Wheat Quality Council

Hard Spring Wheat Technical Committee

2022 Crop

February 22-24, 2023

Olathe, KS

Wheat Quality Council

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Sponsored by the Wheat Quality Council
February 22-24, 2023

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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.

Nine experimental lines of hard spring wheat were grown at up to six locations in 2022 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 2022 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 2022 Wheat Quality Testing Program

Wheat Source

Source/Breeding Program	SWQC Code #	Identification
South Dakota State University	1	Brawn-SD
Limagrain Cereal Seeds	2	LARR19-0024
North Dakota State University	3	NDHRS11-0244-0001
University of Minnesota	4	Linkert (Eastern Check)
North Dakota State University	5	NDHRS13-0273-0036
Syngenta	6	AP Revolution
University of Minnesota	7	MN18032-5
Montana State University	8	MT1939
21st Century Genetics	9	T18C904
Limagrain Cereal Seeds	10	LCS Rebel (Western Check)
21st Century Genetics	11	T18C905

Field Plot Locations and Procedures

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

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

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

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

Field Production Data

Variable	Watertown	Casselton	Havre	Crookston	Minot	Williston
Planting Date	05/06/2022	05/28/2022	05/03/2022	05/24/2022	06/01/2022	05/17/2022
Harvest Date	09/01/2022	09/02/2022	08/11/2022	08/30/2022	09/08/2022	09/05/2022
Fertilizer (lb/acre)						
N	200	120	100	180	138	110 (available N)
P	*	*	20	*	48	24 ppm
K	50	*	10	*	450	500 ppm
Herbicide(rate/acre)						
Broadleaf	Bronate (1.5 pt)	Huskie (15 oz)	Vendetta (16 oz)	Huskie C. (13.7 oz)	Huskie FX (16 oz)	Bronate (24 oz) Starane†
Grass	Parity (0.66 pt)	Axial Bold (15 oz)	*	*	Opensky (16 oz)	Parity (8 oz)
Fungicide	*	Propimax (2 oz) Prosaro (6.5 oz)	Prosaro (5 oz)	Tilt (4 oz)	Prosaro (8 oz)	Prosaro (8 oz)

*No application.
†Application rate not available.

CLIMATOLOGICAL DATA						
	Average Temperature (°F) / Precipitation (in)					
Month	**Watertown**	**Casselton**	**Havre**	**Crookston**	**Minot**	**Williston**
April	35.0 / 2.03	35.1 / 5.59	37.4 / 0.17	33.7 / 3.43	32.0 / 2.44	34.0 / 1.69
May	55.0 / 4.98	54.7 / 4.99	52.7 / 0.41	54.3 / 4.49	53.0 / 2.44	54.0 / 5.59
June	69.0 / 0.63	69.0 / 3.79	61.4 / 3.18	66.5 / 3.15	64.0 / 1.55	64.0 / 1.83
July	71.0 / 2.92	71.3 / 1.98	71.4 / 1.75	70.1 / 1.78	69.0 / 3.09	71.0 / 1.91
August	69.0 / 1.62	68.3 / 1.68	73.8 / 0.60	67.9 / 0.57	69.0 / 0.67	72.0 / 0.57

YIELD DATA						
	Yield (bu/acre) / Test Weight (lb/bu) / Moisture (%)					
SWQC Code #	**Watertown**	**Casselton**	**Havre**	**Crookston†**	**Minot**	**Williston**
1	30.7 / 55.3 / 11.8	75.4 / 62.1 / 12.9	*	80.7 / 62.0 / 14.8	*	*
2	26.5 / 52.1 / 11.4	71.9 / 61.9 / 13.1	19.6 / 62.0 / 9.3	74.8 / 61.6 / 14.1	69.8 / 61.6 / 13.5	32.7 / 60.4 / 11.5
3	*	*	*	*	61.6 / 56.3 / 13.4	33.4 / 58.1 / 11.6
4	33.8 / 54.3 / 11.9	69.8 / 61.1 / 13.1	*	80.1 / 60.5 / 13.9	*	*
5	*	77.8 / 61.3 / 12.6	*	84.0 / 58.7 / 13.9	*	*
6	46.1 / 55.1 / 11.1	78.2 / 59.9 / 12.8	*	90.2 / 54.4 / 13.7	*	*
7	38.7 / 53.9 / 10.3	77.7 / 62.6 / 12.4	*	92.3 / 61.2 / 14.5	69.9 / 58.4 / 13.0	*
8	*	*	29.1 / 60.9 / 9.3	*	74.9 / 59.4 / 13.9	36.2 / 61.3 / 11.1
9	*	78.7 / 60.8 / 12.9	*	99.8 / 60.4 / 14.8	75.9 / 60.2 / 13.4	37.5 / 60.9 / 11.4
10	*	*	29.0 / 61.2 / 9.5	*	69.9 / 62.0 / 13.1	36.8 / 61.1 / 11.5
11	*	76.6 / 59.5 / 13.5	*	86.7 / 59.8 / 14.7	72.5 / 58.7 / 13.0	35.2 / 59.9 / 11.3
Site Totals	**5**	**8**	**3**	**8**	**7**	**6**

†At time of delivery, moisture contents of Crookston samples were, on average, 14.3% and thus had to be dried down prior to analysis.
*Not increased at this site.

Climate, Disease, and Field Conditions

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

	Watertown	Casselton	Havre	Crookston	Minot	Williston
At Planting	The usual planting date of April was extremely wet and cool. Planting conditions were marginal at best in early May when the plot was planted.	Late planting. Field was dry at planting. Good soil moisture conditions for planting. Emergence and stand were very good.	It was very dry at seeding, even on fallow. We struggled with lack of precipitation and had spotty emergence until mid-June.	Ideal conditions. Soil moisture was good.	Planted 2 weeks later than normal. However, planting conditions were very good.	Ideal planting conditions; full soil profile.
During Growth	The month of May was also cool and wet, which slowed growth from the late planting. June was very hot and dry.	Warm conditions with plentiful rain early in the season resulting in good crop development.	Following 1.95" of precipitation between June 5 and 8, ungerminated wheat emerged and filled in all of the blank areas. No disease issues at Havre in 2022.	Conditions were good up until mid-July. Rain stopped. Nights were humid, increasing the chance of disease.	Good growing conditions. No issues.	May and June were excellent luxury consumption.
At Flowering	Conditions in early July at flowering were dry with no threat of Fusarium infection.	Some rain but not enough excess moisture to be concerned with Fusarium infection.	A cooler than normal late June through July gave the late emerging plants time to catch up, head, flower, and produce seeds prior to the heat hitting.	Tilt was applied at 4 fl oz. Didn't see much for disease at this time.	Good growing conditions. Conditions were favorable for FHB.	Conditions becoming hot and dry; crop stressing.
During Maturation	Grain fill was hot and dry, which created limited grain fill and thus, the low yields.	Matured evenly and dried down for a good harvest.	Nothing notable.	Disease was noticed on August 3rd. All the entries had disease in them.	Good growing conditions.	Hot, dry, and windy. Thus, contributing to lower test weight.
At Harvest	Harvest conditions were delayed with rainfall, which reduced test weight.	Harvested the grain dry at approx. 13% moisture. Good harvest conditions.	Nothing notable. No rain that would have any impact on Falling Numbers. Wheat stem sawfly cutting: #2 (15%); #8 (5%); #10 (35%). We harvest in such a way (low and slow) with our plot combine that all cut and lodged stems are picked up in order to achieve maximum yields. Farmers would not achieve the yields that we have at the higher cutting rates.	Ideal for small grain harvest.	Hot and dry conditions were favorable for harvest.	Hot and dry. All varieties threshed like butter.

Description of 2022 Hard Spring Wheat Lines

SWQC #1 – Brawn-SD

'Brawn-SD' (SD4843) is a hard red spring wheat breeding line developed by the South Dakota State University HRS wheat breeding program. It was derived as a single spike from within an F_4 population (SD4507/SD4416) that was originally created in spring 2014. During early-generation observation, the population was tested as 31745 and renamed SD4843 with its placement into the 2018 Preliminary Yield Trial. 'Brawn-SD' was evaluated in Advanced Yield Trials from 2019 through 2022. During 2021 and 2022, 'Brawn-SD' was tested in both the Uniform Regional Spring Wheat Nursery and the South Dakota Crop Performance Testing trials.

Points of note associated with 'Brawn-SD' include:

1. Excellent yield potential;
2. High test weight;
3. Moderate resistance to Fusarium head blight and bacterial leaf streak;
4. Competitive end-use quality performance.

SWQC #2 – LARR19-0024

LARR19-0024 is a hard red spring wheat variety developed by Limagrain Cereal Seeds. LARR19-0024 is an early maturing wheat line similar to 'LCS Cannon.' It is adapted from western North Dakota to the Red River Valley, has good straw strength, excellent grain yield and consistent protein. In addition, LARR19-0024 has good resistance to stem rust, stripe rust and leaf rust and moderate resistance to fusarium head blight. LARR19-0024 has desirable overall end-use quality. Plant Variety Protection will be applied for.

SWQC #3 – NDHRS11-0244-0001

NDHRS11-0244-0001 is a late maturing line with short plant stature and high yield potential. Its pedigree contains an unreleased NDSU experimental, ND822 and the cultivar 'Velva'. It performed well in drier conditions of 2021, and has adequate resistance to Fusarium head blight, and is moderately resistant to bacterial leaf streak. At the time of this publication, it was being considered for variety release.

SWQC #5 – NDHRS13-0273-0036

NDHRS13-0273-0036 is a late maturing line with short plant stature, good straw strength, and yields well in Eastern North Dakota. It is moderately resistant to bacterial leaf streak and has moderate resistance to Fusarium head blight. Its pedigree contains the cultivars 'Faller' and 'Bolles'. At the time of this publication, it was being considered for variety release.

SWQC #6 – AP Revolution

'AP Revolution' is a hard red spring wheat bred and developed by Syngenta Crop Protection, LLC adapted for the Northern Plains, particularly South Dakota in the U.S. It has early heading, similar to 'AP Murdock' with high test weight. It is a standard semi-dwarf, similar in height to 'SY Soren.' Straw strength is moderate to strong. Disease resistance is intermediate for Foliar Diseases and Fusarium head blight. Protein levels are moderately high, similar to 'SY Ingmar.' Overall, breadmaking characteristics are very good.

SWQC #7 – MN18032-5

MN18032-5 (Albany/Faller//Lang-MN) is a medium-late maturing line with above average yield, protein, and test weight. Straw strength is good, comparable to or better than current varieties. MN18032-5 is moderately resistant (rated 4 on 1-9 scale) to scab and bacterial leaf streak, but moderately susceptible (6) to leaf rust.

SWQC #8 – MT1939

MT1939 is a hard red spring wheat under consideration for release by the Montana Agricultural Experiment Station. MT1939 has high yield potential in Montana's rainfed environments and has done well relative to other varieties under drought conditions. MT1939 has good grain protein content, test weight and aluminum tolerance. MT1939 is also semi-solid and moderately resistance to wheat stem sawfly. MT1939 was selected from the cross Lanning///MT1018//Choteau/Yellowstone.

SWQC #9 – T18C904

T18C904 is hard red spring wheat (HRS) developed by 21st Century Genetics Corp (TCG). It was developed from the cross TCG-Spitfire x SY Valda. It is a medium height, medium maturity variety with excellent standability under high yields. Protein and test weight are medium high. It has a general MS reaction to the diseases of the Northern Great Plains (NGP). So, fungicide is a must for best results. It is a high-yielding management HRS adapted to the Red River Valley (RRV) area of ND and MN. It has tolerance to bacterial leaf streak (BLS) and tolerance to preharvest sprouting, maintaining acceptable Falling Numbers. Bread-making quality is good.

SWQC #11 – T18C905

T18C905 is hard red spring wheat (HRS) developed by 21st Century Genetics Corp (TCG). It was developed from the cross TCG-Spitfire x SY Valda. It is a medium short height, medium early variety with excellent standability under high yields. Protein and test weight are medium high. It has a general MS reaction to the diseases of the Northern Great Plains (NGP), so fungicide is a must for best results. It is a high-yielding management HRS adapted to the Red River Valley (RRV) area of ND and MN. It has tolerance to preharvest sprouting, maintaining acceptable Falling Numbers. Bread-making quality is good.

Wheat Production Sites

SWQC Code #	Entry	Source	Production Sites					
			Watertown	Casselton	Havre	Crookston	Minot	Williston
1	Brawn-SD	South Dakota State University	X	X		X		
2	LARR19-0024	Limagrain Cereal Seeds	X	X	X	X	X	X
3	NDHRS11-0244-0001	North Dakota State University					X	X
4	Linkert	Eastern Check	X	X		X		
5	NDHRS13-0273-0036	North Dakota State University		X		X		
6	AP Revolution	Syngenta	X	X		X		
7	MN18032-5	University of Minnesota	X	X		X	X	
8	MT1939	Montana State University			X		X	X
9	T18C904	21st Century Genetics		X		X	X	X
10	LCS Rebel	Western Check			X		X	X
11	T18C905	21st Century Genetics		X		X	X	X

Grain Cleaning and Milling Procedures

Wheat with moisture content above 13.5% were placed in a drier (90º 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 (110 lbs) was tempered to 16.5% moisture content and conditioned for approximately 20-24 hours before milling. Milling was performed on the Miag Multomat. Feed rate was set at 180 lbs/hour. Break rollers were adjusted to the following releases through a U.S. 16 S.S. sieve: first break – 30%; second break – 53%; and third break, clean-up – 66%.

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

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

Methods of Analysis

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

- Flour extraction: % Total product basis (TPB), % tempered wheat basis (TWB), and estimated pounds patent flour/bushel wheat;

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

- Farinograph (AACCI Method 54-21, Brabender Computerized Farinograph system with 50 g mixing bowl):

    - Water absorption: 500 BU and 14% mb;

    - Arrival time: time required for the top of the curve to reach the 500 BU line after addition of water;

    - Peak time: time between addition of water and development of the maximum consistency of the dough;

    - Stability: difference in time between the point at which the top of the curve first intercepts the 500 BU line (arrival time) and the point at which the top of the curve leaves the 500 BU line (departure time);

    - Mechanical Tolerance Index (MTI): difference in BU between the top of the curve at the peak and the top of the curve measured 5 minutes after the peak is reached;

    - Time to Breakdown (TTB): time from the start of mixing to the time at which consistency has decreased 30 BU from the peak point.

- Mixograph (AACCI Method 54-40A, with 35 g mixing bowl):

    - Water absorption (14% mb) = Protein (14% mb) x 1.5 + 43.6
      (The Mixograph Handbook, 1997).

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

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

    - Dough was scaled to 150 g, rounded, molded, placed in extensograph holders, and rested for 45, 90, and 135 minutes at 30°C and 78% relative humidity. The dough was then stretched as described in the procedure referenced above. For conversion purposes, 500 g = 400 BU;

    - Extensograph parameters:

        - Energy (cm^2): area under the curve;

        - Resistance to extension (BU): height of the curve 50 mm after the beginning of torque increase;

        - Extensibility (cm): total length of the curve at the baseline;

- Maximum resistance (BU): maximum curve height;
- Ratio number: quotient of resistance to extension and extensibility;
- Ratio number (max.): quotient of maximum resistance and extensibility.

Test Bake Procedures

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

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

Bake Cooperators

- ADM Milling – Overland Park, KS;
- Ardent Mills – Denver, CO;
- Bay State Milling, Quincy, MA;
- General Mills – Minneapolis, MN;
- Grain Craft – Manhattan, KS;
- Great Plains Analytical Laboratory – Kansas City, MO;
- North Dakota Mill, Grand Forks, ND;
- 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 2022 Hard Spring Wheat Lines

SWQC #1 – Brawn-SD

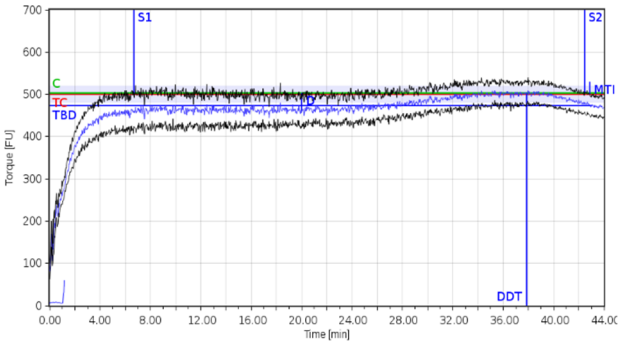
		Watertown		Casselton		Crookston	
		Linkert		Linkert		Linkert	
	Quality Trait	B-4	B-1	C-4	C-1	K-4	K-1
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	17.0	15.5	14.3	14.5	15.8	13.8
2	Flour Protein (%, 14% mb)	16.2	14.0	13.2	12.9	14.5	12.5
3	Market Value (Score 1-6)	3.0	3.0	4.5	4.4	5.3	4.5
4	Market Value (Score 1-10)	10.0	8.8	10.0	9.6	10.0	7.4
5	DON (ppm)	0.70	1.20	nd	0.05	0.10	0.10
6	Test Weight (lb/bu)	56.9	57.9	61.7	62.8	63.0	64.5
7	1000 Kernel Weight (g)	25.9	26.0	34.8	31.0	34.8	34.8
8	Kernel Size, Large (%)	39	43	76	71	78	79
9	Kernel Size, Small (%)	17	16	6	7	6	5
10	Wheat Moisture (%)	12.6	12.4	12.8	12.8	12.8	12.8
11	Wheat Ash (%, 14% mb)	1.91	1.82	1.54	1.56	1.53	1.39
12	Wheat Falling Number (s)	373	376	406	394	430	375
13	SKCS Hardness Index	72.9	72.3	70.6	68.4	75.1	72.5
14	Vitreous Kernels (%)	52	55	42	22	69	55
	Flour Extraction						
15	Tempered Wheat Basis (%)	69.4	71.8	73.2	71.2	72.1	73.9
16	Total Product Basis (%)	70.8	73.4	74.8	73.3	74.4	75.7
17	Flour/Bu Wheat (lb)	39.9	42.3	45.7	45.3	46.3	48.2
	Flour Quality						
18	Flour Color Brightness (*L**)	88.5	88.5	90.3	89.7	90.7	90.2
19	Flour Color Yellowness (*b**)	8.9	11.4	8.9	12.1	8.7	11.7
20	Flour Moisture (%)	13.4	13.8	14.1	13.8	14.2	13.8
21	Flour Ash (%, 14% mb)	0.59	0.54	0.49	0.44	0.47	0.43
22	Flour Falling Number (malted, s)	252	253	250	252	248	256
	Farinograph						
23	Water Absorption (%, 500 BU)	63.7	59.4	61.3	60.3	63.6	61.9
24	Water Absorption (%, 14% mb)	63.3	59.2	61.5	59.9	63.8	61.7
25	Arrival Time (min)	6.7	2.1	2.3	3.7	4.2	3.3
26	Peak Time (min)	37.9	9.6	9.4	8.2	27.9	9.8
27	Dough Stability (min)	35.8	38.2	29.9	24.4	28.1	17.8
28	Mixing Tolerance Index (MTI, BU)	30	15	10	11	31	20
29	Time To Breakdown (TTB, min)	43.1	41.0	33.3	30.4	33.2	25.6
	II. Cooperator Results						
30	Bake Absorption (Average %)	66.9	63.4	64.9	63.9	67.3	65.5
31	Loaf Volume (% of Check)		98.6		98.2		94.4

SWQC #1 – Brawn-SD

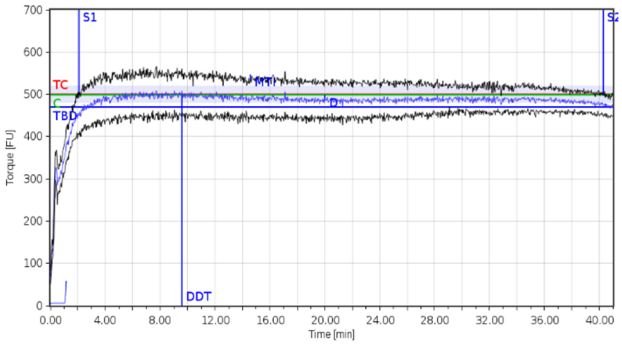
	Quality Trait	Watertown Linkert B-4	Watertown Linkert B-1	Casselton Linkert C-4	Casselton Linkert C-1	Crookston Linkert K-4	Crookston Linkert K-1
	II. Cooperator Results						
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	8.2	7.4	7.2	6.7	7.4	6.0
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.5	6.3	5.8	5.5	6.5	5.3
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		4.8		4.9		4.1
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.6		4.2		3.9
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.6		4.7		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		3.9		4.9		2.6
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		6.1		4.5		6.0
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.5		4.4		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		5.0		4.8		3.6

Farinograms

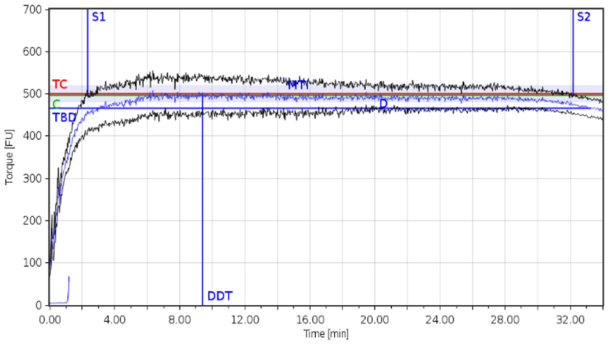
Linkert Check (Watertown, B-4)



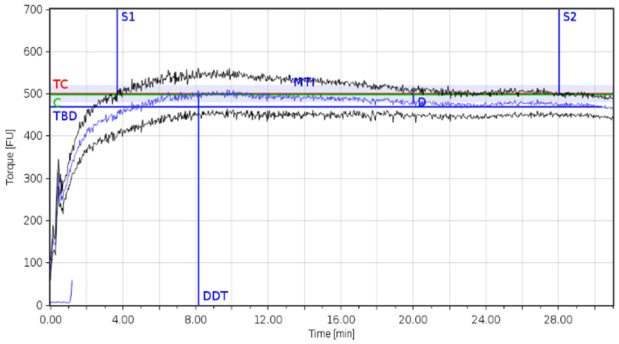
Brawn-SD (Watertown, B-1)



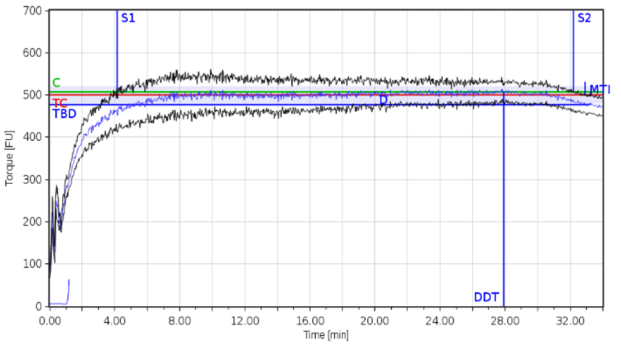
Linkert Check (Casselton, C-4)



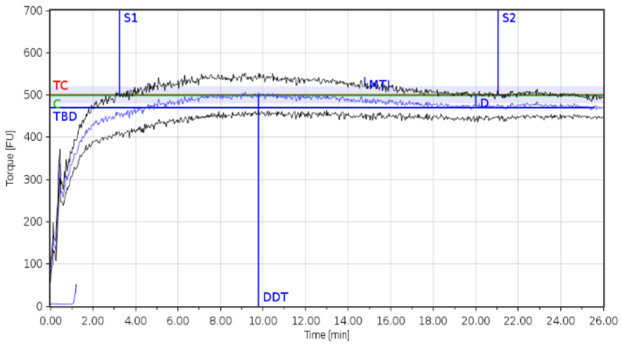
Brawn-SD (Casselton, C-1)



Linkert Check (Crookston, K-4)

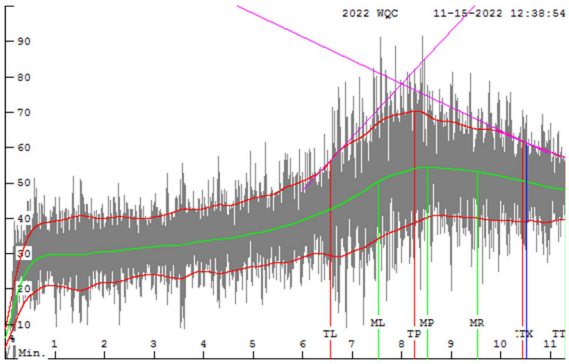


Brawn-SD (Crookston, K-1)

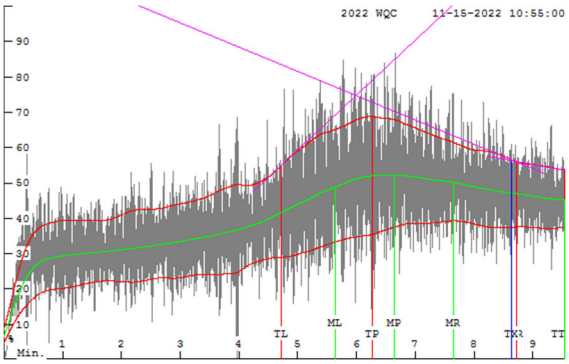


Mixograms

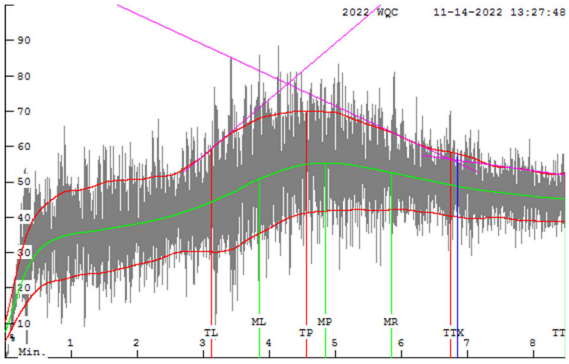
Linkert Check (Watertown, B-4)



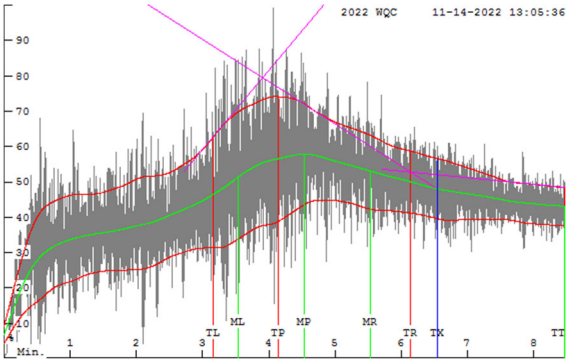
Brawn-SD (Watertown, B-1)



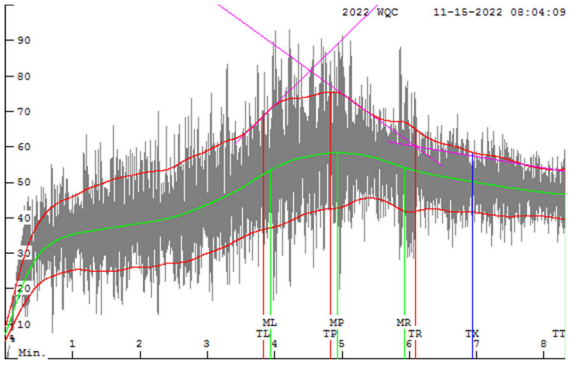
Linkert Check (Casselton, C-4)



Brawn-SD (Casselton, C-1)



Linkert Check (Crookston, K-4)



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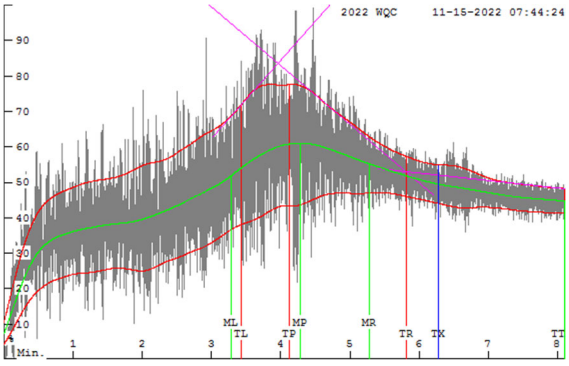
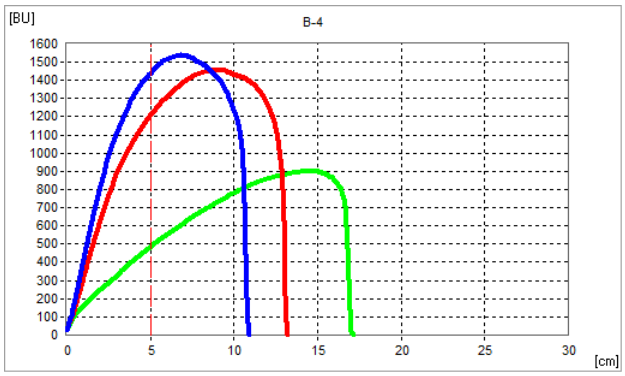
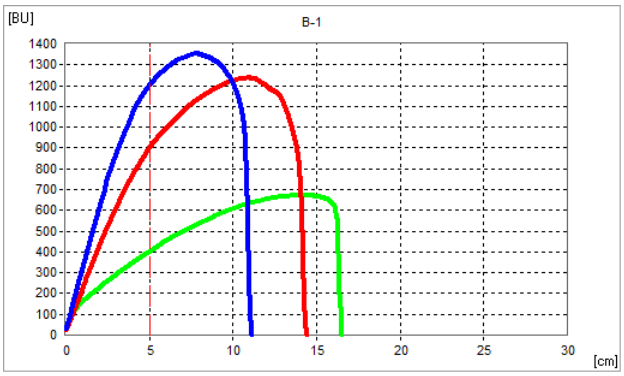


Extensograms

Linkert Check (Watertown, B-4)



Brawn-SD (Watertown, B-1)



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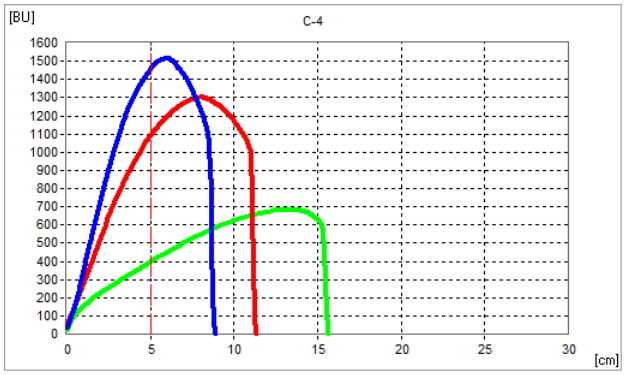
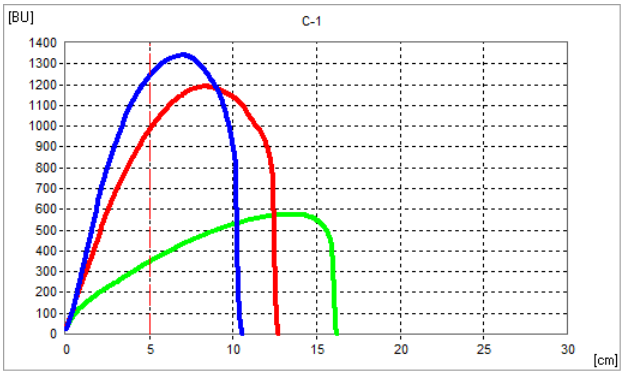
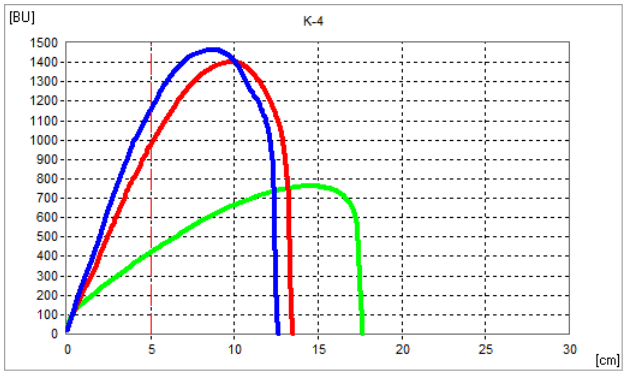


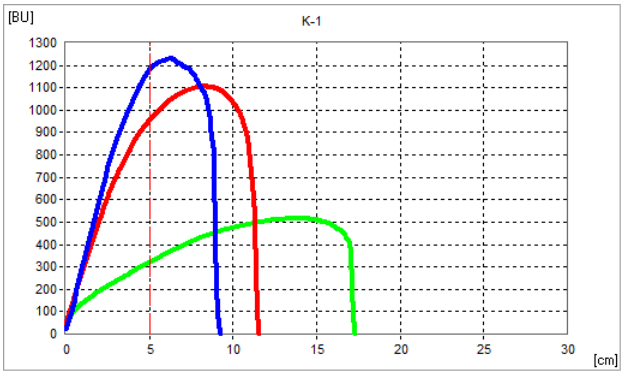
Brawn-SD (Casselton, C-1)



Linkert Check (Crookston, K-4)



Brawn-SD (Crookston, K-1)



45 min; 90 min; 135 min

SWQC #2 – LARR19-0024

		Watertown		Casselton		Havre		Crookston		Minot		Williston	
	Quality Trait	Linkert B-4	B-2	Linkert C-4	C-2	LCS Rebel H-10	H-2	Linkert K-4	K-2	LCS Rebel M-10	M-2	LCS Rebel W-10	W-2
	I. USDA-ARS WQL Data												
1	Wheat Protein (%, 12% mb)	17.0	16.5	14.3	14.3	17.3	17.2	15.8	15.1	15.8	16.5	14.8	14.3
2	Flour Protein (%, 14% mb)	16.2	15.1	13.2	12.8	16.4	16.2	14.5	13.8	14.7	15.1	13.4	13.3
3	Market Value (Score 1-6)	3.0	2.7	4.5	4.0	5.1	5.0	5.3	4.8	5.2	5.3	4.9	4.2
4	Market Value (Score 1-10)	10.0	9.6	10.0	8.8	10.0	9.8	10.0	8.6	10.0	10.0	10.0	9.2
5	DON (ppm)	0.70	0.95	nd	0.05	0.05	nd	0.10	nd	0.10	0.05	nd	nd
6	Test Weight (lb/bu)	56.9	56.7	61.7	62.6	62.1	62.6	63.0	64.0	63.0	62.9	63.3	62.4
7	1000 Kernel Weight (g)	25.9	23.9	34.8	29.9	27.5	27.1	34.8	32.3	33.7	32.0	31.4	25.6
8	Kernel Size, Large (%)	39	28	76	62	22	17	78	70	70	59	46	15
9	Kernel Size, Small (%)	17	24	6	10	19	23	6	8	7	10	11	23
10	Wheat Moisture (%)	12.6	12.4	12.8	12.8	9.4	9.3	12.8	13.0	10.8	10.7	11.4	11.7
11	Wheat Ash (%, 14% mb)	1.91	1.86	1.54	1.50	1.36	1.48	1.53	1.39	1.62	1.58	1.44	1.49
12	Wheat Falling Number (s)	373	341	406	367	431	431	430	383	426	431	436	413
13	SKCS Hardness Index	72.9	73.4	70.6	67.2	71.8	79.9	75.1	71.5	62.6	66.8	70.6	77.1
14	Vitreous Kernels (%)	52	47	42	38	98	86	69	48	88	52	97	92
	Flour Extraction												
15	Tempered Wheat Basis (%)	69.4	67.2	73.2	73.2	72.8	70.7*	72.1	73.0	74.3	73.2	74.2	71.1
16	Total Product Basis (%)	70.8	69.2	74.8	74.7	74.9	72.3*	74.4	74.8	76.0	75.0	75.7	73.0
17	Flour/Bu Wheat (lb)	39.9	38.6	45.7	46.2	45.8	44.8*	46.3	47.1	47.4	46.7	47.9	45.0
	Flour Quality												
18	Flour Color Brightness (*L**)	88.5	88.1	90.3	90.1	90.3	90.1	90.7	90.4	90.7	90.5	90.7	90.7
19	Flour Color Yellowness (*b**)	8.9	10.5	8.9	10.6	9.6	9.5	8.7	10.0	8.9	9.5	9.1	9.6
20	Flour Moisture (%)	13.4	13.5	14.1	13.5	13.4	13.4	14.2	13.6	13.3	13.5	13.0	12.8
21	Flour Ash (%, 14% mb)	0.59	0.56	0.49	0.46	0.42	0.51	0.47	0.44	0.48	0.50	0.44	0.49
22	Flour Falling Number (malted, s)	252	254	250	253	248	247	248	248	250	255	255	246
	Farinograph												
23	Water Absorption (%, 500 BU)	63.7	60.2	61.3	61.5	65.8	64.8	63.6	64.9	63.8	62.9	65.8	63.4
24	Water Absorption (%, 14% mb)	63.3	59.8	61.5	60.9	65.2	64.2	63.8	64.5	63.2	62.5	64.8	62.0
25	Arrival Time (min)	6.7	2.8	2.3	3.1	6.3	5.1	4.2	3.6	2.8	3.8	3.5	3.3
26	Peak Time (min)	37.9	9.1	9.4	8.5	14.6	17.6	27.9	7.1	9.4	9.9	9.7	7.4
27	Dough Stability (min)	35.8	36.1	29.9	11.5	23.3	20.8	28.1	12.7	16.9	20.6	16.9	13.4
28	Mixing Tolerance Index (MTI, BU)	30	8	10	33	3	5	31	26	29	18	16	24
29	Time To Breakdown (TTB, min)	43.1	39.8	33.3	15.5	30.8	26.8	33.2	18.6	18.0	27.4	32.8	18.0

*Received and milled 68 lbs of sample. Minimum of 90 lbs is needed to achieve optimum extraction.

