Wheat Quality Council

Hard Spring Wheat Technical Committee

2025 Crop

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Olathe, KS

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Introduction

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

Ten experimental lines of hard spring wheat were grown at four locations in 2025 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 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 2025 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 is not to be used in any publication or literature or for advertising or publicity purposes.

The 2025 Wheat Quality Testing Program

Wheat Source

Source/Breeding Program	SWQC Code #	Identification
Montana State University	1	MT 21174
Syngenta	2	AP Elevate
Montana State University	3	MT 21484
University of Minnesota	4	MN21089-4
Montana State University	5	Dagmar (alternative western check)
Syngenta	6	AP Dagr
North Dakota State University	7	ND Stampede (alternative check)
Syngenta	8	AP Iconic
University of Minnesota	9	Linkert (Eastern Check)
University of Minnesota	10	MN21172-3
Limagrain Cereal Seeds	11	LCS Rebel (Western Check)
Montana State University	12	MT 21487

Field Plot Locations and Procedures

Coordinator: Joyana Baumann, Assistant Director, Foundation Seedstocks, Department of Plant Sciences, North Dakota State University.

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

- Agronomy Seed Farm, Casselton, ND – Brian Otteson;
- Northern Agricultural Research Center, Havre, MT – Peggy Lamb;
- Northwest Research and Outreach Center, Crookston, MN – Michael Leiseth;
- North Central Agricultural Experiment Station, Minot, ND – Leandro Bortolon.

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

Wheat Production Sites

SWQC Code #	Entry	Production Sites			
		Casselton	Havre	Crookston	Minot
1	MT 21174		X		X
2	AP Elevate	X		X	X
3	MT 21484		X		X
4	MN21089-4	X		X	
5	Dagmar (alternative western check)		X		X
6	AP Dagr	X		X	X
7	ND Stampede (alternative check)	X	X	X	X
8	AP Iconic	X		X	X
9	Linkert (Eastern Check)	X		X	
10	MN21172-3	X		X	
11	LCS Rebel (Western Check)		X		X
12	MT 21487		X		X

Field Production Data

Variable	Casselton	Havre	Crookston	Minot
Planting Date	04/25/2025	05/16/2025	04/25/2025	05/07/2025
Harvest Date	08/14/2025	08/20/2025	08/08/2025	08/13/2025
Fertilizer (lb/ac)				
N	120	50	150	150
P	*	10	52	50
K	*	5	*	*
Herbicide (rate/ac)				
Broadleaf	Huskie Complete (13.7 oz)	Brox M (24 oz)	Huskie Complete (13.7 oz)	Starene Ultra (0.36 pt)
Grass	Huskie Complete (13.7 oz)	*	Huskie Complete (13.7 oz)	Tolvera (22 oz)
Fungicide	Prosaro (6.5 oz)	Prosaro (5 oz)	Stratego YLD (4 oz) Miravis Ace (22 oz)	*

*No application.

CLIMATOLOGICAL DATA				
Average Temperature (°F) / Precipitation (in)				
Month	**Casselton**	**Havre**	**Crookston**	**Minot**
April	43.0 / 2.58	43.9 / 0.34	42.0 / 1.79	42.0 / 0.96
May	59.0 / 2.32	57.5 / 1.50	60.0 / 2.01	56.0 / 5.67
June	65.0 / 3.46	62.3 / 2.22	64.0 / 1.52	64.0 / 0.67
July	70.0 / 2.09	69.2 / 2.32	68.0 / 4.36	67.0 / 5.07
August	69.0 / 6.23	69.9 / 3.57	70.0 / 1.90	66.0 / 1.36

*Data not available.

YIELD DATA				
Yield (bu/acre) / Test Weight (lb/bu) / Moisture (%)				
SWQC Code #	**Casselton**	**Havre**	**Crookston**	**Minot**
1	*	22.0 / 58.6 / 10.9	*	65.9 / 60.3 / 14.5
2	** / 60.7 / 14.4	*	106.5 / 61.7 / 13.9	91.4 / 62.4 / 15.2
3	*	36.7 / 58.5 / 10.8	*	56.5 / 62.4 / 12.0
4	** / 62.1 / 15.3	*	101.4 / 62.4 / 14.7	*
5	*	24.9 / 58.9 / 10.8	*	85.7 / 62.0 / 16.0
6	** / 59.2 / 14.3	*	105.5 / 61.0 / 14.3	83.9 / 62.7 / 13.3
7	** / 60.9 / 14.2	39.5 / 58.5 / 10.8	109.2 / 61.6 / 14.2	80.0 / 63.5 / 13.9
8	** / 60.4 / 13.6	*	113.1 / 61.2 / 14.2	66.8 / 63.6 / 13.5
9	** / 61.2 / 13.8	*	95.8 / 61.5 / 14.4	*
10	** / ** / **	*	111.3 / 61.2 / 14.7	*
11		26.4 / 60.6 / 10.9	*	51.2 / 63.9 / 13.4
12		35.6 / 58.4 / 10.7	*	38.9 / 62.0 / 12.6
Site Totals	**7**	**6**	**7**	**9**

*Not increased at this site.

** Data not available.

Climate, Disease, and Field Conditions

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

	Casselton	Havre	Crookston	Minot
At Planting	None.	Seeding was delayed substantially at Havre because one of the check entries did not show up until after May 12, 2025 (needed by April 10 if at all possible).	None.	None.
During Growth	None.	No issues beyond those congruent with late seeding. April, May, and June precipitation was well below average, resulting in crop stress. July was wetter than normal, which really helped the late seeded SWQC Drill Strips (2.32" vs 1.16" average)	None.	None.
At Flowering	None.	No issues to note.	Multiple rain events in July. Warmer/humid weather.	None.
During Maturation	Major rain event during the first week of August, leading to lodging and water-logging.	No issues to note.	Wind and rain events. Two inches of rain during the first two weeks of August.	None.
At Harvest	August was a wet month, making harvest difficult.	No issues to note. SWQC Drill Strip Harvest was completed around 4 p.m. on August 20. Two hours later, dime to quarter-sized hail, heavy rain, and 50 mph winds leveled the site (we were fortunate to have it in the bag!!).	Entries were slightly lodged.	None.

Description of 2025 Hard Spring Wheat Lines

SWQC #1 – MT 21174

MT 21174 (Dagmar//MT1142/MT1225) is a hard red spring wheat line under consideration for release by the Montana Agricultural Experiment Station. MT 21174 has good yield potential in Montana's rainfed environments, above average grain protein content, and good test weight. MT 21174 is a medium maturity line relative to Vida and has moderate resistance to wheat stem sawfly.

SWQC #2 – AP Elevate

AP Elevate is a medium-short, medium-quality hard red spring wheat variety with wide adaptation across the Northern Plains. AP Elevate has a strong balance of yield and protein for high economic return, with good test weight, straw strength, and moderately resistant to Fusarium head blight and bacterial leaf streak.

SWQC #3 – MT 21484

MT 21484 (Dagmar*2/NS-Presser) is a hard red spring wheat line under consideration for release by the Montana Agricultural Experiment Station. MT 21484 was derived by backcrossing two Clearfield herbicide resistance genes into Dagmar. MT 21484 has many of the same trait attributes as Dagmar plus herbicide resistance.

SWQC #4 – MN21089-4

MN21089-4 (MN14223-5/MN-Rothsay) has high grain yields, comparable to MN-Rothsay, and very high test weight per bushel. Grain protein is also relatively high for this yield level, higher than MN-Rothsay, MN-Torgy, and ND Stampede. Straw strength is good, rated a '3', same as MN-Rothsay, and other traits are acceptable with better FHB resistance than MN-Rothsay. This line may be a candidate for release in January 2027.

SWQC #5 – Dagmar

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

SWQC #6 – AP Dagr

AP Dagr is a medium-short, medium-maturity hard red spring wheat variety adapted to the Northern Plains and South Dakota. It delivers strong yield potential with moderate Fusarium head blight resistance and good test weight.

SWQC #7 – ND Stampede

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

SWQC #8 – AP Iconic

AP Iconic is a medium-tall, medium-maturity hard red spring wheat variety with excellent yield potential across North Dakota and Minnesota, performing well in western North Dakota. AP Iconic has good straw strength and test weight with moderate Fusarium head blight resistance.

SWQC #10 – MN21172-3

MN21172-3 (Bolles/MN-Rothsay) has produced high yields in northern MN locations with high grain protein for its yield level. Straw strength is rated as a '4'. Bacterial leaf streak resistance is very good, rated a '2', and FHB resistance is better than MN-Rothsay. This line may be a candidate for release in January 2028.

SWQC #12 – MT 21487

MT 21487 (Dagmar*2/NS-Presser) is a hard red spring wheat line that is a sister line with MT 21484 under consideration for release by the Montana Agricultural Experiment Station. MT 21487 was derived by backcrossing two Clearfield herbicide resistance genes into Dagmar. MT 21487 has many of the same trait attributes as Dagmar plus herbicide resistance.

Grain Cleaning and Milling Procedures

Wheat (180 lb/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 (35 lb) was tempered to 16.5% moisture content and conditioned for approximately 20-24 h before milling. Milling was performed on the Buhler MLU-202 following AACC method 26-21A. Feed rate was set at approximately 130 g/min.

Flour blending: Six mill streams were blended to straight grade flour. Cumulative ash content was calculated based on product basis milling yield (14% moisture basis).

Milling streams blended to straight grade – 1st Break (1 BK), 2nd Break (2 BK), 3rd Break (3 BK), 1st Reduction (1 R), 2nd Reduction (2 R), and 3rd Reduction (3 R).

Methods of Analysis

- Wheat Market Value Score;

- DON levels – analyzed by North Dakota Grain Inspection, Fargo, ND;

- Vitreous kernel content (DHV) - analyzed by North Dakota Grain Inspection, Fargo, ND;

- Test weight (AACCI Method 55-10);

- Wheat and flour protein (AACCI Method 46-30);

- Wheat and flour ash (AACCI Method 08-01);

- Kernel Size (Sieving according to USDA-ARS WQL);

- Wheat and flour Falling Number (AACCI Method 56-81);

- Single kernel characteristics (Perten Single Kernel Characterization System (SKCS), AACCI Method 55-31):

    o Mean and standard deviation values were calculated from 300 kernels.

- Flour color (Minolta Colorimeter, *L**, *a**, and *b** values);

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

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

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

  - Water absorption: 500 BU and 14% mb;

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

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

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

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

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

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

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

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

  - Solvent: 0.5 M CaCl$_2$ · 2H$_2$O;

  - Temperature: 34ºC;

  - Speed: 1,900 rpm.

  GlutoPeak parameters:

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

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

  - BEM: Peak torque (GPU);

  - PMT: Peak maximum time (s);

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

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

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

- Dough was rounded, molded, placed in extensograph holders, and rested for 45, 90, and 135 min at 30° C and 78% r.h. Dough was then stretched as described in the referenced procedure;

- Extensograph parameters:

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

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

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

  - Maximum resistance (BU): maximum curve height;

  - Ratio number: quotient of resistance to extension and extensibility;

  - Ratio number (max.): quotient of maximum resistance and extensibility.

Baking Procedures

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

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

Baking Collaborators

- ADM Milling – Decatur, IL;

- Ardent Mills – Denver, CO;

- Bay State Milling – Quincy, MA;

- General Mills – Minneapolis, MN;

- Grain Craft – Manhattan, KS;

- Great Plains Analytical Laboratory – Kansas City, MO;

- North Dakota State University, Department of Plant Sciences – Fargo, ND;

- University of Idaho – Aberdeen, ID;

- USDA-ARS Hard Winter Wheat Quality Laboratory – Manhattan, KS;

- 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 2025 Hard Spring Wheat Lines

SWQC #1 – MT 21174

	Quality Trait	Havre		Minot	
		LCS Rebel		LCS Rebel	
		H-11	H-1	M-11	M-1
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	17.9	18.0	15.2	16.5
2	Flour Protein (%, 14% mb)	16.8	16.9	13.8	15.4
3	Market Value (Score 1-6)	4.9	4.3	5.4	4.4
4	Market Value (Score 1-10)	10.0	9.8	10.0	8.0
5	DON (ppm)	ND	ND	ND	ND
6	Test Weight (lb/bu)	62.1	60.4	64.2	62.2
7	1000 Kernel Weight (g)	31.5	30.8	38.7	38.0
8	Kernel Size, Large (%)	26	33	72	71
9	Kernel Size, Small (%)	2	1	1	1
10	Wheat Moisture (%)	10.8	11.0	11.5	11.8
11	Wheat Ash (%, 14% mb)	1.34	1.45	1.45	1.54
12	Wheat Falling Number (s)	375	356	413	274
13	SKCS Hardness Index	67.9	72.8	60.0	72.8
14	Vitreous Kernels (%)	98	97	45	84
	Flour Extraction				
15	Tempered Wheat Basis (%)	71.4	66.2	73.1	69.7
16	Total Product Basis (%)	72.5	67.3	75.0	71.8
17	Flour/Bu Wheat (lb)	45.3	40.6	47.2	43.8
	Flour Quality				
18	Flour Color Brightness (*L**)	90.9	90.1	90.6	89.3
19	Flour Color Yellowness (*b**)	8.8	9.3	8.6	9.4
20	Flour Moisture (%)	12.6	12.6	12.4	12.4
21	Flour Ash (%, 14% mb)	0.50	0.55	0.50	0.57
22	Flour Falling Number (malted, s)	250	255	246	259
	Farinograph				
23	Water Absorption (%, 500 BU)	67.3	67.5	67.2	69.1
24	Water Absorption (%, 14% mb)	65.7	65.9	65.4	67.3
25	Arrival Time (min)	4.1	5.3	2.0	3.4
26	Peak Time (min)	8.1	25.6	6.4	7.6
27	Dough Stability (min)	19.8	27.2	10.1	9.0
28	Mixing Tolerance Index (MTI, BU)	7	11	34	30
29	Time To Breakdown (TTB, min)	43.0	33.1	11.4	13.1
	II. Cooperator Results				
30	Bake Absorption (Average %)	69.0	69.1	67.9	70.0
31	Loaf Volume (% of Check)		100.9		100.4

SWQC #1 – MT 21174

|	Quality Trait	Havre LCS Rebel H-11	H-1	Minot LCS Rebel M-11	M-1
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	**7.4**	**6.3**	**5.9**	**4.5**
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	**7.7**	**6.5**	**6.5**	**5.5**
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		**5.3**		**4.7**
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**5.1**		**4.1**
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		**4.0**		**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		**5.0**		**6.4**
	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		**3.1**		**3.1**
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.9**		**5.0**
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.9**		**4.5**

Farinograms

**LCS Rebel Check (Havre, H-11)**
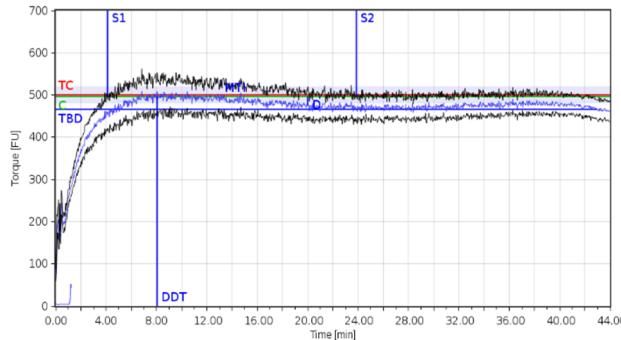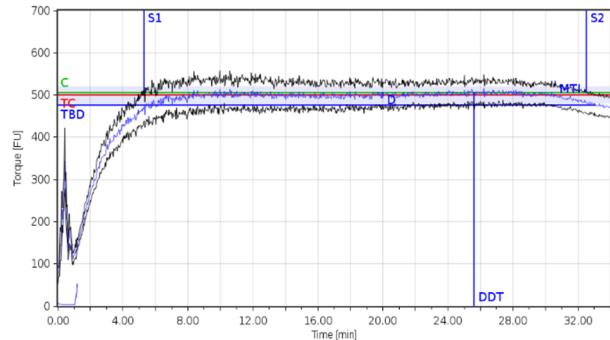
MT 21174 (Havre, H-1)


LCS Rebel Check (Minot, M-11)
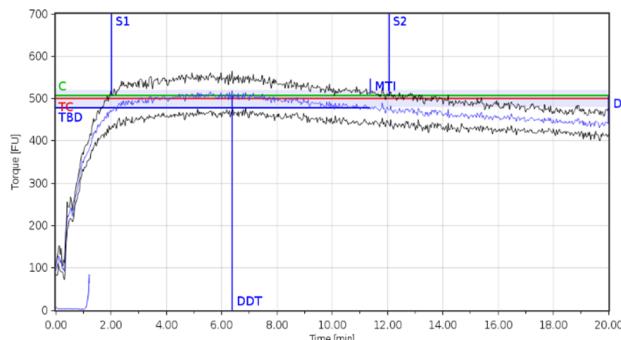

MT 21174 (Minot, M-1)

Mixograms

LCS Rebel Check (Havre, H-11)
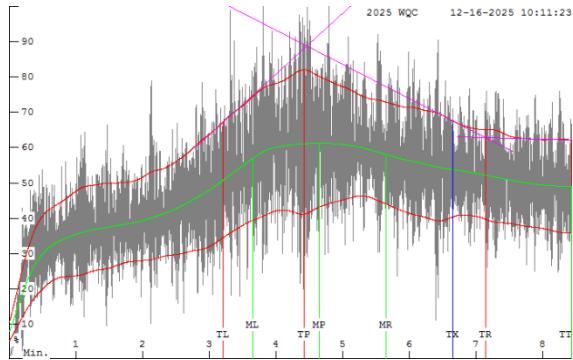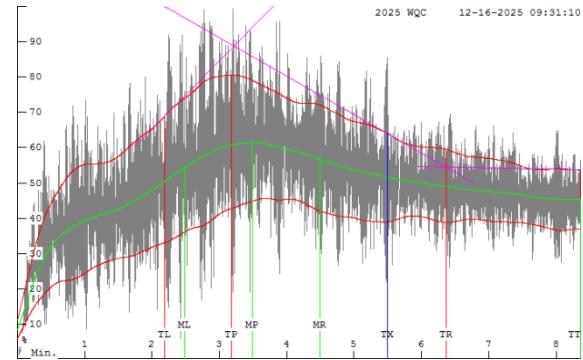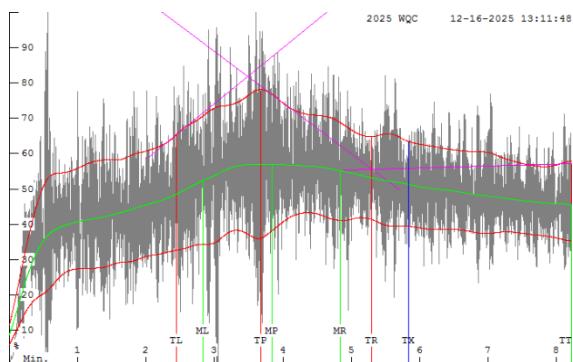
MT 21174 (Havre, H-1)

LCS Rebel Check (Minot, M-11)

MT 21174 (Minot, M-1)

18
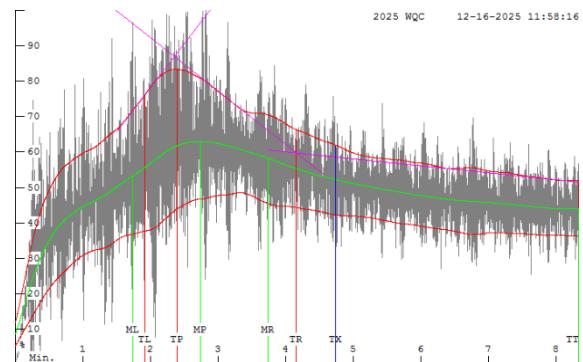
GlutoPeak Curves

LCS Rebel Check (Havre, H-11)
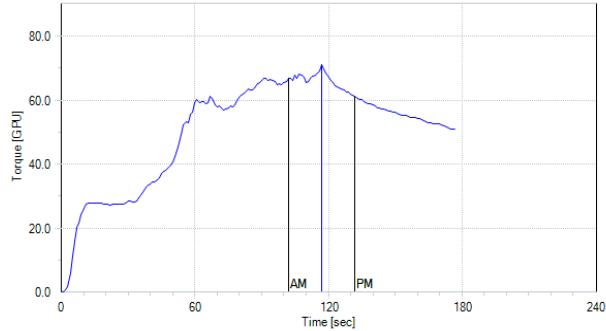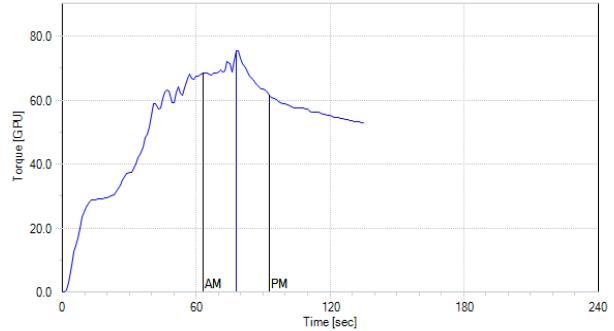
MT 21174 (Havre, H-1)

LCS Rebel Check (Minot, M-11)
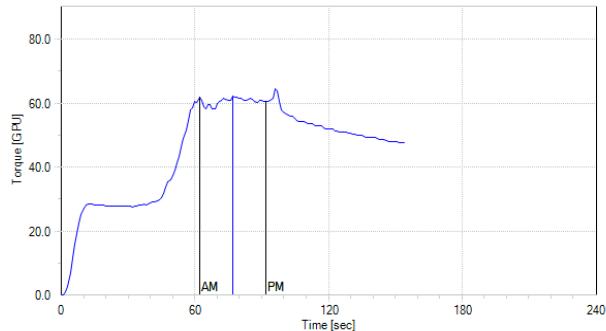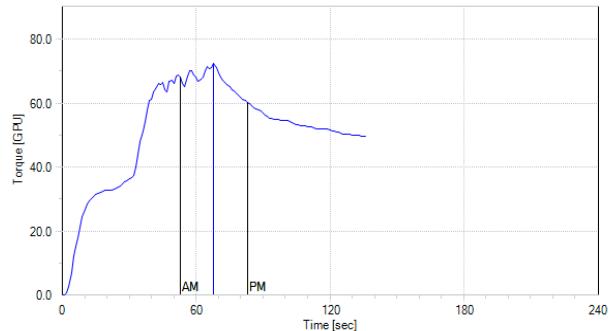
MT 21174 (Minot, M-1)

Extensograms

LCS Rebel Check (Havre, H-11)
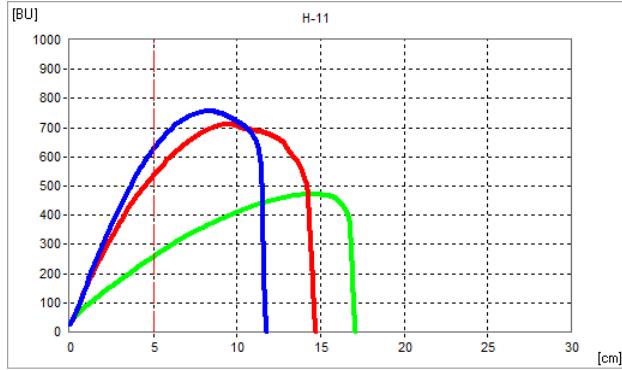
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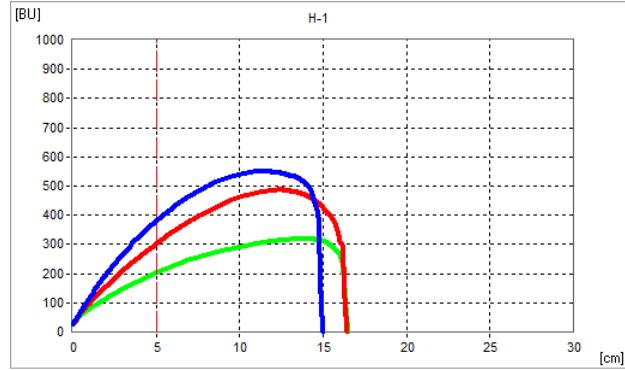
LCS Rebel Check (Minot, M-11)
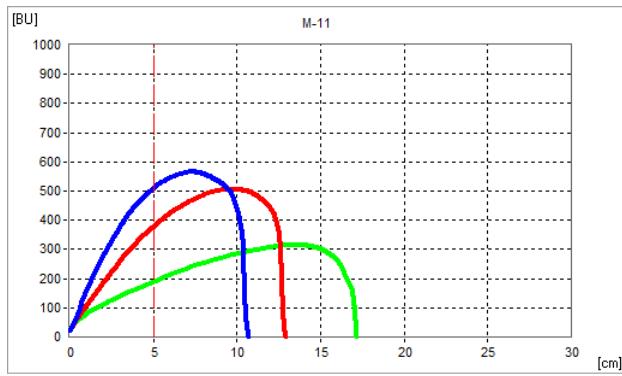

MT 21174 (Minot, M-1)


45 min; 90 min; 135 min

20
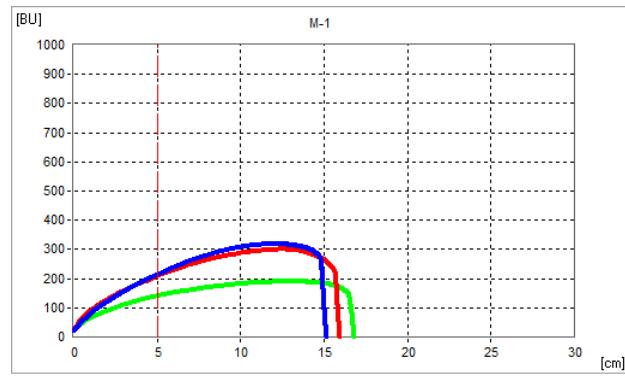
SWQC #2 – AP Elevate

	Quality Trait	Casselton Linkert C-9	C-2	Crookston Linkert K-9	K-2	Minot LCS Rebel M-11	M-2
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	15.4	13.8	14.8	14.4	15.2	16.4
2	Flour Protein (%, 14% mb)	14.1	12.5	13.7	13.1	13.8	15.2
3	Market Value (Score 1-6)	4.9	4.1	5.3	4.8	5.4	5.4
4	Market Value (Score 1-10)	10.0	7.8	10.0	8.8	10.0	9.6
5	DON (ppm)	≤ 0.5	≤ 0.5	ND	ND	ND	ND
6	Test Weight (lb/bu)	61.4	61.3	63.3	63.0	64.2	63.0
7	1000 Kernel Weight (g)	36.2	32.6	38.5	32.9	38.7	34.6
8	Kernel Size, Large (%)	68	51	74	48	72	52
9	Kernel Size, Small (%)	1	1	0	1	1	1
10	Wheat Moisture (%)	13.0	12.7	11.6	12.3	11.5	11.4
11	Wheat Ash (%, 14% mb)	1.62	1.55	1.50	1.44	1.45	1.51
12	Wheat Falling Number (s)	422	415	449	414	413	410
13	SKCS Hardness Index	69.2	64.5	69.6	69.7	60.0	63.8
14	Vitreous Kernels (%)	45	34	56	68	45	69
	Flour Extraction						
15	Tempered Wheat Basis (%)	71.6	72.4	74.0	72.3	73.1	69.3
16	Total Product Basis (%)	73.5	73.9	75.3	74.4	75.0	71.3
17	Flour/Bu Wheat (lb)	44.0	44.7	47.4	46.0	47.2	44.3
	Flour Quality						
18	Flour Color Brightness (*L**)	90.4	90.8	90.5	90.8	90.6	90.7
19	Flour Color Yellowness (*b**)	8.8	11.3	8.4	10.9	8.6	10.5
20	Flour Moisture (%)	12.8	12.9	12.2	12.6	12.4	12.7
21	Flour Ash (%, 14% mb)	0.54	0.53	0.54	0.52	0.50	0.53
22	Flour Falling Number (malted, s)	257	247	255	247	246	259
	Farinograph						
23	Water Absorption (%, 500 BU)	65.7	65.4	66.6	67.6	67.2	70.3
24	Water Absorption (%, 14% mb)	64.3	64.2	64.6	66.0	65.4	68.9
25	Arrival Time (min)	3.6	2.5	2.4	2.6	2.0	4.3
26	Peak Time (min)	9.3	6.7	7.0	5.9	6.4	8.5
27	Dough Stability (min)	23.1	8.9	13.1	8.1	10.1	9.0
28	Mixing Tolerance Index (MTI, BU)	14	34	25	33	34	32
29	Time To Breakdown (TTB, min)	29.1	11.5	15.5	10.8	11.4	14.2
	II. Cooperator Results						
30	Bake Absorption (Average %)	66.7	65.8	67.1	67.5	67.9	70.9
31	Loaf Volume (% of Check)		97.8		100.1		106.2

