

**Wheat Quality Council**

**Hard Spring Wheat Technical Committee**

**2015 Crop**



**February 16-18, 2016**

**Kansas City, MO**

**Wheat Quality Council**  
**Hard Spring Wheat Technical Committee**  
**2015 Crop**



**Sponsored by the Wheat Quality Council**  
**February 16-18, 2016**  
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# **Wheat Quality Council**

## **Hard Spring Wheat Technical Committee**

### **Introduction**

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

Nine experimental lines of hard spring wheat were grown at up to five locations in 2015 and evaluated for kernel, milling, and bread baking quality against the check variety Glenn. 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 at the USDA Hard Red Spring and Durum Wheat Quality Laboratory (WQL), Fargo, ND. Flour samples were shipped to independent laboratories and tested for bread baking quality.

From this report:

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

The results relate only to test samples that were volunteered for testing in the 2015 crop year. Test results from other crop years may differ from those reported herein.

The Hard Spring Wheat Technical Committee, by compilation of data and issuance of this report, does not make or intend any general recommendations or conclusions on its part with respect to the desirability of any wheat included in the tests. Mention of a vendor, product, proprietary product, or procedure does not constitute a guarantee or warranty of the vendor, product, or procedure by the Hard Spring Wheat Technical Committee or by cooperating laboratories, and does not imply its approval to the exclusion of other vendors, products, or procedures that may also be suitable. Data reported herein are not to be used in any publication or literature or for advertising or publicity purposes.

# The 2015 Wheat Quality Testing Program

## Source of Wheat

Source/Breeding Program	SWQAC Code #	Identification
University of Minnesota	1	MN10261-1
North Dakota State University	2	ND820
University of Minnesota	3	Bolles (Check #2)
Syngenta	4	SY Valda
Limagrain	5	LCS Prime
University of Minnesota	6	MN11325-7
North Dakota State University	7	ND821
South Dakota State University	8	SD4383
North Dakota State University	9	Glenn (Check #1)
Limagrain	10	LNR11-0757

## Field Plot Locations and Procedures

Coordinator: Dale Williams, Ph.D., Director, Foundation Seedstocks, Department of Plant Sciences, North Dakota State University.

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

- Northeast Research Station (Watertown), South Shore, SD  
South Dakota State University, Brookings, SD – Jack Ingemansen;
- Agronomy Seed Farm, Casselton, ND – Brian Otteson;
- Northwest Research and Outreach Center, Crookston, MN – Dr. Albert Sims;
- Williston Research Extension Center, Williston, ND – Kyle Dragseth;
- Northern Seed, LLC, Bozeman, MT – Craig Cook.

Wheat was seeded in large-scale plots of  $\frac{1}{2}$  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 locations, nitrogen fertilizer was applied to the test plots at rates approaching higher levels than used commercially to more fully express the potential of each experimental line. Levels of phosphorus and potassium were applied in sufficient amounts so as not to be limiting factors. Each plot was individually harvested and the grain produced was thoroughly blended to obtain a uniform sample representing the entire plot.

## Field Production Data

LOCATION					
Variable	Watertown	Casselton	Crookston	Williston	Bozeman
<b>Planting Date</b>	4/27/2015	4/17/2015	4/28/2015	5/18/2015	5/11/2015
<b>Harvest Date</b>	8/31/2015	8/15/2015	8/12/2015	8/17/2015	8/24/2015
<b>Fertilizer (lb/A)</b>					
N	150	200	152.6	100# (46-0-0)	80
P	100	50	3	50# (11-52-0)	30
K	*	*	166	*	30
<b>Herbicide/rate/A</b>					
Broadleaf	1.7 pt Wolverine/A	1 pt Bronate/A	1 pt Bromac/A	16 oz Bromox/A	0.6 oz Affinity
Grass	*	0.5 pt Puma/A	16 fl oz Axial XL/A	6 oz Fenoxaprop/A	1.25 oz Discover
<b>Fungicide</b>	*	6.5 oz Prosaro/A	*	3 oz Tilt / 8 oz Prosero	4 oz Fitness

\*No application.

Month	CLIMATOLOGICAL DATA				
	Average Temperature (°F) / Precipitation (in)				
	Watertown	Casselton	Crookston	Williston	Bozeman
April	48/0.48	45.3/0.78	44.4/0.57	*/0.28	44.0/2.34
May	55/4.41	54.1/8.38	52.3/2.56	*/1.89	51.0/3.29
June	67/3.03	66.0/4.06	64.7/3.70	*/2.53	67.5/0.60
July	70/5.32	70.8/3.60	69.9/4.96	*/2.32	66.7/2.35
August	68/5.30	73.0/0.62	65.9/1.10	*/1.14	66.8/1.29

\*Data not available.

SWQAC Code #	YIELD DATA				
	Yield (bu/acre) / Test Weight / % Moisture				
	Watertown	Casselton	Crookston	Williston	Bozeman
1	*	60.9/60.0/13.2	**/63/12.05	*	*
2	*	71.0/61.0/12.4	*	**	*
3	60.9/56.6/12.1	74.4/58.0/11.8	**/61/11.32	**	99/60.6/9.9
4	65.9/58.0/12.6	83.4/57.5/12.6	**/61/13.29	**	69/59.8/9.7
5	65.0/55.7/12.1	89.0/59.0/12.8	**/63/11.53	**	81.9/60.4/10.0
6	*	81.3/58.0/13.9	**/60/14.52	*	*
7	*	71.6/59.5/13.2	*	**	*
8	66.0/57.0/12.3	76.8/58.0/12.1	**/62/11.12	*	*
9	53.3/59.4/12.3	78.9/62.0/13.2	**/64/11.64	**	95/60.8/11.2
10	*	*	*	**	85/59.6/10.1
<b>Site Totals</b>	<b>5</b>	<b>9</b>	<b>7</b>	<b>7</b>	<b>5</b>

\*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.

	<b>Watertown</b>	<b>Casselton</b>	<b>Crookston</b>	<b>Williston</b>	<b>Bozeman</b>
<b>At Planting</b>	Extremely dry at planting. No moisture in the seed zone.	Dry conditions at planting.	Started out with adequate moisture for emergence.	Seeded with a seed hawk demo hoe drill. Broadbanded fertilizer at planting.  Sprayed herbicide at 5 leaf stage and included Titl fungicide and sprayed Prosaro fungicide at early flowering stage. No disease or insect pressure.	Crop followed potatoes.
<b>During Growth</b>	Good moisture. Topsoil and subsoil moisture replenished.	Wet, cool conditions in May and June; nearly ideal for wheat development.	Minimum amounts of rain after planting		Early heat and dry conditions. Supplemental irrigation on June 8 <sup>th</sup> and July 4 <sup>th</sup> for an added total of 4" of water.
<b>At Flowering</b>	Dry. No lingering wet periods or fog.	Wet conditions conducive to disease development; sprayed with Prosaro fungicide to protect flag leaf and spike.	Above normal temperatures with frequent rains.	Noted very low orange wheat blossom midge infestation at flowering	
<b>During Maturation</b>	Normal weather. Good grain filling period. Below average precipitation.	Dry, warm conditions.	Above normal temperatures continued during maturity.	The weather turned hot and dry, which lowered test weight during maturation	
<b>At Harvest</b>	High humidity and above average precipitation.	Hot, dry conditions.	No lodging present at harvest.	Remained hot and dry. Only rain received in August was after harvest.	

## Description of 2015 Hard Spring Wheat Lines

### **SWQAC #1 – MN10261-1**

MN10261-1 (Glenn/Sabin) is mid-maturity hard red spring wheat that has relatively high grain yield and protein and has good overall disease resistance, including Fusarium head blight. MN10261-1 ranked 2<sup>nd</sup> out of 39 entries in the 2013 Uniform Regional Nursery trial, a rarity for a higher protein line. Therefore, this line seems to be widely adapted. Straw strength is above average. MN10261-1 is resistant to pre-harvest sprouting and has exhibited good end-use quality characteristics.

### **SWQAC #2 – ND820**

ND820 is an experimental HRSW line developed by the NDSU spring wheat breeding program. ND820 was selected from the cross SD8119/2\*ND721. ND820 is an awned medium to tall semi-dwarf with early to medium maturity similar to Barlow. ND820 has a high test weight with good yield better than Barlow. ND820 has a high protein better than Glenn with good milling and baking qualities. ND820 has a moderately resistant reaction to stem rust and a moderately susceptible reaction to the LR21 leaf rust race. It has average FHB scores similar to Barlow.

### **SWQAC #3 – Bolles**

Bolles is a mid-late maturity hard red spring wheat with very high grain protein content, competitive grain yields, and good straw strength. The pedigree of Bolles is MN02268-1/MN01333-A-1. Bolles has excellent leaf rust resistance and moderate resistance to Fusarium head blight. Bolles is resistant to pre-harvest sprouting and has exhibited excellent end-use quality characteristics.

### **SWQAC #4 – SY Valda**

SY Valda is a hard red spring wheat variety developed by Syngenta Seeds, Inc. with the pedigree of 02S0237-12/Briggs. It has medium-late maturity and very good test weight. It is a standard semi-dwarf, slightly taller than SY Soren. Straw strength is good between SY Ingmar and SY Rowyn. It is moderately resistant to stem rust and resistant to leaf rust. Protection to leaf spotting diseases has been good. Tolerance to FHB has been very good. Protein levels have been moderate, slightly higher than Faller. Overall, breadmaking characteristics are good. SY Valda is very high yielding and broadly adapted to the spring wheat growing areas of the Northern Plains. Certified seed will be available for the 2016 season.

### **SWQAC #5 – LCS Prime**

LCS Prime is a hard red spring wheat marketed by Limagrain Cereal Seeds. LCS Prime was selected for grain yield, straw strength, tillering capacity, resistance to Fusarium head blight, resistance to bacterial leaf blight, and flour extraction rate. LCS Prime is adapted to North Dakota and Minnesota. LCS Prime has excellent flour extraction, better than Glenn, performs well for loaf volume at low protein, and has good mixograph tolerance. Primary use will be for milling and baking of breads using processed and whole wheat flour. Registered and Certified

seed of LCS Prime is available in quantity for Spring 2016 plantings. Plant Variety Protection will be applied for.

### **SWQAC #6 – MN11325-7**

MN11325-7 (Faller//00H04\*J3/MN03130-1-62) is a mid-late maturity hard red spring wheat that is competitive for grain yield with the highest yielding varieties in the region, but with higher protein. MN11325-7 is moderately resistant to important diseases such as leaf rust, bacterial leaf streak, and Fusarium head blight. Straw strength is average. MN11325-7 is resistant to preharvest sprouting and has exhibited acceptable end-use quality characteristics.

### **SWQAC #7 – ND821**

ND821 is an experimental HRSW line developed by the NDSU spring wheat breeding program. ND821 was selected from the experimental line ND820 which has the pedigree SD8119/2\*ND721. ND821 is an awned medium to tall semi-dwarf similar to Elgin-ND with early to medium maturity similar to Barlow. ND821 has a high test weight with good yield better than Barlow. ND821 has a high protein similar to Glenn with good milling and baking qualities. ND821 has a moderately resistant reaction to stem rust and a susceptible reaction to the LR21 leaf rust race. It has average FHB scores similar to Elgin-ND.

### **SWQAC #8 – SD4383**

SD4383 is an advanced experimental hard red spring wheat breeding line developed by the South Dakota Agricultural Experiment Station. It was derived as a single spike from within an  $F_4$  population (SD4011/SD3942) that was originally created in fall 2006. During early generation advancement, the population was tested as 28093 and then renamed as SD4383 with its advancement into the 2011 South Dakota State University Preliminary Yield Trial. Additionally, SD4383 was evaluated in the Spring Wheat Breeding program Advanced Yield Trial from 2012 through 2015, as well as the Uniform Regional Spring Wheat Nursery and South Dakota Crop Performance Testing trials during 2014 and 2015.

Points of note associated with SD4383 include:

1. Good yield potential;
2. Medium test weight;
3. Moderate grain protein concentration;
4. Early heading date;
5. Above average level of Fusarium head blight and bacterial leaf streak resistance.

### **SWQAC #10 – LNR11-0757**

LNR11-0757 is an experimental unreleased line developed by Limagrain Cereal Seeds. LNR11-0757 is adapted to Western North Dakota and Eastern Montana. LNR11-0757 was selected for straw strength, tillering capacity, resistance to Fusarium head blight, and resistance to bacterial leaf blight. LNR11-0757 performs well for loaf volume at low protein and has excellent mixograph tolerance. Breeder seed of LNR11-0757 has been produced.

## Wheat Production Sites

SWQAC Code #	Entry	Source	Production Sites				
			Watertown	Casselton	Crookston	Williston	Bozeman
1	MN10261-1	UMN		X	X		
2	ND820	NDSU		X		X	
3	Bolles	UMN	X	X	X	X	X
4	SY Valda	Syngenta	X	X	X	X	X
5	LCS Prime	Limagrain	X	X	X	X	X
6	MN11325-7	UMN		X	X		
7	ND821	NDSU		X		X	
8	SD4383	SDSU	X	X	X		
9	Glenn	NDSU	X	X	X	X	X
10	LNR11-0757	Limagrain				X	X

## Grain Cleaning and Milling Procedures

Wheat (approximately 3 bu/line) was cleaned in a Carter-Day Bulldog seed cleaner that was equipped with two rotating indent cylinders (#24 – coarse; #16 – fine), a sizer cylinder (#5), vibrator, and air aspiration.

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

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

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

## Methods of Analysis

- Wheat Market Value Score;
- DON levels - analyzed by NDSU, Department of Plant Sciences (gas chromatography method, J. AOAC Int. 79:472, 1996);
- Test weight (AACCI Method 55-10);
- Wheat and flour protein (AACCI Method 46-30 – combustion method);
- Wheat and flour ash (AACCI Method 08-01);
- Kernel Size (Sieving according to USDA-ARS WQL);
- Wheat and flour Falling Number (Perten Falling Number System);
- Single kernel characteristics (Perten Single Kernel Characterization System – SKCS):
  - Mean and standard deviation values were calculated from 300 kernels.
- Vitreous kernel content (DHV analysis by FGIS Grain Testing Service);
- Flour color (Minolta Colorimeter, *L*\* and *b*\* values);
- Flour extraction: % Total product basis (TPB), % tempered wheat basis (TWB), and estimated pounds patent flour/bushel wheat;

- Farinograph (AACCI Method 54-21, Brabender Computerized Farinograph system with 50 g mixing bowl):
  - Water absorption: 500 BU and 14% mb;
  - Arrival time: time required for the top of the curve to reach the 500 BU line after addition of water;
  - Peak time: time between addition of water and development of the maximum consistency of the dough;
  - Stability: difference in time between the point at which the top of the curve first intercepts the 500 BU line (arrival time) and the point at which the top of the curve leaves the 500 BU line (departure time);
  - Mechanical Tolerance Index (MTI): difference in BU between the top of the curve at the peak and the top of the curve measured 5 minutes after the peak is reached;
  - Time to Breakdown (TTB): time from the start of mixing to the time at which consistency has decreased 30 BU from the peak point.
- Mixograph (AACCI Method 54-40A, mixograph with 35 g mixing bowl):
  - Water absorption (14% mb) = Protein (14% mb) x 1.5 + 43.6  
(The Mixograph Handbook, 1997).
- Extensograph (AACCI Method 54-10 with modifications):
  - Flour (100 g, 14% mb), 2.0% NaCl (U.S.P.), and water (farinograph absorption - 2%) were mixed to optimum development in a pin mixer (National Mfg. Co.);
  - Dough was scaled to 150 g, rounded, molded, placed in extensograph holders, and rested for 45, 90, and 135 minutes at 30°C and 78% relative humidity. The dough was then stretched as described in the procedure referenced above. For conversion purposes, 500 g = 400 BU;
  - Extensograph parameters:
    - Energy (cm<sup>2</sup>): area under the curve;
    - Resistance to extension (BU): height of the curve 50 mm after the beginning of torque increase;
    - Extensibility (cm): total length of the curve at the baseline;
    - Maximum resistance (BU): maximum curve height;
    - Ratio number: quotient of resistance to extension and extensibility;
    - Ratio number (max.): quotient of maximum resistance and extensibility.

## Test Bake Procedures

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

## Bake Cooperators

- ADM Milling – Overland Park, KS;
- Ardent Mills – Minnetonka, MN;
- Bay State Milling – Winona, MN;
- Cereal Food Processors, Inc. (Grain Craft) – Wichita, KS;
- General Mills – Minneapolis, MN;
- Limagrain Cereal Seeds LLC – Fort Collins, CO;
- North Dakota Mill – Grand Forks, ND;
- North Dakota State University, Department of Plant Sciences – Fargo, ND;
- Syngenta – Berthoud, CO;
- USDA-ARS Hard Red Spring & Durum Wheat Quality Laboratory – Fargo, ND;
- USDA-ARS Hard Winter Wheat Quality Laboratory – Manhattan, KS;
- USDA-ARS Western Wheat Quality Laboratory – Pullman, WA;
- Wheat Marketing Center – Portland, OR.

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

## Quality Data of 2015 Hard Spring Wheat Lines

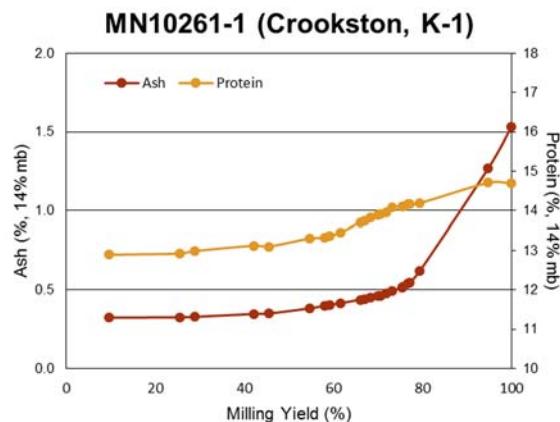
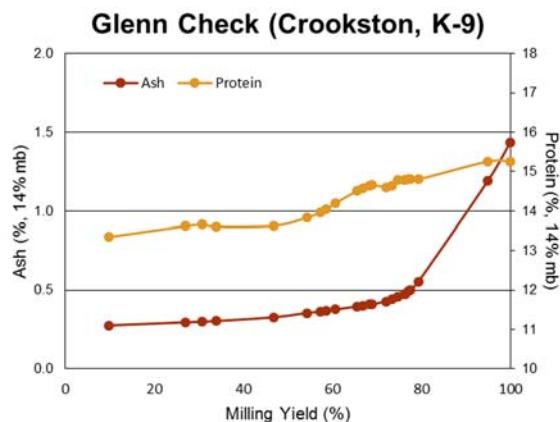
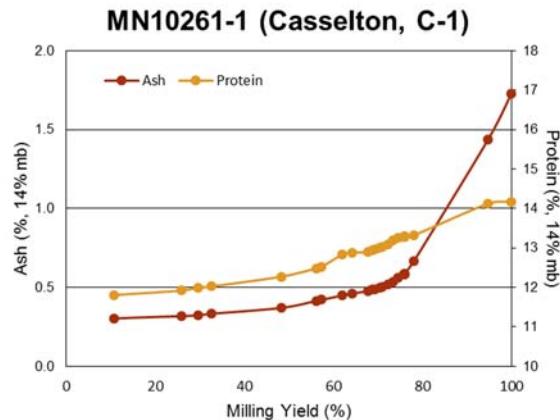
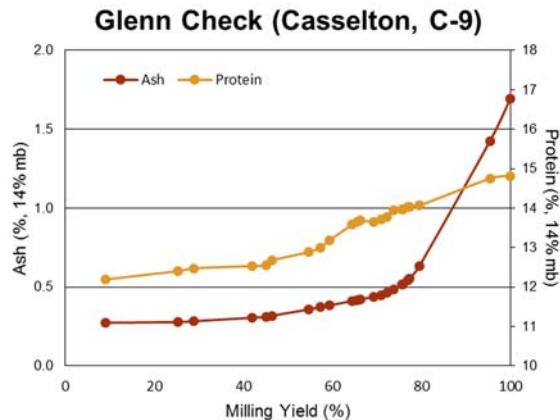
### SWQAC #1 – MN10261-1

	Quality Trait	Casselton		Crookston	
		Glenn C-9	C-1	Glenn K-9	K-1
<b>I. USDA-ARS WQL Data</b>					
1	Wheat Protein (%, 12% mb)	14.9	14.3	15.5	14.6
2	Flour Protein (%, 12% mb)	14.4	13.5	15.3	14.4
3	Market Value (Score 1-6)	4.3	4.0	4.7	4.4
4	Market Value (Score 1-10)	10.0	8.6	10.0	9.0
5	DON (ppm)	0.21	nd	nd	nd
6	Test Weight (lb/bu)	63.4	61.6	64.7	63.5
7	1000 Kernel Weight (g)	31.9	29.3	29.8	28.6
8	Kernel Size, % Large	60	44	47	33
9	Kernel Size, % Small	7	11	11	14
10	Wheat Moisture (%)	10.7	10.7	10.3	10.7
11	Wheat Ash (%, 14% mb)	1.77	1.71	1.42	1.54
12	Wheat Falling Number (sec)	390	418	387	398
13	SKCS Hardness Index	83.0	85.6	85.6	93.4
14	Vitreous Kernels (%)	85.7	88.5	95.6	99.1
<b>Flour Extraction (%)</b>					
15	Tempered Wheat Basis (%)	72.7	71.5	73.5	71.8
16	Total Product Basis (%)	73.7	73.3	74.8	73.2
17	Flour/Bu Wheat (lbs)	46.0	44.7	47.8	45.8
<b>Flour Quality</b>					
18	Flour Color Brightness (L*)	89.6	89.7	90.0	89.8
19	Flour Color Yellowness (b*)	8.9	9.2	8.4	9.4
20	Flour Moisture (%)	13.0	14.0	12.7	13.0
21	Flour Ash (%, 14% mb)	0.51	0.55	0.44	0.49
22	Flour Falling Number (Malted) (sec)	250	250	250	252
<b>Farinograph</b>					
23	Water Absorption (%, 500 BU)	64.6	63.7	63.9	70.7
24	Water Absorption (%, 14% mb)	63.3	63.7	62.1	69.3
25	Arrival Time (min)	3.8	2.3	4.8	3.0
26	Peak Time (min)	7.5	5.2	9.0	5.7
27	Dough Stability (min)	9.5	6.9	9.6	7.2
28	Mixing Tolerance Index (MTI) (BU)	28.0	35.0	28.0	38.0
29	Time To Breakdown (TTB) (min)	12.8	9.4	14.1	10.0
<b>II. Cooperator Results</b>					
30	Bake Absorption (Average %)	66.0	65.0	66.1	68.2
31	Loaf Volume (% of Check)	94.6	nd	96.5	nd

# SWQAC #1 – MN10261-1

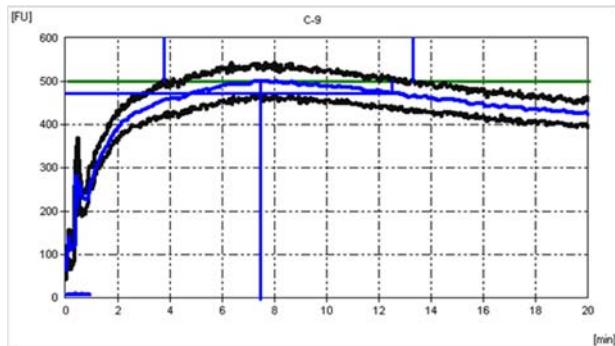
	Quality Trait	Casselton		Crookston	
		Glenn C-9	C-1	Glenn K-9	K-1
<b>II. Cooperator Results</b>					
32	<b>Mixing Requirement</b>  5 = Very Long 4 = Long 3 = Medium 2 = Short 1 = Very Short	3.5	3.0	4.2	3.0
33	<b>Dough Characteristics</b>  5 = Bucky – Tough 4 = Strong – Elastic 3 = Medium – Pliable 2 = Mellow – Very Pliable 1 = Weak – Short or Sticky	3.6	3.5	3.8	3.2
34	<b>Mixing Tolerance</b>  5 = Much More Tolerance Than Check 4 = More Tolerance Than Check 3 = Tolerance Equivalent To Check 2 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		2.5		2.2
35	<b>Internal Crumb Color</b>  5 = Much Brighter Than Check 4 = Brighter Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.7		2.7
36	<b>Internal Grain and Texture</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.2		3.1
<b>III. Cooperator Evaluation</b>					
	<b>Quality Traits 1-2: Protein</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.3		2.3
	<b>Quality Traits 3-22: Milling</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.5		2.0
	<b>Quality Traits 23-36: Baking</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.8		2.5
	<b>Quality Traits 1-36: Overall Comparison</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.5		2.4

## Cumulative Ash and Protein Curves

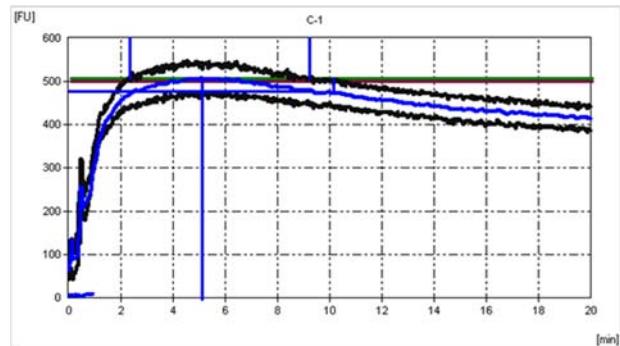


## Farinograms

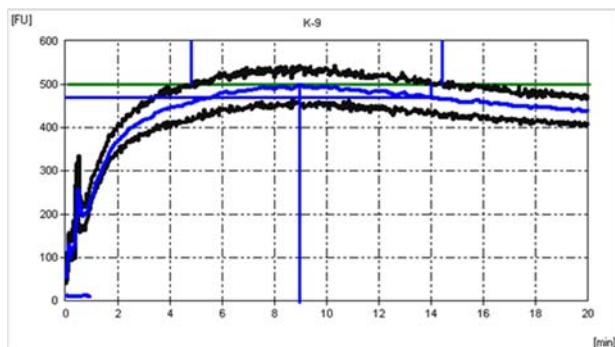
Glenn Check (Casselton, C-9)



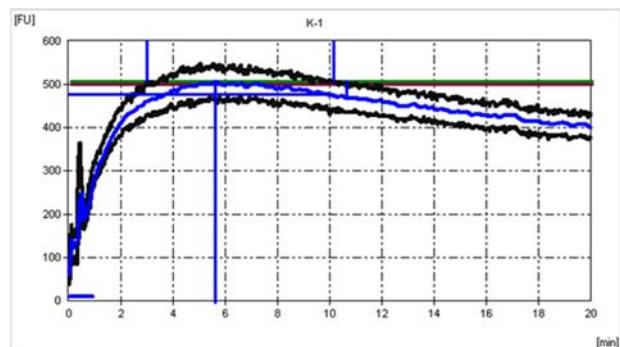
MN10261-1 (Casselton, C-1)



Glenn Check (Crookston, K-9)

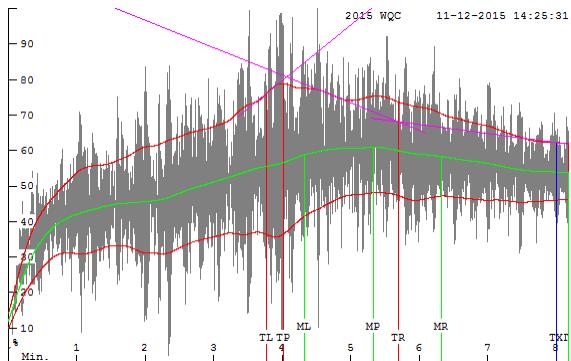


MN10261-1 (Crookston, K-1)

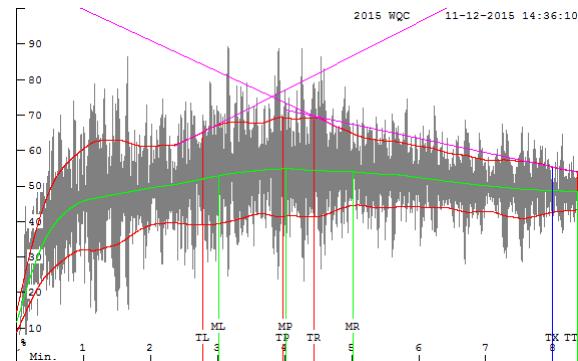


## Mixograms

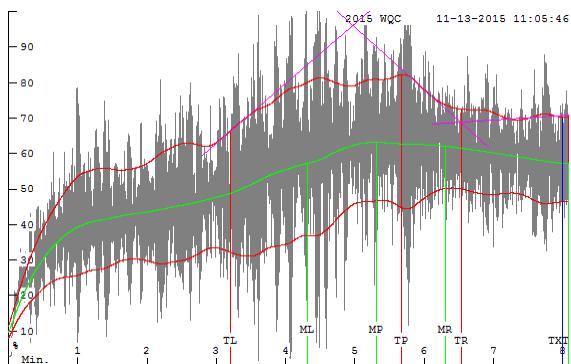
**Glenn Check (Casselton, C-9)**



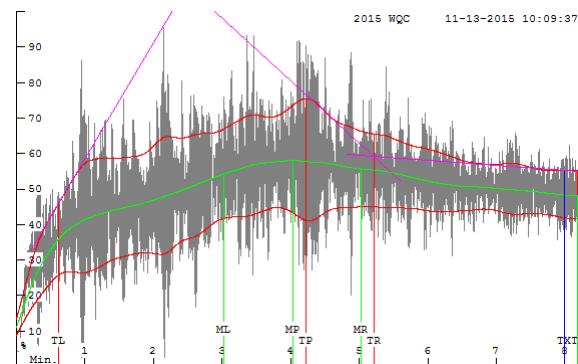
**MN10261-1 (Casselton, C-1)**



**Glenn Check (Crookston, K-9)**

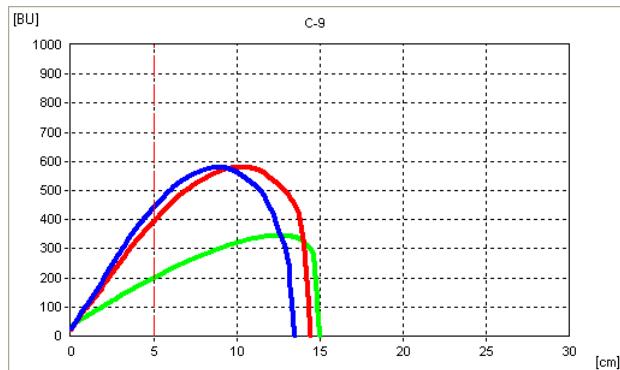


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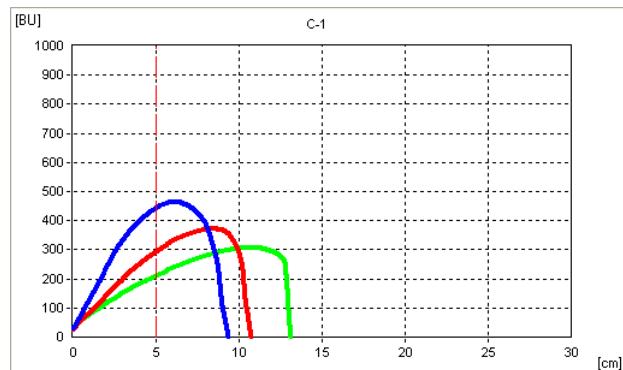


## Extensograms

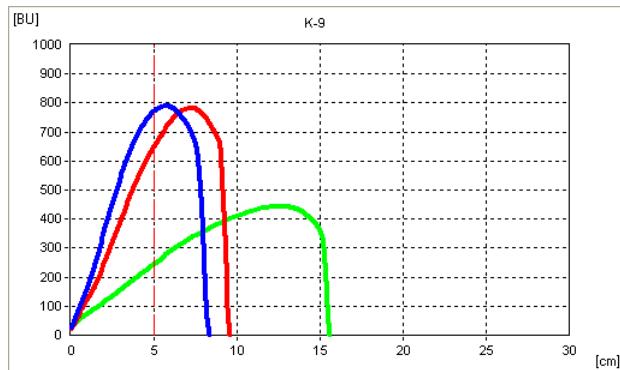
Glenn Check (Casselton, C-9)



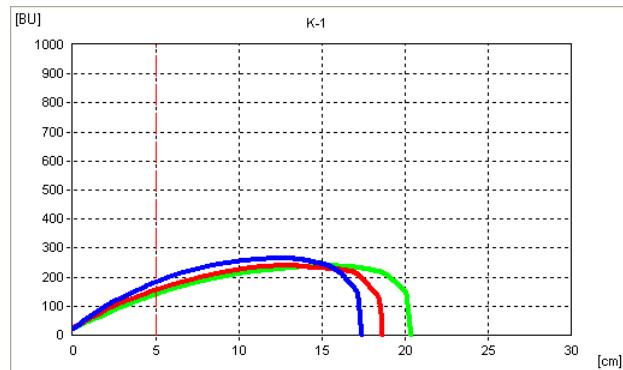
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Glenn Check (Crookston, K-9)



MN10261-1 (Crookston, K-1)



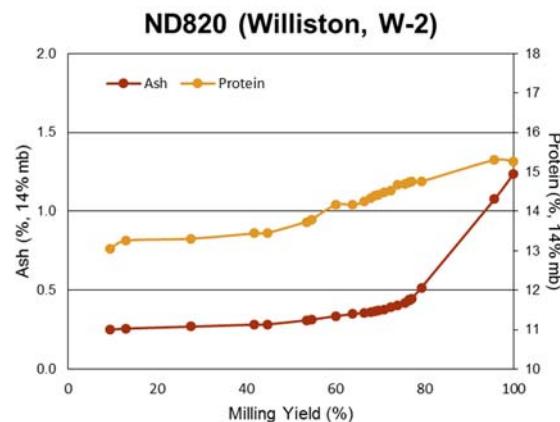
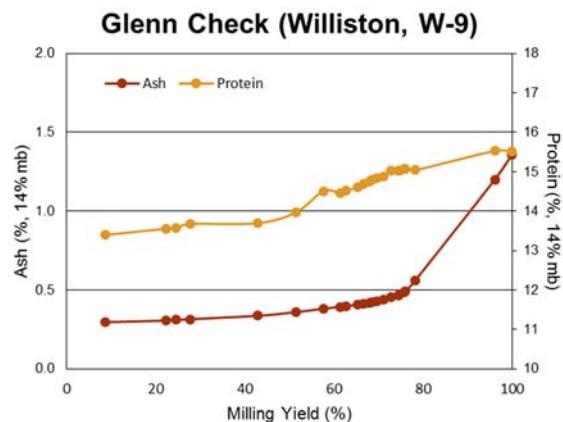
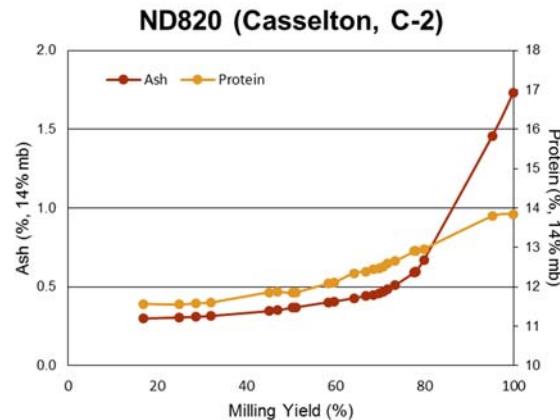
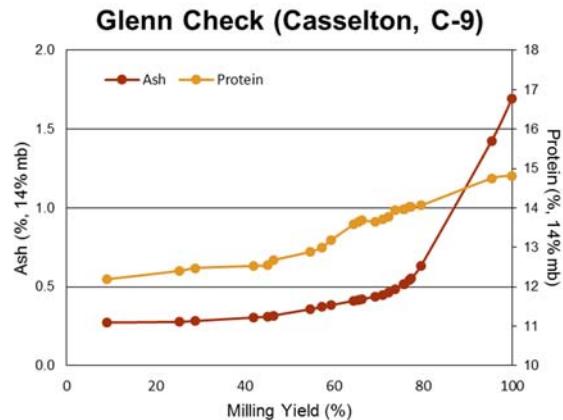
## SWQAC #2 – ND820

Quality Trait	Casselton		Williston	
	Glenn C-9	C-2	Glenn W-9	W-2
<b>I. USDA-ARS WQL Data</b>				
1      Wheat Protein (%, 12% mb)	14.9	13.5	15.7	15.2
2      Flour Protein (%, 12% mb)	14.4	12.6	15.5	15.3
3      Market Value (Score 1-6)	4.3	4.4	4.6	4.7
4      Market Value (Score 1-10)	10.0	8.8	10.0	9.6
5      DON (ppm)	0.21	nd	nd	nd
6      Test Weight (lb/bu)	63.4	62.7	63.6	62.3
7      1000 Kernel Weight (g)	31.9	33.4	25.9	27.3
8      Kernel Size, % Large	60	76	9	25
9      Kernel Size, % Small	7	5	21	14
10     Wheat Moisture (%)	10.7	10.8	9.2	9.2
11     Wheat Ash (%, 14% mb)	1.77	1.65	1.39	1.30
12     Wheat Falling Number (sec)	390	466	390	490
13     SKCS Hardness Index	83.0	67.8	78.8	72.1
14     Vitreous Kernels (%)	85.7	26.2	98.7	97.6
<b>Flour Extraction (%)</b>				
15     Tempered Wheat Basis (%)	72.7	72.2	71.2	71.9
16     Total Product Basis (%)	73.7	71.8	72.9	73.9
17     Flour/Bu Wheat (lbs)	46.0	46.2	45.7	45.3
<b>Flour Quality</b>				
18     Flour Color Brightness (L*)	89.6	89.8	89.9	89.7
19     Flour Color Yellowness (b*)	8.9	8.5	8.4	8.8
20     Flour Moisture (%)	13.0	14.4	12.9	12.4
21     Flour Ash (%, 14% mb)	0.51	0.48	0.46	0.42
22     Flour Falling Number (Malted) (sec)	250	253	256	251
<b>Farinograph</b>				
23     Water Absorption (%, 500 BU)	64.6	63.0	65.2	64.3
24     Water Absorption (%, 14% mb)	63.3	63.6	64.5	62.4
25     Arrival Time (min)	3.8	3.3	4.4	3.5
26     Peak Time (min)	7.5	6.7	9.8	8.0
27     Dough Stability (min)	9.5	8.3	14.9	11.2
28     Mixing Tolerance Index (MTI) (BU)	28.0	31.0	12.0	22.0
29     Time To Breakdown (TTB) (min)	12.8	11.2	18.0	14.7
<b>II. Cooperator Results</b>				
30     Bake Absorption (Average %)	66.0	64.0	66.8	65.6
31     Loaf Volume (% of Check)	93.3		99.0	