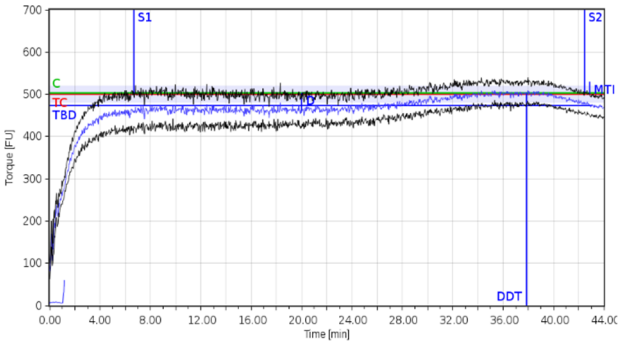
SWQC #2 – LARR19-0024

		Watertown		Casselton		Havre		Crookston		Minot		Williston	
	Quality Trait	Linkert B-4	B-2	Linkert C-4	C-2	LCS Rebel H-10	H-2	Linkert K-4	K-2	LCS Rebel M-10	M-2	LCS Rebel W-10	W-2
	II. Cooperator Results												
30	Bake Absorption (Average %)	66.9	64.1	64.9	64.6	68.9	68.3	67.3	68.2	67.3	66.7	68.1	66.5
31	Loaf Volume (% of Check)		100.6		97.0		102.3		95.6		100.7		102.9
32	Mixing Requirement*	8.2	7.5	7.2	5.1	6.8	6.8	7.4	4.9	7.2	6.1	7.4	6.8
33	Dough Characteristics**	6.5	6.2	5.8	5.2	6.8	6.9	6.5	4.9	7.0	6.5	6.8	6.7
34	Mixing Tolerance†		4.8		3.5		4.5		3.5		4.6		5.3
35	Internal Crumb Color††		5.5		4.3		5.1		4.0		5.0		4.9
36	Internal Crumb Texture‡		4.4		4.9		5.2		4.6		5.0		5.3
	III. Cooperator Evaluation‡												
	Quality Traits 1-2: Protein		4.5		4.7		5.0		3.7		5.3		4.8
	Quality Traits 3-22: Milling		4.4		4.5		4.2		5.1		4.3		3.2
	Quality Traits 23-36: Baking		4.5		3.6		5.2		3.4		5.0		5.0
	Quality Traits 1-36: Overall Comparison		4.5		3.9		4.7		3.7		4.8		4.6

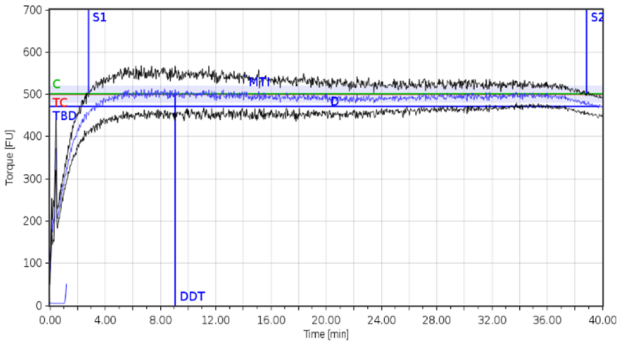
*9 = Very long; 7 = Long; 5 = Medium; 3 = Short; 1 = Very short.
**9 = Bucky – Tough; 7 = Strong – Elastic; 5 = Medium – Pliable; 3 = Mellow – Very Pliable; 1 = Weak – Short or Sticky.
†9 = Much More Tolerance Than Check; 7 = More Tolerance Than Check; 5 = Tolerance Equivalent To Check; 3 = Less Tolerance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

Farinograms

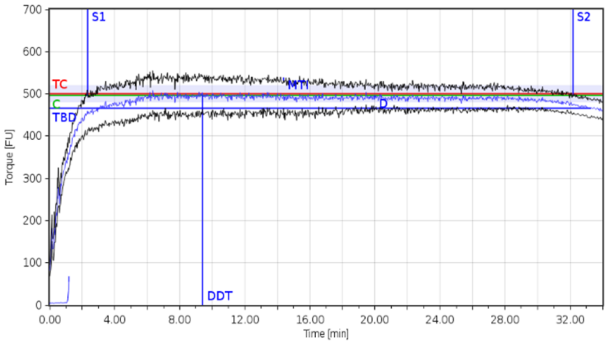
Linkert Check (Watertown, B-4)



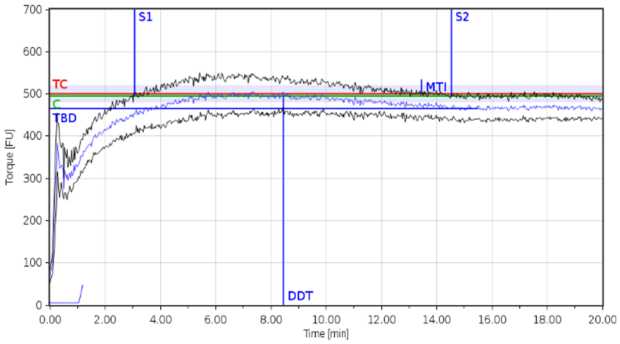
LARR19-0024 (Watertown, B-2)



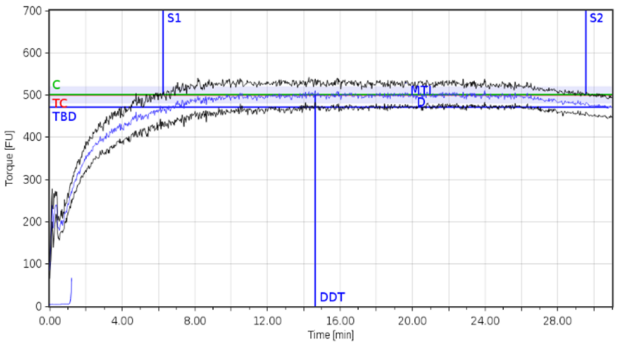
Linkert Check (Casselton, C-4)



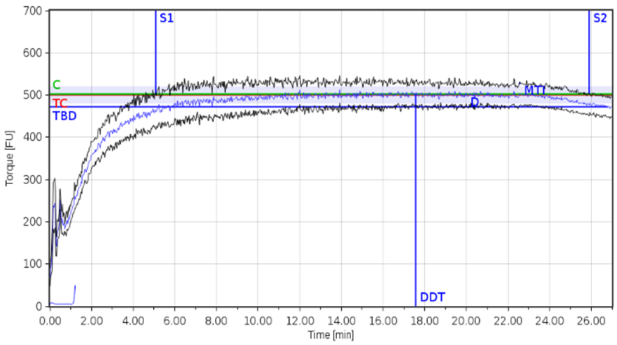
LARR19-0024 (Casselton, C-2)



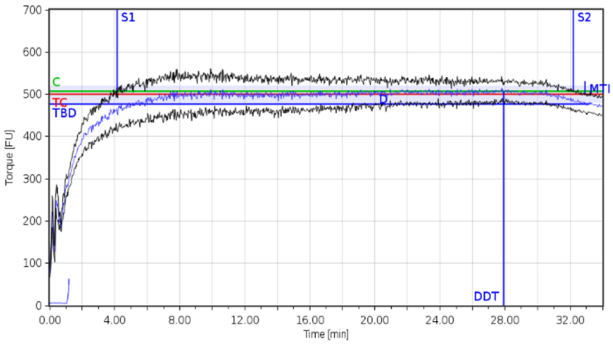
LCS Rebel Check (Havre, H-10)



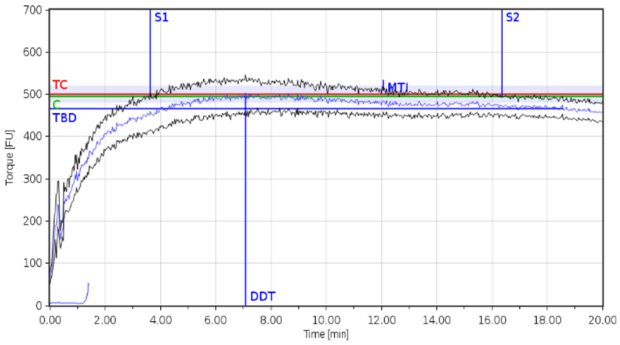
LARR19-0024 (Havre, H-2)



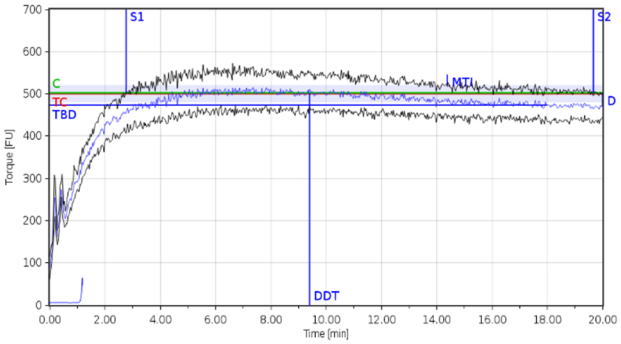
Linkert Check (Crookston, K-4)



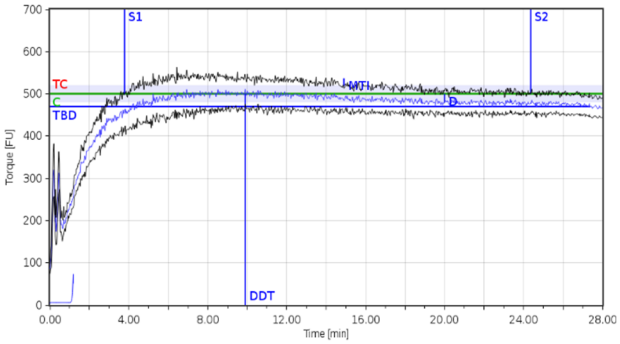
LARR19-0024 (Crookston, K-2)



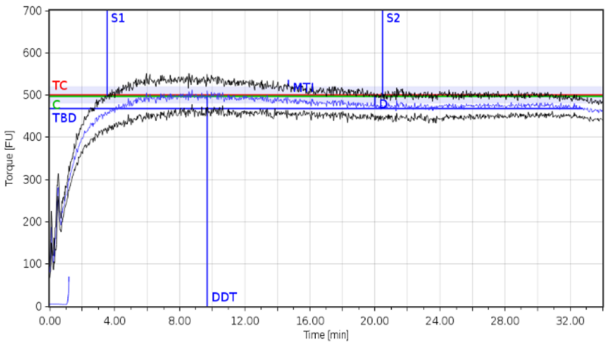
LCS Rebel Check (Minot, M-10)



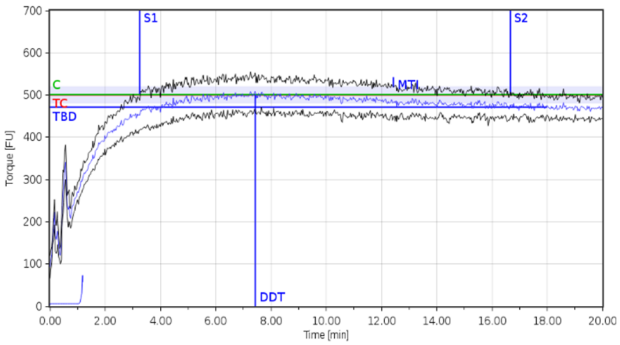
LARR19-0024 (Minot, M-2)



LCS Rebel Check (Williston, W-10)

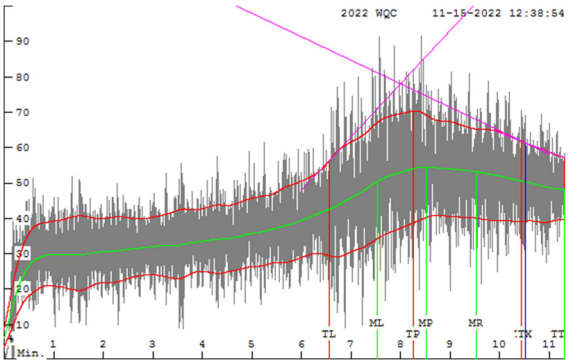


LARR19-0024 (Williston, W-2)

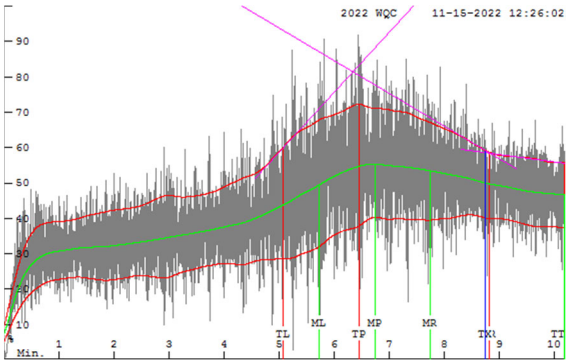


Mixograms

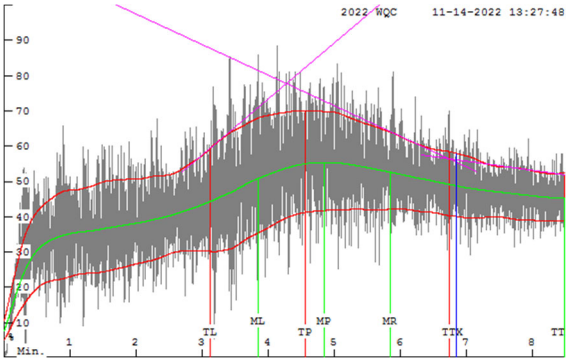
Linkert Check (Watertown, B-4)



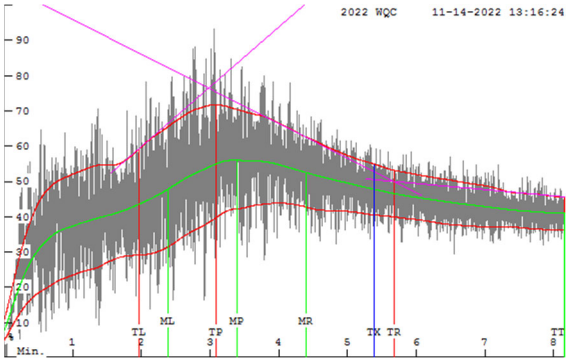
LARR19-0024 (Watertown, B-2)



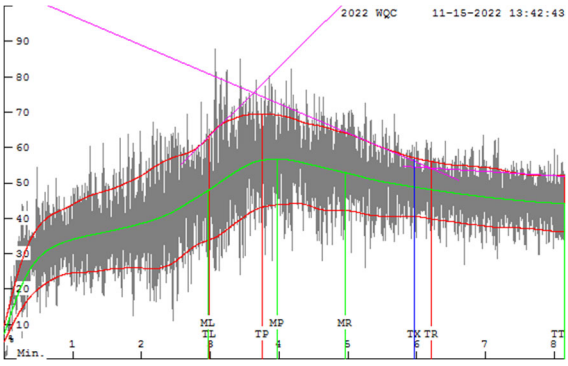
Linkert Check (Casselton, C-4)



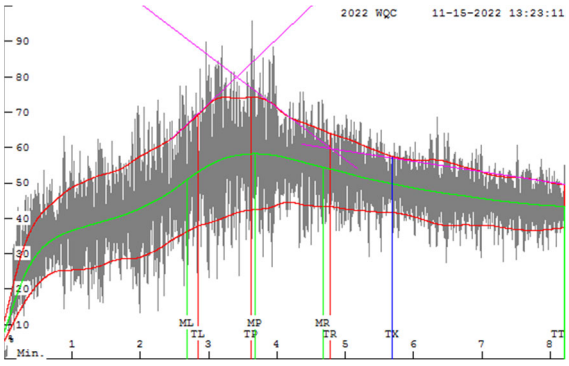
LARR19-0024 (Casselton, C-2)



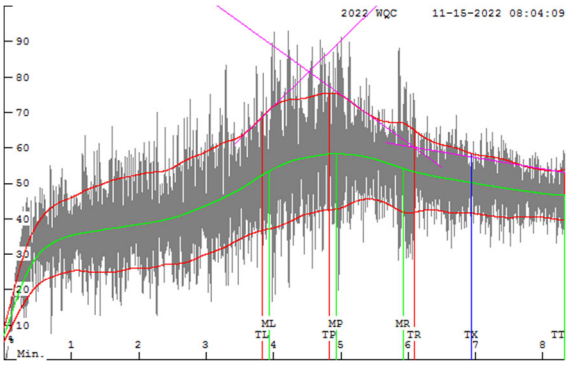
LCS Rebel Check (Havre, H-10)



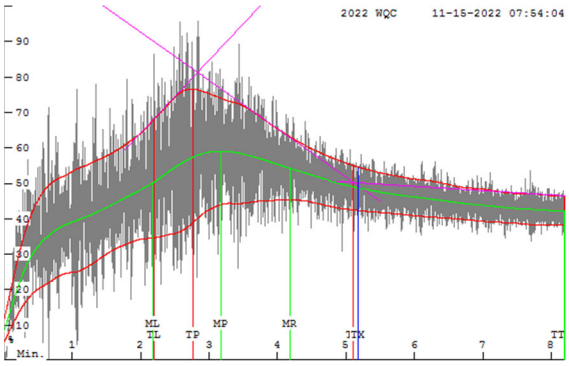
LARR19-0024 (Havre, H-2)



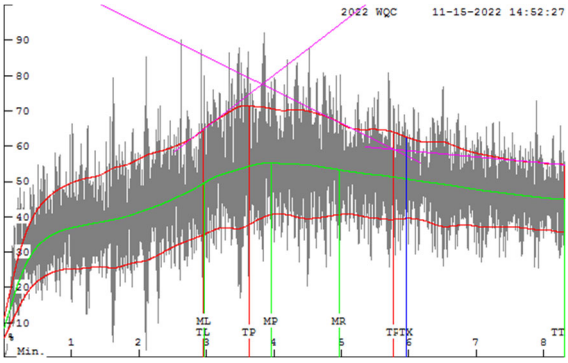
Linkert Check (Crookston, K-4)



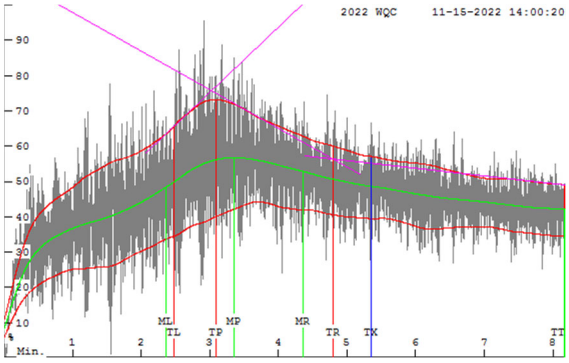
LARR19-0024 (Crookston, K-2)



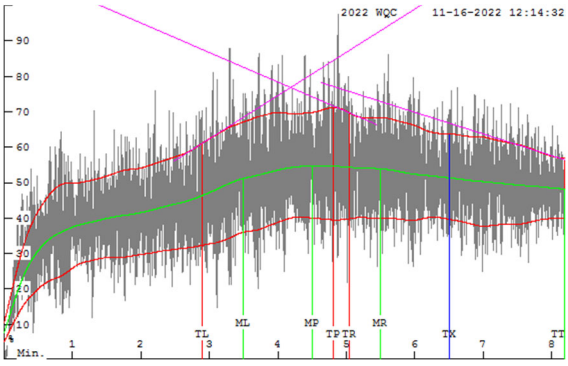
LCS Rebel Check (Minot, M-10)



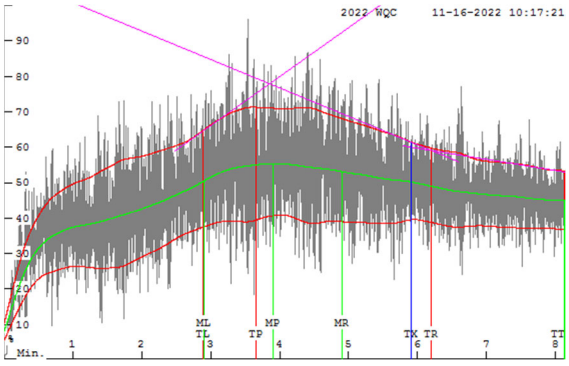
LARR19-0024 (Minot, M-2)



LCS Rebel Check (Williston, W-10)

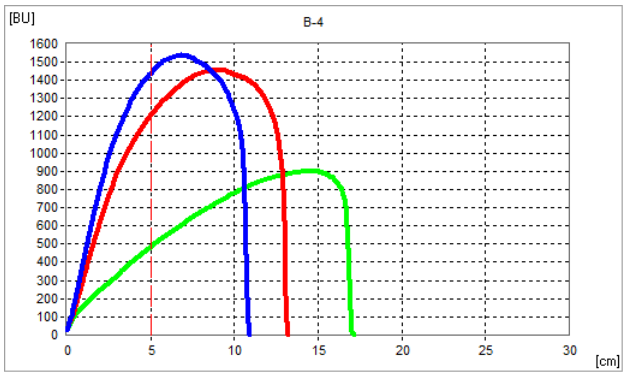


LARR19-0024 (Williston, W-2)

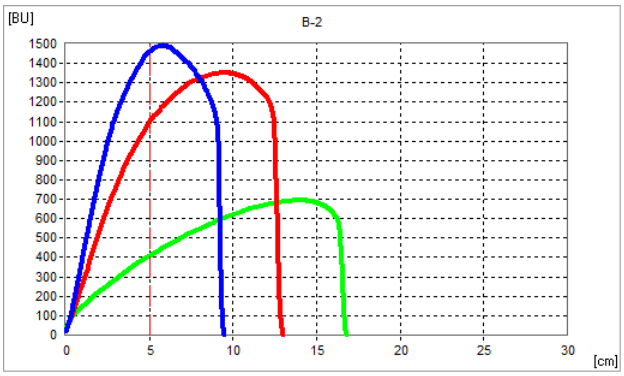


Extensograms

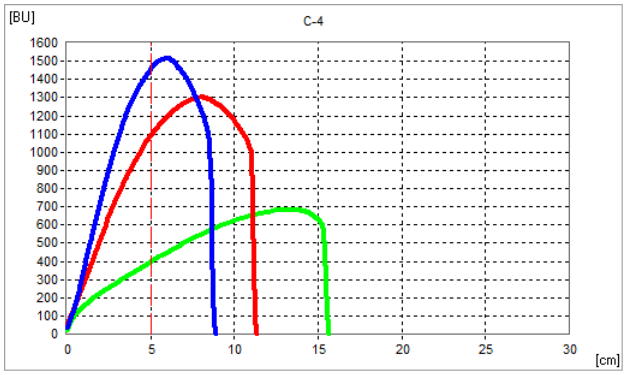
Linkert Check (Watertown, B-4)



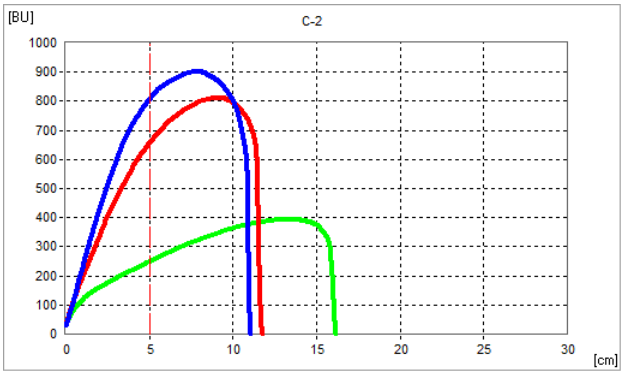
LARR19-0024 (Watertown, B-2)



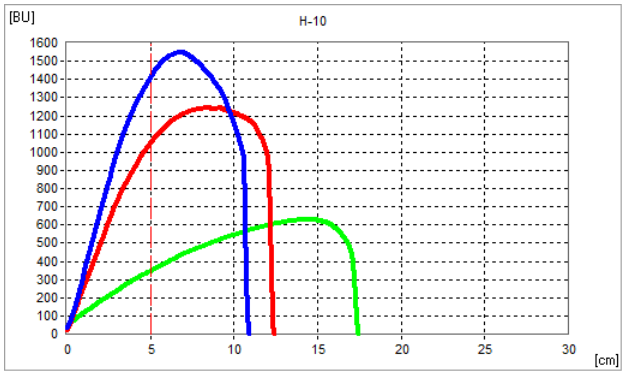
Linkert Check (Casselton, C-4)



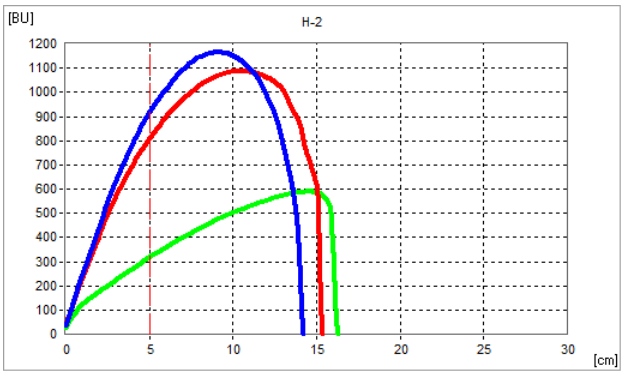
LARR19-0024 (Casselton, C-2)



LCS Rebel Check (Havre, H-10)

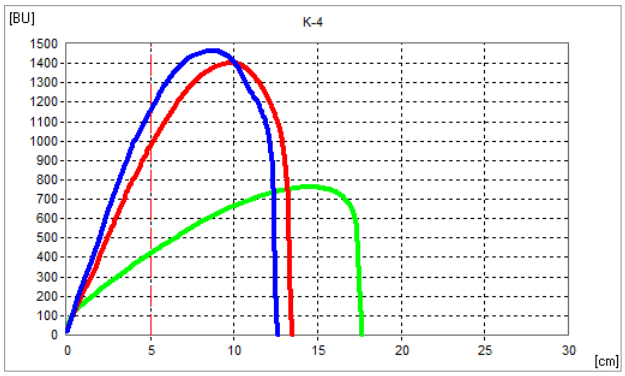


LARR19-0024 (Havre, H-2)

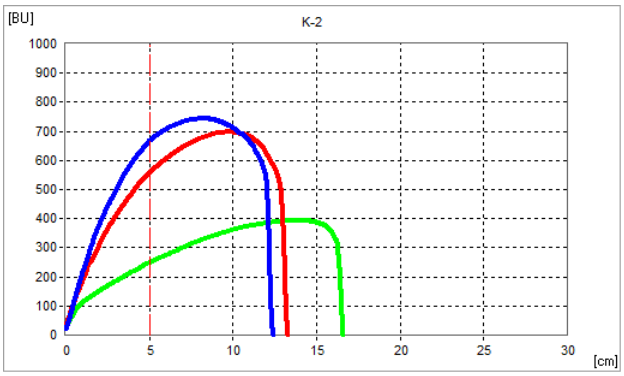


45 min; 90 min; 135 min

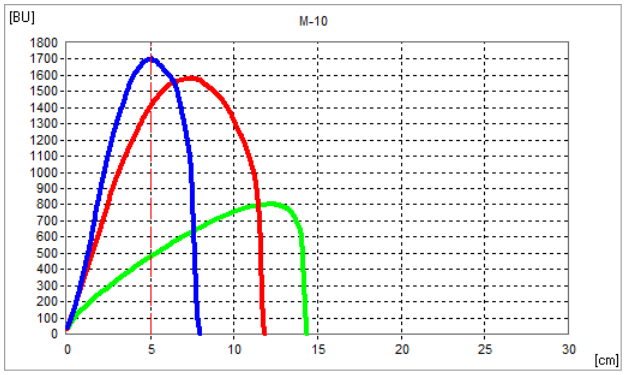
Linkert Check (Crookston, K-4)



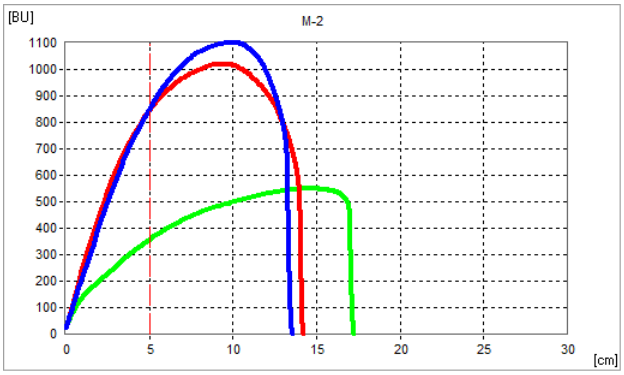
LARR19-0024 (Crookston, K-2)



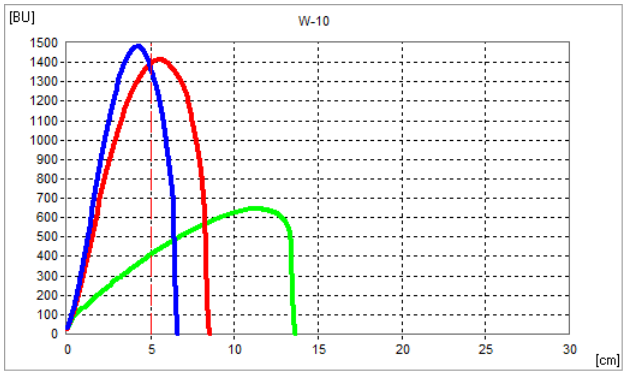
LCS Rebel Check (Minot, M-10)



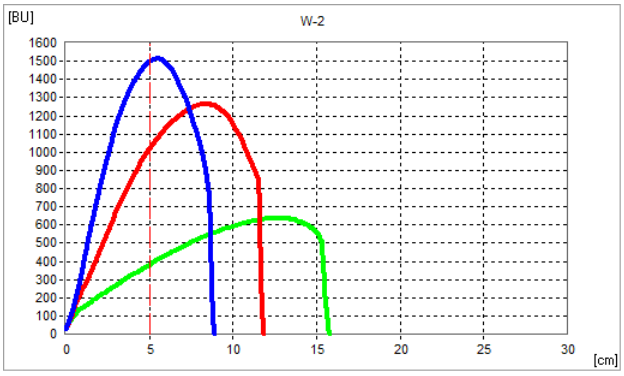
LARR19-0024 (Minot, M-2)



