Milling and Baking Test Results
for Hard Winter Wheat
Harvested in 2010

61st Report on Wheat Quality
Hard Winter Wheat Technical Board of the Wheat Quality Council

A coordinated effort by the agricultural, milling and baking industries to improve wheat quality

This program was carried out in cooperation with the Wheat Quality Council, Pierre, SD, The United States Department of Agriculture (USDA), The Agricultural Experiment Stations of Colorado, Kansas, Montana, Nebraska, Oklahoma, South Dakota, and Texas, Private wheat breeding companies including AgriPro Wheat and Westbred, LLC, and laboratories from milling, baking, grain trade and other firms and research organizations. This technical report was prepared by the USDA-ARS, Hard Winter Wheat Quality Laboratory in Manhattan, KS. Trade names, if used, are used to identify products. No endorsement is intended, nor is criticism implied of similar products not mentioned.

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2010

Milling and Baking Test Results for

Hard Winter Wheats

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The MISSION
of the WHEAT QUALITY COUNCIL:

ADVOCATE THE DEVELOPMENT OF NEW WHEAT VARIETIES THAT IMPROVE THE VALUE OF WHEAT TO ALL PARTIES IN THE UNITED STATES SUPPLY CHAIN.

The GOAL
of the WHEAT QUALITY COUNCIL:

IMPROVE THE VALUE OF ALL U. S. WHEAT CLASSES FOR PRODUCERS, MILLERS, AND PROCESSORS OF WHEAT.

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Description of the 2010 Testing Program

Founded in 1949, this is the **61st** year for the Hard Winter Wheat Milling and Baking Evaluation Program. This program is sponsored by the Wheat Quality Council and coordinated by the USDA-ARS Hard Winter Wheat Quality Laboratory (HWWQL) and Kansas State University Department of Grain Science and Industry. Wheat experimental lines and check varieties were submitted by public and private breeding programs in the Great Plains growing region. This technical report includes FGIS wheat market classification, physical grain testing, milling, analytical, rheological, and bread baking results.

All entries this year were grown in special locations and submitted for small-scale testing by seven wheat breeding programs. Wheat samples were milled on the Miag Multomat mill in the Kansas State University Department of Grain Science and Industry (Methods, Appendix A). The flours were distributed to nineteen cooperators (17 for bread baking, 1 for tortilla and 1 for noodle) for end-product quality evaluation. The wheat physical and chemical tests, flour quality analysis, and dough rheological tests (Mixograph, Farinograph, Alveograph, and Extensigraph) were conducted by the HWWQL.

Also included in this report is alkaline noodle and protein analysis data generated by the HWWQL in Manhattan, KS, and tortilla data generated by Texas A&M University. Methods used to evaluate wheat lines are listed in Appendix A.

2010 HRW Entries

	Test Entry Number	Sample Identification
SOUTH DAKOTA	10-2401	Lyman (check)
	10-2402	SD05118-1
	10-2403	SD06158
COLORADO	10-2404	Hatcher (check)
	10-2405	CO050303-2
	10-2406	CO06052
	10-2407	CO06424
NEBRASKA	10-2408	Millennium (check)
	10-2409	NE03490
	10-2410	NE04490
OKLAHOMA	10-2411	Billings (check)
	10-2412	OK05526
	10-2413	OK05212
	10-2414	OK07231
WESTBRED	10-2415	Smoky Hill (check)
	10-2416	HV9W06-262 R
	10-2417	HV9W06-218 W
MONTANA	10-2418	Yellowstone (check)
	10-2419	MTS0721
TEXAS-AMARILLO	10-2420	TAM 111 (check)
	10-2421	TX05A001822
	10-2422	TX06A001263

Wheat Classification Results from FGIS

FGIS Market Classification

Sample ID	Program	Entry Name	Wht Cl	DKG	TW	M	ODOR	HT	DKT	FM	SHBN	DEF	CCL	WOCL	GRADE
10-2401	South Dakota	Lyman (check)	HRW	0.0	61.8	13.4	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW, INFESTED, DKG 0.0%
10-2402	South Dakota	SD05118-1	HRW	0.0	59.0	13.2	OK	0.0	0.8	0.0	0.3	1.1	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
10-2403	South Dakota	SD06158	HRW	0.0	58.0	13.3	OK	0.0	2.1	0.0	0.6	2.7	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
10-2404	Colorado	Hatcher (check)	HRW	0.0	59.9	9.5	OK	0.0	0.0	0.0	1.6	1.6	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
10-2405	Colorado	CO050303-2	HRW	0.0	59.6	9.9	OK	0.0	0.0	0.0	1.4	1.4	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
10-2406	Colorado	CO06052	HRW	0.0	60.2	9.4	OK	0.0	0.1	0.0	1.3	1.4	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
10-2407	Colorado	CO06424	HRW	0.0	58.0	9.4	OK	0.0	0.1	0.0	1.6	1.7	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
10-2408	Nebraska	Millennium (check)	HRW	0.0	57.8	11.8	OK	0.0	1.1	0.0	1.3	2.4	0.0	1.3	U.S. NO. 3 HRW, DKG 0.0%
10-2409	Nebraska	NE03490	HRW	0.0	56.4	11.6	OK	0.0	0.2	0.0	1.3	1.5	0.0	0.0	U.S. NO. 3 HRW, DKG 0.0%
10-2410	Nebraska	NE04490	HRW	0.0	56.8	11.4	OK	0.0	0.6	0.0	1.5	2.1	0.0	0.0	U.S. NO. 3 HRW, DKG 0.0%
10-2411	Oklahoma	Billings (check)	HRW	0.0	60.5	10.9	OK	0.0	0.2	0.0	0.2	0.4	0.0	0.2	U.S. NO. 1 HRW, DKG 0.0%
10-2412	Oklahoma	OK05526	HRW	0.1	59.9	10.6	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	U.S. NO. 2 HRW, DKG 0.1%
10-2413	Oklahoma	OK05212	HRW	0.0	60.6	10.8	OK	0.0	0.0	0.0	1.0	1.0	0.0	0.2	U.S. NO. 1 HRW, DKG 0.0%
10-2414	Oklahoma	OK07231	HRW	0.0	58.8	10.4	OK	0.0	0.0	0.0	0.9	0.9	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
10-2415	Westbred	Smoky Hill (check)	HRW	0.0	59.4	10.3	OK	0.0	0.1	0.0	1.2	1.3	0.0	0.0	U.S. NO. 2 HRW, DKG 0.0%
10-2416	Westbred	HV9W06-262 R	HRW	0.0	62.0	10.2	OK	0.0	0.0	0.0	0.6	0.6	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
10-2417	Westbred	HV9W06-218 W	HDHW	0.0	62.7	10.3	OK	0.0	2.6	0.0	0.3	2.9	1.4	1.4	U.S. NO. 2 HDHW, DKG 0.0%
10-2418	Montana	Yellowstone (check)	HRW	0.0	61.0	13.0	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
10-2419	Montana	MTS0721	HRW	0.0	60.6	11.6	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
10-2420	Texas	TAM 111 (check)	HRW	0.0	61.1	11.2	OK	0.0	0.0	0.0	0.7	0.7	0.0	0.0	U.S. NO. 1 HRW, DKG 0.0%
10-2421	Texas	TX05A001822	HRW	0.0	59.8	10.9	OK	0.0	0.0	0.0	0.7	0.7	0.0	0.6	U.S. NO. 2 HRW, DKG 0.0%
10-2422	Texas	TX06A001263	HRW	0.0	60.4	11.1	OK	0.0	0.0	0.0	0.7	0.7	0.0	0.6	U.S. NO. 1 HRW, DKG 0.0%

Wht Cl = Wheat class, DKG = Dockage (%), TW = Test weight (lb/bushels), M = Moisture (%), ODOR = Odour; HT = Heat damage (%), DKT = Damaged kernels total (%), FM = Foreign materials (%), SHBN = Shrunken and broken kernels (%), DEF = Defects (%), CCL = Contrasting classes (%), WOCL = wheat of other classes.

Wheat Breeder Plot and Entry Descriptions, Wheat and Flour Analytical, Physical Dough, and Bread Baking Data

Description of Test Plots and Breeder Entries

South Dakota – William Berzonsky

SDSU sent Lyman as a check and two experimental breeding lines SD05118-1 and SD06158 for the 2010 WQC Trials. Samples of equal amounts of seed were sent from locations at Brookings and Highmore, SD (East River locations). The plots were 5 foot wide by 400 ft long at each location. Planting conditions in the fall were dry at the Highmore site. A very mild winter and ample early snow cover resulted in the survival of volunteer spring wheat at several of our SD research locations. In fact, a third intended WQC location at Winner, SD (West River) was not harvested due to excessive volunteer spring wheat in the plots. At harvest, conditions were humid with excessive rain, particularly at the Brookings WQC location. The average grain yield for the SD Winter Wheat Crop Performance Trial (CPT)-East River locations was 66 bu/a compared with 64 bu/a for the 3-year average, and the average grain yield for the same nursery over West River locations was 48 bu/a compared with a 53 bu/a 3-year average. Generally, leaf and stripe rust never developed to a level that significantly reduced grain yields, although some varieties previously exhibiting resistance to stripe rust were susceptible, likely due to an apparent race change in the pathogen. Fusarium head blight was a significant problem for susceptible varieties, leading to reduced test weights and the production of seed exhibiting low germination. Bacterial leaf blight and wheat streak mosaic virus were also problems in winter wheat and probably reduced grain yields to some extent for the more susceptible varieties.

Lyman (Check)

Available as certified seed in 2010, Lyman is a hard red winter wheat variety developed from the cross KS93U134/Arapahoe. It is a medium maturity and medium height variety, and its winter hardiness is similar to Arapahoe. It was targeted as a replacement for both Arapahoe and Harding, and it is complementary to Millennium and Overland in its genetic performance. Lyman has excellent disease resistance, including leaf and stem rust resistance, and it is among the most resistant varieties for scab. It has a tendency to lodge under high moisture conditions, similar to Arapahoe, and is rated as having excellent milling and satisfactory baking quality.

SD05118-1

A hard red winter wheat breeding line with the pedigree Wesley/NE93613, this breeding line is a white chaff reselection from SD05118, which was a mixture of white and red chaff types. In 2010, SD05118-1 was among the top one-third of breeding lines and variety checks for grain yield in 6 of 13 of the statewide CPT locations. By comparison, the best varietal checks, Lyman and Overland, were ranked in the top one-third for yield in 8 of 13 locations. Its average yield across all CPT locations was 61.6 bu/a compared with 62.2 bu/a for Lyman. This was the first year for the reselected line in the SD CPT. In the 2010 Northern Regional Performance Nursery it ranked 16th for average grain yield across locations among 34 evaluated breeding lines and check varieties. It is medium

height with a maturity about 2 days later than Wesley. Marker genotyping indicates it likely carries *Lr34* and a gene for resistance to pre-harvest sprouting. SD05118-1 exhibits some resistance to Hessian fly, excellent resistance to Fusarium head blight, and high test weight. This reselection is expected to have satisfactory milling quality and based on earlier mixograph comparisons with SD05118, SD05118-1 is expected to have stronger mix characteristics than Lyman.

SD06158

A hard red winter wheat breeding line with the pedigree Wesley/CDC Falcon**,** this breeding line is a red chaff type and is similar in appearance to Wesley. In 2010, SD06158 was among the top one-third of breeding lines and variety checks for yield in 6 of 13 of the statewide CPT locations. Its average yield across all CPT locations was 59.9 bu/a compared with 62.2 bu/a for Lyman. This was the second year for SD06158 in the CPT. In the 2010 Northern Regional Performance Nursery it ranked 5th for average grain yield across locations among 34 evaluated breeding lines and check varieties. It is a shorter semi-dwarf type, with a maturity about 3 days later than Wesley. Marker genotyping indicates it likely carries *Lr37*. SD06158 exhibits average to below average resistance to Fusarium head blight, but high test weight. This line is expected to have satisfactory milling quality, and based on mixograph comparisons, SD06158 is expected to have similar or slightly weaker mix characteristics than Lyman.

South Dakota: 2010 (Small-Scale) Samples [a]

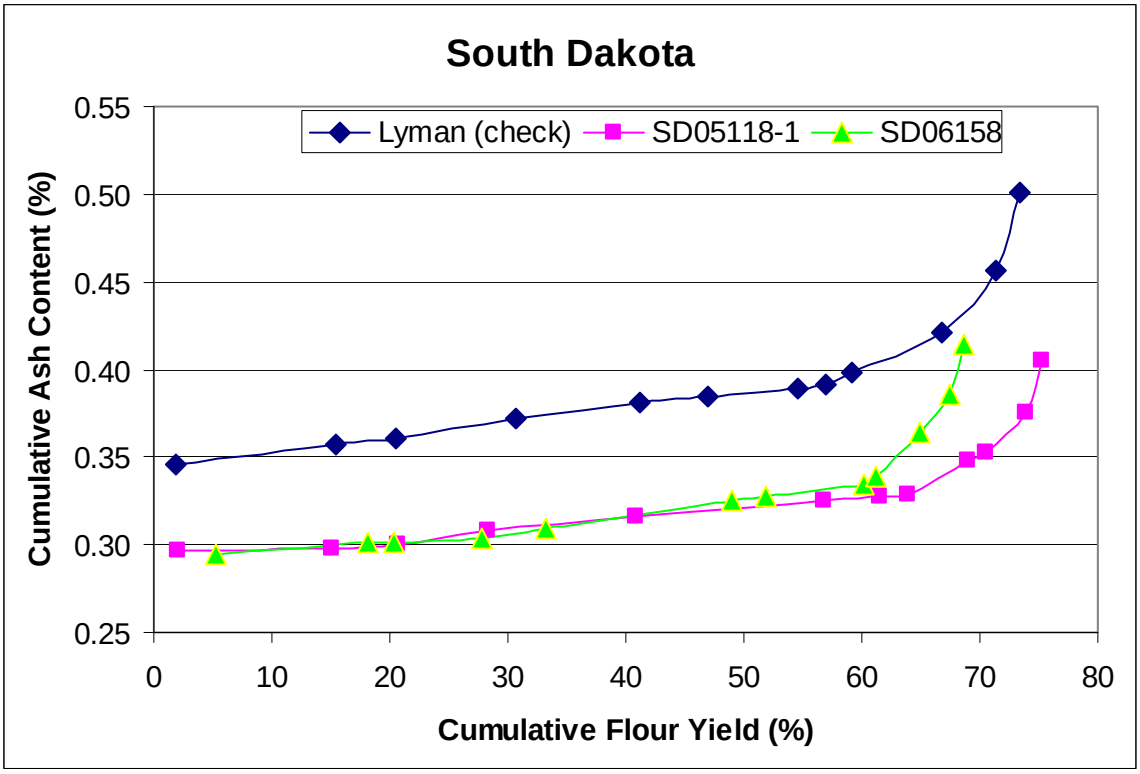
Test entry number	10-2401	10-2402	10-2403
Sample identification	**Lyman (check)**	**SD05118-1**	**SD06158**
Wheat Data			
FGIS classification	1 HRW	2 HRW	1 HRW
Test weight (lb/bu)	61.8	59.0	58.0
Hectoliter weight (kg/hl)	81.3	77.6	76.4
1000 kernel weight (gm)	42.9	32.8	29.8
Wheat kernel size (Rotap)			
Over 7 wire (%)	94.0	71.2	55.7
Over 9 wire (%)	5.9	28.4	43.1
Through 9 wire (%)	0.0	0.3	1.2
Single kernel (skcs)			
Hardness (avg /s.d)	55.9/16.0	52.7/16.1	49.2/16.0
Weight (mg) (avg/s.d)	42.9/8.7	32.8/9.4	29.8/9.2
Diameter (mm)(avg/s.d)	2.97/0.29	2.68/0.34	2.55/0.35
SKCS distribution	09-18-30-43	11-25-31-33	16-32-25-27
Classification	Hard	Mixed	Mixed
Wheat moisture (%)	11.2	12.1	11.5
Wheat protein (12% mb)	12.1	12.4	12.6
Wheat ash (12% mb)	1.68	1.72	1.74
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	73.4	75.3	68.8
Quadrumat Sr. Mill	73.5	73.2	71.6
Flour moisture (%)	10.4	10.6	10.8
Flour protein (14% mb)	10.5	10.7	11.1
Flour ash (14% mb)	0.53	0.46	0.46
Glutomatic			
Wet gluten (%)	29.7	27.2	31.0
Dry gluten (%)	10.4	10.3	11.3
Gluten index	98.5	99.6	99.0
Rapid Visco-Analyser			
Peak Time (min)	6.2	6.1	6.3
Peak Viscosity (RVU)	199.6	216.3	214.9
Breakdown (RVU)	65.3	80.4	71.0
Final Viscosity at 13 min (RVU)	247.2	254.3	257.3
Minolta color meter			
L*	92.4	92.5	93.0
a*	-1.76	-1.60	-1.34
b*	9.53	9.05	7.47
Falling number (sec)	475	409	444
Damaged Starch			
(AI%)	95.82	95.34	95.02
(AACC76-31)	6.13	5.78	5.53

[a] s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

South Dakota: Physical Dough Tests and Gluten Analysis For 2010 (Small-Scale) Samples

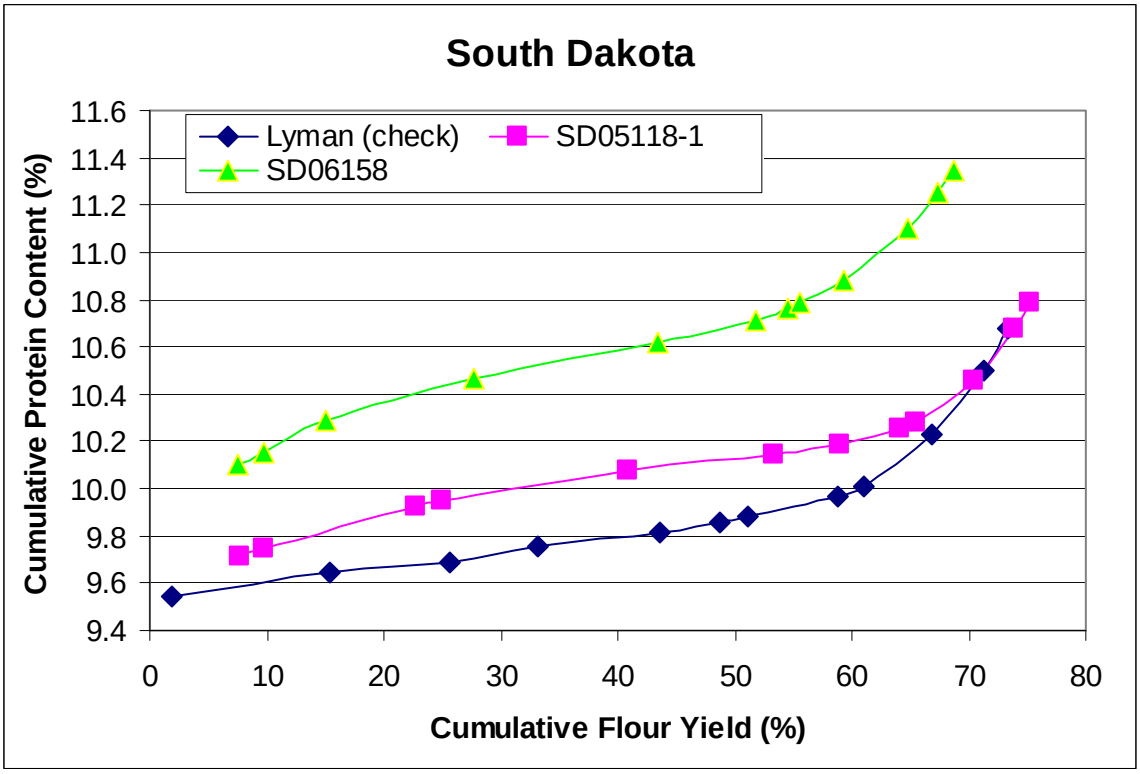
Test Entry Number	10-2401	10-2402	10-2403
Sample Identification	Lyman (check)	SD05118-1	SD06158
MIXOGRAPH			
Flour Abs (% as-is)	64.5	64.6	65.1
Flour Abs (14% mb)	60.4	60.8	61.5
Mix Time (min)	4.63	6.88	5.00
Mix tolerance (0-6)	3	4	3
FARINOGRAPH			
Flour Abs (% as-is)	61.2	59.6	59.2
Flour Abs (14% mb)	57.2	55.8	55.6
Development time (min)	2.5	2.5	3.5
Mix stability (min)	17.3	22.8	22.7
Mix Tolerance Index (FU)	15	19	6
Breakdown time (min)	14.3	12.1	18.5
ALVEOGRAPH			
P(mm. $_{H2O}$): Tenacity	80	75	58
L(mm): Extensibility	105	92	129
G($mm_{0.5}$): Swelling index	22.8	21..4	25.3
W(10^{-4} J): strength (curve area)	299	286	280
P/L: curve configuration ratio	0.76	0.82	0.45
Ie(P_{200}/P): elasticity index	62.8	70.7	67.6
EXTENSIGRAPH			
Resist (BU at 30/60/90 min)	494/703/841	669/996/989	488/802/903
Extensibility (mm at 30/60/90 min)	131/114/115	147/114/109	161/145/130
Energy (cm^2 at 30/60/90 min)	109/125/142	183/155/143	145/196/175
Resist $_{max}$ (BU at 30/60/90 min)	641/941/997	999/996/989	722/996/1000
Ratio (at 30/60/90 min)	3.8/6.2/7.3	4.6/8.8/9.1	3.0/5.5/7.0
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+9, 5+10	2*, 7+8, 5+10
Glu/Gli	0.81	0.98	1.00
HMW/LMW	0.31	0.34	0.27
%IPP	43.82	47.72	46.25
SEDIMENTATION TEST			
Volume (ml)	41.7	52.9	59.8

South Dakota: Cumulative Ash Curves



	Lyman (check) - 2401					SD05118-1 - 2402					SD06158 - 2403				
Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash		Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash		Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash
1M Red	1.94	0.35	1.94	0.35		1M Red	2.11	0.30	2.11	0.30		1M	5.30	0.29	5.30	0.29
2M	13.47	0.36	15.41	0.36		2M	12.99	0.30	15.10	0.30		2M	12.78	0.30	18.08	0.30
1M	5.13	0.37	20.53	0.36		1M	5.64	0.30	20.74	0.30		1M Red	2.20	0.30	20.28	0.30
3M	10.23	0.39	30.76	0.37		1BK	7.64	0.33	28.37	0.31		1BK	7.48	0.31	27.75	0.30
4M	10.44	0.41	41.20	0.38		4M	12.49	0.34	40.86	0.32		2BK	5.54	0.34	33.29	0.31
2BK	5.83	0.41	47.03	0.38		3M	15.83	0.35	56.70	0.33		3M	15.73	0.36	49.02	0.33
1BK	7.58	0.42	54.61	0.39		2BK	4.91	0.35	61.60	0.33		Grader	2.82	0.36	51.84	0.33
Grader	2.40	0.42	57.01	0.39		Grader	2.27	0.36	63.87	0.33		4M	8.26	0.38	60.10	0.33
FILTER FLR	2.14	0.59	59.15	0.40		5M	5.12	0.58	68.99	0.35		FILTER FLR	1.04	0.57	61.14	0.34
5M	7.67	0.60	66.82	0.42		FILTER FLR	1.45	0.59	70.44	0.35		5M	3.69	0.78	64.83	0.36
3BK	4.47	0.98	71.29	0.46		3BK	3.47	0.85	73.90	0.38		3BK	2.59	0.95	67.42	0.39
BRAN FLR	2.09	2.03	73.38	0.50		BRAN FLR	1.36	2.01	75.27	0.41		BRAN FLR	1.28	1.92	68.70	0.41
Break Shorts	3.89	4.49	77.27	0.70		Break Shorts	3.26	4.29	78.53	0.57		Break Shorts	4.77	4.12	73.47	0.66
Red Dog	1.06	3.55	78.33	0.74		Red Dog	0.99	3.54	79.52	0.60		Red Dog	0.93	3.57	74.40	0.69
Red Shorts	0.12	4.43	78.45	0.75		Red Shorts	0.06	4.36	79.58	0.61		Red Shorts	0.05	4.01	74.45	0.69
Filter Bran	0.75	2.49	79.20	0.76		Filter Bran	0.72	2.74	80.30	0.63		Filter Bran	0.72	2.17	75.16	0.71
Bran	20.80	5.69	100.00	1.79		Bran	19.70	5.53	100.00	1.59		Bran	24.84	5.29	100.00	1.85
Wheat		1.64				Wheat		1.68				Wheat		1.70		
St. Grd. Fl.		0.53				St. Grd. Fl.		0.46				St. Grd. Fl.		0.46		

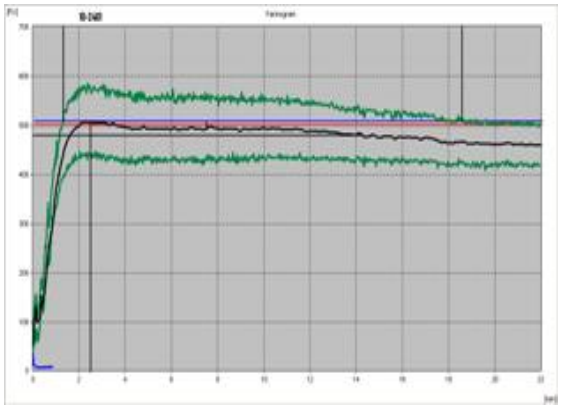
South Dakota: Cumulative Protein Curves



Lyman (check) - 2401					SD05118-1 - 2402					SD06158 - 2403				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1M Red	1.94	9.54	1.94	9.54	1BK	7.64	9.71	7.64	9.71	1BK	7.48	10.10	7.48	10.10
2M	13.47	9.66	15.41	9.65	1M Red	2.11	9.87	9.75	9.75	1M Red	2.20	10.34	9.68	10.16
3M	10.23	9.75	25.63	9.69	2M	12.99	10.06	22.74	9.92	1M	5.30	10.52	14.98	10.29
1BK	7.58	9.99	33.21	9.76	Grader	2.27	10.21	25.00	9.95	2M	12.78	10.68	27.75	10.47
4M	10.44	9.99	43.65	9.81	3M	15.83	10.29	40.84	10.08	3M	15.73	10.90	43.48	10.62
1M	5.13	10.22	48.77	9.86	4M	12.49	10.35	53.33	10.14	4M	8.26	11.20	51.74	10.72
Grader	2.40	10.35	51.17	9.88	1M	5.64	10.58	58.96	10.18	Grader	2.82	11.62	54.56	10.76
5M	7.67	10.53	58.85	9.97	5M	5.12	11.12	64.08	10.26	FILTER FLR	1.04	12.01	55.60	10.79
FILTER FLR	2.14	11.21	60.99	10.01	FILTER FLR	1.45	11.25	65.53	10.28	5M	3.69	12.30	59.29	10.88
2BK	5.83	12.51	66.82	10.23	2BK	4.91	12.80	70.44	10.46	2BK	5.54	13.45	64.83	11.10
3BK	4.47	14.57	71.29	10.50	3BK	3.47	15.17	73.90	10.68	3BK	2.59	15.14	67.42	11.25
BRAN FLR	2.09	16.79	73.38	10.68	BRAN FLR	1.36	16.64	75.27	10.79	BRAN FLR	1.28	16.08	68.70	11.34
Break Shorts	3.89	14.79	77.27	10.89	Break Shorts	3.26	15.21	78.53	10.97	Break Shorts	4.77	14.96	73.47	11.58
Red Dog	1.06	14.00	78.33	10.93	Red Dog	0.99	14.05	79.52	11.01	Red Dog	0.93	14.21	74.40	11.61
Red Shorts	0.12	13.73	78.45	10.93	Red Shorts	0.06	14.53	79.58	11.01	Red Shorts	0.05	14.28	74.45	11.61
Filter Bran	0.75	12.60	79.20	10.95	Filter Bran	0.72	13.32	80.30	11.03	Filter Bran	0.72	13.19	75.16	11.63
Bran	20.80	16.10	100.00	12.02	Bran	19.70	16.87	100.00	12.18	Bran	24.84	15.61	100.00	12.62
Wheat		11.86			Wheat		12.07			Wheat		12.31		
St. Grd. Fl		10.47			St. Grd. Fl		10.74			St. Grd. Fl		11.14		

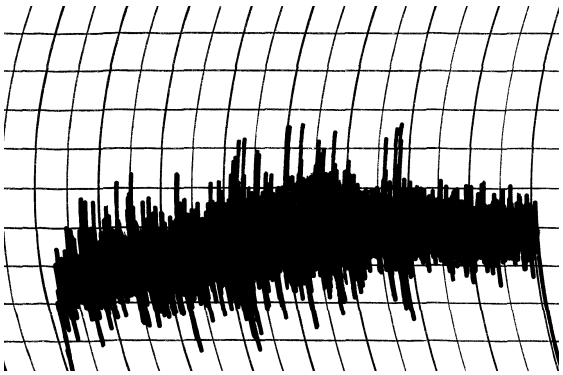
Physical Dough Tests
2010 (Small Scale) Samples – South Dakota

Farinograms



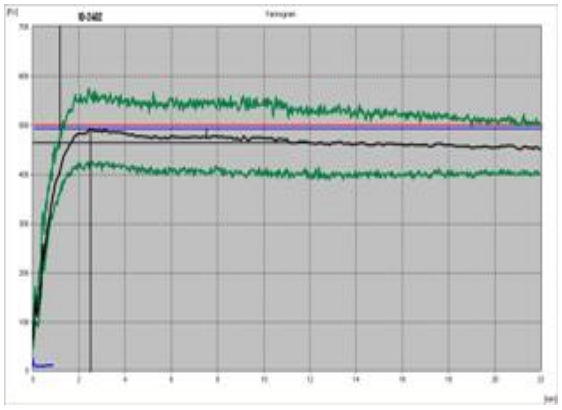
Water abs = 57.2%, Peak time = 2.5 min,
Mix stab = 17.3 min, MTI = 15 FU

Mixograms

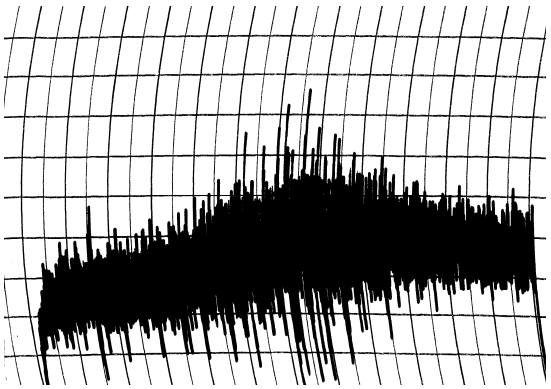


Water abs = 60.4%
Mix time = 4.6 min

Lyman (check) – 10-2401



Water abs = 55.8%, Peak time = 2.5 min,
Mix stab = 22.8 min, MTI = 19 FU



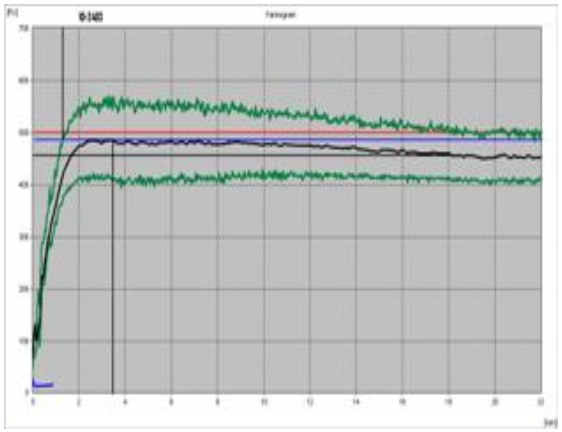
Water abs = 60.8%
Mix time = 6.9 min

SD05118-1 – 10-2402

Physical Dough Tests

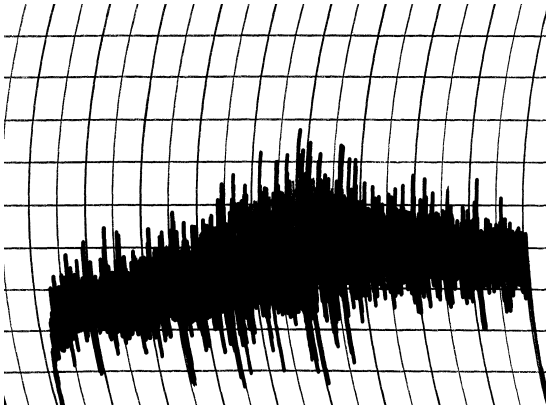
2010 (Small Scale) Samples – South Dakota (continued)

Farinograms



Water abs. = 55.6%, Peak time = 3.5 min,
Mix stab = 22.7 min, MTI = 6 FU

Mixograms

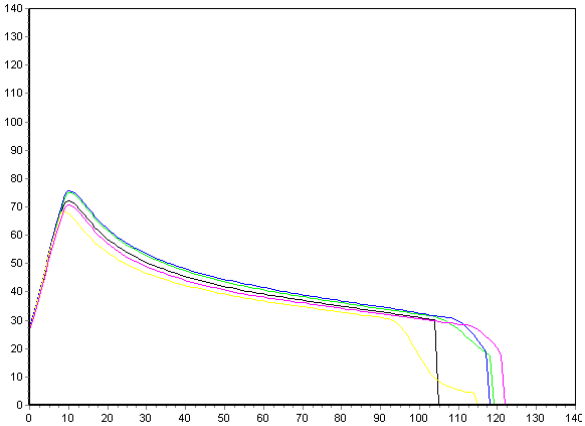


Water abs = 61.5%
Mix time = 5.0 min

SD06158 – 10-2403

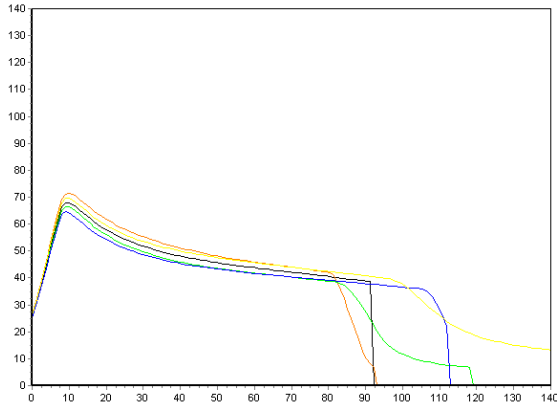
Physical Dough Tests - Alveograph

2010 (Small Scale) Samples – South Dakota



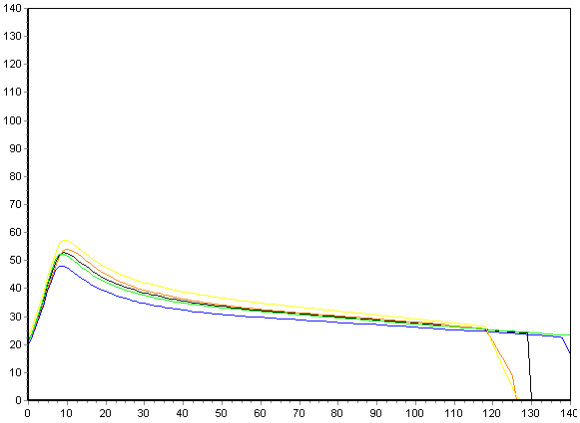
10-2401 (Lyman (check))

P (mm H_20) = 80, L (mm) = 105, W ($10E^{-4}J$) = 299



10-2402 (SD05118-1)

P (mm H_20) = 75, L (mm) = 92, W ($10E^{-4}J$) = 286

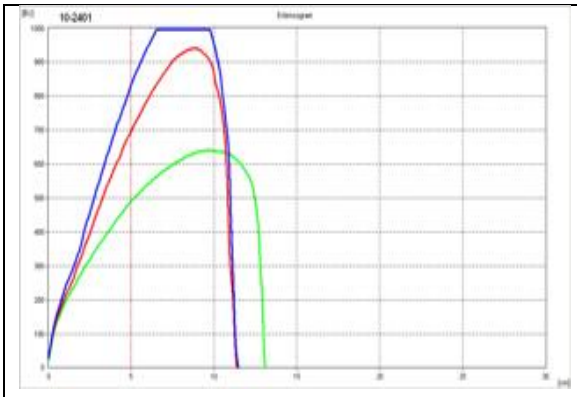


10-2403 (SD06158)

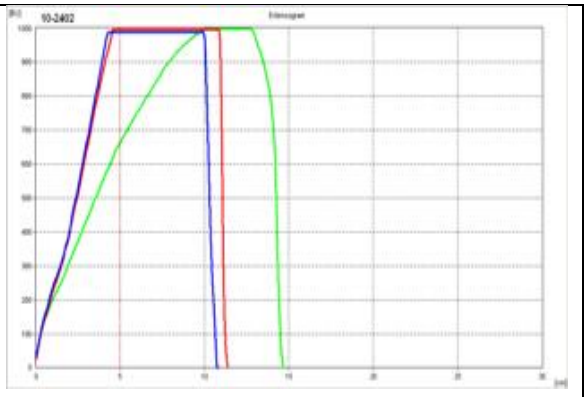
P (mm H_20) = 58, L (mm) = 129, W ($10E^{-4}J$) = 280

Physical Dough Tests - Extensigraph

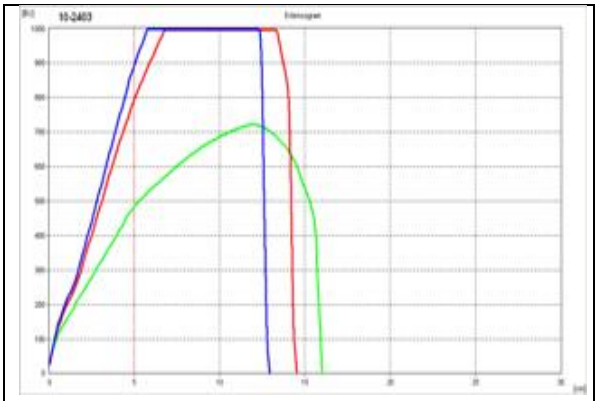
2010 (Small Scale) Samples – South Dakota



Lyman (check) - 2401
R (BU) = 841, E (mm) = 114.6, W (cm^2) = 142.4
Rmax (BU) = 997, Ratio = 7.34 at 90 min



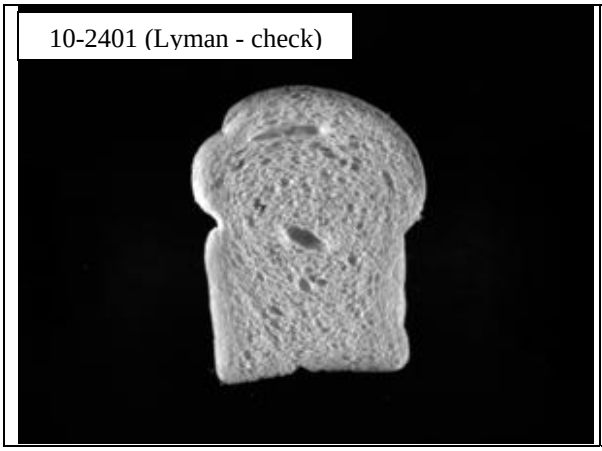
SD05118-1 - 2402
R (BU) = 989, E (mm) = 108.8, W (cm^2) = 142.5
Rmax (BU) = 989, Ratio = 9.09 at 90 min



SD06158 - 2403
R (BU) = 903, E (mm) = 129.5, W (cm^2) = 175.3
Rmax (BU) = 1000, Ratio = 6.97 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

South Dakota: C-Cell Bread Images and Analysis for 2010 (Small-Scale) Samples



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2401	5900	157.6	3768	0.443	1.913	2.648	1.690	-25.60
2402	6409	159.9	4065	0.438	1.888	3.886	1.705	-24.83

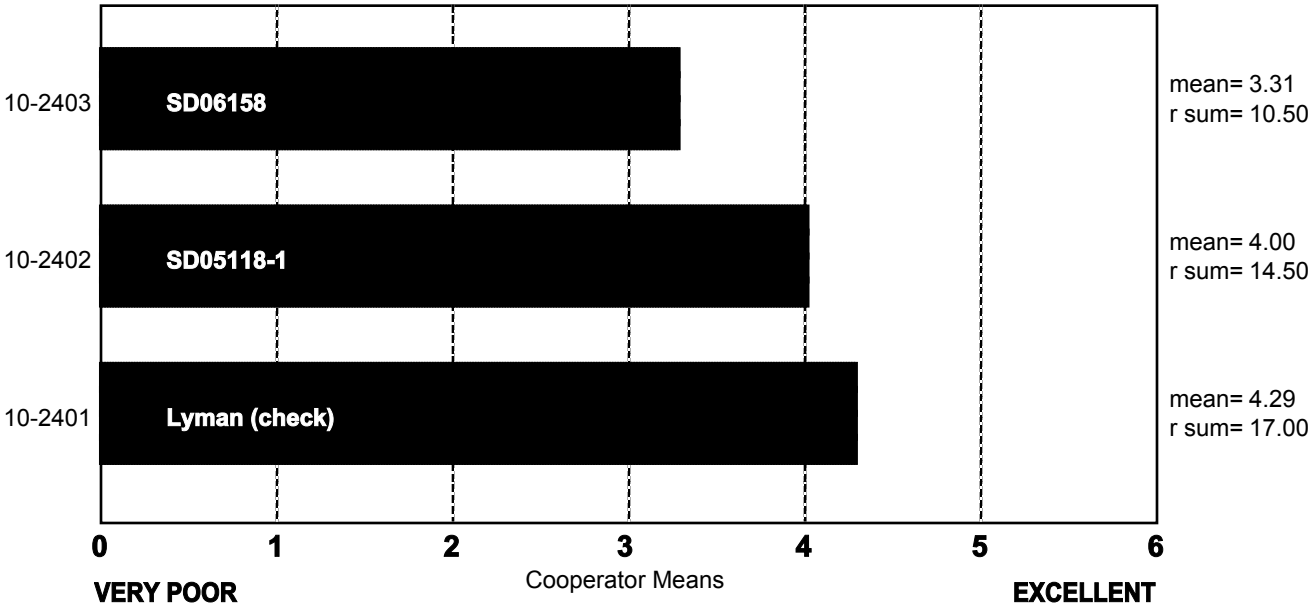
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2403	6669	162.9	4166	0.442	1.983	3.660	1.680	-30.75

SPONGE CHARACTERISTICS

(Small Scale) South Dakota

ncoop= 7
chisq= 3.07
chisqc= 4.53
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

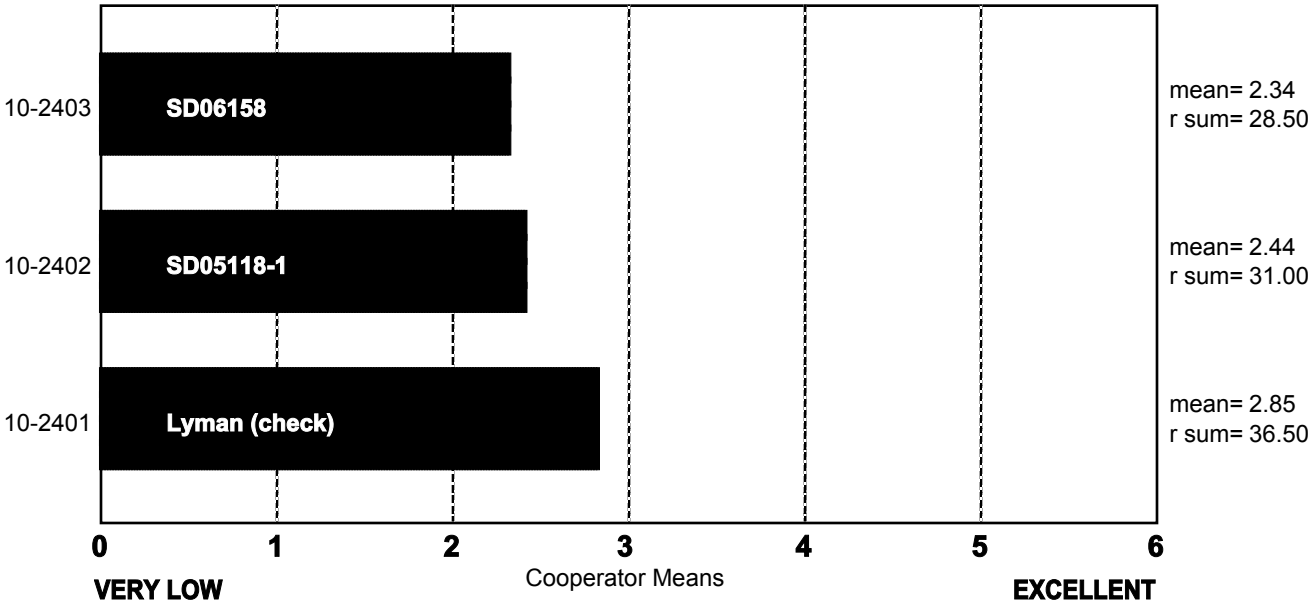


BAKE ABSORPTION

(Small Scale) South Dakota

ncoop= 16
chisq= 2.09
chisqc= 3.35
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) South Dakota

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2401 Lyman (check)	**60.2**	**57.0**	**54.0**	**60.4**	**60.3**	**59.7**	**62.0**	**58.9**	**59.0**	**60.0**	**59.0**	**62.1**	**64.7**	**59.2**	**60.6**	**58.0**	**60.2**
10-2402 SD05118-1	**60.3**	**57.0**	**53.0**	**60.8**	**58.8**	**58.1**	**62.0**	**60.2**	**58.0**	**60.0**	**58.0**	**63.1**	**64.4**	**57.8**	**60.9**	**55.0**	**58.8**
10-2403 SD06158	**61.5**	**58.0**	**52.5**	**61.5**	**57.6**	**57.7**	**61.2**	**63.0**	**58.0**	**60.0**	**57.0**	**63.1**	**65.4**	**57.6**	**61.1**	**56.5**	**58.6**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) South Dakota

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2401 Lyman (check)	**4.8**	**16.0**	**7.0**	**5.0**	**2.5**	**3.8**	**5.2**	**4.1**	**22.0**	**6.0**	**6.0**	**4.0**	**4.6**	**8.0**	**6.0**	**12.0**	**8.0**
10-2402 SD05118-1	**7.5**	**20.0**	**7.0**	**7.5**	**2.3**	**5.5**	**7.9**	**5.8**	**25.0**	**9.0**	**12.0**	**6.0**	**6.9**	**8.5**	**9.8**	**30.0**	**12.0**
10-2403 SD06158	**4.8**	**16.0**	**7.0**	**5.0**	**2.0**	**4.0**	**5.7**	**5.2**	**25.0**	**6.0**	**9.0**	**4.5**	**5.0**	**8.5**	**7.0**	**26.0**	**11.0**

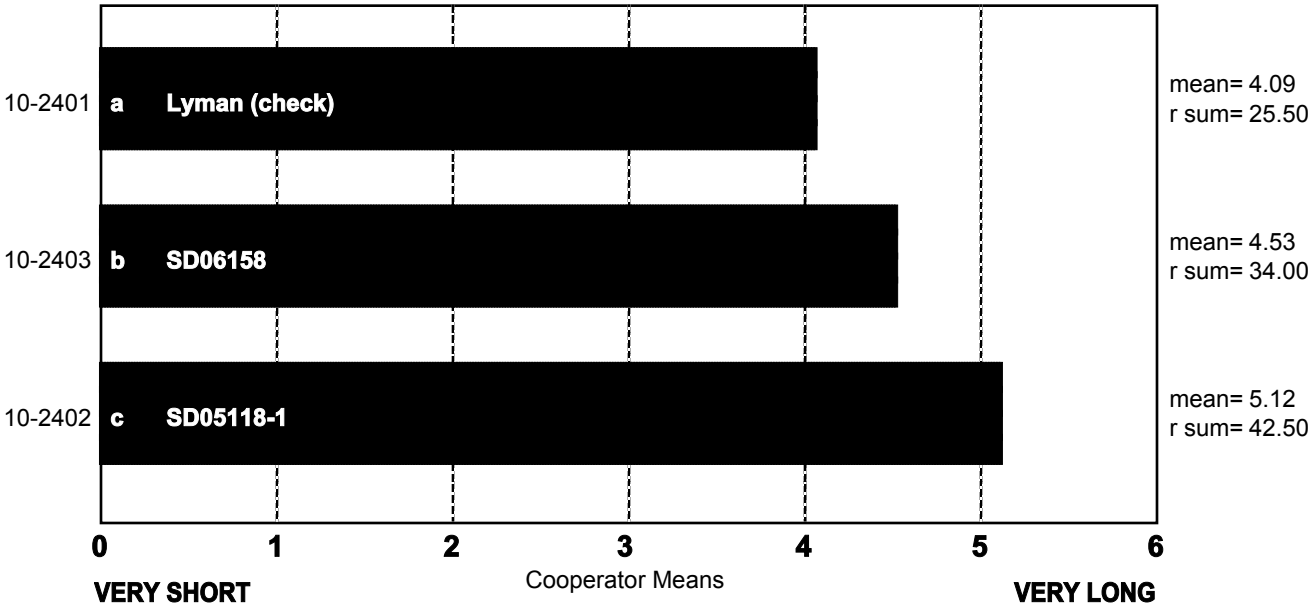
Raw Data

BAKE MIX TIME

(Small Scale) South Dakota

ncoop= 17
chisq= 8.50
chisqc= 12.04
cvchisq= 5.99
crdiff= 8.27

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

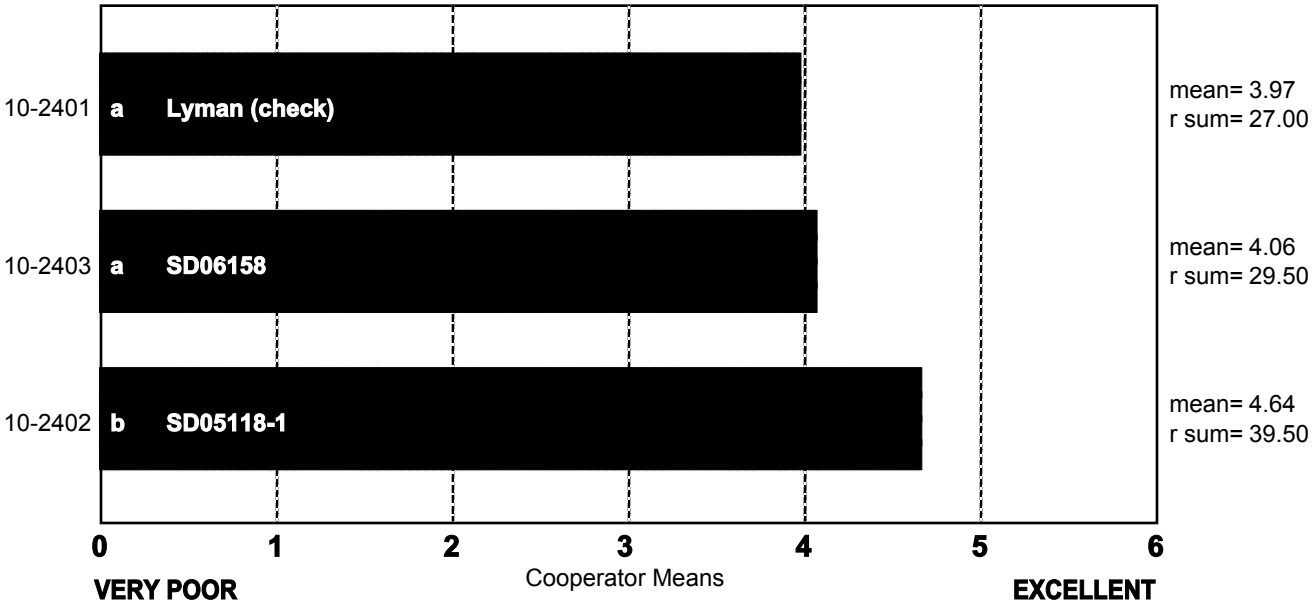


MIXING TOLERANCE

(Small Scale) South Dakota

ncoop= 16
chisq= 5.47
chisqc= 7.00
cvchisq= 5.99
crdiff= 9.32

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



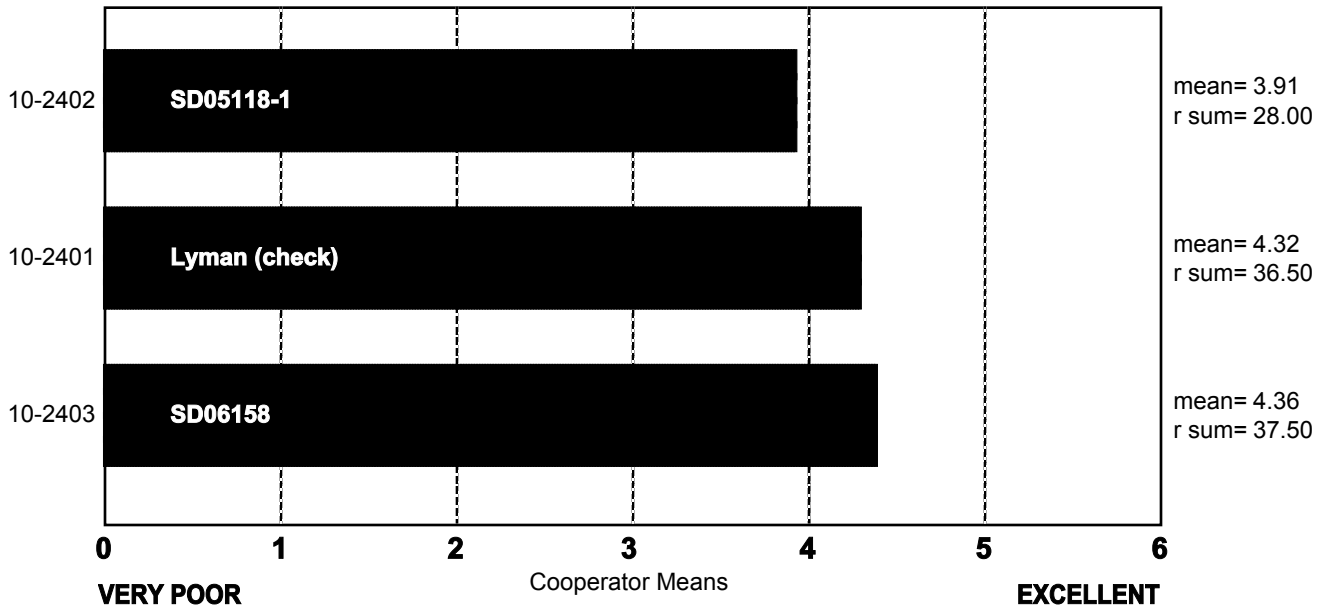
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) South Dakota

ncoop= 17
chisq= 3.21
chisqc= 4.84
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) South Dakota

	Sticky	Wet	Tough	Good	Excellent
10-2401 Lyman (check)	**0**	**0**	**0**	**14**	**3**
10-2402 SD05118-1	**0**	**1**	**8**	**5**	**3**
10-2403 SD06158	**1**	**0**	**1**	**13**	**2**

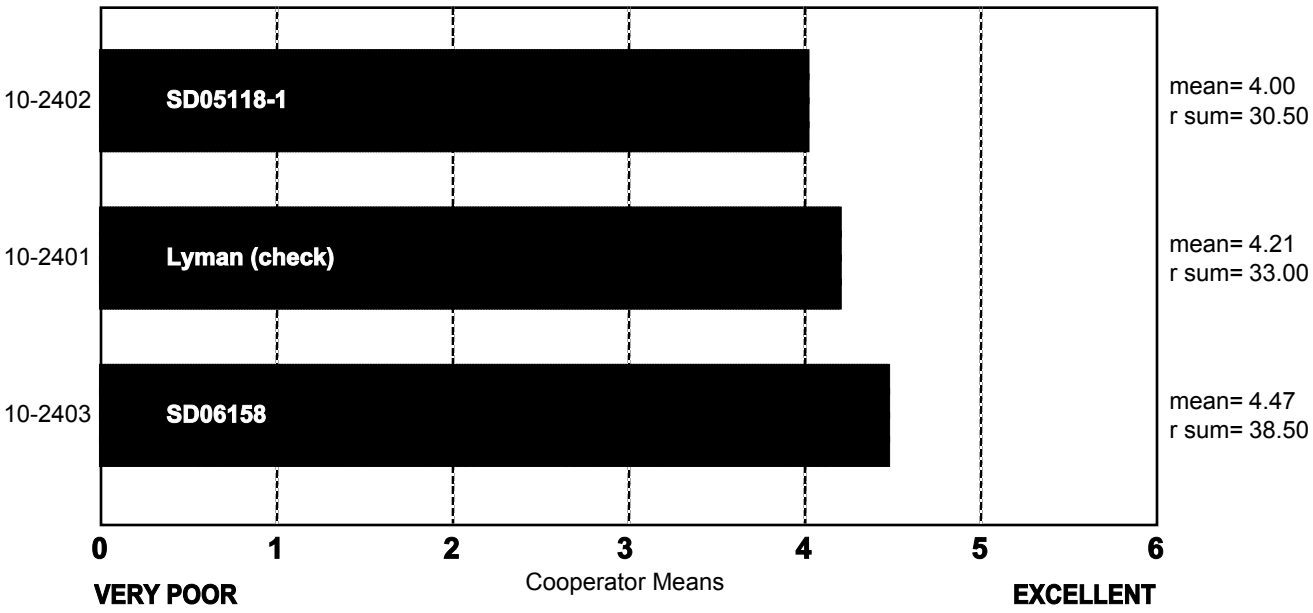
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) South Dakota

ncoop= 17
chisq= 1.97
chisqc= 3.12
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) South Dakota

	Sticky	Wet	Tough	Good	Excellent
10-2401 Lyman (check)	**0**	**0**	**2**	**13**	**2**
10-2402 SD05118-1	**1**	**1**	**6**	**8**	**1**
10-2403 SD06158	**0**	**0**	**0**	**15**	**2**

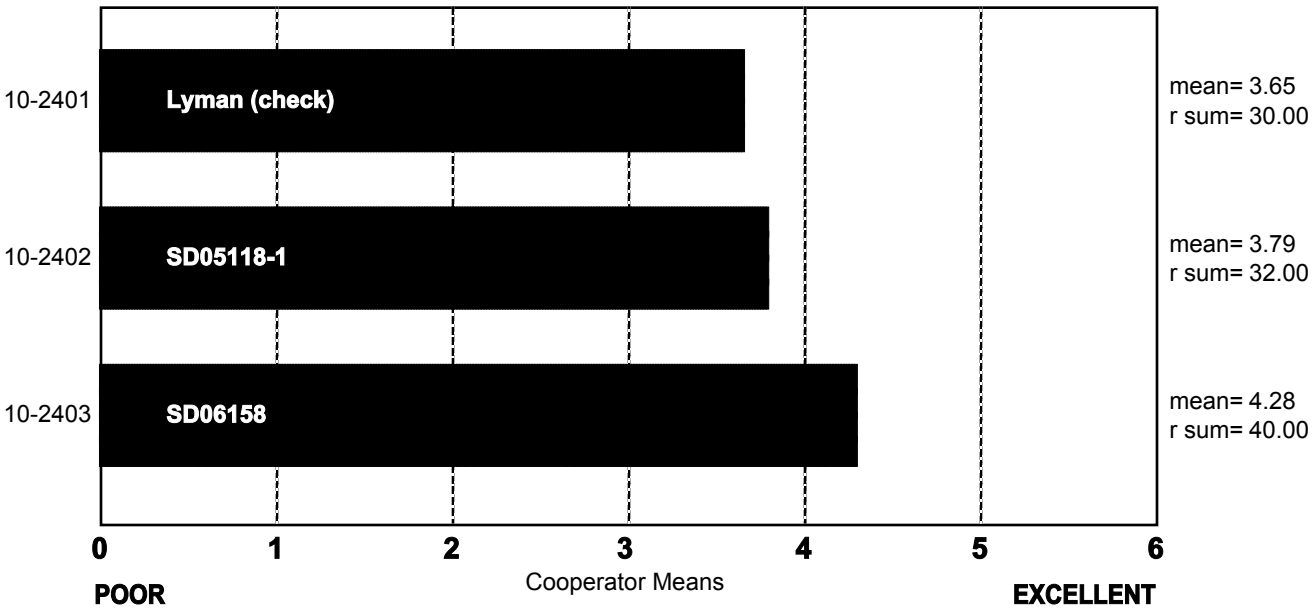
Frequency Table

CRUMB GRAIN

(Small Scale) South Dakota

ncoop= 17
chisq= 3.29
chisqc= 4.00
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) South Dakota

	Open	Fine	Dense
10-2401 Lyman (check)	**9**	**7**	**1**
10-2402 SD05118-1	**5**	**11**	**1**
10-2403 SD06158	**6**	**9**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) South Dakota

	Round	Irregular	Elongated
10-2401 Lyman (check)	**3**	**9**	**5**
10-2402 SD05118-1	**5**	**7**	**5**
10-2403 SD06158	**3**	**5**	**9**

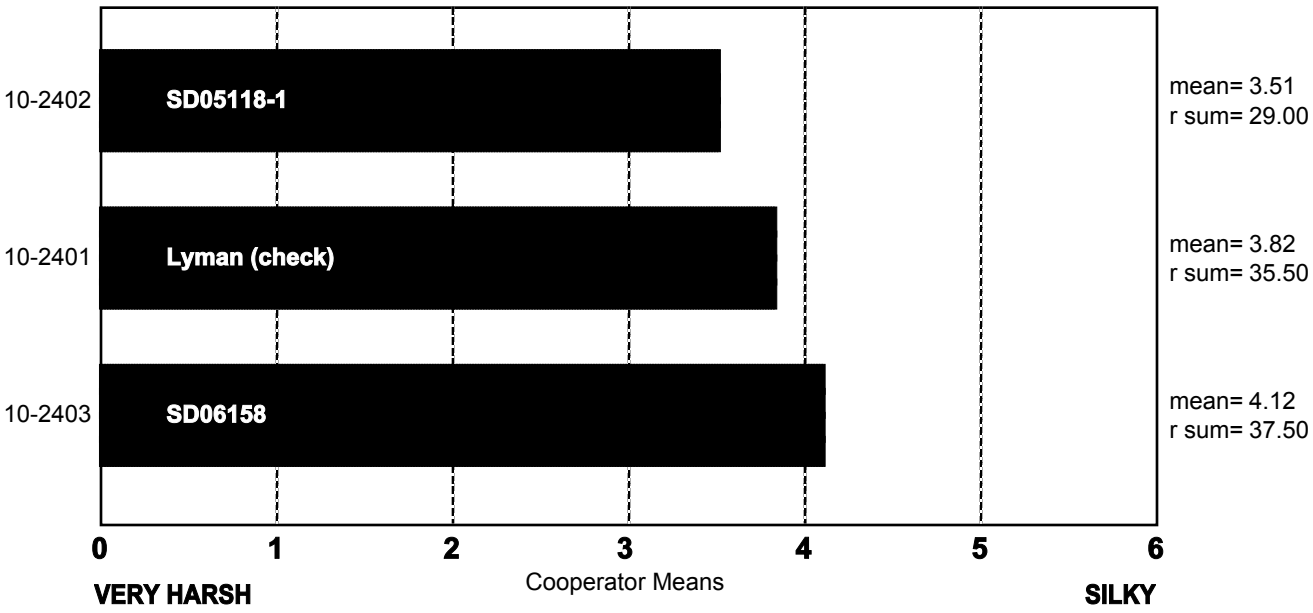
Frequency Table

CRUMB TEXTURE

(Small Scale) South Dakota

ncoop= 17
chisq= 2.32
chisqc= 3.22
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) South Dakota

	Harsh	Smooth	Silky
10-2401 Lyman (check)	**3**	**11**	**3**
10-2402 SD05118-1	**5**	**7**	**5**
10-2403 SD06158	**2**	**9**	**6**

Frequency Table

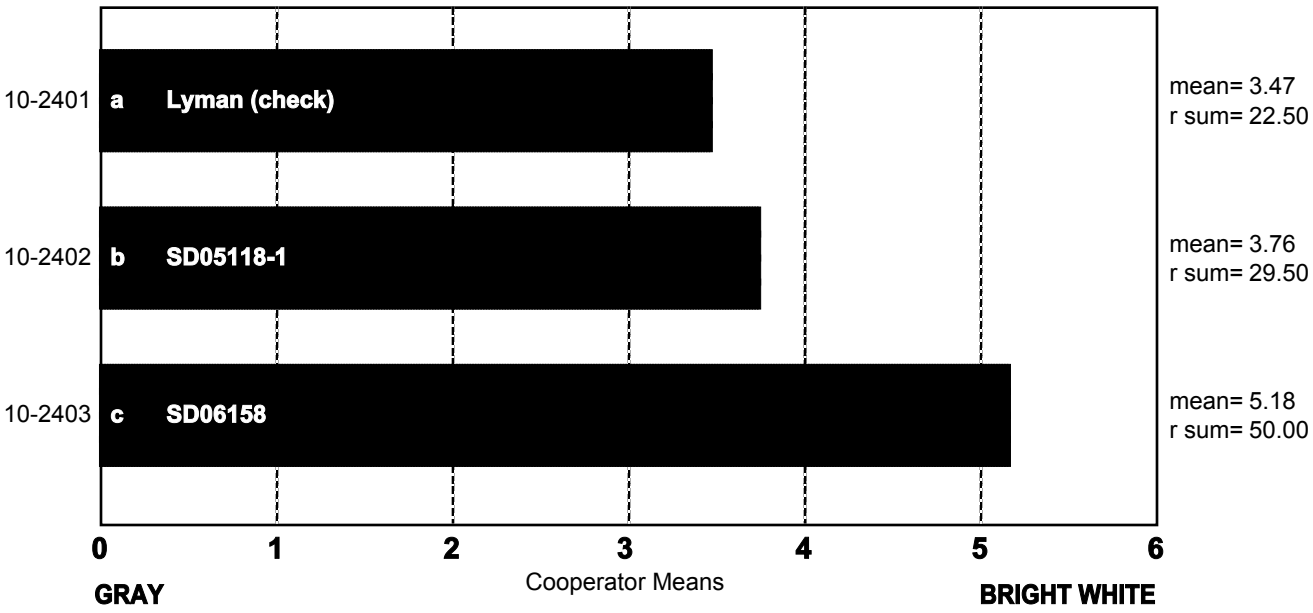
CRUMB COLOR

(Small Scale) South Dakota

ncoop= 17
chisq= 24.03
chisqc= 27.69
cvchisq= 5.99
crdiff= 4.91

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) South Dakota

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
10-2401 Lyman (check)	**0**	**0**	**2**	**5**	**8**	**1**	**0**
10-2402 SD05118-1	**2**	**0**	**0**	**3**	**9**	**3**	**0**
10-2403 SD06158	**0**	**0**	**0**	**1**	**3**	**6**	**7**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) South Dakota

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2401 Lyman (check)	**139.0**	**421.0**	**510.0**	**157.0**	**127.8**	**130.1**	**142.5**	**145.8**	**477.8**	**134.0**	**466.4**	**138.1**	**141.6**	**464.0**	**149.7**	**461.2**	**450.9**
10-2402 SD05118-1	**137.0**	**420.0**	**510.0**	**155.1**	**126.8**	**129.6**	**141.7**	**147.3**	**472.5**	**134.0**	**469.5**	**138.1**	**139.4**	**460.0**	**148.0**	**463.7**	**450.2**
10-2403 SD06158	**139.7**	**418.0**	**505.0**	**155.3**	**126.7**	**128.3**	**140.9**	**150.0**	**485.3**	**134.0**	**468.8**	**137.7**	**138.6**	**461.0**	**149.2**	**460.3**	**454.4**

Raw Data

LOAF VOLUME, ACTUAL

(Small Scale) South Dakota

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2401 Lyman (check)	**930**	**2900**	**2850**	**606**	**680**	**825**	**905**	**863**	**3015**	**927**	**2613**	**820**	**800**	**2525**	**820**	**2650**	**2420**
10-2402 SD05118-1	**1070**	**3100**	**2650**	**682**	**740**	**950**	**840**	**920**	**3104**	**833**	**2700**	**858**	**898**	**2500**	**880**	**2725**	**2333**
10-2403 SD06158	**1075**	**3100**	**3000**	**681**	**775**	**975**	**965**	**963**	**2986**	**1013**	**2650**	**943**	**1006**	**2950**	**955**	**2675**	**2575**

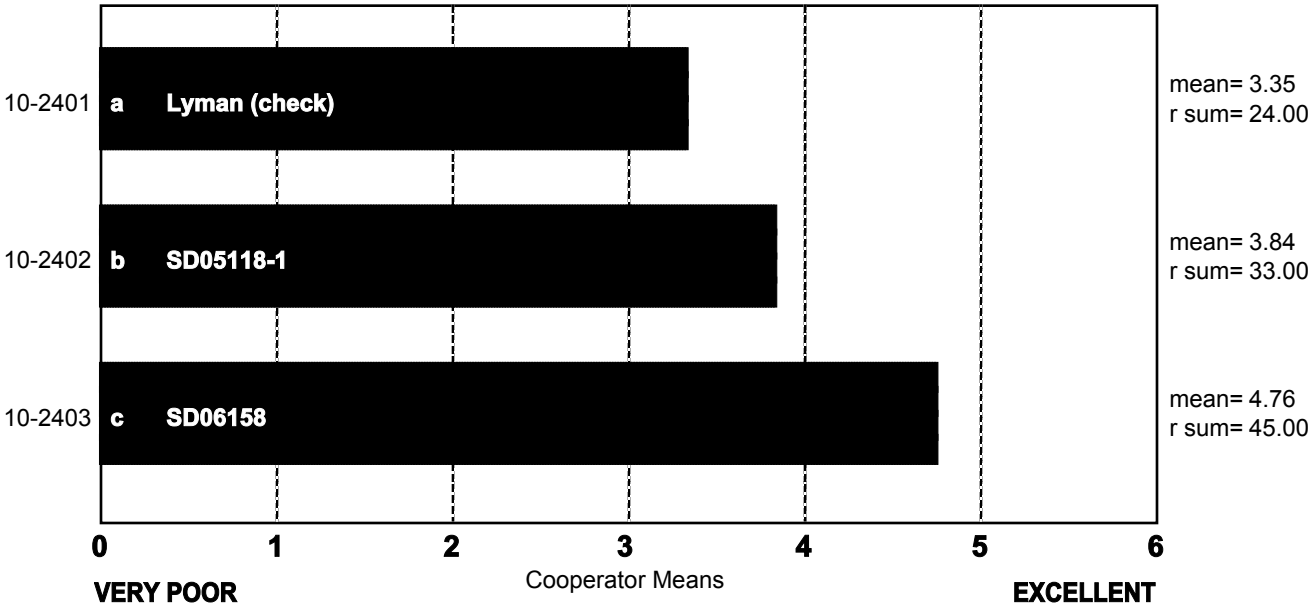
Raw Data

LOAF VOLUME

(Small Scale) South Dakota

ncoop= 17
chisq= 13.06
chisqc= 15.31
cvchisq= 5.99
crdiff= 8.38

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

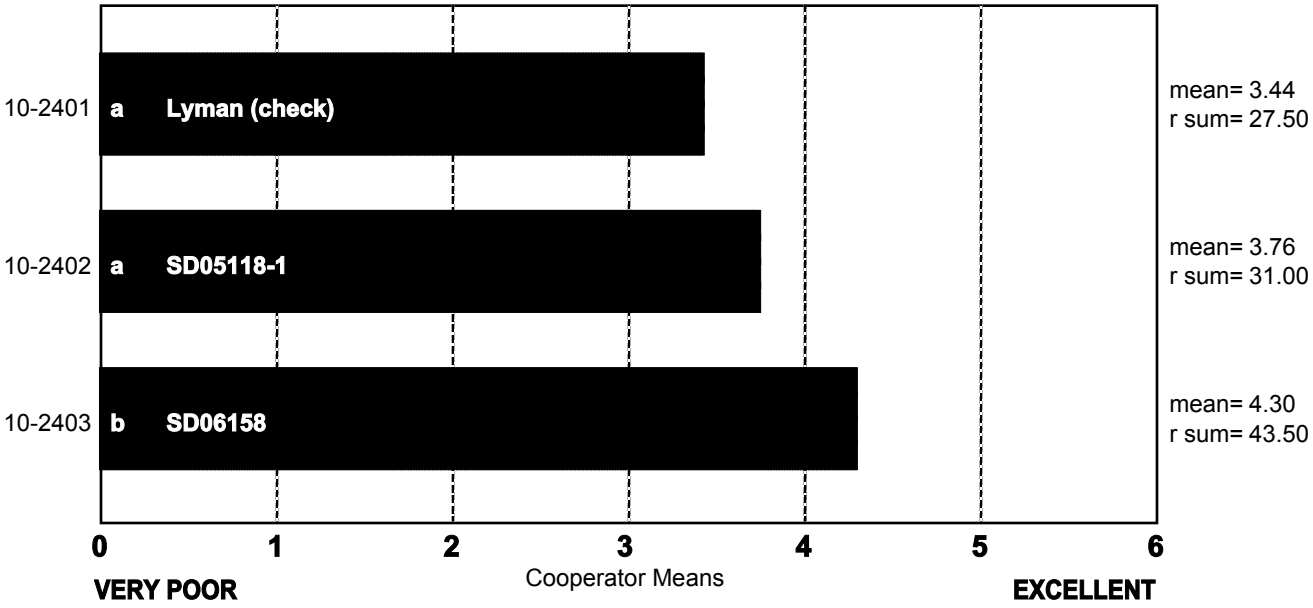


OVERALL BAKING QUALITY

(Small Scale) South Dakota

ncoop= 17
chisq= 8.32
chisqc= 10.48
cvchisq= 5.99
crdiff= 9.07

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS
(Small Scale) South Dakota

COOP. **10-2401** **Lyman (Check)**

A. Rough break and shred.

B. Good mix time, sl. open grain, excellent loaf volume, sl. creamy crumb, lower protein.

C. All flour samples are very dry!!

D. No comment.

E. Low loaf volume, low flour protein.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. sticky dough, hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Dough on the weak side but for 10.5% flour protein it really baked fairly well and performed better than expected.

