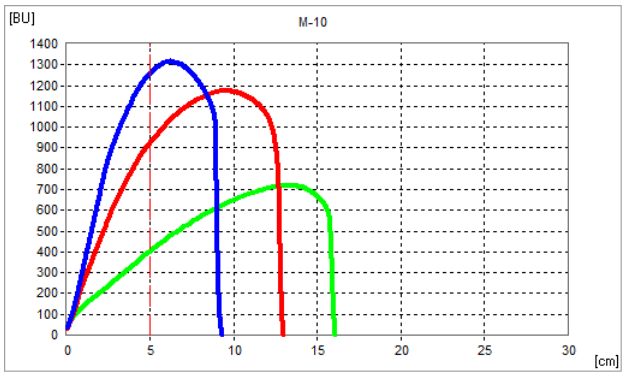
LCS Rebel Check (Havre, H-10)



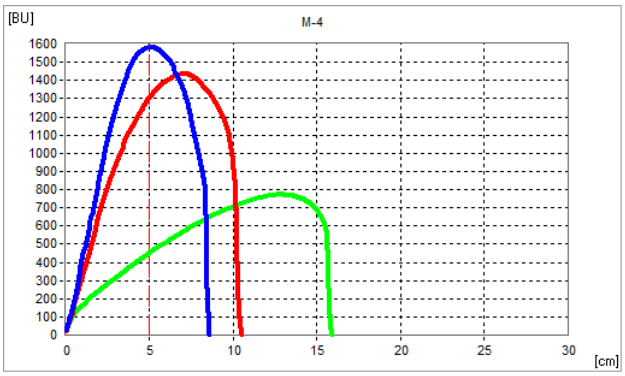
MT 2063 (Havre, H-4)



LCS Rebel Check (Minot, M-10)



MT 2063 (Minot, M-4)



45 min; 90 min; 135 min

SWQC #5 – LCS Boom

		Watertown		Casselton		Havre		Crookston		Minot	
		Linkert		Linkert		LCS Rebel		Linkert		LCS Rebel	
	Quality Trait	B-3	B-5	C-3	C-5	H-10	H-5	K-3	K-5	M-10	M-5
	I. USDA-ARS WQL Data										
1	Wheat Protein (%, 12% mb)	16.5	16.4	15.9	15.5	16.4	16.6	16.9	15.5	16.2	15.8
2	Flour Protein (%, 14% mb)	15.5	15.1	14.7	14.4	15.8	15.9	16.2	14.7	15.2	14.8
3	Market Value (Score 1-6)	5.6	5.8	5.6	5.5	3.5	3.5	5.2	4.8	5.6	5.2
4	Market Value (Score 1-10)	10.0	9.2	10.0	9.6	10.0	10.0	10.0	7.6	10.0	9.6
5	DON (ppm)	nd	nd	0.03	0.01	0.01	0.01	0.02	nd	0.02	nd
6	Test Weight (lb/bu)	62.0	63.1	63.3	63.9	55.8	55.7	60.9	62.4	63.6	63.1
7	1000 Kernel Weight (g)	43.0	40.7	39.7	38.7	19.1	20.1	37.6	35.6	38.9	35.4
8	Kernel Size, Large (%)	95	88	85	80	5	3	79	75	83	75
9	Kernel Size, Small (%)	2	3	5	7	61	60	5	7	5	6
10	Wheat Moisture (%)	12.4	12.4	12.4	12.9	11.0	11.0	12.3	13.1	12.9	12.5
11	Wheat Ash (%, 14% mb)	1.53	1.42	1.60	1.44	1.47	1.52	1.68	1.51	1.40	1.28
12	Wheat Falling Number (s)	456	409	460	416	473	471	454	372	388	375
13	SKCS Hardness Index	62.0	60.2	68.6	67.6	76.2	73.6	68.1	66.0	61.1	63.0
14	Vitreous Kernels (%)	43	46	84	69	98	98	71	56	75	67
	Flour Extraction										
15	Tempered Wheat Basis (%)	68.0	70.1	70.5	69.1	64.4	63.8	68.3	69.4	72.9	70.8
16	Total Product Basis (%)	69.5	73.2	71.7	70.5	66.1	64.9	69.7	70.9	73.5	71.9
17	Flour/Bu Wheat (lb)	43.3	44.4	45.1	45.3	36.2	35.9	42.2	43.6	46.6	45.2
	Flour Quality										
18	Flour Color Brightness (*L**)	90.9	90.5	90.7	90.5	90.4	90.5	90.5	90.1	90.4	90.8
19	Flour Color Yellowness (*b**)	8.3	8.6	8.9	9.8	10.7	10.7	8.4	9.4	8.1	8.9
20	Flour Moisture (%)	13.7	12.7	12.9	13.9	13.1	13.4	13.6	13.7	13.3	13.5
21	Flour Ash (%, 14% mb)	0.50	0.51	0.51	0.48	0.47	0.48	0.47	0.48	0.42	0.42
22	Flour Falling Number (malted, s)	251	252	249	253	254	256	255	254	260	258
	Farinograph										
23	Water Absorption (%, 500 BU)	67.6	67.0	64.6	65.1	65.7	64.1	68.1	64.4	65.9	64.3
24	Water Absorption (%, 14% mb)	67.4	65.6	63.6	65.1	64.7	63.5	67.7	64.2	65.1	63.9
25	Arrival Time (min)	9.3	4.9	3.5	4.0	28.4	6.1	20.3	3.4	3.6	4.4
26	Peak Time (min)	16.8	9.8	8.7	6.9	38.6	30.3	28.4	9.5	8.8	10.2
27	Dough Stability (min)	12.0	11.5	25.5	11.4	14.2	30.9	12.9	18.8	31.1	17.4
28	Mixing Tolerance Index (MTI, BU)	33	15	8	22	29	14	26	11	14	18
29	Time To Breakdown (TTB, min)	22.0	17.2	30.2	16.7	43.6	37.6	33.8	23.0	36.2	23.2

SWQC #5 – LCS Boom

		Watertown		Casselton		Havre		Crookston		Minot	
		Linkert		Linkert		LCS Rebel		Linkert		LCS Rebel	
	Quality Trait	B-3	B-5	C-3	C-5	H-10	H-5	K-3	K-5	M-10	M-5
	II. Cooperator Results										
30	Bake Absorption (Average %)	69.2	68.4	66.8	67.0	67.9	67.0	69.5	66.9	68.5	66.9
31	Loaf Volume (% of Check)		99.0		101.0		100.7		97.9		100.4
32	Mixing Requirement*	6.7	5.0	6.8	4.4	8.0	7.5	7.2	6.1	6.5	5.9
33	Dough Characteristics**	6.5	5.5	6.9	5.2	7.5	7.5	6.9	6.0	6.5	5.5
34	Mixing Tolerance†		4.0		3.5		5.5		4.8		4.4
35	Internal Crumb Color††		5.2		4.5		5.5		3.8		4.7
36	Internal Crumb Texture‡		5.5		4.9		4.7		4.7		5.2
	III. Cooperator Evaluation‡										
	Quality Traits 1-2: Protein		5.0		4.9		5.0		4.0		4.5
	Quality Traits 3-22: Milling		6.1		4.5		4.1		5.5		3.8
	Quality Traits 23-36: Baking		4.4		4.6		5.3		4.5		4.4
	Quality Traits 1-36: Overall Comparison		4.8		4.5		4.9		4.6		4.2

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

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

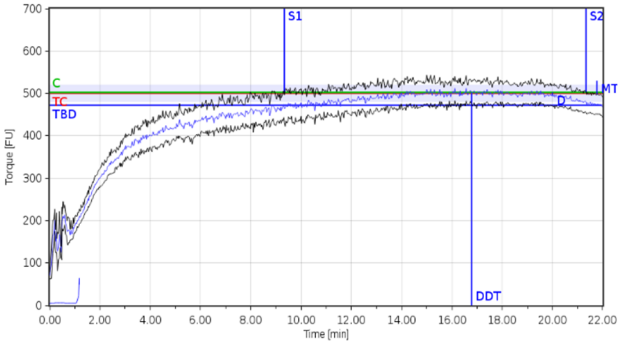
†9 = Much More Tolerance Than Check; 7 = More Tolerance Than Check; 5 = Tolerance Equivalent To Check; 3 = Less Tolerance Than Check; 1 = Much Less Tolerance Than Check.

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

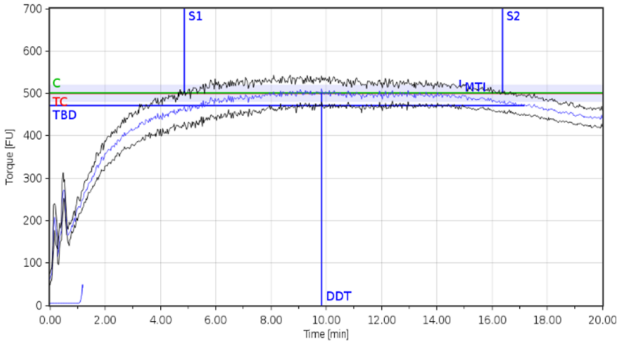
‡9 = Much Better Than Check; 7 = Better Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.

Farinograms

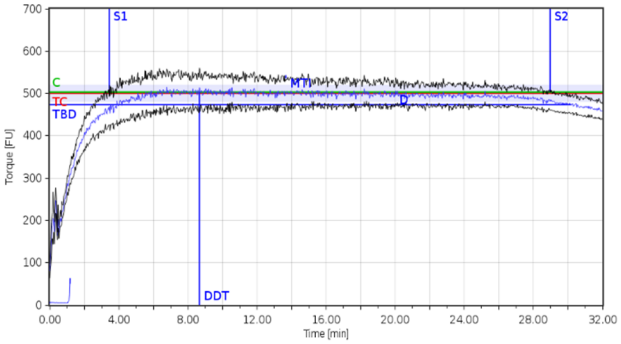
Linkert Check (Watertown, B-3)



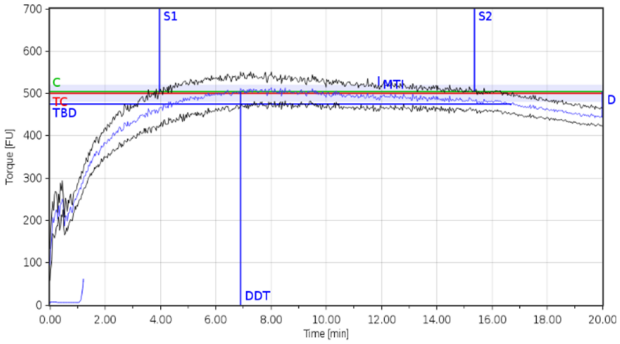
LCS Boom (Watertown, B-5)



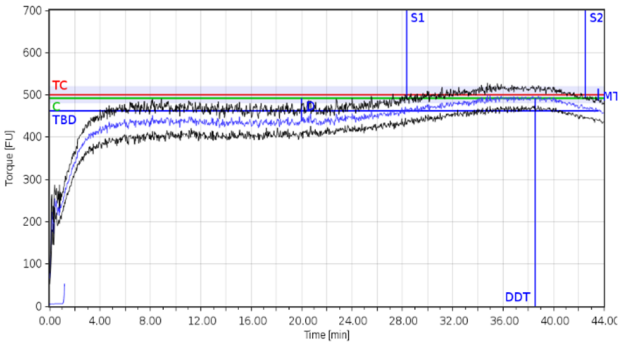
Linkert Check (Casselton, C-3)



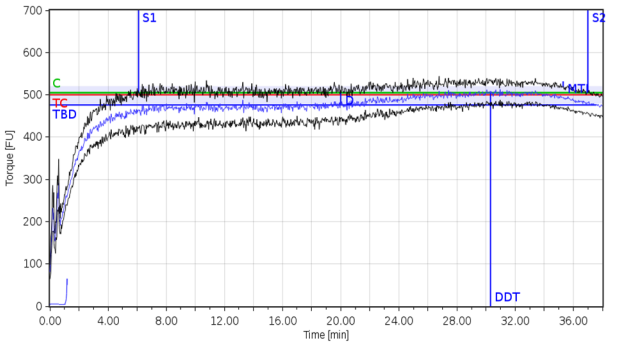
LCS Boom (Casselton, C-5)



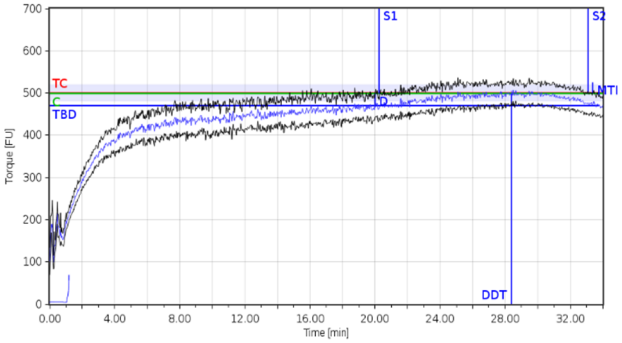
LCS Rebel Check (Havre, H-10)



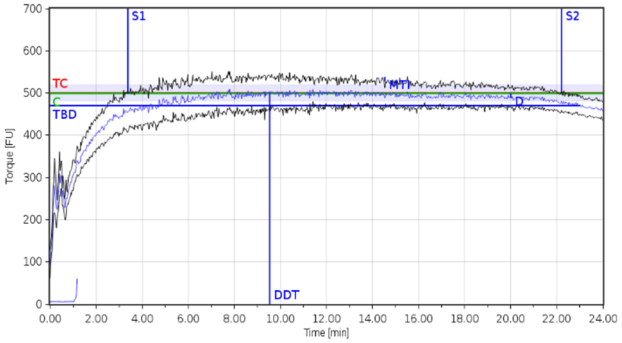
LCS Boom (Havre, H-5)



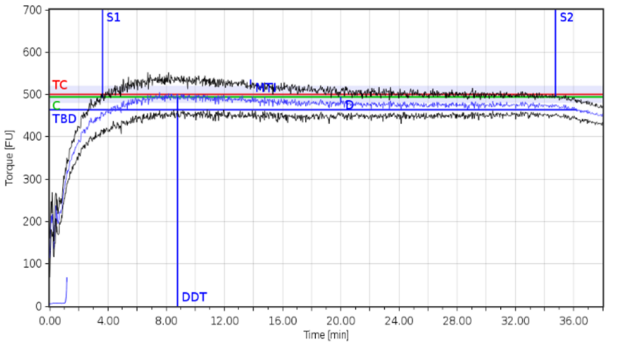
Linkert Check (Crookston, K-3)



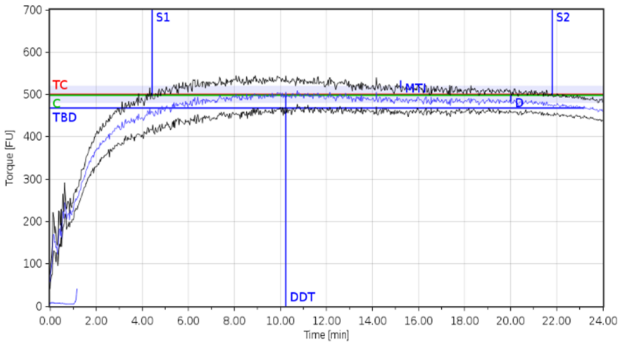
LCS Boom (Crookston, K-5)



LCS Rebel (Minot, M-10)

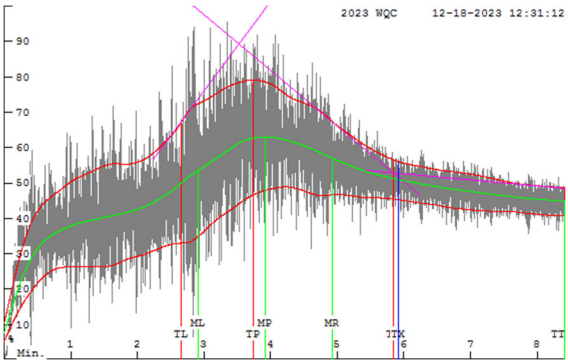


LCS Boom (Minot, M-5)

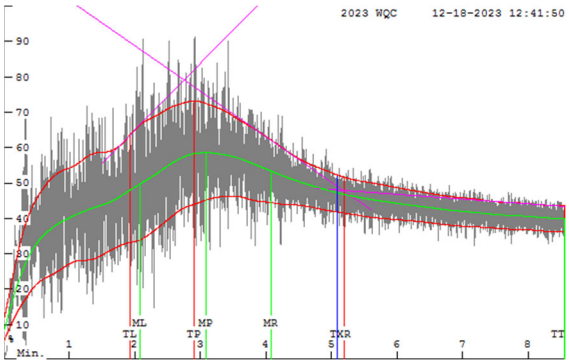


Mixograms

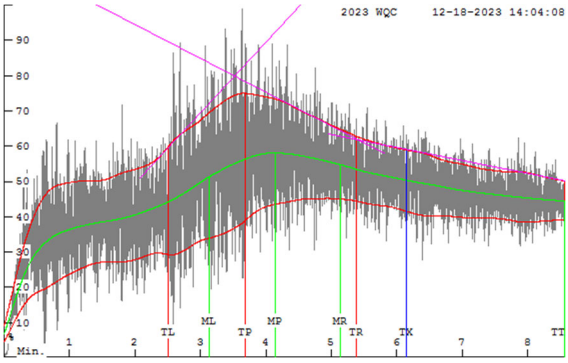
Linkert Check (Watertown, B-3)



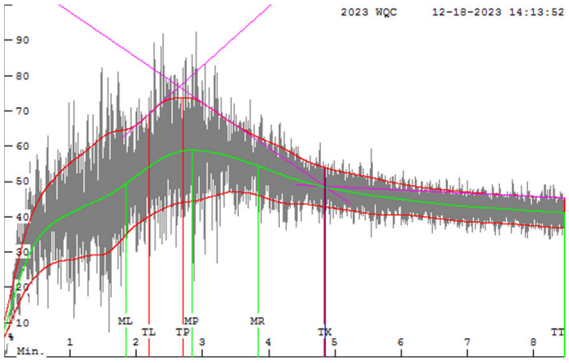
LCS Boom (Watertown, B-5)



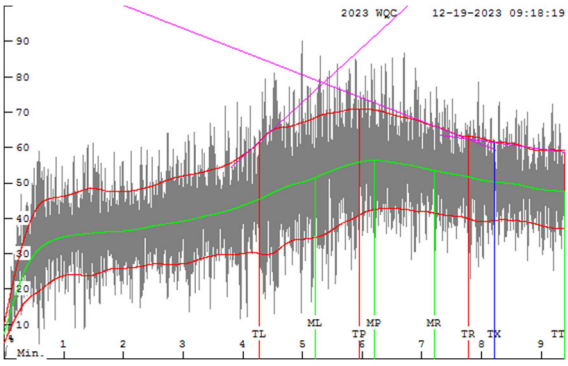
Linkert Check (Casselton, C-3)



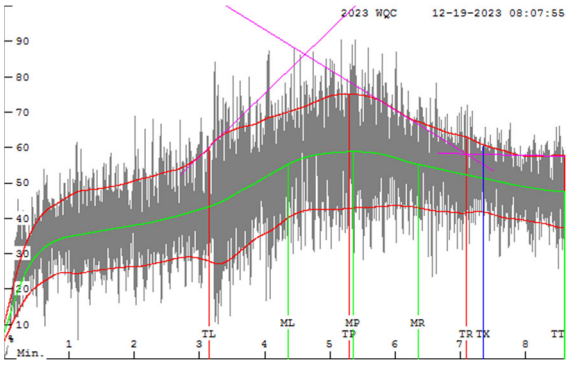
LCS Boom (Casselton, C-5)



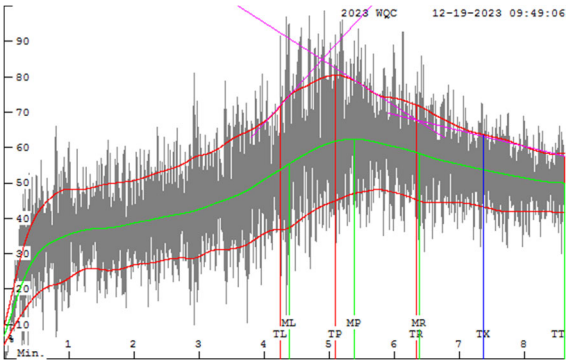
LCS Rebel Check (Havre, H-10)



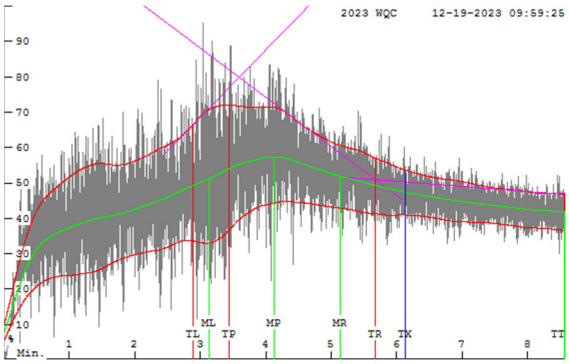
LCS Boom (Havre, H-5)



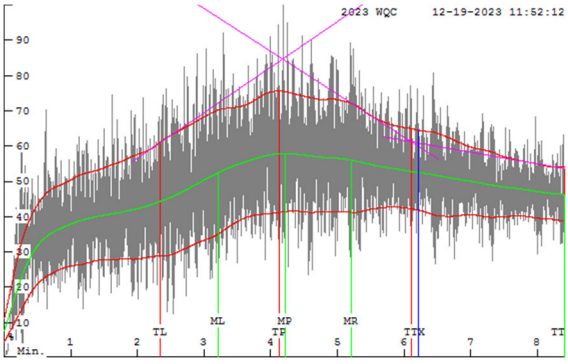
Linkert Check (Crookston, K-3)



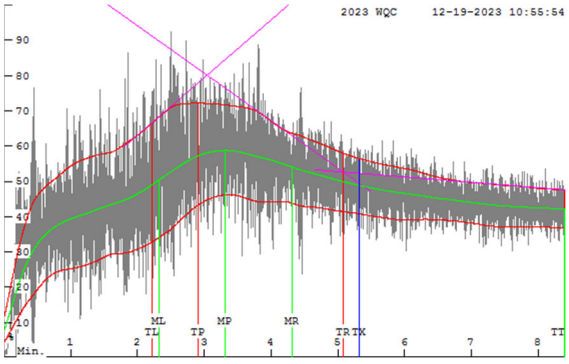
LCS Boom (Crookston, K-5)



LCS Rebel Check (Minot, M-10)

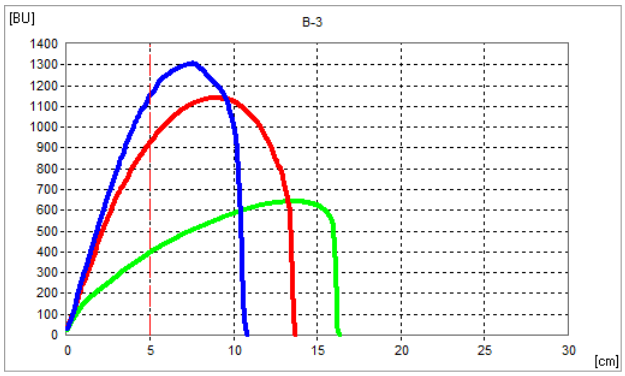


LCS Boom (Minot, M-5)

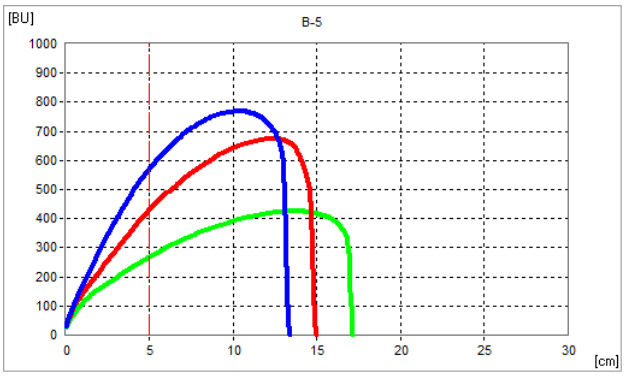


Extensograms

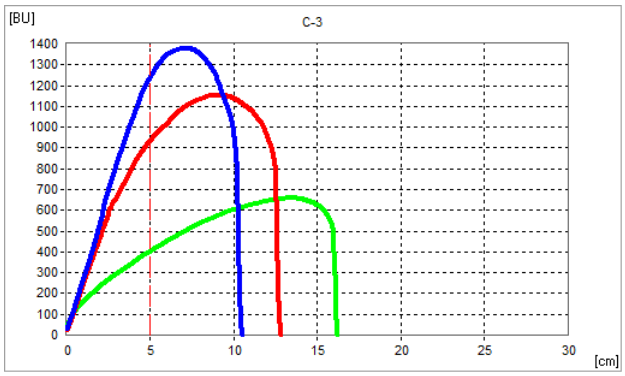
Linkert Check (Watertown, B-3)