SWQC #2 – AP Elevate

	Quality Trait	Casselton		Crookston		Minot	
		Linkert		Linkert		LCS Rebel	
		C-9	C-2	K-9	K-2	M-11	M-2
II. Cooperator Results							
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	**6.3**	**4.6**	**6.7**	**4.7**	**5.9**	**5.3**
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	**6.1**	**5.7**	**6.3**	**5.0**	**6.5**	**6.0**
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		**3.7**		**3.4**		**4.6**
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.0**		**4.6**		**4.1**
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		**4.4**		**5.0**		**5.2**
III. Cooperator Evaluation							
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**3.5**		**4.5**		**6.5**
	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		**5.0**		**4.1**		**3.4**
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**3.9**		**4.9**		**6.3**
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**3.7**		**4.2**		**5.8**

Farinograms

Linkert Check (Casselton, C-9)

AP Elevate (Casselton, C-2)

Linkert Check (Crookston, K-9)

AP Elevate (Crookston, K-2)

LCS Rebel Check (Minot, M-11)

AP Elevate (Minot, M-2)

Mixograms

Linkert Check (Casselton, C-9)
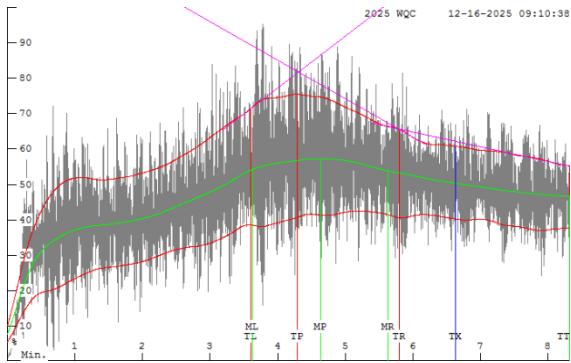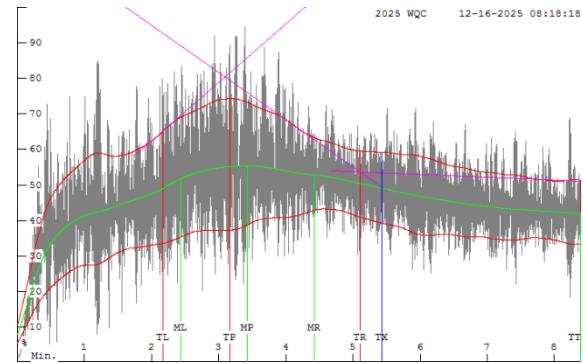
AP Elevate (Casselton, C-2)

Linkert Check (Crookston, K-9)
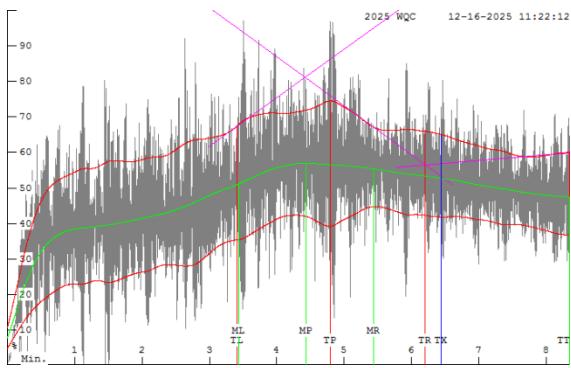
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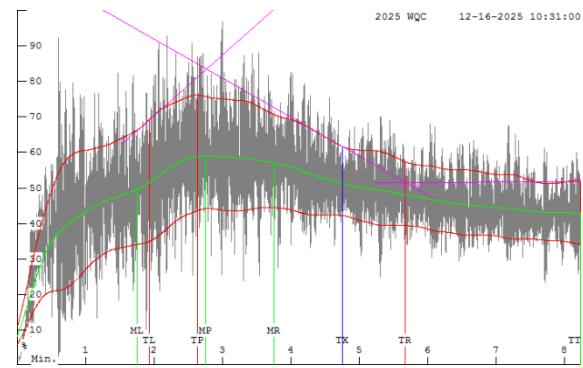
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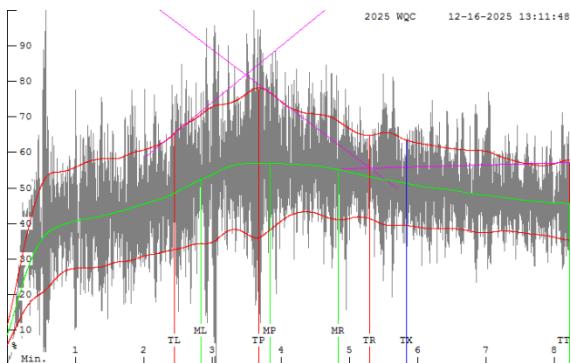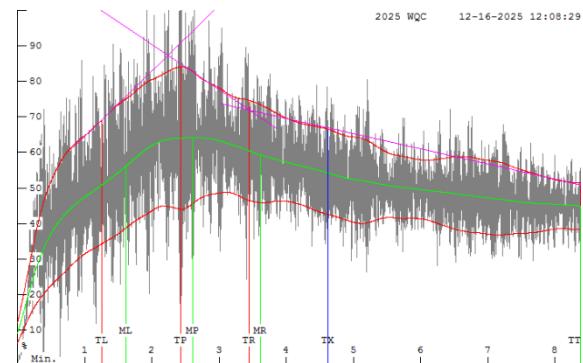
**AP Elevate (Minot, M-2)**

GlutoPeak Curves
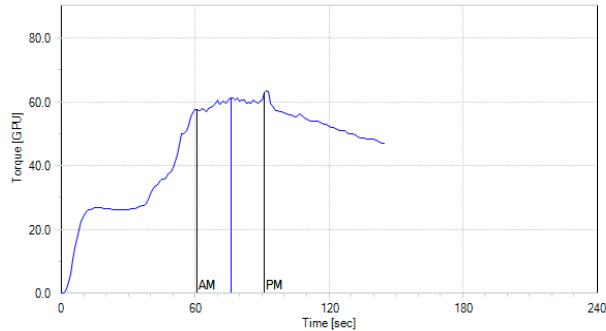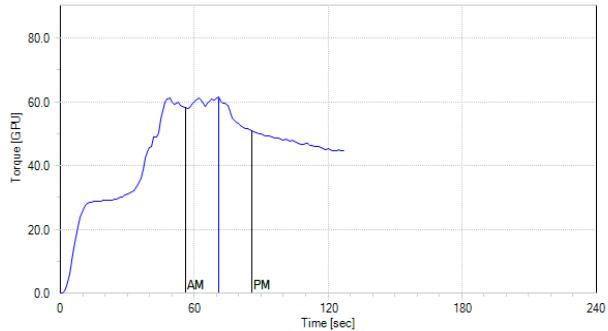
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AP Elevate (Casselton, C-2)

Linkert Check (Crookston, K-9)
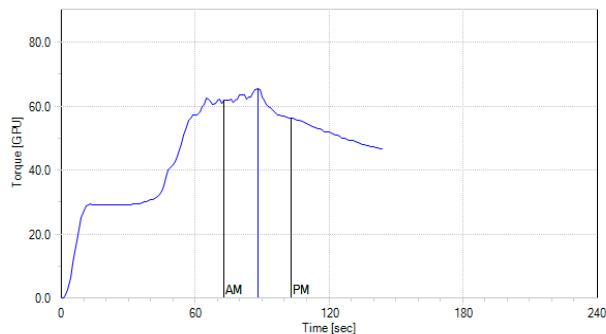
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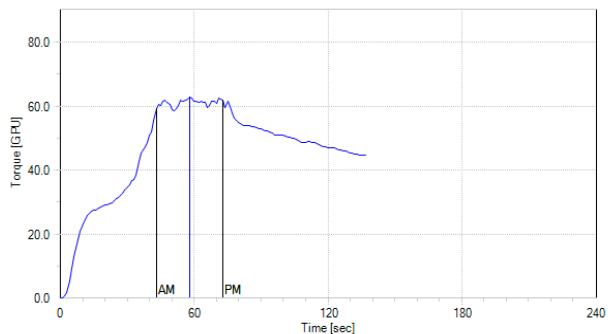
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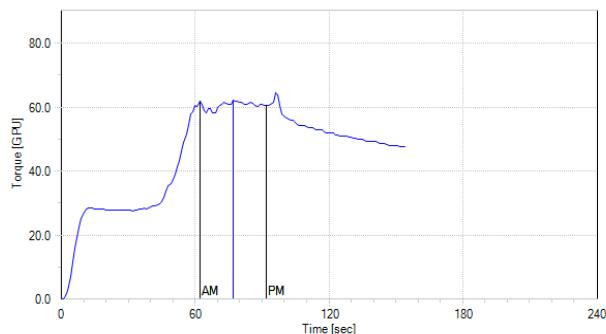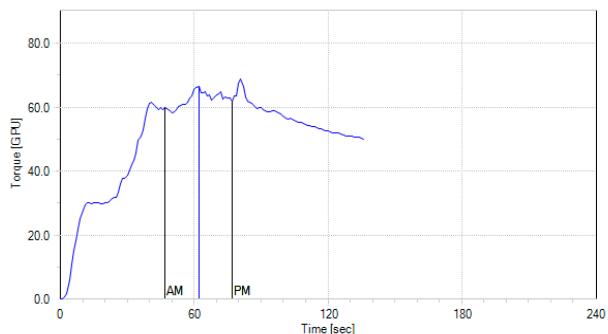
AP Elevate (Minot, M-2)

Extensograms

### Linkert Check (Casselton, C-9)
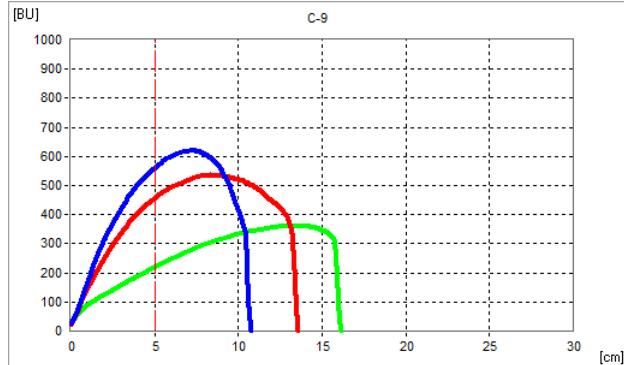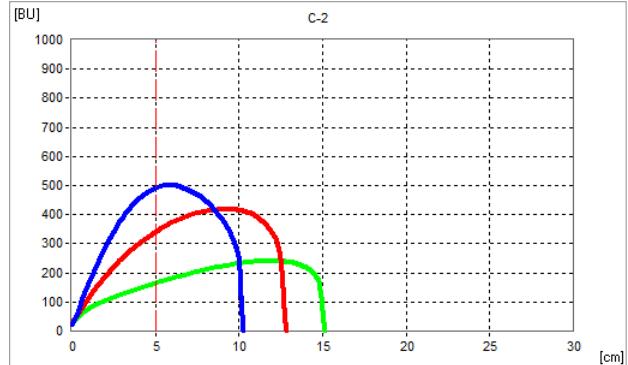

AP Elevate (Casselton, C-2)


Linkert Check (Crookston, K-9)
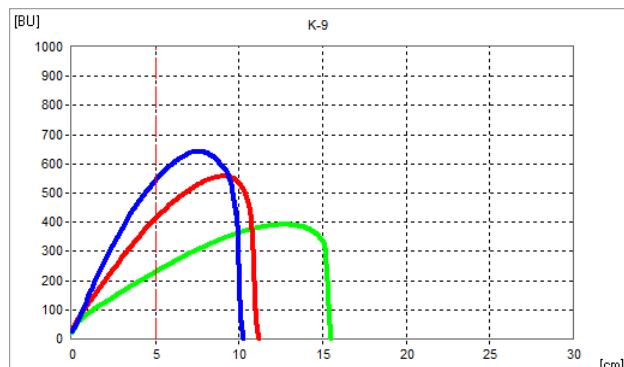
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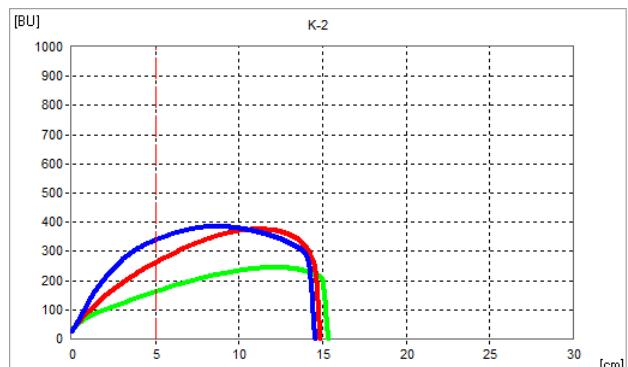
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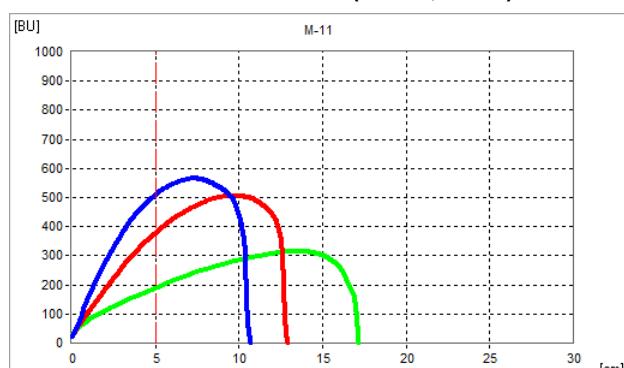
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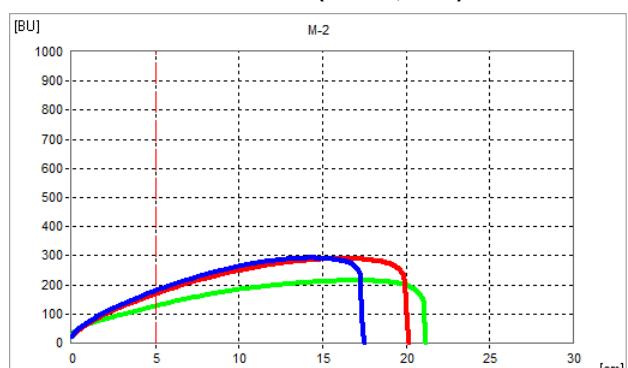
— 45 min; — 90 min; — 135 min

SWQC #3 – MT 21484

	Quality Trait	Havre		Minot	
		LCS Rebel		LCS Rebel	
		H-11	H-3	M-11	M-3
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	17.9	17.6	15.2	14.1
2	Flour Protein (%, 14% mb)	16.8	16.3	13.8	12.7
3	Market Value (Score 1-6)	4.9	4.8	5.4	4.7
4	Market Value (Score 1-10)	10.0	10.0	10.0	8.4
5	DON (ppm)	ND	ND	ND	ND
6	Test Weight (lb/bu)	62.1	60.5	64.2	63.0
7	1000 Kernel Weight (g)	31.5	32.8	38.7	41.9
8	Kernel Size, Large (%)	26	33	72	76
9	Kernel Size, Small (%)	2	1	1	1
10	Wheat Moisture (%)	10.8	10.9	11.5	11.8
11	Wheat Ash (%, 14% mb)	1.34	1.32	1.45	1.50
12	Wheat Falling Number (s)	375	386	413	378
13	SKCS Hardness Index	67.9	64.4	60.0	67.6
14	Vitreous Kernels (%)	98	94	45	63
	Flour Extraction				
15	Tempered Wheat Basis (%)	71.4	70.2	73.1	72.3
16	Total Product Basis (%)	72.5	70.6	75.0	73.4
17	Flour/Bu Wheat (lb)	45.3	43.8	47.2	45.9
	Flour Quality				
18	Flour Color Brightness (*L**)	90.9	90.4	90.6	89.9
19	Flour Color Yellowness (*b**)	8.8	9.5	8.6	9.7
20	Flour Moisture (%)	12.6	13.3	12.4	12.7
21	Flour Ash (%, 14% mb)	0.50	0.50	0.50	0.52
22	Flour Falling Number (malted, s)	250	252	246	254
	Farinograph				
23	Water Absorption (%, 500 BU)	67.3	67.1	67.2	66.0
24	Water Absorption (%, 14% mb)	65.7	66.3	65.4	64.6
25	Arrival Time (min)	4.1	7.0	2.0	2.3
26	Peak Time (min)	8.1	29.1	6.4	4.4
27	Dough Stability (min)	19.8	26.8	10.1	10.8
28	Mixing Tolerance Index (MTI, BU)	7	27	34	20
29	Time To Breakdown (TTB, min)	43.0	34.6	11.4	13.0
	II. Cooperator Results				
30	Bake Absorption (Average %)	69.0	68.5	67.9	66.6
31	Loaf Volume (% of Check)		97.4		94.8

SWQC #3 – MT 21484

	Quality Trait	Havre		Minot	
		LCS Rebel		**LCS Rebel**	
		H-11	**H-3**	**M-11**	**M-3**
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	**7.4**	**6.7**	**5.9**	**5.1**
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	**7.7**	**6.9**	**6.5**	**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		5.6		4.8
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.6		4.2
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.8		5.0
	III. Cooperator Evaluation				
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		5.0		3.3
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.6		4.8
	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		5.1		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		5.3		4.6

Farinograms

LCS Rebel Check (Havre, H-11)
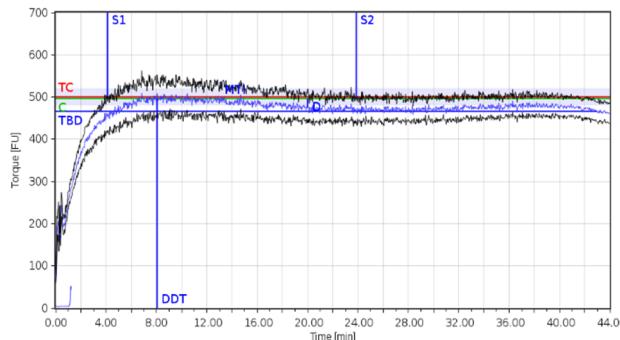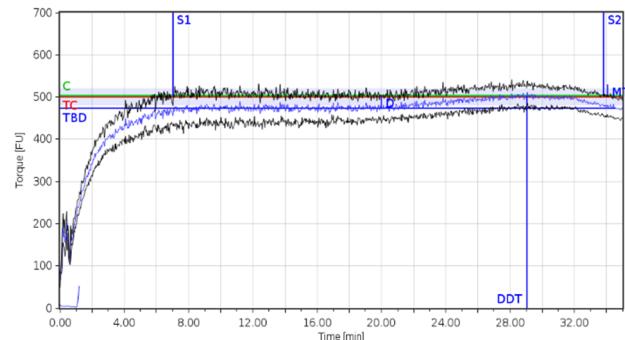
MT 21484 (Havre, H-3)

LCS Rebel Check (Minot, M-11)
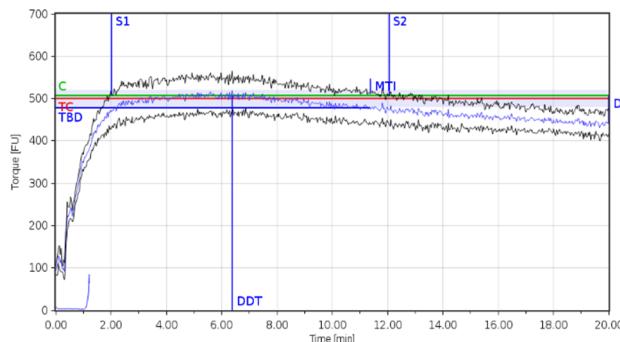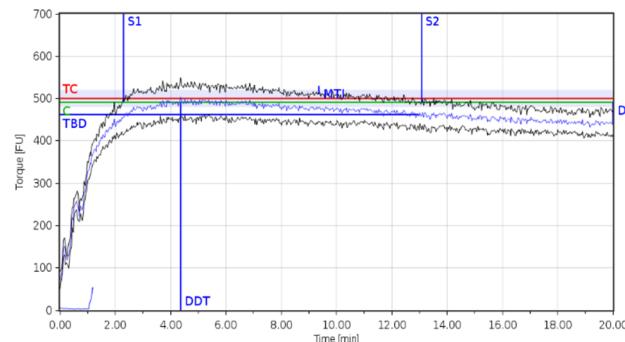
MT 21484 (Minot, M-3)

Mixograms

LCS Rebel Check (Havre, H-11)
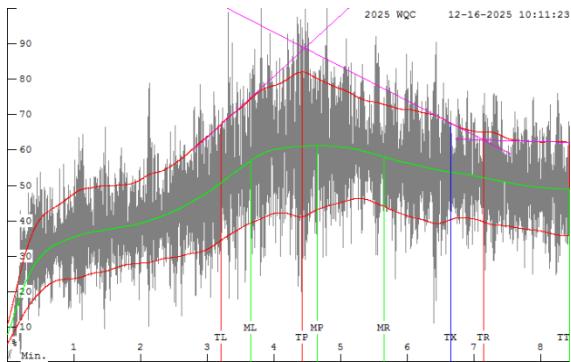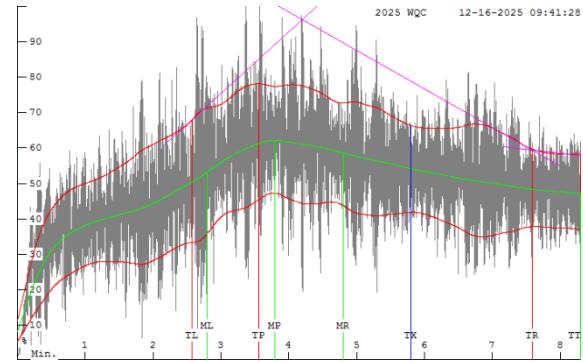
MT 21484 (Havre, H-3)

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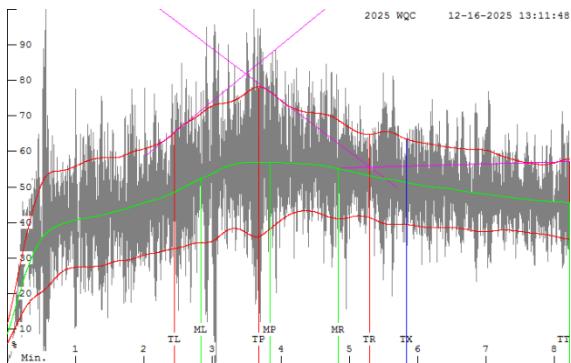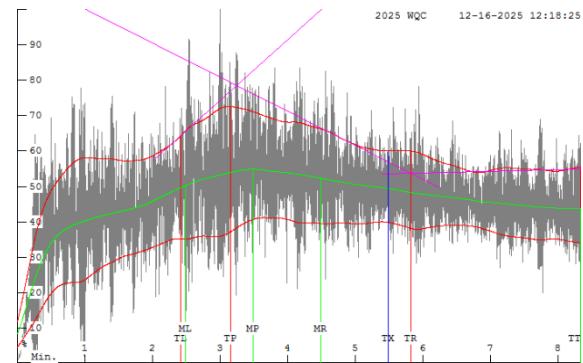
MT 21484 (Minot, M-3)

GlutoPeak Curves

LCS Rebel Check (Havre, H-11)
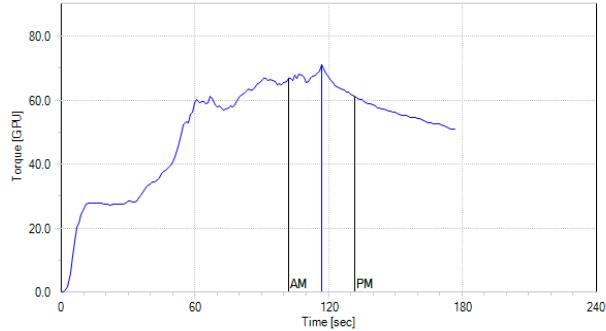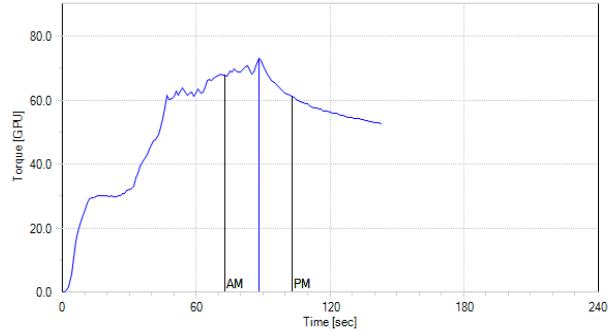
MT 21484 (Havre, H-3)

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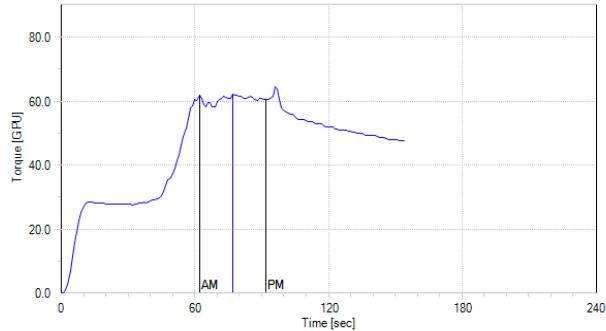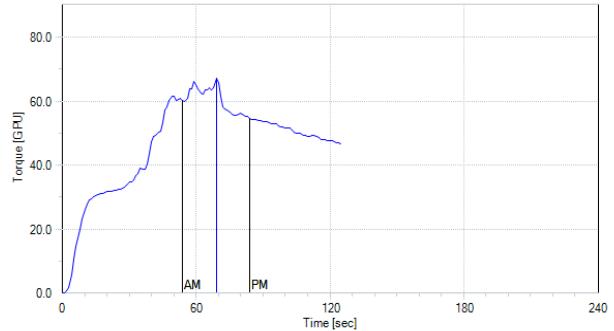
MT 21484 (Minot, M-3)