I. Fairly tight grain, sl. smooth texture, very good volume.

J. OK bake quality, decent for the protein level, showed weaker mix tolerance and had pliable dough handling.

K. Sl. low absorption, average mix time and volume, good grain.

L. No comment.

M. No comment.

N. No comment.

O. Good dough at mix and pan, satisfactory crumb grain, flour protein and loaf volume low.

P. No comment.

Q. Good volume and crumb rating.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) South Dakota

COOP. **10-2402** **SD05118-1**

A. Slow dough pickup during mixing, long mix time, sl. wet, very rough break.

B. Tough and bucky, very open grain, good volume, sl. creamy crumb, lower protein, long mix.

C. No comment.

D. No comment.

E. Low loaf volume, low flour protein.

F. No comment.

G. Normal absorption, vey long mix time, wet and sl. sticky dough, hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Very nice bread and dough properties for a low protein flour.

I. Sl. open grain, thick cell walls, excellent volume.

J. Very underdeveloped on the shorter mix times, shows great mix tolerance for the protein level, would perform better with increased mix times.

K. Sl. low absorption, long mix time, good grain, white crumb, good volume.

L. No comment.

M. No comment.

N. No comment.

O. Rated higher than check, excellent dough and crumb grain, creamy color, long mix time.

P. No comment.

Q. Good volume and crumb rating.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) South Dakota

COOP. **10-2403** **SD06158**

A. Slow dough pickup during mixing, nice exterior.

B. Good volume, good mix time, good out of mixer and makeup, open grain, br. crumb color.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption, med long mix time, wet and sl. sticky dough, very hi OS, open and elongated cells, white crumb, smooth and resilient texture.

H. Very nice bread and dough properties.

I. Tight, consistent, smooth grain, good volume.

J. Excellent bake quality and dough handling, great for protein level, nice grain.

K. Low absorption, good mix time, very nice grain, bright white crumb, average volume.

L. No comment.

M. Dough smears around the bowl, slow pickup.

N. No comment.

O. Rated higher than check, very nice dough and crumb grain, creamy color, long mix time.

P. No comment.

Q. Dense grain, good volume.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

Colorado – Scott Haley

Growing Location & Conditions

The Wheat Quality Council samples from Colorado originated from strip increases grown under dryland conditions at the USDA-ARS Central Great Plains Research Station at Akron, CO. The strip increases were fertilized prior to planting based on a soil test and a 60 bu/a yield goal. The planting date was 9/29/09 and the harvest date was 7/12/10.

Growing conditions including relatively late planting into marginal soil moisture, mediocre fall stands and growth with good spring tillering, significant stripe rust infection during grain formation and filling, and slightly delayed harvest due to wet conditions in early July.

Grain yields of the adjacent state variety trial were quite good, averaging 57.5 bu/a (46.9-63.8 bu/a range) with an average test weight of 59.5 lb/bu (56.2-62.6 lb/bu range). Average grain protein content (12% moisture basis) from the group of 8 strips harvested for the WQC was 11.9%.

Hatcher (check)

Hatcher is a hard red winter wheat that was released in 2004. Hatcher was tested in previous WQC sample sets as a check and initially under its experimental number CO980607. Hatcher was chosen because it has shown good milling and baking quality characteristics and because it is the number one cultivar in Colorado acreage estimates (26.5% of the 2010 crop).

CO050303-2

CO050303-2 is a hard red winter wheat from the cross CO980829/TAM 111 made in 2001. CO980829 is an unreleased experimental line from CSU with the pedigree Yuma/T-57//CO850034/3/4*Yuma/4/(KS91H174/Rio Blanco//KS91HW29/3/N87V106) and TAM 111 is a hard red winter wheat cultivar released by Texas A&M University in 2002. CO050303-2 is medium-late maturing and medium-tall, and has a medium-length coleoptile, good straw strength, and good test weight. CO050303-2 is resistant to stripe rust, susceptible to leaf rust, susceptible to wheat soilborne/wheat spindle streak mosaic virus, and its reaction to Fusarium head blight is unknown. CO050303-2 was the third highest yielding entry in its first year in the dryland 2010 CSU Uniform Variety Performance Trial (UVPT) and is the second highest yielding entry on a two-year average over dryland Colorado locations in the CSU Elite Trial. CO050303-2 has shown good overall milling properties and average overall baking properties in tests conducted in the CSU Wheat Quality Lab. CO050303-2

is on foundation seed increase in 2011 with the intent to release as a new cultivar in fall 2011.

CO06424

CO06424 is a hard red winter wheat from the cross TAM 112/CO970547-7 made in 2002. CO970547-7 is an unreleased experimental line from CSU with the pedigree Ike/Halt and TAM 112 is a hard red winter wheat cultivar released by Texas A&M University in 2005. CO06424 is medium maturing and medium height, and has a medium-length coleoptile, good straw strength, and good test weight. CO06424 is moderately resistant to stripe rust, moderately susceptible to leaf rust and wheat soilborne/wheat spindle streak mosaic virus, and its reaction to Fusarium head blight is unknown. CO06424 was the highest yielding entry in its first year in the dryland 2010 CSU Uniform Variety Performance Trial (UVPT) and is the highest yielding entry on a two-year average over dryland Colorado locations in the CSU Elite Trial. CO06424 has shown excellent overall milling properties and excellent overall baking properties in tests conducted in the CSU Wheat Quality Lab. CO06424 is on foundation seed increase in 2011 with the intent to release as a new cultivar in fall 2011.

CO06052

CO06052 is a two-gene *Clearfield** hard red winter wheat from the cross Teal 11A/Above//CO99314 made in 2003. Above is a single-gene *Clearfield** wheat cultivar released by CSU in 2001, CO99314 is an unreleased experimental line from CSU with the pedigree TX91V4931/Halt, and Teal 11A is a *Clearfield** hard red spring wheat line from BASF Corporation. CO06052 carries two genes for tolerance to *Beyond*^{TM} herbicide for enhanced weed control and crop safety compared to single-gene *Clearfield** wheat cultivars. CO06052 is early maturing and medium height, and has a medium-long coleoptile, excellent straw strength, and excellent test weight. CO06052 is moderately resistant to stripe rust, moderately susceptible to leaf rust and wheat soilborne/wheat spindle streak mosaic virus, and its reaction to Fusarium head blight is unknown. In its first year in the dryland 2010 CSU Uniform Variety Performance Trial (UVPT), CO06052 showed average grain yield statewide but higher grain yield than other CSU *Clearfield** cultivars in northeast Colorado. In two years of testing in northeast Colorado dryland locations of the CSU Elite Trial, CO06052 was the highest yielding *Clearfield** wheat in the trial. CO06052 has shown good overall milling properties and excellent overall baking properties in tests conducted in the CSU Wheat Quality Lab. CO06052 is on foundation seed increase in 2011 with the intent to release as a new cultivar in fall 2011.

Colorado: 2010 (Small-Scale) Samples [a]

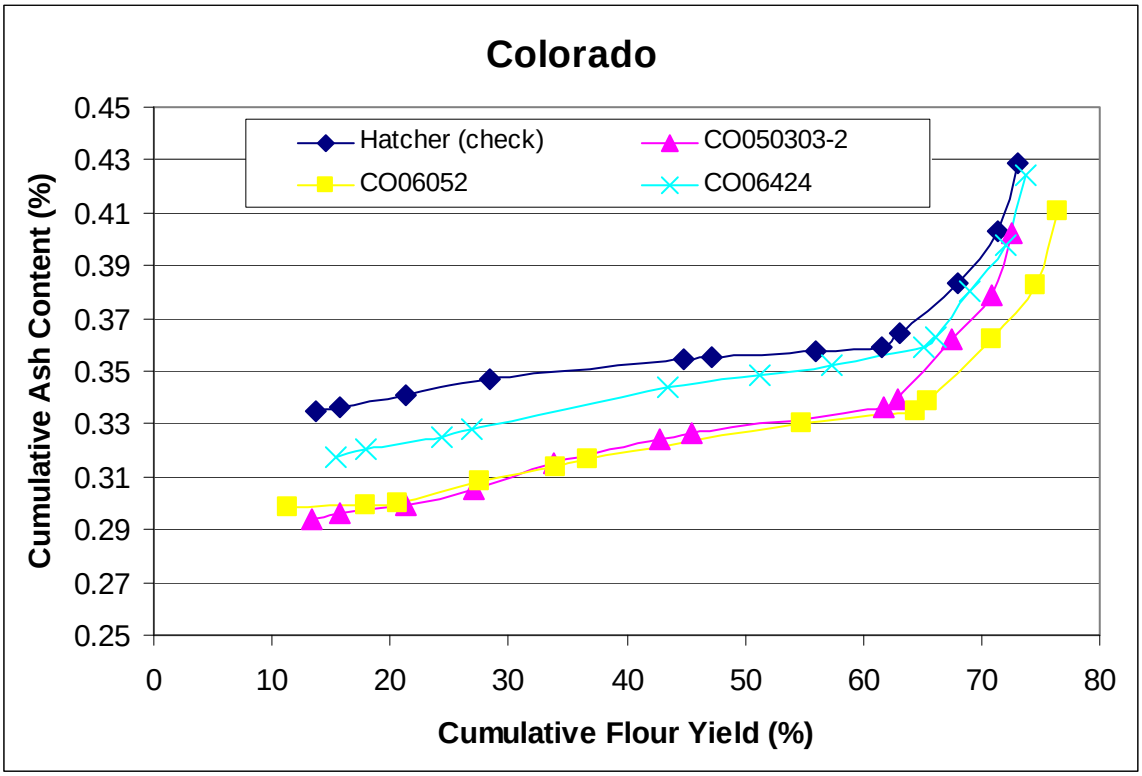
Test entry number	10-2404	10-2405	10-2406	10-2407
Sample identification	**Hatcher (check)**	**CO050303-2**	**CO06052**	**CO06424**
Wheat Data				
FGIS classification	2 HRW	2 HRW	1 HRW	2 HRW
Test weight (lb/bu)	59.9	59.6	60.2	58.0
Hectoliter weight (kg/hl)	78.8	78.4	79.2	76.4
1000 kernel weight (gm)	27.9	27.2	25.4	22.8
Wheat kernel size (Rotap)				
Over 7 wire (%)	40.1	34.9	41.2	21.6
Over 9 wire (%)	58.3	63.0	57.3	74.4
Through 9 wire (%)	1.5	2.1	1.5	4.0
Single kernel (skcs)				
Hardness (avg /s.d)	58.5/16.9	60.4/14.8	63.9/14.9	61.8/18.5
Weight (mg) (avg/s.d)	27.9/8.8	27.2/7.8	25.4/7.2	22.8/6.4
Diameter (mm)(avg/s.d)	2.48/0.32	2.43/0.29	2.46/0.31	2.33/0.27
SKCS distribution	06-13-30-51	04-12-32-52	02-11-27-60	05-13-26-56
Classification	Hard	Hard	Hard	Hard
Wheat moisture (%)	9.1	9.2	9.2	9.2
Wheat protein (12% mb)	12.5	13.5	13.0	12.3
Wheat ash (12% mb)	1.43	1.50	1.48	1.51
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	73.1	72.7	76.5	73.9
Quadrumat Sr. Mill	71.1	71.1	71.7	73.5
Flour moisture (%)	10.8	10.8	10.7	10.7
Flour protein (14% mb)	11.1	11.8	11.8	10.9
Flour ash (14% mb)	0.48	0.44	0.44	0.46
Glutomatic				
Wet gluten (%)	30.5	34.7	32.3	25.7
Dry gluten (%)	10.8	12.0	11.4	9.5
Gluten index	97.7	95.7	98.0	99.6
Rapid Visco-Analyser				
Peak Time (min)	6.1	6.4	6.3	6.2
Peak Viscosity (RVU)	194.7	211.8	240.6	257.3
Breakdown (RVU)	55.7	48.7	70.4	85.4
Final Viscosity at 13 min (RVU)	268.8	291.0	297.7	315.5
Minolta color meter				
L*	92.6	92.6	92.4	92.3
a*	-1.47	-1.80	-2.04	-1.95
b*	8.73	9.91	10.4	10.4
Falling number (sec)	490	482	468	526
Damaged Starch				
(AI%)	95.90	94.45	94.87	94.91
(AACC76-31)	6.20	5.13	5.43	5.45

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Colorado: Physical Dough Tests and Gluten Analysis For 2010 (Small-Scale) Samples

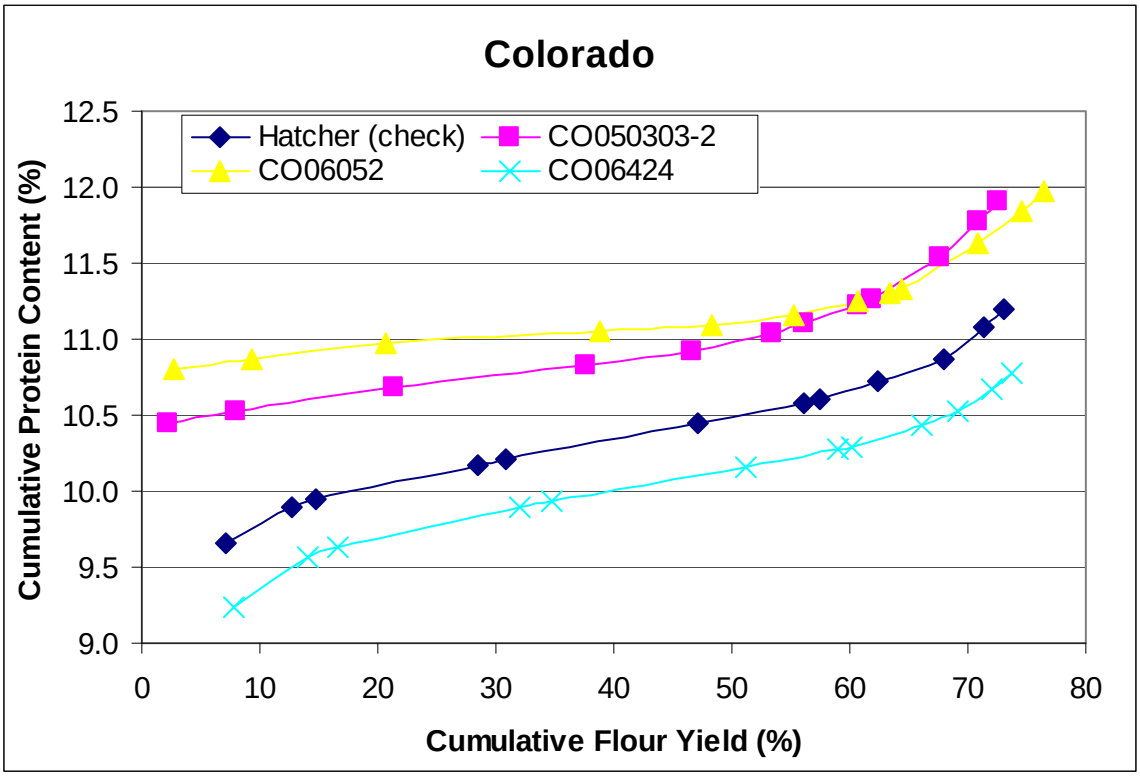
Test Entry Number	10-2404	10-2405	10-2406	10-2407
Sample Identification	Hatcher (check)	CO050303-2	CO06052	CO06424
MIXOGRAPH				
Flour Abs (% as-is)	64.1	66.2	65.4	63.8
Flour Abs (14% mb)	60.5	62.6	61.7	60.1
Mix Time (min)	4.38	3.75	4.63	7.63
Mix tolerance (0-6)	3	3	4	4
FARINOGRAPH				
Flour Abs (% as-is)	58.6	60.8	59.8	56.7
Flour Abs (14% mb)	55.0	57.2	56.1	53.0
Development time (min)	2.5	5.2	7.2	3.2
Mix stability (min)	24.1	24.1	23.8	32.6
Mix Tolerance Index (FU)	14	19	10	12
Breakdown time (min)	15.5	13.1	20.5	17.9
ALVEOGRAPH				
P(mm. $_{H2O}$): Tenacity	65	65	69	52
L(mm): Extensibility	101	113	107	68
G($mm_{0.5}$): Swelling index	22.4	23.7	23.0	18.4
W(10^{-4} J): strength (curve area)	244	244	272	145
P/L: curve configuration ratio	0.64	0.58	0.64	0.76
Ie(P_{200}/P): elasticity index	63.7	58.9	65.1	64.5
EXTENSIGRAPH				
Resist (BU at 30/60/90 min)	464/635/804	374/573/689	460/902/992	701/985/997
Extensibility (mm at 30/60/90 min)	142/121/130	164/165/152	143/125/95	130/112/92
Energy (cm^2 at 30/60/90 min)	114/126/170	115/176/194	114/165/117	157/160/130
Resist $_{max}$ (BU at 30/60/90 min)	615/832/996	529/843/999	631/1000/992	977/985/997
Ratio (at 30/60/90 min)	3.3/5.3/6.2	2.3/3.5/4.6	3.2/7.2/10.4	5.4/8.8/10.9
PROTEIN ANALYSIS				
HMW-GS Composition	1, 7+8, 5+10	2*, 7+9, 2+12	2*, 7+8, 5+10	2*, 7+8, 5+10
Glu/Gli	0.98	0.74	0.92	0.81
HMW/LMW	0.38	0.25	0.24	0.26
%IPP	47.94	47.70	46.64	52.28
SEDIMENTATION TEST				
Volume (ml)	52.5	60.8	63.6	65.3

Colorado: Cumulative Ash Curves



Hatcher (check) - 2404					CO05303-2 - 2405					CO06052 - 2406					CO06424 - 2407				
Mill	Strm-yld	Ash	Cumulative (14%)		Mill	Strm-yld	Ash	Cumulative (14%)		Mill	Strm-yld	Ash	Cumulative (14%)		Mill	Strm-yld	Ash	Cumulative (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	13.68	0.33	13.68	0.33	2M	13.44	0.29	13.44	0.29	2M	11.33	0.30	11.33	0.30	2M	15.40	0.32	15.40	0.32
1M Red	2.10	0.35	15.78	0.34	1M Red	2.23	0.31	15.67	0.30	1M	6.67	0.30	18.00	0.30	1M Red	2.58	0.34	17.98	0.32
1M	5.57	0.35	21.35	0.34	1M	5.66	0.31	21.33	0.30	1M Red	2.65	0.30	20.64	0.30	1M	6.32	0.34	24.29	0.32
1BK	7.14	0.37	28.49	0.35	2BK	5.71	0.33	27.04	0.31	1BK	6.94	0.33	27.58	0.31	Grader	2.61	0.36	26.91	0.33
3M	16.38	0.37	44.87	0.35	1BK	6.79	0.35	33.83	0.32	2BK	6.42	0.34	34.01	0.31	3M	16.57	0.37	43.48	0.34
Grader	2.30	0.37	47.16	0.36	4M	8.98	0.36	42.80	0.32	Grader	2.69	0.36	36.70	0.32	1BK	7.76	0.38	51.24	0.35
4M	8.86	0.37	56.03	0.36	Grader	2.62	0.36	45.42	0.33	3M	18.11	0.36	54.81	0.33	2BK	6.04	0.38	57.28	0.35
2BK	5.58	0.37	61.61	0.36	3M	16.35	0.36	61.77	0.34	4M	9.63	0.36	64.44	0.34	4M	7.77	0.41	65.04	0.36
FILTER FLR	1.48	0.60	63.09	0.36	FILTER FLR	1.18	0.52	62.95	0.34	FILTER FLR	1.09	0.54	65.53	0.34	FILTER FLR	1.10	0.58	66.14	0.36
5M	4.82	0.63	67.91	0.38	5M	4.61	0.67	67.56	0.36	5M	5.33	0.65	70.86	0.36	3BK	2.90	0.78	69.04	0.38
3BK	3.45	0.79	71.36	0.40	3BK	3.29	0.72	70.86	0.38	3BK	3.75	0.77	74.61	0.38	5M	2.97	0.80	72.01	0.40
BRAN FLR	1.67	1.52	73.03	0.43	BRAN FLR	1.70	1.38	72.56	0.40	BRAN FLR	1.76	1.61	76.38	0.41	BRAN FLR	1.68	1.58	73.69	0.42
Break Shorts	4.05	3.59	77.08	0.59	Break Shorts	3.73	3.68	76.29	0.56	Break Shorts	3.48	3.60	79.86	0.55	Break Shorts	2.96	3.91	76.65	0.56
Red Dog	1.27	3.16	78.35	0.64	Red Dog	1.21	3.10	77.50	0.60	Red Dog	1.21	2.96	81.06	0.59	Red Dog	1.01	3.17	77.65	0.59
Red Shorts	0.14	3.89	78.49	0.64	Red Shorts	0.18	3.70	77.67	0.61	Red Shorts	0.12	3.52	81.18	0.59	Red Shorts	0.09	3.98	77.74	0.60
Filter Bran	0.89	2.40	79.37	0.66	Filter Bran	0.79	2.29	78.46	0.63	Filter Bran	0.67	2.48	81.86	0.61	Filter Bran	0.79	2.75	78.53	0.62
Bran	20.63	4.27	100.00	1.41	Bran	21.54	4.44	100.00	1.45	Bran	18.14	4.56	100.00	1.32	Bran	21.47	4.58	100.00	1.47
Wheat		1.40			Wheat		1.46			Wheat		1.45			Wheat		1.48		
St. Grd. Fl.		0.48			St. Grd. Fl.		0.44			St. Grd. Fl.		0.44			St. Grd. Fl.		0.46		

Colorado: Cumulative Protein Curves

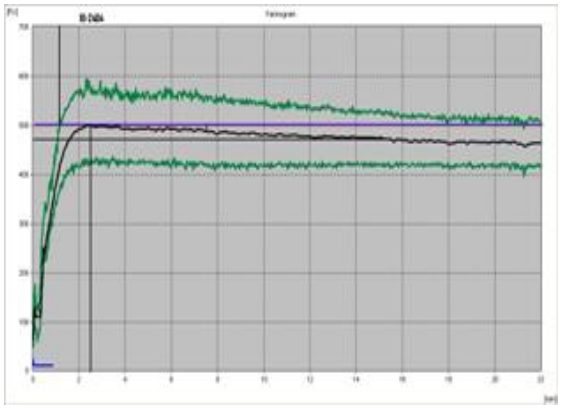


Hatcher (check) - 2404					CO050303-2 - 2405					CO06052 - 2406					CO06424 - 2407				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1BK	7.14	9.66	7.14	9.66	1M Red	2.23	10.45	2.23	10.45	1M Red	2.65	10.80	2.65	10.80	1BK	7.76	9.23	7.76	9.23
1M	5.57	10.18	12.71	9.89	1M	5.66	10.56	7.88	10.53	1M	6.67	10.90	9.31	10.87	1M	6.32	9.97	14.08	9.56
1M Red	2.10	10.26	14.81	9.94	2M	13.44	10.78	21.33	10.69	2M	11.33	11.06	20.64	10.98	1M Red	2.58	10.04	16.66	9.64
2M	13.68	10.41	28.49	10.17	3M	16.35	11.02	37.68	10.83	3M	18.11	11.13	38.75	11.05	2M	15.40	10.17	32.05	9.90
Grader	2.30	10.79	30.79	10.21	4M	8.98	11.27	46.66	10.92	4M	9.63	11.25	48.39	11.09	Grader	2.61	10.33	34.67	9.93
3M	16.38	10.89	47.16	10.45	1BK	6.79	11.84	53.44	11.03	1BK	6.94	11.68	55.33	11.16	3M	16.57	10.62	51.24	10.15
4M	8.86	11.26	56.03	10.58	Grader	2.62	12.44	56.06	11.10	5M	5.33	12.20	60.66	11.25	4M	7.77	11.06	59.00	10.27
FILTER FLR	1.48	11.73	57.51	10.61	5M	4.61	12.66	60.67	11.22	Grader	2.69	12.46	63.35	11.30	FILTER FLR	1.10	11.36	60.10	10.29
5M	4.82	12.16	62.33	10.73	FILTER FLR	1.18	13.34	61.85	11.26	FILTER FLR	1.09	12.91	64.44	11.33	2BK	6.04	11.93	66.14	10.44
2BK	5.58	12.52	67.91	10.87	2BK	5.71	14.54	67.56	11.54	2BK	6.42	14.57	70.86	11.63	5M	2.97	12.38	69.11	10.52
3BK	3.45	15.14	71.36	11.08	3BK	3.29	16.56	70.86	11.77	3BK	3.75	16.06	74.61	11.85	3BK	2.90	14.34	72.01	10.68
BRAN FLR	1.67	16.35	73.03	11.20	BRAN FLR	1.70	17.87	72.56	11.91	BRAN FLR	1.76	17.28	76.38	11.97	BRAN FLR	1.68	15.27	73.69	10.78
Break Shorts	4.05	15.46	77.08	11.42	Break Shorts	3.73	16.48	76.29	12.14	Break Shorts	3.48	15.07	79.86	12.11	Break Shorts	2.96	15.21	76.65	10.95
Red Dog	1.27	13.95	78.35	11.46	Red Dog	1.21	15.19	77.50	12.18	Red Dog	1.21	13.70	81.06	12.13	Red Dog	1.01	13.50	77.65	10.99
Red Shorts	0.14	14.54	78.49	11.47	Red Shorts	0.18	15.29	77.67	12.19	Red Shorts	0.12	13.81	81.18	12.13	Red Shorts	0.09	14.01	77.74	10.99
Filter Bran	0.89	13.08	79.37	11.49	Filter Bran	0.79	14.55	78.46	12.21	Filter Bran	0.67	14.35	81.86	12.15	Filter Bran	0.79	14.53	78.53	11.02
Bran	20.63	17.09	100.00	12.64	Bran	21.54	17.57	100.00	13.37	Bran	18.14	16.65	100.00	12.97	Bran	21.47	16.50	100.00	12.20
Wheat		12.20			Wheat		13.17			Wheat		12.68			Wheat		12.02		
St. Grd. Fl		11.10			St. Grd. Fl		11.82			St. Grd. Fl		11.84			St. Grd. Fl		10.85		

Physical Dough Tests

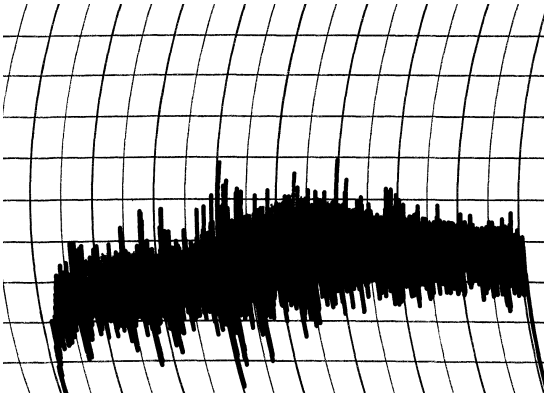
2010 (Small Scale) Samples – Colorado

Farinograms



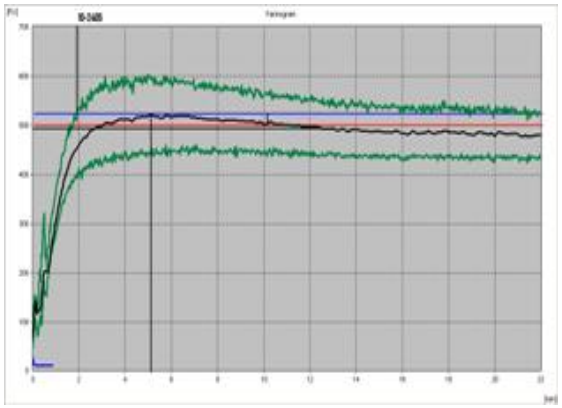
Water abs = 55.0%, Peak time = 2.5 min,
Mix stab = 24.1 min, MTI = 14 FU

Mixograms

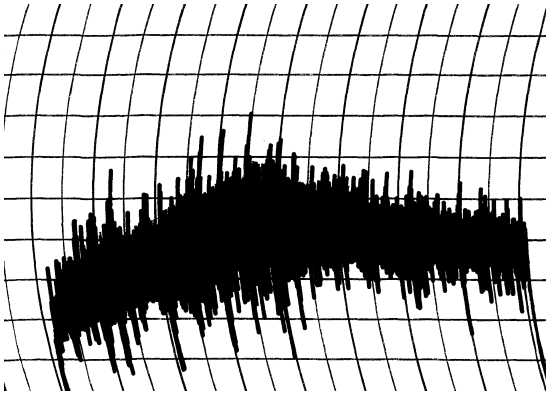


Water abs = 60.5%
Mix time = 4.4 min

10-2404, Hatcher (check)



Water abs = 57.2%, Peak time = 5.2 min,
Mix stab = 24.1 min, MTI = 19 FU



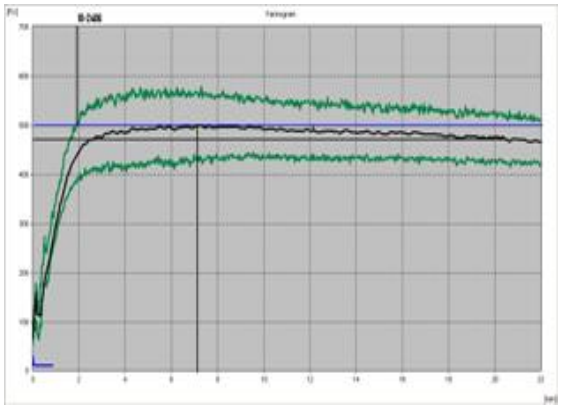
Water abs = 62.6%
Mix time = 3.8 min

10-2405, CO050303-2

Physical Dough Tests

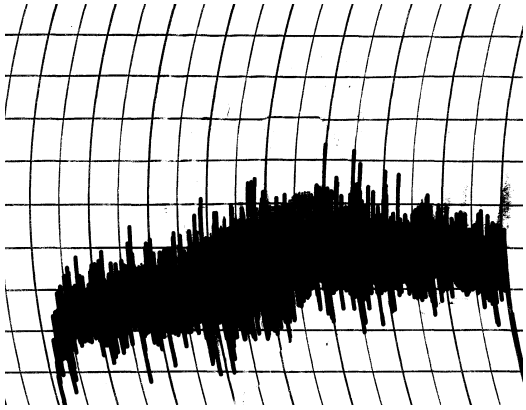
2010 (Small Scale) Samples – Colorado (continued)

Farinograms



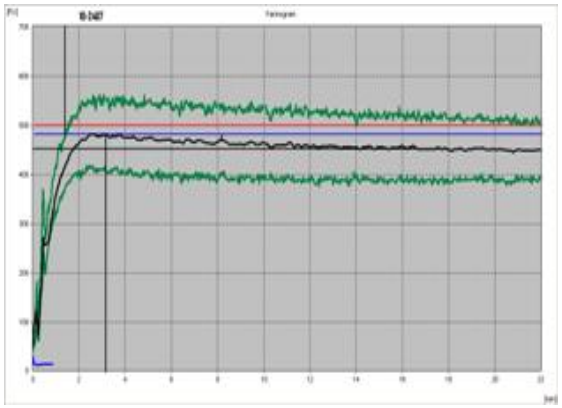
Water abs. = 56.1%, Peak time = 7.2 min,
Mix stab = 23.8 min, MTI = 10 FU

Mixograms

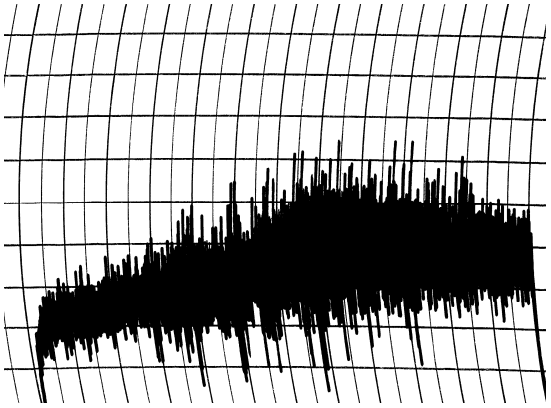


Water abs = 61.7%
Mix time = 4.6 min

10-2406, CO060502



Water abs. = 53.0%, Peak time = 3.2 min,
Mix stab = 32.6 min, MTI = 12 FU

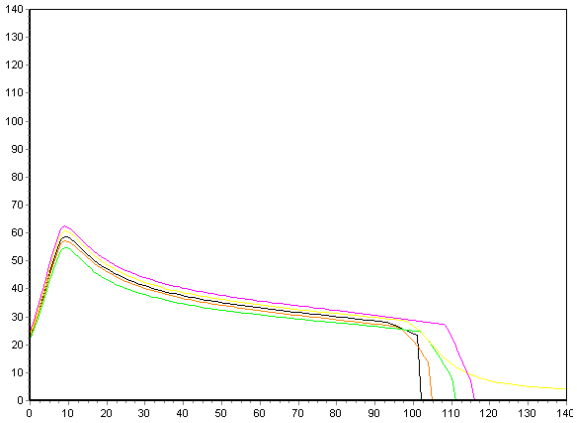


Water abs = 60.1%
Mix time = 7.6 min

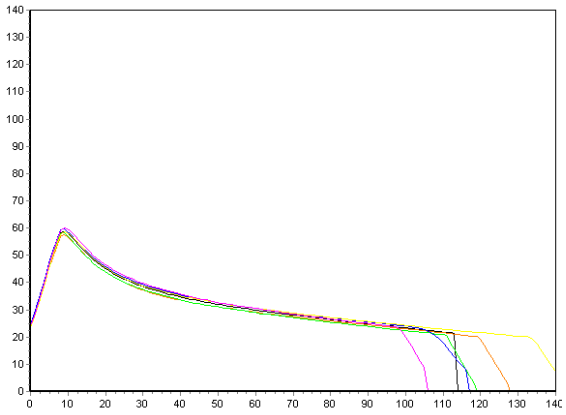
10-2407, CO06424

Physical Dough Tests - Alveograph

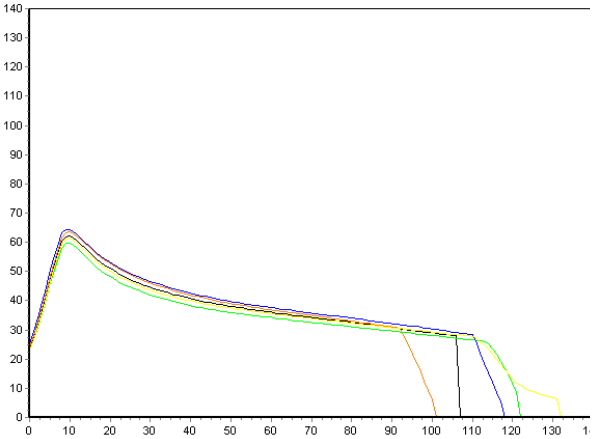
2010 (Small Scale) Samples – Colorado



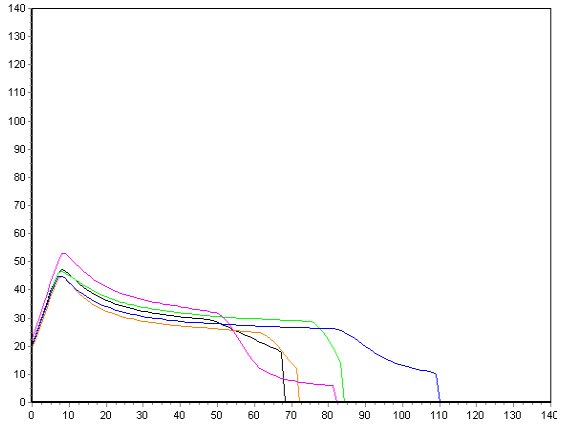
10-2404 (Hatcher – check)
P(mm H_20)=65, L(mm)=101, W(10^{-4} J)=244



10-2405 (CO050303-2
P(mm H_20)=65, L(mm)=113, W(10^{-4} J)=244



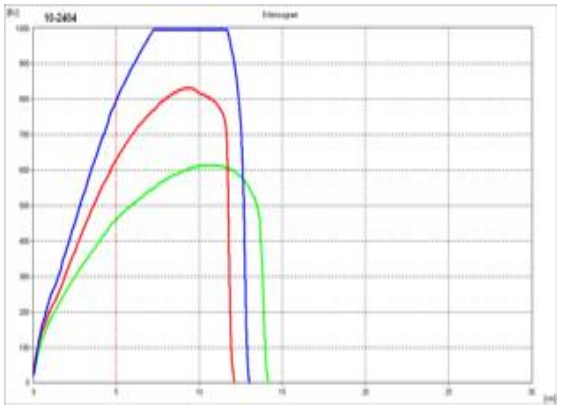
10-2406 (CO060502)
P(mm H_20)=69, L(mm)=107, W(10^{-4} J)=272



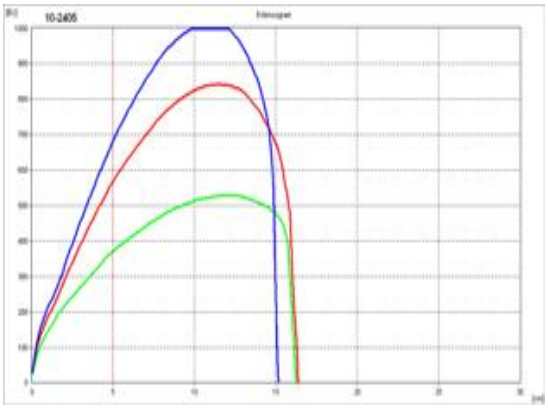
10-2407 (CO06424)
P(mm H_20)=52, L(mm)=68, W(10^{-4} J)=145

Physical Dough Tests - Extensigraph

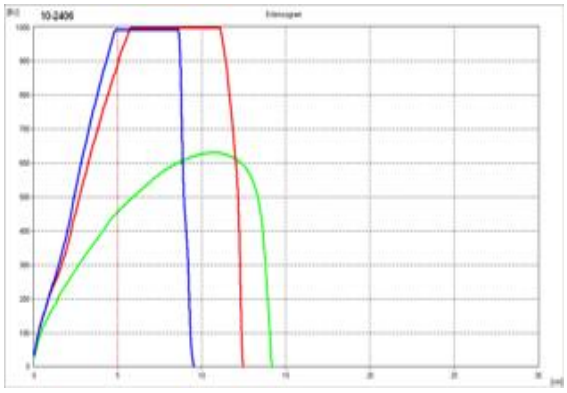
2010 (Small Scale) Samples – Colorado



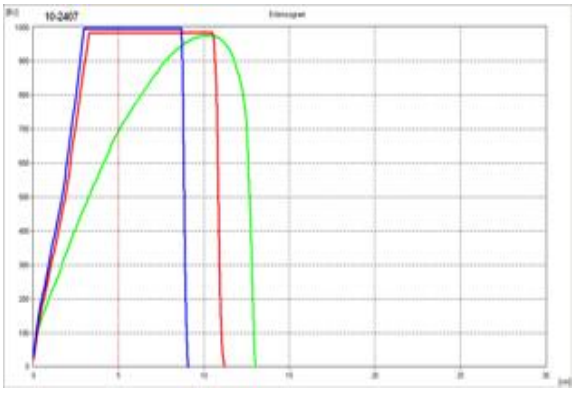
10-2404 (Hatcher - check)
R (BU) = 804, E (mm) = 130.2, W (cm^2) = 170.3
Rmax (BU) = 996, Ratio = 6.2 at 90 min



10-2405 (CO050303-2)
R (BU) = 689, E (mm) = 151.5, W (cm^2) = 193.5
Rmax (BU) = 999, Ratio = 4.6 at 90 min



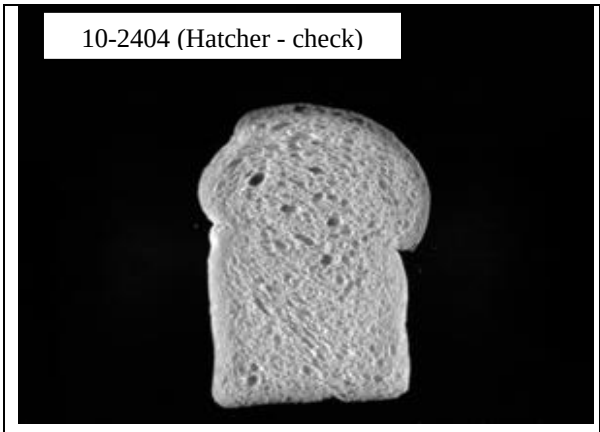
10-2406 (CO060502)
R (BU) = 992, E (mm) = 95.4, W (cm^2) = 117.4
Rmax (BU) = 992, Ratio = 10.4 at 90 min



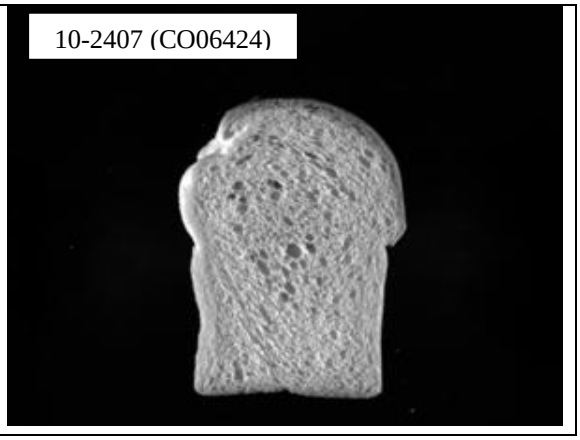
10-2407 (CO06424)
R (BU) = 997, E (mm) = 91.7, W (cm^2) = 129.5
Rmax (BU) = 997, Ratio = 10.9 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

Colorado: C-Cell Bread Images and Analysis for 2010 (Small-Scale) Samples



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2404	6173	162.6	3982	0.439	1.912	2.359	1.653	-22.15
2405	5912	162.0	3870	0.437	1.887	5.613	1.630	-23.93



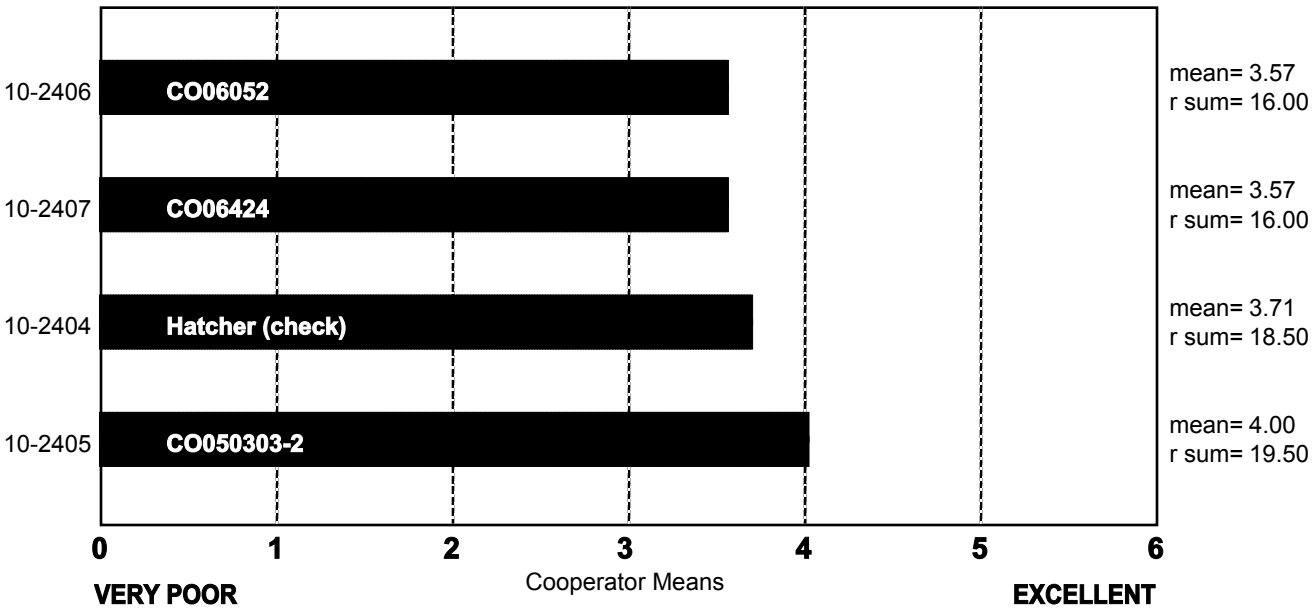
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2406	6428	158.8	4060	0.442	1.999	1.743	1.678	-20.75
2407	6470	156.2	4095	0.438	1.957	1.953	1.693	-24.73

SPONGE CHARACTERISTICS

(Small Scale) Colorado

ncoop= 7
chisq= 0.81
chisqc= 1.16
cvchisq= 7.82
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

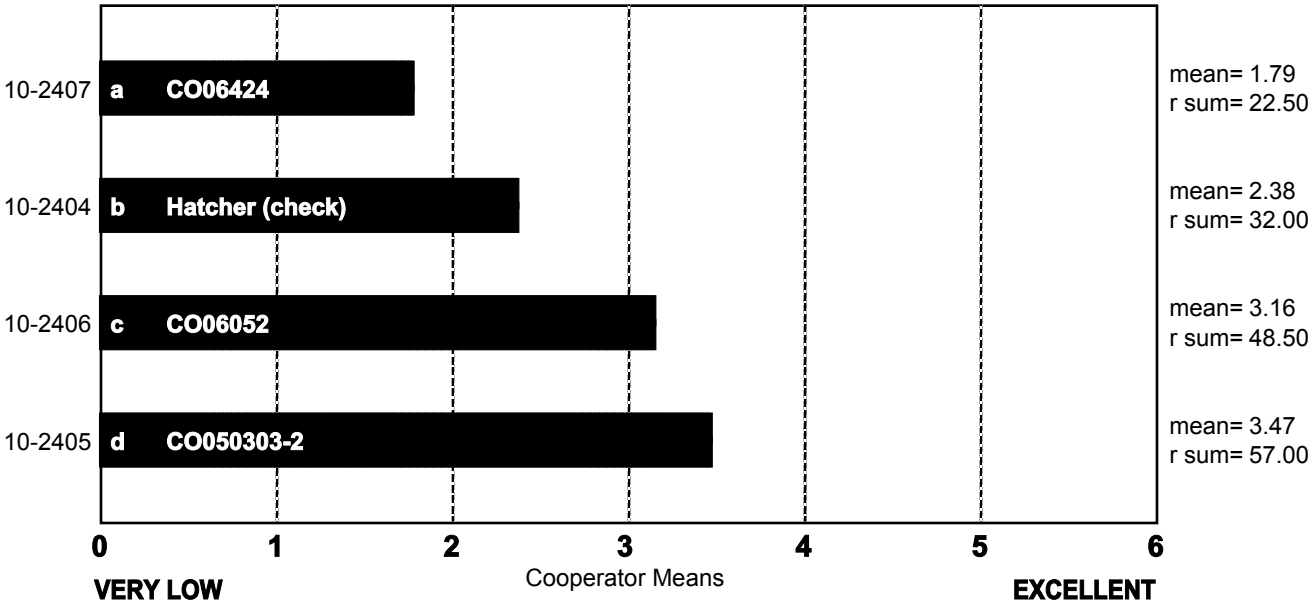


BAKE ABSORPTION

(Small Scale) Colorado

ncoop= 16
chisq= 27.43
chisqc= 34.83
cvchisq= 7.82
crdiff= 7.06

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Colorado

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2404 Hatcher (check)	**61.6**	**57.0**	**52.0**	**60.5**	**57.5**	**57.1**	**62.0**	**63.4**	**58.0**	**60.0**	**57.0**	**62.1**	**63.9**	**57.0**	**60.1**	**58.0**	**58.0**
10-2405 CO050303-2	**62.6**	**58.0**	**54.0**	**62.6**	**59.3**	**59.3**	**62.1**	**62.5**	**59.0**	**62.0**	**59.0**	**65.1**	**66.4**	**59.2**	**62.6**	**59.0**	**60.2**
10-2406 CO06052	**62.6**	**58.0**	**53.0**	**61.7**	**58.5**	**58.3**	**61.0**	**63.4**	**58.0**	**62.0**	**60.0**	**64.0**	**65.4**	**58.1**	**60.0**	**58.5**	**59.1**
10-2407 CO06424	**60.5**	**57.0**	**50.0**	**60.1**	**57.0**	**55.2**	**60.0**	**60.4**	**56.0**	**60.0**	**57.0**	**62.1**	**63.9**	**55.0**	**60.0**	**55.5**	**56.0**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Colorado

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2404 Hatcher (check)	**4.3**	**17.0**	**7.0**	**5.0**	**1.5**	**3.5**	**5.3**	**5.3**	**25.0**	**6.0**	**5.0**	**4.0**	**4.4**	**9.0**	**5.9**	**14.0**	**10.0**
10-2405 CO050303-2	**4.0**	**18.0**	**7.0**	**4.5**	**1.8**	**2.8**	**4.4**	**3.7**	**25.0**	**6.0**	**5.0**	**3.5**	**3.8**	**8.5**	**4.9**	**20.0**	**12.0**
10-2406 CO06052	**4.8**	**18.0**	**7.0**	**5.5**	**1.8**	**3.3**	**5.8**	**5.0**	**25.0**	**6.0**	**10.0**	**4.3**	**4.6**	**8.0**	**5.6**	**23.0**	**12.0**
10-2407 CO06424	**8.0**	**20.0**	**7.0**	**8.0**	**2.8**	**5.5**	**10.1**	**8.5**	**25.0**	**6.0**	**18.0**	**9.8**	**8.6**	**9.5**	**11.0**	**30.0**	**17.0**

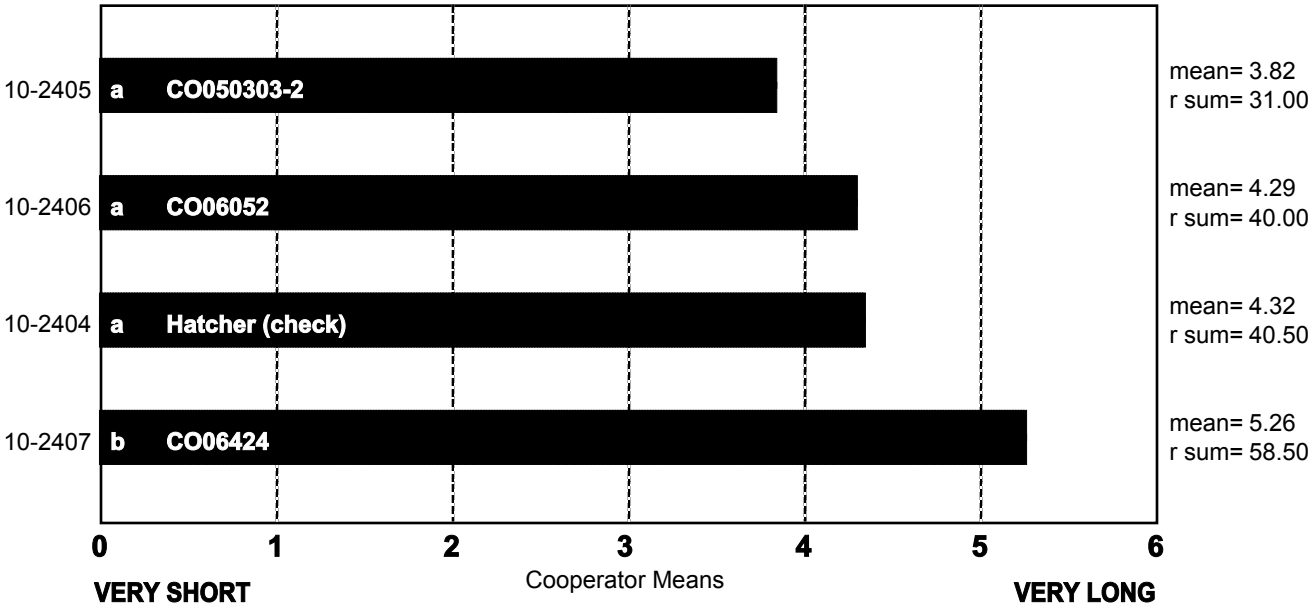
Raw Data

BAKE MIX TIME

(Small Scale) Colorado

ncoop= 17
chisq= 14.06
chisqc= 20.61
cvchisq= 7.82
crdiff= 9.95

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

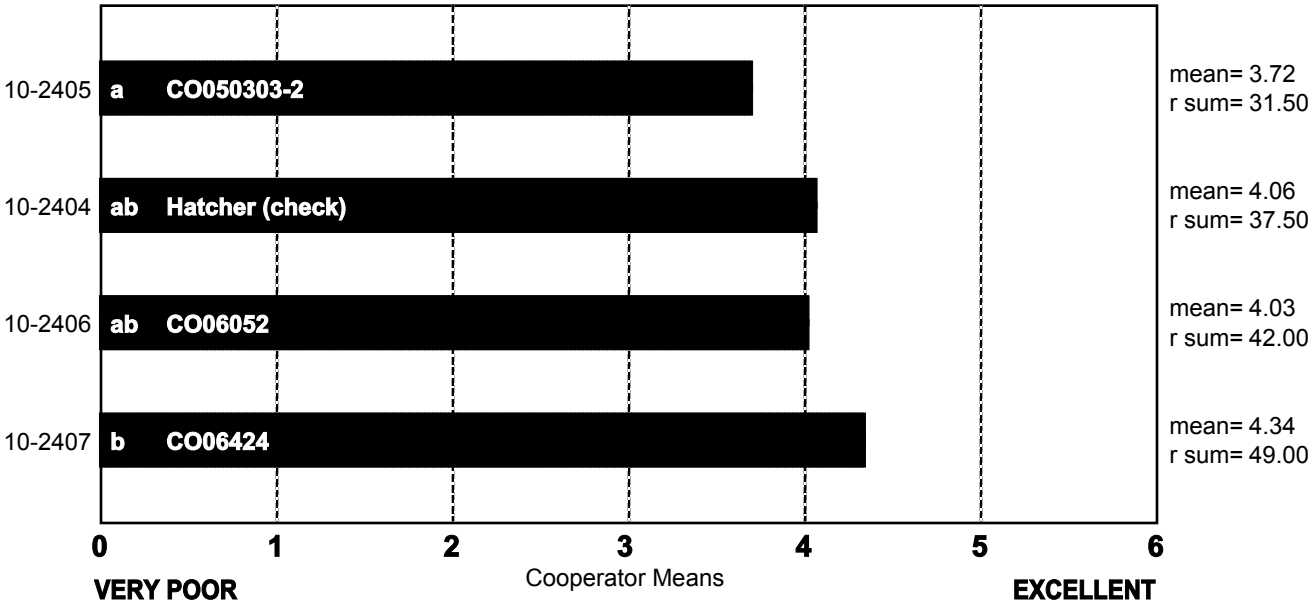


MIXING TOLERANCE

(Small Scale) Colorado

ncoop= 16
chisq= 6.13
chisqc= 8.24
cvchisq= 7.82
crdiff= 11.92

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

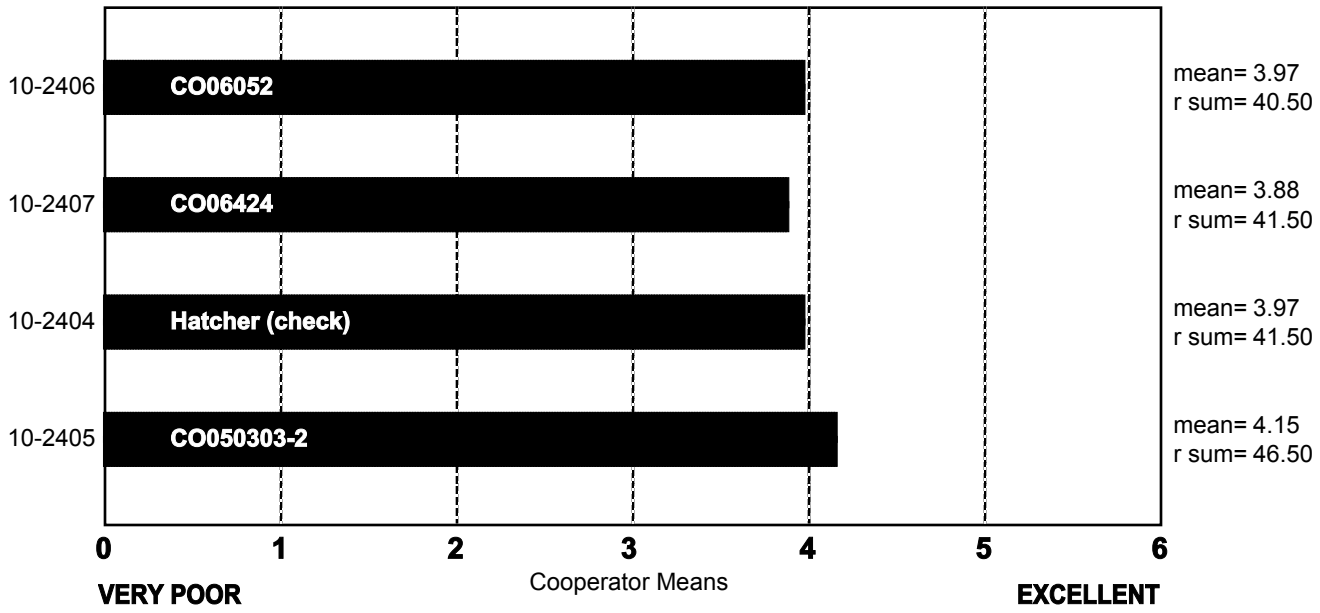


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Colorado

ncoop= 17
chisq= 0.78
chisqc= 1.22
cvchisq= 7.82
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Colorado

	Sticky	Wet	Tough	Good	Excellent
10-2404 Hatcher (check)	**1**	**1**	**4**	**10**	**1**
10-2405 CO050303-2	**1**	**2**	**3**	**9**	**2**
10-2406 CO06052	**3**	**1**	**5**	**6**	**2**
10-2407 CO06424	**2**	**0**	**6**	**9**	**0**

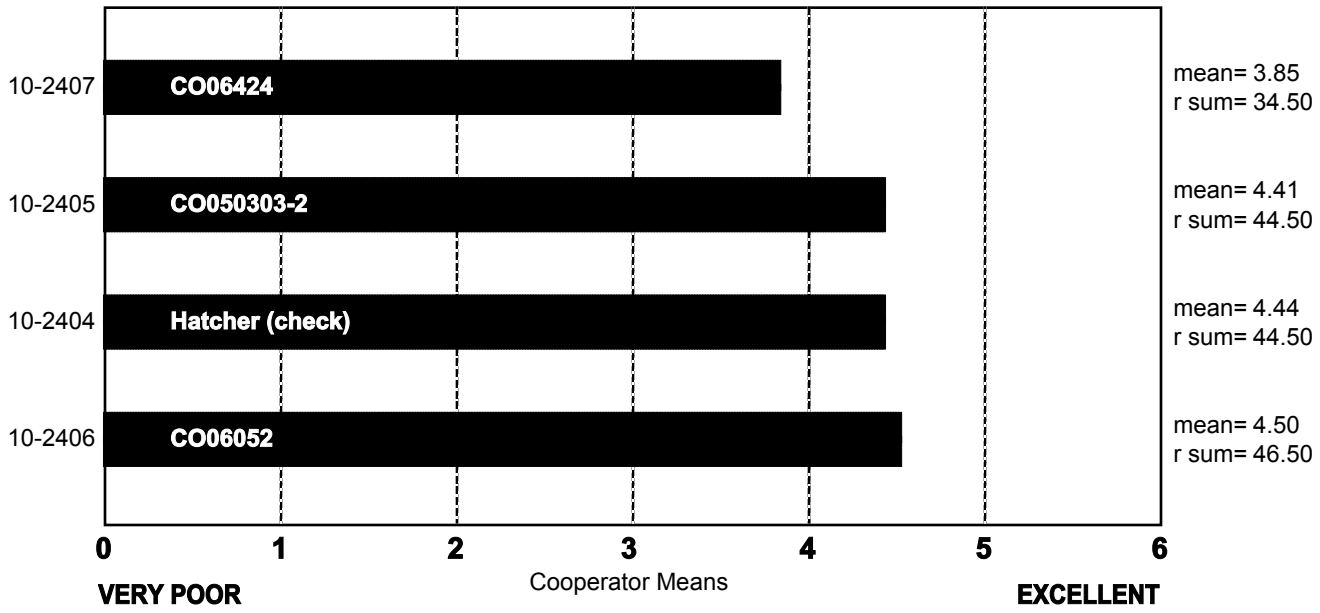
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Colorado

ncoop= 17
chisq= 3.11
chisqc= 5.23
cvchisq= 7.82
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Colorado

	Sticky	Wet	Tough	Good	Excellent
10-2404 Hatcher (check)	**0**	**0**	**4**	**12**	**1**
10-2405 CO050303-2	**1**	**1**	**3**	**10**	**2**
10-2406 CO06052	**0**	**0**	**5**	**10**	**2**
10-2407 CO06424	**0**	**0**	**8**	**9**	**0**

Frequency Table

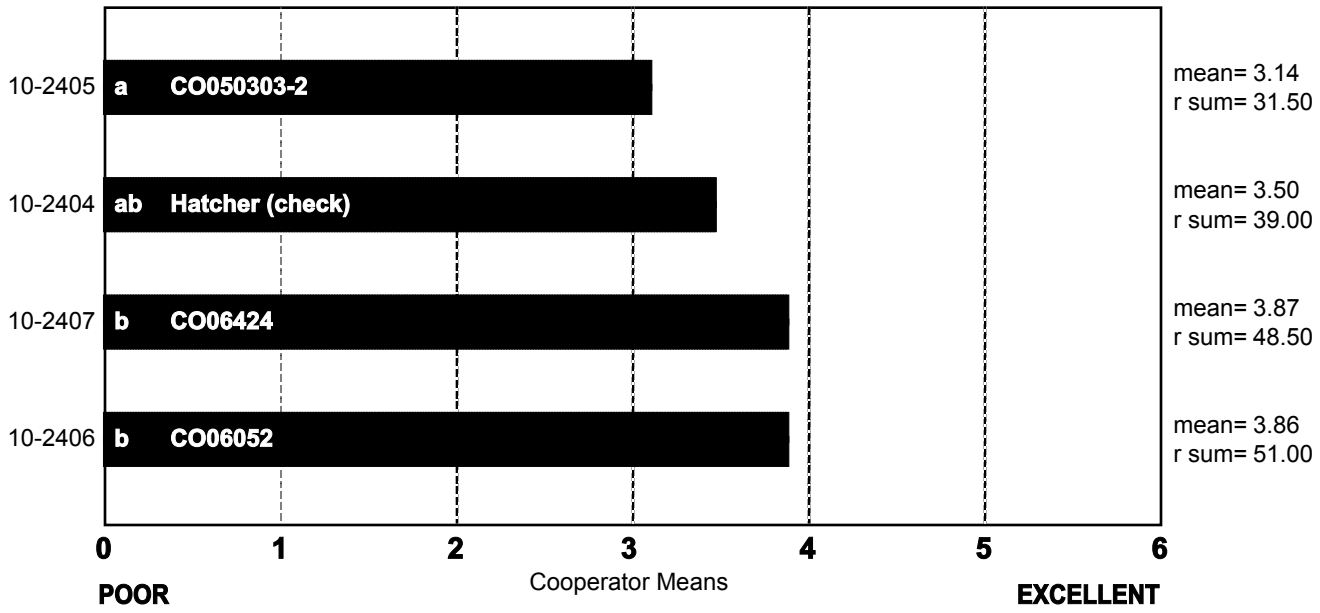
CRUMB GRAIN

(Small Scale) Colorado

ncoop= 17
chisq= 8.52
chisqc= 10.65
cvchisq= 7.82
crdiff= 12.41

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Colorado

	Open	Fine	Dense
10-2404 Hatcher (check)	**9**	**4**	**4**
10-2405 CO050303-2	**10**	**3**	**4**
10-2406 CO06052	**8**	**7**	**2**
10-2407 CO06424	**7**	**8**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Colorado

	Round	Irregular	Elongated
10-2404 Hatcher (check)	**3**	**9**	**5**
10-2405 CO050303-2	**7**	**6**	**4**
10-2406 CO06052	**3**	**9**	**5**
10-2407 CO06424	**4**	**9**	**4**

Frequency Table

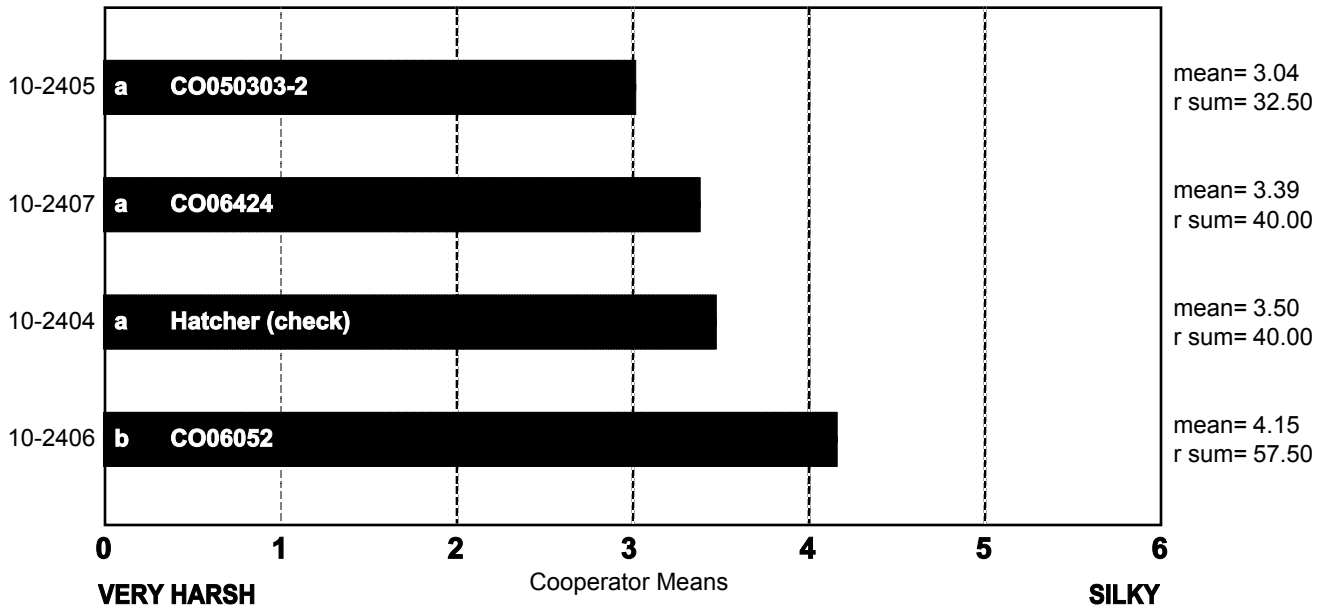
CRUMB TEXTURE

(Small Scale) Colorado

ncoop= 17
chisq= 11.91
chisqc= 15.58
cvchisq= 7.82
crdiff= 11.37

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Colorado

	Harsh	Smooth	Silky
10-2404 Hatcher (check)	**4**	**11**	**2**
10-2405 CO050303-2	**8**	**7**	**2**
10-2406 CO06052	**1**	**11**	**5**
10-2407 CO06424	**5**	**9**	**3**

Frequency Table

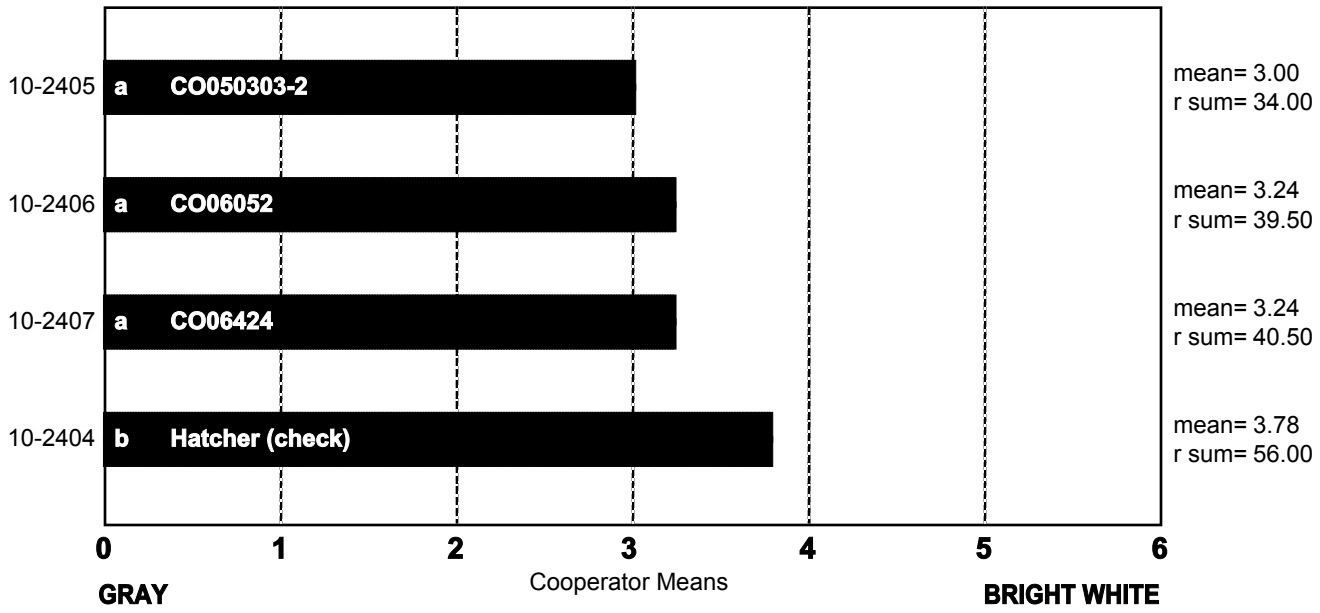
CRUMB COLOR

(Small Scale) Colorado

ncoop= 17
chisq= 9.44
chisqc= 14.46
cvchisq= 7.82
crdiff= 10.67

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Colorado

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
10-2404 Hatcher (check)	**0**	**1**	**0**	**3**	**12**	**1**	**0**
10-2405 CO050303-2	**0**	**2**	**3**	**6**	**5**	**0**	**0**
10-2406 CO06052	**0**	**0**	**6**	**2**	**7**	**1**	**0**
10-2407 CO06424	**0**	**1**	**4**	**3**	**7**	**1**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Colorado

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2404 Hatcher (check)	**142.0**	**418.0**	**505.0**	**155.9**	**127.7**	**129.5**	**140.1**	**154.4**	**486.0**	**134.0**	**467.1**	**136.0**	**140.5**	**467.0**	**148.8**	**464.9**	**448.9**
10-2405 CO050303-2	**144.0**	**421.0**	**500.0**	**155.9**	**131.3**	**130.9**	**142.6**	**154.6**	**484.4**	**134.0**	**466.0**	**139.4**	**143.3**	**468.0**	**150.5**	**463.0**	**455.6**
10-2406 CO06052	**142.2**	**414.0**	**500.0**	**154.8**	**129.0**	**125.4**	**140.8**	**152.4**	**482.5**	**134.0**	**468.1**	**136.3**	**140.6**	**466.0**	**147.3**	**465.2**	**452.6**
10-2407 CO06424	**137.5**	**413.0**	**510.0**	**155.2**	**125.7**	**123.1**	**139.3**	**147.8**	**479.8**	**134.0**	**469.2**	**137.7**	**138.0**	**467.0**	**147.2**	**463.4**	**456.6**

LOAF VOLUME, ACTUAL

(Small Scale) Colorado

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2404 Hatcher (check)	**935**	**3100**	**2450**	**660**	**625**	**870**	**843**	**913**	**2956**	**978**	**2513**	**968**	**838**	**2700**	**845**	**2725**	**2520**
10-2405 CO050303-2	**870**	**2850**	**2850**	**642**	**575**	**860**	**828**	**915**	**3015**	**953**	**2413**	**963**	**796**	**2900**	**800**	**2600**	**2475**
10-2406 CO06052	**1100**	**3100**	**3050**	**717**	**735**	**950**	**940**	**1018**	**3104**	**1023**	**2675**	**965**	**916**	**3025**	**905**	**2750**	**2650**
10-2407 CO06424	**1105**	**3100**	**2550**	**740**	**680**	**900**	**930**	**1014**	**3162**	**948**	**2713**	**885**	**926**	**2925**	**920**	**2925**	**2400**

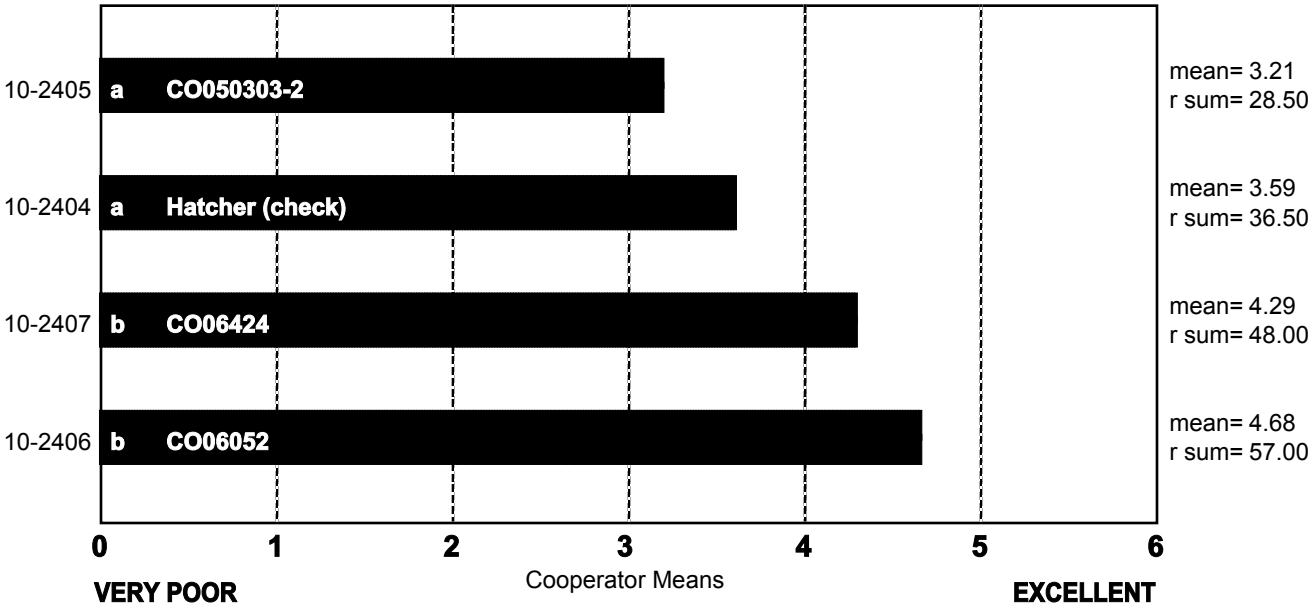
Raw Data

LOAF VOLUME

(Small Scale) Colorado

ncoop= 17
chisq= 16.68
chisqc= 21.32
cvchisq= 7.82
crdiff= 10.53

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

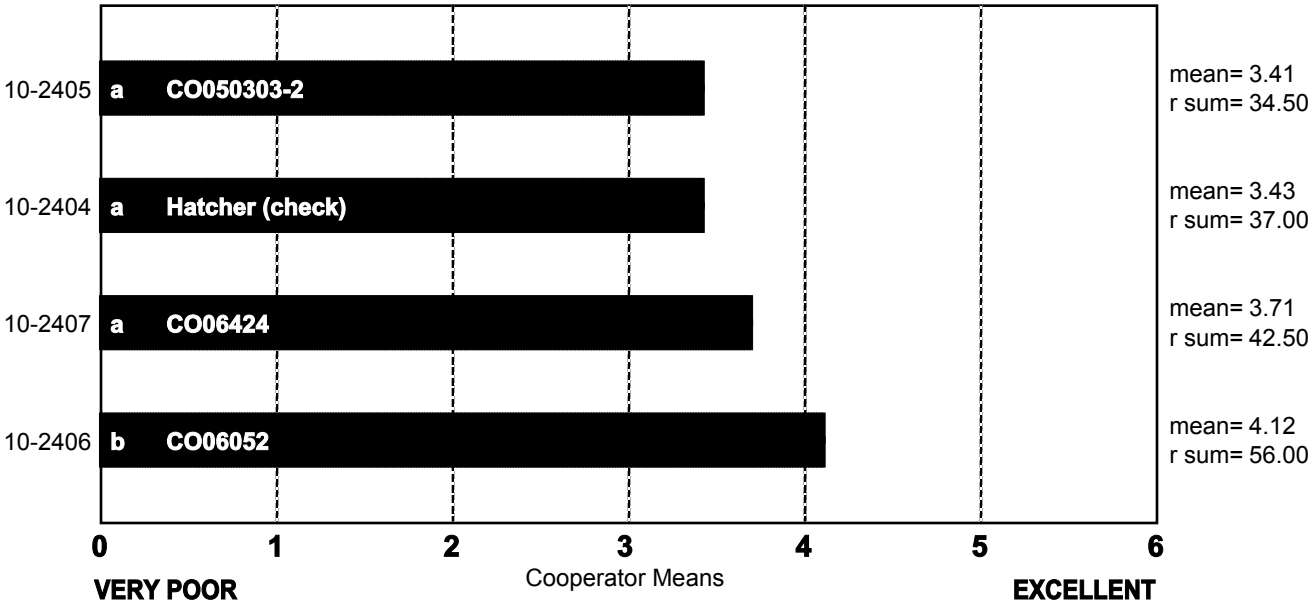


OVERALL BAKING QUALITY

(Small Scale) Colorado

ncoop= 17
chisq= 9.76
chisqc= 10.70
cvchisq= 7.82
crdiff= 13.24

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS
(Small Scale) Colorado

COOP. **10-2404** **Hatcher (Check)**

A. No comment.

B. Sl. tough out of mixer, open grain, excellent volume, sl. creamy.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. sticky dough, hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Good performance.