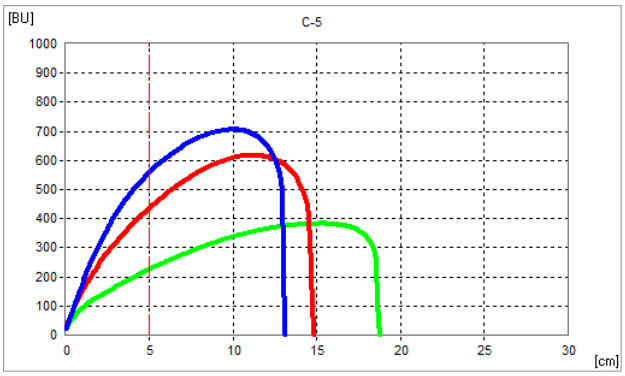
LCS Boom (Watertown, B-5)



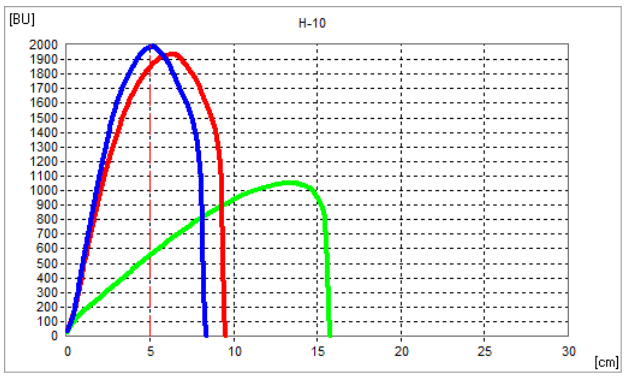
Linkert Check (Casselton, C-3)



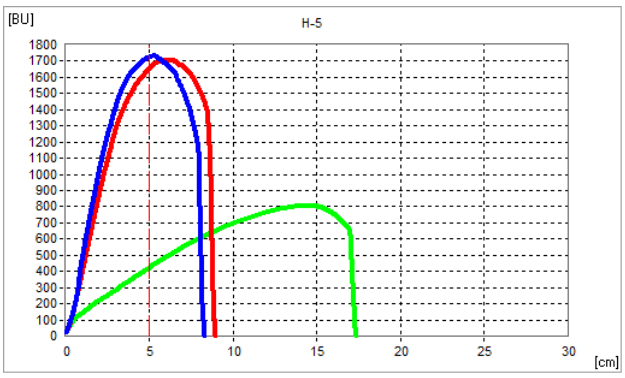
LCS Boom (Casselton, C-5)



LCS Rebel Check (Havre, H-10)

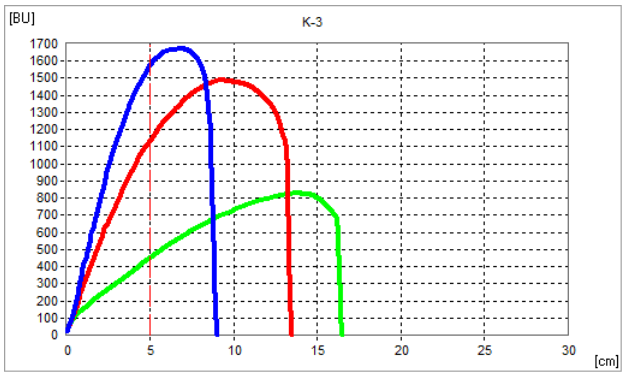


LCS Boom (Havre, H-5)

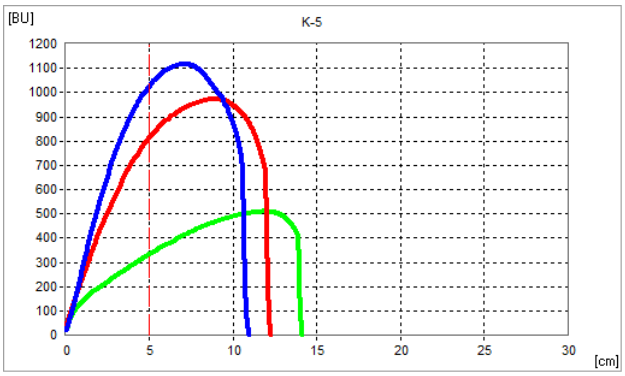


45 min; 90 min; 135 min

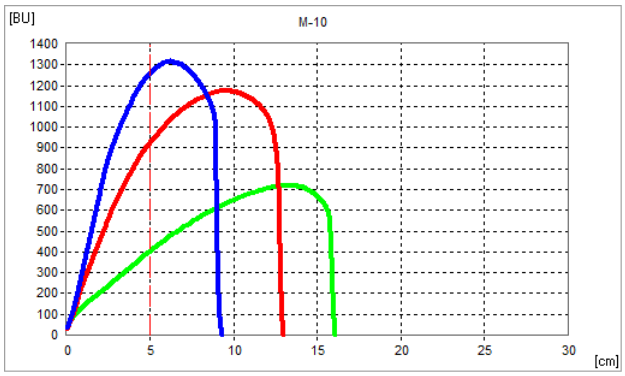
Linkert Check (Crookston, K-3)



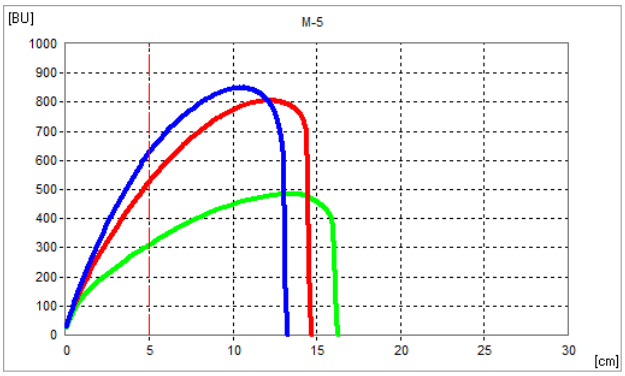
LCS Boom (Crookston, K-5)



LCS Rebel Check (Minot, M-10)



LCS Boom (Minot, M-5)



45 min; 90 min; 135 min

SWQC #6 – LCS Cannon

		Watertown		Casselton		Havre		Crookston		Minot	
		Linkert		Linkert		LCS Rebel		Linkert		LCS Rebel	
	Quality Trait	B-3	B-6	C-3	C-6	H-10	H-6	K-3	K-6	M-10	M-6
	I. USDA-ARS WQL Data										
1	Wheat Protein (%, 12% mb)	16.5	16.2	15.9	14.9	16.4	18.1	16.9	15.5	16.2	15.7
2	Flour Protein (%, 14% mb)	15.5	15.0	14.7	13.8	15.8	17.5	16.2	14.6	15.2	14.7
3	Market Value (Score 1-6)	5.6	5.6	5.6	5.1	3.5	3.6	5.2	4.4	5.6	5.1
4	Market Value (Score 1-10)	10.0	8.8	10.0	8.6	10.0	10.0	10.0	6.4	10.0	9.0
5	DON (ppm)	nd	nd	0.03	0.01	0.01	0.01	0.02	nd	0.02	0.02
6	Test Weight (lb/bu)	62.0	63.3	63.3	63.8	55.8	56.8	60.9	62.4	63.6	63.2
7	1000 Kernel Weight (g)	43.0	39.9	39.7	37.8	19.1	21.3	37.6	35.4	38.9	36.0
8	Kernel Size, Large (%)	95	89	85	84	5	7	79	71	83	79
9	Kernel Size, Small (%)	2	4	5	5	61	50	5	9	5	5
10	Wheat Moisture (%)	12.4	12.5	12.4	13.2	11.0	10.5	12.3	13.1	12.9	12.2
11	Wheat Ash (%, 14% mb)	1.53	1.39	1.60	1.42	1.47	1.50	1.68	1.48	1.40	1.30
12	Wheat Falling Number (s)	456	387	460	395	473	534	454	324	388	366
13	SKCS Hardness Index	62.0	62.3	68.6	66.4	76.2	66.1	68.1	68.0	61.1	64.6
14	Vitreous Kernels (%)	43	39	84	70	98	98	71	52	75	71
	Flour Extraction										
15	Tempered Wheat Basis (%)	68.0	70.1	70.5	71.0	64.4	66.4	68.3	70.7	72.9	69.8
16	Total Product Basis (%)	69.5	71.6	71.7	72.1	66.1	67.7	69.7	72.6	73.5	71.7
17	Flour/Bu Wheat (lb)	43.3	45.0	45.1	46.0	36.2	38.0	42.2	44.5	46.6	45.1
	Flour Quality										
18	Flour Color Brightness (*L**)	90.9	90.6	90.7	90.3	90.4	90.3	90.5	90.2	90.4	90.8
19	Flour Color Yellowness (*b**)	8.3	8.7	8.9	9.9	10.7	10.8	8.4	9.2	8.1	9.0
20	Flour Moisture (%)	13.7	13.6	12.9	13.4	13.1	13.3	13.6	13.8	13.3	13.9
21	Flour Ash (%, 14% mb)	0.50	0.47	0.51	0.48	0.47	0.45	0.47	0.48	0.42	0.40
22	Flour Falling Number (malted, s)	251	251	249	258	254	255	255	254	260	251
	Farinograph										
23	Water Absorption (%, 500 BU)	67.6	65.5	64.6	65.2	65.7	68.1	68.1	64.6	65.9	63.5
24	Water Absorption (%, 14% mb)	67.4	65.1	63.6	64.6	64.7	67.5	67.7	64.4	65.1	63.5
25	Arrival Time (min)	9.3	4.6	3.5	3.7	28.4	27.3	20.3	3.0	3.6	2.6
26	Peak Time (min)	16.8	12.1	8.7	8.1	38.6	34.6	28.4	12.5	8.8	9.3
27	Dough Stability (min)	12.0	13.7	25.5	12.7	14.2	17.6	12.9	19.7	31.1	25.7
28	Mixing Tolerance Index (MTI, BU)	33	15	8	24	29	8	26	14	14	10
29	Time To Breakdown (TTB, min)	22.0	18.7	30.2	17.5	43.6	45.9	33.8	23.6	36.2	29.1

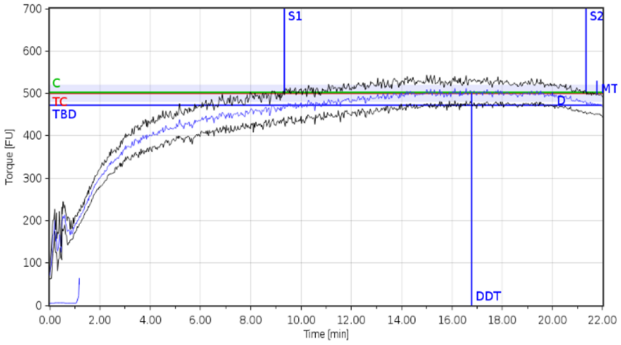
SWQC #6 – LCS Cannon

	Quality Trait	Watertown Linkert B-3	Watertown Linkert B-6	Casselton Linkert C-3	Casselton Linkert C-6	Havre LCS Rebel H-10	Havre LCS Rebel H-6	Crookston Linkert K-3	Crookston Linkert K-6	Minot LCS Rebel M-10	Minot LCS Rebel M-6
	II. Cooperator Results										
30	Bake Absorption (Average %)	69.2	67.8	66.8	67.2	67.9	70.3	69.5	67.0	68.5	66.6
31	Loaf Volume (% of Check)		100.6		100.4		101.3		98.9		101.9
32	Mixing Requirement*	6.7	5.5	6.8	4.8	8.0	8.2	7.2	6.3	6.5	6.5
33	Dough Characteristics**	6.5	6.2	6.9	5.6	7.5	7.2	6.9	6.3	6.5	5.8
34	Mixing Tolerance†		4.1		3.7		5.3		4.5		4.8
35	Internal Crumb Color††		4.8		4.9		5.2		4.6		4.9
36	Internal Crumb Texture‡		5.5		4.8		5.2		4.7		4.9
	III. Cooperator Evaluation‡										
	Quality Traits 1-2: Protein		4.9		4.0		6.7		4.0		4.5
	Quality Traits 3-22: Milling		5.8		4.9		5.8		6.1		3.9
	Quality Traits 23-36: Baking		4.9		4.7		5.1		4.7		5.1
	Quality Traits 1-36: Overall Comparison		5.1		4.5		6.1		5.3		4.8

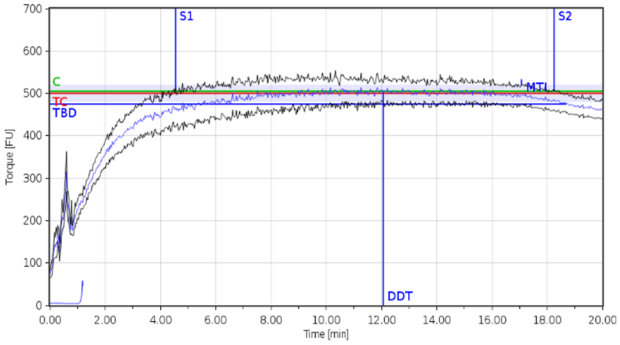
*9 = Very long; 7 = Long; 5 = Medium; 3 = Short; 1 = Very short.
**9 = Bucky – Tough; 7 = Strong – Elastic; 5 = Medium – Pliable; 3 = Mellow – Very Pliable; 1 = Weak – Short or Sticky.
†9 = Much More Tolerance Than Check; 7 = More Tolerance Than Check; 5 = Tolerance Equivalent To Check; 3 = Less Tolerance Than Check; 1 = Much Less Tolerance Than Check.
††9 = Much Brighter Than Check; 7 = Brighter Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.
‡9 = Much Better Than Check; 7 = Better Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.

Farinograms

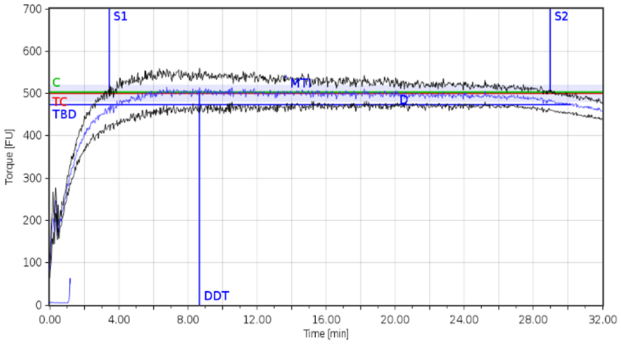
Linkert Check (Watertown, B-3)



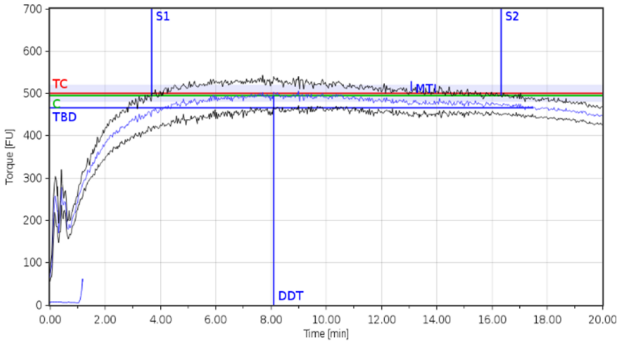
LCS Cannon (Watertown, B-6)



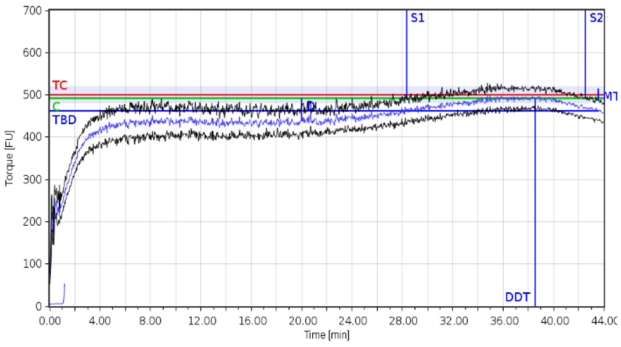
Linkert Check (Casselton, C-3)



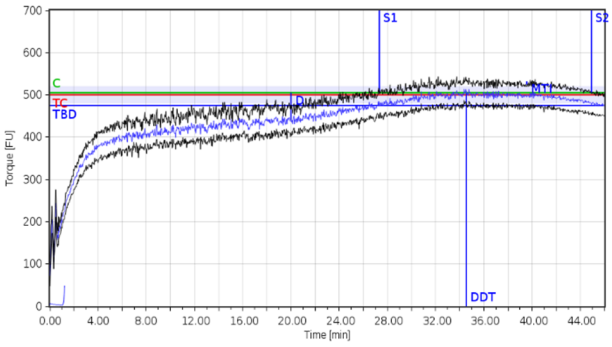
LCS Cannon (Casselton, C-6)



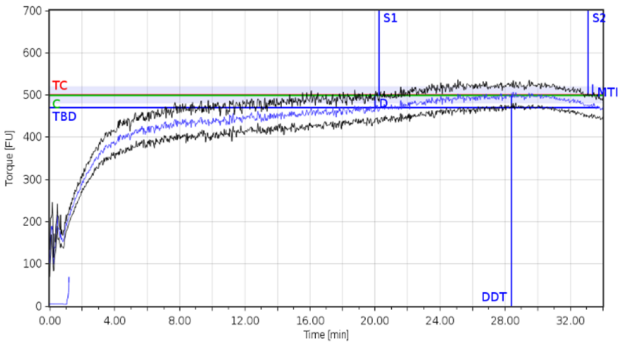
LCS Rebel Check (Havre, H-10)



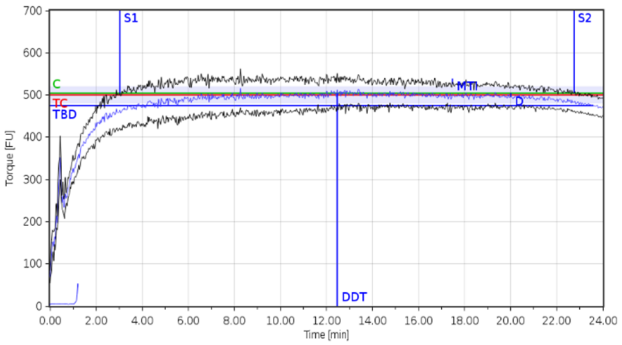
LCS Cannon (Havre, H-6)



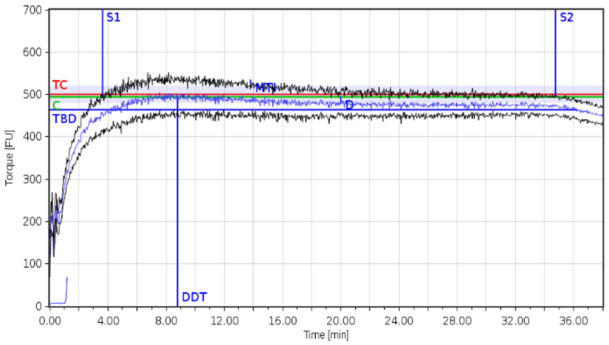
Linkert Check (Crookston, K-3)



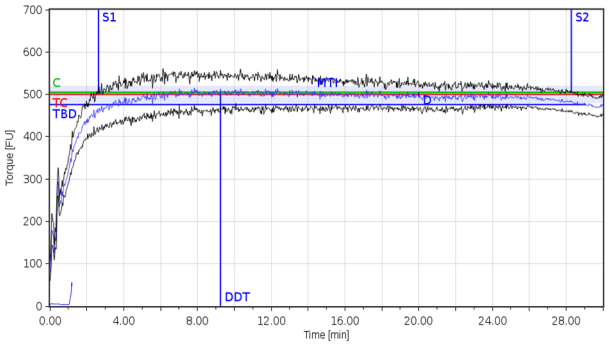
LCS Cannon (Crookston, K-6)



LCS Rebel (Minot, M-10)

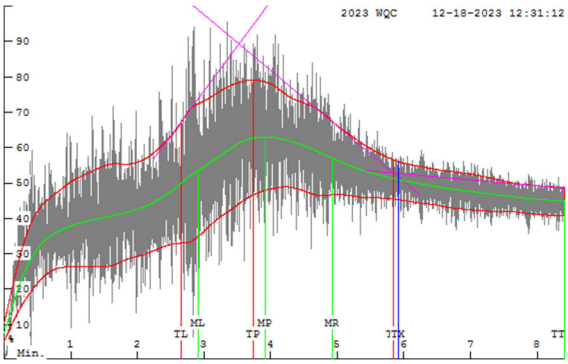


LCS Cannon (Minot, M-6)

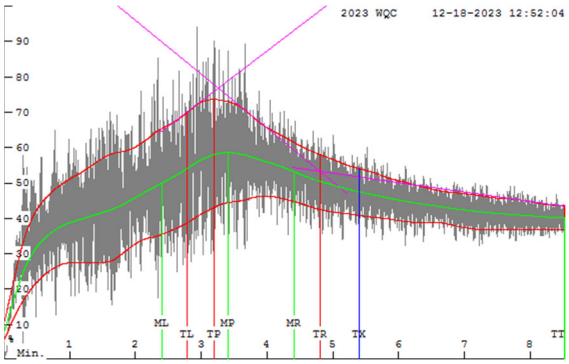


Mixograms

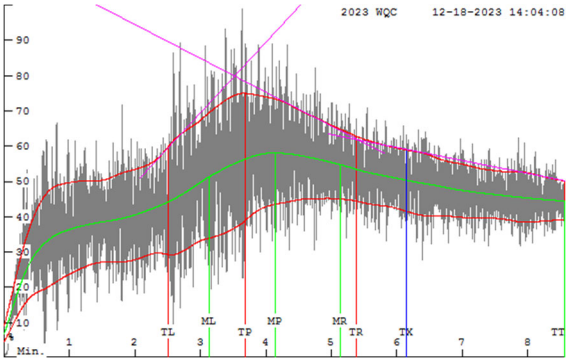
Linkert Check (Watertown, B-3)



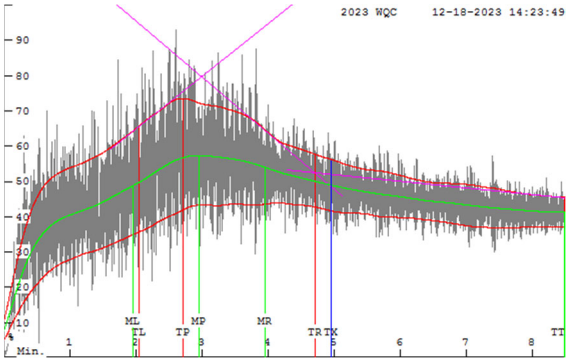
LCS Cannon (Watertown, B-6)



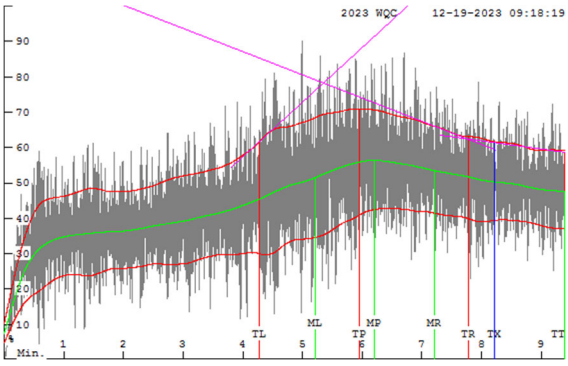
Linkert Check (Casselton, C-3)



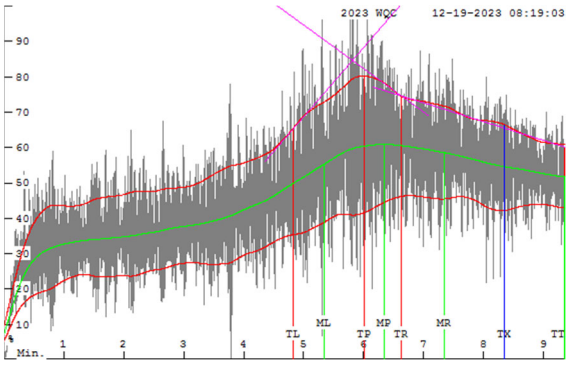
LCS Cannon (Casselton, C-6)



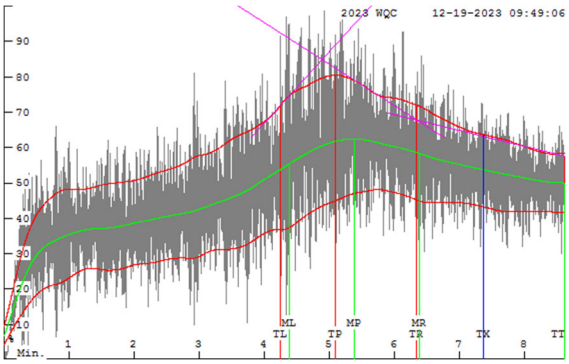
LCS Rebel Check (Havre, H-10)