# SWQAC #2 – ND820

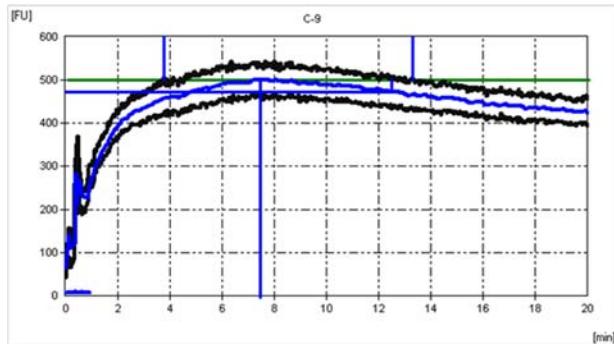
	Quality Trait	Casselton		Williston	
		Glenn C-9	C-2	Glenn W-9	W-2
<b>II. Cooperator Results</b>					
32	<b>Mixing Requirement</b>  5 = Very Long 4 = Long 3 = Medium 2 = Short 1 = Very Short	3.5	2.8	4.1	3.6
33	<b>Dough Characteristics</b>  5 = Bucky – Tough 4 = Strong – Elastic 3 = Medium – Pliable 2 = Mellow – Very Pliable 1 = Weak – Short or Sticky	3.6	3.0	4.0	3.7
34	<b>Mixing Tolerance</b>  5 = Much More Tolerance Than Check 4 = More Tolerance Than Check 3 = Tolerance Equivalent To Check 2 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		2.7		2.5
35	<b>Internal Crumb Color</b>  5 = Much Brighter Than Check 4 = Brighter Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.3		3.2
36	<b>Internal Grain and Texture</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.5		3.5
<b>III. Cooperator Evaluation</b>					
	<b>Quality Traits 1-2: Protein</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		1.5		2.7
	<b>Quality Traits 3-22: Milling</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.7		3.3
	<b>Quality Traits 23-36: Baking</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.7		3.2
	<b>Quality Traits 1-36: Overall Comparison</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.4		3.0

## Cumulative Ash and Protein Curves

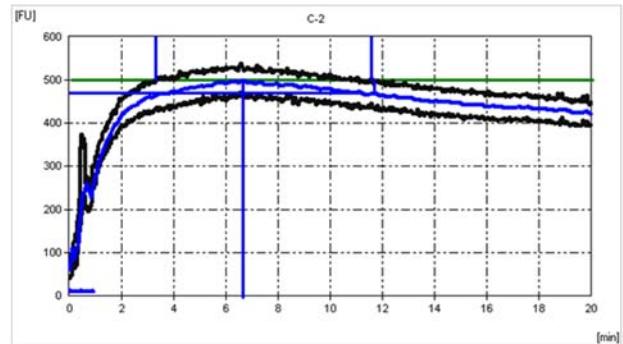


## Farinograms

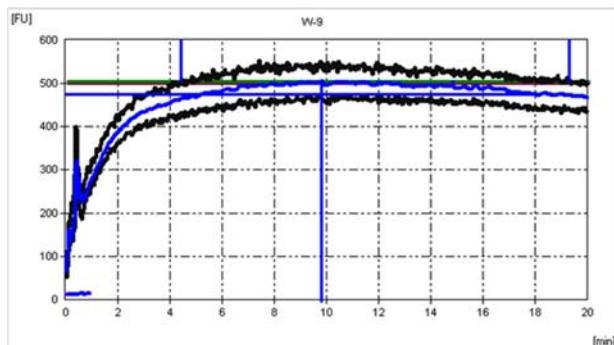
Glenn Check (Casselton, C-9)



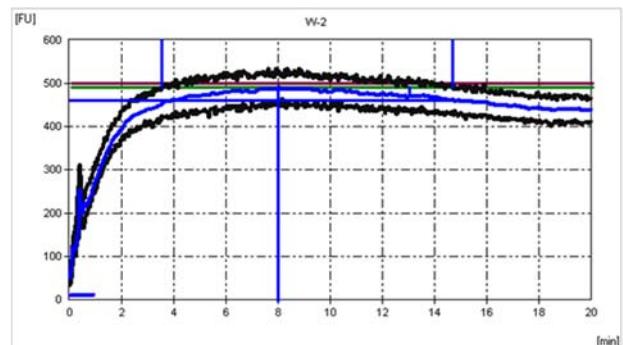
ND820 (Casselton, C-2)



Glenn Check (Williston, W-9)

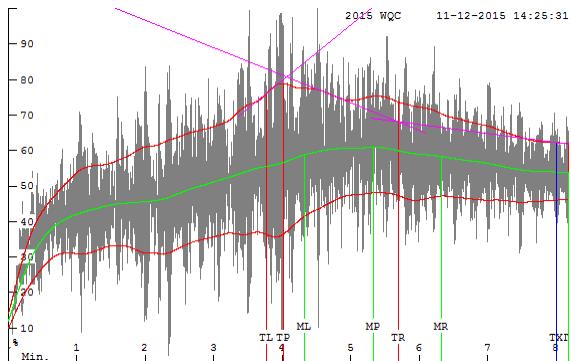


ND820 (Williston, W-2)

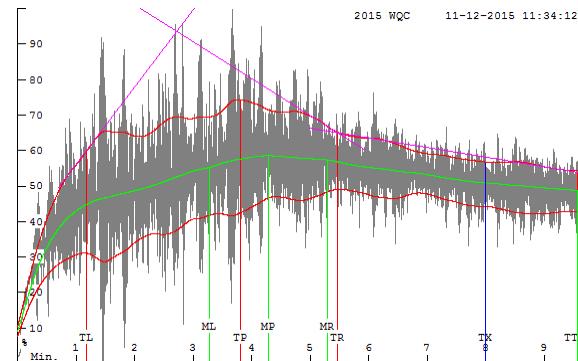


## Mixograms

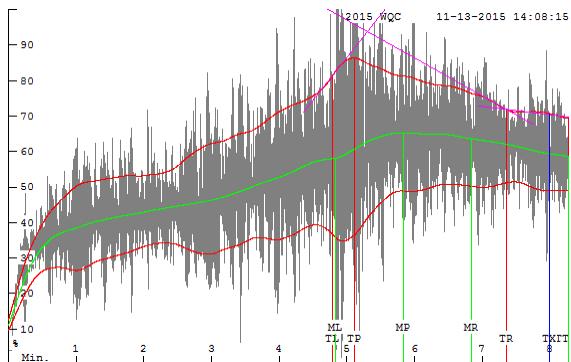
**Glenn Check (Casselton, C-9)**



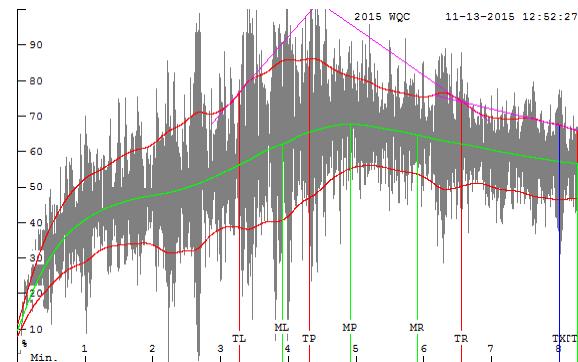
**ND820 (Casselton, C-2)**



**Glenn Check (Williston, W-9)**

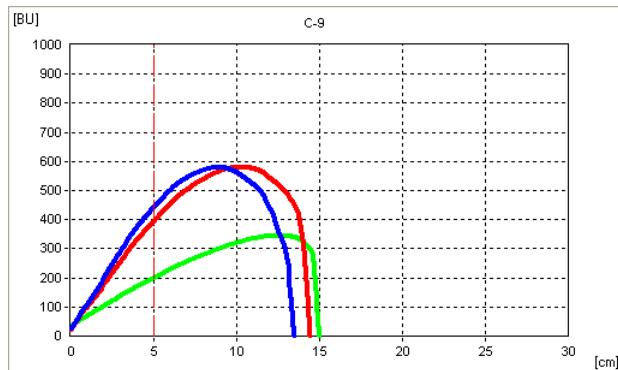


**ND820 (Williston, W-2)**

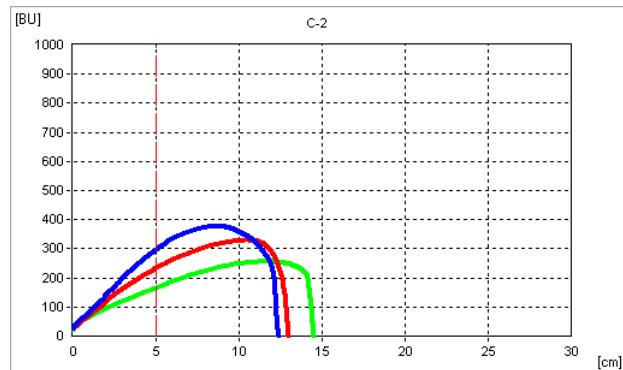


## Extensograms

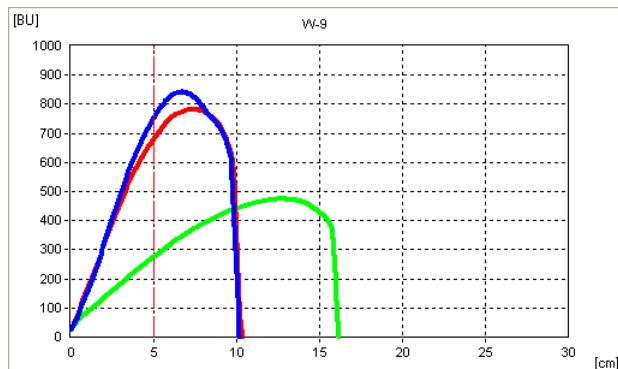
Glenn Check (Casselton, C-9)



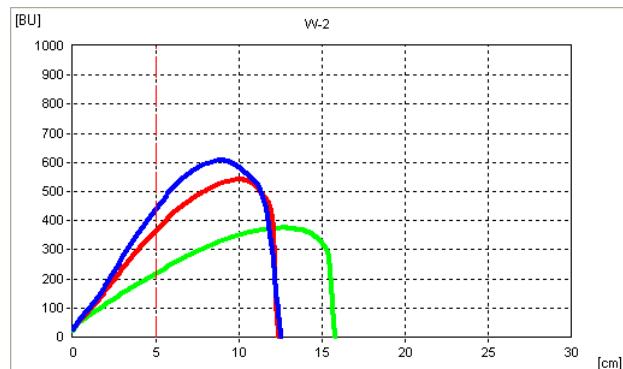
ND820 (Casselton, C-2)



Glenn Check (Williston, W-9)



ND820 (Williston, W-2)



— 45 min; — 90 min; — 135 min

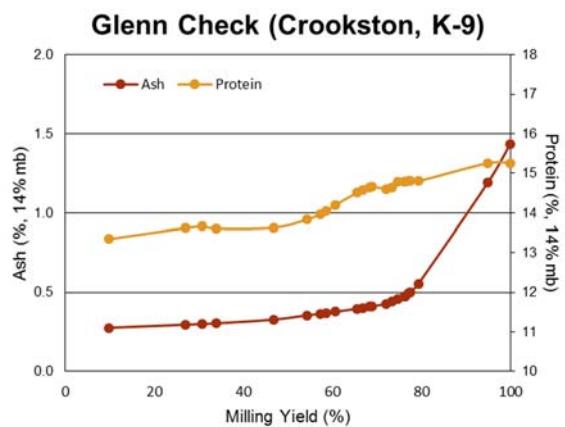
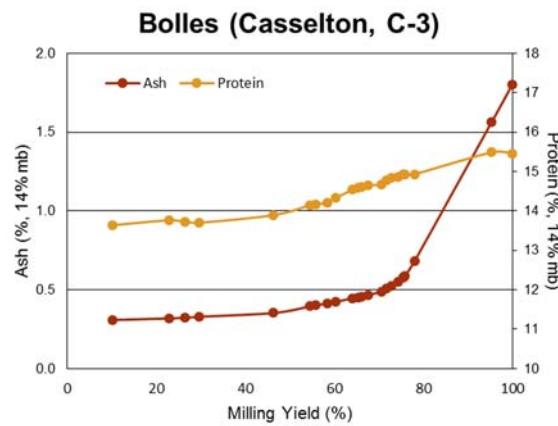
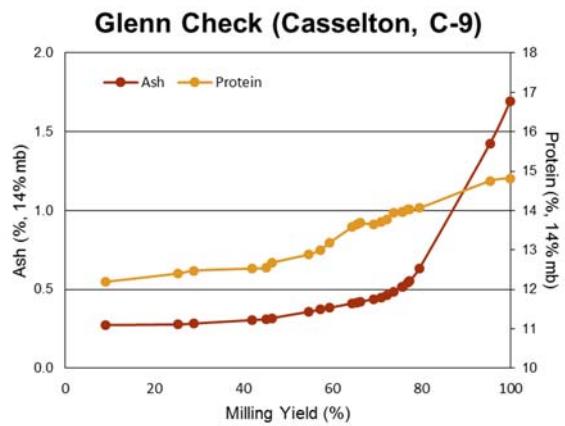
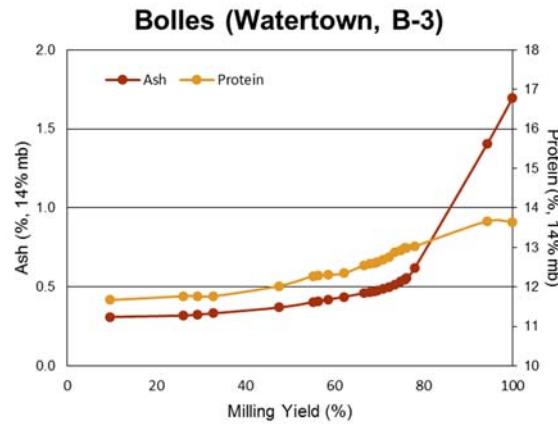
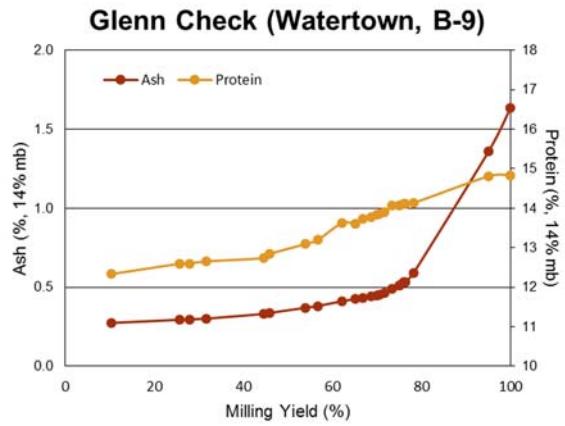
## SWQAC #3 - Bolles

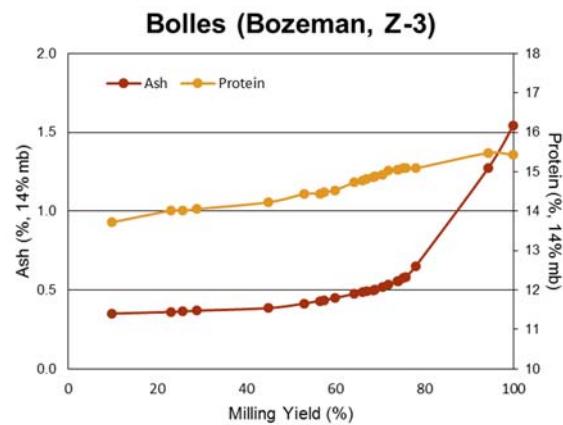
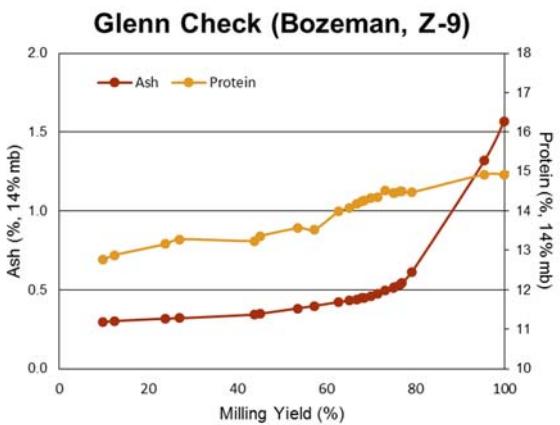
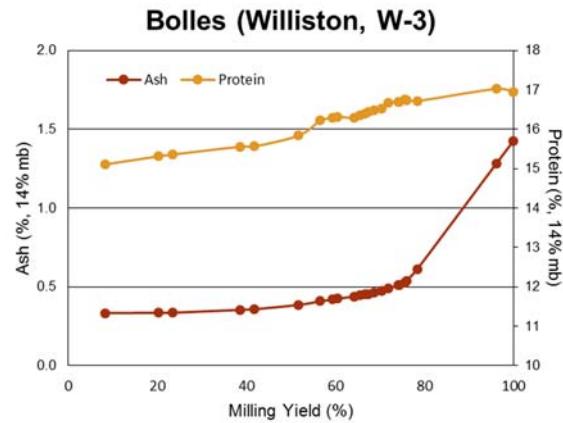
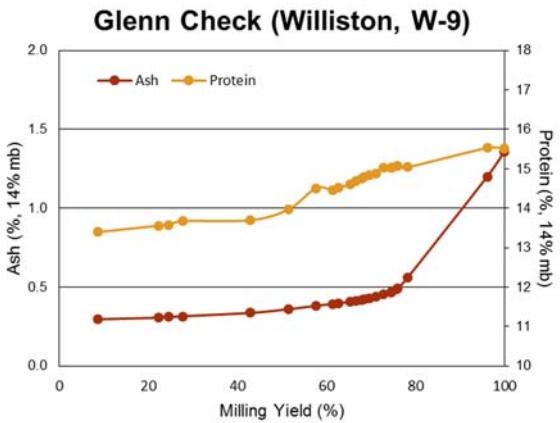
Quality Trait	Watertown		Casselton		Crookston		Williston		Bozeman	
	Glenn B-9	B-3	Glenn C-9	C-3	Glenn K-9	K-3	Glenn W-9	W-3	Glenn Z-9	Z-3
<b>I. USDA-ARS WQL Data</b>										
1 Wheat Protein (%, 12% mb)	15.5	13.7	14.9	15.8	15.5	16.2	15.7	17.0	15.1	15.9
2 Flour Protein (%, 12% mb)	14.5	13.1	14.4	15.2	15.3	16.2	15.5	17.3	14.5	15.5
3 Market Value (Score 1-6)	4.4	3.7	4.3	4.0	4.7	4.9	4.6	5.0	4.6	4.9
4 Market Value (Score 1-10)	10.0	7.4	10.0	8.4	10.0	9.0	10.0	9.6	10.0	9.2
5 DON (ppm)	nd	nd	0.21	0.98	nd	nd	nd	nd	nd	nd
6 Test Weight (lb/bu)	62.0	59.0	63.4	59.6	64.7	61.8	63.6	61.6	65.4	63.0
7 1000 Kernel Weight (g)	33.3	32.9	31.9	28.1	29.8	32.8	25.9	28.6	37.2	37.7
8 Kernel Size, % Large	75	73	60	50	47	68	9	23	79	83
9 Kernel Size, % Small	5	7	7	12	11	7	21	10	4	5
10 Wheat Moisture (%)	10.9	11.0	10.7	10.3	10.3	10.9	9.2	10.3	10.3	10.1
11 Wheat Ash (%, 14% mb)	1.63	1.63	1.77	1.76	1.42	1.60	1.39	1.43	1.58	1.58
12 Wheat Falling Number (sec)	366	430	390	462	387	415	390	501	347	347
13 SKCS Hardness Index	76.2	75.7	83.0	83.2	85.6	87.5	78.8	73.6	82.5	77.2
14 Vitreous Kernels (%)	76.2	47.3	85.7	86.6	95.6	97.4	98.7	98.4	96.4	95.4
<b>Flour Extraction (%)</b>										
15 Tempered Wheat Basis (%)	70.6	72.0	72.7	70.7	73.5	72.6	71.2	70.0	71.5	70.1
16 Total Product Basis (%)	73.5	73.7	73.7	72.8	74.8	74.2	72.9	72.0	73.2	72.0
17 Flour/Bu Wheat (lbs)	43.4	42.3	46.0	43.4	47.8	45.1	45.7	43.6	47.2	44.0
<b>Flour Quality</b>										
18 Flour Color Brightness ( $L^*$ )	89.8	90.0	89.6	89.4	90.0	89.6	89.9	89.4	89.7	89.7
19 Flour Color Yellowness ( $b^*$ )	8.0	8.5	8.9	9.7	8.4	9.0	8.4	9.3	8.9	10.0
20 Flour Moisture (%)	12.4	12.8	13.0	14.4	12.7	13.4	12.9	13.5	12.9	12.4
21 Flour Ash (%, 14% mb)	0.49	0.51	0.51	0.53	0.44	0.50	0.46	0.47	0.50	0.52
22 Flour Falling Number (Malted) (sec)	251	249	250	243	250	247	256	250	251	244
<b>Farinograph</b>										
23 Water Absorption (%, 500 BU)	65.5	62.1	64.6	61.2	63.9	64.6	65.2	64.8	71.0	68.5
24 Water Absorption (%, 14% mb)	63.4	60.5	63.3	61.7	62.1	64.0	64.5	64.3	69.6	66.6
25 Arrival Time (min)	2.7	2.7	3.8	3.1	4.8	4.6	4.4	6.2	4.5	4.3
26 Peak Time (min)	7.9	8.3	7.5	7.0	9.0	9.2	9.8	10.7	5.9	6.9
27 Dough Stability (min)	11.1	11.8	9.5	13.0	9.6	12.5	14.9	19.2	6.2	5.8
28 Mixing Tolerance Index (MTI) (BU)	25.0	27.0	28.0	11.0	28.0	23.0	12.0	15.0	26.0	40.0
29 Time To Breakdown (TTB) (min)	13.3	13.1	12.8	15.3	14.1	15.9	18.0	20.9	11.1	10.4
<b>II. Cooperator Results</b>										
30 Bake Absorption (Average %)	66.4	64.2	66.0	64.7	66.1	66.5	66.8	66.9	68.3	67.7
31 Loaf Volume (% of Check)		94.7		98.4		100.4		102.4		89.9

## SWQAC #3 - Bolles

	Quality Trait	Watertown		Casselton		Crookston		Williston		Bozeman	
		Glenn B-9	B-3	Glenn C-9	C-3	Glenn K-9	K-3	Glenn W-9	W-3	Glenn Z-9	Z-3
<b>II. Cooperator Results</b>											
32	<b>Mixing Requirement</b> <small>5 = Very Long 4 = Long 3 = Medium 2 = Short 1 = Very Short</small>	3.8	4.0	3.5	3.8	4.2	3.8	4.1	3.8	2.0	1.5
33	<b>Dough Characteristics</b> <small>5 = Bucky – Tough 4 = Strong – Elastic 3 = Medium – Pliable 2 = Mellow – Very Pliable 1 = Weak – Short or Sticky</small>	4.0	3.9	3.6	4.0	3.8	3.8	4.0	4.1	2.4	1.9
34	<b>Mixing Tolerance</b> <small>5 = Much More Tolerance Than Check 4 = More Tolerance Than Check 3 = Tolerance Equivalent To Check 2 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check</small>		3.2		3.5		3.1		3.2		2.1
35	<b>Internal Crumb Color</b> <small>5 = Much Brighter Than Check 4 = Brighter Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		3.1		2.7		2.8		2.6		1.7
36	<b>Internal Grain and Texture</b> <small>5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		3.1		3.2		3.1		3.4		1.8
<b>III. Cooperator Evaluation</b>											
	<b>Quality Traits 1-2: Protein</b> <small>5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		2.2		3.8		3.8		4.2		4.0
	<b>Quality Traits 3-22: Milling</b> <small>5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		3.0		2.2		2.5		2.7		2.3
	<b>Quality Traits 23-36: Baking</b> <small>5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		2.8		3.0		2.9		3.3		1.5
	<b>Quality Traits 1-36: Overall Comparison</b> <small>5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		2.6		3.2		3.2		3.3		1.8

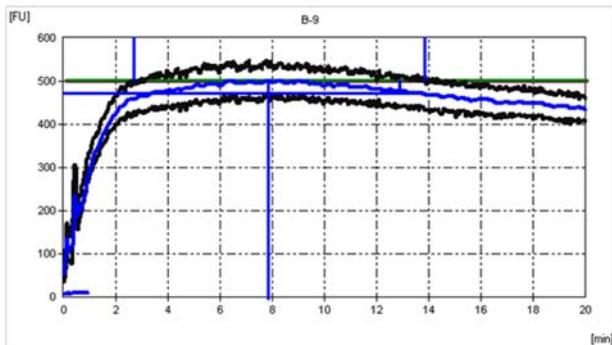
## Cumulative Ash and Protein Curves



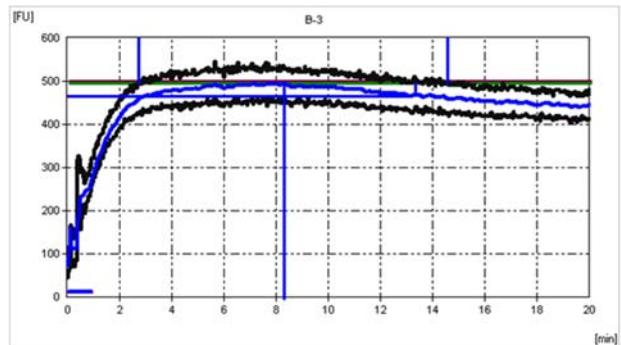


## Farinograms

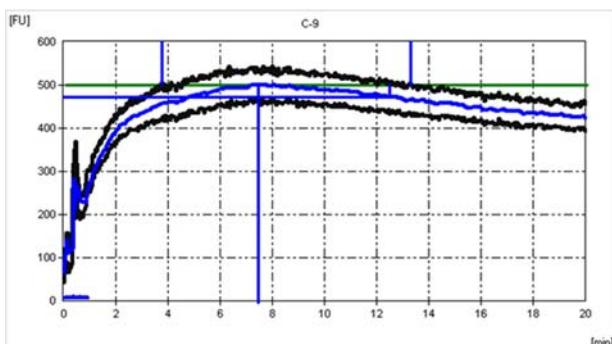
Glenn Check (Watertown, B-9)



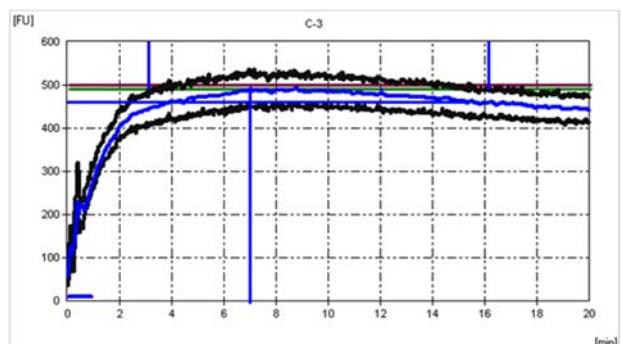
Bolles (Watertown, B-3)



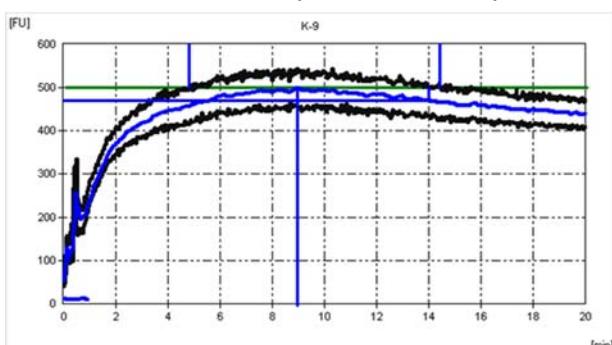
Glenn Check (Casselton, C-9)



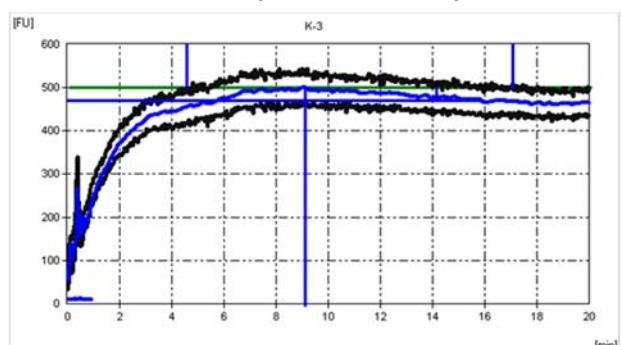
Bolles (Casselton, C-3)



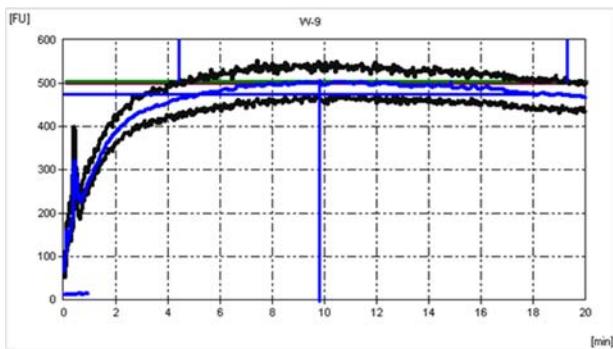
Glenn Check (Crookston, K-9)



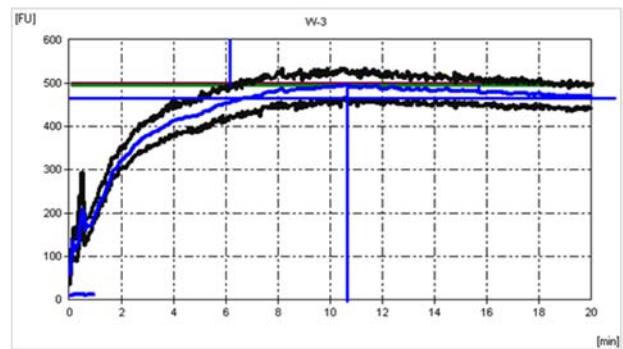
Bolles (Crookston, K-3)



