Milling and Baking Test Results for Hard Winter Wheat

Harvested in 2013

64th 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, Brighton, CO, The United States Department of Agriculture (USDA) - ARS, The Agricultural Experiment Stations of Colorado, Kansas, Montana, Nebraska, Oklahoma, South Dakota, and Texas, Private wheat breeding companies including Syngenta (AgriPro Wheat), Monsanto (Westbred, LLC), Limagrain, and laboratories from milling, baking, grain trade and other firms and research organizations. This annual 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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Downloading or printing of this report is available through Wheat Quality Council (http://www.wheatqualitycouncil.org), if you are member of WQC or a registered participant of the Annual WQC meeting. Otherwise, please contact:

Ben Handcock
The Wheat Quality Council
5231 Tall Spruce St.
Brighton, CO 80601
Voice: (303) 558-0101
Fax: (303) 558-0100
Email: BhWQC@aol.com
http://www.wheatqualitycouncil.org

2013

Milling and Baking Test Results for

Hard Winter Wheats

Editor: **Richard Y. Chen, Ph.D**
Research Food Technologist, Associate Director
USDA-ARS-CGAHR
Hard Winter Wheat Quality Laboratory
1515 College Ave.
Manhattan, KS 66502

Co-Editor: **Bradford W. Seabourn, Ph.D**
Supervisory Research Chemist, Director
USDA-ARS-CGAHR
Hard Winter Wheat Quality Laboratory
1515 College Ave.
Manhattan, KS 66502

Coordinator: **Ben Handcock**
Executive Vice President
Wheat Quality Council
5231 Tall Spruce St.
Brighton, CO 80601

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 2013 Testing Program

Founded in 1949, this is the **64th** 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 twenty one cooperators (19 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.

2013 WQC Hard Winter Wheat Entries

	Test Entry Number	Sample Identification
LIMAGRAIN	13-2401	Check Blend (check)
	13-2402	LCH08-80
	13-2403	LCS Mint
KANSAS-HAYS	13-2404	Danby (check)
	13-2405	Oakley CL
	13-2406	KS10HW78-1
SOUTH DAKOTA	13-2407	Lyman (check)
	13-2408	SD08200
	13-2409	SD09192
AGRIPRO	13-2410	Postrock (check)
	13-2411	04BC574-2
NEBRASKA	13-2412	Millennium (check)
	13-2413	NE09521
	13-2414	NE08499
MONTANA	13-2415	Yellowstone (check)
	13-2416	MT1090
	13-2417	MTW08168
OKLAHOMA	13-2418	Ruby Lee (check)
	13-2419	Doublestop CL+
	13-2420	OK09125