Extensograms

LCS Rebel Check (Havre, H-11)
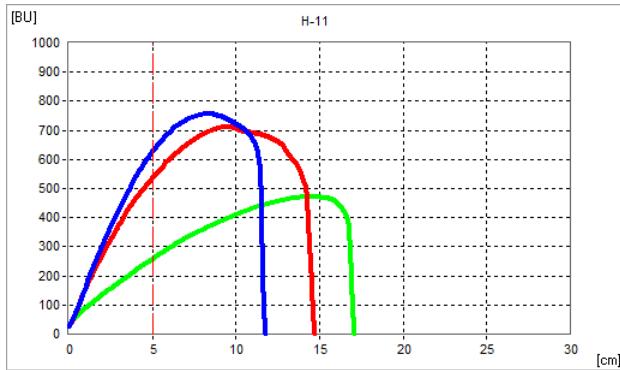
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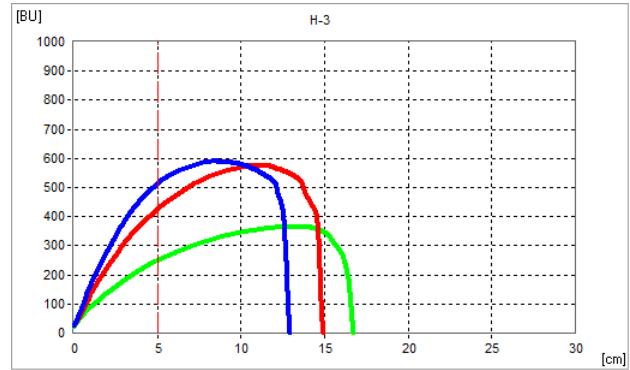
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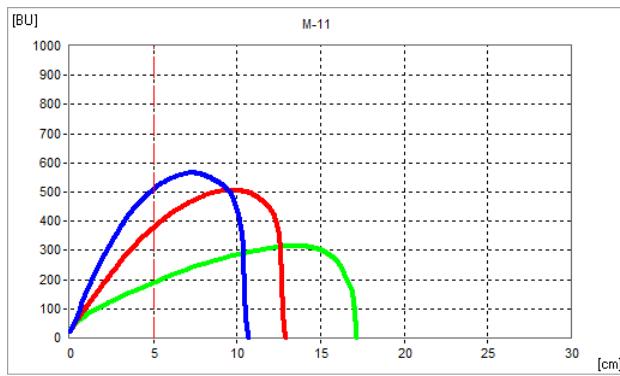
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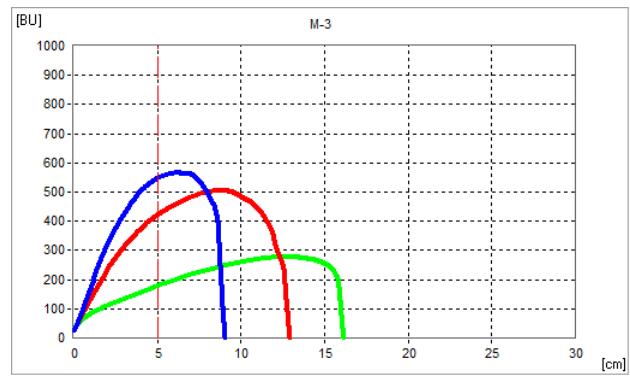
45 min; 90 min; 135 min

SWQC #4 – MN21089-4

	Quality Trait	Casselton Linkert		Crookston Linkert	
		C-9	C-4	K-9	K-4
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	15.4	15.1	14.8	14.2
2	Flour Protein (%, 14% mb)	14.1	13.5	13.7	12.8
3	Market Value (Score 1-6)	4.9	5.2	5.3	5.1
4	Market Value (Score 1-10)	10.0	10.0	10.0	9.0
5	DON (ppm)	≤ 0.5	ND	ND	ND
6	Test Weight (lb/bu)	61.4	63.2	63.3	64.2
7	1000 Kernel Weight (g)	36.2	36.3	38.5	36.8
8	Kernel Size, Large (%)	68	57	74	59
9	Kernel Size, Small (%)	1	1	0	1
10	Wheat Moisture (%)	13.0	12.6	11.6	11.8
11	Wheat Ash (%, 14% mb)	1.62	1.48	1.50	1.39
12	Wheat Falling Number (s)	422	419	449	437
13	SKCS Hardness Index	69.2	66.8	69.6	69.1
14	Vitreous Kernels (%)	45	50	56	69
	Flour Extraction				
15	Tempered Wheat Basis (%)	71.6	70.7	74.0	72.6
16	Total Product Basis (%)	73.5	72.4	75.3	74.5
17	Flour/Bu Wheat (lb)	44.0	44.9	47.4	47.2
	Flour Quality				
18	Flour Color Brightness (*L**)	90.4	90.4	90.5	90.2
19	Flour Color Yellowness (*b**)	8.8	9.9	8.4	9.8
20	Flour Moisture (%)	12.8	12.9	12.2	13.0
21	Flour Ash (%, 14% mb)	0.54	0.48	0.54	0.53
22	Flour Falling Number (malted, s)	257	248	255	250
	Farinograph				
23	Water Absorption (%, 500 BU)	65.7	65.6	66.6	64.6
24	Water Absorption (%, 14% mb)	64.3	64.4	64.6	63.4
25	Arrival Time (min)	3.6	2.8	2.4	2.5
26	Peak Time (min)	9.3	6.7	7.0	5.8
27	Dough Stability (min)	23.1	9.5	13.1	8.6
28	Mixing Tolerance Index (MTI, BU)	14	34	25	37
29	Time To Breakdown (TTB, min)	29.1	12.5	15.5	11.3
	II. Cooperator Results				
30	Bake Absorption (Average %)	66.7	66.3	67.1	65.4
31	Loaf Volume (% of Check)		96.7		96.2

SWQC #4 – MN21089-4

|	Quality Trait	Casselton Linkert C-9	C-4	Crookston Linkert K-9	K-4
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.3	4.2	6.7	4.6
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.1	5.0	6.3	5.0
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		3.7		3.5
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		4.3		4.7
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		4.6		4.9
	III. Cooperator Evaluation				
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.5		4.2
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.7		4.4
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.5		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		4.1		4.2

Farinograms

Linkert Check (Casselton, C-9)
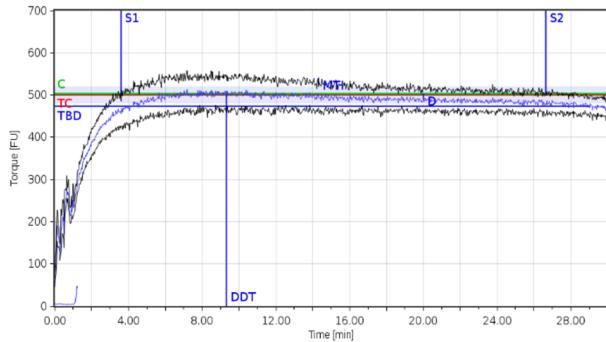
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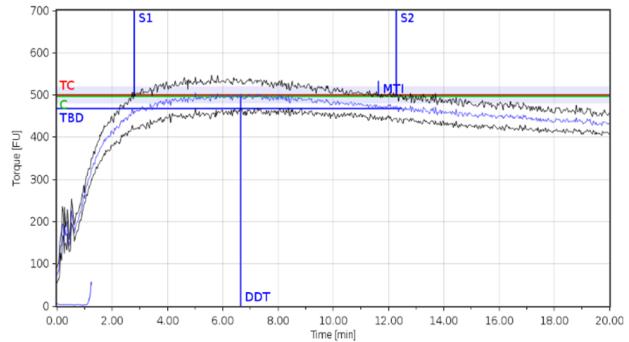
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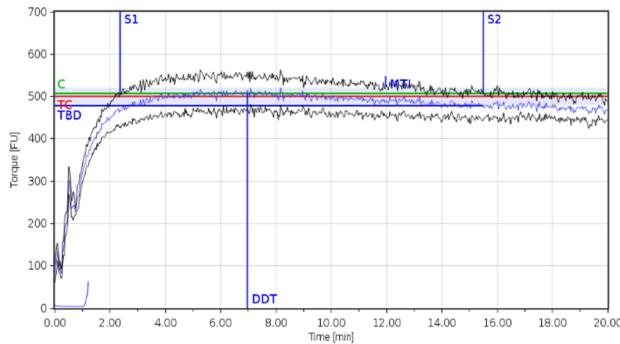
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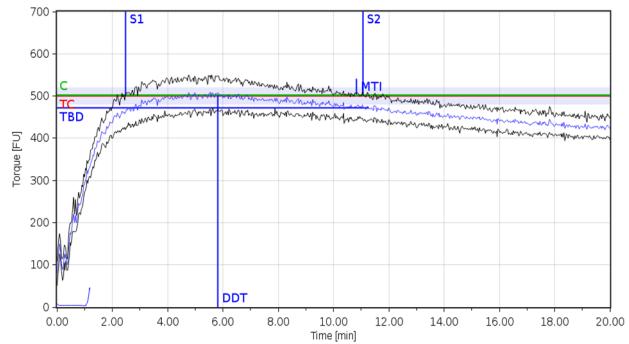
Mixograms

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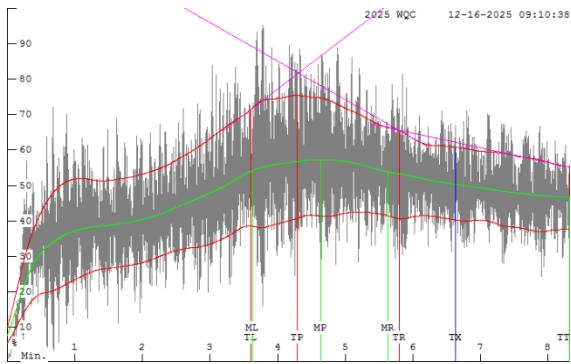
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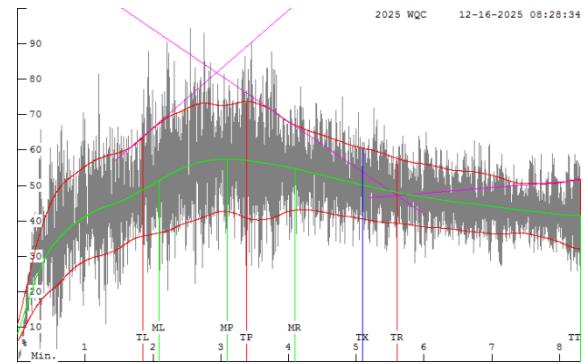
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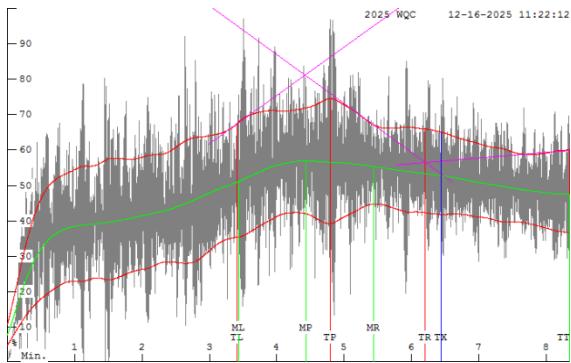
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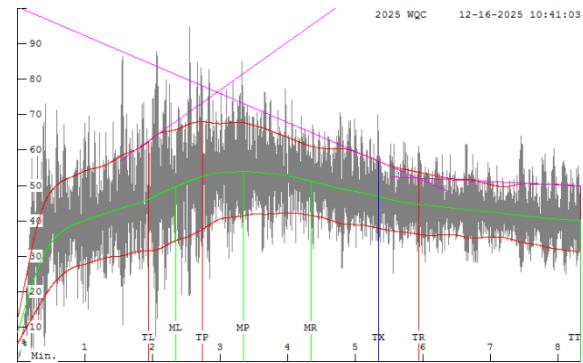
GlutoPeak Curves

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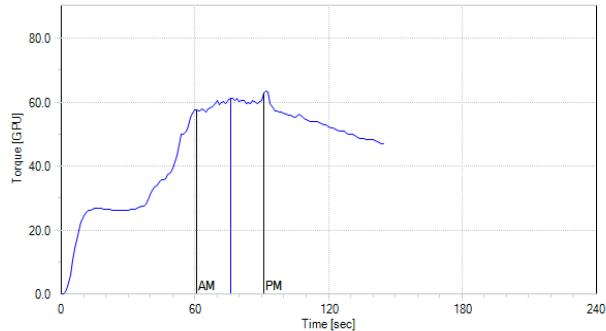
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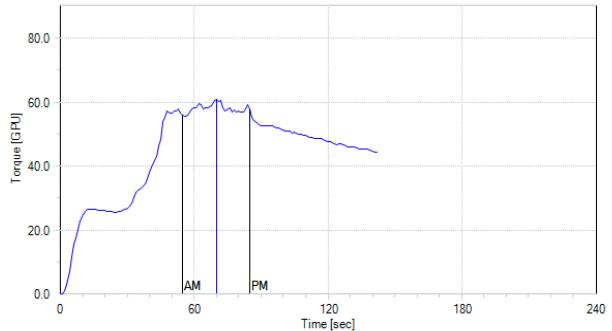
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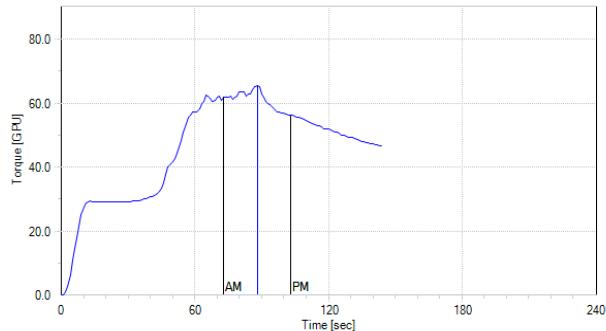
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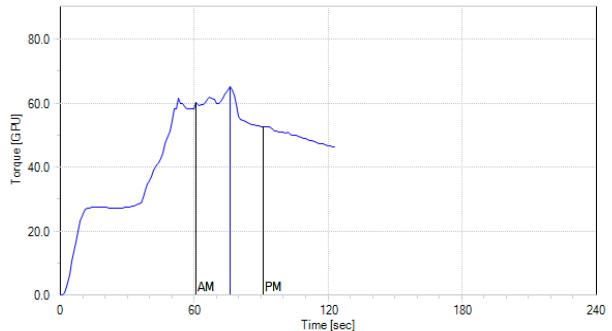
Extensograms

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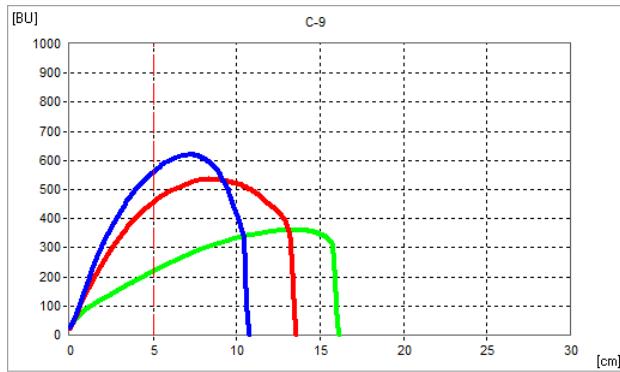
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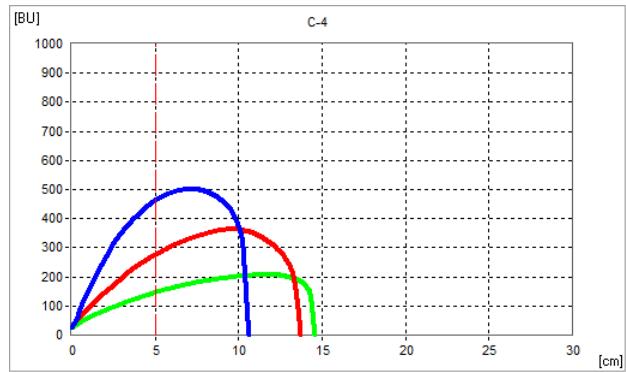
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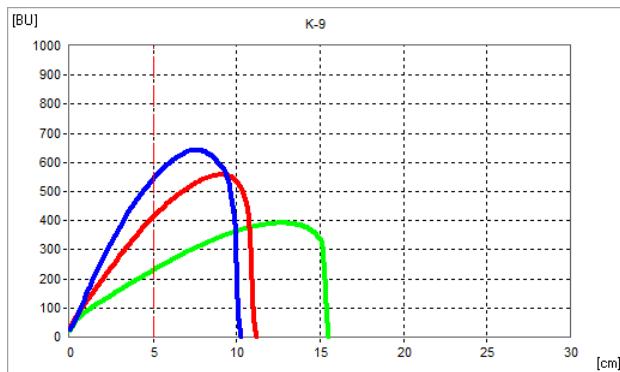
MN21089-4 (Crookston, K-4)

45 min; 90 min; 135 min

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SWQC #5 – Dagmar

	Quality Trait	Havre LCS Rebel H-11	H-5	Minot LCS Rebel M-11	M-5
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	17.9	17.8	15.2	17.3
2	Flour Protein (%, 14% mb)	16.8	16.4	13.8	15.8
3	Market Value (Score 1-6)	4.9	3.9	5.4	5.2
4	Market Value (Score 1-10)	10.0	8.4	10.0	8.6
5	DON (ppm)	ND	ND	ND	ND
6	Test Weight (lb/bu)	62.1	60.6	64.2	62.7
7	1000 Kernel Weight (g)	31.5	33.2	38.7	40.6
8	Kernel Size, Large (%)	26	34	72	73
9	Kernel Size, Small (%)	2	1	1	1
10	Wheat Moisture (%)	10.8	11.0	11.5	11.6
11	Wheat Ash (%, 14% mb)	1.34	1.34	1.45	1.50
12	Wheat Falling Number (s)	375	266	413	353
13	SKCS Hardness Index	67.9	68.5	60.0	66.2
14	Vitreous Kernels (%)	98	96	45	86
	Flour Extraction				
15	Tempered Wheat Basis (%)	71.4	66.3	73.1	70.6
16	Total Product Basis (%)	72.5	67.9	75.0	71.9
17	Flour/Bu Wheat (lb)	45.3	41.2	47.2	45.3
	Flour Quality				
18	Flour Color Brightness (*L**)	90.9	90.4	90.6	89.6
19	Flour Color Yellowness (*b**)	8.8	8.9	8.6	9.2
20	Flour Moisture (%)	12.6	13.0	12.4	13.4
21	Flour Ash (%, 14% mb)	0.50	0.48	0.50	0.50
22	Flour Falling Number (malted, s)	250	259	246	250
	Farinograph				
23	Water Absorption (%, 500 BU)	67.3	68.0	67.2	68.1
24	Water Absorption (%, 14% mb)	65.7	66.8	65.4	67.5
25	Arrival Time (min)	4.1	6.0	2.0	3.4
26	Peak Time (min)	8.1	28.0	6.4	7.5
27	Dough Stability (min)	19.8	27.4	10.1	11.0
28	Mixing Tolerance Index (MTI, BU)	7	23	34	21
29	Time To Breakdown (TTB, min)	43.0	33.8	11.4	15.2
	II. Cooperator Results				
30	Bake Absorption (Average %)	69.0	69.7	67.9	69.4
31	Loaf Volume (% of Check)		98.4		104.5

SWQC #5 – Dagmar

|	Quality Trait	Havre		Minot	
		LCS Rebel		LCS Rebel	
		H-11	H-5	M-11	M-5
	II. Cooperator Results				
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	**7.4**	**6.7**	**5.9**	**5.2**
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	**7.7**	**6.2**	**6.5**	**6.0**
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		**5.5**		**5.2**
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**5.3**		**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		**4.4**		**4.5**
	III. Cooperator Evaluation				
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.7**		**7.2**
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**3.3**		**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		**5.1**		**5.8**
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		**4.9**		**5.5**

Farinograms

LCS Rebel Check (Havre, H-11)
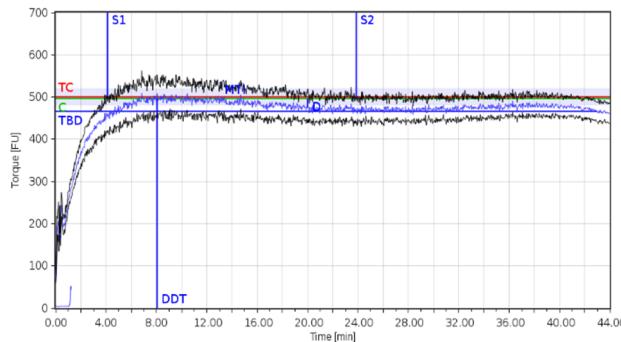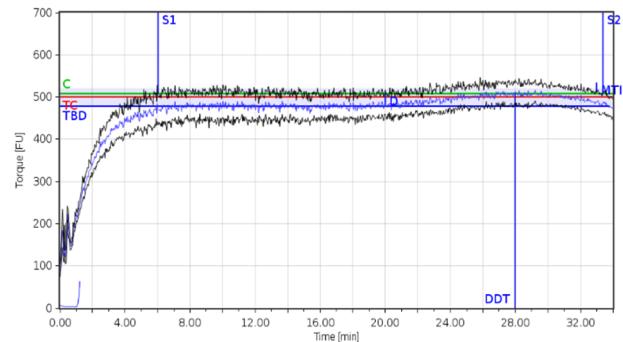
Dagmar (Havre, H-5)

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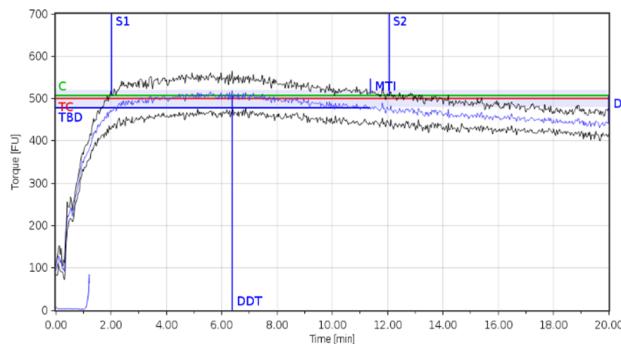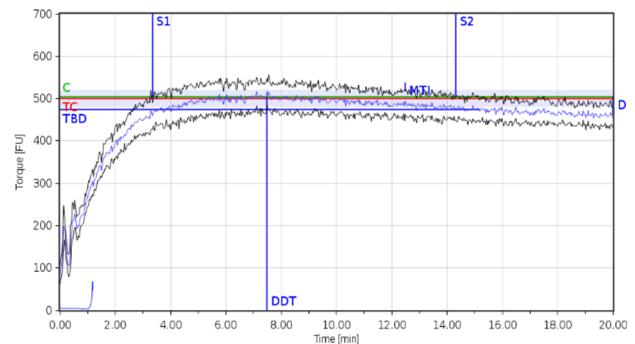
Dagmar (Minot, M-5)

Mixograms

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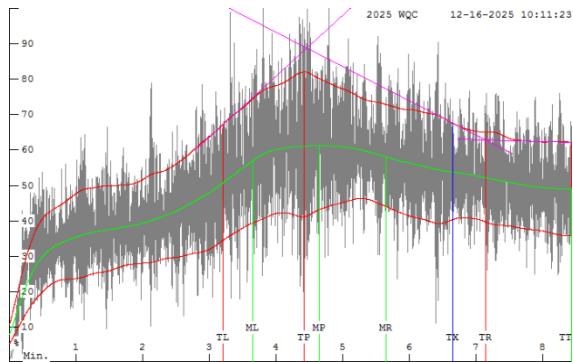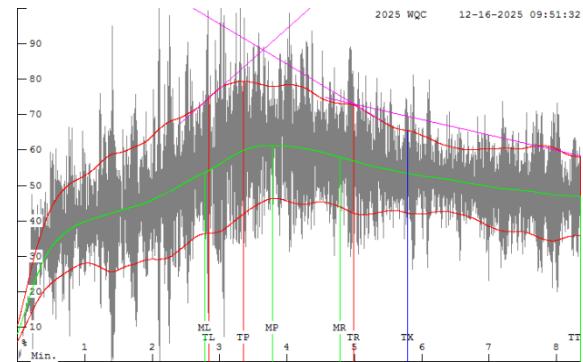
Dagmar (Havre, H-5)

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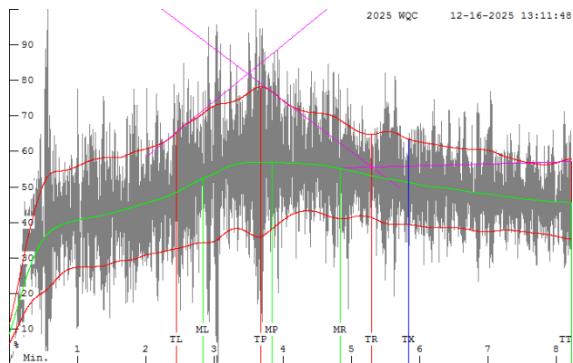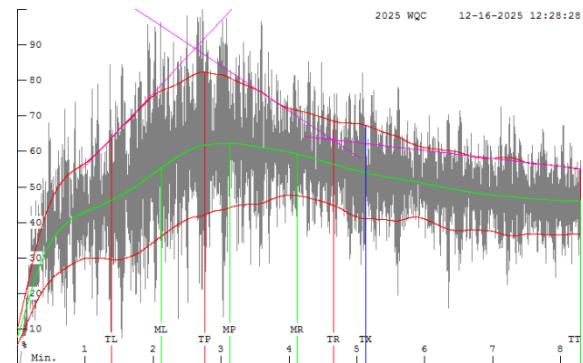
Dagmar (Minot, M-5)

GlutoPeak Curves

LCS Rebel Check (Havre, H-11)
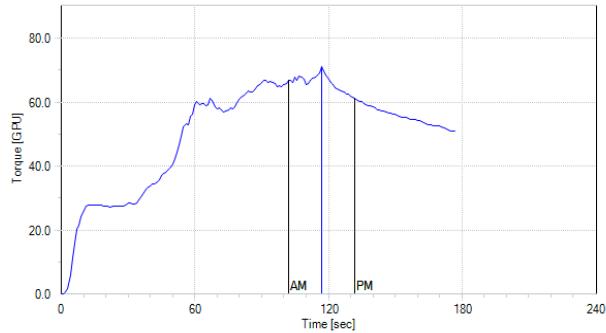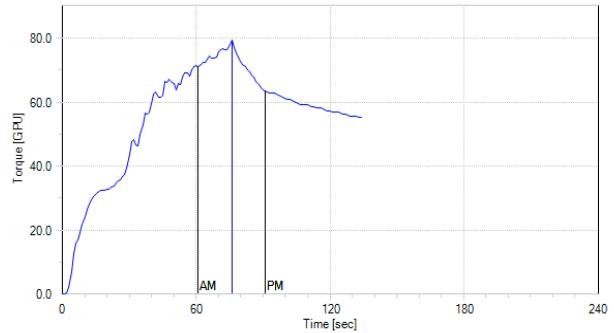
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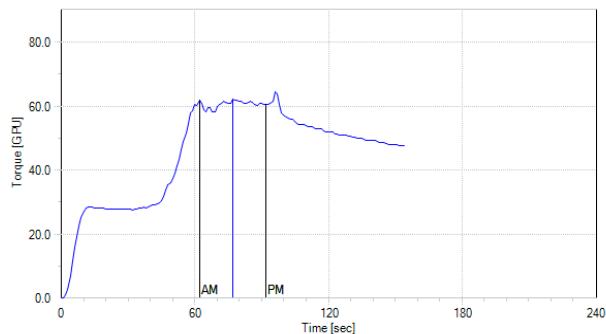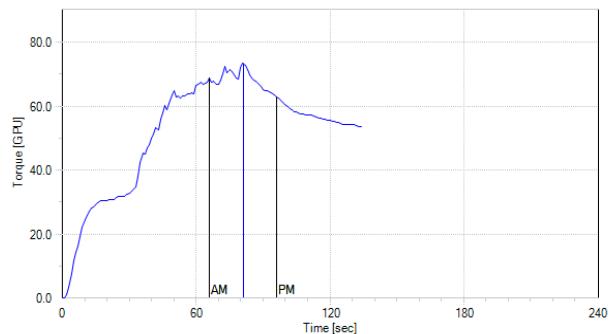
Dagmar (Minot, M-5)