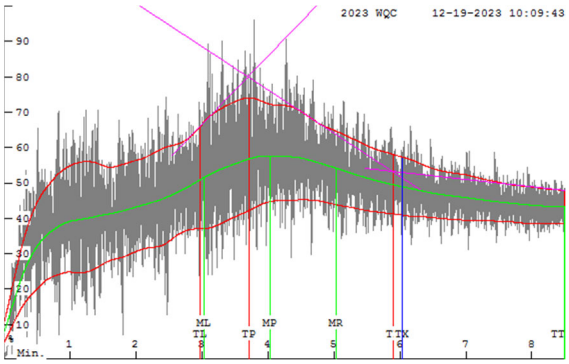
LCS Cannon (Havre, H-6)



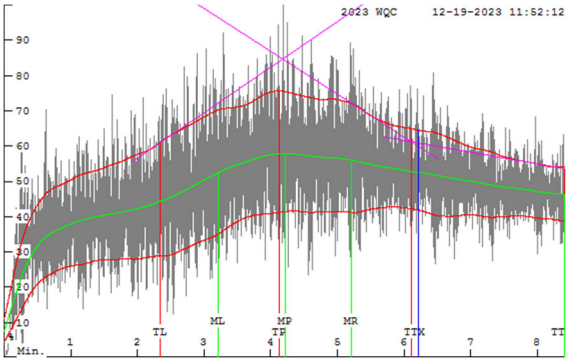
Linkert Check (Crookston, K-3)



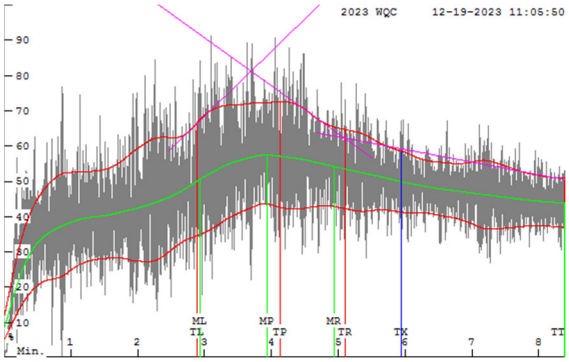
LCS Cannon (Crookston, K-6)



LCS Rebel Check (Minot, M-10)

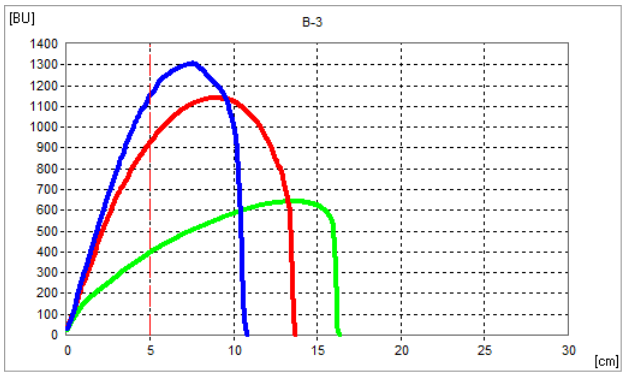


LCS Cannon (Minot, M-6)

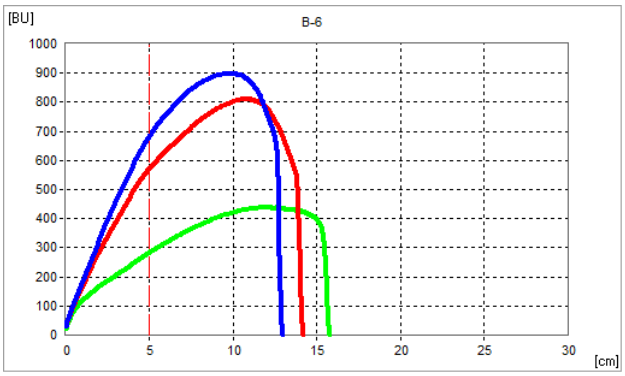


Extensograms

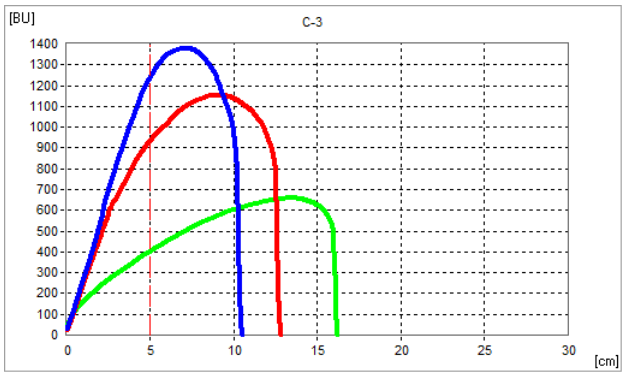
Linkert Check (Watertown, B-3)



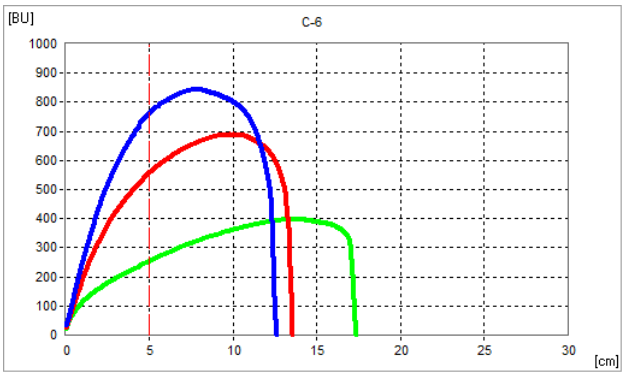
LCS Cannon (Watertown, B-6)



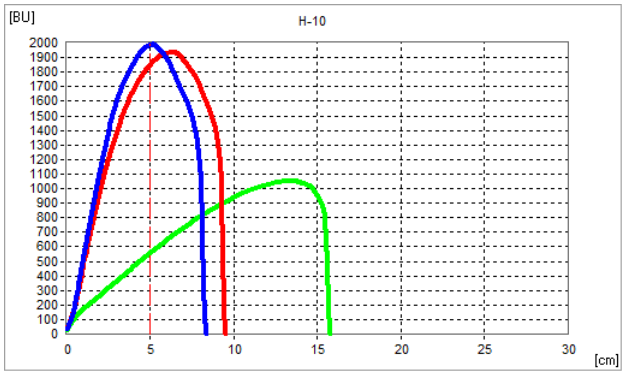
Linkert Check (Casselton, C-3)



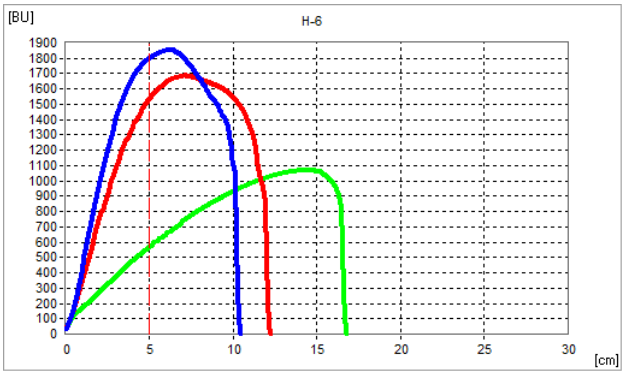
LCS Cannon (Casselton, C-6)



LCS Rebel Check (Havre, H-10)

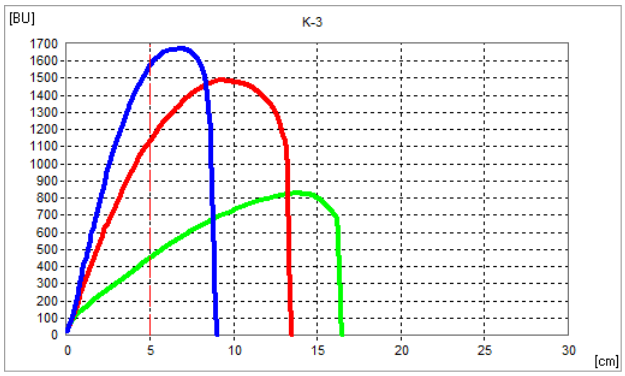


LCS Cannon (Havre, H-6)

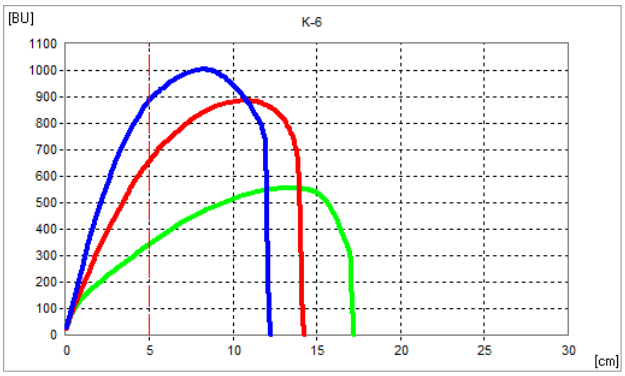


45 min; 90 min; 135 min

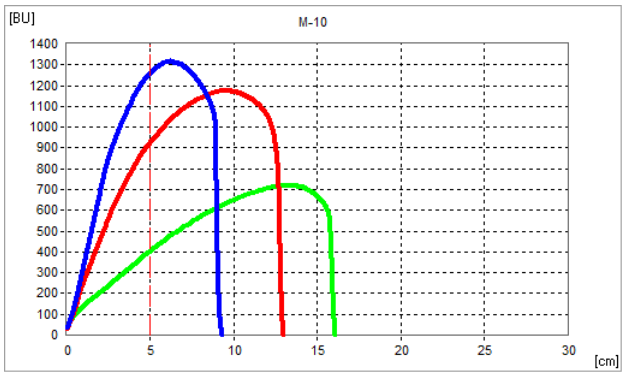
Linkert Check (Crookston, K-3)



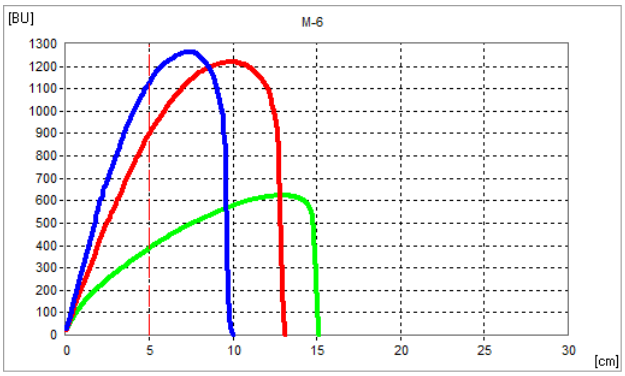
LCS Cannon (Crookston, K-6)



LCS Rebel Check (Minot, M-10)



LCS Cannon (Minot, M-6)



45 min; 90 min; 135 min

SWQC #7 – LCS Buster

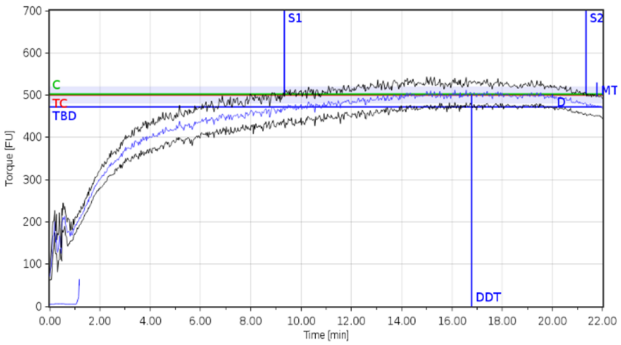
		Watertown		Casselton		Havre		Minot	
		Linkert		Linkert		LCS Rebel		LCS Rebel	
	Quality Trait	B-3	B-7	C-3	C-7	H-10	H-7	M-10	M-7
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	16.5	14.7	15.9	11.9	16.4	16.7	16.2	12.8
2	Flour Protein (%, 14% mb)	15.5	13.5	14.7	10.9	15.8	16.1	15.2	11.8
3	Market Value (Score 1-6)	5.6	5.1	5.6	3.8	3.5	3.8	5.6	3.9
4	Market Value (Score 1-10)	10.0	8.2	10.0	5.4	10.0	9.6	10.0	5.8
5	DON (ppm)	nd	nd	0.03	0.01	0.01	nd	0.02	0.01
6	Test Weight (lb/bu)	62.0	61.3	63.3	61.3	55.8	55.4	63.6	61.3
7	1000 Kernel Weight (g)	43.0	41.9	39.7	35.9	19.1	23.5	38.9	35.8
8	Kernel Size, Large (%)	95	91	85	69	5	4	83	69
9	Kernel Size, Small (%)	2	2	5	8	61	40	5	8
10	Wheat Moisture (%)	12.4	12.5	12.4	12.4	11.0	10.5	12.9	12.7
11	Wheat Ash (%, 14% mb)	1.53	1.37	1.60	1.45	1.47	1.39	1.40	1.38
12	Wheat Falling Number (s)	456	433	460	400	473	465	388	381
13	SKCS Hardness Index	62.0	59.8	68.6	67.1	76.2	64.4	61.1	68.6
14	Vitreous Kernels (%)	43	32	84	56	98	92	75	77
	Flour Extraction								
15	Tempered Wheat Basis (%)	68.0	69.8	70.5	70.5	64.4	65.2	72.9	69.6
16	Total Product Basis (%)	69.5	71.4	71.7	71.9	66.1	66.3	73.5	71.4
17	Flour/Bu Wheat (lb)	43.3	43.1	45.1	43.7	36.2	36.4	46.6	43.1
	Flour Quality								
18	Flour Color Brightness (*L**)	90.9	90.5	90.7	90.5	90.4	90.4	90.4	90.6
19	Flour Color Yellowness (*b**)	8.3	9.8	8.9	11.6	10.7	12.3	8.1	11.0
20	Flour Moisture (%)	13.7	13.2	12.9	13.5	13.1	13.3	13.3	13.5
21	Flour Ash (%, 14% mb)	0.50	0.47	0.51	0.50	0.47	0.47	0.42	0.45
22	Flour Falling Number (malted, s)	251	256	249	252	254	249	260	252
	Farinograph								
23	Water Absorption (%, 500 BU)	67.6	61.9	64.6	57.8	65.7	62.1	65.9	58.9
24	Water Absorption (%, 14% mb)	67.4	61.1	63.6	57.2	64.7	61.5	65.1	58.5
25	Arrival Time (min)	9.3	2.3	3.5	0.8	28.4	7.8	3.6	1.3
26	Peak Time (min)	16.8	17.4	8.7	4.1	38.6	28.4	8.8	7.2
27	Dough Stability (min)	12.0	23.5	25.5	12.2	14.2	27.8	31.1	21.4
28	Mixing Tolerance Index (MTI, BU)	33	9	8	16	29	13	14	12
29	Time To Breakdown (TTB, min)	22.0	26.8	30.2	11.5	43.6	36.6	36.2	22.6
	II. Cooperator Results								
30	Bake Absorption (Average %)	69.2	64.5	66.8	61.1	67.9	65.6	68.5	61.9
31	Loaf Volume (% of Check)		94.6		89.0		95.1		89.3

SWQC #7 – LCS Buster

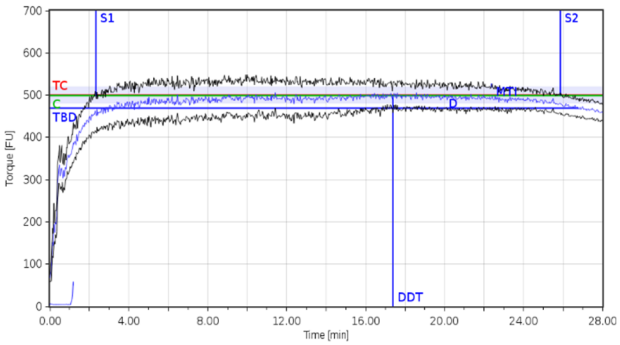
	Quality Trait	Watertown Linkert B-3	Watertown Linkert B-7	Casselton Linkert C-3	Casselton Linkert C-7	Havre LCS Rebel H-10	Havre LCS Rebel H-7	Minot LCS Rebel M-10	Minot LCS Rebel M-7
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.7	7.2	6.8	5.5	8.0	8.2	6.5	7.3
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.5	6.7	6.9	5.4	7.5	6.8	6.5	5.7
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		5.2		4.0		5.4		5.0
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.5		4.1		4.6		3.5
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.2		4.0		4.5		4.7
	III. Cooperator Evaluation								
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		3.5		1.5		5.3		1.9
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.8		4.6		5.2		3.5
	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		4.1		2.5		4.1		3.2
	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		2.7		4.5		2.9

Farinograms

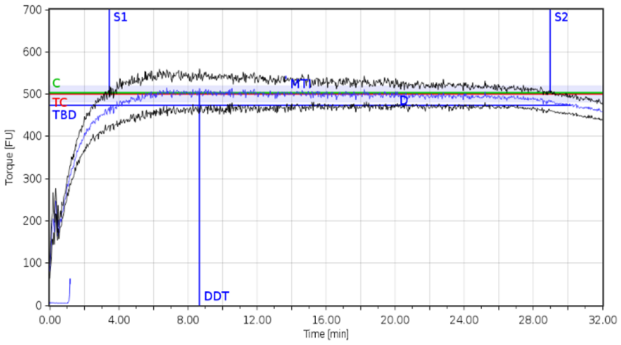
Linkert Check (Watertown, B-3)



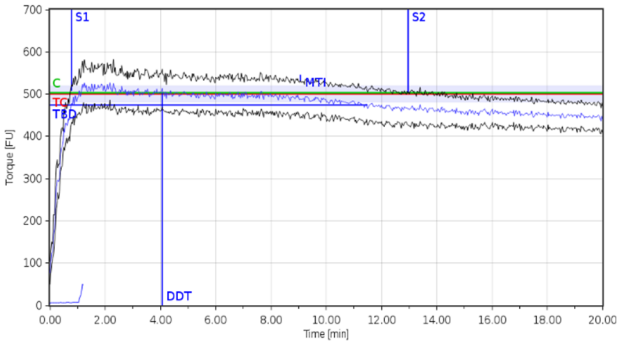
LCS Buster (Watertown, B-7)



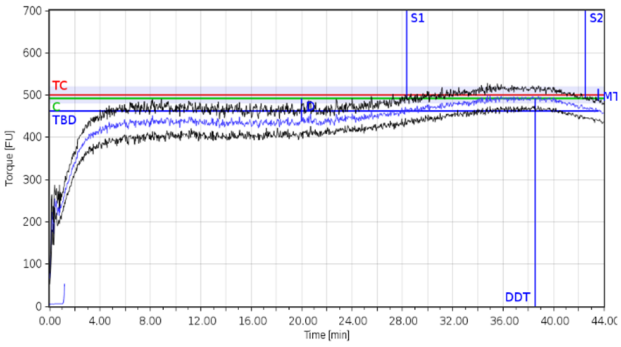
Linkert Check (Casselton, C-3)



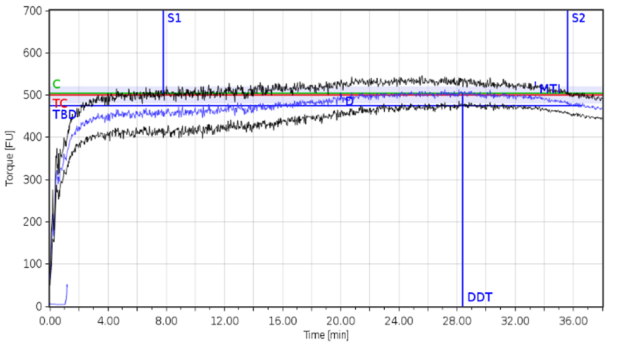
LCS Buster (Casselton, C-7)



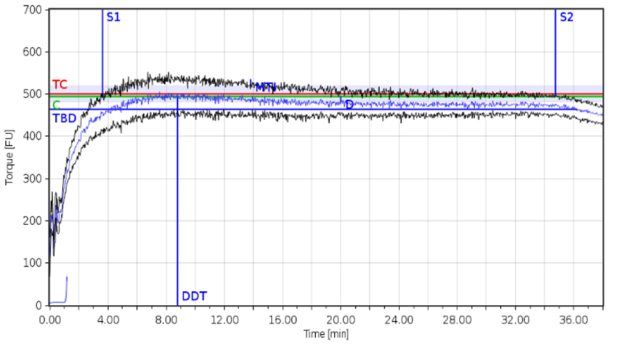
LCS Rebel Check (Havre, H-10)



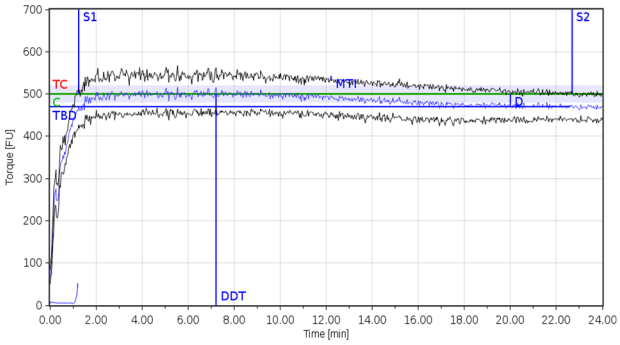
LCS Buster (Havre, H-7)



LCS Rebel Check (Minot, M-10)

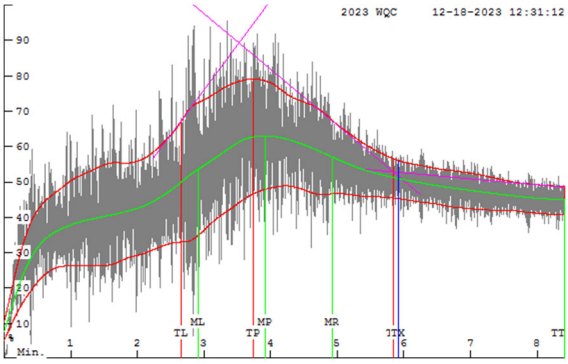


LCS Buster (Minot, M-7)

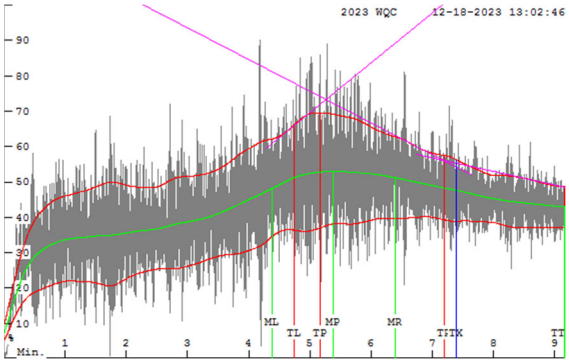


Mixograms

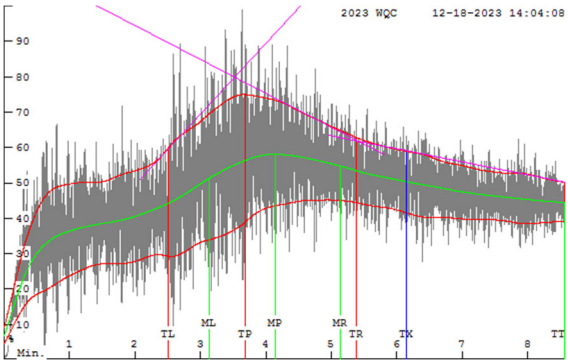
Linkert Check (Watertown, B-3)



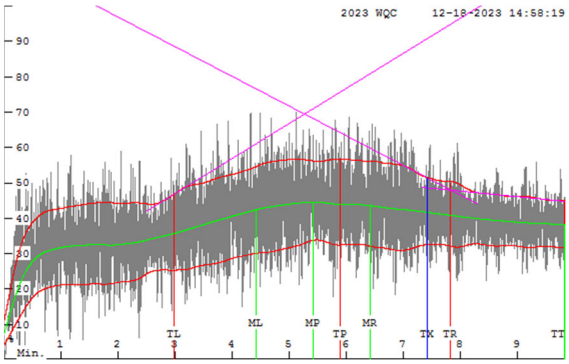
LCS Buster (Watertown, B-7)



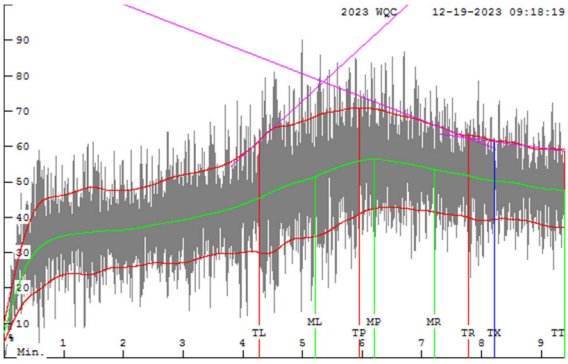
Linkert Check (Casselton, C-3)