2013 Wheat Classification Results from GIPSA

GIPSA Wheat Market Classification

ID	CL	DKG	TW	M	ODOR	HT	DKT	FM	SHBN	DEF	CCL	WOCL	GRADE	REMARKS
13-2401	HRW	0.00	59.1	12.3	OK	0.0	0.0	0.0.	0.5	0.5	0.0	0.0	**U.S. NO. 2 HRW, DKG 0.0%**	
13-2402	HRW	0.00	61.0	12.4	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	**U.S. NO. 1 HRW, DKG 0.0%**	
13-2403	HRW	0.02	60.6	11.9	OK	0.0	0.0	0.0	1.8	1.8	0.0	0.4	**U.S. NO. 1 HRW, DKG 0.0%**	
13-2404	HDWH	0.00	62.0	11.9	OK	0.0	0.0	0.0	0.5	0.5	0.1	0.1	**U.S. NO. 1 HDWH, DKG 0.0%**	
13-2405	HRW	0.00	59.0	11.6	OK	0.0	0.0	0.0	0.7	0.7	0.4	0.4	**U.S. NO. 2 HRW, DKG 0.0%**	
13-2406	HDWH	0.00	60.9	11.6	OK	0.0	0.0	0.0	0.5	0.5	1.1	1.1	**U.S. NO. 2 HDWH, DKG 0.0%**	
13-2407	HRW	0.00	59.3	12.3	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**U.S. NO. 2 HRW, DKG 0.0%**	
13-2408	HRW	0.00	58.2	12.0	OK	0.0	0.0	0.0	0.6	0.6	0.0	0.0	**U.S. NO. 2 HRW, DKG 0.0%**	
13-2409	HRW	0.00	58.2	12.5	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.3	**U.S. NO. 2 HRW, DKG 0.0%**	
13-2410	HRW	0.00	61.6	10.6	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**U.S. NO. 1 HRW, DKG 0.0%**	
13-2411	HRW	0.00	61.3	10.8	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**U.S. NO. 1 HRW, DKG 0.0%**	
13-2412	HRW	0.00	62.2	11.4	OK	0.0	0.1	0.0	0.1	0.2	0.0	0.0	**U.S. NO. 1 HRW, DKG 0.0%**	
13-2413	HRW	0.00	59.9	11.6	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	**U.S. NO. 2 HRW, DKG 0.0%**	1 stone
13-2414	HRW	0.10	60.1	11.4	OK	0.0	0.0	0.0	1.3	1.3	0.0	0.0	**U.S. NO. 1 HRW, DKG 0.1%**	
13-2415	HRW	0.00	62.3	10.0	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**U.S. NO. 1 HRW, DKG 0.0%**	
13-2416	HRW	0.00	59.7	9.6	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	**U.S. NO. 2 HRW, DKG 0.0%**	
13-2417	HDWH	0.00	59.9	9.5	OK	0.0	0.0	0.0	0.1	0.1	0.2	0.2	**U.S. NO. 2 HDWH, DKG 0.0%**	
13-2418	HRW	0.01	60.1	11.8	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	**U.S. NO. 1 HRW, DKG 0.0%**	
13-2419	HRW	0.00	62.1	11.3	OK	0.0	0.1	0.1	0.1	0.3	0.0	0.0	**U.S. NO. 1 HRW, DKG 0.0%**	
13-2420	HRW	0.00	58.3	10.8	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	**U.S. NO. 2 HRW, DKG 0.0%**	

Cl = Wheat class, DKG = Dockage (%), TW = Test weight (lb/bushels), 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

LIMAGRAIN

13-2401	Check Blend (check)
13-2402	LCH08-80
13-2403	LCS Mint

Description of Test Plots and Breeder Entries

Limagrain – Marla Barnett

Growing Location & Conditions

The hard red winter Wheat Quality Council samples from Limagrain Cereal Seeds originated from strip increases grown under dryland conditions at Newton, KS and Wichita, KS. Equal parts of grain from both locations were blended together to attain the 3 bushel sample requested by the WQC. The field containing the strip increases at Wichita was fertilized with 65 lbs N, planted on 10/4/12, and harvested on 6/27/13. The field at Newton was fertilized with 50 lbs N, planted on 10/1/12 and harvested on 6/29/13.

Growing conditions included timely planting into excellent soil moisture, excellent fall stands and growth. Cool spring temperatures resulted in late heading (2 weeks later than normal) and a very late harvest. Spring freezes and ice were experienced at both locations during jointing and heading. Stripe rust was present at very low levels late in the season at Wichita.

Grain yields of the adjacent yield trails were quite good given the late spring freezes averaging 38.7 bu/ac (25.4-52.2 bu/ac range) at Newton, KS and 72.9 bu/ac (55.8-86.7 bu/ac range) at Wichita, KS. Average grain protein content (12% moisture basis) was 12.38% at Newton and 10.03% at Wichita with test weights averaging 59.9 lbs/bu and 60.1 lbs/bu for Newton and Wichita trails, respectively.

T153/T154/Everest/Duster (blended check)

A blended check was chosen to represent the local grain supply chain currently available in south central Kansas.

LCH 08-80 (LCS Wizard)

LCS Wizard is a hard red winter wheat variety released by Limagrain Cereal Seeds in 2013; the line was tested as LCH 08-80 in both the 2012 and 2013 NRPN, SPRN trials. LCS Wizard is a widely adapted, mid-season, medium height, hard red winter wheat with high yield potential and excellent straw strength. LCS Wizard is widely adapted to the central and eastern regions of Oklahoma and Kansas and the southwestern irrigated regions of Nebraska providing growers in those regions with a high-yielding variety that is tolerant to acid soils, and resistant to *Wheat Soil Borne Mosaic Virus* and *Barley Yellow Dwarf Virus*. In addition, LCS Wizard expresses moderate resistance to powdery mildew, leaf rust, stripe rust, glume blotch, and head scab. LCS Wizard is also resistant to Hessian fly biotypes GP, B and O.