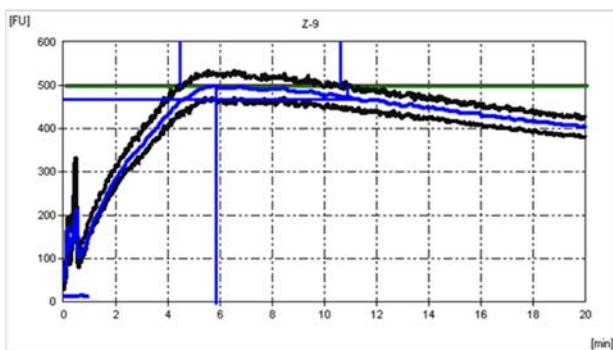
**Glenn Check (Williston, W-9)**



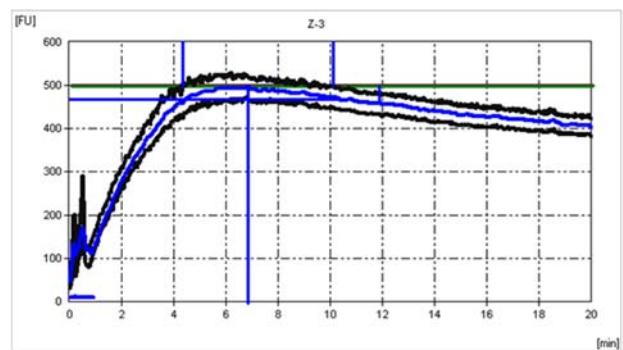
**Bolles (Williston, W-3)**



**Glenn Check (Bozeman, Z-9)**

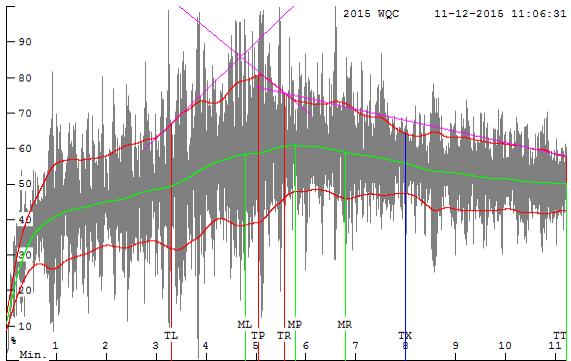


**Bolles (Bozeman, Z-3)**

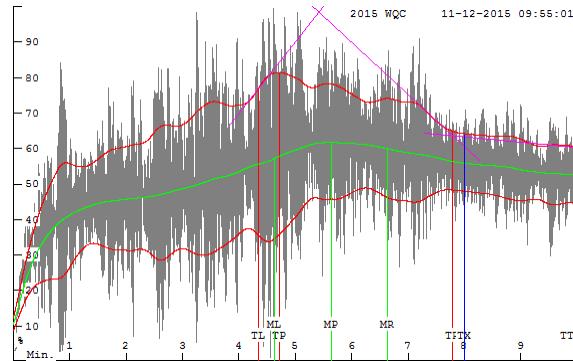


## Mixograms

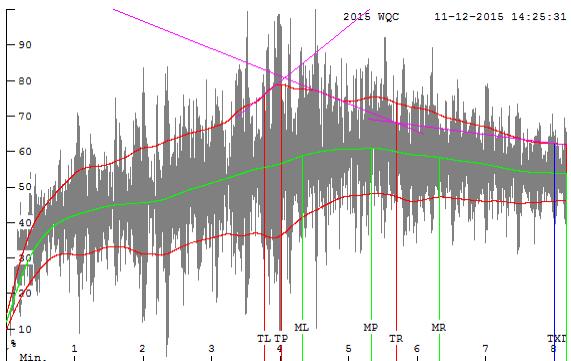
**Glenn Check (Watertown, B-9)**



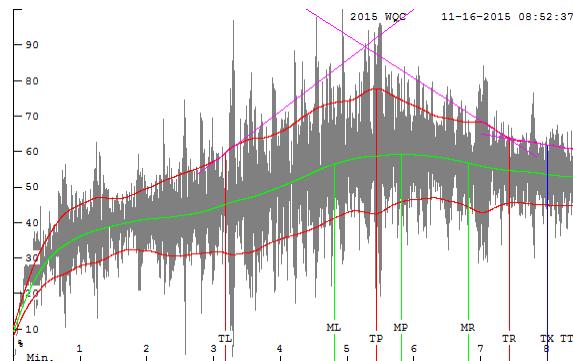
**Bolles (Watertown, B-3)**



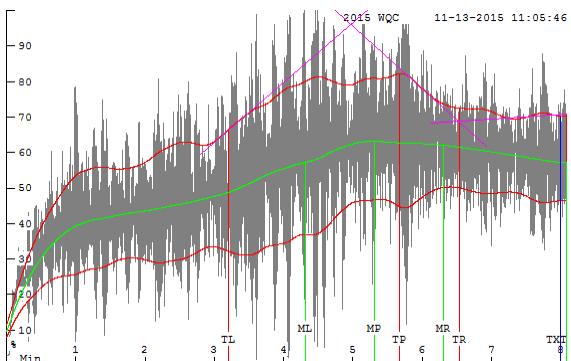
**Glenn Check (Casselton, C-9)**



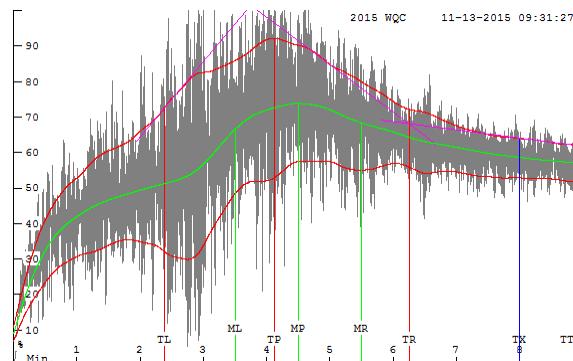
**Bolles (Casselton, C-3)**



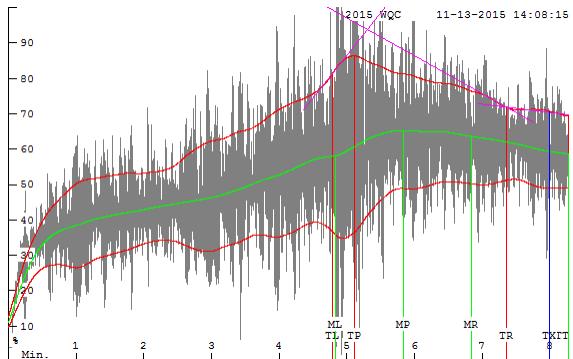
**Glenn Check (Crookston, K-9)**



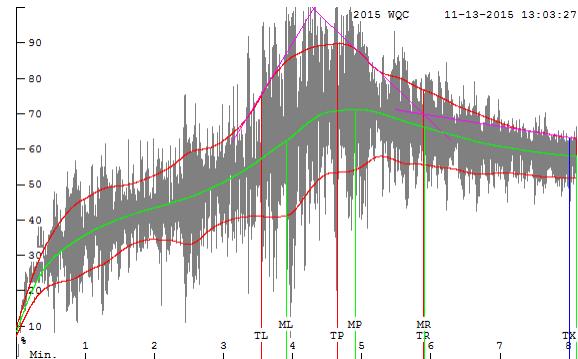
**Bolles (Crookston, K-3)**



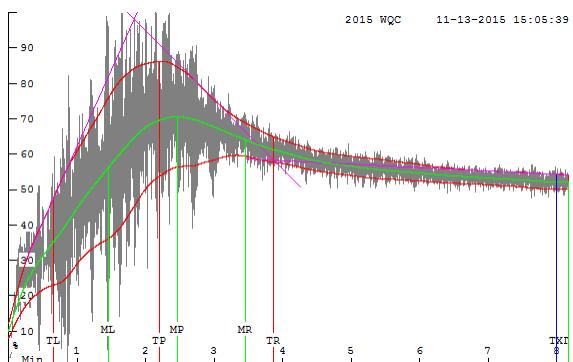
**Glenn Check (Williston, W-9)**



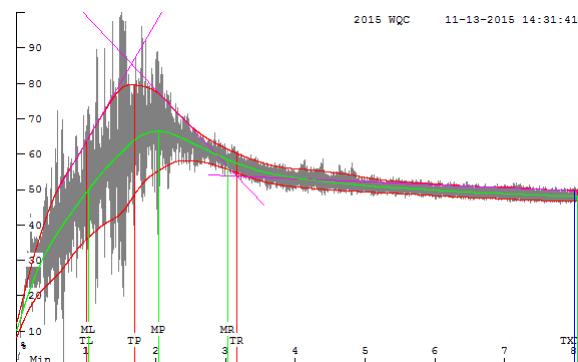
**Bolles (Williston, W-3)**



**Glenn Check (Bozeman, Z-9)**

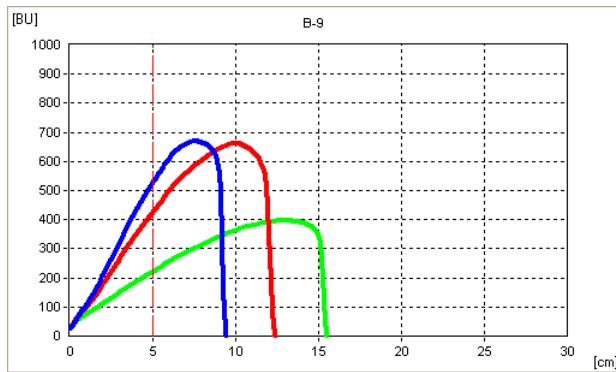


**Bolles (Bozeman, Z-3)**

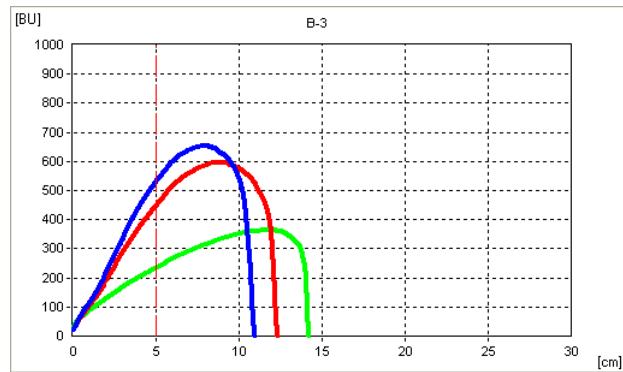


## Extensograms

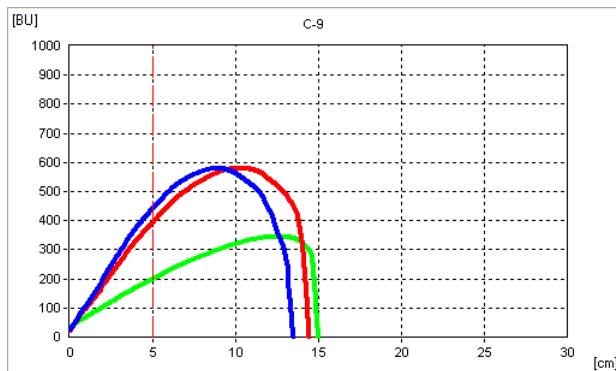
**Glenn Check (Watertown, B-9)**



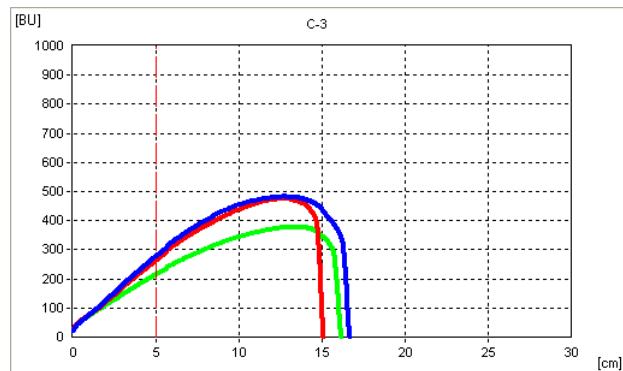
**Bolles (Watertown, B-3)**



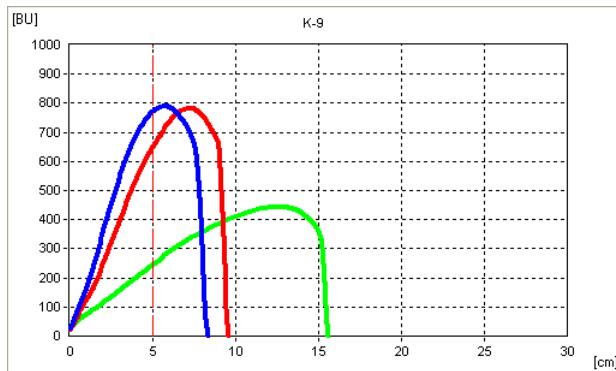
**Glenn Check (Casselton, C-9)**



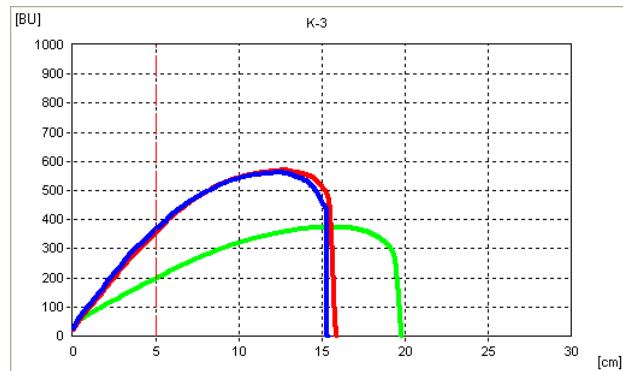
**Bolles (Casselton, C-3)**



**Glenn Check (Crookston, K-9)**

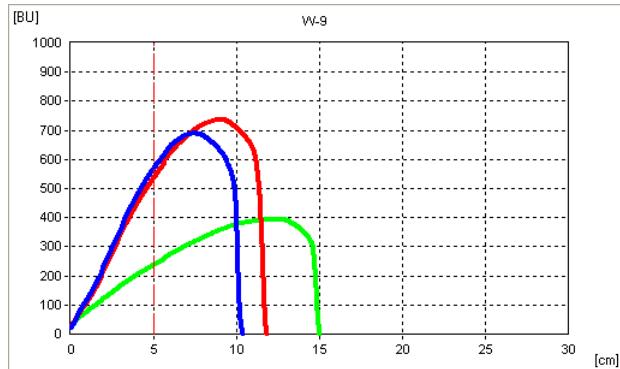


**Bolles (Crookston, K-3)**

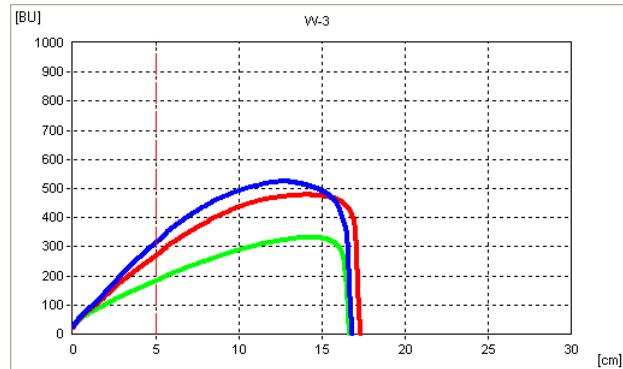


— 45 min; — 90 min; — 135 min

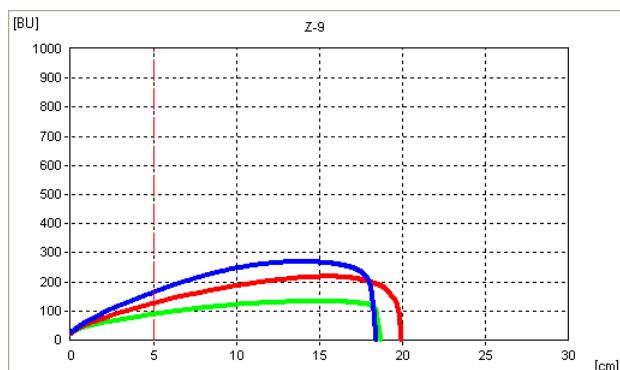
**Glenn Check (Williston, W-9)**



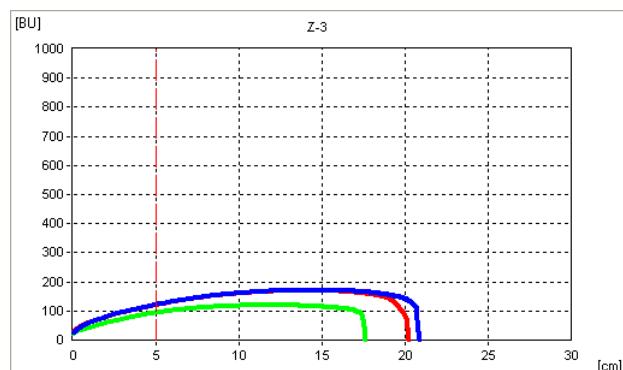
**Bolles (Williston, W-3)**



**Glenn Check (Bozeman, Z-9)**



**Bolles (Bozeman, Z-3)**



— 45 min; — 90 min; — 135 min

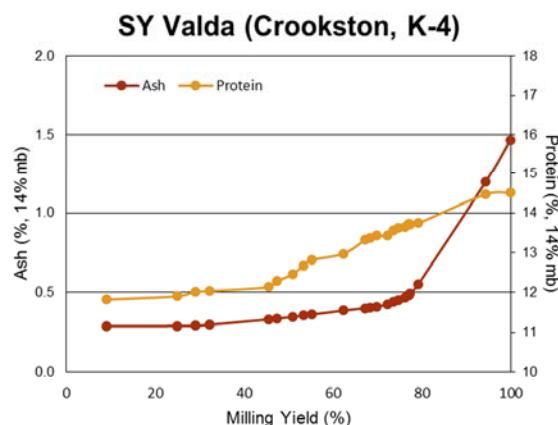
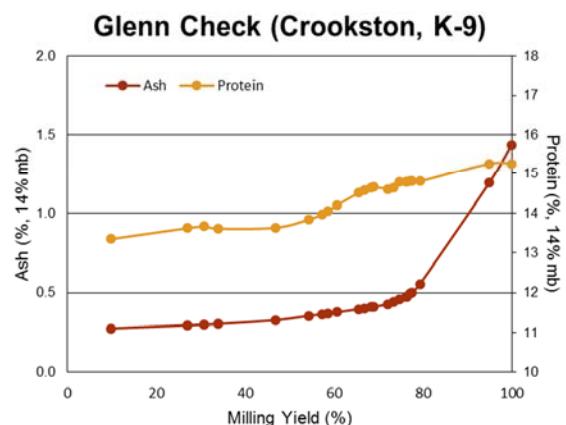
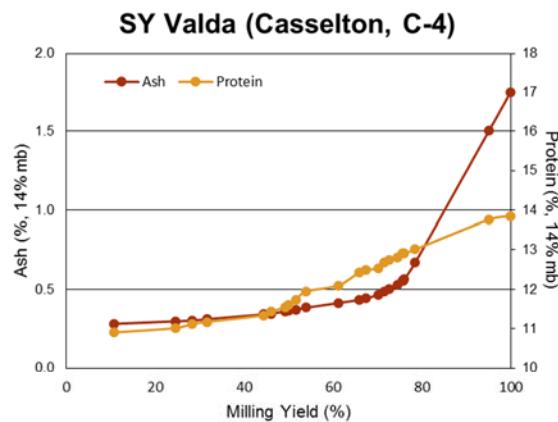
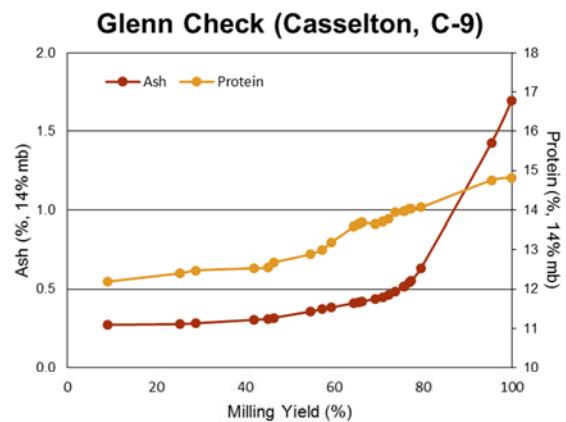
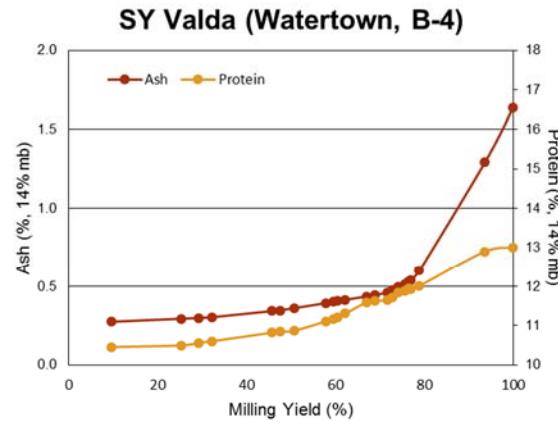
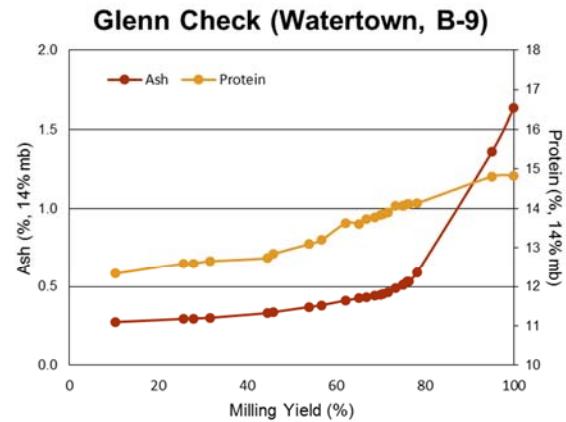
## SWQAC #4 – SY Valda

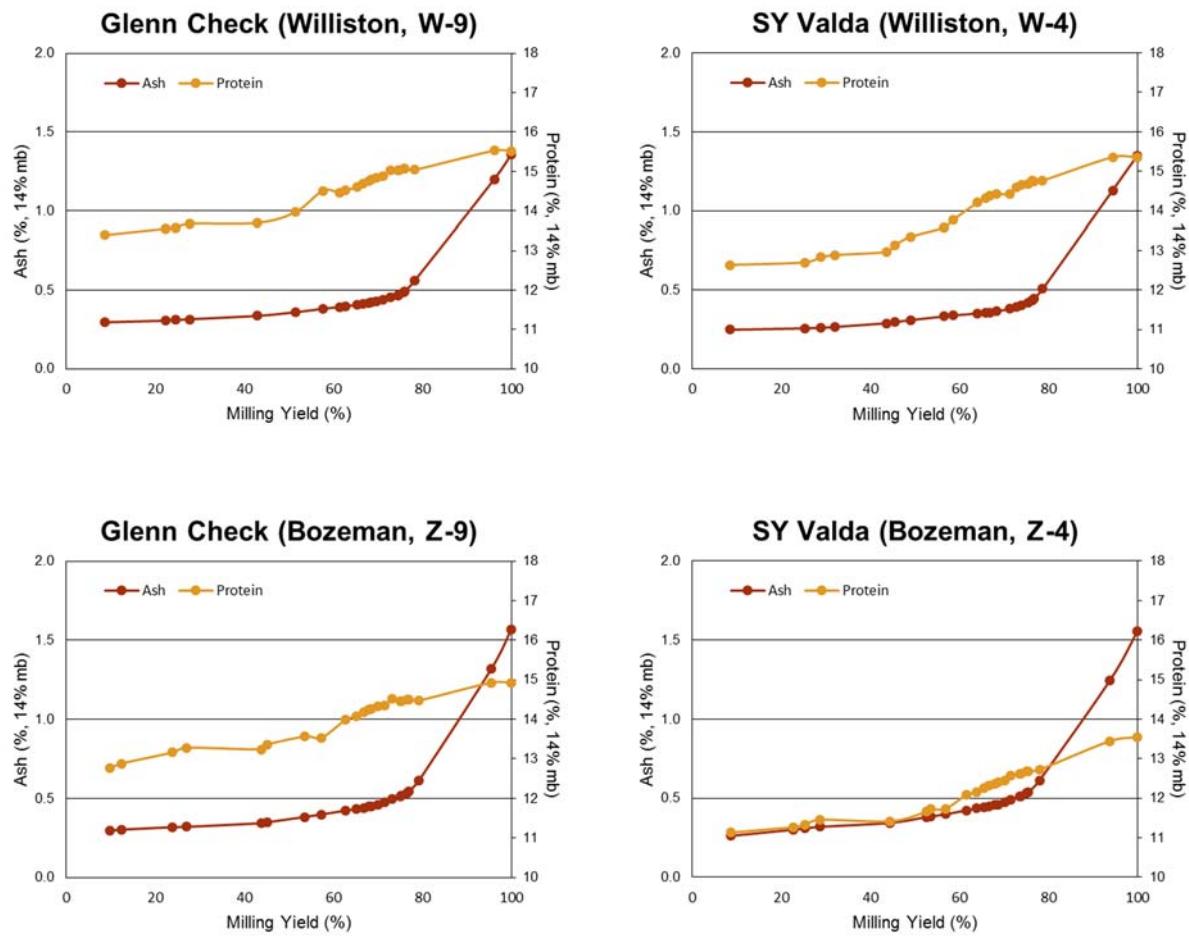
Quality Trait	Watertown		Casselton		Crookston		Williston		Bozeman	
	Glenn B-9	B-4	Glenn C-9	C-4	Glenn K-9	K-4	Glenn W-9	W-4	Glenn Z-9	Z-4
<b>I. USDA-ARS WQL Data</b>										
1 Wheat Protein (%, 12% mb)	15.5	13.0	14.9	13.8	15.5	14.4	15.7	15.3	15.1	13.6
2 Flour Protein (%, 12% mb)	14.5	11.8	14.4	12.8	15.3	13.9	15.5	15.4	14.5	12.9
3 Market Value (Score 1-6)	4.4	3.6	4.3	3.5	4.7	4.6	4.6	4.6	4.6	4.2
4 Market Value (Score 1-10)	10.0	6.8	10.0	7.2	10.0	8.0	10.0	9.2	10.0	8.4
5 DON (ppm)	nd	nd	0.21	0.15	nd	nd	nd	nd	nd	nd
6 Test Weight (lb/bu)	62.0	59.9	63.4	60.2	64.7	62.3	63.6	61.4	65.4	63.5
7 1000 Kernel Weight (g)	33.3	32.4	31.9	29.4	29.8	32.7	25.9	27.0	37.2	38.6
8 Kernel Size, % Large	75	72	60	56	47	62	9	22	79	85
9 Kernel Size, % Small	5	7	7	10	11	7	21	18	4	4
10 Wheat Moisture (%)	10.9	11.3	10.7	10.3	10.3	10.6	9.2	9.1	10.3	10.1
11 Wheat Ash (%, 14% mb)	1.63	1.57	1.77	1.73	1.42	1.49	1.39	1.33	1.58	1.53
12 Wheat Falling Number (sec)	366	409	390	411	387	417	390	452	347	335
13 SKCS Hardness Index	76.2	66.6	83.0	78.1	85.6	79.1	78.8	68.8	82.5	85.3
14 Vitreous Kernels (%)	76.2	40.1	85.7	66.5	95.6	96.1	98.7	97.7	96.4	93.6
<b>Flour Extraction (%)</b>										
15 Tempered Wheat Basis (%)	70.6	72.5	72.7	71.2	73.5	73.1	71.2	72.7	71.5	69.6
16 Total Product Basis (%)	73.5	74.2	73.7	72.7	74.8	74.7	72.9	74.1	73.2	71.5
17 Flour/Bu Wheat (lbs)	43.4	43.3	46.0	43.6	47.8	46.0	45.7	45.2	47.2	44.3
<b>Flour Quality</b>										
18 Flour Color Brightness ( $L^*$ )	89.8	89.6	89.6	89.4	90.0	89.5	89.9	89.5	89.7	89.7
19 Flour Color Yellowness ( $b^*$ )	8.0	7.8	8.9	8.5	8.4	8.0	8.4	8.1	8.9	8.1
20 Flour Moisture (%)	12.4	12.9	13.0	14.2	12.7	13.4	12.9	13.4	12.9	12.7
21 Flour Ash (%, 14% mb)	0.49	0.51	0.51	0.51	0.44	0.46	0.46	0.40	0.50	0.47
22 Flour Falling Number (Malted) (sec)	251	254	250	251	250	256	256	246	251	250
<b>Farinograph</b>										
23 Water Absorption (%, 500 BU)	65.5	61.3	64.6	60.2	63.9	63.4	65.2	62.6	71.0	68.2
24 Water Absorption (%, 14% mb)	63.4	60.4	63.3	60.4	62.1	62.7	64.5	61.8	69.6	66.4
25 Arrival Time (min)	2.7	3.3	3.8	3.2	4.8	3.7	4.4	4.6	4.5	3.0
26 Peak Time (min)	7.9	6.8	7.5	5.8	9.0	6.0	9.8	9.5	5.9	4.4
27 Dough Stability (min)	11.1	6.2	9.5	6.4	9.6	5.2	14.9	11.6	6.2	2.8
28 Mixing Tolerance Index (MTI) (BU)	25.0	58.0	28.0	40.0	28.0	43.0	12.0	28.0	26.0	84.0
29 Time To Breakdown (TTB) (min)	13.3	9.5	12.8	9.7	14.1	8.7	18.0	15.1	11.1	6.0
<b>II. Cooperator Results</b>										
30 Bake Absorption (Average %)	66.4	62.3	66.0	62.5	66.1	64.4	66.8	64.8	68.3	66.1
31 Loaf Volume (% of Check)		89.5		92.8		96.4		100.8		82.3

## SWQAC #4 – SY Valda

Quality Trait	Watertown		Casselton		Crookston		Williston		Bozeman		
	Glenn B-9	B-4	Glenn C-9	C-4	Glenn K-9	K-4	Glenn W-9	W-4	Glenn Z-9	Z-4	
<b>II. Cooperator Results</b>											
32	<b>Mixing Requirement</b>  5 = Very Long 4 = Long 3 = Medium 2 = Short 1 = Very Short	3.8	3.0	3.5	2.7	4.2	2.5	4.1	3.4	2.0	1.0
33	<b>Dough Characteristics</b>  5 = Bucky – Tough 4 = Strong – Elastic 3 = Medium – Pliable 2 = Mellow – Very Pliable 1 = Weak – Short or Sticky	4.0	3.1	3.6	2.8	3.8	2.8	4.0	3.2	2.4	1.5
34	<b>Mixing Tolerance</b>  5 = Much More Tolerance Than Check 4 = More Tolerance Than Check 3 = Tolerance Equivalent To Check 2 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		1.7		1.9		1.8		2.1		1.2
35	<b>Internal Crumb Color</b>  5 = Much Brighter Than Check 4 = Brighter Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.8		2.8		3.3		3.3		2.1
36	<b>Internal Grain and Texture</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.8		3.2		3.0		3.6		1.8
<b>III. Cooperator Evaluation</b>											
	<b>Quality Traits 1-2: Protein</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		1.3		1.9		2.3		2.8		1.7
	<b>Quality Traits 3-22: Milling</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.1		2.4		2.7		3.7		2.3
	<b>Quality Traits 23-36: Baking</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.2		2.8		2.6		3.2		1.2
	<b>Quality Traits 1-36: Overall Comparison</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.0		2.3		2.8		3.2		1.3

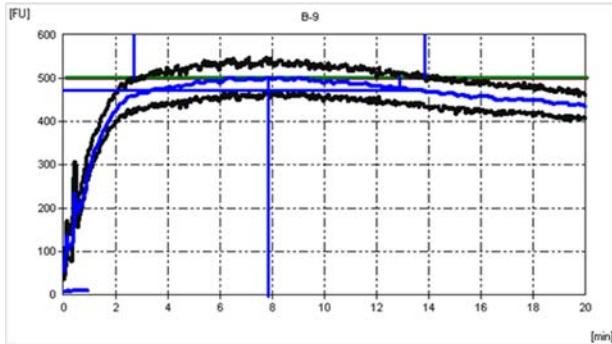
## Cumulative Ash and Protein Curves



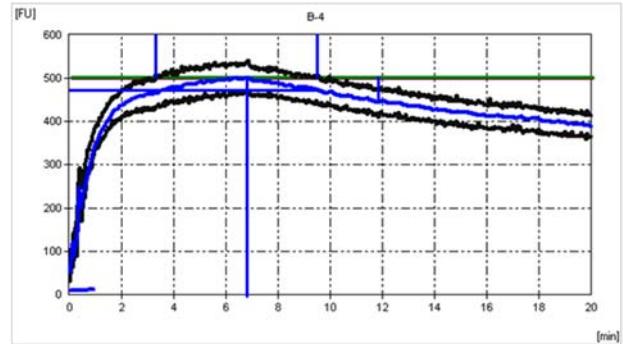


## Farinograms

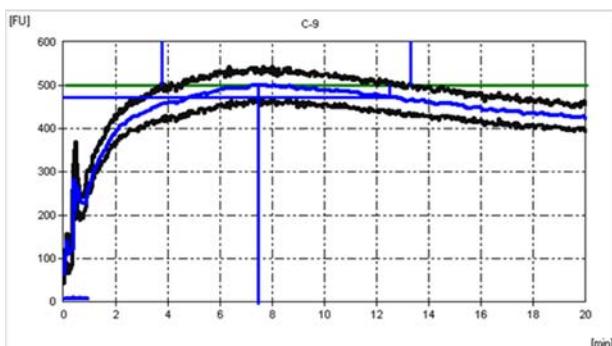
Glenn Check (Watertown, B-9)



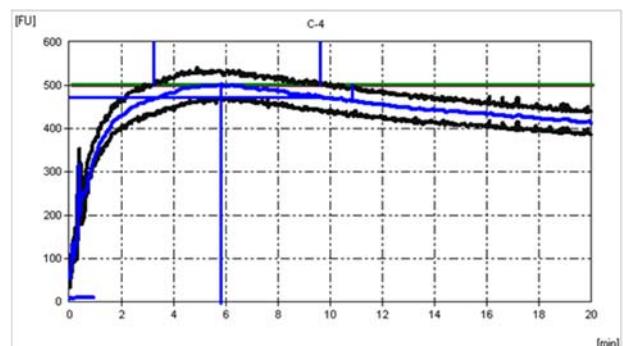
SY Valda (Watertown, B-4)



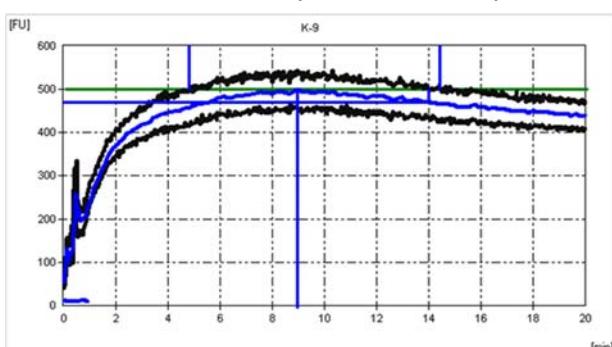
Glenn Check (Casselton, C-9)



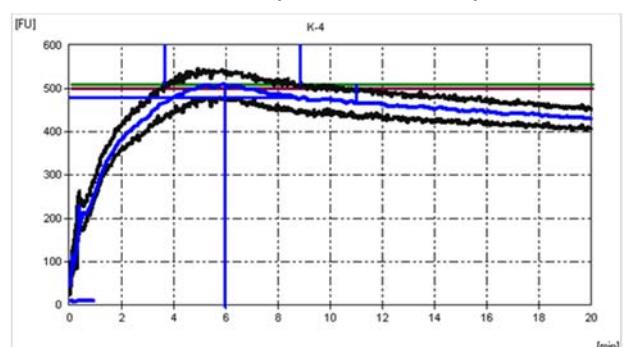
SY Valda (Casselton, C-4)



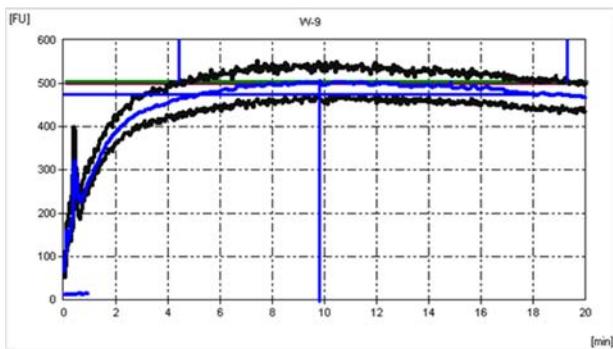
Glenn Check (Crookston, K-9)



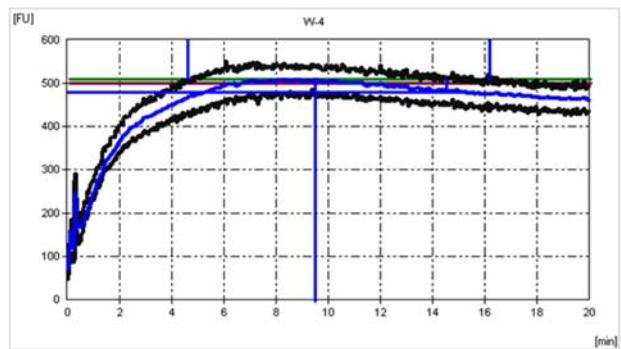
SY Valda (Crookston, K-4)



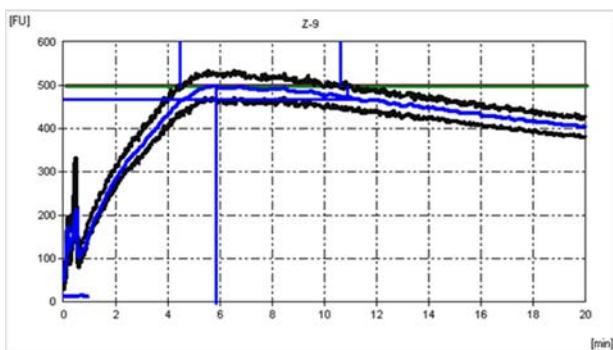
**Glenn Check (Williston, W-9)**



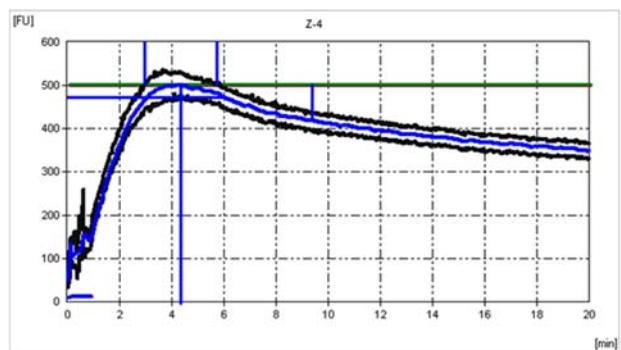
**SY Valda (Williston, W-4)**



**Glenn Check (Bozeman, Z-9)**

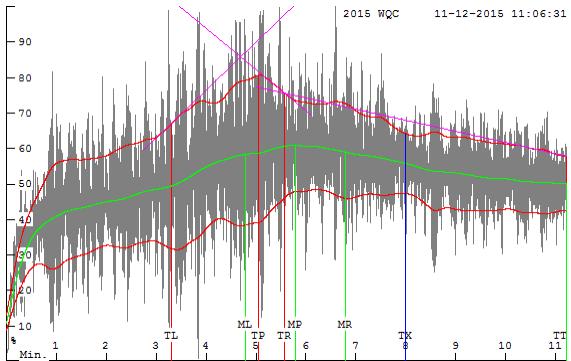


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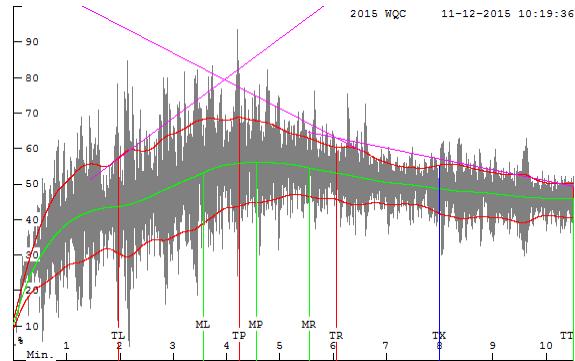