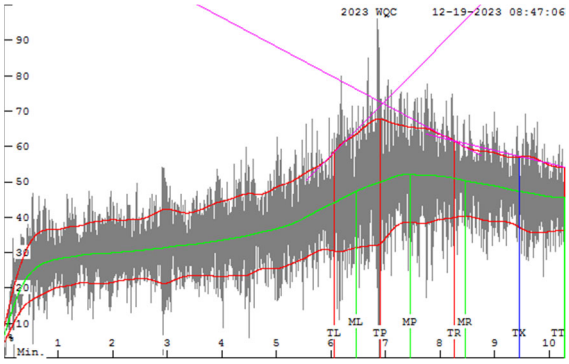
LCS Buster (Casselton, C-7)



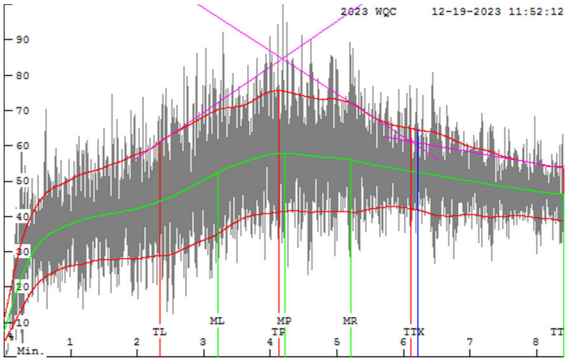
LCS Rebel Check (Havre, H-10)



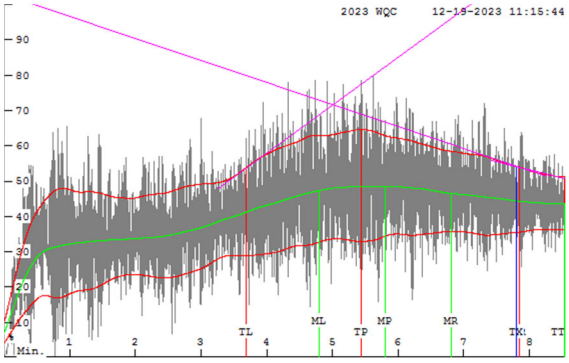
LCS Buster (Havre, H-7)



LCS Rebel Check (Minot, M-10)

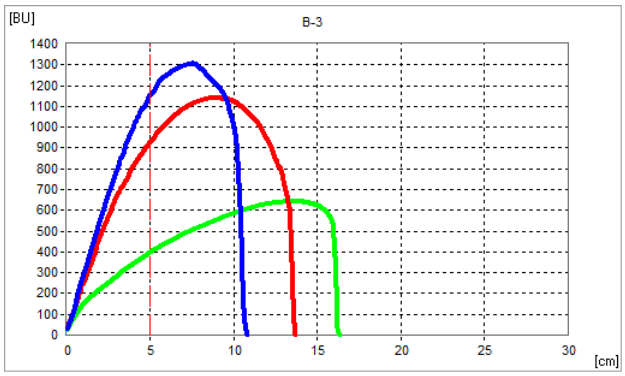


LCS Buster (Minot, M-7)

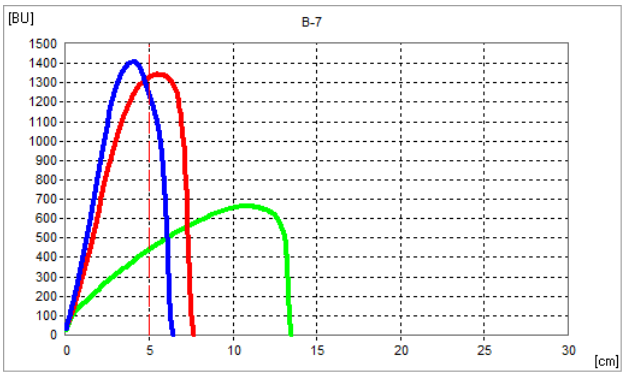


Extensograms

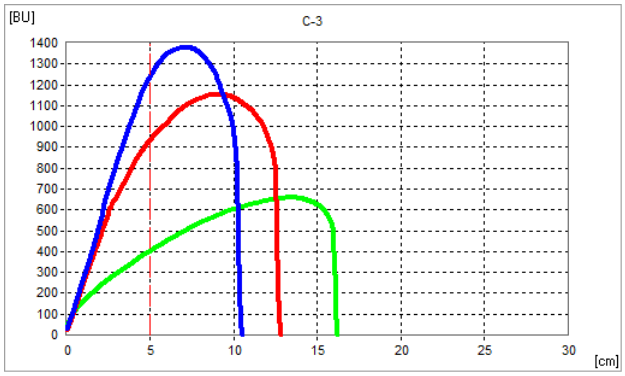
Linkert Check (Watertown, B-3)



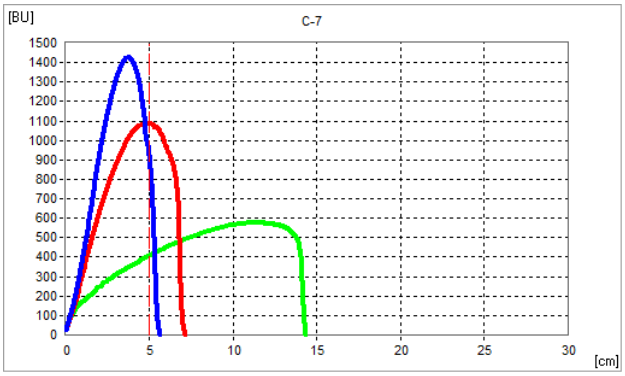
LCS Buster (Watertown, B-7)



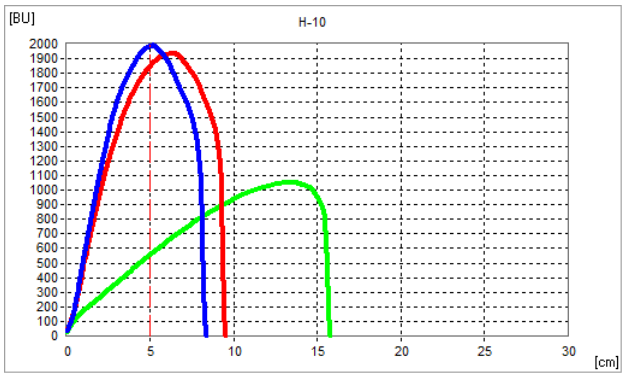
Linkert Check (Casselton, C-3)



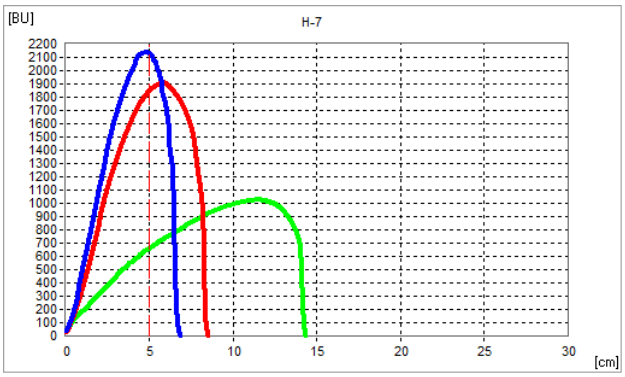
LCS Buster (Casselton, C-7)



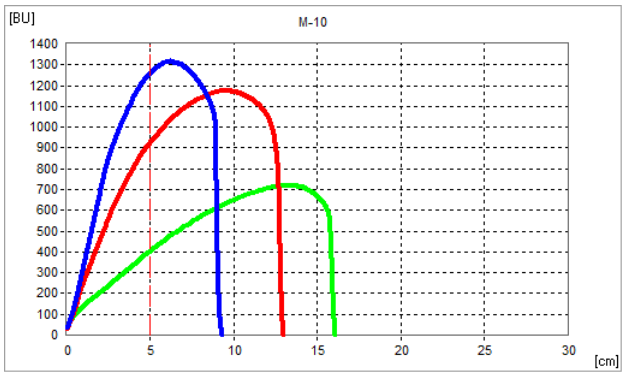
LCS Rebel Check (Havre, H-10)



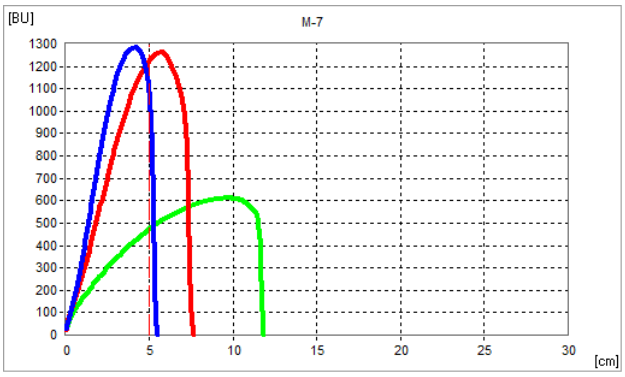
LCS Buster (Havre, H-7)



LCS Rebel Check (Minot, M-10)



LCS Buster (Minot, M-7)



45 min; 90 min; 135 min

SWQC #8 – NDHRS14-0134-C03

		Watertown		Casselton		Havre		Crookston		Minot	
		Linkert		Linkert		LCS Rebel		Linkert		LCS Rebel	
	Quality Trait	B-3	B-8	C-3	C-8	H-10	H-8	K-3	K-8	M-10	M-8
	I. USDA-ARS WQL Data										
1	Wheat Protein (%, 12% mb)	16.5	15.5	15.9	14.3	16.4	18.6	16.9	15.4	16.2	15.7
2	Flour Protein (%, 14% mb)	15.5	14.2	14.7	13.4	15.8	18.0	16.2	14.5	15.2	14.8
3	Market Value (Score 1-6)	5.6	5.0	5.6	5.0	3.5	3.4	5.2	3.9	5.6	4.9
4	Market Value (Score 1-10)	10.0	7.8	10.0	7.4	10.0	9.0	10.0	6.4	10.0	9.2
5	DON (ppm)	nd	nd	0.03	0.05	0.01	nd	0.02	0.02	0.02	0.01
6	Test Weight (lb/bu)	62.0	61.6	63.3	62.6	55.8	54.4	60.9	60.6	63.6	62.0
7	1000 Kernel Weight (g)	43.0	40.4	39.7	36.1	19.1	19.0	37.6	34.7	38.9	35.8
8	Kernel Size, Large (%)	95	89	85	71	5	3	79	72	83	72
9	Kernel Size, Small (%)	2	3	5	8	61	69	5	8	5	7
10	Wheat Moisture (%)	12.4	12.6	12.4	12.3	11.0	10.3	12.3	12.9	12.9	11.9
11	Wheat Ash (%, 14% mb)	1.53	1.36	1.60	1.45	1.47	1.55	1.68	1.47	1.40	1.36
12	Wheat Falling Number (s)	456	370	460	428	473	488	454	308	388	373
13	SKCS Hardness Index	62.0	67.4	68.6	79.6	76.2	65.9	68.1	74.8	61.1	67.7
14	Vitreous Kernels (%)	43	48	84	85	98	97	71	58	75	81
	Flour Extraction										
15	Tempered Wheat Basis (%)	68.0	65.8	70.5	68.8	64.4	61.8	68.3	64.5	72.9	69.9
16	Total Product Basis (%)	69.5	67.6	71.7	69.8	66.1	62.9	69.7	67.2	73.5	70.7
17	Flour/Bu Wheat (lb)	43.3	40.9	45.1	43.9	36.2	33.9	42.2	39.5	46.6	44.1
	Flour Quality										
18	Flour Color Brightness (*L**)	90.9	90.7	90.7	90.6	90.4	89.9	90.5	90.1	90.4	90.9
19	Flour Color Yellowness (*b**)	8.3	7.9	8.9	8.4	10.7	9.4	8.4	8.0	8.1	7.5
20	Flour Moisture (%)	13.7	13.2	12.9	13.2	13.1	13.3	13.6	13.7	13.3	13.4
21	Flour Ash (%, 14% mb)	0.50	0.43	0.51	0.46	0.47	0.45	0.47	0.47	0.42	0.43
22	Flour Falling Number (malted, s)	251	252	249	248	254	252	255	258	260	252
	Farinograph										
23	Water Absorption (%, 500 BU)	67.6	67.1	64.6	65.0	65.7	73.5	68.1	68.0	65.9	65.8
24	Water Absorption (%, 14% mb)	67.4	66.1	63.6	64.2	64.7	73.1	67.7	67.8	65.1	65.2
25	Arrival Time (min)	9.3	3.6	3.5	2.6	28.4	33.7	20.3	3.9	3.6	3.0
26	Peak Time (min)	16.8	18.0	8.7	7.6	38.6	41.5	28.4	19.6	8.8	33.4
27	Dough Stability (min)	12.0	19.5	25.5	22.6	14.2	16.1	12.9	22.5	31.1	35.7
28	Mixing Tolerance Index (MTI, BU)	33	25	8	17	29	12	26	17	14	20
29	Time To Breakdown (TTB, min)	22.0	24.1	30.2	28.5	43.6	51.6	33.8	27.4	36.2	40.0

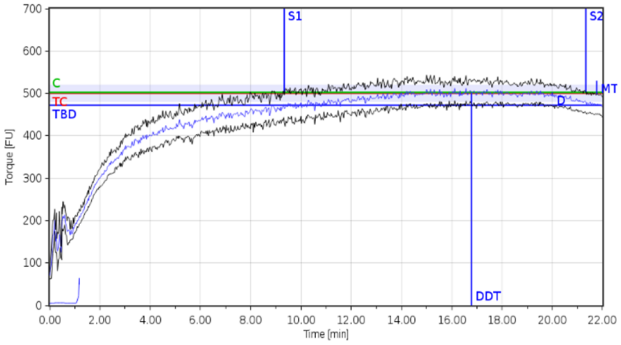
SWQC #8 – NDHRS14-0134-C03

	Quality Trait	Watertown Linkert B-3	Watertown Linkert B-8	Casselton Linkert C-3	Casselton Linkert C-8	Havre LCS Rebel H-10	Havre LCS Rebel H-8	Crookston Linkert K-3	Crookston Linkert K-8	Minot LCS Rebel M-10	Minot LCS Rebel M-8
	II. Cooperator Results										
30	Bake Absorption (Average %)	69.2	68.7	66.8	67.0	67.9	74.4	69.5	69.7	68.5	68.0
31	Loaf Volume (% of Check)		97.0		99.0		98.7		95.5		100.1
32	Mixing Requirement*	6.7	6.8	6.8	6.5	8.0	8.1	7.2	6.8	6.5	7.4
33	Dough Characteristics**	6.5	6.5	6.9	6.5	7.5	7.6	6.9	6.4	6.5	6.5
34	Mixing Tolerance†		5.4		4.8		5.8		4.8		6.4
35	Internal Crumb Color††		5.1		5.4		5.1		4.8		5.0
36	Internal Crumb Texture‡		5.3		5.2		4.7		4.5		5.3
	III. Cooperator Evaluation‡										
	Quality Traits 1-2: Protein		4.2		3.7		6.9		4.0		4.5
	Quality Traits 3-22: Milling		4.0		3.7		3.0		3.4		3.5
	Quality Traits 23-36: Baking		4.6		4.8		4.9		4.3		5.1
	Quality Traits 1-36: Overall Comparison		4.4		4.5		4.9		3.6		4.4

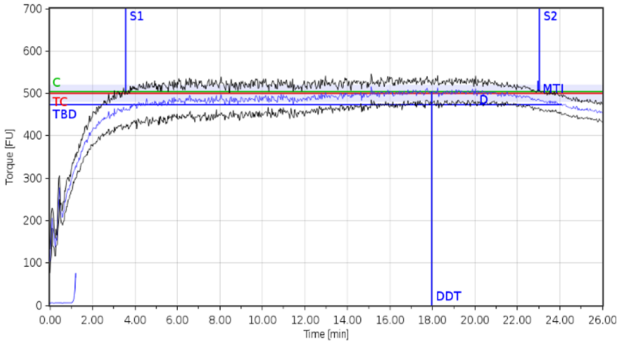
*9 = Very long; 7 = Long; 5 = Medium; 3 = Short; 1 = Very short.
**9 = Bucky – Tough; 7 = Strong – Elastic; 5 = Medium – Pliable; 3 = Mellow – Very Pliable; 1 = Weak – Short or Sticky.
†9 = Much More Tolerance Than Check; 7 = More Tolerance Than Check; 5 = Tolerance Equivalent To Check; 3 = Less Tolerance Than Check; 1 = Much Less Tolerance Than Check.
††9 = Much Brighter Than Check; 7 = Brighter Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.
‡9 = Much Better Than Check; 7 = Better Than Check; 5 = Equivalent To Check; 3 = Poorer Than Check; 1 = Much Poorer Than Check.

Farinograms

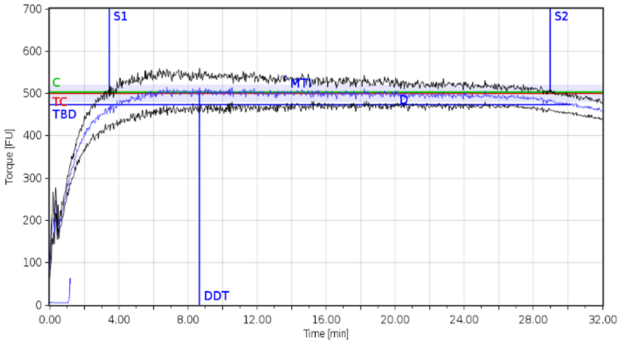
Linkert Check (Watertown, B-3)



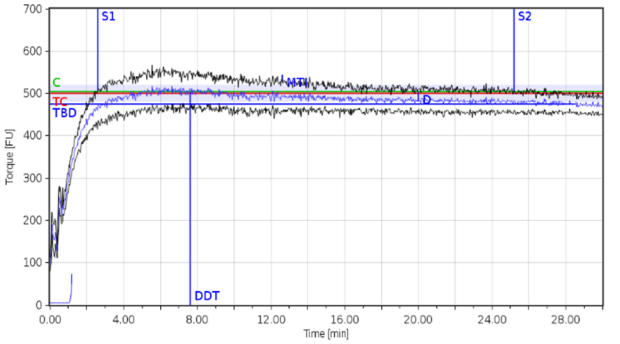
NDHRS14-0134-C03 (Watertown, B-8)



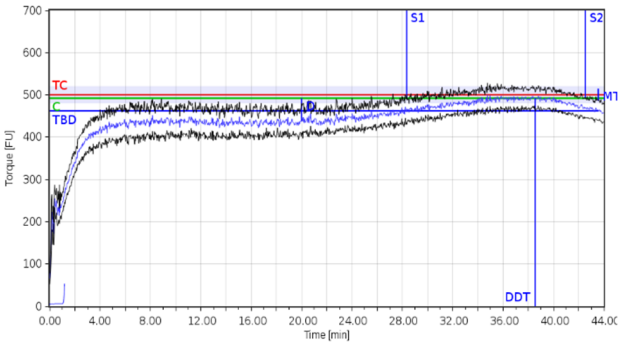
Linkert Check (Casselton, C-3)



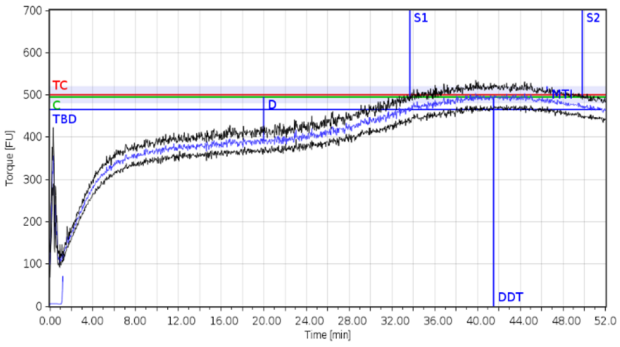
NDHRS14-0134-C03 (Casselton, C-8)



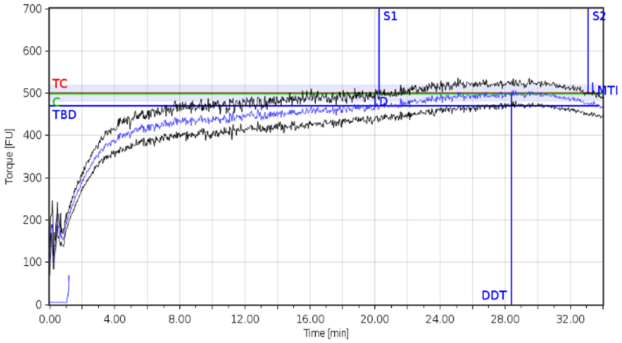
LCS Rebel Check (Havre, H-10)



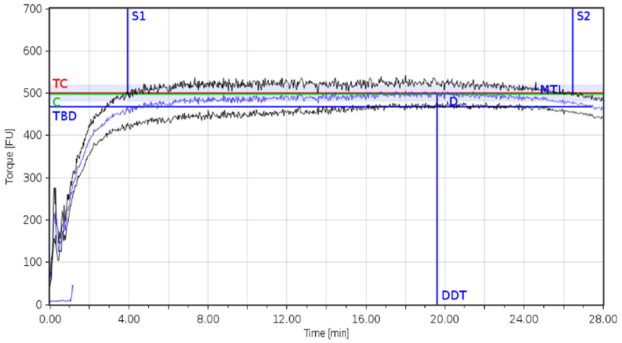
NDHRS14-0134-C03 (Havre, H-8)



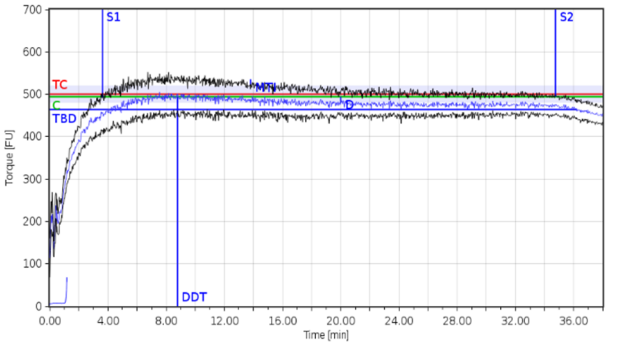
Linkert Check (Crookston, K-3)



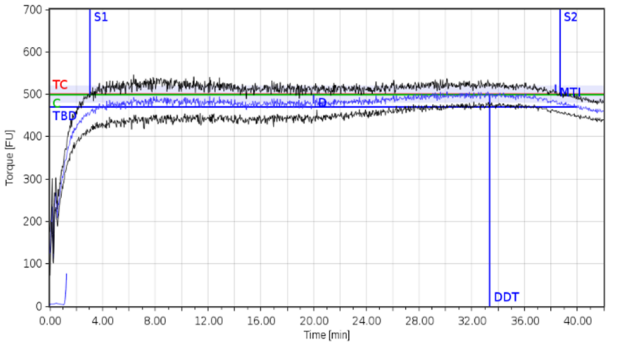
NDHRS14-0134-C03 (Crookston, K-8)



LCS Rebel (Minot, M-10)

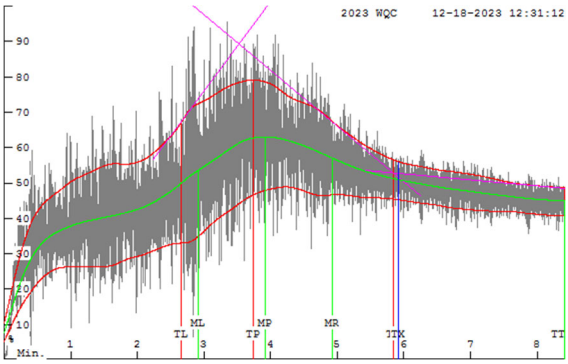


NDHRS14-0134-C03 (Minot, M-8)