In two years of testing (2012, 2013), LCS Wizard had an average grain yield of 61.2 bu/ac over 23 locations. Milling and baking quality data from LCS shows acceptable overall milling and baking qualities with one weakness of mixing tolerance.

LCS Mint

LCS Mint is a hard red winter wheat variety released by Limagrain Cereal Seeds in 2012. LCS Mint is medium height and medium maturing (photoperiod sensitive), and has excellent test weight. Areas of adaption include south, central and western Kansas, north central Oklahoma, and eastern Colorado. LCS Mint is tolerant to acid soils, resistant to soil borne mosaic virus and stripe rust (including the 2012 race), and moderately susceptible to both powdery mildew and leaf rust. Its reaction to Fusarium head blight is unknown.

In two years of testing (2012-2013), LCS Mint had an average grain yield of 62.8 bu/ac over 23 locations. LCS Mint has shown excellent overall milling and baking properties in tests conducted by the LCS milling and baking quality lab.

Limagrain: 2013 (Small-Scale) Samples

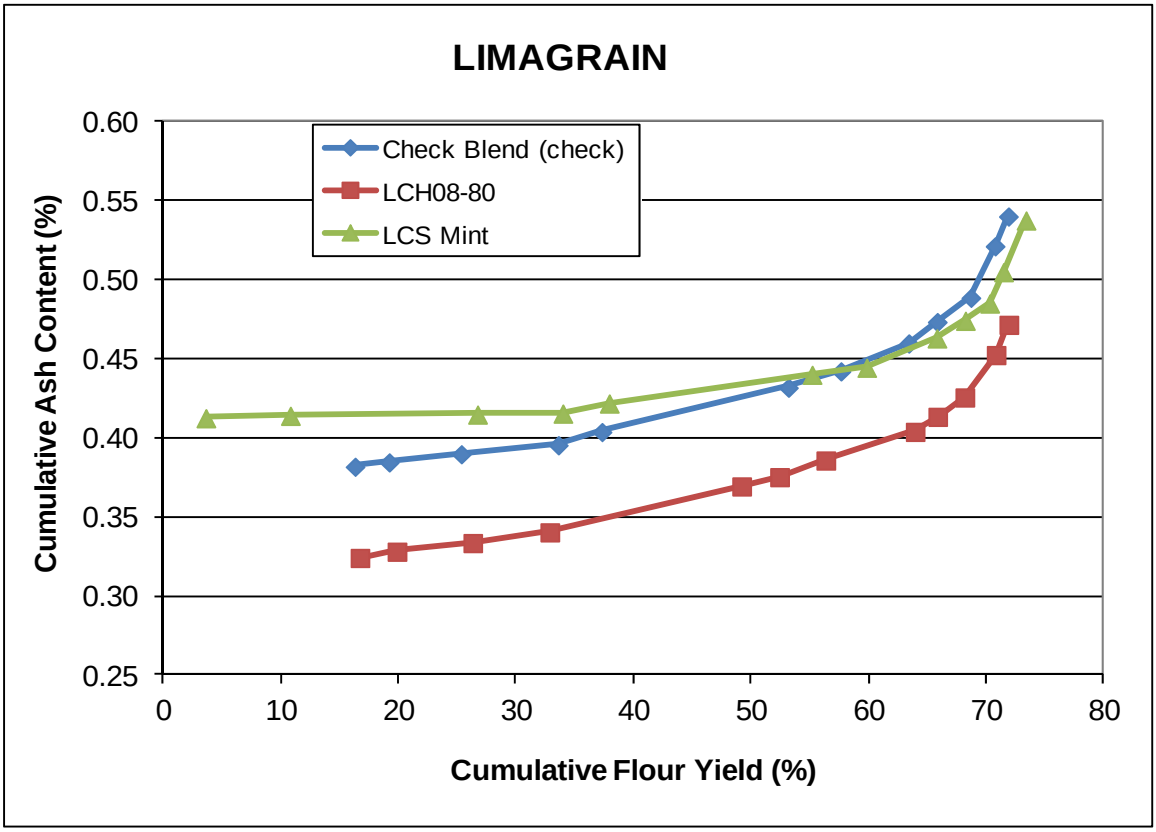
Test entry number	13-2401	13-2402	13-2403
Sample identification	**Check Blend (check)**	**LCH08-80**	**LCS Mint**
Wheat Data			