I. Open, irregular grain, good volume.

J. Good bake quality and dough handling, nice grain.

K. Low absorption, tough dough, open grain, sl. low volume.

L. No comment.

M. No comment.

N. No comment.

O. Good dough at mix and pan, low absorption, long mix time, questionable crumb grain.

P. No comment.

Q. Dense grain, good volume.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Colorado

COOP. **10-2405** **CO050303-2**

A. Weak dough, low loaf volume.

B. Good mix, sl. tough dough, average volume, sl. open grain, creamy crumb.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. sticky dough, hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Dough and interior a little weak looking.

I. Open, irregular, coarse grain; very good volume.

J. OK bake quality, had nice dough handling but showed drop in tolerance.

K. Sl. low absorption, tough dough, very open grain, dark yellow crumb, low volume.

L. No comment.

M. Dough smears around the bowl, slow pick up.

N. No comment.

O. Best absorption and mix time of CO set, rated lower than check Hatcher.

P. No comment.

Q. Dense grain, good volume.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Colorado

COOP. **10-2406** **CO06052**

A. Rough break and shred.

B. Good mix, tough and bucky, good volume, nice interior, sl. creamy crumb.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption, medium long mix time, wet, soft and sl. sticky dough, very hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Very good overall performance, good value of the protein.

I. Open, irregular grain, harsh texture, excellent volume.

J. Good dough handling, great volume and tolerance; however, was docked for having a very yellow crumb color, otherwise was great.

K. Good mix time, yellow crumb, average absorption and volume.

L. No comment.

M. Dough smears around the bowl, slow pick up.

N. No comment.

O. Best crumb grain of the set, good loaf volume and rated higher than check Hatcher.

P. No comment.

Q. Excellent dense grain, excellent volume.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Colorado

COOP. **10-2407** **CO06424**

A. Slow dough pick up during mixing, long mix time, excellent exterior.

B. Very tough and bucky, good volume, sl. open grain, sl. creamy interior, long mix.

C. No comment.

D. No comment.

E. Low loaf volume, low bake absorption.

F. No comment.

G. Normal absorption, very long mix time, wet, soft and sl. sticky dough, very hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Very good overall performance, good value of the protein.

I. Low absorption, extremely strong mixing flour, sl. open, irregular grain; excellent volume.

J. Good dough handling, volume, and grain; however, was docked for having a very yellow crumb color.

K. Low absorption, very long mix time, yellow crumb, good volume.

L. No comment.

M. Dough smears around the bowl, very slow pick up.

N. No comment.

O. Good absorption and loaf volume, very long mix time; rated higher than Hatcher.

P. No comment.

Q. Excellent dense grain, good volume, long mix time.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

Nebraska – Stephen Baenziger

Growing Conditions of Wheat Quality Samples:

The samples are a composite of approximately 1 bu each produced at Sidney, North Platte, and Mead NE. All the samples were grown under normal production practices for those regions. The 2009-2010 growing season was unusually wet in most of Nebraska, so the protein levels of the samples are expected to be lower than normal due to high yields or N leaching from the soils. Stand establishment and winter survival were problematic at North Platte where thin stands were often found at harvest. In addition, there was rain throughout harvest at Lincoln and above normal rainfall at North Platte which could reduce test weight and increase kernel bleaching. Sidney had higher grain yields, but was harvested on time. Diseases were present throughout the state with foliar diseases being most prevalent in eastern Nebraska.

Lines submitted for testing:

NE03490: the pedigree of NE03490 is WI90-540W/*2 Culver.

It is a moderately early, medium height, bright chaff, semi-dwarf wheat with good winterhardiness and average straw strength. In our tests, it is moderately resistant to leaf and stem rust, moderately resistant to moderately susceptible to yellow (stripe) rust, and susceptible to soilborne wheat mosaic virus, Hessian fly, and greendug (biotype E). It has performed well for grain yield in western NE under rainfed or irrigated conditions. In its performance it is similar to the newly released NI04421 (Husker Genetics Brand Robidoux). In addition, in our end-use quality assays it has acceptable end-use quality. It was tested in the SRPN in 2006 (data available at http://www.ars.usda.gov/Research/docs.htm?docid=11932) and in the Nebraska State Variety Trials (data available at: http://cropwatch.unl.edu/web/varietytest/wheat).

NE04490: The pedigree of NE04490 is NE95589/NE94632/NE95510 where the pedigree of NE95589 is: Abiline//Colt/Cody/3/NE87636; the pedigree of NE94632 is Abilene/Norkan//Rawhide; and the pedigree of NE95510 is Abilene/Arapahoe.

It is a medium maturity, medium height, bronze chaffed, semi-dwarf wheat with good winterhardiness and medium straw strength. In our tests, it is moderately resistant to moderately susceptible to leaf, yellow (stripe) rust, and stem rust. It is moderately resistant to soilborne wheat mosaic virus and moderately resistant to moderately susceptible to Hessian fly (possibly having the Marquillo-Kawvale resistance) and is susceptible to wheat streak mosaic virus. It has performed well in rainfed conditions in south eastern, south central, and west central NE. In these areas, its main competitors

will be Overland, Infinity CL, and NE01481 (marketed under Husker Genetics Brand McGill). It is not recommended for irrigated wheat production where better cultivars exist. In addition, in our end-use quality assays it has above average end-use quality. It was tested in the NRPN in 2007 and 2008 (data available at http://www.ars.usda.gov/Research/docs.htm?docid=11932) and in the Nebraska State Variety Trials (data available at: http://cropwatch.unl.edu/web/varietytest/wheat).

Milling and baking check is **Millennium**.

Nebraska: 2010 (Small-Scale) Samples [a]

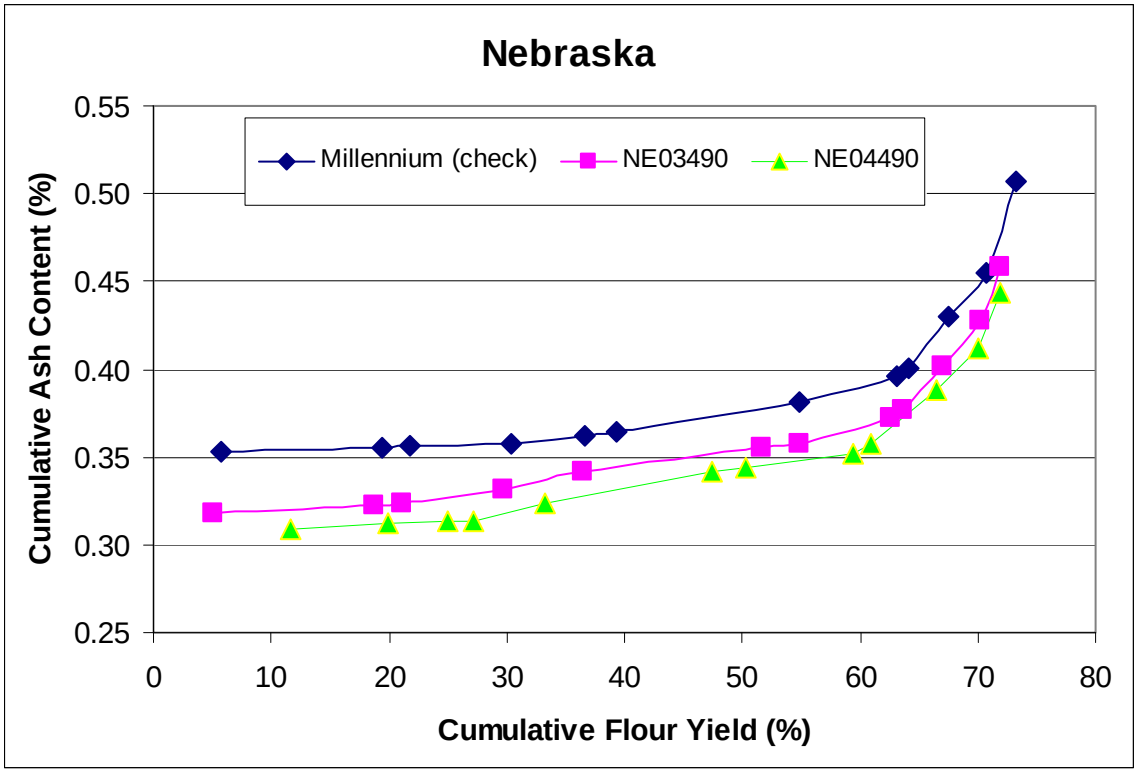
Test entry number	10-2408	10-2409	10-2410
Sample identification	**Millennium (check)**	**NE03490**	**NE04490**
Wheat Data			
FGIS classification	3 HRW	3 HRW	3 HRW
Test weight (lb/bu)	57.8	56.4	56.8
Hectoliter weight (kg/hl)	76.1	74.3	74.8
1000 kernel weight (gm)	29.6	28.2	27.2
Wheat kernel size (Rotap)			
Over 7 wire (%)	56.8	52.0	57.3
Over 9 wire (%)	41.5	45.7	40.7
Through 9 wire (%)	1.7	2.3	2.1
Single kernel (skcs)			
Hardness (avg /s.d)	55.1/20.8	51.48/19.7	54.2/19.7
Weight (mg) (avg/s.d)	29.6/9.0	28.2/8.7	27.2/8.9
Diameter (mm)(avg/s.d)	2.57/0.35	2.53/0.34	2.51/0.33
SKCS distribution	12-28-20-40	18-23-25-34	14-22-22-42
Classification	Mixed	Mixed	Mixed
Wheat moisture (%)	10.8	10.5	10.5
Wheat protein (12% mb)	12.3	12.7	12.6
Wheat ash (12% mb)	1.77	1.67	1.76
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	73.4	72.0	71.9
Quadrumat Sr. Mill	71.2	69.8	68.9
Flour moisture (%)	10.7	10.8	10.7
Flour protein (14% mb)	10.7	11.2	10.9
Flour ash (14% mb)	0.49	0.53	0.51
Glutomatic			
Wet gluten (%)	28.6	31.5	30.4
Dry gluten (%)	10.0	10.8	10.4
Gluten index	97.9	97.1	97.4
Rapid Visco-Analyser			
Peak time (min)	5.9	6.1	6.0
Peak viscosity (RVU)	173.4	217.5	188.1
Breakdown (RVU)	82.2	82.6	66.0
Final viscosity at 13 min (RVU)	185.1	247.5	236.8
Minolta color meter			
L*	92.0	92.4	92.1
a*	-1.59	-1.58	-1.60
b*	9.05	8.88	9.23
Falling number (sec)	382	452	406
Damaged Starch			
(AI%)	94.64	95.45	94.63
(AACC76-31)	5.26	5.85	5.26

[a] s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Nebraska: Physical Dough Tests and Gluten Analysis For 2010 (Small-Scale) Samples

Test Entry Number	10-2408	10-2409	10-2410
Sample Identification	Millennium (check)	NE03490	NE04490
MIXOGRAPH			
Flour Abs (% as-is)	64.4	65.3	63.8
Flour Abs (14% mb)	60.7	61.7	60.1
Mix Time (min)	4.38	4.25	3.38
Mix tolerance (0-6)	3	4	3
FARINOGRAPH			
Flour Abs (% as-is)	58.5	58.6	59.9
Flour Abs (14% mb)	54.8	55.0	56.2
Development time (min)	4.2	3.0	5.9
Mix stability (min)	11.5	13.2	10.9
Mix Tolerance Index (FU)	31	24	40
Breakdown time (min)	8.9	9.1	9.6
ALVEOGRAPH			
P(mm. H2O): Tenacity	57	53	59
L(mm): Extensibility	101	135	112
G($mm_{0.5}$): Swelling index	22.4	25.9	23.6
W(10^{-4} J): strength (curve area)	197	229	212
P/L: curve configuration ratio	0.56	0.39	0.53
Ie(P_{200}/P): elasticity index	57.8	58.6	56.7
EXTENSIGRAPH			
Resist (BU at 30/60/90 min)	412/649/659	351/477/594	297/400/437
Extensibility (mm at 30/60/90 min)	146/132/125	165/142/149	163/159/157
Energy (cm2 at 30/60/90 min)	105/145/136	113/126/170	93/120/126
Resist $_{max}$ (BU at 30/60/90 min)	549/858/868	528/717/905	431/581/616
Ratio (at 30/60/90 min)	2.8/4.9/5.3	2.1/3.4/4.0	1.8/2.5/2.8
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+9, 5+10	2*, 17+18, 5+10
Glu/Gli	0.90	0.68	0.88
HMW/LMW	0.24	0.31	0.40
%IPP	45.80	46.48	47.02
SEDIMENTATION TEST			
Volume (ml at 14% mc)	41.4	51.1	44.3

Nebraska: Cumulative Ash Curves



Millennium (check) - 2408

Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash
1M	5.69	0.35	5.69	0.35
2M	13.76	0.36	19.45	0.36
1M Red	2.25	0.36	21.70	0.36
1BK	8.61	0.36	30.31	0.36
2BK	6.38	0.38	36.70	0.36
Grader	2.67	0.40	39.36	0.36
3M	15.53	0.42	54.89	0.38
4M	8.19	0.50	63.08	0.40
FILTER FLR	0.98	0.64	64.06	0.40
3BK	3.53	0.97	67.59	0.43
5M	3.12	1.00	70.71	0.45
BRAN FLR	2.60	1.93	73.31	0.51
Break Shorts	3.28	4.59	76.59	0.68
Red Dog	1.14	3.74	77.73	0.73
Red Shorts	0.07	4.35	77.81	0.73
Filter Bran	0.90	2.12	78.70	0.75
Bran	21.30	5.62	100.00	1.78
Wheat		1.73		
St. Grd. Fl.		0.49		

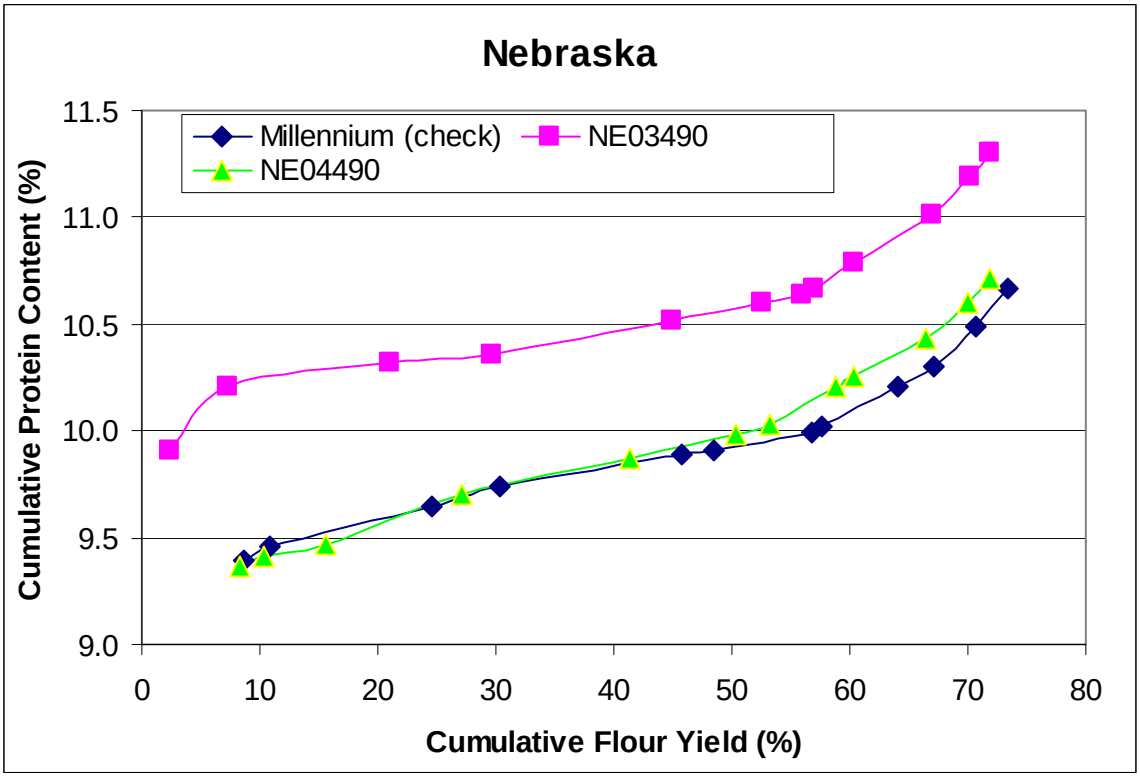
NE03490 - 2409

Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash
1M	5.00	0.32	5.00	0.32
2M	13.73	0.32	18.73	0.32
1M Red	2.32	0.34	21.05	0.32
1BK	8.67	0.35	29.72	0.33
2BK	6.69	0.39	36.41	0.34
3M	15.22	0.39	51.63	0.36
Grader	3.30	0.39	54.93	0.36
4M	7.62	0.47	62.55	0.37
FILTER FLR	1.16	0.63	63.70	0.38
3BK	3.24	0.89	66.94	0.40
5M	3.24	0.98	70.19	0.43
BRAN FLR	1.66	1.74	71.85	0.46
Break Shorts	3.30	4.51	75.15	0.64
Red Dog	1.09	3.67	76.24	0.68
Red Shorts	0.09	4.27	76.33	0.68
Filter Bran	0.84	2.82	77.16	0.71
Bran	22.84	5.13	100.00	1.72
Wheat		1.64		
St. Grd. Fl.		0.53		

NE04490 - 2410

Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash
2M	11.61	0.31	11.61	0.31
1BK	8.25	0.32	19.86	0.31
1M	5.17	0.32	25.04	0.31
1M Red	2.14	0.32	27.18	0.31
2BK	6.11	0.37	33.30	0.32
3M	14.13	0.39	47.43	0.34
Grader	2.87	0.39	50.30	0.34
4M	9.11	0.39	59.41	0.35
FILTER FLR	1.52	0.57	60.93	0.36
5M	5.56	0.72	66.49	0.39
3BK	3.54	0.85	70.03	0.41
BRAN FLR	1.80	1.68	71.82	0.44
Break Shorts	3.66	4.28	75.49	0.63
Red Dog	1.34	3.71	76.82	0.68
Red Shorts	0.17	4.46	76.99	0.69
Filter Bran	0.82	2.28	77.81	0.71
Bran	22.19	5.08	100.00	1.68
Wheat		1.72		
St. Grd. Fl.		0.51		

Nebraska: Cumulative Protein Curves

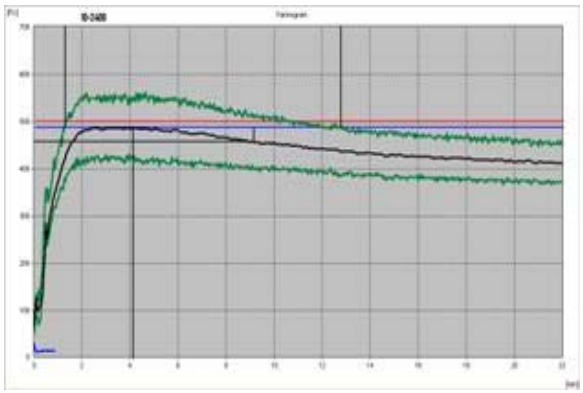


Millennium (check) - 2408					NE03490 - 2409					NE04490 - 2410				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1BK	8.61	9.39	8.61	9.39	1M Red	2.32	9.91	2.32	9.91	1BK	8.25	9.36	8.25	9.36
1M Red	2.25	9.71	10.86	9.46	1M	5.00	10.35	7.32	10.21	1M Red	2.14	9.59	10.40	9.41
2M	13.76	9.79	24.63	9.64	2M	13.73	10.38	21.05	10.32	1M	5.17	9.59	15.57	9.47
1M	5.69	10.14	30.31	9.74	1BK	8.67	10.45	29.72	10.36	2M	11.61	10.01	27.18	9.70
3M	15.53	10.19	45.84	9.89	3M	15.22	10.81	44.94	10.51	3M	14.13	10.20	41.31	9.87
Grader	2.67	10.20	48.51	9.91	4M	7.62	11.11	52.56	10.60	4M	9.11	10.51	50.42	9.99
4M	8.19	10.51	56.70	9.99	Grader	3.30	11.26	55.86	10.64	Grader	2.87	10.81	53.29	10.03
FILTER FLR	0.98	11.33	57.68	10.02	FILTER FLR	1.16	12.26	57.02	10.67	5M	5.56	11.92	58.85	10.21
2BK	6.38	11.97	64.06	10.21	5M	3.24	12.82	60.26	10.79	FILTER FLR	1.52	12.05	60.37	10.25
5M	3.12	12.11	67.18	10.30	2BK	6.69	13.07	66.95	11.01	2BK	6.11	12.17	66.49	10.43
3BK	3.53	14.09	70.71	10.49	3BK	3.24	14.81	70.19	11.19	3BK	3.54	13.78	70.03	10.60
BRAN FLR	2.60	15.55	73.31	10.67	BRAN FLR	1.66	16.11	71.85	11.30	BRAN FLR	1.80	15.21	71.82	10.72
Break Shorts	3.28	15.96	76.59	10.89	Break Shorts	3.30	16.43	75.15	11.53	Break Shorts	3.66	16.70	75.49	11.01
Red Dog	1.14	14.43	77.73	10.95	Red Dog	1.09	14.85	76.24	11.58	Red Dog	1.34	15.75	76.82	11.09
Red Shorts	0.07	14.70	77.81	10.95	Red Shorts	0.09	14.78	76.33	11.58	Red Shorts	0.17	15.57	76.99	11.10
Filter Bran	0.90	12.01	78.70	10.96	Filter Bran	0.84	12.85	77.16	11.59	Filter Bran	0.82	13.28	77.81	11.12
Bran	21.30	16.43	100.00	12.13	Bran	22.84	16.60	100.00	12.74	Bran	22.19	16.64	100.00	12.35
Wheat		11.97			Wheat		12.39			Wheat		12.35		
St. Grd. Fl		10.65			St. Grd. Fl		11.23			St. Grd. Fl		10.88		

Physical Dough Tests

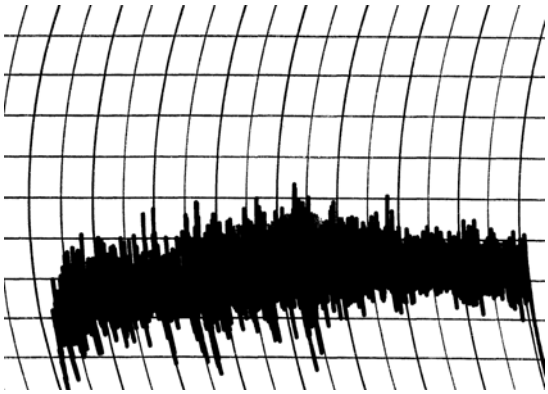
2010 (Small Scale) Samples – Nebraska

Farinograms



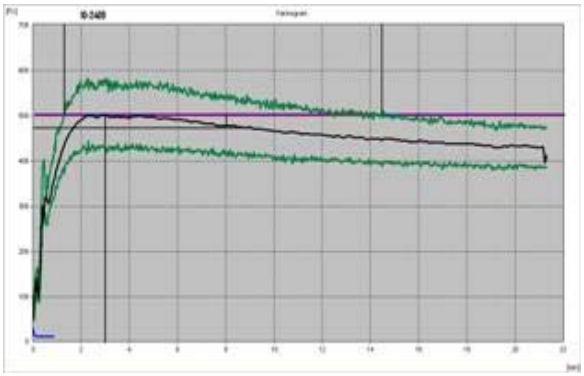
Water abs= 54.8%, Peak time = 4.2 min,
Mix stab = 11.5 min, MTI = 31 FU

Mixograms

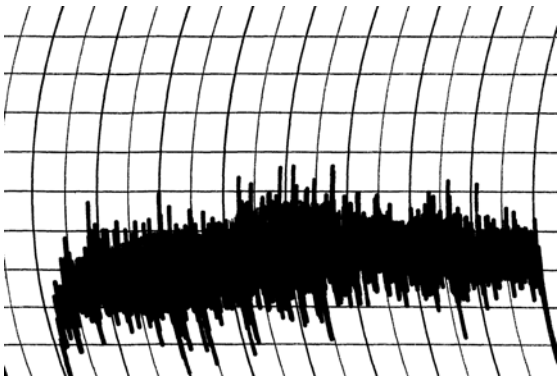


Water abs = 60.7%
Mix time = 4.4 min

10-2408, Millennium (check)



Water abs = 55.0%, Peak time = 3.0 min,
Mix stab = 13.2 min, MTI = 24 FU



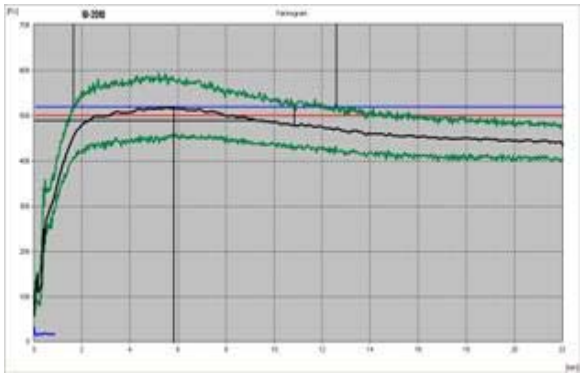
Water abs = 61.7%
Mix time = 4.3 min

10-2409, NE03490

Physical Dough Tests

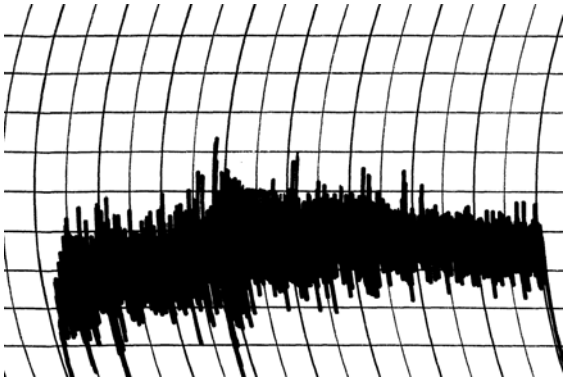
2010 (Small Scale) Samples – Nebraska (continued)

Farinograms



Water abs = 56.2%, Peak time = 5.9 min,
Mix stab = 10.9 min, MTI = 40 FU

Mixograms

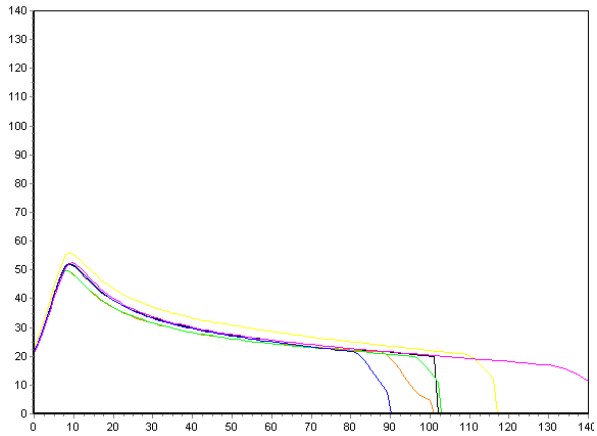


Water abs = 60.1%
Mix time = 3.4 min

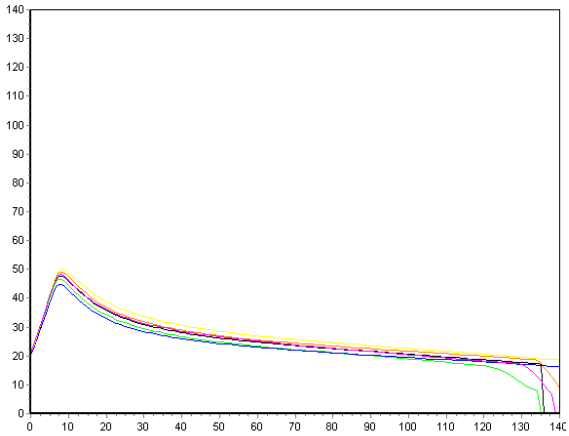
10-2410, NE04490

Physical Dough Tests - Alveograph

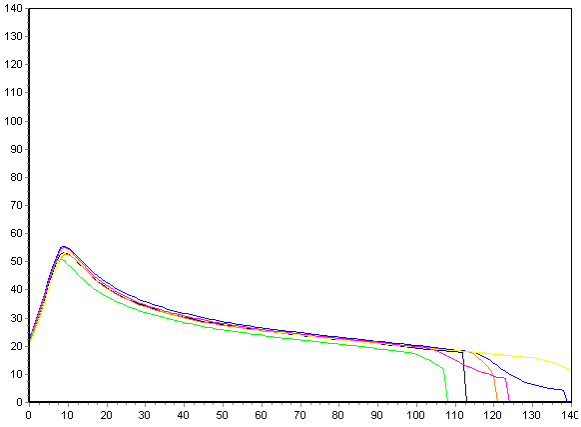
2010 (Small Scale) Samples – Nebraska



10-2408 (Millennium - check)
P (mm H_2O)=57, L(mm) =101, W($10E^{-4}$ J) =197



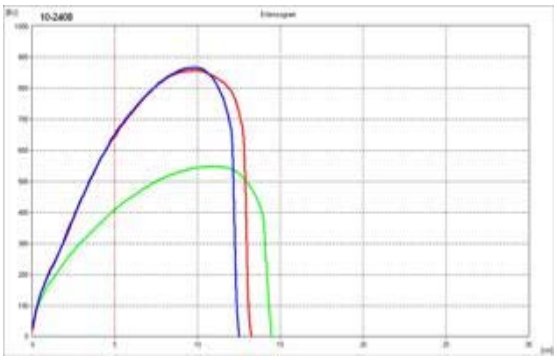
10-2409 (NE03490)
P (mm H_2O)=53, L(mm) =135, W($10E^{-4}$ J) =229



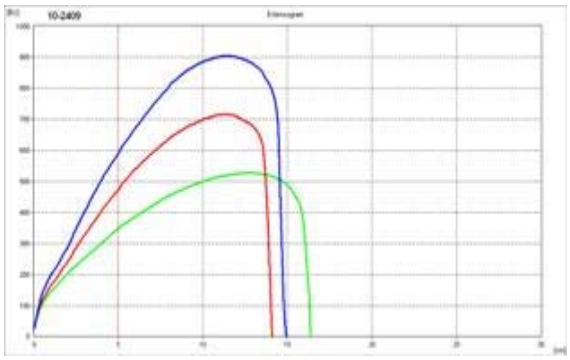
10-2410 (NE04490)
P (mm H_2O)=59, L(mm) =112, W($10E^{-4}$ J) =212

Physical Dough Tests - Extensigraph

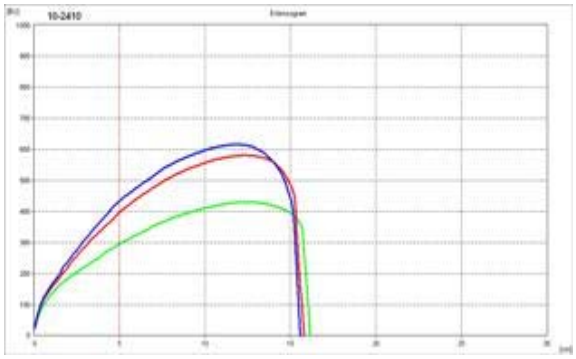
2010 (Small Scale) Samples – Nebraska



10-2408 (Millennium - check)
R (BU) = 659, E (mm) =125.2, W (cm^2) = 135.6
Rmax (BU) = 868, Ratio = 5.3 at 90 min



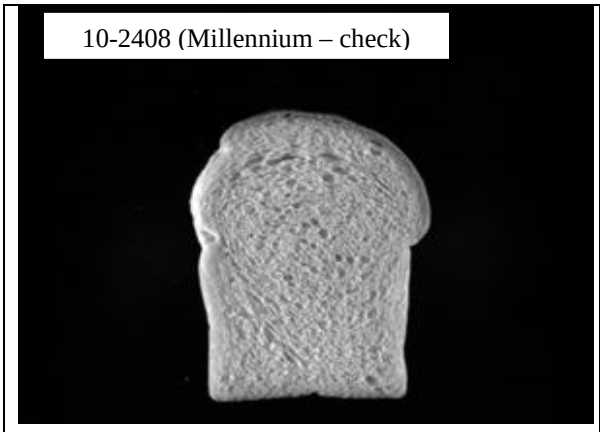
10-2409 (NE03490)
R (BU) = 594, E (mm) =149.4 W (cm^2) = 169.8
Rmax (BU) = 905, Ratio = 4.0 at 90 min

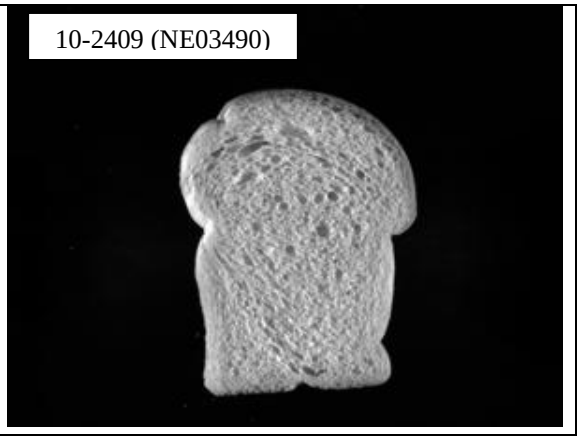


10-2410 (NE04490)
R (BU) = 437, E (mm) =157.1, W (cm^2) = 125.5
Rmax (BU) = 616, Ratio = 2.8 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

Nebraska: C-Cell Bread Images and Analysis for 2010 (Small-Scale) Samples





Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2408	6307	157.0	4217	0.435	1.857	4.499	1.663	-27.55
2409	6365	157.1	4139	0.439	1.897	2.019	1.660	-19.50

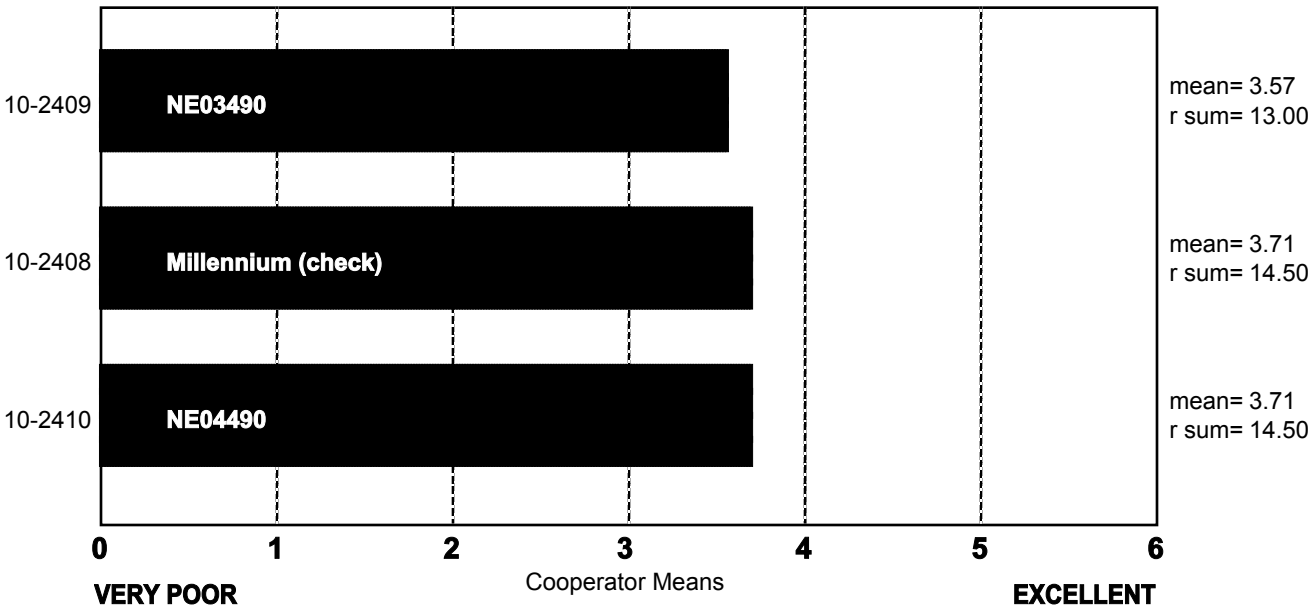
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2410	6140	154.4	4038	0.436	1.865	1.419	1.620	-27.18

SPONGE CHARACTERISTICS

(Small Scale) Nebraska

ncoop= 7
chisq= 0.21
chisqc= 0.33
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

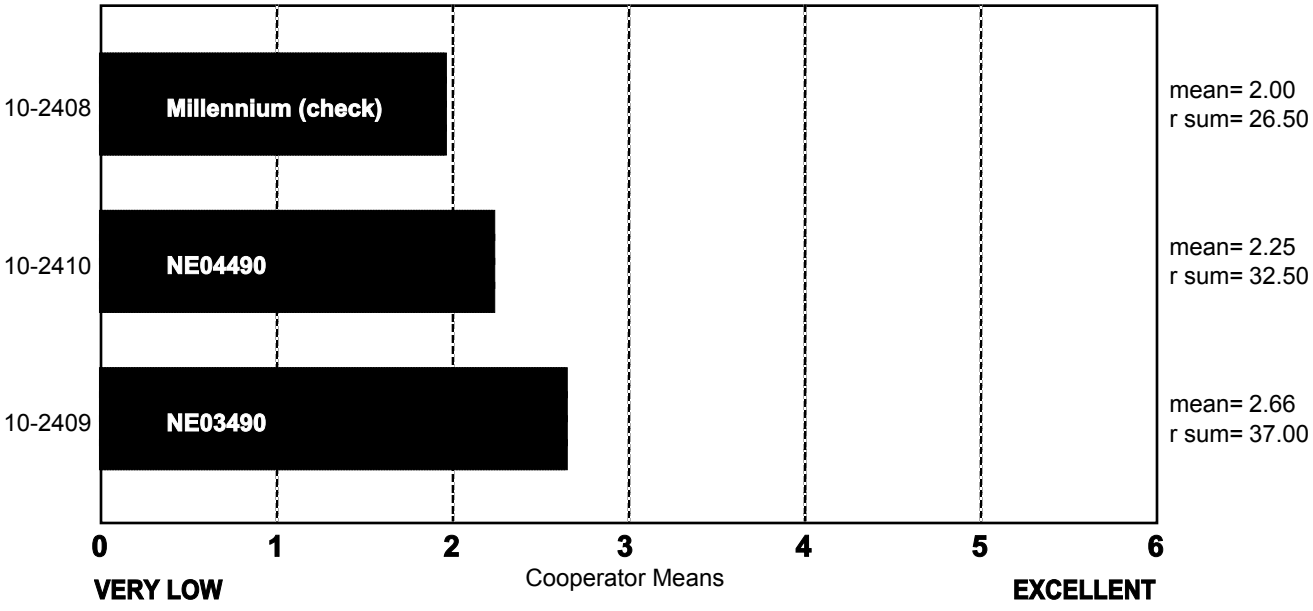


BAKE ABSORPTION

(Small Scale) Nebraska

ncoop= 16
chisq= 3.47
chisqc= 4.93
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Nebraska

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2408 Millennium (check)	**59.5**	**57.0**	**52.0**	**60.7**	**57.8**	**57.0**	**61.0**	**59.4**	**57.0**	**60.0**	**56.0**	**63.1**	**64.4**	**56.8**	**59.0**	**57.0**	**57.8**
10-2409 NE03490	**61.5**	**58.0**	**52.0**	**61.7**	**57.5**	**57.1**	**61.0**	**61.9**	**58.0**	**60.0**	**57.0**	**64.0**	**65.4**	**57.0**	**59.1**	**58.0**	**58.0**
10-2410 NE04490	**60.5**	**57.0**	**53.0**	**60.1**	**57.7**	**58.4**	**62.0**	**60.4**	**58.0**	**60.0**	**57.0**	**62.1**	**63.9**	**58.2**	**60.1**	**57.5**	**59.2**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Nebraska

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2408 Millennium (check)	**4.3**	**9.0**	**7.0**	**5.0**	**1.8**	**3.5**	**5.1**	**4.3**	**25.0**	**6.0**	**4.0**	**4.0**	**4.4**	**6.0**	**5.0**	**14.0**	**7.0**
10-2409 NE03490	**4.3**	**10.0**	**7.0**	**5.0**	**1.5**	**3.0**	**5.1**	**4.6**	**25.0**	**6.0**	**7.0**	**4.0**	**4.3**	**6.0**	**5.5**	**19.0**	**7.0**
10-2410 NE04490	**4.0**	**9.0**	**7.0**	**4.5**	**1.5**	**3.0**	**4.3**	**4.4**	**20.0**	**3.0**	**3.0**	**3.0**	**3.4**	**6.0**	**4.5**	**8.0**	**6.0**

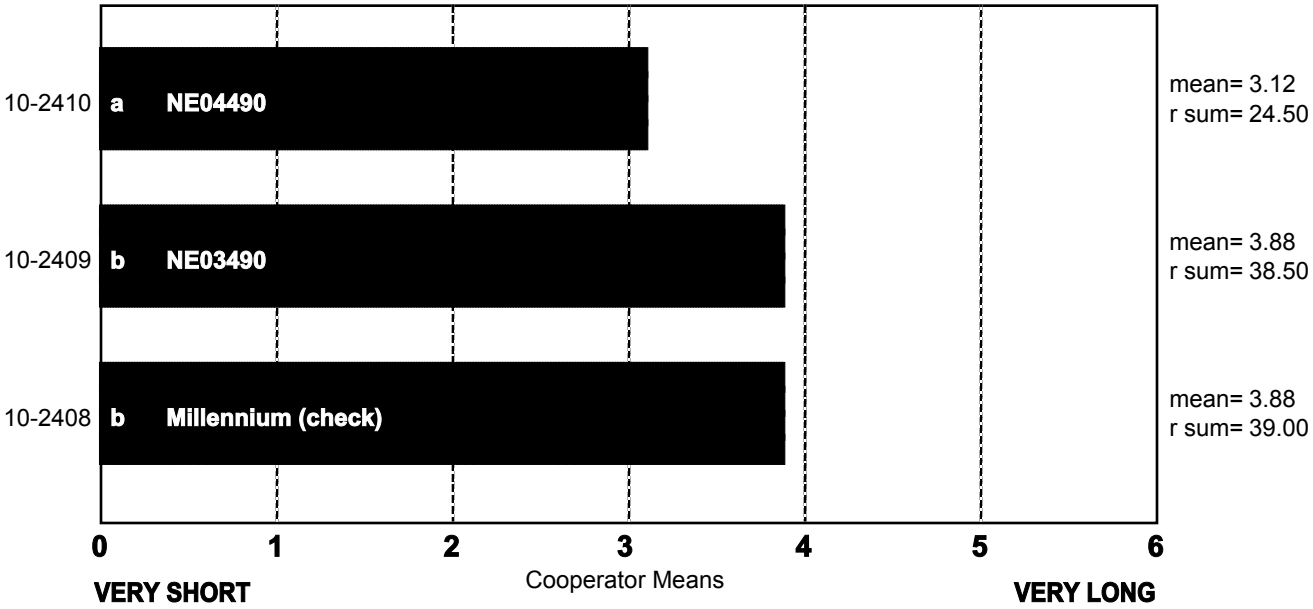
Raw Data

BAKE MIX TIME

(Small Scale) Nebraska

ncoop= 17
chisq= 7.97
chisqc= 16.42
cvchisq= 5.99
crdiff= 6.13

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

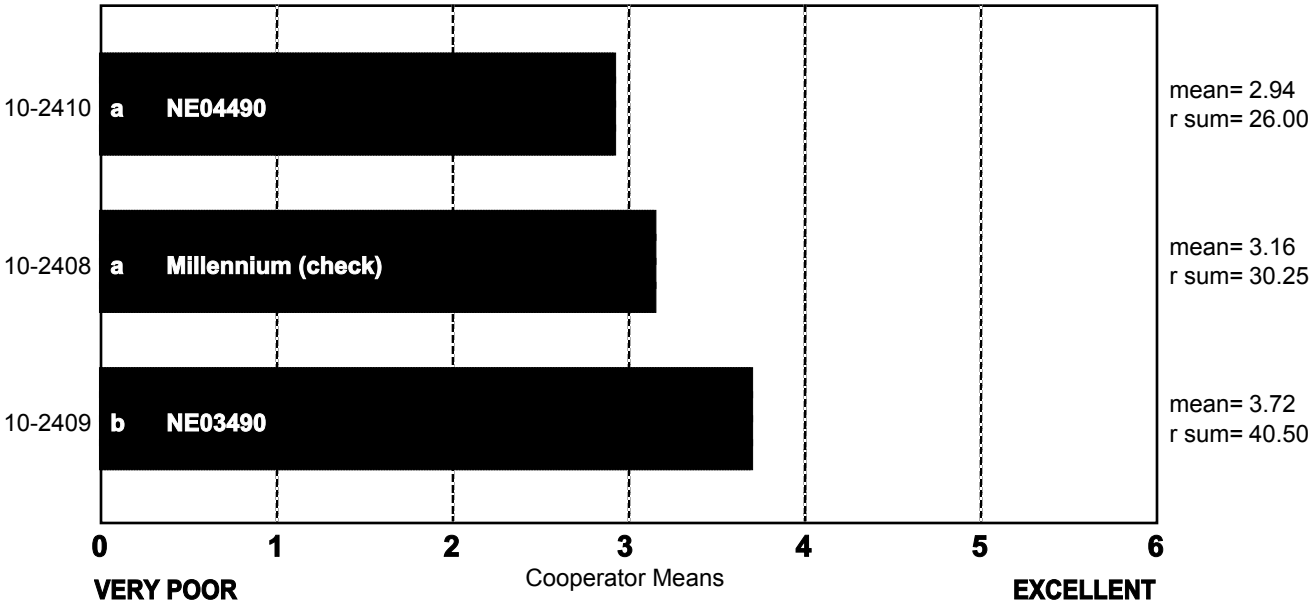


MIXING TOLERANCE

(Small Scale) Nebraska

ncoop= 16
chisq= 9.96
chisqc= 13.89
cvchisq= 5.99
crdiff= 7.63

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

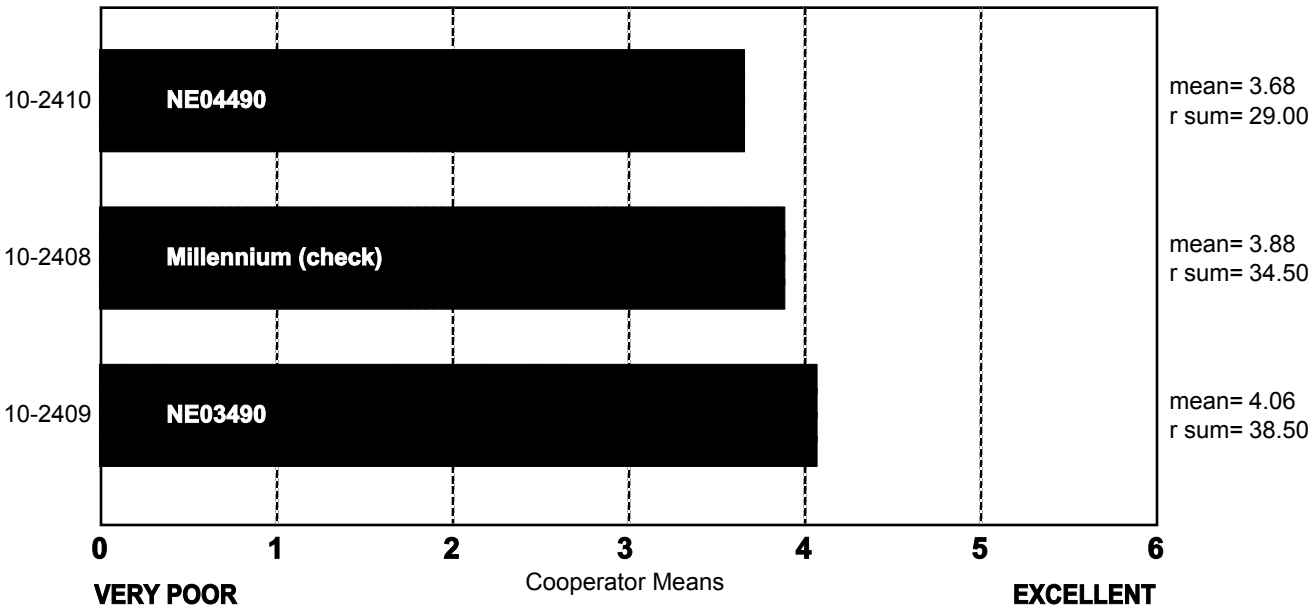


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Nebraska

ncoop= 17
chisq= 2.68
chisqc= 4.92
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
10-2408 Millennium (check)	**2**	**1**	**3**	**8**	**3**
10-2409 NE03490	**2**	**1**	**2**	**10**	**2**
10-2410 NE04490	**1**	**3**	**1**	**11**	**1**

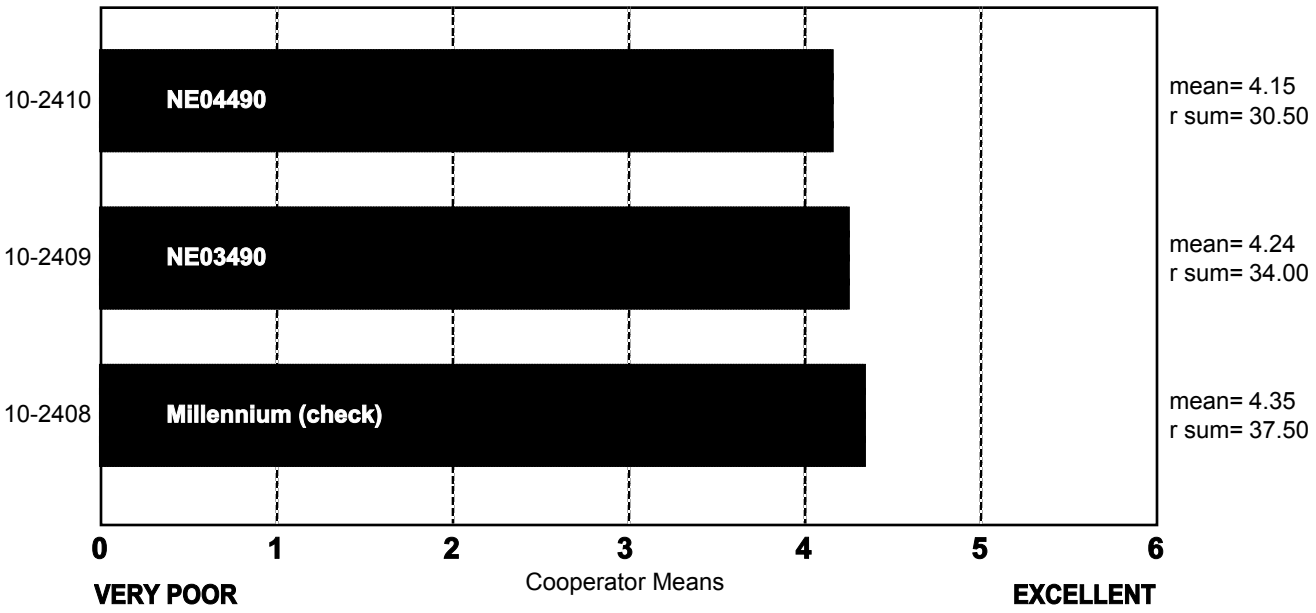
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Nebraska

ncoop= 17
chisq= 1.44
chisqc= 2.45
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
10-2408 Millennium (check)	**0**	**3**	**3**	**8**	**3**
10-2409 NE03490	**1**	**1**	**2**	**10**	**3**
10-2410 NE04490	**1**	**3**	**0**	**12**	**1**

Frequency Table

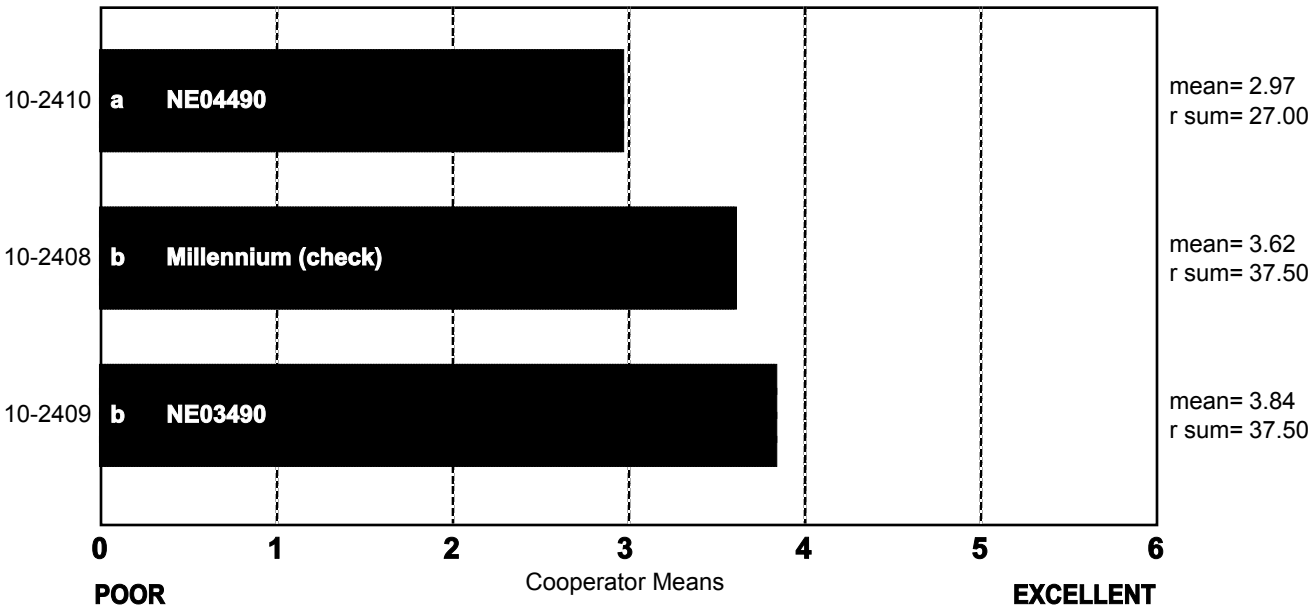
CRUMB GRAIN

(Small Scale) Nebraska

ncoop= 17
chisq= 4.32
chisqc= 7.17
cvchisq= 5.99
crdiff= 8.44

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Nebraska

	Open	Fine	Dense
10-2408 Millennium (check)	**7**	**8**	**2**
10-2409 NE03490	**10**	**6**	**1**
10-2410 NE04490	**9**	**7**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Nebraska

	Round	Irregular	Elongated
10-2408 Millennium (check)	**5**	**6**	**6**
10-2409 NE03490	**7**	**3**	**7**
10-2410 NE04490	**6**	**7**	**4**

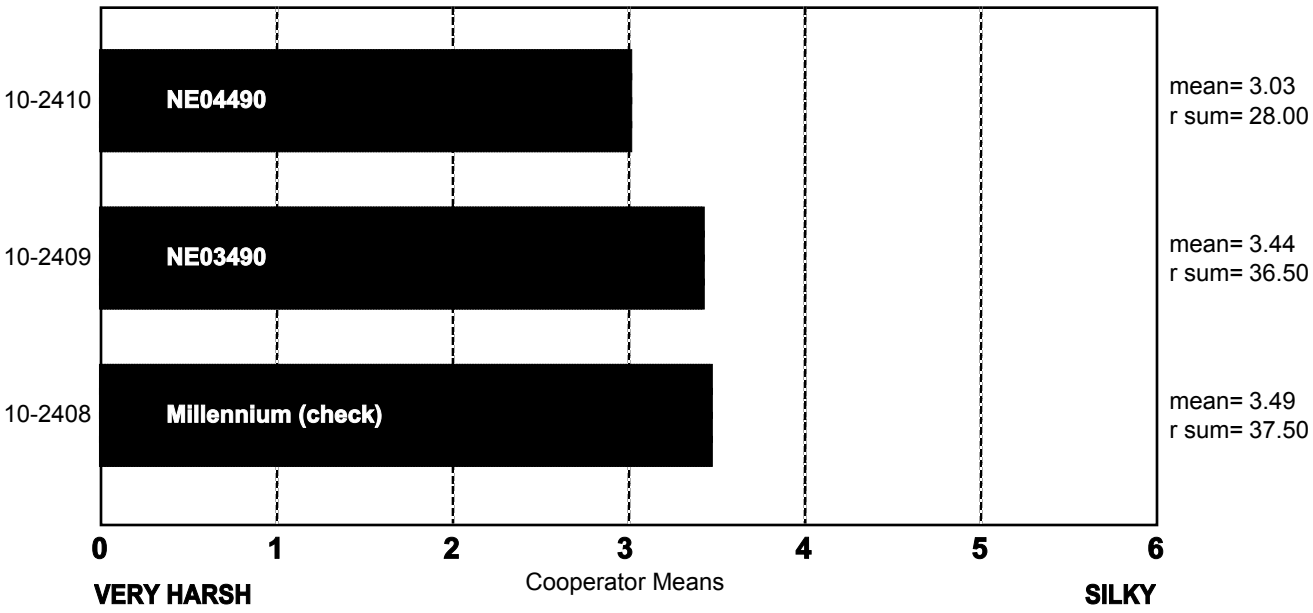
Frequency Table

CRUMB TEXTURE

(Small Scale) Nebraska

ncoop= 17
chisq= 3.21
chisqc= 5.07
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Nebraska

	Harsh	Smooth	Silky
10-2408 Millennium (check)	**7**	**7**	**3**
10-2409 NE03490	**6**	**8**	**3**
10-2410 NE04490	**9**	**6**	**2**

Frequency Table

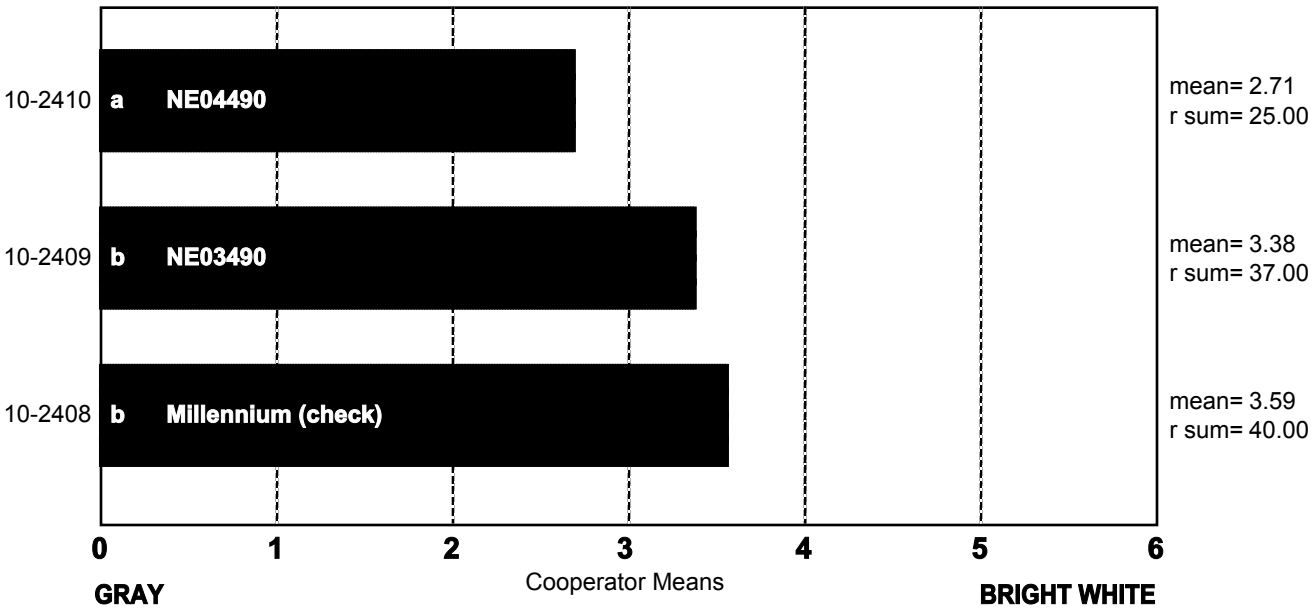
CRUMB COLOR

(Small Scale) Nebraska

ncoop= 17
chisq= 7.41
chisqc= 12.29
cvchisq= 5.99
crdiff= 7.60

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Nebraska

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
10-2408 Millennium (check)	**2**	**0**	**0**	**2**	**10**	**3**	**0**
10-2409 NE03490	**1**	**0**	**0**	**6**	**10**	**0**	**0**
10-2410 NE04490	**1**	**2**	**2**	**5**	**6**	**1**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Nebraska

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2408 Millennium (check)	**142.5**	**418.0**	**500.0**	**156.1**	**128.3**	**127.4**	**143.0**	**156.0**	**484.2**	**134.0**	**469.3**	**138.4**	**139.2**	**461.0**	**148.3**	**460.5**	**453.5**
10-2409 NE03490	**144.7**	**421.0**	**505.0**	**156.8**	**128.4**	**128.1**	**142.2**	**153.5**	**483.9**	**134.0**	**468.6**	**137.4**	**140.6**	**464.0**	**146.4**	**458.4**	**455.1**
10-2410 NE04490	**140.7**	**418.0**	**510.0**	**156.3**	**127.6**	**129.0**	**142.2**	**147.9**	**489.7**	**134.0**	**469.3**	**140.2**	**142.9**	**466.0**	**148.0**	**457.3**	**452.4**

Raw Data

LOAF VOLUME, ACTUAL

(Small Scale) Nebraska

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2408 Millennium (check)	**885**	**2900**	**3000**	**680**	**645**	**955**	**903**	**945**	**2839**	**970**	**2525**	**870**	**865**	**2775**	**860**	**2700**	**2417**
10-2409 NE03490	**915**	**2925**	**2900**	**614**	**650**	**850**	**855**	**993**	**2986**	**971**	**2600**	**903**	**877**	**2850**	**870**	**2725**	**2500**
10-2410 NE04490	**870**	**2900**	**2600**	**587**	**645**	**845**	**900**	**815**	**2691**	**928**	**2500**	**823**	**728**	**2700**	**850**	**2625**	**2520**

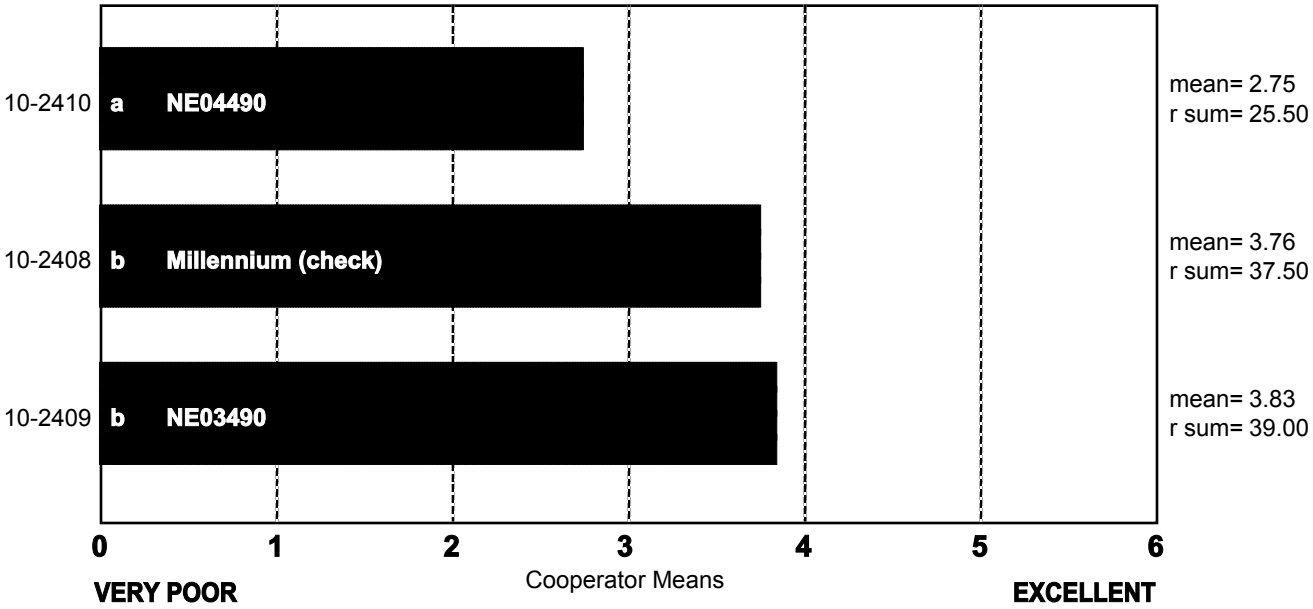
Raw Data

LOAF VOLUME

(Small Scale) Nebraska

ncoop= 17
chisq= 6.44
chisqc= 9.32
cvchisq= 5.99
crdiff= 8.67

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

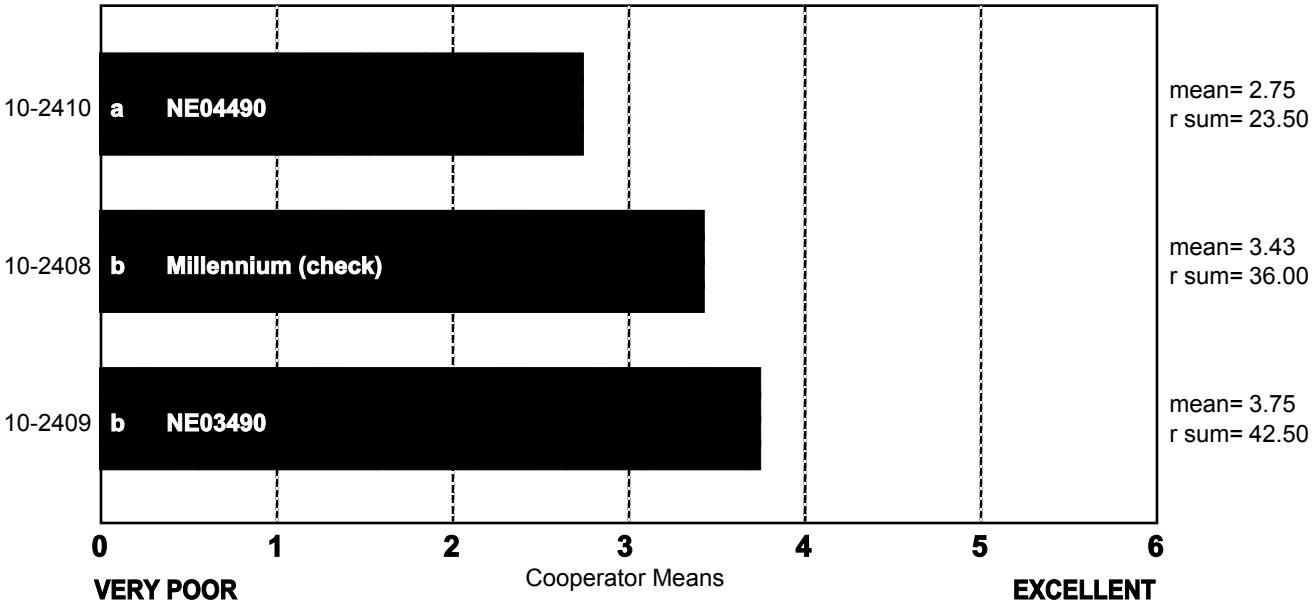


OVERALL BAKING QUALITY

(Small Scale) Nebraska

ncoop= 17
chisq= 10.97
chisqc= 13.81
cvchisq= 5.99
crdiff= 8.41

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS
(Small Scale) Nebraska

COOP. **10-2408** **Millennium (Check)**

A. No comment.

B. Sl. soft out of mixer, good volume, good recovery at make up, short mix, low protein, fine grain.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. sticky dough, very hi OS, fine and elongated cells, sl. yellow crumb, smooth and resilient texture.