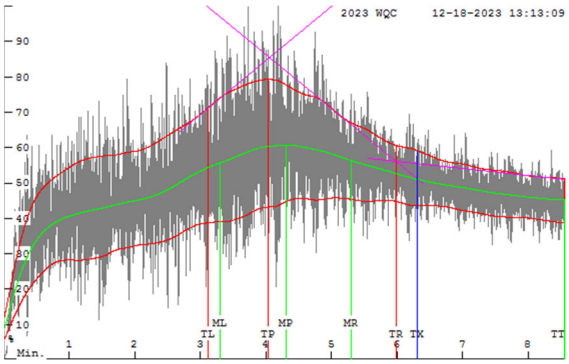


Mixograms

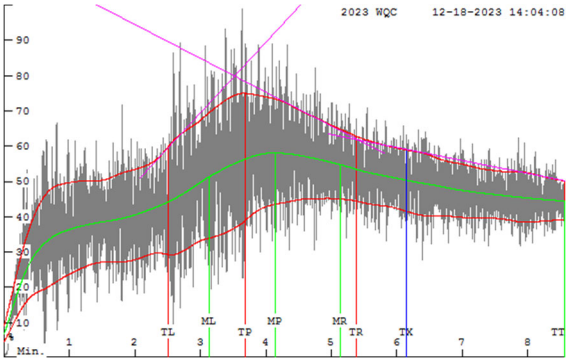
Linkert Check (Watertown, B-3)



NDHRS14-0134-C03 (Watertown, B-8)



Linkert Check (Casselton, C-3)



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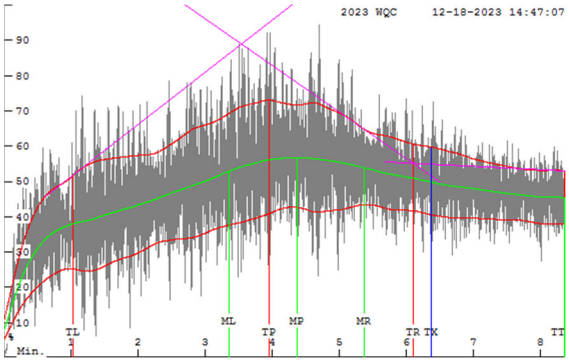

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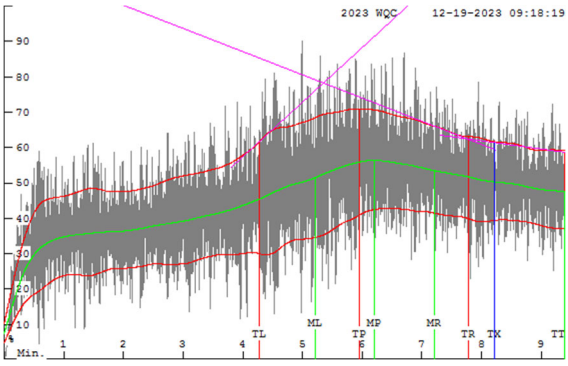

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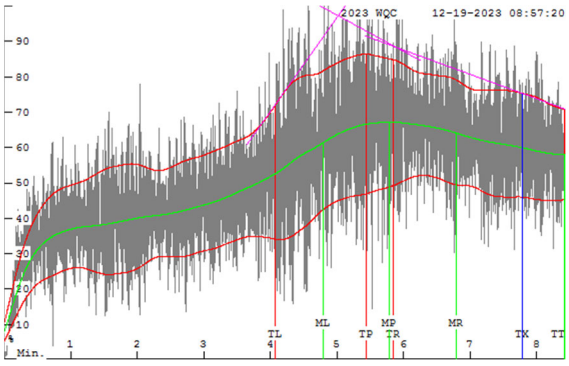

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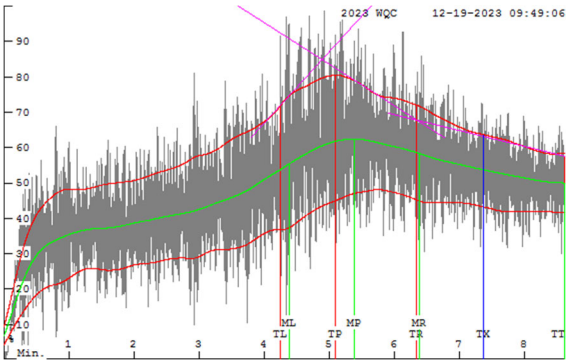

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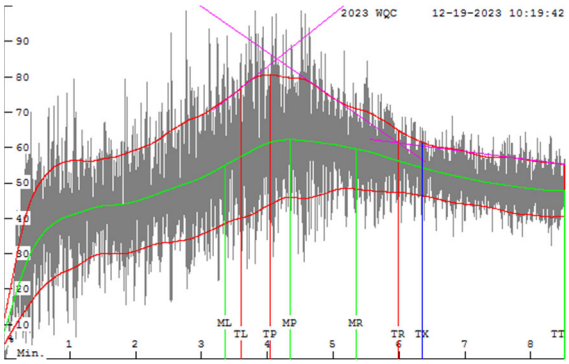

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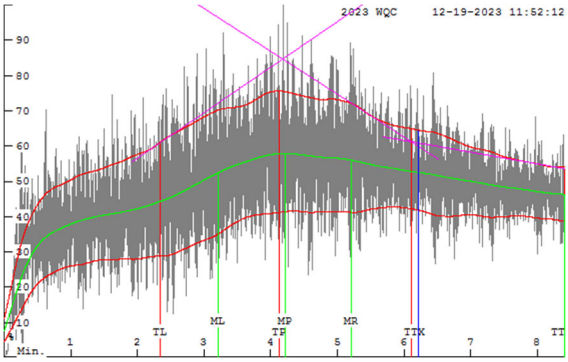

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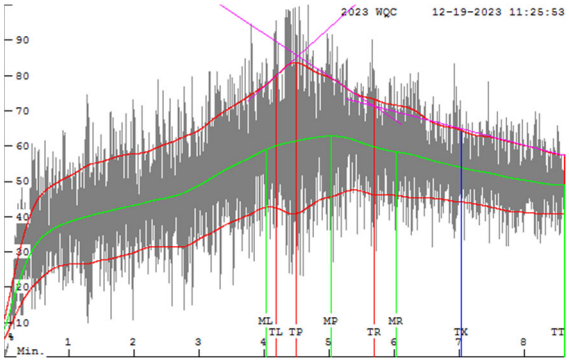
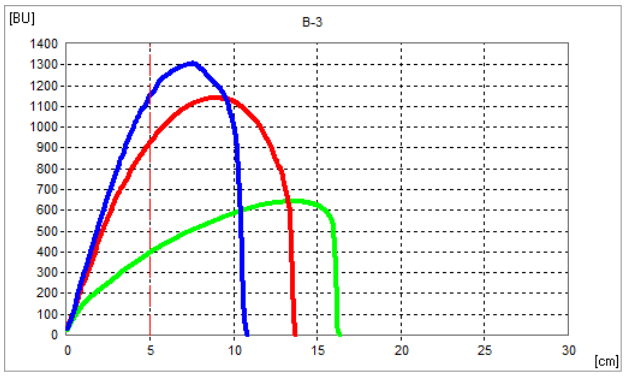


Extensograms

Linkert Check (Watertown, B-3)



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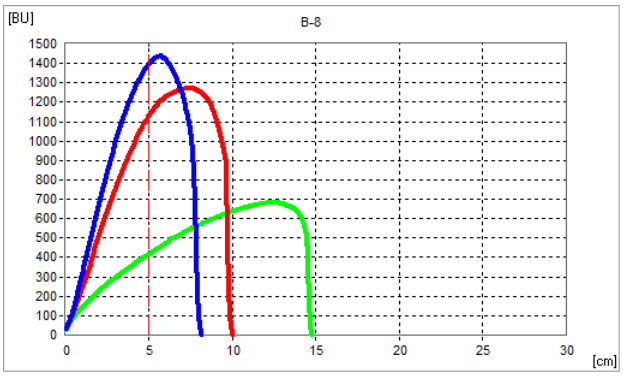

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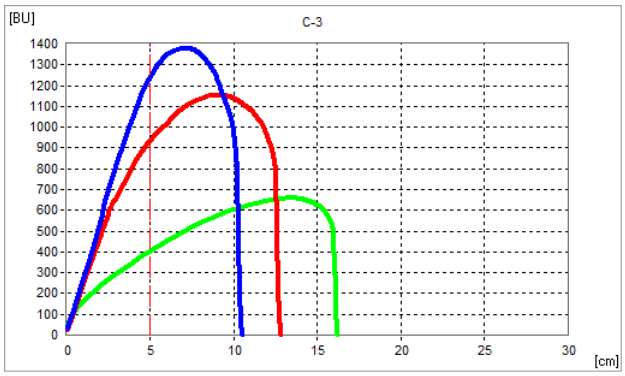

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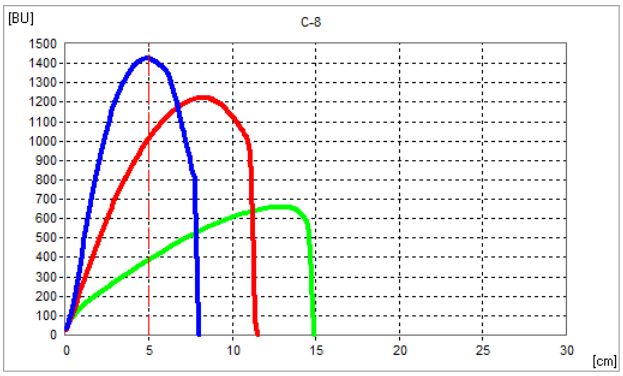
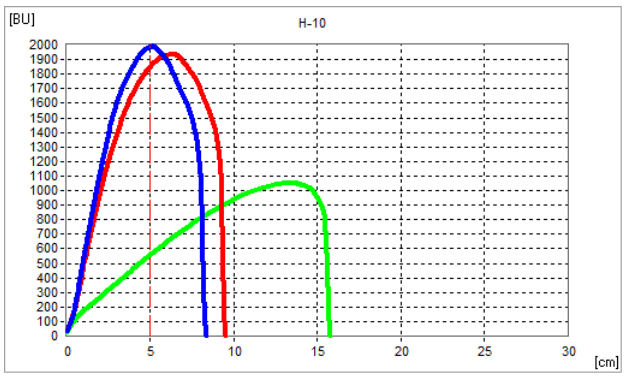


LCS Rebel Check (Havre, H-10)



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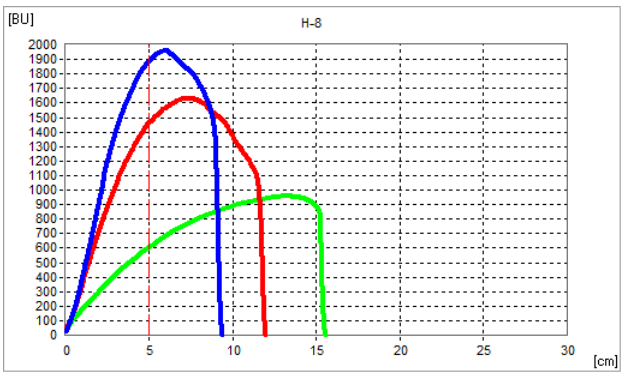
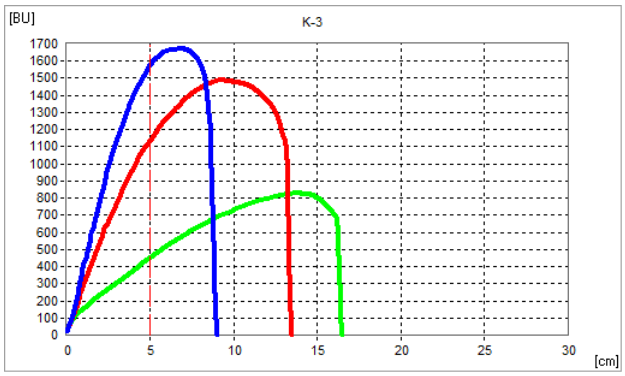


45 min; 90 min; 135 min

Linkert Check (Crookston, K-3)



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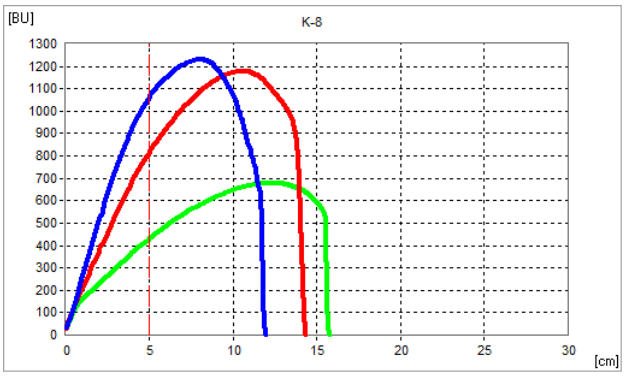

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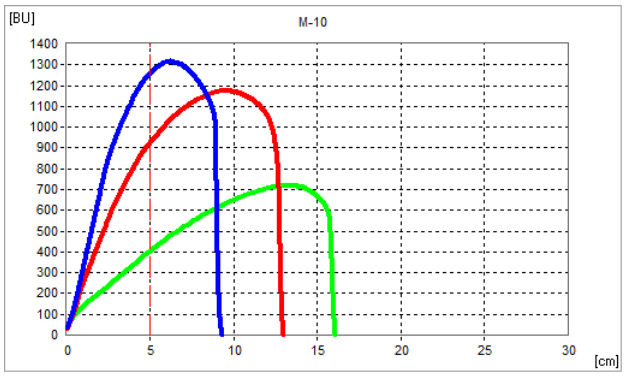

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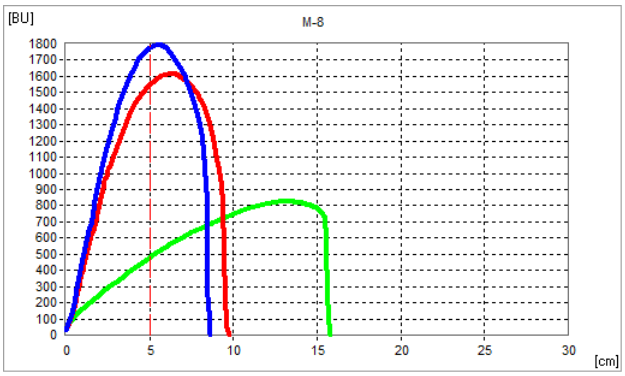


45 min; 90 min; 135 min

SWQC #9 – MT 2030

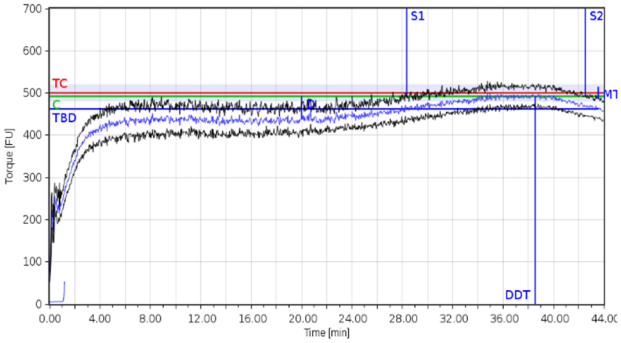
		Havre		Minot	
		LCS Rebel		LCS Rebel	
	Quality Trait	H-10	H-9	M-10	M-9
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	16.4	17.2	16.2	15.7
2	Flour Protein (%, 14% mb)	15.8	16.4	15.2	14.7
3	Market Value (Score 1-6)	3.5	3.7	5.6	5.3
4	Market Value (Score 1-10)	10.0	10.0	10.0	9.2
5	DON (ppm)	0.01	0.01	0.02	0.03
6	Test Weight (lb/bu)	55.8	55.7	63.6	62.5
7	1000 Kernel Weight (g)	19.1	22.3	38.9	37.0
8	Kernel Size, Large (%)	5	8	83	81
9	Kernel Size, Small (%)	61	42	5	6
10	Wheat Moisture (%)	11.0	10.3	12.9	12.6
11	Wheat Ash (%, 14% mb)	1.47	1.48	1.40	1.61
12	Wheat Falling Number (s)	473	498	388	430
13	SKCS Hardness Index	76.2	72.1	61.1	64.6
14	Vitreous Kernels (%)	98	91	75	76
	Flour Extraction				
15	Tempered Wheat Basis (%)	64.4	64.8	72.9	70.6
16	Total Product Basis (%)	66.1	66.4	73.5	72.4
17	Flour/Bu Wheat (lb)	36.2	36.5	46.6	44.7
	Flour Quality				
18	Flour Color Brightness (*L**)	90.4	90.0	90.4	90.8
19	Flour Color Yellowness (*b**)	10.7	9.6	8.1	8.4
20	Flour Moisture (%)	13.1	13.4	13.3	13.7
21	Flour Ash (%, 14% mb)	0.47	0.43	0.42	0.47
22	Flour Falling Number (malted, s)	254	257	260	264
	Farinograph				
23	Water Absorption (%, 500 BU)	65.7	66.9	65.9	63.7
24	Water Absorption (%, 14% mb)	64.7	66.3	65.1	63.5
25	Arrival Time (min)	28.4	9.3	3.6	4.0
26	Peak Time (min)	38.6	18.0	8.8	11.0
27	Dough Stability (min)	14.2	12.9	31.1	19.6
28	Mixing Tolerance Index (MTI, BU)	29	32	14	9
29	Time To Breakdown (TTB, min)	43.6	23.1	36.2	24.7
	II. Cooperator Results				
30	Bake Absorption (Average %)	67.9	68.8	68.5	66.7
31	Loaf Volume (% of Check)		98.5		99.1

SWQC #9 – MT 2030

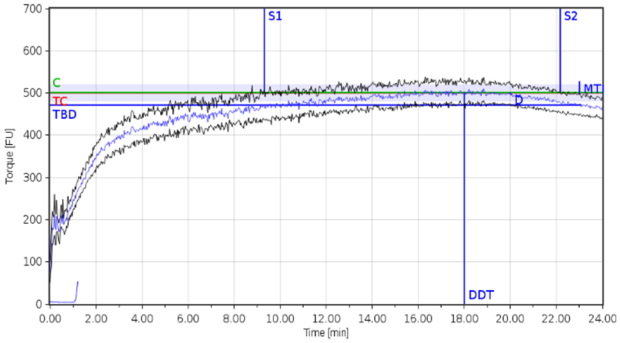
	Quality Trait	Havre LCS Rebel H-10	Havre H-9	Minot LCS Rebel M-10	Minot M-9
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	8.0	6.3	6.5	6.2
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	7.5	6.9	6.5	5.8
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		3.5		4.6
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.1		5.0
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.5		5.0
	III. Cooperator Evaluation				
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.4		4.5
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.9		4.0
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.0		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		5.1		4.3

Farinograms

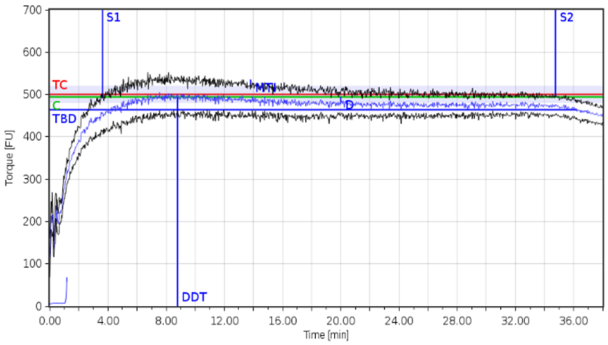
LCS Rebel Check (Havre, H-10)



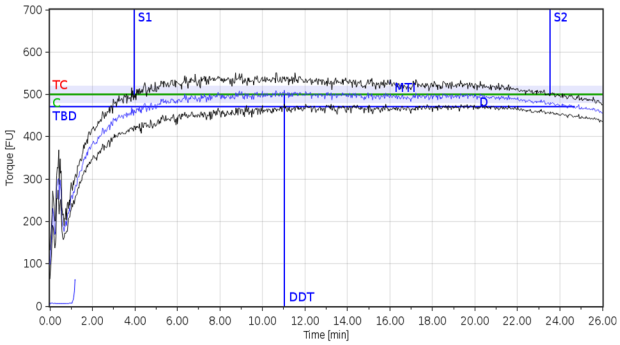
MT 2030 (Havre, H-9)



LCS Rebel Check (Minot, M-10)

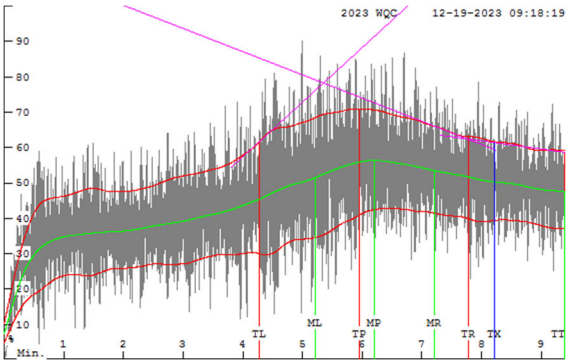


MT 2030 (Minot, M-9)



Mixograms

LCS Rebel Check (Havre, H-10)



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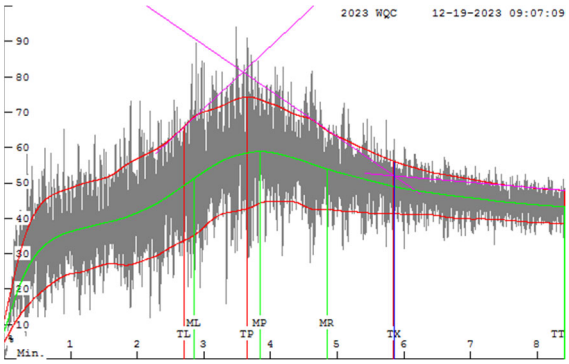
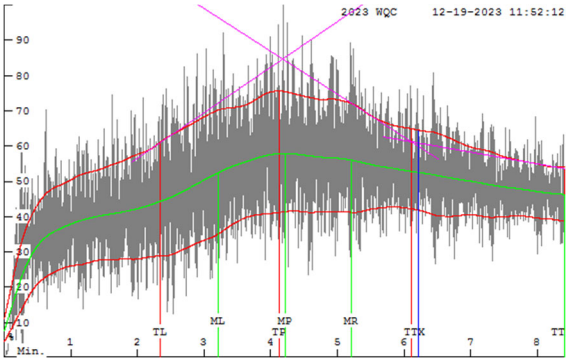
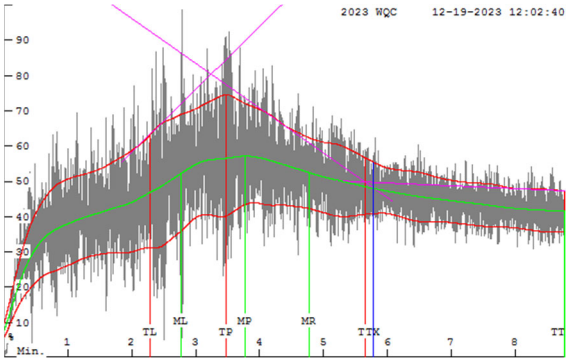


LCS Rebel Check (Minot, M-10)

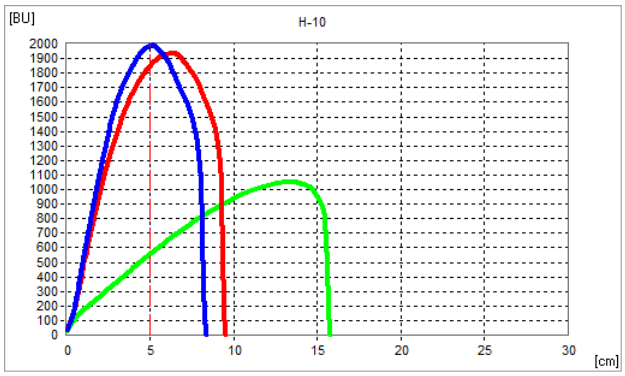


MT 2030 (Minot, M-9)



Extensograms

LCS Rebel Check (Havre, H-10)



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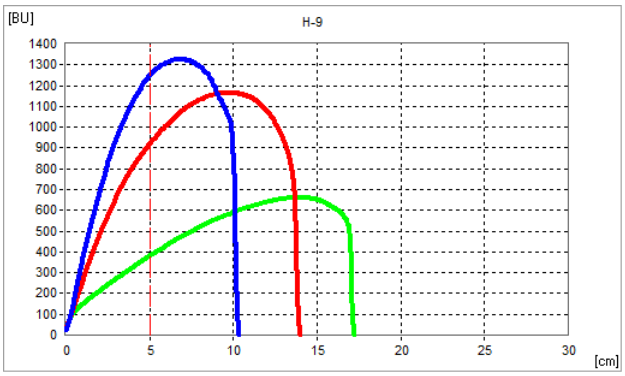

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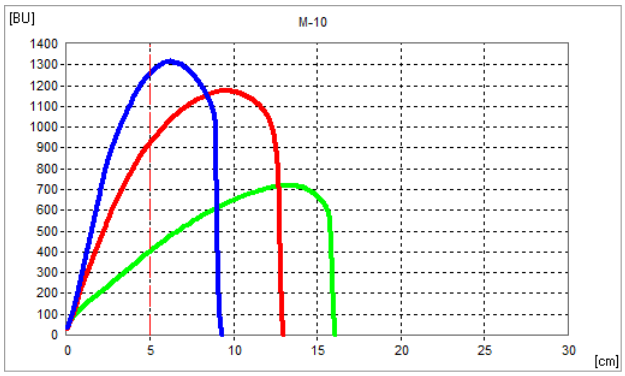

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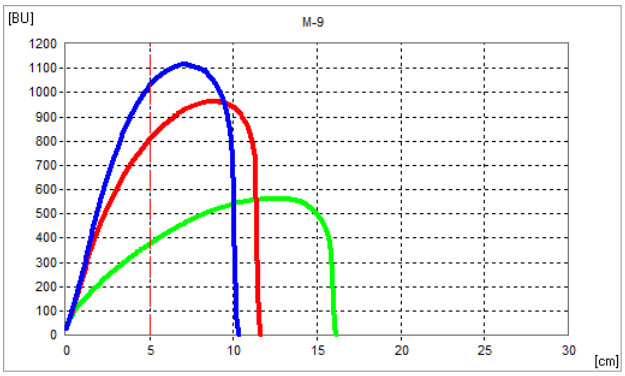

45 min; 90 min; 135 min

Appendix

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Wheat Market Value Score

The development of a Wheat Market Value Score (WMS) or Export Market Value Score was discussed at the Hard Spring Wheat Planning Meeting in March, 2004. The purpose for developing a WMS was to facilitate a better understanding of wheat quality in marketing systems. Two WMS methods were developed and tested. For each method, the quality variables of Test Weight (TW), 1000 Kernel Weight (KWT), Falling Number (FN), Wheat Protein (WP), and Wheat Ash (WA) were incorporated for calculating the WMS.