GIPSA classification	2 HRW	1 HRW	1 HRW
Test weight (lb/bu)	59.0	61.0	60.3
Hectoliter weight (kg/hl)	77.6	80.2	79.3
1000 kernel weight (gm)	26.7	27.8	28.6
Wheat kernel size (Rotap)			
Over 7 wire (%)	57.8	60.8	58.0
Over 9 wire (%)	41.2	38.7	40.6
Through 9 wire (%)	1.0	0.6	1.4
Single kernel (skcs)[a]			
Hardness (avg /s.d)	65.8/19.5	69.2/19.0	65.7/19.9
Weight (mg) (avg/s.d)	26.7/7.5	27.8/7.6	28.6/7.3
Diameter (mm)(avg/s.d)	2.52/0.30	2.61/0.31	2.58/0.30
Moisture (avg/s.d)	12.3/0.3	12.4/0.3	11.8/0.4
SKCS distribution	05-11-22-62-01	04-07-19-70-01	07-10-15-68-02
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	11.2	11.9	11.3
Wheat ash (12% mb)	1.56	1.44	1.49
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	71.9	71.8	73.3
Quadrumat Sr. Mill	71.4	72.7	70.9
Flour moisture (%)	13.0	12.3	12.1
Flour protein (14% mb)	10.1	10.6	10.4
Flour ash (14% mb)	0.54	0.49	0.55
Rapid Visco-Analyser			
Peak Time (min)	6.4	6.2	6.1
Peak Viscosity (RVU)	244.3	247.7	229.8
Breakdown (RVU)	80.7	101.1	83.7
Final Viscosity at 13 min (RVU)	284.5	256.3	271.0
Minolta color meter			
L*	92.77	91.99	92.25
a*	-2.31	-2.07	-2.23
b*	9.50	9.67	9.95
PPO value	0.590	0.468	0.537
Falling number (sec)	570	500	449
Damaged Starch			
(AI%)	95.68	96.70	96.63
(AACC76-31)	6.03	6.82	6.77