LCS Rebel Check (Williston, W-10)



LARR19-0024 (Williston, W-2)



45 min; 90 min; 135 min

SWQC #3 – NDHRS11-0244-0001

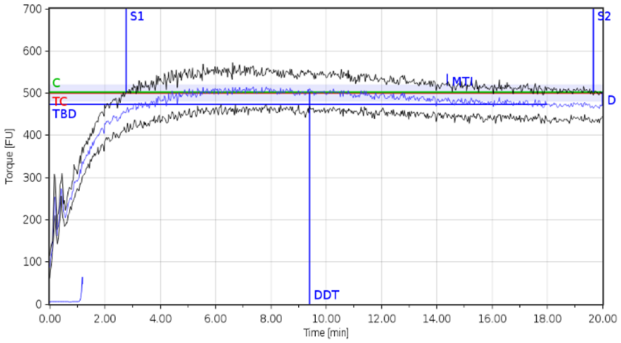
		Minot		Williston	
		LCS Rebel		LCS Rebel	
	Quality Trait	M-10	M-3	W-10	W-3
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	15.8	16.2	14.8	14.0
2	Flour Protein (%, 14% mb)	14.7	14.8	13.4	12.7
3	Market Value (Score 1-6)	5.2	4.1	4.9	3.8
4	Market Value (Score 1-10)	10.0	8.0	10.0	7.8
5	DON (ppm)	0.10	0.30	nd	nd
6	Test Weight (lb/bu)	63.0	60.6	63.3	61.3
7	1000 Kernel Weight (g)	33.7	30.6	31.4	26.9
8	Kernel Size, Large (%)	70	58	46	31
9	Kernel Size, Small (%)	7	10	11	18
10	Wheat Moisture (%)	10.8	10.7	11.4	11.3
11	Wheat Ash (%, 14% mb)	1.62	1.69	1.44	1.49
12	Wheat Falling Number (s)	426	371	436	396
13	SKCS Hardness Index	62.6	72.2	70.6	73.4
14	Vitreous Kernels (%)	88	77	97	95
	Flour Extraction				
15	Tempered Wheat Basis (%)	74.3	71.8	74.2	71.1
16	Total Product Basis (%)	76.0	73.5	75.7	73.0
17	Flour/Bu Wheat (lb)	47.4	44.1	47.9	44.6
	Flour Quality				
18	Flour Color Brightness (*L**)	90.7	90.4	90.7	90.7
19	Flour Color Yellowness (*b**)	8.9	9.3	9.1	9.4
20	Flour Moisture (%)	13.3	13.3	13.0	13.3
21	Flour Ash (%, 14% mb)	0.48	0.47	0.44	0.45
22	Flour Falling Number (malted, s)	250	260	255	255
	Farinograph				
23	Water Absorption (%, 500 BU)	63.8	61.9	65.8	61.5
24	Water Absorption (%, 14% mb)	63.2	61.3	64.8	60.9
25	Arrival Time (min)	2.8	3.0	3.5	2.2
26	Peak Time (min)	9.4	8.2	9.7	5.9
27	Dough Stability (min)	16.9	34.2	16.9	31.1
28	Mixing Tolerance Index (MTI, BU)	29	22	16	11
29	Time To Breakdown (TTB, min)	18.0	38.8	32.8	35.1
	II. Cooperator Results				
30	Bake Absorption (Average %)	67.3	65.8	68.1	64.9
31	Loaf Volume (% of Check)		102.2		104.2

SWQC #3 – NDHRS11-0244-0001

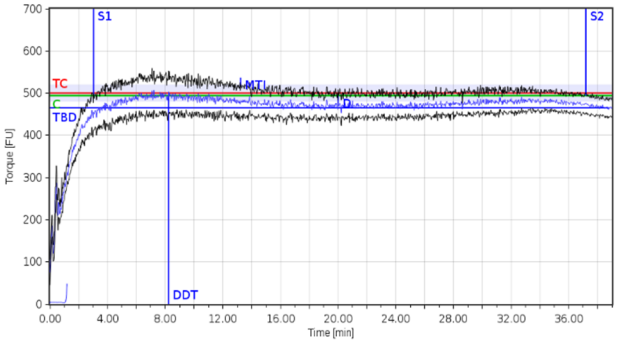
	Quality Trait	Minot LCS Rebel M-10	Minot LCS Rebel M-3	Williston LCS Rebel W-10	Williston LCS Rebel W-3
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	**7.2**	**7.0**	**7.4**	**7.2**
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	**7.0**	**6.8**	**6.8**	**6.5**
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		**5.5**		**6.1**
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.9**		**4.8**
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.7**		**4.9**
	III. Cooperator Evaluation				
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**5.1**		**3.9**
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**3.4**		**3.3**
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**5.3**		**4.9**
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.5**		**4.3**

Farinograms

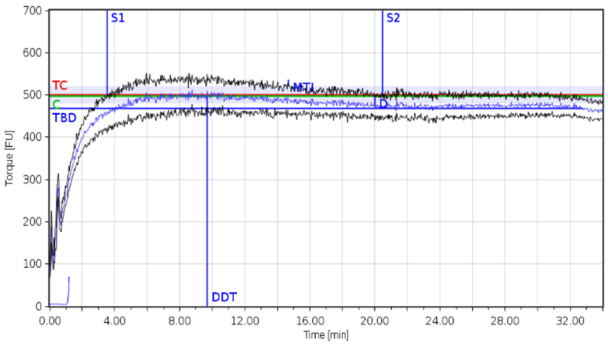
LCS Rebel Check (Minot, M-10)



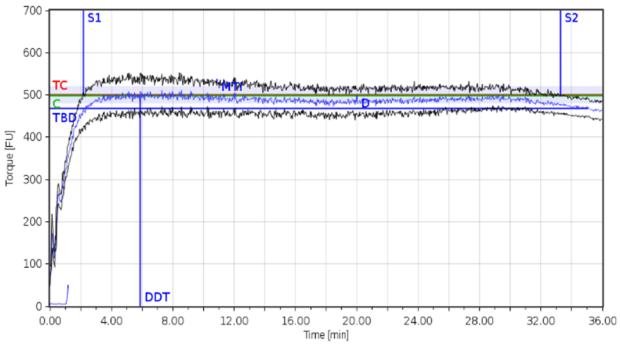
NDHRS11-0244-0001 (Minot, M-3)



LCS Rebel Check (Williston, W-10)

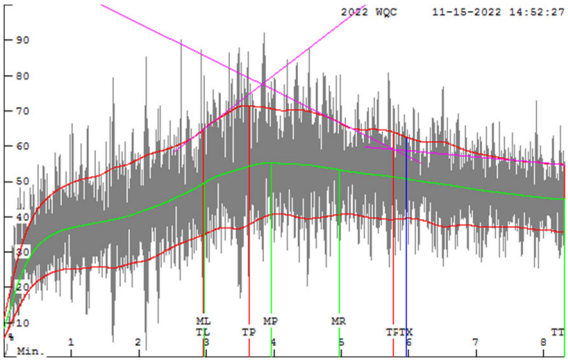


NDHRS11-0244-0001 (Williston, W-3)

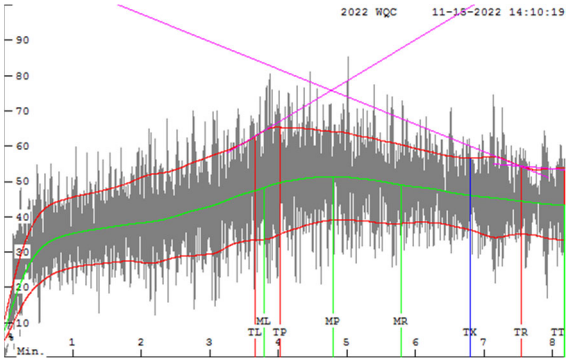


Mixograms

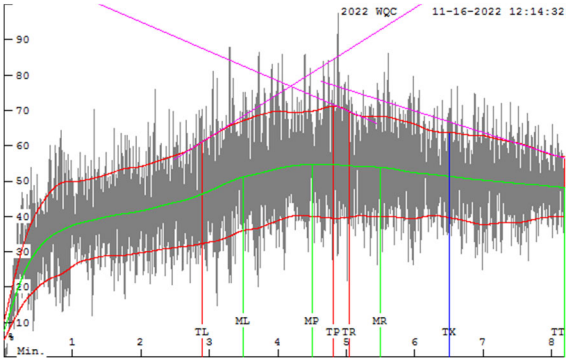
LCS Rebel Check (Minot, M-10)



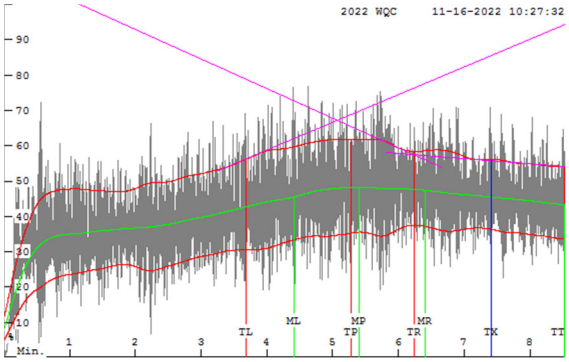
NDHRS11-0244-0001 (Minot, M-3)



LCS Rebel Check (Williston, W-10)

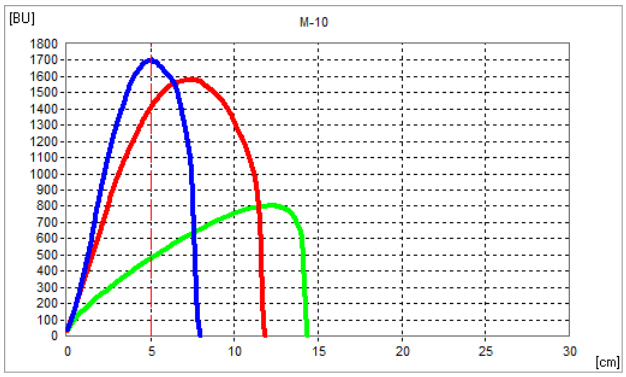


NDHRS11-0244-0001 (Williston, W-3)

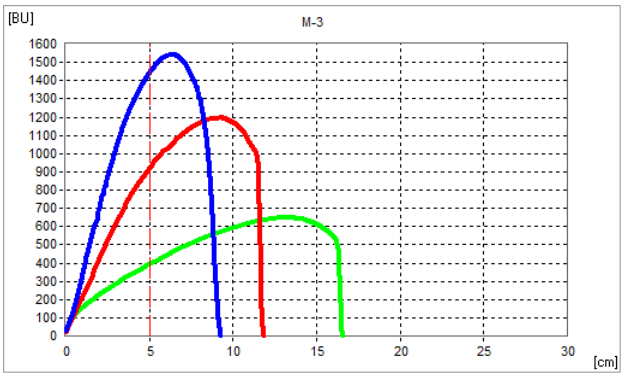


Extensograms

LCS Rebel Check (Minot, M-10)



NDHRS11-0244-0001 (Minot, M-3)



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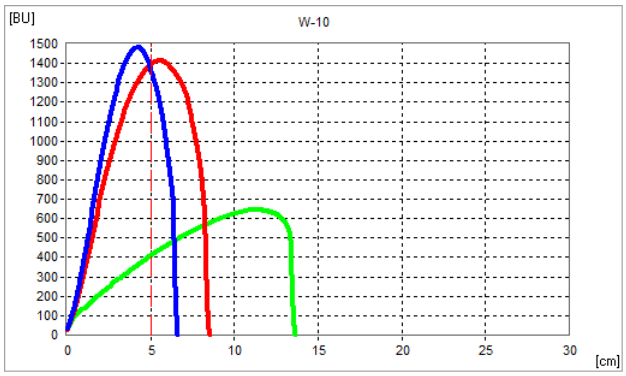
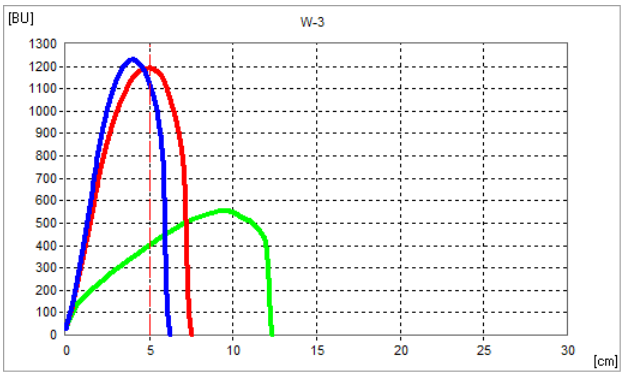


NDHRS11-0244-0001 (Williston, W-3)



45 min; 90 min; 135 min

SWQC #5 – NDHRS13-0273-0036

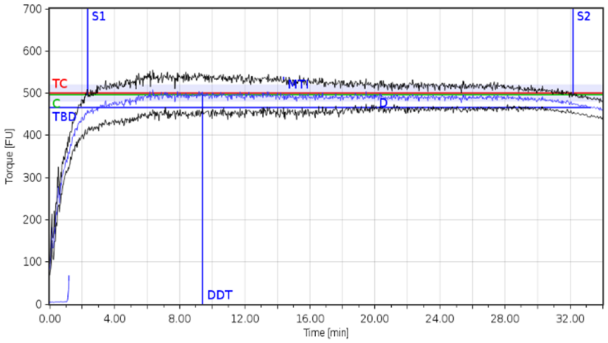
		Casselton		Crookston	
		Linkert		Linkert	
	Quality Trait	C-4	C-5	K-4	K-5
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	14.3	14.6	15.8	15.3
2	Flour Protein (%, 14% mb)	13.2	13.3	14.5	14.0
3	Market Value (Score 1-6)	4.5	4.4	5.3	5.1
4	Market Value (Score 1-10)	10.0	9.6	10.0	10.0
5	DON (ppm)	nd	0.05	0.10	0.10
6	Test Weight (lb/bu)	61.7	61.5	63.0	62.4
7	1000 Kernel Weight (g)	34.8	31.3	34.8	33.1
8	Kernel Size, Large (%)	76	72	78	78
9	Kernel Size, Small (%)	6	6	6	6
10	Wheat Moisture (%)	12.8	12.7	12.8	12.9
11	Wheat Ash (%, 14% mb)	1.54	1.50	1.53	1.42
12	Wheat Falling Number (s)	406	411	430	425
13	SKCS Hardness Index	70.6	71.4	75.1	76.5
14	Vitreous Kernels (%)	42	24	69	62
	Flour Extraction				
15	Tempered Wheat Basis (%)	73.2	71.2	72.1	72.0
16	Total Product Basis (%)	74.8	73.1	74.4	74.1
17	Flour/Bu Wheat (lb)	45.7	44.2	46.3	45.6
	Flour Quality				
18	Flour Color Brightness (*L**)	90.3	90.2	90.7	90.3
19	Flour Color Yellowness (*b**)	8.9	8.8	8.7	8.8
20	Flour Moisture (%)	14.1	13.5	14.2	14.1
21	Flour Ash (%, 14% mb)	0.49	0.45	0.47	0.42
22	Flour Falling Number (malted, s)	250	248	248	247
	Farinograph				
23	Water Absorption (%, 500 BU)	61.3	63.3	63.6	63.7
24	Water Absorption (%, 14% mb)	61.5	62.7	63.8	64.1
25	Arrival Time (min)	2.3	2.3	4.2	3.2
26	Peak Time (min)	9.4	8.3	27.9	23.4
27	Dough Stability (min)	29.9	24.8	28.1	25.1
28	Mixing Tolerance Index (MTI, BU)	10	12	31	26
29	Time To Breakdown (TTB, min)	33.3	28.4	33.2	29.6
	II. Cooperator Results				
30	Bake Absorption (Average %)	64.9	66.2	67.3	67.2
31	Loaf Volume (% of Check)		101.3		100.9

SWQC #5 – NDHRS13-0273-0036

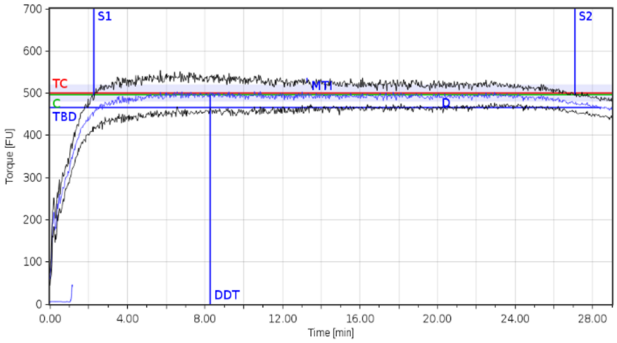
	Quality Trait	Casselton Linkert C-4	Casselton Linkert C-5	Crookston Linkert K-4	Crookston Linkert K-5
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	**7.2**	**5.9**	**7.4**	**6.3**
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	**5.8**	**5.3**	**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		**4.5**		**5.0**
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**5.2**		**4.9**
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**5.5**		**4.9**
	III. Cooperator Evaluation				
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**5.0**		**4.7**
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.5**		**4.9**
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**5.1**		**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		**4.5**		**5.0**

Farinograms

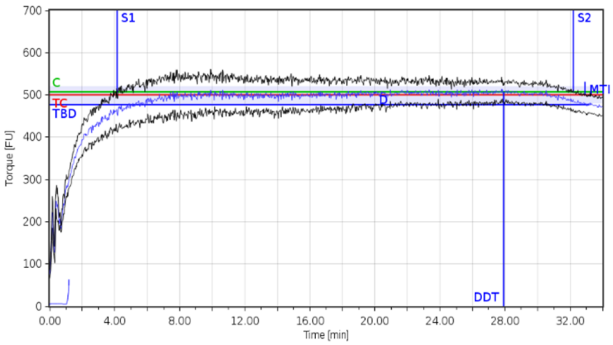
Linkert Check (Casselton, C-4)



NDHRS13-0273-0036 (Casselton, C-5)



Linkert Check (Crookston, K-4)



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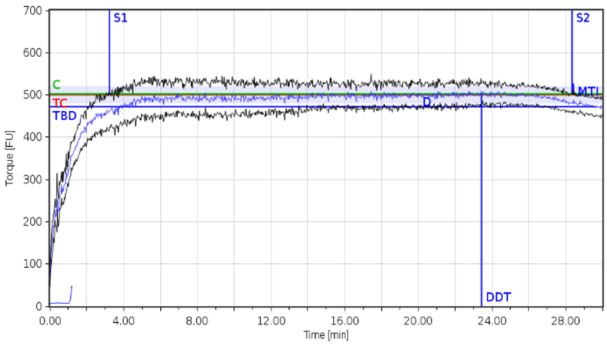
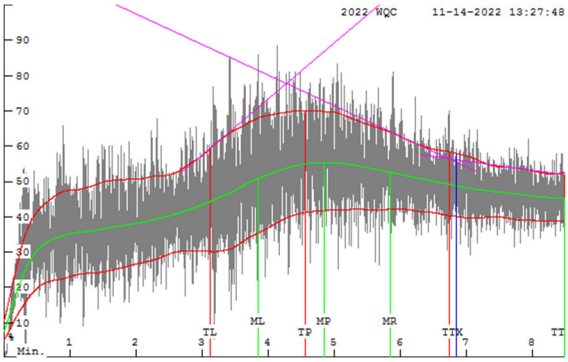
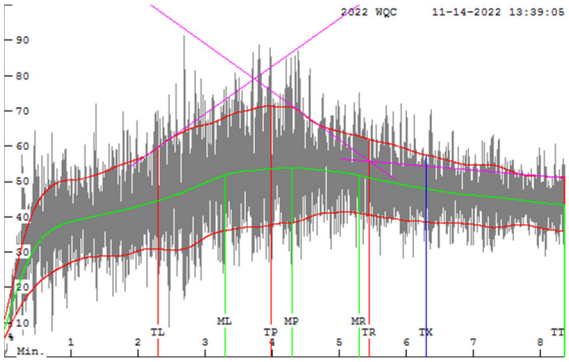


Mixograms

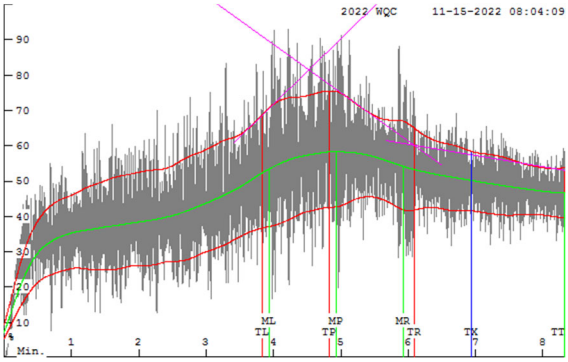
Linkert Check (Casselton, C-4)



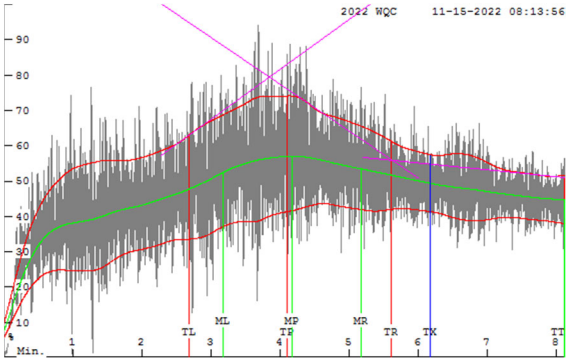
NDHRS13-0273-0036 (Casselton, C-5)



Linkert Check (Crookston, K-4)

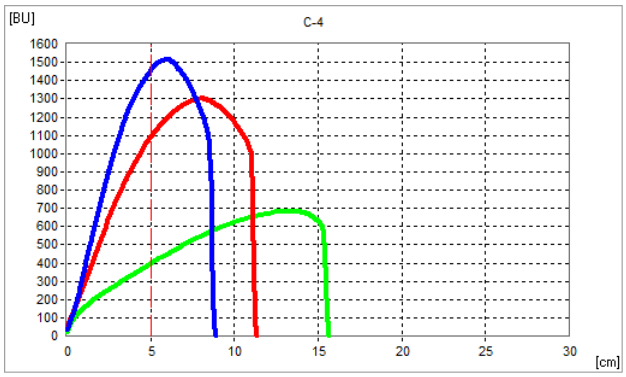


NDHRS13-0273-0036 (Crookston, K-5)

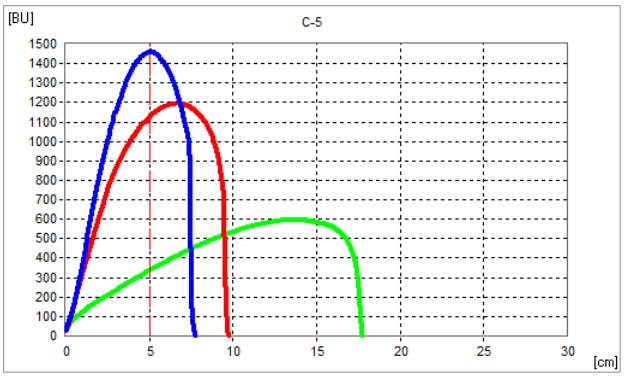


Extensograms

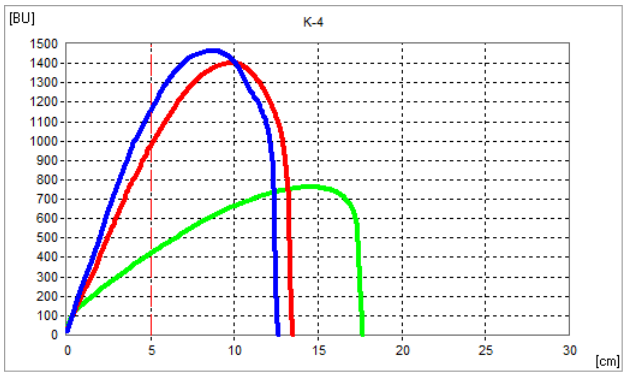
Linkert Check (Casselton, C-4)



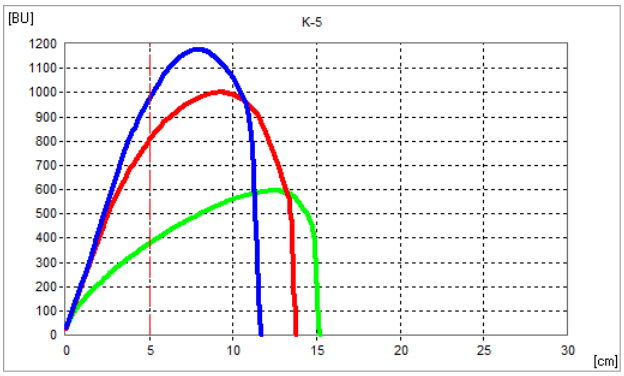
NDHRS13-0273-0036 (Casselton, C-5)



Linkert Check (Crookston, K-4)



NDHRS13-0273-0036 (Crookston, K-5)



45 min; 90 min; 135 min

SWQC #6 – AP Revolution

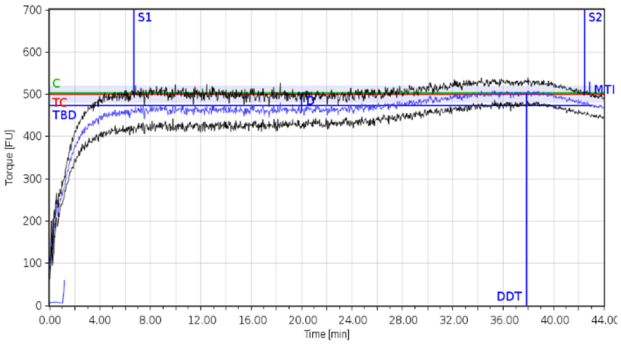
		Watertown		Casselton		Crookston	
		Linkert		Linkert		Linkert	
	Quality Trait	B-4	B-6	C-4	C-6	K-4	K-6
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	17.0	16.3	14.3	13.9	15.8	14.1
2	Flour Protein (%, 14% mb)	16.2	15.3	13.2	12.7	14.5	13.1
3	Market Value (Score 1-6)	3.0	3.1	4.5	3.8	5.3	4.1
4	Market Value (Score 1-10)	10.0	9.0	10.0	9.2	10.0	7.0
5	DON (ppm)	0.70	0.30	nd	nd	0.10	0.10
6	Test Weight (lb/bu)	56.9	57.8	61.7	60.8	63.0	62.0
7	1000 Kernel Weight (g)	25.9	26.8	34.8	29.6	34.8	30.2
8	Kernel Size, Large (%)	39	44	76	57	78	60
9	Kernel Size, Small (%)	17	16	6	13	6	12
10	Wheat Moisture (%)	12.6	12.0	12.8	12.8	12.8	13.1
11	Wheat Ash (%, 14% mb)	1.91	1.79	1.54	1.59	1.53	1.50
12	Wheat Falling Number (s)	373	344	406	409	430	395
13	SKCS Hardness Index	72.9	69.5	70.6	65.5	75.1	70.9
14	Vitreous Kernels (%)	52	40	42	22	69	47
	Flour Extraction						
15	Tempered Wheat Basis (%)	69.4	70.2	73.2	71.8	72.1	73.4
16	Total Product Basis (%)	70.8	72.6	74.8	73.9	74.4	75.7
17	Flour/Bu Wheat (lb)	39.9	41.2	45.7	44.3	46.3	45.9
	Flour Quality						
18	Flour Color Brightness (*L**)	88.5	89.0	90.3	90.4	90.7	90.6
19	Flour Color Yellowness (*b**)	8.9	10.7	8.9	12.9	8.7	12.7
20	Flour Moisture (%)	13.4	13.4	14.1	14.0	14.2	13.8
21	Flour Ash (%, 14% mb)	0.59	0.55	0.49	0.45	0.47	0.48
22	Flour Falling Number (malted, s)	252	254	250	251	248	251
	Farinograph						
23	Water Absorption (%, 500 BU)	63.7	63.4	61.3	59.5	63.6	61.0
24	Water Absorption (%, 14% mb)	63.3	62.8	61.5	59.7	63.8	60.8
25	Arrival Time (min)	6.7	30.1	2.3	2.2	4.2	2.7
26	Peak Time (min)	37.9	37.5	9.4	36.8	27.9	38.2
27	Dough Stability (min)	35.8	13.4	29.9	40.5	28.1	43.6
28	Mixing Tolerance Index (MTI, BU)	30	18	10	21	31	15
29	Time To Breakdown (TTB, min)	43.1	44.9	33.3	45.1	33.2	48.7
	II. Cooperator Results						
30	Bake Absorption (Average %)	66.9	66.5	64.9	63.4	67.3	65.3
31	Loaf Volume (% of Check)		103.3		100.1		98.3

SWQC #6 – AP Revolution

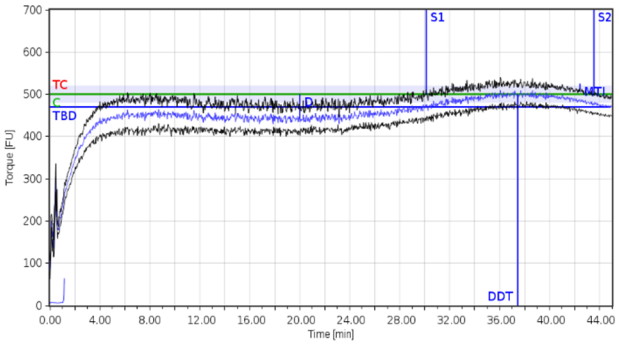
	Quality Trait	Watertown Linkert B-4	Watertown Linkert B-6	Casselton Linkert C-4	Casselton Linkert C-6	Crookston Linkert K-4	Crookston Linkert K-6
	II. Cooperator Results						
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	8.2	8.1	7.2	7.6	7.4	8.3
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.5	6.9	5.8	7.0	6.5	7.1
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		4.5		5.7		6.6
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		5.5		2.7		2.7
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.8		5.1		4.3
	III. Cooperator Evaluation						
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.6		4.7		3.4
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.4		4.2		5.2
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.4		4.6		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		5.5		4.2		4.1

Farinograms

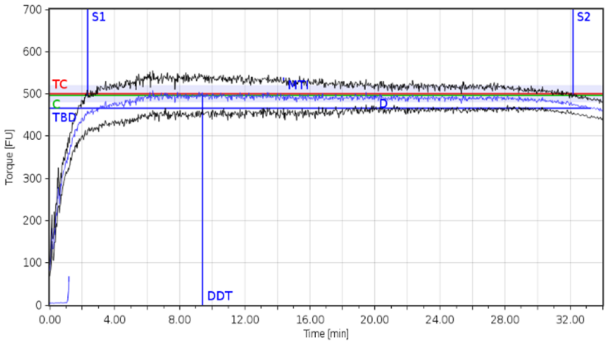
Linkert Check (Watertown, B-4)



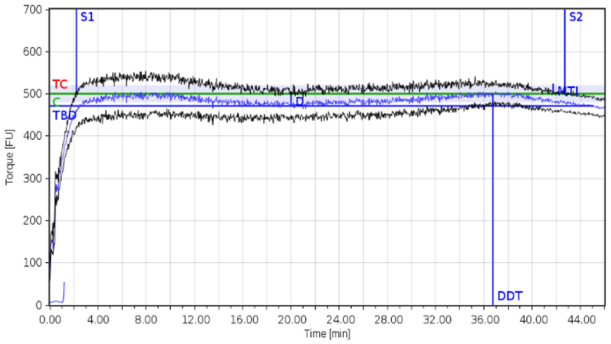
AP Revolution (Watertown, B-6)



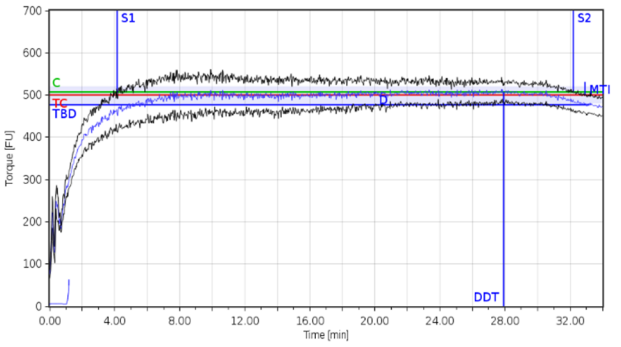
Linkert Check (Casselton, C-4)



AP Revolution (Casselton, C-6)



Linkert Check (Crookston, K-4)



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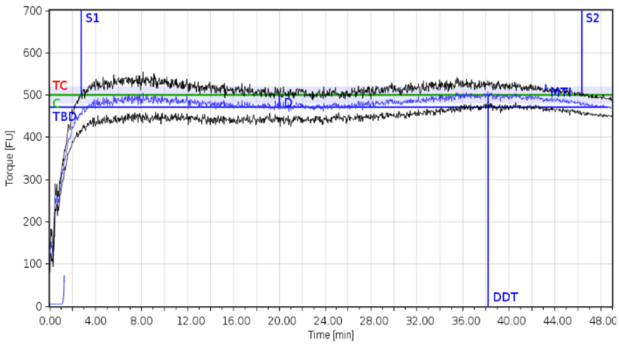
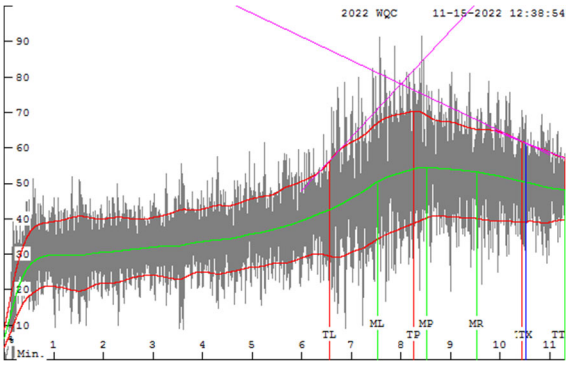


Mixograms

Linkert Check (Watertown, B-4)