H. Interior and dough a little weaker than the last two but still good performance for a lower protein flour.

I. Low absorption, open, irregular grain; coarse texture, sl. low volume.

J. OK bake quality given protein level, but had weak dough handling and open grain.

K. Very low absorption, short mix time, sl. low volume.

L. No comment.

M. No comment.

N. No comment.

O. Excellent dough at mix and pan; good mix time and crumb grain; low absorption and loaf volume.

P. No comment.

Q. Excellent dense grain, good volume.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Nebraska

COOP. **10-2409** **NE03490**

A. No comment.

B. Sl. soft out of mixer, good volume, good recovery at make up, short mix, low protein, fine grain, sl. creamy color.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. sticky dough, hi OS, open and elongated cells, creamy crumb, smooth and resilient texture.

H. No comment.

I. Fairly tight grain, smooth texture, good volume.

J. OK bake quality, had good dough handling but showed poor mix tolerance.

K. Low absorption, tough dough, open grain, average volume.

L. No comment.

M. Dough smears around the bowl, slow pick up.

N. No comment.

O. Rated equal to check Millennium.

P. No comment.

Q. Excellent dense grain, good volume.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Nebraska

COOP. **10-2410** **NE04490**

A. No comment.

B. Sl. soft out of mixer, good volume, shorter mix, nice interior, low protein.

C. No comment.

D. No comment.

E. Low loaf volume, low flour protein.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. sticky dough, hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Weaker crumb and dough protein performance not as good.

I. Open grain, round cell structure, very low volume.

J. Marginal bake quality, poor tolerance, open grain, and weak dough handling.

K. Low absorption, very short mix time, yellow crumb, sl. low volume.

L. No comment.

M. No comment.

N. No comment.

O. Rated lower than Millennium; mellow dough with good mix time.

P. No comment.

Q. Excellent dense grain, good volume.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

Oklahoma State University - Brett Carver

Oklahoma's 2010 WQC grain samples were produced at the same locations as in past years: 1) the Oklahoma Panhandle Research and Extension Center at Goodwell, OK (High Plains region) with limited supplemental irrigation, and 2) the North Central Agronomy Research Station at Lahoma (near Enid, OK) with no supplemental irrigation.

The grow-out at Goodwell produced grain yields in the 70-to-90 bu/ac range, though standard pre-plant fertilization practices were used for an anticipated 100 bu/ac yield level. Wheat protein content averaged 13.3% at Goodwell, slightly below the long-term average at this site, whereas milling quality was about normal with kernel weight and kernel diameter averaging 33 mg and 2.74 mm, respectively.

Grain yields never materialized at Lahoma based on early grain-filling expectations. Average yields at Lahoma fell well short of the soil-fertility target of 50 bu/ac, averaging <30 bu/ac. The poor yields were reflected in poor kernel weight values, averaging about 27 mg. Not surprisingly, wheat protein levels at Lahoma were slightly above-average, or about 13.5%. Speculating, an extremely hot, dry windy period soon after flowering, and stem damage caused by hail, were possible reasons for the reduced yields. All entries included in this evaluation provided effective resistance to the diseases present.

Entries included in the 2010 WQC Oklahoma sample feature a wide range of protein content and kernel size attributes. All three experimental lines appeared in the 2010 SRPN. None are adequately confirmed to have a meaningful level of FHB resistance, although OK05212 may have a 5AS genotype worthy of further field testing. Limited greenhouse testing indicates a MS reaction for OK05212 (data provided by Guihua Bai, USDA-ARS, Manhattan, KS).

Billings (check)

Previously tested in the WQC under the experimental number OK03522, Billings resulted from a single cross of a line developed by the Institute of Plant Breeding in Odessa, Ukraine (N566) and OK94P597, an OSU experimental line derived from a three-way cross (HBY3598/Fundulea 133//TAM 200) performed in the Pioneer hard winter wheat program. Based on 2010 variety testing in Kansas, Oklahoma, and Texas, Billings may have broader adaptation than originally expected. This early maturing HRW variety was licensed to Oklahoma Genetics, Inc. in 2009, the year of foundation seed production. Billings has moderately high protein content, very large kernel size, excellent test weight, good mixing tolerance, and average bake absorption. Agronomic data indicate high top-end yielding ability with effective levels of resistance to diseases that commonly occur in Oklahoma. Billings is tolerant of acidic soils.

OK05526

Previously tested in the 2009 WQC, OK05526 (KS94U275/OK94P549) remains a candidate HRW cultivar, though a purified reselection (OK05526-RHf) is now under foundation seed increase for potential release. Wheat protein content, mixograph performance, and milling properties are almost identical to Billings, but one distinguishing feature is OK05526's lower kernel hardness score. OK05526 has lower stripe rust resistance and acid-soil tolerance than Billings but is otherwise similar in adaptation range and yielding ability.

OK05212

This HRW candidate (OK95616-1/Hickok//Betty) is undergoing a second and final year of foundation seed increase, and if approved for release, will be recommended for all areas of Oklahoma and beyond, including dual-purpose management schemes. Its reproductive developmental pattern is similar to Endurance, but with superior grain yield performance (+10%) in 2009 and 2010 and with improved resistance to leaf spotting diseases, stripe rust, and spindle-streak mosaic virus. Acid soil tolerance is equal or superior to Endurance. OK05212 has the expected kernel size of a later-maturing line (ca. 30 mg kernel weight, 2.50 mm diameter), average protein content (slightly better than Endurance), good mixing tolerance, and average bake properties.

OK07231

OK07231 (OK92P577-RMH3099/OK93P656-RMH3299) is on track for potential release in 2011, pending a successful foundation seed increase, and will be targeted for dual-purpose management schemes in all relevant production zones. It shows effective levels of adult-plant resistance to diseases that commonly occur in Oklahoma, resistance to Hessian fly biotypes common to Oklahoma, and a high level of acid-soil tolerance. Overall, OK07231 has milling characteristics similar to Duster and baking characteristics similar to Billings.

Oklahoma: 2009 (Small-Scale) Samples [a]

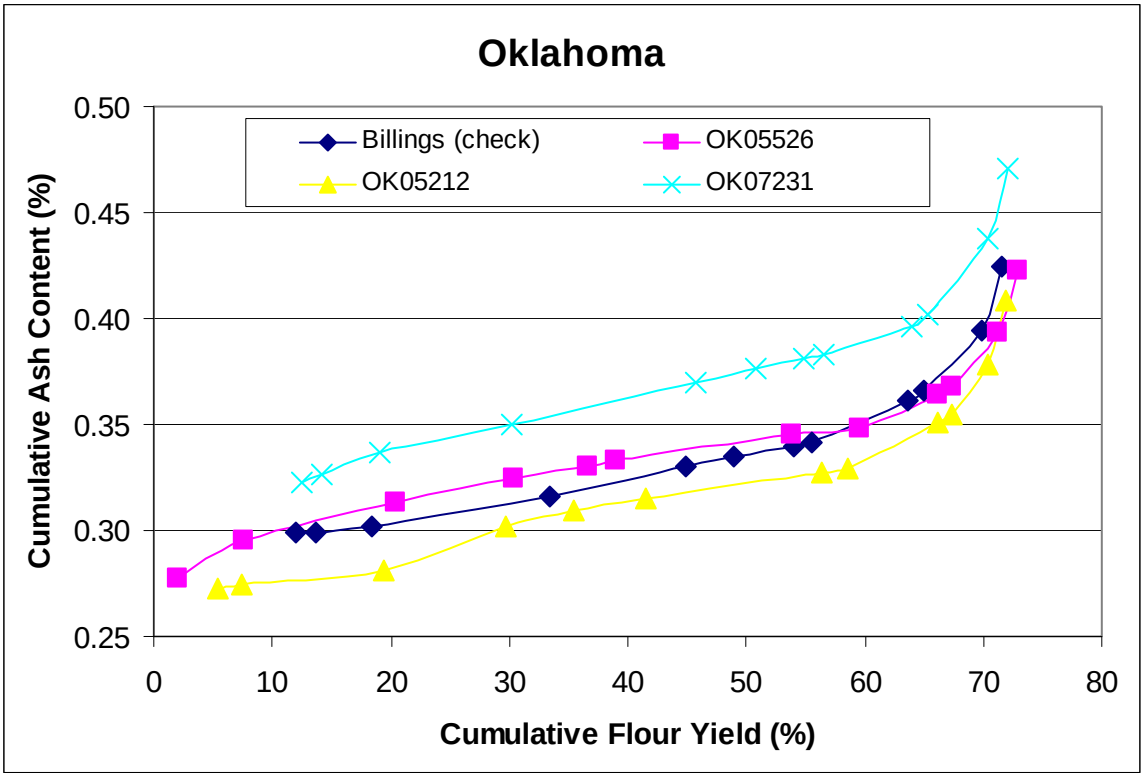
Test entry number	10-2411	10-2412	10-2413	10-2414
Sample identification	**Billings (check)**	**OK05526**	**OK05212**	**OK07231**
Wheat Data				
FGIS classification	1 HRW	2 HRW	1 HRW	2 HRW
Test weight (lb/bu)	60.5	59.9	60.6	58.8
Hectoliter weight (kg/hl)	79.6	78.8	79.7	77.4
1000 kernel weight (gm)	32.7	31.4	30.0	29.9
Wheat kernel size (Rotap)				
Over 7 wire (%)	60.4	71.3	58.5	58.4
Over 9 wire (%)	39.1	28.4	41.2	41.3
Through 9 wire (%)	0.5	0.3	0.3	0.3
Single kernel (skcs)				
Hardness (avg /s.d)	77.1/20.7	64.1/19.5	66.9/21.0	80.1/19.4
Weight (mg) (avg/s.d)	32.7/11.4	31.4/9.7	30.0/7.8	29.9/9.1
Diameter (mm)(avg/s.d)	2.70/0.38	2.70/0.38	2.54/0.30	2.66/0.35
SKCS distribution	02-05-14-79	06-15-18-61	04-13-24-59	01-05-10-84
Classification	Hard	Hard	Hard	Hard
Wheat moisture (%)	10.1	10.2	10.1	10.0
Wheat protein (12% mb)	14.7	14.3	14.3	13.8
Wheat ash (12% mb)	1.68	1.53	1.53	1.59
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	71.6	72.9	72.0	73.0
Quadrumat Sr. Mill	70.1	70.6	70.0	70.3
Flour moisture (%)	10.5	10.4	10.7	10.5
Flour protein (14% mb)	12.8	12.5	13.1	12.4
Flour ash (14% mb)	0.48	0.47	0.45	0.50
Glutomatic				
Wet gluten (%)	35.0	35.1	39.9	33.4
Dry gluten (%)	12.0	12.4	13.5	11.5
Gluten index	97.1	96.3	83.6	98.4
Rapid Visco-Analyser				
Peak time (min)	6.3	6.3	6.3	6.3
Peak viscosity (RVU)	197.8	250.4	226.4	205.4
Breakdown (RVU)	53.7	80.8	72.9	59.6
Final viscosity at 13 min (RVU)	265.9	302.4	271.0	265.1
Minolta color meter				
L*	91.5	92.0	92.1	91.8
a*	-1.24	-1.35	-1.26	-1.46
b*	9.09	8.93	8.54	10.0
Falling number (sec)	525	504	541	534
Damaged Starch				
(AI%)	95.88	94.95	95.08	96.43
(AACC76-31)	6.18	5.49	5.58	6.61

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Oklahoma: Physical Dough Tests and Gluten Analysis For 2010 (Small-Scale) Samples

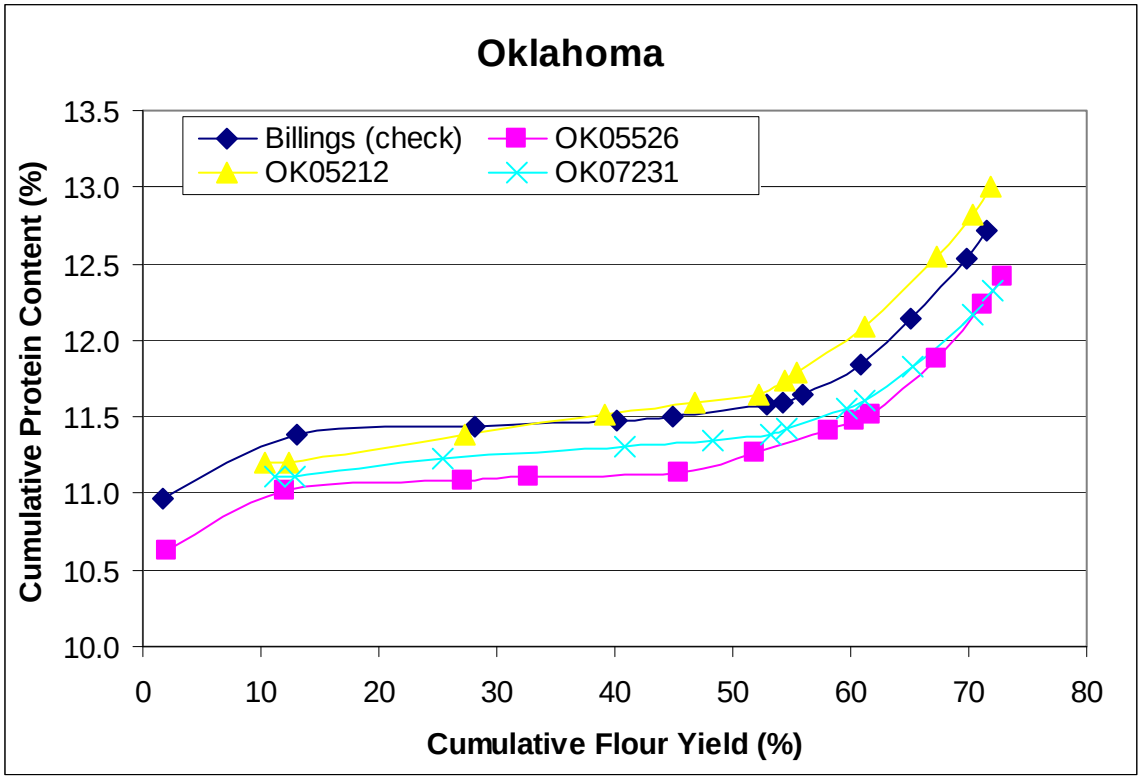
Test Entry Number	10-2411	10-2412	10-2413	10-2414
Sample Identification	Billings (check)	OK05526	OK05212	OK07231
MIXOGRAPH				
Flour Abs (% as-is)	68.1	67.9	68.5	67.5
Flour Abs (14% mb)	64.2	63.9	64.8	63.6
Mix Time (min)	4.50	4.00	2.13	4.50
Mix tolerance (0-6)	4	4	4	4
FARINOGRAPH				
Flour Abs (% as-is)	65.7	63.1	65.5	63.8
Flour Abs (14% mb)	61.8	59.1	61.8	59.9
Development time (min)	5.8	7.8	6.5	6.7
Mix stability (min)	20.0	21.7	13.2	21.5
Mix Tolerance Index (FU)	17	22	34	17
Breakdown time (min)	14.4	18.0	11.1	16.0
ALVEOGRAPH				
P(mm. $_{H2O}$): Tenacity	113	80	88	95
L(mm): Extensibility	104	111	110	101
G($mm_{0.5}$): Swelling index	22.7	23.5	23.3	22.4
W(10^{-4} J): strength (curve area)	416	320	321	360
P/L: curve configuration ratio	1.09	0.72	0.80	0.94
Ie(P_{200}/P): elasticity index	63	64.2	59.6	65.4
EXTENSIGRAPH				
Resist (BU at 30/60/90 min)	473/853/909	456/649/748	314/364/368	479/756/842
Extensibility (mm at 30/60/90 min)	142/131/118	164/155/144	183/185/191	144/144/135
Energy (cm^2 at 30/60/90 min)	120/176/157	144/194/191	117/130/142	127/192/178
Resist $_{max}$ (BU at 30/60/90 min)	663/998/997	694/1000/994	478/516/546	714/997/999
Ratio (at 30/60/90 min)	3.3/6.5/7.7	2.8/4.2/5.2	1.7/1.9/1.9	3.3/5.2/6.2
PROTEIN ANALYSIS				
HMW-GS Composition	1, 7+9, 5+10	2*, 7+9, 2+12	2*, 7+9, 2+12	2*, 7+8, 5+10
Glu/Gli	0.80	0.80	0.79	0.78
HMW/LMW	0.32	0.44	0.39	0.45
%IPP	47.68	48.14	44.81	47.31
SEDIMENTATION TEST				
Volume (ml)	61.3	60.9	53.1	48.5

Oklahoma: Cumulative Ash Curves



Billings (check) - 2411					OK05526 - 2412					OK05212 - 2413					OK07231 - 2414				
Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash
2M	11.95	0.30	11.95	0.30	1M Red	2.02	0.28	2.02	0.28	1M	5.37	0.27	5.37	0.27	2M	12.41	0.32	12.41	0.32
1M Red	1.74	0.30	13.68	0.30	1M	5.64	0.30	7.66	0.29	1M Red	2.02	0.28	7.39	0.27	1M Red	1.81	0.35	14.23	0.33
1M	4.75	0.31	18.43	0.30	2M	12.69	0.32	20.35	0.31	2M	11.94	0.29	19.33	0.28	1M	4.91	0.37	19.13	0.34
3M	15.06	0.33	33.49	0.32	4M	10.07	0.35	30.42	0.32	4M	10.41	0.34	29.75	0.30	4M	11.13	0.37	30.27	0.35
4M	11.36	0.37	44.85	0.33	1BK	6.29	0.36	36.71	0.33	1BK	5.70	0.35	35.45	0.31	3M	15.48	0.41	45.74	0.37
2BK	4.12	0.38	48.97	0.33	Grader	2.25	0.37	38.96	0.33	2BK	6.10	0.35	41.55	0.32	1BK	5.12	0.44	50.87	0.38
1BK	5.03	0.38	54.00	0.34	3M	14.95	0.38	53.91	0.35	3M	14.81	0.36	56.35	0.33	2BK	4.01	0.44	54.87	0.38
Grader	1.61	0.41	55.61	0.34	2BK	5.70	0.38	59.61	0.35	Grader	2.23	0.37	58.58	0.33	Grader	1.59	0.46	56.46	0.38
5M	8.00	0.50	63.61	0.36	5M	6.48	0.50	66.09	0.36	5M	7.62	0.52	66.21	0.35	5M	7.42	0.49	63.88	0.40
FILTER FLR	1.43	0.56	65.05	0.37	FILTER FLR	1.23	0.57	67.32	0.37	FILTER FLR	1.10	0.56	67.30	0.35	FILTER FLR	1.39	0.66	65.28	0.40
3BK	4.80	0.77	69.84	0.39	3BK	3.90	0.84	71.22	0.39	3BK	3.08	0.90	70.38	0.38	3BK	5.14	0.90	70.42	0.44
BRAN FLR	1.67	1.70	71.52	0.42	BRAN FLR	1.65	1.67	72.88	0.42	BRAN FLR	1.56	1.76	71.94	0.41	BRAN FLR	1.65	1.86	72.06	0.47
Break Shorts	4.42	3.68	75.94	0.61	Break Shorts	3.91	3.88	76.79	0.60	Break Shorts	4.58	3.18	76.52	0.57	Break Shorts	4.32	3.66	76.38	0.65
Red Dog	1.59	3.09	77.53	0.66	Red Dog	1.43	2.96	78.22	0.64	Red Dog	1.43	2.97	77.94	0.62	Red Dog	1.74	3.10	78.13	0.71
Red Shorts	0.17	3.71	77.70	0.67	Red Shorts	0.15	3.82	78.36	0.65	Red Shorts	0.15	3.80	78.09	0.62	Red Shorts	0.16	2.64	78.28	0.71
Filter Bran	0.82	3.08	78.51	0.70	Filter Bran	0.63	2.42	78.99	0.66	Filter Bran	0.63	2.22	78.72	0.64	Filter Bran	0.77	2.60	79.05	0.73
Bran	21.49	5.01	100.00	1.62	Bran	21.01	5.17	100.00	1.61	Bran	21.28	5.22	100.00	1.61	Bran	20.95	4.75	100.00	1.57
Wheat		1.64			Wheat		1.49			Wheat		1.50			Wheat		1.56		
St. Grd. Fl.		0.48			St. Grd. Fl.		0.47			St. Grd. Fl.		0.45			St. Grd. Fl.		0.50		

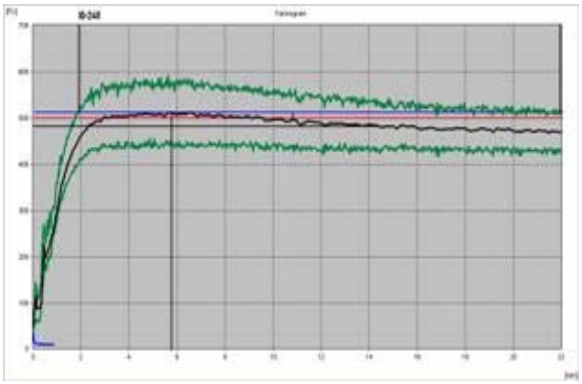
Oklahoma: Cumulative Protein Curves



	Billings (check) - 2411					OK05526 - 2412					OK05212 - 2413					OK07231 - 2414				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1M Red	1.74	10.97	1.74	10.97	1M Red	2.02	10.62	2.02	10.62	4M	10.41	11.20	10.41	11.20	4M	11.13	11.11	11.13	11.11
4M	11.36	11.45	13.10	11.39	4M	10.07	11.10	12.10	11.02	1M Red	2.02	11.25	12.44	11.21	1M Red	1.81	11.11	12.95	11.11
3M	15.06	11.49	28.16	11.44	3M	14.95	11.14	27.05	11.09	3M	14.81	11.54	27.24	11.39	2M	12.41	11.36	25.36	11.23
2M	11.95	11.54	40.10	11.47	1M	5.64	11.17	32.69	11.10	2M	11.94	11.80	39.19	11.52	3M	15.48	11.44	40.84	11.31
1M	4.75	11.81	44.85	11.51	2M	12.69	11.22	45.37	11.14	5M	7.62	11.97	46.81	11.59	5M	7.42	11.58	48.26	11.35
5M	8.00	11.97	52.86	11.58	5M	6.48	12.17	51.85	11.26	1M	5.37	12.12	52.18	11.64	1M	4.91	11.68	53.16	11.38
FILTER FLR	1.43	12.32	54.29	11.60	1BK	6.29	12.65	58.14	11.41	Grader	2.23	13.96	54.41	11.74	FILTER FLR	1.39	13.01	54.56	11.42
Grader	1.61	13.46	55.90	11.65	Grader	2.25	12.93	60.39	11.47	FILTER FLR	1.10	14.43	55.50	11.79	1BK	5.12	13.03	59.68	11.56
1BK	5.03	13.96	60.92	11.84	FILTER FLR	1.23	13.64	61.62	11.51	1BK	5.70	14.92	61.21	12.08	Grader	1.59	13.13	61.27	11.60
2BK	4.12	16.58	65.05	12.14	2BK	5.70	15.80	67.32	11.88	2BK	6.10	17.24	67.30	12.55	2BK	4.01	15.33	65.28	11.83
3BK	4.80	17.91	69.84	12.54	3BK	3.90	18.45	71.22	12.24	3BK	3.08	18.86	70.38	12.83	3BK	5.14	16.53	70.42	12.17
BRAN FLR	1.67	20.47	71.52	12.72	BRAN FLR	1.65	20.04	72.88	12.41	BRAN FLR	1.56	20.87	71.94	13.00	BRAN FLR	1.65	18.98	72.06	12.33
Break Shorts	4.42	15.91	75.94	12.91	Break Shorts	3.91	16.84	76.79	12.64	Break Shorts	4.58	14.54	76.52	13.09	Break Shorts	4.32	15.34	76.38	12.50
Red Dog	1.59	15.07	77.53	12.95	Red Dog	1.43	15.16	78.22	12.69	Red Dog	1.43	14.34	77.94	13.12	Red Dog	1.74	14.57	78.13	12.55
Red Shorts	0.17	15.31	77.70	12.96	Red Shorts	0.15	15.44	78.36	12.69	Red Shorts	0.15	14.40	78.09	13.12	Red Shorts	0.16	14.15	78.28	12.55
Filter Bran	0.82	14.08	78.51	12.97	Filter Bran	0.63	12.91	78.99	12.69	Filter Bran	0.63	13.59	78.72	13.12	Filter Bran	0.77	13.33	79.05	12.56
Bran	21.49	18.98	100.00	14.26	Bran	21.01	19.05	100.00	14.03	Bran	21.28	17.31	100.00	14.01	Bran	20.95	17.62	100.00	13.62
Wheat		14.34			Wheat		13.93			Wheat		13.99			Wheat		13.48		
St. Grd. Fl		12.78			St. Grd. Fl		12.52			St. Grd. Fl		13.10			St. Grd. Fl		12.41		

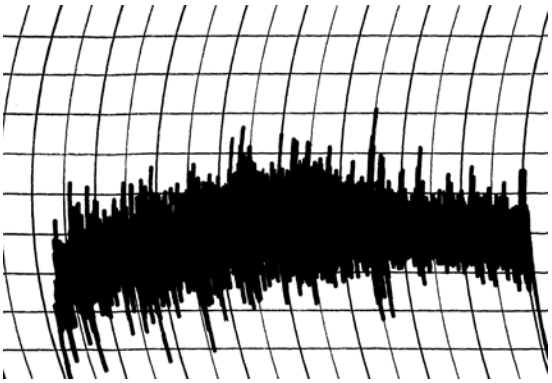
Physical Dough Tests
2010 (Small Scale) Samples - Oklahoma

Farinograms



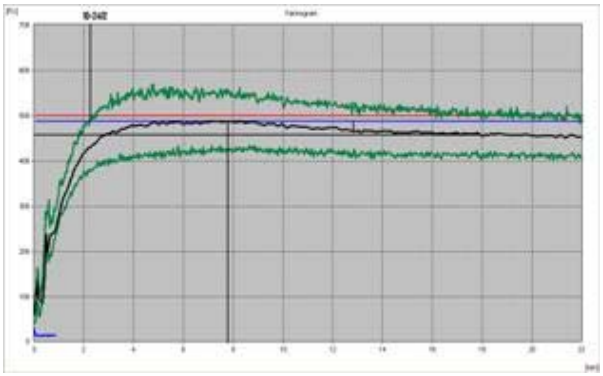
Water abs = 61.8%, Peak time = 5.8 min,
Mix stab = 20.0 min, MTI = 17 FU

Mixograms

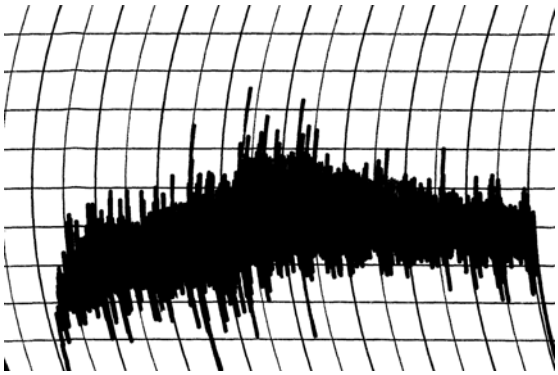


Water abs = 64.2%
Mix time = 4.5 min

10-2411, Billings (check)



Water abs = 59.1%, Peak time = 7.8 min,
Mix stab = 21.7 min, MTI = 22 FU



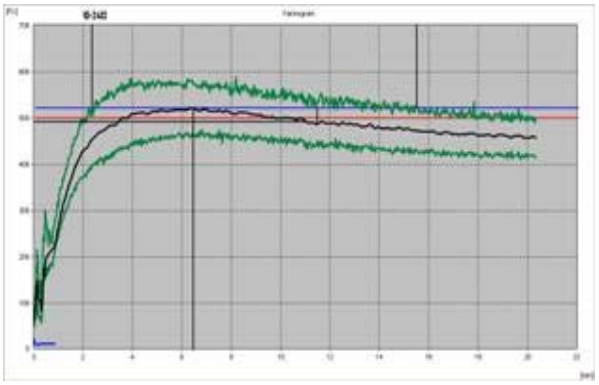
Water abs = 63.9%
Mix time = 4.0 min

10-2412, OK05526

Physical Dough Tests

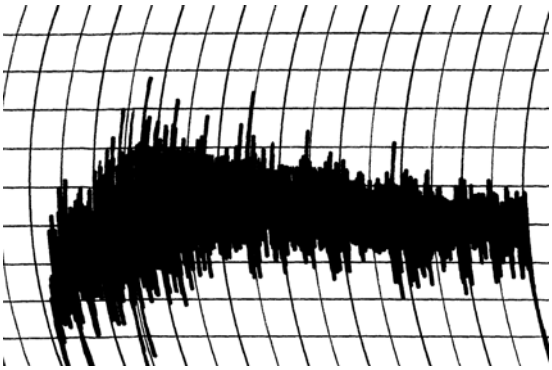
2009 (Small Scale) Samples - Oklahoma (continued)

Farinograms



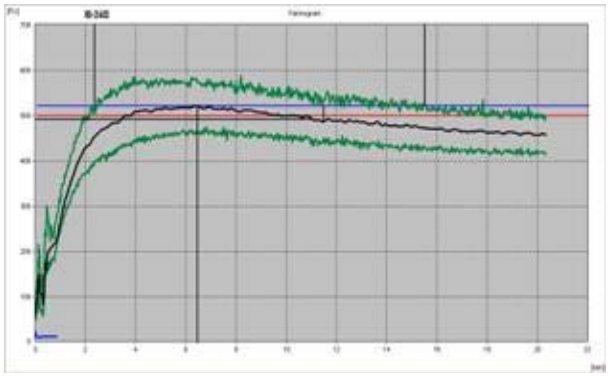
Water abs= 61.8%, Peak time = 6.5 min,
Mix stab = 13.2 min, MTI = 34 FU

Mixograms

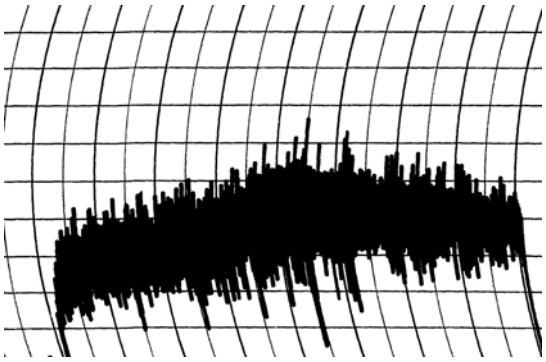


Water abs = 64.8%
Mix time = 2.1 min

10-2413, OK05212



Water abs= 59.9%, Peak time = 6.7 min,
Mix stab = 21.5 min, MTI = 17 FU

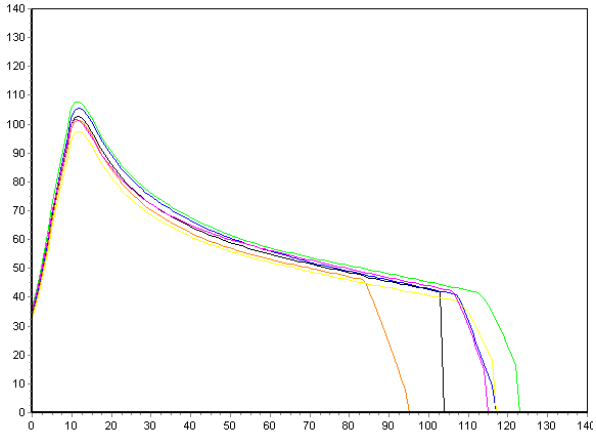


Water abs = 63.6%
Mix time = 4.5 min

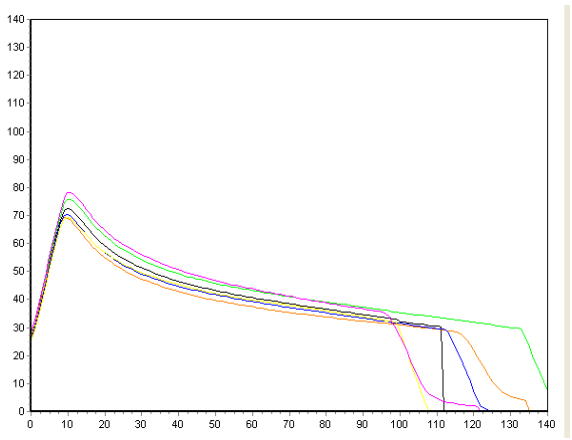
10-2414, OK07231

Physical Dough Tests - Alveograph

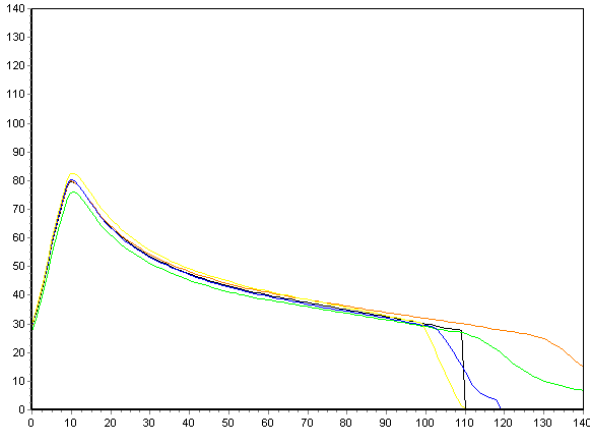
2010 (Small Scale) Samples – Oklahoma



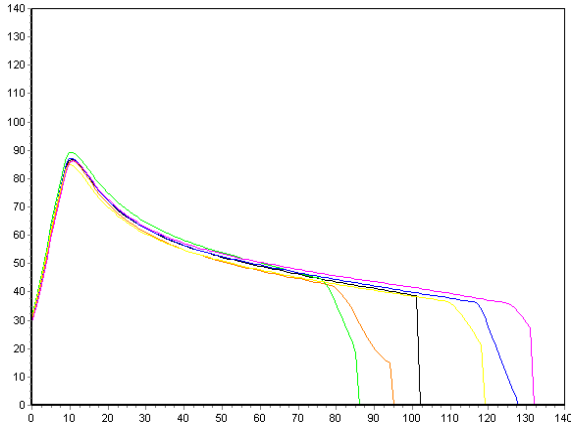
10-24011 (Billings - check)
P(mm H_20)=113, L(mm)=104, W($10E^{-4}$ J)=416



10-2412 (OK05526)
P(mm H_20)=80, L(mm)=111, W($10E^{-4}$ J)=320



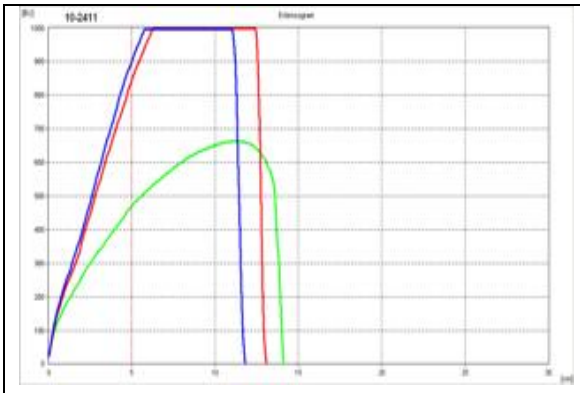
10-2413 (OK05212)
P(mm H_20)=88, L(mm)=110, W($10E^{-4}$ J)=321



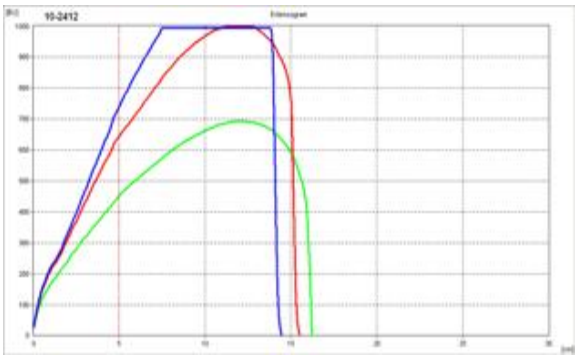
10-2414 (OK07231)
P(mm H_20)=95, L(mm)=101, W($10E^{-4}$ J)=360

Physical Dough Tests - Extensigraph

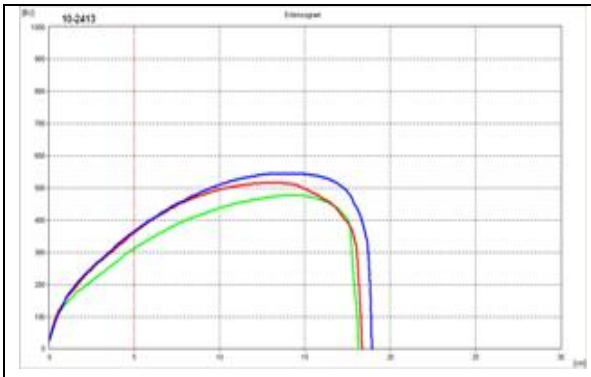
2010 (Small Scale) Samples – Oklahoma



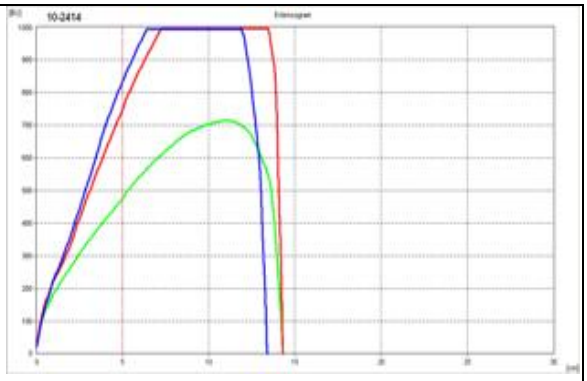
10-2411 (Billings - check)
R (BU) = 909, E (mm) =118, W (cm^2) = 157
Rmax (BU) = 997, Ratio = 7.7 at 90 min



10-2412 (OK05526)
R (BU) = 748, E (mm) =144, W (cm^2) = 191
Rmax (BU) = 994, Ratio = 5.2 at 90 min



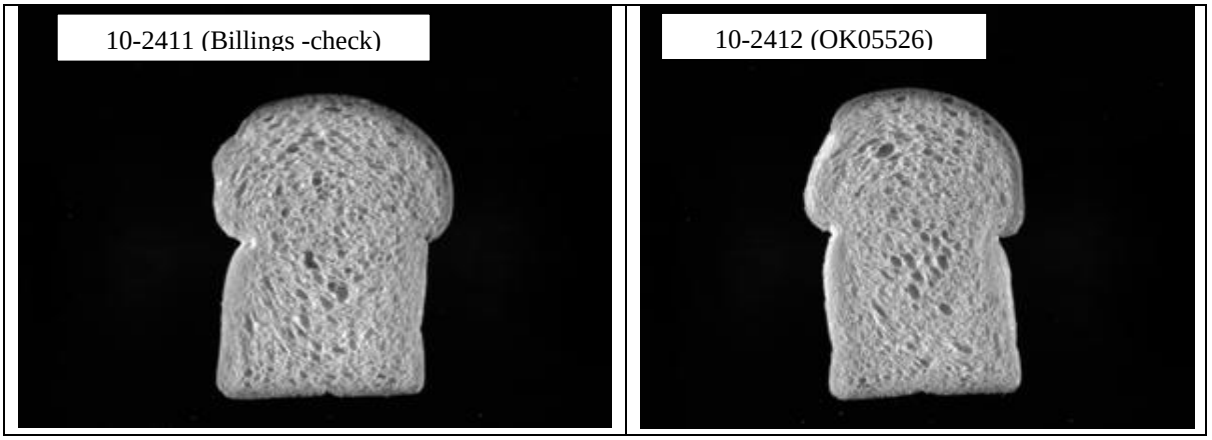
10-2413 (OK05212)
R (BU) = 368, E (mm) =191, W (cm^2) = 142
Rmax (BU) = 546, Ratio = 1.9 at 90 min



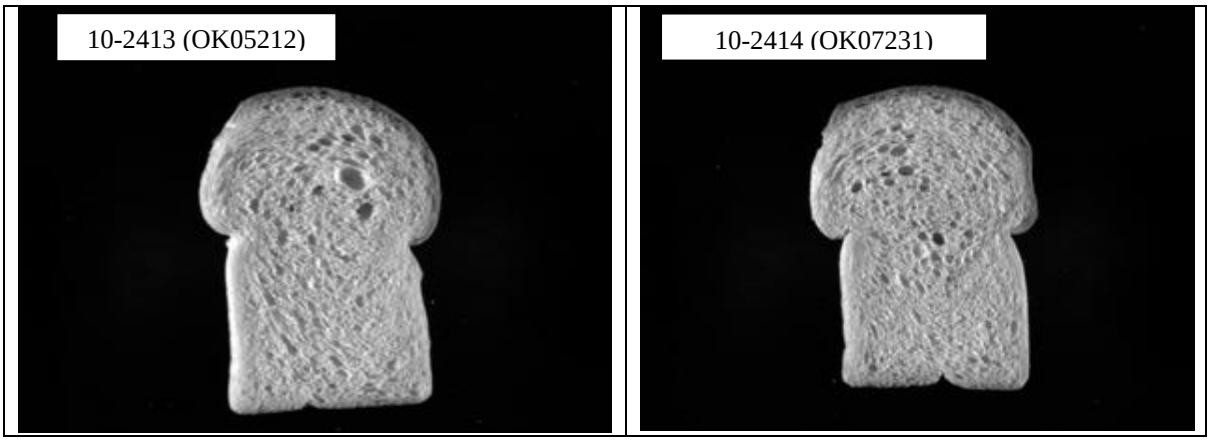
10-2414 (OK07231)
R (BU) = 842, E (mm) =135, W (cm^2) = 178
Rmax (BU) = 999, Ratio = 6.2 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

Oklahoma: C-Cell Bread Images and Analysis for 2010 (Small-Scale) Samples



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2411	6316	154.5	3977	0.441	1.970	1.185	1.700	-13.60
2412	6351	155.9	4022	0.439	1.966	1.645	1.640	-20.20



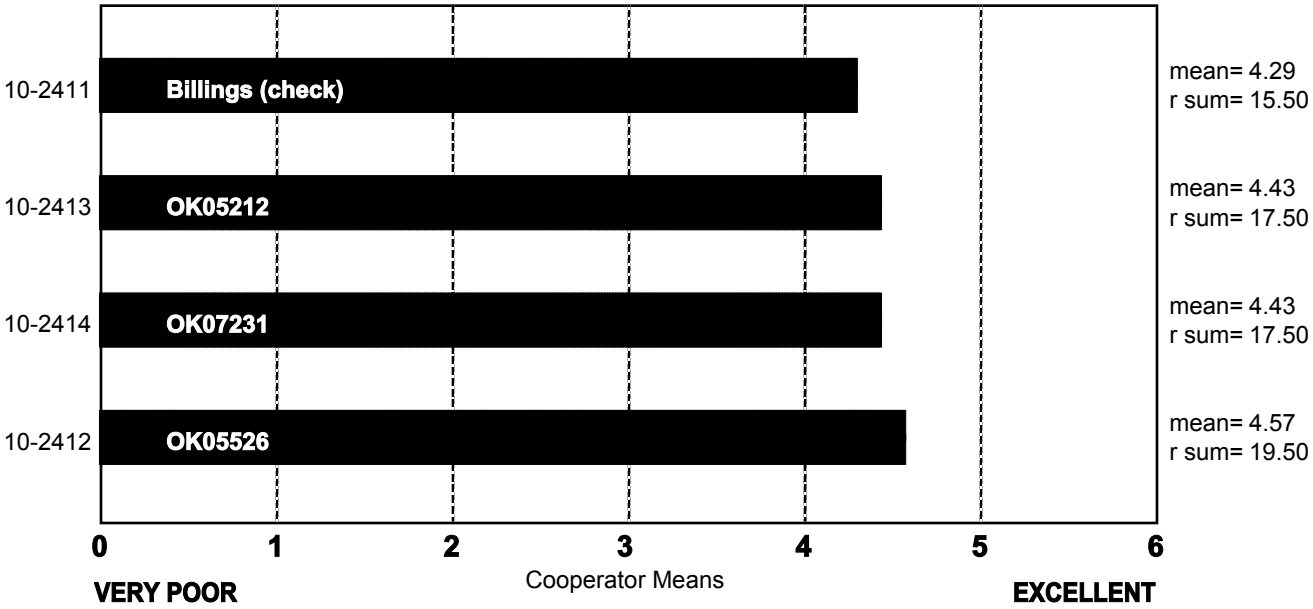
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2413	6649	160.0	4071	0.449	2.111	2.345	1.653	-20.45
2414	6408	153.8	4042	0.442	1.952	4.898	1.695	-25.10

SPONGE CHARACTERISTICS

(Small Scale) Oklahoma

ncoop= 7
chisq= 0.69
chisqc= 1.50
cvchisq= 7.82
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

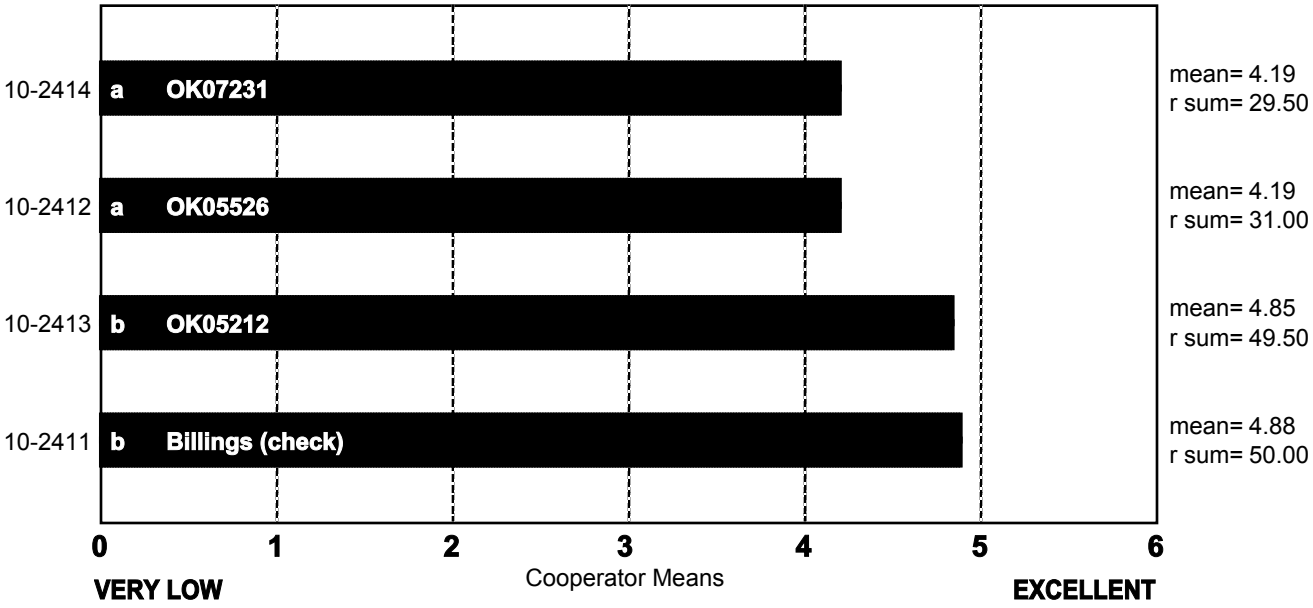


BAKE ABSORPTION

(Small Scale) Oklahoma

ncoop= 16
chisq= 14.31
chisqc= 24.09
cvchisq= 7.82
crdiff= 8.26

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2411 Billings (check)	**64.2**	**59.0**	**59.0**	**64.2**	**62.3**	**64.2**	**64.0**	**65.6**	**61.0**	**63.0**	**63.0**	**66.1**	**68.2**	**63.8**	**62.8**	**62.0**	**64.8**
10-2412 OK05526	**64.3**	**59.0**	**56.0**	**63.9**	**60.1**	**61.6**	**62.5**	**64.5**	**60.0**	**63.0**	**61.0**	**66.1**	**67.7**	**65.9**	**63.6**	**60.5**	**62.1**
10-2413 OK05212	**64.7**	**60.0**	**59.0**	**64.8**	**60.8**	**64.0**	**65.0**	**65.4**	**61.0**	**64.0**	**63.0**	**67.1**	**68.5**	**66.8**	**64.0**	**61.0**	**64.8**
10-2414 OK07231	**63.4**	**59.0**	**57.0**	**63.6**	**61.6**	**62.3**	**62.5**	**65.1**	**60.0**	**63.0**	**61.0**	**66.1**	**67.6**	**65.6**	**63.3**	**60.0**	**62.9**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2411 Billings (check)	**4.5**	**20.0**	**7.0**	**5.5**	**1.5**	**3.3**	**5.9**	**4.3**	**25.0**	**9.0**	**7.0**	**4.0**	**4.5**	**7.5**	**5.9**	**29.0**	**9.0**
10-2412 OK05526	**4.3**	**20.0**	**7.0**	**5.0**	**1.5**	**3.3**	**4.2**	**4.4**	**25.0**	**6.0**	**8.0**	**3.8**	**4.0**	**7.0**	**5.5**	**24.0**	**10.0**
10-2413 OK05212	**3.0**	**11.0**	**7.0**	**4.0**	**1.3**	**2.5**	**3.4**	**3.6**	**25.0**	**6.0**	**6.0**	**2.3**	**2.1**	**6.0**	**3.5**	**16.0**	**6.0**
10-2414 OK07231	**4.8**	**20.0**	**7.0**	**5.5**	**2.0**	**3.8**	**5.8**	**4.9**	**25.0**	**6.0**	**7.0**	**4.0**	**4.5**	**6.5**	**6.4**	**28.0**	**8.0**

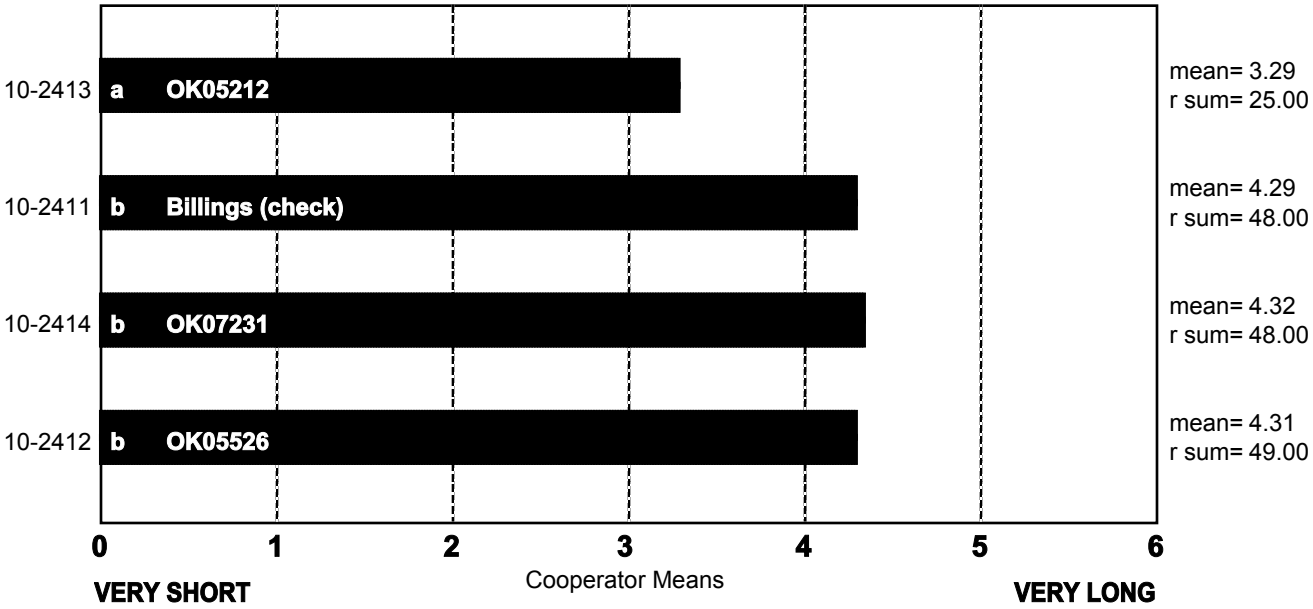
Raw Data

BAKE MIX TIME

(Small Scale) Oklahoma

ncoop= 17
chisq= 14.44
chisqc= 25.56
cvchisq= 7.82
crdiff= 8.28

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

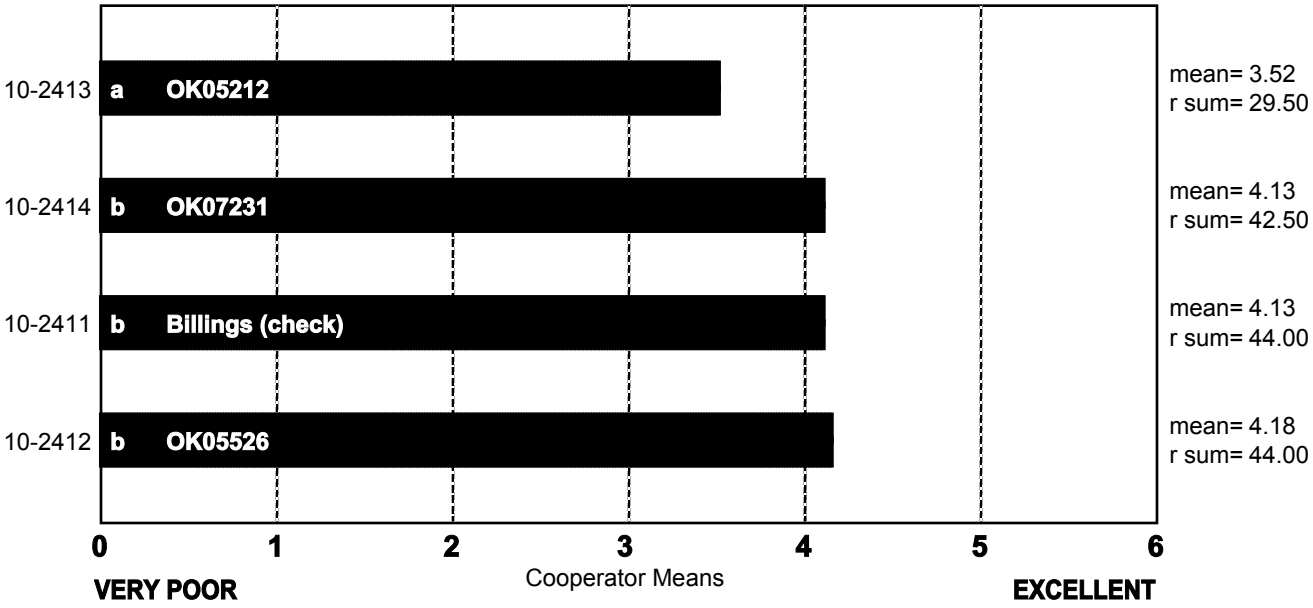


MIXING TOLERANCE

(Small Scale) Oklahoma

ncoop= 16
chisq= 5.57
chisqc= 10.73
cvchisq= 7.82
crdiff= 9.64

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



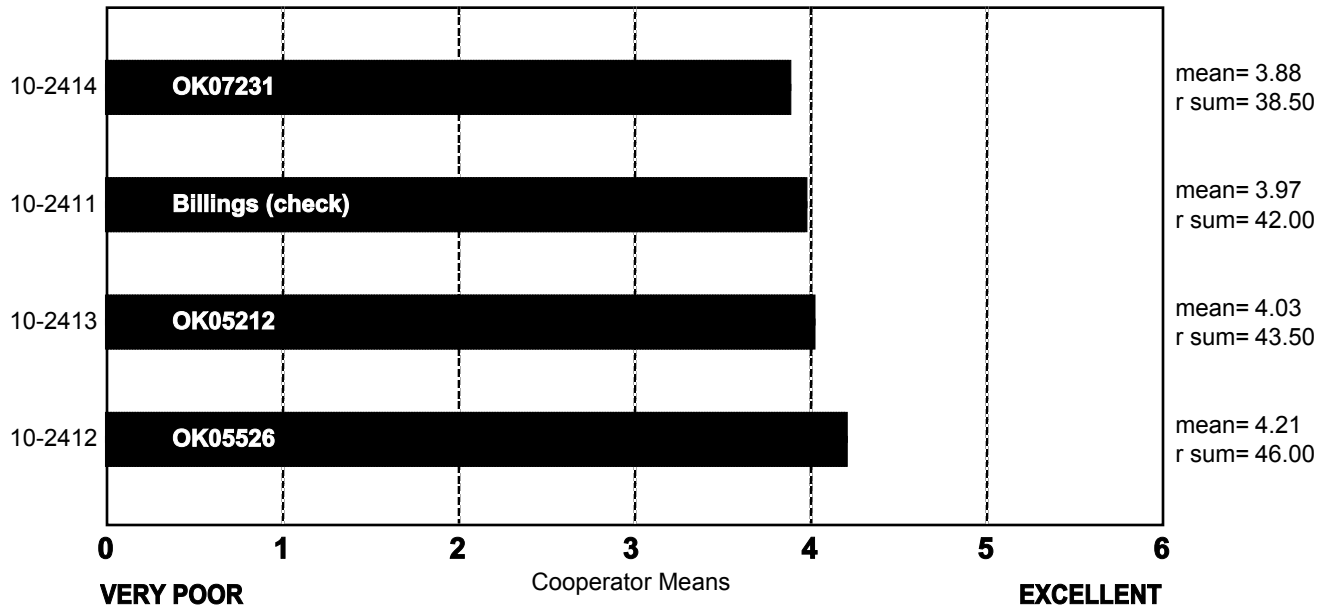
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Oklahoma

ncoop= 17
chisq= 1.04
chisqc= 1.64
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
10-2411 Billings (check)	**1**	**0**	**4**	**9**	**3**
10-2412 OK05526	**2**	**1**	**3**	**6**	**5**
10-2413 OK05212	**1**	**1**	**2**	**11**	**2**
10-2414 OK07231	**0**	**0**	**5**	**10**	**2**

Frequency Table

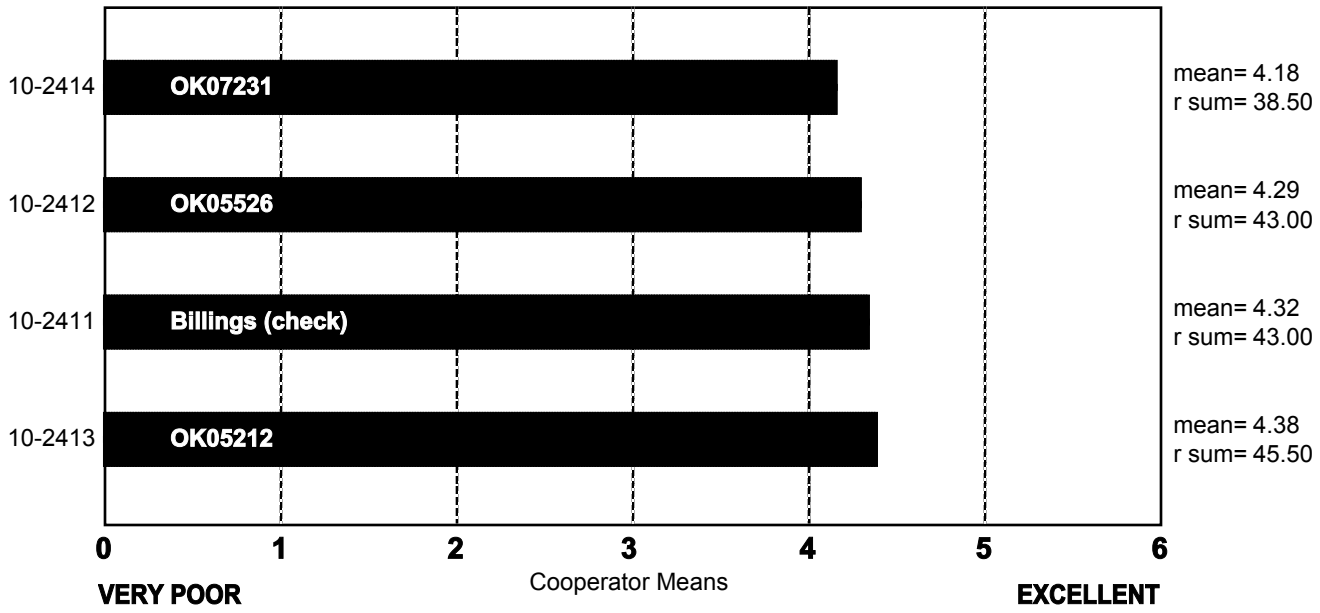
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Oklahoma

ncoop= 17
chisq= 0.90
chisqc= 1.58
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
10-2411 Billings (check)	**1**	**0**	**5**	**7**	**4**
10-2412 OK05526	**1**	**0**	**3**	**10**	**3**
10-2413 OK05212	**0**	**0**	**2**	**14**	**1**
10-2414 OK07231	**0**	**0**	**6**	**9**	**2**

Frequency Table

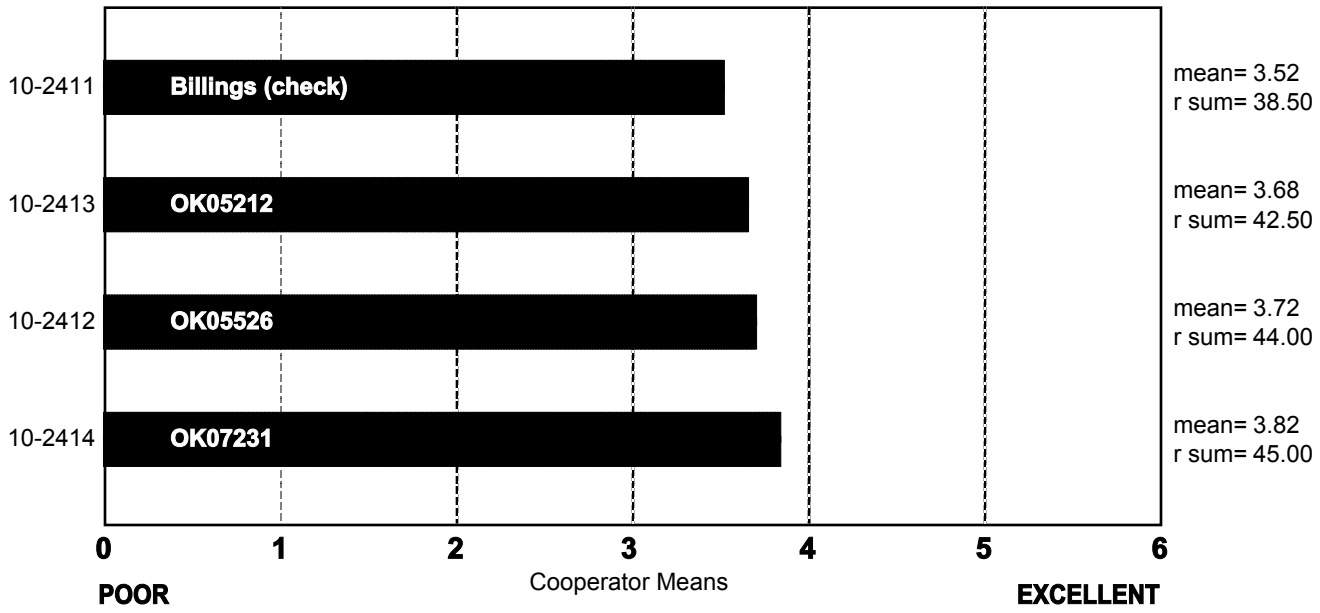
CRUMB GRAIN

(Small Scale) Oklahoma

ncoop= 17
chisq= 0.86
chisqc= 1.14
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Oklahoma

	Open	Fine	Dense
10-2411 Billings (check)	**10**	**7**	**0**
10-2412 OK05526	**6**	**11**	**0**
10-2413 OK05212	**9**	**8**	**0**
10-2414 OK07231	**10**	**7**	**0**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Oklahoma

	Round	Irregular	Elongated
10-2411 Billings (check)	**3**	**8**	**6**
10-2412 OK05526	**4**	**8**	**5**
10-2413 OK05212	**4**	**7**	**6**
10-2414 OK07231	**5**	**7**	**5**

Frequency Table

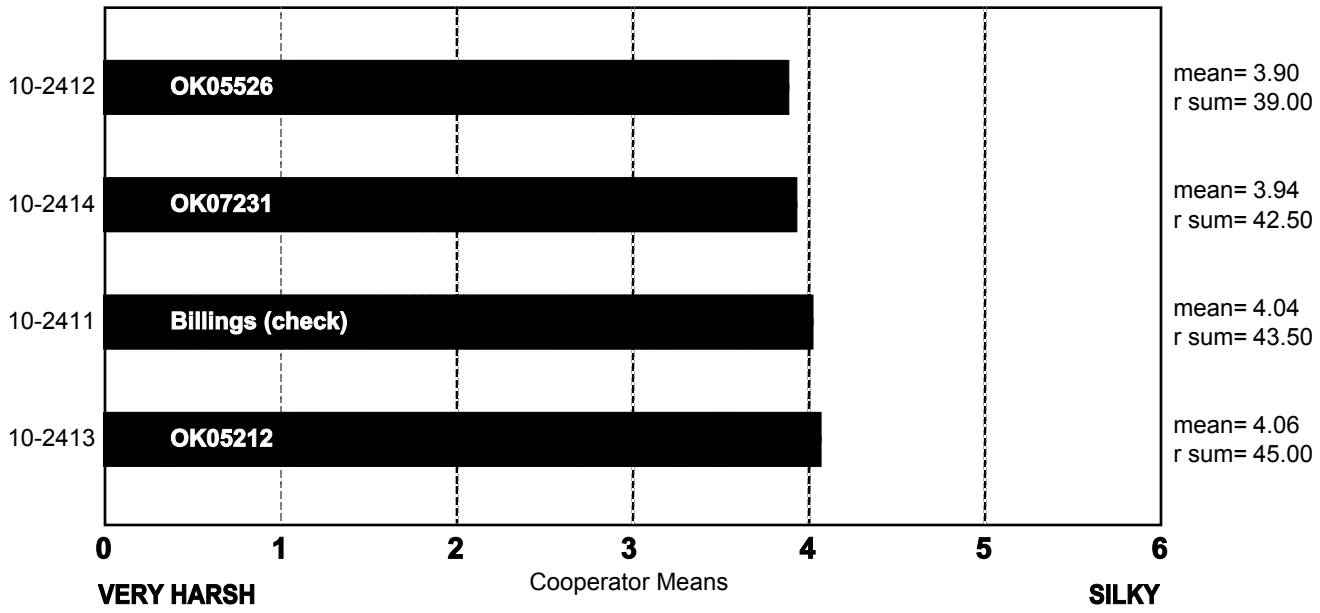
CRUMB TEXTURE

(Small Scale) Oklahoma

ncoop= 17
chisq= 0.69
chisqc= 1.04
cvchisq= 7.82
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Oklahoma