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

Limagrain: Physical Dough Tests and Gluten Analysis For 2013 (Small-Scale) Samples

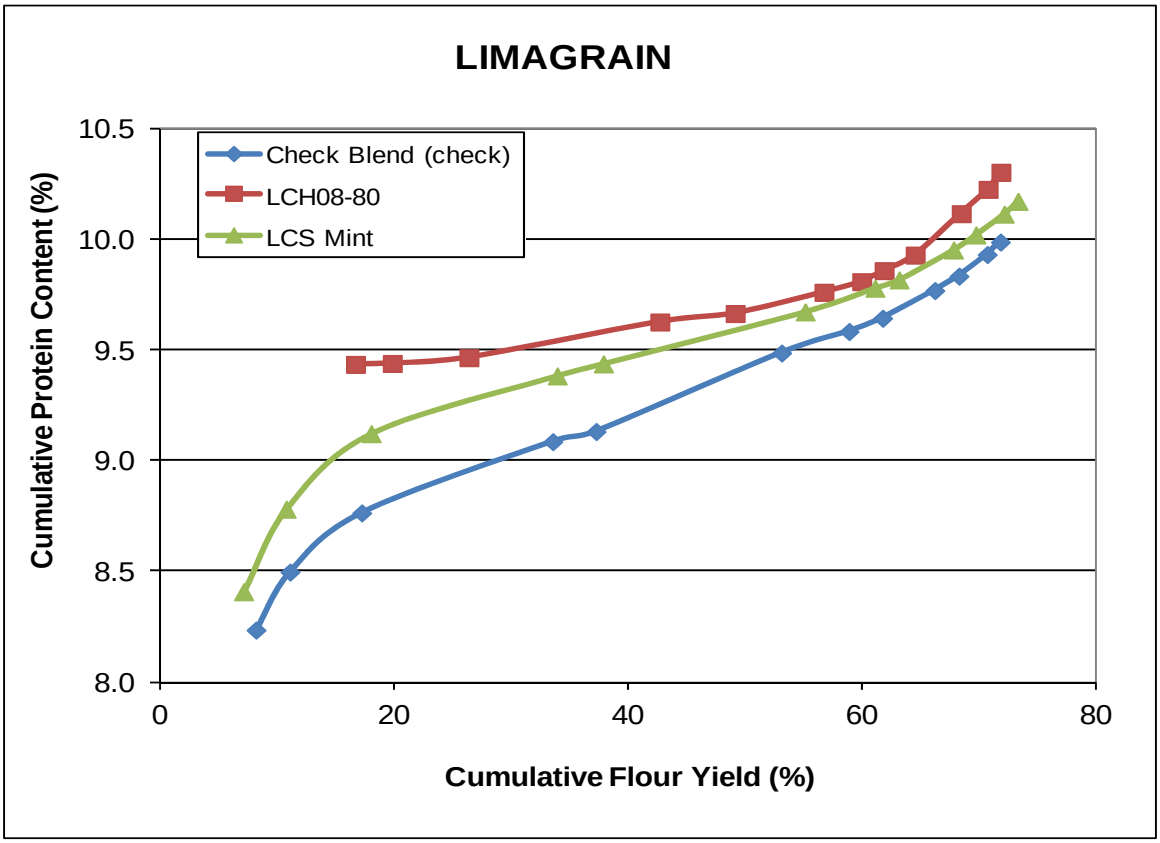
Test Entry Number	13-2401	13-2402	13-2403
Sample Identification	Check Blend (check)	LCH08-80	LCS Mint
MIXOGRAPH			
Flour Abs (% as-is)	61.0	62.5	62.5
Flour Abs (14% mb)	59.8	60.6	60.3
Mix Time (min)	3.9	2.9	4.9
Mix tolerance (0-6)	4	2	3
FARINOGRAPH			
Flour Abs (% as-is)	57.0	57.6	55.6
Flour Abs (14% mb)	55.8	55.7	53.4
Development time (min)	2.5	4.3	7.7
Mix stability (min)	15.9	9.9	19.3
Mix Tolerance Index (FU)	16	32	12
Breakdown time (min)	11.6	8.4	19.9
ALVEOGRAPH			
P(mm): Tenacity	76	50	59
L(mm): Extensibility	105	178	90
G(mm): Swelling index	22.8	29.7	21.1
W(10^{-4} J): strength (curve area)	259	221	205
P/L: curve configuration ratio	0.72	0.28	0.66
Ie(P_{200}/P): elasticity index	55.8	50.6	64.6
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	394/553/523	269/345/351	450/864/993
Extensibility (mm at 45/90/135 min)	137/133/132	160/163/161	143/122/105
Energy (cm^2 at 45/90/135 min)	95/127/115	78/100/105	117/160/139
Resist $_{max}$ (BU at 45/90/135 min)	515/739/673	356/452/483	646/997/993
Ratio (at 45/90/135 min)	2.87/4.16/3.97	1.68/2.12/2.18	3.15/7.10/9.49
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+8, 2+12	Null, 7+8, 2+12	1, 7+8, 5+10
%IPP	45.42	39.24	53.12
SEDIMENTATION TEST			
Volume (ml)	37.6	39.2	42.6