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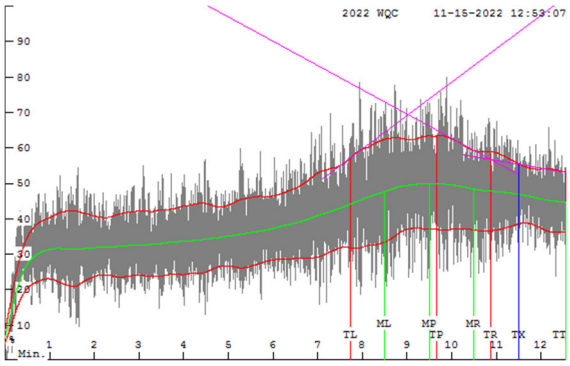
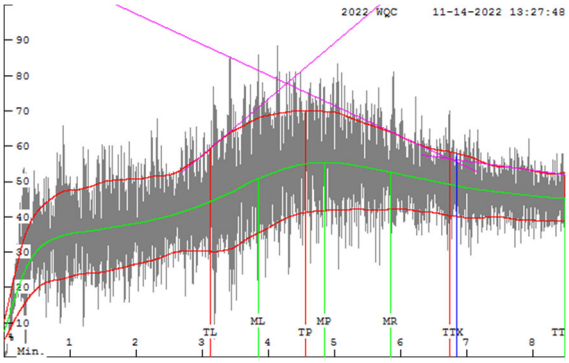


Linkert Check (Casselton, C-4)



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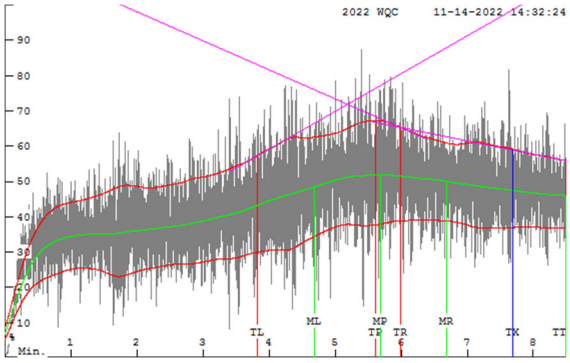

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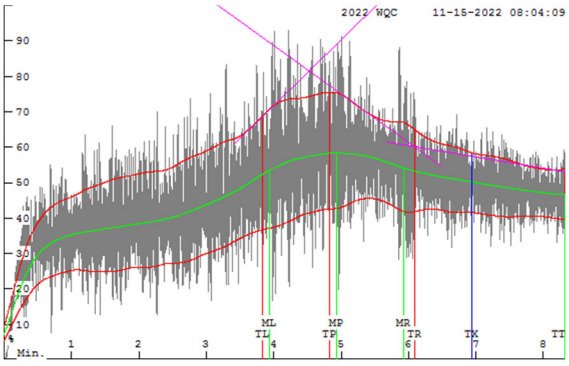

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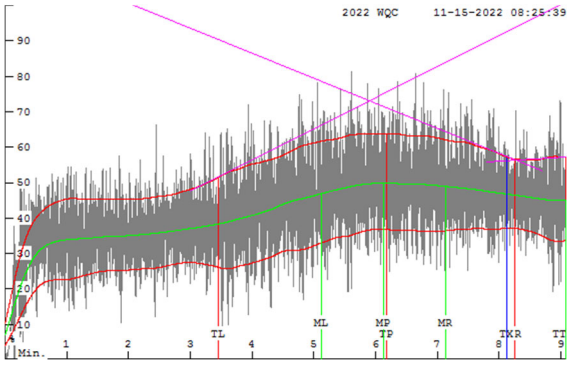
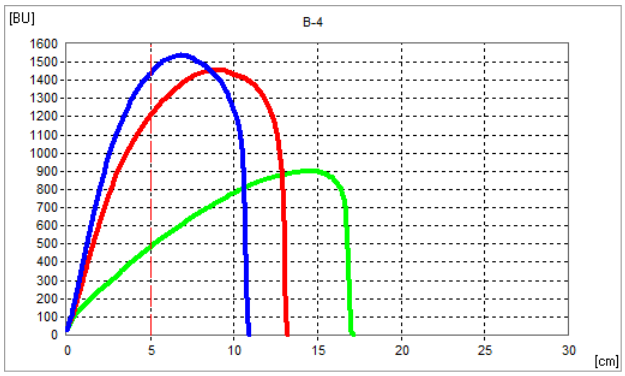


Extensograms

Linkert Check (Watertown, B-4)



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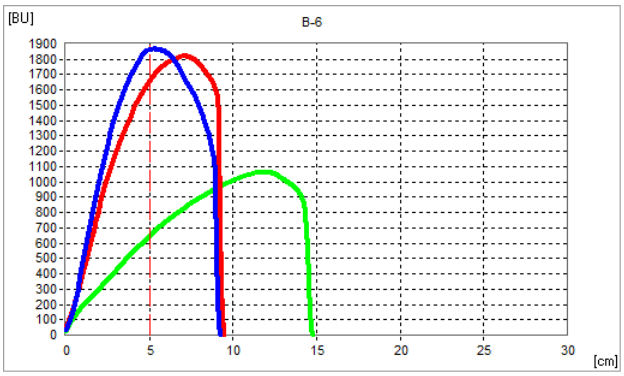

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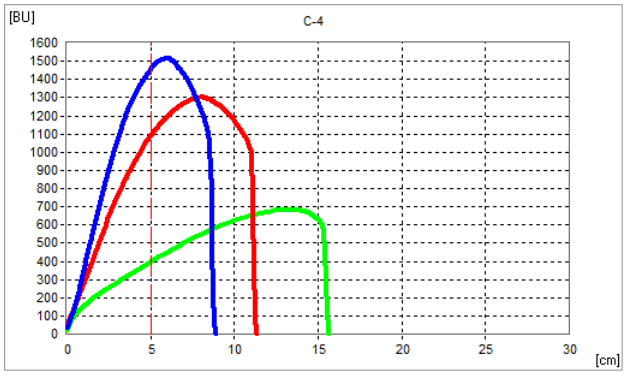

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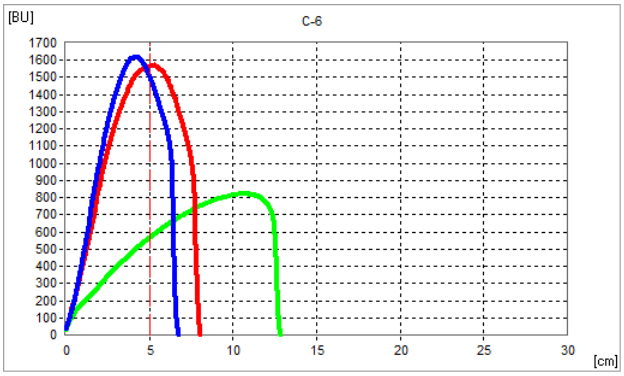
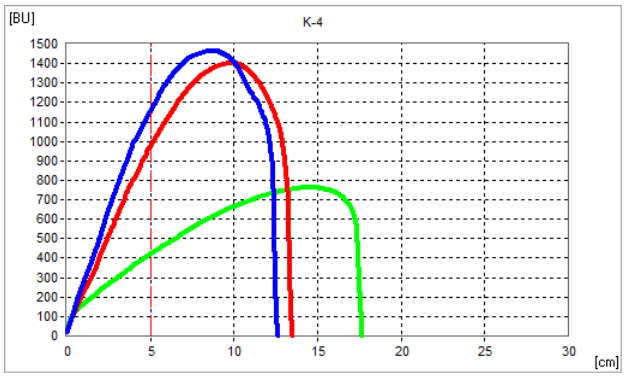
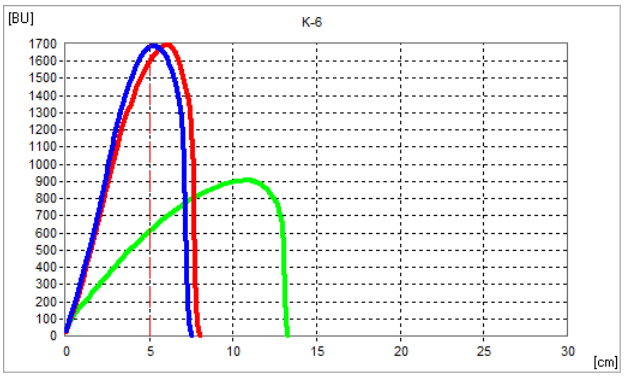


Linkert Check (Crookston, K-4)



AP Revolution (Crookston, K-6)



45 min; 90 min; 135 min

SWQC #7 – MN18032-5

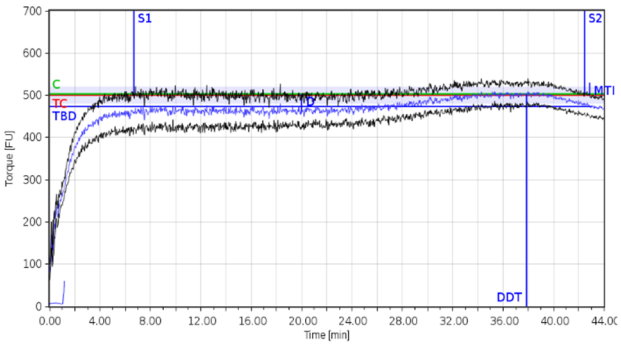
		Watertown		Casselton		Crookston		Minot	
		Linkert		Linkert		Linkert		LCS Rebel	
	Quality Trait	B-4	B-7	C-4	C-7	K-4	K-7	M-10	M-7
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	17.0	16.8	14.3	14.4	15.8	15.4	15.8	16.7
2	Flour Protein (%, 14% mb)	16.2	15.7	13.2	13.1	14.5	14.1	14.7	15.6
3	Market Value (Score 1-6)	3.0	3.5	4.5	4.4	5.3	5.3	5.2	4.8
4	Market Value (Score 1-10)	10.0	10.0	10.0	9.2	10.0	10.0	10.0	8.8
5	DON (ppm)	0.70	0.75	nd	nd	0.10	0.10	0.10	0.30
6	Test Weight (lb/bu)	56.9	57.7	61.7	62.7	63.0	64.1	63.0	61.4
7	1000 Kernel Weight (g)	25.9	25.5	34.8	30.7	34.8	34.4	33.7	29.1
8	Kernel Size, Large (%)	39	29	76	56	78	72	70	43
9	Kernel Size, Small (%)	17	22	6	12	6	8	7	13
10	Wheat Moisture (%)	12.6	11.8	12.8	13.0	12.8	12.7	10.8	10.9
11	Wheat Ash (%, 14% mb)	1.91	1.74	1.54	1.46	1.53	1.39	1.62	1.56
12	Wheat Falling Number (s)	373	397	406	400	430	425	426	468
13	SKCS Hardness Index	72.9	75.8	70.6	73.7	75.1	76.3	62.6	70.0
14	Vitreous Kernels (%)	52	49	42	47	69	61	88	98
	Flour Extraction								
15	Tempered Wheat Basis (%)	69.4	70.0	73.2	72.4	72.1	72.9	74.3	73.1
16	Total Product Basis (%)	70.8	72.2	74.8	74.3	74.4	75.4	76.0	74.5
17	Flour/Bu Wheat (lb)	39.9	41.4	45.7	45.8	46.3	47.1	47.4	45.3
	Flour Quality								
18	Flour Color Brightness (*L**)	88.5	89.3	90.3	90.7	90.7	90.5	90.7	90.6
19	Flour Color Yellowness (*b**)	8.9	9.1	8.9	9.6	8.7	8.8	8.9	8.8
20	Flour Moisture (%)	13.4	13.9	14.1	13.8	14.2	13.4	13.3	13.2
21	Flour Ash (%, 14% mb)	0.59	0.54	0.49	0.44	0.47	0.43	0.48	0.45
22	Flour Falling Number (malted, s)	252	253	250	255	248	248	250	249
	Farinograph								
23	Water Absorption (%, 500 BU)	63.7	62.3	61.3	60.0	63.6	63.6	63.8	62.4
24	Water Absorption (%, 14% mb)	63.3	62.3	61.5	59.8	63.8	63.0	63.2	61.6
25	Arrival Time (min)	6.7	4.1	2.3	2.2	4.2	3.1	2.8	3.5
26	Peak Time (min)	37.9	34.8	9.4	8.7	27.9	8.4	9.4	8.2
27	Dough Stability (min)	35.8	36.8	29.9	21.7	28.1	24.0	16.9	19.5
28	Mixing Tolerance Index (MTI, BU)	30	20	10	21	31	15	29	13
29	Time To Breakdown (TTB, min)	43.1	42.5	33.3	31.2	33.2	29.2	18.0	22.8
	II. Cooperator Results								
30	Bake Absorption (Average %)	66.9	65.7	64.9	63.7	67.3	66.8	67.3	66.4
31	Loaf Volume (% of Check)		104.5		101.4		98.9		105.2

SWQC #7 – MN18032-5

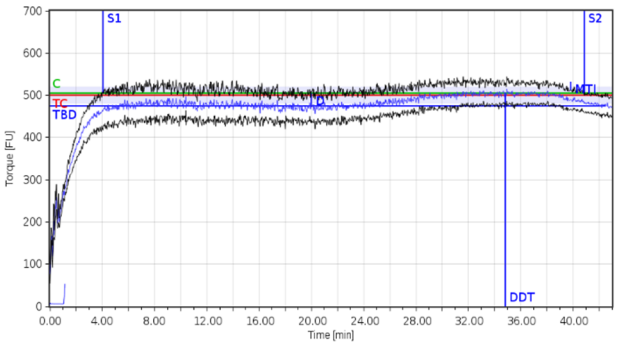
	Quality Trait	Watertown Linkert B-4	Watertown Linkert B-7	Casselton Linkert C-4	Casselton Linkert C-7	Crookston Linkert K-4	Crookston Linkert K-7	Minot LCS Rebel M-10	Minot LCS Rebel M-7
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	8.2	7.9	7.2	6.6	7.4	7.1	7.2	7.2
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.5	6.8	5.8	6.2	6.5	6.5	7.0	6.7
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		4.7		4.8		5.6		5.1
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.7		4.9		4.8		5.3
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.1		5.5		4.5		5.5
	III. Cooperator Evaluation								
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.4		5.0		4.9		5.7
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.5		4.7		5.5		3.8
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.7		5.5		4.5		5.9
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.6		5.3		5.0		5.3

Farinograms

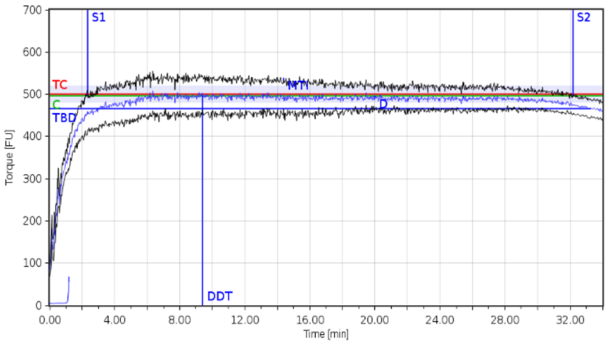
Linkert Check (Watertown, B-4)



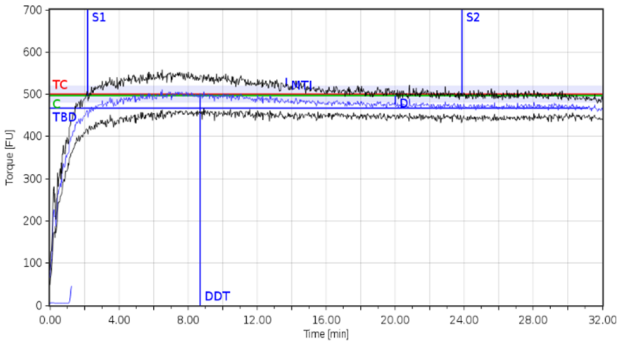
MN18032-5 (Watertown, B-7)



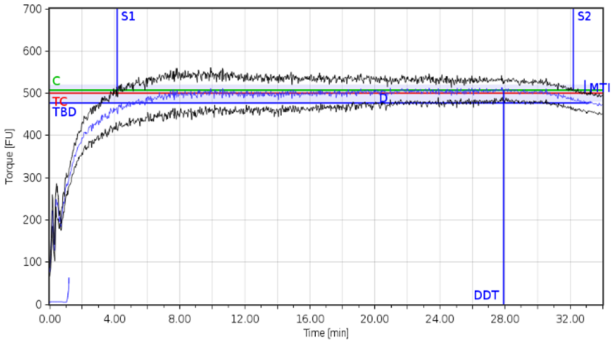
Linkert Check (Casselton, C-4)



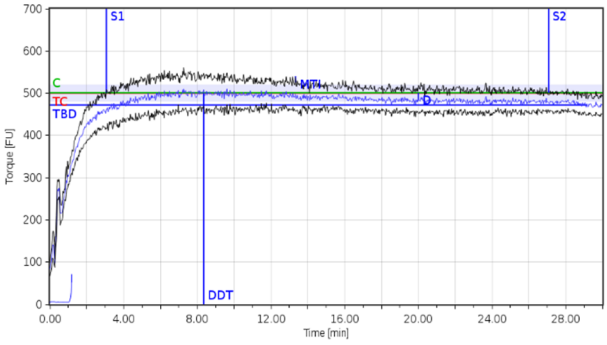
MN18032-5 (Casselton, C-7)



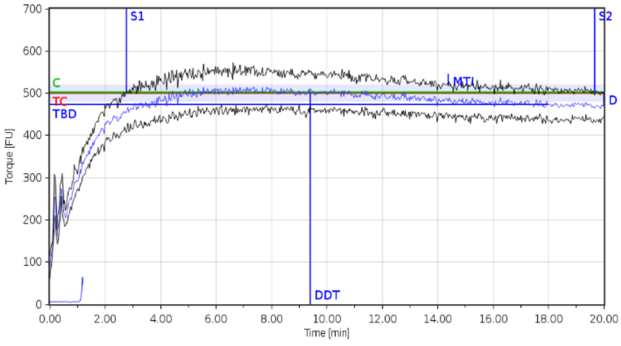
Linkert Check (Crookston, K-4)



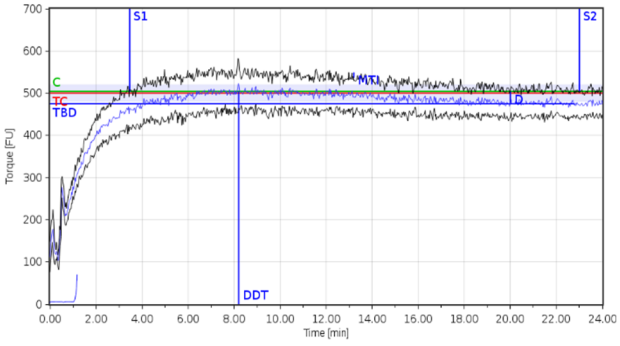
MN18032-5 (Crookston, K-7)



LCS Rebel Check (Minot, M-10)

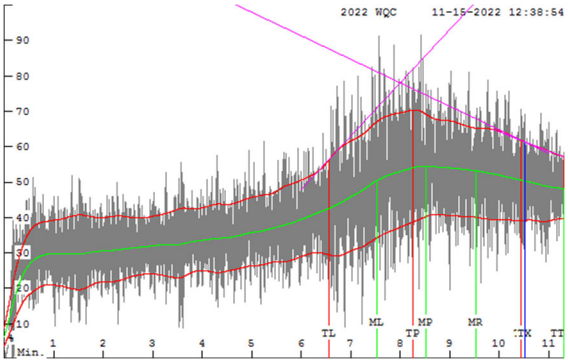


MN18032-5 (Minot, M-7)

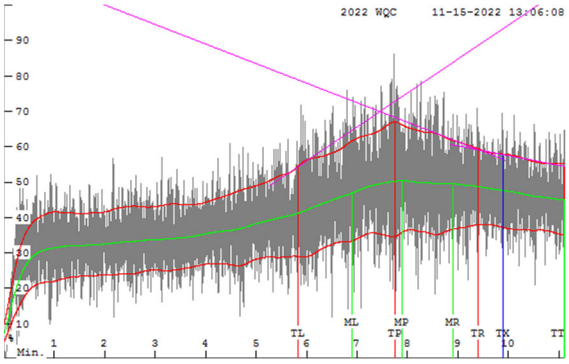


Mixograms

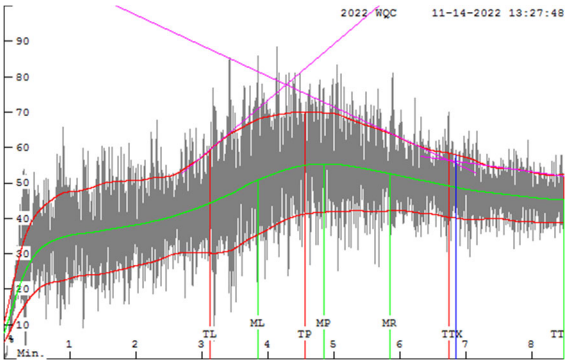
Linkert Check (Watertown, B-4)



MN18032-5 (Watertown, B-7)



Linkert Check (Casselton, C-4)



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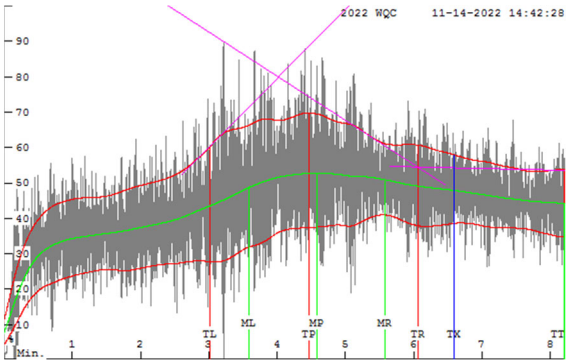
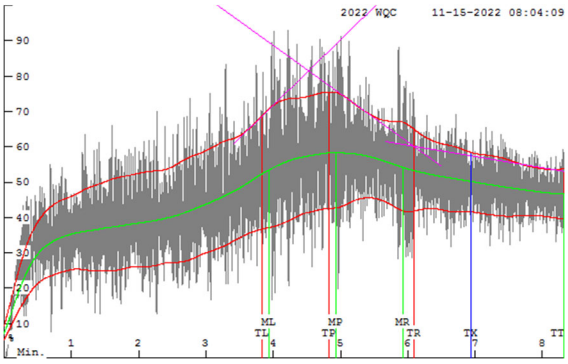


Linkert Check (Crookston, K-4)



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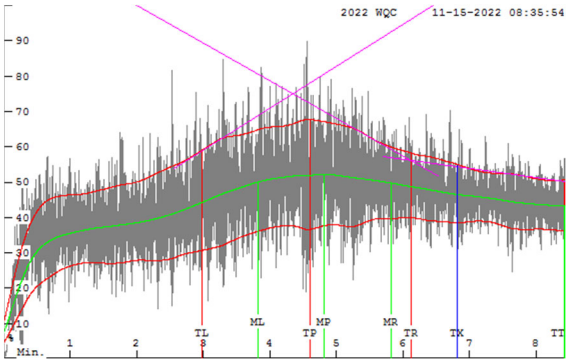
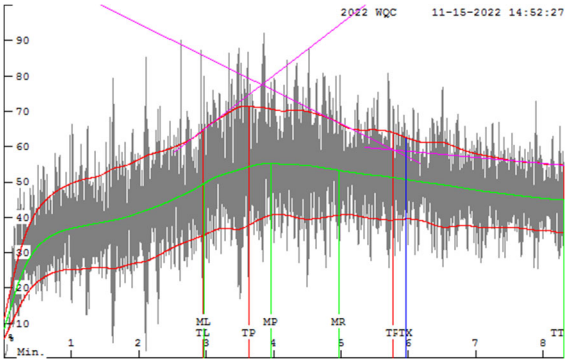


LCS Rebel Check (Minot, M-10)



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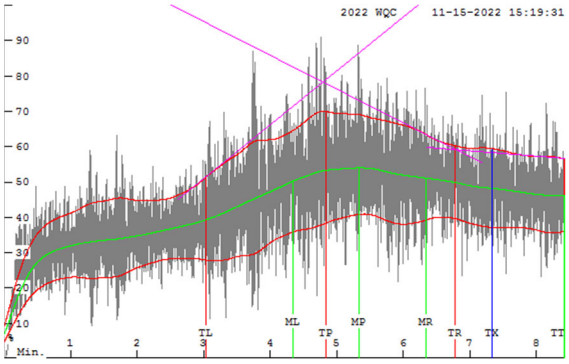
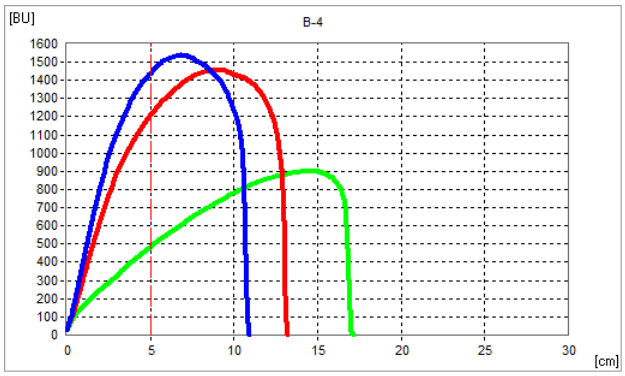


Extensograms

Linkert Check (Watertown, B-4)



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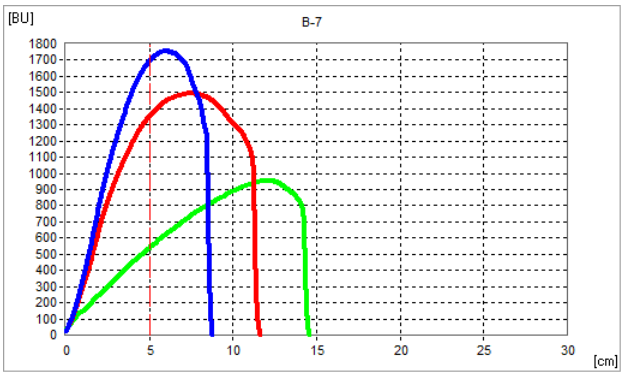

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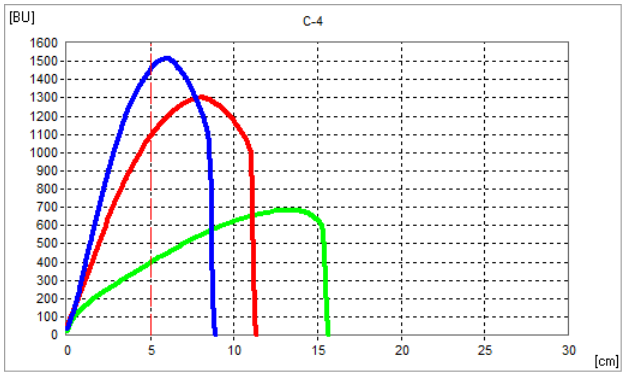
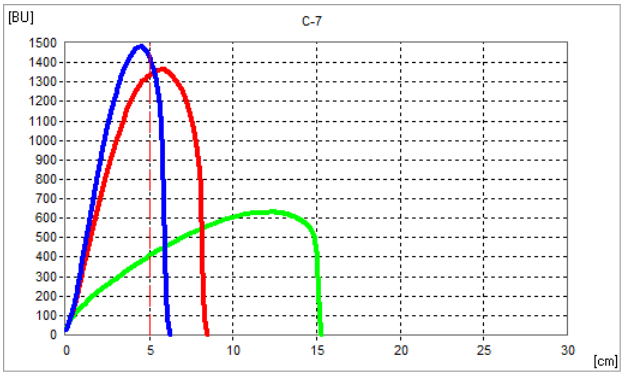
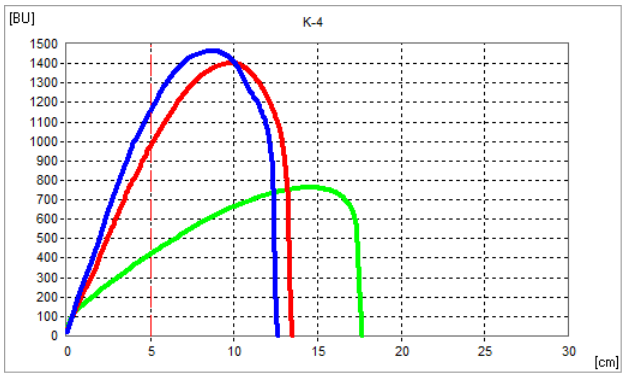


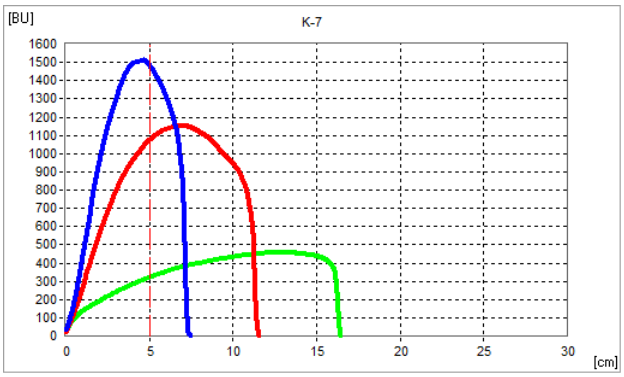
MN18032-5 (Casselton, C-7)



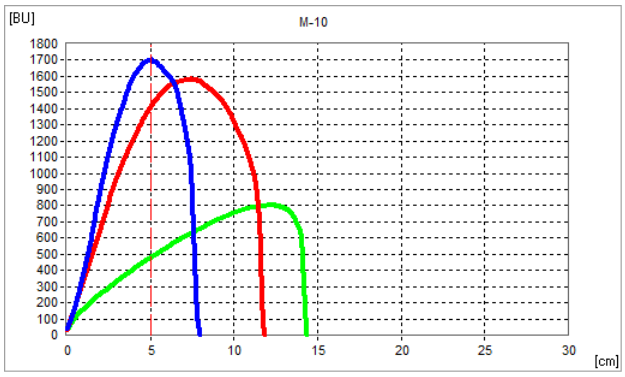
Linkert Check (Crookston, K-4)



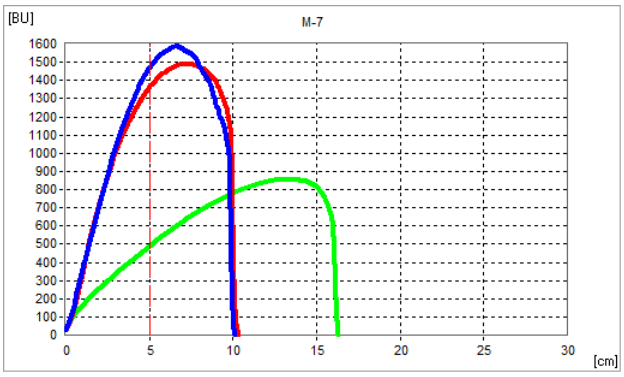
MN18032-5 (Crookston, K-7)



LCS Rebel Check (Minot, M-10)



MN18032-5 (Minot, M-7)



45 min; 90 min; 135 min

SWQC #8 – MT1939

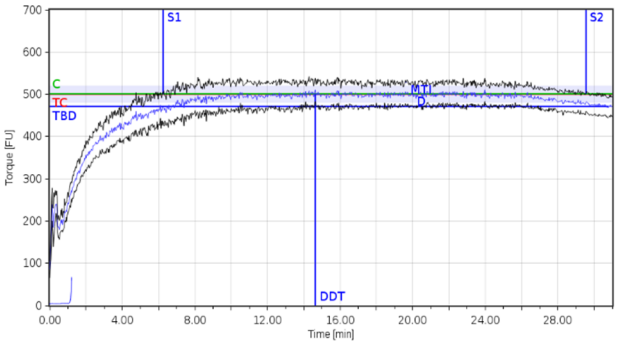
		Havre		Minot		Williston	
		LCS Rebel		LCS Rebel		LCS Rebel	
	Quality Trait	H-10	H-8	M-10	M-8	W-10	W-8
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	17.3	16.3	15.8	16.3	14.8	11.4
2	Flour Protein (%, 14% mb)	16.4	15.6	14.7	15.2	13.4	10.6
3	Market Value (Score 1-6)	5.1	4.9	5.2	4.7	4.9	3.6
4	Market Value (Score 1-10)	10.0	9.4	10.0	9.2	10.0	6.6
5	DON (ppm)	0.05	nd	0.10	1.10	nd	nd
6	Test Weight (lb/bu)	62.1	61.2	63.0	60.8	63.3	63.0
7	1000 Kernel Weight (g)	27.5	30.0	33.7	33.1	31.4	31.2
8	Kernel Size, Large (%)	22	47	70	72	46	60
9	Kernel Size, Small (%)	19	11	7	6	11	7
10	Wheat Moisture (%)	9.4	9.4	10.8	10.8	11.4	11.5
11	Wheat Ash (%, 14% mb)	1.36	1.39	1.62	1.70	1.44	1.53
12	Wheat Falling Number (s)	431	439	426	423	436	399
13	SKCS Hardness Index	71.8	70.3	62.6	64.7	70.6	63.7
14	Vitreous Kernels (%)	98	89	88	95	97	67
	Flour Extraction						
15	Tempered Wheat Basis (%)	72.8	71.2	74.3	71.2	74.2	70.9
16	Total Product Basis (%)	74.9	73.1	76.0	72.9	75.7	72.7
17	Flour/Bu Wheat (lb)	45.8	44.1	47.4	43.7	47.9	45.6
	Flour Quality						
18	Flour Color Brightness (*L**)	90.3	90.8	90.7	90.6	90.7	91.3
19	Flour Color Yellowness (*b**)	9.6	8.6	8.9	8.9	9.1	8.6
20	Flour Moisture (%)	13.4	13.4	13.3	12.9	13.0	13.1
21	Flour Ash (%, 14% mb)	0.42	0.43	0.48	0.49	0.44	0.44
22	Flour Falling Number (malted, s)	248	245	250	261	255	253
	Farinograph						
23	Water Absorption (%, 500 BU)	65.8	67.1	63.8	64.9	65.8	61.2
24	Water Absorption (%, 14% mb)	65.2	66.7	63.2	63.7	64.8	60.2
25	Arrival Time (min)	6.3	5.8	2.8	4.3	3.5	1.6
26	Peak Time (min)	14.6	9.5	9.4	9.5	9.7	6.0
27	Dough Stability (min)	23.3	10.9	16.9	17.2	16.9	10.5
28	Mixing Tolerance Index (MTI, BU)	3	11	29	12	16	29
29	Time To Breakdown (TTB, min)	30.8	17.8	18.0	30.5	32.8	12.2
	II. Cooperator Results						
30	Bake Absorption (Average %)	68.9	69.5	67.3	67.7	68.1	63.8
31	Loaf Volume (% of Check)		100.3		104.2		97.3