Extensograms

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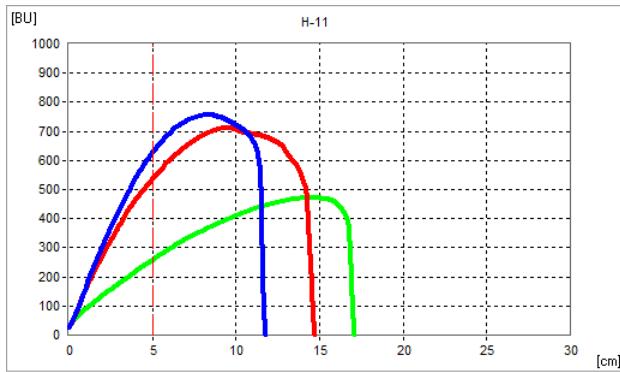
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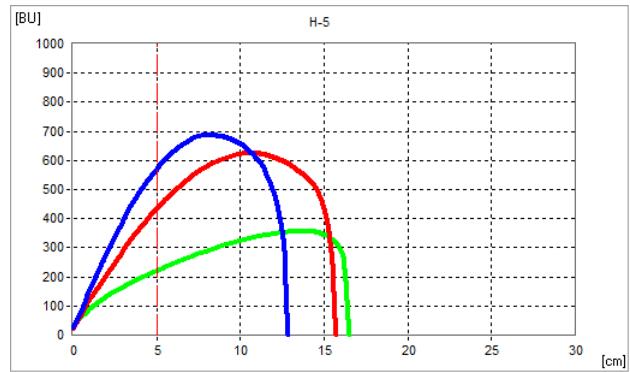
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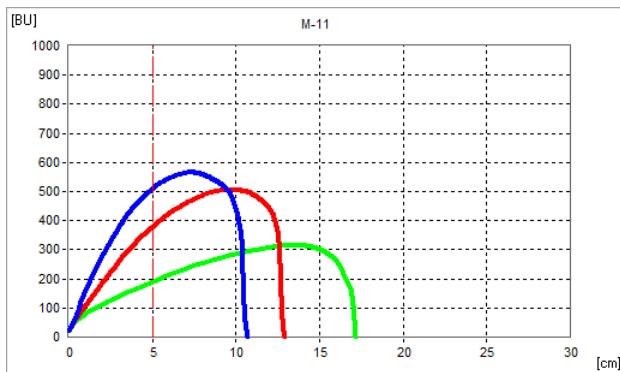
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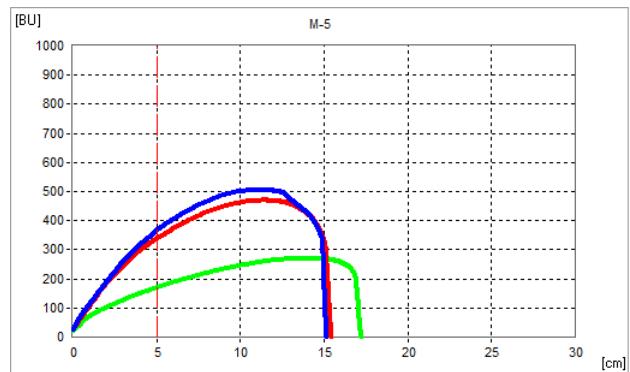
45 min; 90 min; 135 min

SWQC #6 – AP Dagr

	Quality Trait	Casselton Linkert		Crookston Linkert		Minot LCS Rebel	
		C-9	C-6	K-9	K-6	M-11	M-6
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	15.4	14.4	14.8	12.6	15.2	14.3
2	Flour Protein (%, 14% mb)	14.1	12.9	13.7	11.2	13.8	13.0
3	Market Value (Score 1-6)	4.9	4.1	5.3	4.3	5.4	5.2
4	Market Value (Score 1-10)	10.0	7.8	10.0	6.4	10.0	9.0
5	DON (ppm)	≤ 0.5	ND	ND	ND	ND	ND
6	Test Weight (lb/bu)	61.4	60.1	63.3	62.4	64.2	63.2
7	1000 Kernel Weight (g)	36.2	29.8	38.5	34.1	38.7	36.6
8	Kernel Size, Large (%)	68	29	74	46	72	54
9	Kernel Size, Small (%)	1	3	0	2	1	1
10	Wheat Moisture (%)	13.0	12.7	11.6	12.0	11.5	11.6
11	Wheat Ash (%, 14% mb)	1.62	1.47	1.50	1.35	1.45	1.38
12	Wheat Falling Number (s)	422	436	449	417	413	438
13	SKCS Hardness Index	69.2	80.1	69.6	79.5	60.0	76.8
14	Vitreous Kernels (%)	45	73	56	62	45	82
	Flour Extraction						
15	Tempered Wheat Basis (%)	71.6	71.0	74.0	70.3	73.1	69.4
16	Total Product Basis (%)	73.5	71.5	75.3	71.1	75.0	70.2
17	Flour/Bu Wheat (lb)	44.0	42.7	47.4	44.3	47.2	44.9
	Flour Quality						
18	Flour Color Brightness (L*)	90.4	89.7	90.5	90.0	90.6	90.1
19	Flour Color Yellowness (b*)	8.8	9.6	8.4	9.3	8.6	9.0
20	Flour Moisture (%)	12.8	12.7	12.2	13.0	12.4	13.2
21	Flour Ash (%, 14% mb)	0.54	0.55	0.54	0.54	0.50	0.52
22	Flour Falling Number (malted, s)	257	244	255	253	246	255
	Farinograph						
23	Water Absorption (%, 500 BU)	65.7	63.0	66.6	63.6	67.2	65.4
24	Water Absorption (%, 14% mb)	64.3	61.6	64.6	62.4	65.4	64.4
25	Arrival Time (min)	3.6	1.9	2.4	1.5	2.0	3.0
26	Peak Time (min)	9.3	9.4	7.0	3.7	6.4	7.3
27	Dough Stability (min)	23.1	17.5	13.1	11.0	10.1	12.8
28	Mixing Tolerance Index (MTI, BU)	14	21	25	21	34	23
29	Time To Breakdown (TTB, min)	29.1	18.0	15.5	12.2	11.4	14.6
	II. Cooperator Results						
30	Bake Absorption (Average %)	66.7	64.9	67.1	64.5	67.9	66.6
31	Loaf Volume (% of Check)		95.0		84.6		96.0

SWQC #6 – AP Dagr

	Quality Trait	Casselton		Crookston		Minot	
		Linkert		Linkert		LCS Rebel	
		C-9	C-6	K-9	K-6	M-11	M-6
	II. Cooperator Results						
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.3	7.3	6.7	6.8	5.9	6.5
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.1	6.8	6.3	6.3	6.5	6.5
34	**Mixing Tolerance** 9 = Much More Tolerance Than Check 7 = More Tolerance Than Check 5 = Tolerance Equivalent To Check 3 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check	5.1		4.3		6.0	
35	**Internal Crumb Color** 9 = Much Brighter Than Check 7 = Brighter Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check	4.4		4.3		5.2	
36	**Internal Grain and Texture** 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check	4.5		4.4		5.8	
	III. Cooperator Evaluation						
	Quality Traits 1-2: Protein 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check	3.7		2.2		4.2	
	Quality Traits 3-22: Milling 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check	3.8		3.0		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	4.1		3.9		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	4.2		3.5		4.9	

Farinograms

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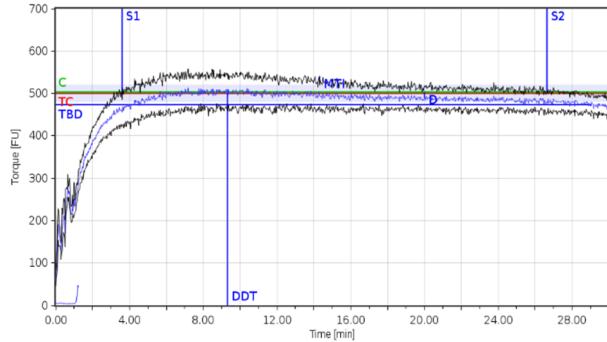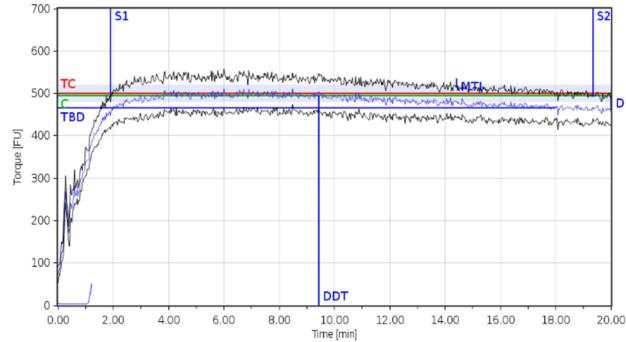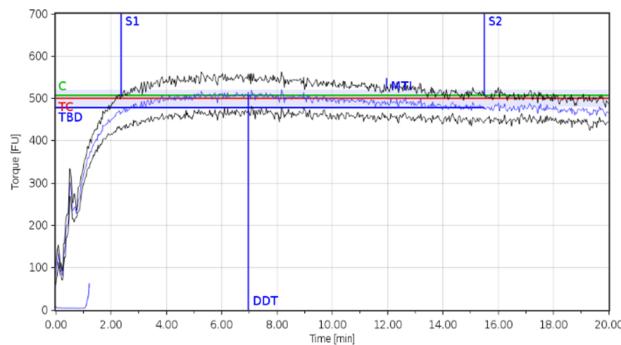
AP Dagr (Casselton, C-6)

Linkert Check (Crookston, K-9)

AP Dagr (Crookston, K-6)

LCS Rebel Check (Minot, M-11)

AP Dagr (Minot, M-6)

47
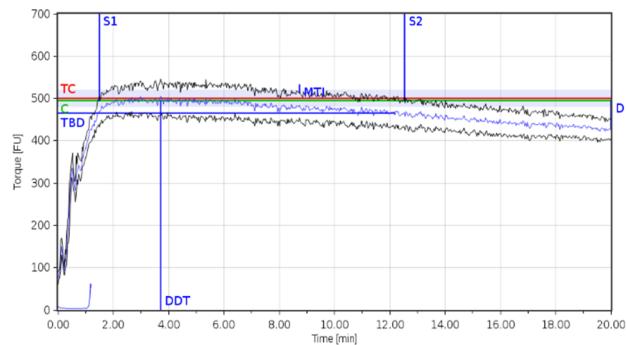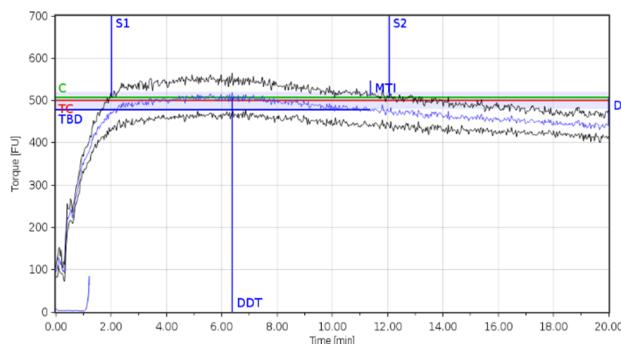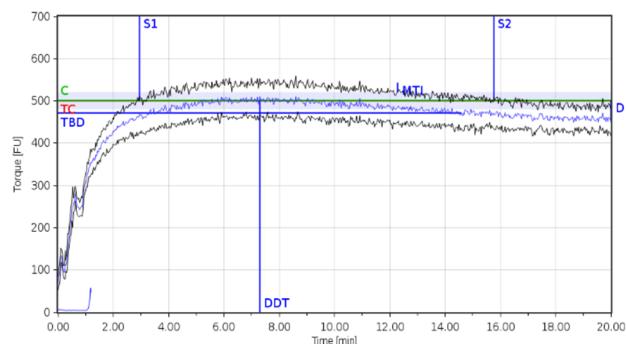
Mixograms

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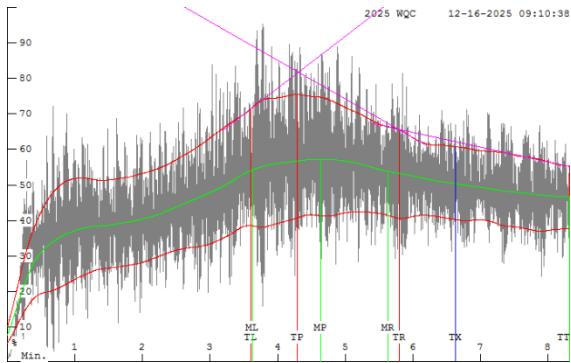
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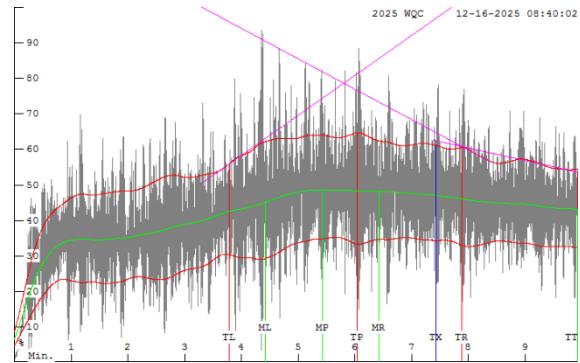
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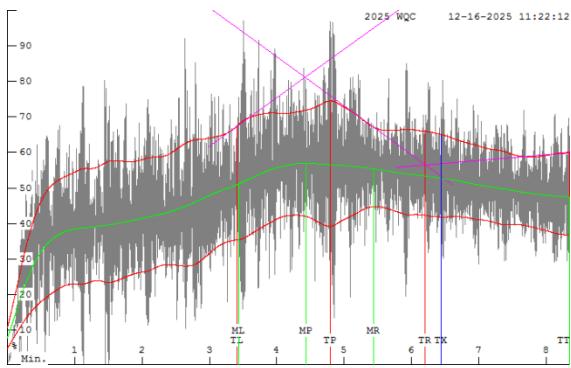
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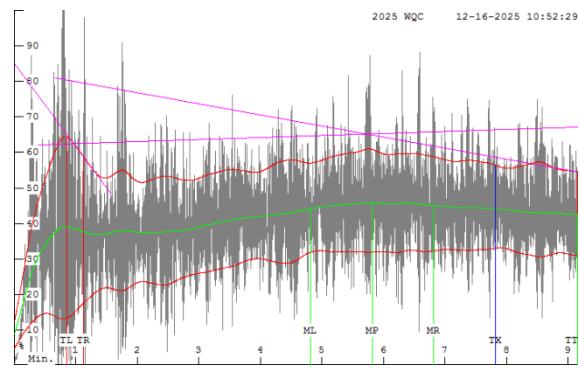
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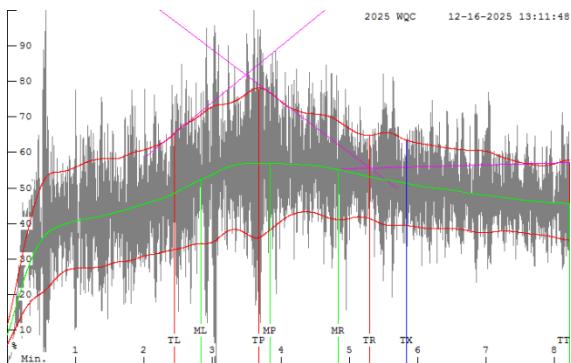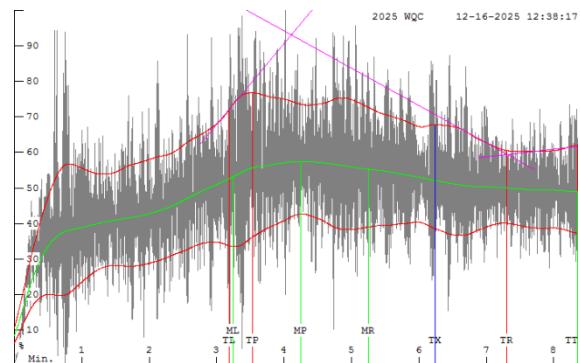
AP Dagr (Minot, M-6)

GlutoPeak Curves
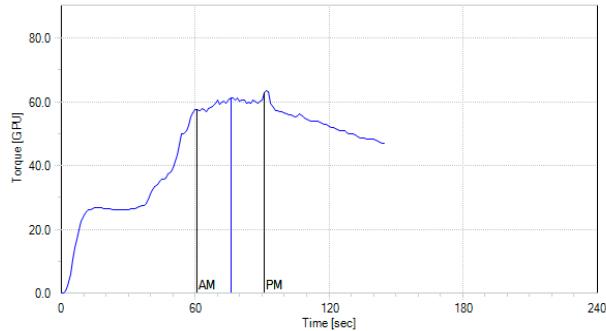
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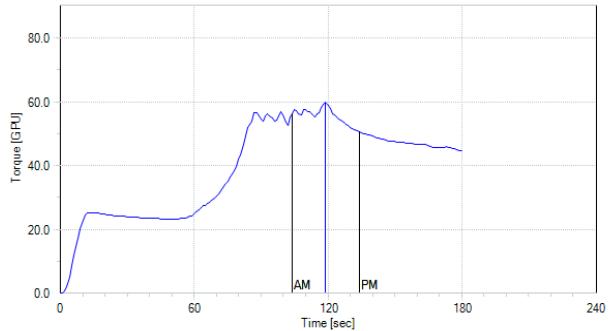
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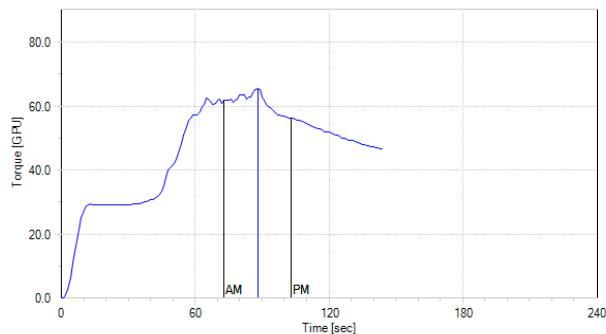
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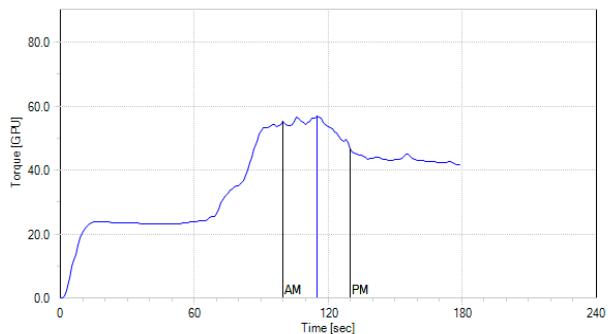
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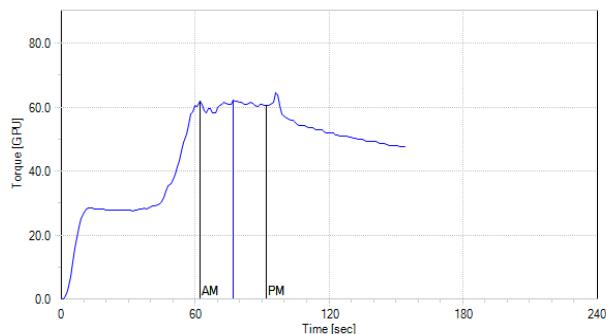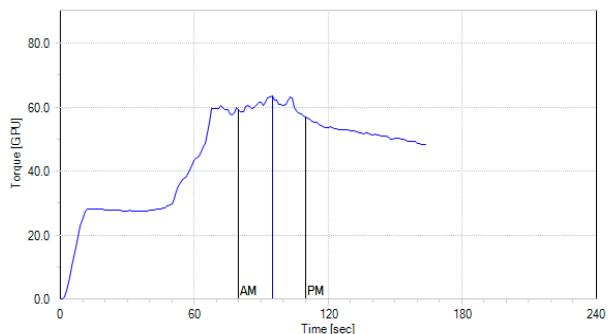
AP Dagr (Minot, M-6)

Extensograms

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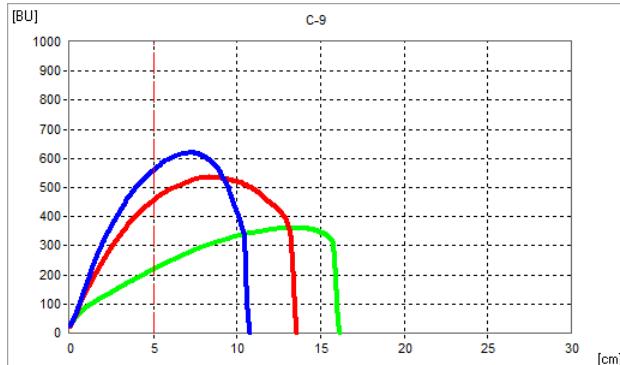
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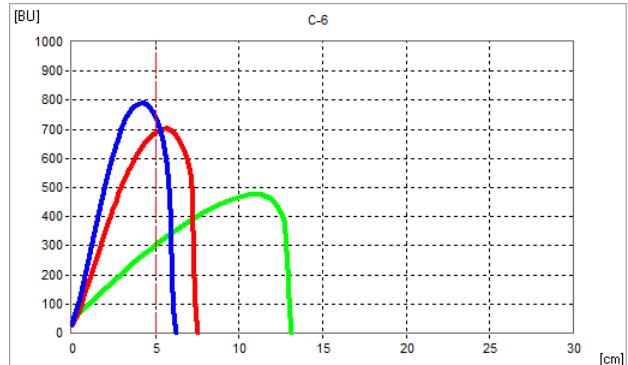
Linkert Check (Crookston, K-9)
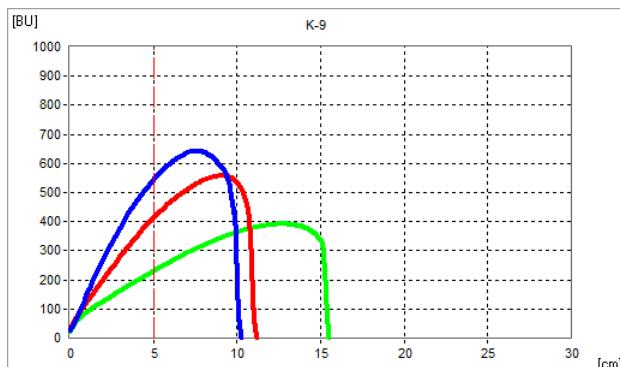
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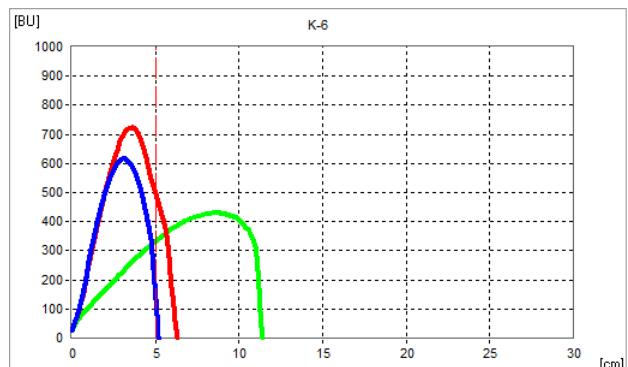
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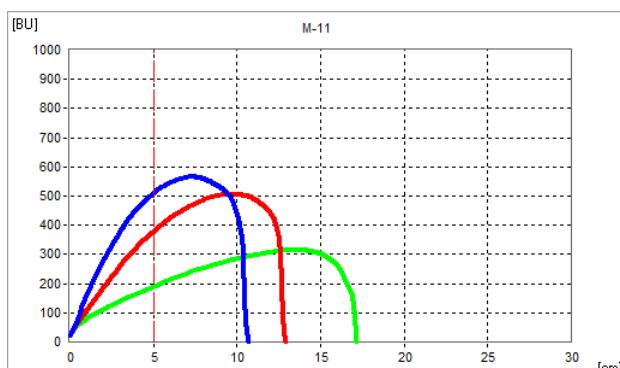
AP Dagr (Minot, M-6)
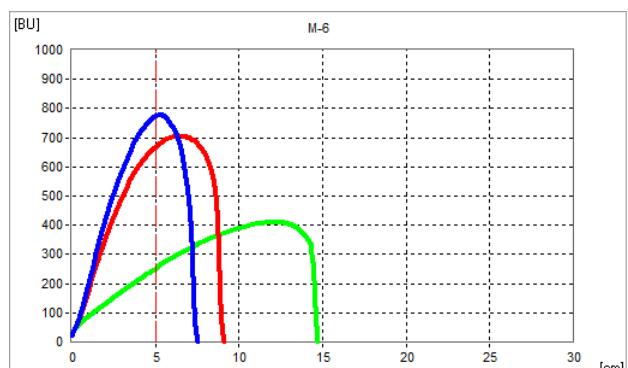
— 45 min; — 90 min; — 135 min

SWQC #7 – ND Stampede

	Quality Trait	Casselton		Havre		Crookston		Minot	
		Linkert		LCS Rebel		Linkert		LCS Rebel	
		C-9	C-7	H-11	H-7	K-9	K-7	M-11	M-7
	I. USDA-ARS WQL Data								
1	Wheat Protein (%, 12% mb)	15.4	14.4	17.9	17.3	14.8	14.6	15.2	15.7
2	Flour Protein (%, 14% mb)	14.1	12.9	16.8	16.4	13.7	13.2	13.8	14.5
3	Market Value (Score 1-6)	4.9	4.1	4.9	4.7	5.3	4.7	5.4	5.3
4	Market Value (Score 1-10)	10.0	8.6	10.0	8.6	10.0	8.4	10.0	9.6
5	DON (ppm)	≤ 0.5	≤ 0.5	ND	ND	ND	≤ 0.5	ND	ND
6	Test Weight (lb/bu)	61.4	61.4	62.1	60.6	63.3	63.0	64.2	63.7
7	1000 Kernel Weight (g)	36.2	32.7	31.5	29.5	38.5	34.4	38.7	37.2
8	Kernel Size, Large (%)	68	51	26	12	74	51	72	59
9	Kernel Size, Small (%)	1	1	2	2	0	1	1	1
10	Wheat Moisture (%)	13.0	12.5	10.8	10.8	11.6	12.0	11.5	11.6
11	Wheat Ash (%, 14% mb)	1.62	1.52	1.34	1.29	1.50	1.39	1.45	1.29
12	Wheat Falling Number (s)	422	381	375	402	449	383	413	380
13	SKCS Hardness Index	69.2	76.2	67.9	73.2	69.6	77.6	60.0	72.2
14	Vitreous Kernels (%)	45	42	98	93	56	64	45	73
	Flour Extraction								
15	Tempered Wheat Basis (%)	71.6	69.8	71.4	67.2	74.0	67.3	73.1	67.2
16	Total Product Basis (%)	73.5	70.7	72.5	68.1	75.3	68.6	75.0	68.6
17	Flour/Bu Wheat (lb)	44.0	42.9	45.3	41.5	47.4	43.2	47.2	43.7
	Flour Quality								
18	Flour Color Brightness (L*)	90.4	90.4	90.9	90.8	90.5	90.5	90.6	90.6
19	Flour Color Yellowness (b*)	8.8	8.1	8.8	7.7	8.4	8.1	8.6	7.7
20	Flour Moisture (%)	12.8	12.4	12.6	13.0	12.2	12.9	12.4	13.1
21	Flour Ash (%, 14% mb)	0.54	0.53	0.50	0.52	0.54	0.47	0.50	0.45
22	Flour Falling Number (malted, s)	257	251	250	252	255	259	246	259
	Farinograph								
23	Water Absorption (%, 500 BU)	65.7	67.0	67.3	70.8	66.6	67.9	67.2	68.8
24	Water Absorption (%, 14% mb)	64.3	65.2	65.7	69.6	64.6	66.7	65.4	67.8
25	Arrival Time (min)	3.6	2.2	4.1	29.5	2.4	2.1	2.0	2.5
26	Peak Time (min)	9.3	7.2	8.1	36.2	7.0	9.2	6.4	8.7
27	Dough Stability (min)	23.1	11.5	19.8	11.3	13.1	12.9	10.1	14.0
28	Mixing Tolerance Index (MTI, BU)	14	26	7	29	25	29	34	21
29	Time To Breakdown (TTB, min)	29.1	14.0	43.0	41.5	15.5	15.4	11.4	17.6
	II. Cooperator Results								
30	Bake Absorption (Average %)	66.7	67.4	69.0	70.8	67.1	68.5	67.9	69.6
31	Loaf Volume (% of Check)		95.4		98.4		98.3		100.2