Method #1 was developed on a scale of 0 to 6 where the Check (i.e. Linkert, LCS Rebel) is evaluated along with the experimental lines for each growing location. Method #2 was developed on a scale of 0 to 10 where the experimental lines is evaluated against the Check for each growing location.

Wheat Market Value Score – Method #1

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

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

Wheat Market Value Score – Method #2

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

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

Miag Mill Streams

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

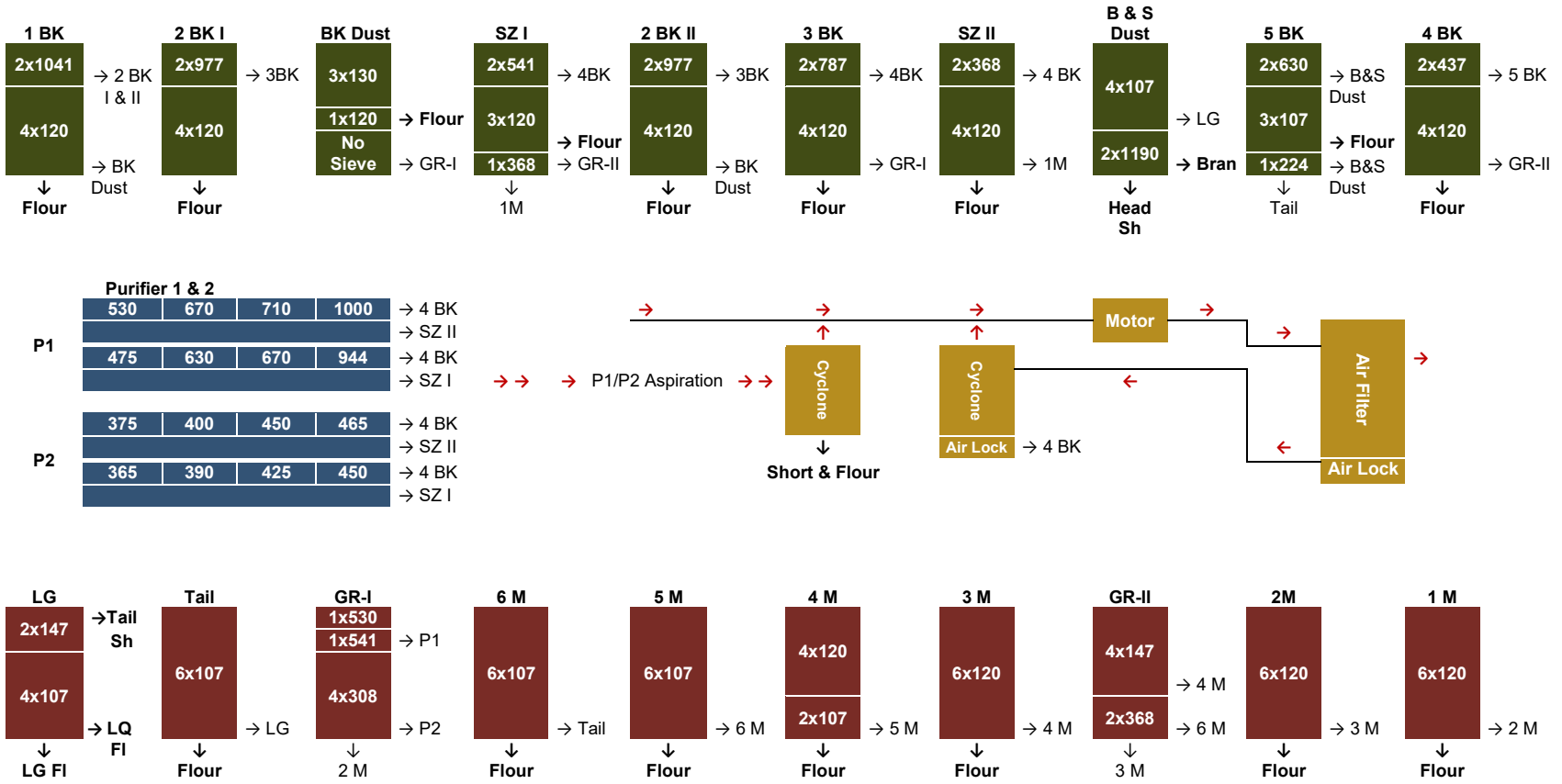
*Tail Cyclone fraction was separated into flour and shorts by rebolting.

Calculation of flour extraction:

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

Miag Multomat Mill Flow Chart

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



Sieve Opening Size - µm

Wheat Kernel Characteristics by Location

Location	ID	Entry	Wheat Market Value Score 1-6	Wheat Market Value Score 1-10	Test Weight (lb/bu)	1000 Kernel Weight (g)	Kernel Size Large (%)	Kernel Size Small (%)	Vitreous Kernels (%)	SKCS Hardness Index	Moisture (%)	Protein (%, 12% mb)	Ash (%, 14% mb)	Falling Number (s)	DON (ppm)
Watertown	B-2	SD4930	4.9	7.0	61.2	38.6	86	4	37	58.5	12.5	14.7	1.42	407	nd
	B-3	**Linkert**	**5.6**	**10.0**	**62.0**	**43.0**	**95**	**2**	**43**	**62.0**	**12.4**	**16.5**	**1.53**	**456**	**nd**
	B-5	LCS Boom	5.8	9.2	63.1	40.7	88	3	46	60.2	12.4	16.4	1.42	409	nd
	B-6	LCS Cannon	5.6	8.8	63.3	39.9	89	4	39	62.3	12.5	16.2	1.39	387	nd
	B-7	LCS Buster	5.1	8.2	61.3	41.9	91	2	32	59.8	12.5	14.7	1.37	433	nd
	B-8	NDHRS14-0134-C03	5.0	7.8	61.6	40.4	89	3	48	67.4	12.6	15.5	1.36	370	nd
Casselton	C-1	NDHRS14-0134-C09	4.6	7.0	61.7	34.2	67	10	78	78.4	12.6	14.1	1.46	435	0.07
	C-2	SD4930	4.1	5.2	62.4	33.3	72	10	77	66.9	13.0	13.6	1.54	383	0.09
	C-3	**Linkert**	**5.6**	**10.0**	**63.3**	**39.7**	**85**	**5**	**84**	**68.6**	**12.4**	**15.9**	**1.60**	**460**	**0.03**
	C-5	LCS Boom	5.5	9.6	63.9	38.7	80	7	69	67.6	12.9	15.5	1.44	416	0.01
	C-6	LCS Cannon	5.1	8.6	63.8	37.8	84	5	70	66.4	13.2	14.9	1.42	395	0.01
	C-7	LCS Buster	3.8	5.4	61.3	35.9	69	8	56	67.1	12.4	11.9	1.45	400	0.01
	C-8	NDHRS14-0134-C03	5.0	7.4	62.6	36.1	71	8	85	79.6	12.3	14.3	1.45	428	0.05
Havre	H-4	MT 2063	3.4	9.4	55.2	20.6	9	50	95	66.1	10.9	17.2	1.65	426	0.01
	H-5	LCS Boom	3.5	10.0	55.7	20.1	3	60	98	73.6	11.0	16.6	1.52	471	0.01
	H-6	LCS Cannon	3.6	10.0	56.8	21.3	7	50	98	66.1	10.5	18.1	1.50	534	0.01
	H-7	LCS Buster	3.8	9.6	55.4	23.5	4	40	92	64.4	10.5	16.7	1.39	465	nd
	H-8	NDHRS14-0134-C03	3.4	9.0	54.4	19.0	3	69	97	65.9	10.3	18.6	1.55	488	nd
	H-9	MT 2030	3.7	10.0	55.7	22.3	8	42	91	72.1	10.3	17.2	1.48	498	0.01
	H-10	**LCS Rebel**	**3.5**	**10.0**	**55.8**	**19.1**	**5**	**61**	**98**	**76.2**	**11.0**	**16.4**	**1.47**	**473**	**0.01**
Crookston	K-1	NDHRS14-0134-C09	4.0	6.2	60.6	31.7	65	9	69	77.9	12.5	14.9	1.45	366	0.06
	K-2	SD4930	4.1	5.8	61.1	33.9	76	8	48	62.8	12.5	14.2	1.51	384	nd
	K-3	**Linkert**	**5.2**	**10.0**	**60.9**	**37.6**	**79**	**5**	**71**	**68.1**	**12.3**	**16.9**	**1.68**	**454**	**0.02**
	K-5	LCS Boom	4.8	7.6	62.4	35.6	75	7	56	66.0	13.1	15.5	1.51	372	nd
	K-6	LCS Cannon	4.4	6.4	62.4	35.4	71	9	52	68.0	13.1	15.5	1.48	324	nd
	K-8	NDHRS14-0134-C03	3.9	6.4	60.6	34.7	72	8	58	74.8	12.9	15.4	1.47	308	0.02
Minot	M-1	NDHRS14-0134-C09	4.5	6.2	61.4	32.8	59	10	76	71.3	12.7	14.6	1.20	397	0.01
	M-4	MT 2063	4.6	7.2	60.9	34.2	68	6	74	60.7	12.4	15.0	1.39	399	0.06
	M-5	LCS Boom	5.2	9.6	63.1	35.4	75	6	67	63.0	12.5	15.8	1.28	375	nd
	M-6	LCS Cannon	5.1	9.0	63.2	36.0	79	5	71	64.6	12.2	15.7	1.30	366	0.02
	M-7	LCS Buster	3.9	5.8	61.3	35.8	69	8	77	68.6	12.7	12.8	1.38	381	0.01
	M-8	NDHRS14-0134-C03	4.9	9.2	62.0	35.8	72	7	81	67.7	11.9	15.7	1.36	373	0.01
	M-9	MT 2030	5.3	9.2	62.5	37.0	81	6	76	64.6	12.6	15.7	1.61	430	0.03
	M-10	**LCS Rebel**	**5.6**	**10.0**	**63.6**	**38.9**	**83**	**5**	**75**	**61.1**	**12.9**	**16.2**	**1.40**	**388**	**0.02**

Flour Characteristics by Location

Location	ID	Entry	Extraction*			Color			Moisture	Protein	Ash	Wet Gluten	Gluten	Falling Number
			TWB (%)	TPB (%)	Flour/bu Wheat (lb)	*L**	*a**	*b**	(%)	(%, 14% mb)	(%, 14% mb)	(%)	Index	(Malted, s)
Watertown	B-2	SD4930	72.8	74.6	45.0	90.8	-1.21	9.6	13.3	13.6	0.48	36.0	95	250
	B-3	**Linkert**	**68.0**	**69.5**	**43.3**	**90.9**	**-0.71**	**8.3**	**13.7**	**15.5**	**0.50**	**41.7**	**96**	**251**
	B-5	LCS Boom	70.1	73.2	44.4	90.5	-0.75	8.6	12.7	15.1	0.51	44.0	84	252
	B-6	LCS Cannon	70.1	71.6	45.0	90.6	-0.74	8.7	13.6	15.0	0.47	42.4	88	251
	B-7	LCS Buster	69.8	71.4	43.1	90.5	-1.05	9.8	13.2	13.5	0.47	35.0	98	256
	B-8	NDHRS14-0134-C03	65.8	67.6	40.9	90.7	-0.64	7.9	13.2	14.2	0.43	39.6	96	252
Casselton	C-1	NDHRS14-0134-C09	70.0	72.0	44.2	90.7	-0.64	8.4	13.6	12.8	0.49	33.9	96	248
	C-2	SD4930	70.3	72.0	44.0	90.9	-1.46	11.0	13.3	12.4	0.46	32.9	96	262
	C-3	**Linkert**	**70.5**	**71.7**	**45.1**	**90.7**	**-0.78**	**8.9**	**12.9**	**14.7**	**0.51**	**38.5**	**96**	**249**
	C-5	LCS Boom	69.1	70.5	45.3	90.5	-0.98	9.8	13.9	14.4	0.48	40.8	83	253
	C-6	LCS Cannon	71.0	72.1	46.0	90.3	-0.98	9.9	13.4	13.8	0.48	38.6	90	258
	C-7	LCS Buster	70.5	71.9	43.7	90.5	-1.51	11.6	13.5	10.9	0.50	26.1	98	252
	C-8	NDHRS14-0134-C03	68.8	69.8	43.9	90.6	-0.72	8.4	13.2	13.4	0.46	35.2	98	248
Havre	H-4	MT 2063	66.5	67.2	36.9	90.2	-0.89	11.0	13.1	16.8	0.47	41.8	94	254
	H-5	LCS Boom	63.8	64.9	35.9	90.5	-1.06	10.7	13.4	15.9	0.48	42.2	96	256
	H-6	LCS Cannon	66.4	67.7	38.0	90.3	-0.92	10.8	13.3	17.5	0.45	44.2	97	255
	H-7	LCS Buster	65.2	66.3	36.4	90.4	-1.46	12.3	13.3	16.1	0.47	38.6	97	249
	H-8	NDHRS14-0134-C03	61.8	62.9	33.9	89.9	-0.41	9.4	13.3	18.0	0.45	45.0	97	252
	H-9	MT 2030	64.8	66.4	36.5	90.0	-0.39	9.6	13.4	16.4	0.43	45.6	87	257
	H-10	**LCS Rebel**	**64.4**	**66.1**	**36.2**	**90.4**	**-1.05**	**10.7**	**13.1**	**15.8**	**0.47**	**40.8**	**97**	**254**
Crookston	K-1	NDHRS14-0134-C09	67.8	68.7	41.4	90.1	-0.54	8.4	13.2	13.9	0.47	37.7	91	255
	K-2	SD4930	72.4	73.7	44.9	90.8	-1.47	11.0	13.8	13.3	0.41	34.1	96	249
	K-3	**Linkert**	**68.3**	**69.7**	**42.2**	**90.5**	**-0.60**	**8.4**	**13.6**	**16.2**	**0.47**	**41.8**	**98**	**255**
	K-5	LCS Boom	69.4	70.9	43.6	90.1	-0.90	9.4	13.7	14.7	0.48	41.0	90	254
	K-6	LCS Cannon	70.7	72.6	44.5	90.2	-0.84	9.2	13.8	14.6	0.48	39.9	93	254
	K-8	NDHRS14-0134-C03	64.5	67.2	39.5	90.1	-0.58	8.0	13.7	14.5	0.47	38.5	96	258
Minot	M-1	NDHRS14-0134-C09	70.4	71.6	43.8	91.1	-0.62	7.7	13.8	13.8	0.40	36.6	97	251
	M-4	MT 2063	70.3	71.8	43.4	90.9	-0.87	8.8	13.6	14.1	0.43	34.7	98	256
	M-5	LCS Boom	70.8	71.9	45.2	90.8	-0.89	8.9	13.5	14.8	0.42	41.3	90	258
	M-6	LCS Cannon	69.8	71.7	45.1	90.8	-0.84	9.0	13.9	14.7	0.40	39.9	94	251
	M-7	LCS Buster	69.6	71.4	43.1	90.6	-1.43	11.0	13.5	11.8	0.45	28.6	99	252
	M-8	NDHRS14-0134-C03	69.9	70.7	44.1	90.9	-0.56	7.5	13.4	14.8	0.43	38.6	98	252
	M-9	MT 2030	70.6	72.4	44.7	90.8	-0.52	8.4	13.7	14.7	0.47	41.1	91	264
	M-10	**LCS Rebel**	**72.9**	**73.5**	**46.6**	**90.4**	**-0.65**	**8.1**	**13.3**	**15.2**	**0.42**	**40.7**	**94**	**260**

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

Farinograph Characteristics by Location

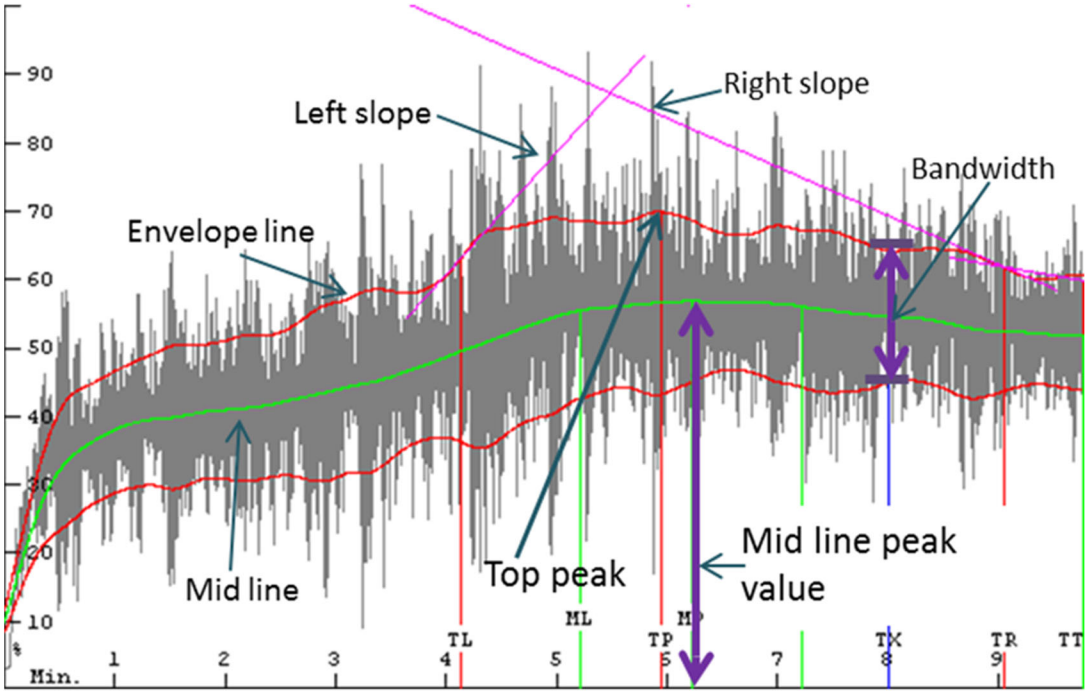
Location	ID	Entry	Water Absorption (%, 500 BU)	Water Absorption (%, 14% mb)	Arrival Time (min)	Peak Time (min)	Dough Stability (min)	MTI* (BU)	TTB* (min)
Watertown	B-2	SD4930	61.1	60.3	2.6	13.7	19.4	16	22.6
	B-3	**Linkert**	**67.6**	**67.4**	**9.3**	**16.8**	**12.0**	**33**	**22.0**
	B-5	LCS Boom	67.0	65.6	4.9	9.8	11.5	15	17.2
	B-6	LCS Cannon	65.5	65.1	4.6	12.1	13.7	15	18.7
	B-7	LCS Buster	61.9	61.1	2.3	17.4	23.5	9	26.8
	B-8	NDHRS14-0134-C03	67.1	66.1	3.6	18.0	19.5	25	24.1
Casselton	C-1	NDHRS14-0134-C09	64.2	63.8	2.4	6.3	8.9	36	11.8
	C-2	SD4930	58.5	57.9	1.9	6.1	13.9	27	13.7
	C-3	**Linkert**	**64.6**	**63.6**	**3.5**	**8.7**	**25.5**	**8**	**30.2**
	C-5	LCS Boom	65.1	65.1	4.0	6.9	11.4	22	16.7
	C-6	LCS Cannon	65.2	64.6	3.7	8.1	12.7	24	17.5
	C-7	LCS Buster	57.8	57.2	0.8	4.1	12.2	16	11.5
	C-8	NDHRS14-0134-C03	65.0	64.2	2.6	7.6	22.6	17	28.5
Havre	H-4	MT 2063	66.5	65.5	30.4	34.6	10.5	18	41.8
	H-5	LCS Boom	64.1	63.5	6.1	30.3	30.9	14	37.6
	H-6	LCS Cannon	68.1	67.5	27.3	34.6	17.6	8	45.9
	H-7	LCS Buster	62.1	61.5	7.8	28.4	27.8	13	36.6
	H-8	NDHRS14-0134-C03	73.5	73.1	33.7	41.5	16.1	12	51.6
	H-9	MT 2030	66.9	66.3	9.3	18.0	12.9	32	23.1
	H-10	**LCS Rebel**	**65.7**	**64.7**	**28.4**	**38.6**	**14.2**	**29**	**43.6**
Crookston	K-1	NDHRS14-0134-C09	66.9	66.1	2.0	7.7	14.0	21	17.3
	K-2	SD4930	59.2	59.0	2.5	7.8	19.4	14	22.4
	K-3	**Linkert**	**68.1**	**67.7**	**20.3**	**28.4**	**12.9**	**26**	**33.8**
	K-5	LCS Boom	64.4	64.2	3.4	9.5	18.8	11	23.0
	K-6	LCS Cannon	64.6	64.4	3.0	12.5	19.7	14	23.6
	K-8	NDHRS14-0134-C03	68.0	67.8	3.9	19.6	22.5	17	27.4
Minot	M-1	NDHRS14-0134-C09	63.1	62.9	2.4	8.0	17.0	22	39.3
	M-4	MT 2063	62.4	62.2	6.0	42.8	43.6	16	53.7
	M-5	LCS Boom	64.3	63.9	4.4	10.2	17.4	18	23.2
	M-6	LCS Cannon	63.5	63.5	2.6	9.3	25.7	10	29.1
	M-7	LCS Buster	58.9	58.5	1.3	7.2	21.4	12	22.6
	M-8	NDHRS14-0134-C03	65.8	65.2	3.0	33.4	35.7	20	40.0
	M-9	MT 2030	63.7	63.5	4.0	11.0	19.6	9	24.7
	M-10	**LCS Rebel**	**65.9**	**65.1**	**3.6**	**8.8**	**31.1**	**14**	**36.2**