	Harsh	Smooth	Silky
10-2411 Billings (check)	**3**	**11**	**3**
10-2412 OK05526	**3**	**10**	**4**
10-2413 OK05212	**0**	**15**	**2**
10-2414 OK07231	**2**	**12**	**3**

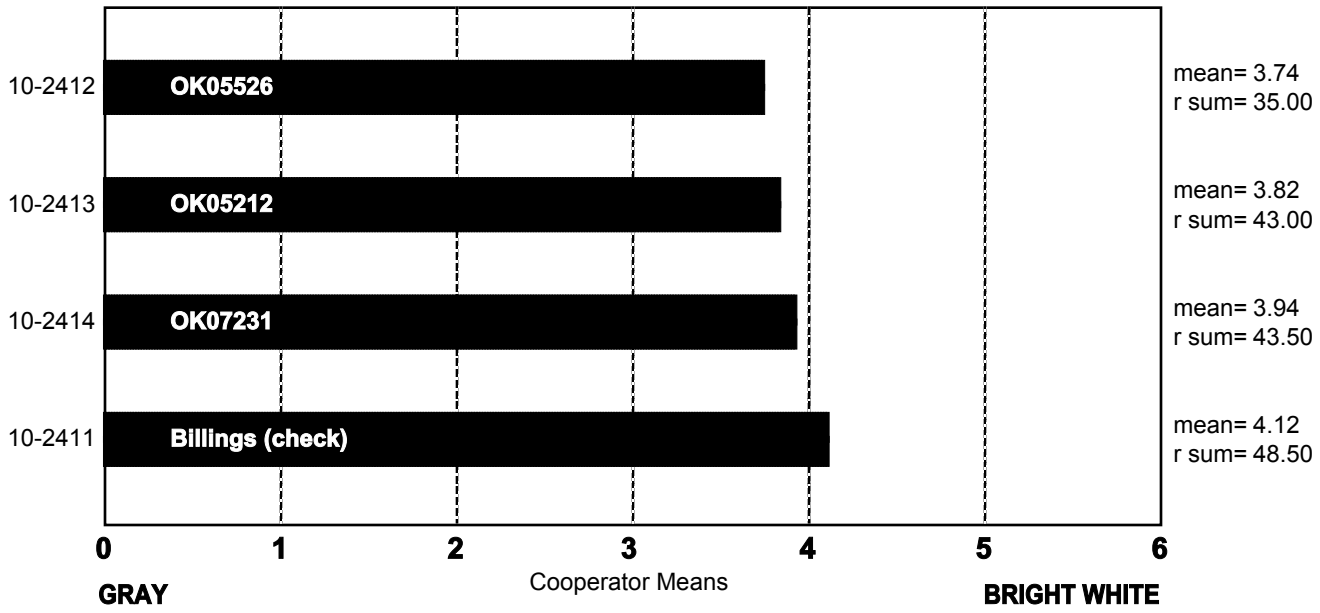
Frequency Table

CRUMB COLOR

(Small Scale) Oklahoma

ncoop= 17
chisq= 3.30
chisqc= 5.19
cvchisq= 7.82
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Oklahoma

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
10-2411 Billings (check)	**0**	**0**	**1**	**4**	**6**	**4**	**2**
10-2412 OK05526	**0**	**0**	**0**	**3**	**9**	**4**	**0**
10-2413 OK05212	**2**	**0**	**0**	**2**	**8**	**5**	**0**
10-2414 OK07231	**0**	**0**	**0**	**4**	**8**	**5**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2411 Billings (check)	**140.8**	**421.0**	**495.0**	**156.2**	**131.5**	**134.4**	**143.9**	**153.4**	**487.5**	**134.0**	**466.6**	**138.3**	**142.1**	**461.0**	**148.4**	**463.6**	**455.1**
10-2412 OK05526	**143.8**	**421.0**	**505.0**	**154.7**	**130.7**	**131.5**	**147.0**	**154.1**	**479.5**	**134.0**	**469.5**	**137.7**	**141.4**	**462.0**	**149.3**	**460.9**	**451.8**
10-2413 OK05212	**144.6**	**419.0**	**500.0**	**155.7**	**130.9**	**132.4**	**147.3**	**152.1**	**483.2**	**134.0**	**466.6**	**141.5**	**146.6**	**461.0**	**151.5**	**460.6**	**452.4**
10-2414 OK07231	**144.2**	**417.0**	**505.0**	**155.6**	**130.3**	**133.2**	**143.4**	**153.0**	**476.8**	**134.0**	**469.1**	**140.6**	**141.8**	**460.0**	**150.9**	**466.7**	**450.7**

Raw Data

LOAF VOLUME, ACTUAL

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2411 Billings (check)	**1195**	**3000**	**3250**	**625**	**750**	**925**	**923**	**1035**	**3104**	**1000**	**2650**	**1013**	**936**	**3075**	**900**	**2700**	**2592**
10-2412 OK05526	**1005**	**3000**	**2850**	**655**	**660**	**955**	**843**	**1028**	**3104**	**982**	**2600**	**1078**	**952**	**2675**	**900**	**2725**	**2600**
10-2413 OK05212	**980**	**2900**	**3150**	**615**	**650**	**925**	**900**	**1008**	**3104**	**1098**	**2675**	**938**	**832**	**2900**	**950**	**2625**	**2400**
10-2414 OK07231	**1000**	**3000**	**2850**	**644**	**710**	**885**	**865**	**1015**	**3045**	**1005**	**2588**	**975**	**936**	**2875**	**915**	**2600**	**2525**

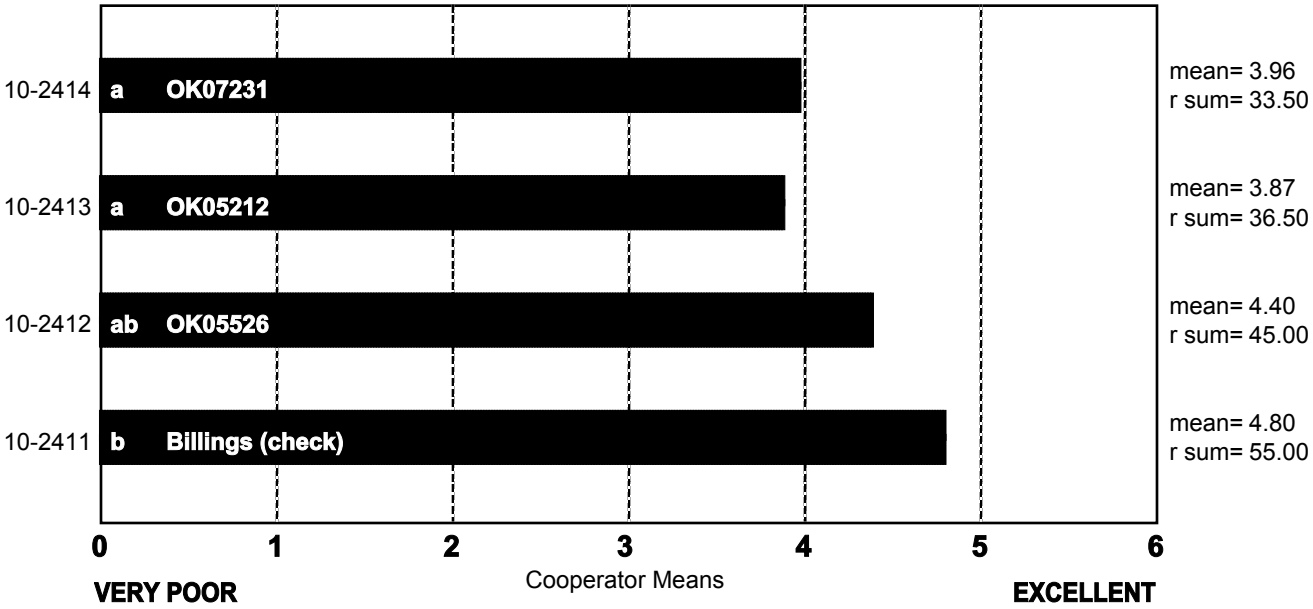
Raw Data

LOAF VOLUME

(Small Scale) Oklahoma

ncoop= 17
chisq= 9.86
chisqc= 12.24
cvchisq= 7.82
crdiff= 12.21

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

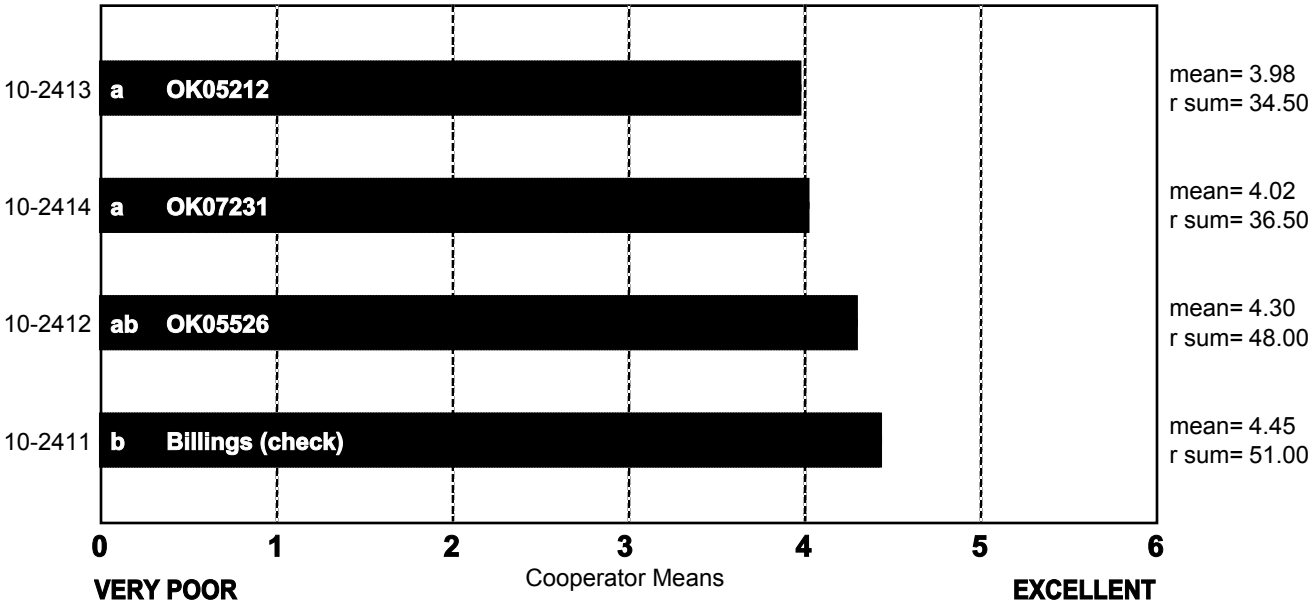


OVERALL BAKING QUALITY

(Small Scale) Oklahoma

ncoop= 17
chisq= 7.15
chisqc= 7.94
cvchisq= 7.82
crdiff= 13.60

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS
(Small Scale) Oklahoma

COOP. **10-2411** **OK Billings (Check)**

A. Excellent exterior.

B. Tough and bucky, very open grain, good volume, sl. creamy crumb, long mix.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Hi absorption, med long mix time, wet, soft and sl. strong dough, hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Good performance.

I. Open, streaky, variable grain, excellent volume, good absorption.

J. Excellent bake quality, best sample of the set, strong dough handling, great mix tolerance and volume, also had nice grain.

K. Hi absorption, tough dough, open grain, white crumb, average volume.

L. No comment.

M. No comment.

N. No comment.

O. Great flour protein and good loaf volume, dark crust, poor crumb grain.

P. No comment.

Q. Excellent volume and grain rating.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Oklahoma

COOP. **10-2412** **OK05526**

A. Weak dough.

B. Tough and bucky, good volume, long mix, sl. open grain, sl. creamy color.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. sticky dough, hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Good performance.

I. Fairly tight grain, excellent volume.

J. Great bake quality, nice volume and grain, dough handling was lively!

K. Good mix time, tough dough, average absorption and volume.

L. No comment.

M. No comment.

N. No comment.

O. Good flour protein, disappointing crumb grain.

P. No comment.

Q. Excellent volume and grain rating.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Oklahoma

COOP. **10-2413** **OK05212**

A. Short mix time.

B. Good out of mixer and make up, short mix, good volume, open grain, creamy.

C. No comment.

D. No comment.

E. Low loaf volume, short mix time.

F. No comment.

G. Hi absorption and mix time, wet, soft and sl. sticky dough, hi OS, open and elongated cells, creamy crumb, smooth and resilient texture.

H. Average performance.

I. Tight, consistent, smooth grain, excellent volume.

J. Excellent bake quality, HUGE volume and great tolerance, nice grain and dough handling characteristics.

K. High absorption, average mix time and volume.

L. No comment.

M. No comment.

N. No comment.

O. Good flour protein, absorption, mix time and loaf volume; crumb grain questionable, rated higher than check.

P. No comment.

Q. Open grain, good volume.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Oklahoma

COOP. **10-2414** **OK07231**

A. Weak dough.

B. Tough and bucky, excellent volume, long mix, open grain, br. crumb color.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption and med long mix time, wet, soft and sl. strong dough, hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Good performance.

I. Fairly tight, consistent grain, very good volume.

J. Good bake quality and dough handling.

K. Tough dough, good grain.

L. No comment.

M. No comment.

N. No comment.

O. Good flour protein, long mix time, dark crust, rated sl. higher than check.

P. No comment.

Q. Excellent volume and good crumb rating.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

WestBred – Sid Perry

The samples were produced at our Haven, Kansas location. The plots were seeded on October 10, 2009, at a rate of 70 lb/acre. A pre-plant fertilizer application of 30 lb N was followed up with a top-dress application of 40 lb N and a late boot application of 10 lb N. Yield levels were 50 bushels/acre. Plots were sprayed with a fungicide.

Smoky Hill (check)

Smoky Hill has been a very consistent variety in its target environment, and remains a good quality check in our commercial lineup since it's release in 2006. Best adaptation has been in areas north of I-70. Performance in northwest KS, northeast Colorado, and southwest Nebraska has been very good. Smoky Hill has been a top yielding hard winter wheat variety in the South Dakota state tests since 2008. Smoky Hill has good leaf, and stem rust resistance. It is susceptible to the new race of stripe rust. Test weights have been good and straw strength average, with intermediate resistances to speckled leaf blotch and tan spot. It is susceptible to fusarium head blight.

HV9W06-262R

HV9W06-262R is a hard red winter wheat with the pedigree TX98U8134/3/KARL92*2/RAVI-36. It has shown broad adaptation. It has very good leaf and stem rust resistance. Maturity is early. It is resistant to soil borne mosaic, and moderately resistant to tan spot and speckled leaf blotch. It has good shatter resistance, straw strength, and very good test weights. It is susceptible to fusarium head blight, and susceptible to the new stripe rust race of 2010.

HV9W06-218W

HV9W06-218W is a hard white winter wheat with the pedigree CO970531/CO980362W//KS920946W. Best adaptation has been west of I-135. It is early maturing, with good straw strength. It is resistant to leaf and stem rust, but moderately susceptible to the new stripe rust race of 2010. It is resistant to soil borne mosaic virus and susceptible to fusarium head blight. It is susceptible to head sprout.

Westbred: 2010 (Small-Scale) Samples [a]

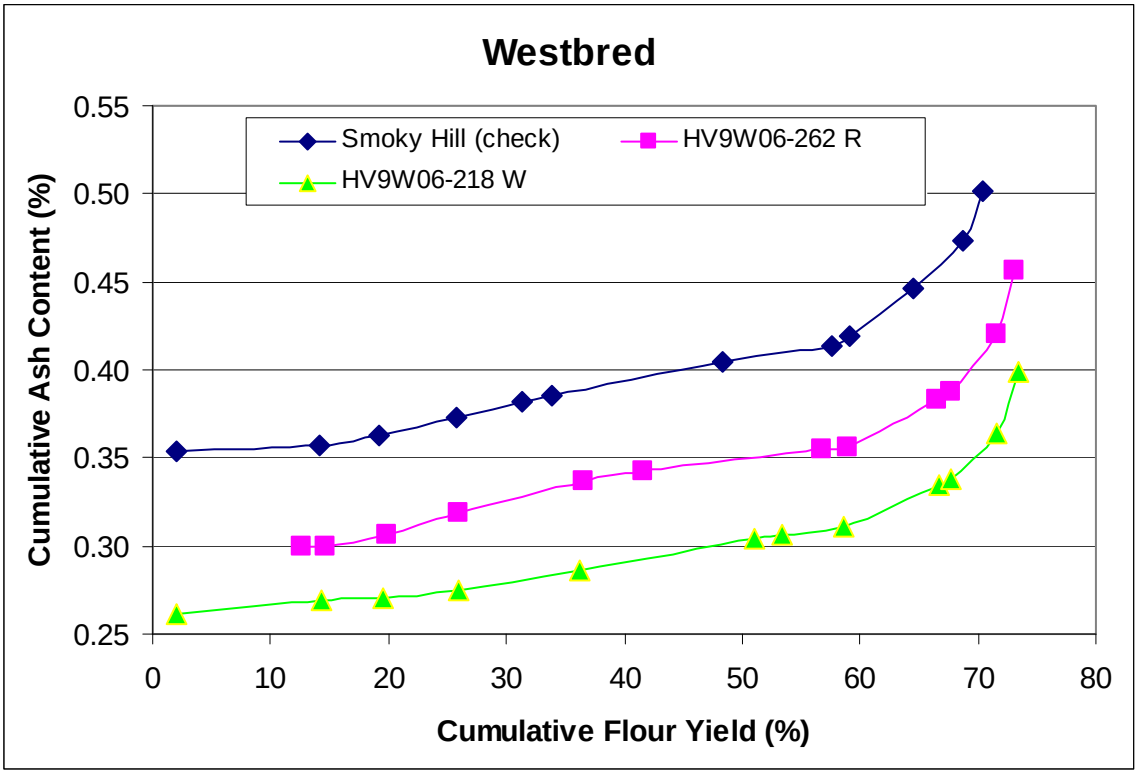
Test entry number	10-2415	10-2416	10-2417
Sample identification	**Smoky Hill (check)**	**HV9W06-262R**	**HV9W06-218R**
Wheat Data			
FGIS classification	2 HRW	1 HRW	2 HDHW
Test weight (lb/bu)	59.4	62.0	62.7
Hectoliter weight (kg/hl)	78.2	81.5	82.4
1000 kernel weight (gm)	27.0	28.8	35.6
Wheat kernel size (Rotap)			
Over 7 wire (%)	44.6	58.1	83.7
Over 9 wire (%)	53.3	40.8	16.0
Through 9 wire (%)	2.2	1.2	0.3
Single kernel (skcs)			
Hardness (avg /s.d)	71.2/16.2	71.4/15.2	63.6/14.1
Weight (mg) (avg/s.d)	27.0/8.4	28.8/7.5	35.6/10.1
Diameter (mm)(avg/s.d)	2.49/0.31	2.59/0.31	2.89/0.38
SKCS distribution	01-05-16-78	00-04-17-79	02-08-28-62
Classification	Hard	Hard	Hard
Wheat moisture (%)	9.5	9.6	9.7
Wheat protein (12% mb)	15.3	13.8	13.8
Wheat ash (12% mb)	1.62	1.72	1.51
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	70.6	73.2	73.4
Quadrumat Sr. Mill	68.0	71.8	71.6
Flour moisture (%)	10.6	11.0	10.7
Flour protein (14% mb)	13.9	12.3	12.1
Flour ash (14% mb)	0.55	0.49	0.43
Glutomatic			
Wet gluten (%)	36.1	30.9	33.6
Dry gluten (%)	12.1	11.2	11.7
Gluten index	99.6	99.0	98.4
Rapid Visco-Analyser			
Peak Time (min)	6.3	6.3	6.0
Peak Viscosity (RVU)	233.2	230.1	200.0
Breakdown (RVU)	75.2	68.2	81.9
Final Viscosity at 13 min (RVU)	279.9	283.0	220.8
Minolta color meter			
L*	91.9	92.1	92.7
a*	-1.14	-1.45	-1.51
b*	8.60	9.60	8.75
Falling number (sec)	544	513	420
Damaged Starch			
(AI%)	94.41	95.18	95.97
(AACC76-31)	5.11	5.65	6.25

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Westbred: Physical Dough Tests and Gluten Analysis For 2010 (Small-Scale) Samples

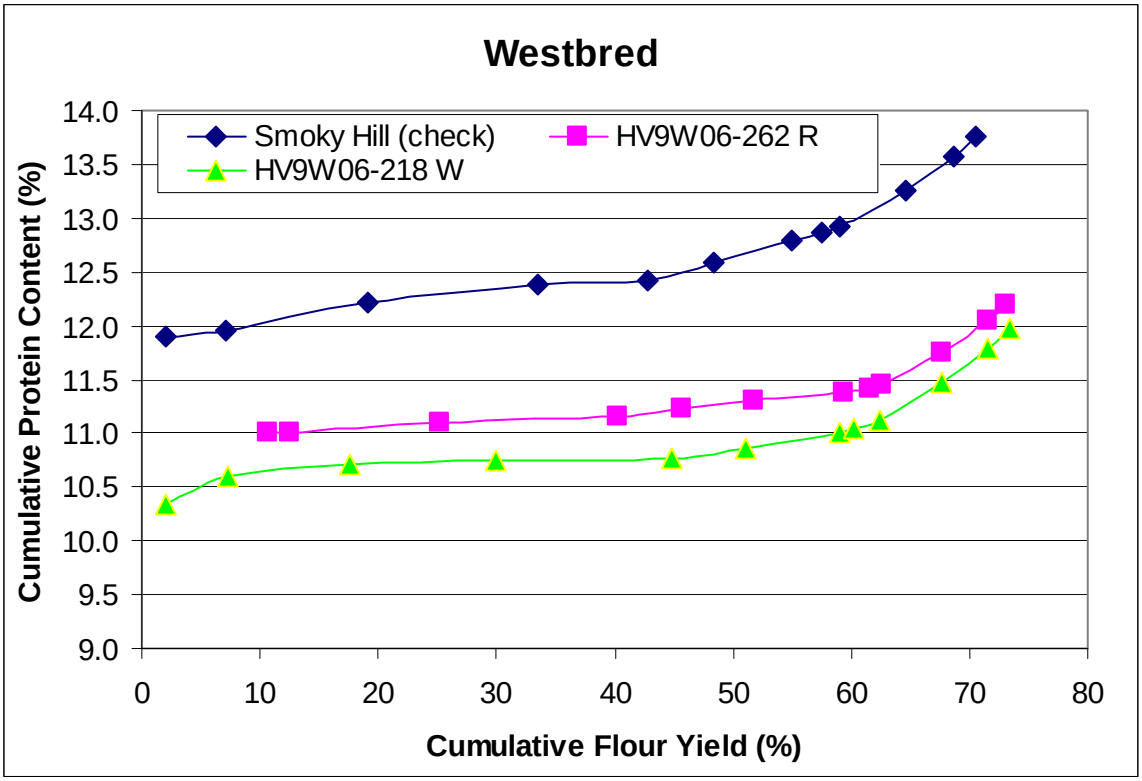
Test Entry Number	10-2415	10-2416	10-2417
Sample Identification	Smoky Hill (check)	HV9W06-262R	HV9W06-218R
MIXOGRAPH			
Flour Abs (% as-is)	69.9	66.8	66.8
Flour Abs (14% mb)	66.0	63.4	63.1
Mix Time (min)	8.50	8.00	5.00
Mix tolerance (0-6)	5	4	4
FARINOGRAPH			
Flour Abs (% as-is)	61.1	61.7	61.8
Flour Abs (14% mb)	57.3	58.3	58.1
Development time (min)	7.7	2.4	3.5
Mix stability (min)	30.5	14.1	14.7
Mix Tolerance Index (FU)	15	34	28
Breakdown time (min)	26.6	6.3	9.0
ALVEOGRAPH			
P(mm. $_{H2O}$): Tenacity	78	92	72
L(mm): Extensibility	114	76	104
G($mm_{0.5}$): Swelling index	23.8	19.4	22.7
W(10^{-4} J): strength (curve area)	373	313	296
P/L: curve configuration ratio	0.68	1.21	0.69
Ie(P_{200}/P): elasticity index	74.2	75.4	69.3
EXTENSIGRAPH			
Resist (BU at 30/60/90 min)	673/995/995	827/987/998	512/809/899
Extensibility (mm at 30/60/90 min)	133/99/80	119/89/85	142/135/120
Energy (cm^2 at 30/60/90 min)	144/137/107	155/124/117	132/179/159
Resist $_{max}$ (BU at 30/60/90 min)	860/995/997	999/987/998	746/998/993
Ratio (at 30/60/90 min)	5.1/10.1/12.5	7.0/11.1/11.7	3.6/6.0/7.5
PROTEIN ANALYSIS			
HMW-GS Composition	1, 7+9, 5+10	2*, 17+18, 5+10	2*, 7+8, 5+10
Glu/Gli	0.70	0.74	0.67
HMW/LMW	0.42	0.29	0.40
%IPP	51.50	51.73	47.91
SEDIMENTATION TEST			
Volume (ml)	68.5	50.7	58.7

Westbred: Cumulative Ash Curves



Smoky Hill (check) - 2415					HV9W06-262 R - 2416					HV9W06-218 W - 2417				
Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash
1M Red	2.07	0.35	2.07	0.35	2M	12.55	0.30	12.55	0.30	1M Red	2.00	0.26	2.00	0.26
2M	12.13	0.36	14.20	0.36	1M Red	2.02	0.30	14.57	0.30	2M	12.35	0.27	14.35	0.27
1M	4.97	0.38	19.17	0.36	1M	5.34	0.32	19.91	0.31	1M	5.20	0.27	19.55	0.27
1BK	6.64	0.40	25.82	0.37	1BK	6.11	0.36	26.02	0.32	1BK	6.34	0.29	25.89	0.28
2BK	5.57	0.42	31.38	0.38	4M	10.58	0.38	36.59	0.34	4M	10.34	0.31	36.23	0.29
Grader	2.54	0.44	33.93	0.39	2BK	5.02	0.38	41.61	0.34	3M	14.86	0.35	51.09	0.30
3M	14.38	0.45	48.30	0.40	3M	15.17	0.39	56.78	0.35	Grader	2.34	0.35	53.43	0.31
4M	9.23	0.46	57.54	0.41	Grader	2.09	0.40	58.87	0.36	2BK	5.23	0.35	58.67	0.31
FILTER FLR	1.51	0.66	59.05	0.42	5M	7.67	0.59	66.54	0.38	5M	7.94	0.51	66.61	0.33
5M	5.53	0.73	64.58	0.45	FILTER FLR	1.09	0.61	67.63	0.39	FILTER FLR	1.09	0.55	67.71	0.34
3BK	4.10	0.91	68.69	0.47	3BK	3.94	1.00	71.57	0.42	3BK	3.91	0.82	71.61	0.36
BRAN FLR	1.79	1.56	70.47	0.50	BRAN FLR	1.51	2.16	73.07	0.46	BRAN FLR	1.76	1.80	73.37	0.40
Break Shorts	4.07	4.06	74.55	0.70	Break Shorts	3.54	3.66	76.61	0.60	Break Shorts	4.36	3.22	77.73	0.56
Red Dog	1.68	3.15	76.23	0.75	Red Dog	1.27	3.08	77.88	0.64	Red Dog	1.42	2.95	79.16	0.60
Red Shorts	0.15	4.11	76.38	0.76	Red Shorts	0.16	3.12	78.04	0.65	Red Shorts	0.12	3.76	79.27	0.60
Filter Bran	0.76	2.55	77.14	0.77	Filter Bran	0.58	2.41	78.63	0.66	Filter Bran	0.72	1.85	79.99	0.62
Bran	22.86	4.70	100.00	1.67	Bran	21.37	5.17	100.00	1.63	Bran	20.01	4.85	100.00	1.46
Wheat		1.58			Wheat		1.68			Wheat		1.48		
St. Grd. Fl.		0.55			St. Grd. Fl.		0.49			St. Grd. Fl.		0.43		

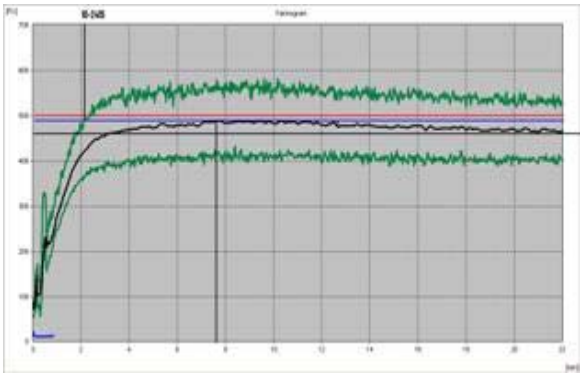
Westbred: Cumulative Protein Curves



Smoky Hill (check) - 2415					HV9W06-262 R - 2416					HV9W06-218 W - 2417				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1M Red	2.07	11.91	2.07	11.91	4M	10.58	11.01	10.58	11.01	1M Red	2.00	10.34	2.00	10.34
1M	4.97	11.97	7.05	11.95	1M Red	2.02	11.06	12.59	11.02	1M	5.20	10.69	7.20	10.59
2M	12.13	12.38	19.17	12.22	2M	12.55	11.17	25.15	11.09	4M	10.34	10.78	17.54	10.70
3M	14.38	12.59	33.55	12.38	3M	15.17	11.28	40.31	11.16	2M	12.35	10.79	29.89	10.74
4M	9.23	12.60	42.78	12.43	1M	5.34	11.69	45.65	11.22	3M	14.86	10.84	44.75	10.77
5M	5.53	13.80	48.32	12.58	1BK	6.11	11.83	51.76	11.30	1BK	6.34	11.51	51.09	10.86
1BK	6.64	14.25	54.96	12.79	5M	7.67	11.94	59.43	11.38	5M	7.94	11.92	59.04	11.01
Grader	2.54	14.54	57.50	12.86	Grader	2.09	12.71	61.52	11.42	FILTER FLR	1.09	12.99	60.13	11.04
FILTER FLR	1.51	14.88	59.02	12.92	FILTER FLR	1.09	13.39	62.62	11.46	Grader	2.34	12.99	62.47	11.12
2BK	5.57	16.82	64.58	13.25	2BK	5.02	15.33	67.63	11.75	2BK	5.23	15.68	67.71	11.47
3BK	4.10	18.69	68.69	13.58	3BK	3.94	17.11	71.57	12.04	3BK	3.91	17.30	71.61	11.79
BRAN FLR	1.79	20.42	70.47	13.75	BRAN FLR	1.51	19.33	73.07	12.19	BRAN FLR	1.76	19.83	73.37	11.98
Break Shorts	4.07	17.55	74.55	13.96	Break Shorts	3.54	15.21	76.61	12.33	Break Shorts	4.36	16.09	77.73	12.21
Red Dog	1.68	15.94	76.23	14.00	Red Dog	1.27	14.36	77.88	12.36	Red Dog	1.42	16.07	79.16	12.28
Red Shorts	0.15	16.27	76.38	14.01	Red Shorts	0.16	13.93	78.04	12.37	Red Shorts	0.12	15.86	79.27	12.28
Filter Bran	0.76	15.97	77.14	14.03	Filter Bran	0.58	13.61	78.63	12.38	Filter Bran	0.72	12.75	79.99	12.29
Bran	22.86	18.90	100.00	15.14	Bran	21.37	17.37	100.00	13.44	Bran	20.01	19.49	100.00	13.73
Wheat		14.93			Wheat		13.51			Wheat		13.47		
St. Grd. Fl		13.86			St. Grd. Fl		12.30			St. Grd. Fl		12.09		

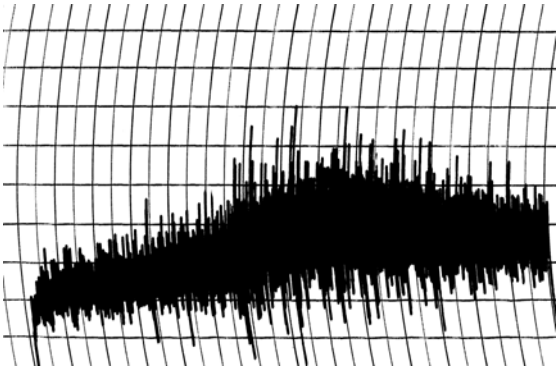
Physical Dough Tests
2010 (Small Scale) Samples – Westbred

Farinograms



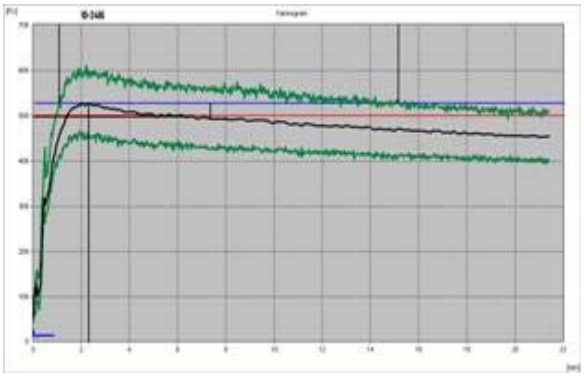
Water abs = 57.3%, Peak time = 7.7 min,
Mix stab = 30.5 min, MTI = 15 FU

Mixograms

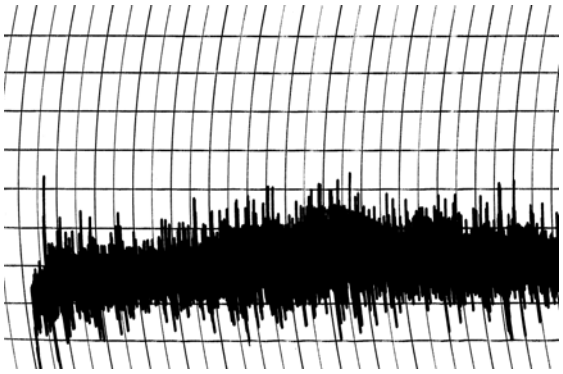


Water abs = 66.0%
Mix time = 8.5 min

10-2415, Smoky Hill (check)



Water abs = 58.3%, Peak time = 2.4 min,
Mix stab = 14.1 min, MTI = 34 FU



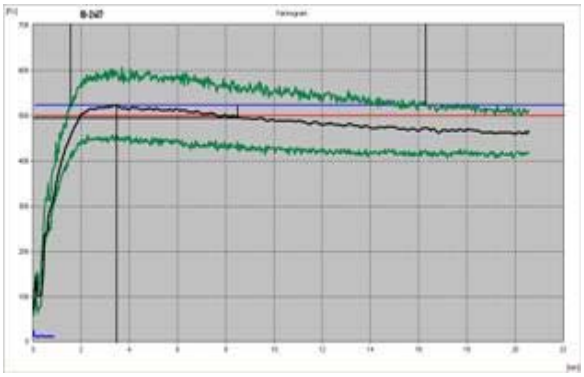
Water abs = 63.4%
Mix time = 8.0 min

10-2416, HV9W06-262R

Physical Dough Tests

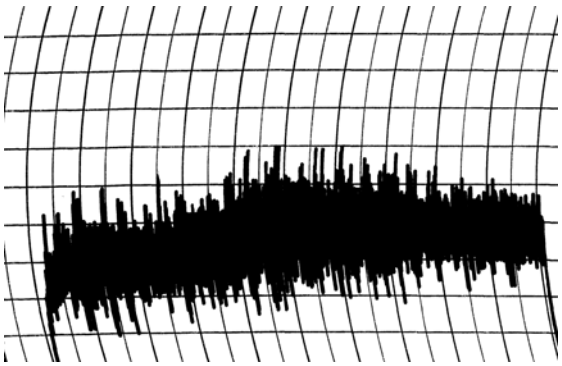
2010 (Small Scale) Samples – Westbred (continued)

Farinograms



Water abs. = 58.1%, Peak time = 3.5 min,
Mix stab = 14.7 min, MTI = 28 FU

Mixograms

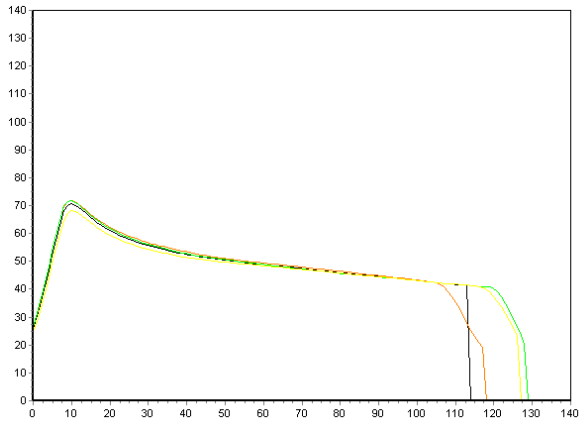


Water abs = 63.1%
Mix time = 5.0 min

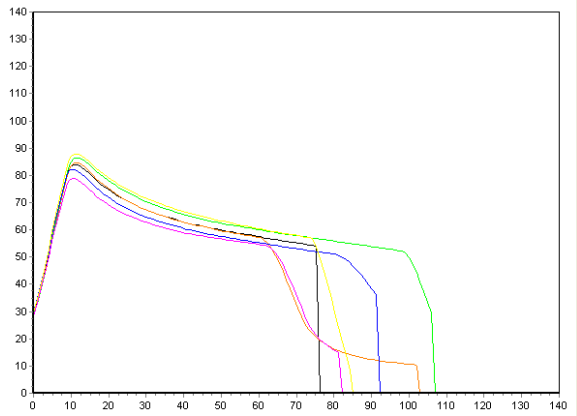
10-2417, HV9W06-218W

Physical Dough Tests - Alveograph

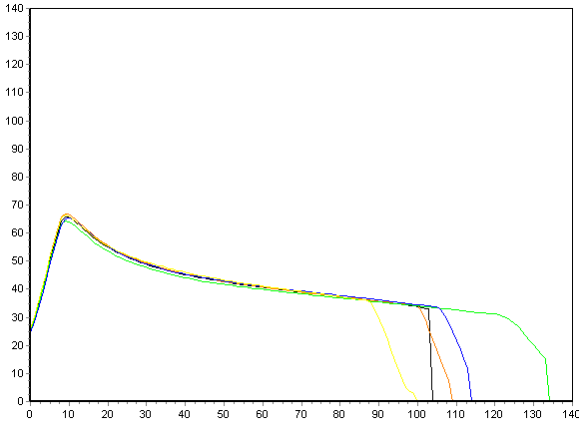
2010 (Small Scale) Samples – Westbred



10-2415 (Smoky Hill (check))
P (mm H_20) = 78, L (mm) = 114, W ($10E^{-4}J$) = 373



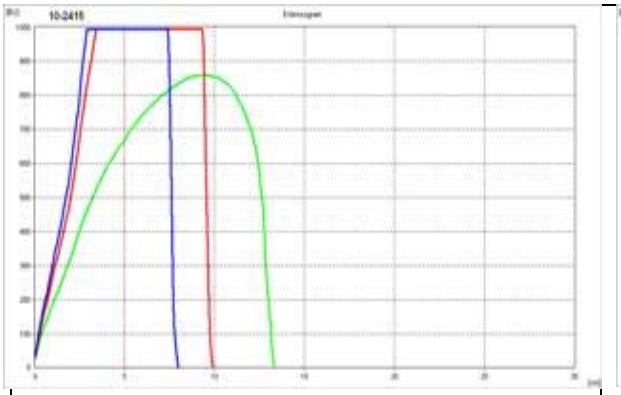
10-2416 (262 R)
P (mm H_20) = 92, L (mm) = 76, W ($10E^{-4}J$) = 313



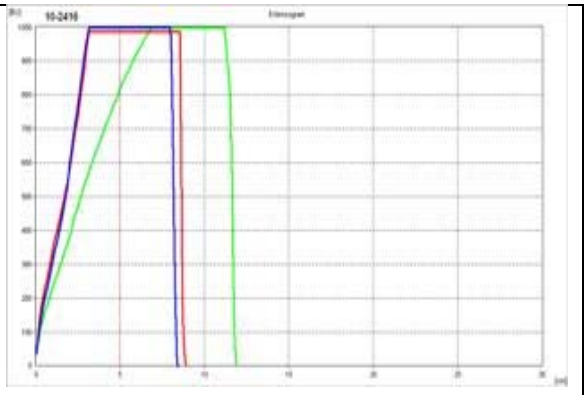
10-2417 (218 W)
P (mm H_20) = 72, L (mm) = 104, W ($10E^{-4}J$) = 296

Physical Dough Tests - Extensigraph

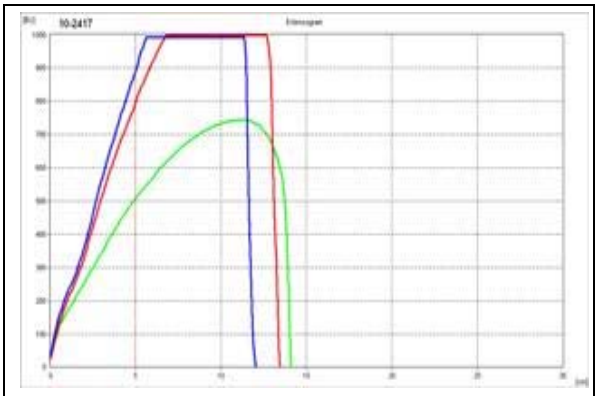
2010 (Small Scale) Samples – Westbred



10-2415 (Smoky Hill -check)
R (BU) = 995, E (mm) = 79.7, W (cm^2) = 107
Rmax (BU) = 997, Ratio = 12.5 at 90 min



10-2416 (HV9W06-262 R)
R (BU) = 998, E (mm) = 85.3, W (cm^2) = 117
Rmax (BU) = 998, Ratio = 11.7 at 90 min



10-2417 (HV9W06-218W)
R (BU) = 899, E (mm) = 120.2, W (cm^2) = 159
Rmax (BU) = 993, Ratio = 7.5 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

Westbred: C-Cell Bread Images and Analysis for 2010 (Small-Scale) Samples

Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2415	6742	150.1	4127	0.442	2.022	9.626	1.663	-20.58
2416	5843	149.8	3879	0.434	1.859	1.656	1.670	-19.25

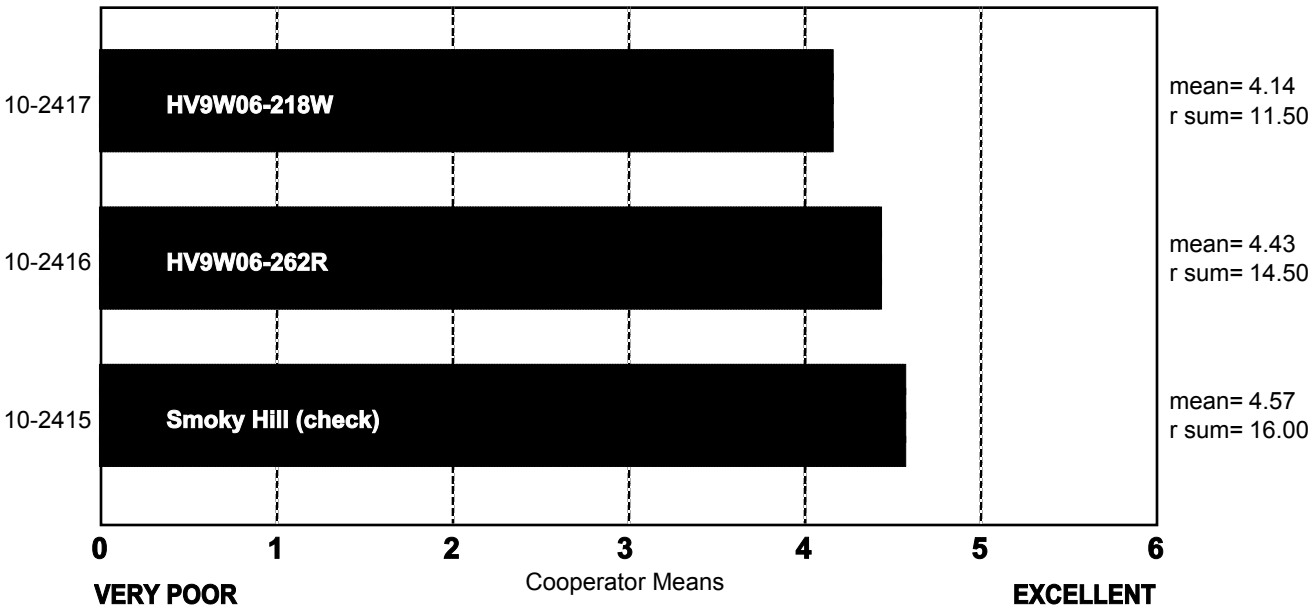
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2417	6247	159.1	4149	0.432	1.85	7.207	1.678	-32.48

SPONGE CHARACTERISTICS

(Small Scale) Westbred

ncoop= 7
chisq= 1.50
chisqc= 2.80
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

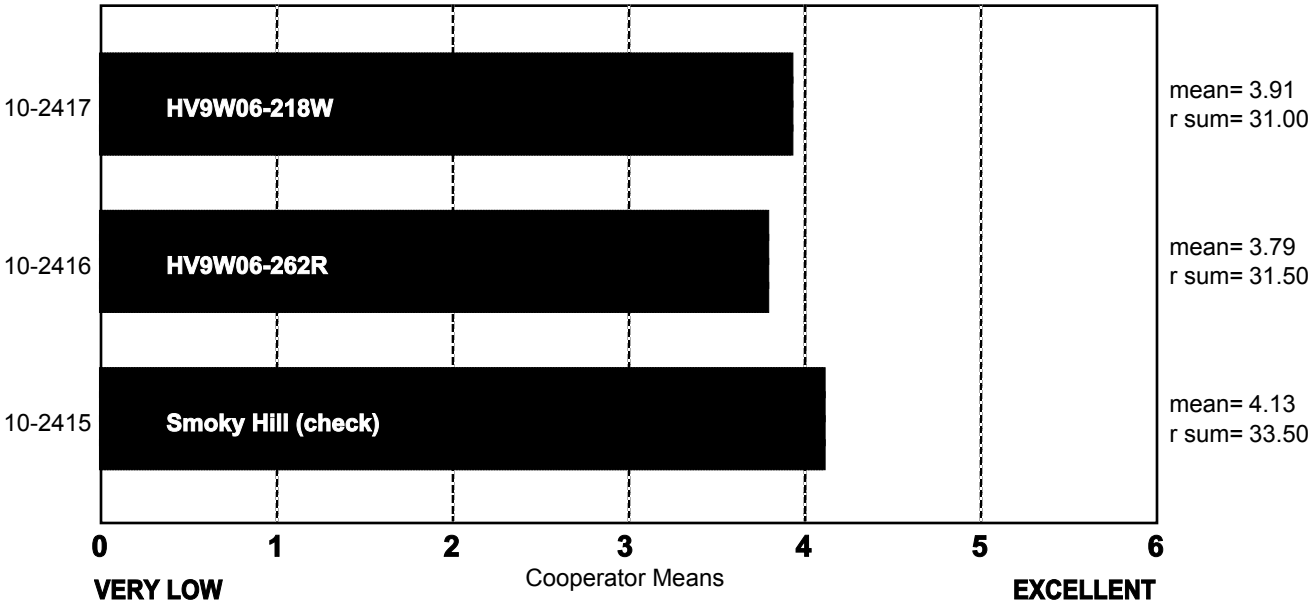


BAKE ABSORPTION

(Small Scale) Westbred

ncoop= 16
chisq= 0.22
chisqc= 0.39
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Westbred

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2415 Smoky Hill (check)	**66.5**	**60.0**	**54.5**	**66.0**	**58.5**	**59.6**	**64.0**	**66.7**	**59.0**	**64.0**	**60.0**	**68.1**	**69.6**	**68.0**	**65.8**	**58.5**	**60.3**
10-2416 HV9W06-262R	**63.0**	**59.0**	**55.5**	**63.4**	**60.1**	**60.2**	**65.0**	**64.7**	**59.0**	**63.0**	**60.0**	**65.1**	**66.7**	**65.4**	**61.3**	**57.5**	**61.3**
10-2417 HV9W06-218W	**62.9**	**59.0**	**55.0**	**63.1**	**60.1**	**60.3**	**64.0**	**66.4**	**59.0**	**62.0**	**61.0**	**65.1**	**67.0**	**65.1**	**62.0**	**59.5**	**61.1**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Westbred

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2415 Smoky Hill (check)	**6.8**	**20.0**	**7.0**	**6.5**	**1.8**	**5.0**	**7.2**	**7.7**	**25.0**	**9.0**	**18.0**	**7.5**	**7.5**	**8.0**	**10.0**	**30.0**	**22.0**
10-2416 HV9W06-262R	**8.0**	**20.0**	**7.0**	**8.0**	**2.5**	**6.5**	**8.8**	**8.7**	**25.0**	**9.0**	**21.0**	**7.8**	**7.5**	**5.5**	**10.0**	**30.0**	**14.0**
10-2417 HV9W06-218W	**4.8**	**11.0**	**7.0**	**5.0**	**1.8**	**4.0**	**5.8**	**5.0**	**25.0**	**6.0**	**7.0**	**4.5**	**4.7**	**5.5**	**6.1**	**27.0**	**12.0**

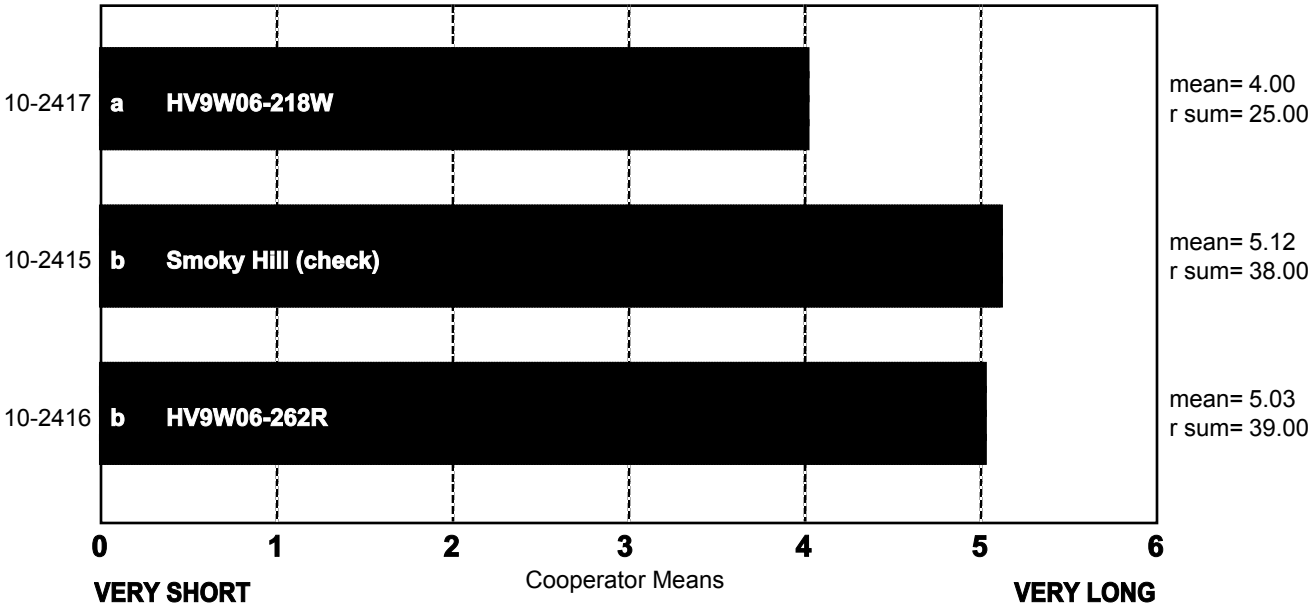
Raw Data

BAKE MIX TIME

(Small Scale) Westbred

ncoop= 17
chisq= 7.18
chisqc= 10.38
cvchisq= 5.99
crdiff= 8.48

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

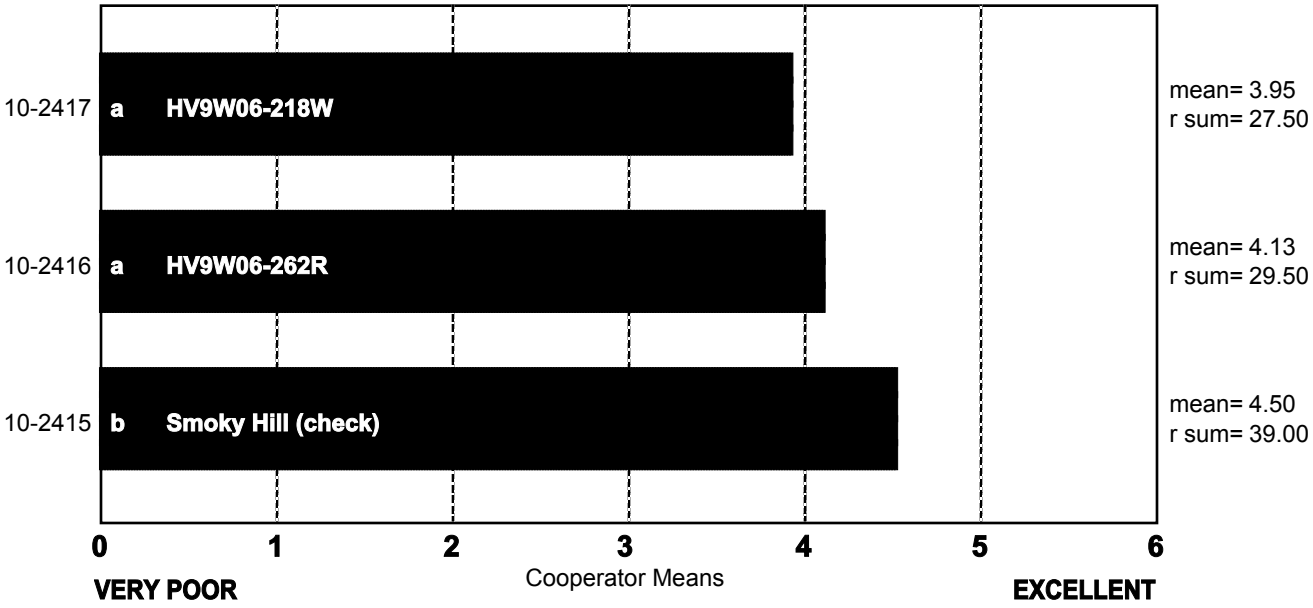


MIXING TOLERANCE

(Small Scale) Westbred

ncoop= 16
chisq= 4.72
chisqc= 7.74
cvchisq= 5.99
crdiff= 8.11

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

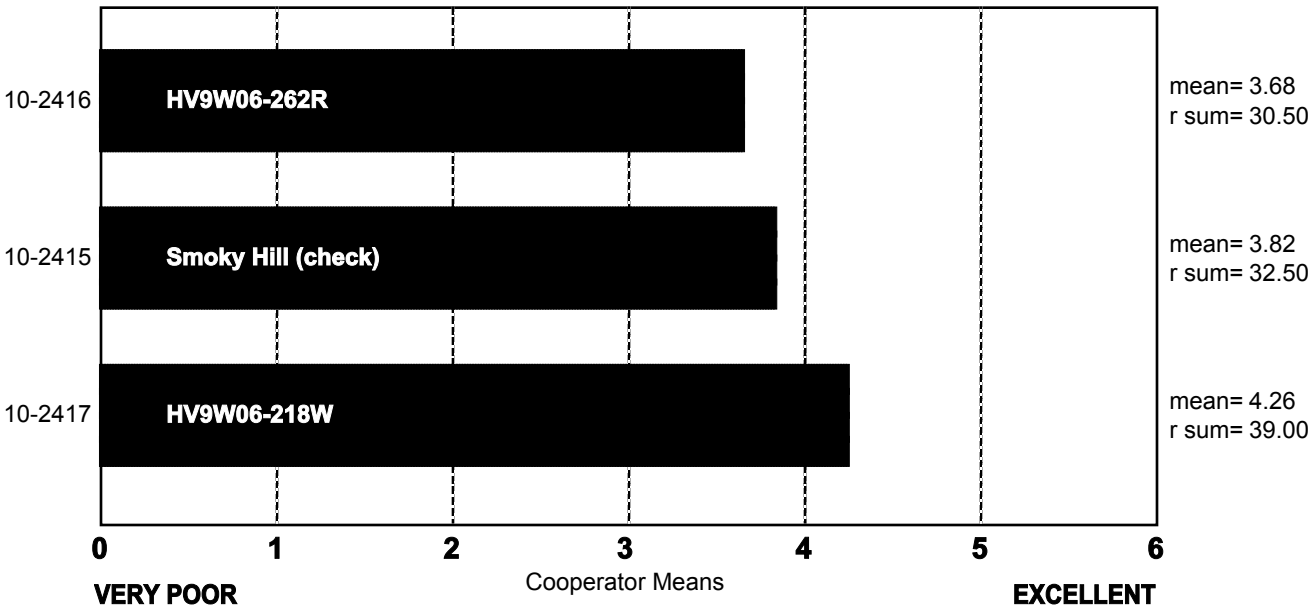


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Westbred

ncoop= 17
chisq= 2.32
chisqc= 3.67
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Westbred

	Sticky	Wet	Tough	Good	Excellent
10-2415 Smoky Hill (check)	**0**	**1**	**7**	**7**	**2**
10-2416 HV9W06-262R	**2**	**0**	**7**	**7**	**1**
10-2417 HV9W06-218W	**2**	**0**	**1**	**11**	**3**

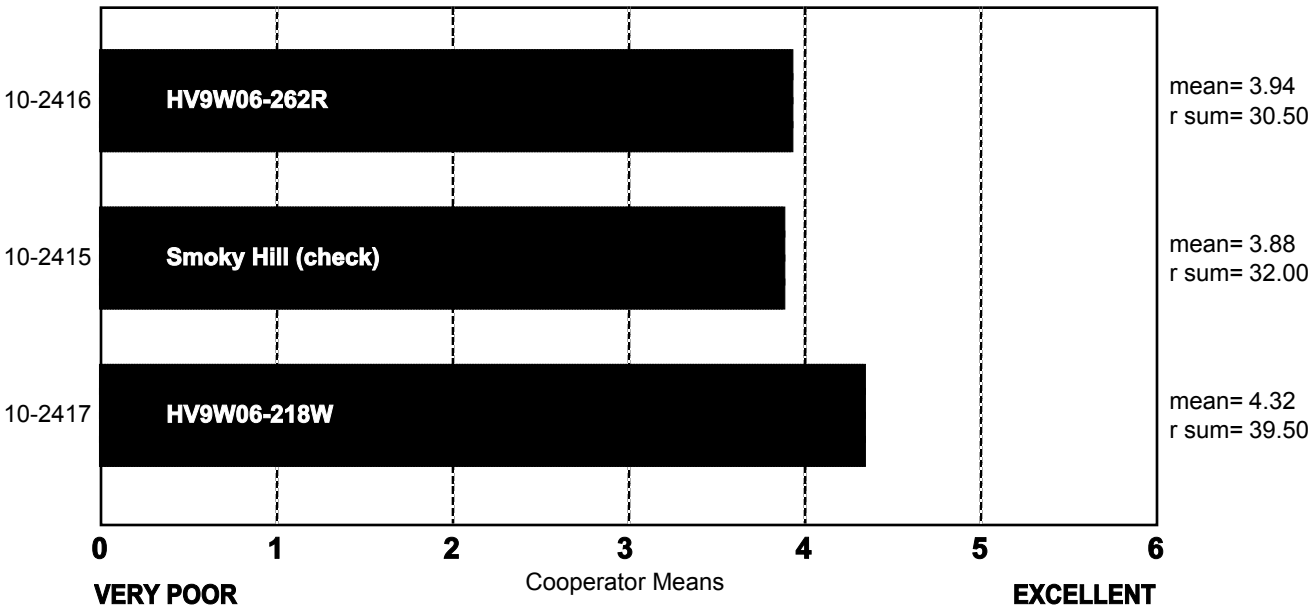
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Westbred

ncoop= 17
chisq= 2.74
chisqc= 4.04
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Westbred

	Sticky	Wet	Tough	Good	Excellent
10-2415 Smoky Hill (check)	**0**	**0**	**6**	**8**	**3**
10-2416 HV9W06-262R	**1**	**0**	**7**	**8**	**1**
10-2417 HV9W06-218W	**0**	**0**	**2**	**12**	**3**

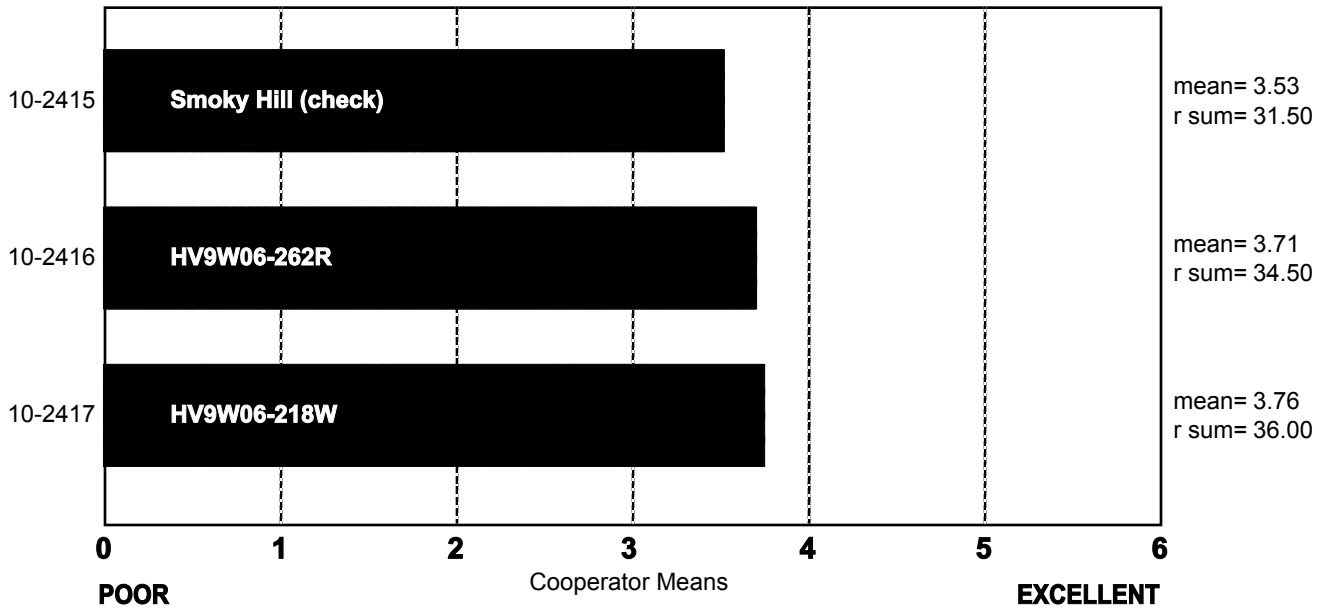
Frequency Table

CRUMB GRAIN

(Small Scale) Westbred

ncoop= 17
chisq= 0.62
chisqc= 0.75
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Westbred

	Open	Fine	Dense
10-2415 Smoky Hill (check)	**7**	**10**	**0**
10-2416 HV9W06-262R	**6**	**10**	**1**
10-2417 HV9W06-218W	**8**	**8**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Westbred

	Round	Irregular	Elongated
10-2415 Smoky Hill (check)	**6**	**6**	**5**
10-2416 HV9W06-262R	**5**	**7**	**5**
10-2417 HV9W06-218W	**7**	**5**	**5**

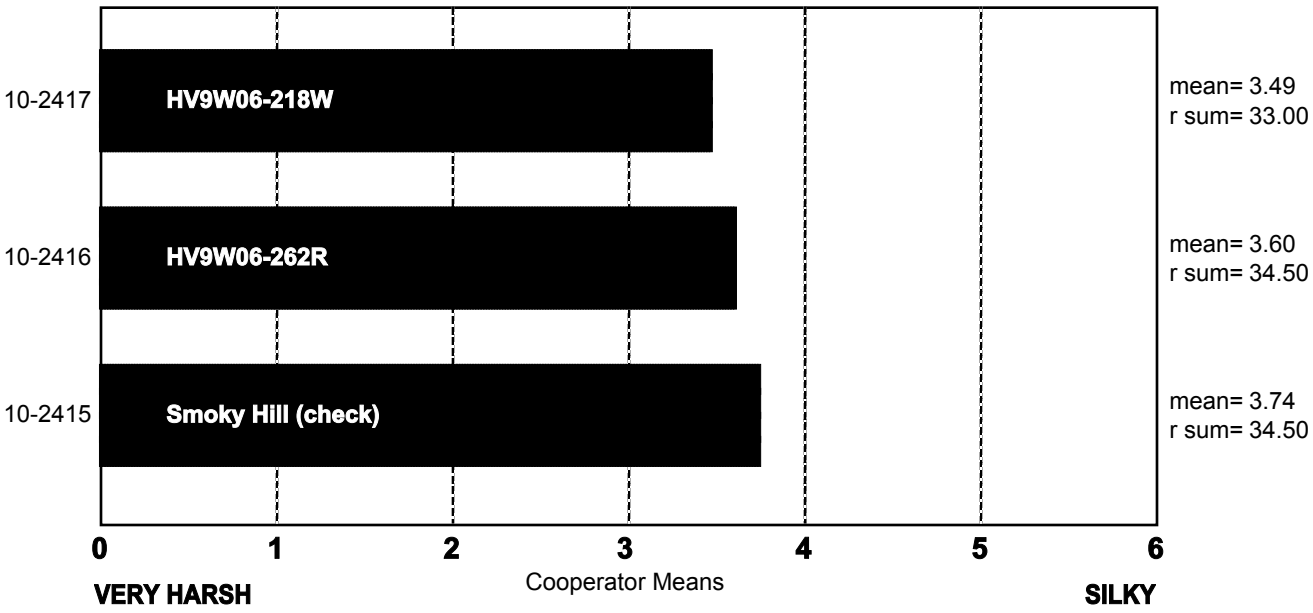
Frequency Table

CRUMB TEXTURE

(Small Scale) Westbred

ncoop= 17
chisq= 0.09
chisqc= 0.13
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Westbred

	Harsh	Smooth	Silky
10-2415 Smoky Hill (check)	**5**	**6**	**6**
10-2416 HV9W06-262R	**5**	**7**	**5**
10-2417 HV9W06-218W	**6**	**9**	**2**

Frequency Table

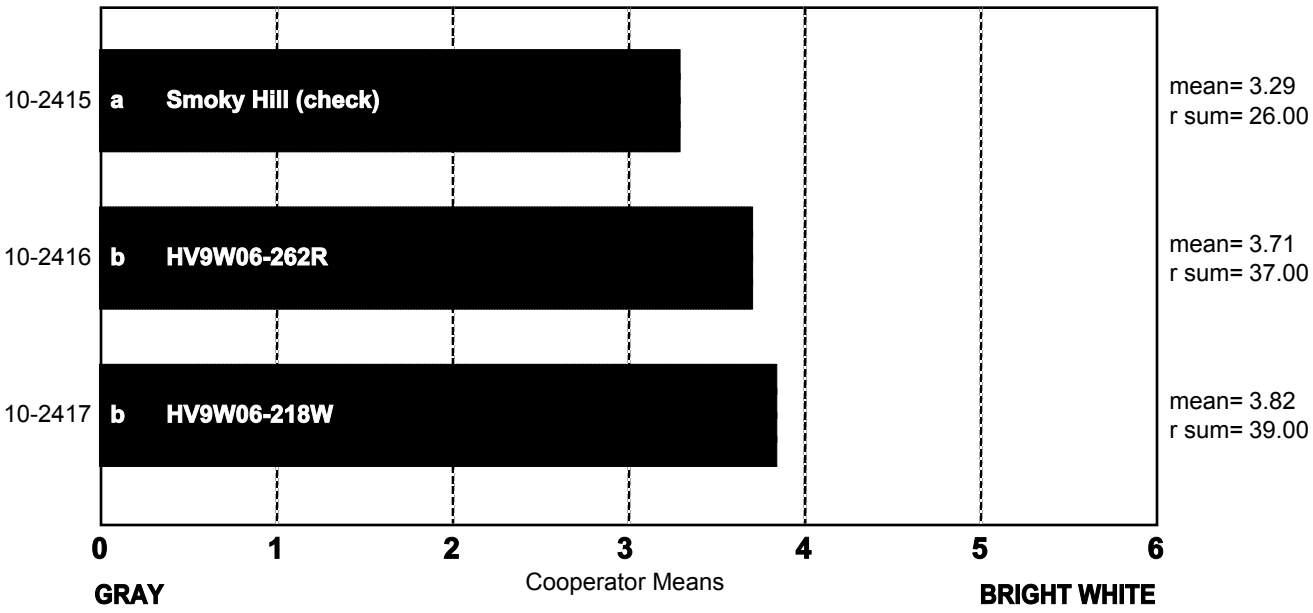
CRUMB COLOR

(Small Scale) Westbred

ncoop= 17
chisq= 5.76
chisqc= 10.59
cvchisq= 5.99
crdiff= 7.49

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Westbred

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
10-2415 Smoky Hill (check)	**1**	**1**	**1**	**6**	**6**	**1**	**1**
10-2416 HV9W06-262R	**1**	**0**	**0**	**2**	**11**	**2**	**0**
10-2417 HV9W06-218W	**1**	**0**	**0**	**2**	**8**	**3**	**1**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Westbred

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2415 Smoky Hill (check)	**144.5**	**419.0**	**510.0**	**155.6**	**132.1**	**130.0**	**144.8**	**153.0**	**483.6**	**134.0**	**470.1**	**136.1**	**143.8**	**464.0**	**151.2**	**463.6**	**459.0**
10-2416 HV9W06-262R	**140.4**	**418.0**	**505.0**	**155.2**	**129.0**	**128.1**	**143.5**	**152.8**	**484.4**	**134.0**	**469.6**	**138.5**	**142.3**	**466.0**	**149.7**	**461.3**	**456.1**
10-2417 HV9W06-218W	**142.3**	**420.0**	**505.0**	**155.4**	**129.6**	**130.9**	**144.8**	**157.6**	**474.2**	**134.0**	**469.8**	**141.1**	**142.2**	**462.0**	**151.2**	**459.2**	**451.8**

Raw Data

LOAF VOLUME, ACTUAL

(Small Scale) Westbred

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2415 Smoky Hill (check)	**990**	**3100**	**2600**	**644**	**690**	**965**	**893**	**1035**	**3162**	**993**	**2538**	**1048**	**1004**	**3100**	**980**	**2625**	**2460**
10-2416 HV9W06-262R	**1120**	**3100**	**2700**	**650**	**685**	**875**	**945**	**923**	**3104**	**887**	**2550**	**915**	**902**	**2550**	**795**	**2650**	**2450**
10-2417 HV9W06-218W	**1030**	**2900**	**2650**	**618**	**685**	**910**	**918**	**1038**	**2986**	**910**	**2663**	**958**	**922**	**2850**	**880**	**2575**	**2560**

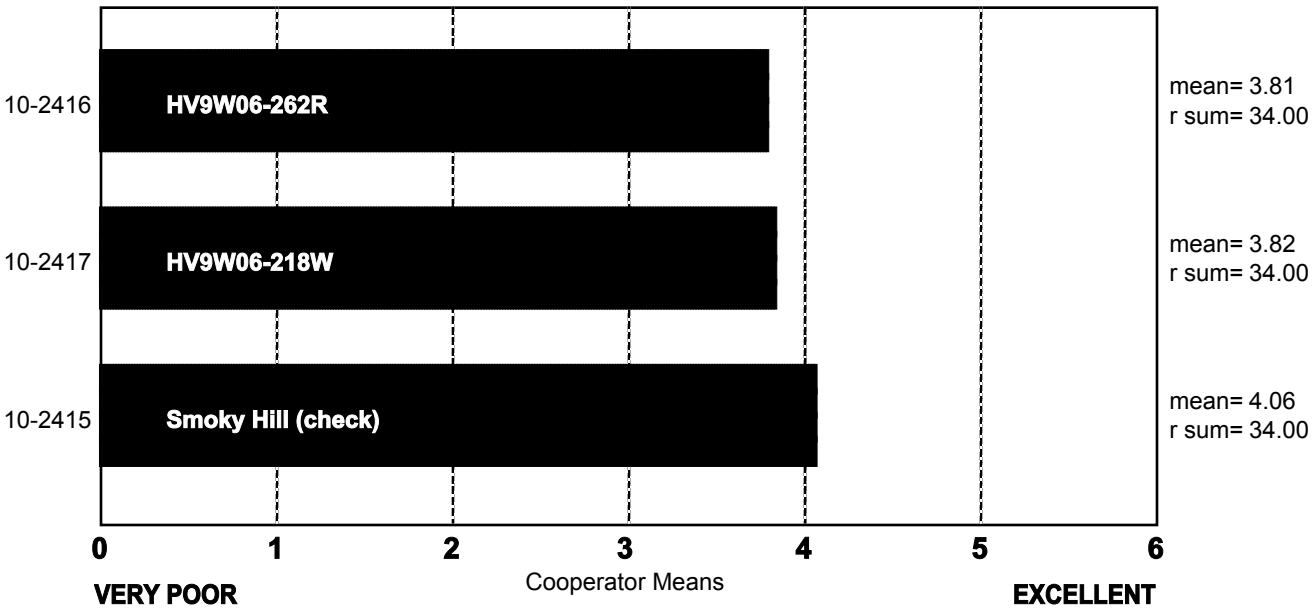
Raw Data

LOAF VOLUME

(Small Scale) Westbred

ncoop= 17
chisq= 0.00
chisqc= 0.00
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

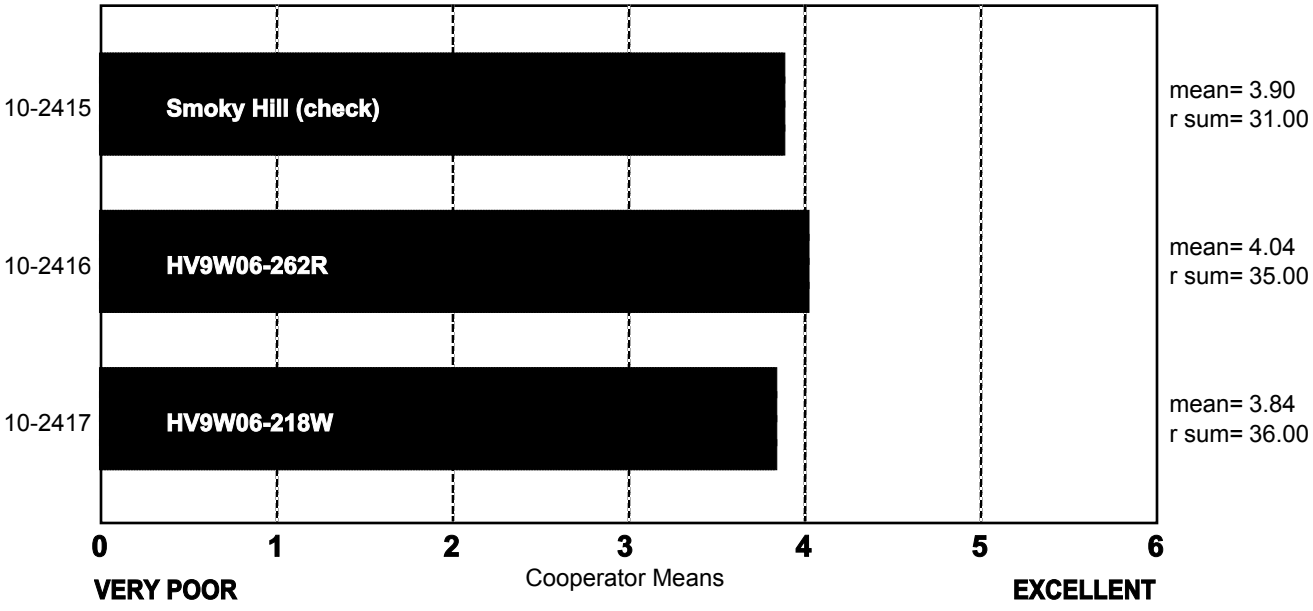


OVERALL BAKING QUALITY

(Small Scale) Westbred

ncoop= 17
chisq= 0.82
chisqc= 0.97
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



COOPERATOR'S COMMENTS
(Small Scale) Westbred

COOP. **10-2415** **Smoky Hill (Check)**

A. Slow dough pick up during mixing.

B. Tough and bucky, dry, very open grain, sl. dull crumb, hi protein, good volume.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption and long mix time, wet, soft and sl. sticky and strong dough, very hi OS, open and elongated cells, sl. yellow crumb, smooth and resilient texture.