SWQC #7 – ND Stampede

	Quality Trait	Casselton		Havre		Crookston		Minot	
		Linkert C-9	C-7	LCS Rebel H-11	H-7	Linkert K-9	K-7	LCS Rebel M-11	M-7
	II. Cooperator Results								
32	**Mixing Requirement** 9 = Very Long 7 = Long 5 = Medium 3 = Short 1 = Very Short	6.3	5.7	7.4	7.7	6.7	5.9	5.9	6.2
33	**Dough Characteristics** 9 = Bucky – Tough 7 = Strong – Elastic 5 = Medium – Pliable 3 = Mellow – Very Pliable 1 = Weak – Short or Sticky	6.1	5.4	7.7	7.6	6.3	5.6	6.5	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		4.0		5.0		4.5		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		4.8		5.3		5.6		5.8
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		5.1		4.4		5.5		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		3.5		4.5		4.7		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		3.3		3.6		2.8		3.0
	Quality Traits 23-36: Baking 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.3		5.5		5.4		5.1
	Quality Traits 1-36: Overall Comparison 9 = Much Better Than Check 7 = Better Than Check 5 = Equivalent To Check 3 = Poorer Than Check 1 = Much Poorer Than Check		4.2		5.0		4.8		4.6

Farinograms

Linkert Check (Casselton, C-9)
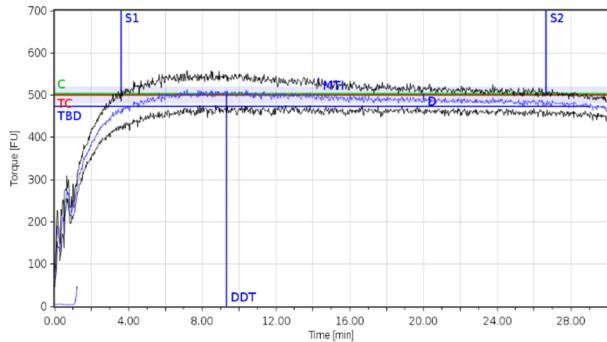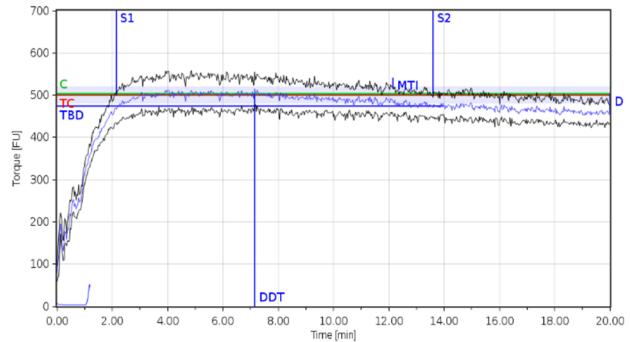
ND Stampede (Casselton, C-7)

LCS Rebel Check (Havre, H-11)
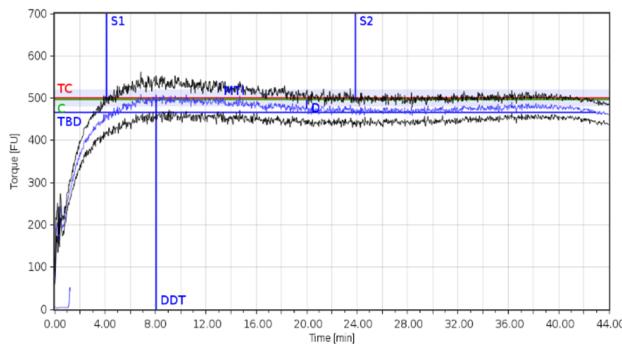
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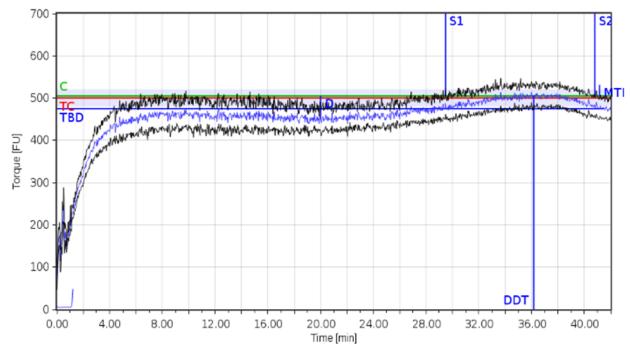
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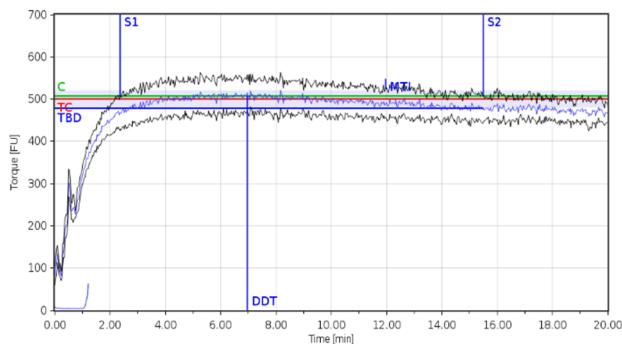
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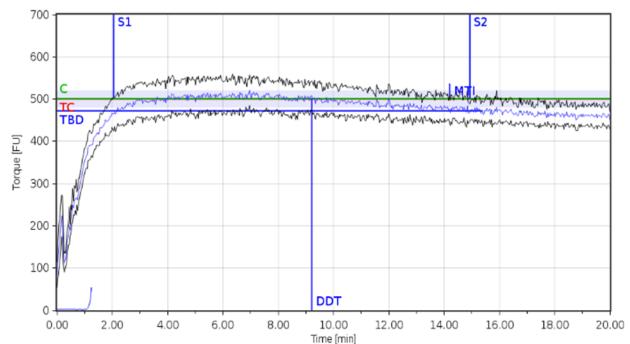
LCS Rebel Check (Minot, M-11)
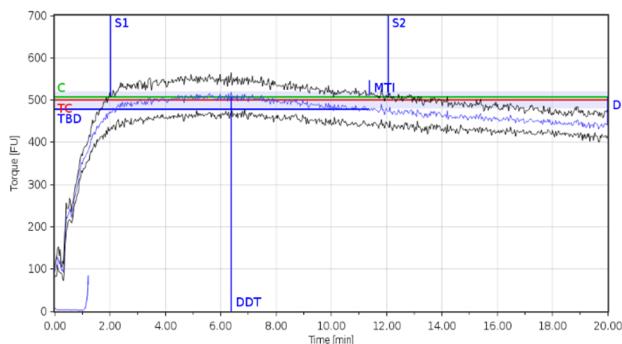
ND Stampede (Minot, M-7)

Mixograms

Linkert Check (Casselton, C-9)

ND Stampede (Casselton, C-7)

LCS Rebel Check (Havre, H-11)

ND Stampede (Havre, H-7)

Linkert Check (Crookston, K-9)

ND Stampede (Crookston, K-7)

LCS Rebel Check (Minot, M-11)

ND Stampede (Minot, M-7)

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GlutoPeak Curves

Linkert Check (Casselton, C-9)

ND Stampede (Casselton, C-7)

LCS Rebel Check (Havre, H-11)

ND Stampede (Havre, H-7)

Linkert Check (Crookston, K-9)

ND Stampede (Crookston, K-7)

LCS Rebel Check (Minot, M-11)

ND Stampede (Minot, M-7)

55
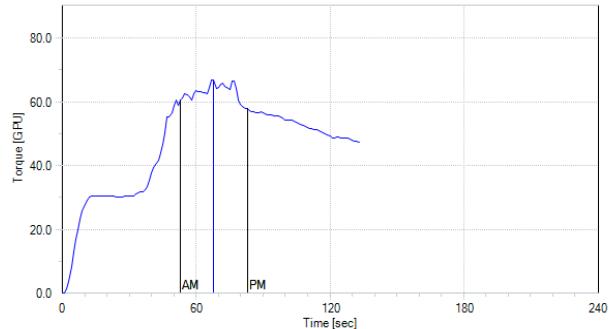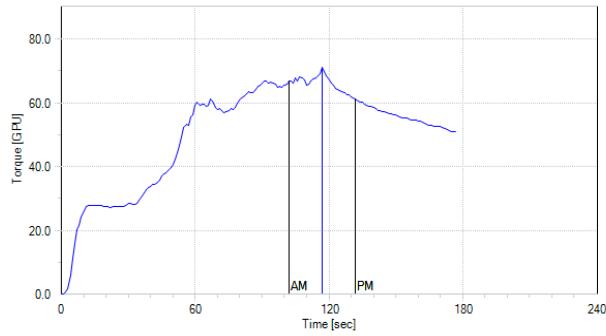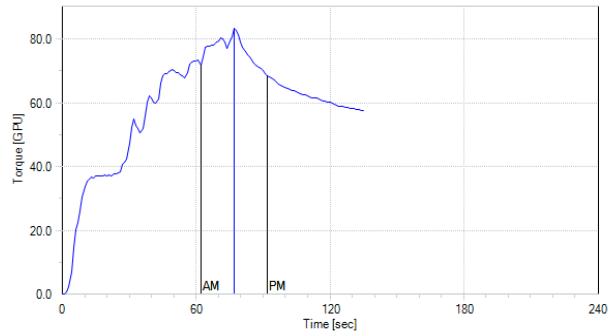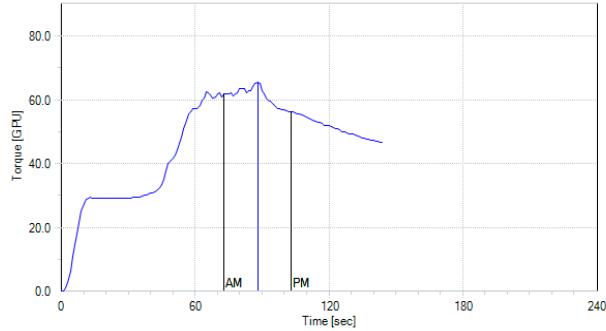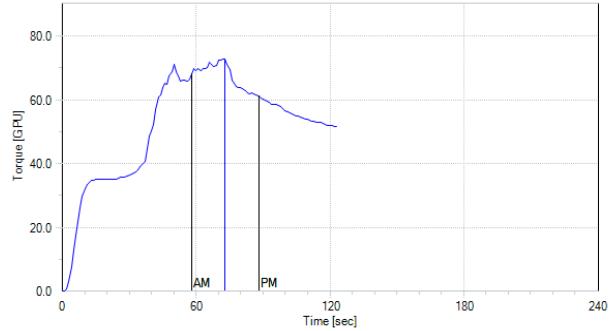
Extensograms

Linkert Check (Casselton, C-9)

ND Stampede (Casselton, C-7)

LCS Rebel Check (Havre, H-11)

ND Stampede (Havre, H-7)

Linkert Check (Crookston, K-9)

ND Stampede (Crookston, K-7)

LCS Rebel Check (Minot, M-11)

ND Stampede (Minot, M-7)

—— 45 min; —— 90 min; —— 135 min

56

SWQC #8 – AP Iconic

		Casselton		Crookston		Minot	
		Linkert		Linkert		LCS Rebel	
	Quality Trait	C-9	C-8	K-9	K-8	M-11	M-8
	I. USDA-ARS WQL Data						
1	Wheat Protein (%, 12% mb)	15.4	13.8	14.8	13.9	15.2	15.1
2	Flour Protein (%, 14% mb)	14.1	12.4	13.7	12.6	13.8	13.8
3	Market Value (Score 1-6)	4.9	3.8	5.3	4.5	5.4	5.0
4	Market Value (Score 1-10)	10.0	7.0	10.0	7.8	10.0	8.8
5	DON (ppm)	≤ 0.5	ND	ND	ND	ND	ND
6	Test Weight (lb/bu)	61.4	60.9	63.3	63.4	64.2	63.6
7	1000 Kernel Weight (g)	36.2	29.6	38.5	31.2	38.7	31.9
8	Kernel Size, Large (%)	68	37	74	45	72	40
9	Kernel Size, Small (%)	1	2	0	1	1	2
10	Wheat Moisture (%)	13.0	13.4	11.6	12.2	11.5	11.3
11	Wheat Ash (%, 14% mb)	1.62	1.62	1.50	1.42	1.45	1.40
12	Wheat Falling Number (s)	422	412	449	402	413	454
13	SKCS Hardness Index	69.2	65.9	69.6	71.3	60.0	71.2
14	Vitreous Kernels (%)	45	16	56	49	45	44
	Flour Extraction						
15	Tempered Wheat Basis (%)	71.6	70.3	74.0	74.3	73.1	70.6
16	Total Product Basis (%)	73.5	72.1	75.3	75.3	75.0	72.3
17	Flour/Bu Wheat (lb)	44.0	42.5	47.4	47.5	47.2	46.0
	Flour Quality						
18	Flour Color Brightness (*L*)	90.4	90.2	90.5	90.1	90.6	90.5
19	Flour Color Yellowness (*b*)	8.8	11.4	8.4	11.4	8.6	11.0
20	Flour Moisture (%)	12.8	12.8	12.2	12.8	12.4	13.7
21	Flour Ash (%, 14% mb)	0.54	0.55	0.54	0.53	0.50	0.52
22	Flour Falling Number (malted, s)	257	258	255	251	246	252
	Farinograph						
23	Water Absorption (%, 500 BU)	65.7	63.1	66.6	64.5	67.2	66.0
24	Water Absorption (%, 14% mb)	64.3	61.7	64.6	63.1	65.4	65.6
25	Arrival Time (min)	3.6	2.5	2.4	2.1	2.0	3.4
26	Peak Time (min)	9.3	7.2	7.0	5.6	6.4	6.4
27	Dough Stability (min)	23.1	10.5	13.1	8.2	10.1	8.6
28	Mixing Tolerance Index (MTI, BU)	14	30	25	37	34	26
29	Time To Breakdown (TTB, min)	29.1	13.1	15.5	10.7	11.4	12.7
	II. Cooperator Results						
30	Bake Absorption (Average %)	66.7	64.5	67.1	65.6	67.9	67.0
31	Loaf Volume (% of Check)		100.1		101.4		105.3

SWQC #8 – AP Iconic

| Quality Trait | Casselton | | Crookston | | Minot | |
| | Linkert | | Linkert | | LCS Rebel | |
	C-9	C-8	K-9	K-8	M-11	M-8
II. Cooperator Results						
32 Mixing Requirement	**6.3**	**5.5**	**6.7**	**5.7**	**5.9**	**5.3**
9 = Very Long						
7 = Long						
5 = Medium						
3 = Short						
1 = Very Short						
33 Dough Characteristics	**6.1**	**5.3**	**6.3**	**4.6**	**6.5**	**6.1**
9 = Bucky – Tough						
7 = Strong – Elastic						
5 = Medium – Pliable						
3 = Mellow – Very Pliable						
1 = Weak – Short or Sticky						
34 Mixing Tolerance		**4.0**		**3.9**		**4.4**
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						
35 Internal Crumb Color		**4.4**		**4.5**		**4.3**
9 = Much Brighter Than Check						
7 = Brighter Than Check						
5 = Equivalent To Check						
3 = Poorer Than Check						
1 = Much Poorer Than Check						
36 Internal Grain and Texture		**5.0**		**4.6**		**4.9**
9 = Much Better Than Check						
7 = Better Than Check						
5 = Equivalent To Check						
3 = Poorer Than Check						
1 = Much Poorer Than Check						
III. Cooperator Evaluation						
Quality Traits 1-2: Protein		**2.8**		**3.6**		**5.0**
9 = Much Better Than Check						
7 = Better Than Check						
5 = Equivalent To Check						
3 = Poorer Than Check						
1 = Much Poorer Than Check						
Quality Traits 3-22: Milling		**3.6**		**4.4**		**3.7**
9 = Much Better Than Check						
7 = Better Than Check						
5 = Equivalent To Check						
3 = Poorer Than Check						
1 = Much Poorer Than Check						
Quality Traits 23-36: Baking		**4.7**		**5.3**		**5.4**
9 = Much Better Than Check						
7 = Better Than Check						
5 = Equivalent To Check						
3 = Poorer Than Check						
1 = Much Poorer Than Check						
Quality Traits 1-36: Overall Comparison		**4.1**		**4.4**		**4.6**
9 = Much Better Than Check						
7 = Better Than Check						
5 = Equivalent To Check						
3 = Poorer Than Check						
1 = Much Poorer Than Check						

Farinograms

Linkert Check (Casselton, C-9)

AP Iconic (Casselton, C-8)

Linkert Check (Crookston, K-9)

AP Iconic (Crookston, K-8)

LCS Rebel Check (Minot, M-11)

AP Iconic (Minot, M-8)

Mixograms

Linkert Check (Casselton, C-9)
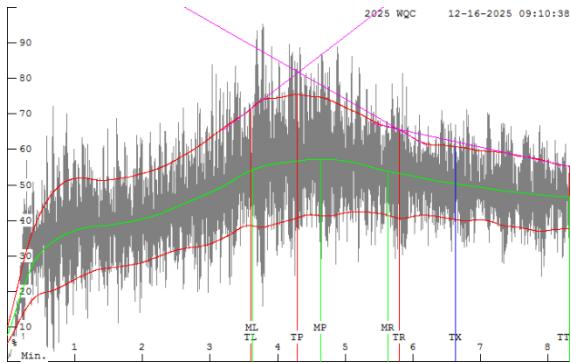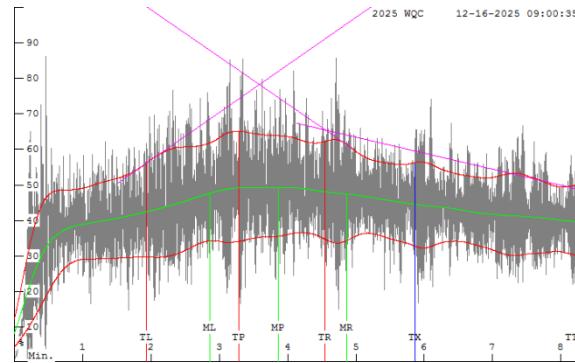
AP Iconic (Casselton, C-8)

Linkert Check (Crookston, K-9)
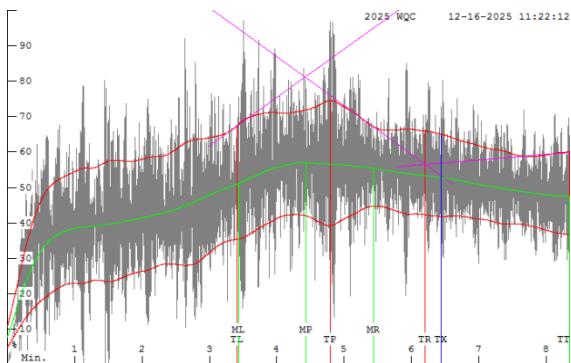
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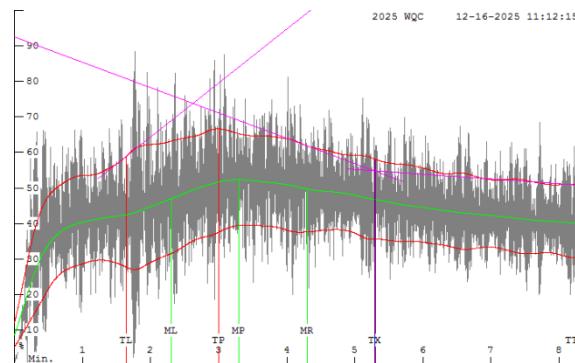
LCS Rebel Check (Minot, M-11)
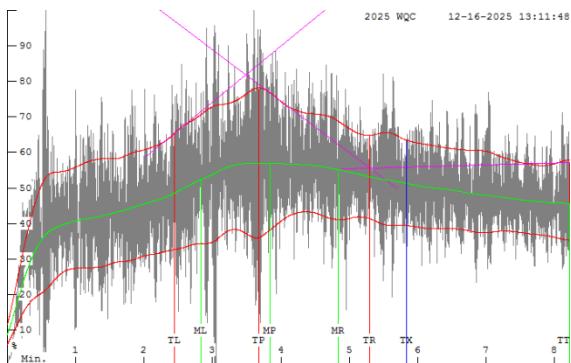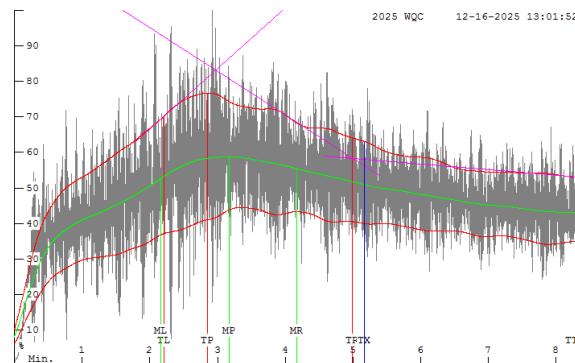
AP Iconic (Minot, M-8)

GlutoPeak Curves
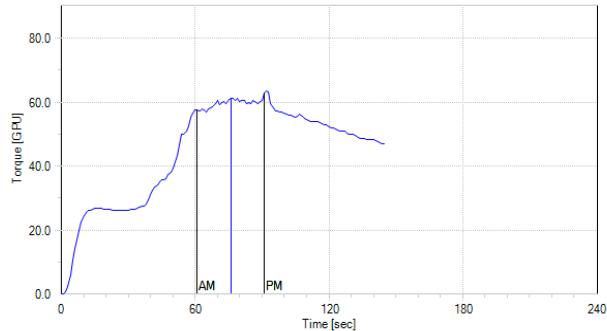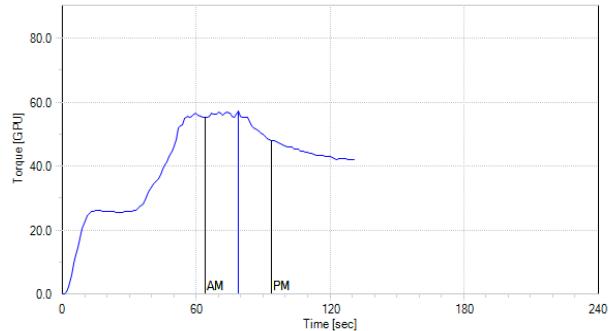
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AP Iconic (Casselton, C-8)

Linkert Check (Crookston, K-9)
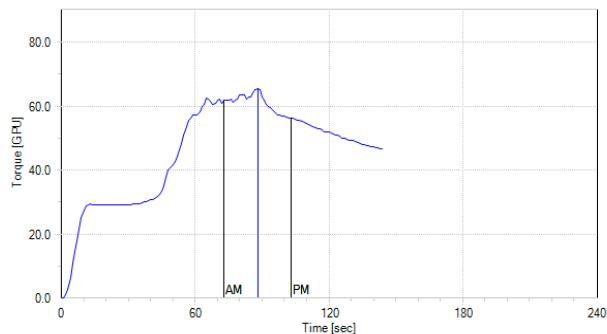
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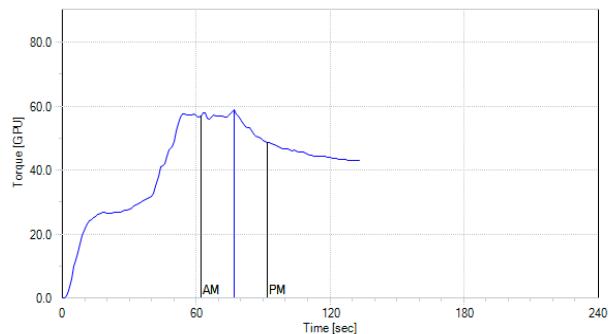
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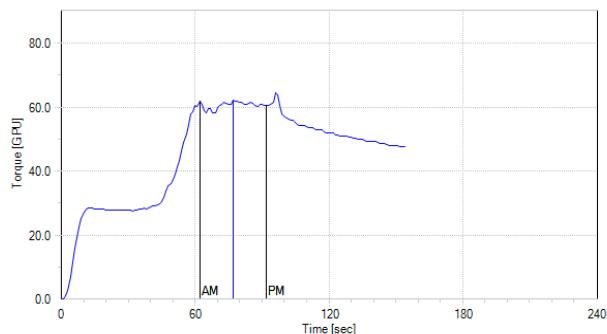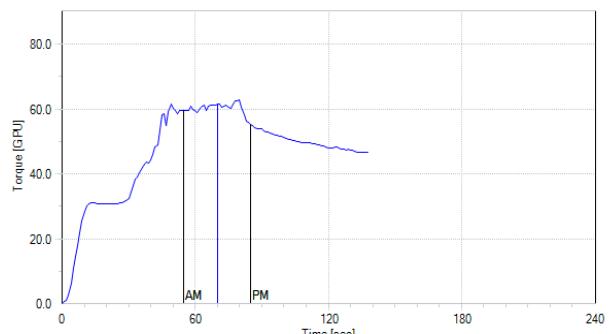
AP Iconic (Minot, M-8)

Extensograms

Linkert Check (Casselton, C-9)
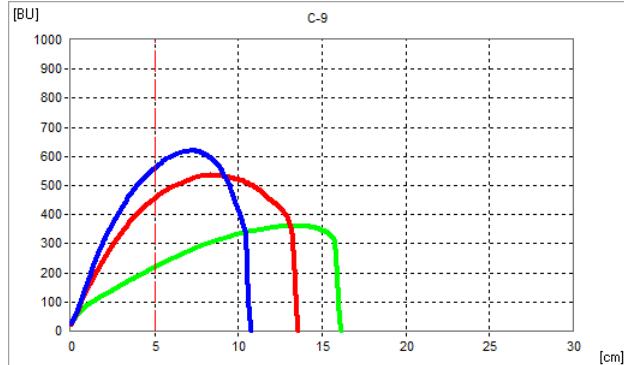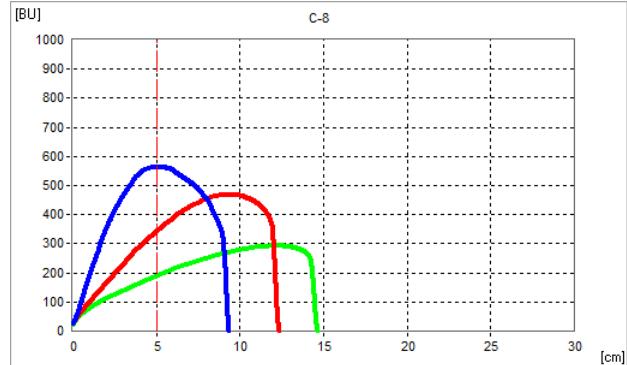
AP Iconic (Casselton, C-8)