Limagrain: Cumulative Ash Curves



Check Blend (check)					LCH08-80					LCS Mint				
Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash
2M	16.33	0.38	16.33	0.38	2M	16.75	0.32	16.75	0.32	1M Red	3.65	0.41	3.65	0.41
1M Red	2.90	0.40	19.23	0.38	1M Red	3.15	0.35	19.90	0.33	1BK	7.19	0.42	10.83	0.41
1M	6.13	0.41	25.37	0.39	1M	6.44	0.35	26.34	0.33	2M	15.91	0.42	26.74	0.42
1BK	8.25	0.41	33.61	0.40	1BK	6.55	0.37	32.89	0.34	1M	7.26	0.42	34.00	0.42
Grader	3.71	0.48	37.32	0.40	3M	16.32	0.43	49.21	0.37	Grader	3.94	0.48	37.94	0.42
3M	15.85	0.50	53.18	0.43	Grader	3.22	0.47	52.43	0.38	3M	17.25	0.48	55.19	0.44
2BK	4.47	0.57	57.64	0.44	2BK	3.93	0.53	56.36	0.39	2BK	4.65	0.50	59.84	0.44
4M	5.77	0.64	63.41	0.46	4M	7.60	0.54	63.96	0.40	4M	5.97	0.65	65.81	0.46
3BK	2.42	0.83	65.83	0.47	FILTER FLR	1.92	0.73	65.87	0.41	3BK	2.42	0.78	68.23	0.47
FILTER FLR	2.86	0.84	68.69	0.49	3BK	2.31	0.77	68.18	0.43	FILTER FLR	2.07	0.84	70.29	0.49
5M	2.06	1.61	70.76	0.52	5M	2.66	1.14	70.84	0.45	BRAN FLR	1.17	1.69	71.47	0.51
BRAN FLR	1.13	1.72	71.88	0.54	BRAN FLR	1.08	1.72	71.92	0.47	5M	1.92	1.75	73.38	0.54
Red Dog	2.19	2.92	74.07	0.61	Red Dog	3.17	2.05	75.09	0.54	Red Dog	2.15	2.74	75.53	0.60
Filter Bran	4.19	3.59	78.26	0.77	Filter Bran	1.89	2.90	76.98	0.60	Filter Bran	0.86	2.89	76.39	0.63
Red Shorts	0.84	3.65	79.10	0.80	Red Shorts	0.79	3.03	77.77	0.62	Red Shorts	0.66	3.39	77.06	0.65
Break Shorts	3.40	3.85	82.51	0.93	Break Shorts	3.21	3.35	80.98	0.73	Break Shorts	3.01	3.53	80.06	0.76
Bran	17.49	4.85	100.0	1.61	Bran	19.02	4.53	100.0	1.45	Bran	19.94	4.70	100.0	1.55
Wheat		1.53					1.41					1.45		
St. Grd. Fl.		0.54					0.49					0.55		