SWQC #8 – MT1939

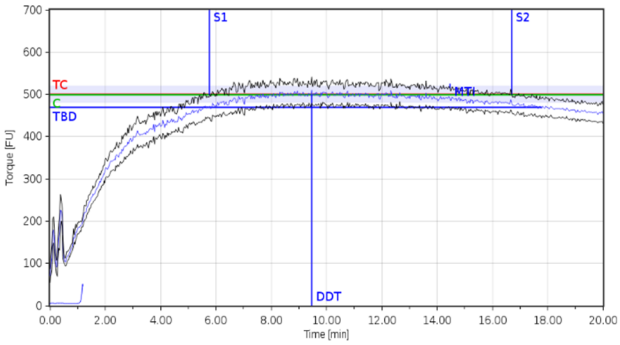
	Quality Trait	Havre LCS Rebel H-10	Havre H-8	Minot LCS Rebel M-10	Minot M-8	Williston LCS Rebel W-10	Williston W-8
	II. Cooperator Results						
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.8	5.5	7.2	5.6	7.4	5.5
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.8	4.9	7.0	5.4	6.8	5.6
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		3.2		4.4		4.1
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.9		5.2		4.6
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.8		4.6		4.6
	III. Cooperator Evaluation						
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.1		5.2		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		4.5		3.3		3.7
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.5		4.9		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		4.3		4.5		2.8

Farinograms

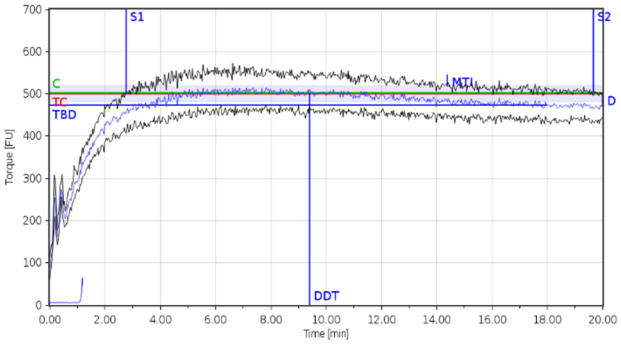
LCS Rebel Check (Havre, H-10)



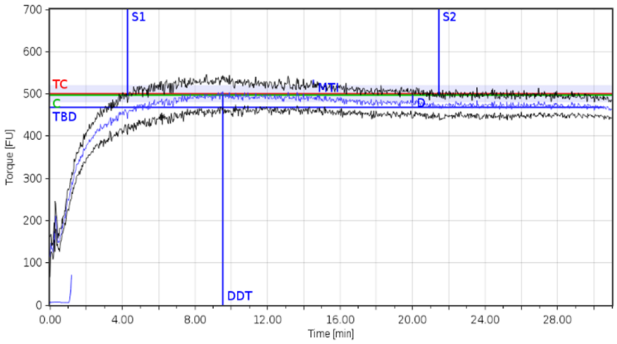
MT1939 (Havre, H-8)



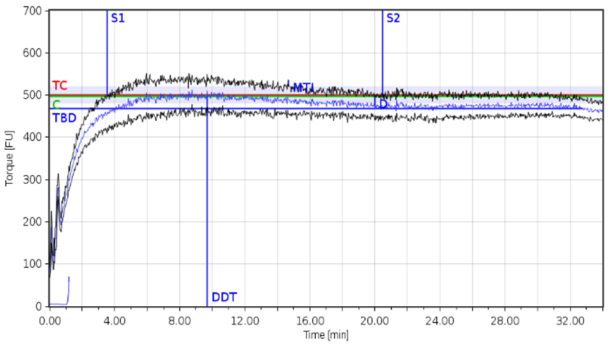
LCS Rebel Check (Minot, M-10)



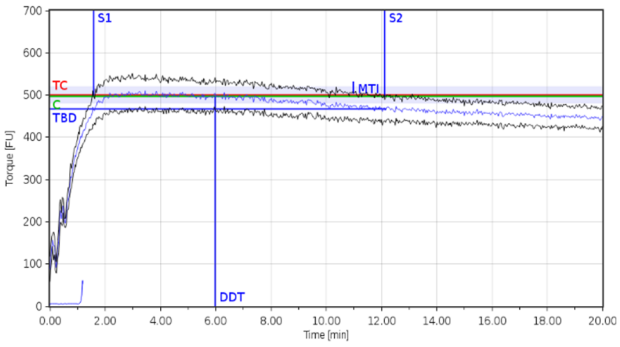
MT1939 (Minot, M-8)



LCS Rebel Check (Williston, W-10)

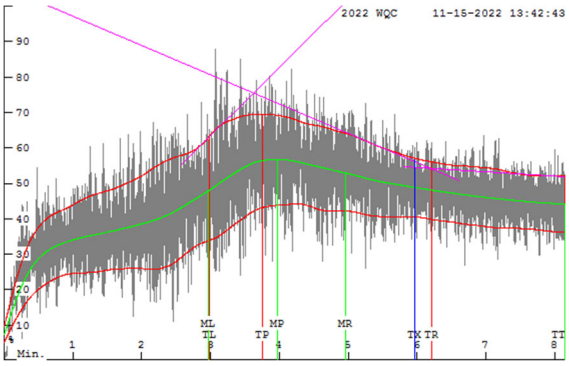


MT1939 (Williston, W-8)

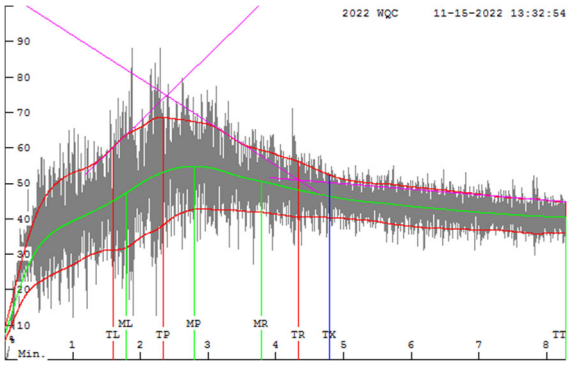


Mixograms

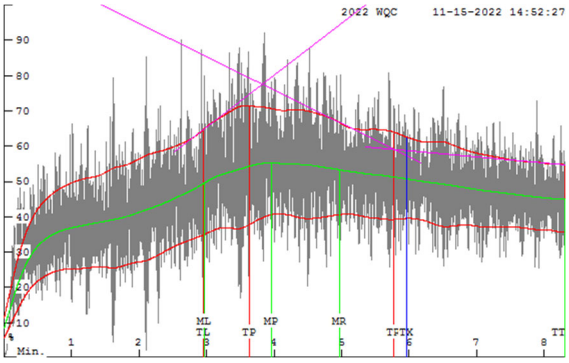
LCS Rebel Check (Havre, H-10)



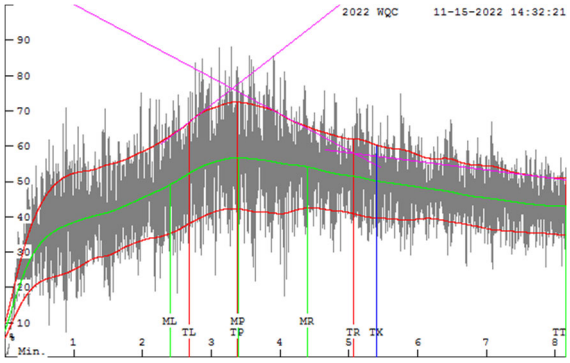
MT1939 (Havre, H-8)



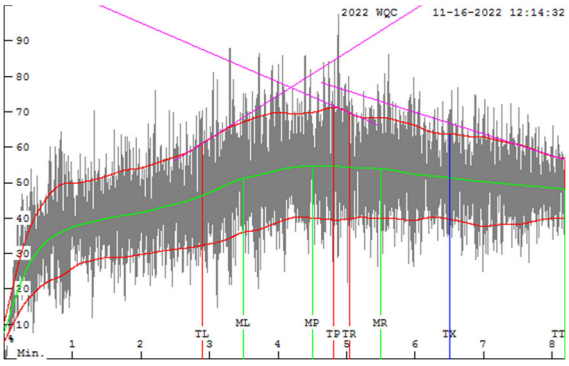
LCS Rebel Check (Minot, M-10)



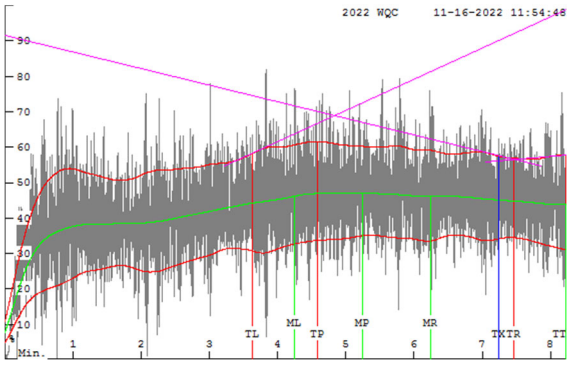
MT1939 (Minot, M-8)



LCS Rebel Check (Williston, W-10)

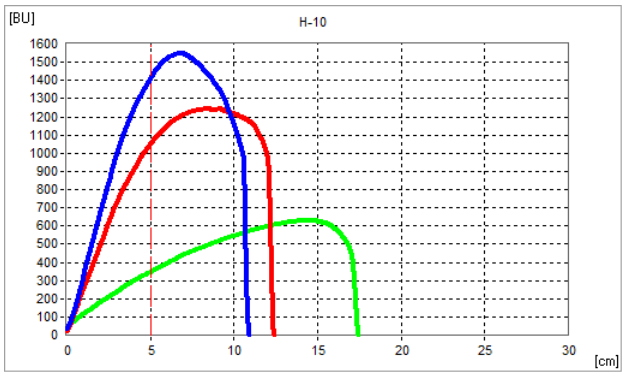


MT1939 (Williston, W-8)

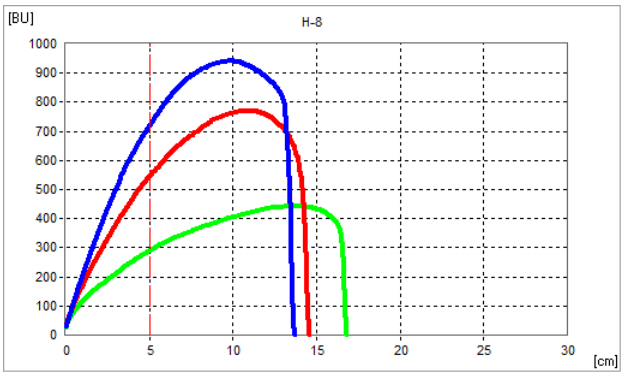


Extensograms

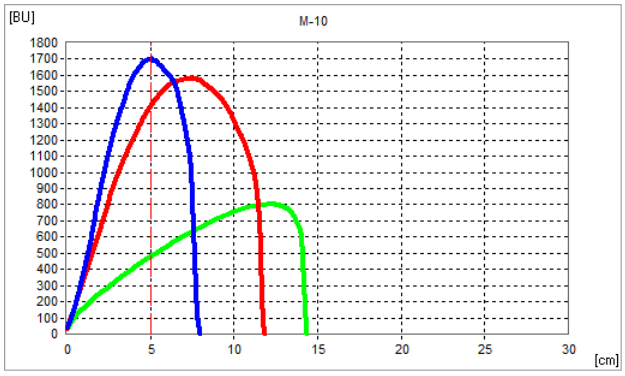
LCS Rebel Check (Havre, H-10)



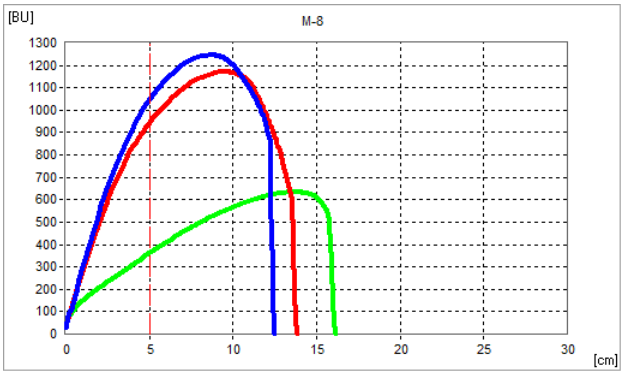
MT1939 (Havre, H-8)



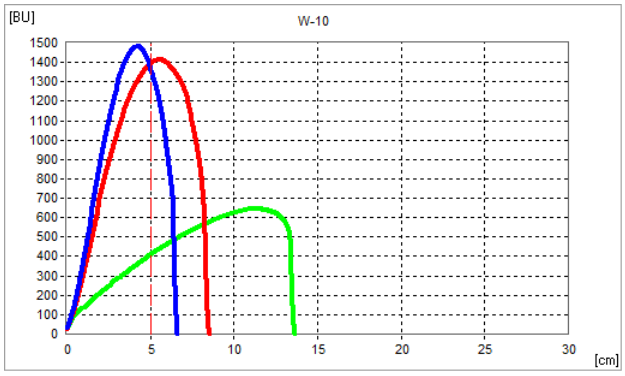
LCS Rebel Check (Minot, M-10)



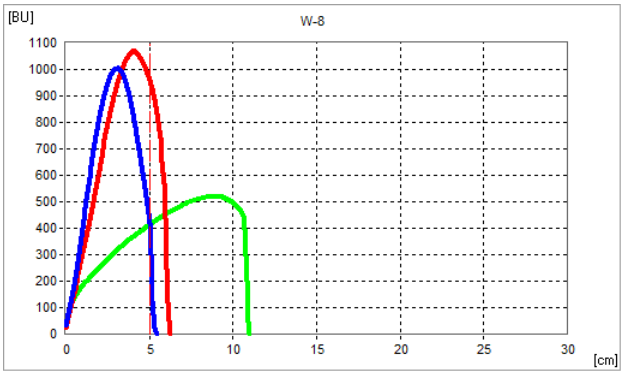
MT1939 (Minot, M-8)



LCS Rebel Check (Williston, W-10)



MT1939 (Williston, W-8)



45 min; 90 min; 135 min

SWQC #9 – T18C904

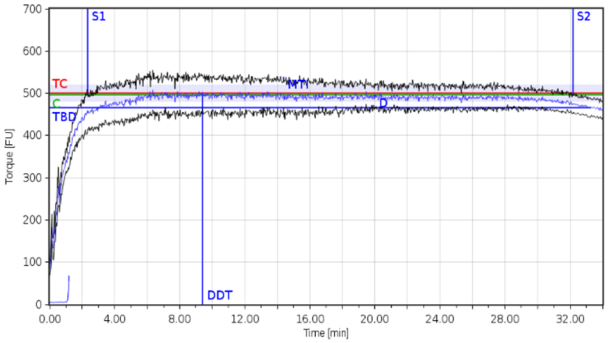
		Casselton		Crookston		Minot		Williston	
		Linkert		Linkert		LCS Rebel		LCS Rebel	
	Quality Trait	C-4	C-9	K-4	K-9	M-10	M-9	W-10	W-9
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	14.3	14.3	15.8	15.0	15.8	16.3	14.8	14.2
2	Flour Protein (%, 14% mb)	13.2	13.1	14.5	13.7	14.7	15.1	13.4	13.0
3	Market Value (Score 1-6)	4.5	4.2	5.3	5.0	5.2	4.8	4.9	4.7
4	Market Value (Score 1-10)	10.0	9.6	10.0	9.4	10.0	9.6	10.0	9.4
5	DON (ppm)	nd	nd	0.10	0.20	0.10	0.20	nd	nd
6	Test Weight (lb/bu)	61.7	61.4	63.0	63.2	63.0	61.0	63.3	62.7
7	1000 Kernel Weight (g)	34.8	32.1	34.8	34.9	33.7	32.3	31.4	31.6
8	Kernel Size, Large (%)	76	68	78	81	70	67	46	45
9	Kernel Size, Small (%)	6	8	6	5	7	6	11	9
10	Wheat Moisture (%)	12.8	12.9	12.8	12.7	10.8	10.7	11.4	11.3
11	Wheat Ash (%, 14% mb)	1.54	1.58	1.53	1.50	1.62	1.64	1.44	1.44
12	Wheat Falling Number (s)	406	411	430	415	426	441	436	429
13	SKCS Hardness Index	70.6	66.9	75.1	70.0	62.6	65.2	70.6	68.9
14	Vitreous Kernels (%)	42	43	69	54	88	96	97	91
	Flour Extraction								
15	Tempered Wheat Basis (%)	73.2	71.7	72.1	72.4	74.3	71.6	74.2	73.4
16	Total Product Basis (%)	74.8	73.9	74.4	74.1	76.0	73.8	75.7	73.6
17	Flour/Bu Wheat (lb)	45.7	44.4	46.3	46.5	47.4	44.3	47.9	47.0
	Flour Quality								
18	Flour Color Brightness (*L**)	90.3	90.0	90.7	89.8	90.7	89.6	90.7	90.2
19	Flour Color Yellowness (*b**)	8.9	11.5	8.7	11.2	8.9	10.8	9.1	10.7
20	Flour Moisture (%)	14.1	13.6	14.2	14.0	13.3	13.4	13.0	13.0
21	Flour Ash (%, 14% mb)	0.49	0.45	0.47	0.44	0.48	0.51	0.44	0.44
22	Flour Falling Number (malted, s)	250	255	248	254	250	255	255	250
	Farinograph								
23	Water Absorption (%, 500 BU)	61.3	63.2	63.6	65.3	63.8	66.4	65.8	66.1
24	Water Absorption (%, 14% mb)	61.5	62.8	63.8	65.5	63.2	65.8	64.8	64.9
25	Arrival Time (min)	2.3	4.5	4.2	4.8	2.8	5.3	3.5	4.0
26	Peak Time (min)	9.4	9.5	27.9	7.9	9.4	10.4	9.7	8.5
27	Dough Stability (min)	29.9	14.4	28.1	12.3	16.9	12.5	16.9	15.8
28	Mixing Tolerance Index (MTI, BU)	10	20	31	13	29	21	16	14
29	Time To Breakdown (TTB, min)	33.3	21.1	33.2	18.5	18.0	20.3	32.8	21.6
	II. Cooperator Results								
30	Bake Absorption (Average %)	64.9	66.1	67.3	68.2	67.3	69.2	68.1	67.7
31	Loaf Volume (% of Check)		103.7		102.0		106.9		102.7

SWQC #9 – T18C904

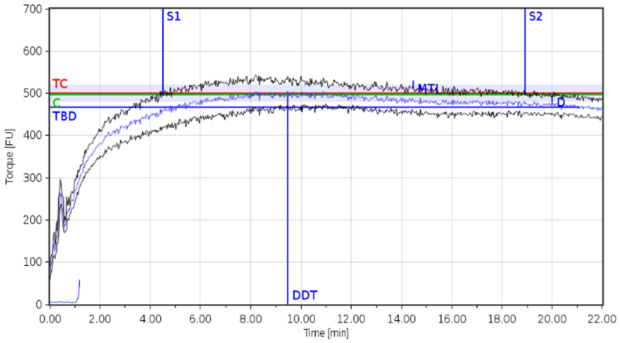
	Quality Trait	Casselton Linkert C-4	Casselton Linkert C-9	Crookston Linkert K-4	Crookston Linkert K-9	Minot LCS Rebel M-10	Minot LCS Rebel M-9	Williston LCS Rebel W-10	Williston LCS Rebel W-9
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	7.2	5.1	7.4	4.4	7.2	4.4	7.4	5.3
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	5.8	5.1	6.5	4.9	7.0	5.7	6.8	5.9
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		3.5		3.1		3.0		4.1
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.1		3.9		4.7		4.6
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.9		4.8		4.6		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		5.0		4.3		5.2		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		4.5		5.0		3.6		4.3
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.6		4.3		4.5		4.6
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.5		4.5		4.2		4.3

Farinograms

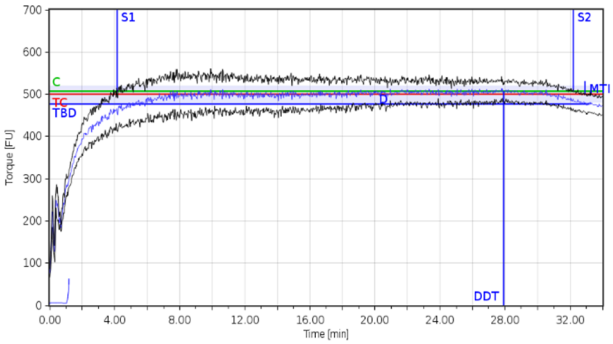
Linkert Check (Casselton, C-4)



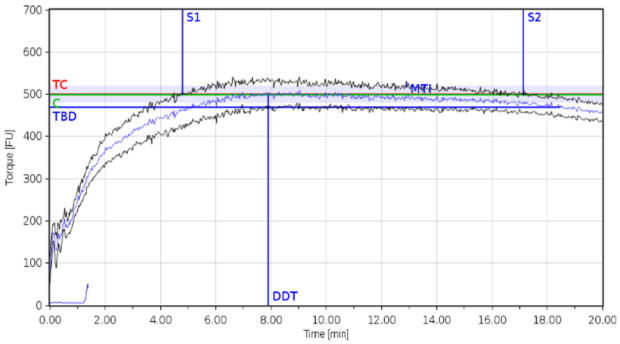
T18C904 (Casselton, C-9)



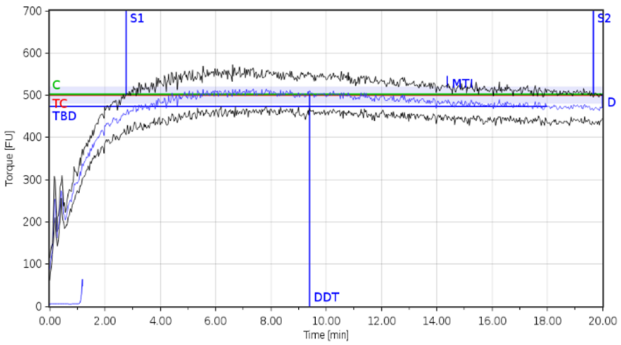
Linkert Check (Crookston, K-4)



T18C904 (Crookston, K-9)



LCS Rebel Check (Minot, M-10)



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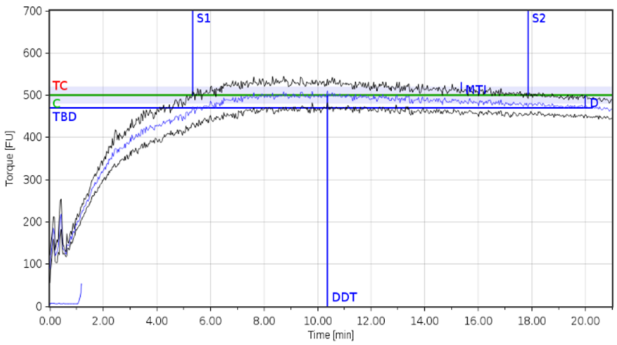
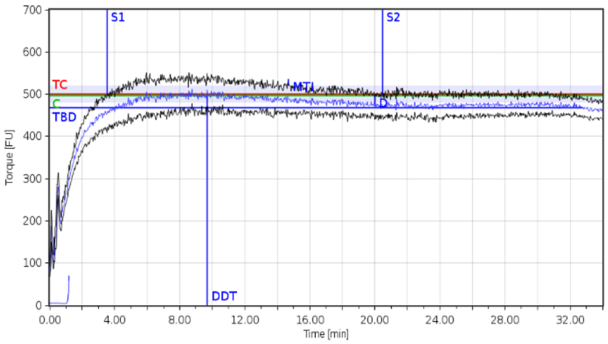


LCS Rebel Check (Williston, W-10)



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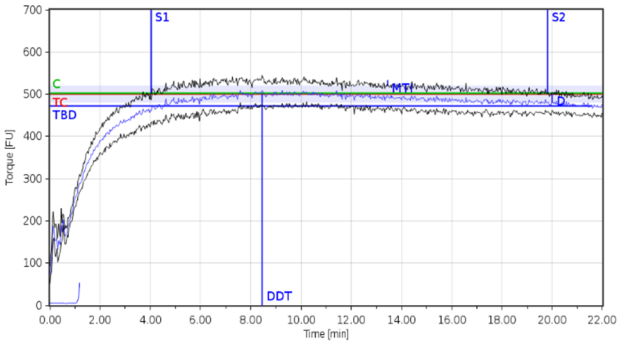
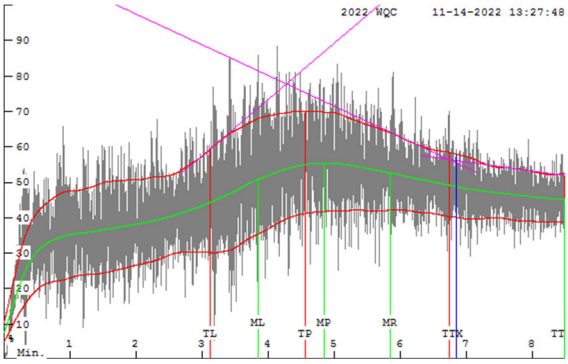


Mixograms

Linkert Check (Casselton, C-4)



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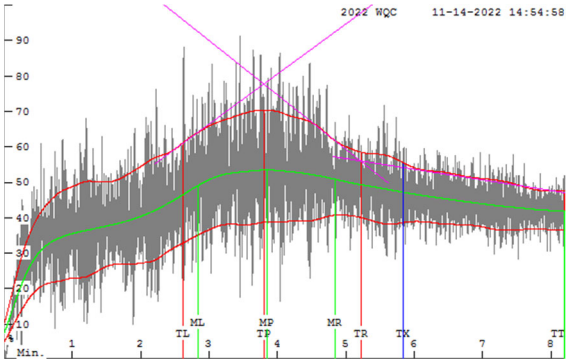

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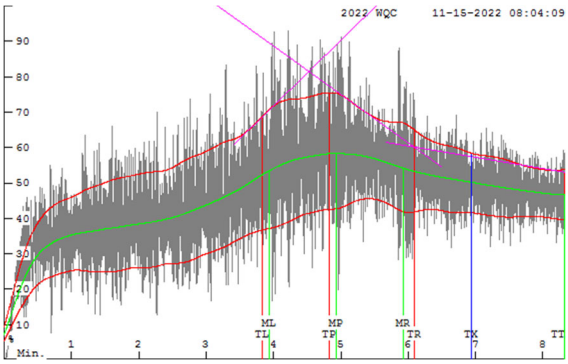
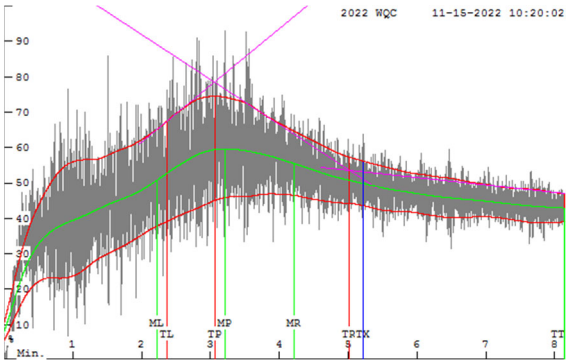
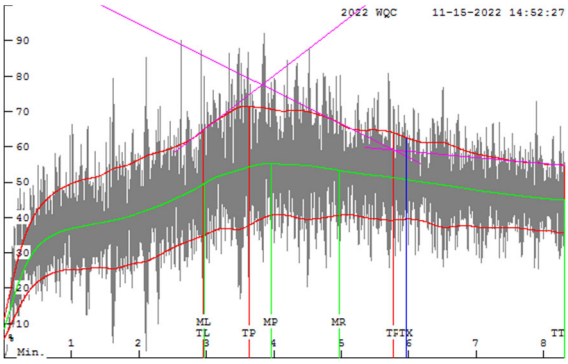


T18C904 (Crookston, K-9)



LCS Rebel Check (Minot, M-10)



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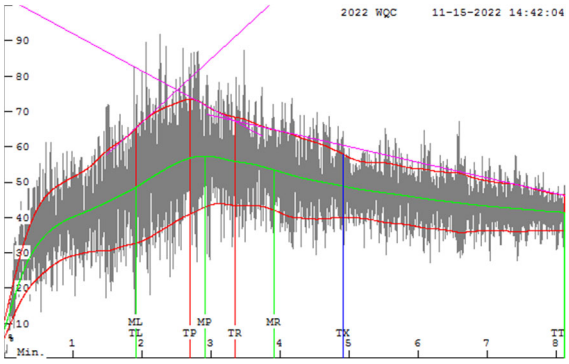
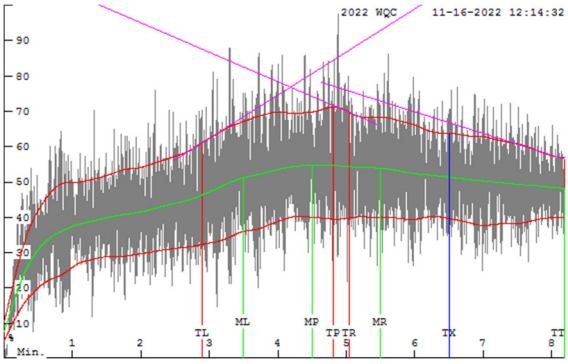
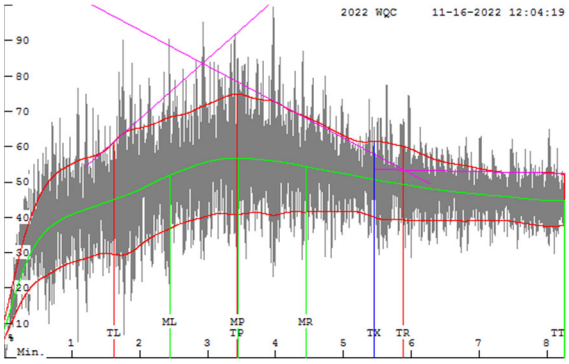


LCS Rebel Check (Williston, W-10)

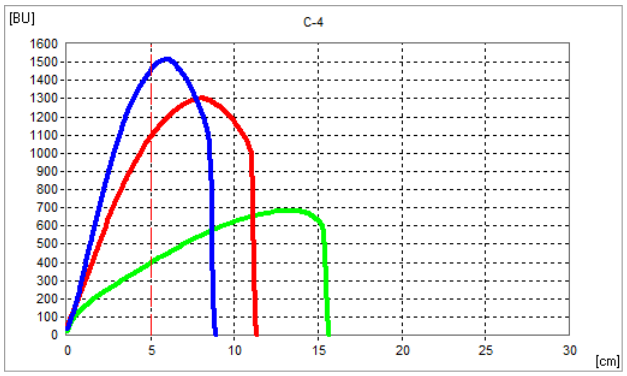


T18C904 (Williston, W-9)



Extensograms

Linkert Check (Casselton, C-4)



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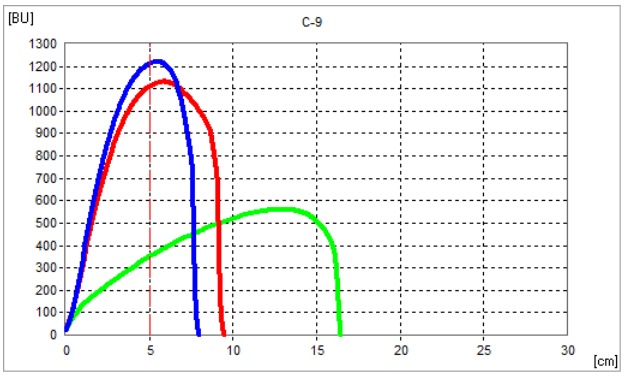

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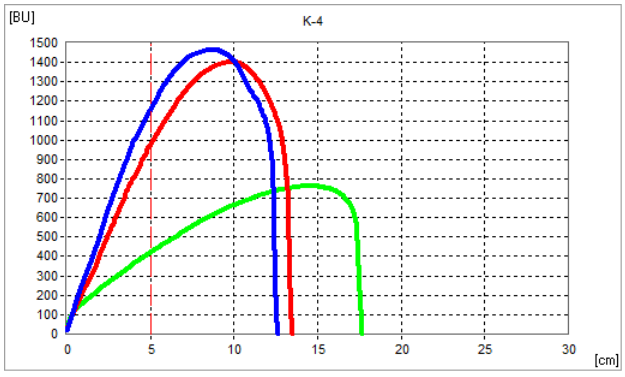