Linkert Check (Crookston, K-9)
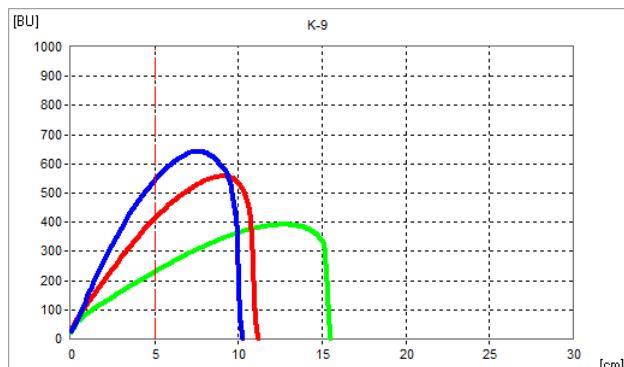
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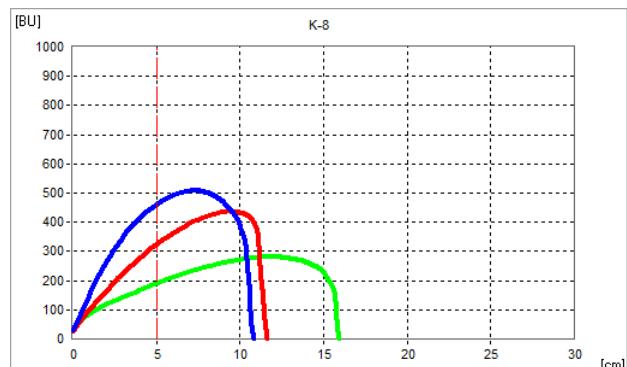
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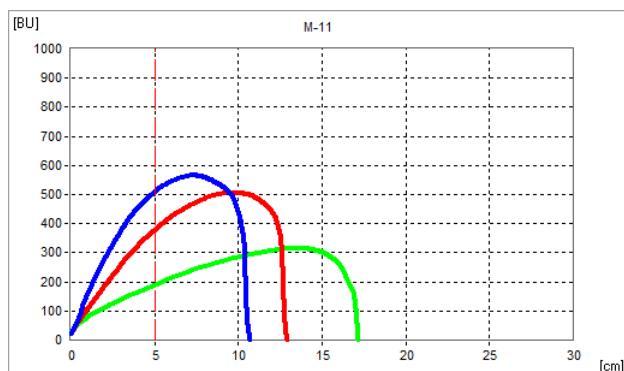
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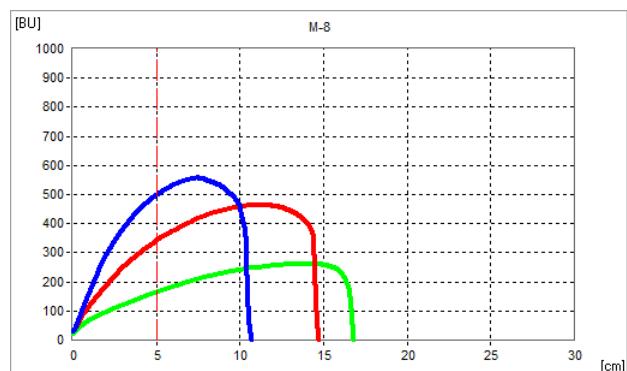
45 min;   90 min;   135 min

SWQC #10 – MN21172-3

	Quality Trait	Casselton Linkert C-9	Casselton C-10	Crookston Linkert K-9	Crookston K-10
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	15.4	14.3	14.8	14.6
2	Flour Protein (%, 14% mb)	14.1	13.1	13.7	13.2
3	Market Value (Score 1-6)	4.9	4.7	5.3	5.1
4	Market Value (Score 1-10)	10.0	8.8	10.0	9.2
5	DON (ppm)	≤ 0.5	ND	ND	ND
6	Test Weight (lb/bu)	61.4	61.6	63.3	63.2
7	1000 Kernel Weight (g)	36.2	36.1	38.5	38.0
8	Kernel Size, Large (%)	68	60	74	60
9	Kernel Size, Small (%)	1	1	0	1
10	Wheat Moisture (%)	13.0	12.5	11.6	11.9
11	Wheat Ash (%, 14% mb)	1.62	1.53	1.50	1.42
12	Wheat Falling Number (s)	422	422	449	396
13	SKCS Hardness Index	69.2	71.0	69.6	73.9
14	Vitreous Kernels (%)	45	47	56	86
	Flour Extraction				
15	Tempered Wheat Basis (%)	71.6	73.2	74.0	72.4
16	Total Product Basis (%)	73.5	75.2	75.3	75.0
17	Flour/Bu Wheat (lb)	44.0	45.7	47.4	46.5
	Flour Quality				
18	Flour Color Brightness (*L**)	90.4	90.1	90.5	90.1
19	Flour Color Yellowness (*b**)	8.8	9.8	8.4	9.7
20	Flour Moisture (%)	12.8	12.7	12.2	12.7
21	Flour Ash (%, 14% mb)	0.54	0.55	0.54	0.52
22	Flour Falling Number (malted, s)	257	257	255	256
	Farinograph				
23	Water Absorption (%, 500 BU)	65.7	63.6	66.6	65.1
24	Water Absorption (%, 14% mb)	64.3	62.2	64.6	63.7
25	Arrival Time (min)	3.6	2.0	2.4	1.8
26	Peak Time (min)	9.3	4.7	7.0	3.4
27	Dough Stability (min)	23.1	11.8	13.1	10.5
28	Mixing Tolerance Index (MTI, BU)	14	19	25	16
29	Time To Breakdown (TTB, min)	29.1	14.1	15.5	13.0
	II. Cooperator Results				
30	Bake Absorption (Average %)	66.7	64.9	67.1	66.4
31	Loaf Volume (% of Check)		98.2		95.9

SWQC #10 – MN21172-3

	Quality Trait	Casselton		Crookston	
		Linkert C-9	C-10	Linkert K-9	K-10
	II. Cooperator Results				
32	**Mixing Requirement**	**6.3**	**4.0**	**6.7**	**4.6**
	9 = Very Long				
	7 = Long				
	5 = Medium				
	3 = Short				
	1 = Very Short				
33	**Dough Characteristics**	**6.1**	**5.1**	**6.3**	**4.9**
	9 = Bucky – Tough				
	7 = Strong – Elastic				
	5 = Medium – Pliable				
	3 = Mellow – Very Pliable				
	1 = Weak – Short or Sticky				
34	**Mixing Tolerance**		**3.5**		**4.2**
	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				
35	**Internal Crumb Color**		**4.7**		**4.4**
	9 = Much Brighter Than Check				
	7 = Brighter Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				
36	**Internal Grain and Texture**		**4.6**		**4.2**
	9 = Much Better Than Check				
	7 = Better Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				
	III. Cooperator Evaluation				
	Quality Traits 1-2: Protein		**4.1**		**4.8**
	9 = Much Better Than Check				
	7 = Better Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				
	Quality Traits 3-22: Milling		**5.9**		**4.8**
	9 = Much Better Than Check				
	7 = Better Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				
	Quality Traits 23-36: Baking		**4.0**		**3.9**
	9 = Much Better Than Check				
	7 = Better Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				
	Quality Traits 1-36: Overall Comparison		**4.1**		**4.2**
	9 = Much Better Than Check				
	7 = Better Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				

Farinograms

Linkert Check (Casselton, C-9)

MN21172-3 (Casselton, C-10)

Linkert Check (Crookston, K-9)

MN21172-3 (Crookston, K-10)

Mixograms

Linkert Check (Casselton, C-9)

MN21172-3 (Casselton, C-10)

Linkert Check (Crookston, K-9)

MN21172-3 (Crookston, K-10)

GlutoPeak Curves

Linkert Check (Casselton, C-9)
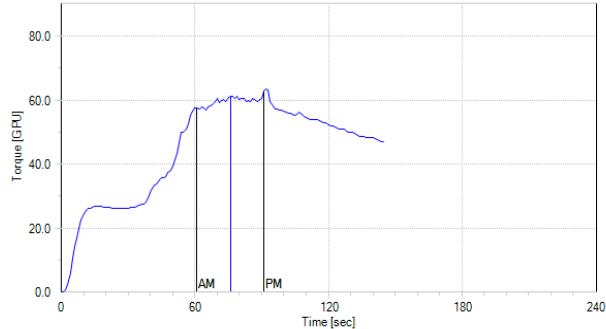
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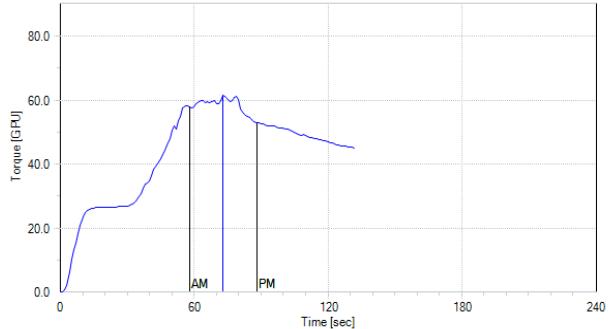
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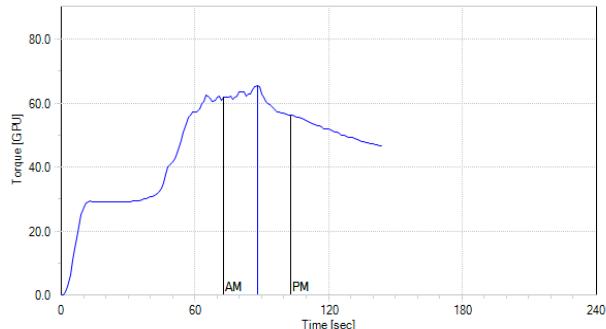
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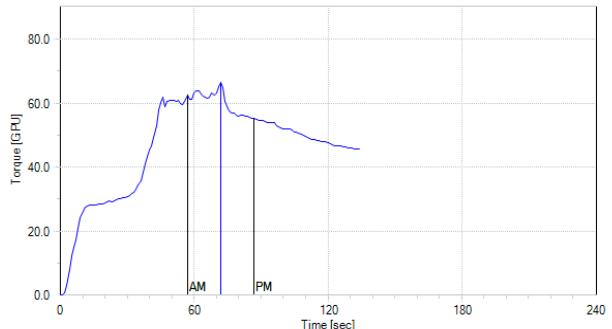
Extensograms

Linkert Check (Casselton, C-9)
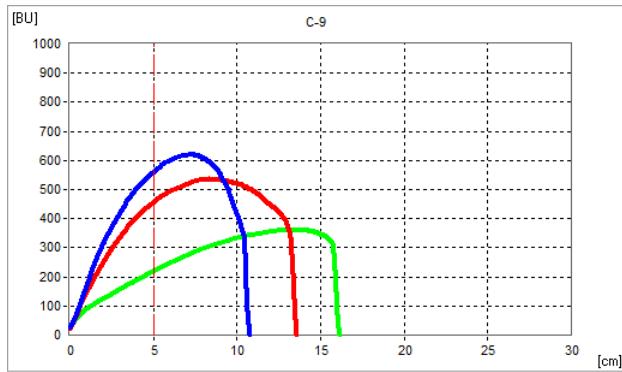
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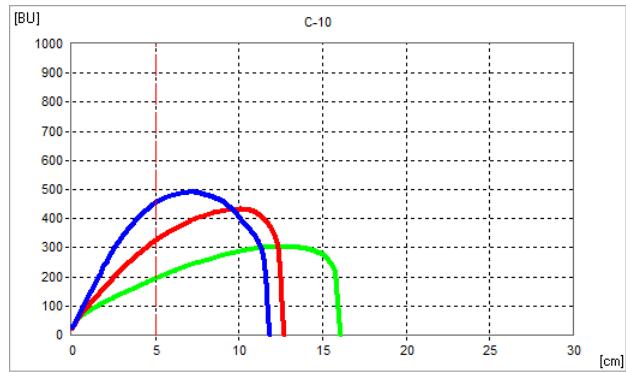
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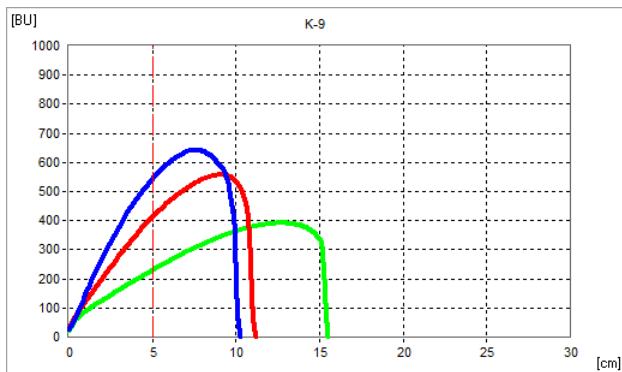
MN21172-3 (Crookston, K-10)

45 min;   90 min;   135 min

68
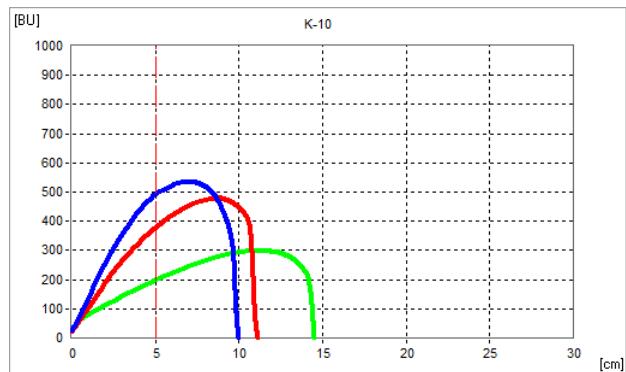
SWQC #12 – MT 21487

	Quality Trait	Havre		Minot	
		LCS Rebel		LCS Rebel	
		H-11	H-12	M-11	M-12
	I. USDA-ARS WQL Data				
1	Wheat Protein (%, 12% mb)	17.9	17.5	15.2	15.1
2	Flour Protein (%, 14% mb)	16.8	16.0	13.8	13.7
3	Market Value (Score 1-6)	4.9	4.8	5.4	5.3
4	Market Value (Score 1-10)	10.0	9.6	10.0	10.0
5	DON (ppm)	ND	ND	ND	ND
6	Test Weight (lb/bu)	62.1	60.2	64.2	63.0
7	1000 Kernel Weight (g)	31.5	29.5	38.7	37.8
8	Kernel Size, Large (%)	26	19	72	69
9	Kernel Size, Small (%)	2	3	1	1
10	Wheat Moisture (%)	10.8	10.6	11.5	11.4
11	Wheat Ash (%, 14% mb)	1.34	1.27	1.45	1.40
12	Wheat Falling Number (s)	375	438	413	409
13	SKCS Hardness Index	67.9	68.2	60.0	66.8
14	Vitreous Kernels (%)	98	96	45	50
	Flour Extraction				
15	Tempered Wheat Basis (%)	71.4	70.7	73.1	71.4
16	Total Product Basis (%)	72.5	71.3	75.0	72.0
17	Flour/Bu Wheat (lb)	45.3	43.2	47.2	45.9
	Flour Quality				
18	Flour Color Brightness ($L*$)	90.9	90.1	90.6	90.2
19	Flour Color Yellowness ($b*$)	8.8	9.4	8.6	9.1
20	Flour Moisture (%)	12.6	12.4	12.4	13.3
21	Flour Ash (%, 14% mb)	0.50	0.50	0.50	0.45
22	Flour Falling Number (malted, s)	250	247	246	255
	Farinograph				
23	Water Absorption (%, 500 BU)	67.3	67.2	67.2	64.9
24	Water Absorption (%, 14% mb)	65.7	65.4	65.4	64.1
25	Arrival Time (min)	4.1	5.1	2.0	2.3
26	Peak Time (min)	8.1	36.4	6.4	6.8
27	Dough Stability (min)	19.8	35.8	10.1	14.3
28	Mixing Tolerance Index (MTI, BU)	7	31	34	18
29	Time To Breakdown (TTB, min)	43.0	41.6	11.4	15.0
	II. Cooperator Results				
30	Bake Absorption (Average %)	69.0	69.3	67.9	67.0
31	Loaf Volume (% of Check)		99.6		99.2

SWQC #12 – MT 21487

	Quality Trait	Havre		Minot	
		LCS Rebel		LCS Rebel	
		H-11	H-12	M-11	M-12
	II. Cooperator Results				
32	**Mixing Requirement**	**7.4**	**7.9**	**5.9**	**6.5**
	9 = Very Long				
	7 = Long				
	5 = Medium				
	3 = Short				
	1 = Very Short				
33	**Dough Characteristics**	**7.7**	**7.3**	**6.5**	**6.0**
	9 = Bucky – Tough				
	7 = Strong – Elastic				
	5 = Medium – Pliable				
	3 = Mellow – Very Pliable				
	1 = Weak – Short or Sticky				
34	**Mixing Tolerance**		**6.2**		**5.8**
	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				
35	**Internal Crumb Color**		**5.3**		**4.8**
	9 = Much Brighter Than Check				
	7 = Brighter Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				
36	**Internal Grain and Texture**		**4.5**		**5.5**
	9 = Much Better Than Check				
	7 = Better Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				
	III. Cooperator Evaluation				
	Quality Traits 1-2: Protein		**4.7**		**5.0**
	9 = Much Better Than Check				
	7 = Better Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				
	Quality Traits 3-22: Milling		**4.8**		**4.5**
	9 = Much Better Than Check				
	7 = Better Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				
	Quality Traits 23-36: Baking		**5.0**		**5.1**
	9 = Much Better Than Check				
	7 = Better Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				
	Quality Traits 1-36: Overall Comparison		**5.3**		**5.1**
	9 = Much Better Than Check				
	7 = Better Than Check				
	5 = Equivalent To Check				
	3 = Poorer Than Check				
	1 = Much Poorer Than Check				

Farinograms

LCS Rebel Check (Havre, H-11)

MT 21487 (Havre, H-12)

LCS Rebel Check (Minot, M-11)

MT 21487 (Minot, M-12)

71

Mixograms

LCS Rebel Check (Havre, H-11)

MT 21487 (Havre, H-12)

LCS Rebel Check (Minot, M-11)

MT 21487 (Minot, M-12)

GlutoPeak Curves

LCS Rebel Check (Havre, H-11)
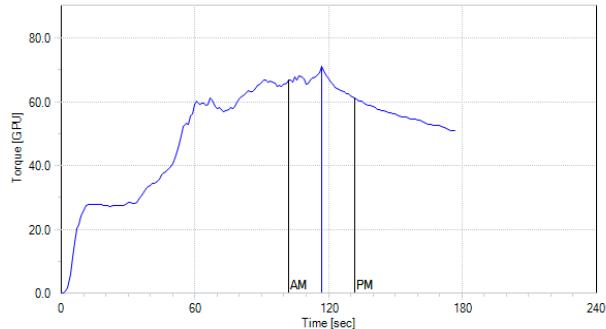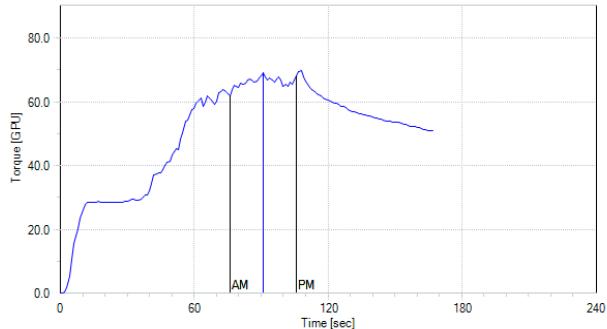
MT 21487 (Havre, H-12)

LCS Rebel Check (Minot, M-11)
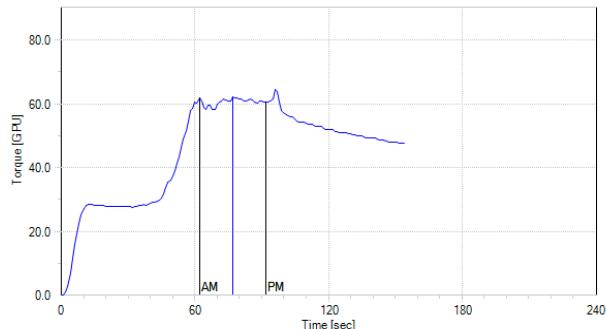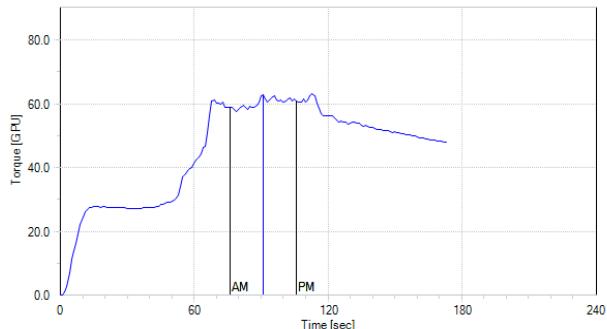
MT 21487 (Minot, M-12)

Extensograms

LCS Rebel Check (Havre, H-11)
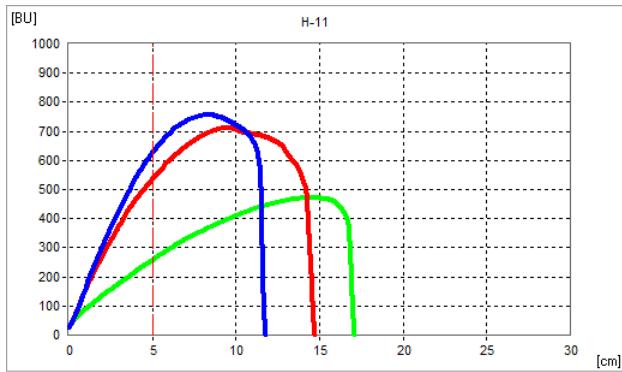
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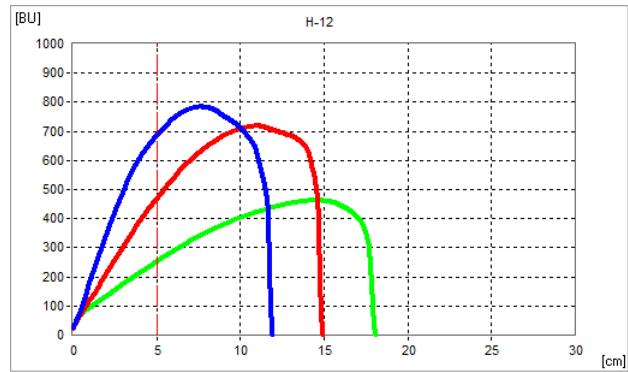
LCS Rebel Check (Minot, M-11)
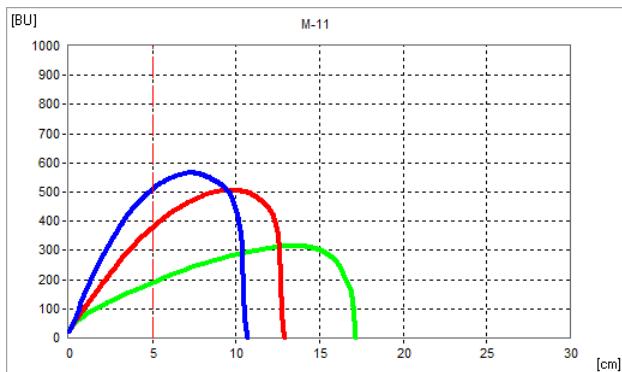
MT 21487 (Minot, M-12)
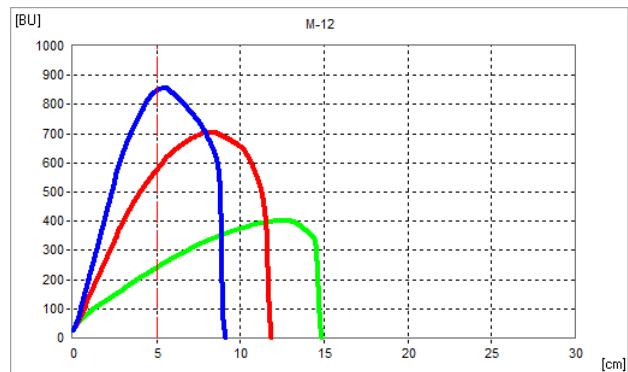
45 min;   90 min;   135 min

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)