## Mixograms

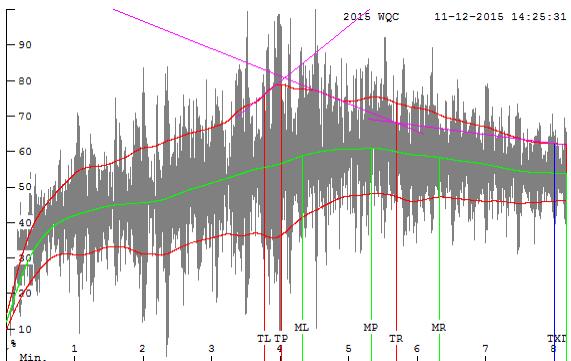
**Glenn Check (Watertown, B-9)**



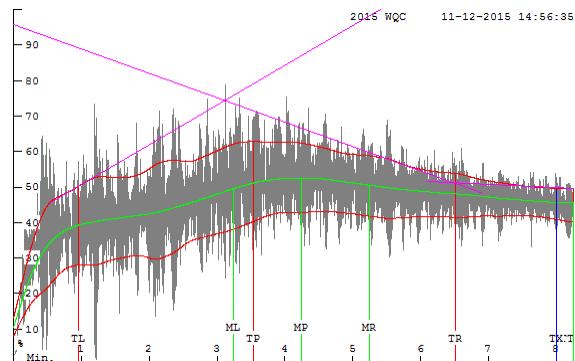
**SY Valda (Watertown, B-4)**



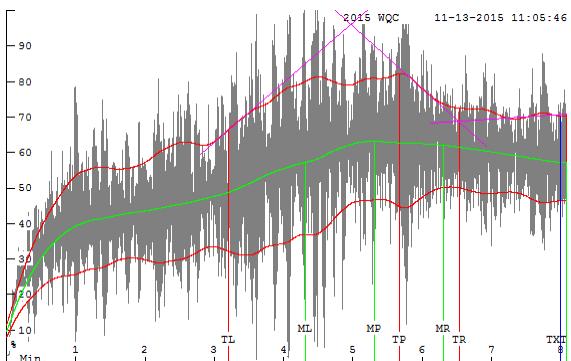
**Glenn Check (Casselton, C-9)**



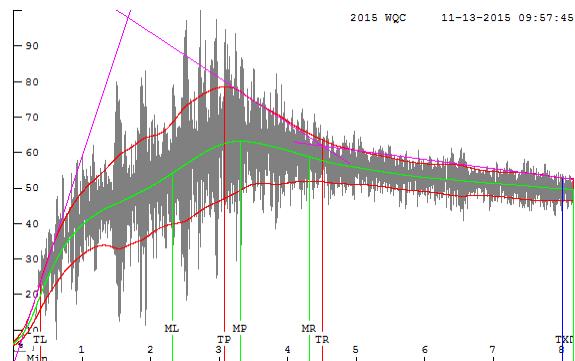
**SY Valda (Casselton, C-4)**



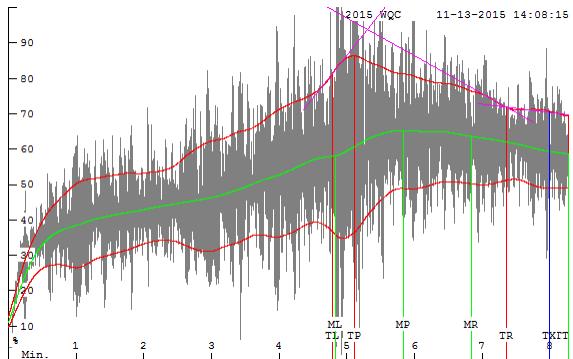
**Glenn Check (Crookston, K-9)**



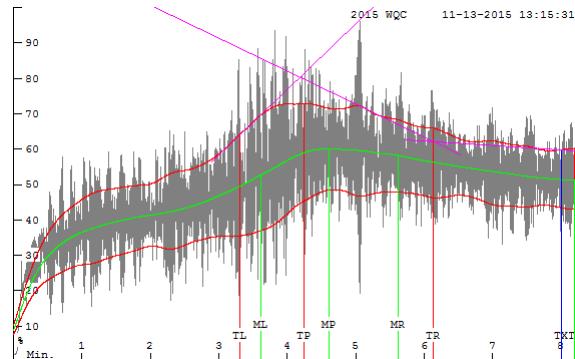
**SY Valda (Crookston, K-4)**



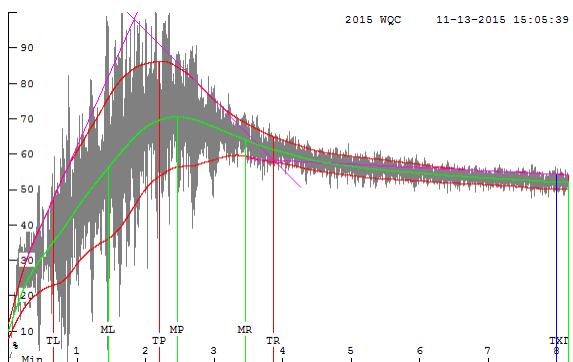
**Glenn Check (Williston, W-9)**



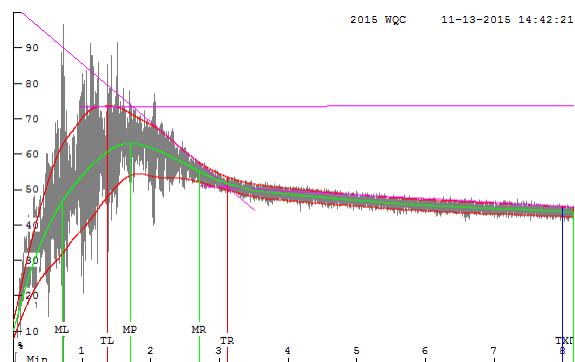
**SY Valda (Williston, W-4)**



**Glenn Check (Bozeman, Z-9)**

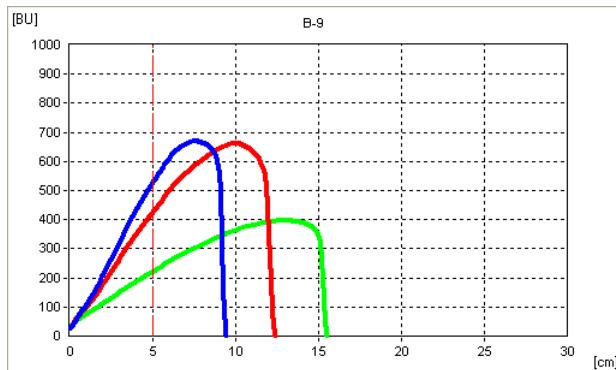


**SY Valda (Bozeman, Z-4)**

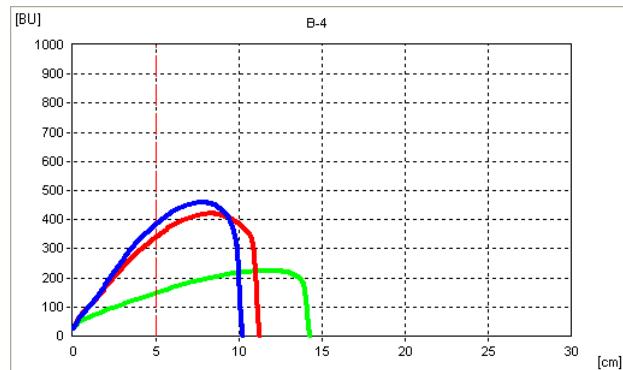


## Extensograms

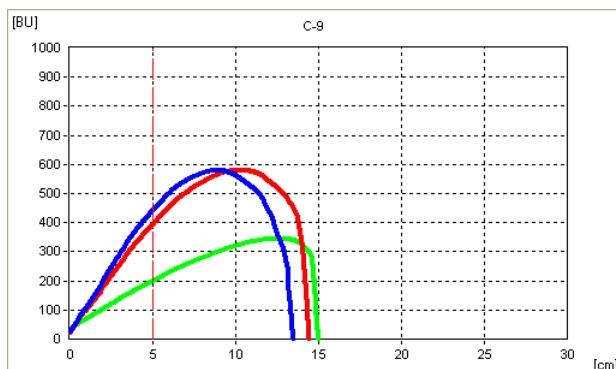
**Glenn Check (Watertown, B-9)**



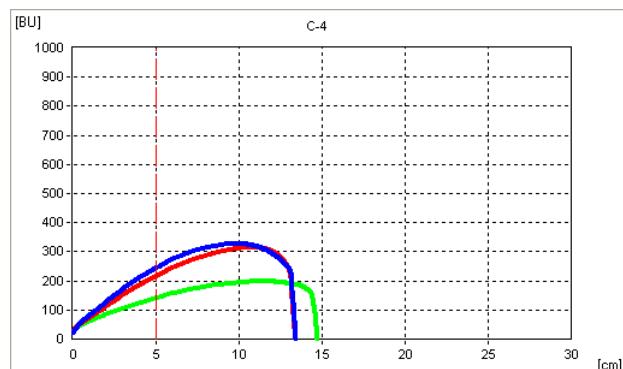
**SY Valda (Watertown, B-4)**



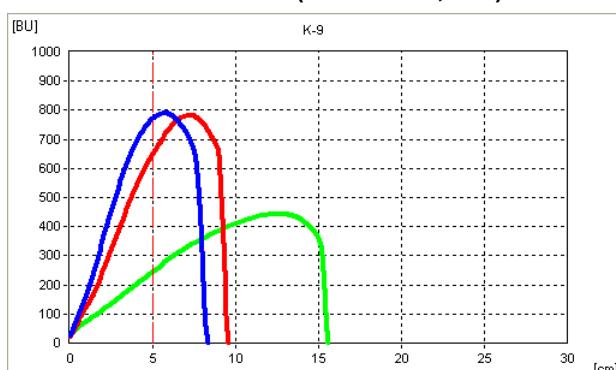
**Glenn Check (Casselton, C-9)**



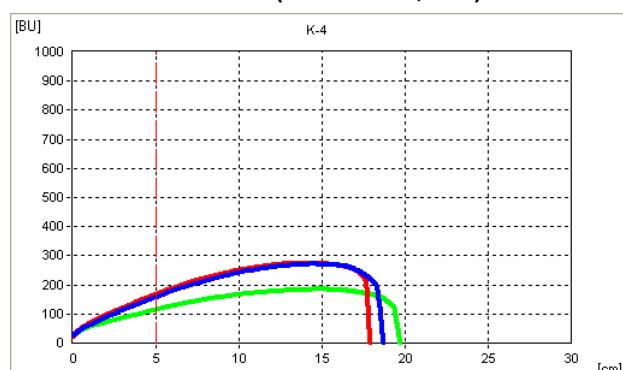
**SY Valda (Casselton, C-4)**



**Glenn Check (Crookston, K-9)**

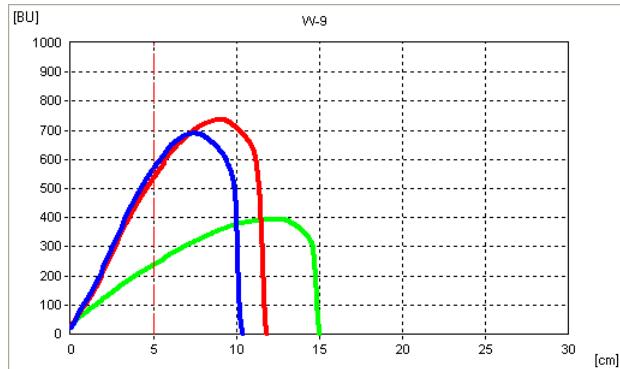


**SY Valda (Crookston, K-4)**

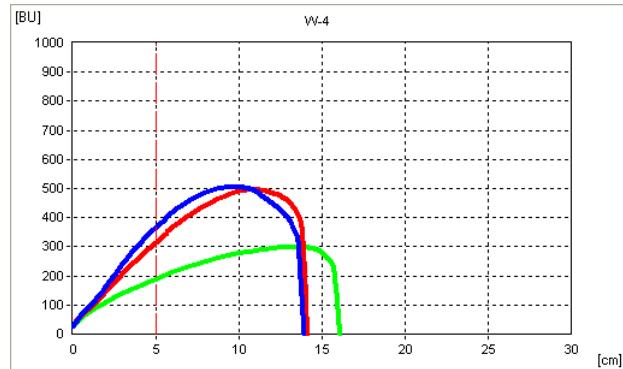


— 45 min; — 90 min; — 135 min

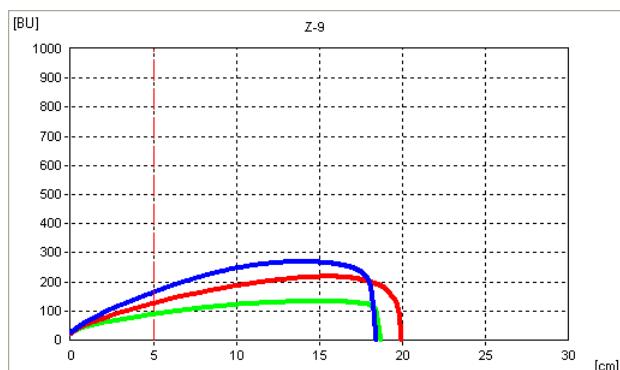
**Glenn Check (Williston, W-9)**



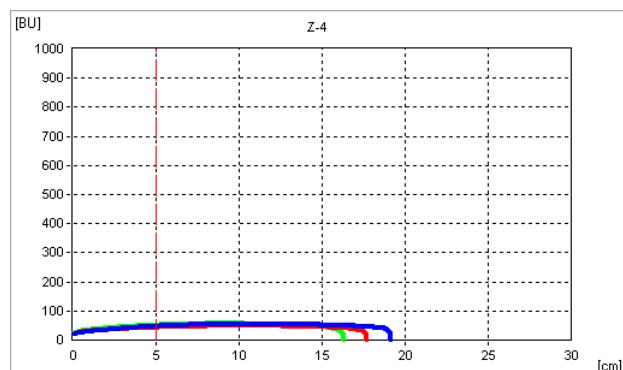
**SY Valda (Williston, W-4)**



**Glenn Check (Bozeman, Z-9)**



**SY Valda (Bozeman, Z-4)**



— 45 min; — 90 min; — 135 min

## SWQAC #5 – LCS Prime

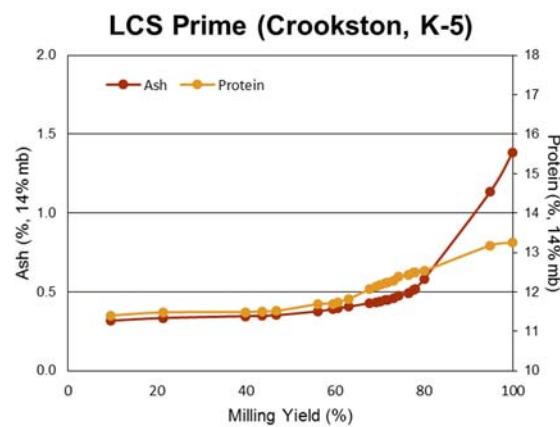
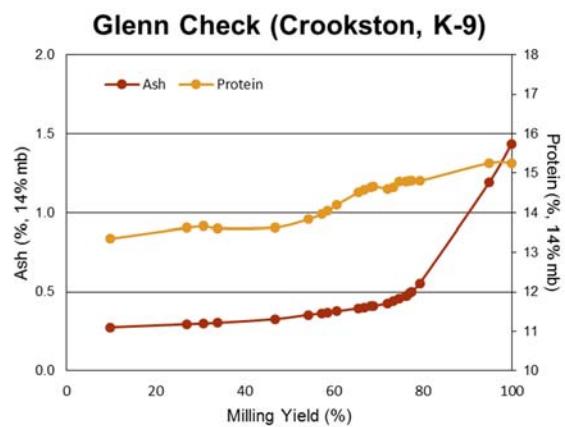
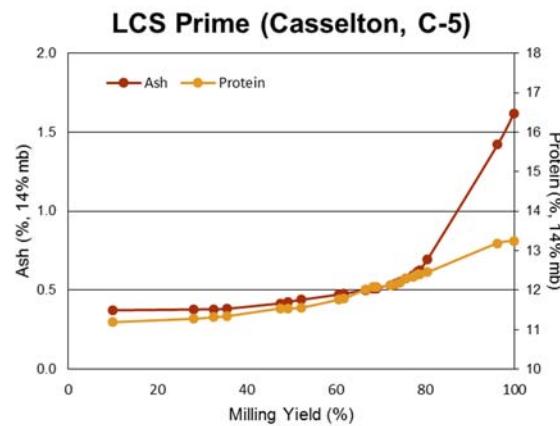
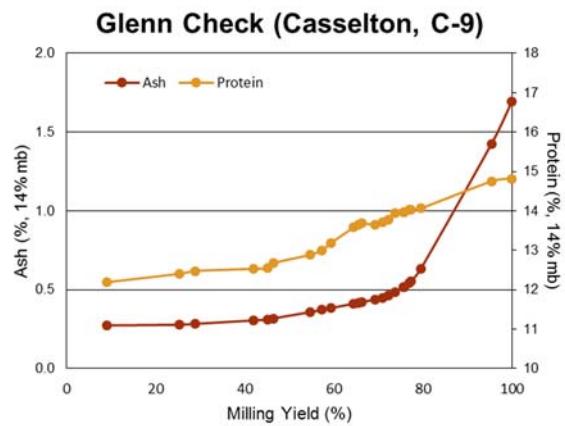
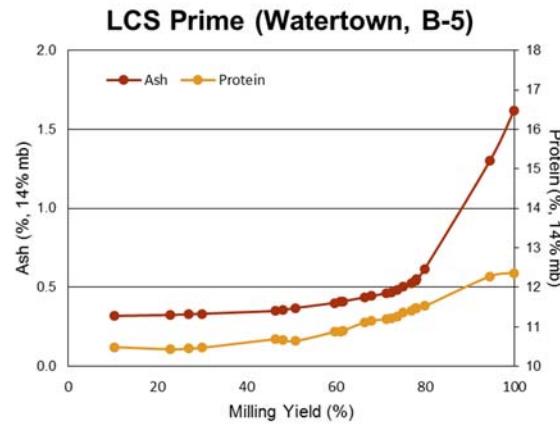
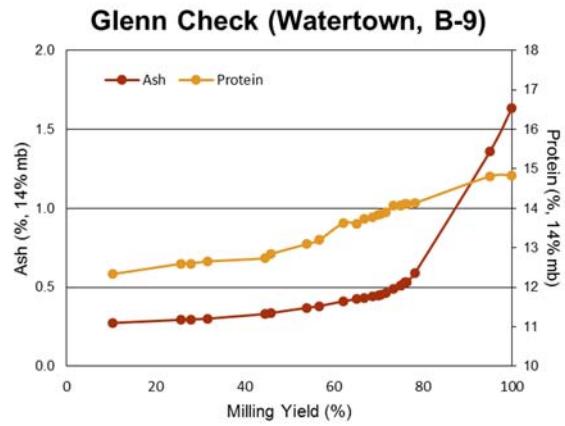
Quality Trait	Watertown		Casselton		Crookston		Williston		Bozeman	
	Glenn B-9	B-5	Glenn C-9	C-5	Glenn K-9	K-5	Glenn W-9	W-5	Glenn Z-9	Z-5
<b>I. USDA-ARS WQL Data</b>										
1 Wheat Protein (%, 12% mb)	15.5	12.7	14.9	13.2	15.5	13.2	15.7	14.0	15.1	13.2
2 Flour Protein (%, 12% mb)	14.5	11.6	14.4	12.1	15.3	12.7	15.5	13.2	14.5	12.4
3 Market Value (Score 1-6)	4.4	3.4	4.3	3.5	4.7	4.1	4.6	4.5	4.6	4.2
4 Market Value (Score 1-10)	10.0	6.2	10.0	7.0	10.0	7.2	10.0	8.2	10.0	8.2
5 DON (ppm)	nd	nd	0.21	0.29	nd	nd	nd	nd	nd	nd
6 Test Weight (lb/bu)	62.0	59.9	63.4	60.5	64.7	63.1	63.6	62.7	65.4	65.7
7 1000 Kernel Weight (g)	33.3	33.4	31.9	29.1	29.8	29.4	25.9	27.6	37.2	40.8
8 Kernel Size, % Large	75	72	60	59	47	47	9	33	79	83
9 Kernel Size, % Small	5	8	7	12	11	14	21	18	4	5
10 Wheat Moisture (%)	10.9	10.9	10.7	10.1	10.3	10.4	9.2	9.3	10.3	10.3
11 Wheat Ash (%, 14% mb)	1.63	1.59	1.77	1.62	1.42	1.44	1.39	1.30	1.58	1.44
12 Wheat Falling Number (sec)	366	396	390	411	387	401	390	428	347	331
13 SKCS Hardness Index	76.2	69.2	83.0	78.5	85.6	95.0	78.8	82.3	82.5	81.9
14 Vitreous Kernels (%)	76.2	36.7	85.7	37.0	95.6	96.8	98.7	94.5	96.4	63.3
<b>Flour Extraction (%)</b>										
15 Tempered Wheat Basis (%)	70.6	73.9	72.7	72.8	73.5	73.8	71.2	72.8	71.5	73.0
16 Total Product Basis (%)	73.5	75.0	73.7	75.7*	74.8	74.4	72.9	73.7	73.2	74.7
17 Flour/Bu Wheat (lbs)	43.4	44.0	46.0	44.4	47.8	46.8	45.7	46.0	47.2	48.3
<b>Flour Quality</b>										
18 Flour Color Brightness ( $L^*$ )	89.8	89.7	89.6	89.4	90.0	89.8	89.9	90.0	89.7	89.9
19 Flour Color Yellowness ( $b^*$ )	8.0	8.1	8.9	8.5	8.4	8.4	8.4	8.3	8.9	8.0
20 Flour Moisture (%)	12.4	12.8	13.0	13.4	12.7	13.0	12.9	13.1	12.9	13.0
21 Flour Ash (%, 14% mb)	0.49	0.49	0.51	0.56	0.44	0.47	0.46	0.42	0.50	0.54
22 Flour Falling Number (Malted) (sec)	251	253	250	254	250	248	256	252	251	252
<b>Farinograph</b>										
23 Water Absorption (%, 500 BU)	65.5	59.6	64.6	62.1	63.9	61.8	65.2	62.6	71.0	70.7
24 Water Absorption (%, 14% mb)	63.4	58.0	63.3	61.4	62.1	60.5	64.5	61.7	69.6	69.4
25 Arrival Time (min)	2.7	1.6	3.8	2.3	4.8	2.2	4.4	2.4	4.5	3.0
26 Peak Time (min)	7.9	6.5	7.5	5.5	9.0	6.3	9.8	7.3	5.9	4.2
27 Dough Stability (min)	11.1	10.5	9.5	7.5	9.6	9.7	14.9	12.6	6.2	3.4
28 Mixing Tolerance Index (MTI) (BU)	25.0	27.0	28.0	36.0	28.0	31.0	12.0	23.0	26.0	58.0
29 Time To Breakdown (TTB) (min)	13.3	11.8	12.8	9.9	14.1	11.2	18.0	13.5	11.1	6.8
<b>II. Cooperator Results</b>										
30 Bake Absorption (Average %)	66.4	61.8	66.0	63.4	66.1	63.6	66.8	64.4	68.3	67.2
31 Loaf Volume (% of Check)		92.8		94.5		95.6		98.5		90.0

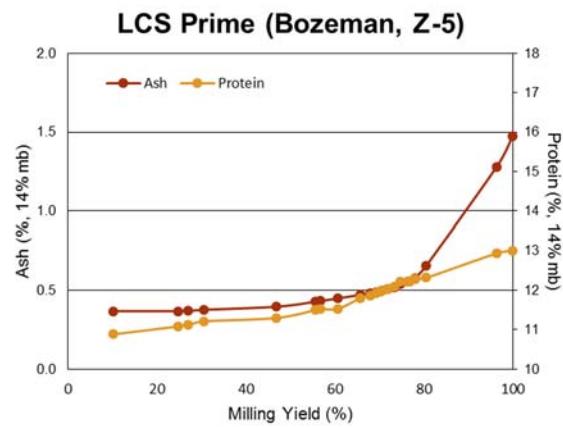
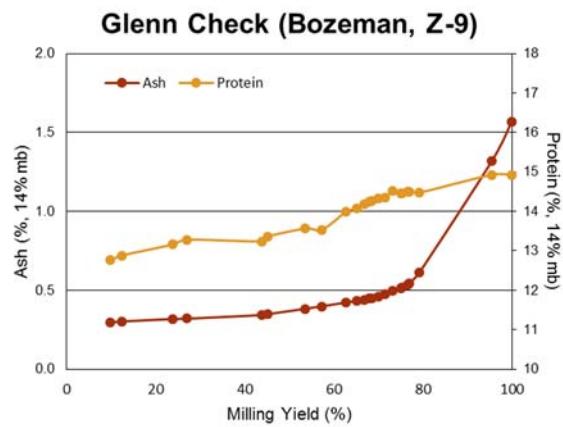
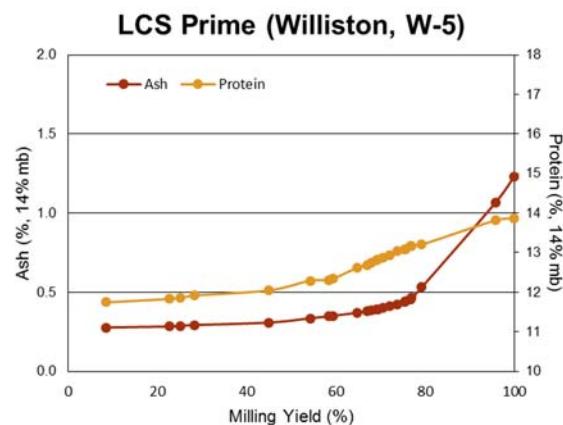
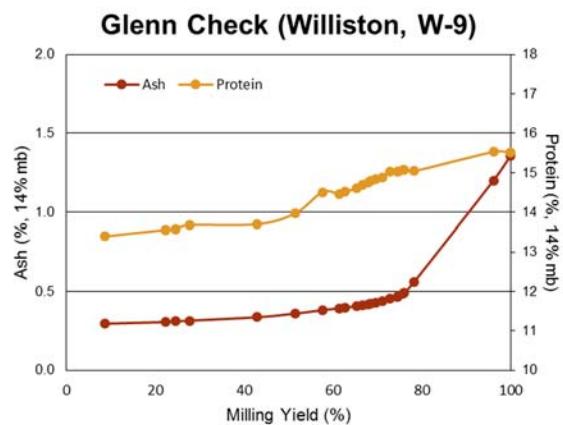
\*Choke at bran pickup was found and cleaned during sample C-5. This affected TPB but not patent flour characteristics.

## SWQAC #5 – LCS Prime

Quality Trait	Watertown		Casselton		Crookston		Williston		Bozeman		
	Glenn B-9	B-5	Glenn C-9	C-5	Glenn K-9	K-5	Glenn W-9	W-5	Glenn Z-9	Z-5	
<b>II. Cooperator Results</b>											
32	<b>Mixing Requirement</b> <small>5 = Very Long 4 = Long 3 = Medium 2 = Short 1 = Very Short</small>	3.8	3.9	3.5	3.3	4.2	3.9	4.1	4.2	2.0	1.2
33	<b>Dough Characteristics</b> <small>5 = Bucky – Tough 4 = Strong – Elastic 3 = Medium – Pliable 2 = Mellow – Very Pliable 1 = Weak – Short or Sticky</small>	4.0	3.8	3.6	3.2	3.8	3.5	4.0	4.0	2.4	1.5
34	<b>Mixing Tolerance</b> <small>5 = Much More Tolerance Than Check 4 = More Tolerance Than Check 3 = Tolerance Equivalent To Check 2 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check</small>		2.7		2.5		2.8		2.8		1.8
35	<b>Internal Crumb Color</b> <small>5 = Much Brighter Than Check 4 = Brighter Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		3.2		2.8		3.0		3.1		2.5
36	<b>Internal Grain and Texture</b> <small>5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		2.8		3.1		3.2		3.3		2.6
<b>III. Cooperator Evaluation</b>											
	<b>Quality Traits 1-2: Protein</b> <small>5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		1.3		1.4		1.5		1.8		1.4
	<b>Quality Traits 3-22: Milling</b> <small>5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		3.5		2.7		2.8		3.8		3.8
	<b>Quality Traits 23-36: Baking</b> <small>5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		2.5		2.9		2.9		3.2		2.0
	<b>Quality Traits 1-36: Overall Comparison</b> <small>5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check</small>		2.2		2.5		2.8		2.9		1.9

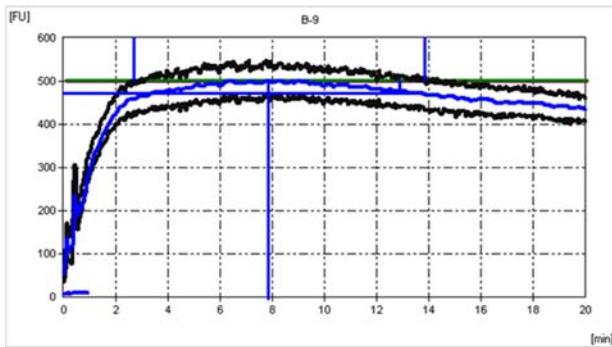
## Cumulative Ash and Protein Curves



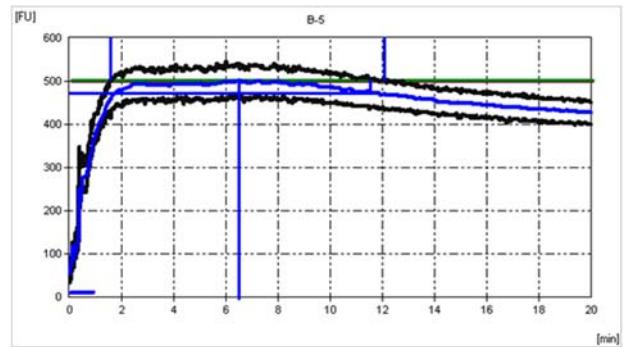


## Farinograms

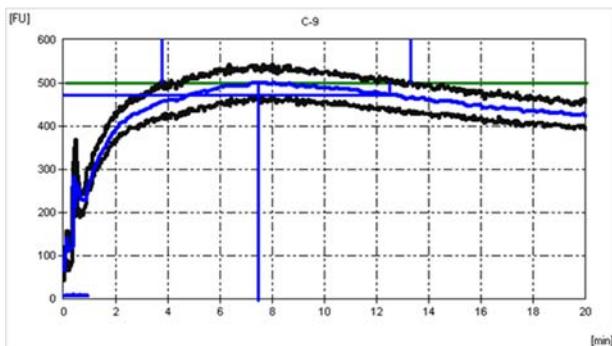
Glenn Check (Watertown, B-9)



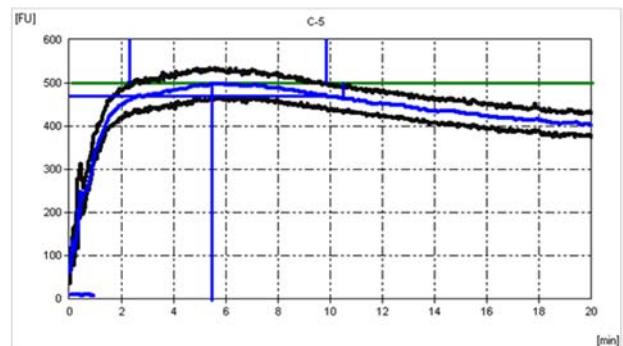
LCS Prime (Watertown, B-5)



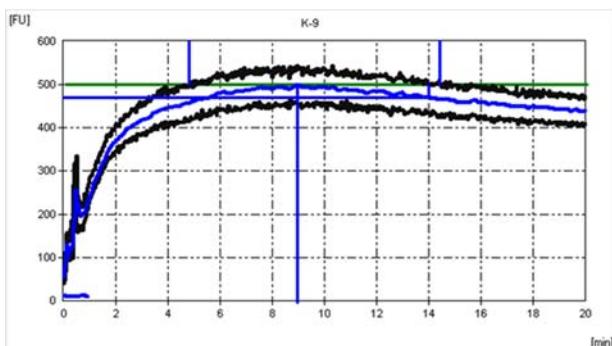
Glenn Check (Casselton, C-9)



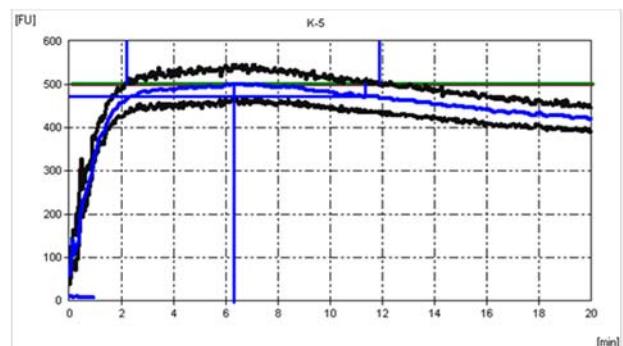
LCS Prime (Casselton, C-5)



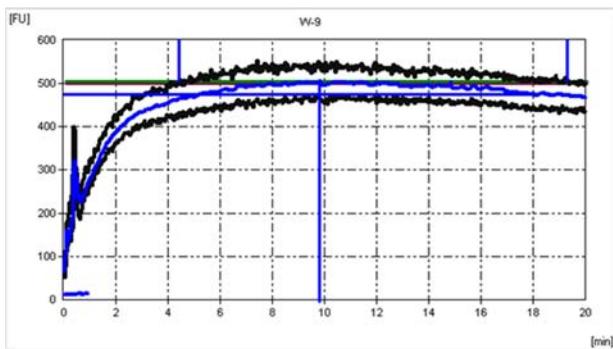
Glenn Check (Crookston, K-9)



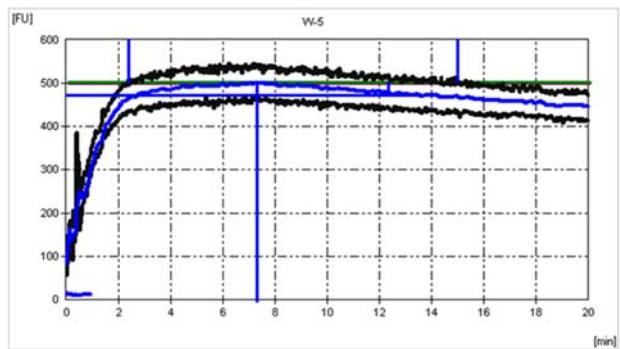
LCS Prime (Crookston, K-5)



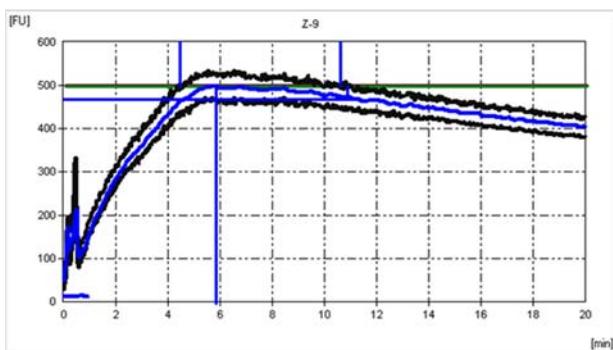
**Glenn Check (Williston, W-9)**



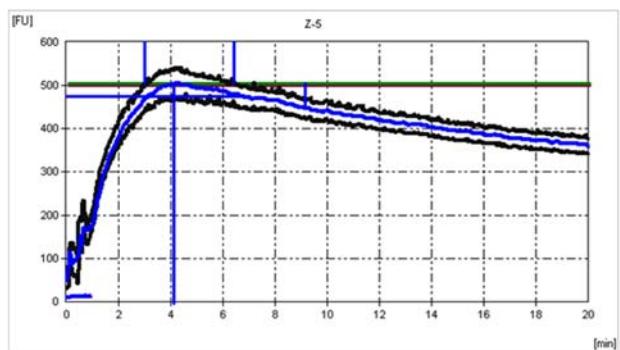
**LCS Prime (Williston, W-5)**



**Glenn Check (Bozeman, Z-9)**

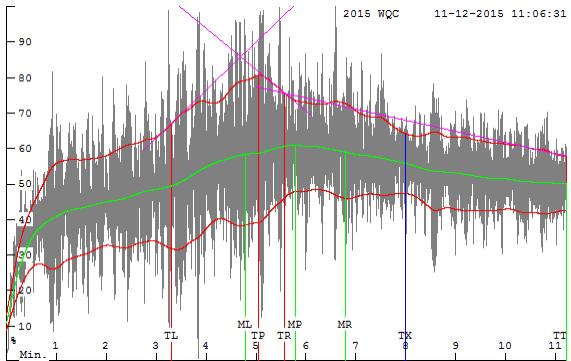


**LCS Prime (Bozeman, Z-5)**

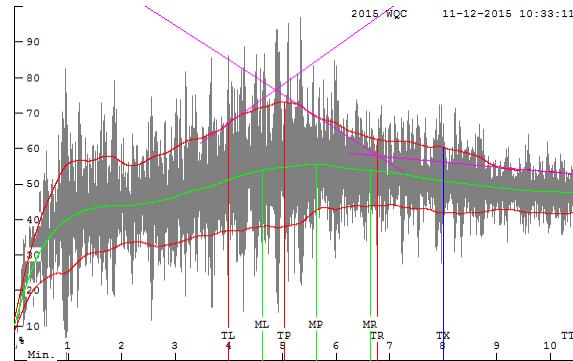


## Mixograms

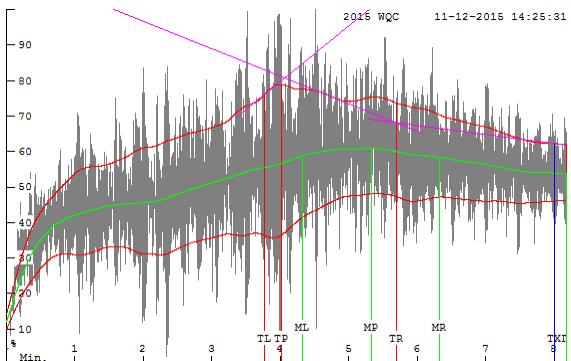
**Glenn Check (Watertown, B-9)**



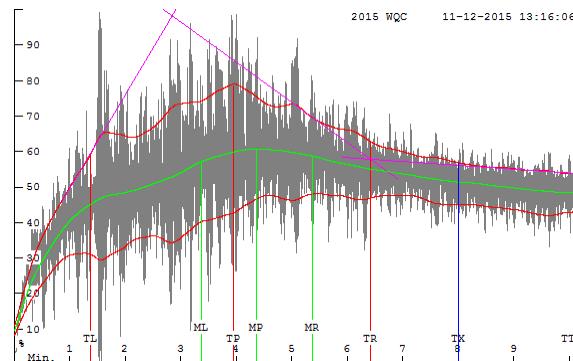
**LCS Prime (Watertown, B-5)**



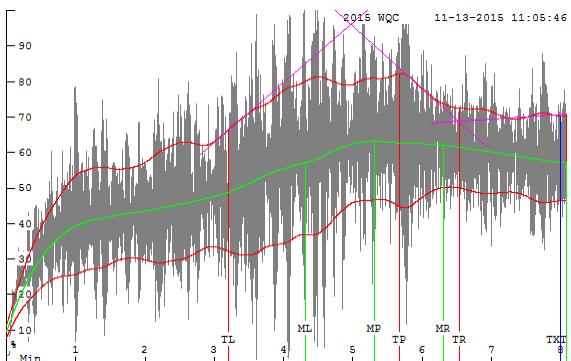
**Glenn Check (Casselton, C-9)**



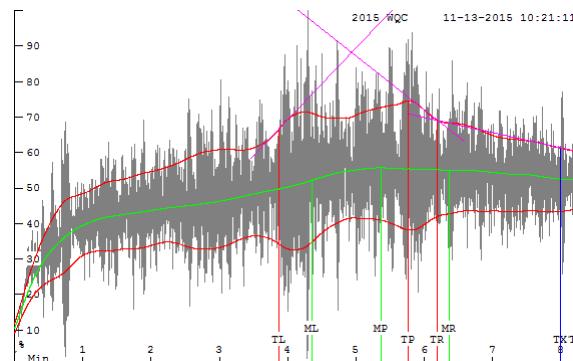
**LCS Prime (Casselton, C-5)**



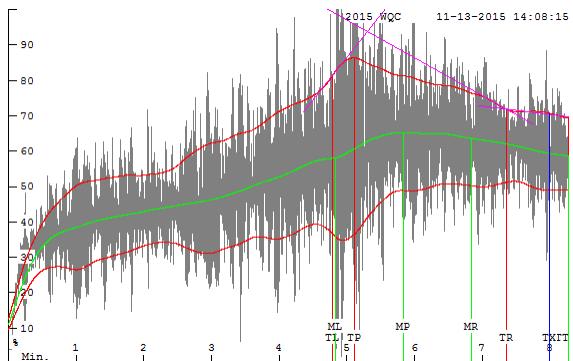
**Glenn Check (Crookston, K-9)**



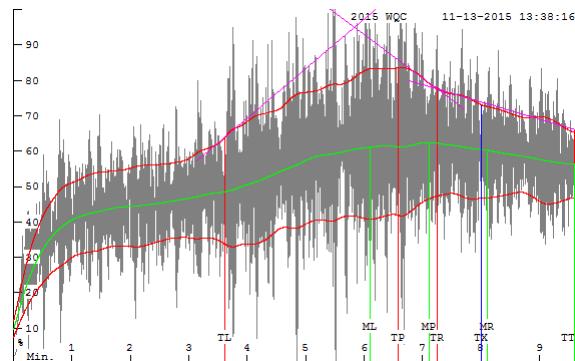
**LCS Prime (Crookston, K-5)**



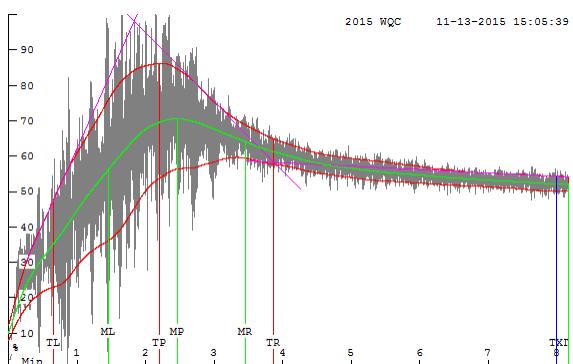
**Glenn Check (Williston, W-9)**



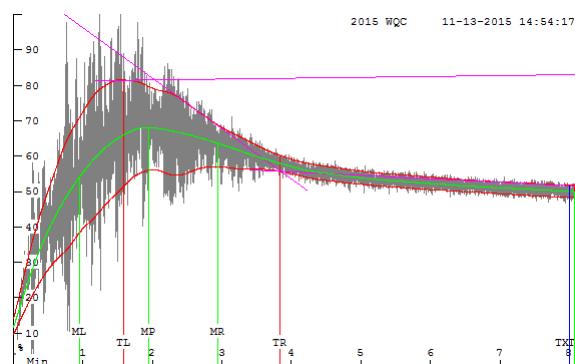
**LCS Prime (Williston, W-5)**



**Glenn Check (Bozeman, Z-9)**

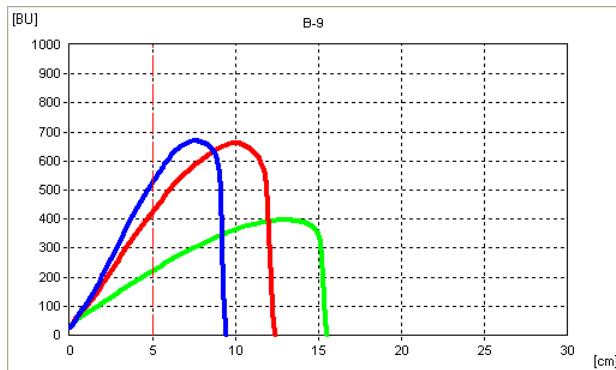


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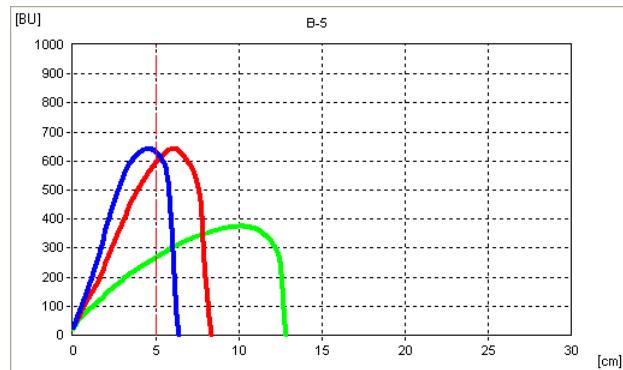