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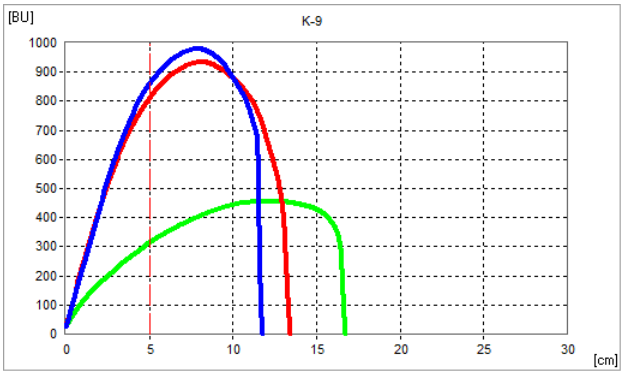
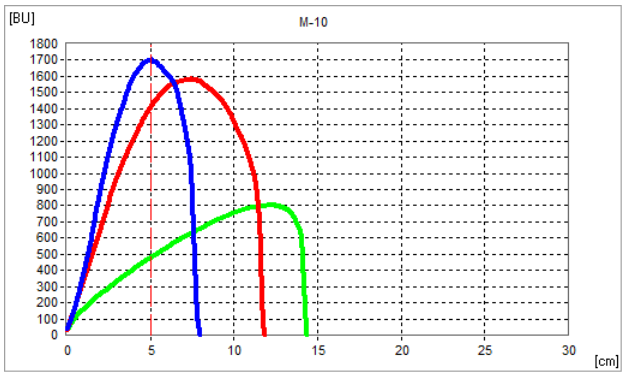


LCS Rebel Check (Minot, M-10)



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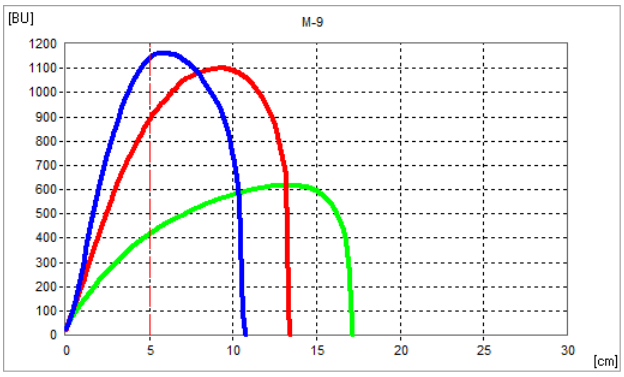
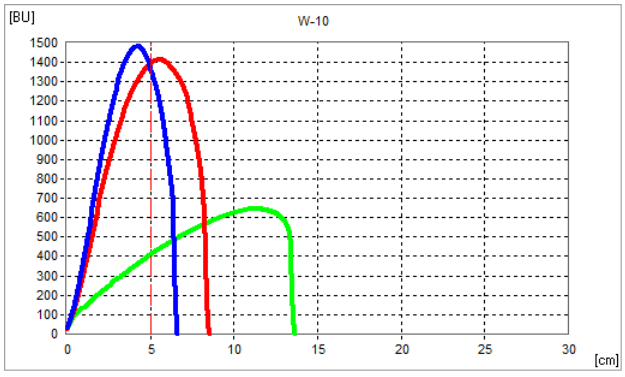
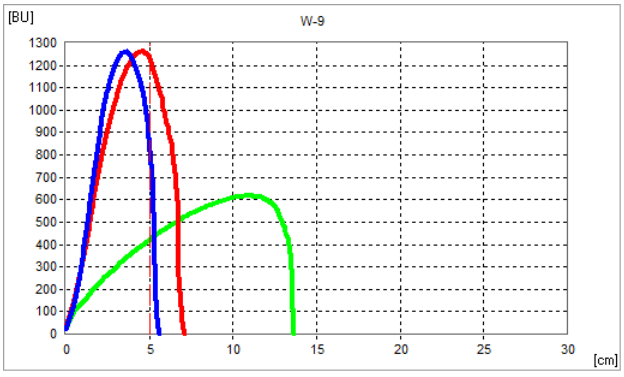


LCS Rebel Check (Williston, W-10)



T18C904 (Williston, W-9)



45 min; 90 min; 135 min

SWQC #11 – T18C905

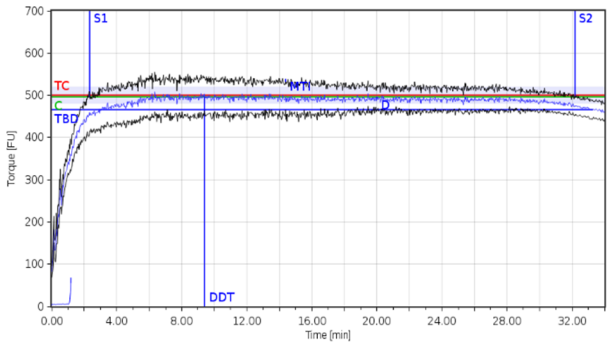
		Casselton		Crookston		Minot		Williston	
		Linkert		Linkert		LCS Rebel		LCS Rebel	
	Quality Trait	C-4	C-11	K-4	K-11	M-10	M-11	W-10	W-11
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	14.3	15.4	15.8	15.3	15.8	16.2	14.8	13.7
2	Flour Protein (%, 14% mb)	13.2	14.2	14.5	14.2	14.7	15.3	13.4	13.0
3	Market Value (Score 1-6)	4.5	4.4	5.3	4.9	5.2	4.6	4.9	4.4
4	Market Value (Score 1-10)	10.0	9.6	10.0	9.6	10.0	8.8	10.0	8.8
5	DON (ppm)	nd	0.15	0.10	0.10	0.10	0.25	nd	nd
6	Test Weight (lb/bu)	61.7	61.8	63.0	62.6	63.0	60.6	63.3	63.0
7	1000 Kernel Weight (g)	34.8	31.9	34.8	34.3	33.7	30.8	31.4	30.1
8	Kernel Size, Large (%)	76	73	78	81	70	59	46	44
9	Kernel Size, Small (%)	6	6	6	5	7	8	11	11
10	Wheat Moisture (%)	12.8	12.4	12.8	12.7	10.8	10.7	11.4	11.4
11	Wheat Ash (%, 14% mb)	1.54	1.63	1.53	1.51	1.62	1.67	1.44	1.49
12	Wheat Falling Number (s)	406	391	430	397	426	437	436	431
13	SKCS Hardness Index	70.6	69.9	75.1	70.1	62.6	73.2	70.6	74.4
14	Vitreous Kernels (%)	42	53	69	64	88	95	97	95
	Flour Extraction								
15	Tempered Wheat Basis (%)	73.2	71.6	72.1	73.0	74.3	71.9	74.2	71.0
16	Total Product Basis (%)	74.8	73.8	74.4	74.4	76.0	72.8	75.7	73.5
17	Flour/Bu Wheat (lb)	45.7	44.8	46.3	46.3	47.4	43.8	47.9	45.9
	Flour Quality								
18	Flour Color Brightness (*L**)	90.3	89.9	90.7	90.0	90.7	90.0	90.7	90.4
19	Flour Color Yellowness (*b**)	8.9	9.7	8.7	9.6	8.9	9.1	9.1	9.3
20	Flour Moisture (%)	14.1	13.5	14.2	13.8	13.3	12.9	13.0	13.4
21	Flour Ash (%, 14% mb)	0.49	0.47	0.47	0.46	0.48	0.52	0.44	0.47
22	Flour Falling Number (malted, s)	250	258	248	255	250	253	255	252
	Farinograph								
23	Water Absorption (%, 500 BU)	61.3	65.5	63.6	67.2	63.8	66.5	65.8	66.0
24	Water Absorption (%, 14% mb)	61.5	65.1	63.8	67.0	63.2	65.5	64.8	65.4
25	Arrival Time (min)	2.3	5.4	4.2	5.6	2.8	5.3	3.5	4.6
26	Peak Time (min)	9.4	10.5	27.9	10.9	9.4	11.3	9.7	11.8
27	Dough Stability (min)	29.9	13.1	28.1	13.4	16.9	22.3	16.9	20.1
28	Mixing Tolerance Index (MTI, BU)	10	21	31	21	29	14	16	16
29	Time To Breakdown (TTB, min)	33.3	19.6	33.2	21.4	18.0	32.1	32.8	28.2
	II. Cooperator Results								
30	Bake Absorption (Average %)	64.9	68.0	67.3	69.6	67.3	69.4	68.1	68.3
31	Loaf Volume (% of Check)		105.8		101.6		104.7		100.8

SWQC #11 – T18C905

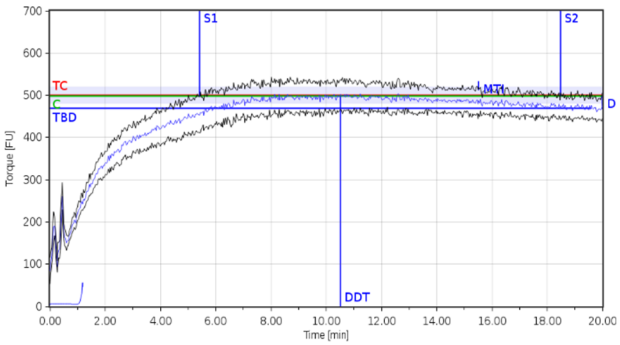
	Quality Trait	Casselton Linkert C-4	Casselton Linkert C-11	Crookston Linkert K-4	Crookston Linkert K-11	Minot LCS Rebel M-10	Minot LCS Rebel M-11	Williston LCS Rebel W-10	Williston LCS Rebel W-11
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	7.2	5.7	7.4	4.8	7.2	6.6	7.4	6.7
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	5.8	5.5	6.5	5.5	7.0	7.2	6.8	6.5
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		3.9		3.4		5.1		5.5
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.8		4.8		5.5		5.3
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.5		4.8		5.0		4.8
	III. Cooperator Evaluation								
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		6.5		5.0		5.4		4.0
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.5		5.2		3.2		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		5.5		4.5		5.7		5.0
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.7		4.9		5.0		4.5

Farinograms

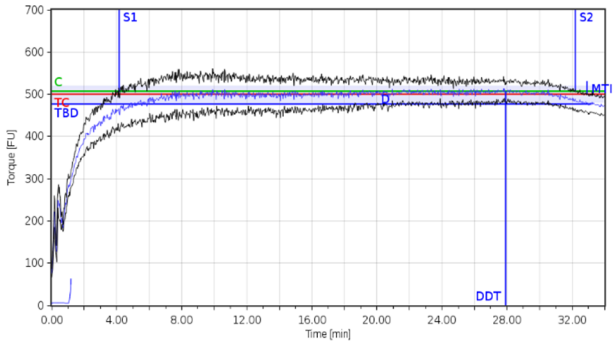
Linkert Check (Casselton, C-4)



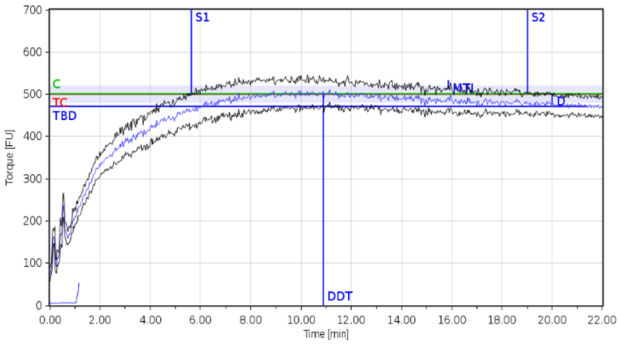
T18C905 (Casselton, C-11)



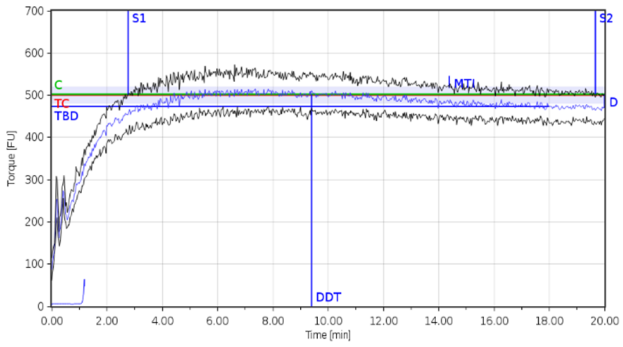
Linkert Check (Crookston, K-4)



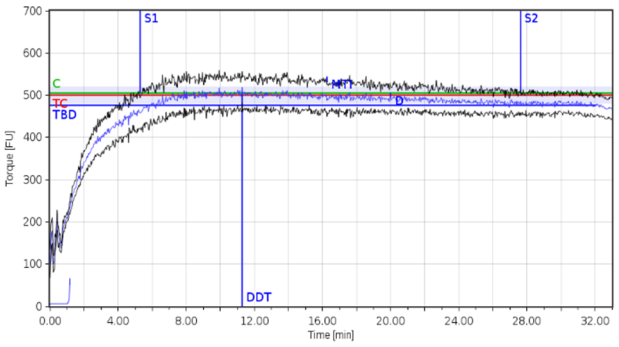
T18C905 (Crookston, K-11)



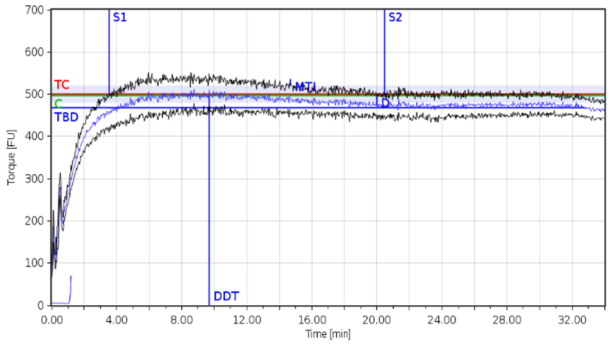
LCS Rebel Check (Minot, M-10)



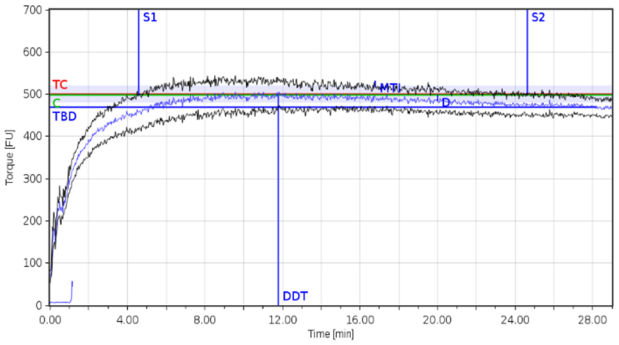
T18C905 (Minot, M-11)



LCS Rebel Check (Williston, W-10)

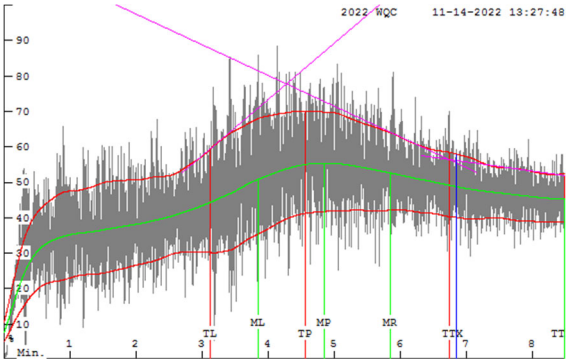


T18C905 (Williston, W-11)

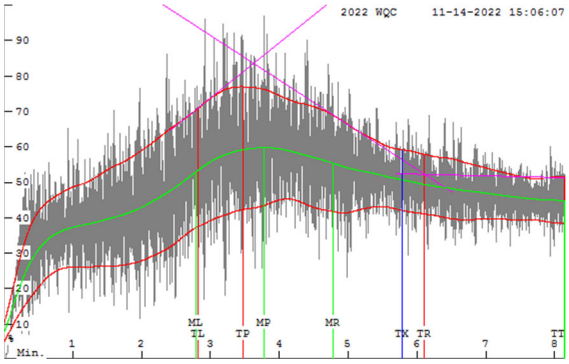


Mixograms

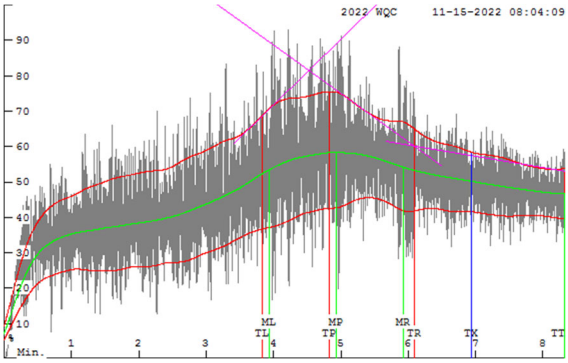
Linkert Check (Casselton, C-4)



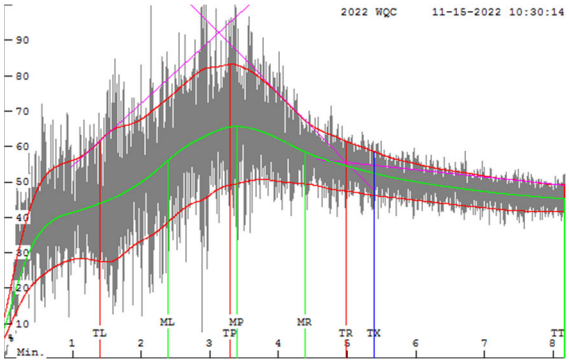
T18C905 (Casselton, C-11)



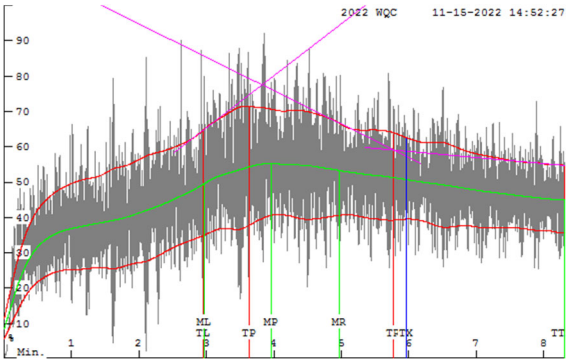
Linkert Check (Crookston, K-4)



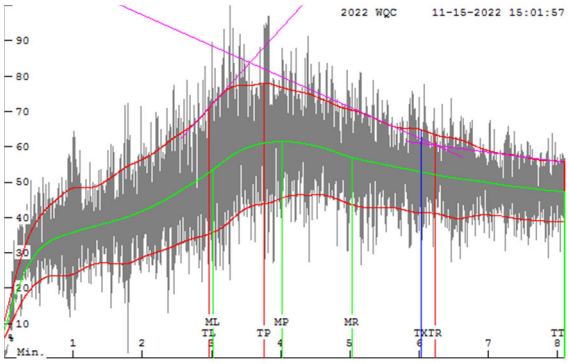
T18C905 (Crookston, K-11)



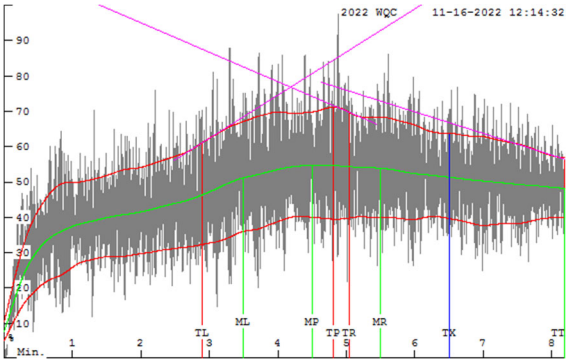
LCS Rebel Check (Minot, M-10)



T18C905 (Minot, M-11)



LCS Rebel Check (Williston, W-10)



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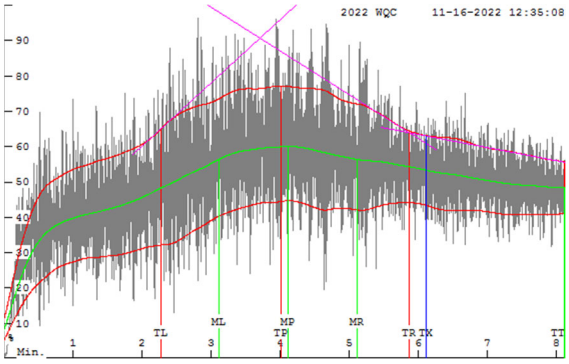
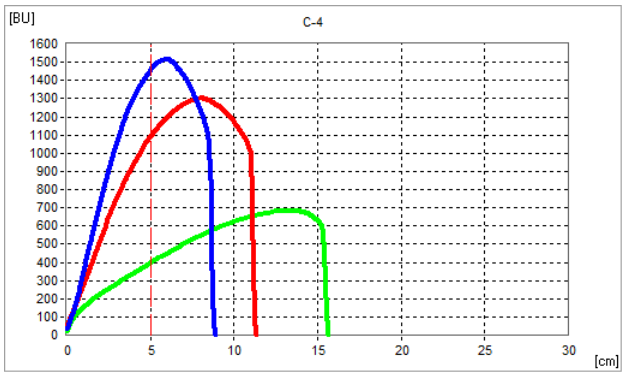
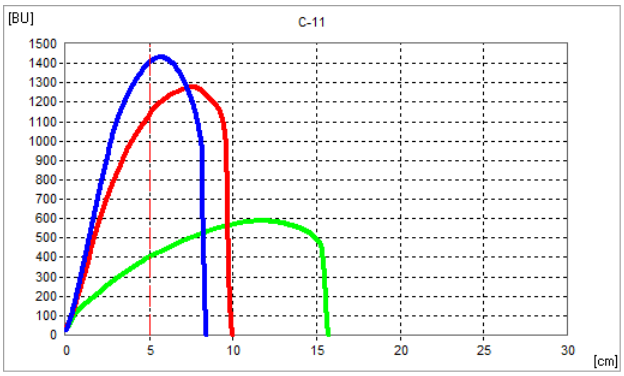


Extensograms

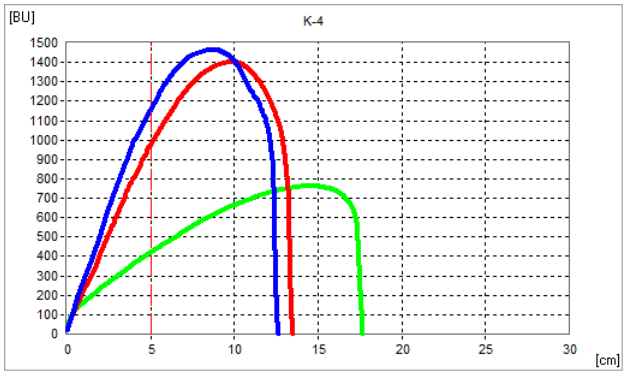
Linkert Check (Casselton, C-4)



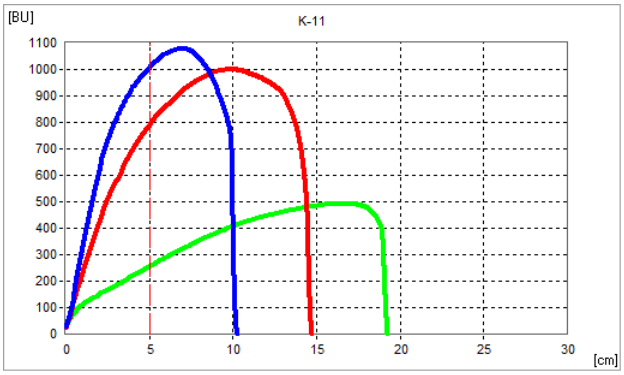
T18C905 (Casselton, C-11)



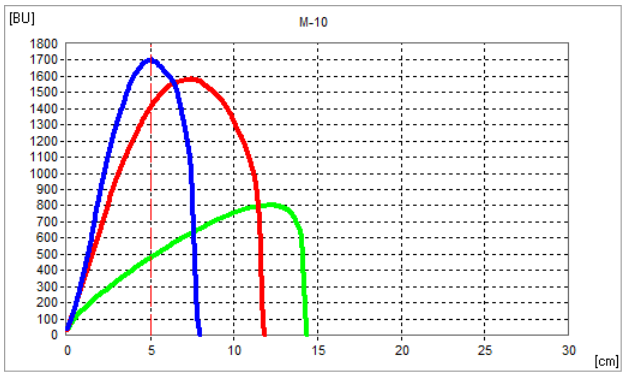
Linkert Check (Crookston, K-4)



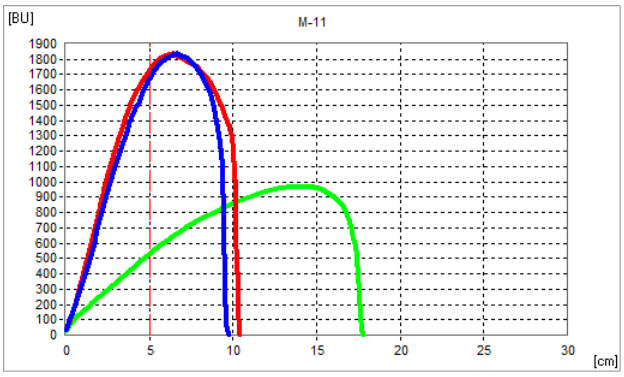
T18C905 (Crookston, K-11)



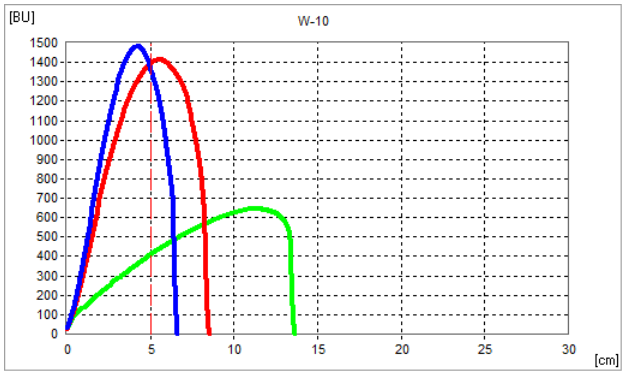
LCS Rebel Check (Minot, M-10)



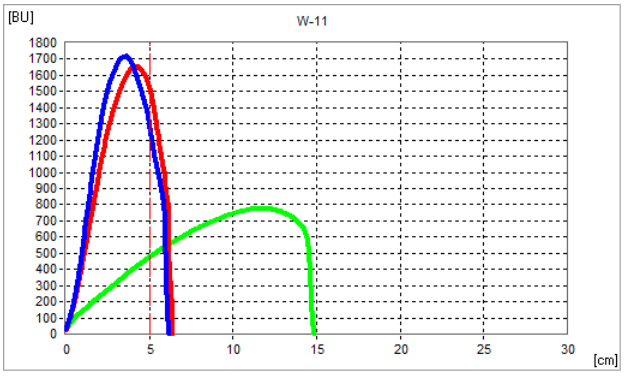
T18C905 (Minot, M-11)



LCS Rebel Check (Williston, W-10)



T18C905 (Williston, W-11)



45 min; 90 min; 135 min

Appendix

Wheat Market Value Score

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

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

Wheat Market Value Score – Method #1

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

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

Wheat Market Value Score – Method #2

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

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

Miag 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			

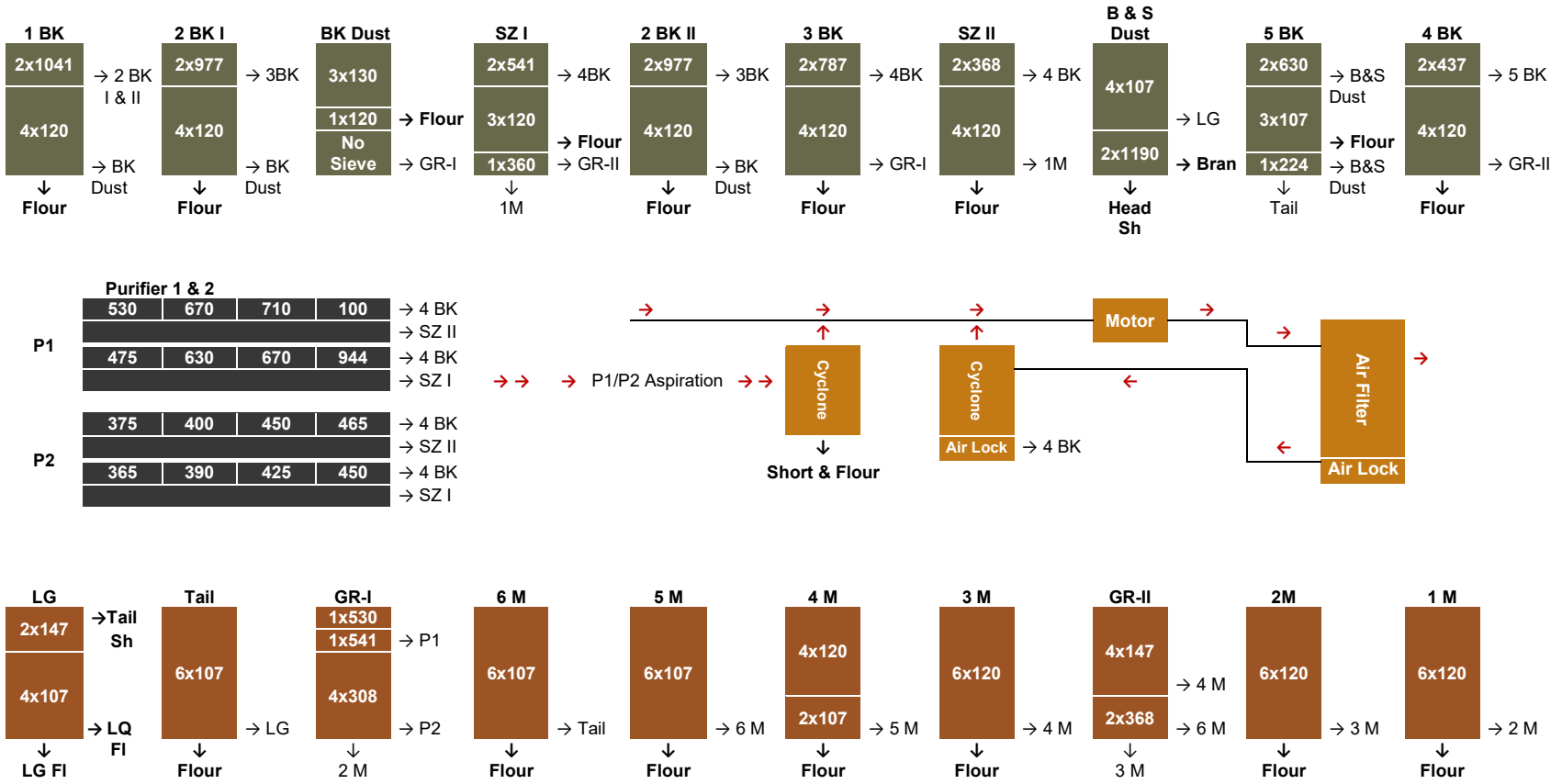
*Tail Cyclone fraction was separated into flour and shorts by rebolting.