Wheat Kernel Characteristics by Location

Location	ID	Entry	Wheat Market Value Score		Test Weight	1000 Kernel Weight	Kernel Size		Vitreous Kernels	SKCS Hardness	Moisture	Protein	Ash	Falling Number	DON
			1-6	1-10	(lb/bu)	(g)	Large (%)	Small (%)	(%)	Index	(%)	(%, 12% mb)	(%, 14% mb)	(s)	(ppm)
Casselton	C-2	AP Elevate	4.1	7.8	61.3	32.6	51	1	34	64.5	12.7	13.8	1.55	415	≤ 0.5
	C-4	MN21089-4	5.2	10.0	63.2	36.3	57	1	50	66.8	12.6	15.1	1.48	419	ND
	C-6	AP Dagr	4.1	7.8	60.1	29.8	29	3	73	80.1	12.7	14.4	1.47	436	ND
	C-7	ND Stampede	4.1	8.6	61.4	32.7	51	1	42	76.2	12.5	14.4	1.52	381	≤ 0.5
	C-8	AP Iconic	3.8	7.0	60.9	29.6	37	2	16	65.9	13.4	13.8	1.62	412	ND
	C-9	Linkert	4.9	10.0	61.4	36.2	68	1	45	69.2	13.0	15.4	1.62	422	≤ 0.5
	C-10	MN21172-3	4.7	8.8	61.6	36.1	60	1	47	71.0	12.5	14.3	1.53	422	ND
Havre	H-1	MT 21174	4.3	9.8	60.4	30.8	33	1	97	72.8	11.0	18.0	1.45	356	ND
	H-3	MT 21484	4.8	10.0	60.5	32.8	33	1	94	64.4	10.9	17.6	1.32	386	ND
	H-5	Dagmar	3.9	8.4	60.6	33.2	34	1	96	68.5	11.0	17.8	1.34	266	ND
	H-7	ND Stampede	4.7	8.6	60.6	29.5	12	2	93	73.2	10.8	17.3	1.29	402	ND
	H-11	LCS Rebel	4.9	10.0	62.1	31.5	26	2	98	67.9	10.8	17.9	1.34	375	ND
	H-12	MT 21487	4.8	9.6	60.2	29.5	19	3	96	68.2	10.6	17.5	1.27	438	ND
Crookston	K-2	AP Elevate	4.8	8.8	63.0	32.9	48	1	68	69.7	12.3	14.4	1.44	414	ND
	K-4	MN21089-4	5.1	9.0	64.2	36.8	59	1	69	69.1	11.8	14.2	1.39	437	ND
	K-6	AP Dagr	4.3	6.4	62.4	34.1	46	2	62	79.5	12.0	12.6	1.35	417	ND
	K-7	ND Stampede	4.7	8.4	63.0	34.4	51	1	64	77.6	12.0	14.6	1.39	383	≤ 0.5
	K-8	AP Iconic	4.5	7.8	63.4	31.2	45	1	49	71.3	12.2	13.9	1.42	402	ND
	K-9	Linkert	5.3	10.0	63.3	38.5	74	0	56	69.6	11.6	14.8	1.50	449	ND
	K-10	MN21172-3	5.1	9.2	63.2	38.0	60	1	86	73.9	11.9	14.6	1.42	396	ND
Minot	M-1	MT 21174	4.4	8.0	62.2	38.0	71	1	84	72.8	11.8	16.5	1.54	274	ND
	M-2	AP Elevate	5.4	9.6	63.0	34.6	52	1	69	63.8	11.4	16.4	1.51	410	ND
	M-3	MT 21484	4.7	8.4	63.0	41.9	76	1	63	67.6	11.8	14.1	1.50	378	ND
	M-5	Dagmar	5.2	8.6	62.7	40.6	73	1	86	66.2	11.6	17.3	1.50	353	ND
	M-6	AP Dagr	5.2	9.0	63.2	36.6	54	1	82	76.8	11.6	14.3	1.38	438	ND
	M-7	ND Stampede	5.3	9.6	63.7	37.2	59	1	73	72.2	11.6	15.7	1.29	380	ND
	M-8	AP Iconic	5.0	8.8	63.6	31.9	40	2	44	71.2	11.3	15.1	1.40	454	ND
	M-11	LCS Rebel	5.4	10.0	64.2	38.7	72	1	45	60.0	11.5	15.2	1.45	413	ND
	M-12	MT 21487	5.3	10.0	63.0	37.8	69	1	50	66.8	11.4	15.1	1.40	409	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)
Casselton	C-2	AP Elevate	72.4	73.9	44.7	90.8	-1.66	11.3	12.9	12.5	0.53	33.1	98	247
	C-4	MN21089-4	70.7	72.4	44.9	90.4	-1.03	9.9	12.9	13.5	0.48	36.0	96	248
	C-6	AP Dagr	71.0	71.5	42.7	89.7	-0.87	9.6	12.7	12.9	0.55	29.7	99	244
	C-7	ND Stampede	69.8	70.7	42.9	90.4	-0.75	8.1	12.4	12.9	0.53	32.6	99	251
	C-8	AP Iconic	70.3	72.1	42.5	90.2	-1.59	11.4	12.8	12.4	0.55	29.7	98	258
	C-9	**Linkert**	**71.6**	**73.5**	**44.0**	**90.4**	**-0.88**	**8.8**	**12.8**	**14.1**	**0.54**	**33.9**	**98**	**257**
	C-10	MN21172-3	73.2	75.2	45.7	90.1	-1.02	9.8	12.7	13.1	0.55	32.8	98	257
Havre	H-1	MT 21174	66.2	67.3	40.6	90.1	-0.53	9.3	12.6	16.9	0.55	46.9	93	255
	H-3	MT 21484	70.2	70.6	43.8	90.4	-0.76	9.5	13.3	16.3	0.50	43.7	97	252
	H-5	Dagmar	66.3	67.9	41.2	90.4	-0.61	8.9	13.0	16.4	0.48	44.7	96	259
	H-7	ND Stampede	67.2	68.1	41.5	90.8	-0.62	7.7	13.0	16.4	0.52	43.9	99	252
	H-11	**LCS Rebel**	**71.4**	**72.5**	**45.3**	**90.9**	**-0.83**	**8.8**	**12.6**	**16.8**	**0.50**	**42.9**	**99**	**250**
	H-12	MT 21487	70.7	71.3	43.2	90.1	-0.73	9.4	12.4	16.0	0.50	41.9	98	247
Crookston	K-2	AP Elevate	72.3	74.4	46.0	90.8	-1.48	10.9	12.6	13.1	0.52	34.1	98	247
	K-4	MN21089-4	72.6	74.5	47.2	90.2	-0.91	9.8	13.0	12.8	0.53	32.9	97	250
	K-6	AP Dagr	70.3	71.1	44.3	90.0	-0.84	9.3	13.0	11.2	0.54	24.2	99	253
	K-7	ND Stampede	67.3	68.6	43.2	90.5	-0.67	8.1	12.9	13.2	0.47	33.3	98	259
	K-8	AP Iconic	74.3	75.3	47.5	90.1	-1.39	11.4	12.8	12.6	0.53	30.6	98	251
	K-9	**Linkert**	**74.0**	**75.3**	**47.4**	**90.5**	**-0.75**	**8.4**	**12.2**	**13.7**	**0.54**	**32.3**	**99**	**255**
	K-10	MN21172-3	72.4	75.0	46.5	90.1	-0.90	9.7	12.7	13.2	0.52	33.8	97	256
Minot	M-1	MT 21174	69.7	71.8	43.8	89.3	-0.60	9.4	12.4	15.4	0.57	41.2	93	259
	M-2	AP Elevate	69.3	71.3	44.3	90.7	-1.46	10.5	12.7	15.2	0.53	41.4	94	259
	M-3	MT 21484	72.3	73.4	45.9	89.9	-0.89	9.7	12.7	12.7	0.52	31.7	99	254
	M-5	Dagmar	70.6	71.9	45.3	89.6	-0.54	9.2	13.4	15.8	0.50	41.1	96	250
	M-6	AP Dagr	69.4	70.2	44.9	90.1	-0.76	9.0	13.2	13.0	0.52	30.3	99	255
	M-7	ND Stampede	67.2	68.6	43.7	90.6	-0.65	7.7	13.1	14.5	0.45	36.9	99	259
	M-8	AP Iconic	70.6	72.3	46.0	90.5	-1.43	11.0	13.7	13.8	0.52	33.8	98	252
	M-11	**LCS Rebel**	**73.1**	**75.0**	**47.2**	**90.6**	**-0.83**	**8.6**	**12.4**	**13.8**	**0.50**	**34.4**	**99**	**246**
	M-12	MT 21487	71.4	72.0	45.9	90.2	-0.76	9.1	13.3	13.7	0.45	33.6	99	255

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

Farinograph Characteristics by Location

Location	ID	Entry	Water Absorption (%, 500 BU)	Water Absorption (%, 14% mb)	Arrival Time (min)	Peak Time (min)	Dough Stability (min)	MTI* (BU)	TTB* (min)
Casselton	C-2	AP Elevate	65.4	64.2	2.5	6.7	8.9	34	11.5
	C-4	MN21089-4	65.6	64.4	2.8	6.7	9.5	34	12.5
	C-6	AP Dagr	63.0	61.6	1.9	9.4	17.5	21	18.0
	C-7	ND Stampede	67.0	65.2	2.2	7.2	11.5	26	14.0
	C-8	AP Iconic	63.1	61.7	2.5	7.2	10.5	30	13.1
	C-9	**Linkert**	**65.7**	**64.3**	**3.6**	**9.3**	**23.1**	**14**	**29.1**
	C-10	MN21172-3	63.6	62.2	2.0	4.7	11.8	19	14.1
Havre	H-1	MT 21174	67.5	65.9	5.3	25.6	27.2	11	33.1
	H-3	MT 21484	67.1	66.3	7.0	29.1	26.8	27	34.6
	H-5	Dagmar	68.0	66.8	6.0	28.0	27.4	23	33.8
	H-7	ND Stampede	70.8	69.6	29.5	36.2	11.3	29	41.5
	H-11	**LCS Rebel**	**67.3**	**65.7**	**4.1**	**8.1**	**19.8**	**7**	**43.0**
	H-12	MT 21487	67.2	65.4	5.1	36.4	35.8	31	41.6
Crookston	K-2	AP Elevate	67.6	66.0	2.6	5.9	8.1	33	10.8
	K-4	MN21089-4	64.6	63.4	2.5	5.8	8.6	37	11.3
	K-6	AP Dagr	63.6	62.4	1.5	3.7	11.0	21	12.2
	K-7	ND Stampede	67.9	66.7	2.1	9.2	12.9	29	15.4
	K-8	AP Iconic	64.5	63.1	2.1	5.6	8.2	37	10.7
	K-9	**Linkert**	**66.6**	**64.6**	**2.4**	**7.0**	**13.1**	**25**	**15.5**
	K-10	MN21172-3	65.1	63.7	1.8	3.4	10.5	16	13.0
Minot	M-1	MT 21174	69.1	67.3	3.4	7.6	9.0	30	13.1
	M-2	AP Elevate	70.3	68.9	4.3	8.5	9.0	32	14.2
	M-3	MT 21484	66.0	64.6	2.3	4.4	10.8	20	13.0
	M-5	Dagmar	68.1	67.5	3.4	7.5	11.0	21	15.2
	M-6	AP Dagr	65.4	64.4	3.0	7.3	12.8	23	14.6
	M-7	ND Stampede	68.8	67.8	2.5	8.7	14.0	21	17.6
	M-8	AP Iconic	66.0	65.6	3.4	6.4	8.6	26	12.7
	M-11	**LCS Rebel**	**67.2**	**65.4**	**2.0**	**6.4**	**10.1**	**34**	**11.4**
	M-12	MT 21487	64.9	64.1	2.3	6.8	14.3	18	15.0

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

Mixograph Characteristics
by Location

Location	ID	Entry	Envelope Peak Time (min)	Envelope Peak Value (%)	Envelope Peak Width (%)	Midline Peak Time (min)	Midline Peak Value (%)	Midline Peak Width (%)	Midline Peak Integral (% TQ*min)
	C-2	AP Elevate	3.2	74.3	37.1	3.4	55.4	34.5	149.7
	C-4	MN21089-4	3.4	73.7	33.0	3.1	57.4	30.1	135.4
	C-6	AP Dagr	6.0	64.6	31.5	5.4	48.6	29.3	204.1
Casselton	C-7	ND Stampede	5.2	69.9	30.8	4.2	54.8	25.7	181.6
	C-8	AP Iconic	3.3	65.1	31.0	3.9	49.3	28.3	158.1
	C-9	**Linkert**	**4.3**	**75.4**	**34.7**	**4.6**	**57.2**	**33.4**	**198.7**
	C-10	MN21172-3	3.4	68.7	33.8	4.0	52.0	30.5	164.1
	H-1	MT 21174	3.2	80.6	37.9	3.5	61.4	34.2	156.3
	H-3	MT 21484	3.6	78.2	32.8	3.8	62.1	30.2	166.6
Havre	H-5	Dagmar	3.4	79.4	37.5	3.8	61.3	31.6	169.6
	H-7	ND Stampede	4.1	88.3	49.3	4.8	66.1	35.6	236.8
	H-11	**LCS Rebel**	**4.4**	**82.0**	**40.9**	**4.7**	**61.2**	**36.9**	**201.9**
	H-12	MT 21487	4.5	79.0	39.8	4.8	59.2	36.9	208.5
	K-2	AP Elevate	2.6	76.1	32.6	2.8	59.1	31.6	121.9
	K-4	MN21089-4	2.7	68.0	30.3	3.4	53.9	26.3	142.9
	K-6	AP Dagr	0.9	64.3	51.1	5.8	45.8	28.9	226.6
Crookston	K-7	ND Stampede	3.6	80.2	39.5	4.0	60.8	35.4	191.3
	K-8	AP Iconic	3.0	66.6	29.0	3.3	52.3	25.8	136.6
	K-9	**Linkert**	**4.8**	**74.4**	**35.3**	**4.4**	**57.0**	**30.0**	**189.2**
	K-10	MN21172-3	3.4	69.8	29.5	3.8	55.0	25.9	164.3
	M-1	MT 21174	2.4	83.4	39.4	2.7	62.9	34.1	127.1
	M-2	AP Elevate	2.4	84.1	40.1	2.6	64.2	37.1	127.4
	M-3	MT 21484	3.2	72.6	35.3	3.5	54.8	30.5	149.3
	M-5	Dagmar	2.8	82.3	40.2	3.1	62.3	36.6	146.0
Minot	M-6	AP Dagr	3.5	76.8	40.5	4.3	57.5	30.9	186.1
	M-7	ND Stampede	3.6	88.4	51.9	4.0	65.2	40.8	198.9
	M-8	AP Iconic	2.9	76.8	35.7	3.2	58.8	30.6	140.9
	M-11	**LCS Rebel**	**3.7**	**78.1**	**42.1**	**3.8**	**57.0**	**38.8**	**170.4**
	M-12	MT 21487	4.2	71.4	36.4	4.7	53.1	31.0	198.4

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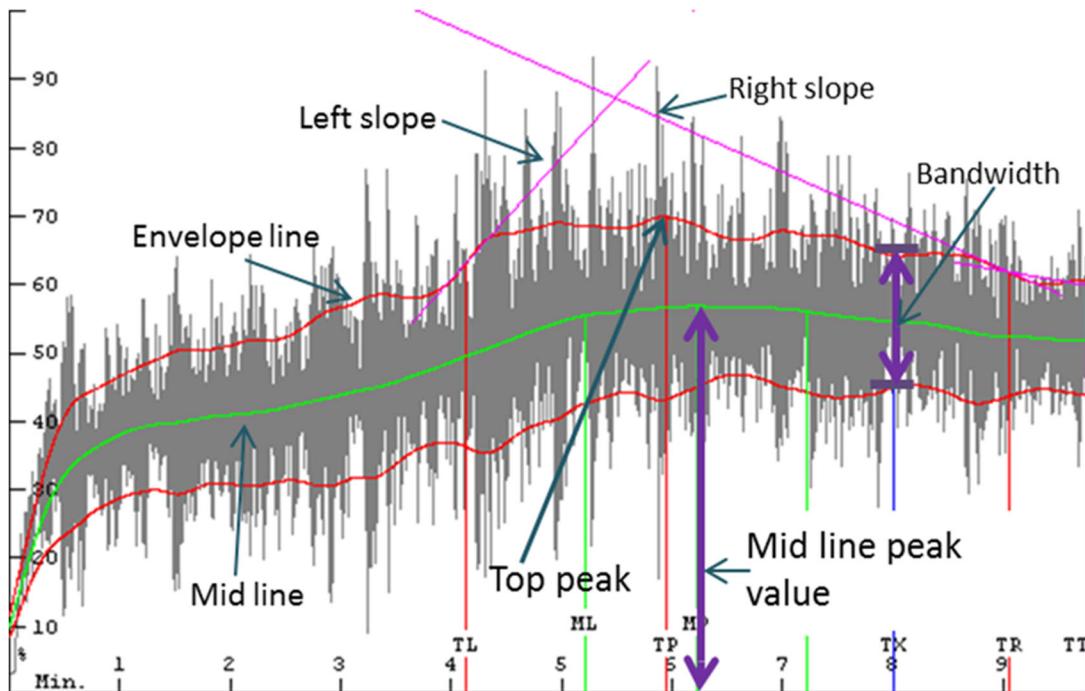
Among the numbers on the previous page, the time to peak (maximum mixing resistance) for both the top of the envelope and midline is shown, including envelope and midline % of full value. These values are traditionally the most meaningful. A midline peak time around 3-5 minutes and 60% scale are usually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

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

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

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

GlutoPeak Characteristics
by Location

Location	ID	Entry	AM (GPU)	PM (GPU)	BEM (GPU)	PMT (s)	Aggregation Energy (cm²)
Casselton	C-2	AP Elevate	58	51	61	71	1744
	C-4	MN21089-4	56	58	61	70	1765
	C-6	AP Dagr	56	50	60	119	1690
	C-7	ND Stampede	60	58	67	68	1922
	C-8	AP Iconic	55	48	57	79	1641
	C-9	**Linkert**	**58**	**63**	**61**	**76**	**1811**
	C-10	MN21172-3	58	53	62	73	1775
Havre	H-1	MT 21174	68	62	76	78	2084
	H-3	MT 21484	68	61	73	88	2054
	H-5	Dagmar	71	64	80	76	2198
	H-7	ND Stampede	72	69	83	77	2330
	H-11	**LCS Rebel**	**67**	**61**	**71**	**117**	**2005**
	H-12	MT 21487	62	68	69	91	2016
Crookston	K-2	AP Elevate	59	62	63	58	1854
	K-4	MN21089-4	60	53	65	76	1778
	K-6	AP Dagr	55	47	57	115	1633
	K-7	ND Stampede	68	61	73	73	2049
	K-8	AP Iconic	57	49	59	77	1665
	K-9	**Linkert**	**62**	**56**	**65**	**88**	**1849**
	K-10	MN21172-3	62	55	66	72	1829
Minot	M-1	MT 21174	68	60	72	68	2041
	M-2	AP Elevate	60	62	66	62	1896
	M-3	MT 21484	60	55	67	69	1845
	M-5	Dagmar	69	63	74	81	2080
	M-6	AP Dagr	59	57	64	95	1841
	M-7	ND Stampede	71	63	74	83	2093
	M-8	AP Iconic	60	55	62	70	1832
	M-11	**LCS Rebel**	**62**	**60**	**62**	**77**	**1835**
	M-12	MT 21487	59	61	63	91	1831

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

Extensograph Characteristics by Location

			45 Minutes Resting					
Location	ID	Entry	Energy (cm²)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
Casselton	C-2	AP Elevate	48	165	151	240	1.1	1.6
	C-4	MN21089-4	40	148	146	207	1.0	1.4
	C-6	AP Dagr	74	301	131	477	2.3	3.6
	C-7	ND Stampede	69	210	155	361	1.4	2.3
	C-8	AP Iconic	55	190	147	293	1.3	2.0
	C-9	**Linkert**	**74**	**219**	**162**	**360**	**1.4**	**2.2**
	C-10	MN21172-3	63	195	161	303	1.2	1.9
Havre	H-1	MT 21174	68	205	165	319	1.2	1.9
	H-3	MT 21484	80	250	167	365	1.5	2.2
	H-5	Dagmar	76	221	165	357	1.3	2.2
	H-7	ND Stampede	102	276	172	481	1.6	2.8
	H-11	**LCS Rebel**	**99**	**261**	**171**	**472**	**1.5**	**2.8**
	H-12	MT 21487	104	254	181	462	1.4	2.6
Crookston	K-2	AP Elevate	49	162	154	244	1.1	1.6
	K-4	MN21089-4	41	153	146	205	1.1	1.4
	K-6	AP Dagr	61	331	114	429	2.9	3.8
	K-7	ND Stampede	74	204	170	347	1.2	2.0
	K-8	AP Iconic	59	191	160	280	1.2	1.8
	K-9	**Linkert**	**75**	**231**	**155**	**392**	**1.5**	**2.5**
	K-10	MN21172-3	55	199	145	299	1.4	2.1
Minot	M-1	MT 21174	45	142	168	190	0.8	1.1
	M-2	AP Elevate	62	128	212	214	0.6	1.0
	M-3	MT 21484	58	179	162	277	1.1	1.7
	M-5	Dagmar	61	171	172	270	1.0	1.6
	M-6	AP Dagr	74	252	148	410	1.7	2.8
	M-7	ND Stampede	79	203	170	381	1.2	2.2
	M-8	AP Iconic	58	167	168	262	1.0	1.6
	M-11	**LCS Rebel**	**68**	**189**	**171**	**314**	**1.1**	**1.8**
	M-12	MT 21487	73	241	149	401	1.6	2.7

Location	ID	Entry	Energy (cm²)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
					90 Minutes Resting			
Casselton	C-2	AP Elevate	71	339	129	418	2.6	3.3
	C-4	MN21089-4	64	276	137	364	2.0	2.7
	C-6	AP Dagr	62	688	75	702	9.2	9.3
	C-7	ND Stampede	98	489	132	561	3.7	4.3
	C-8	AP Iconic	72	346	124	469	2.8	3.8
	C-9	**Linkert**	**98**	**455**	**136**	**536**	**3.4**	**3.9**
	C-10	MN21172-3	69	325	127	432	2.6	3.4
Havre	H-1	MT 21174	101	306	165	486	1.9	3.0
	H-3	MT 21484	113	427	150	576	2.9	3.9
	H-5	Dagmar	126	435	157	627	2.8	4.0
	H-7	ND Stampede	123	587	134	687	4.4	5.1
	H-11	**LCS Rebel**	**137**	**541**	**147**	**710**	**3.7**	**4.8**
	H-12	MT 21487	134	474	149	717	3.2	4.8
Crookston	K-2	AP Elevate	73	262	149	375	1.8	2.5
	K-4	MN21089-4	55	217	139	314	1.6	2.3
	K-6	AP Dagr	50	495	63	723	7.9	11.5
	K-7	ND Stampede	100	414	151	484	2.8	3.2
	K-8	AP Iconic	62	324	117	436	2.8	3.7
	K-9	**Linkert**	**74**	**413**	**112**	**557**	**3.7**	**5.0**
	K-10	MN21172-3	66	380	111	478	3.4	4.3
Minot	M-1	MT 21174	64	211	160	300	1.3	1.9
	M-2	AP Elevate	78	170	202	290	0.8	1.4
	M-3	MT 21484	85	425	129	505	3.3	3.9
	M-5	Dagmar	96	338	154	470	2.2	3.1
	M-6	AP Dagr	80	667	91	703	7.3	7.7
	M-7	ND Stampede	107	460	137	609	3.4	4.5
	M-8	AP Iconic	91	342	147	463	2.3	3.1
	M-11	**LCS Rebel**	**83**	**378**	**129**	**506**	**2.9**	**3.9**
	M-12	MT 21487	105	576	119	704	4.9	5.9

Location	ID	Entry	Energy (cm²)	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
					135 Minutes Resting				
Casselton	C-2	AP Elevate	68	493	103	500	4.8	4.9
	C-4	MN21089-4	70	462	106	502	4.4	4.7
	C-6	AP Dagr	58	740	62	790	11.9	12.7
	C-7	ND Stampede	84	512	115	577	4.5	5.0
	C-8	AP Iconic	69	562	94	563	6.0	6.0
	C-9	**Linkert**	**86**	**559**	**108**	**619**	**5.2**	**5.7**
	C-10	MN21172-3	76	454	119	490	3.8	4.1
Havre	H-1	MT 21174	107	383	150	550	2.6	3.7
	H-3	MT 21484	104	512	130	589	4.0	4.6
	H-5	Dagmar	113	569	129	686	4.4	5.3
	H-7	ND Stampede	111	670	115	764	5.8	6.6
	H-11	**LCS Rebel**	**115**	**627**	**118**	**757**	**5.3**	**6.4**
	H-12	MT 21487	122	686	119	784	5.8	6.6
Crookston	K-2	AP Elevate	79	339	146	385	2.3	2.6
	K-4	MN21089-4	64	338	124	382	2.7	3.1
	K-6	AP Dagr	37	132	53	618	2.5	11.7
	K-7	ND Stampede	92	495	125	547	4.0	4.4
	K-8	AP Iconic	72	459	108.1	508	4.2	4.7
	K-9	**Linkert**	**81**	**546**	**103**	**642**	**5.3**	**6.3**
	K-10	MN21172-3	68	493	100	535	4.9	5.3
Minot	M-1	MT 21174	63	216	152	319	1.4	2.1
	M-2	AP Elevate	67	181	175	292	1.0	1.7
	M-3	MT 21484	66	550	91	566	6.1	6.2
	M-5	Dagmar	101	370	152	505	2.4	3.3
	M-6	AP Dagr	68	773	75	778	10.3	10.4
	M-7	ND Stampede	112	550	135	639	4.1	4.8
	M-8	AP Iconic	78	499	107	556	4.7	5.2
	M-11	**LCS Rebel**	**78**	**509**	**107**	**566**	**4.8**	**5.3**
	M-12	MT 21487	97	848	91	856	9.3	9.4

Ash Content in Mill Streams

Linkert Check – Casselton (C-9)
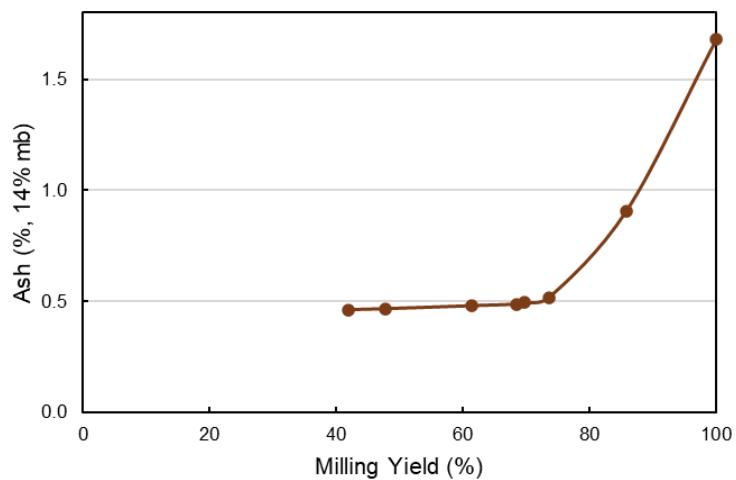
Mill Stream	Stream (%, 14% mb)		Cumulative (%, 14% mb)	
	Yield	Ash	Yield	Ash
Straight Grade:				
1 R	41.9	0.46	41.9	0.46
1 Bk	5.8	0.50	47.7	0.47
2 R	13.5	0.53	61.3	0.48
2 Bk	7.1	0.55	68.4	0.49
3 Bk	1.3	0.91	69.7	0.49
3 R	3.9	0.92	73.5	0.52
Bran & Shorts:				
Shorts	12.3	3.26	85.8	0.91
Bran	14.2	6.36	100.0	1.68
Straight Grade		**0.54**		
Wheat		**1.62**		

Cooperators' Bake Data

Linkert Checks

CASSELTON (C-9)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	60.0	3050	5	5
B	66.0	2937	7	7
C	69.5	887	6	6
D	69.3	935	7	6
E	64.0	850	5	6
F	68.7	2421	7	6
G	66.3	2575	9	7
H	68.1	1040	5	7
I	66.3	1815	5	5
J	68.3	2404	7	6
Avg.	66.7		6.3	6.1
S.D.	2.9		1.3	0.7

CROOKSTON (K-9)				
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	60.0	3200	7	5
B	66.0	2952	7	7
C	69.4	853	6	6
D	69.6	875	8	6
E	64.0	800	6	7
F	69.6	2308	5	5
G	66.6	2825	9	7
H	69.5	1005	7	7
I	66.6	1925	5	7
J	69.7	2410	7	6
Avg.	67.1		6.7	6.3
S.D.	3.2		1.3	0.8

LCS Rebel Checks

| | | HAVRE (H-11) | | |
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	63.0	3125	9	9
B	66.0	2997	9	9
C	70.6	940	6	5
D	72.9	985	9	9
E	68.0	925	5	5
F	70.3	2213	6	6
G	67.7	2675	9	9
H	70.9	1125	5	8
I	67.7	1833	7	9
J	73.3	2460	9	8
Avg.	69.0		7.4	7.7
S.D.	3.2		1.8	1.7

| | | MINOT (M-11) | | |
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Mixing Requirement	Dough Characteristics
A	60.0	2800	5	5
B	67.0	2877	7	7
C	70.3	849	6	6
D	69.8	810	7	7
E	64.0	875	5	6
F	70.2	2142	5	7
G	67.4	2550	7	7
H	73.0	1060	6	8
I	67.4	1885	5	5
J	69.7	2387	6	7
Avg.	67.9		5.9	6.5
S.D.	3.7		0.9	1.0