H. Good dough and interior.

I. Extremely strong, somewhat dark crumb color, excellent volume.

J. Excellent bake quality; great volume, grain, and mix tolerance, very long mix requirement, strong and elastic dough handling even at 9 minute mix.

K. Very long mix time, tough dough, open grain, yellow crumb, sl. low volume.

L. No comment.

M. Dough smears around the bowl, slow pick up.

N. No comment.

O. Good mixograph tolerance, flour protein, absorption, crumb grain and loaf volume.

P. No comment.

Q. Good rating and volume, tough dough, long mix time.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Westbred

COOP. **10-2416** **HV9W06-262R**

A. Excellent exterior, long mix time.

B. Tough dough, good volume, long mix, very open grain, creamy.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption and long mix time, wet, soft and sl. strong dough, very hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Good dough and interior.

I. Very strong dough, open grain, excellent volume.

J. Great bake quality; nice volume, grain, and mix tolerance, very long mix requirement, doughs were underdeveloped until 9 minute mix.

K. Very long mix time, average absorption.

L. No comment.

M. No comment.

N. No comment.

O. Rated below Smoky Hill check due to very long mix time, questionable crumb grain and low loaf volume.

P. No comment.

Q. Good rating and volume, tough dough, long mix time.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Westbred

COOP. **10-2417** **HV9W06-218W**

A. Excellent exterior.

B. Good out of mixer, shorter mix, good volume, sl. open grain, creamy.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. strong dough, very hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Very good overall performance, good value of the protein.

I. Sl. open, sl. irregular grain, good volume.

J. OK bake quality, good dough handling but showed drop in tolerance.

K. Average absorption, mix time and volume.

L. No comment.

M. No comment.

N. No comment.

O. Shorter mix time and satisfactory crumb grain.

P. No comment.

Q. Excellent rating for volume and color, long mix time.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

Montana – Phil Bruckner/Jim Berg

2010 Crop Year – Bozeman, MT

The Post Agronomy Farm (6mi west of Bozeman) had above average rainfall for the 2010 crop year (17.4in versus 16.1in for the 53yr average). There was adequate snow cover during winter months and no winterkill was observed. Spring heading was later than average by 8 days due to below average May and June temperatures. There was also above average moisture recorded in both those months. Average July and August temperatures following late heading led to later maturity of the crop (harvested in early September instead of mid-August). A hail storm, with golf ball size stones, occurred on June 30th and caused around 25% stem breakage (7-63% depending on variety). Many trials, including all regional and Montana Intrastate Tests (varieties and elite lines), were not harvested. Yields on tests that were harvested averaged ~100 bu/a (Montana winter wheat producers average = 48 bu/a, a record year) with below average test weights (59.6 lb/bu). Proteins were above average at 13.8%.

Yellowstone (MT check) – hard red winter wheat developed by the Montana Agricultural Experiment Station and released to seed growers in 2005. Yellowstone is a very high yielding winter-hardy variety with medium test weight, maturity, height, and grain protein. Yellowstone has excellent baking and good Asian noodle quality. It is moderately resistant to TCK smut and resistant to stripe rust, but susceptible to stem rust. PVP, Title V has been issued (Certificate #200600284). Yellowstone continues to be the second leading winter wheat variety (after Genou) planted in Montana in 2010 with 18.0% of the acreage (378,600 acres).

MTS0721 – a solid stemmed hard red winter wheat line with a complex pedigree. It consists of a composite of 5 lines with a common parent, 98X69 = Dominant Male Sterile line/Rampart//Pronghorn/3/Rampart crossed to Rampart, Nuplains, and three separate Montana experimental lines. MTS0721 has average yield, protein and test weight. It has average heading date and is shorter than most Montana lines. Like most solid stem lines, it does not appear to be very winter-hardy in eastern Montana and western North Dakota, in limited testing. MTS0721 is resistant to stem rust, but susceptible to stripe rust. Milling characteristics were above average and baking was average in Montana tests.

Montana: 2010 (Small-Scale) Samples [a]

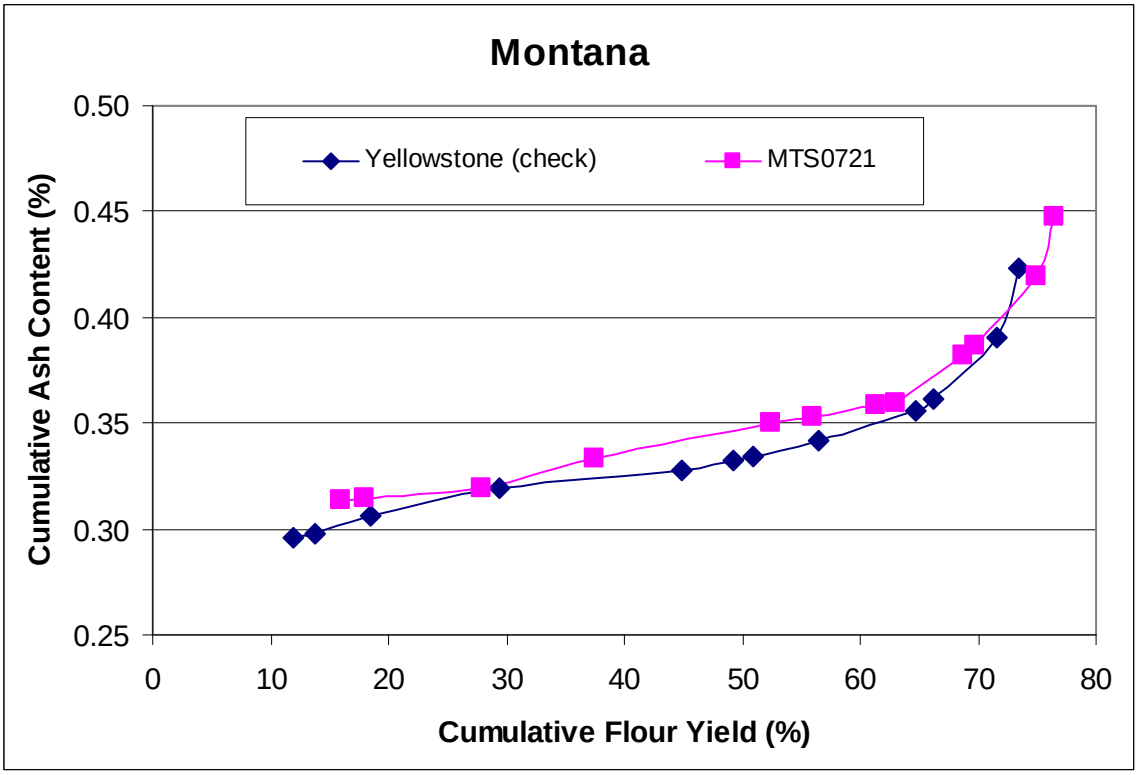
Test entry number	10-2418	10-2419
Sample identification	**Yellowstone (check)**	**MTS0721**
Wheat Data		
FGIS classification	1 HRW	1 HRW
Test weight (lb/bu)	61.0	60.6
Hectoliter weight (kg/hl)	80.2	79.7
1000 kernel weight (gm)	43.7	35.0
Wheat kernel size (Rotap)		
Over 7 wire (%)	92.3	78.1
Over 9 wire (%)	7.7	21.7
Through 9 wire (%)	0.0	0.1
Single kernel (skcs)		
Hardness (avg /s.d)	61.6/13.7	61.4/14.8
Weight (mg) (avg/s.d)	43.7/8.4	35.0/8.4
Diameter (mm)(avg/s.d)	2.97/0.34	2.75/0.31
SKCS distribution	02-11-30-57	01-13-31-55
Classification	Hard	Hard
Wheat moisture (%)	11.7	11.0
Wheat protein (12% mb)	13.7	14.7
Wheat ash (12% mb)	1.59	1.52
Milling and Flour Quality Data		
Flour yield (%, str. grade)		
Miag Multomat Mill	73.5	76.5
Quadrumat Sr. Mill	73.2	73.2
Flour moisture (%)	10.6	10.6
Flour protein (14% mb)	12.5	13.1
Flour ash (14% mb)	0.47	0.47
Glutomatic		
Wet gluten (%)	32.9	39.6
Dry gluten (%)	11.8	13.7
Gluten index	99.4	75.6
Rapid Visco-Analyser		
Peak time (min)	6.3	6.2
Peak viscosity (RVU)	201.3	204.9
Breakdown (RVU)	62.3	64.5
Final viscosity at 13 min (RVU)	244.6	255.6
Minolta color meter		
L*	92.4	92.4
a*	-1.42	-1.62
b*	9.16	9.06
Falling number (sec)	479	394
Damaged Starch		
(AI%)	95.41	95.61
(AACC76-31)	5.83	5.97

[a]s.d.= standard deviation; skcs = Single Kernel Characterization System 4100.

Montana: Physical Dough Tests and Gluten Analysis For 2010 (Small-Scale) Samples

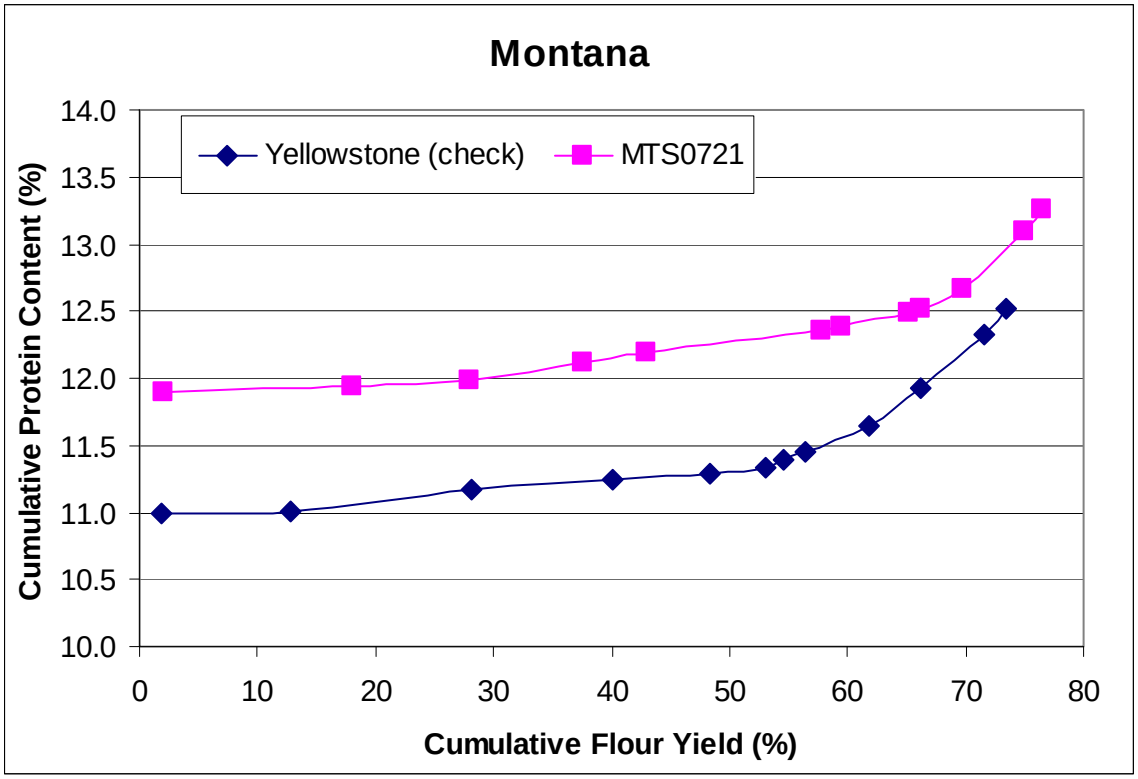
Test Entry Number	**10-2418**	**10-2419**
Sample Identification	**Yellowstone (check)**	**MTS0721**
MIXOGRAPH		
Flour Abs (% as-is)	69.6	68.5
Flour Abs (14% mb)	65.8	64.6
Mix Time (min)	6.25	3.13
Mix tolerance (0-6)	5	2
FARINOGRAPH		
Flour Abs (% as-is)	64.3	65.2
Flour Abs (14% mb)	60.5	61.4
Development time (min)	6.5	8.0
Mix stability (min)	18.1	14.0
Mix Tolerance Index (FU)	25	29
Breakdown time (min)	12.6	13.0
ALVEOGRAPH		
P(mm. $_{H2O}$): Tenacity	103	72
L(mm): Extensibility	110	100
G($mm_{0.5}$): Swelling index	23.3	22.3
W(10^{-4} J): strength (curve area)	457	260
P/L: curve configuration ratio	0.94	0.72
Ie(P_{200}/P): elasticity index	72.3	63.1
EXTENSIGRAPH		
Resist (BU at 30/60/90 min)	692/937/999	371/500/554
Extensibility (mm at 30/60/90 min)	136/121/110	163/153/144
Energy (cm^2 at 30/60/90 min)	151/164/150	96/138/143
Resist $_{max}$ (BU at 30/60/90 min)	894/996/999	457/729/816
Ratio (at 30/60/90 min)	5.1/7.8/9.1	2.0/3.3/3.8
PROTEIN ANALYSIS		
HMW-GS Composition	1, 7+8, 5+10	2*, 7+8, 5+10
Glu/Gli	0.88	0.61
HMW/LMW	0.34	0.36
%IPP	49.63	43.11
SEDIMENTATION TEST		
Volume (ml)	67.8	48.1

Montana: Cumulative Ash Curves



Yellowstone (check) - 2418					MTS0721 - 2419				
Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash
2M	11.90	0.30	11.90	0.30	2M	15.93	0.31	15.93	0.31
1M Red	1.86	0.31	13.76	0.30	1M Red	2.02	0.32	17.95	0.31
1M	4.77	0.33	18.53	0.31	1M	9.99	0.33	27.95	0.32
4M	10.96	0.34	29.49	0.32	4M	9.61	0.38	37.56	0.33
3M	15.35	0.35	44.84	0.33	3M	14.80	0.39	52.36	0.35
2BK	4.33	0.38	49.17	0.33	2BK	3.56	0.41	55.92	0.35
Grader	1.80	0.39	50.97	0.33	1BK	5.41	0.41	61.33	0.36
1BK	5.47	0.41	56.44	0.34	Grader	1.62	0.41	62.95	0.36
5M	8.19	0.45	64.63	0.36	5M	5.81	0.63	68.75	0.38
FILTER FLR	1.53	0.58	66.16	0.36	FILTER FLR	1.06	0.64	69.81	0.39
3BK	5.38	0.75	71.54	0.39	3BK	5.11	0.87	74.92	0.42
BRAN FLR	1.83	1.70	73.37	0.42	BRAN FLR	1.61	1.75	76.53	0.45
Break Shorts	3.59	3.64	76.97	0.57	Break Shorts	3.32	3.81	79.85	0.59
Red Dog	1.24	3.33	78.20	0.62	Red Dog	1.15	3.45	80.99	0.63
Red Shorts	0.09	4.53	78.29	0.62	Red Shorts	0.06	4.08	81.05	0.63
Filter Bran	0.52	1.95	78.82	0.63	Filter Bran	0.41	1.73	81.46	0.64
Bran	21.18	5.26	100.00	1.61	Bran	18.54	4.80	100.00	1.41
Wheat		1.55			Wheat				1.49
St. Grd. Fl.		0.47			St. Grd. Fl.				0.47

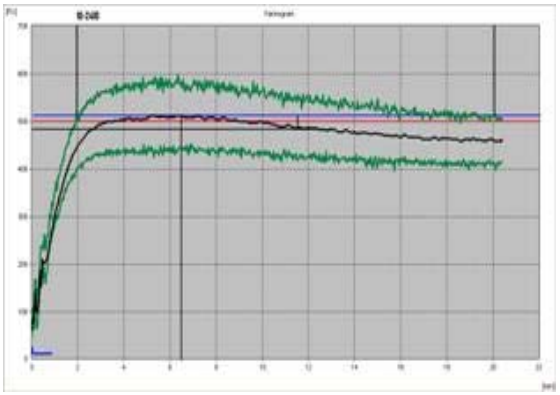
Montana: Cumulative Protein Curves



Yellowstone (check) - 2418					MTS0721 - 2419				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1M Red	1.86	10.99	1.86	10.99	1M Red	2.02	11.89	2.02	11.89
4M	10.96	11.00	12.82	11.00	2M	15.93	11.95	17.95	11.95
3M	15.35	11.30	28.17	11.17	1M	9.99	12.04	27.95	11.98
2M	11.90	11.42	40.07	11.24	4M	9.61	12.53	37.56	12.12
5M	8.19	11.51	48.26	11.29	1BK	5.41	12.70	42.97	12.19
1M	4.77	11.85	53.03	11.34	3M	14.80	12.80	57.77	12.35
FILTER FLR	1.53	13.16	54.57	11.39	Grader	1.62	13.58	59.39	12.38
Grader	1.80	13.37	56.37	11.45	5M	5.81	13.59	65.19	12.49
1BK	5.47	13.70	61.83	11.65	FILTER FLR	1.06	13.72	66.25	12.51
2BK	4.33	15.81	66.16	11.92	2BK	3.56	15.68	69.81	12.67
3BK	5.38	17.37	71.54	12.33	3BK	5.11	18.97	74.92	13.10
BRAN FLR	1.83	20.07	73.37	12.52	BRAN FLR	1.61	20.57	76.53	13.26
Break Shorts	3.59	14.89	76.97	12.64	Break Shorts	3.32	16.47	79.85	13.39
Red Dog	1.24	14.46	78.20	12.66	Red Dog	1.15	15.45	80.99	13.42
Red Shorts	0.09	14.36	78.29	12.67	Red Shorts	0.06	15.34	81.05	13.42
Filter Bran	0.52	12.66	78.82	12.67	Filter Bran	0.41	13.52	81.46	13.42
Bran	21.18	18.28	100.00	13.85	Bran	18.54	19.61	100.00	14.57
Wheat		13.43			Wheat		14.33		
St. Grd. Fl		12.52			St. Grd. Fl		13.05		

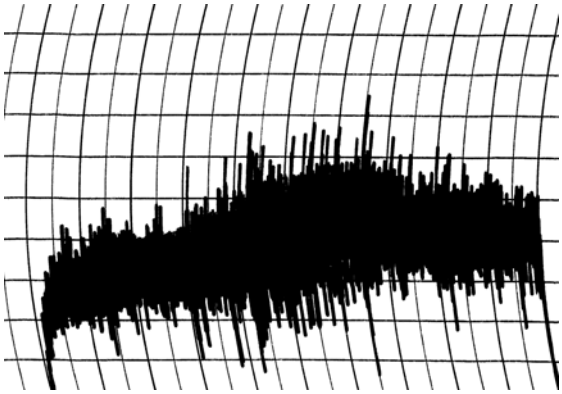
Physical Dough Tests
2010 (Small Scale) Samples – Montana

Farinograms



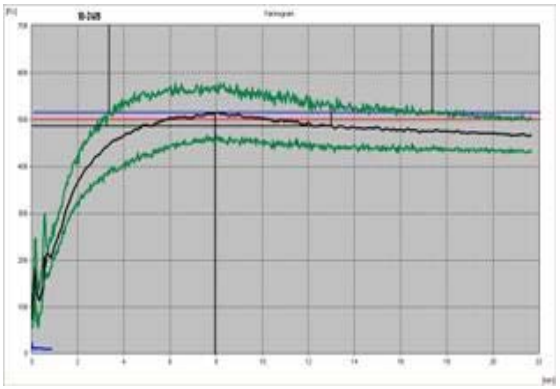
Water abs = 60.5%, Peak time = 6.5 min,
Mix stab = 18.1 min, MTI = 25 FU

Mixograms

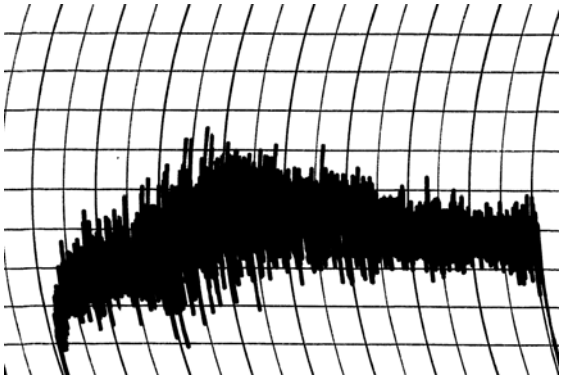


Water abs = 65.8%
Mix time = 6.3 min

10-2418, Yellowstone (check)



Water abs = 61.4%, Peak time = 8.0 min,
Mix stab = 14.0 min, MTI = 29 FU

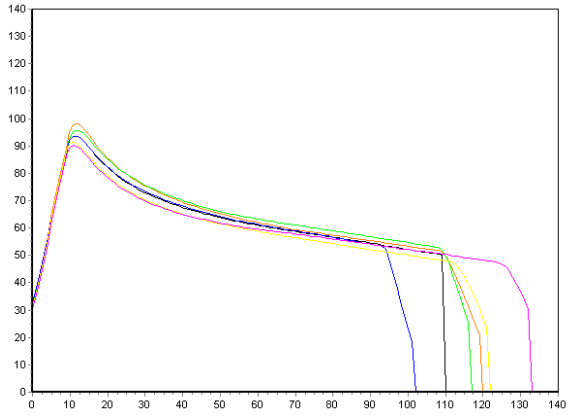


Water abs = 64.6%
Mix time = 3.1 min

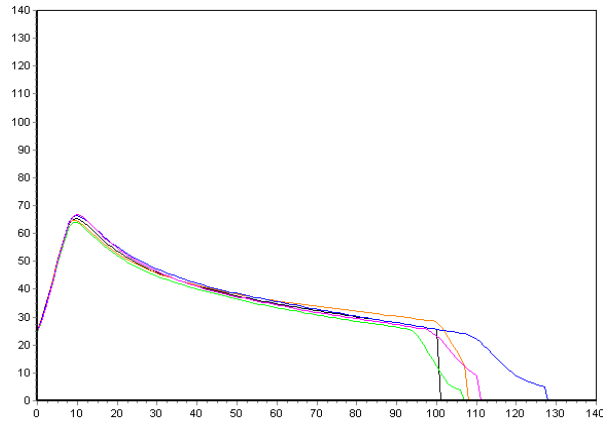
10-2419, MTS0721

Physical Dough Tests - Alveograph

2010 (Small Scale) Samples – Montana



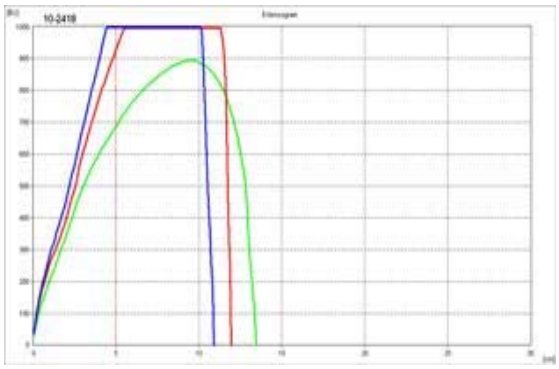
10-2418 (Yellowstone (check))
P(mm H_20)=103, L(mm)=110, W($10E^{-4}$ J)=457



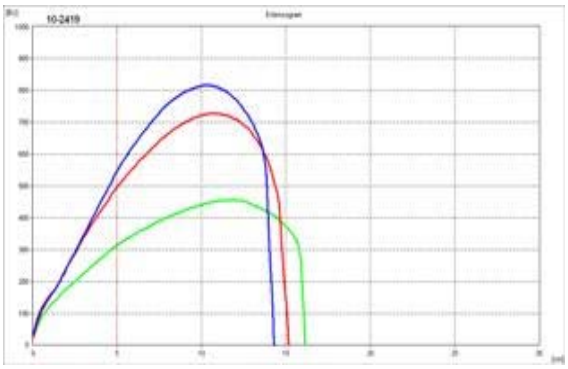
10-2419 (MTS0721)
P(mm H_20)=72, L(mm)=100, W($10E^{-4}$ J)=260

Physical Dough Tests - Extensigraph

2010 (Small Scale) Samples – Montana



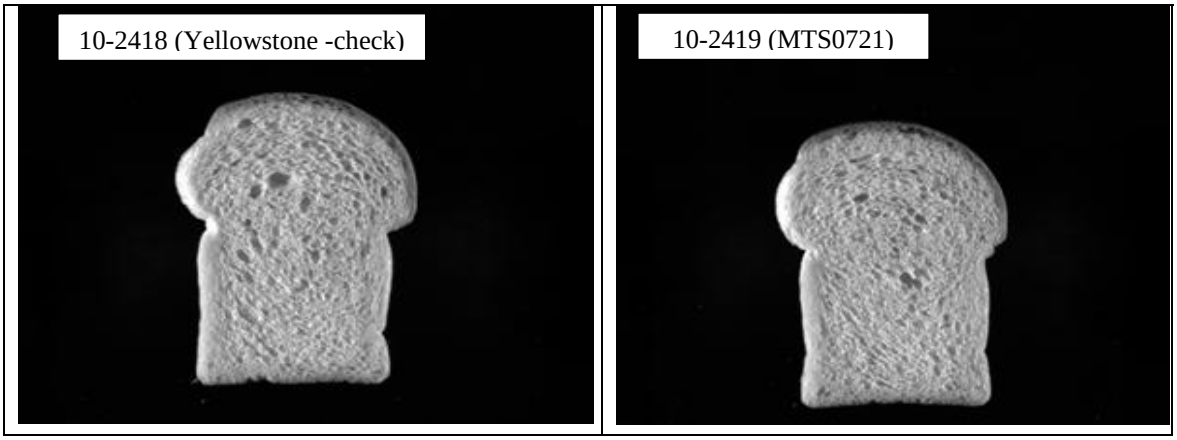
10-2418 (Yellowstone - check)
R (BU) = 999, E (mm) =110, W (cm^2) = 150
Rmax (BU) = 999, Ratio = 9.1 at 90 min



10-2419 (MTS0721)
R (BU) = 554, E (mm) =144, W (cm^2) = 143
Rmax (BU) = 816, Ratio = 3.8 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

Montana: C-Cell Bread Images and Analysis for 2010 (Small-Scale) Samples



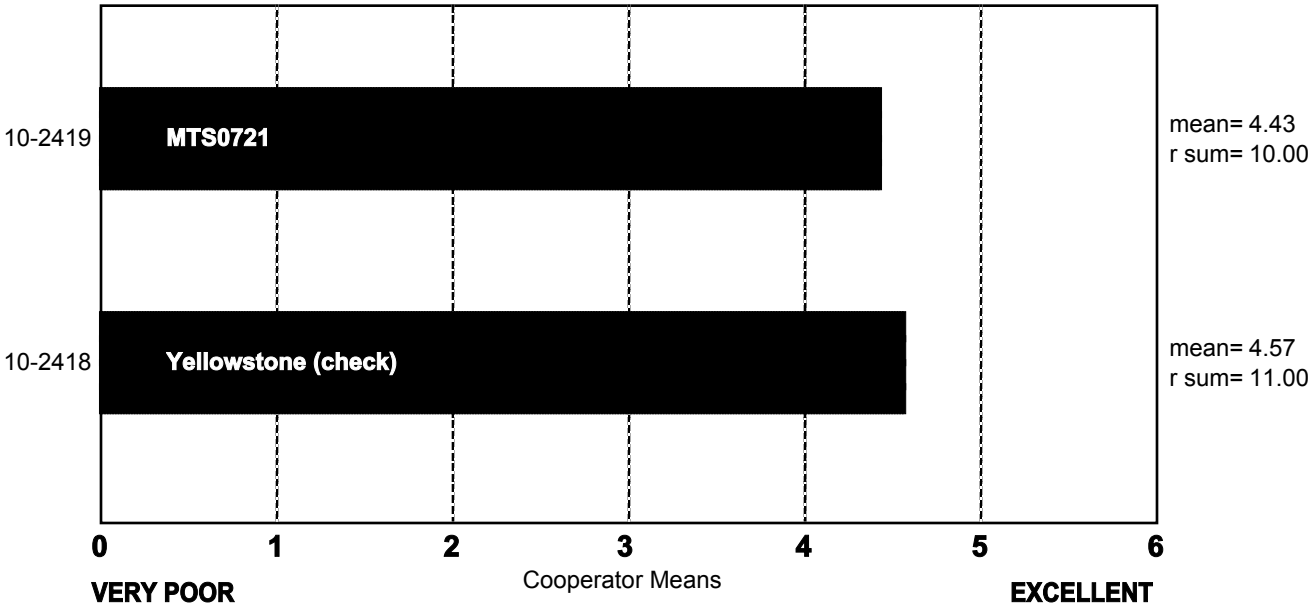
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2418	6301	156.4	3739	0.452	2.091	1.699	1.633	-20.08
2419	6111	156.0	3689	0.450	2.055	6.432	1.638	-29.75

SPONGE CHARACTERISTICS

(Small Scale) Montana

ncoop= 7
chisq= 0.14
chisqc= 0.50
cvchisq= 3.84
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

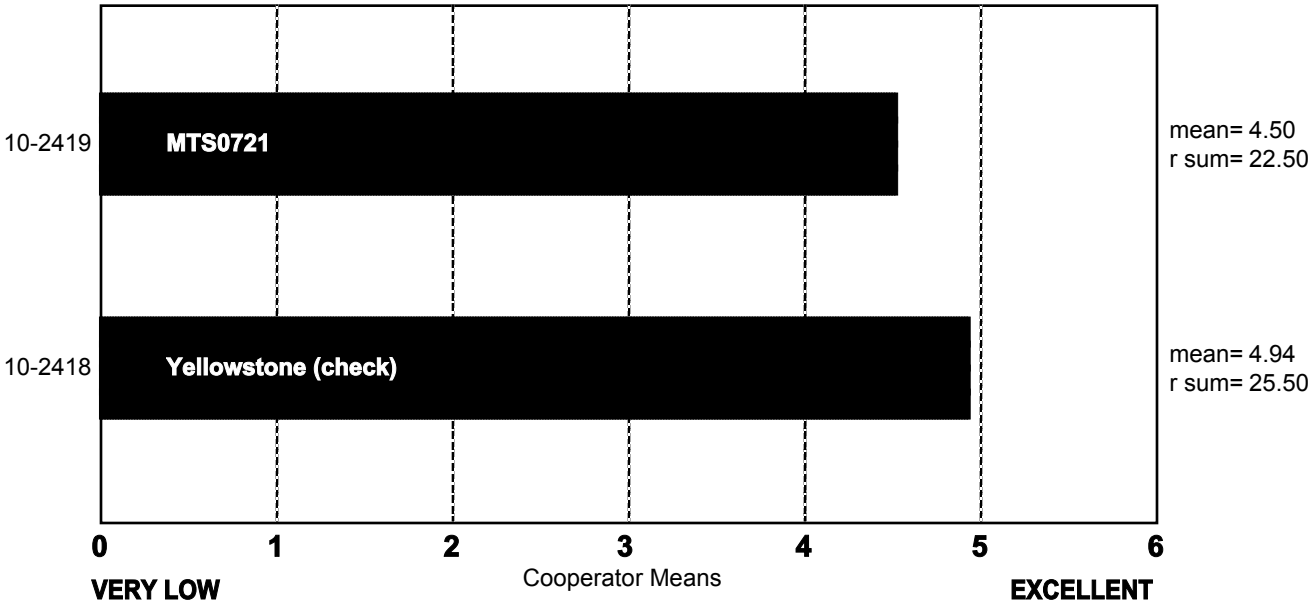


BAKE ABSORPTION

(Small Scale) Montana

ncoop= 16
chisq= 0.56
chisqc= 1.13
cvchisq= 3.84
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Montana

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2418 Yellowstone (check)	**63.6**	**59.0**	**57.5**	**65.8**	**62.0**	**62.8**	**63.0**	**66.0**	**61.0**	**63.0**	**63.0**	**68.1**	**69.6**	**67.8**	**65.4**	**60.0**	**63.5**
10-2419 MTS0721	**64.7**	**60.0**	**58.5**	**64.6**	**60.9**	**63.7**	**64.0**	**63.7**	**61.0**	**64.0**	**61.0**	**67.1**	**68.6**	**66.6**	**62.8**	**58.5**	**64.4**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Montana

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2418 Yellowstone (check)	**5.5**	**20.0**	**7.0**	**6.0**	**2.3**	**5.3**	**5.8**	**4.4**	**25.0**	**6.0**	**16.0**	**6.0**	**6.0**	**6.0**	**8.0**	**30.0**	**15.0**
10-2419 MTS0721	**3.3**	**10.0**	**7.0**	**4.5**	**1.5**	**3.0**	**4.5**	**5.0**	**21.0**	**3.0**	**6.0**	**3.0**	**3.1**	**5.5**	**4.0**	**22.0**	**8.0**

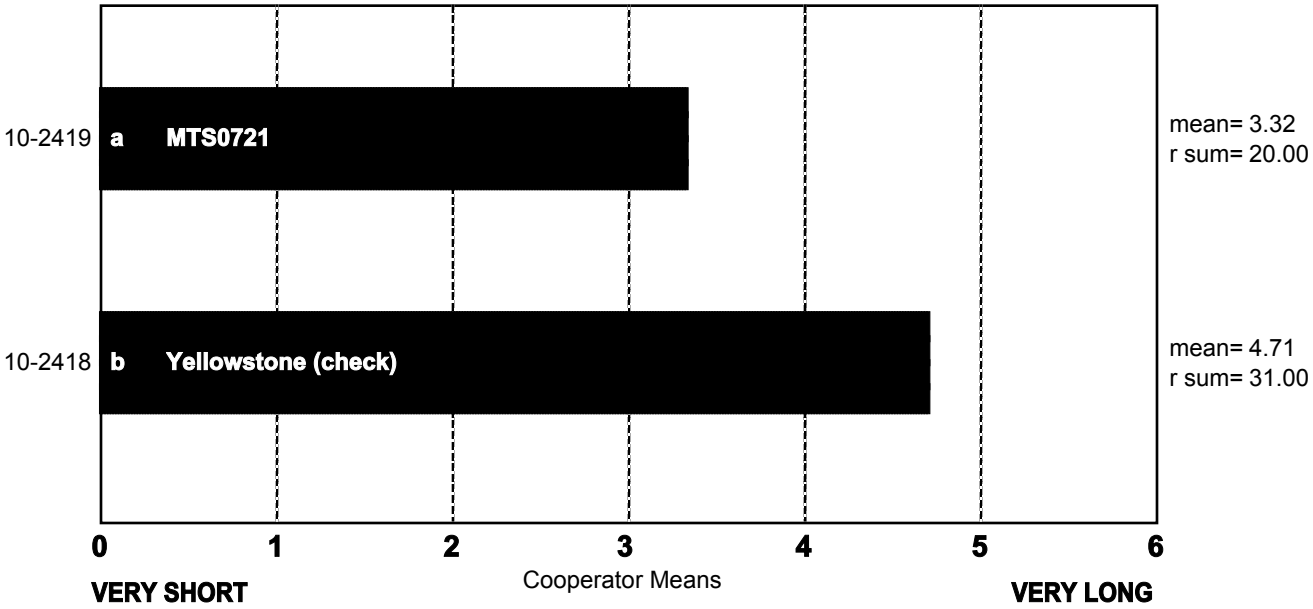
Raw Data

BAKE MIX TIME

(Small Scale) Montana

ncoop= 17
chisq= 7.12
chisqc= 8.07
cvchisq= 3.84
crdiff= 3.24

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

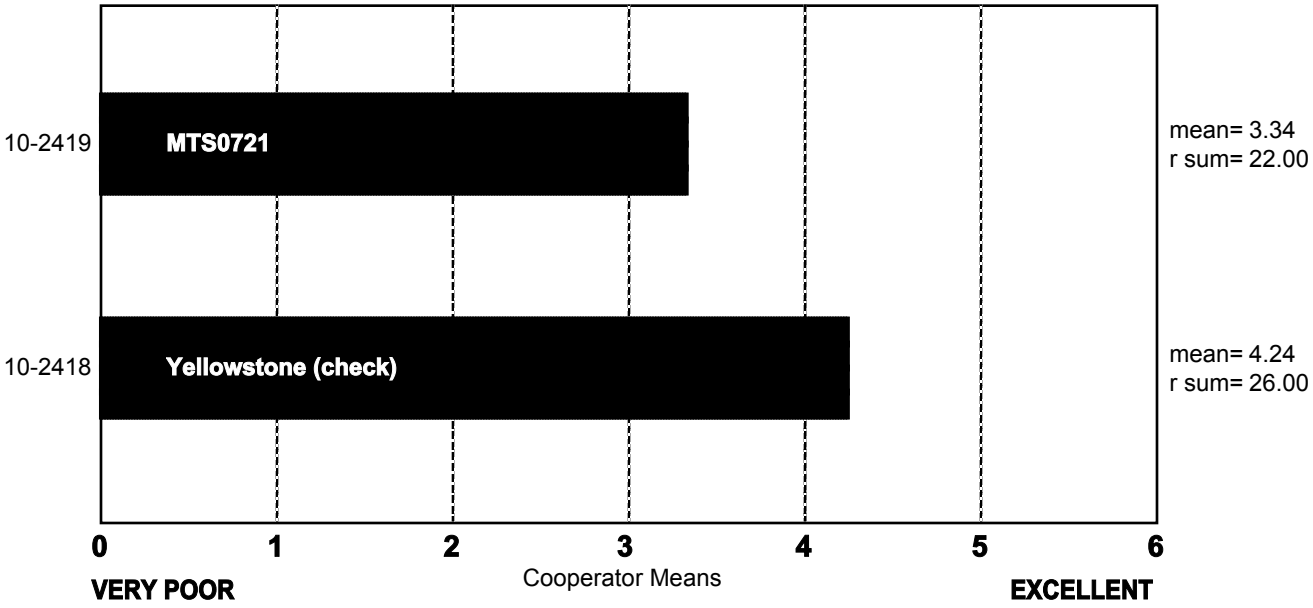


MIXING TOLERANCE

(Small Scale) Montana

ncoop= 16
chisq= 1.00
chisqc= 1.14
cvchisq= 3.84
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



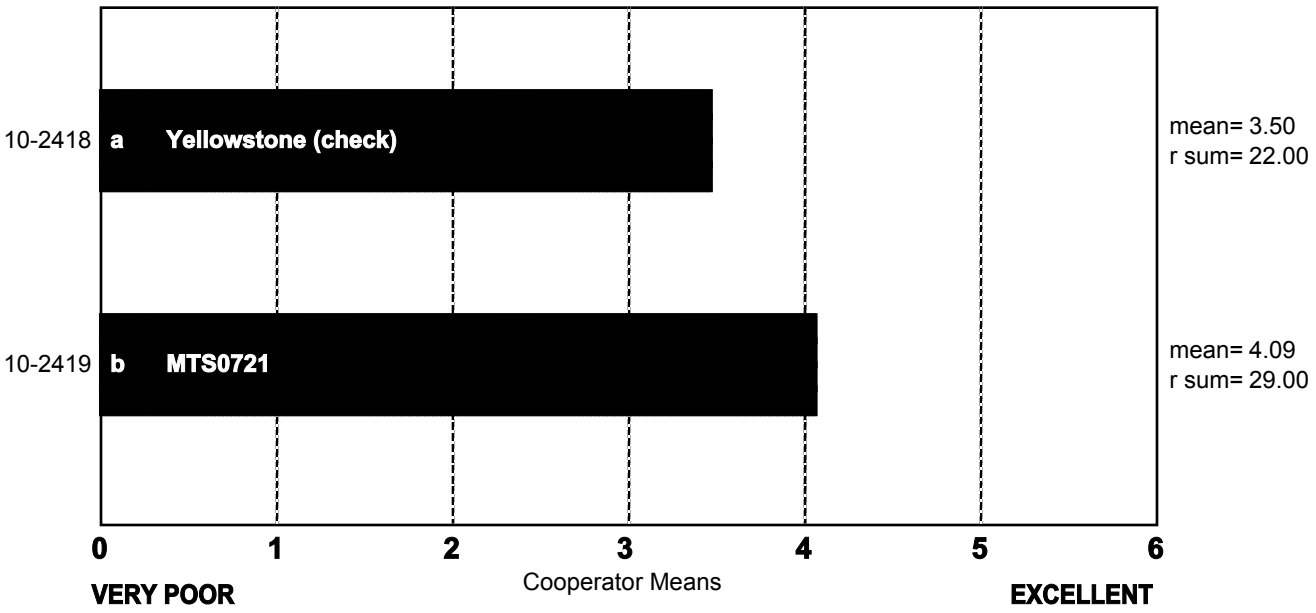
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Montana

ncoop= 17
chisq= 2.88
chisqc= 4.08
cvchisq= 3.84
crdiff= 3.29

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Montana

	Sticky	Wet	Tough	Good	Excellent
10-2418 Yellowstone (check)	**1**	**1**	**6**	**8**	**1**
10-2419 MTS0721	**3**	**2**	**0**	**10**	**2**

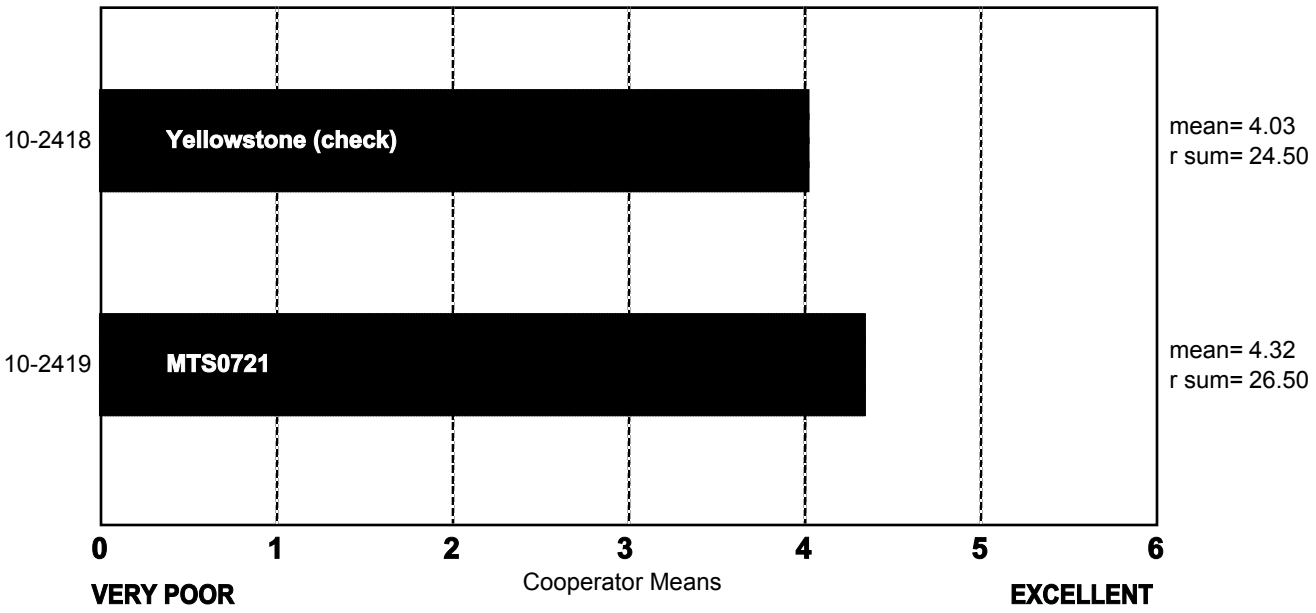
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Montana

ncoop= 17
chisq= 0.24
chisqc= 0.33
cvchisq= 3.84
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Montana

	Sticky	Wet	Tough	Good	Excellent
10-2418 Yellowstone (check)	**1**	**0**	**4**	**10**	**2**
10-2419 MTS0721	**1**	**2**	**0**	**12**	**2**

Frequency Table

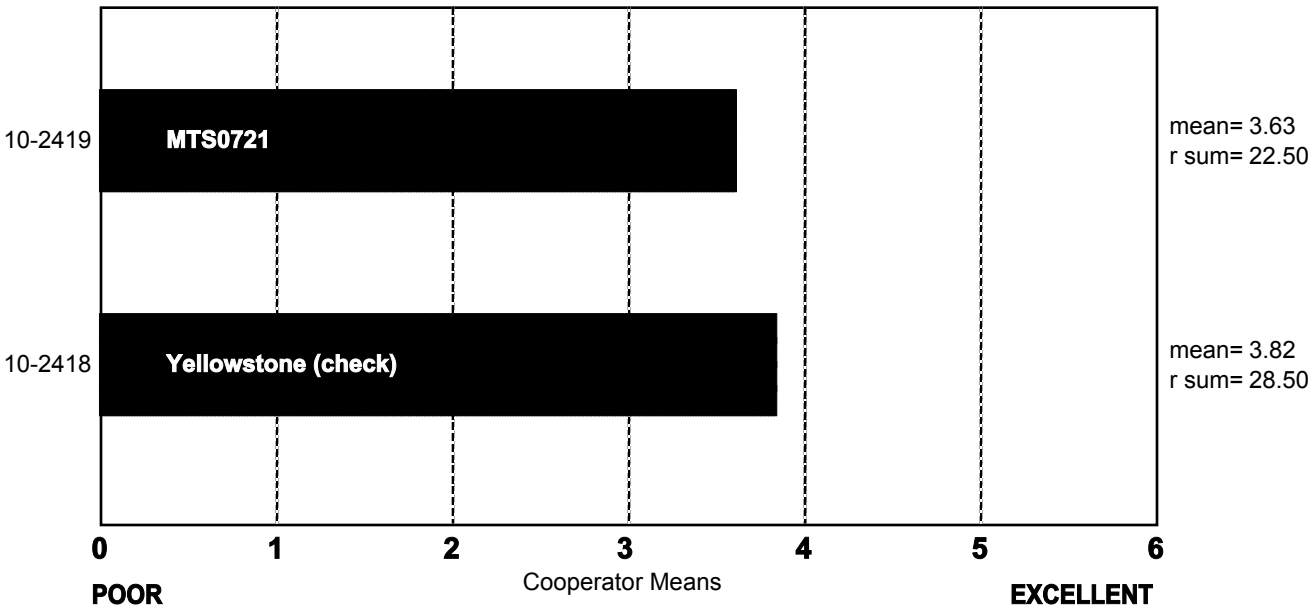
CRUMB GRAIN

(Small Scale) Montana

ncoop= 17
chisq= 2.12
chisqc= 3.00
cvchisq= 3.84
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Montana

	Open	Fine	Dense
10-2418 Yellowstone (check)	**5**	**11**	**1**
10-2419 MTS0721	**11**	**6**	**0**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Montana

	Round	Irregular	Elongated
10-2418 Yellowstone (check)	**5**	**6**	**6**
10-2419 MTS0721	**5**	**9**	**3**

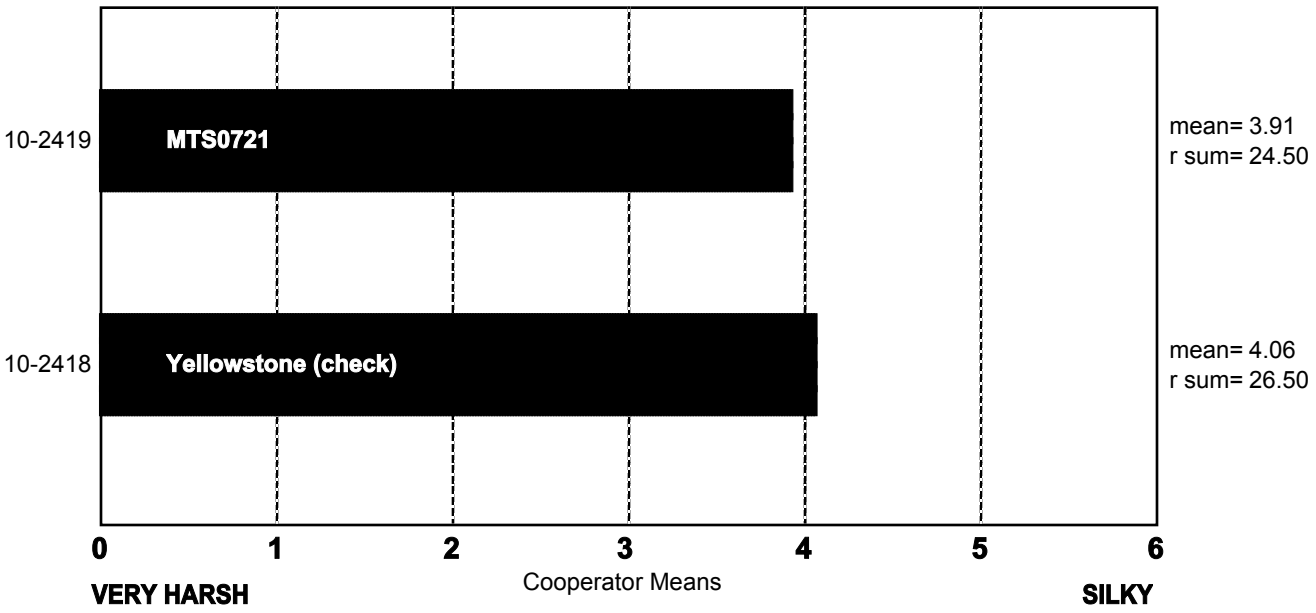
Frequency Table

CRUMB TEXTURE

(Small Scale) Montana

ncoop= 17
chisq= 0.24
chisqc= 0.50
cvchisq= 3.84
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Montana

	Harsh	Smooth	Silky
10-2418 Yellowstone (check)	**3**	**9**	**5**
10-2419 MTS0721	**3**	**9**	**5**

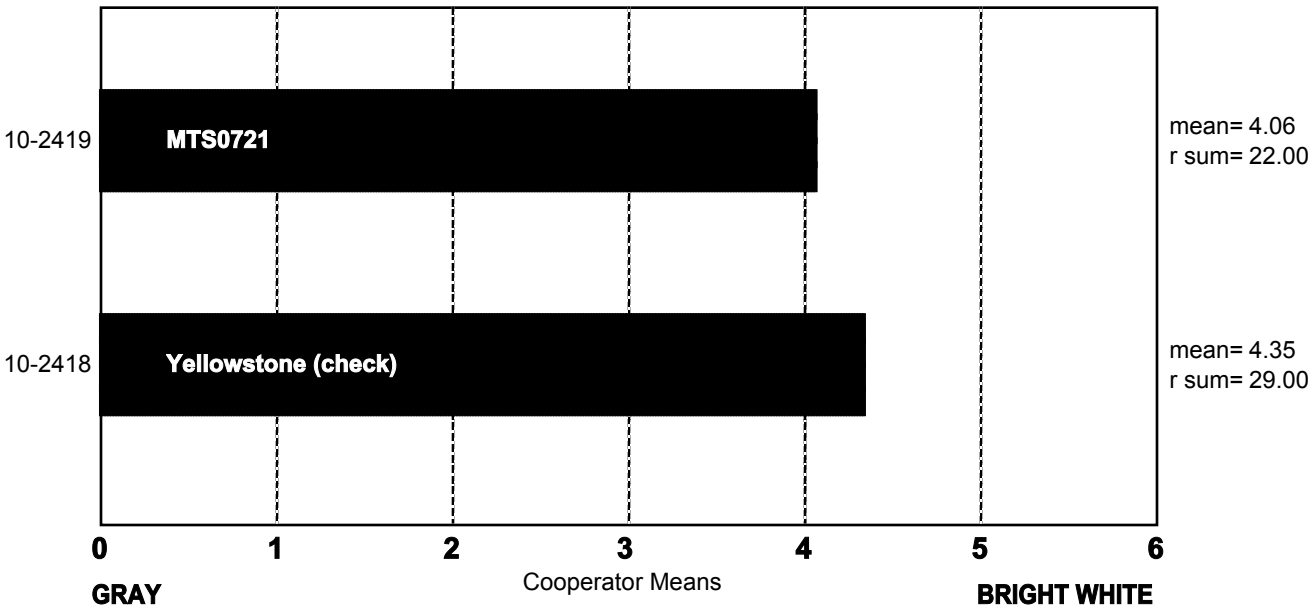
Frequency Table

CRUMB COLOR

(Small Scale) Montana

ncoop= 17
chisq= 2.88
chisqc= 3.50
cvchisq= 3.84
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Montana

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
10-2418 Yellowstone (check)	**1**	**0**	**0**	**2**	**5**	**8**	**1**
10-2419 MTS0721	**0**	**0**	**0**	**1**	**11**	**3**	**1**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Montana

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2418 Yellowstone (check)	**143.6**	**420.0**	**505.0**	**154.8**	**129.9**	**129.9**	**143.3**	**157.0**	**476.7**	**134.0**	**465.7**	**135.9**	**142.2**	**462.0**	**153.2**	**460.4**	**453.7**
10-2419 MTS0721	**145.1**	**421.0**	**500.0**	**155.1**	**128.1**	**132.4**	**144.8**	**153.3**	**485.2**	**134.0**	**468.1**	**142.4**	**142.0**	**461.0**	**152.7**	**457.5**	**459.3**

Raw Data

LOAF VOLUME, ACTUAL

(Small Scale) Montana

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2418 Yellowstone (check)	**1020**	**3000**	**3100**	**656**	**720**	**965**	**843**	**1058**	**3074**	**933**	**2625**	**1020**	**978**	**2950**	**900**	**2700**	**2460**
10-2419 MTS0721	**965**	**3000**	**3200**	**606**	**825**	**950**	**830**	**875**	**2927**	**928**	**2438**	**1000**	**1000**	**3050**	**835**	**2600**	**2100**

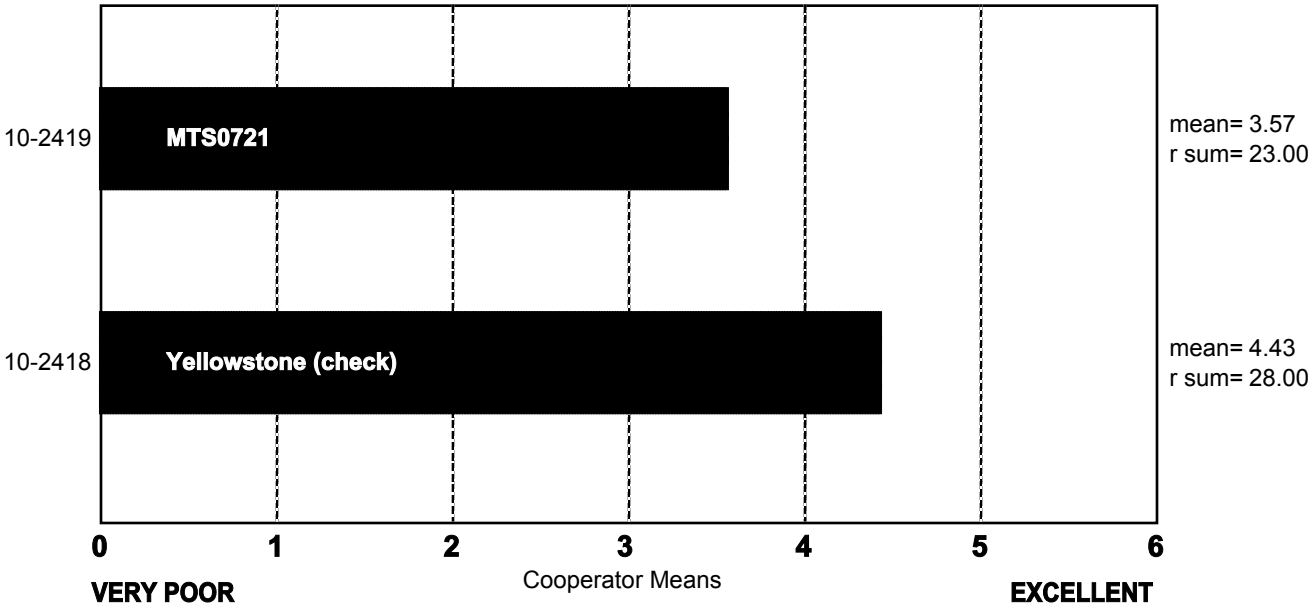
Raw Data

LOAF VOLUME

(Small Scale) Montana

ncoop= 17
chisq= 1.47
chisqc= 1.92
cvchisq= 3.84
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

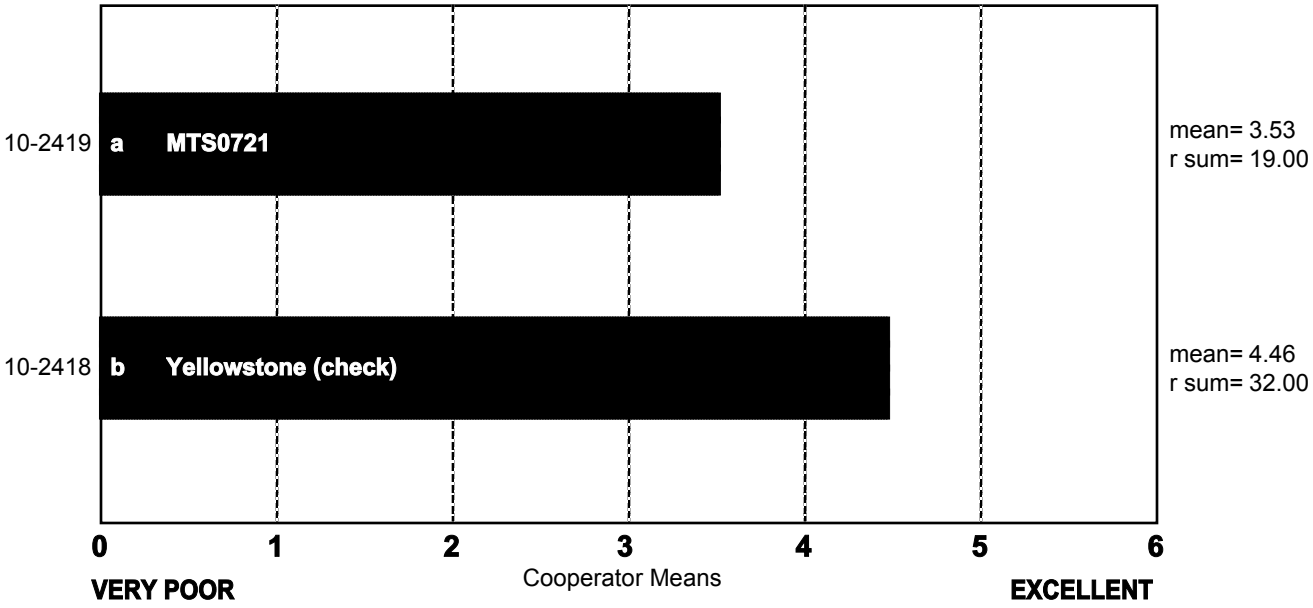


OVERALL BAKING QUALITY

(Small Scale) Montana

ncoop= 17
chisq= 9.94
chisqc= 13.00
cvchisq= 3.84
crdiff= 2.02

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS
(Small Scale) Montana

COOP. **10-2418** **Yellowstone (Check)**

A. Excellent exterior.

B. Very tough and bucky, good volume, very open grain, creamy interior, long mix.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. strong dough, hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Very good overall performance, good value of the protein.

I. Bright crumb color, sl. streaky grain, excellent volume.

J. Great bake quality, great mix tolerance and strong dough handling.

K. High absorption, very long mix time, white crumb, average volume.

L. No comment.

M. Dough smears around the bowl, slow pick up.

N. No comment.

O. Good mixograph tolerance, flour protein, absorption, crumb grain and loaf volume; long mix time.

P. No comment.

Q. Good rating, good volume, long mix time.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Montana

COOP. **10-2419** **MTS0721**

A. No comment.

B. Good out of mixer and make up, short mix, good volume, open grain, creamy.

C. No comment.

D. No comment.

E. No comment.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. sticky and strong dough, hi OS, fine and elongated cells, sl. yellow crumb, smooth and resilient texture.

H. Strong dough and good absorption.

I. Sl. open, sl. variable grain, above average volume.

J. OK bake quality, poorer than we would expect given the protein level; showed weaker, sl. tacky dough handling and poorer tolerance.

K. Sticky dough, low volume, average absorption and mix time.

L. No comment.

M. No comment.

N. No comment.

O. Good flour protein, poor tolerance in dough; low absorption, loaf volume and crumb grain.

P. No comment.

Q. Good rating, low volume.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

Texas-Amarillo – Jackie Rudd and Amir Ibrahim

Texas AgriLife Research, Amarillo

The Wheat Quality Council samples submitted by Texas AgriLife Research were harvested from strips planted adjacent to our irrigated yield trials at Bushland (near Amarillo in the Texas Panhandle). We fertilized for a yield goal of 100 bu/a. The grain yields of TAM 111, TX05A001822, and TX06A001263 were 88, 81, and 86 bu/a respectively. The crop was flood irrigated four times from early March to early May. Crop development was normal for the Texas Panhandle and there were no significant abiotic or biotic stresses except some post-anthesis heat and slight BYDV/stunting. Leaf and stripe rust appeared late in the season, but only had a slight impact on yield.

TAM 111 (Check)

TAM 111 (TX95A3091), a hard red winter wheat from the cross
TAM 107//TX78V3620/CTK78/3/TX87V1233, was released in 2002 and licensed to AgriPro Wheat. It has good yield under dryland and irrigated conditions and is resistant to stripe rust. The 2010 Texas Wheat Variety Survey indicated that TAM 111 is the most widely grown variety in the state occupying 16% of the total state acreage and 26% of the acreage in the Texas Panhandle.

TX05A001822

This hard red winter wheat experimental was selected from the TAM Wheat Improvement Program in Amarillo from the cross 2145/Overley. It is resistant to leaf rust and stem rust, but is susceptible to the Yr17 virulent race of stripe rust that was widespread in 2010. It has good yield under a wide range of environments across Texas and the Great Plains. TX05A001822 has good test weight and strong dough characteristics.

TX06A001263

This hard red winter wheat experimental was selected from the TAM Wheat Improvement Program in Amarillo from the cross TX97V3006/TX98V6239. It is resistant to leaf, stripe, and stem rust. It has good yield under a wide range of environments across Texas and the Great Plains, but is particularly suited for the warmer and higher rainfall areas of Northeast, Central and South Texas. TX06A001263 has good test weight and mellow dough characteristics.