## Extensograms

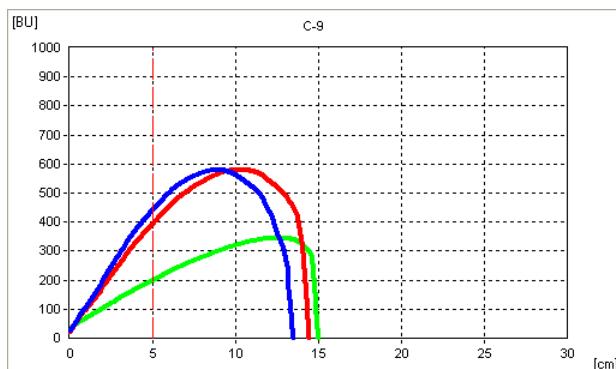
**Glenn Check (Watertown, B-9)**



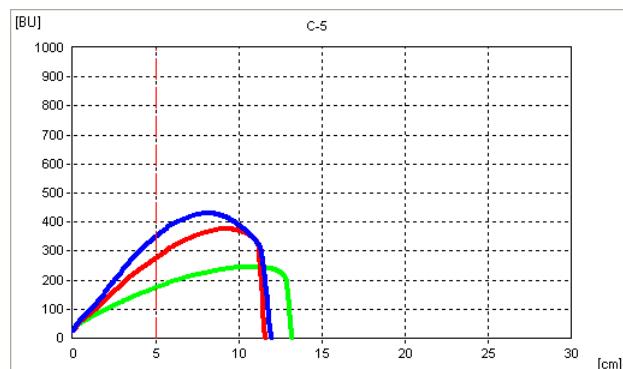
**LCS Prime (Watertown, B-5)**



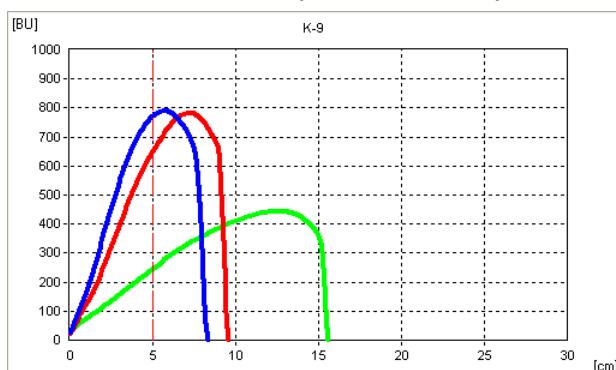
**Glenn Check (Casselton, C-9)**



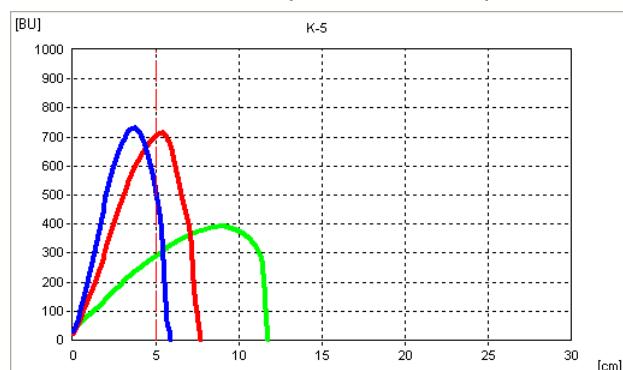
**LCS Prime (Casselton, C-5)**



**Glenn Check (Crookston, K-9)**

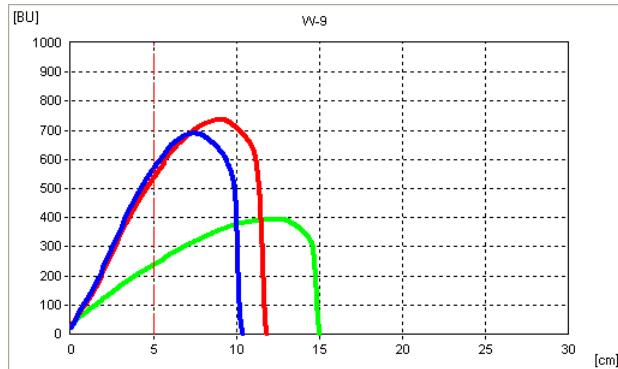


**LCS Prime (Crookston, K-5)**

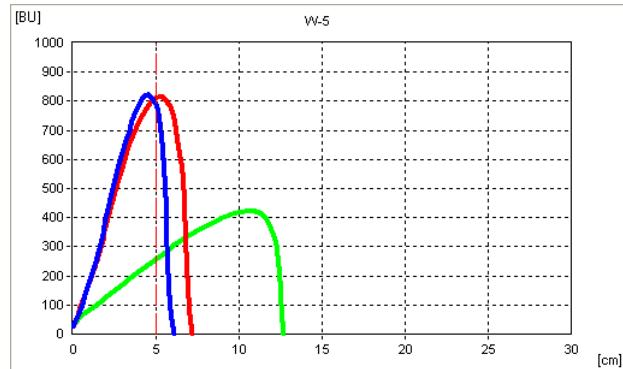


— 45 min; — 90 min; — 135 min

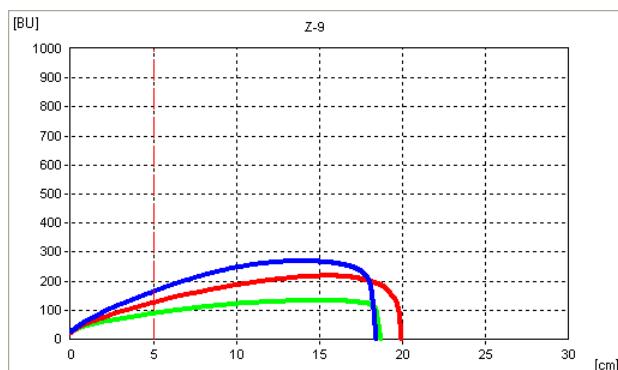
**Glenn Check (Williston, W-9)**



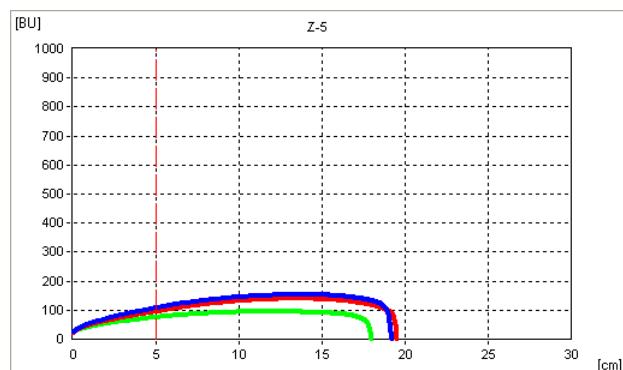
**LCS Prime (Williston, W-5)**



**Glenn Check (Bozeman, Z-9)**



**LCS Prime (Bozeman, Z-5)**



— 45 min; — 90 min; — 135 min

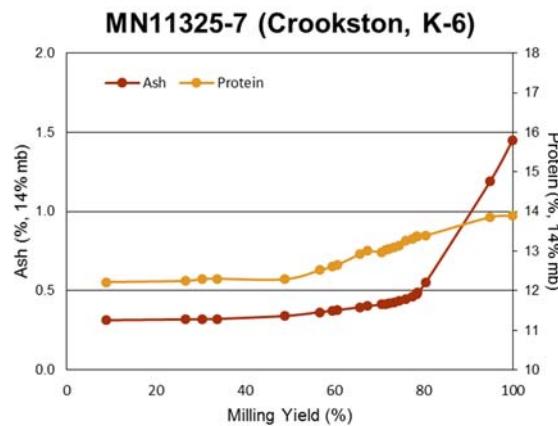
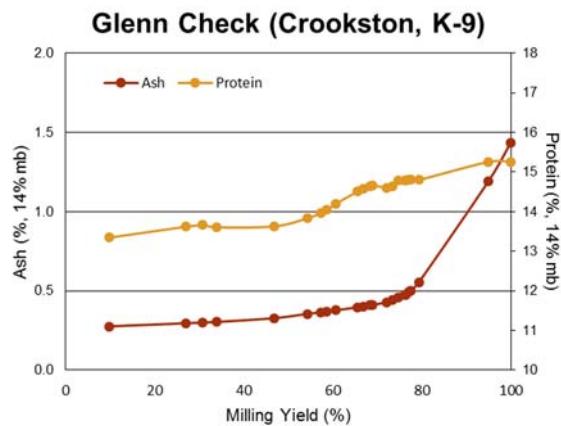
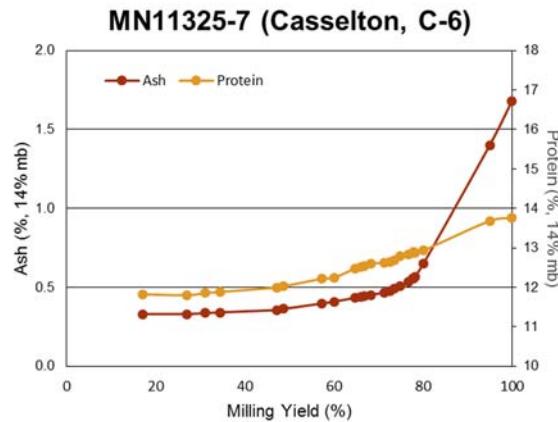
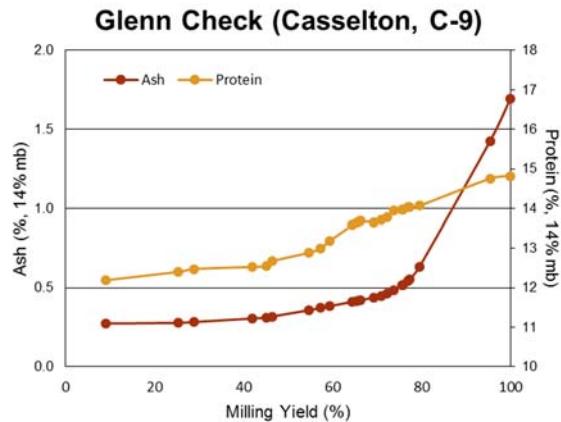
## SWQAC #6 – MN11325-7

	Quality Trait	Casselton		Crookston	
		Glenn C-9	C-6	Glenn K-9	K-6
<b>I. USDA-ARS WQL Data</b>					
1	Wheat Protein (%, 12% mb)	14.9	13.8	15.5	13.8
2	Flour Protein (%, 12% mb)	14.4	13.0	15.3	13.8
3	Market Value (Score 1-6)	4.3	3.5	4.7	4.6
4	Market Value (Score 1-10)	10.0	7.2	10.0	7.8
5	DON (ppm)	0.21	nd	nd	nd
6	Test Weight (lb/bu)	63.4	59.9	64.7	62.7
7	1000 Kernel Weight (g)	31.9	27.9	29.8	32.1
8	Kernel Size, % Large	60	43	47	57
9	Kernel Size, % Small	7	13	11	9
10	Wheat Moisture (%)	10.7	10.1	10.3	11.1
11	Wheat Ash (%, 14% mb)	1.77	1.68	1.42	1.44
12	Wheat Falling Number (sec)	390	456	387	432
13	SKCS Hardness Index	83.0	74.2	85.6	84.1
14	Vitreous Kernels (%)	85.7	59.1	95.6	95.5
<b>Flour Extraction (%)</b>					
15	Tempered Wheat Basis (%)	72.7	73.4	73.5	73.6
16	Total Product Basis (%)	73.7	75.0	74.8	76.0
17	Flour/Bu Wheat (lbs)	46.0	44.4	47.8	46.8
<b>Flour Quality</b>					
18	Flour Color Brightness (L*)	89.6	89.3	90.0	89.9
19	Flour Color Yellowness (b*)	8.9	8.6	8.4	8.0
20	Flour Moisture (%)	13.0	13.3	12.7	13.2
21	Flour Ash (%, 14% mb)	0.51	0.49	0.44	0.44
22	Flour Falling Number (Malted) (sec)	250	251	250	245
<b>Farinograph</b>					
23	Water Absorption (%, 500 BU)	64.6	60.9	63.9	61.0
24	Water Absorption (%, 14% mb)	63.3	60.1	62.1	59.8
25	Arrival Time (min)	3.8	2.4	4.8	2.7
26	Peak Time (min)	7.5	5.5	9.0	8.2
27	Dough Stability (min)	9.5	8.5	9.6	10.0
28	Mixing Tolerance Index (MTI) (BU)	28.0	24.0	28.0	37.0
29	Time To Breakdown (TTB) (min)	12.8	11.0	14.1	12.7
<b>II. Cooperator Results</b>					
30	Bake Absorption (Average %)	66.0	63.0	66.1	63.6
31	Loaf Volume (% of Check)		96.0		96.6

# SWQAC #6 – MN11325-7

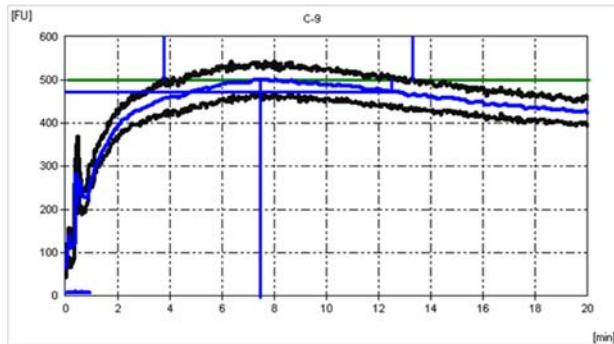
	Quality Trait	Casselton		Crookston	
		Glenn C-9	C-6	Glenn K-9	K-6
<b>II. Cooperator Results</b>					
32	<b>Mixing Requirement</b>  5 = Very Long 4 = Long 3 = Medium 2 = Short 1 = Very Short	3.5	3.0	4.2	3.8
33	<b>Dough Characteristics</b>  5 = Bucky – Tough 4 = Strong – Elastic 3 = Medium – Pliable 2 = Mellow – Very Pliable 1 = Weak – Short or Sticky	3.6	3.1	3.8	3.7
34	<b>Mixing Tolerance</b>  5 = Much More Tolerance Than Check 4 = More Tolerance Than Check 3 = Tolerance Equivalent To Check 2 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		2.5		2.8
35	<b>Internal Crumb Color</b>  5 = Much Brighter Than Check 4 = Brighter Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.7		2.8
36	<b>Internal Grain and Texture</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.3		3.3
<b>III. Cooperator Evaluation</b>					
	<b>Quality Traits 1-2: Protein</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.2		2.0
	<b>Quality Traits 3-22: Milling</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.0		3.2
	<b>Quality Traits 23-36: Baking</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.8		2.8
	<b>Quality Traits 1-36: Overall Comparison</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.7		2.8

## Cumulative Ash and Protein Curves

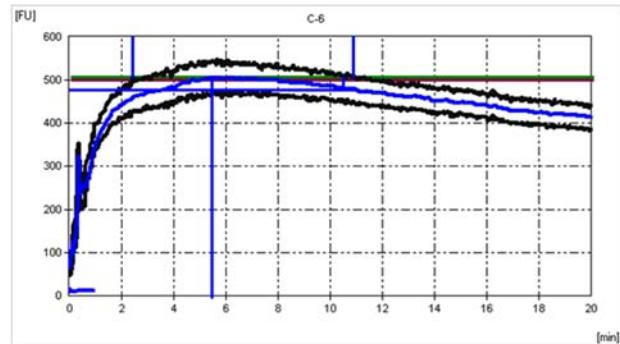


## Farinograms

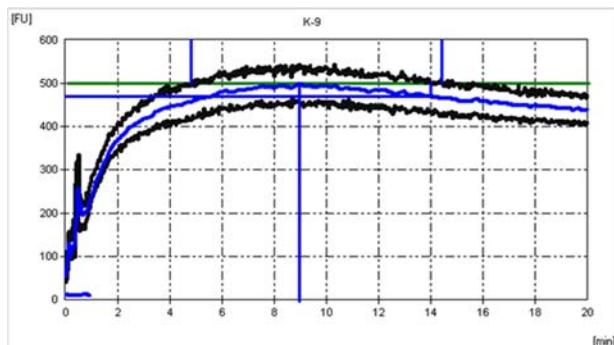
Glenn Check (Casselton, C-9)



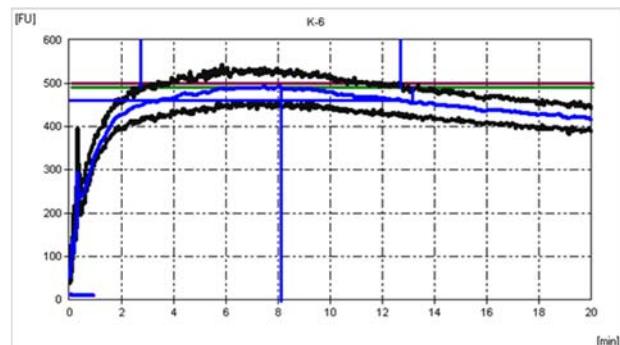
MN11325-7 (Casselton, C-6)



Glenn Check (Crookston, K-9)

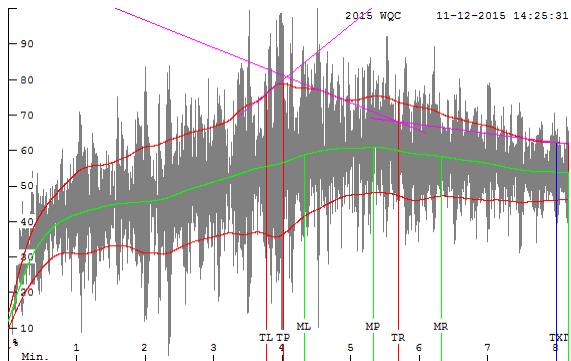


MN11325-7 (Crookston, K-6)

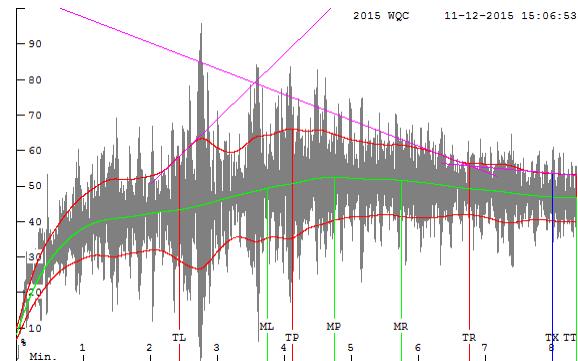


## Mixograms

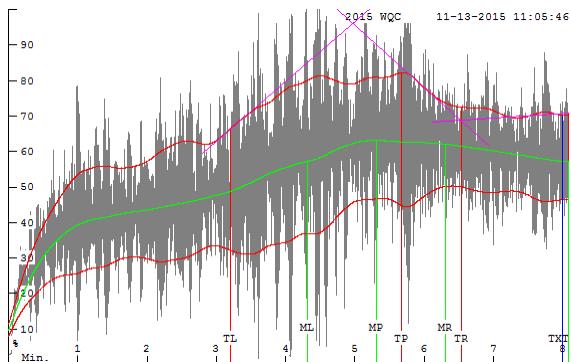
**Glenn Check (Casselton, C-9)**



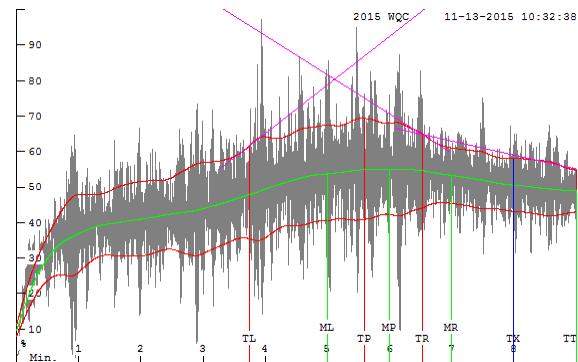
**MN11325-7 (Casselton, C-6)**



**Glenn Check (Crookston, K-9)**

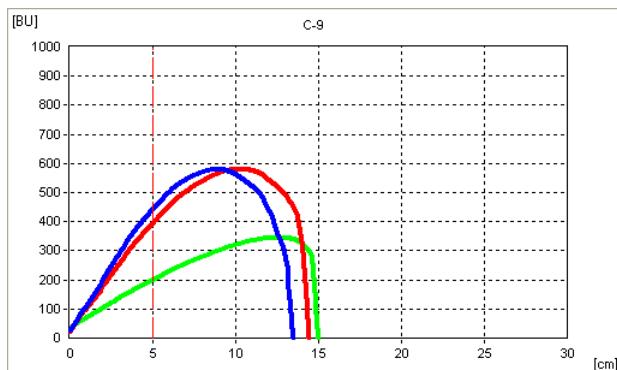


**MN11325-7 (Crookston, K-6)**

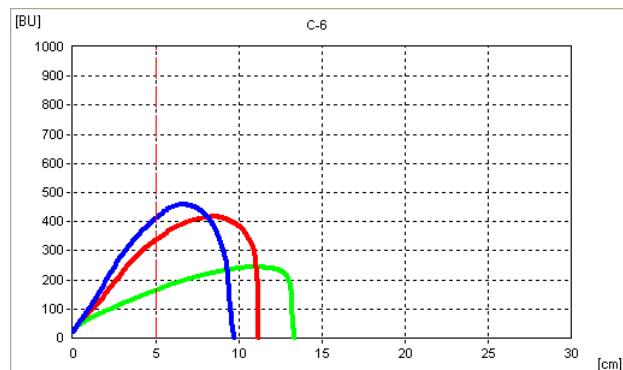


## Extensograms

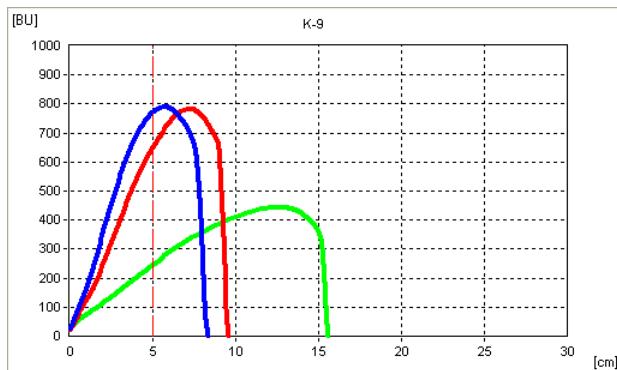
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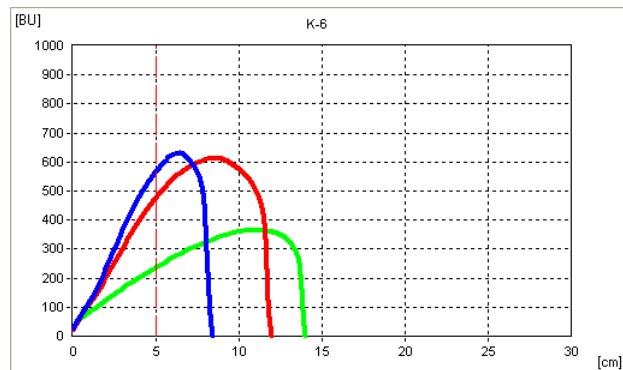
MN11325-7 (Casselton, C-6)



Glenn Check (Crookston, K-9)



MN11325-7 (Crookston, K-6)



— 45 min; — 90 min; — 135 min

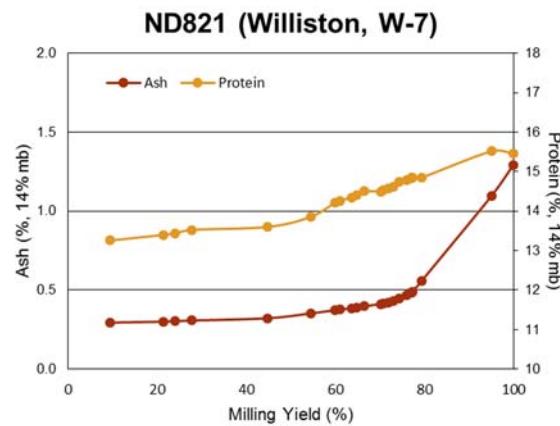
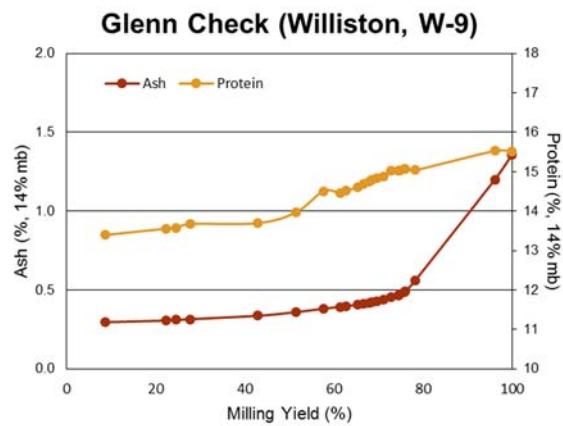
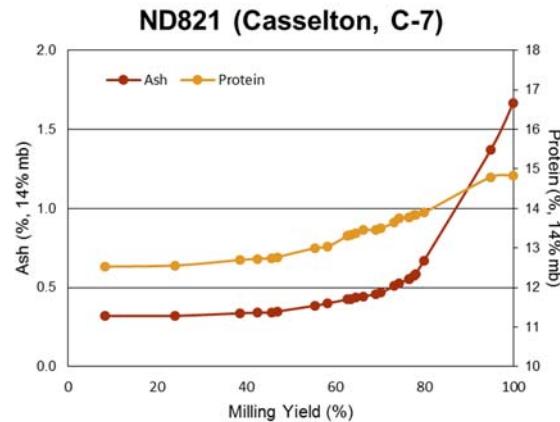
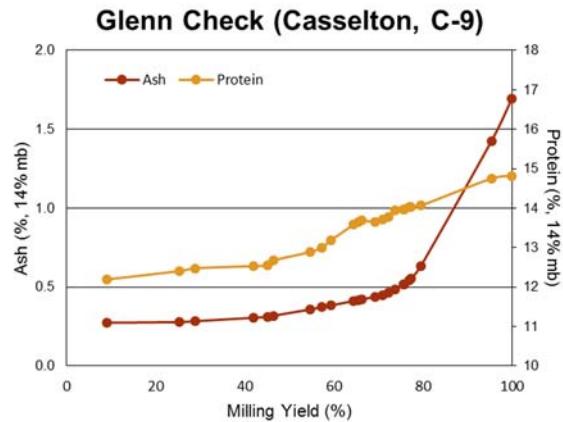
## SWQAC #7 – ND821

	Quality Trait	Casselton		Williston	
		Glenn C-9	C-7	Glenn W-9	W-7
<b>I. USDA-ARS WQL Data</b>					
1	Wheat Protein (%, 12% mb)	14.9	15.0	15.7	15.3
2	Flour Protein (%, 12% mb)	14.4	14.2	15.5	14.9
3	Market Value (Score 1-6)	4.3	4.2	4.6	4.6
4	Market Value (Score 1-10)	10.0	8.8	10.0	9.2
5	DON (ppm)	0.21	0.16	nd	nd
6	Test Weight (lb/bu)	63.4	60.9	63.6	61.3
7	1000 Kernel Weight (g)	31.9	29.8	25.9	27.7
8	Kernel Size, % Large	60	63	9	27
9	Kernel Size, % Small	7	8	21	16
10	Wheat Moisture (%)	10.7	10.5	9.2	9.3
11	Wheat Ash (%, 14% mb)	1.77	1.68	1.39	1.35
12	Wheat Falling Number (sec)	390	424	390	423
13	SKCS Hardness Index	83.0	80.1	78.8	74.8
14	Vitreous Kernels (%)	85.7	56.5	98.7	98.1
<b>Flour Extraction (%)</b>					
15	Tempered Wheat Basis (%)	72.7	74.6	71.2	73.0
16	Total Product Basis (%)	73.7	74.4	72.9	74.4
17	Flour/Bu Wheat (lbs)	46.0	45.8	45.7	45.0
<b>Flour Quality</b>					
18	Flour Color Brightness (L*)	89.6	89.4	89.9	89.7
19	Flour Color Yellowness (b*)	8.9	9.2	8.4	8.9
20	Flour Moisture (%)	13.0	13.3	12.9	13.4
21	Flour Ash (%, 14% mb)	0.51	0.51	0.46	0.44
22	Flour Falling Number (Malted) (sec)	250	245	256	253
<b>Farinograph</b>					
23	Water Absorption (%, 500 BU)	64.6	63.8	65.2	63.6
24	Water Absorption (%, 14% mb)	63.3	62.9	64.5	62.7
25	Arrival Time (min)	3.8	4.1	4.4	4.6
26	Peak Time (min)	7.5	8.0	9.8	9.0
27	Dough Stability (min)	9.5	7.8	14.9	10.2
28	Mixing Tolerance Index (MTI) (BU)	28.0	43.0	12.0	26.0
29	Time To Breakdown (TTB) (min)	12.8	12.0	18.0	14.2
<b>II. Cooperator Results</b>					
30	Bake Absorption (Average %)	66.0	65.0	66.8	65.2
31	Loaf Volume (% of Check)		97.1		101.5

# SWQAC #7 – ND821

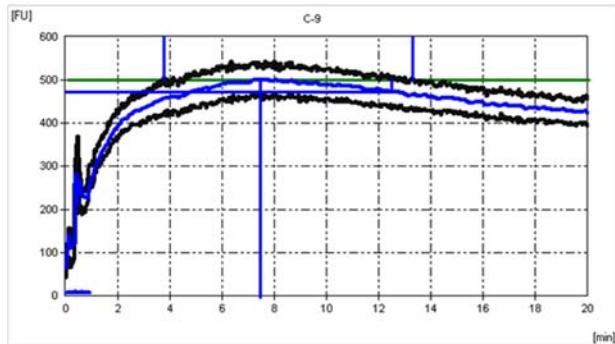
	Quality Trait	Casselton		Williston	
		Glenn C-9	C-7	Glenn W-9	W-7
<b>II. Cooperator Results</b>					
32	<b>Mixing Requirement</b>  5 = Very Long 4 = Long 3 = Medium 2 = Short 1 = Very Short	3.5	3.2	4.1	3.5
33	<b>Dough Characteristics</b>  5 = Bucky – Tough 4 = Strong – Elastic 3 = Medium – Pliable 2 = Mellow – Very Pliable 1 = Weak – Short or Sticky	3.6	3.1	4.0	3.7
34	<b>Mixing Tolerance</b>  5 = Much More Tolerance Than Check 4 = More Tolerance Than Check 3 = Tolerance Equivalent To Check 2 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		2.4		2.2
35	<b>Internal Crumb Color</b>  5 = Much Brighter Than Check 4 = Brighter Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.7		3.2
36	<b>Internal Grain and Texture</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.4		3.5
<b>III. Cooperator Evaluation</b>					
	<b>Quality Traits 1-2: Protein</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.2		2.7
	<b>Quality Traits 3-22: Milling</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.5		3.6
	<b>Quality Traits 23-36: Baking</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.8		3.2
	<b>Quality Traits 1-36: Overall Comparison</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.9		3.1

## Cumulative Ash and Protein Curves

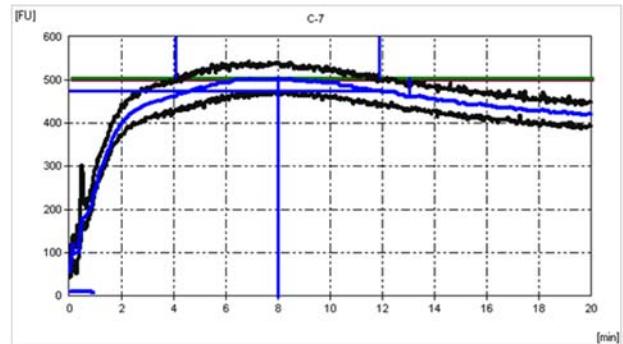


## Farinograms

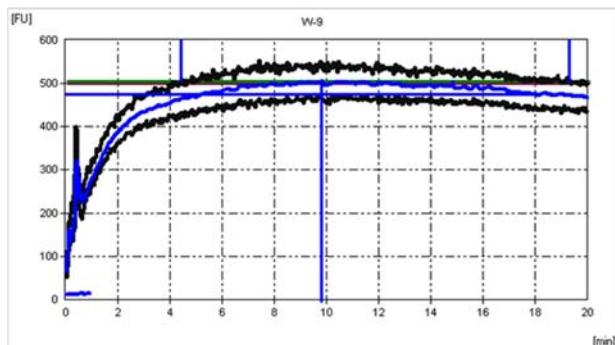
Glenn Check (Casselton, C-9)



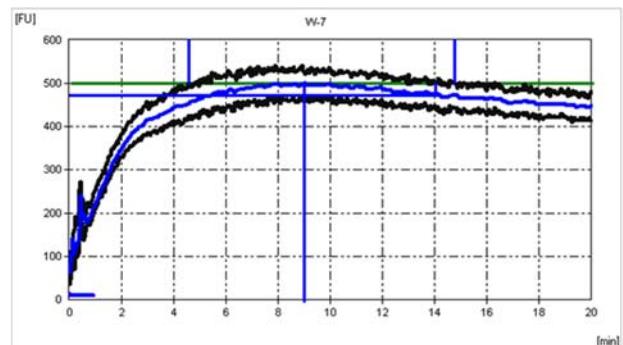
ND821 (Casselton, C-7)



Glenn Check (Williston, W-9)

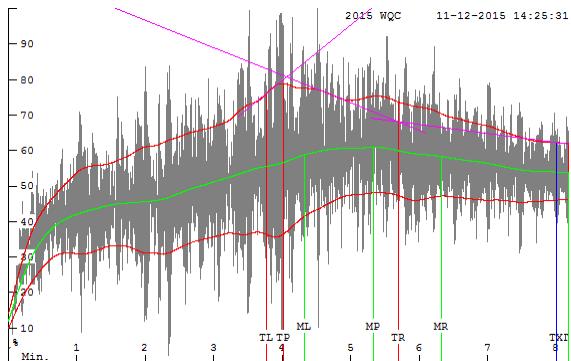


ND821 (Williston, W-7)

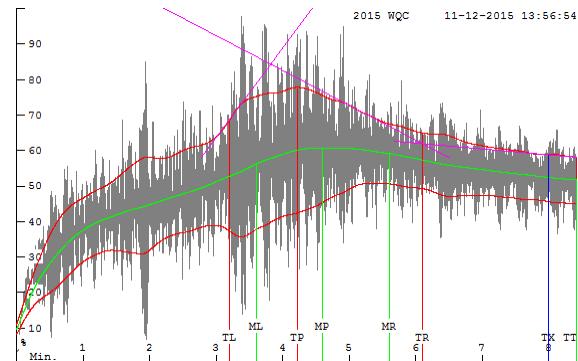


## Mixograms

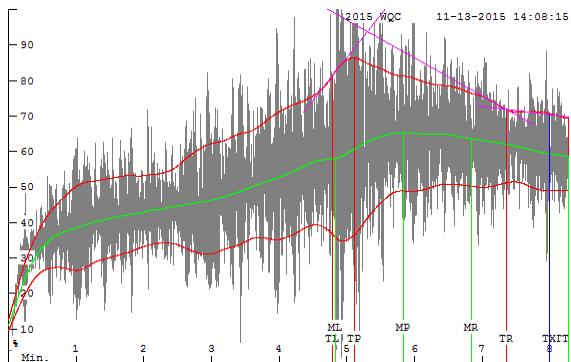
**Glenn Check (Casselton, C-9)**



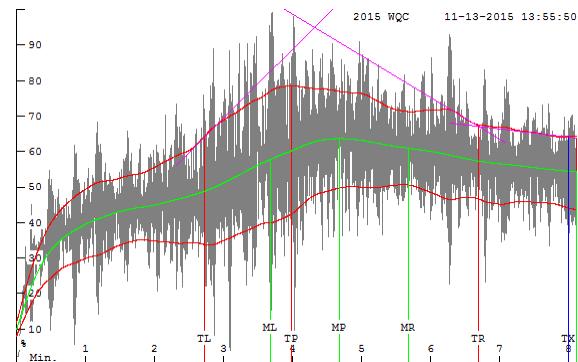
**ND821 (Casselton, C-7)**



**Glenn Check (Williston, W-9)**

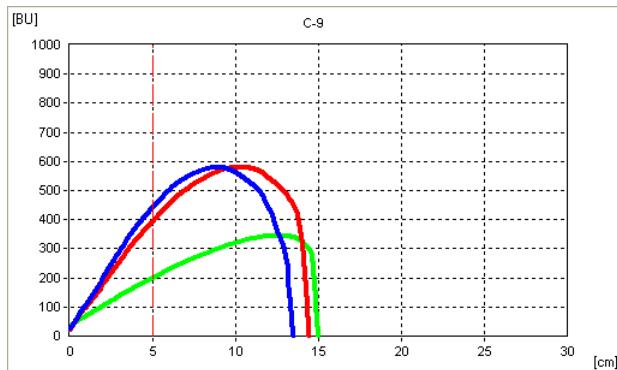


**ND821 (Williston, W-7)**

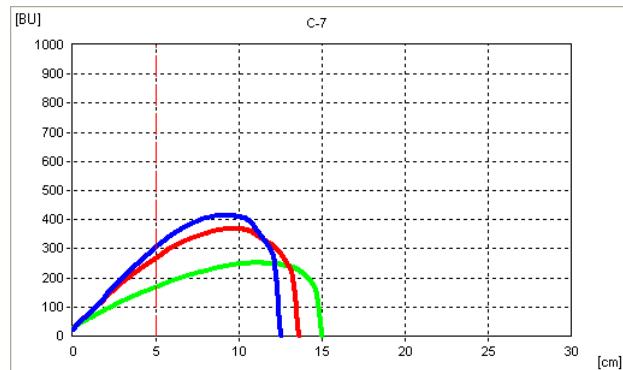


## Extensograms

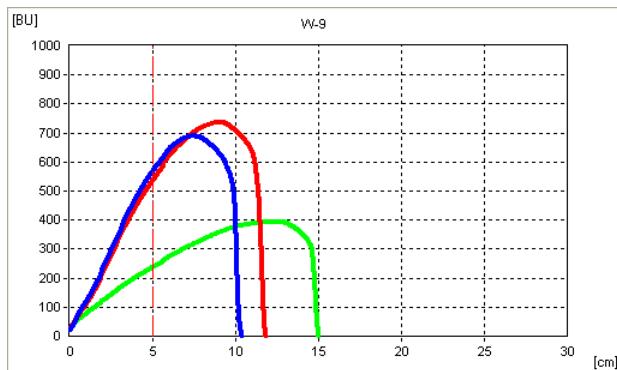
Glenn Check (Casselton, C-9)



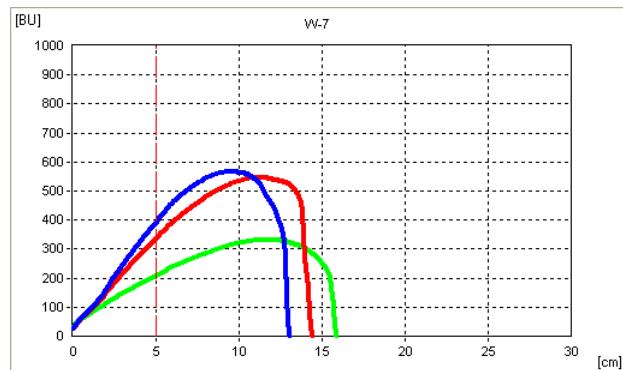
ND821 (Casselton, C-7)



Glenn Check (Williston, W-9)



ND821 (Williston, W-7)