SWQC #1 – MT 21174

	HAVRE (H-1)											
	Bake	Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
	Absorption			Mixing	Dough	Mixing	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
Cooperator	(%)	(mL)	(% of Check)	Requirement	Characteristics	Tolerance						
A	63.0	2950	94.4	7	5	3	5	5	5	5	7	7
B	66.0	2817	94.0	9	9	5	5	3	5	5	3	5
C	71.1	889	94.6	4	5	4	5	4	5	3	3	4
D	73.0	1065	108.1	5	5	3	8	3	5	1	6	5
E	68.0	975	105.4	4	6	6	4	4	5	4	4	4
F	70.5	2372	107.2	7	7	7	5	5	5	3	5	5
G	67.9	2750	102.8	9	7	5	5	3	5	5	5	5
H	71.1	1110	98.7	4	7	8	6	6	5	3	6	6
I	67.9	1860	101.5	5	7	8	3	2	5	1	4	4
J	72.4	2519	102.4	9	7	4	5	5	5	1	6	4
Avg.	69.1		100.9	6.3	6.5	5.3	5.1	4.0	5.0	3.1	4.9	4.9
S.D.	3.1		5.3	2.2	1.3	1.9	1.3	1.2	0.0	1.7	1.4	1.0

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	MINOT (M-1)											
	Bake	Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
	Absorption			Mixing	Dough	Mixing	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
Cooperator	(%)	(mL)	(% of Check)	Requirement	Characteristics	Tolerance						
A	61.0	2600	92.9	5	5	5	5	7	7	5	5	5
B	68.0	2607	90.6	7	7	7	3	3	7	3	3	1
C	72.3	969	114.1	4	6	5	5	6	6	3	7	5
D	71.8	980	121.0	4	4	3	5	4	8	2	6	6
E	68.0	900	102.9	3	5	5	5	3	7	4	5	5
F	72.1	2002	93.5	5	5	4	3	4	6	4	4	3
G	69.3	2675	104.9	3	7	3	3	3	7	3	7	5
H	74.0	1110	104.7	3	5	4	6	6	6	3	6	6
I	69.3	1662	88.2	4	5	5	3	7	3	1	6	5
J	74.0	2178	91.2	7	6	6	3	3	7	3	1	4
Avg.	70.0		100.4	4.5	5.5	4.7	4.1	4.6	6.4	3.1	5.0	4.5
S.D.	3.9		11.0	1.5	1.0	1.3	1.2	1.7	1.3	1.1	1.9	1.5

SWQC #2 – AP Elevate

CASSELTON (C-2)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	58.0	2750	90.2	5	5	5	7	3	5	5	3	3
B	66.0	2787	94.9	3	5	3	3	3	3	5	1	1
C	69.4	858	96.7	5	6	5	4	6	4	3	4	4
D	66.3	905	96.8	5	6	5	2	3	2	5	3	3
E	62.0	850	100.0	3	5	6	3	4	3	5	3	4
F	68.4	2246	92.8	5	6	3	3	4	4	5	5	4
G	66.2	2800	108.7	5	7	3	3	7	3	5	7	5
H	67.8	985	94.7	4	9	3	3	3	3	5	3	3
I	66.2	1860	102.5	5	5	1	7	5	3	5	5	4
J	67.9	2423	100.8	6	3	3	5	6	5	7	5	6
Avg.	65.8		97.8	4.6	5.7	3.7	4.0	4.4	3.5	5.0	3.9	3.7
S.D.	3.4		5.4	1.0	1.6	1.5	1.8	1.5	1.0	0.9	1.7	1.3

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CROOKSTON (K-2)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2875	89.8	7	1	3	7	5	5	5	3	3
B	67.0	2952	100.0	5	5	3	3	5	5	5	5	5
C	71.1	865	101.4	5	7	6	4	6	5	2	7	5
D	67.1	930	106.3	5	6	4	1	5	4	4	5	5
E	64.0	825	103.1	3	7	5	4	3	4	4	4	4
F	70.6	2291	99.3	5	6	3	3	5	4	4	5	4
G	68.0	2825	100.0	3	5	1	7	3	5	5	5	3
H	71.2	1080	107.5	4	3	3	6	7	4	4	6	4
I	68.0	1794	93.2	4	5	3	7	4	5	5	4	5
J	68.9	2429	100.8	6	5	3	4	7	4	3	5	4
Avg.	67.5		100.1	4.7	5.0	3.4	4.6	5.0	4.5	4.1	4.9	4.2
S.D.	3.7		5.3	1.3	1.8	1.3	2.1	1.4	0.5	1.0	1.1	0.8

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2775	99.1	5	7	5	7	5	7	5	5	5
B	69.0	2907	101.0	7	7	5	3	5	7	3	7	7
C	74.1	956	112.6	4	7	6	5	4	6	1	7	5
D	72.1	975	120.4	5	7	3	1	7	7	2	7	6
E	68.0	1000	114.3	3	4	5	4	4	7	5	6	5
F	73.3	2317	108.2	6	5	3	3	5	6	4	6	5
G	70.9	2800	109.8	9	7	5	7	5	5	5	7	7
H	74.9	1150	108.5	3	8	4	3	6	6	3	6	6
I	70.9	1681	89.2	5	5	5	5	8	7	3	7	7
J	74.6	2372	99.4	6	3	5	3	3	7	3	5	5
Avg.	70.9		106.2	5.3	6.0	4.6	4.1	5.2	6.5	3.4	6.3	5.8
S.D.	4.2		9.1	1.8	1.6	1.0	1.9	1.5	0.7	1.3	0.8	0.9

MINOT (M-2)

Quality Score Compared to Check (LCS Rebel)

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SWQC #3 – MT 21484

		HAVRE (H-3)										
	Bake	Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
	Absorption			Mixing	Dough	Mixing	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
Cooperator	(%)	(mL)	(% of Check)	Requirement	Characteristics	Tolerance						
A	62.0	2925	93.6	7	7	5	5	5	5	5	7	7
B	67.0	3027	101.0	9	9	5	5	5	5	5	7	7
C	71.1	848	90.2	5	7	6	5	6	5	5	7	6
D	73.7	885	89.8	6	8	5	5	3	5	2	4	4
E	62.0	975	105.4	4	7	6	5	4	4	5	4	5
F	70.1	2397	108.3	8	6	6	5	6	4	5	5	5
G	68.3	2625	98.1	9	7	5	3	3	5	5	5	5
H	70.2	1075	95.6	5	7	8	4	6	5	5	4	4
I	68.3	1734	94.6	5	5	7	4	5	7	5	4	5
J	72.7	2384	96.9	9	6	3	5	5	5	4	4	5
Avg.	68.5		97.4	6.7	6.9	5.6	4.6	4.8	5.0	4.6	5.1	5.3
S.D.	4.0		6.1	1.9	1.1	1.3	0.7	1.1	0.8	1.0	1.4	1.1

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		MINOT (M-3)										
	Bake	Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
	Absorption			Mixing	Dough	Mixing	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
Cooperator	(%)	(mL)	(% of Check)	Requirement	Characteristics	Tolerance						
A	59.0	2525	90.2	5	5	5	5	7	5	5	5	5
B	66.0	2847	99.0	7	7	7	3	5	3	5	5	5
C	69.5	840	98.9	6	6	6	5	4	4	6	6	5
D	68.1	885	109.3	6	5	3	3	5	2	4	5	5
E	64.0	775	88.6	4	7	6	4	5	4	4	4	5
F	69.0	2027	94.6	4	3	3	4	4	3	5	4	4
G	66.6	2550	100.0	5	7	3	5	5	3	5	5	5
H	71.6	960	90.6	5	7	5	4	5	3	4	4	4
I	66.6	1629	86.4	5	7	7	5	6	3	5	5	5
J	66.0	2153	90.2	4	5	3	4	4	3	5	1	3
Avg.	66.6		94.8	5.1	5.9	4.8	4.2	5.0	3.3	4.8	4.4	4.6
S.D.	3.4		7.0	1.0	1.4	1.7	0.8	0.9	0.8	0.6	1.3	0.7

SWQC #4 – MN21089-4

CASSELTON (C-4)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2825	92.6	5	5	5	5	3	5	5	3	3
B	65.0	2922	99.5	3	5	3	3	3	5	5	3	3
C	69.4	863	97.3	4	7	5	5	5	5	3	4	4
D	68.4	910	97.3	5	5	5	3	4	4	4	4	4
E	63.0	775	91.2	3	5	6	4	4	4	5	4	5
F	68.6	2192	90.5	5	5	3	4	4	4	5	4	3
G	66.4	2575	100.0	3	5	3	5	7	3	5	7	5
H	68.0	1050	101.0	3	4	3	2	3	5	4	4	4
I	66.4	1841	101.4	5	5	1	7	8	7	7	8	6
J	68.6	2318	96.4	6	4	3	5	5	3	4	4	4
Avg.	66.3		96.7	4.2	5.0	3.7	4.3	4.6	4.5	4.7	4.5	4.1
S.D.	3.2		4.0	1.1	0.8	1.5	1.4	1.7	1.2	1.1	1.6	1.0

CROOKSTON (K-4)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2775	86.7	5	1	3	5	5	5	5	3	3
B	64.0	2892	98.0	5	7	3	3	5	5	5	3	5
C	68.3	809	94.8	5	6	5	5	7	5	3	6	5
D	66.5	825	94.3	5	6	4	3	4	3	4	4	4
E	63.0	825	103.1	5	5	6	4	5	3	5	5	5
F	67.6	2279	98.7	5	5	3	4	4	5	5	5	5
G	65.4	2650	93.8	3	5	3	5	3	5	5	5	3
H	67.9	985	98.0	4	3	3	6	6	3	4	5	4
I	65.4	1898	98.6	4	6	3	7	4	5	5	4	5
J	67.0	2305	95.6	5	6	2	5	6	3	3	4	3
Avg.	65.4		96.2	4.6	5.0	3.5	4.7	4.9	4.2	4.4	4.4	4.2
S.D.	2.8		4.3	0.7	1.8	1.2	1.3	1.2	1.0	0.8	1.0	0.9

The Quality Score columns (Mixing Tolerance, Internal Crumb Color, Internal Grain & Texture, Protein, Milling, Baking, Overall) are Quality Scores Compared to Check (Linkert).

SWQC #5 – Dagmar

HAVRE (H-5)												
	Bake	Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
	Absorption			Mixing	Dough	Mixing	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
Cooperator	(%)	(mL)	(% of Check)	Requirement	Characteristics	Tolerance						
A	62.0	2750	88.0	7	5	3	5	5	5	5	7	7
B	68.0	2952	98.5	9	9	5	5	3	5	5	5	5
C	71.8	851	90.5	5	6	5	5	4	5	4	6	5
D	73.4	975	99.0	6	6	7	8	3	5	1	5	5
E	68.0	1025	110.8	5	5	5	5	4	4	4	5	4
F	71.0	2348	106.1	7	6	6	6	6	5	4	4	5
G	68.8	2700	100.9	9	9	5	3	5	5	5	5	5
H	71.3	1120	99.6	5	6	8	5	5	5	3	6	6
I	68.8	1726	94.2	5	5	7	4	5	3	1	4	4
J	73.6	2376	96.6	9	5	4	7	4	5	1	4	3
Avg.	69.7		98.4	6.7	6.2	5.5	5.3	4.4	4.7	3.3	5.1	4.9
S.D.	3.4		6.8	1.8	1.5	1.5	1.4	1.0	0.7	1.7	1.0	1.1

MINOT (M-5)												
	Bake	Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
	Absorption			Mixing	Dough	Mixing	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
Cooperator	(%)	(mL)	(% of Check)	Requirement	Characteristics	Tolerance						
A	62.0	2650	94.6	5	7	5	5	5	7	5	5	5
B	68.0	2862	99.5	7	7	7	3	5	7	5	5	5
C	72.5	949	111.8	5	6	5	5	6	6	4	8	6
D	71.8	1015	125.3	5	5	5	7	4	9	2	7	7
E	69.0	1000	114.3	3	5	5	6	5	7	5	6	6
F	71.1	2092	97.7	5	6	4	5	5	7	5	5	5
G	69.5	2525	99.0	7	7	3	5	3	7	5	5	5
H	72.1	1100	103.8	4	7	6	5	4	7	3	4	4
I	69.5	1753	93.0	5	5	7	3	4	6	3	4	5
J	68.1	2527	105.9	6	5	5	4	4	9	3	9	7
Avg.	69.4		104.5	5.2	6.0	5.2	4.8	4.5	7.2	4.0	5.8	5.5
S.D.	3.1		10.1	1.2	0.9	1.2	1.2	0.8	1.0	1.2	1.7	1.0

SWQC #6 – AP Dagr

CASSELTON (C-6)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2725	89.3	5	5	5	5	5	5	5	5	5
B	65.0	2892	98.5	7	7	5	3	3	3	3	3	5
C	66.5	818	92.2	8	6	7	5	4	4	1	5	3
D	68.2	795	85.0	9	7	5	4	5	3	3	3	3
E	63.0	775	91.2	6	7	6	5	4	3	4	4	4
F	66.0	2347	96.9	7	6	5	4	4	4	4	4	4
G	63.6	2550	99.0	9	7	5	5	7	3	5	7	7
H	66.5	975	93.8	8	9	4	4	4	4	5	3	3
I	63.6	1973	108.7	7	7	3	5	5	5	3	6	5
J	67.1	2289	95.2	7	7	6	4	4	3	5	1	3
Avg.	64.9		95.0	7.3	6.8	5.1	4.4	4.5	3.7	3.8	4.1	4.2
S.D.	2.7		6.5	1.3	1.0	1.1	0.7	1.1	0.8	1.3	1.7	1.3

CROOKSTON (K-6)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	57.0	2625	82.0	9	5	5	5	5	3	5	5	5
B	64.0	2892	98.0	5	5	3	3	3	3	5	3	5
C	67.3	692	81.1	9	9	9	5	4	4	1	8	4
D	65.5	680	77.7	8	5	4	3	4	1	1	2	2
E	61.0	600	75.0	7	8	4	3	4	2	3	5	4
F	66.6	2022	87.6	3	3	3	4	4	3	4	2	3
G	64.4	2250	79.6	7	7	3	5	3	3	5	1	3
H	67.9	870	86.6	9	8	4	6	5	1	3	4	2
I	64.4	1741	90.4	5	7	5	5	7	1	1	7	5
J	66.6	2119	87.9	6	6	3	4	5	1	2	2	2
Avg.	64.5		84.6	6.8	6.3	4.3	4.3	4.4	2.2	3.0	3.9	3.5
S.D.	3.3		6.8	2.0	1.8	1.8	1.1	1.2	1.1	1.7	2.3	1.3

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
						Quality Score Compared to Check (LCS Rebel)						
A	59.0	2625	93.8	5	7	5	5	7	5	5	5	5
B	66.0	3072	106.8	7	7	7	3	7	3	3	7	7
C	69.6	788	92.8	7	7	7	5	7	5	2	8	5
D	68.7	755	93.2	8	7	7	5	4	3	1	4	4
E	65.0	775	88.6	6	6	5	5	8	4	4	4	5
F	68.4	2284	106.6	5	7	5	6	4	5	4	4	4
G	66.4	2425	95.1	9	7	7	7	5	5	5	3	7
H	70.6	930	87.7	8	3	6	4	5	3	3	3	3
I	66.4	1859	98.6	5	7	7	7	4	5	3	4	5
J	65.4	2303	96.5	5	7	4	5	7	4	3	5	4
Avg.	66.6		96.0	6.5	6.5	6.0	5.2	5.8	4.2	3.3	4.7	4.9
S.D.	3.2		6.5	1.5	1.3	1.2	1.2	1.5	0.9	1.3	1.6	1.3

MINOT (M-6)

SWQC #7 – ND Stampede

CASSELTON (C-7)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
								Quality Score Compared to Check (Linkert)				
A	59.0	2750	90.2	5	5	5	5	5	5	5	5	5
B	67.0	2892	98.5	7	5	5	3	3	3	3	3	5
C	70.3	877	98.9	6	5	5	5	5	4	2	4	3
D	68.8	855	91.4	6	6	7	5	4	3	2	4	4
E	63.0	825	97.1	5	7	5	7	7	3	4	4	5
F	70.0	2129	87.9	5	4	3	4	4	4	4	5	4
G	67.2	2575	100.0	5	7	3	5	5	3	3	5	5
H	70.8	1020	98.1	6	5	3	5	4	4	4	5	4
I	67.2	1830	100.8	6	7	1	5	8	3	3	7	5
J	71.0	2188	91.0	6	3	3	4	6	3	3	1	2
Avg.	67.4		95.4	5.7	5.4	4.0	4.8	5.1	3.5	3.3	4.3	4.2
S.D.	3.8		4.7	0.7	1.3	1.7	1.0	1.5	0.7	0.9	1.6	1.0

HAVRE (H-7)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
								Quality Score Compared to Check (LCS Rebel)				
A	62.0	2925	93.6	9	9	5	5	5	5	5	5	5
B	70.0	2967	99.0	9	9	5	5	5	5	5	5	5
C	74.4	848	90.2	6	7	6	5	3	5	2	7	5
D	78.2	1030	104.6	8	7	7	8	2	5	1	6	5
E	62.0	950	102.7	5	8	5	7	4	4	4	5	5
F	73.8	2326	105.1	9	7	6	6	6	4	5	5	6
G	71.6	2650	99.1	9	9	5	5	5	5	7	5	7
H	74.2	1080	96.0	6	8	3	4	4	4	4	5	4
I	71.6	1662	90.7	7	5	3	3	6	3	1	5	4
J	70.0	2527	102.7	9	7	5	5	4	5	2	7	4
Avg.	70.8		98.4	7.7	7.6	5.0	5.3	4.4	4.5	3.6	5.5	5.0
S.D.	5.2		5.5	1.6	1.3	1.2	1.4	1.3	0.7	2.0	0.8	0.9

CROOKSTON (K-7)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2925	91.4	9	5	5	5	5	5	5	5	5
B	68.0	2907	98.5	7	5	5	3	5	5	5	5	5
C	71.9	865	101.4	5	6	5	5	5	5	1	7	4
D	70.5	880	100.6	6	6	5	7	6	4	1	5	5
E	65.0	850	106.3	5	6	3	7	3	4	4	4	4
F	70.9	2323	100.6	6	5	4	5	5	5	3	6	6
G	68.7	2625	92.9	5	7	3	5	5	5	5	5	5
H	71.3	1110	110.4	5	6	5	7	6	5	2	7	6
I	68.7	1708	88.7	4	5	5	7	8	5	1	7	5
J	71.1	2221	92.2	7	5	5	5	7	4	1	3	3
Avg.	68.5		98.3	5.9	5.6	4.5	5.6	5.5	4.7	2.8	5.4	4.8
S.D.	3.9		7.0	1.4	0.7	0.8	1.3	1.4	0.5	1.8	1.3	0.9

Quality Score Compared to Check (Linkert)

MINOT (M-7)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2525	90.2	5	5	5	5	7	5	5	5	5
B	69.0	2727	94.8	7	7	7	5	5	5	3	3	1
C	72.8	906	106.7	6	7	6	5	5	5	1	8	5
D	73.5	870	107.4	6	6	7	7	5	7	1	6	6
E	67.0	925	105.7	5	6	4	7	5	6	4	6	5
F	71.8	2116	98.8	6	7	5	5	4	5	4	3	3
G	69.8	2600	102.0	9	7	7	7	5	5	5	7	7
H	73.1	1080	101.9	6	9	6	5	5	6	2	5	5
I	69.8	1806	95.8	5	7	8	7	3	7	4	3	5
J	68.9	2361	98.9	7	6	6	5	7	6	1	5	4
Avg.	69.6		100.2	6.2	6.7	6.1	5.8	5.1	5.7	3.0	5.1	4.6
S.D.	4.0		5.6	1.2	1.1	1.2	1.0	1.2	0.8	1.6	1.7	1.6

Quality Score Compared to Check (LCS Rebel)

SWQC #8 – AP Iconic

CASSELTON (C-8)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	58.0	2875	94.3	5	5	5	7	5	5	5	5	5
B	64.0	3027	103.1	7	5	5	3	3	3	3	5	5
C	66.9	875	98.6	5	5	5	4	6	4	1	3	3
D	67.2	900	96.3	6	6	5	2	5	2	4	3	4
E	62.0	825	97.1	5	6	5	4	4	3	4	4	4
F	66.1	2446	101.0	5	5	4	4	5	3	5	5	5
G	63.7	2675	103.9	5	5	3	7	7	1	5	7	5
H	66.5	1010	97.1	6	5	3	1	2	3	4	2	2
I	63.7	1996	110.0	5	5	1	7	8	1	1	8	4
J	67.0	2406	100.1	6	6	4	5	5	3	4	5	4
Avg.	64.5		100.1	5.5	5.3	4.0	4.4	5.0	2.8	3.6	4.7	4.1
S.D.	2.9		4.6	0.7	0.5	1.3	2.1	1.8	1.2	1.5	1.8	1.0

CROOKSTON (K-8)

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	3075	96.1	5	1	3	7	5	5	5	3	3
B	65.0	3087	104.6	7	5	5	3	3	3	5	5	5
C	67.9	833	97.7	6	6	6	5	6	5	1	7	4
D	67.2	830	94.9	6	7	5	3	5	2	5	4	4
E	63.0	850	106.3	5	5	5	3	2	3	4	5	4
F	67.5	2349	101.8	5	4	3	4	4	4	4	5	5
G	65.1	2850	100.9	7	5	3	5	3	5	3	5	5
H	68.9	1045	104.0	6	5	3	5	5	3	5	4	4
I	65.1	1970	102.3	4	5	3	5	7	3	7	8	5
J	67.4	2533	105.1	6	3	3	5	6	3	5	7	5
Avg.	65.6		101.4	5.7	4.6	3.9	4.5	4.6	3.6	4.4	5.3	4.4
S.D.	2.9		3.9	0.9	1.6	1.2	1.3	1.6	1.1	1.6	1.6	0.7

Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
MINOT (M-8)												
						Quality Score Compared to Check (LCS Rebel)						
A	60.0	2725	97.3	5	5	5	7	7	5	5	5	5
B	66.0	3072	106.8	7	7	7	3	5	5	5	7	7
C	70.7	902	106.2	5	7	6	5	5	5	1	7	4
D	66.9	880	108.6	6	7	3	3	6	5	3	6	5
E	66.0	925	105.7	5	5	5	4	3	5	5	5	5
F	69.0	2291	107.0	5	6	3	4	5	5	4	5	4
G	67.6	3000	117.6	5	5	3	3	7	5	3	7	5
H	69.7	1025	96.7	5	9	4	3	6	5	3	3	3
I	67.6	1952	103.6	5	5	4	7	1	5	5	2	3
J	66.0	2473	103.6	5	5	4	4	4	5	3	7	5
Avg.	**67.0**		**105.3**	**5.3**	**6.1**	**4.4**	**4.3**	**4.9**	**5.0**	**3.7**	**5.4**	**4.6**
S.D.	**2.9**		**5.9**	**0.7**	**1.4**	**1.3**	**1.6**	**1.9**	**0.0**	**1.3**	**1.8**	**1.2**

SWQC #10 – MN21172-3

| CASSELTON (C-10) | | | | | | | | | | | |
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2975	97.5	5	3	5	5	3	5	5	3	3
B	64.0	2952	100.5	3	7	3	3	3	3	5	5	3
C	67.0	847	95.5	5	6	5	5	7	4	5	4	4
D	67.1	905	96.8	5	7	3	3	4	3	7	4	4
E	63.0	800	94.1	3	6	7	5	4	4	6	3	5
F	66.6	2269	93.7	3	4	2	5	5	4	6	4	4
G	64.2	2775	107.8	3	5	3	7	7	3	5	7	5
H	67.1	980	94.2	5	4	3	4	4	4	6	3	3
I	64.2	1859	102.4	5	6	3	5	3	7	7	3	5
J	66.9	2391	99.5	3	3	1	5	6	4	7	4	5
Avg.	64.9		98.2	4.0	5.1	3.5	4.7	4.6	4.1	5.9	4.0	4.1
S.D.	2.6		4.5	1.1	1.5	1.7	1.2	1.6	1.2	0.9	1.2	0.9

| CROOKSTON (K-10) | | | | | | | | | | | |
Cooperator	Bake Absorption (%)	Loaf Volume (mL)	Loaf Volume (% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	3050	95.3	7	1	3	5	5	5	5	3	3
B	65.0	2952	100.0	7	5	5	3	5	5	5	5	5
C	68.5	809	94.8	5	9	7	5	5	5	4	8	6
D	68.0	830	94.9	5	7	4	3	4	4	5	4	4
E	65.0	800	100.0	2	6	6	3	1	4	5	4	4
F	68.1	2140	92.7	3	3	3	4	4	4	5	3	4
G	65.7	2550	90.3	5	5	3	7	5	5	5	3	3
H	69.6	1060	105.5	4	5	4	6	5	5	4	5	5
I	65.7	1825	94.8	4	5	5	5	3	7	7	3	5
J	69.1	2177	90.3	4	3	2	3	5	4	3	1	3
Avg.	66.4		95.9	4.6	4.9	4.2	4.4	4.2	4.8	4.8	3.9	4.2
S.D.	3.1		4.7	1.6	2.2	1.5	1.4	1.3	0.9	1.0	1.9	1.0

SWQC #12 – MT 21487

		HAVRE (H-12)										
	Bake Absorption	Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	(%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	62.0	3025	96.8	9	9	5	5	5	5	5	5	5
B	67.0	2967	99.0	9	9	5	5	5	5	5	5	5
C	70.3	875	93.1	6	6	6	5	4	5	3	7	5
D	73.9	940	95.4	9	6	5	8	3	4	3	4	4
E	68.0	1050	113.5	6	6	6	6	7	4	5	6	6
F	70.2	2367	107.0	9	7	6	6	5	4	5	5	5
G	67.4	2575	96.3	9	9	5	5	3	5	7	3	7
H	72.0	1075	95.6	6	7	9	5	6	5	5	6	5
I	67.4	1801	98.3	7	7	8	4	3	5	5	3	5
J	74.6	2479	100.8	9	7	7	4	4	5	5	6	6
Avg.	69.3		99.6	7.9	7.3	6.2	5.3	4.5	4.7	4.8	5.0	5.3
S.D.	3.7		6.2	1.4	1.3	1.4	1.2	1.4	0.5	1.1	1.3	0.8

		MINOT (M-12)										
	Bake Absorption	Loaf Volume				Quality Score Compared to Check (LCS Rebel)						
Cooperator	(%)	(mL)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2525	90.2	5	5	5	5	7	5	5	5	5
B	66.0	2832	98.4	7	7	7	3	5	5	5	5	5
C	69.1	899	105.9	7	6	6	5	6	5	3	7	5
D	71.7	875	108.0	8	6	7	5	7	5	3	6	6
E	66.0	925	105.7	7	6	5	5	5	5	5	4	5
F	67.9	2028	94.7	5	3	6	4	4	5	4	3	4
G	66.1	2500	98.0	7	7	3	7	3	5	5	5	5
H	70.0	1075	101.4	7	8	6	4	5	5	4	4	4
I	66.1	1756	93.2	6	7	8	7	8	5	7	7	7
J	67.4	2307	96.6	6	5	5	3	5	5	4	5	5
Avg.	67.0		99.2	6.5	6.0	5.8	4.8	5.5	5.0	4.5	5.1	5.1
S.D.	3.1		5.9	1.0	1.4	1.4	1.4	1.5	0.0	1.2	1.3	0.9

Hard 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.