Limagrain: Cumulative Protein Curves

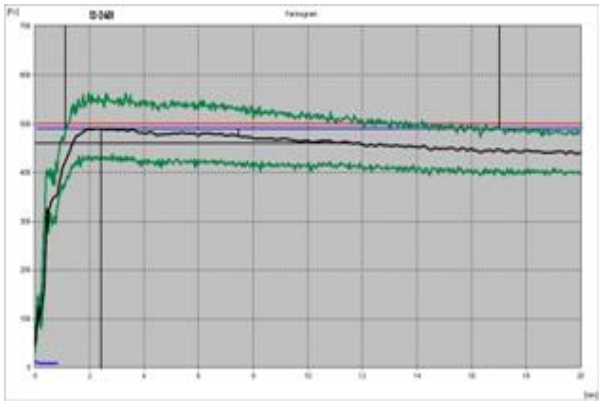


Check Blend (check)					LCH08-80					LCS Mint				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1BK	8.25	8.24	8.25	8.24	2M	16.75	9.44	16.75	9.44	1BK	7.19	8.41	7.19	8.41
1M Red	2.90	9.24	11.15	8.50	1M Red	3.15	9.46	19.90	9.44	1M Red	3.65	9.52	10.83	8.78
1M	6.13	9.25	17.28	8.76	1BK	6.55	9.55	26.44	9.47	1M	7.26	9.63	18.09	9.12
2M	16.33	9.43	33.61	9.09	3M	16.32	9.89	42.76	9.63	2M	15.91	9.68	34.00	9.38
Grader	3.71	9.55	37.32	9.13	1M	6.44	9.92	49.21	9.67	Grader	3.94	9.91	37.94	9.44
3M	15.85	10.32	53.18	9.49	4M	7.60	10.38	56.80	9.76	3M	17.25	10.19	55.19	9.67
4M	5.77	10.48	58.95	9.58	Grader	3.22	10.66	60.02	9.81	4M	5.97	10.77	61.16	9.78
FILTER FLR	2.86	10.88	61.81	9.64	FILTER FLR	1.92	11.40	61.94	9.86	FILTER FLR	2.07	10.93	63.23	9.82
2BK	4.47	11.50	66.28	9.77	5M	2.66	11.57	64.60	9.93	2BK	4.65	11.79	67.87	9.95
5M	2.06	11.92	68.34	9.83	2BK	3.93	13.19	68.53	10.12	5M	1.92	12.44	69.79	10.02
3BK	2.42	12.68	70.76	9.93	3BK	2.31	13.47	70.84	10.23	3BK	2.42	12.82	72.21	10.11
BRAN FLR	1.13	13.54	71.88	9.99	BRAN FLR	1.08	15.36	71.92	10.30	BRAN FLR	1.17	13.71	73.38	10.17
Break Shorts	3.40	13.21	75.29	10.13	Break Shorts	3.21	13.99	75.13	10.46	Break Shorts	3.01	13.34	76.39	10.30
Red Dog	2.19	13.14	77.48	10.22	Red Dog	3.17	13.35	78.31	10.58	Red Dog	2.15	13.29	78.54	10.38
Red Shorts	0.84	12.89	78.32	10.25	Red Shorts	0.79	13.18	79.09	10.60	Red Shorts	0.66	12.96	79.20	10.40
Filter Bran	4.19	13.94	82.51	10.43	Filter Bran	1.89	12.05	80.98	10.64	Filter Bran	0.86	11.45	80.06	10.41
Bran	17.49	14.49	100.00	11.14	Bran	19.02	14.36	100.00	11.35	Bran	19.94	15.25	100.00	11.37
Wheat		10.9					11.6					11.1		
St. Grd. Fl		10.1					10.6					10.4		

Physical Dough Tests

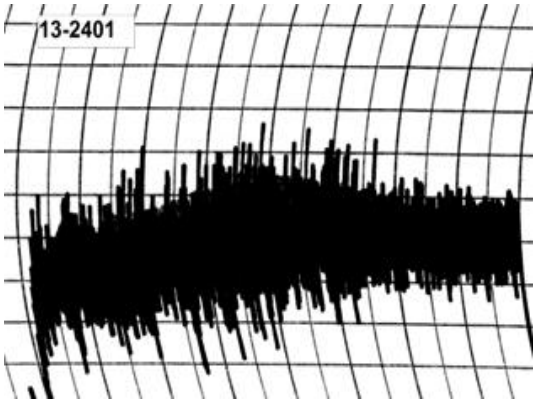
2013 (Small Scale) Samples – Limagrain

Farinograms



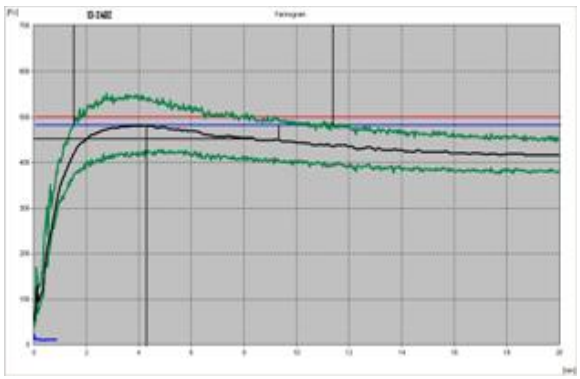
Water abs = 55.8%, Peak time = 2.5 min,
Mix stab = 15.9 min, MTI = 16 FU