Texas-Amarillo: 2010 (Small-Scale) Samples [a]

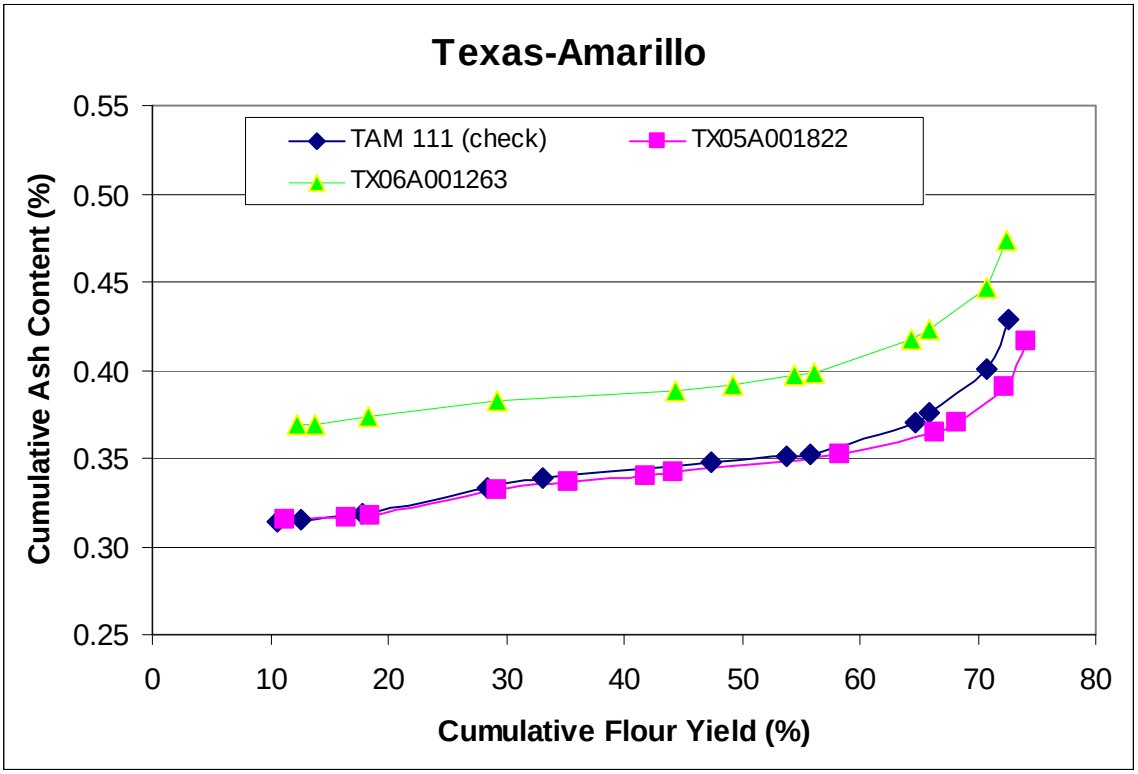
Test entry number	10-2420	10-2421	10-2422
Sample identification	TAM 111 (check)	TX05A001822	TX06A001263
Wheat Data			
FGIS classification	1 HRW	2 HRW	1 HRW
Test weight (lb/bu)	61.1	59.8	60.4
Hectoliter weight (kg/hl)	80.4	78.7	79.5
1000 kernel weight (gm)	31.3	29.7	28.9
Wheat kernel size (Rotap)			
Over 7 wire (%)	62.4	53.8	50.3
Over 9 wire (%)	36.7	44.9	48.0
Through 9 wire (%)	0.9	1.3	1.7
Single kernel (skcs)			
Hardness (avg /s.d)	72.1/14.7	62.7/19.7	79.7/18.0
Weight (mg) (avg/s.d)	31.3/9.1	29.7/7.8	28.9/8.6
Diameter (mm)(avg/s.d)	2.61/0.33	2.58/0.33	2.57/0.33
SKCS distribution	00-03-13-84	07-14-23-56	00-03-06-91
Classification	Hard	Hard	Hard
Wheat moisture (%)	10.2	10.2	10.2
Wheat protein (12% mb)	13.5	14.7	13.8
Wheat ash (12% mb)	1.50	1.44	1.66
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	72.7	74.2	72.5
Quadrumat Sr. Mill	71.3	71.4	70.2
Flour moisture (%)	10.9	10.8	10.2
Flour protein (14% mb)	11.8	13.0	12.2
Flour ash (14% mb)	0.45	0.46	0.51
Glutomatic			
Wet gluten (%)	35.1	35.2	33.6
Dry gluten (%)	12.2	12.3	11.4
Gluten index	89.6	97.0	92.6
Rapid Visco-Analyser			
Peak Time (min)	6.2	6.3	6.3
Peak Viscosity (RVU)	222.3	226.8	252.3
Breakdown (RVU)	73.8	60.0	95.9
Final Viscosity at 13 min (RVU)	266.3	291.6	257.6
Minolta color meter			
L*	92.3	92.3	91.9
a*	-1.62	-1.90	-1.55
b*	9.86	11.1	10.0
Falling number (sec)	446	466	486
Damaged Starch			
(AI%)	94.88	95.34	95.94
(AACC76-31)	5.43	5.77	6.23

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Texas-Amarillo: Physical Dough Tests and Gluten Analysis For 2010 (Small-Scale) Samples

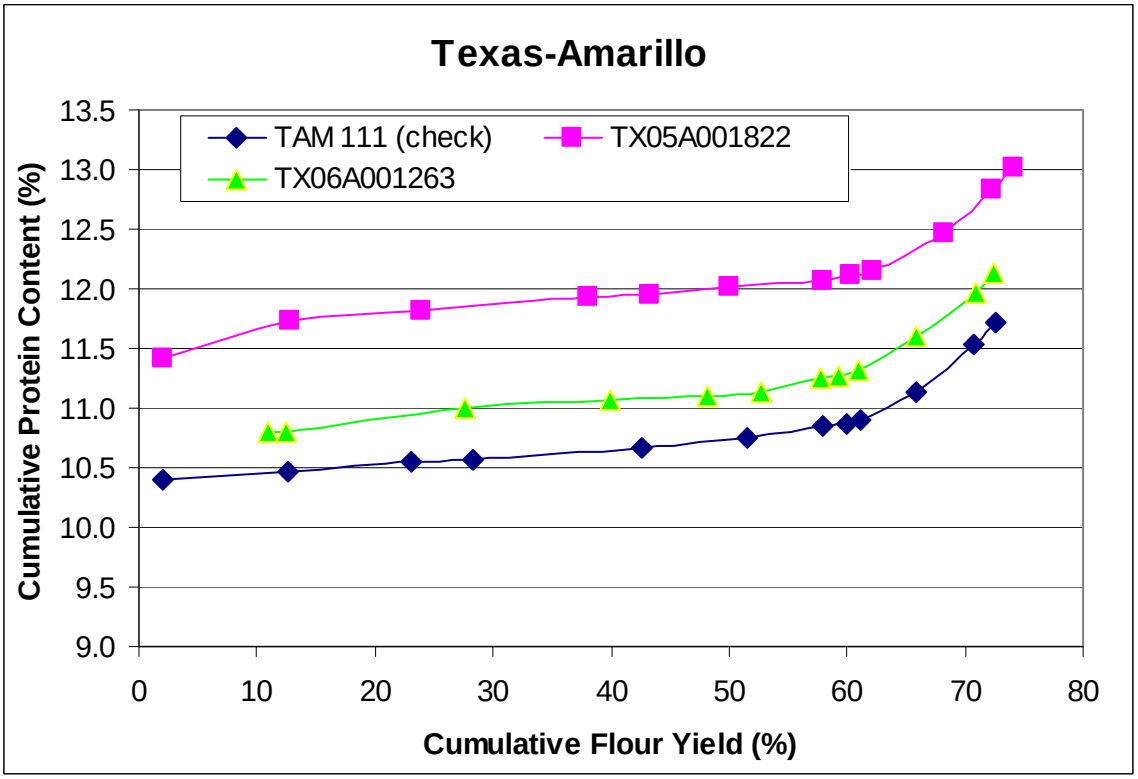
Test Entry Number	**10-2420**	**10-2421**	**10-2422**
Sample Identification	TAM 111 (check)	TX05A001822	TX06A001263
MIXOGRAPH			
Flour Abs (% as-is)	66.1	68.3	65.9
Flour Abs (14% mb)	62.6	64.7	61.7
Mix Time (min)	2.88	4.50	2.88
Mix tolerance (0-6)	2	4	2
FARINOGRAPH			
Flour Abs (% as-is)	61.9	61.8	64.1
Flour Abs (14% mb)	58.4	58.2	59.5
Development time (min)	5.5	10.0	6.9
Mix stability (min)	12.5	23.0	12.5
Mix Tolerance Index (FU)	25	18	26
Breakdown time (min)	10.9	22.1	13.3
ALVEOGRAPH			
P(mm. $_{H2O}$): Tenacity	68	76	89
L(mm): Extensibility	103	85	96
G($mm_{0.5}$): Swelling index	22.6	20.5	21.8
W(10^{-4} J): strength (curve area)	225	267	289
P/L: curve configuration ratio	0.66	0.89	0.93
Ie(P_{200}/P): elasticity index	56.3	70.1	57.8
EXTENSIGRAPH			
Resist (BU at 30/60/90 min)	277/416/456	393/700/854	350/478/533
Extensibility (mm at 30/60/90 min)	171/161/154	157/137/142	151/146/148
Energy (cm^2 at 30/60/90 min)	90/132/132	119/170/194	98/128/147
Resist $_{max}$ (BU at 30/60/90 min)	386642/692	603/996/994	482/699/779
Ratio (at 30/60/90 min)	1.6/2.6/3.0	2.5/5.1/6.0	2.3/3.3/3.6
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+9, 2+12	1, 7+8, 5+10	1, 7+9, 5+10
Glu/Gli	0.82	0.78	0.69
HMW/LMW	0.24	0.30	0.29
%IPP	45.23	47.11	45.87
SEDIMENTATION TEST			
Volume (ml)	41.5	62.7	45.2

Texas-Amarillo: Cumulative Ash Curves



TAM 111 (check) - 2420					TX05A001822 - 2421					TX06A001263 - 2422				
Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumulative (14%) Yield	Ash
2M	10.64	0.31	10.64	0.31	2M	11.25	0.31	11.25	0.31	2M	12.24	0.37	12.24	0.37
1M Red	1.94	0.32	12.58	0.31	1M	5.26	0.32	16.51	0.32	1M Red	1.61	0.37	13.85	0.37
1M	5.22	0.33	17.80	0.32	1M Red	2.04	0.32	18.54	0.32	1M	4.51	0.39	18.36	0.37
4M	10.58	0.36	28.38	0.33	4M	10.70	0.36	29.24	0.33	4M	10.92	0.40	29.28	0.38
2BK	4.81	0.37	33.19	0.34	2BK	6.01	0.36	35.25	0.34	3M	15.17	0.40	44.45	0.39
3M	14.28	0.37	47.47	0.35	1BK	6.65	0.36	41.90	0.34	2BK	4.84	0.42	49.29	0.39
1BK	6.39	0.38	53.85	0.35	Grader	2.34	0.38	44.24	0.34	1BK	5.16	0.45	54.44	0.40
Grader	1.94	0.39	55.80	0.35	3M	14.13	0.38	58.37	0.35	Grader	1.72	0.46	56.16	0.40
5M	8.89	0.49	64.69	0.37	5M	8.00	0.46	66.36	0.36	5M	8.20	0.54	64.37	0.42
FILTER FLR	1.18	0.65	65.87	0.38	FILTER FLR	1.81	0.58	68.17	0.37	FILTER FLR	1.46	0.69	65.83	0.42
3BK	4.90	0.73	70.77	0.40	3BK	4.12	0.71	72.29	0.39	3BK	5.00	0.75	70.83	0.45
BRAN FLR	1.86	1.50	72.63	0.43	BRAN FLR	1.82	1.46	74.11	0.42	BRAN FLR	1.60	1.67	72.43	0.47
Break Shorts	3.79	3.67	76.41	0.59	Break Shorts	0.65	3.85	74.76	0.45	Break Shorts	3.94	3.97	76.37	0.65
Red Dog	1.51	3.00	77.92	0.64	Red Dog	1.34	3.15	76.10	0.49	Red Dog	1.70	3.34	78.07	0.71
Red Shorts	0.18	3.84	78.10	0.64	Red Shorts	0.17	3.99	76.26	0.50	Red Shorts	0.13	4.76	78.20	0.72
Filter Bran	0.36	1.72	78.47	0.65	Filter Bran	1.81	1.86	78.08	0.53	Filter Bran	0.44	2.02	78.64	0.73
Bran	21.53	4.44	100.00	1.47	Bran	21.92	4.25	100.00	1.35	Bran	21.36	4.83	100.00	1.60
Wheat		1.46			Wheat		1.41			Wheat		1.62		
St. Grd. Fl.		0.45			St. Grd. Fl.		0.46			St. Grd. Fl.		0.51		

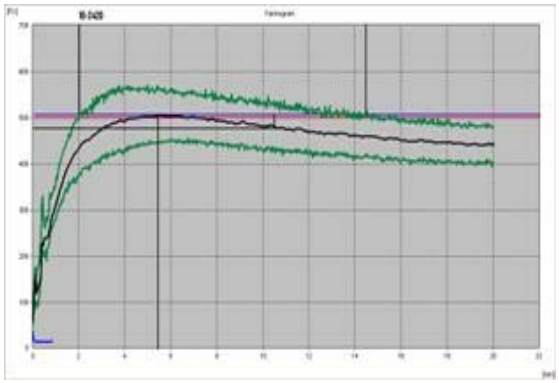
Texas-Amarillo: Cumulative Protein Curves



TAM 111 (check) - 2420					TX05A001822 - 2421					TX06A001263 - 2422				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
1M Red	1.94	10.40	1.94	10.40	1M Red	2.04	11.41	2.04	11.41	4M	10.92	10.80	10.92	10.80
2M	10.64	10.49	12.58	10.47	4M	10.70	11.80	12.73	11.74	1M Red	1.61	10.83	12.53	10.81
4M	10.58	10.63	23.16	10.55	2M	11.25	11.91	23.98	11.82	3M	15.17	11.17	27.70	11.01
1M	5.22	10.69	28.38	10.57	3M	14.13	12.12	38.11	11.93	2M	12.24	11.19	39.94	11.06
3M	14.28	10.84	42.65	10.66	1M	5.26	12.13	43.37	11.96	5M	8.20	11.34	48.14	11.11
5M	8.89	11.13	51.55	10.74	1BK	6.65	12.39	50.02	12.01	1M	4.51	11.48	52.65	11.14
1BK	6.39	11.64	57.93	10.84	5M	8.00	12.44	58.01	12.07	1BK	5.16	12.30	57.81	11.24
Grader	1.94	11.81	59.88	10.87	Grader	2.34	13.04	60.36	12.11	FILTER FLR	1.46	12.47	59.27	11.27
FILTER FLR	1.18	12.44	61.06	10.90	FILTER FLR	1.81	13.20	62.16	12.14	Grader	1.72	12.55	60.99	11.31
2BK	4.81	14.01	65.87	11.13	2BK	6.01	15.84	68.17	12.47	2BK	4.84	15.25	65.83	11.60
3BK	4.90	16.97	70.77	11.53	3BK	4.12	18.81	72.29	12.83	3BK	5.00	16.88	70.83	11.97
BRAN FLR	1.86	18.68	72.63	11.72	BRAN FLR	1.82	20.14	74.11	13.01	BRAN FLR	1.60	19.35	72.43	12.13
Break Shorts	3.79	15.82	76.41	11.92	Break Shorts	0.65	17.13	74.76	13.05	Break Shorts	3.94	15.83	76.37	12.32
Red Dog	1.51	15.03	77.92	11.98	Red Dog	1.34	16.38	76.10	13.10	Red Dog	1.70	15.08	78.07	12.38
Red Shorts	0.18	15.07	78.10	11.99	Red Shorts	0.17	16.35	76.26	13.11	Red Shorts	0.13	15.61	78.20	12.39
Filter Bran	0.36	12.71	78.47	11.99	Filter Bran	1.81	14.73	78.08	13.15	Filter Bran	0.44	13.08	78.64	12.39
Bran	21.53	18.01	100.00	13.29	Bran	21.92	19.79	100.00	14.60	Bran	21.36	18.22	100.00	13.64
Wheat		13.18			Wheat		14.37			Wheat		13.53		
St. Grd. Fl		11.78			St. Grd. Fl		13.03			St. Grd. Fl		12.17		

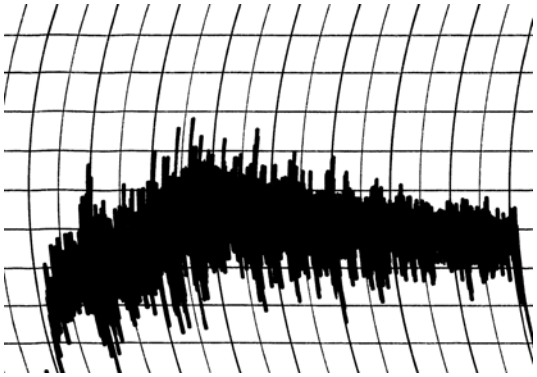
Physical Dough Tests
2010 (Small Scale) Samples – Texas-Amarillo

Farinograms



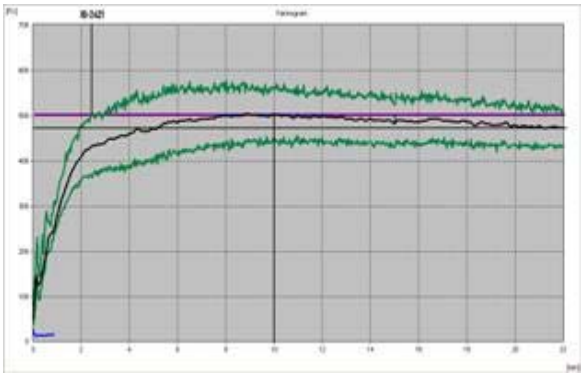
Water abs = 58.4%, Peak time = 5.5 min,
Mix stab = 12.5 min, MTI = 25 FU

Mixograms

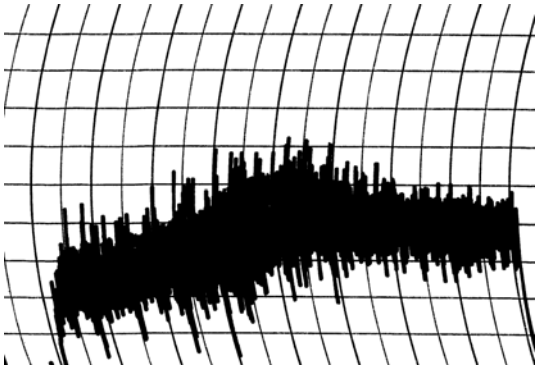


Water abs = 62.6%
Mix time = 2.9 min

10-2420, TAM 111 (check)



Water abs = 58.2%, Peak time = 10.0 min,
Mix stab = 23 min, MTI = 18 FU



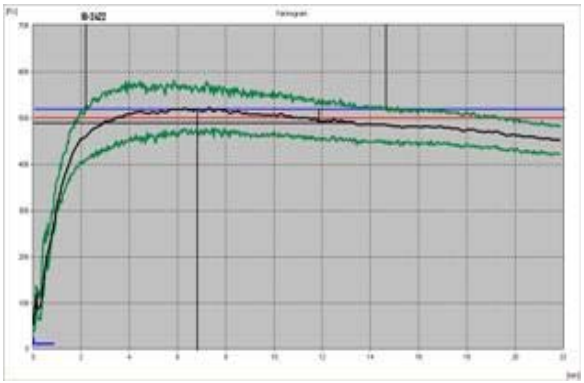
Water abs = 64.7%
Mix time = 4.5 min

10-2421, TX05A001822

Physical Dough Tests

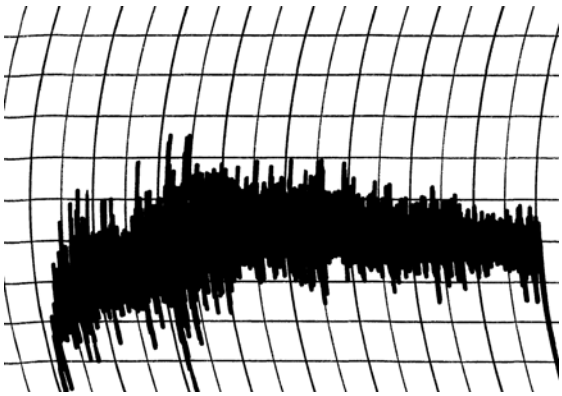
2010 (Small Scale) Samples – Texas-Amarillo (continued)

Farinograms



Water abs. = 59.5%, Peak time = 6.9 min,
Mix stab = 12.5 min, MTI = 26 FU

Mixograms

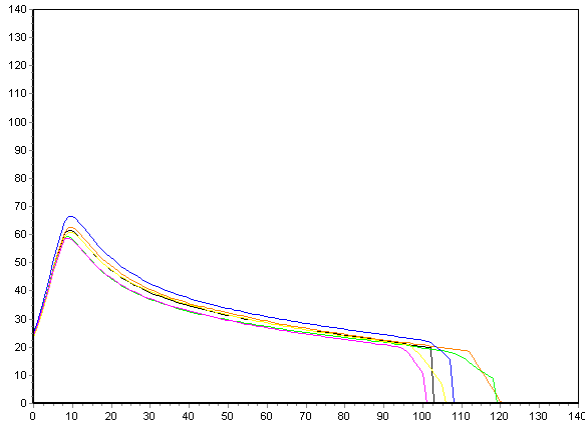


Water abs = 61.7%
Mix time = 2.9 min

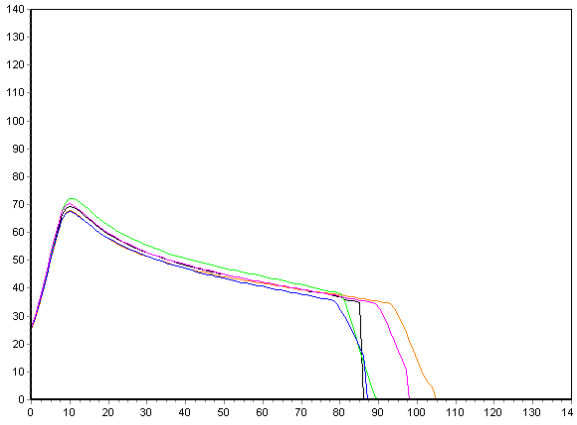
10-2422, TX06A001263

Physical Dough Tests - Alveograph

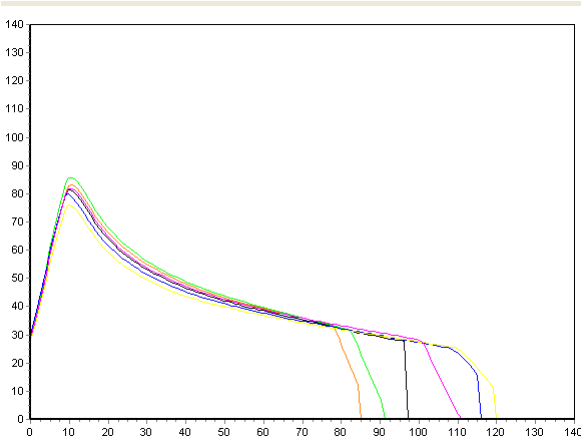
2010 (Small Scale) Samples – Texas-Amarillo



10-2420 (TAM 111 (check))
P (mm H_20) = 68, L (mm) = 103, W ($10E^{-4}J$) = 225



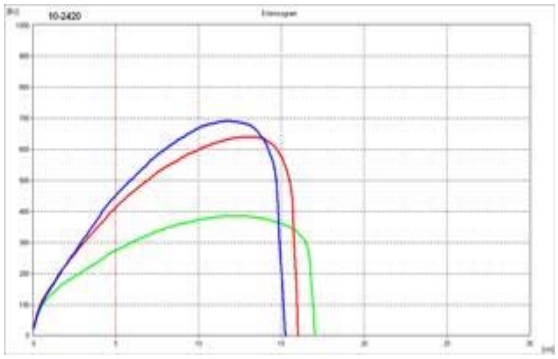
10-2421 (TX05A001822)
P (mm H_20) = 76, L (mm) = 85, W ($10E^{-4}J$) = 267



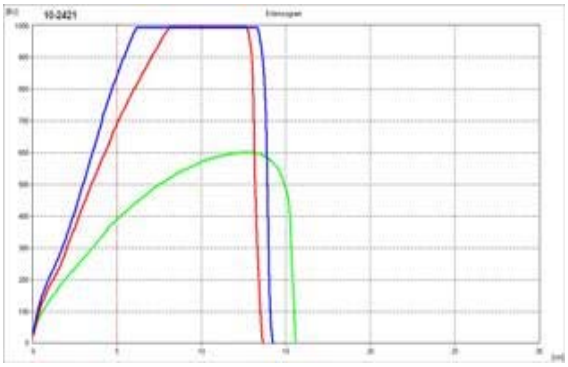
10-2422 (TX06A001263)
P (mm H_20) = 89, L (mm) = 96, W ($10E^{-4}J$) = 289

Physical Dough Tests - Extensigraph

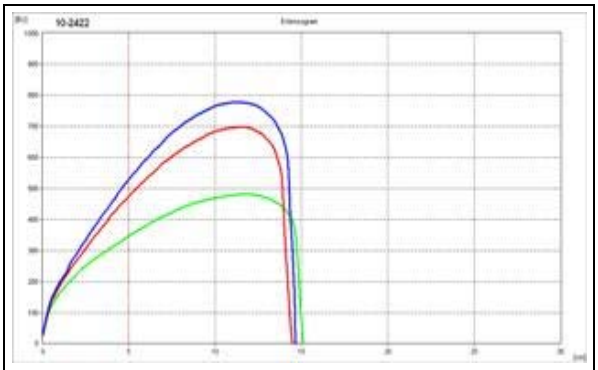
2010 (Small Scale) Samples – Texas-Amarillo



10-2420 (TAM 111 – check)
R (BU) = 456, E (mm) = 153.6, W (cm^2) = 132
Rmax (BU) = 692, Ratio = 3.0 at 90 min



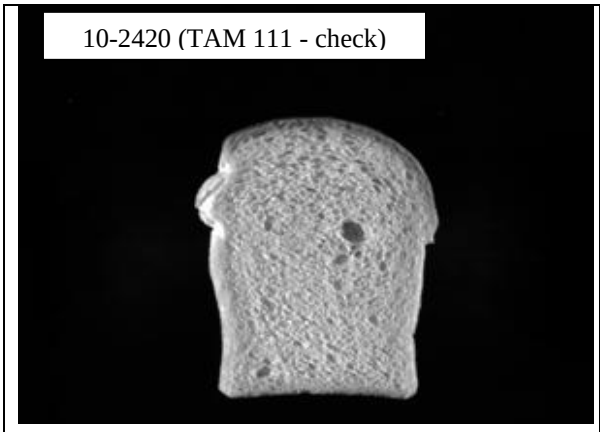
10-2421 (TX05A001822)
R (BU) = 854, E (mm) = 142, W (cm^2) = 194
Rmax (BU) = 994, Ratio = 6.0 at 90 min



10-2422 (TX06A001263)
R (BU) = 533, E (mm) = 148, W (cm^2) = 147
Rmax (BU) = 779, Ratio = 3.6 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

Texas-Amarillo: C-Cell Bread Images and Analysis for 2010 (Small-Scale) Samples



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2420	6041	159.1	3928	0.435	1.854	2.162	1.598	-26.90
2421	6814	158.2	4373	0.430	1.895	0.933	1.650	-16.53

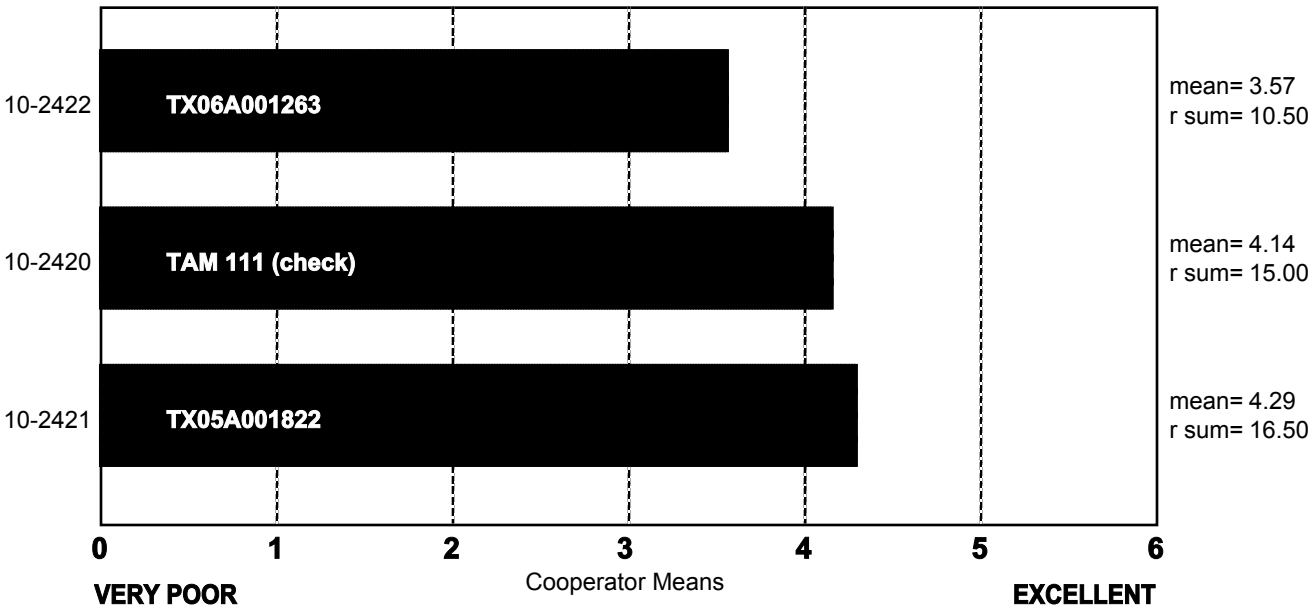
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2422	6531	156.9	3914	0.450	2.115	1.919	1.645	-27.15

SPONGE CHARACTERISTICS

(Small Scale) Texas-Amarillo

ncoop= 7
chisq= 2.79
chisqc= 5.57
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.

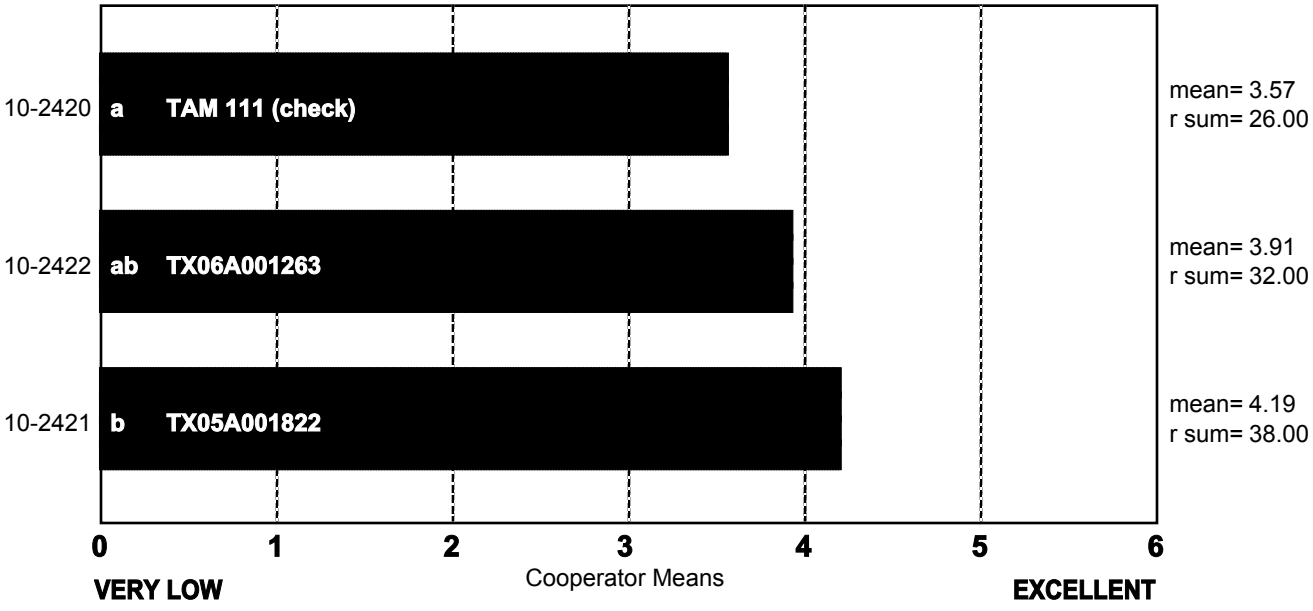


BAKE ABSORPTION

(Small Scale) Texas-Amarillo

ncoop= 16
chisq= 4.50
chisqc= 6.00
cvchisq= 5.99
crdiff= 9.31

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Texas-Amarillo

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2420 TAM 111 (check)	**62.6**	**58.0**	**55.5**	**62.6**	**58.7**	**60.4**	**61.0**	**64.1**	**59.0**	**62.0**	**59.0**	**65.1**	**66.3**	**64.6**	**60.2**	**58.0**	**61.4**
10-2421 TX05A001822	**64.7**	**60.0**	**55.0**	**64.7**	**58.5**	**60.3**	**64.0**	**64.5**	**59.0**	**64.0**	**60.0**	**67.1**	**68.5**	**66.7**	**63.1**	**59.0**	**61.2**
10-2422 TX06A001263	**62.0**	**59.0**	**56.5**	**61.7**	**61.0**	**62.6**	**63.0**	**62.8**	**60.0**	**62.0**	**61.0**	**64.0**	**65.8**	**63.7**	**60.5**	**60.5**	**62.5**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Texas-Amarillo

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2420 TAM 111 (check)	**3.5**	**13.0**	**7.0**	**4.0**	**1.3**	**2.5**	**4.3**	**5.2**	**25.0**	**3.0**	**4.0**	**2.5**	**2.9**	**5.0**	**3.8**	**15.0**	**6.0**
10-2421 TX05A001822	**4.5**	**14.0**	**7.0**	**5.5**	**1.5**	**3.3**	**5.9**	**3.6**	**25.0**	**6.0**	**9.0**	**4.3**	**4.5**	**7.0**	**5.6**	**30.0**	**12.0**
10-2422 TX06A001263	**3.3**	**8.0**	**7.0**	**4.5**	**1.5**	**3.0**	**4.7**	**3.5**	**20.0**	**6.0**	**5.0**	**3.0**	**2.9**	**5.5**	**4.0**	**9.0**	**6.0**

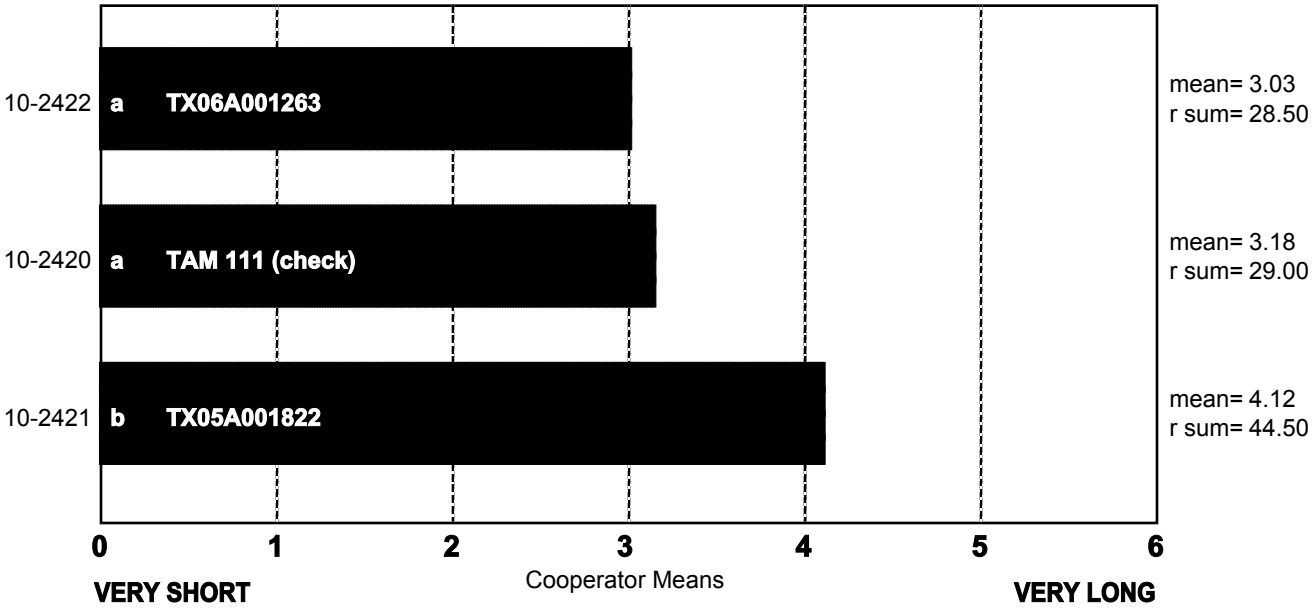
Raw Data

BAKE MIX TIME

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 9.74
chisqc= 13.51
cvchisq= 5.99
crdiff= 8.07

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

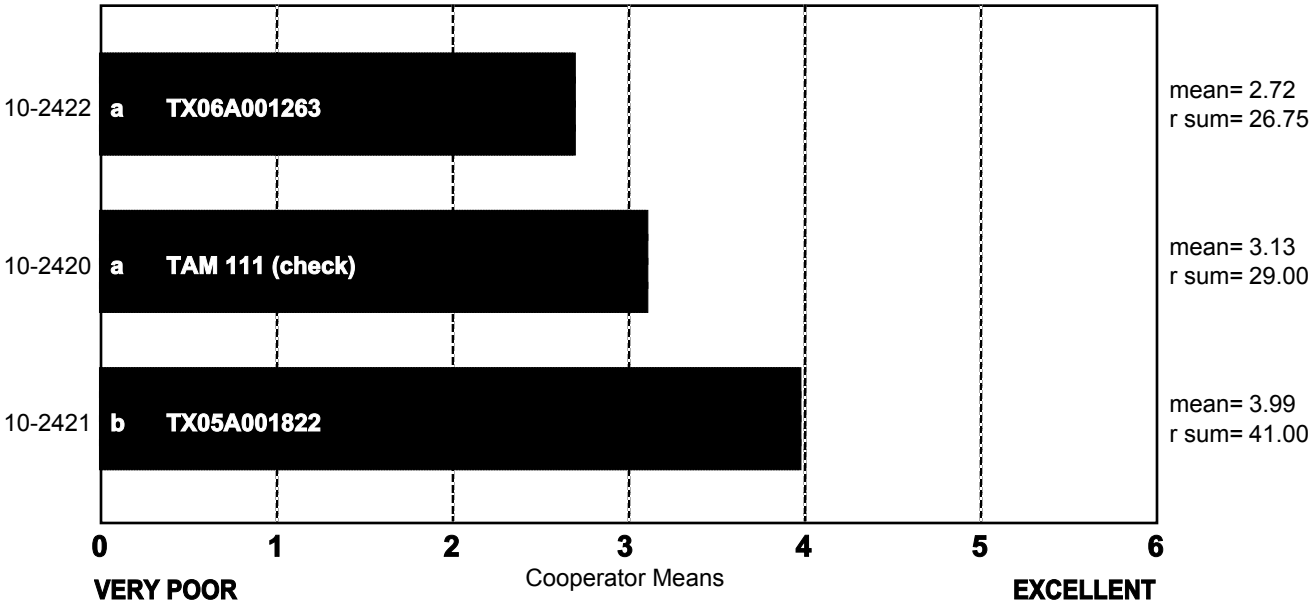


MIXING TOLERANCE

(Small Scale) Texas-Amarillo

ncoop= 16
chisq= 10.35
chisqc= 11.18
cvchisq= 5.99
crdiff= 8.88

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

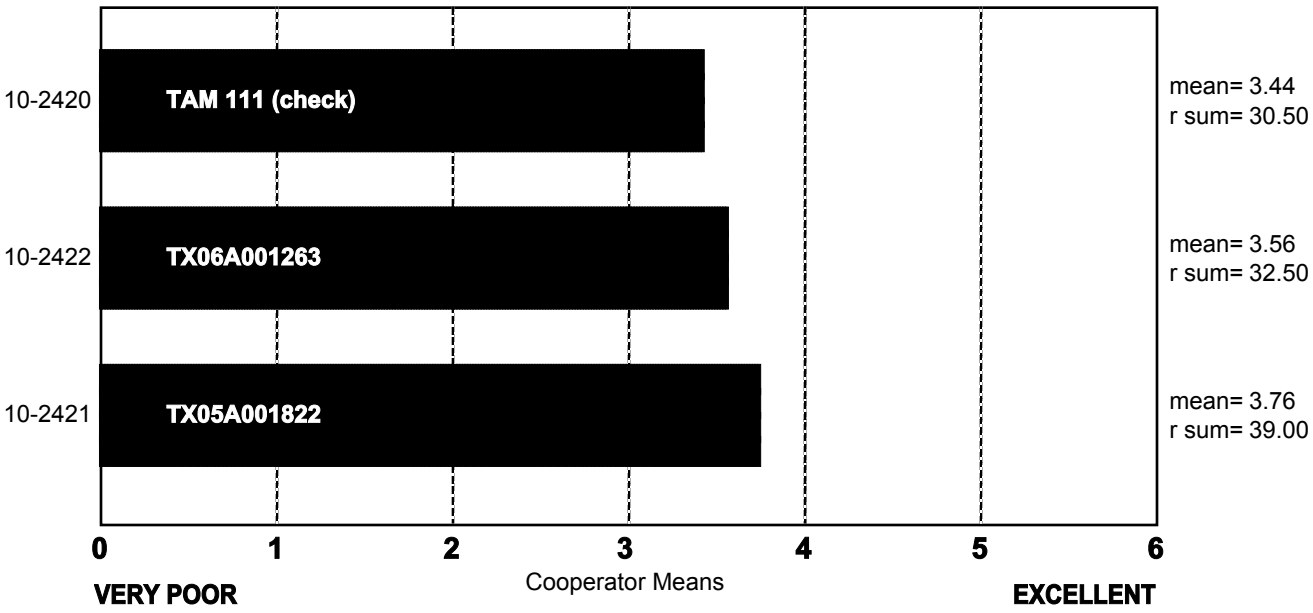


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 2.32
chisqc= 2.77
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Texas-Amarillo

	Sticky	Wet	Tough	Good	Excellent
10-2420 TAM 111 (check)	**4**	**1**	**2**	**9**	**1**
10-2421 TX05A001822	**3**	**1**	**5**	**8**	**0**
10-2422 TX06A001263	**4**	**0**	**3**	**10**	**0**

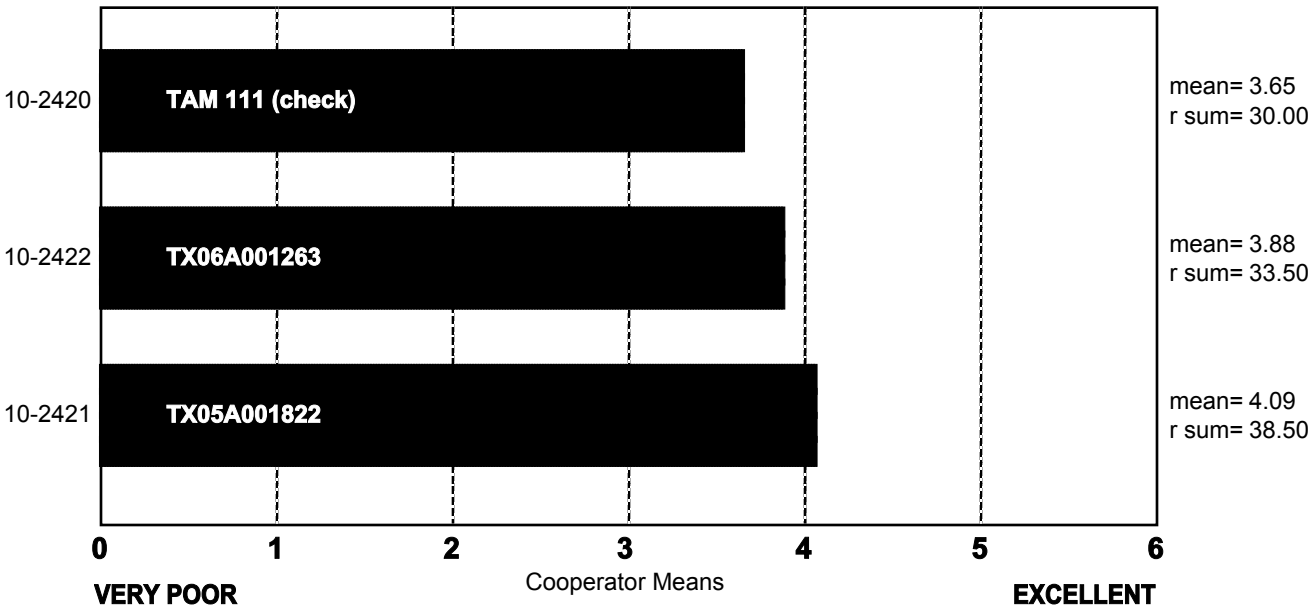
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 2.15
chisqc= 2.61
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Texas-Amarillo

	Sticky	Wet	Tough	Good	Excellent
10-2420 TAM 111 (check)	**2**	**3**	**3**	**8**	**1**
10-2421 TX05A001822	**1**	**1**	**3**	**11**	**1**
10-2422 TX06A001263	**2**	**1**	**2**	**11**	**1**

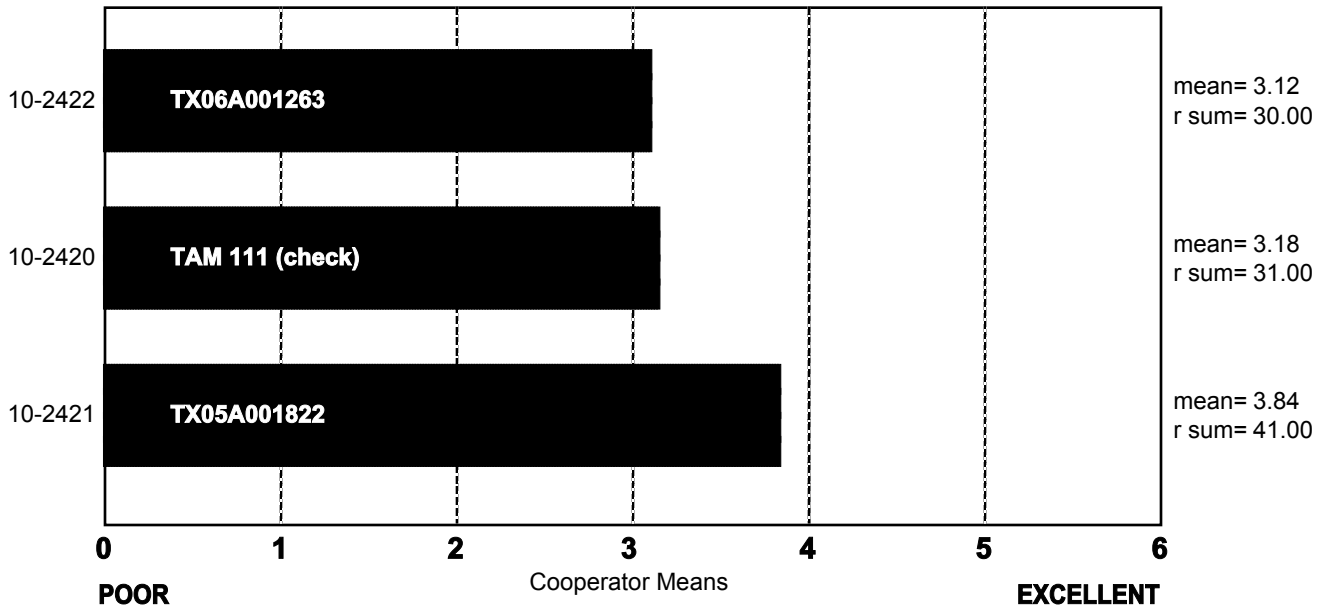
Frequency Table

CRUMB GRAIN

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 4.35
chisqc= 5.48
cvchisq= 5.99
crdiff=

Variety order by rank sum.
No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Texas-Amarillo

	Open	Fine	Dense
10-2420 TAM 111 (check)	**10**	**5**	**2**
10-2421 TX05A001822	**11**	**6**	**0**
10-2422 TX06A001263	**14**	**3**	**0**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Texas-Amarillo

	Round	Irregular	Elongated
10-2420 TAM 111 (check)	**9**	**5**	**3**
10-2421 TX05A001822	**7**	**4**	**6**
10-2422 TX06A001263	**6**	**9**	**2**

Frequency Table

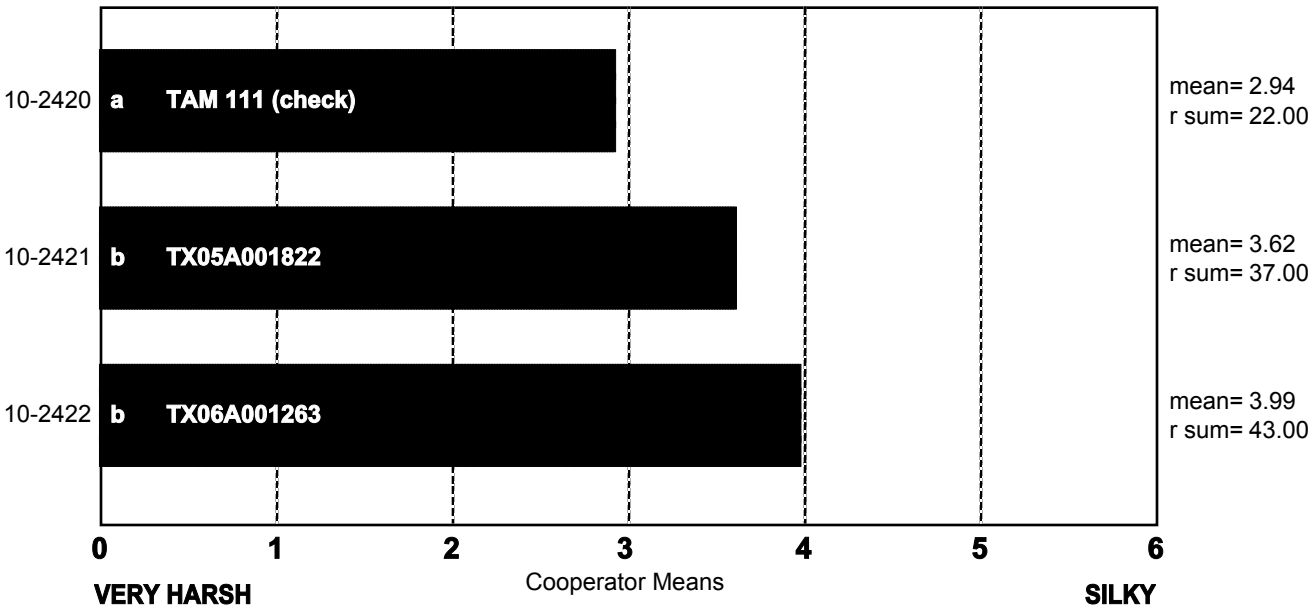
CRUMB TEXTURE

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 13.76
chisqc= 17.02
cvchisq= 5.99
crdiff= 7.78

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Texas-Amarillo

	Harsh	Smooth	Silky
10-2420 TAM 111 (check)	**11**	**3**	**3**
10-2421 TX05A001822	**3**	**11**	**3**
10-2422 TX06A001263	**3**	**9**	**5**

Frequency Table

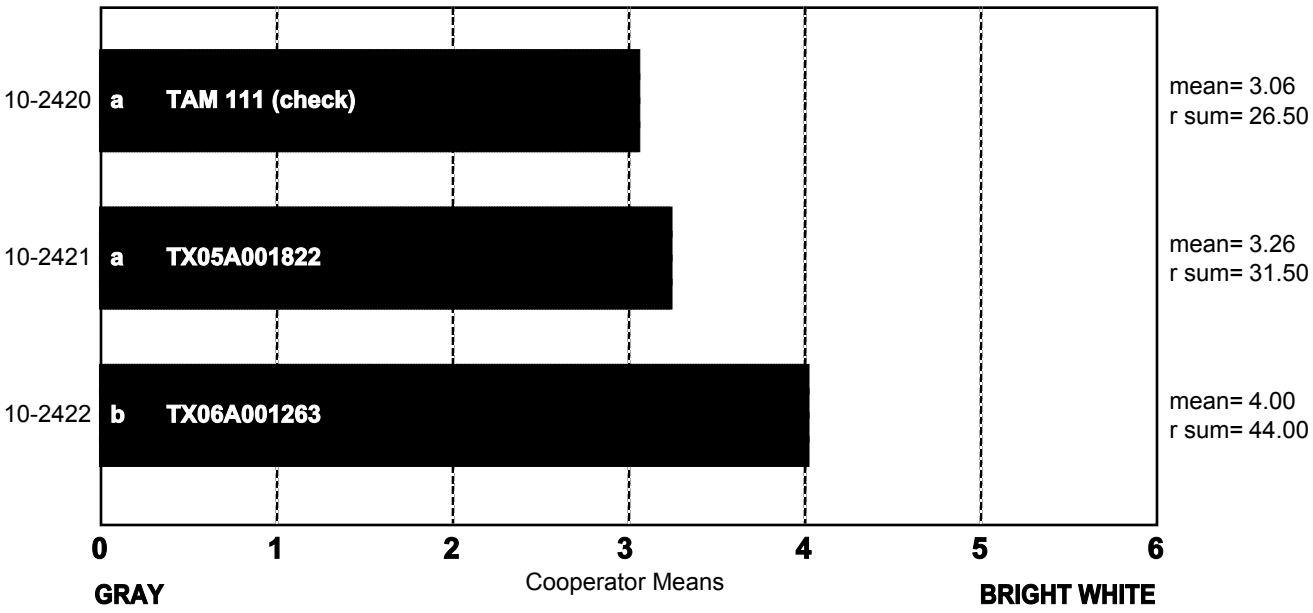
CRUMB COLOR

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 9.56
chisqc= 14.44
cvchisq= 5.99
crdiff= 7.55

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Texas-Amarillo

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
10-2420 TAM 111 (check)	**0**	**1**	**4**	**4**	**7**	**1**	**0**
10-2421 TX05A001822	**0**	**2**	**3**	**3**	**5**	**4**	**0**
10-2422 TX06A001263	**0**	**1**	**0**	**3**	**9**	**3**	**1**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Texas-Amarillo

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2420 TAM 111 (check)	**140.8**	**422.0**	**500.0**	**154.6**	**128.2**	**133.9**	**142.5**	**155.4**	**492.5**	**134.0**	**466.8**	**143.1**	**142.4**	**460.0**	**150.1**	**460.8**	**455.0**
10-2421 TX05A001822	**140.6**	**419.0**	**500.0**	**154.7**	**128.1**	**129.2**	**144.1**	**155.3**	**480.0**	**134.0**	**471.0**	**139.3**	**141.6**	**459.0**	**150.4**	**461.5**	**458.4**
10-2422 TX06A001263	**139.3**	**417.0**	**505.0**	**154.5**	**127.0**	**133.0**	**142.5**	**155.5**	**474.3**	**134.0**	**465.3**	**139.4**	**140.6**	**461.0**	**147.0**	**455.8**	**448.4**

Raw Data

LOAF VOLUME, ACTUAL

(Small Scale) Texas-Amarillo

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
10-2420 TAM 111 (check)	**900**	**2800**	**3200**	**599**	**660**	**860**	**868**	**788**	**2956**	**883**	**2613**	**948**	**877**	**2800**	**825**	**2600**	**2275**
10-2421 TX05A001822	**1160**	**3100**	**3250**	**635**	**810**	**985**	**935**	**1073**	**3104**	**1038**	**2688**	**1090**	**1127**	**2875**	**960**	**2725**	**2350**
10-2422 TX06A001263	**990**	**3000**	**3100**	**680**	**750**	**925**	**885**	**1043**	**3074**	**973**	**2688**	**943**	**915**	**2775**	**915**	**2700**	**2620**

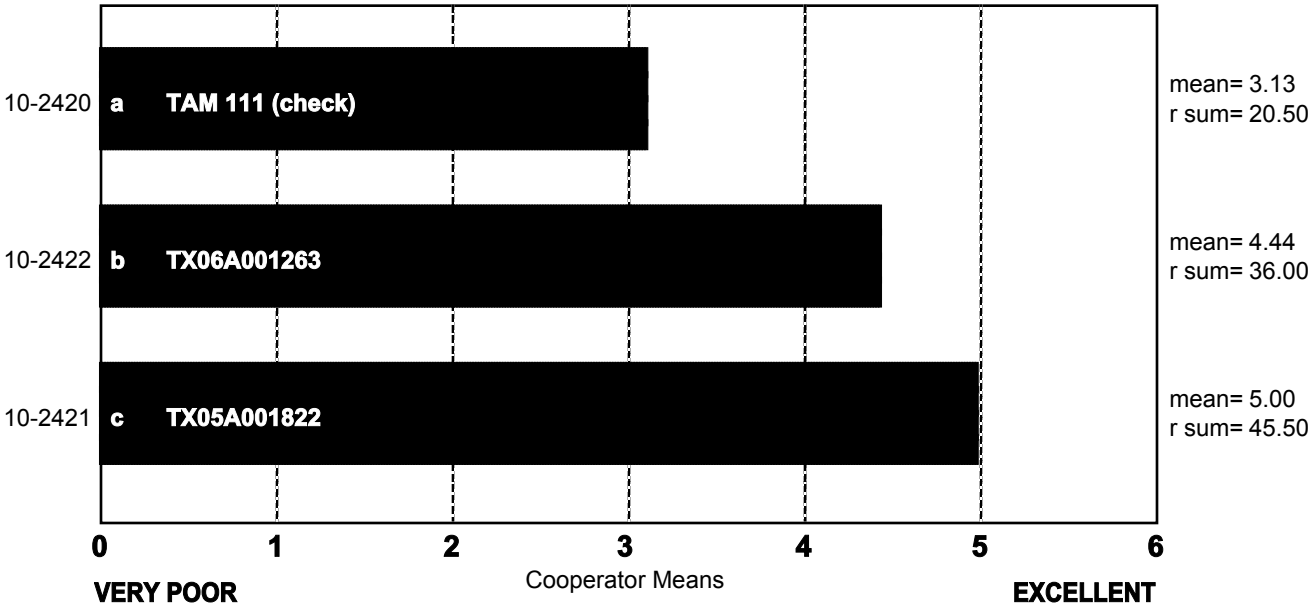
Raw Data

LOAF VOLUME

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 18.74
chisqc= 20.89
cvchisq= 5.99
crdiff= 7.20

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.

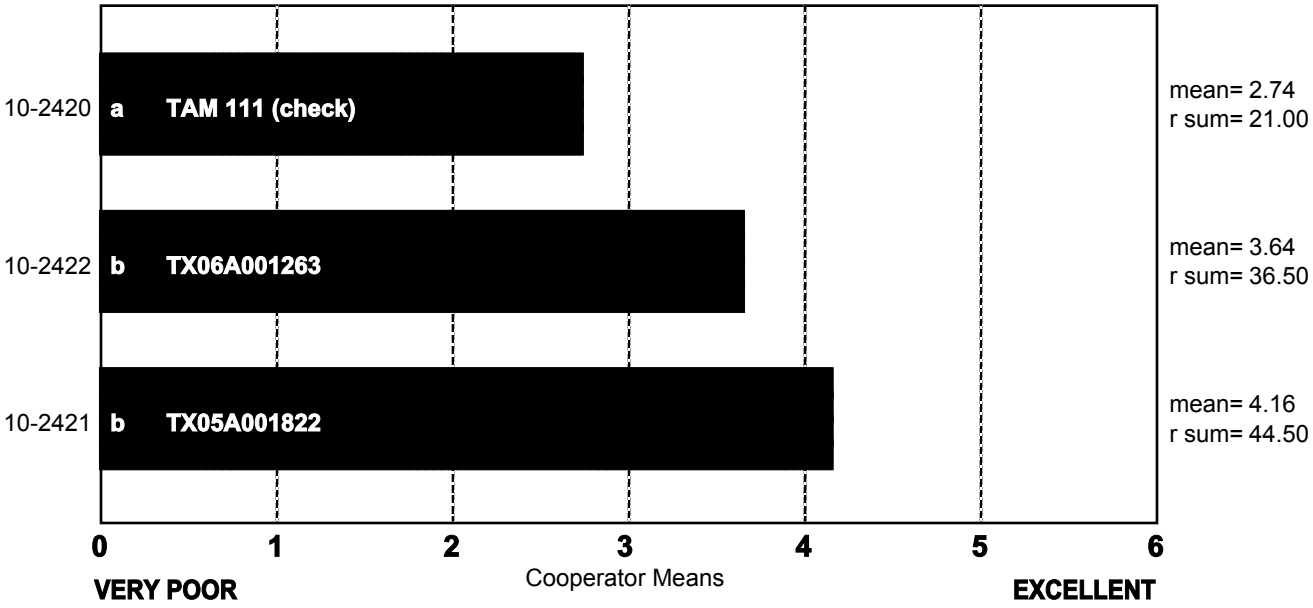


OVERALL BAKING QUALITY

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 16.79
chisqc= 18.13
cvchisq= 5.99
crdiff= 8.05

Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



COOPERATOR'S COMMENTS
(Small Scale) Texas-Amarillo

COOP. **10-2420** **Tam 111 (Check)**

A. Weak dough.

B. Good out of mixer, average volume, sl. open grain, sl. creamy, average mix for protein.

C. No comment.

D. No comment.

E. Low loaf volume, short mix time.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. sticky and weak dough, hi OS, open and elongated cells, yellow crumb, smooth and resilient texture.

H. Very poor interior and poor protein performance.

I. Open, irregular grain, thick cell walls, good volume.

J. Poor bake quality, weak dough handling, poor tolerance, volume and grain.

K. Sl. low absorption, short mix time, tough dough, open grain, yellow crumb, average volume.

L. No comment.

M. No comment.

N. No comment.

O. Low absorption and loaf volume, good mix time, yellow crumb.

P. No comment.

Q. Low volume, open grain.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Texas-Amarillo

COOP. **10-2421** **TX05A001822**

A. Rough break and shred.

B. Very good dough, excellent volume, very open grain, sl. creamy.

C. No comment.

D. No comment.

E. No comment.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. sticky and strong dough, very hi OS, open and elongated cells, sl. yellow crumb, smooth and resilient texture.

H. Best of show.

I. Dull crumb color, sl. open grain, excellent volume.

J. Great bake quality; nice, gassy dough handling characteristics, good volume and grain.

K. Good mix time, yellow crumb, average absorption and volume.

L. No comment.

M. No comment.

N. No comment.

O. Rated higher than check TAM 111, good mixograph tolerance; good flour protein, absorption, crumb grain and loaf volume, yellow crumb.

P. No comment.

Q. Open grain, good volume.

Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

COOPERATOR'S COMMENTS
(Small Scale) Texas-Amarillo

COOP. **10-2422** **TX06A001263**

A. Excellent exterior.

B. Sl. soft out of mixer, short mix for protein, good volume, very open grain, sl. creamy.

C. No comment.

D. No comment.

E. Low loaf volume.

F. No comment.

G. Normal absorption and mix time, wet, soft and sl. sticky and strong dough, very hi OS, fine and elongated cells, creamy crumb, smooth and resilient texture.

H. Weak looking interior.

I. Open, irregular grain, harsh texture, excellent volume.

J. OK bake quality, had weaker and pliable dough handling, open grain.

K. Sticky dough, open grain, average absorption and volume.

L. No comment.

M. No comment.

N. No comment.

O. Good flour protein, mix time and loaf volume; rated sl. higher than check, questionable crumb grain.

P. No comment.

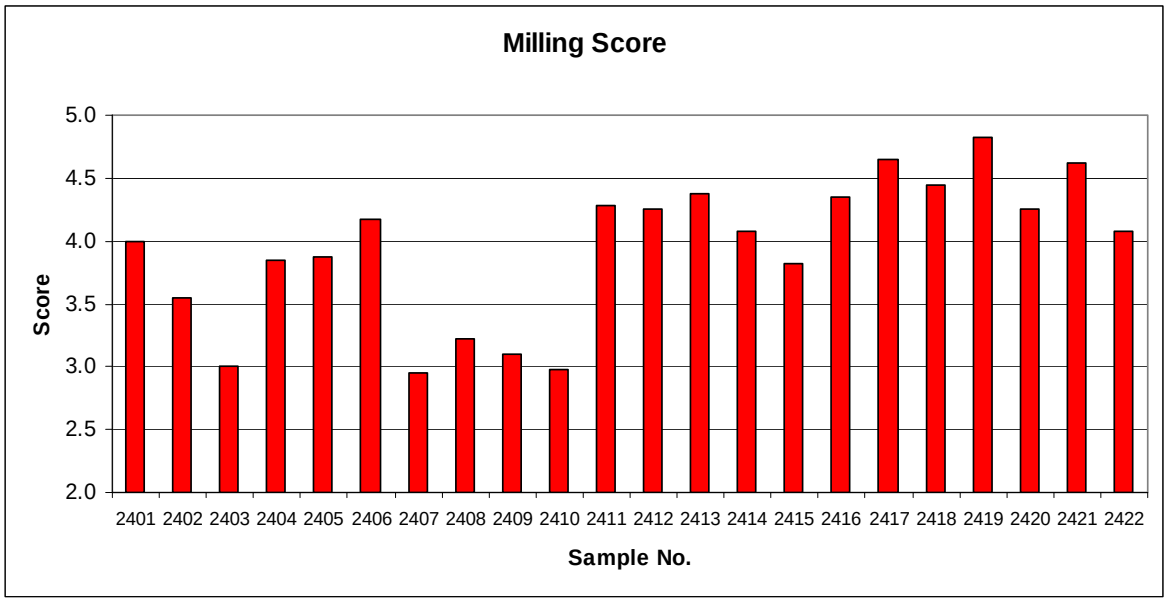
Q. Open grain, excellent volume.

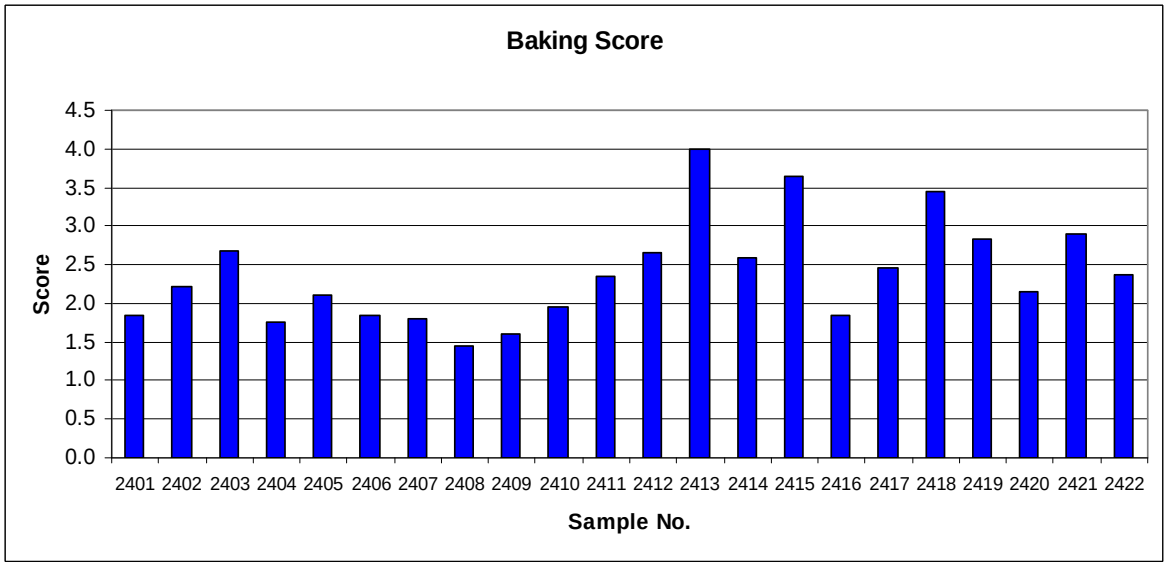
Notes: **B, C, I, J, K, P and Q** conducted sponge and dough bake tests

2010 WQC Milling and Baking Scores

2010 WQC Milling & Baking Scores

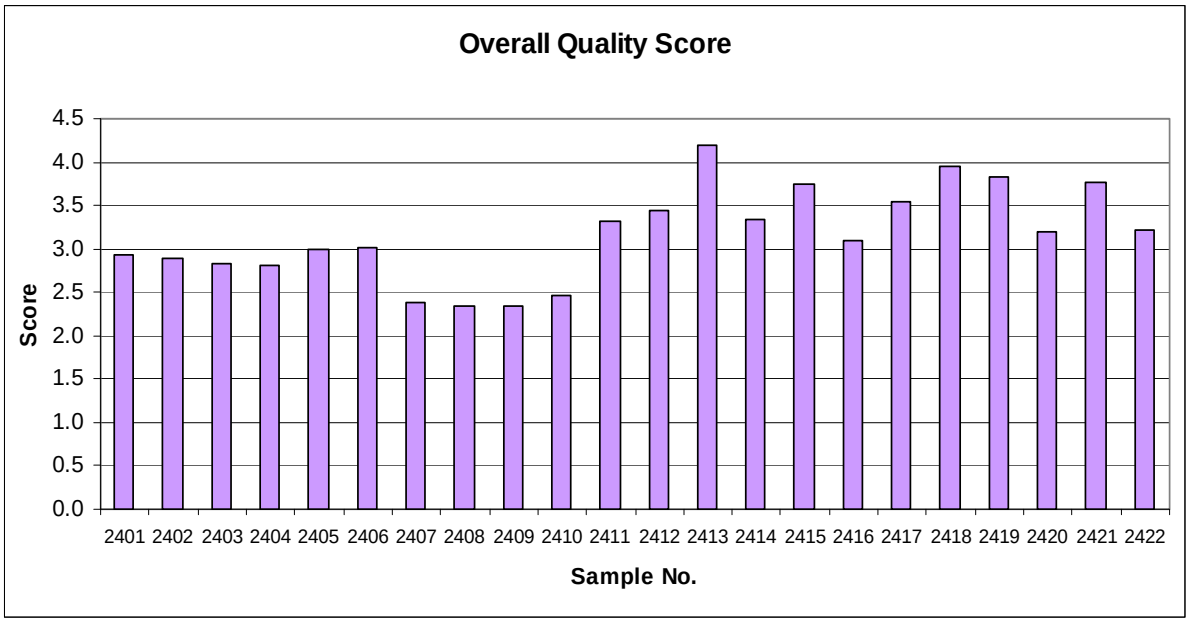
(Based upon HWWQL Quality Data)





2010 WQC Milling & Baking Scores

(Based upon HWWQL Quality Data)



Marketing Scores

Achieving acceptable end-use (milling and baking) quality is a fundamental objective of wheat breeding programs throughout the U.S. hard winter wheat region. Numerous statistical methods have been developed to measure quality. Several years ago, Dr. Scott Haley (Colorado State University), in conjunction with the USDA-ARS Hard Winter Wheat Quality Laboratory (HWWQL), developed a relational database for summarization and interpretation of regional performance nursery wheat end-use quality data generated annually by the HWWQL (Scott D. Haley, Rod D. May, Bradford W. Seabourn, and Okkyung K. Chung. 1999. *Relational database system for summarization and interpretation of Hard Winter Wheat regional quality data*. Crop Sci. 39:309–315). Until that time, few tools were available to assist in the decision-making process when faced with a large number of parameters from comprehensive milling and baking tests. The database system uses a graphical interface that requires input from the user. The database system provides simultaneous assessment of multiple quality traits on a standardized scale, *user-specified prioritization* of end-use quality traits for numerical and qualitative ratings of genotypes, tabulation of major quality deficiencies of genotypes, and summarization of quality ratings for a genotype across multiple nurseries.

As an extension of this relational database, and in keeping with the precedent set by Dr. Gary Hareland and the Hard Spring wheat region with the introduction of a 'marketing score' into their 2004 annual crop report to the Wheat Quality Council, the HWWQL developed (using the HRS system as a guide) a similar marketing score for both milling and baking for the Hard Winter Wheat Region, as shown below.

Variation(+/-) from Target Value:	SCORE	TW lbs/bu	Kernel Size % Large	Kernel Weight g/1000	Wheat Protein 12%mb	Kernel Hardness NIR	Str Grd Flour Yield %	Wheat Ash 14%mb	Wheat Falling Number Seconds
	6	63	39	45	15.0	100	76	1.30	375
	5	62	36	40	14.0	90	74	1.40	350
	4	61	33	35	13.0	80	72	1.50	325
TARGET VALUE:	**3**	60	30	30	12.0	70	70	1.60	300
	2	59	26	25	11.0	60	68	1.70	275
	1	58	22	20	10.0	50	66	1.80	250
	0	57	18	15	9.0	40	64	1.90	225

Milling Marketing Score = (TW*1.5) + (largeK*1) + (1000KWT*0.5) + + (protein*2.5) + (NIRHS*1) + (YLD*1.5) + (ash*1) + (FN*1)/10 (where TW = test weight, largeK = large kernel size %, 1000KWT = thousand kernel weight, protein = protein content %, NIRHS = NIR hardness score, YLD = flour yield, ash = wheat ash content %, and FN = falling number value).

Variation(+/-) from Target Value:	SCORE	Absorption Actual (%)	Volume Actual (cc)	Color Rating Score	Grain Rating Score	Texture Rating Score	SCORE	Mix Time Actual (min)
	6	65	1050	6.0	6.0	6.0	**0**	5.00
	5	64	1000	5.4	5.4	5.4	**2**	4.50
	4	63	950	4.7	4.7	4.7	**4**	4.00
TARGET VALUE:	**3**	62	900	4.0	4.0	4.0	**6**	3.50
	2	61	850	3.3	3.3	3.3	**4**	3.00
	1	60	800	1.6	1.6	1.6	**2**	2.50
	0	59	750	1.0	1.0	1.0	**0**	2.00

Bake Marketing Score = (Abs*3) + (Lvol*2) + (color*1) + (grain*1.5) + (texture*1) + (MT*1.5)/10 (where Abs = mixograph water absorption %, Lvol = loaf volume [cc], color = crumb color [0-6 scale], grain = crumb grain [0-6 scale], texture = crumb texture [0-6 scale], and MT = mixograph mix time).

Alkaline Noodle Quality Tests
of
2010 WQC Hard Winter Wheat Samples

USDA-ARS Hard Winter Wheat Quality Laboratory
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Alkaline Noodle Quality Report of 2010 WQC Samples

Objectives: Evaluate noodle color and cooking characteristics of 2010 WQC hard winter wheat samples.

Materials: 22 WQC samples harvested in 2010.

Methods:

PPO (Polypenol Oxidase) Test:
The PPO level in wheat meal was determined using a method modified from AACCI Approved Method 22-85.

1. Grind wheat using a Udy Mill and blend the sample thoroughly.
2. Weigh 75 mg of wheat meal in a 2-mL microfuge tube.
3. Dispense 1.5 mL of 5 mM L-DOPA in 50 mM MOPS (pH 6.5) solution.
4. Vortex 10 min.
5. Centrifuge 4 min at 10,000 rpm.
6. Read absorbance at 475 nm.

Noodle Making:

Formulation:
Alkaline Noodles were made using 100 g flour from each sample, 1-g Na_2CO_3, and 35- mL of water (fixed).