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		Test Weight	1000 Kernel Weight	Kernel Size		Vitreous Kernels	SKC Hardness Index	Moisture	Protein	Ash	Falling Number	DON
			1-6	1-10	(lb/bu)	(g)	Large (%)	Small (%)	(%)		(%)	(%, 12% mb)	(%, 14% mb)	(s)	(ppm)
Watertown	B-1	Brawn-SD	3.0	8.8	57.9	26.0	43	16	55	72.3	12.4	15.5	1.82	376	1.20
	B-2	LARR19-0024	2.7	9.6	56.7	23.9	28	24	47	73.4	12.4	16.5	1.86	341	0.95
	B-4	**Linkert**	**3.0**	**10.0**	**56.9**	**25.9**	**39**	**17**	**52**	**72.9**	**12.6**	**17.0**	**1.91**	**373**	**0.70**
	B-6	AP Revolution	3.1	9.0	57.8	26.8	44	16	40	69.5	12.0	16.3	1.79	344	0.30
	B-7	MN18032-5	3.5	10.0	57.7	25.5	29	22	49	75.8	11.8	16.8	1.74	397	0.75
Casselton	C-1	Brawn-SD	4.4	9.6	62.8	31.0	71	7	22	68.4	12.8	14.5	1.56	394	0.05
	C-2	LARR19-0024	4.0	8.8	62.6	29.9	62	10	38	67.2	12.8	14.3	1.50	367	0.05
	C-4	**Linkert**	**4.5**	**10.0**	**61.7**	**34.8**	**76**	**6**	**42**	**70.6**	**12.8**	**14.3**	**1.54**	**406**	**nd**
	C-5	NDHRS13-0273-0036	4.4	9.6	61.5	31.3	72	6	24	71.4	12.7	14.6	1.50	411	0.05
	C-6	AP Revolution	3.8	9.2	60.8	29.6	57	13	22	65.5	12.8	13.9	1.59	409	nd
	C-7	MN18032-5	4.4	9.2	62.7	30.7	56	12	47	73.7	13.0	14.4	1.46	400	nd
	C-9	T18C904	4.2	9.6	61.4	32.1	68	8	43	66.9	12.9	14.3	1.58	411	nd
	C-11	T18C905	4.4	9.6	61.8	31.9	73	6	53	69.9	12.4	15.4	1.63	391	0.15
Havre	H-2	LARR19-0024	5.0	9.8	62.6	27.1	17	23	86	79.9	9.3	17.2	1.48	431	nd
	H-8	MT1939	4.9	9.4	61.2	30.0	47	11	89	70.3	9.4	16.3	1.39	439	nd
	H-10	**LCS Rebel**	**5.1**	**10.0**	**62.1**	**27.5**	**22**	**19**	**98**	**71.8**	**9.4**	**17.3**	**1.36**	**431**	**0.05**
Crookston	K-1	Brawn-SD	4.5	7.4	64.5	34.8	79	5	55	72.5	12.8	13.8	1.39	375	0.10
	K-2	LARR19-0024	4.8	8.6	64.0	32.3	70	8	48	71.5	13.0	15.1	1.39	383	nd
	K-4	**Linkert**	**5.3**	**10.0**	**63.0**	**34.8**	**78**	**6**	**69**	**75.1**	**12.8**	**15.8**	**1.53**	**430**	**0.10**
	K-5	NDHRS13-0273-0036	5.1	10.0	62.4	33.1	78	6	62	76.5	12.9	15.3	1.42	425	0.10
	K-6	AP Revolution	4.1	7.0	62.0	30.2	60	12	47	70.9	13.1	14.1	1.50	395	0.10
	K-7	MN18032-5	5.3	10.0	64.1	34.4	72	8	61	76.3	12.7	15.4	1.39	425	0.10
	K-9	T18C904	5.0	9.4	63.2	34.9	81	5	54	70.0	12.7	15.0	1.50	415	0.20
	K-11	T18C905	4.9	9.6	62.6	34.3	81	5	64	70.1	12.7	15.3	1.51	397	0.10
Minot	M-2	LARR19-0024	5.3	10.0	62.9	32.0	59	10	52	66.8	10.7	16.5	1.58	431	0.05
	M-3	NDHRS11-0244-0001	4.1	8.0	60.6	30.6	58	10	77	72.2	10.7	16.2	1.69	371	0.30
	M-7	MN18032-5	4.8	8.8	61.4	29.1	43	13	98	70.0	10.9	16.7	1.56	468	0.30
	M-8	MT1939	4.7	9.2	60.8	33.1	72	6	95	64.7	10.8	16.3	1.70	423	1.10
	M-9	T18C904	4.8	9.6	61.0	32.3	67	6	96	65.2	10.7	16.3	1.64	441	0.20
	M-10	**LCS Rebel**	**5.2**	**10.0**	**63.0**	**33.7**	**70**	**7**	**88**	**62.6**	**10.8**	**15.8**	**1.62**	**426**	**0.10**
	M-11	T18C905	4.6	8.8	60.6	30.8	59	8	95	73.2	10.7	16.2	1.67	437	0.25
Williston	W-2	LARR19-0024	4.2	9.2	62.4	25.6	15	23	92	77.1	11.7	14.3	1.49	413	nd
	W-3	NDHRS11-0244-0001	3.8	7.8	61.3	26.9	31	18	95	73.4	11.3	14.0	1.49	396	nd
	W-8	MT1939	3.6	6.6	63.0	31.2	60	7	67	63.7	11.5	11.4	1.53	399	nd
	W-9	T18C904	4.7	9.4	62.7	31.6	45	9	91	68.9	11.3	14.2	1.44	429	nd
	W-10	**LCS Rebel**	**4.9**	**10.0**	**63.3**	**31.4**	**46**	**11**	**97**	**70.6**	**11.4**	**14.8**	**1.44**	**436**	**nd**
	W-11	T18C905	4.4	8.8	63.0	30.1	44	11	95	74.4	11.4	13.7	1.49	431	nd

Flour Characteristics by Location

Location	ID	Entry	Extraction* TWB (%)	Extraction* TPB (%)	Extraction* Flour/bu Wheat (lb)	Color L*	Color a*	Color b*	Moisture (%)	Protein (%, 14% mb)	Ash (%, 14% mb)	Wet Gluten (%)	Gluten Index	Falling Number (Malted, s)
Watertown	B-1	Brawn-SD	71.8	73.4	42.3	88.5	-1.50	11.4	13.8	14.0	0.54	32.2	100	253
	B-2	LARR19-0024	67.2	69.2	38.6	88.1	-1.34	10.5	13.5	15.1	0.56	36.0	98	254
	B-4	**Linkert**	**69.4**	**70.8**	**39.9**	**88.5**	**-0.99**	**8.9**	**13.4**	**16.2**	**0.59**	**36.6**	**100**	**252**
	B-6	AP Revolution	70.2	72.6	41.2	89.0	-1.55	10.7	13.4	15.3	0.55	34.6	99	254
	B-7	MN18032-5	70.0	72.2	41.4	89.3	-1.05	9.1	13.9	15.7	0.54	37.2	99	253
Casselton	C-1	Brawn-SD	71.2	73.3	45.3	89.7	-1.64	12.1	13.8	12.9	0.44	32.0	99	252
	C-2	LARR19-0024	73.2	74.7	46.2	90.1	-1.33	10.6	13.5	12.8	0.46	35.3	95	253
	C-4	**Linkert**	**73.2**	**74.8**	**45.7**	**90.3**	**-0.97**	**8.9**	**14.1**	**13.2**	**0.49**	**32.3**	**99**	**250**
	C-5	NDHRS13-0273-0036	71.2	73.1	44.2	90.2	-0.77	8.8	13.5	13.3	0.45	35.0	98	248
	C-6	AP Revolution	71.8	73.9	44.3	90.4	-1.96	12.9	14.0	12.7	0.45	30.7	99	251
	C-7	MN18032-5	72.4	74.3	45.8	90.7	-1.16	9.6	13.8	13.1	0.44	33.1	98	255
	C-9	T18C904	71.7	73.9	44.4	90.0	-1.47	11.5	13.6	13.1	0.45	34.1	96	255
	C-11	T18C905	71.6	73.8	44.8	89.9	-1.03	9.7	13.5	14.2	0.47	35.8	97	258
Havre	H-2	LARR19-0024	70.7†	72.3†	44.8†	90.1	-1.00	9.5	13.4	16.2	0.51	45.1	94	247
	H-8	MT1939	71.2	73.1	44.1	90.8	-0.79	8.6	13.4	15.6	0.43	44.5	81	245
	H-10	**LCS Rebel**	**72.8**	**74.9**	**45.8**	**90.3**	**-0.89**	**9.6**	**13.4**	**16.4**	**0.42**	**43.2**	**94**	**248**
Crookston	K-1	Brawn-SD	73.9	75.7	48.2	90.2	-1.62	11.7	13.8	12.5	0.43	31.1	99	256
	K-2	LARR19-0024	73.0	74.8	47.1	90.4	-1.15	10.0	13.6	13.8	0.44	38.8	93	248
	K-4	**Linkert**	**72.1**	**74.4**	**46.3**	**90.7**	**-0.86**	**8.7**	**14.2**	**14.5**	**0.47**	**36.4**	**98**	**248**
	K-5	NDHRS13-0273-0036	72.0	74.1	45.6	90.3	-0.57	8.8	14.1	14.0	0.42	36.0	98	247
	K-6	AP Revolution	73.4	75.7	45.9	90.6	-1.92	12.7	13.8	13.1	0.48	30.2	99	251
	K-7	MN18032-5	72.9	75.4	47.1	90.5	-0.87	8.8	13.4	14.1	0.43	36.6	96	248
	K-9	T18C904	72.4	74.1	46.5	89.8	-1.24	11.2	14.0	13.7	0.44	36.4	91	254
	K-11	T18C905	73.0	74.4	46.3	90.0	-0.90	9.6	13.8	14.2	0.46	35.9	95	255
Minot	M-2	LARR19-0024	73.2	75.0	46.7	90.5	-1.01	9.5	13.5	15.1	0.50	42.9	94	255
	M-3	NDHRS11-0244-0001	71.8	73.5	44.1	90.4	-0.78	9.3	13.3	14.8	0.47	39.6	96	260
	M-7	MN18032-5	73.1	74.5	45.3	90.6	-0.82	8.8	13.2	15.6	0.45	40.5	97	249
	M-8	MT1939	71.2	72.9	43.7	90.6	-0.80	8.9	12.9	15.2	0.49	41.4	97	261
	M-9	T18C904	71.6	73.8	44.3	89.6	-1.10	10.8	13.4	15.1	0.51	42.2	89	255
	M-10	**LCS Rebel**	**74.3**	**76.0**	**47.4**	**90.7**	**-0.90**	**8.9**	**13.3**	**14.7**	**0.48**	**39.8**	**98**	**250**
	M-11	T18C905	71.9	72.8	43.8	90.0	-0.77	9.1	12.9	15.3	0.52	39.3	98	253
Williston	W-2	LARR19-0024	71.1	73.0	45.0	90.7	-1.24	9.6	12.8	13.3	0.49	35.6	97	246
	W-3	NDHRS11-0244-0001	71.1	73.0	44.6	90.7	-0.99	9.4	13.3	12.7	0.45	31.4	98	255
	W-8	MT1939	70.9	72.7	45.6	91.3	-1.06	8.6	13.1	10.6	0.44	25.8	99	253
	W-9	T18C904	73.4	73.6	47.0	90.2	-1.27	10.7	13.0	13.0	0.44	35.9	92	250
	W-10	**LCS Rebel**	**74.2**	**75.7**	**47.9**	**90.7**	**-0.97**	**9.1**	**13.0**	**13.4**	**0.44**	**35.4**	**98**	**255**
	W-11	T18C905	71.0	73.5	45.9	90.4	-0.97	9.3	13.4	13.0	0.47	32.9	98	252

*TWB = Tempered wheat basis; TPB = Total product basis.
†Received and milled 68 lbs of sample. Minimum of 90 lbs is needed to achieve optimum extraction.

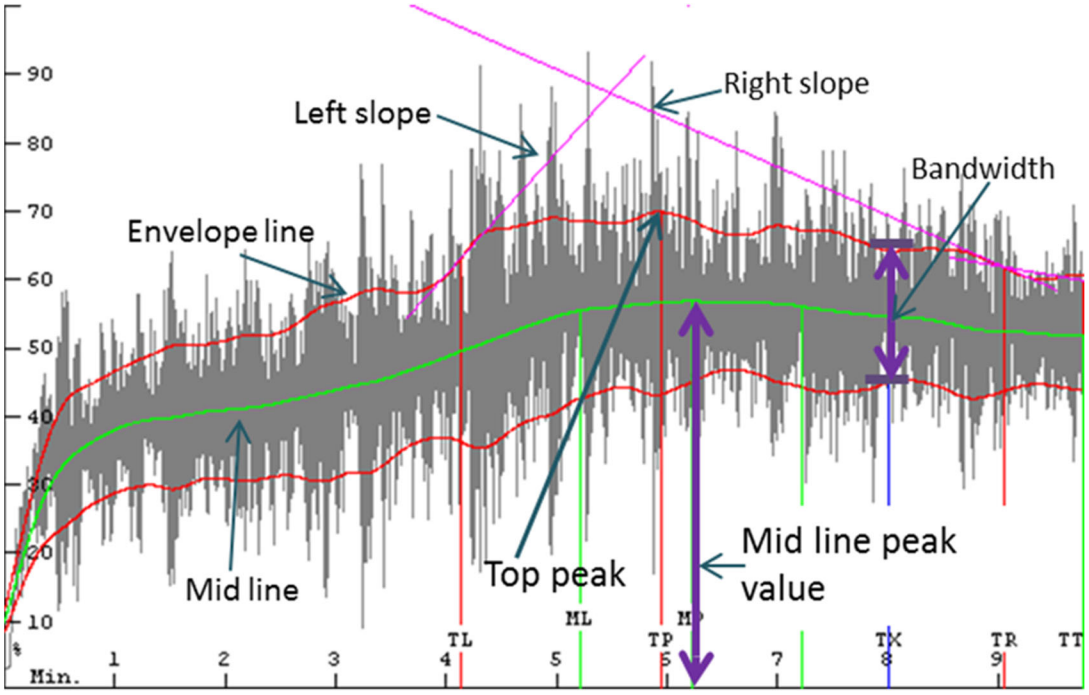
Farinograph Characteristics by Location

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-1	Brawn-SD	59.4	59.2	2.1	9.6	38.2	15	41.0
	B-2	LARR19-0024	60.2	59.8	2.8	9.1	36.1	8	39.8
	B-4	**Linkert**	**63.7**	**63.3**	**6.7**	**37.9**	**35.8**	**30**	**43.1**
	B-6	AP Revolution	63.4	62.8	30.1	37.5	13.4	18	44.9
	B-7	MN18032-5	62.3	62.3	4.1	34.8	36.8	20	42.5
Casselton	C-1	Brawn-SD	60.3	59.9	3.7	8.2	24.4	11	30.4
	C-2	LARR19-0024	61.5	60.9	3.1	8.5	11.5	33	15.5
	C-4	**Linkert**	**61.3**	**61.5**	**2.3**	**9.4**	**29.9**	**10**	**33.3**
	C-5	NDHRS13-0273-0036	63.3	62.7	2.3	8.3	24.8	12	28.4
	C-6	AP Revolution	59.5	59.7	2.2	36.8	40.5	21	45.1
	C-7	MN18032-5	60.0	59.8	2.2	8.7	21.7	21	31.2
	C-9	T18C904	63.2	62.8	4.5	9.5	14.4	20	21.1
	C-11	T18C905	65.5	65.1	5.4	10.5	13.1	21	19.6
Havre	H-2	LARR19-0024	64.8	64.2	5.1	17.6	20.8	5	26.8
	H-8	MT1939	67.1	66.7	5.8	9.5	10.9	11	17.8
	H-10	**LCS Rebel**	**65.8**	**65.2**	**6.3**	**14.6**	**23.3**	**3**	**30.8**
Crookston	K-1	Brawn-SD	61.9	61.7	3.3	9.8	17.8	20	25.6
	K-2	LARR19-0024	64.9	64.5	3.6	7.1	12.7	26	18.6
	K-4	**Linkert**	**63.6**	**63.8**	**4.2**	**27.9**	**28.1**	**31**	**33.2**
	K-5	NDHRS13-0273-0036	63.7	64.1	3.2	23.4	25.1	26	29.6
	K-6	AP Revolution	61.0	60.8	2.7	38.2	43.6	15	48.7
	K-7	MN18032-5	63.6	63.0	3.1	8.4	24.0	15	29.2
	K-9	T18C904	65.3	65.5	4.8	7.9	12.3	13	18.5
	K-11	T18C905	67.2	67.0	5.6	10.9	13.4	21	21.4
Minot	M-2	LARR19-0024	62.9	62.5	3.8	9.9	20.6	18	27.4
	M-3	NDHRS11-0244-0001	61.9	61.3	3.0	8.2	34.2	22	38.8
	M-7	MN18032-5	62.4	61.6	3.5	8.2	19.5	13	22.8
	M-8	MT1939	64.9	63.7	4.3	9.5	17.2	12	30.5
	M-9	T18C904	66.4	65.8	5.3	10.4	12.5	21	20.3
	M-10	**LCS Rebel**	**63.8**	**63.2**	**2.8**	**9.4**	**16.9**	**29**	**18.0**
	M-11	T18C905	66.5	65.5	5.3	11.3	22.3	14	32.1
Williston	W-2	LARR19-0024	63.4	62.0	3.3	7.4	13.4	24	18.0
	W-3	NDHRS11-0244-0001	61.5	60.9	2.2	5.9	31.1	11	35.1
	W-8	MT1939	61.2	60.2	1.6	6.0	10.5	29	12.2
	W-9	T18C904	66.1	64.9	4.0	8.5	15.8	14	21.6
	W-10	**LCS Rebel**	**65.8**	**64.8**	**3.5**	**9.7**	**16.9**	**16**	**32.8**
	W-11	T18C905	66.0	65.4	4.6	11.8	20.1	16	28.2

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)
	B-1	Brawn-SD	6.3	68.7	33.4	6.6	52.2	30.4	241.6
	B-2	LARR19-0024	6.5	72.1	34.3	6.7	55.3	30.9	252.1
Watertown	**B-4**	**Linkert**	**8.3**	**70.4**	**31.6**	**8.5**	**54.5**	**28.8**	**309.5**
	B-6	AP Revolution	9.7	63.5	26.3	9.5	49.9	26.2	345.5
	B-7	MN18032-5	7.8	66.8	32.4	7.9	50.3	30.4	289.7
	C-1	Brawn-SD	4.2	74.1	35.2	4.5	57.8	28.5	182.6
	C-2	LARR19-0024	3.1	71.7	32.1	3.4	56.0	28.1	138.7
	C-4	**Linkert**	**4.6**	**70.1**	**28.9**	**4.9**	**55.3**	**28.1**	**197.8**
Casselton	C-5	NDHRS13-0273-0036	4.0	71.3	33.6	4.3	53.8	32.8	183.5
	C-6	AP Revolution	5.6	67.2	29.4	5.7	51.9	29.2	222.5
	C-7	MN18032-5	4.5	69.7	32.3	4.6	52.7	31.9	180.2
	C-9	T18C904	3.8	70.4	31.6	3.9	53.5	31.4	154.1
	C-11	T18C905	3.5	76.9	34.6	3.8	59.7	32.7	162.4
	H-2	LARR19-0024	3.6	74.3	32.0	3.7	58.2	31.8	154.2
Havre	H-8	MT1939	2.3	68.6	30.3	2.8	54.7	24.7	115.0
	H-10	**LCS Rebel**	**3.8**	**69.5**	**26.4**	**4.0**	**56.7**	**25.4**	**156.8**
	K-1	Brawn-SD	4.1	77.6	34.1	4.3	60.9	33.7	180.3
	K-2	LARR19-0024	2.8	76.6	37.7	3.2	59.0	29.9	137.1
	K-4	**Linkert**	**4.8**	**75.5**	**32.9**	**4.9**	**58.3**	**32.7**	**205.5**
Crookston	K-5	NDHRS13-0273-0036	4.1	74.1	32.8	4.2	57.1	32.5	180.1
	K-6	AP Revolution	6.2	63.9	27.1	6.1	49.8	27.0	233.7
	K-7	MN18032-5	4.6	67.7	31.0	4.8	52.2	29.4	195.6
	K-9	T18C904	3.1	74.5	29.4	3.2	59.6	28.3	140.1
	K-11	T18C905	3.3	83.2	34.1	3.4	65.7	33.5	158.9
	M-2	LARR19-0024	3.1	73.1	33.1	3.4	56.7	29.7	137.9
	M-3	NDHRS11-0244-0001	4.0	65.4	30.2	4.8	51.4	25.0	191.0
	M-7	MN18032-5	4.8	70.0	31.6	5.3	54.0	28.2	206.8
Minot	M-8	MT1939	3.4	72.5	30.2	3.4	56.7	30.2	143.0
	M-9	T18C904	2.7	73.4	32.5	2.9	57.3	29.0	123.6
	M-10	**LCS Rebel**	**3.6**	**71.5**	**33.7**	**4.0**	**55.2**	**30.0**	**163.7**
	M-11	T18C905	3.8	78.0	34.2	4.0	61.5	31.2	173.4
	W-2	LARR19-0024	3.7	71.3	31.8	3.9	55.3	30.3	163.8
	W-3	NDHRS11-0244-0001	5.3	61.8	26.5	5.4	48.2	26.2	208.8
Williston	W-8	MT1939	4.6	61.5	27.8	5.3	47.1	25.2	208.8
	W-9	T18C904	3.4	74.8	34.1	3.5	56.8	34.0	151.5
	W-10	**LCS Rebel**	**4.8**	**71.1**	**31.7**	**4.5**	**54.7**	**29.8**	**189.7**
	W-11	T18C905	4.0	77.1	32.6	4.1	60.0	32.3	187.6

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

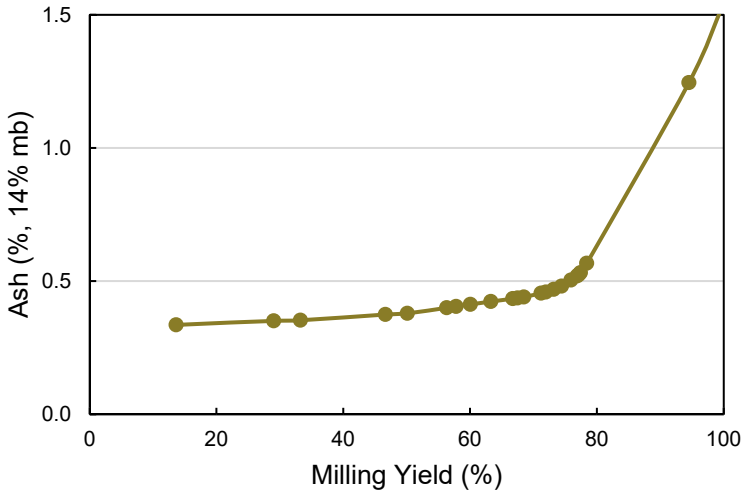
45 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-1	Brawn-SD	142	402	166	672	2.4	4.1
	B-2	LARR19-0024	146	408	168	695	2.4	4.1
	B-4	**Linkert**	**186**	**485**	**172**	**900**	**2.8**	**5.2**
	B-6	AP Revolution	188	642	148	1062	4.4	7.2
	B-7	MN18032-5	162	546	146	955	3.7	6.6
Casselton	C-1	Brawn-SD	118	350	162	575	2.2	3.5
	C-2	LARR19-0024	83	250	162	393	1.6	2.4
	C-4	**Linkert**	**132**	**398**	**156**	**684**	**2.6**	**4.4**
	C-5	NDHRS13-0273-0036	132	338	177	597	1.9	3.4
	C-6	AP Revolution	130	566	129	821	4.4	6.4
	C-7	MN18032-5	123	409	153	631	2.7	4.1
	C-9	T18C904	117	352	164	561	2.1	3.4
	C-11	T18C905	121	404	157	587	2.6	3.7
Havre	H-2	LARR19-0024	114	319	163	589	2.0	3.6
	H-8	MT1939	98	290	168	444	1.7	2.6
	H-10	**LCS Rebel**	**135**	**351**	**174**	**628**	**2.0**	**3.6**
Crookston	K-1	Brawn-SD	117	321	173	517	1.9	3.0
	K-2	LARR19-0024	85	250	166	394	1.5	2.4
	K-4	**Linkert**	**168**	**421**	**177**	**763**	**2.4**	**4.3**
	K-5	NDHRS13-0273-0036	113	379	152	595	2.5	3.9
	K-6	AP Revolution	146	609	133	905	4.6	6.8
	K-7	MN18032-5	102	322	165	456	2.0	2.8
	K-9	T18C904	102	315	167	456	1.9	2.7
	K-11	T18C905	119	258	192	493	1.3	2.6
Minot	M-2	LARR19-0024	125	356	172	551	2.1	3.2
	M-3	NDHRS11-0244-0001	137	398	166	647	2.4	3.9
	M-7	MN18032-5	172	488	163	855	3.0	5.2
	M-8	MT1939	126	363	162	634	2.3	3.9
	M-9	T18C904	139	417	171	617	2.4	3.6
	M-10	**LCS Rebel**	**138**	**479**	**144**	**803**	**3.3**	**5.6**
	M-11	T18C905	210	533	178	967	3.0	5.4
Williston	W-2	LARR19-0024	125	380	158	638	2.4	4.1
	W-3	NDHRS11-0244-0001	86	402	124	554	3.3	4.5
	W-8	MT1939	74	414	110	520	3.8	4.7
	W-9	T18C904	105	420	136	617	3.1	4.5
	W-10	**LCS Rebel**	**107**	**411**	**136**	**644**	**3.0**	**4.7**
	W-11	T18C905	140	475	149	776	3.2	5.2

90 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-1	Brawn-SD	226	910	145	1237	6.3	8.6
	B-2	LARR19-0024	228	1101	130	1350	8.5	10.4
	B-4	**Linkert**	**255**	**1209**	**133**	**1457**	**9.1**	**11.0**
	B-6	AP Revolution	215	1659	95	1822	17.5	19.2
	B-7	MN18032-5	224	1354	116	1494	11.7	12.9
Casselton	C-1	Brawn-SD	194	985	127	1190	7.8	9.4
	C-2	LARR19-0024	123	657	118	811	5.6	6.9
	C-4	**Linkert**	**187**	**1092**	**114**	**1300**	**9.6**	**11.4**
	C-5	NDHRS13-0273-0036	150	1126	98	1194	11.5	12.2
	C-6	AP Revolution	153	1569	80	1571	19.6	19.6
	C-7	MN18032-5	139	1334	85	1364	15.7	16.1
	C-9	T18C904	139	1111	95	1131	11.7	11.9
	C-11	T18C905	160	1138	100	1279	11.4	12.8
Havre	H-2	LARR19-0024	217	807	154	1088	5.3	7.1
	H-8	MT1939	144	546	146	771	3.7	5.3
	H-10	**LCS Rebel**	**203**	**1051**	**125**	**1242**	**8.4**	**10.0**
Crookston	K-1	Brawn-SD	167	956	116	1106	8.3	9.5
	K-2	LARR19-0024	123	558	133	698	4.2	5.3
	K-4	**Linkert**	**230**	**990**	**135**	**1402**	**7.3**	**10.4**
	K-5	NDHRS13-0273-0036	178	807	138	1001	5.8	7.2
	K-6	AP Revolution	151	1600	81	1696	19.9	21.1
	K-7	MN18032-5	172	1075	116	1152	9.3	10.0
	K-9	T18C904	163	809	134	934	6.0	7.0
	K-11	T18C905	196	790	147	999	5.4	6.8
Minot	M-2	LARR19-0024	193	847	142	1019	6.0	7.2
	M-3	NDHRS11-0244-0001	175	918	119	1195	7.8	10.1
	M-7	MN18032-5	197	1367	104	1490	13.2	14.4
	M-8	MT1939	210	944	139	1171	6.8	8.5
	M-9	T18C904	192	890	134	1100	6.6	8.2
	M-10	**LCS Rebel**	**236**	**1410**	**119**	**1581**	**11.9**	**13.3**
	M-11	T18C905	242	1728	105	1835	16.5	17.6
Williston	W-2	LARR19-0024	185	1021	118	1265	8.6	10.7
	W-3	NDHRS11-0244-0001	109	1190	76	1191	15.7	15.8
	W-8	MT1939	75	958	62	1072	15.4	17.2
	W-9	T18C904	102	1231	71	1262	17.4	17.8
	W-10	**LCS Rebel**	**145**	**1397**	**86**	**1414**	**16.3**	**16.5**
	W-11	T18C905	121	1514	64	1653	23.5	25.7

135 Minutes Resting								
Location	ID	Entry	Energy (cm^2)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Watertown	B-1	Brawn-SD	195	1202	111	1352	10.8	12.2
	B-2	LARR19-0024	182	1460	95	1491	15.4	15.7
	B-4	**Linkert**	**223**	**1441**	**109**	**1538**	**13.2**	**14.1**
	B-6	AP Revolution	217	1863	93	1867	20.1	20.1
	B-7	MN18032-5	187	1696	88	1758	19.3	20.0
Casselton	C-1	Brawn-SD	180	1243	106	1342	11.8	12.7
	C-2	LARR19-0024	132	807	111	901	7.3	8.1
	C-4	**Linkert**	**166**	**1463**	**89**	**1516**	**16.4**	**17.0**
	C-5	NDHRS13-0273-0036	137	1460	78	1460	18.8	18.8
	C-6	AP Revolution	127	1500	68	1620	22.2	24.0
	C-7	MN18032-5	104	1425	63	1483	22.8	23.7
	C-9	T18C904	120	1213	80	1222	15.2	15.3
	C-11	T18C905	150	1408	84	1433	16.7	17.0
Havre	H-2	LARR19-0024	209	917	142	1164	6.5	8.2
	H-8	MT1939	168	728	137	942	5.3	6.9
	H-10	**LCS Rebel**	**212**	**1414**	**109**	**1550**	**12.9**	**14.2**
Crookston	K-1	Brawn-SD	141	1180	92	1230	12.8	13.3
	K-2	LARR19-0024	126	668	125	743	5.4	6.0
	K-4	**Linkert**	**230**	**1161**	**126**	**1465**	**9.2**	**11.6**
	K-5	NDHRS13-0273-0036	170	976	117	1177	8.4	10.1
	K-6	AP Revolution	144	1683	76	1689	22.3	22.4
	K-7	MN18032-5	137	1484	74	1511	20.0	20.3
	K-9	T18C904	150	860	118	980	7.3	8.3
	K-11	T18C905	146	1012	103	1076	9.9	10.5
Minot	M-2	LARR19-0024	191	849	136	1100	6.2	8.1
	M-3	NDHRS11-0244-0001	169	1445	93	1542	15.6	16.6
	M-7	MN18032-5	199	1470	101	1585	14.5	15.6
	M-8	MT1939	205	1048	125	1245	8.4	9.9
	M-9	T18C904	160	1142	108	1163	10.6	10.8
	M-10	**LCS Rebel**	**159**	**1701**	**80**	**1702**	**21.3**	**21.4**
	M-11	T18C905	214	1675	98	1835	17.1	18.7
Williston	W-2	LARR19-0024	163	1504	89	1512	16.9	17.0
	W-3	NDHRS11-0244-0001	91	1118	63	1229	17.8	19.6
	W-8	MT1939	61	416	55	1005	7.6	18.4
	W-9	T18C904	79	817	56	1262	14.6	22.5
	W-10	**LCS Rebel**	**113**	**1360**	**66**	**1484**	**20.6**	**22.4**
	W-11	T18C905	122	1271	62	1719	20.5	27.7

Ash Content in Mill Streams

Linkert Check – Crookston (K-4)



Mill Stream	Stream (%, 14% mb) Yield	Stream (%, 14% mb) Ash	Cumulative (%, 14% mb) Yield	Cumulative (%, 14% mb) Ash
Patent:				
1 M	13.6	0.34	13.6	0.34
2 M	15.4	0.36	29.0	0.35
Sz I	4.2	0.37	33.3	0.35
3 M	13.4	0.43	46.7	0.37
Sz II	3.5	0.44	50.1	0.38
4 M	6.2	0.57	56.3	0.40
1 Bk	1.5	0.59	57.8	0.40
Bk Dust	2.2	0.61	60.0	0.41
3 Bk	3.2	0.62	63.3	0.42
4 Bk	3.5	0.64	66.7	0.43
2 Bk I	0.7	0.66	67.5	0.44
2 Bk II	1.0	0.68	68.5	0.44
6 M	2.7	0.81	71.2	0.45
TC	0.7	0.88	72.0	0.46
Tail	1.2	1.05	73.2	0.47
5 Bk	1.2	1.21	74.4	0.48
Clear Flour:				
LG	1.5	1.63	75.9	0.50
5 M	1.0	1.71	76.9	0.52
LQ	0.2	2.09	77.2	0.52
Bran & Shorts:				
TC Sh	0.2	2.64	77.4	0.53
Tail Sh	1.0	3.36	78.4	0.57
Head Sh	16.1	4.55	94.5	1.25
Bran	5.5	6.75	100.0	1.55
Patent (Rebolted)	**0.47**			
Wheat	**1.53**			

Cooperators' Bake Data

Linkert Checks

WATERTOWN (B-4)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	62.0	2800	9	9
B	68.5	982	7	7
C	77.2	994	9	5
D	64.2	1075	8	5
E	73.0	1150	9	5
F	63.7	2046	6	6
G	65.3	2400	9	5
H	63.7	2291	9	8
I	69.5	910	6	5
J	66.0	2307	9	9
K	63.0	2853	9	7
Avg.	66.9		8.2	6.5
S.D.	4.7		1.3	1.6

CASSSELTON (C-4)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	60.0	2925	9	7
B	66.4	922	6	5
C	75.2	954	5	5
D	63.5	923	6	5
E	69.7	1000	9	6
F	61.3	1846	5	5
G	63.5	2650	9	7
H	61.3	2529	6	6
I	66.5	980	6	6
J	64.6	2236	9	5
K	62.0	2941	9	7
Avg.	64.9		7.2	5.8
S.D.	4.4		1.8	0.9

CROOKSTON (K-4)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	61.0	2800	9	9
B	68.8	927	6	5
C	79.2	961	6	3
D	65.6	938	6	5
E	71.7	1135	8	7
F	63.6	2072	6	5
G	65.8	2525	9	9
H	63.6	2486	9	8
I	70.7	1025	4	5
J	66.3	2283	9	9
K	64.0	2780	9	7
Avg.	67.3		7.4	6.5
S.D.	5.1		1.8	2.1

LCS Rebel Checks

HAVRE (H-10)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	63.0	2825	9	9
B	70.0	992	5	5
C	81.7	978	5	5
D	66.4	1076	4	6
E	72.9	1185	7	7
F	65.8	1952	7	6
G	67.2	2725	9	9
H	65.8	2295	6	6
I	70.6	1070	5	6
J	68.0	2443	9	7
K	66.0	3162	9	9
Avg.	68.9		6.8	6.8
S.D.	5.1		1.9	1.5

MINOT (M-10)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	62.0	2875	9	9
B	68.0	949	5	6
C	80.2	945	5	8
D	65.2	1016	5	6
E	72.9	1065	9	6
F	63.8	1929	9	4
G	65.2	2550	9	9
H	63.8	2283	6	6
I	68.7	1125	4	5
J	66.1	2282	9	9
K	64.0	2971	9	9
Avg.	67.3		7.2	7.0
S.D.	5.2		2.1	1.8

WILLISTON (W-10)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	60.0	2825	9	7
B	69.8	878	6	5
C	80.2	854	6	8
D	66.4	871	7	6
E	69.5	915	7	7
F	65.8	2018	7	5
G	66.8	2600	9	7
H	65.8	2431	6	6
I	71.9	970	6	6
J	68.0	2267	9	9
K	65.0	2824	9	9
Avg.	68.1		7.4	6.8
S.D.	5.1		1.4	1.4

SWQC #1 – Brawn-SD

WATERTOWN (B-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	60.0	2825	100.9	9	7	5	5	5	5	5	5	5
B	64.1	920	93.7	6	6	4	4	4	3	6	1	3
C	74.7	969	97.5	7	8	5	7	2	4	7	4	5
D	62.2	975	90.7	7	4	5	7	5	7	8	4	7
E	69.8	1050	91.3	9	6	5	6	4	3	5	4	4
F	59.4	1953	95.5	6	5	5	6	5	4	6	4	5
G	61.2	2475	103.1	9	7	5	5	5	1	5	3	3
H	59.4	2300	100.4	6	5	4	3	5	3	6	4	4
I	64.9	950	104.4	4	5	5	5	6	3	5	6	5
J	63.1	2375	102.9	9	7	5	7	5	3	9	7	7
K	59.0	2971	104.1	9	9	5	7	5	7	5	7	7
Avg.	**63.4**		**98.6**	**7.4**	**6.3**	**4.8**	**5.6**	**4.6**	**3.9**	**6.1**	**4.5**	**5.0**
S.D.	**4.9**		**5.1**	**1.7**	**1.5**	**0.4**	**1.4**	**1.0**	**1.8**	**1.4**	**1.8**	**1.5**