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)
Watertown	B-2	SD4930	4.2	70.8	35.3	4.6	53.5	30.4	177.1
	B-3	**Linkert**	**3.7**	**79.1**	**32.5**	**3.9**	**63.0**	**30.7**	**171.5**
	B-5	LCS Boom	2.9	73.2	29.3	3.1	58.6	27.2	133.3
	B-6	LCS Cannon	3.2	73.6	30.4	3.4	58.6	28.5	145.3
	B-7	LCS Buster	5.2	69.6	32.5	5.4	53.0	30.9	208.2
	B-8	NDHRS14-0134-C03	4.0	79.2	36.1	4.3	60.7	33.0	197.4
Casselton	C-1	NDHRS14-0134-C09	3.2	68.5	31.6	3.5	52.7	31.5	150.3
	C-2	SD4930	3.8	60.9	28.7	4.7	46.8	21.1	170.1
	C-3	**Linkert**	**3.7**	**75.0**	**36.0**	**4.1**	**58.1**	**29.8**	**172.6**
	C-5	LCS Boom	2.7	73.8	29.7	2.9	58.8	29.2	123.2
	C-6	LCS Cannon	2.7	73.5	31.5	3.0	57.3	28.9	126.1
	C-7	LCS Buster	5.9	56.7	24.3	5.4	44.5	22.4	190.7
	C-8	NDHRS14-0134-C03	4.0	73.0	32.2	4.4	56.7	29.0	189.5
Havre	H-4	MT 2063	6.7	72.3	30.0	6.8	56.7	29.7	258.1
	H-5	LCS Boom	5.3	75.2	32.4	5.4	58.8	32.3	226.4
	H-6	LCS Cannon	6.0	80.2	38.5	6.3	60.9	33.8	258.8
	H-7	LCS Buster	6.9	67.7	35.2	7.5	52.1	26.8	260.1
	H-8	NDHRS14-0134-C03	5.4	86.3	39.5	5.8	67.1	36.1	265.2
	H-9	MT 2030	3.7	74.3	31.5	3.9	58.9	29.1	161.3
	H-10	**LCS Rebel**	**6.0**	**70.9**	**29.9**	**6.2**	**56.3**	**28.1**	**253.4**
Crookston	K-1	NDHRS14-0134-C09	4.2	69.3	27.9	4.3	54.8	27.9	189.3
	K-2	SD4930	4.9	67.2	32.2	5.4	50.8	24.9	201.5
	K-3	**Linkert**	**5.1**	**80.4**	**35.4**	**5.4**	**62.4**	**32.0**	**230.3**
	K-5	LCS Boom	3.4	72.0	35.5	4.1	57.4	27.1	175.8
	K-6	LCS Cannon	3.7	74.1	31.9	4.0	57.6	27.5	173.7
	K-8	NDHRS14-0134-C03	4.0	80.5	36.7	4.4	62.2	33.6	199.4
Minot	M-1	NDHRS14-0134-C09	4.1	70.7	29.5	4.2	55.0	29.5	183.2
	M-4	MT 2063	5.2	67.0	31.1	5.9	51.2	27.0	234.5
	M-5	LCS Boom	2.9	72.1	28.9	3.3	58.8	25.5	142.8
	M-6	LCS Cannon	4.1	72.6	29.9	3.9	57.4	28.7	167.5
	M-7	LCS Buster	5.4	64.6	31.7	5.8	48.5	28.4	217.5
	M-8	NDHRS14-0134-C03	4.5	83.6	42.8	5.0	62.8	33.6	232.5
	M-9	MT 2030	3.5	74.4	34.3	3.8	57.1	28.6	162.1
	M-10	**LCS Rebel**	**4.1**	**75.6**	**34.4**	**4.2**	**57.9**	**34.1**	**181.1**

Interpreting Mixogram Results



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

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

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

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

Extensograph Characteristics by Location

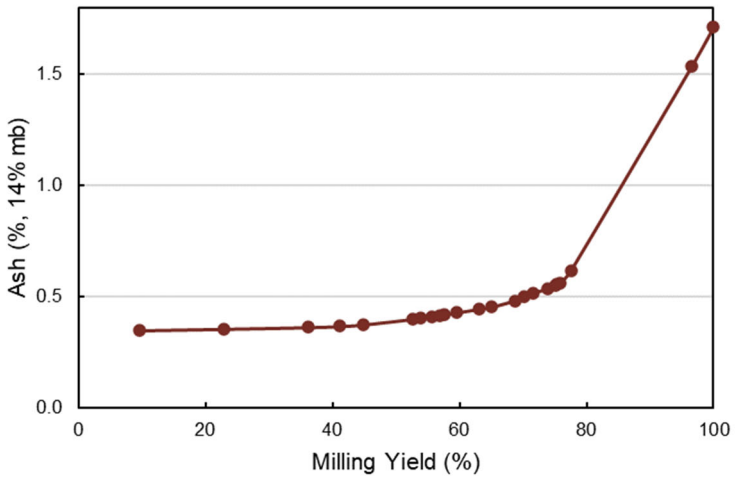
45 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-2	SD4930	104	414	138	588	3.0	4.3
	B-3	**Linkert**	**133**	**402**	**163**	**643**	**2.5**	**4.0**
	B-5	LCS Boom	96	269	172	425	1.6	2.5
	B-6	LCS Cannon	90	285	158	436	1.8	2.8
	B-7	LCS Buster	111	444	135	665	3.3	4.9
	B-8	NDHRS14-0134-C03	124	420	148	683	2.8	4.6
Casselton	C-1	NDHRS14-0134-C09	97	402	134	573	3.0	4.3
	C-2	SD4930	96	348	145	517	2.4	3.6
	C-3	**Linkert**	**136**	**406**	**162**	**658**	**2.5**	**4.1**
	C-5	LCS Boom	94	228	188	383	1.2	2.0
	C-6	LCS Cannon	91	256	173	397	1.5	2.3
	C-7	LCS Buster	109	410	143	576	2.9	4.0
	C-8	NDHRS14-0134-C03	119	390	149	660	2.6	4.4
Havre	H-4	MT 2063	172	495	163	879	3.1	5.4
	H-5	LCS Boom	169	427	174	806	2.5	4.6
	H-6	LCS Cannon	215	574	168	1069	3.4	6.4
	H-7	LCS Buster	179	665	143	1024	4.6	7.1
	H-8	NDHRS14-0134-C03	188	611	156	957	3.9	6.2
	H-9	MT 2030	144	381	173	660	2.2	3.8
	H-10	**LCS Rebel**	**195**	**560**	**158**	**1052**	**3.6**	**6.7**
Crookston	K-1	NDHRS14-0134-C09	108	413	140	608	3.0	4.3
	K-2	SD4930	115	410	145	626	2.8	4.3
	K-3	**Linkert**	**166**	**455**	**165**	**826**	**2.8**	**5.0**
	K-5	LCS Boom	91	335	141	509	2.4	3.6
	K-6	LCS Cannon	123	346	172	556	2.0	3.2
	K-8	NDHRS14-0134-C03	137	434	158	680	2.8	4.3
Minot	M-1	NDHRS14-0134-C09	122	474	139	701	3.4	5.1
	M-4	MT 2063	151	453	159	771	2.8	4.8
	M-5	LCS Boom	102	311	162	484	1.9	3.0
	M-6	LCS Cannon	118	392	151	622	2.6	4.1
	M-7	LCS Buster	93	477	118	611	4.1	5.2
	M-8	NDHRS14-0134-C03	160	479	158	824	3.0	5.2
	M-9	MT 2030	119	379	162	562	2.3	3.5
	M-10	**LCS Rebel**	**141**	**407**	**161**	**719**	**2.5**	**4.5**

90 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-2	SD4930	142	1143	95	1226	12.1	13.0
	B-3	**Linkert**	**203**	**931**	**137**	**1139**	**6.8**	**8.3**
	B-5	LCS Boom	126	433	150	674	2.9	4.5
	B-6	LCS Cannon	144	575	142	810	4.1	5.7
	B-7	LCS Buster	121	1331	77	1343	17.4	17.5
	B-8	NDHRS14-0134-C03	155	1138	100	1271	11.4	12.7
Casselton	C-1	NDHRS14-0134-C09	110	752	103	896	7.3	8.7
	C-2	SD4930	116	928	94	1047	9.9	11.2
	C-3	**Linkert**	**192**	**940**	**128**	**1155**	**7.4**	**9.0**
	C-5	LCS Boom	119	438	148	617	3.0	4.2
	C-6	LCS Cannon	126	561	136	689	4.1	5.1
	C-7	LCS Buster	92	1086	71	1086	15.3	15.3
	C-8	NDHRS14-0134-C03	177	1021	115	1222	8.9	10.6
Havre	H-4	MT 2063	217	1163	122	1360	9.5	11.1
	H-5	LCS Boom	194	1656	89	1707	18.6	19.2
	H-6	LCS Cannon	269	1542	122	1686	12.6	13.8
	H-7	LCS Buster	189	1854	85	1907	21.9	22.5
	H-8	NDHRS14-0134-C03	250	1475	120	1632	12.3	13.6
	H-9	MT 2030	214	920	140	1165	6.6	8.3
	H-10	**LCS Rebel**	**232**	**1856**	**95**	**1938**	**19.5**	**20.4**
Crookston	K-1	NDHRS14-0134-C09	113	874	95	1027	9.2	10.9
	K-2	SD4930	149	1253	92	1383	13.6	15.1
	K-3	**Linkert**	**258**	**1141**	**134**	**1489**	**8.5**	**11.1**
	K-5	LCS Boom	156	818	123	973	6.7	7.9
	K-6	LCS Cannon	165	661	143	886	4.6	6.2
	K-8	NDHRS14-0134-C03	211	826	143	1178	5.8	8.2
Minot	M-1	NDHRS14-0134-C09	137	1106	94	1183	11.8	12.6
	M-4	MT 2063	190	1312	105	1438	12.5	13.7
	M-5	LCS Boom	150	531	147	806	3.6	5.5
	M-6	LCS Cannon	200	908	131	1219	6.9	9.3
	M-7	LCS Buster	109	1231	76	1265	16.1	16.6
	M-8	NDHRS14-0134-C03	197	1545	97	1616	15.9	16.6
	M-9	MT 2030	147	809	117	964	6.9	8.3
	M-10	**LCS Rebel**	**198**	**930**	**130**	**1176**	**7.2**	**9.1**

135 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-2	SD4930	127	1291	80	1293	16.2	16.2
	B-3	**Linkert**	**175**	**1160**	**108**	**1305**	**10.7**	**12.1**
	B-5	LCS Boom	133	574	134	767	4.3	5.7
	B-6	LCS Cannon	148	687	130	897	5.3	6.9
	B-7	LCS Buster	102	1222	64	1408	19.1	22.0
	B-8	NDHRS14-0134-C03	135	1403	81	1437	17.3	17.7
Casselton	C-1	NDHRS14-0134-C09	84	942	73	951	13.0	13.1
	C-2	SD4930	93	1049	61	1292	17.3	21.3
	C-3	**Linkert**	**179**	**1248**	**105**	**1379**	**11.9**	**13.1**
	C-5	LCS Boom	123	563	131	706	4.3	5.4
	C-6	LCS Cannon	145	766	126	846	6.1	6.7
	C-7	LCS Buster	86	857	56	1428	15.3	25.5
	C-8	NDHRS14-0134-C03	143	1425	80	1428	17.9	17.9
Havre	H-4	MT 2063	177	1404	94	1469	15.0	15.6
	H-5	LCS Boom	182	1727	83	1731	20.8	20.8
	H-6	LCS Cannon	249	1804	104	1856	17.3	17.8
	H-7	LCS Buster	161	2129	68	2140	31.2	31.4
	H-8	NDHRS14-0134-C03	228	1895	94	1961	20.2	20.9
	H-9	MT 2030	179	1249	103	1325	12.1	12.8
	H-10	**LCS Rebel**	**205**	**1989**	**84**	**1990**	**23.8**	**23.8**
Crookston	K-1	NDHRS14-0134-C09	95	1082	74	1095	14.7	14.8
	K-2	SD4930	146	1581	79	1582	20.1	20.1
	K-3	**Linkert**	**187**	**1583**	**90**	**1670**	**17.7**	**18.6**
	K-5	LCS Boom	157	1028	109	1118	9.4	10.2
	K-6	LCS Cannon	165	891	122	1004	7.3	8.2
	K-8	NDHRS14-0134-C03	184	1072	119	1231	9.0	10.3
Minot	M-1	NDHRS14-0134-C09	121	1219	81	1274	15.1	15.8
	M-4	MT 2063	168	1580	86	1581	18.4	18.4
	M-5	LCS Boom	145	633	133	850	4.8	6.4
	M-6	LCS Cannon	156	1133	100	1265	11.4	12.7
	M-7	LCS Buster	79	1004	55	1285	18.3	23.4
	M-8	NDHRS14-0134-C03	193	1780	87	1791	20.6	20.7
	M-9	MT 2030	148	1031	103	1115	10.0	10.8
	M-10	**LCS Rebel**	**157**	**1263**	**93**	**1317**	**13.6**	**14.2**

Ash Content in Mill Streams

Linkert Check – Casselton (C-3)



Mill Stream	Stream (%, 14% mb) Yield	Ash	Cumulative (%, 14% mb) Yield	Ash
Patent:				
1 M	9.6	0.35	9.6	0.35
2 M	13.3	0.36	22.9	0.35
3 M	13.3	0.37	36.2	0.36
Sz I	4.9	0.40	41.1	0.37
Sz II	3.7	0.45	44.8	0.37
4 M	7.9	0.54	52.7	0.40
1 Bk	1.2	0.61	53.9	0.40
Bk Dust	1.7	0.63	55.7	0.41
2 Bk II	1.2	0.64	56.9	0.41
2 Bk I	0.7	0.67	57.6	0.42
3 Bk	2.0	0.69	59.6	0.43
4 Bk	3.4	0.72	63.1	0.44
TC	2.0	0.74	65.0	0.45
6 M	3.7	1.00	68.7	0.48
Tail	1.5	1.28	70.2	0.50
5 Bk	1.5	1.39	71.7	0.52
Clear Flour:				
5 M	2.2	1.13	73.9	0.53
LG	1.2	1.56	75.1	0.55
LQ	0.2	1.78	75.4	0.56
Bran & Shorts:				
TC Sh	0.5	1.24	75.9	0.56
Tail Sh	1.7	3.16	77.6	0.62
Head Sh	19.0	5.28	96.6	1.53
Bran	3.4	6.67	100.0	1.71
Patent (Rebolted)		**0.51**		**0.52**
Wheat		**1.60**		**1.71**

Cooperators' Bake Data

Linkert Checks

WATERTOWN (B-3)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	72.3	946	4	7
B	70.2	963	5	7
C	64.0	2825	9	9
D	70.0	2779	9	7
E	67.6	2089	7	6
F	72.4	1020	6	5
G	68.0	2839	7	9
H	69.4	2900	9	5
I	68.2	982	5	6
J	70.6	2488	8	4
K	68.0	1050	5	7
Avg.	69.2		6.7	6.5
S.D.	2.4		1.8	1.6

CASSSELTON (C-3)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	68.4	893	5	6
B	70.7	930	5	7
C	63.0	3000	9	9
D	67.9	2795	9	7
E	64.6	2004	8	7
F	70.2	1035	5	7
G	65.0	2853	9	9
H	65.6	2875	9	7
I	66.1	900	5	6
J	67.6	2299	6	5
K	65.6	1010	5	6
Avg.	66.8		6.8	6.9
S.D.	2.4		1.9	1.2

CROOKSTON (K-3)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	72.8	911	6	6
B	71.7	980	5	8
C	64.0	2925	9	9
D	71.2	2725	9	5
E	68.1	2043	6	7
F	71.3	1125	7	7
G	68.0	2883	9	9
H	69.7	2900	7	7
I	69.2	1069	6	6
J	71.1	2281	9	4
K	67.6	1090	6	8
Avg.	69.5		7.2	6.9
S.D.	2.5		1.5	1.6

LCS Rebel Checks

HAVRE (H-10)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	69.7	953	6	7
B	71.2	1003	6	8
C	64.0	3100	9	9
D	69.2	2673	9	9
E	65.7	2136	9	5
F	70.8	1010	9	6
G	65.0	3252	9	9
H	66.7	2900	9	9
I	67.4	1066	7	6
J	68.7	2551	9	7
K	68.6	1055	6	8
Avg.	67.9		8.0	7.5
S.D.	2.4		1.4	1.4

MINOT (M-10)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	70.1	944	4	8
B	71.2	943	5	8
C	63.0	2800	9	9
D	68.3	2570	5	5
E	65.9	2065	7	6
F	75.9	1005	7	6
G	66.0	2897	9	7
H	67.1	2725	9	5
I	68.4	1092	4	6
J	68.9	2233	8	5
K	68.7	1085	5	6
Avg.	68.5		6.5	6.5
S.D.	3.3		2.0	1.4

SWQC #1 – NDHRS14-0134-C09

CASSELTON (C-1)												
		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	68.8	826	92.5	5	6	5	5	6	3	2	3	2
B	69.2	830	89.2	4	6	1	6	4	3	5	3	3
C	61.0	3050	101.7	7	7	5	5	5	3	5	5	5
D	67.1	2521	90.2	5	3	3	3	5	3	5	3	3
E	64.2	1943	97.0	6	5	4	5	5	4	5	4	4
F	67.2	815	78.7	6	7	3	7	4	3	5	3	3
G	64.0	2765	96.9	3	7	3	3	3	1	3	3	3
H	65.8	2925	101.7	7	5	1	9	5	1	5	5	5
I	66.8	901	100.1	5	6	6	5	5	2	5	5	5
J	67.2	2222	96.7	3	7	3	5	4	3	5	5	4
K	66.7	920	91.1	5	4	2	6	5	3	5	4	4
Avg.	66.2		94.2	5.1	5.7	3.3	5.4	4.6	2.6	4.5	3.9	3.7
S.D.	2.3		6.8	1.4	1.3	1.6	1.7	0.8	0.9	1.0	0.9	1.0

CROOKSTON (K-1)												
		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	71.2	829	91.0	5	6	4	5	5	2	2	4	1
B	69.7	814	83.1	5	5	2	4	4	3	4	2	3
C	62.0	2875	98.3	7	7	5	5	5	4	5	5	5
D	70.0	2534	93.0	5	5	3	5	5	1	5	3	1
E	66.9	1850	90.6	6	6	5	4	5	3	5	3	3
F	69.9	835	74.2	7	5	4	5	5	3	4	2	3
G	67.0	2868	99.5	7	7	5	5	5	3	5	5	3
H	68.1	2925	100.9	9	5	5	3	7	1	5	5	7
I	69.6	931	87.1	5	6	5	6	5	7	4	4	4
J	69.9	2197	96.3	6	5	3	6	7	3	5	4	6
K	69.7	965	88.5	5	5	5	4	6	3	4	4	4
Avg.	68.5		91.1	6.1	5.6	4.2	4.7	5.4	3.0	4.4	3.7	3.6
S.D.	2.5		7.9	1.3	0.8	1.1	0.9	0.9	1.6	0.9	1.1	1.9

MINOT (M-1)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	67.7	840	89.0	4	7	5	6	5	3	1	2	1
B	69.7	904	95.9	5	7	7	6	5	3	3	4	5
C	62.0	2750	98.2	9	9	5	5	5	5	5	5	5
D	66.0	2527	98.3	5	6	5	5	4	3	3	5	3
E	63.1	1938	93.8	9	7	8	5	7	3	4	3	4
F	69.5	915	91.0	6	6	4	5	6	3	4	4	4
G	63.0	2927	101.0	9	7	7	5	5	5	3	7	5
H	64.9	2750	100.9	9	5	5	5	3	1	5	5	5
I	66.4	980	89.7	5	5	5	5	4	6	3	4	4
J	66.1	2289	102.5	8	5	5	6	7	3	4	5	5
K	67.5	1000	92.2	4	4	3	5	6	3	4	4	4
Avg.	**66.0**		**95.7**	**6.6**	**6.2**	**5.4**	**5.3**	**5.2**	**3.5**	**3.5**	**4.4**	**4.1**
S.D.	**2.6**		**4.8**	**2.2**	**1.4**	**1.4**	**0.5**	**1.3**	**1.4**	**1.1**	**1.3**	**1.2**

SWQC #2 – SD4930

WATERTOWN (B-2)												
		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	65.5	862	91.1	4	7	5	4	5	3	6	2	3
B	69.7	900	93.5	5	6	2	5	3	4	7	4	5
C	62.0	2925	103.5	9	9	5	5	5	5	5	5	5
D	63.7	2546	91.6	5	6	3	5	5	1	9	3	3
E	61.1	2095	100.3	6	8	4	5	6	5	7	4	4
F	67.9	910	89.2	7	5	5	3	5	3	6	3	3
G	61.0	3015	106.2	9	9	5	3	5	5	5	7	7
H	62.3	2850	98.3	9	5	7	9	7	1	7	5	7
I	63.6	920	93.7	5	5	5	4	6	6	7	4	5
J	64.1	2430	97.7	7	5	4	4	6	3	7	5	5
K	64.8	915	87.1	5	5	6	5	6	3	6	4	4
Avg.	64.2		95.7	6.5	6.4	4.6	4.7	5.4	3.5	6.5	4.2	4.6
S.D.	2.7		6.0	1.9	1.6	1.4	1.6	1.0	1.6	1.1	1.3	1.4

CASSELTON (C-2)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	63.0	861	96.4	5	6	5	4	5	3	2	2	1
B	68.7	868	93.3	5	6	3	6	4	3	5	3	4
C	60.0	3050	101.7	5	5	5	5	5	3	5	5	5
D	62.1	2512	89.9	5	3	3	3	5	1	5	3	3
E	58.5	2211	110.3	4	4	3	5	5	4	5	5	5
F	65.1	820	79.2	6	4	3	1	4	2	5	3	3
G	59.0	2927	102.6	3	7	3	3	3	3	3	3	3
H	59.9	2750	95.7	9	7	3	3	7	1	5	3	3
I	61.9	929	103.2	4	5	5	4	6	2	5	4	4
J	61.5	2289	99.6	4	4	7	3	6	3	5	3	4
K	62.2	890	88.1	4	3	3	3	6	2	5	3	3
Avg.	62.0		96.4	4.9	4.9	3.9	3.6	5.1	2.5	4.5	3.4	3.5
S.D.	2.9		8.6	1.6	1.4	1.4	1.4	1.1	0.9	1.0	0.9	1.1

CROOKSTON (K-2)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	64.1	872	95.7	5	6	4	4	4	2	6	2	1
B	69.7	854	87.1	6	6	3	6	4	3	8	3	4
C	61.0	2800	95.7	9	9	5	5	5	4	5	5	5
D	62.4	2678	98.3	5	5	3	7	3	1	9	5	5
E	59.2	2037	99.7	6	4	5	6	5	3	6	4	4
F	67.5	860	76.4	7	5	4	1	7	2	7	2	3
G	59.0	3148	109.2	9	9	7	3	3	5	7	7	7
H	61.0	3000	103.4	9	7	7	5	5	1	7	5	7
I	62.3	1003	93.8	5	5	4	5	5	6	7	5	6
J	62.2	2453	107.5	6	5	4	3	7	3	7	5	6
K	61.5	925	84.9	5	6	6	2	4	3	6	2	3
Avg.	**62.7**		**95.6**	**6.5**	**6.1**	**4.7**	**4.3**	**4.7**	**3.0**	**6.8**	**4.1**	**4.6**
S.D.	**3.3**		**9.8**	**1.7**	**1.6**	**1.4**	**1.8**	**1.3**	**1.5**	**1.1**	**1.6**	**1.9**

SWQC #4 – MT 2063

HAVRE (H-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	70.7	1018	106.8	6	7	5	5	5	6	5	6	6
B	72.2	992	98.9	6	7	5	6	5	6	6	5	6
C	65.0	3100	100.0	9	9	5	5	5	5	5	5	5
D	70.0	2712	101.5	9	9	5	5	5	7	9	5	9
E	66.5	2044	95.7	9	7	5	5	4	6	5	4	4
F	69.8	1120	110.9	9	5	4	5	5	6	6	6	6
G	66.0	3252	100.0	9	9	5	5	5	7	5	5	5
H	67.5	3000	103.4	9	7	5	5	5	7	5	5	5
I	67.0	1259	118.1	7	6	4	5	5	3	6	6	6
J	69.5	2401	94.1	9	6	6	5	4	6	6	5	5
K	66.4	1090	103.3	6	7	4	4	4	6	5	4	4
Avg.	68.2		103.0	8.0	7.2	4.8	5.0	4.7	5.9	5.7	5.1	5.5
S.D.	2.3		6.9	1.4	1.3	0.6	0.4	0.5	1.1	1.2	0.7	1.4

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	67.3	924	97.9	6	6	6	4	5	4	2	5	3
B	70.2	968	102.7	5	7	5	6	4	4	3	6	5
C	62.0	2925	104.5	9	9	5	5	5	5	5	5	5
D	65.0	2799	108.9	9	7	9	3	5	3	3	9	5
E	62.4	2081	100.8	9	7	8	6	5	3	4	5	4
F	68.2	1015	101.0	7	5	5	3	7	3	4	5	5
G	63.0	3000	103.6	9	9	9	5	5	5	3	7	7
H	64.2	3000	110.1	9	7	7	5	5	3	5	9	7
I	63.7	1070	98.0	7	5	5	4	5	7	3	3	3
J	65.4	2299	103.0	8	6	6	5	5	4	4	5	5
K	64.9	1085	100.0	5	4	6	3	5	4	4	4	4
Avg.	65.1		102.8	7.5	6.5	6.5	4.5	5.1	4.1	3.6	5.7	4.8
S.D.	2.5		4.0	1.6	1.6	1.6	1.1	0.7	1.2	0.9	1.9	1.3