Procedure:

100-g flour 1-g Na_2CO_3 + 35-mL Water

↓ ←

Mix at medium speed for 10 min (100-g Micro Mixer-no pins in the bowl, National MFG. Co., Lincoln, NE)

↓

Rest for 30 min in a plastic bag

↓

Plug roll gap with plastic tubing and pour mixed dough

↓

Sheeting: roll gaps 4 (2 x), 3, 2.3, 1.75, 1.35, & 1.1 (mm) → Measure color at 0 and 24 hr

↓

Cutting

Measurement of Noodle Dough Color:

Noodle dough color (*L**, lightness; *a**, redness-greenness; *b**, yellowness-blueness) was measured using a Minolta Colorimeter (Model CR-300) at 0 and 24 hr.

Cooking Noodles:

1. After cutting noodles, rest noodles in plastic bags for 2 hr at 21 ^{o}C.
2. Put the noodles (25 g) in boiling distilled water (300 mL).
3. Cook continuously with gentle stirring for 4 min 30 sec or until fully cooked.
4. Pour noodles and hot water through colander and collect the cooking water for calculation of cooking loss.
5. Immerse the cooked noodles in a bowl with distilled water (100 mL) for 1 min.
6. Drain water by shaking the colander 10 times. Measure the cooked noodle weight for calculation of water uptake.
7. Test noodle texture immediately.

Measurement of Cooking Loss and Water Uptake:

Cooking Loss:

1. Pre-weigh (tare) 500-mL beaker to 0.01 g.
2. Quantitatively transfer cooking/rinse water to beaker.
3. Evaporate to dryness (constant weight) in air oven at 95 $\pm$5 ^{o}C.
   Drying time is about 20 hr.
4. Cool beakers and weigh to 0.01 g.
   For 25 g sample, multiply by 4 → % cooking loss.

Water Uptake:

Water Uptake (%) = (Cooked noodle weight-Raw noodle weight)/Raw noodle weight x 100

Noodle Texture Profile Analysis (TPA):

Immediately after cooking the noodles, a TPA was conducted using TA-XTplus (Texture Technologies, NY) on 3 strings of noodles with a 1-mm flat perspex Knife Blade (A/LKB-F). TPA provides objective sensory results on various quality parameters as follows:

- **Hardness (N):** maximum peak force during the first compression cycle (first bite) and often used interchangeably with the term “firmness”.

- **Springiness (elasticity, ratio):** ratio related to the height that the food recovers during the time that elapses between the end of the first bite and the start of the second bite.

- **Resilience (ratio):** measurement of how the sample recovers from deformation both in terms of speed and forces derived.

- **Cohesiveness (ratio):** ratio of the positive force area during the second compression to that during the first compression.

- **Chewiness:** hardness x cohesiveness x springiness.

Results:

Top 3 samples showing desirable properties were selected in each category.

Table I shows the following.

Noodle Color (*L* value, Higher is better.) ***at 0 hr***: 2401 (86.14), 2402 (85.74), 2418 (85.72)

Noodle Color (*L* value, Higher is better.) ***at 24 hr***: 2401 (73.34), 2402 (73.33), 2410 (72.87)

Delta L (Change of *L* value, Lower absolute value is better.)
2416 (-11.7), 2410 (-11.9), 2414 (-12.3)

PPO (Lower is better.): 2414 (0.183), 2411 (0.218), 2418 (0.357)

Table II shows the following.

Hardness : 2413 (2.721), 2414 (2.684), 2416 (2.644)

Springiness : 2408 (1.027), 2420 (1.01), 24019(0.986)

Chewiness : 2420 (1.704), 2418 (1.701), 2414 (1.687)

Resilience : 2419 (0.406), 2418 (0.404), 2421 (0.402)

Cohesiveness : 2418 (0.688), 2419 (0.681), 2421 (0.678)

Water Uptake : 2421 (98.24), 2413 (97.12), 2422 (96.36)

Cooking Loss : 2413 (4.04), 2422 (4.40), 2412 (4.48)

Discussion

Sample 2401 had the brightest noodle color at 0 hr and at 24 hr respectively, and was quite soft in texture after cooking. The sample 2401 would be a good noodle flour for white salted noodles (Japanese Udon-type), which are preferred to have a bright, creamy white color, and soft, smooth texture. Sample 2418 had the highest cohesiveness, the second highest chewiness, the second highest resilience in texture, the third brightest noodle color at 0 hr, the third lowest PPO level, and brightest noodle color at 24 hr. A firm texture after cooking is considered a desirable characteristic for alkaline noodles. Thus, sample 2418 would be most favorable for alkaline noodles. Sample 2414 had the second highest hardness, third highest chewiness in texture, third highest Delta L, and the lowest PPO level.

Table I. Noodle Color and PPO Level

Sample ID	L @ 0	L @ 24	a @ 0	a @ 24	b @ 0	b @ 24	delta L	delta a	delta b	PPO
10-2401	86.14	73.34	-1.88	-0.36	16.29	23.21	-12.80	1.52	6.92	0.655
10-2402	85.74	73.33	-1.73	-0.86	16.23	22.55	-12.41	0.87	6.32	0.668
10-2403	84.31	68.49	-1.58	-0.46	17.09	22.18	-15.83	1.12	5.09	0.726
10-2404	84.76	70.76	-1.48	-0.33	17.13	24.17	-14.01	1.15	7.04	0.670
10-2405	84.72	69.30	-2.01	-0.52	19.58	26.06	-15.43	1.50	6.48	0.715
10-2406	84.22	68.03	-1.95	-0.64	19.49	25.79	-16.20	1.32	6.30	0.725
10-2407	83.40	69.17	-1.87	-0.46	19.18	24.79	-14.24	1.41	5.61	0.764
10-2408	84.19	71.17	-1.60	-0.44	16.99	24.00	-13.03	1.16	7.01	0.704
10-2409	83.54	68.27	-1.43	-0.11	16.64	24.66	-15.27	1.32	8.03	0.724
10-2410	84.77	72.87	-1.59	-0.50	16.30	22.41	-11.90	1.10	6.11	0.860
10-2411	83.39	70.38	-1.44	-0.24	18.29	24.26	-13.01	1.20	5.97	0.218
10-2412	83.22	67.38	-1.28	0.27	17.17	25.17	-15.85	1.54	8.00	0.610
10-2413	83.55	67.38	-1.40	0.42	17.61	23.77	-16.17	1.82	6.16	0.560
10-2414	82.68	70.38	-1.13	-0.10	19.00	25.31	-12.30	1.03	6.32	0.183
10-2415	80.49	67.30	-0.90	0.56	21.57	22.97	-13.20	1.46	1.40	0.838
10-2416	83.42	71.75	-1.35	-0.60	17.28	23.13	-11.67	0.76	5.86	0.855
10-2417	83.77	71.02	-1.45	-0.27	16.26	23.43	-12.75	1.18	7.17	0.964
10-2418	85.72	70.81	-1.48	-0.22	15.41	23.59	-14.91	1.26	8.18	0.357
10-2419	83.31	65.26	-1.76	0.16	17.49	23.04	-18.05	1.92	5.55	0.876
10-2420	84.67	70.30	-1.97	-0.61	18.90	24.27	-14.37	1.36	5.37	0.604
10-2421	82.53	67.65	-2.04	-0.53	22.51	24.88	-14.89	1.52	2.38	0.493
10-2422	83.51	67.89	-2.05	-0.27	19.98	23.51	-15.62	1.79	3.53	0.831
Avg	83.91	69.64	-1.61	-0.28	18.02	23.96	-14.27	1.33	5.94	0.663

Table II. Texture Profile Analysis of Cooked Noodle, Water Uptake and Cooking Loss

Sample ID	Springiness ratio	Hardness (N)	Chewiness	Resilience ratio	Cohesive-ness ratio	Water uptake (%)	Cook loss (%)
10-2401	0.951	2.474	1.523	0.356	0.648	92.24	6.44
10-2402	0.947	2.318	1.474	0.394	0.672	92.36	5.56
10-2403	0.959	2.413	1.496	0.371	0.647	94.92	5.36
10-2404	0.957	2.316	1.433	0.364	0.647	88.60	6.48
10-2405	0.973	2.480	1.572	0.367	0.651	88.56	5.60
10-2406	0.971	2.542	1.604	0.370	0.650	90.72	5.40
10-2407	0.965	2.334	1.522	0.399	0.676	88.28	5.48
10-2408	1.027	2.272	1.492	0.357	0.640	94.88	6.16
10-2409	0.947	2.533	1.548	0.356	0.646	94.76	4.88
10-2410	0.949	2.447	1.451	0.328	0.625	93.72	5.12
10-2411	0.957	2.548	1.638	0.401	0.672	92.80	5.08
10-2412	0.959	2.587	1.646	0.390	0.663	91.80	4.48
10-2413	0.955	2.721	1.667	0.364	0.642	97.12	4.04
10-2414	0.961	2.684	1.687	0.372	0.654	87.56	6.52
10-2415	0.961	2.317	1.484	0.384	0.666	91.80	4.88
10-2416	0.965	2.644	1.680	0.376	0.658	88.36	5.32
10-2417	0.949	2.520	1.550	0.368	0.648	90.36	5.64
10-2418	0.967	2.555	1.701	0.404	0.688	87.64	5.20
10-2419	0.986	2.323	1.560	0.406	0.681	95.04	5.04
10-2420	1.010	2.549	1.704	0.374	0.662	95.36	5.04
10-2421	0.961	2.542	1.656	0.402	0.678	98.24	4.84
10-2422	0.957	2.546	1.632	0.399	0.670	96.36	4.40
Avg	**0.965**	**2.485**	**1.578**	**0.377**	**0.658**	**92.34**	**5.32**

TORTILLA BAKING TEST of 2010 WQC SAMPLES

Bhimalingeswarappa Geera, Joseph M. Awika and Lloyd W. Rooney

Cereal Quality Lab, Department of Soil and Crop Sciences

Texas A&M University, College Station, TX

(January 2011)

Procedures to Produce and Evaluate Wheat Flour Tortillas Using a Commercial Hot Press Baking Procedure

Tortilla Formulation

Ingredients	Amount
Wheat flour	100%
Salt	1.5%
Sodium Stearoyl Lactylate	0.5%
Sodium Propionate	0.4%
Potassium Sorbate	0.4%
All purpose Shortening	6.0%
Sodium Bicarbonate	0.6%
Fumaric Acid - encapsulated	0.33%
Sodium Aluminum Sulfate	0.58%

Tortilla Processing

MIX

Dry ingredients - 1 min, low speed, paddle
Add shortening - 3 min, low speed, paddle
Add water (35°C) - 1 min, low speed, hook, then mix at variable time at medium speed.

Subjective Dough Evaluation

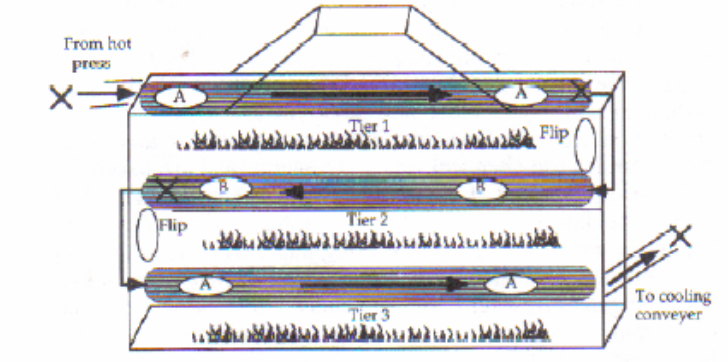
PROOF
5 min, 32°C, 70% RH

DIVIDE and ROUND
Obtain 43-g dough balls

PROOF
10 min, 32°C, 70% RH

Top and bottom of press platen = 395°F; pressure = 1100 psi; press time = 1.4 sec

HOT-PRESS



Oven temperature = 390°F; baking time = 30 sec

BAKE

COOL and PACKAGE

Cool tortillas on cooling conveyor and on a clean table, then package in low density polyethylene bags.

Subjective Dough Evaluation

The dough properties are evaluated subjectively for smoothness, softness and toughness right after mixing, and for press rating after the first proofing. These parameters are evaluated primarily to determine the machinability of the dough.

Smoothness refers to the appearance and texture of the dough surface, and gives an idea how cohesive the dough is.
Softness refers to the viscosity or firmness of the dough when compressed. It is obtained by pressing the dough with the fingers.
Force to extend refers to the elasticity of the dough when pulled apart. It is obtained by pulling the dough at the same point where softness is ranked.
Extensibility refers to the length the dough extends when pulled apart. It is obtained by pulling the dough.
Press rating refers to the force required to press the dough on the stainless steel round plate before dividing and rounding.

Scales:	Smoothness	Softness	Force to Extend	Extensibility	Press Rating
1 =	very smooth	very soft	less force	breaks immed.	less force
2 =	**smooth**	**soft**	**slight force**	some extension	**slight force**
3 =	slightly smooth	slightly hard	some force	**extension**	some force
4 =	rough	hard	more force,	more extension	more force
5 =	very rough	very hard	extreme force	extends readily	extreme force

BOLD values = desired dough properties.

Evaluation of Tortilla Properties

First day after processing, tortillas are evaluated for weight, diameter, thickness and opacity.

1. Weight
Ten tortillas are weighed on an analytical balance. The weight of one tortilla is calculated by dividing total weight by 10. This ranges from 39 to 41 g.

2. Diameter
Ten tortillas are measured by using a ruler at two points across the tortilla: the larger diameter and the smaller diameter. Values from measurements of ten tortillas are averaged. This varies widely among wheat samples depending on flour quality; desired values are > 165 mm.

3. Thickness
Ten tortillas are stacked and a digital caliper is used to measure their height. The thickness of one tortilla is calculated by dividing the height of the stack by 10. This ranges from 2.5 to 3.5 mm.

4. Moisture
Moisture is determined using a two-stage procedure (AACC, Method 44-15A, 2000). This ranges from 30 to 34%.

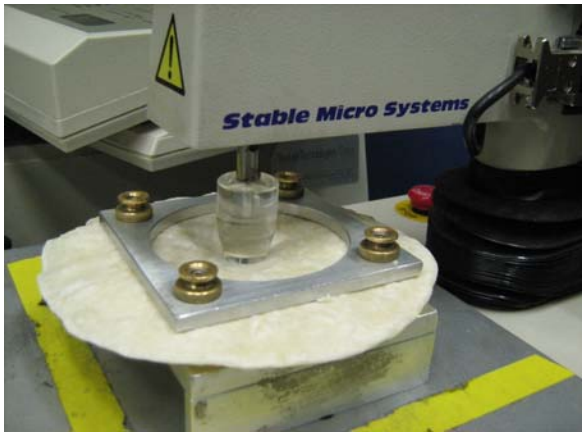
5. Color Values
The color values of lightness (L*), ±a* (redness and greenness) and ±b* (yellowness and blueness) of tortillas are determined using a handheld colorimeter (model CR-300, Minolta Camera Co., Ltd., Chuo-Ku, Osaka, Japan). L*-values correlate with opacity and are usually greater than 80.

6. Specific Volume
Specific volume (cm^3/g) is calculated: = π * (Diameter/2)^2 * height * 1000 / weight. This corresponds to fluffiness of the tortilla; desired value is > 1.5 cm^3/g.

7. Tortilla Rollability Score
Two tortillas are evaluated on 4, 8, 12, and 16 days of storage by wrapping a tortilla around a dowel (1.0 cm diameter). The cracking and breakage of the tortilla is rated using a continuous scale of 1-5 (5 = no cracking, 4 = signs of cracking, but no breaking, 3 = cracking and breaking beginning on the surface, 2 = cracking and breaking imminent on both sides, 1 = unrollable, breaks easily). This measures shelf-stability, and the desired value is > 3 on the 16th day.

8. Objective rheological test

Extensibility of two tortillas is measured on 0, 4, 8 and 12 days of storage using a texture analyzer (model TA XT2, Texture Technologies Corp., Scarsdale, NY/Stable Micro Systems, Godalming, Surrey, UK). The tortilla is mounted on the circular frame and a rounded nose probe (TA-108a, 7/16" diameter cylinder with a rounded edge) pushes into the tortilla during the test. Deformation modulus, force, work and distance required to rupture are measured.



WHEAT QUALITY COUNCIL - 2010 DATA WORKSHEET

COOPERATOR NAME:	B. Geera, J.M. Awika and L.W. Rooney
COOOPERATOR TYPE: MILLER, BAKER, QUALITY LAB	University, Quality Lab
MIXING TOLERANCE METHOD: FARINOGRAPH, MIXOGRAPH, MIXING SERIES, OTHER	
BAKE TEST METHOD: STRAIGHT DOUGH, SPONGE & DOUGH, OTHER	Tortilla Bake Test
DOUGH WEIGHT:	43 gram
Resting TIME:	10 min
Hot-Press Temp (top/bottom):	395 / 395 F
Hot-Press Time:	1.40 sec
Hot-Press Pressure:	1100 psi
OVEN TEMPERATURE:	390 F
BAKE TIME:	30 sec

Table 1. Protein content, and mixograph and farinograph data of the wheat samples*

TEST No.	Protein (%, 14% mb)	Mix Time (min)	Mix Tolerance (scale of 1-6)	Devt. Time (min)	Stability (min)	Tolerance Index (FU)	Breakdown (min)
10-2401	10.5	4.6	3	2.5	17.3	15	14.3
10-2402	10.7	6.9	4	2.5	22.8	19	12.1
10-2403	11.1	5.0	3	3.5	22.7	6	18.5
10-2404	11.1	4.4	3	2.5	24.1	14	15.5
10-2405	11.8	3.8	3	5.2	24.1	19	13.1
10-2406	11.8	4.6	4	7.2	23.8	10	20.5
10-2407	10.8	7.6	4	3.2	32.6	12	17.9
10-2408	10.7	4.4	3	4.2	11.5	31	8.9
10-2409	11.2	4.3	4	3.0	13.2	24	9.1
10-2410	10.9	3.4	3	5.9	10.9	40	9.6
10-2411	12.8	4.5	4	5.8	20.0	17	14.4
10-2412	12.5	4.0	4	7.8	21.7	22	18.0
10-2413	13.1	2.1	4	6.5	13.2	34	11.1
10-2414	12.4	4.5	4	6.7	21.5	17	16.0
10-2415	13.9	8.5	5	7.7	30.5	15	26.6
10-2416	12.3	8.0	4	2.4	14.1	34	6.3
10-2417	12.1	5.0	4	3.5	14.7	28	9.0
10-2418	12.5	6.3	5	6.5	18.1	25	12.6
10-2419	13.0	3.1	2	8.0	14.0	29	13.0
10-2420	11.8	2.9	2	5.5	12.5	25	10.9
10-2421	13.0	4.5	4	10.0	23.0	18	22.1
10-2422	12.2	2.9	2	6.9	12.5	26	13.3

*All data in this table were provided together with the flour samples.

Table 2. Water absorption, mixing time and subjectively evaluated dough properties

TEST No.	Dough Absorp*	Mix time at medium speed**	Dough Temp	Smooth-ness	Soft-ness	Extensi-bility	Force to Extend	Press Rating
	%	(min)	(°C)	(Rating)	(Rating)	(Rating)	(Rating)	(Rating)
10-2401	52	5	34.0	3.0	2.8	2.3	3.0	3.5
10-2402	53	7	32.6	2.5	3.3	2.0	3.3	3.8
10-2403	53	5	36.5	2.0	2.0	3.5	2.3	2.5
10-2404	53	4	35.0	2.3	2.3	2.3	2.5	2.8
10-2405	54	4	35.2	2.3	2.3	2.0	2.8	2.5
10-2406	54	5	35.7	2.0	2.0	3.3	2.3	2.3
10-2407	54	8	33.0	3.0	3.0	1.5	3.3	3.8
10-2408	54	4	34.2	2.8	2.5	2.3	3.0	3.5
10-2409	54	4	35.1	2.8	2.8	3.0	2.3	2.8
10-2410	54	3	35.2	2.8	2.3	2.0	2.5	2.5
10-2411	54	5	34.9	2.3	2.3	2.8	2.3	2.8
10-2412	54	4	33.4	2.0	2.0	3.5	2.0	2.8
10-2413	54	2	36.3	2.0	1.8	3.5	2.0	2.3
10-2414	54	5	35.0	2.3	2.5	3.0	2.5	2.8
10-2415	54	9	35.5	3.0	3.0	3.3	3.0	3.3
10-2416	54	8	35.2	3.0	3.0	2.3	3.5	3.8
10-2417	54	5	35.8	2.0	2.3	3.3	2.5	2.8
10-2418	54	6	35.8	1.8	2.3	2.8	2.5	3.0
10-2419	54	3	35.3	2.3	2.0	2.5	2.5	2.5
10-2420	54	3	35.2	2.3	2.0	3.0	2.0	2.3
10-2421	54	5	35.3	2.3	1.8	3.5	2.0	2.3
10-2422	54	3	36.3	2.3	2.0	3.0	2.3	2.8
Control	54	6	30.3	2.0	2.0	3.0	2.0	2.0
HSD (α = 0.05)			*6.2*	*1.2*	*1.5*	*2.0*	*1.5*	*1.8*
Descriptors or Scale	record actual absorption		record actual tempe-rature	*from* 1 = satin smooth *to* 5 = very rough	*from* 1 = very soft *to* 5 = very hard	*from* 1 = breaks immediately *to* 5 = extends readily	*from* 1 = less force *to* 5 = extreme force	*from* 1 = less force *to* 5 = extreme force

* Tortilla dough water absorption was the percent absorption from Farinograph analysis minus 10 units, e.g., if Farinograph absorption was 61% then the tortilla dough absorption was 51%.
** Dough was mixed at medium speed at variable mixing times based on mixograph peak times.
All doughs were generally easy to process (i.e., no excessive stickiness or firmness). Samples 2416 and 2401, however, were slightly firm and hard to press (to the stainless steel plate).

Table 3. Physical properties of tortillas

TEST No.	Moisture	Weight	Thickness	Diameter	Sp. Volume	Lightness*
	%	g	mm	mm	cm^3/g	L-value
10-2401	32.4	43.1	3.4	135	1.2	82.3
10-2402	32.9	40.4	3.4	134	1.2	82.0
10-2403	31.0	41.3	3.3	149	1.4	83.0
10-2404	34.4	43.6	3.5	152	1.5	82.3
10-2405	32.6	39.3	3.3	151	1.5	83.2
10-2406	34.3	41.9	3.3	148	1.4	82.7
10-2407	32.6	41.1	3.5	135	1.2	81.8
10-2408	31.5	40.7	3.2	151	1.4	82.3
10-2409	31.4	39.9	3.2	149	1.4	82.1
10-2410	32.7	42.1	3.3	150	1.4	80.4
10-2411	31.1	41.2	3.1	151	1.4	80.3
10-2412	29.7	41.6	3.4	155	1.6	82.3
10-2413	31.4	41.3	3.3	162	1.6	83.1
10-2414	31.7	41.8	3.4	151	1.4	82.0
10-2415	32.2	41.9	3.2	142	1.2	78.1
10-2416	32.4	43.5	3.4	144	1.2	80.4
10-2417	31.6	41.4	3.5	146	1.4	81.3
10-2418	30.1	42.3	3.4	154	1.5	81.7
10-2419	32.0	40.6	3.2	150	1.4	81.6
10-2420	31.8	39.5	3.6	159	1.8	83.6
10-2421	33.3	39.4	3.1	152	1.4	82.0
10-2422	34.2	40.5	3.5	156	1.7	83.5
Control	33.2	38.7	2.6	171	1.5	82.9
HSD (α = 0.05)	*4.6*	*4.9*	*1.0*	*37.2*	*0.6*	*5.5*
Descriptors or Scale	Calculate using two-step method	Record actual weight	Record actual thickness	Record actual diameter	Calculate as = π(radius)^2 *thickness *1000/wt	Record actual L-value; 0 = black to 100 = white

*L-value measured from twice-baked side of tortilla

None of the tested samples, apart from the control, had the desired diameter (at least 165 mm). Generally, those with small diameters had corresponding low opacity and specific volume (<1.5 cm^3/g; less fluffy). L*-values for whiter tortillas are usually greater than 80 and sample 2415 did not meet this requirement.

Table 4. Texture profile of tortillas measured on day of processing and after 12 days of storage

TEST No.	Modulus day 0	Force day 0	Distance day 0	Work day 0	Modulus day 12	Force day 12	Distance day 12	Work day 12
	(N/mm)	(N)	(mm)	(N.mm)	(N/mm)	(N)	(mm)	(N.mm)
10-2401	0.3	7.4	27.7	69.7	0.9	8.6	12.1	37.8
10-2402	0.7	10.5	24.2	96.2	1.3	12.3	12.9	67.0
10-2403	0.6	7.8	22.5	63.2	1.0	8.6	12.1	44.1
10-2404	0.7	9.4	22.4	79.4	1.0	10.2	12.8	53.9
10-2405	0.5	7.7	23.3	63.6	1.1	9.7	12.5	48.8
10-2406	0.6	9.5	24.1	82.7	1.0	11.9	14.1	65.7
10-2407	0.9	10.9	21.2	98.8	0.9	11.4	14.6	68.8
10-2408	0.6	7.4	19.0	50.9	1.0	8.9	12.2	38.3
10-2409	0.6	7.8	22.6	62.2	0.6	7.2	13.3	35.2
10-2410	0.6	8.3	21.7	65.0	0.6	8.2	13.2	36.9
10-2411	0.5	10.3	27.7	100.9	0.9	14.2	14.7	76.0
10-2412	0.6	8.7	23.9	75.1	0.6	11.5	15.3	66.3
10-2413	0.5	7.1	22.3	58.7	0.6	7.1	13.0	32.1
10-2414	0.7	10.0	23.6	82.7	0.7	10.2	13.9	49.8
10-2415	1.0	15.5	28.2	177.0	0.8	14.2	16.5	89.4
10-2416	0.8	12.0	25.1	115.1	1.0	12.1	13.8	63.8
10-2417	0.8	11.4	23.9	107.0	1.2	11.4	11.7	50.3
10-2418	0.7	10.6	25.1	105.8	0.8	11.2	14.4	58.1
10-2419	0.5	8.5	26.3	90.4	0.5	8.7	14.2	40.4
10-2420	0.5	7.2	22.3	54.7	0.5	7.7	14.4	38.1
10-2421	0.5	8.2	27.0	96.1	0.7	9.4	14.2	47.2
10-2422	0.4	7.4	23.6	56.1	0.6	8.6	14.0	44.2
Control	0.5	5.6	15.8	35.1	0.5	4.6	11.0	16.2
HSD (α = 0.05)	0.3	9.9	11.9	141.9	*0.7*	*9.6*	*5.5*	*73.2*
Descriptors or Scale	Determine parameters using texture analyzer on day of processing				Determine parameters using texture analyzer after 12 days of storage			

All samples had tortillas that became less extensible with storage. Sample 2415 consistently had the highest force, distance and work needed to rupture the tortillas especially after 12 days of storage at room temperature. These were the most extensible (less prone to break) compared to the other samples.

Table 5. Subjective rollability scores, tortilla diameter and sample ratings

TEST No.	Rollability Scores (RS)				Diameter	Rating*
	4 days	8 days	12 days	16 days	mm	
10-2401	4.1	3.8	3.8	3.0	135	Poor
10-2402	3.8	2.9	2.8	2.6	134	Poor
10-2403	4.5	3.8	3.1	2.8	149	Poor
10-2404	3.4	2.3	2.3	2.0	152	Poor
10-2405	4.5	4.0	3.9	3.5	151	Poor
10-2406	4.0	3.5	3.5	3.3	148	Poor
10-2407	4.0	4.0	3.5	3.4	135	Poor
10-2408	4.0	3.0	2.4	2.0	151	Poor
10-2409	4.3	3.8	3.6	3.4	149	Poor
10-2410	3.9	3.5	2.8	2.6	150	Poor
10-2411	4.0	3.9	3.8	3.4	151	Poor
10-2412	4.3	4.0	3.4	3.4	155	Poor
10-2413	4.4	3.5	3.0	2.8	162	Poor
10-2414	4.0	4.0	3.9	3.3	151	Poor
10-2415	4.4	4.0	4.1	3.9	142	Poor
10-2416	4.1	4.0	3.1	2.9	144	Poor
10-2417	4.3	4.5	3.1	2.9	146	Poor
10-2418	4.3	4.0	3.8	3.6	154	Poor
10-2419	4.5	3.5	3.9	3.8	150	Poor
10-2420	4.0	3.8	2.9	2.8	159	Poor
10-2421	4.5	3.8	3.8	3.5	152	Poor
10-2422	3.9	3.5	3.4	2.5	156	Poor
Control	4.0	2.6	2.4	2.3	171	Poor
Descriptors or Scale	*from* 1 = breaks when rolled to 5 = rolls easily				Record actual diameter	

*Subjective rating based mainly on diameter and rollability scores (day 16):
Good = rollability score >3 on day 16, ≥165 mm
Fair = rollability score >3 on day 16, 157-164 mm
Poor = rollability score <3 on day 16, any diameter

None of the tested samples had acceptable diameter and rollability scores. Some samples had good rollability scores but small diameters (typical of strong flours that give doughs that shrink when hot-pressed).

FLOUR PROTEIN ANALYSIS

Michael Tilley, Sushma Prakash and Val Pierucci

USDA, CGAHR, Manhattan, KS

Procedures

1. Determination of High Molecular Weight Glutenin Subunit (HMW-GS) composition

Sequential protein extraction:

- 100 mg flour + 1 ml 50 mM Tris-HCl buffer, pH 7.8, containing 100 mM KCl and 5 mM EDTA- vortex for 5 min, centrifuge for 5 min at 12,000 x g. Discard the supernatant (contains albumins and globulins).
- Repeat the procedure one more time to ensure complete removal of those proteins.
- Repeat the procedure two more times using water, to remove salt from the pellet. Discard the supernatants.
- Add 1 ml 50% 1-propanol to the pellet and vortex for 5 min, centrifuge for 5 min at 12,000 x g. Discard the supernatant (contains gliadins).
- Repeat the extraction with 50% 1-propanol one more time. Discard the supernatant
- Add 1 ml 50% 1-propanol containing 2% tris(2-carboxyethyl)phosphine (TCEP reducing agent) to the pellet and vortex for 30 min, centrifuge for 5 min at 12,000 x g. Collect the supernatant (contains the glutenin: HMW-GS and LMW-GS).
- Analyze protein in the supernatant using the Agilent 2100 Bioanalyzer (lab-on-a-chip).

2. Determination of HMW-GS to LMW-GS ratio

- Extract protein as described above.
- Alkylate 300 µl of protein extract with 20 µl 4-vinylpyridine for 15 min at 60°C.
- The resulting protein sample was analyzed by RP-HPLC (Agilent 1100 Series, Agilent Technologies, Palo Alto, CA).
- Inject 1 µl of protein sample into a Poroshell 300SB-C8, 2.1 x 75 mm, 5 µm particle size column (Agilent Technologies, Palo Alto, CA) kept at 65°C.
- Solvent flow rate was 0.7 ml/min and composed of a non-linear gradient of water (A) and acetonitrile (B), both containing 0.1% trifluoroacetic acid. The gradient was as follow: from 0 to 1 min., 23% B; from 1 to 3 min., the gradient increased from 23 to 30% B; from 3 to 11 min., increased from 30 to 44% B; from 11 to 12 min., the gradient decreased from 44 to 23% B and kept at 23% B until 13 min.
- Detection of protein peaks was carried out by a UV detector at 206 nm (Naeem and Sapirstein 2007).
- Determine areas of the curve corresponding the HMW-GS and LMW-GS by manual integration and calculate the ratio HMW-GS/LMW-GS.

3. Determination of polymeric to monomeric protein ratio

- Protein extraction (Gupta et al 1993**)**:
- 20 mg flour + 1 ml 0.05M Sodium phosphate buffer, pH 6.9, containing 0.5% SDS (w/v)- sonicate for 15 s at power setting 10 W. Collect the supernatant (contains total protein).
- Filter the supernatant in a 0.45 µm filter and analyze by size-exclusion HPLC (SE-HPLC).

- SE-HPLC was conducted using a 300.0 x 7.8 mm BioSep S4000 column (Phenomenex, Torrance, CA), kept at 50°C, with a constant gradient composed of 50 mM Sodium phosphate buffer, pH 7.0, containing 1% SDS, flow rate of 1.0 ml/min during 20 min.
- The chromatograms were manually integrated. The area of the first peak corresponds to Glutenin and the area of the second peak to Gliadin. The ratio Glutenin/Gliadin was determined using the areas of the chromatograms.

4. Determination of the Percentage of Insoluble Polymeric Protein (%IPP)

- Protein extraction (Bean et al, 1998): 100 mg flour + 1 ml 50% 1-propanol- vortex for 5 min, centrifuge for 5 min at 12,000 x g. Discard supernatant.
- Repeat this procedure two more times and discard the supernatants (the supernatants contain the monomeric and soluble polymeric proteins).
- Lyophylize the pellet, which contains the insoluble polymeric proteins.
- Determine pellet protein content by Nitrogen combustion (LECO analysis).
- Insoluble polymeric protein percentage (%IPP) is calculated by multiplying nitrogen values by a conversion factor of 5.7 and dividing by total flour protein.

References

Bean, S.R.; Lyne, R.K.; Tilley, K.A.; Chung, O.K.; Lookhart, G.L. 1998. A rapid method for quantitation of insoluble polymeric proteins in flour. *Cereal Chemistry* 75:374-379.

Gupta, R.B.; Khan, K.; MacRitchie, F. 1993. Biochemical basis of flour properties in bread wheats. I. Effects of variation in the quantity and size distribution of polymeric protein. *Journal of Cereal Science* 18:23-41.

Naeem, H.A.; Sapirstein, H.D. 2007. Ultra-fast separation of wheat glutenin subunits by reversed-phase HPLC using a superficially porous silica-based column. *Journal of Cereal Science* 46:157-168.

Results of Flour Protein Analysis

2010	*HMW-GS composition*	*Polymeric/Monomeric Protein ratio*	*HMW-GS/LMW-GS ratio*	*% IPP*
ID CODE	**HMW-GS**	**polymeric/monomeric**	**HMW/LMW**	**%IPP**
10-002401	2*,7+9, 5+10	0.81	0.31	43.82
10-002402	2*,7+9, 5+10	0.98	0.34	47.72
10-002403	2*, 7+8, 5+10	1.00	0.27	46.25
10-002404	1, 7+8, 5+10	0.98	0.38	47.94
10-002405	2*, 7+9, 2+12	0.74	0.25	47.70
10-002406	2*, 7+8, 5+10	0.92	0.24	46.64
10-002407	2*, 7+8, 5+10	0.81	0.26	52.28
10-002408	2*, 7+9, 5+10	0.90	0.24	45.80
10-002409	2*, 7+9, 5+10	0.68	0.31	46.48
10-002410	2*, 17+18, 5+10	0.88	0.40	47.02
10-002411	1, 7+9, 5+10	0.80	0.32	47.68
10-002412	2*, 7+9, 2+12	0.80	0.44	48.14
10-002413	2*, 7+9, 2+12	0.79	0.39	44.81
10-002414	2*, 7+8, 5+10	0.78	0.45	47.31
10-002415	1, 7+9, 5+10	0.70	0.42	51.50
10-002416	2*, 17+18, 5+10	0.74	0.29	51.73
10-002417	2*, 7+8, 5+10	0.67	0.40	47.91
10-002418	1, 7+8, 5+10	0.88	0.34	49.63
19-002419	2*, 7+8, 5+10	0.61	0.36	43.11
10-002420	2*,7+9, 2+12	0.82	0.24	45.23
10-002421	1, 7+8, 5+10	0.78	0.30	47.11
10-002422	1, 7+9, 5+10	0.69	0.29	45.87
Descriptors or Scale	Determined by bioanalyzer	Determined by SE-HPLC- area of chromatograms	Determined by RP-HPLC- area of chromatograms	Determined by LECO

APPENDIX A
Credits and Methods

CREDITS

Milling, Sample Analysis, Ingredients and Report Preparation

Single Kernel Analysis, Kernel Size Distribution, Test Weight, and Quadrumatic Sr. Mill	USDA/ARS/HWWQL Manhattan, KS
Flour Milling (Miag Multomat)	KSU Dept. Grain Science & Ind. Manhattan, KS
Wheat Classification	Federal Grain Inspection Service Kansas City, MO
Moisture, Ash, Protein, and Minolta Flour Color	USDA/ARS/HWWQL Manhattan, KS
Mixograph, Farinograph Tests, Extensigraph, and Alveograph Tests	USDA/ARS/HWWQL Manhattan, KS
Glutomatic, Rapid Visco-Analyzer, and Sedimentation Tests	USDA/ARS/HWWQL Manhattan, KS
Marketing Scores Sedimentation Tests	USDA/ARS/HWWQL Manhattan, KS
Flour Protein Analysis	USDA/ARS/GQSRU Manhattan, KS
Falling Number Test and Starch Damage	USDA/ARS/HWWQL Manhattan, KS
Doh-Tone 2 as Fungi α-amylase	Caravan Ingredients Company 3947 Broadway Kansas City, MO 64111
Tortilla Evaluation	TAMU, Cereal Quality Lab College Station, TX
Alkaline Noodle Evaluation	USDA/ARS/HWWQL Manhattan, KS
Data Compilation and Final Report	USDA/ARS/HWWQL Manhattan, KS

CREDITS

Wheat Breeders

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Mennel Milling Co. Findlay & Vine Street Fostoria, OH 44830	Miller	**C.J. Lin** (419) 436-5130 Cjlin@mennel.com
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METHODS

Test Weight – AACC Approved Method 55-10. Test weight is the weight per Winchester bushel expressed to the nearest tenth of a pound. This method determines the weight of dockage-free grain.

Weight per Hectoliter - Weight per Winchester Bu x 1.292 + 1.419 (all wheats except Durum) expressed to the nearest tenth of a kilogram. Example: 60.5 lb/bu x 1.292 + 1.419 = 79.6 kg/hl.

1000 Kernel Weight - The weight in grams of 1000 kernels of wheat, determined with an electronic seed counter using a 40g sample from which all foreign material and broken kernels have been removed (reported on 12% moisture basis).

Wheat Kernel Size Test - 200g of wheat are placed on the top sieve of a stack of 3 (8inch diameter) Tyler No. 7, 9 & 12 sieves (2.79, 1.98, & 1.40 mm openings; US Equiv. No. 7, 10 & 12) and sifted for 60 seconds on a Ro-Tap sifter. The percentage remaining on each sieve is reported.

Wheat and Flour Moisture - AACC Approved Method 44-15A. Wheat (ground in Falling Number 3303 burr-type mill to prevent drying before grinding) or flour is dried in a forced air oven at 130^0 C for one hour.

Wheat and Flour Protein - AACC Approved Method 46-30 wheat meal and flour. Combustion nitrogen method.

Ash - AACC Approved Method 08-01. Sample remaining after ignition is expressed as percent.

Experimental Milling Test - Brabender Quadrumat Sr. is used to mill wheat samples with 15% of tempering moisture for more than 16 hours and feed rate is 150 g/min.

Miag Multomat (Small Scale) Milling - Each coded variety is cleaned with a Carter dockage tester, placed in drums, and sampled for physical wheat tests and analysis. Each variety is then tempered using a double cone blender with enough added water to bring the wheat moisture to 16%. The tempered wheat is held in drums for approximately 20 hours before milling. Milling is performed on the Miag Multomat, which consists of 3 breaks, 5 reductions, and a bran duster. Feed rate is set at 850 to 900 grams per minute. The mill is warmed up and adjusted using KSU mill mix, after which 2-3 bushels of each coded experimental sample are milled.

Break rollers are adjusted to the following releases through a U.S. 20 S.S. sieve:

First Break	50%
Second Break	50%
Third Break	clean-up

Flour yields are calculated from scale weights and expressed as percentage of total products recovered from the mill.

Flour Color – Evaluated using Minolta Chroma Meter. The flour color results are reported in terms of 3-dimensional color values based on L*, a*, and b*.

Wet Gluten - AACC Approved Method (38-12). 10 g. of flour and 5.2 ml. of 2% salt solution are mixed in a Glutomatic test chamber for 20 seconds and then washed for 5 minutes to separate the gluten and the soluble starch products. The gluten ball is divided and placed in a centrifuge for one minute to remove excess water. Percent Wet Gluten is calculated as weight of the centrifuged gluten x 10.

Dry Gluten - Gluten from the wet gluten test is dried between two heated, Teflon coated plates for approximately 4 minutes. Percent Dry Gluten is calculated as weight of the dry gluten x 10.

Falling Number - AACC Approved Method 56-18A. Determination is made by the method of Hagberg (Cereal Chemistry 38:202, 1961) using 7g of flour.

Wheat Hardness - AACC Approved Methods 39-70A (NIR hardness) and 55-31 (using Perten 4100 Single Kernel Characterization System).

Damaged Starch - AACC Approved Method 76-33 using SDmatic. Results are given in an iodine absorption index percentage (AI%) and AACC 76-31 results converted from the testing.

Flour Treatment - Fungal alpha-amylase is added to the flour by each baking cooperator.

Mixograph and Farinograph - AACC Approved Methods (54-40A and 54-21) respectively. These instruments measure and record the resistance to mixing of a flour-and-water dough. The recorded curve rises to a "peak" as the gluten is developed and then falls as the gluten is broken down by continued mixing. Curves made by the two instruments are not directly comparable.

The time required for a Mixograph or Farinograph curve to reach the "peak" is an estimate of the amount of mixing required to properly develop the dough for handling and baking. The rate at which a curve falls and narrows after the peak and stability of

peak height on either side of the peak are indicators of mixing tolerance. Terms used to describe the Farinograph curve or "farinogram" include:

Absorption - Reported on a 14% moisture basis. Percentage of water required to center the curve on the 500 Farinograph Unit (FU) line at maximum dough consistency (peak). This may not be optimum absorption in a bakery, because baking ingredients influence absorption and flours vary in "slacking-out" during fermentation.

Peak Time - Also called Mixing Time or Dough Development Time. Time (minutes) required for the curve to reach its full development or maximum consistency. High peak values are usually associated with strong wheats that have long mixing requirements.

Stability - Also called Tolerance. This is the time (minutes) that the top of the curve remains above the 500 FU line. Greater stability indicates that the flour can stand more mixing abuse and longer fermentation.

Rapid Visco-Analyzer Test – AACC Approved Methods (61-02).

Sedimentation Test - AACC Approved Methods (56-60).

Alveograph – AACC Approved Methods (54-30A). The instrument measures resistance of dough extension, extensibility, and dough strength. A sheet of dough of definite thickness prepared is expanded by air pressure into a bubble until it is ruptured. The internal pressure in bubble is recorded on automated integrator. P = Tenacity (resistance to extension), L = extensibility, W = baking strength (curve area), P/L = curve configuration ratio, G = swelling index (the square root of the volume of air needed to rupture the bubble), Ie = P200/P, elasticity index (P200: pressure 4 cm from the start of the curve, Ie will be 0 if the extensibility is shorter than 4 cm).

Extensigraph – AACC Approved Method (54-10). The Extensograph® -E stretches the dough prepared by a modified method published in AACC International's Cereal Chemistry (86(5):582-589). The instrument measures resistance of dough extension (R), extensibility (E), maximum resistance (Rmax), and energy (W).

Cumulative Ash and Protein Curves

Ideally, the miller would like to separate wheat bran from endosperm, and reduce endosperm particle size, without producing any bran powder at any stage of the milling process. Unfortunately, current milling technology does not allow this "ideal" situation to occur, and once bran powder is produced it goes into the flour and can never be removed. Ash determination has traditionally been used as an analytical tool in managing the extraction rate of wheat during the milling process. Ash determination consists of burning a known mass of the material to be analyzed and then measuring the residue. Since burning destroys everything but the mineral components, the mass of the residue provides an indication of the contribution that minerals made to the original material. The application of this method to determining bran content of flour has been justified by the

fact that endosperm has a lower mineral content than bran. Ash content is lowest in the center of the kernel and increases toward the outer parts because the bran layer contains several times more minerals than pure endosperm.

Many millers have flour refinement specifications (ash content or flour color) that must be met. Therefore, the overall milling value of a wheat sample is determined not only by flour yield, but also flour refinement. A commonly used index of wheat milling value is the cumulative ash curve (Lillard and Hertsgaard 1983). Cumulative ash curves are determined by arranging millstreams in ascending order of ash content, and tabulating the ash content of the total flour produced with the addition of successive millstreams. Wheat that gives low ash content at low extraction, and a slow rate of ash content increase with increasing extraction rate, has a high milling value because of the potential to produce a high percentage of patent flour, which usually sells for a premium in many markets. It should be noted that several authors have indicated that ash curves can be influenced by hardness, variety, whole grain ash, and milling system (Seibel 1974; Posner and Deyoe 1986; Li and Posner 1987, 1989). Natural endosperm ash is typically regarded to be 0.30%; anything above that is generally considered to be due to the milling process.

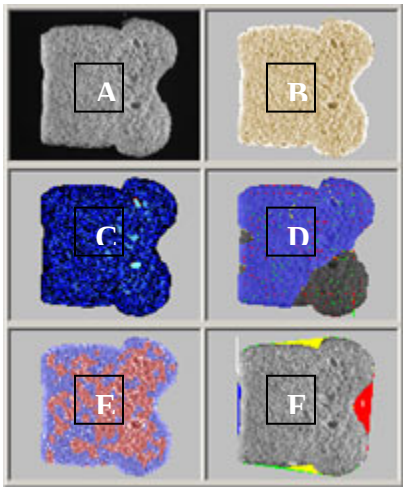
Similarly, cumulative protein curves are determined by arranging millstreams in ascending order of protein content, and tabulating the protein content of the total flour produced with the addition of successive millstreams. Wheat that gives high protein content at low extraction, and a fast rate of protein content increase with increasing extraction rate, has a high milling value because high protein flour typically sells for a premium in many markets.

LI, Y. Z., and POSNER, E. S. 1987. The influence of kernel size on wheatmillability. Bull. Assoc. Operative Millers November: 5089-5098.
LI, Y. Z., and POSNER, E. S. 1989. An experimental milling techniquefor various flour extraction levels. Cereal Chem. 66:324-328.
LILLARD, D.W. and HERTSGAARD, D.M. 1983. Computer analysis and plotting of milling data: HRS wheat cumulative ash curves. Cereal Chem. 60:42-46.

C-Cell Image Analysis

Pup loaves were baked in duplicate and evaluated with the C-Cell system and its image analysis software (Campden & Chorleywood Food Research Association (CCFRA) and Calibre Control International©) at the USDA-ARS Hard Winter Wheat Quality Laboratory (HWWQL) in Manhattan, KS. Two slices from each loaf were scanned: with the break facing the observer, slice 4 and 5 from the right end of the loaf were selected and evaluated with the break side of the slice oriented on the left. Images of the internal grain and crumb structure of each slice represent only the fourth slice of replicate 1, and are shown in the report. Selected numerical data from the image analysis of slice 4 represent the average of slice 4 from replicates 1 and 2, and are shown in the report. General capabilities of the instrument and image analysis are shown below:

Images:



(A) Raw Image *(B) Brightness Correction Image*

(C) Cell Image *(D) Elongation Image*

(E) Cell Distribution Image *(F) Cell Size & Shape Image*

Data:

Forty-eight (48) individual measurements are presented in the data display screens and are saved to the database.

Cell Size: Numbers and dimensions of cells and holes are measured. Wall thickness & coarse/fine clustering.

Cell Elongation and Orientation: Cell alignment and elongation, circulation and curvature

Dimensions: Sample area, height, breadth, ratios and wrapper length.

Brightness: Sample brightness and cell contrast.

Shape: Various physical features including, break, concavity and roundness.

Slice Area: The total area of a product slice (mm^2).

Slice Brightness: The mean grey level (0-255) of pixels within the slice. The value is lower for products with a darker crumb and for products with larger or deeper cells that contribute to greater shadows. The measurement provides a useful indication of product reflectance.

Number of Cells: The number of discrete cells detected within the slice. Higher values may be due to a finer structure or a larger total slice area. The cells are shown in the Cell image. When interpreting this image, cells only touching diagonally are considered to be discrete.

Wall Thickness: The average thickness of cell walls (mm). for bright slices, saturation of some regions may be interpreted as thick walls. Walls close to the edge of the slice are given a reduced weighting in the calculation.

Cell Diameter: The average diameter of cells (mm), based on measurements of the average cell area. This is a good general purpose indicator of the coarseness of the texture, but does not take the depth of cells into account.

Non-Uniformity: A measure of the lack of uniformity between fine and coarse texture (including holes) across the slice. High values indicate less uniformity of texture. The value is useful for comparing slices of similar types of product, but comparisons between products of differing type tend to be less easily interpreted.

Average Cell Elongation: The average length to breadth ratio of cells, independent of their relative orientation. Lower weighting is given to cells close to the edge of the slice. Values close to 1 indicate rounded cells. Higher values indicate greater elongation.

Cell Angle to Vertical (^{0}): The angle (degrees) of the direction of Net Cell Elongation, measured clockwise from the slice vertical. Lower weighting is given to cells close to the edge of the slice. Values are given in the range of -90 to +90 degrees. Values close to 0 represent a vertical orientation. Values close to + or – 90 represent a horizontal orientation.

Collaborators' Baking Test Profiles

Coop	No.	Test Methods	Est. Flour Wt (g)*	Mixing Tolerance	Fermentation time	Oven Temp	Baking Time
A	1	Pop loaf straight	100 g	Mixograph	90 min	400 F	25 min
B	2	Sponge and dough	700 g for 2 doughs	Other	210 min for sponge, 45-50 min for ferm	420 F	20 min
C	3	Sponge and dough	700 g for 2 doughs	Farinograph	240 min for sponge, 70 min for ferm	420 F	20 min
D	4	Pop loaf straight	100 g	Mixograph	**65 min**	420 F	**12 min**
E	5	Pop loaf straight	100 g	Farinograph	180 min	400 F	25 min
F	6	Pop loaf straight	100 g	Farinograph	120 min	425 F	25 min
G	7	Pop loaf straight	100 g	Farinograph and Mixograph	180 min	400 F	25 min
H	8	Pop loaf straight	100 g	Mixograph	90 min	425 F	21 min
I	9	Sponge and dough	700 g for 2 doughs	Fariongraph	**2 min for sponge and 210 min for ferm**	430 F	23 min
J	10	Sponge and dough	**100 g**	Mixing series	240 min for sponge and 60 min for ferm	425 F	**16 min**
K	11	Sponge and dough	700 g for 2 doughs	Mix Series	240 min for sponge and 60 min (var.) for ferm	420 F	20 min
L	12	Pop loaf straight	100 g		90 min	400 F	22 min
M	13	Pop loaf straight	100 g	Mixograph	180 min	419 F	24 min
N	14	**1 lb straight dough**	**700 g for 2 doughs**		120 min	400 F	25 min
O	15	Pop loaf straight	100 g	Mixograph	120 min	420 F	18 min
P	16	Sponge and dough	700 g for 2 doughs		270 min for fermentation	400 F	18 min
Q	17	Sponge and dough	700 g for 2 doughs	Farinograph	Sponge 1 min@ low + 3 min@ med + 240 min for ferm	425 F	25 min

*100 = pup loaf, 350 = one pound loaf

APPENDIX B

Hard Winter Wheat Quality Council
Goals for Hard Winter Wheat Breeders

Hard Winter Wheat Quality Council

2010 Technical Board Officers

CHAIR:	**Becky Miller**, Kansas State University
VICE CHAIR:	**Sid Perry**, WestBred/Monsanto
SECRETARY:	**Craig Warner**, Sara Lee
MEMBER:	**Theresa Sutton**, AIB
MEMBER:	**Justin Turner**, Horizon Milling

2010 Quality Evaluation & Advisory Committee

Brad Seabourn, USDA/ARS/HWWQL

Allan Fritz, Kansas State University

Brian Strouts, American Institute of Baking

Ken Ulbrich, Bay State Milling

Richard Chen, USDA/ARS/HWWQL

Hard Winter Wheat Quality Council (HWWQC)

Charter
Revised and Approved (February 20, 2003)

Mission, Policy, and Operating Procedure

The mission of the HWWQC is to provide a forum for leadership and communication in promoting continuous quality improvement among the various elements of the community of hard winter wheat interests. The HWWQC will provide an organization structure to evaluate the quality of hard winter wheat experimental lines and cultivars that may be grown in the traditional growing regions of the United States. The HWWQC also will establish other activities as requested by the membership. The HWWQC operates under the direction and supervision of the Wheat Quality Council (WQC).

Objectives

- Encourage wide participation by all members of the hard winter wheat industry.
- Determine, through professional consulting expertise, the parameters and ranges that adequately describe the performance characteristics that members seek in new and existing cultivars.
- Promote the enhancement of hard winter wheat quality in new cultivars.
- Emphasize the importance of communication across all sectors and provide resources for education on the continuous quality improvement and utilization of hard winter wheat.
- Encourage the organizations vital to hard winter wheat quality enhancement to continue to make positive contributions through research and communications.
- Offer advice and support for the U.S.D.A. - A.R.S. Hard Winter Wheat Quality Laboratory in Manhattan, KS.

Membership

- The membership of the HWWQC will consist of members of the WQC.

HWWQC Technical Board

- The Technical Board shall be the administrative unit responsible for managing the functions of the HWWQC.
- The Technical Board shall consist of five members, elected from the membership, to serve three-year terms.
- Officers of the technical board shall consist of a chair, vice-chair, and secretary.
- Each officer serves three years in his or her office.
- Terms start the day after the annual meeting of the HWWQC.
- The vice-chair generally replaces the chair at the conclusion of the chair's term and the secretary generally replaces the vice-chair at the conclusion of the vice-chair's term.
- Officers (normally only the secretary) shall be elected annually at the annual meeting of the HWWQC by nomination and majority vote.
- Any eligible member may be reelected after being out of office for one year.
- Vacancies that occur during the term of office of the members of the technical board shall be filled by nomination and majority vote of the remaining members of the technical board and the WQC Executive Vice President. The appointee will serve the remaining term of the vacancy (up to three years).
- Exceptions to the above may be granted if voted on by the Technical Board or by majority vote of the HWWQC at the annual meeting.

Duties of the Technical Board

- The chair shall be responsible to establish a meeting place and preside at all meetings of the technical board and Wheat Quality Council (selected elements of the General Meeting).
- The vice-chair shall preside at meetings in absence of the chair and assume such duties as may be assigned by the chair of the technical board.
- The secretary shall be responsible for taking minutes of the technical board meetings.
- The Technical Board will direct the Executive Vice President of the WQC on disbursement of allocated funds.
- The chair shall be responsible for communicating budget needs to the Executive Vice President.
- The Technical Board is responsible for presenting budget updates to the general membership at the annual meeting.

Compensation

- Technical Board members shall serve without compensation.

Expenses

- The WQC Executive Vice President for some technical board functions may authorize certain paid expenses.

Hard Winter Wheat Quality Evaluation and Advisory Committee

Committee Purpose

A technical committee entitled "Hard Winter Wheat Quality Evaluation and Advisory Committee" shall be established and consist of the five technical board members and key WQC members working on hard winter wheat. Those members should include, but are not limited to:

- The director of the USDA Hard Winter Wheat Quality Laboratory, Manhattan, KS.
- At least one hard winter wheat breeder from the Great Plains area.
- At least one cooperator from hard winter wheat milling or baking laboratories.
- The senior scientist/editor responsible for the hard winter wheat quality annual report.

Evaluation and Responsibilities

- Establish procedures and requirements for the annual grow out (if applicable), handling, evaluation and reporting of the experimental test line quality evaluation program.
- Annual approval of the samples submitted by hard winter wheat breeders.
- The collection milling and reporting of the experimental and check samples.
- Distribution of samples to cooperators (member companies willing to conduct testing and baking evaluations on the samples prepared)
- Preparation of an annual quality report.

Sample/Locations

- Each breeder entity shall have the privilege of submitting two experimental test lines and one check cultivar each year for evaluation. If slots are available by some breeders not submitting the full allotment, other breeders may submit more than two up to a maximum of 30 samples annually.

Annual Meeting

- The annual meeting of the HWWQC shall coincide with the annual meeting of the WQC. If for some reason the WQC annual meeting is not held, it shall be the duty of the technical board chair to establish an annual meeting time and place.
- The purpose of the meeting shall be to discuss the results of the cooperators quality testing program, elect board members and carry on other business as required by the HWWQC.
- The Technical Board may establish other meetings determined to be necessary.

Finances and Budget

- The executive board of the WQC shall designate the finances required to meet the operating expenses of the HWWQC.
- The budget shall be presented for membership approval at the annual meeting.

Amendments

- Amendments to the policy and operation procedure of the HWWQC can be made by majority vote of the HWWQC members.
- The proposed changes must be submitted in writing and must be in the hands of the membership two weeks prior to voting on the change.

Outlined Goals for Hard Winter Wheat Breeders

Developed by the Grain Trade, Operative Millers, and Mill Chemists Subcommittees of the Wheat Quality Council Hard Winter Wheat Technical Committee

1. Adaptability. Varieties should be adaptable and retain their quality integrity over a large geographic area.

2. Varieties should be resistant to diseases, to insect infestation (including stored grain insects), and to sprouting.

3. Emphasize quality evaluation in earlier generations. Obtain milling and baking data before F7. Grain and Texture should be considered along with loaf volume, absorption, mixing, and dough properties when evaluating baking quality.
4. Kernel Characteristics:
   A. Visual Appearance typical of class.
   B. Hardness significantly greater than soft wheat, but not so hard that milling or flour properties are negatively influenced.
   C. Uniformly large, plump, vitreous.

	Objective	Minimum Acceptable
Bushel Weight (lb.)	60+	58
Thousand Kernel Wt. (g)	30+	24
Over 7 Wire (%)	60+	50

5. Milling Performance. Should mill easily to produce a high extraction (yield) of quality flour. Reduction, sifting, and stock-handling consistent with class history.

Performance on KSU Pilot Mill

	Objective	Acceptable
Straight Grade Extraction % at .48% ash	76	74 (minimum)
Str.-Gr. Agtron Color	50	40 (minimum)
Str.-Gr. Flour Ash (%)	0.46	0.50 (maximum)

6. Gluten Strength-Mixing Time. About 60% strong and 40% mellow should be acceptable in the seeded acreage. A reasonably broad range of gluten strength

is needed to meet current demands of various flour users. One variety or gluten type is undesirable.

7. Improved Mixing Tolerance with ‘extensible gluten’, not bucky or tough.

APPENDIX C

Hard Red Winter Wheat Quality Targets

RECOMMENDED* QUALITY TARGETS FOR HARD RED WINTER WHEAT

HWW Quality Targets Committee
Approved February, 2006

** "The purpose of Recommended Quality Targets (RQT) for Hard Red Winter Wheat (HRW) is to provide specific quality 'goals' for the breeding community, wheat producers, and marketing programs in order to assist and guide the decisions needed to maintain the consistency and end-use quality of the U.S. HRW market class. The RQT will be dynamic over time in direct response to the primary needs of the marketplace (domestic and foreign), and the needs of the U.S. industry to breed, produce and market wheats to meet market needs. The RQT should NOT be used as essential criteria for variety release decisions in breeding programs, or as marketing/grading standards for private companies or federal/state agencies. This* ***Statement of Purpose*** *must accompany all published forms of the RQT."* *HWWQT Committee, 2006*

Quality Parameter (End-Use: Pan Bread)	Recommended Target Value
Wheat	
Test Weight (lb/bu)	***> 60***
SKCS-Hardness Index (SK-HI)	***60 – 80***
SK-HI Standard Deviation	***< 17.0***
SKCS-Weight (SK-WT, mg)	***> 30.0***
SK-WT Standard Deviation	***< 8.0***
SKCS-Diameter (SK-SZ, mm)	***> 2.40***
SK-SZ Standard Deviation	***< 0.40***
Protein Content (%, 12% mb)	***> 12.0***
Ash Content (%, 12% mb)	***< 1.60***
Falling Number (sec)	***> 300***
Straight Grade Flour Yield (%)	***> 68***
Flour	
Flour Color L-Value (Minolta Colorimeter)	***> 90***
Gluten Index	***> 95***
Sedimentation Volume (cc)	***> 40***
Farinograph:	
Water Absorption (%, 14% mb)	***62+***
Peak Time (min)	***4.00 – 8.00***
Stability (min)	***10.00-16.00***
Mixograph:	
Water Absorption (%, 14% mb)	***62+***
Peak Time (min)	***3.00 – 6.00***
Mixing Tolerance (HWWQL Score, 0-6)	***3.0***
Straight Dough Pup Method:	
Water Absorption (%, 14% mb)	***62+***
Mix Time (min)	***3.00 – 5.00***
Loaf Volume (cc)	***> 850***
Crumb Score (HWWQL Score, 0-6)	***> 3.0***

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APPENDIX D

Hard White Wheat Quality Targets
Adopted from PNW for Great Plains

Hard White Wheat Quality Targets

Dual Purpose -- Chinese Noodles and Western Pan Bread

Updated on March 1, 2002 at Hard White Wheat Quality Targets Meeting
Wheat Marketing Center, Portland, Oregon

	Chinese Hard-Bite Noodles (1)	**Pan Bread**
Wheat Quality Parameter		
Test Weight (lb/bu)	60 Minimum	60 Minimum
Kernel Hardness (SKCS 4100)	65 - 90	65 Minimum
Kernel Diameter (mm) (SKCS 4100)	2.5 Minimum	2.5 Minimum
Falling Number (seconds)	300 Minimum	300 Minimum
Protein (%, 12% mb)	11-15.0	11.5-14.0
Ash (%, 14% mb)	1.4 Maximum	1.6 Maximum
PPO Level by L-DOPA (WWQL Method)	0	N/A
Flour Quality Parameter		
Protein (%, 14% mb)	10-13.5	10.2-13
Ash (14% mb)	0.38-0.45	N/A
Patent Flour Yield at 0.4% Ash (%)	60 (by Buhler)	N/A
Straight-Grade Flour Yield at 0.45% Ash (%)	70 (by Buhler)	N/A
L* (Minolta Colorimeter CR 310)	91 Minimum	N/A
Wet Gluten (%, 14% mb)	30 Minimum (2)	28
Farinograph Absorption (%, 14% mb)	60 Minimum (2)	60
Farinograph Stability (minutes)	12 Minimum (2)	12
Amylograph Peak Viscosity (Bu) (3)	500-850	500 minimum
Mixograph Peak Time (minutes)	N/A	3-7 @ 5.5 mm peak ht.
Mixograph Absorption (%)	N/A	60
Chinese Raw Noodle Quality Parameter (Refer to WMC Protocol) (4)		
Chinese Raw Noodle Dough Sheet L*24 h	72 Minimum	N/A
Chinese Raw Noodle Dough Sheet L*0-L*24	10 Maximum	N/A
Chinese Raw Noodle Dough Sheet b* 24 h	25 Maximum	N/A
Cooked Noodle Hardness (g)	1250 Minimum (2)	N/A
Pan Bread Quality Parameter		
Pup Loaf Volume (cc)	N/A	900 @11% flour protein

Notes:

(1) Chinese raw, Chinese wet, Chinese instant fried, Philippine instant fried, Malaysia hokkien and Thai bamee noodles.

(2) Straight-grade flour of 12% protein wheat.

(3) Method: 65 g untreated flour + 450 ml deionized water.

(4) Noodle formula: straight-grade flour, 100%; water, 28%; and sodium chloride, 1.2%.
Noodle sizes: 2.5 mm (width) x 1.2 mm (thickness).
Noodle textural measurement: cook 100 g noodles in 1000 ml deionized water for 5 min, rinse in 27^0C water and drain. Measure noodle texture on five noodle strands by compressing to 70% of noodle thickness with a 5-mm flat probe attached to TA.XT2 Texture Analyzer.

These end-use quality targets emphasize the broadest possible utilization of hard white wheats.

Wheat Marketing Center, Portland, Oregon

	Korean Instant Noodles	Chinese Northern-Type Steamed Bread	Hamburger/Hotdog Buns
Wheat Quality Parameter			
Test Weight (lb/bu)	60 Minimum	60 Minimum	60 Minimum
Kernel Hardness (SKCS 4100)	65 Minimum	65 Minimum	65 Minimum
Kernel Diameter (mm) (SKCS 4100)	2.5 Minimum	2.5 Minimum	2.5 Minimum
Falling Number (seconds)	300 Minimum	350-400	300 Minimum
Protein (%, 12% mb)	10-11.0	10-11.5	13-15.0
Ash (%, 14% mb)	1.4 Maximum	1.4 Maximum	1.6 Maximum
PPO Level by L-DOPA (WWQL Method)	0-0.2	0-0.2	N/A
Flour Quality Parameter			
Protein (%, 14% mb)	8.5-9.5	8.5-10.0	12.2-13.0
Ash (14% mb)	0.38-0.40	0.38-0.45	N/A
Patent Flour Yield at 0.4% Ash (%)	60 (by Buhler)	60 (by Buhler)	N/A
Straight-Grade Flour Yield at 0.45% Ash (%)	70 (by Buhler)	70 (by Buhler)	N/A
L* (Minolta Colorimeter CR 310)	91 Minimum	91 Minimum	N/A
Wet Gluten (%, 14% mb)	N/A	28-30	34.5
Farinograph Absorption (%, 14% mb)	58-60	60-62	64
Farinograph Stability (minutes)	7.5-8.5	4-6.0	15-18.0
Amylograph Peak Viscosity (Bu) (1)	800 Minimum	500 Minimum	500 Minimum
Amylograph Breakdown (Bu)	200 Minimum	N/A	N/A
Mixograph Peak Time (minutes)	N/A	N/A	4-7 @ 5.8 mm peak ht.
Mixograph Absorption (%)	N/A	N/A	64
Pan Bread Quality Parameter			
Pup Loaf Volume (cc)	N/A	N/A	980 @ 13% flour protein

Notes:
(1) Method: 65 g untreated flour + 450 ml deionized water.

APPENDIX E

WQC Business Meeting Minutes

by **Sid Perry**

Annual Meeting Feb. 16-18, 2010

Hard Winter Wheat Quality Council Meeting Minutes
Annual Meeting February 16-18, 2010

Minutes of the Hard Winter Wheat Technical Committee February 16, 2010

Margo Caley called the meeting to order at 8:05 a.m., and reported that the 2009 minutes had been posted to the WQC website. A motion from the floor to accept the 2009 minutes was seconded and approved.

Slate of Officers for 2010-2011
Chair: Margo Caley
Vice Chair: Becky Miller
Secretary: Sid Perry
Member: Theresa Sutton nominated by Scott Haley
Member: Justin Turner nominated by Laura McLaughlin

Vote to accept new members was passed by voice vote.

Report by Richard Chen on WQC Report for 2009

- This was the largest number of samples since 2002
- Damaged starch content included as an additional test
- There would be no flour particle size data
- Mill stream protein, ash, cumulative curves included
- Collaborator bake and test information included beginning page 248
- Acknowledged Scott Haley in helping evaluate the baking results

Ben Handcock thanked Dr. Chen for his work as Editor of the WQC Milling and Baking Test Results for Hard Winter Wheats book.

Overview of 2008 Milling and Sampling by Brad Seabourn
There were 18 breeders and 19 cooperators. KSU grain science was instrumental in providing excellent sample handling. Brad thanked Dr. Chen for the report. No changes are expected in handling or milling for the 2010 samples.

Comments by Ben Handcock
Ben recognized Joe Martin, KSU breeder at Hays, for his years of contribution, and congratulations on his impending retirement. Ben noted that there is a surplus in the budget, and there has been increased membership. Recognized Brian Walker's term as Chair of the WQC and thanked him for the excellent leadership that he provided. The new Chair will be Hayden Wands of Sara Lee, the first baker in this position for a number of years. Ben thanked Laura McLaughlin for reducing shipping costs considerably with a new approach.

Overseas Varietal Analysis (OVA) Program Review
Steve Wirsching made the presentation. Steve will be taking the lead in place of John Oades, who will be moving to a half time role. Steve covered the objectives of the OVA, and gave an overview of the 2008 samples. There were:

- 19 HRW cooperators (overseas labs)
- 16 SRW
- 25 HRS
- 18 SW
- 9 Durum

The 2009 crop will have:

- 22 HRW
- 15 SRW
- 24 HRS
- 17 SW
- 11 Durum

There were a total of 42 cooperators and 705 samples. Varieties were Hatcher (check), Ripper, Postrock, TAM 111, TAM 112, Duster, OK Rising, and Genou

Ripper, TAM 112, Genou, Hatcher, and Postrock were preferred for French bread.
Postrock and TAM 111 were preferred for steam bread.
Duster and TAM 112 were preferred for Asian fresh white noodles.
Ripper, Genou, Hatcher, OK Rising, and TAM 112 were preferred for white pan bread.

Special thanks were given to KSU Grain Science, the HWWQL, the SWQL, NDSU, and the WWQL in Pullman, as well as the Durum Milling.

The Wheat Quality Improvement Team visited North Africa and western Europe. There were 6 breeders and 6 nationalities, representing both public and private breeding programs. The following market trends were noted:

UK: Spring wheat not too strong; like the consistency; concerned with food safety, color, and prefers small, tight, cell structure. They are not ready for GMO, but acknowledge it will happen.

Spain: Prefer strong doughs; like our durum color; consistency is good; prefer low wheat ash; need to be aware of cadmium levels; recommend subclasses of extra strong and strong.

Italy: Concerned with food safety; watch cadmium levels; using glutograph instead of alveograph. No to GMO.

North Africa: Concerned with color; durum protein needs minimum 13.5; gluten index 80%; do not want specks on kernels; prefer durum vitreousness of 80% or greater.

OVA Discussion
Dave Green asked the question, "In general, the World would buy more of our wheat if:"?
The answer:
The Durum wheat was more yellow,
The Spring wheat had longer stability,
The Winter wheat was more consistent.

Steve Baenziger asked when will Europe accept GMO? No timetable, but they have a resigned acceptance in the UK.

Ochratoxin Standards are becoming more important. Some are basing purchases on maximum ochratoxin levels. The U.S. wheat does not tend to have a problem.

Update on Crop Conditions

Montana State – Jim Berg

Normal crop year. Winter wheat had 25% greater yield level. MSU will have a new release called Decade.

CSU-Scott Haley
Good moisture, cool season, and nice yields. Late harvest. Good planting conditions this fall.

SDSU-Bill Berzonsky
First crop year for Bill. Little winterkill, late harvest. New release called Lyman with very good scab resistance.

KSU-Joe Martin
Very good yields. Fall moisture good, lot of early planting. Stands look good.

WestBred- Sid Perry
South Central KS had a difficult harvest with BYDV, late frost, wet conditions and scab. This fall's planting consists of very early planting which has good stands and growth. Over half of the acres, however, were delayed to later than desired due to wet conditions. Very little ground cover on this late planting. Much of southeast KS was not planted.

Agripro- Jon Rich
Northeast KS had a decent harvest, but also saw a lot of BYDV. Like south central KS, this fall's planting has an early set of acres, and a delayed set due to excessive rain during prime planting time.

Oklahoma- Brett Carver
Oklahoma suffered from significant late freeze damage, and wet harvest conditions. Like Kansas, this fall's planting had delays during prime planting season.

Texas- Jackie Rudd
Like Oklahoma, north TX and parts of the panhandle experienced significant freeze damage.
Dry conditions affected much of the wheat crop. This fall had improved planting conditions, the crop appears in good shape.

Closing Comments
Ben Handcock noted that the glutomatic machine at the HWWQL was "dead". Any donations to the lab would be appreciated!

Laura McLaughlin moved to adjourn, Scott Haley seconded. Vote to adjourn passed by voice vote. Meeting adjourned at 9:09 a.m.

Thank you very much for reviewing the 2010 HRW WQC report. Please let me know if you have any suggestions or recommendations for improving the report. I can be reached at (785)776-2750 or by email, Richard.chen@ars.usda.gov