— 45 min; — 90 min; — 135 min

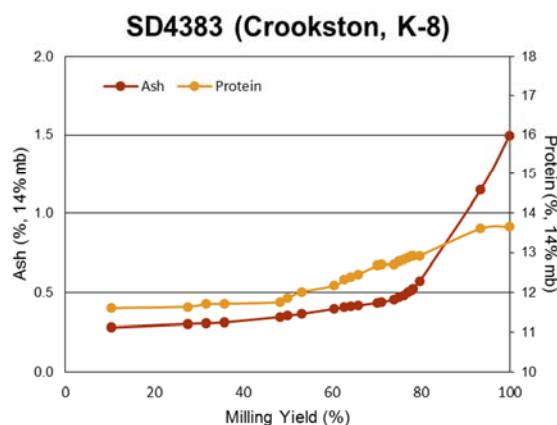
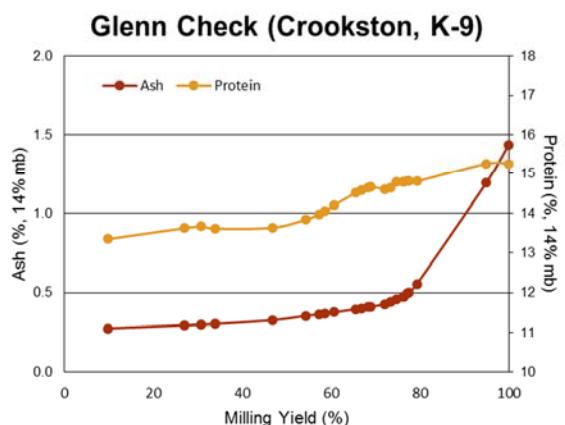
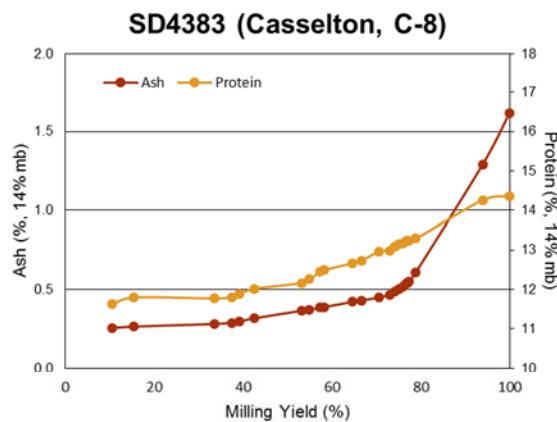
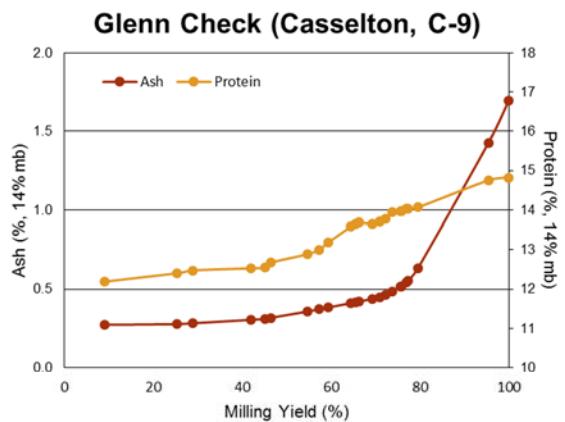
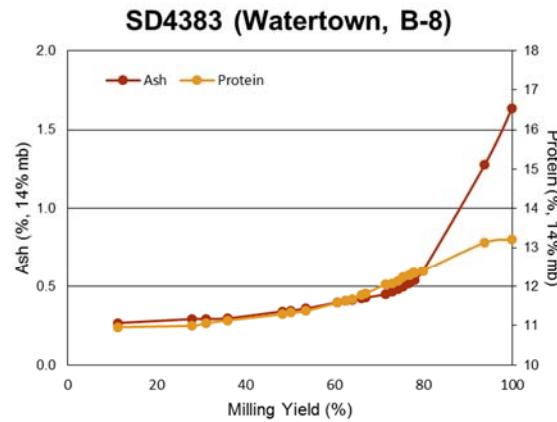
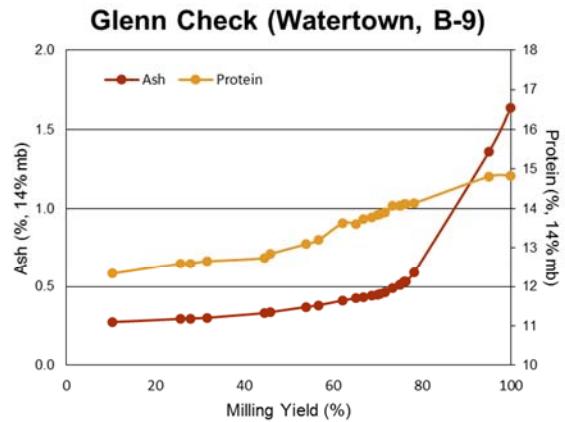
## SWQAC #8 – SD4383

	Quality Trait	Watertown		Casselton		Crookston	
		Glenn B-9	B-8	Glenn C-9	C-8	Glenn K-9	K-8
<b>I. USDA-ARS WQL Data</b>							
1	Wheat Protein (%, 12% mb)	15.5	13.3	14.9	14.4	15.5	13.8
2	Flour Protein (%, 12% mb)	14.5	12.6	14.4	13.6	15.3	13.2
3	Market Value (Score 1-6)	4.4	3.1	4.3	3.3	4.7	3.6
4	Market Value (Score 1-10)	10.0	6.0	10.0	8.0	10.0	6.6
5	DON (ppm)	nd	nd	0.21	nd	nd	nd
6	Test Weight (lb/bu)	62.0	58.7	63.4	59.4	64.7	62.2
7	1000 Kernel Weight (g)	33.3	31.2	31.9	26.9	29.8	27.7
8	Kernel Size, % Large	75	65	60	43	47	36
9	Kernel Size, % Small	5	6	7	13	11	16
10	Wheat Moisture (%)	10.9	11.0	10.7	10.1	10.3	10.1
11	Wheat Ash (%, 14% mb)	1.63	1.55	1.77	1.70	1.42	1.51
12	Wheat Falling Number (sec)	366	379	390	401	387	353
13	SKCS Hardness Index	76.2	55.5	83.0	61.6	85.6	77.0
14	Vitreous Kernels (%)	76.2	20.8	85.7	22.2	95.6	93.4
<b>Flour Extraction (%)</b>							
15	Tempered Wheat Basis (%)	70.6	73.6	72.7	72.5	73.5	74.3
16	Total Product Basis (%)	73.5	75.5	73.7	75.0	74.8	76.2
17	Flour/Bu Wheat (lbs)	43.4	43.1	46.0	43.6	47.8	46.8
<b>Flour Quality</b>							
18	Flour Color Brightness ( $L^*$ )	89.8	89.7	89.6	89.9	90.0	90.0
19	Flour Color Yellowness ( $b^*$ )	8.0	8.7	8.9	9.3	8.4	9.2
20	Flour Moisture (%)	12.4	12.8	13.0	13.5	12.7	12.9
21	Flour Ash (%, 14% mb)	0.49	0.50	0.51	0.48	0.44	0.47
22	Flour Falling Number (Malted) (sec)	251	255	250	252	250	249
<b>Farinograph</b>							
23	Water Absorption (%, 500 BU)	65.5	59.6	64.6	61.4	63.9	60.4
24	Water Absorption (%, 14% mb)	63.4	57.9	63.3	60.7	62.1	59.0
25	Arrival Time (min)	2.7	2.0	3.8	4.0	4.8	3.5
26	Peak Time (min)	7.9	7.0	7.5	6.8	9.0	6.5
27	Dough Stability (min)	11.1	10.1	9.5	7.8	9.6	7.4
28	Mixing Tolerance Index (MTI) (BU)	25.0	30.0	28.0	30.0	28.0	40.0
29	Time To Breakdown (TTB) (min)	13.3	11.3	12.8	11.8	14.1	10.6
<b>II. Cooperator Results</b>							
30	Bake Absorption (Average %)	66.4	61.6	66.0	63.4	66.1	62.8
31	Loaf Volume (% of Check)		94.0		97.7		97.1

# SWQAC #8 – SD4383

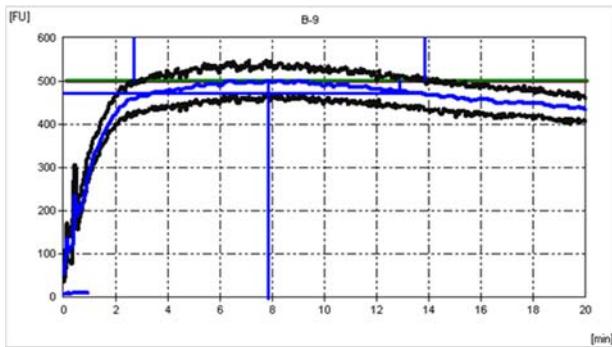
	Quality Trait	Watertown		Casselton		Crookston	
		Glenn B-9	B-8	Glenn C-9	C-8	Glenn K-9	K-8
<b>II. Cooperator Results</b>							
32	<b>Mixing Requirement</b>  5 = Very Long 4 = Long 3 = Medium 2 = Short 1 = Very Short	3.8	4.1	3.5	3.2	4.2	3.7
33	<b>Dough Characteristics</b>  5 = Bucky – Tough 4 = Strong – Elastic 3 = Medium – Pliable 2 = Mellow – Very Pliable 1 = Weak – Short or Sticky	4.0	4.0	3.6	3.2	3.8	3.2
34	<b>Mixing Tolerance</b>  5 = Much More Tolerance Than Check 4 = More Tolerance Than Check 3 = Tolerance Equivalent To Check 2 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		2.8		2.6		2.4
35	<b>Internal Crumb Color</b>  5 = Much Brighter Than Check 4 = Brighter Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.9		2.7		2.7
36	<b>Internal Grain and Texture</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.8		3.3		3.3
<b>III. Cooperator Evaluation</b>							
	<b>Quality Traits 1-2: Protein</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		1.8		2.5		1.8
	<b>Quality Traits 3-22: Milling</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.2		2.6		3.1
	<b>Quality Traits 23-36: Baking</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.5		3.0		3.1
	<b>Quality Traits 1-36: Overall Comparison</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.2		2.8		2.7

## Cumulative Ash and Protein Curves

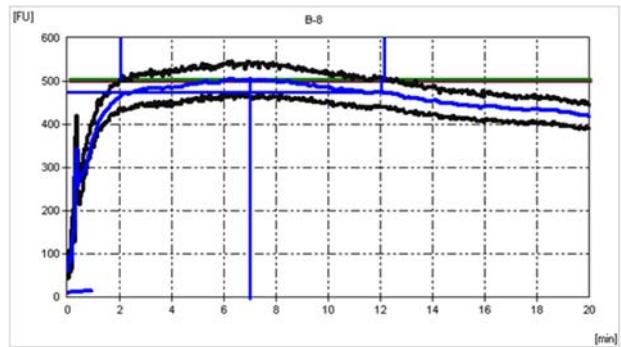


## Farinograms

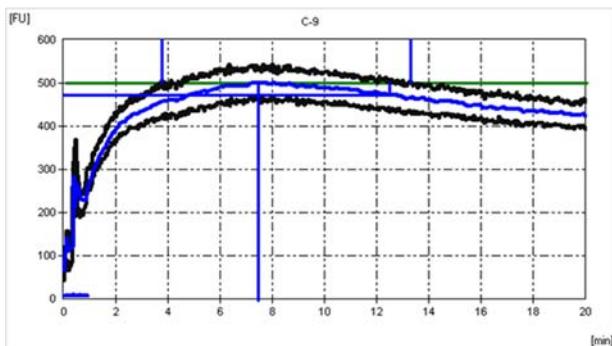
Glenn Check (Watertown, B-9)



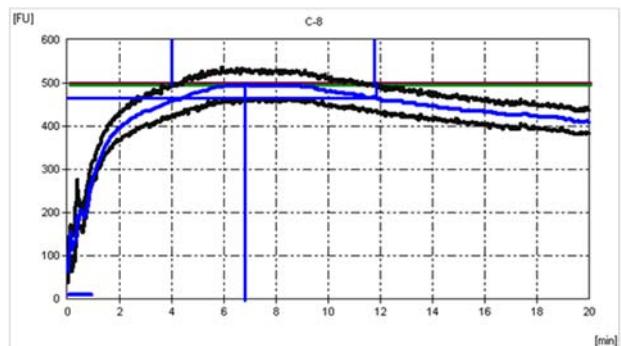
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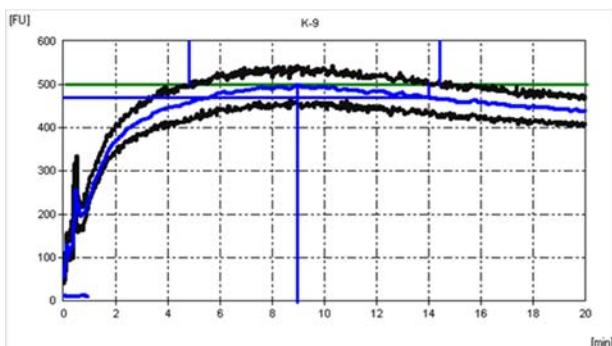
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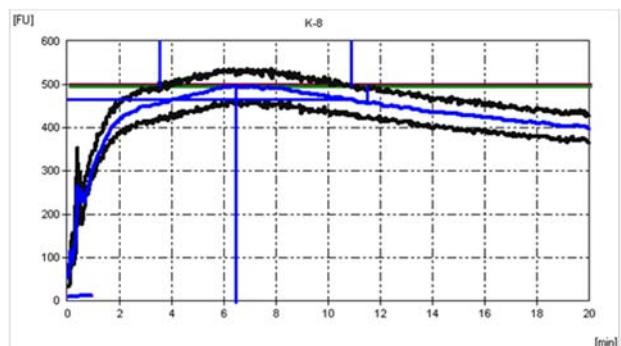
SD4383 (Casselton, C-8)



Glenn Check (Crookston, K-9)

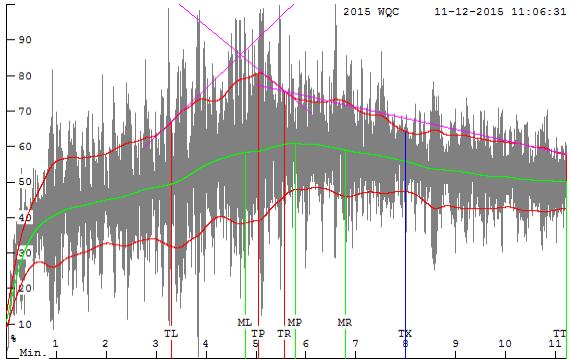


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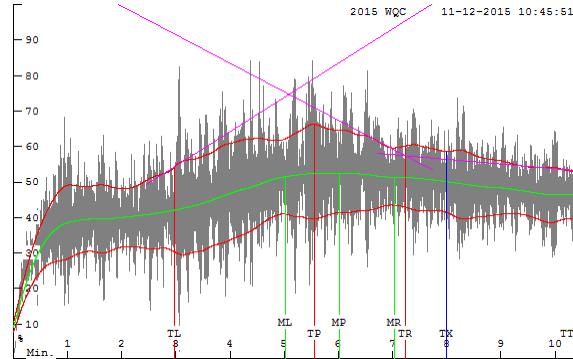


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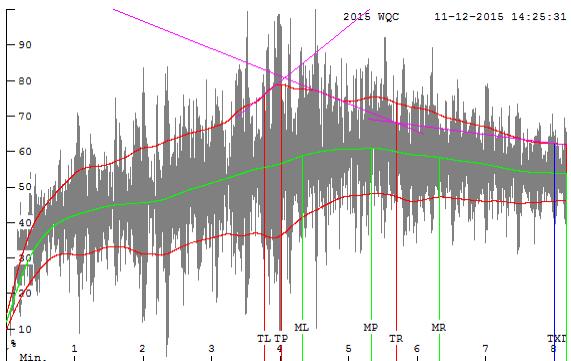
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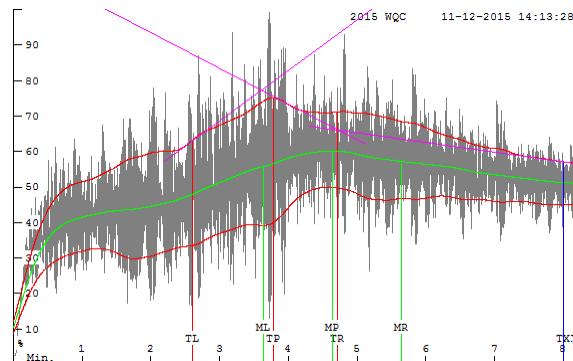
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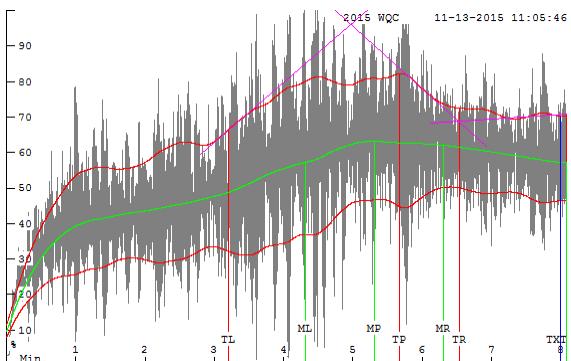
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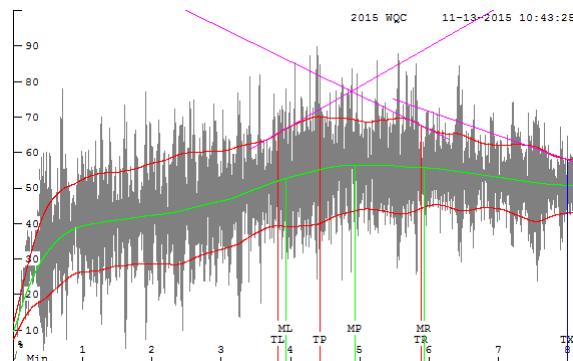
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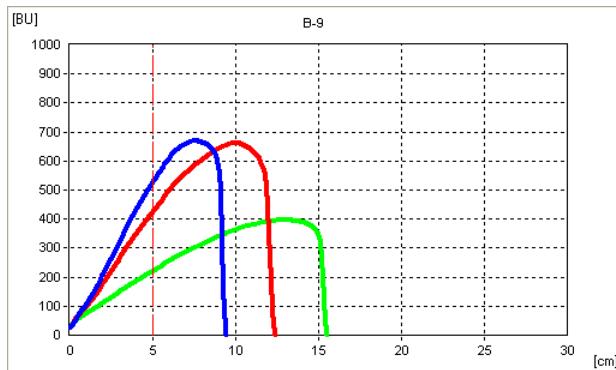


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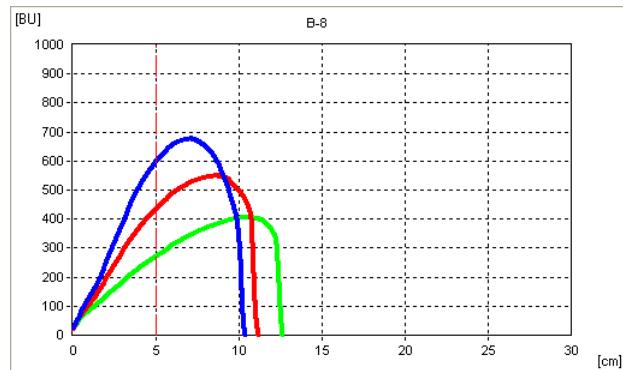


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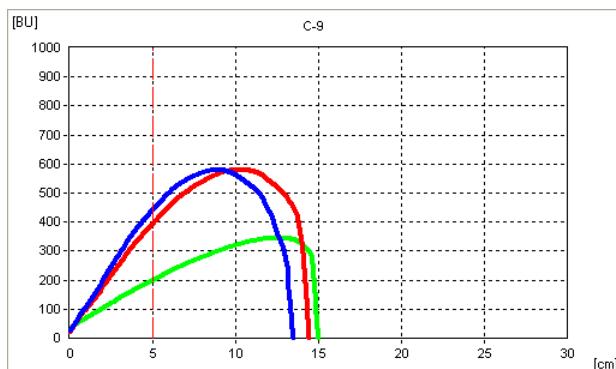
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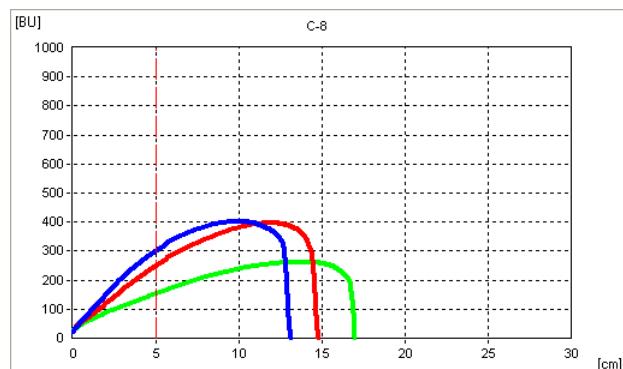
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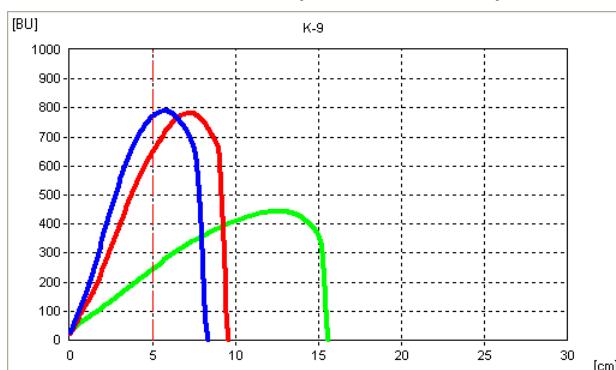
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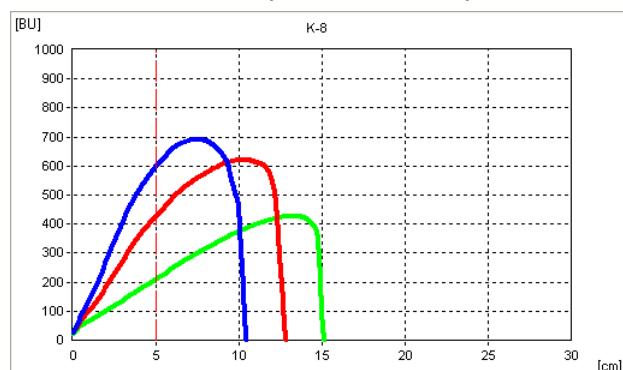
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**Glenn Check (Crookston, K-9)**



**SD4383 (Crookston, K-8)**



— 45 min; — 90 min; — 135 min

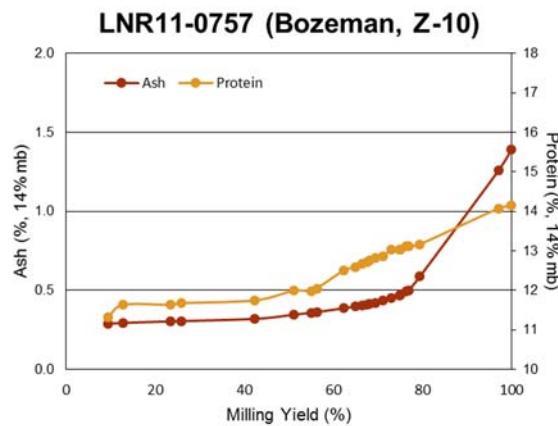
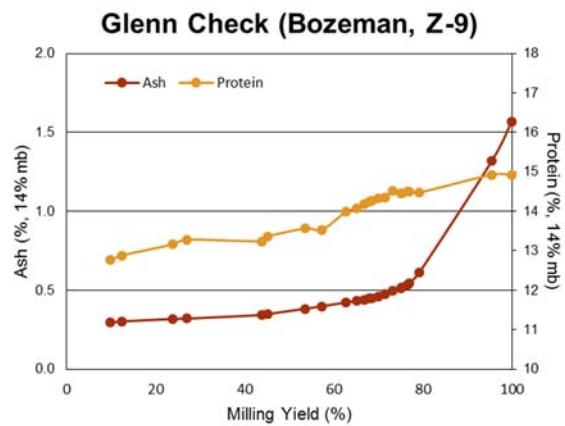
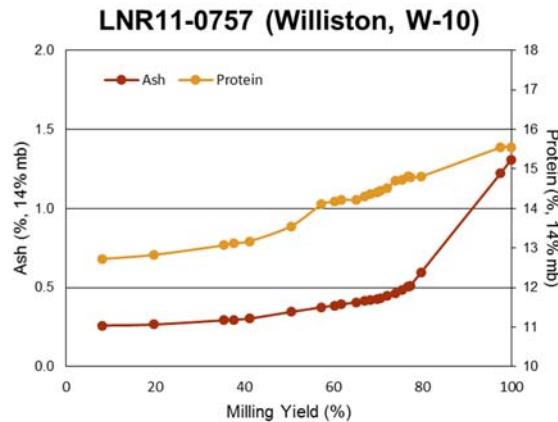
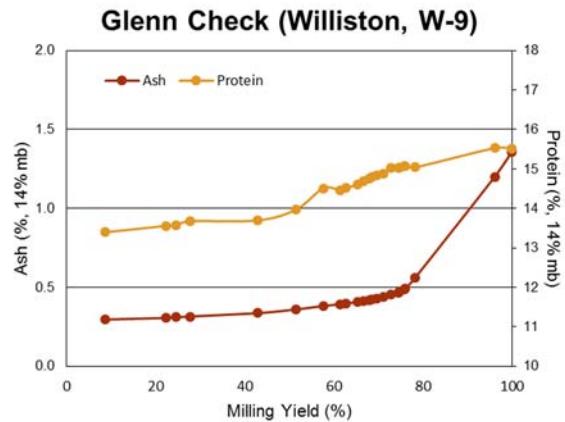
## SWQAC #10 - LNR11-0757

	Quality Trait	Williston		Bozeman	
		Glenn W-9	W-10	Glenn Z-9	Z-10
<b>I. USDA-ARS WQL Data</b>					
1	Wheat Protein (%, 12% mb)	15.7	15.5	15.1	14.2
2	Flour Protein (%, 12% mb)	15.5	15.0	14.5	13.2
3	Market Value (Score 1-6)	4.6	4.5	4.6	4.2
4	Market Value (Score 1-10)	10.0	9.2	10.0	7.8
5	DON (ppm)	nd	nd	nd	nd
6	Test Weight (lb/bu)	63.6	61.0	65.4	63.2
7	1000 Kernel Weight (g)	25.9	25.8	37.2	31.2
8	Kernel Size, % Large	9	2	79	36
9	Kernel Size, % Small	21	29	4	15
10	Wheat Moisture (%)	9.2	9.5	10.3	10.0
11	Wheat Ash (%, 14% mb)	1.39	1.35	1.58	1.41
12	Wheat Falling Number (sec)	390	451	347	359
13	SKCS Hardness Index	78.8	64.8	82.5	76.5
14	Vitreous Kernels (%)	98.7	91.1	96.4	95.3
<b>Flour Extraction (%)</b>					
15	Tempered Wheat Basis (%)	71.2	71.9	71.5	71.0
16	Total Product Basis (%)	72.9	74.0	73.2	73.1
17	Flour/Bu Wheat (lbs)	45.7	44.0	47.2	44.8
<b>Flour Quality</b>					
18	Flour Color Brightness (L*)	89.9	89.1	89.7	89.8
19	Flour Color Yellowness (b*)	8.4	8.8	8.9	10.1
20	Flour Moisture (%)	12.9	12.9	12.9	12.8
21	Flour Ash (%, 14% mb)	0.46	0.48	0.50	0.46
22	Flour Falling Number (Malted) (sec)	256	252	251	242
<b>Farinograph</b>					
23	Water Absorption (%, 500 BU)	65.2	63.2	71.0	64.8
24	Water Absorption (%, 14% mb)	64.5	61.8	69.6	63.3
25	Arrival Time (min)	4.4	4.3	4.5	3.7
26	Peak Time (min)	9.8	9.8	5.9	6.5
27	Dough Stability (min)	14.9	14.8	6.2	6.0
28	Mixing Tolerance Index (MTI) (BU)	12.0	18.0	26.0	45.0
29	Time To Breakdown (TTB) (min)	18.0	19.2	11.1	9.1
<b>II. Cooperator Results</b>					
30	Bake Absorption (Average %)	66.8	65.4	68.3	64.8
31	Loaf Volume (% of Check)		103.7		102.3

# SWQAC #10 - LNR11-0757

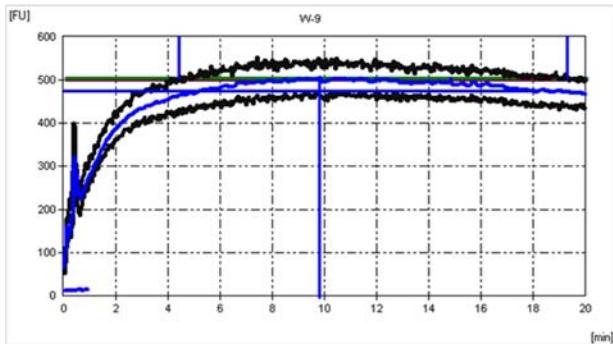
	Quality Trait	Williston		Bozeman	
		Glenn W-9	W-10	Glenn Z-9	Z-10
<b>II. Cooperator Results</b>					
32	<b>Mixing Requirement</b>  5 = Very Long 4 = Long 3 = Medium 2 = Short 1 = Very Short	4.1	3.5	2.0	2.6
33	<b>Dough Characteristics</b>  5 = Bucky – Tough 4 = Strong – Elastic 3 = Medium – Pliable 2 = Mellow – Very Pliable 1 = Weak – Short or Sticky	4.0	4.1	2.4	3.1
34	<b>Mixing Tolerance</b>  5 = Much More Tolerance Than Check 4 = More Tolerance Than Check 3 = Tolerance Equivalent To Check 2 = Less Tolerance Than Check 1 = Much Less Tolerance Than Check		2.7		3.4
35	<b>Internal Crumb Color</b>  5 = Much Brighter Than Check 4 = Brighter Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.2		2.8
36	<b>Internal Grain and Texture</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.2		3.7
<b>III. Cooperator Evaluation</b>					
	<b>Quality Traits 1-2: Protein</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.0		2.1
	<b>Quality Traits 3-22: Milling</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		2.8		2.5
	<b>Quality Traits 23-36: Baking</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.2		3.5
	<b>Quality Traits 1-36: Overall Comparison</b>  5 = Much Better Than Check 4 = Better Than Check 3 = Equivalent To Check 2 = Poorer Than Check 1 = Much Poorer Than Check		3.0		3.2

## Cumulative Ash and Protein Curves

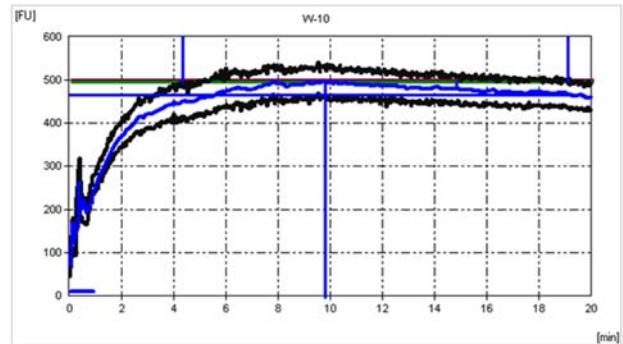


## Farinograms

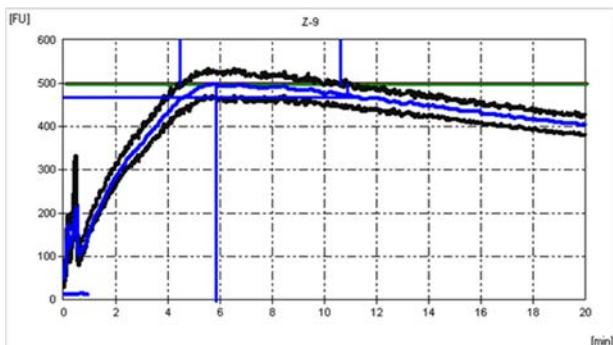
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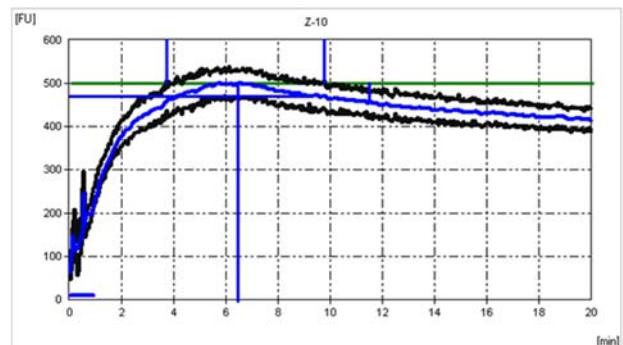
LNR11-0757 (Williston, W-10)



Glenn Check (Bozeman, Z-9)

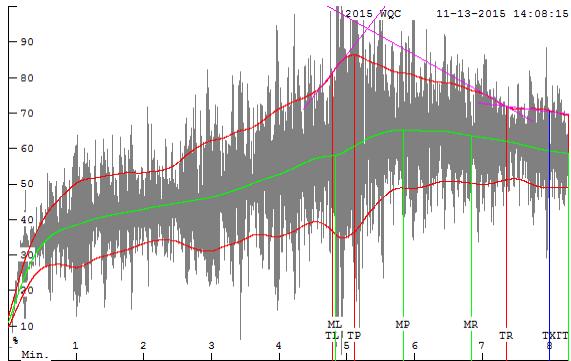


LNR11-0757 (Bozeman, Z-10)

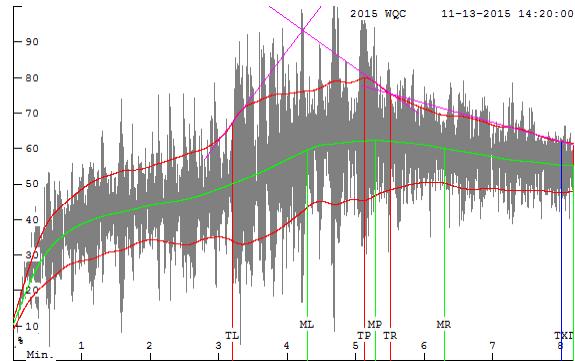


## Mixograms

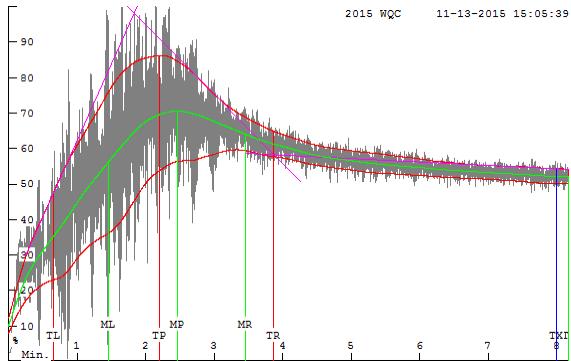
**Glenn Check (Williston, W-9)**



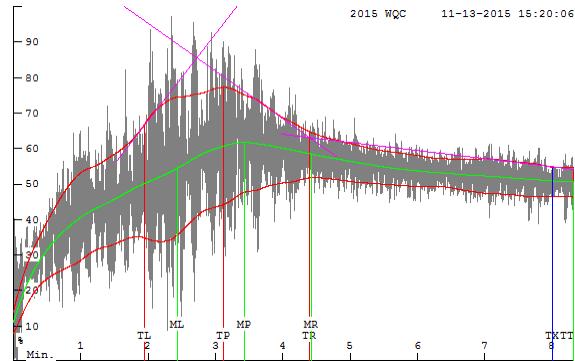
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**Glenn Check (Bozeman, Z-9)**

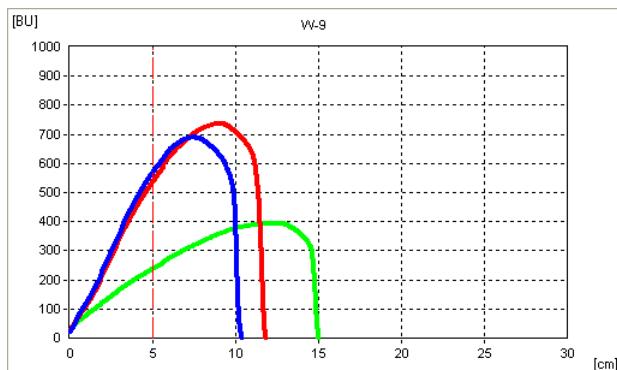


**LNR11-0757 (Bozeman, Z-10)**

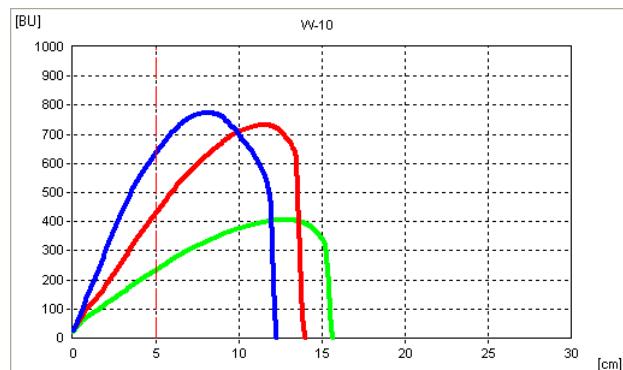


## Extensograms

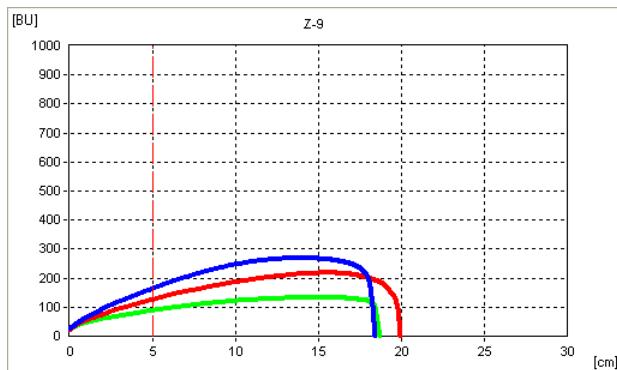
Glenn Check (Williston, W-9)



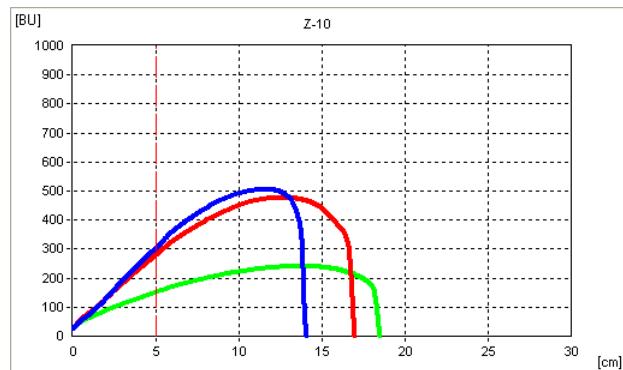
LNR11-0757 (Williston, W-10)



Glenn Check (Bozeman, Z-9)



LNR11-0757 (Bozeman, Z-10)



— 45 min; — 90 min; — 135 min

## Appendix

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## Wheat Marketing Score

The development of a Wheat Marketing Score (WMS) or Export Marketing 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 Glenn Check was evaluated along with the experimental lines for each growing locations. Method #2 was developed on a scale of 0 to 10 where the experimental lines were evaluated against the Glenn Check for each growing locations.