SWQC #5 – LCS Boom

WATERTOWN (B-5)												
		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	70.6	905	95.7	3	6	4	5	6	5	6	4	5
B	71.2	874	90.8	3	6	3	4	2	5	6	3	4
C	63.0	2875	101.8	7	7	5	5	5	5	5	5	5
D	69.6	2653	95.5	5	4	1	7	7	5	7	3	5
E	67.0	2141	102.5	6	6	4	4	6	5	7	4	5
F	70.3	1000	98.0	5	6	3	7	6	5	6	5	5
G	66.0	2736	96.4	5	7	3	3	5	5	5	3	3
H	67.6	2900	100.0	7	5	5	7	5	5	7	5	5
I	68.4	1100	112.0	3	5	4	5	7	5	7	6	6
J	70.0	2412	96.9	8	5	7	4	4	5	6	4	4
K	69.2	1050	100.0	3	4	5	6	7	5	5	6	6
Avg.	68.4		99.0	5.0	5.5	4.0	5.2	5.5	5.0	6.1	4.4	4.8
S.D.	2.4		5.4	1.8	1.0	1.5	1.4	1.5	0.0	0.8	1.1	0.9

CASSELTON (C-5)												
		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	70.1	890	99.7	4	5	4	5	6	5	4	4	4
B	69.7	928	99.8	3	7	4	5	4	5	4	5	5
C	62.0	3100	103.3	5	5	5	5	5	5	5	5	5
D	68.6	2694	96.4	5	3	3	5	5	5	5	5	5
E	65.1	2158	107.7	4	5	3	6	4	5	5	5	5
F	68.6	965	93.2	5	6	3	3	6	5	4	4	4
G	65.0	2648	92.8	3	7	3	3	3	5	5	1	3
H	67.1	2950	102.6	7	5	3	5	5	5	5	5	5
I	66.6	990	110.0	3	5	3	5	6	5	4	6	5
J	68.1	2373	103.2	6	6	5	4	5	5	4	6	5
K	66.4	1030	102.0	3	3	3	4	5	4	4	5	4
Avg.	67.0		101.0	4.4	5.2	3.5	4.5	4.9	4.9	4.5	4.6	4.5
S.D.	2.4		5.4	1.4	1.3	0.8	0.9	0.9	0.3	0.5	1.4	0.7

HAVRE (H-5)

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	68.5	892	93.6	5	7	4	5	4	5	4	6	4
B	71.2	1001	99.8	5	8	6	5	5	5	3	5	5
C	64.0	3075	99.2	9	9	5	5	5	5	5	5	5
D	67.7	2724	101.9	9	7	5	7	5	5	3	5	5
E	64.1	2051	96.0	9	8	5	6	4	5	4	4	4
F	71.1	980	97.0	8	7	4	5	7	5	4	5	5
G	64.0	3332	102.5	9	9	5	5	5	5	5	7	7
H	65.5	2925	100.9	9	9	9	7	5	5	5	5	5
I	66.5	1168	109.6	6	5	5	5	4	5	4	4	4
J	67.1	2570	100.7	9	7	5	5	4	5	4	6	4
K	66.8	1125	106.6	5	7	8	6	4	5	4	6	6
Avg.	**67.0**		**100.7**	**7.5**	**7.5**	**5.5**	**5.5**	**4.7**	**5.0**	**4.1**	**5.3**	**4.9**
S.D.	**2.6**		**4.6**	**1.9**	**1.2**	**1.6**	**0.8**	**0.9**	**0.0**	**0.7**	**0.9**	**0.9**

CROOKSTON (K-5)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Quality Score Compared to Check (Linkert): Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	69.2	884	97.0	4	5	3	5	5	3	5	4	3
B	70.7	910	92.9	4	6	4	4	3	4	6	4	4
C	63.0	2825	96.6	7	7	5	5	5	4	5	5	5
D	66.3	2601	95.4	7	7	3	3	3	3	7	3	5
E	64.4	2199	107.6	7	5	6	5	6	4	5	7	6
F	71.4	1025	91.1	5	6	4	3	5	3	6	4	4
G	64.0	3177	110.2	9	9	7	3	3	5	5	7	7
H	66.2	2875	99.1	9	7	7	3	7	3	5	5	5
I	67.2	1064	99.5	4	5	3	5	4	7	5	4	4
J	67.4	2097	91.9	7	4	5	3	6	4	6	4	5
K	65.8	1035	95.0	4	5	6	3	5	4	5	3	3
Avg.	**66.9**		**97.9**	**6.1**	**6.0**	**4.8**	**3.8**	**4.7**	**4.0**	**5.5**	**4.5**	**4.6**
S.D.	**2.7**		**6.1**	**2.0**	**1.4**	**1.5**	**1.0**	**1.3**	**1.2**	**0.7**	**1.4**	**1.2**

MINOT (M-5)												
		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	68.9	951	100.7	4	6	5	5	5	4	3	4	3
B	69.7	954	101.2	4	7	7	6	5	4	3	5	4
C	63.0	2750	98.2	9	7	5	5	5	5	5	5	5
D	67.3	2680	104.3	5	4	3	3	4	3	3	7	5
E	64.3	2030	98.3	6	6	5	7	8	5	4	4	4
F	71.2	1035	103.0	6	5	4	5	7	4	4	5	5
G	64.0	2692	92.9	7	5	3	3	3	5	3	1	3
H	65.9	2800	102.8	9	5	3	5	5	5	5	5	5
I	66.9	1139	104.3	3	6	4	4	3	6	4	3	3
J	67.3	2282	102.2	8	5	6	5	6	4	4	5	5
K	67.9	1045	96.3	4	4	3	4	6	4	4	4	4
Avg.	**66.9**		**100.4**	**5.9**	**5.5**	**4.4**	**4.7**	**5.2**	**4.5**	**3.8**	**4.4**	**4.2**
S.D.	**2.5**		**3.6**	**2.1**	**1.0**	**1.4**	**1.2**	**1.5**	**0.8**	**0.8**	**1.5**	**0.9**

SWQC #6 – LCS Cannon

WATERTOWN (B-6)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	70.1	931	98.4	3	5	4	5	6	5	4	4	3
B	70.7	928	96.4	3	7	3	5	5	5	6	5	5
C	63.0	3000	106.2	9	9	5	5	5	5	5	5	5
D	67.8	2701	97.2	6	5	3	5	7	5	7	5	7
E	65.5	2185	104.6	4	7	2	5	6	5	7	6	6
F	70.3	1000	98.0	5	6	3	5	5	5	6	5	5
G	66.0	2868	101.0	7	7	5	3	5	5	5	5	5
H	67.1	2825	97.4	9	5	5	5	7	5	7	5	5
I	67.6	1108	112.8	3	6	5	3	4	5	6	4	5
J	68.5	2350	94.5	8	5	5	5	5	5	6	4	5
K	69.0	1055	100.5	4	6	5	7	5	4	5	6	5
Avg.	**67.8**		**100.6**	**5.5**	**6.2**	**4.1**	**4.8**	**5.5**	**4.9**	**5.8**	**4.9**	**5.1**
S.D.	**2.3**		**5.3**	**2.4**	**1.3**	**1.1**	**1.1**	**0.9**	**0.3**	**1.0**	**0.7**	**0.9**

CASSELTON (C-6)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	69.5	869	97.3	4	5	4	5	5	4	4	4	3
B	69.7	905	97.3	4	7	4	5	5	4	5	4	4
C	62.0	2875	95.8	7	7	5	5	5	5	5	5	5
D	69.1	2683	96.0	5	5	3	3	3	3	5	5	5
E	65.2	2012	100.4	4	5	3	4	5	5	5	4	5
F	69.2	1000	96.6	5	7	3	3	4	4	5	4	4
G	65.0	2986	104.7	5	7	3	5	5	5	5	5	5
H	66.6	2950	102.6	7	5	3	9	5	3	5	5	5
I	67.8	1019	113.2	3	6	4	5	4	4	5	5	5
J	68.2	2349	102.2	6	3	6	5	5	4	5	6	5
K	66.9	990	98.0	3	5	3	5	7	3	5	5	4
Avg.	**67.2**		**100.4**	**4.8**	**5.6**	**3.7**	**4.9**	**4.8**	**4.0**	**4.9**	**4.7**	**4.5**
S.D.	**2.4**		**5.2**	**1.4**	**1.3**	**1.0**	**1.6**	**1.0**	**0.8**	**0.3**	**0.6**	**0.7**

HAVRE (H-6)

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	72.6	1026	107.7	7	6	6	5	5	7	5	7	9
B	73.2	968	96.5	6	9	6	4	4	7	6	4	4
C	66.0	3000	96.8	9	9	5	5	5	5	5	5	5
D	71.1	2538	94.9	9	7	7	5	7	9	9	3	9
E	68.1	2019	94.5	9	8	5	4	3	7	6	3	4
F	73.0	1150	113.9	9	6	5	7	7	7	6	7	7
G	68.0	3332	102.5	9	9	5	5	5	7	5	7	7
H	69.5	2650	91.4	9	7	5	5	5	9	5	3	5
I	69.3	1166	109.4	8	6	5	5	6	2	6	6	6
J	71.1	2462	96.5	9	4	4	6	5	7	6	5	5
K	70.9	1165	110.4	6	8	5	6	5	7	5	6	6
Avg.	**70.3**		**101.3**	**8.2**	**7.2**	**5.3**	**5.2**	**5.2**	**6.7**	**5.8**	**5.1**	**6.1**
S.D.	**2.3**		**7.7**	**1.3**	**1.6**	**0.8**	**0.9**	**1.2**	**1.9**	**1.2**	**1.6**	**1.8**

CROOKSTON (K-6)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Quality Score Compared to Check (Linkert) Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	69.2	922	101.2	5	7	4	5	6	3	6	4	4
B	70.7	885	90.3	5	7	3	5	4	4	7	3	5
C	63.0	2900	99.1	9	9	5	5	5	4	5	5	5
D	66.9	2672	98.1	5	3	3	3	3	3	7	5	5
E	64.6	2024	99.1	5	5	4	6	5	4	5	5	5
F	70.6	1010	89.8	5	6	4	5	5	3	6	4	4
G	65.0	3177	110.2	9	9	5	3	3	5	7	7	7
H	66.4	3000	103.4	9	7	7	5	5	3	7	5	7
I	67.4	1042	97.5	5	6	4	5	6	7	6	5	6
J	67.6	2363	103.6	8	5	5	5	6	4	6	5	6
K	66.0	1040	95.4	4	5	6	4	4	4	5	4	4
Avg.	**67.0**		**98.9**	**6.3**	**6.3**	**4.5**	**4.6**	**4.7**	**4.0**	**6.1**	**4.7**	**5.3**
S.D.	**2.4**		**5.9**	**2.0**	**1.8**	**1.2**	**0.9**	**1.1**	**1.2**	**0.8**	**1.0**	**1.1**

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	68.6	920	97.5	4	7	5	6	5	4	4	4	4
B	70.7	978	103.7	5	7	3	5	5	4	3	6	6
C	63.0	2750	98.2	9	7	5	5	5	5	5	5	5
D	66.1	2752	107.1	5	5	5	5	4	3	3	7	5
E	63.5	2006	97.1	6	5	5	7	7	5	4	4	4
F	71.6	1000	99.5	6	5	4	3	4	4	4	4	4
G	64.0	3282	113.3	9	7	5	5	5	5	3	7	7
H	65.5	2800	102.8	9	5	5	5	5	5	5	5	5
I	66.8	1096	100.4	5	6	5	3	4	6	4	4	4
J	66.5	2294	102.7	8	5	7	5	5	5	4	5	5
K	65.8	1070	98.6	5	5	4	5	5	4	4	5	4
Avg.	**66.6**		**101.9**	**6.5**	**5.8**	**4.8**	**4.9**	**4.9**	**4.5**	**3.9**	**5.1**	**4.8**
S.D.	**2.8**		**4.9**	**1.9**	**1.0**	**1.0**	**1.1**	**0.8**	**0.8**	**0.7**	**1.1**	**1.0**

SWQC #7 – LCS Buster

WATERTOWN (B-7)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	66.1	830	87.7	5	7	6	4	4	3	6	3	3
B	69.2	831	86.3	6	8	2	3	3	4	5	2	4
C	62.0	2925	103.5	9	9	5	5	7	5	5	5	5
D	63.7	2550	91.8	9	7	5	5	5	1	7	3	3
E	61.9	2150	102.9	6	7	4	6	6	4	6	6	6
F	67.9	825	80.9	8	5	5	3	5	3	6	3	3
G	62.0	3074	108.3	9	9	7	3	5	5	5	7	7
H	63.1	2900	100.0	9	5	7	7	7	1	7	5	7
I	65.1	917	93.4	6	6	6	4	5	6	6	3	4
J	64.9	2527	101.6	7	4	3	5	5	3	6	5	5
K	63.7	890	84.8	5	7	7	4	5	3	5	3	3
Avg.	64.5		94.6	7.2	6.7	5.2	4.5	5.2	3.5	5.8	4.1	4.5
S.D.	2.4		9.1	1.7	1.6	1.7	1.3	1.2	1.6	0.8	1.6	1.6

CASSELTON (C-7)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	62.4	767	85.9	6	5	6	4	4	1	3	1	1
B	66.7	751	80.8	5	8	3	4	2	1	5	2	2
C	59.0	2825	94.2	5	3	3	5	7	3	5	3	3
D	60.5	2398	85.8	3	5	1	5	3	1	5	1	1
E	57.8	1920	95.8	6	6	4	6	6	3	5	4	5
F	63.2	690	66.7	8	4	5	3	1	1	5	1	1
G	58.0	3000	105.2	5	7	3	3	3	3	3	3	3
H	59.2	2650	92.2	9	7	3	3	7	1	5	3	3
I	61.7	801	89.0	6	5	6	4	2	1	5	3	4
J	60.8	2386	103.8	2	6	7	5	5	1	5	3	5
K	62.4	810	80.2	6	3	3	3	4	1	5	3	2
Avg.	61.1		89.0	5.5	5.4	4.0	4.1	4.0	1.5	4.6	2.5	2.7
S.D.	2.6		11.1	2.0	1.6	1.8	1.0	2.0	0.9	0.8	1.0	1.5

HAVRE (H-7)

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	66.5	882	92.5	6	6	5	5	4	5	4	4	2
B	72.2	910	90.7	7	8	4	6	5	6	5	3	4
C	64.0	3050	98.4	9	9	5	5	5	5	5	5	5
D	66.1	2589	96.9	9	5	5	7	3	5	7	5	7
E	62.1	2045	95.7	9	7	5	5	5	5	5	3	4
F	69.9	880	87.1	9	6	5	3	5	6	5	3	4
G	62.0	3148	96.8	9	9	5	5	3	5	5	5	5
H	63.5	2850	98.3	9	7	7	3	5	5	5	5	5
I	65.0	1005	94.3	7	6	5	4	4	5	5	3	3
J	65.1	2636	103.3	9	7	5	5	5	6	6	5	6
K	64.8	970	91.9	7	5	8	3	5	5	5	4	4
Avg.	**65.6**		**95.1**	**8.2**	**6.8**	**5.4**	**4.6**	**4.5**	**5.3**	**5.2**	**4.1**	**4.5**
S.D.	**3.1**		**4.4**	**1.2**	**1.4**	**1.1**	**1.3**	**0.8**	**0.5**	**0.8**	**0.9**	**1.4**

MINOT (M-7)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Quality Score Compared to Check (LCS Rebel): Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	63.4	759	80.4	5	6	6	3	3	1	2	1	1
B	67.7	802	85.0	6	8	3	6	4	2	3	3	4
C	58.0	2700	96.4	9	7	5	5	7	4	5	5	5
D	61.6	2417	94.0	5	4	3	3	3	1	3	3	1
E	58.9	1873	90.7	9	6	8	7	9	3	4	3	4
F	65.4	745	74.1	9	5	4	1	2	1	3	1	2
G	59.0	2927	101.0	9	7	5	3	3	3	3	5	3
H	60.5	2650	97.2	9	5	5	3	9	1	5	5	5
I	62.5	885	81.0	7	6	6	3	4	1	3	2	2
J	61.9	2290	102.6	6	6	6	3	5	2	4	5	3
K	61.5	865	79.7	6	3	4	2	3	2	4	2	2
Avg.	**61.9**		**89.3**	**7.3**	**5.7**	**5.0**	**3.5**	**4.7**	**1.9**	**3.5**	**3.2**	**2.9**
S.D.	**2.9**		**9.7**	**1.7**	**1.4**	**1.5**	**1.8**	**2.5**	**1.0**	**0.9**	**1.6**	**1.4**

SWQC #8 – NDHRS14-0134-C03

WATERTOWN (B-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	71.1	865	91.4	4	7	5	5	6	4	3	4	4
B	72.2	927	96.3	5	8	4	4	4	4	4	5	4
C	62.0	2875	101.8	9	9	5	5	5	5	5	5	5
D	69.7	2501	90.0	9	3	3	7	7	3	3	1	1
E	67.1	1982	94.9	8	7	7	4	5	4	4	5	5
F	70.8	920	90.2	6	6	5	7	3	4	4	4	4
G	67.0	3089	108.8	9	9	7	5	7	5	5	7	7
H	68.1	2825	97.4	9	5	7	5	5	3	5	5	5
I	68.6	1024	104.3	4	6	6	4	8	6	4	7	5
J	70.1	2414	97.0	8	6	4	5	4	4	4	4	4
K	68.9	1000	95.2	4	6	6	5	4	4	3	4	4
Avg.	68.7		97.0	6.8	6.5	5.4	5.1	5.3	4.2	4.0	4.6	4.4
S.D.	2.8		5.9	2.2	1.8	1.4	1.0	1.6	0.9	0.8	1.6	1.4

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	69.1	886	99.2	4	7	4	5	6	4	3	5	4
B	69.2	901	96.9	5	8	4	5	4	4	3	4	4
C	61.0	2825	94.2	9	9	5	5	5	5	5	5	5
D	69.0	2471	88.4	7	7	3	3	3	3	3	1	1
E	65.0	1972	98.4	6	5	3	6	6	4	4	4	4
F	69.9	925	89.4	6	4	5	7	6	3	4	5	4
G	65.0	3104	108.8	9	9	7	5	5	5	5	7	7
H	66.2	2850	99.1	9	5	5	7	5	3	3	5	5
I	66.9	979	108.8	5	6	6	5	6	3	4	6	5
J	68.1	2373	103.2	6	7	7	6	6	4	4	6	6
K	67.8	1040	103.0	5	5	4	5	5	3	3	5	4
Avg.	67.0		99.0	6.5	6.5	4.8	5.4	5.2	3.7	3.7	4.8	4.5
S.D.	2.6		6.8	1.8	1.7	1.4	1.1	1.0	0.8	0.8	1.5	1.5

HAVRE (H-8)

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	78.1	1031	108.2	7	6	6	5	4	7	4	9	9
B	73.7	1034	103.1	5	9	6	6	4	7	2	6	5
C	66.0	3000	96.8	9	9	5	5	5	5	5	5	5
D	76.0	2505	93.7	9	7	9	7	7	9	1	3	5
E	73.5	1401	65.6	9	9	5	2	2	7	3	1	1
F	81.0	1125	111.4	9	7	5	5	6	8	2	7	7
G	73.0	3044	93.6	9	9	5	5	7	7	5	5	5
H	75.1	2775	95.7	9	7	5	5	3	9	3	5	5
I	73.1	1170	109.8	8	7	7	5	4	1	1	2	1
J	76.5	2538	99.5	9	7	6	7	6	9	3	6	5
K	72.3	1140	108.1	6	7	5	4	4	7	4	5	6
Avg.	**74.4**		**98.7**	**8.1**	**7.6**	**5.8**	**5.1**	**4.7**	**6.9**	**3.0**	**4.9**	**4.9**
S.D.	**3.8**		**12.8**	**1.4**	**1.1**	**1.3**	**1.4**	**1.6**	**2.3**	**1.4**	**2.3**	**2.3**

CROOKSTON (K-8)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Quality Score Compared to Check (Linkert) Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	72.8	877	96.3	4	7	3	5	6	3	3	6	3
B	70.2	895	91.3	5	7	4	5	4	4	3	3	4
C	63.0	2750	94.0	9	9	5	5	5	4	5	5	5
D	71.0	2683	98.5	9	5	5	7	3	3	1	5	1
E	68.0	1829	89.5	5	6	4	3	5	4	5	3	4
F	72.4	985	87.6	6	6	4	3	3	3	2	3	3
G	68.0	2971	103.1	9	9	5	5	5	5	5	5	5
H	69.8	2625	90.5	9	5	7	5	5	3	5	3	3
I	70.3	1028	96.2	5	6	5	5	5	7	3	5	4
J	71.0	2396	105.0	9	4	4	6	6	4	2	6	5
K	70.4	1075	98.6	5	6	7	4	2	4	3	3	3
Avg.	**69.7**		**95.5**	**6.8**	**6.4**	**4.8**	**4.8**	**4.5**	**4.0**	**3.4**	**4.3**	**3.6**
S.D.	**2.7**		**5.6**	**2.1**	**1.6**	**1.3**	**1.2**	**1.3**	**1.2**	**1.4**	**1.3**	**1.2**

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	70.0	926	98.1	4	8	5	6	6	4	2	6	4
B	69.7	967	102.5	5	8	6	5	4	4	2	6	4
C	63.0	2725	97.3	9	7	5	5	5	5	5	5	5
D	68.4	2542	98.9	9	3	9	5	4	3	3	5	3
E	65.8	2075	100.5	9	6	8	7	7	5	4	3	4
F	72.0	1000	99.5	7	8	5	3	3	4	4	3	4
G	66.0	3074	106.1	9	7	5	5	5	5	3	7	5
H	67.2	2725	100.0	9	7	7	3	7	5	5	5	5
I	68.2	1075	98.4	6	6	6	4	6	6	2	5	3
J	68.8	2225	99.6	9	6	8	6	6	4	4	5	6
K	68.5	1090	100.5	5	5	6	6	5	4	4	6	5
Avg.	**68.0**		**100.1**	**7.4**	**6.5**	**6.4**	**5.0**	**5.3**	**4.5**	**3.5**	**5.1**	**4.4**
S.D.	**2.4**		**2.4**	**2.0**	**1.5**	**1.4**	**1.3**	**1.3**	**0.8**	**1.1**	**1.2**	**0.9**

SWQC #9 – MT 2030

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	71.5	951	99.8	4	6	3	5	6	5	4	6	4
B	71.7	946	94.3	4	8	3	4	4	6	5	4	4
C	64.0	2875	92.7	9	9	5	5	5	5	5	5	5
D	70.0	2795	104.6	7	5	1	5	7	7	5	7	7
E	66.9	2030	95.0	7	7	3	6	4	5	5	4	4
F	72.0	990	98.0	5	7	3	5	7	6	5	5	5
G	67.0	3104	95.4	9	9	5	5	5	5	5	5	5
H	68.3	2850	98.3	9	7	3	5	3	5	5	5	5
I	68.3	1161	108.9	4	6	3	5	7	3	5	6	6
J	69.9	2402	94.2	8	7	5	6	7	6	5	3	6
K	67.6	1075	101.9	3	5	4	5	5	6	5	5	5
Avg.	68.8		98.5	6.3	6.9	3.5	5.1	5.5	5.4	4.9	5.0	5.1
S.D.	2.5		5.0	2.3	1.4	1.2	0.5	1.4	1.0	0.3	1.1	0.9

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	68.7	898	95.1	3	7	4	5	5	4	4	3	3
B	70.7	917	97.2	5	7	6	5	4	4	4	4	4
C	63.0	2750	98.2	9	7	5	5	5	5	5	5	5
D	66.7	2635	102.5	5	7	5	5	5	3	3	5	3
E	63.7	1909	92.4	6	5	5	6	7	5	4	3	4
F	71.5	990	98.5	5	4	4	5	5	4	4	5	5
G	64.0	2986	103.1	9	7	5	5	5	5	3	7	5
H	65.5	2900	106.4	9	5	3	5	5	5	5	7	5
I	66.0	1101	100.8	4	6	4	4	4	6	4	4	4
J	66.7	2231	99.9	9	6	6	5	5	4	4	5	5
K	67.1	1040	95.9	4	3	4	5	5	4	4	4	4
Avg.	66.7		99.1	6.2	5.8	4.6	5.0	5.0	4.5	4.0	4.7	4.3
S.D.	2.7		4.0	2.4	1.4	0.9	0.4	0.8	0.8	0.6	1.3	0.8

Hard Red Spring Wheat Breeding Quality Target Values

	Quality Parameter	Target Value*
Wheat	Test Weight (lb/bu, Grading Factor)	60
	Protein (%, 12% mb)	14.5
	Ash (%, 14% mb)	< 1.65
	Vitreousness (% dark, hard & vitreous, DHV)	80
	1000 Kernel Weight (g)	> 31
	Falling Number (sec)	400
	Wheat Hardness (SKCS)	80
	Wheat Hardness (NIR)	70
Milling	Flour Extraction:	
	Buhler Lab Mill (%, 0.48% ash)	70
	Quadrumat Senior (%, 0.48% ash)	70
	Protein Loss (%)	< 1.0
Flour	Ash (%, 14% mb)	0.48
	Color (*L** value)	90
	Wet Gluten (%, 14% mb, 13.5% protein)	36
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.