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	60.0	2850	97.4	9	7	5	5	5	5	5	5	5
B	64.7	892	96.7	6	4	4	5	5	5	4	3	4
C	74.2	923	96.8	5	6	5	4	4	5	5	4	5
D	62.4	876	94.9	5	4	4	4	3	5	4	4	4
E	69.4	990	99.0	9	5	7	3	5	5	5	5	5
F	60.3	2016	109.2	5	7	5	5	5	5	5	5	5
G	61.9	2575	97.2	7	5	5	5	5	5	5	3	5
H	60.3	2279	90.1	5	6	5	3	4	4	4	3	4
I	64.8	955	97.4	5	5	4	5	6	5	4	5	5
J	64.6	2152	96.2	9	5	5	4	5	5	3	4	4
K	60.0	3104	105.5	9	7	5	3	5	5	5	7	7
Avg.	**63.9**		**98.2**	**6.7**	**5.5**	**4.9**	**4.2**	**4.7**	**4.9**	**4.5**	**4.4**	**4.8**
S.D.	**4.5**		**5.1**	**1.9**	**1.1**	**0.8**	**0.9**	**0.8**	**0.3**	**0.7**	**1.2**	**0.9**

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	59.0	2850	101.8	5	5	3	5	5	3	5	3	5
B	66.7	894	96.4	5	6	5	4	6	3	6	3	4
C	78.2	907	94.4	5	7	4	4	4	3	6	4	4
D	64.0	867	92.4	5	3	3	3	3	2	7	3	4
E	67.4	965	85.0	5	6	4	3	5	1	5	2	3
F	61.9	1966	94.9	6	6	5	5	5	3	6	5	4
G	63.7	2625	104.0	7	5	5	5	7	3	5	3	3
H	61.9	2252	90.6	6	7	6	3	5	3	6	3	4
I	69.1	920	89.8	4	5	3	4	2	2	6	3	2
J	66.4	2154	94.3	9	3	4	4	5	3	9	3	4
K	62.0	2633	94.7	9	5	3	3	5	3	5	3	3
Avg.	**65.5**		**94.4**	**6.0**	**5.3**	**4.1**	**3.9**	**4.7**	**2.6**	**6.0**	**3.2**	**3.6**
S.D.	**5.2**		**5.3**	**1.7**	**1.3**	**1.0**	**0.8**	**1.3**	**0.7**	**1.2**	**0.8**	**0.8**

SWQC #2 – LARR19-0024

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	61.0	2750	98.2	9	7	5	5	5	5	5	3	5
B	64.9	966	98.4	6	7	4	4	4	4	4	2	3
C	74.2	1009	101.5	9	8	5	6	4	4	5	5	5
D	62.3	1046	97.3	6	6	5	5	5	6	4	5	5
E	71.2	1105	96.1	9	4	5	6	3	4	5	4	4
F	60.2	1921	93.9	5	5	5	6	4	4	6	4	5
G	61.8	2400	100.0	9	5	5	5	5	3	3	3	3
H	60.2	2304	100.6	6	4	4	6	4	4	4	5	4
I	65.9	1030	113.2	6	6	5	5	4	4	4	5	4
J	63.7	2360	102.3	9	7	5	5	5	4	3	6	4
K	60.0	3000	105.2	9	9	5	7	5	7	5	7	7
Avg.	**64.1**		**100.6**	**7.5**	**6.2**	**4.8**	**5.5**	**4.4**	**4.5**	**4.4**	**4.5**	**4.5**
S.D.	**4.7**		**5.2**	**1.7**	**1.6**	**0.4**	**0.8**	**0.7**	**1.1**	**0.9**	**1.4**	**1.1**

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	60.0	2850	97.4	5	5	3	5	5	5	5	3	5
B	65.9	887	96.2	4	4	4	5	5	5	2	2	2
C	73.7	945	99.1	3	4	6	4	5	5	5	5	4
D	63.7	932	101.0	4	6	3	4	4	5	5	4	4
E	68.6	940	94.0	5	6	5	3	4	5	5	4	5
F	61.5	1977	107.1	3	7	3	5	5	5	5	5	5
G	62.9	2625	99.1	9	5	3	5	5	5	3	3	3
H	61.5	2301	91.0	5	7	4	3	4	4	5	4	4
I	67.2	905	92.3	4	5	2	6	7	5	5	4	4
J	65.1	2172	97.1	7	5	3	4	5	5	5	3	4
K	61.0	2721	92.5	7	3	3	3	5	3	5	3	3
Avg.	**64.6**		**97.0**	**5.1**	**5.2**	**3.5**	**4.3**	**4.9**	**4.7**	**4.5**	**3.6**	**3.9**
S.D.	**4.1**		**4.6**	**1.9**	**1.3**	**1.1**	**1.0**	**0.8**	**0.6**	**1.0**	**0.9**	**0.9**

HAVRE (H-2)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Quality Score Compared to Check (LCS Rebel): Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	63.0	2875	101.8	9	9	5	5	5	5	5	5	5
B	69.0	971	97.9	5	5	5	5	5	5	3	5	4
C	83.7	1004	102.7	5	8	3	5	6	5	4	7	6
D	65.7	1072	99.6	4	7	5	5	7	5	4	6	5
E	73.9	1160	97.9	7	6	4	5	5	5	5	5	5
F	64.8	2036	104.3	7	6	4	5	4	5	5	5	5
G	66.2	2925	107.3	9	7	5	5	7	5	5	5	5
H	64.8	2331	101.6	6	5	4	5	4	5	3	5	4
I	68.6	1145	107.0	5	5	4	4	4	5	4	4	4
J	67.0	2541	104.0	9	9	5	7	5	5	3	5	4
K	65.0	3207	101.4	9	9	5	5	5	5	5	5	5
Avg.	**68.3**		**102.3**	**6.8**	**6.9**	**4.5**	**5.1**	**5.2**	**5.0**	**4.2**	**5.2**	**4.7**
S.D.	**5.9**		**3.2**	**1.9**	**1.6**	**0.7**	**0.7**	**1.1**	**0.0**	**0.9**	**0.8**	**0.6**

CROOKSTON (K-2)

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	61.0	2975	106.3	5	5	3	5	5	5	5	3	5
B	69.3	892	96.2	4	6	4	4	6	4	4	3	3
C	79.7	888	92.4	4	4	4	4	4	4	5	4	4
D	67.4	1003	106.9	3	4	3	4	7	4	5	6	5
E	70.2	1010	89.0	5	5	3	3	5	3	5	3	3
F	64.9	1940	93.6	6	5	4	5	3	5	5	4	4
G	66.5	2675	105.9	5	5	3	5	7	3	5	3	5
H	64.9	2169	87.2	4	6	6	4	5	4	5	3	4
I	74.7	950	92.7	4	4	2	3	2	4	5	2	3
J	66.4	2183	95.6	7	5	3	4	4	4	7	3	4
K	65.0	2397	86.2	7	5	3	3	3	1	5	3	1
Avg.	**68.2**		**95.6**	**4.9**	**4.9**	**3.5**	**4.0**	**4.6**	**3.7**	**5.1**	**3.4**	**3.7**
S.D.	**5.2**		**7.6**	**1.3**	**0.7**	**1.0**	**0.8**	**1.6**	**1.1**	**0.7**	**1.0**	**1.2**

MINOT (M-2)

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	62.0	2875	100.0	9	9	5	5	5	5	5	5	5
B	67.4	944	99.5	4	5	4	5	5	5	3	4	2
C	82.7	920	97.4	4	5	3	5	5	5	4	4	4
D	64.3	1037	102.1	3	6	4	5	6	4	4	5	4
E	71.2	1110	104.2	5	6	3	5	4	6	5	5	5
F	62.9	1928	99.9	6	5	3	5	4	5	5	5	5
G	64.5	2725	106.9	9	9	7	5	7	5	5	7	7
H	62.9	2397	105.0	6	6	6	5	4	6	4	5	5
I	67.6	1050	93.3	3	5	6	5	6	6	4	5	6
J	65.6	2257	98.9	9	7	5	5	4	6	3	5	5
K	63.0	2986	100.5	9	9	5	5	5	5	5	5	5
Avg.	**66.7**		**100.7**	**6.1**	**6.5**	**4.6**	**5.0**	**5.0**	**5.3**	**4.3**	**5.0**	**4.8**
S.D.	**5.9**		**3.8**	**2.5**	**1.7**	**1.4**	**0.0**	**1.0**	**0.6**	**0.8**	**0.8**	**1.3**

WILLISTON (W-2)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Quality Score Compared to Check (LCS Rebel): Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2875	101.8	9	7	5	5	5	5	5	5	5
B	67.0	904	103.0	4	6	5	6	6	5	1	4	3
C	81.2	913	106.9	5	8	5	6	7	5	3	7	6
D	64.4	897	103.0	5	6	5	5	5	5	3	5	4
E	69.3	950	103.8	7	7	5	5	6	5	4	5	5
F	63.4	1943	96.3	8	6	7	5	6	5	4	5	5
G	64.0	2800	107.7	9	7	3	5	7	5	3	5	5
H	63.4	2371	97.5	5	6	5	4	4	5	3	4	4
I	69.7	965	99.5	5	5	4	4	4	4	4	4	4
J	65.7	2344	103.4	9	9	9	4	3	4	2	4	3
K	63.0	3074	108.9	9	7	5	5	5	5	3	7	7
Avg.	**66.5**		**102.9**	**6.8**	**6.7**	**5.3**	**4.9**	**5.3**	**4.8**	**3.2**	**5.0**	**4.6**
S.D.	**5.7**		**4.0**	**2.0**	**1.1**	**1.6**	**0.7**	**1.3**	**0.4**	**1.1**	**1.1**	**1.2**

SWQC #3 – NDHRS11-0244-0001

MINOT (M-3)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	62.0	2875	100.0	9	9	5	5	5	5	5	5	5
B	66.5	978	103.1	5	6	5	5	4	5	2	6	3
C	80.2	965	102.1	7	6	4	4	3	5	4	4	4
D	63.3	982	96.7	5	7	5	6	5	5	3	5	4
E	70.8	1110	104.2	8	7	7	5	3	5	3	5	4
F	61.9	2064	107.0	6	5	3	5	6	6	4	6	5
G	63.3	2825	110.8	9	9	9	5	7	5	3	7	7
H	61.9	2318	101.5	5	5	6	5	6	5	2	6	5
I	66.7	1050	93.3	5	5	7	4	4	5	4	4	4
J	65.3	2391	104.8	9	7	5	5	4	5	2	5	3
K	62.0	3000	101.0	9	9	5	5	5	5	5	5	5
Avg.	65.8		102.2	7.0	6.8	5.5	4.9	4.7	5.1	3.4	5.3	4.5
S.D.	5.5		4.7	1.8	1.6	1.6	0.5	1.3	0.3	1.1	0.9	1.1

WILLISTON (W-3)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2975	105.3	9	7	5	5	5	5	5	5	5
B	65.9	916	104.3	5	6	5	5	5	4	1	4	2
C	78.7	889	104.1	8	6	4	5	5	4	4	6	4
D	63.4	843	96.8	7	6	5	5	6	2	3	5	3
E	66.8	930	101.6	7	9	7	5	4	3	4	4	5
F	61.5	2147	106.4	7	6	6	5	6	5	4	6	5
G	62.9	2725	104.8	9	7	7	5	7	3	3	5	5
H	61.5	2537	104.4	4	5	7	5	5	4	3	5	4
I	67.3	965	99.5	5	5	7	4	3	4	4	4	4
J	64.6	2466	108.8	9	5	9	4	3	4	2	3	3
K	61.0	3104	109.9	9	9	5	5	5	5	3	7	7
Avg.	64.9		104.2	7.2	6.5	6.1	4.8	4.9	3.9	3.3	4.9	4.3
S.D.	5.2		3.8	1.8	1.4	1.4	0.4	1.2	0.9	1.1	1.1	1.3

SWQC #5 – NDHRS-0273-0036

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	60.0	2875	98.3	5	5	3	5	3	5	5	3	3
B	67.9	913	99.0	5	5	5	5	5	5	4	4	4
C	76.2	973	102.0	5	5	5	5	4	5	5	6	5
D	65.1	988	107.0	4	5	5	5	8	5	4	6	5
E	69.1	995	99.5	5	6	7	7	7	5	5	6	5
F	63.3	2065	111.9	4	5	4	5	7	5	5	5	5
G	64.7	2775	104.7	9	5	5	5	7	5	5	7	5
H	63.3	2308	91.3	5	7	5	5	4	5	4	5	4
I	69.0	940	95.9	5	5	4	5	6	5	4	4	4
J	66.3	2276	101.8	9	5	4	5	5	5	3	5	4
K	63.0	3015	102.5	9	5	3	5	5	5	5	5	5
Avg.	66.2		101.3	5.9	5.3	4.5	5.2	5.5	5.0	4.5	5.1	4.5
S.D.	4.3		5.5	2.0	0.6	1.1	0.6	1.6	0.0	0.7	1.1	0.7

CROOKSTON (K-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	61.0	2875	102.7	5	5	3	5	5	5	5	3	5
B	68.9	954	102.9	4	7	5	5	5	5	4	5	4
C	79.7	927	96.5	5	6	6	5	3	5	5	3	4
D	65.9	1038	110.7	5	6	5	5	6	5	5	6	6
E	69.8	1080	95.2	5	6	5	5	7	5	5	5	5
F	63.7	1919	92.6	5	5	4	5	4	5	5	5	5
G	66.1	2725	107.9	9	7	5	5	7	5	5	5	7
H	63.7	2380	95.7	8	7	5	5	5	4	5	4	4
I	70.0	1040	101.5	5	5	5	4	3	4	5	4	4
J	66.4	2198	96.3	9	7	5	5	4	4	5	5	4
K	64.0	3015	108.5	9	7	7	5	5	5	5	7	7
Avg.	67.2		100.9	6.3	6.2	5.0	4.9	4.9	4.7	4.9	4.7	5.0
S.D.	5.0		6.2	2.0	0.9	1.0	0.3	1.4	0.5	0.3	1.2	1.2

SWQC #6 – AP Revolution

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	61.0	2900	103.6	9	9	5	5	5	5	5	5	5
B	68.0	1013	103.2	7	7	6	4	5	4	6	3	4
C	76.7	1036	104.2	9	7	4	6	4	4	6	5	5
D	64.3	1026	95.4	8	5	5	4	4	6	6	4	5
E	72.0	1160	100.9	9	7	5	6	4	4	5	5	5
F	63.4	2160	105.6	6	5	4	6	5	4	5	5	5
G	64.8	2575	107.3	9	7	5	5	5	3	5	5	5
H	63.4	2459	107.3	8	6	4	5	6	4	5	7	6
I	69.2	915	100.5	6	5	2	4	5	4	5	4	4
J	66.0	2286	99.1	9	9	5	9	5	4	6	7	7
K	63.0	3118	109.3	9	9	5	7	5	9	5	9	9
Avg.	66.5		103.3	8.1	6.9	4.5	5.5	4.8	4.6	5.4	5.4	5.5
S.D.	4.6		4.1	1.2	1.6	1.0	1.5	0.6	1.6	0.5	1.7	1.4

CASSELTON (C-6)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	3000	102.6	9	9	5	3	3	5	5	5	3
B	64.5	934	101.3	7	5	6	3	4	5	2	4	3
C	76.2	973	102.0	7	7	6	4	3	5	5	5	5
D	61.7	931	100.9	7	6	6	2	4	4	4	4	4
E	67.7	995	99.5	9	6	7	1	7	5	5	4	4
F	59.5	1890	102.4	5	7	5	5	5	5	5	5	5
G	61.7	2725	102.8	9	7	7	5	7	5	3	7	5
H	59.5	2541	100.5	8	7	4	2	6	4	4	5	4
I	64.8	850	86.7	5	5	7	2	7	4	4	4	4
J	63.3	2109	94.3	9	9	5	2	7	5	4	3	4
K	60.0	3192	108.5	9	9	5	1	3	5	5	5	5
Avg.	63.4		100.1	7.6	7.0	5.7	2.7	5.1	4.7	4.2	4.6	4.2
S.D.	5.0		5.5	1.6	1.5	1.0	1.4	1.8	0.5	1.0	1.0	0.8

CROOKSTON (K-6)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2925	104.5	9	9	5	3	5	5	5	5	5
B	65.7	954	102.9	7	6	6	3	5	3	3	6	4
C	76.2	957	99.6	8	7	7	3	5	4	6	4	5
D	63.1	992	105.8	7	7	6	1	5	3	6	5	5
E	69.4	1035	91.2	9	6	7	1	5	2	5	3	3
F	61.0	2053	99.1	9	6	9	5	4	4	5	5	4
G	62.8	2500	99.0	9	9	7	5	5	3	3	5	3
H	61.0	2439	98.1	9	8	5	2	3	3	6	4	3
I	72.2	800	78.0	6	2	7	1	2	2	6	1	2
J	65.6	2198	96.3	9	9	5	3	3	3	7	3	4
K	61.0	2971	106.9	9	9	9	3	5	5	5	7	7
Avg.	**65.3**		**98.3**	**8.3**	**7.1**	**6.6**	**2.7**	**4.3**	**3.4**	**5.2**	**4.4**	**4.1**
S.D.	**5.3**		**8.1**	**1.1**	**2.1**	**1.4**	**1.4**	**1.1**	**1.0**	**1.3**	**1.6**	**1.4**

SWQC #7 – MN18032-5

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	61.0	2900	103.6	9	9	5	5	5	5	5	5	5
B	67.1	1054	107.3	6	7	5	5	5	5	6	4	5
C	76.2	1031	103.7	9	7	4	5	5	5	7	5	5
D	63.3	1148	106.8	8	6	5	6	6	5	6	6	6
E	71.4	1145	99.6	9	6	5	6	3	5	5	5	5
F	62.3	2018	98.6	5	5	5	6	5	5	5	5	5
G	64.3	2500	104.2	9	7	5	5	5	5	5	5	5
H	62.3	2510	109.6	8	5	3	6	6	5	5	7	6
I	67.7	940	103.3	6	5	5	5	6	5	5	6	5
J	65.0	2294	99.4	9	9	5	7	5	5	6	6	6
K	62.0	3236	113.4	9	9	5	7	5	9	5	9	9
Avg.	65.7		104.5	7.9	6.8	4.7	5.7	5.1	5.4	5.5	5.7	5.6
S.D.	4.6		4.5	1.5	1.6	0.6	0.8	0.8	1.2	0.7	1.3	1.2

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	59.0	2875	98.3	9	7	5	5	5	5	5	5	5
B	64.7	912	98.9	5	5	5	5	5	5	3	3	3
C	75.7	932	97.7	6	7	4	4	5	5	5	7	7
D	62.0	966	104.7	5	6	5	4	6	5	5	6	6
E	68.9	975	97.5	7	5	7	5	5	5	5	5	5
F	60.0	1958	106.1	4	5	4	5	5	5	5	5	5
G	61.8	2575	97.2	9	7	5	5	5	5	5	5	3
H	60.0	2504	99.0	5	5	5	6	6	5	5	6	6
I	64.4	995	101.5	5	5	3	6	6	5	5	6	6
J	63.9	2488	111.3	9	7	5	4	7	5	4	6	5
K	60.0	3044	103.5	9	9	5	5	5	5	5	7	7
Avg.	63.7		101.4	6.6	6.2	4.8	4.9	5.5	5.0	4.7	5.5	5.3
S.D.	4.9		4.5	2.0	1.3	1.0	0.7	0.7	0.0	0.6	1.1	1.3

CROOKSTON (K-7)

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	61.0	2875	102.7	9	9	5	5	5	5	5	5	5
B	68.0	904	97.5	5	6	4	5	5	5	5	4	4
C	79.2	886	92.2	5	7	7	5	4	5	6	3	5
D	65.5	973	103.7	6	5	5	4	5	5	6	5	6
E	69.9	1020	89.9	7	6	5	7	5	5	5	5	5
F	63.6	1891	91.3	9	6	9	5	4	5	5	5	5
G	65.0	2700	106.9	9	7	5	5	5	5	5	5	5
H	63.6	2360	94.9	5	7	6	5	5	4	6	4	5
I	69.3	1030	100.5	5	5	5	2	1	4	5	2	3
J	66.0	2289	100.3	9	5	4	5	5	4	7	4	5
K	64.0	3015	108.5	9	9	7	5	5	7	5	7	7
Avg.	**66.8**		**98.9**	**7.1**	**6.5**	**5.6**	**4.8**	**4.5**	**4.9**	**5.5**	**4.5**	**5.0**
S.D.	**4.9**		**6.3**	**1.9**	**1.4**	**1.5**	**1.2**	**1.2**	**0.8**	**0.7**	**1.3**	**1.0**

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	62.0	3000	104.3	9	9	5	5	5	5	5	5	5
B	66.6	1035	109.1	5	6	5	5	5	6	1	6	3
C	80.7	998	105.6	7	7	5	4	5	6	4	6	5
D	64.0	1099	108.2	6	6	5	6	6	3	4	6	5
E	72.8	1120	105.2	9	6	7	6	5	8	4	6	6
F	62.4	1969	102.1	6	5	3	5	5	5	5	5	5
G	63.6	2700	105.9	9	7	5	5	7	7	3	7	5
H	62.4	2409	105.5	5	5	6	6	6	6	4	6	6
I	68.3	1130	100.4	5	5	5	6	6	6	4	6	6
J	65.6	2413	105.7	9	9	5	5	5	6	3	5	5
K	62.0	3118	104.9	9	9	5	5	5	5	5	7	7
Avg.	**66.4**		**105.2**	**7.2**	**6.7**	**5.1**	**5.3**	**5.5**	**5.7**	**3.8**	**5.9**	**5.3**
S.D.	**5.8**		**2.4**	**1.8**	**1.6**	**0.9**	**0.6**	**0.7**	**1.3**	**1.2**	**0.7**	**1.0**

SWQC #8 – MT1939

HAVRE (H-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	63.0	2825	100.0	3	3	3	5	5	5	5	3	3
B	71.5	941	94.9	5	6	4	5	5	4	6	4	5
C	80.7	1072	109.6	4	3	3	6	5	5	4	7	6
D	67.7	1145	106.4	3	4	4	5	5	6	4	6	5
E	70.9	1070	90.3	5	6	3	5	3	5	5	4	4
F	67.1	2195	112.4	4	5	2	5	4	4	5	5	5
G	68.7	2825	103.7	9	7	3	5	7	3	5	5	5
H	67.1	2331	101.6	6	5	4	5	5	4	4	5	5
I	71.9	1040	97.2	5	5	2	5	4	3	4	3	3
J	68.8	2356	96.4	9	5	4	5	5	3	3	4	3
K	67.0	2868	90.7	7	5	3	3	5	3	5	3	3
Avg.	69.5		100.3	5.5	4.9	3.2	4.9	4.8	4.1	4.5	4.5	4.3
S.D.	4.5		7.3	2.1	1.2	0.8	0.7	1.0	1.0	0.8	1.3	1.1

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	62.0	2900	100.9	3	5	3	5	3	5	5	3	3
B	68.9	986	103.9	5	6	5	5	5	5	4	6	5
C	81.7	936	99.0	4	4	3	5	5	5	3	3	4
D	65.7	1095	107.8	4	4	5	6	6	4	2	6	4
E	71.9	1105	103.8	5	5	3	5	3	7	3	4	4
F	64.9	2087	108.2	6	4	4	5	3	5	4	5	5
G	65.7	2800	109.8	7	5	5	5	7	5	3	5	5
H	64.9	2371	103.9	6	5	5	5	5	6	2	5	5
I	69.1	1110	98.7	4	5	5	4	5	5	4	5	5
J	66.4	2403	105.3	9	7	5	5	4	5	1	5	3
K	64.0	3118	104.9	9	9	5	7	5	5	5	7	7
Avg.	67.7		104.2	5.6	5.4	4.4	5.2	4.6	5.2	3.3	4.9	4.5
S.D.	5.4		3.6	2.0	1.5	0.9	0.8	1.3	0.8	1.3	1.2	1.1

WILLISTON (W-8)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	58.0	2700	95.6	5	5	3	5	5	3	5	3	3
B	65.2	806	91.8	5	5	4	6	5	2	5	1	2
C	73.2	832	97.4	6	9	6	4	5	2	3	4	4
D	62.6	816	93.7	8	4	5	5	5	1	2	4	2
E	64.6	780	85.2	8	8	5	3	2	1	5	2	2
F	61.2	2181	108.1	5	5	4	5	6	4	4	4	4
G	62.2	2675	102.9	3	7	1	5	5	1	3	3	1
H	61.2	2349	96.6	4	4	4	5	5	1	3	4	3
I	67.2	895	92.3	5	5	3	3	3	2	4	2	2
J	64.9	2267	100.0	5	5	7	5	5	1	2	3	3
K	61.0	3000	106.2	7	5	3	5	5	3	5	5	5
Avg.	**63.8**		**97.3**	**5.5**	**5.6**	**4.1**	**4.6**	**4.6**	**1.9**	**3.7**	**3.2**	**2.8**
S.D.	**4.0**		**6.7**	**1.6**	**1.6**	**1.6**	**0.9**	**1.1**	**1.0**	**1.2**	**1.2**	**1.2**

SWQC #9 – T18C904

CASSELTON (C-9)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2950	100.9	3	3	3	5	3	5	5	3	3
B	67.8	910	98.7	5	5	4	4	6	5	4	3	4
C	75.7	916	96.0	5	9	5	4	4	5	5	4	3
D	64.6	936	101.4	5	4	4	4	5	5	4	5	4
E	69.2	955	95.5	5	7	5	3	5	5	5	5	5
F	63.2	2173	117.7	3	5	3	5	5	5	5	5	5
G	64.8	3000	113.2	5	5	3	5	7	5	5	5	5
H	63.2	2671	105.6	6	5	4	4	6	5	4	6	5
I	68.8	985	100.5	5	5	2	4	5	5	4	5	5
J	66.7	2339	104.6	7	5	3	4	3	5	4	3	4
K	63.0	3148	107.0	7	3	3	3	5	5	5	7	7
Avg.	66.1		103.7	5.1	5.1	3.5	4.1	4.9	5.0	4.5	4.6	4.5
S.D.	4.2		6.9	1.3	1.7	0.9	0.7	1.2	0.0	0.5	1.3	1.1

CROOKSTON (K-9)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	3000	107.1	3	3	1	5	5	5	5	1	3
B	70.5	887	95.7	5	4	4	4	5	4	5	3	5
C	77.2	923	96.0	4	6	4	4	4	4	5	4	5
D	66.5	957	102.0	4	5	3	4	4	4	5	5	5
E	69.6	980	86.3	5	7	4	3	7	3	5	3	3
F	65.3	2337	112.8	4	5	3	4	4	5	5	5	5
G	67.5	2775	109.9	5	5	3	5	7	3	5	7	5
H	65.3	2526	101.6	4	6	4	4	6	4	5	6	5
I	72.9	990	96.6	4	5	2	3	2	4	5	3	2
J	68.0	2393	104.8	5	5	3	4	4	4	5	3	4
K	66.0	3044	109.5	5	3	3	3	5	7	5	7	7
Avg.	68.2		102.0	4.4	4.9	3.1	3.9	4.8	4.3	5.0	4.3	4.5
S.D.	4.3		7.9	0.7	1.2	0.9	0.7	1.5	1.1	0.0	1.9	1.4

MINOT (M-9)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Quality Score Compared to Check (LCS Rebel): Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	62.0	3000	104.3	1	3	1	5	3	5	5	1	1
B	71.0	999	105.3	4	6	5	4	5	5	4	6	5
C	80.7	981	103.8	4	9	1	4	5	5	3	4	3
D	67.3	1081	106.4	3	5	4	4	4	4	3	4	3
E	73.9	1095	102.8	5	8	3	5	5	7	3	5	5
F	66.4	2239	116.1	5	5	2	5	4	5	3	4	4
G	67.8	3000	117.6	5	5	3	5	7	5	5	7	7
H	66.4	2584	113.2	6	5	4	5	6	6	2	7	6
I	71.2	1065	94.7	3	5	4	3	4	5	4	4	4
J	68.0	2482	108.8	7	5	3	5	3	5	3	3	3
K	66.0	3044	102.5	5	7	3	7	5	5	5	5	5
Avg.	**69.2**		**106.9**	**4.4**	**5.7**	**3.0**	**4.7**	**4.6**	**5.2**	**3.6**	**4.5**	**4.2**
S.D.	**5.0**		**6.7**	**1.6**	**1.7**	**1.3**	**1.0**	**1.2**	**0.8**	**1.0**	**1.8**	**1.7**

WILLISTON (W-9)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Quality Score Compared to Check (LCS Rebel): Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	3100	109.7	5	5	3	5	5	5	5	3	3
B	69.9	843	96.0	5	6	4	5	5	5	4	4	4
C	75.2	860	100.7	4	9	5	5	6	4	4	5	5
D	66.7	814	93.5	5	4	4	4	4	4	4	4	4
E	68.4	830	90.7	5	9	3	3	6	4	4	3	4
F	66.1	2333	115.6	6	5	4	5	6	5	4	5	5
G	66.9	2800	107.7	7	5	3	5	7	5	5	7	5
H	66.1	2643	108.7	5	5	5	5	4	5	4	6	5
I	71.2	915	94.3	4	5	4	4	4	4	4	3	3
J	68.0	2413	106.4	5	5	7	5	4	4	4	4	4
K	66.0	3015	106.8	7	7	3	5	5	5	5	7	5
Avg.	**67.7**		**102.7**	**5.3**	**5.9**	**4.1**	**4.6**	**5.1**	**4.5**	**4.3**	**4.6**	**4.3**
S.D.	**3.8**		**8.1**	**1.0**	**1.7**	**1.2**	**0.7**	**1.0**	**0.5**	**0.5**	**1.5**	**0.8**

SWQC #11 – T18C905

CASSELTON (C-11)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2925	100.0	5	5	3	5	5	7	5	3	5
B	69.9	931	101.0	5	5	5	5	6	6	4	5	5
C	77.2	946	99.2	5	9	7	5	4	6	5	6	6
D	67.1	951	103.0	5	4	5	5	6	6	4	6	5
E	70.0	1010	101.0	5	8	5	3	5	9	5	5	5
F	65.5	2223	120.4	3	5	3	5	5	6	5	6	6
G	67.1	2800	105.7	7	5	3	5	7	7	5	5	7
H	65.5	2678	105.9	6	5	3	6	6	6	4	7	6
I	71.2	1090	111.2	4	6	2	6	6	6	4	6	6
J	68.0	2446	109.4	9	5	4	5	5	7	4	5	5
K	65.0	3162	107.5	9	3	3	3	5	5	5	7	7
Avg.	68.0		105.8	5.7	5.5	3.9	4.8	5.5	6.5	4.5	5.5	5.7
S.D.	4.2		6.3	1.9	1.7	1.4	1.0	0.8	1.0	0.5	1.1	0.8

CROOKSTON (K-11)												
		Loaf Volume				Quality Score Compared to Check (Linkert)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2925	104.5	5	5	3	5	5	5	5	3	5
B	72.2	927	100.0	5	4	4	5	6	5	5	4	4
C	80.2	896	93.2	4	9	4	4	5	5	5	3	4
D	67.8	930	99.1	4	5	3	4	4	5	5	4	5
E	71.4	1020	89.9	5	7	4	7	7	5	5	5	5
F	67.2	2192	105.8	4	5	4	4	3	5	5	5	5
G	69.0	2825	111.9	5	5	3	5	7	5	5	7	7
H	67.2	2525	101.6	4	6	4	5	5	5	5	6	5
I	73.4	1000	97.6	5	5	2	4	2	4	5	2	3
J	69.0	2348	102.8	5	5	3	7	4	4	7	4	4
K	67.0	3089	111.1	7	5	3	3	5	7	5	7	7
Avg.	69.6		101.6	4.8	5.5	3.4	4.8	4.8	5.0	5.2	4.5	4.9
S.D.	4.8		6.8	0.9	1.4	0.7	1.3	1.5	0.8	0.6	1.6	1.2

MINOT (M-11)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	62.0	2975	103.5	7	7	5	5	3	5	5	5	5
B	70.4	986	103.9	5	6	6	5	5	5	2	7	4
C	85.5	968	102.4	5	9	4	5	4	5	3	4	4
D	66.5	1048	103.1	5	7	5	5	5	4	2	5	3
E	72.5	1060	99.5	8	7	5	6	6	8	3	6	5
F	66.5	2053	106.4	5	5	2	5	4	5	3	4	4
G	67.5	2875	112.7	9	9	7	5	7	5	3	7	7
H	66.5	2463	107.9	7	5	6	7	6	7	2	7	7
I	71.7	1110	98.7	4	6	6	5	5	5	4	5	5
J	68.6	2442	107.0	9	9	5	7	5	5	3	6	4
K	66.0	3162	106.4	9	9	5	5	5	5	5	7	7
Avg.	69.4		104.7	6.6	7.2	5.1	5.5	5.0	5.4	3.2	5.7	5.0
S.D.	6.1		4.0	1.9	1.6	1.3	0.8	1.1	1.1	1.1	1.2	1.4

WILLISTON (W-11)												
		Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	Bake Absorption (%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	3050	108.0	9	5	5	5	5	5	5	5	5
B	70.4	829	94.4	6	5	4	6	5	5	4	5	4
C	81.5	870	101.9	5	9	5	5	6	4	3	5	4
D	66.2	758	87.0	6	7	5	5	4	3	3	4	3
E	68.8	870	95.1	7	8	7	5	6	4	5	5	5
F	66.0	1913	94.8	8	7	7	5	5	5	5	4	4
G	67.4	2700	103.8	9	5	5	5	5	3	5	5	5
H	66.0	2402	98.8	6	7	5	5	3	4	3	5	4
I	70.8	1050	108.2	4	7	6	5	4	3	4	5	4
J	68.0	2404	106.0	5	5	6	5	5	3	2	5	4
K	66.0	3133	110.9	9	7	5	7	5	5	5	7	7
Avg.	68.3		100.8	6.7	6.5	5.5	5.3	4.8	4.0	4.0	5.0	4.5
S.D.	5.2		7.4	1.8	1.4	0.9	0.6	0.9	0.9	1.1	0.8	1.0

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.