### Wheat Marketing Score – Method #1

Wheat Marketing Score or Export Marketing Score						
Score	Test Weight (lb/bu)	1000 KWT (g)	Falling Number (sec)	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	
<b>Target Value</b>	<b>3</b>	<b>60</b>	<b>30</b>	<b>350</b>	<b>13.5</b>	<b>1.65</b>
	2	59	26	325	12.5	1.75
	1	58	22	300	11.5	1.85
	0	57	18	275	10.5	1.95
<b>Variation (+/-) from Target Value</b>		<b>1</b>	<b>3 g up, 4 g down</b>	<b>25</b>	<b>1.0</b>	<b>0.10</b>

$$\text{Wheat Marketing Score} = [(TW^2) + (1000 KWT^2) + (FN^2) + (WP * 3) + WA] / 10$$

## Wheat Marketing Score – Method #2

Component Score	Wheat Protein (% , 12% mb)	Test Weight (lb/bu)	Falling Number (sec)	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
<b>10</b>	<b>-0.5 ≤ Diff ≤ 2.0</b>	<b>-1 ≤ Diff ≤ 2</b>	<b>Diff ≥ -25</b>	<b>-2 ≤ Diff ≤ 4</b>	<b>Diff ≤ 0.1</b>
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	--
<b>Weight of each factor</b>	<b>0.3</b>	<b>0.2</b>	<b>0.2</b>	<b>0.2</b>	<b>0.1</b>

$$\text{Wheat Marketing Score} = (\text{WP}*0.3) + (\text{TW}*0.2) + (\text{FN}*0.2) + (1000 \text{ TKW})*0.2 + (\text{WA}*0.1)$$

## Miag Mill Streams

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

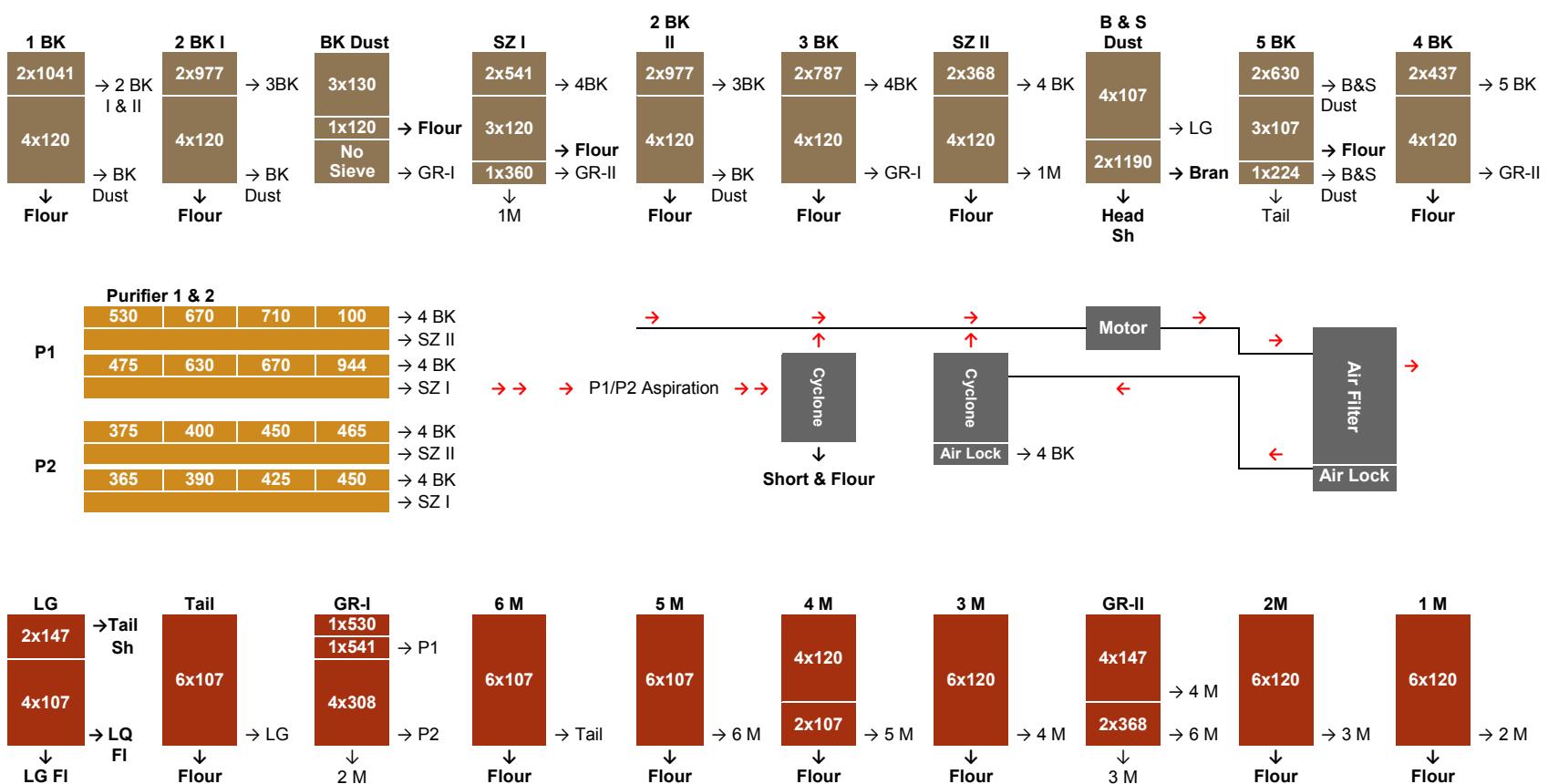
\*Tail Cyclone fraction was separated into flour and short by reboiling using NDSU and NCI sieves.

### Calculation of flour extraction:

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

## Miag Multomat Mill Flow Chart

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



Sieve Opening Size -  $\mu\text{m}$



## Flour Characteristics by Location

Location	ID	Entry	Flour Extraction				Flour Color				Flour Moisture %	Flour Protein (% , 12% mb)	Flour Ash (% , 14% mb)	Flour FN Malted (sec)
			TWB %	TPB %	Flour/bu Wheat (lbs)	L*	b*	L	b					
<b>Watertown</b>	B-3	Bolles	72.0	73.7	42.3	90.0	8.5	87.3	8.1	12.8	13.1	0.51	249	
	B-4	SY Valda	72.5	74.2	43.3	89.6	7.8	86.9	7.5	12.9	11.8	0.51	254	
	B-5	LCS Prime	73.9	75.0	44.0	89.7	8.1	87.0	7.8	12.8	11.6	0.49	253	
	B-8	SD4383	73.6	75.5	43.1	89.7	8.7	87.0	8.3	12.8	12.6	0.50	255	
	<b>B-9 Glenn</b>		<b>70.6</b>	<b>73.5</b>	<b>43.4</b>	<b>89.8</b>	<b>8.0</b>	<b>87.1</b>	<b>7.7</b>	<b>12.4</b>	<b>14.5</b>	<b>0.49</b>	<b>251</b>	
<b>Casselton</b>	C-1	MN10261-1	71.5	73.3	44.7	89.7	9.2	87.0	8.8	14.0	13.5	0.55	250	
	C-2	ND820	72.2	71.8	46.2	89.8	8.5	87.2	8.1	14.4	12.6	0.48	253	
	C-3	Bolles	70.7	72.8	43.4	89.4	9.7	86.6	9.2	14.4	15.2	0.53	243	
	C-4	SY Valda	71.2	72.7	43.6	89.4	8.5	86.6	8.1	14.2	12.8	0.51	251	
	C-5	LCS Prime	72.8	75.7*	44.4	89.4	8.5	86.6	8.1	13.4	12.1	0.56	254	
	C-6	MN11325-7	73.4	75.0	44.4	89.3	8.6	86.5	8.2	13.3	13.0	0.49	251	
	C-7	ND821	74.6	74.4	45.8	89.4	9.2	86.6	8.7	13.3	14.2	0.51	245	
	C-8	SD4383	72.5	75.0	43.6	89.9	9.3	87.2	8.8	13.5	13.6	0.48	252	
<b>Crookston</b>	<b>C-9 Glenn</b>		<b>72.7</b>	<b>73.7</b>	<b>46.0</b>	<b>89.6</b>	<b>8.9</b>	<b>86.9</b>	<b>8.5</b>	<b>13.0</b>	<b>14.4</b>	<b>0.51</b>	<b>250</b>	
	K-1	MN10261-1	71.8	73.2	45.8	89.8	9.4	87.1	9.0	13.0	14.4	0.49	252	
	K-3	Bolles	72.6	74.2	45.1	89.6	9.0	86.9	8.6	13.4	16.2	0.50	247	
	K-4	SY Valda	73.1	74.7	46.0	89.5	8.0	86.7	7.7	13.4	13.9	0.46	256	
	K-5	LCS Prime	73.8	74.4	46.8	89.8	8.4	87.1	8.1	13.0	12.7	0.47	248	
<b>Williston</b>	K-6	MN11325-7	73.6	76.0	46.8	89.9	8.0	87.3	7.7	13.2	13.8	0.44	245	
	K-8	SD4383	74.3	76.2	46.8	90.0	9.2	87.4	8.8	12.9	13.2	0.47	249	
	<b>K-9 Glenn</b>		<b>73.5</b>	<b>74.8</b>	<b>47.8</b>	<b>90.0</b>	<b>8.4</b>	<b>87.3</b>	<b>8.1</b>	<b>12.7</b>	<b>15.3</b>	<b>0.44</b>	<b>250</b>	
	W-2	ND820	71.9	73.9	45.3	89.7	8.8	86.9	8.5	12.4	15.3	0.42	251	
	W-3	Bolles	70.0	72.0	43.6	89.4	9.3	86.6	8.8	13.5	17.3	0.47	250	
<b>Bozeman</b>	W-4	SY Valda	72.7	74.1	45.2	89.5	8.1	86.8	7.8	13.4	15.4	0.40	246	
	W-5	LCS Prime	72.8	73.7	46.0	90.0	8.3	87.4	7.9	13.1	13.2	0.42	252	
	W-7	ND821	73.0	74.4	45.0	89.7	8.9	87.0	8.5	13.4	14.9	0.44	253	
	<b>W-9 Glenn</b>		<b>71.2</b>	<b>72.9</b>	<b>45.7</b>	<b>89.9</b>	<b>8.4</b>	<b>87.2</b>	<b>8.0</b>	<b>12.9</b>	<b>15.5</b>	<b>0.46</b>	<b>256</b>	
	W-10	LNR11-0757	71.9	74.0	44.0	89.1	8.8	86.2	8.3	12.9	15.0	0.48	252	
<b>Bozeman</b>	Z-3	Bolles	70.1	72.0	44.0	89.7	10.0	87.0	9.5	12.4	15.5	0.52	244	
	Z-4	SY Valda	69.6	71.5	44.3	89.7	8.1	86.9	7.8	12.7	12.9	0.47	250	
	Z-5	LCS Prime	73.0	74.7	48.3	89.9	8.0	87.2	7.7	13.0	12.4	0.54	252	
	<b>Z-9 Glenn</b>		<b>71.5</b>	<b>73.2</b>	<b>47.2</b>	<b>89.7</b>	<b>8.9</b>	<b>87.0</b>	<b>8.5</b>	<b>12.9</b>	<b>14.5</b>	<b>0.50</b>	<b>251</b>	
	Z-10	LNR11-0757	71.0	73.1	44.8	89.8	10.1	87.2	9.6	12.8	13.2	0.46	242	

\*Choke at bran pickup was found and cleaned during sample C-5. This affected TPB but not patent flour characteristics.

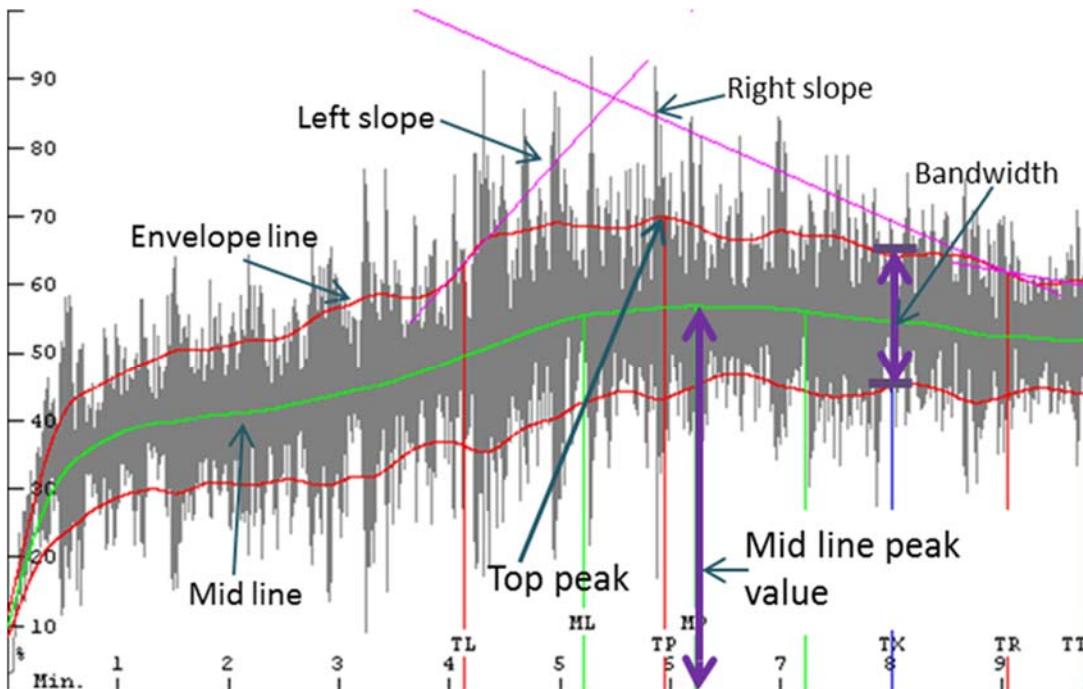
## Farinograph Characteristics by Location

Location	ID	Entry	Water Abs. (%, 500 BU)	Water Abs. (%, 14% mb)	Arrival Time (min)	Peak Time (min)	Dough Stability (min)	MTI (BU)	TTB (min)
Watertown	B-3	Bolles	62.1	60.5	2.7	8.3	11.8	27.0	13.1
	B-4	SY Valda	61.3	60.4	3.3	6.8	6.2	58.0	9.5
	B-5	LCS Prime	59.6	58.0	1.6	6.5	10.5	27.0	11.8
	B-8	SD4383	59.6	57.9	2.0	7.0	10.1	30.0	11.3
	<b>B-9</b>	<b>Glenn</b>	<b>65.5</b>	<b>63.4</b>	<b>2.7</b>	<b>7.9</b>	<b>11.1</b>	<b>25.0</b>	<b>13.3</b>
Casselton	C-1	MN10261-1	63.7	63.7	2.3	5.2	6.9	35.0	9.4
	C-2	ND820	63.0	63.6	3.3	6.7	8.3	31.0	11.2
	C-3	Bolles	61.2	61.7	3.1	7.0	13.0	11.0	15.3
	C-4	SY Valda	60.2	60.4	3.2	5.8	6.4	40.0	9.7
	C-5	LCS Prime	62.1	61.4	2.3	5.5	7.5	36.0	9.9
	C-6	MN11325-7	60.9	60.1	2.4	5.5	8.5	24.0	11.0
	C-7	ND821	63.8	62.9	4.1	8.0	7.8	43.0	12.0
	C-8	SD4383	61.4	60.7	4.0	6.8	7.8	30.0	11.8
	<b>C-9</b>	<b>Glenn</b>	<b>64.6</b>	<b>63.3</b>	<b>3.8</b>	<b>7.5</b>	<b>9.5</b>	<b>28.0</b>	<b>12.8</b>
Crookston	K-1	MN10261-1	70.7	69.3	3.0	5.7	7.2	38.0	10.0
	K-3	Bolles	64.6	64.0	4.6	9.2	12.5	23.0	15.9
	K-4	SY Valda	63.4	62.7	3.7	6.0	5.2	43.0	8.7
	K-5	LCS Prime	61.8	60.5	2.2	6.3	9.7	31.0	11.2
	K-6	MN11325-7	61.0	59.8	2.7	8.2	10.0	37.0	12.7
	K-8	SD4383	60.4	59.0	3.5	6.5	7.4	40.0	10.6
Williston	<b>K-9</b>	<b>Glenn</b>	<b>63.9</b>	<b>62.1</b>	<b>4.8</b>	<b>9.0</b>	<b>9.6</b>	<b>28.0</b>	<b>14.1</b>
	W-2	ND820	64.3	62.4	3.5	8.0	11.2	22.0	14.7
	W-3	Bolles	64.8	64.3	6.2	10.7	19.2	15.0	20.9
	W-4	SY Valda	62.6	61.8	4.6	9.5	11.6	28.0	15.1
	W-5	LCS Prime	62.6	61.7	2.4	7.3	12.6	23.0	13.5
	W-7	ND821	63.6	62.7	4.6	9.0	10.2	26.0	14.2
	<b>W-9</b>	<b>Glenn</b>	<b>65.2</b>	<b>64.5</b>	<b>4.4</b>	<b>9.8</b>	<b>14.9</b>	<b>12.0</b>	<b>18.0</b>
Bozeman	W-10	LNR11-0757	63.2	61.8	4.3	9.8	14.8	18.0	19.2
	Z-3	Bolles	68.5	66.6	4.3	6.9	5.8	40.0	10.4
	Z-4	SY Valda	68.2	66.4	3.0	4.4	2.8	84.0	6.0
	Z-5	LCS Prime	70.7	69.4	3.0	4.2	3.4	58.0	6.8
	<b>Z-9</b>	<b>Glenn</b>	<b>71.0</b>	<b>69.6</b>	<b>4.5</b>	<b>5.9</b>	<b>6.2</b>	<b>26.0</b>	<b>11.1</b>
	Z-10	LNR11-0757	64.8	63.3	3.7	6.5	6.0	45.0	9.1

## Mixograph Characteristics by Location

Location	ID	Entry	Envelope Peak Time (min)	Envelope Peak Value (%)	Envelope Peak Width (%)	Midline Peak Time (min)	Midline Peak Value (%)	Midline Peak Width (%)	Midline Peak Integral (% TQ*min)
Watertown	B-3	Bolles	4.7	81.4	45.4	5.6	61.7	32.5	267.9
	B-4	SY Valda	4.3	68.7	25.0	4.6	56.1	23.0	200.2
	B-5	LCS Prime	5.0	73.0	35.0	5.6	55.6	26.3	254.0
	B-8	SD4383	5.6	66.2	26.7	6.0	52.5	23.2	256.1
	<b>B-9</b>	<b>Glenn</b>	<b>5.1</b>	<b>80.5</b>	<b>41.5</b>	<b>5.8</b>	<b>60.9</b>	<b>25.6</b>	<b>277.2</b>
Casselton	C-1	MN10261-1	4.0	69.3	27.8	4.0	54.8	27.6	188.2
	C-2	ND820	3.8	74.4	31.8	4.3	58.5	24.8	201.1
	C-3	Bolles	5.4	77.7	35.2	5.8	59.3	28.7	256.3
	C-4	SY Valda	3.5	62.8	22.6	4.2	52.5	19.6	179.7
	C-5	LCS Prime	4.0	78.8	36.2	4.4	60.7	28.7	204.2
	C-6	MN11325-7	4.1	66.1	30.8	4.8	52.4	24.2	198.3
	C-7	ND821	4.2	77.8	35.3	4.6	60.7	30.0	207.6
	C-8	SD4383	3.8	75.0	35.1	4.6	60.1	21.2	215.4
	<b>C-9</b>	<b>Glenn</b>	<b>4.0</b>	<b>78.8</b>	<b>42.3</b>	<b>5.3</b>	<b>60.9</b>	<b>27.2</b>	<b>257.6</b>
Crookston	K-1	MN10261-1	4.2	75.4	34.3	4.0	58.0	30.1	183.4
	K-3	Bolles	4.1	92.1	39.2	4.5	73.8	32.7	230.7
	K-4	SY Valda	3.1	78.5	31.4	3.3	63.2	27.6	145.3
	K-5	LCS Prime	5.8	74.5	36.4	5.4	55.7	31.7	237.3
	K-6	MN11325-7	5.6	69.3	28.4	6.0	54.9	25.7	262.5
	K-8	SD4383	4.4	70.1	30.0	4.9	56.4	25.6	215.6
	<b>K-9</b>	<b>Glenn</b>	<b>5.7</b>	<b>82.3</b>	<b>37.5</b>	<b>5.3</b>	<b>63.1</b>	<b>34.2</b>	<b>245.2</b>
Williston	W-2	ND820	4.3	86.1	39.2	4.9	67.7	25.9	242.5
	W-3	Bolles	4.6	89.8	36.4	4.9	71.2	34.1	232.4
	W-4	SY Valda	4.3	72.9	27.5	4.6	60.0	23.0	197.9
	W-5	LCS Prime	6.6	83.6	41.6	7.1	62.4	32.6	347.7
	W-7	ND821	4.0	78.5	36.1	4.7	63.6	27.2	218.2
	<b>W-9</b>	<b>Glenn</b>	<b>5.1</b>	<b>86.3</b>	<b>49.8</b>	<b>5.8</b>	<b>65.3</b>	<b>32.4</b>	<b>274.0</b>
	W-10	LNR11-0757	5.1	79.8	34.5	5.3	62.2	31.8	247.2
Bozeman	Z-3	Bolles	1.7	79.6	31.0	2.0	66.5	21.9	95.0
	Z-4	SY Valda	1.4	73.6	25.7	1.7	63.0	17.4	79.2
	Z-5	LCS Prime	1.6	81.6	30.1	2.0	68.1	23.7	97.3
	<b>Z-9</b>	<b>Glenn</b>	<b>2.2</b>	<b>86.3</b>	<b>32.4</b>	<b>2.5</b>	<b>70.5</b>	<b>28.2</b>	<b>119.0</b>
	W-10	LNR11-0757	3.1	77.2	33.1	3.4	61.7	27.5	157.1

## Interpreting Mixogram Results



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

Delayed peaks and narrow widths (especially at about 8 minutes) 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 in order to develop the dough.

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

## Extensograph Characteristics by Location

45 Minutes Resting								
Location	ID	Entry	Energy (cm <sup>2</sup> )	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
<b>Watertown</b>	B-3	Bolles	65	237	142	363	1.7	2.6
	B-4	SY Valda	41	149	143	225	1.0	1.6
	B-5	LCS Prime	60	269	128	374	2.1	2.9
	B-8	SD4383	62	274	126	404	2.2	3.2
	<b>B-9</b>	<b>Glenn</b>	<b>74</b>	<b>223</b>	<b>155</b>	<b>395</b>	<b>1.4</b>	<b>2.6</b>
<b>Casselton</b>	C-1	MN10261-1	51	212	131	307	1.6	2.3
	C-2	ND820	47	167	145	256	1.2	1.8
	C-3	Bolles	75	218	162	378	1.4	2.3
	C-4	SY Valda	39	142	147	199	1.0	1.4
	C-5	LCS Prime	42	176	132	246	1.3	1.9
	C-6	MN11325-7	41	166	134	242	1.2	1.8
	C-7	ND821	48	170	150	251	1.1	1.7
	C-8	SD4383	57	156	170	262	0.9	1.5
	<b>C-9</b>	<b>Glenn</b>	<b>63</b>	<b>201</b>	<b>150</b>	<b>344</b>	<b>1.3</b>	<b>2.3</b>
<b>Crookston</b>	K-1	MN10261-1	64	142	203	238	0.7	1.2
	K-3	Bolles	94	200	198	373	1.0	1.9
	K-4	SY Valda	49	116	197	184	0.6	0.9
	K-5	LCS Prime	56	292	117	392	2.5	3.3
	K-6	MN11325-7	63	238	140	365	1.7	2.6
	K-8	SD4383	73	212	152	427	1.4	2.8
	<b>K-9</b>	<b>Glenn</b>	<b>82</b>	<b>246</b>	<b>156</b>	<b>444</b>	<b>1.6</b>	<b>2.9</b>
<b>Williston</b>	W-2	ND820	73	219	158	374	1.4	2.4
	W-3	Bolles	68	185	167	331	1.1	2.0
	W-4	SY Valda	62	189	161	298	1.2	1.9
	W-5	LCS Prime	61	259	127	421	2.1	3.3
	W-7	ND821	66	210	159	332	1.3	2.1
	<b>W-9</b>	<b>Glenn</b>	<b>73</b>	<b>240</b>	<b>150</b>	<b>393</b>	<b>1.6</b>	<b>2.6</b>
<b>Bozeman</b>	W-10	LNR11-0757	77	236	157	406	1.5	2.6
	Z-3	Bolles	31	95	176	119	0.5	0.7
	Z-4	SY Valda	14	51	163	56	0.3	0.3
	Z-5	LCS Prime	25	76	180	94	0.4	0.5
	<b>Z-9</b>	<b>Glenn</b>	<b>35</b>	<b>89</b>	<b>187</b>	<b>133</b>	<b>0.5</b>	<b>0.7</b>

90 Minutes Resting								
Location	ID	Entry	Energy (cm <sup>2</sup> )	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
<b>Watertown</b>	B-3	Bolles	89	453	123	597	3.7	4.9
	B-4	SY Valda	60	342	112	420	3.0	3.7
	B-5	LCS Prime	60	600	83	643	7.2	7.7
	B-8	SD4383	75	438	112	548	3.9	4.9
	<b>B-9</b>	<b>Glenn</b>	<b>93</b>	<b>430</b>	<b>124</b>	<b>663</b>	<b>3.5</b>	<b>5.4</b>
<b>Casselton</b>	C-1	MN10261-1	48	295	108	371	2.8	3.5
	C-2	ND820	53	237	130	329	1.8	2.5
	C-3	Bolles	85	266	151	476	1.8	3.2
	C-4	SY Valda	53	218	135	314	1.6	2.3
	C-5	LCS Prime	53	278	116	376	2.4	3.2
	C-6	MN11325-7	59	339	112	417	3.0	3.7
	C-7	ND821	63	270	137	369	2.0	2.7
	C-8	SD4383	72	252	148	396	1.7	2.7
	<b>C-9</b>	<b>Glenn</b>	<b>103</b>	<b>399</b>	<b>144</b>	<b>580</b>	<b>2.8</b>	<b>4.0</b>
<b>Crookston</b>	K-1	MN10261-1	60	157	186	239	0.8	1.3
	K-3	Bolles	114	360	159	569	2.3	3.6
	K-4	SY Valda	65	170	179	274	1.0	1.5
	K-5	LCS Prime	59	708	77	714	9.2	9.3
	K-6	MN11325-7	89	482	120	614	4.0	5.1
	K-8	SD4383	95	431	128	620	3.4	4.8
	<b>K-9</b>	<b>Glenn</b>	<b>85</b>	<b>657</b>	<b>96</b>	<b>783</b>	<b>6.8</b>	<b>8.2</b>
<b>Williston</b>	W-2	ND820	79	369	124	541	3.0	4.4
	W-3	Bolles	105	272	174	478	1.6	2.8
	W-4	SY Valda	86	316	142	496	2.2	3.5
	W-5	LCS Prime	65	812	72	816	11.3	11.4
	W-7	ND821	95	338	144	548	2.3	3.8
	<b>W-9</b>	<b>Glenn</b>	<b>103</b>	<b>543</b>	<b>118</b>	<b>736</b>	<b>4.6</b>	<b>6.2</b>
<b>Bozeman</b>	W-10	LNR11-0757	119	435	140	732	3.1	5.2
	Z-3	Bolles	49	121	202	170	0.6	0.8
	Z-4	SY Valda	13	43	177	48	0.2	0.3
	Z-5	LCS Prime	38	96	195	140	0.5	0.7
	<b>Z-9</b>	<b>Glenn</b>	<b>57</b>	<b>127</b>	<b>199</b>	<b>217</b>	<b>0.6</b>	<b>1.1</b>
	Z-10	LNR11-0757	101	282	169	478	1.7	2.8

135 Minutes Resting								
Location	ID	Entry	Energy (cm <sup>2</sup> )	Resistance (BU)	Extensibility (mm)	Maximum (BU)	Ratio Number	Ratio Number (max)
<b>Watertown</b>	B-3	Bolles	85	536	110	652	4.9	6.0
	B-4	SY Valda	57	387	103	458	3.8	4.5
	B-5	LCS Prime	48	629	64	641	9.8	10.0
	B-8	SD4383	84	603	104	676	5.8	6.5
<b>Casselton</b>	<b>B-9</b>	<b>Glenn</b>	<b>70</b>	<b>533</b>	<b>95</b>	<b>669</b>	<b>5.6</b>	<b>7.1</b>
	C-1	MN10261-1	53	445	93	464	4.8	5.0
	C-2	ND820	58	299	124	377	2.4	3.0
	C-3	Bolles	99	281	167	482	1.7	2.9
	C-4	SY Valda	57	246	135	327	1.8	2.4
	C-5	LCS Prime	64	353	120	429	3.0	3.6
	C-6	MN11325-7	53	415	98	459	4.3	4.7
	C-7	ND821	63	310	125	416	2.5	3.3
	C-8	SD4383	67	303	131	401	2.3	3.1
	<b>C-9</b>	<b>Glenn</b>	<b>96</b>	<b>447</b>	<b>135</b>	<b>580</b>	<b>3.3</b>	<b>4.3</b>
<b>Crookston</b>	K-1	MN10261-1	61	185	174	264	1.1	1.5
	K-3	Bolles	111	370	154	560	2.4	3.6
	K-4	SY Valda	66	159	187	271	0.9	1.5
	K-5	LCS Prime	47	484	59	731	8.2	12.4
	K-6	MN11325-7	59	571	84	631	6.8	7.5
	K-8	SD4383	89	603	105	693	5.8	6.6
<b>Williston</b>	<b>K-9</b>	<b>Glenn</b>	<b>77</b>	<b>774</b>	<b>83</b>	<b>789</b>	<b>9.3</b>	<b>9.5</b>
	W-2	ND820	89	444	125	607	3.6	4.9
	W-3	Bolles	111	317	168	524	1.9	3.1
	W-4	SY Valda	88	369	139	506	2.7	3.6
	W-5	LCS Prime	51	776	61	823	12.7	13.4
	W-7	ND821	88	397	130	567	3.1	4.4
<b>Bozeman</b>	<b>W-9</b>	<b>Glenn</b>	<b>84</b>	<b>576</b>	<b>104</b>	<b>691</b>	<b>5.5</b>	<b>6.7</b>
	W-10	LNR11-0757	119	642	122	774	5.3	6.3
	Z-3	Bolles	52	122	209	172	0.6	0.8
	Z-4	SY Valda	16	47	191	55	0.3	0.3
	Z-5	LCS Prime	42	109	192	153	0.6	0.8
<b>Z-9</b>	<b>Glenn</b>	<b>66</b>	<b>167</b>	<b>184</b>	<b>269</b>	<b>0.9</b>	<b>1.5</b>	
	Z-10	LNR11-0757	85	307	141	506	2.2	3.6



















**LNR11-0757 (Z-10)**

Mill Stream Patent:	Stream (%, 14% mb)			Cumulative (%, 14% mb)		
	Yield	Ash	Protein	Yield	Ash	Protein
1 M	9.5	0.29	11.3	9.5	0.29	11.3
Sz I	3.4	0.31	12.5	12.9	0.29	11.6
2 M	10.5	0.32	11.6	23.5	0.30	11.6
Sz II	2.4	0.32	12.1	25.9	0.31	11.7
3 M	16.6	0.34	11.9	42.5	0.32	11.7
4 M	8.7	0.47	13.2	51.2	0.35	12.0
6 M	3.9	0.53	11.7	55.1	0.36	12.0
1 Bk	1.3	0.55	15.4	56.4	0.36	12.0
4 Bk	6.1	0.61	16.7	62.5	0.39	12.5
Bk Dust	2.5	0.66	14.5	65.0	0.40	12.6
3 Bk	1.5	0.71	16.1	66.5	0.40	12.7
2 Bk II	1.0	0.73	16.1	67.5	0.41	12.7
2 Bk I	0.6	0.80	17.3	68.2	0.41	12.8
TC	1.3	0.90	15.2	69.5	0.42	12.8
Tail	1.7	0.96	14.7	71.2	0.44	12.9
5 Bk	1.9	1.11	19.4	73.1	0.45	13.0
<b>Clear Flour:</b>						
5 M	1.9	1.08	13.5	74.9	0.47	13.0
LQ	0.2	1.36	13.1	75.2	0.47	13.0
LG	1.3	1.67	17.3	76.5	0.49	13.1
<b>Bran &amp; Shorts:</b>						
TC Sh	0.5	1.90	13.3	77.0	0.50	13.1
Tail Sh	2.5	3.29	14.9	79.5	0.59	13.2
Head Sh	17.6	4.28	18.2	97.1	1.26	14.1
Bran	2.9	5.83	16.5	100.0	1.39	14.1
<b>Patent (Rebolted)</b>	<b>0.46</b>	<b>12.9</b>				
<b>Wheat</b>	<b>1.41</b>	<b>13.9</b>				

## Cooperators' Bake Data

### Glenn Checks

WATERTOWN (B-9)				
Cooperator	Bake Absorption (%)	Loaf Volume (cc)	Mixing Requirement	Dough Characteristics
A	60.0	3000	5	5
B	64.0	1030	3	4
C	65.5	2200	3	4
D	62.0	3015	5	5
E	65.5	2952	4	4
F	69.4	1175	5	4
G	62.0	2900	3	3
H	71.8	1125	4	3
I	70.7	1190	3	4
J	65.8	1103	3	3
K	67.0	1080	4	5
L	69.3	1215	3	4
M	70.3	986	4	4
Avg.	<b>66.4</b>		<b>3.8</b>	<b>4.0</b>
S.D.	3.7		0.8	0.7

CASSELTON (C-9)				
Cooperator	Bake Absorption (%)	Loaf Volume (cc)	Mixing Requirement	Dough Characteristics
A	60.0	2900	3	3
B	64.0	1050	3	4
C	64.5	2300	3	3
D	62.0	3104	5	5
E	64.6	3065	3	3
F	68.7	1225	4	4
G	63.0	2900	3	3
H	70.4	1120	4	3
I	68.5	1160	3	4
J	64.3	1090	3	3
K	68.2	1010	4	4
L	70.0	990	4	4
M	69.8	949	3	4
Avg.	<b>66.0</b>		<b>3.5</b>	<b>3.6</b>
S.D.	3.4		0.7	0.7

CROOKSTON (K-9)				
Cooperator	Bake Absorption (%)	Loaf Volume (cc)	Mixing Requirement	Dough Characteristics
A	61.0	3050	5	5
B	64.0	945	3	4
C	64.0	2175	4	4
D	61.0	3015	5	5
E	63.9	3131	4	3
F	70.2	1210	5	4
G	62.0	2800	3	3
H	69.9	1200	5	4
I	71.0	1125	4	4
J	63.3	1023	3	3
K	69.3	1125	5	3
L	70.7	1045	5	4
M	69.0	969	4	3
Avg.	66.1		4.2	3.8
S.D.	3.9		0.8	0.7

WILLISTON (W-9)				
Cooperator	Bake Absorption (%)	Loaf Volume (cc)	Mixing Requirement	Dough Characteristics
A	61.0	3100	5	5
B	64.0	1000	3	4
C	65.0	2150	3	2
D	63.0	3015	5	5
E	65.2	2911	4	4
F	70.9	980	5	4
G	63.0	2650	3	3
H	70.1	1155	5	5
I	69.8	1180	3	4
J	64.5	983	3	3
K	70.1	1080	5	4
L	71.4	990	5	5
M	70.4	960	4	4
Avg.	66.8		4.1	4.0
S.D.	3.7		1.0	0.9

BOZEMAN (Z-9)				
Cooperator	Bake Absorption (%)	Loaf Volume (cc)	Mixing Requirement	Dough Characteristics
A	60.0	2675	1	1
B	64.0	900	3	3
C	71.0	2125	2	2
D	66.0	2750	3	3
E	71.0	2841	2	2
F	69.5	1045	2	3
G	65.0	3000	3	3
H	71.9	1010	3	3
I	68.0	995	1	1
J	69.2	1000	2	3
K	67.0	1025	1	1
L	69.9	1045	1	4
M	75.9	954	2	2
Avg.	68.3		2.0	2.4
S.D.	4.0		0.8	1.0

## MN10261-1

Cooperator	Bake Absorption (%)	CASSELTON (C-1)										
		Loaf Volume			Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	3100	106.9	3	3	3	3	4	3	3	3	3
B	64.0	985	93.8	3	4	2	3	3	2	3	2	3
C	63.5	2325	101.1	2	2	2	3	3	2	2	3	2
D	63.0	3045	98.1	5	5	3	3	3	2	2	3	2
E	63.7	3017	98.4	3	3	3	2	3	2	2	3	3
F	66.9	1050	85.7	3	3	2	2	2	3	2	2	1
G	62.0	2600	89.7	2	2	2	2	2	2	2	2	2
H	68.7	1055	94.2	3	3	1	3	4	2	2	3	2
I	66.5	1070	92.2	3	5	2	3	4	2	3	3	3
J	64.0	898	82.4	3	3	3	2	3	2	2	2	2
K	66.2	975	96.5	3	5	3	3	4	3	3	4	4
L	69.2	930	93.9	3	4	3	3	3	3	3	3	3
M	68.5	916	96.5	3	3	3	3	4	2	3	3	3
Avg.	65.0		94.6	3.0	3.5	2.5	2.7	3.2	2.3	2.5	2.8	2.5
S.D.	3.0		6.4	0.7	1.1	0.7	0.5	0.7	0.5	0.5	0.6	0.8

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Cooperator	Bake Absorption (%)	CROOKSTON (K-1)										
		Loaf Volume			Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	2900	95.1	3	3	2	3	3	3	2	2	3
B	64.0	1005	106.3	3	4	1	3	3	2	2	1	1
C	70.0	2350	108.0	2	5	2	2	2	2	3	2	1
D	66.0	2897	96.1	5	5	3	3	4	2	2	3	3
E	70.7	2933	93.7	3	2	2	2	3	2	2	2	2
F	68.5	1040	86.0	3	3	2	2	3	2	1	2	1
G	65.0	2800	100.0	2	3	2	3	3	2	1	3	3
H	71.5	1100	91.7	3	2	2	2	3	2	2	2	2
I	67.1	975	86.7	2	3	2	2	2	2	2	1	2
J	68.7	1070	104.6	3	3	3	3	2	2	2	3	3
K	67.7	1065	94.7	3	3	2	3	5	3	3	4	4
L	71.0	1035	99.0	3	4	3	3	3	3	3	3	3
M	75.9	897	92.6	4	2	2	4	4	3	1	4	3
Avg.	68.2		96.5	3.0	3.2	2.2	2.7	3.1	2.3	2.0	2.5	2.4
S.D.	4.0		6.9	0.8	1.0	0.6	0.6	0.9	0.5	0.7	1.0	1.0

## ND820

Cooperator	Bake Absorption (%)	CASSELTON (C-2)										
		Loaf Volume			Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	58.0	3000	103.4	3	3	3	3	4	2	3	3	3
B	62.0	985	93.8	3	4	3	3	3	1	2	2	2
C	63.0	2275	98.9	2	2	2	3	3	1	4	3	2
D	63.0	3045	98.1	5	5	3	4	3	2	3	3	3
E	63.0	2894	94.4	3	2	3	4	4	1	3	2	3
F	65.7	1040	84.9	3	3	2	3	2	2	3	2	2
G	62.0	2600	89.7	2	2	2	3	3	1	3	1	2
H	66.7	1020	91.1	3	1	2	3	4	1	3	2	1
I	64.0	1055	90.9	2	3	2	4	5	1	2	4	2
J	62.5	915	83.9	3	3	4	2	2	2	2	2	2
K	64.7	970	96.0	3	4	3	3	5	2	2	4	4
L	69.2	930	93.9	2	4	3	4	3	2	2	4	3
M	68.2	890	93.8	3	3	3	4	4	1	3	3	2
Avg.	64.0		93.3	2.8	3.0	2.7	3.3	3.5	1.5	2.7	2.7	2.4
S.D.	3.0		5.4	0.8	1.1	0.6	0.6	1.0	0.5	0.6	0.9	0.8

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Cooperator	Bake Absorption (%)	WILLISTON (W-2)										
		Loaf Volume			Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	2950	95.2	5	5	3	3	3	3	3	3	3
B	64.0	995	99.5	3	4	3	3	4	3	3	3	3
C	64.5	2250	104.7	3	3	2	4	4	3	4	4	3
D	61.0	3104	103.0	5	5	3	3	3	2	3	3	3
E	64.3	3026	104.0	4	5	3	4	3	3	3	3	3
F	69.5	1000	102.0	4	3	3	3	3	3	2	3	2
G	62.0	2700	101.9	1	2	2	3	3	2	3	3	3
H	68.6	1135	98.3	4	4	2	3	4	2	3	2	2
I	68.5	1060	89.8	3	3	2	3	4	2	4	4	3
J	63.0	875	89.0	3	3	3	3	3	3	4	2	3
K	68.5	1025	94.9	5	4	3	3	4	3	4	4	4
L	68.8	1035	104.5	3	4	2	3	4	3	3	4	4
M	69.3	961	100.1	4	3	2	3	4	3	4	3	3
Avg.	65.6		99.0	3.6	3.7	2.5	3.2	3.5	2.7	3.3	3.2	3.0
S.D.	3.3		5.3	1.1	0.9	0.5	0.4	0.5	0.5	0.6	0.7	0.6

## Bolles

Cooperator	Bake Absorption (%)	WATERTOWN (B-3)											
		Loaf Volume				Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall	
A	59.0	2900	96.7	5	5	3	3	3	3	3	3	3	3
B	63.0	975	94.7	3	4	3	3	3	2	2	2	3	3
C	62.0	2250	102.3	3	4	4	3	3	2	3	3	2	2
D	62.0	3045	101.0	5	5	3	3	2	2	3	3	2	2
E	62.1	3021	102.3	4	3	3	3	3	2	4	3	3	3
F	66.6	1030	87.7	4	3	3	3	3	2	2	2	1	1
G	60.0	2900	100.0	4	4	4	4	4	2	4	4	4	4
H	68.0	1130	100.4	4	4	4	3	3	2	4	3	3	3
I	68.0	1015	85.3	3	4	3	2	3	2	3	3	3	3
J	62.4	945	85.7	3	3	3	3	4	2	3	3	3	3
K	65.4	1010	93.5	5	4	3	3	3	2	3	3	3	3
L	68.8	1080	88.9	5	4	3	3	2	3	3	2	2	2
M	66.9	910	92.3	4	4	3	4	4	2	2	3	2	2
Avg.	64.2		94.7	4.0	3.9	3.2	3.1	3.1	2.2	3.0	2.8	2.6	
S.D.	3.3		6.3	0.8	0.6	0.4	0.5	0.6	0.4	0.7	0.6	0.8	

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Cooperator	Bake Absorption (%)	CASSELTON (C-3)											
		Loaf Volume				Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall	
A	61.0	3000	103.4	4	4	4	3	4	4	3	4	3	3
B	64.0	995	94.8	3	4	3	3	3	4	3	3	2	3
C	61.0	2350	102.2	5	5	4	3	4	4	2	4	3	3
D	61.0	2927	94.3	5	5	3	3	3	2	4	3	2	2
E	61.2	3027	98.8	4	3	5	3	3	4	1	2	3	3
F	69.7	1070	87.3	4	3	3	1	3	4	1	1	2	2
G	60.0	2550	87.9	5	5	4	2	2	4	2	4	4	4
H	65.9	1175	104.9	3	4	4	1	1	4	2	1	3	3
I	68.0	1060	91.4	3	4	4	2	3	4	2	2	3	3
J	63.5	1023	93.9	3	3	3	3	5	4	2	3	3	3
K	68.6	1055	104.5	4	4	2	3	5	3	2	5	5	5
L	70.7	1095	110.6	3	4	3	5	4	3	3	4	4	4
M	66.2	1004	105.8	4	4	4	3	3	4	2	4	3	3
Avg.	64.7		98.4	3.8	4.0	3.5	2.7	3.2	3.8	2.2	3.0	3.2	
S.D.	3.7		7.4	0.8	0.7	0.8	1.0	1.2	0.4	0.7	1.3	0.8	

Cooperator	Bake Absorption (%)	CROOKSTON (K-3)											
		Loaf Volume			Quality Score Compared to Check (Glenn)								
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall	
A	62.0	3100	101.6	5	5	3	3	3	3	3	3	3	
B	64.0	1025	108.5	3	4	3	3	4	4	2	5	4	
C	64.5	2250	103.4	3	3	4	3	3	4	4	3	4	
D	63.0	2897	96.1	5	5	3	3	2	4	2	2	2	
E	64.6	2897	92.5	4	4	3	3	4	4	2	2	3	
F	71.3	1035	85.5	4	3	3	2	3	4	1	1	2	
G	62.0	2800	100.0	4	3	2	2	2	4	2	2	2	
H	70.1	1215	101.3	3	3	4	3	3	4	2	3	4	
I	70.5	1100	97.8	3	4	4	2	2	4	3	1	2	
J	63.1	965	94.3	3	4	2	2	3	4	2	3	3	
K	68.7	1140	101.3	4	3	3	3	5	5	3	5	4	
L	71.5	1170	112.0	4	4	3	5	3	3	3	4	4	
M	69.5	1078	111.2	4	4	3	3	3	3	4	4	4	
<b>Avg.</b>	<b>66.5</b>	<b>100.4</b>	<b>3.8</b>	<b>3.8</b>	<b>3.1</b>	<b>2.8</b>	<b>3.1</b>	<b>3.8</b>	<b>3.8</b>	<b>2.5</b>	<b>2.9</b>	<b>3.2</b>	
<b>S.D.</b>	<b>3.8</b>	<b>7.5</b>	<b>0.7</b>	<b>0.7</b>	<b>0.6</b>	<b>0.8</b>	<b>0.9</b>	<b>0.6</b>	<b>0.9</b>	<b>1.3</b>	<b>0.9</b>	<b>0.9</b>	

Cooperator	Bake Absorption (%)	WILLISTON (W-3)											
		Loaf Volume			Quality Score Compared to Check (Glenn)								
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall	
A	63.0	2950	95.2	5	5	3	3	3	4	3	3	3	
B	64.0	975	97.5	3	4	3	3	3	5	3	2	3	
C	65.0	2300	107.0	3	5	5	3	3	4	5	4	4	
D	63.0	2927	97.1	5	5	3	3	3	4	2	3	3	
E	64.8	3217	110.5	5	5	3	3	4	4	2	3	4	
F	72.7	1070	109.2	4	3	3	2	3	4	1	3	1	
G	63.0	2650	100.0	5	5	4	2	2	4	2	3	3	
H	69.2	1135	98.3	3	4	5	3	4	4	2	4	4	
I	70.5	1060	89.8	3	2	2	2	5	5	3	4	4	
J	62.7	893	90.8	3	3	2	2	2	4	3	3	3	
K	69.6	1185	109.7	4	4	2	3	4	4	3	4	4	
L	72.6	1160	117.2	3	4	3	3	5	4	3	4	4	
M	69.9	1044	108.8	4	4	3	2	3	4	3	3	3	
<b>Avg.</b>	<b>66.9</b>	<b>102.4</b>	<b>3.8</b>	<b>4.1</b>	<b>3.2</b>	<b>2.6</b>	<b>3.4</b>	<b>4.2</b>	<b>2.7</b>	<b>3.3</b>	<b>3.3</b>	<b>3.3</b>	
<b>S.D.</b>	<b>3.9</b>	<b>8.5</b>	<b>0.9</b>	<b>1.0</b>	<b>1.0</b>	<b>0.5</b>	<b>1.0</b>	<b>0.4</b>	<b>0.9</b>	<b>0.6</b>	<b>0.6</b>	<b>0.9</b>	

Cooperator	Bake Absorption (%)	BOZEMAN (Z-3)							Quality Score Compared to Check (Glenn)				
		Loaf Volume			Dough Characteristics		Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
		(cc)	(% of Check)	Mixing Requirement									
A	61.0	2550	95.3	1	1	1	2	3	4	3	1	1	1
B	64.0	850	94.4	3	3	2	3	1	4	2	2	3	
C	68.5	2175	102.4	2	2	3	2	2	4	3	2	2	2
D	65.0	2515	91.5	1	3	1	2	1	4	2	1	1	1
E	68.5	2525	88.9	1	1	2	1	1	4	2	1	1	1
F	70.5	800	76.6	2	2	1	1	1	4	1	1	1	1
G	65.0	2500	83.3	2	2	2	1	1	5	2	1	1	2
H	71.8	1070	105.9	1	1	3	2	4	4	2	3	3	3
I	70.5	880	88.4	1	1	2	1	1	4	2	1	1	1
J	66.1	715	71.5	1	2	2	1	1	4	3	1	1	1
K	65.5	965	94.1	1	2	3	3	2	4	3	2	3	3
L	69.8	925	88.5	1	3	3	2	2	3	3	1	2	
M	73.4	832	87.2	2	2	2	1	4	4	2	2	2	3
Avg.	67.7	89.9	1.5	1.9	2.1	1.7	1.8	4.0	2.3	1.5	1.8		
S.D.	3.5	9.4	0.7	0.8	0.8	0.8	1.1	0.4	0.6	0.7	0.9		

## SY Valda

Cooperator	Bake Absorption (%)	WATERTOWN (B-4)						Quality Score Compared to Check (Glenn)					
		Loaf Volume			Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
		(cc)	(% of Check)	Mixing									
A	58.0	2800	93.3	3	3	2	3	3	2	2	1	2	
B	61.0	945	91.7	3	4	2	3	3	1	2	1	1	
C	61.5	2175	98.9	2	4	1	3	2	1	3	2	2	
D	59.0	2868	95.1	5	3	2	3	2	1	3	2	2	
E	61.3	2910	98.6	2	2	1	2	2	1	4	2	2	
F	64.6	965	82.1	4	3	2	3	3	1	3	2	1	
G	60.0	2850	98.3	1	1	1	1	2	2	4	2	2	
H	68.2	985	87.6	3	3	1	3	3	1	4	2	2	
I	63.5	960	80.7	3	3	2	2	4	1	4	4	3	
J	61.4	848	76.9	3	3	2	3	3	1	3	2	2	
K	61.1	940	87.0	4	4	2	3	3	2	3	3	3	
L	64.4	975	80.2	3	4	2	3	2	2	3	2	2	
M	66.3	917	93.0	3	3	2	4	4	1	2	3	2	
Avg.	62.3		89.5	3.0	3.1	1.7	2.8	2.8	1.3	3.1	2.2	2.0	
S.D.	2.9		7.6	1.0	0.9	0.5	0.7	0.7	0.5	0.8	0.8	0.6	

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Cooperator	Bake Absorption (%)	CASSELTON (C-4)						Quality Score Compared to Check (Glenn)					
		Loaf Volume			Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
		(cc)	(% of Check)	Mixing									
A	59.0	3100	106.9	3	3	3	3	4	2	3	3	3	
B	63.0	940	89.5	3	4	3	3	3	2	3	3	1	
C	60.0	2450	106.5	3	3	2	4	4	2	2	2	4	
D	59.0	3104	100.0	3	3	1	3	2	2	2	3	2	
E	60.2	2825	92.2	2	2	2	2	3	3	2	2	2	
F	65.9	1060	86.5	3	2	1	3	3	3	2	1	2	
G	59.0	2550	87.9	1	2	2	2	2	2	2	2	2	
H	65.0	980	87.5	3	3	1	2	2	2	2	2	2	
I	62.8	985	84.9	2	2	2	2	3	4	1	2	4	
J	60.4	880	80.7	3	3	2	2	2	2	2	3	2	
K	64.5	940	93.1	3	3	2	3	5	2	3	5	5	
L	67.9	965	97.5	3	4	2	2	4	2	3	4	3	
M	65.3	882	92.9	3	2	2	4	4	2	2	3	2	
Avg.	62.5		92.8	2.7	2.8	1.9	2.8	3.2	1.9	2.4	2.8	2.3	
S.D.	3.1		8.0	0.6	0.7	0.6	0.7	1.0	0.3	0.7	1.2	1.0	

Cooperator	CROOKSTON (K-4)											
	Bake Absorption (%)	Loaf Volume				Quality Score Compared to Check (Glenn)						
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	3100	101.6	2	2	2	3	3	3	2	2	2
B	64.0	930	98.4	3	4	2	3	4	1	3	2	3
C	63.5	2250	103.4	2	3	2	2	2	2	4	3	3
D	62.0	2839	94.2	5	4	2	3	3	2	3	2	2
E	63.4	3044	97.2	1	3	1	3	4	2	3	3	3
F	67.9	1085	89.7	3	3	1	3	2	2	1	2	1
G	62.0	2850	101.8	1	1	1	2	2	3	3	2	2
H	65.9	1030	85.8	3	2	1	4	1	2	2	1	2
I	66.0	1100	97.8	2	2	2	4	3	2	3	3	3
J	62.1	900	88.0	2	3	2	4	3	2	3	2	3
K	64.7	1005	89.3	3	4	2	3	4	3	2	4	4
L	67.5	1105	105.7	2	4	3	5	4	3	3	5	5
M	68.5	966	99.7	3	2	2	4	4	3	3	3	3
Avg.	64.4		96.4	2.5	2.8	1.8	3.3	3.0	2.3	2.7	2.6	2.8
S.D.	2.6		6.4	1.1	1.0	0.6	0.9	1.0	0.6	0.8	1.0	1.0

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Cooperator	WILLISTON (W-4)											
	Bake Absorption (%)	Loaf Volume				Quality Score Compared to Check (Glenn)						
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	61.0	3000	96.8	4	4	2	3	3	3	3	3	3
B	64.0	1020	102.0	3	4	3	3	3	3	4	2	3
C	62.5	2300	107.0	3	1	2	4	5	3	4	3	3
D	61.0	3045	101.0	5	5	3	3	3	2	4	3	3
E	62.6	2921	100.3	4	3	2	4	3	3	4	3	4
F	69.3	1055	107.7	4	3	2	3	3	3	2	4	2
G	61.0	2900	109.4	1	1	1	4	4	2	4	4	4
H	66.1	1015	87.9	4	3	2	2	3	2	4	2	2
I	67.5	1090	92.4	3	3	1	4	4	3	4	3	3
J	61.2	870	88.5	3	3	2	3	3	3	5	2	3
K	65.6	1060	98.1	4	4	2	3	5	3	4	5	4
L	72.5	1075	108.6	3	4	3	3	5	3	3	4	4
M	67.5	1058	110.2	3	3	2	4	3	3	3	3	3
Avg.	64.8		100.8	3.4	3.2	2.1	3.3	3.6	2.8	3.7	3.2	3.2
S.D.	3.7		7.8	1.0	1.1	0.6	0.6	0.9	0.4	0.8	0.9	0.7

Cooperator	Bake Absorption (%)	BOZEMAN (Z-4)										
		Loaf Volume			Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	2600	97.2	1	1	1	3	3	2	3	1	1
B	63.0	675	75.0	1	3	1	3	1	1	2	1	1
C	68.0	2200	103.5	1	2	1	2	2	2	4	2	2
D	65.0	2397	87.2	1	1	1	2	2	2	2	1	1
E	68.2	2406	84.7	1	1	1	2	2	1	1	1	1
F	66.2	760	72.7	1	2	1	1	1	2	1	1	1
G	65.0	2450	81.7	1	1	1	1	1	1	2	1	2
H	69.2	900	89.1	1	1	1	2	3	2	2	1	1
I	64.5	700	70.4	1	1	1	2	2	1	2	2	1
J	66.4	720	72.0	1	2	1	1	1	2	3	1	1
K	63.7	780	76.1	1	1	3	3	1	2	3	1	2
L	67.7	850	81.3	1	2	2	3	1	2	2	1	1
M	73.1	756	79.2	1	2	1	2	4	2	3	2	2
Avg.	66.1	82.3	1.0	1.5	1.2	2.1	1.8	1.7	2.3	1.2	1.3	
S.D.	3.4	10.0	0.0	0.7	0.6	0.8	1.0	0.5	0.9	0.4	0.5	

## LCS Prime

Cooperator	Bake Absorption (%)	WATERTOWN (B-5)						Quality Score Compared to Check (Glenn)					
		Loaf Volume			Dough Characteristics			Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
		(cc)	(% of Check)	Mixing Requirement			Mixing Tolerance						
A	58.0	3100	103.3	5	5	5	3	3	4	2	2	2	3
B	61.0	945	91.7	3	4	3	3	3	3	1	2	1	1
C	59.5	2125	96.6	4	5	2	3	2	2	1	3	2	2
D	58.0	2986	99.0	5	5	3	3	3	2	1	3	1	2
E	59.6	2985	101.1	3	3	2	2	2	2	1	5	3	2
F	64.1	1075	91.5	5	4	3	3	3	3	1	4	5	3
G	59.0	2800	96.6	2	2	2	2	2	2	2	5	2	2
H	66.5	1025	91.1	4	4	2	4	4	4	1	4	3	2
I	64.0	1100	92.4	3	4	3	4	5	1	1	4	5	3
J	60.6	895	81.1	4	3	3	3	3	2	1	4	2	2
K	63.0	925	85.6	5	4	3	3	3	2	2	3	2	2
L	65.8	955	78.6	4	4	3	4	1	2	2	4	2	3
M	64.4	962	97.6	4	3	3	4	4	1	2	3	2	2
Avg.	61.8		92.8	3.9	3.8	2.7	3.2	2.8	1.3	3.5	2.5	2.2	
S.D.	3.0		7.4	1.0	0.9	0.5	0.7	1.2	0.5	1.1	1.3	0.6	

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Cooperator	Bake Absorption (%)	CASSELTON (C-5)						Quality Score Compared to Check (Glenn)					
		Loaf Volume			Dough Characteristics			Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
		(cc)	(% of Check)	Mixing Requirement			Mixing Tolerance						
A	58.0	3000	103.4	2	3	3	3	4	2	3	3	3	3
B	62.0	975	92.9	3	4	3	3	3	1	4	2	2	2
C	62.0	2275	98.9	3	3	2	3	2	1	2	3	2	2
D	60.0	3105	100.0	5	5	3	3	2	2	2	3	2	2
E	62.1	3049	99.5	3	3	2	3	3	1	3	2	2	2
F	65.3	1125	91.8	4	3	2	2	3	1	1	4	2	2
G	60.0	2600	89.7	2	2	2	3	3	2	3	2	2	2
H	67.6	1050	93.8	4	3	2	1	1	1	3	2	1	1
I	64.5	1035	89.2	3	3	2	3	4	1	3	4	3	3
J	62.5	873	80.1	3	3	3	3	3	1	2	2	2	2
K	65.1	950	94.1	4	3	3	3	4	2	2	4	4	4
L	67.5	975	98.5	3	4	2	4	4	2	4	5	5	5
M	67.0	918	96.7	4	3	3	3	4	1	2	3	2	2
Avg.	63.4		94.5	3.3	3.2	2.5	2.8	3.1	1.4	2.7	2.9	2.5	
S.D.	3.1		6.1	0.9	0.7	0.5	0.7	1.0	0.5	0.9	1.0	1.1	

Cooperator	Bake Absorption (%)	CROOKSTON (K-5)						Quality Score Compared to Check (Glenn)					
		Loaf Volume			Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
		(cc)	(% of Check)										
A	59.0	3000	98.4	5	5	3	3	4	2	3	3	3	3
B	62.0	995	105.3	3	4	1	3	4	2	3	1	2	2
C	62.0	2175	100.0	2	3	3	3	2	2	3	3	3	3
D	60.0	3015	100.0	5	5	3	3	3	2	3	3	3	3
E	61.8	3112	99.4	4	3	3	4	4	1	3	3	3	3
F	66.0	1110	91.7	4	3	3	3	3	1	2	4	2	2
G	60.0	2600	92.9	3	2	2	2	2	1	3	2	2	2
H	67.6	1030	85.8	4	3	3	1	3	1	2	1	1	1
I	66.0	1100	97.8	3	3	4	4	3	1	3	4	4	4
J	62.2	920	89.9	4	3	3	3	2	1	3	2	2	2
K	65.2	990	88.0	5	4	3	3	5	2	3	4	4	4
L	68.5	970	92.8	5	4	3	3	3	2	3	4	4	4
M	66.8	980	101.1	4	4	3	4	4	2	3	4	3	3
Avg.	63.6	95.6	3.9	3.5	2.8	3.0	3.2	1.5	2.8	2.9	2.8	2.8	2.8
S.D.	3.2	5.8	1.0	0.9	0.7	0.8	0.9	0.5	0.4	1.1	0.9	0.9	0.9

Cooperator	Bake Absorption (%)	WILLISTON (W-5)						Quality Score Compared to Check (Glenn)					
		Loaf Volume			Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
		(cc)	(% of Check)										
A	59.0	2950	95.2	5	5	3	3	3	2	3	3	3	3
B	64.0	955	95.5	3	4	3	3	3	2	4	2	2	2
C	62.5	2200	102.3	3	4	2	3	4	2	4	3	3	3
D	61.0	2986	99.0	5	5	3	3	3	2	4	3	3	3
E	62.5	3105	106.7	4	4	3	3	3	2	4	3	3	3
F	67.0	1075	109.7	5	4	3	3	3	1	3	5	3	3
G	61.0	2500	94.3	2	2	2	2	2	2	3	4	2	3
H	68.3	1040	90.0	5	4	2	4	5	2	4	4	4	2
I	67.0	1200	101.7	4	4	5	4	3	1	4	4	3	3
J	61.8	963	98.0	4	4	3	3	2	2	4	2	3	3
K	66.8	1030	95.4	5	4	3	3	4	2	4	4	4	4
L	69.2	900	90.9	4	4	3	3	4	2	3	3	3	3
M	67.7	982	102.3	5	4	2	3	4	1	4	3	3	3
Avg.	64.4	98.5	4.2	4.0	2.8	3.1	3.3	1.8	3.8	3.2	2.9	2.9	2.9
S.D.	3.4	5.8	1.0	0.7	0.8	0.5	0.9	0.6	0.4	0.9	0.5	0.5	0.5

Cooperator	Bake Absorption (%)	BOZEMAN (Z-5)								Quality Score Compared to Check (Glenn)			
		Loaf Volume			Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
		(cc)	(% of Check)										
A	58.0	2475	92.5	1	1	2	3	3	2	3	2	2	2
B	62.0	795	88.3	3	3	2	3	1	1	4	2	1	1
C	70.5	2125	100.0	1	2	2	2	2	2	2	4	2	2
D	66.0	2485	90.4	1	1	1	2	2	2	2	4	1	1
E	70.7	2636	92.8	1	1	1	2	4	1	5	2	2	2
F	65.8	845	80.9	2	2	1	3	2	1	4	2	2	2
G	65.0	2700	90.0	1	1	1	1	1	1	1	4	1	2
H	71.5	945	93.6	1	1	1	2	3	1	4	1	1	1
I	65.0	865	86.9	1	1	4	3	4	1	4	4	4	3
J	68.6	840	84.0	1	2	2	3	2	1	3	2	2	2
K	63.6	935	91.2	1	1	3	3	3	2	4	3	3	3
L	71.0	965	92.3	1	2	2	3	3	2	3	2	2	2
M	75.9	826	86.6	1	2	2	2	4	1	4	2	2	2
Avg.	67.2	90.0	1.2	1.5	1.8	2.5	2.6	1.4	3.8	2.0	1.9		
S.D.	4.8	4.8	0.6	0.7	0.9	0.7	1.0	0.5	0.6	0.8	0.6		

## MN11325-7

Cooperator	Bake Absorption (%)	CASSELTON (C-6)										
		Loaf Volume			Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	3000	103.4	3	3	3	3	4	3	3	3	3
B	63.0	1050	100.0	3	4	3	3	3	2	4	3	3
C	61.0	2325	101.1	2	2	2	3	3	2	1	2	2
D	59.0	2956	95.2	5	5	3	3	2	2	3	2	2
E	60.9	2807	91.6	3	4	3	3	3	2	4	3	3
F	66.5	1150	93.9	4	3	2	2	3	2	1	3	2
G	60.0	2600	89.7	2	2	2	2	2	2	3	2	2
H	66.4	1060	94.6	3	3	2	1	1	2	4	1	2
I	64.5	1050	90.5	2	3	1	3	4	2	4	3	2
J	60.5	893	81.9	3	3	3	2	3	2	4	2	2
K	65.6	975	96.5	4	1	3	3	5	2	3	5	5
L	66.9	1080	109.1	2	4	3	4	5	3	3	5	5
M	66.0	952	100.3	3	3	3	3	5	2	2	3	2
Avg.	63.0		96.0	3.0	3.1	2.5	2.7	3.3	2.2	3.0	2.8	2.7
S.D.	3.1		7.0	0.9	1.0	0.7	0.8	1.3	0.4	1.1	1.1	1.1

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Cooperator	Bake Absorption (%)	CROOKSTON (K-6)										
		Loaf Volume			Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	60.0	3000	98.4	5	5	3	3	4	3	3	3	3
B	63.0	985	104.2	3	4	2	3	4	2	3	3	3
C	61.0	2225	102.3	3	3	3	3	3	2	4	3	2
D	59.0	3104	103.0	5	5	3	3	3	2	3	2	2
E	61.0	2939	93.9	4	4	3	3	4	1	3	3	4
F	67.3	1055	87.2	4	3	3	2	3	2	2	2	2
G	60.0	2650	94.6	3	2	2	2	2	2	3	2	2
H	66.6	1075	89.6	4	3	3	2	4	1	3	2	2
I	66.1	1085	96.4	3	4	2	3	2	1	5	2	2
J	60.6	880	86.0	3	3	3	3	2	2	3	2	3
K	66.4	1040	92.4	5	4	3	3	4	3	3	4	4
L	70.3	1100	105.3	5	4	3	3	4	2	3	5	5
M	66.1	988	102.0	3	4	3	3	4	3	4	3	3
Avg.	63.6		96.6	3.8	3.7	2.8	2.8	3.3	2.0	3.2	2.8	2.8
S.D.	3.6		6.6	0.9	0.9	0.4	0.4	0.9	0.7	0.7	0.9	1.0

# ND821

## CASSELTON (C-7)

Cooperator	Bake Absorption (%)	Loaf Volume				Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall	
A	60.0	3000	103.4	3	4	3	3	4	3	3	3	3	
B	64.0	1015	96.7	3	4	3	3	3	3	3	3	3	
C	64.0	2325	101.1	2	2	2	3	3	4	2	3	2	
D	62.0	3104	100.0	5	5	3	3	3	3	3	3	3	
E	63.8	2891	94.3	3	3	3	4	4	3	5	3	4	
F	67.9	1090	89.0	4	3	2	2	3	3	3	2	2	
G	61.0	2600	89.7	2	2	2	2	3	4	4	4	4	
H	69.4	1110	99.1	3	2	2	1	3	3	4	2	2	
I	66.6	1045	90.1	3	3	2	2	2	3	4	2	2	
J	64.1	1023	93.9	3	3	2	2	3	3	4	2	3	
K	66.0	995	98.5	4	2	3	3	4	3	4	4	4	
L	67.9	990	100.0	3	4	2	4	5	3	3	3	3	
M	68.5	1015	107.0	3	3	2	3	4	3	3	3	3	
Avg.	65.0		97.1	3.2	3.1	2.4	2.7	3.4	3.2	3.5	2.8	2.9	
S.D.	3.0		5.5	0.8	1.0	0.5	0.9	0.8	0.4	0.8	0.7	0.8	

## WILLISTON (W-7)

Cooperator	Bake Absorption (%)	Loaf Volume				Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall	
A	61.0	3050	98.4	4	4	3	3	3	3	3	3	3	
B	63.0	1025	102.5	3	4	3	3	4	3	4	2	3	
C	63.5	2200	102.3	3	4	1	4	5	3	4	4	2	
D	62.0	3104	103.0	5	5	3	3	3	2	4	3	3	
E	63.6	3139	107.8	4	4	2	3	2	3	4	3	3	
F	69.9	1085	110.7	4	3	3	3	3	3	2	4	2	
G	62.0	2700	101.9	1	2	2	3	3	2	4	2	3	
H	67.1	1060	91.8	3	4	1	4	3	2	4	3	2	
I	68.0	1100	93.2	3	4	2	3	4	3	4	4	4	
J	63.1	908	92.4	3	3	2	3	2	2	4	2	3	
K	68.5	1105	102.3	5	4	2	3	4	3	4	4	4	
L	67.5	1100	111.1	5	4	3	4	5	3	3	5	5	
M	68.5	978	101.9	3	3	2	3	4	3	3	3	3	
Avg.	65.2		101.5	3.5	3.7	2.2	3.2	3.5	2.7	3.6	3.2	3.1	
S.D.	3.1		6.3	1.1	0.8	0.7	0.4	1.0	0.5	0.7	0.9	0.9	

## SD4383

Cooperator	Bake Absorption (%)	WATERTOWN (B-8)						Quality Score Compared to Check (Glenn)					
		Loaf Volume			Dough Characteristics			Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
		(cc)	(% of Check)	Mixing Requirement			Mixing Tolerance						
A	59.0	3100	103.3	5	5	3	3	4	2	2	2	3	
B	62.0	940	91.3	3	4	3	3	3	2	3	2	2	
C	59.5	2250	102.3	3	5	3	3	3	2	2	2	2	
D	57.0	3104	103.0	5	5	3	3	2	2	3	2	2	
E	59.6	3015	102.1	4	4	3	2	2	1	5	2	2	
F	65.8	1090	92.8	5	4	3	3	3	2	3	4	3	
G	59.0	2800	96.6	2	2	2	2	2	2	5	2	2	
H	60.4	1040	92.4	5	4	2	2	3	1	4	2	1	
I	64.0	1115	93.7	3	4	3	3	4	2	4	4	3	
J	60.2	915	83.0	4	4	2	3	2	2	3	2	2	
K	63.6	925	85.6	5	4	3	3	3	2	3	3	3	
L	66.8	915	75.3	5	4	3	4	1	2	4	1	2	
M	64.4	992	100.6	4	3	3	4	4	2	1	3	2	
Avg.	61.6		94.0	4.1	4.0	2.8	2.9	2.8	1.8	3.2	2.5	2.2	
S.D.	3.0		8.7	1.0	0.8	0.4	0.6	0.9	0.4	1.2	0.9	0.6	

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Cooperator	Bake Absorption (%)	CASSELTON (C-8)						Quality Score Compared to Check (Glenn)					
		Loaf Volume			Dough Characteristics			Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
		(cc)	(% of Check)	Mixing Requirement			Mixing Tolerance						
A	60.0	3100	106.9	2	3	3	3	3	3	3	3	3	3
B	64.0	1020	97.1	3	4	3	3	3	3	2	4	3	3
C	61.5	2375	103.3	3	3	2	3	2	3	3	1	2	2
D	60.0	3045	98.1	5	5	3	3	3	3	2	3	3	3
E	61.4	2844	92.8	3	3	3	3	3	4	2	3	3	3
F	67.0	1140	93.1	4	3	2	2	2	2	3	1	3	2
G	60.0	2600	89.7	2	2	2	2	2	2	3	3	3	3
H	65.8	1110	99.1	3	3	2	1	4	2	3	3	3	2
I	65.0	1110	95.7	3	3	2	3	3	3	2	4	3	3
J	61.7	985	90.4	3	3	3	3	2	3	2	2	2	2
K	65.3	980	97.0	4	3	3	3	3	5	3	3	4	4
L	66.6	1010	102.0	3	4	3	4	5	3	3	4	4	4
M	66.4	994	104.7	4	3	3	3	4	2	1	3	2	
Avg.	63.4		97.7	3.2	3.2	2.6	2.7	3.3	2.5	2.6	3.0	2.8	
S.D.	2.7		5.4	0.8	0.7	0.5	0.8	1.0	0.5	1.0	0.6	0.7	

Cooperator	Bake Absorption (%)	CROOKSTON (K-8)										
		Loaf Volume			Quality Score Compared to Check (Glenn)							
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall
A	59.0	3050	100.0	5	5	3	3	4	3	3	3	3
B	63.0	1015	107.4	3	4	2	3	4	2	4	3	3
C	60.5	2225	102.3	2	3	2	2	3	2	2	3	2
D	58.0	3104	103.0	5	5	3	3	2	2	4	2	2
E	60.4	2973	95.0	2	3	2	3	4	1	4	3	4
F	66.5	1065	88.0	4	3	3	3	3	1	2	3	2
G	59.0	2550	91.1	2	1	1	1	2	2	4	2	2
H	66.2	1095	91.3	5	3	2	3	4	1	2	3	2
I	65.8	1135	100.9	3	3	3	2	2	1	5	3	2
J	60.1	933	91.2	3	3	3	2	3	2	3	2	2
K	66.1	995	88.4	5	2	3	3	5	2	3	5	4
L	66.9	1030	98.6	5	4	2	3	3	2	3	5	5
M	65.3	1026	105.9	4	3	2	4	4	2	1	3	2
Avg.	62.8		97.1	3.7	3.2	2.4	2.7	3.3	1.8	3.1	3.1	2.7
S.D.	3.4		6.7	1.3	1.1	0.7	0.8	0.9	0.6	1.1	1.0	1.0

## LNR11-0757

Cooperator	Bake Absorption (%)	Loaf Volume				WILLISTON (W-10)									Quality Score Compared to Check (Glenn)			
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall						
A	61.0	2975	96.0	2	2	1	3	3	3	3	2	2						
B	64.0	1000	100.0	3	4	3	3	3	3	3	2	3						
C	63.0	2150	100.0	4	5	3	4	3	3	3	3	3						
D	61.0	3104	103.0	5	5	3	3	3	3	3	3	3						
E	63.2	3095	106.3	4	4	3	3	3	3	3	3	3						
F	70.2	1185	120.9	4	4	2	3	3	3	3	1	5						
G	62.0	2700	101.9	3	3	3	3	2	3	3	3	3						
H	68.1	1185	102.6	3	5	3	3	4	3	3	4	3						
I	68.4	1200	101.7	3	4	2	4	2	3	3	4	2						
J	62.4	953	96.9	3	3	3	3	3	3	3	3	2						
K	68.5	1090	100.9	5	5	3	3	5	3	3	2	5						
L	69.9	1075	108.6	3	5	3	4	5	3	3	4	4						
M	68.4	1053	109.7	4	4	3	2	3	3	3	3	3						
Avg.	65.4		103.7	3.5	4.1	2.7	3.2	3.2	3.0	2.8	3.2	3.0						
S.D.	3.5		6.5	0.9	1.0	0.6	0.6	0.9	0.0	0.7	1.1	0.7						

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Cooperator	Bake Absorption (%)	Loaf Volume				BOZEMAN (Z-10)									Quality Score Compared to Check (Glenn)			
		(cc)	(% of Check)	Mixing Requirement	Dough Characteristics	Mixing Tolerance	Internal Crumb Color	Internal Grain & Texture	Protein	Milling	Baking	Overall						
A	59.0	2650	99.1	1	1	2	3	3	3	3	2	2						
B	63.0	905	100.6	3	4	3	3	3	2	3	3	3						
C	65.0	2300	108.2	3	3	3	3	2	2	2	2	2						
D	62.0	3045	110.7	5	5	5	3	5	2	2	2	4						
E	64.8	2927	103.0	2	2	5	3	4	2	3	3	4						
F	66.9	1090	104.3	3	3	3	2	3	2	1	1	5						
G	63.0	2750	91.7	3	3	3	3	3	2	3	3	3						
H	67.7	1035	102.5	2	4	3	1	4	2	3	3	2						
I	66.5	1110	111.6	2	2	4	3	5	1	3	3	5						
J	63.6	1003	100.3	2	3	5	2	3	2	3	3	3						
K	64.7	1015	99.0	3	3	4	3	5	2	2	3	5						
L	65.8	1020	97.6	2	4	2	4	5	3	3	4	4						
M	70.0	972	101.9	3	3	2	3	3	2	1	3	2						
Avg.	64.8		102.3	2.6	3.1	3.4	2.8	3.7	2.1	2.5	3.5	3.2						
S.D.	2.8		5.5	1.0	1.0	1.1	0.7	1.0	0.5	0.8	1.1	1.0						

## Hard Red Spring Wheat Breeding Quality Target Values

	<b>Quality Parameter</b>	<b>Target Value*</b>
<b>Wheat</b>	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
<b>Milling</b>	Flour Extraction:	
	Buhler Lab Mill (%, 0.48% ash)	70
	Quadrumat Senior (%, 0.48% ash)	70
<b>Flour</b>	Protein Loss (%)	< 1.0
	Ash (%, 14% mb)	0.48
	Color ( $L^*$ value)	90
<b>Farinograph (50 g bowl)</b>	Wet Gluten (%, 14% mb, 13.5% protein)	36
	Absorption (%)	64
	Peak Time (min)	6-8
<b>Mixograph</b>	Stability (min)	15-17
	Peak time (min)	5
<b>Bread Baking<sup>‡</sup></b>	Loaf Volume (cc)	1050
	Grain & Texture (1 = poor, 10 = excellent) <sup>†</sup>	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.

<sup>†</sup>Subjective ratings and classifications are from North Dakota State University, Hard Red Spring Wheat Quality Laboratory.

<sup>‡</sup>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.