Mixograms

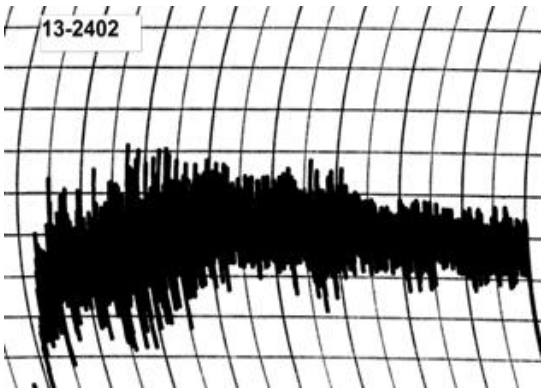


Water abs = 59.8%
Mix time = 3.9 min

13-2401, Check Blend (check)



Water abs = 55.7%, Peak time = 4.3 min,
Mix stab = 9.9 min, MTI = 32 FU

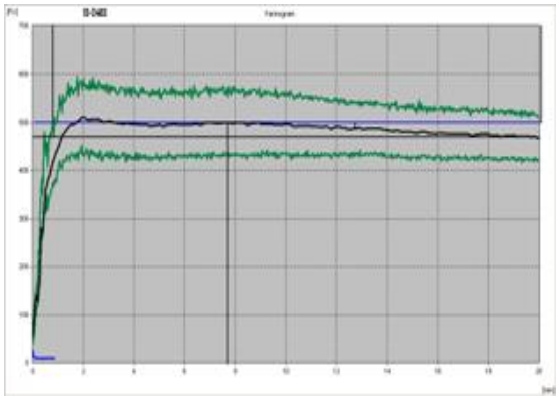


Water abs = 60.6%
Mix time = 2.9 min

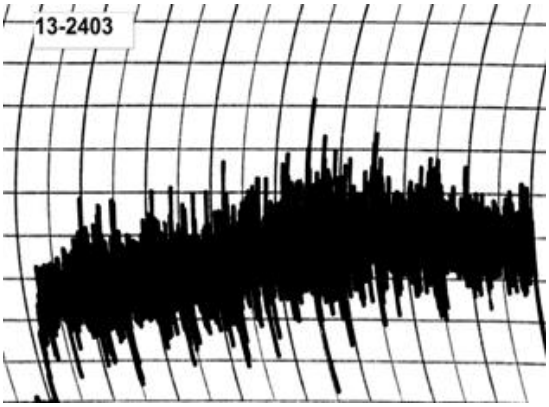
13-2402, LCH08-80

Physical Dough Tests

2013 (Small Scale) Samples – Limagrain



Water abs = 53.4%, Peak time = 7.7 min,
Mix stab = 19.3 min, MTI = 12 FU

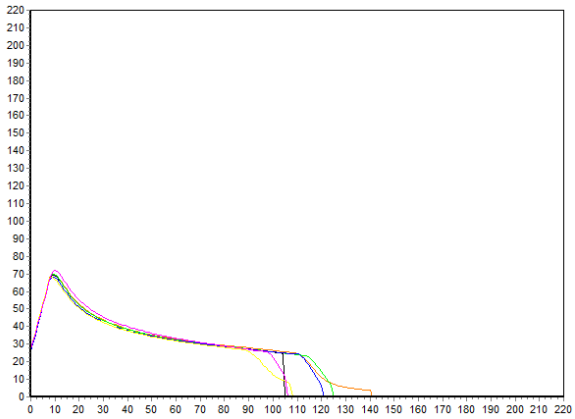


Water abs = 60.3%
Mix time = 4.9 min

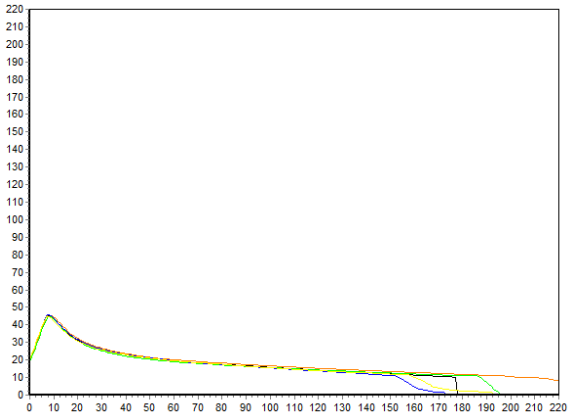
13-2403, LCS Mint

Physical Dough Tests - Alveograph

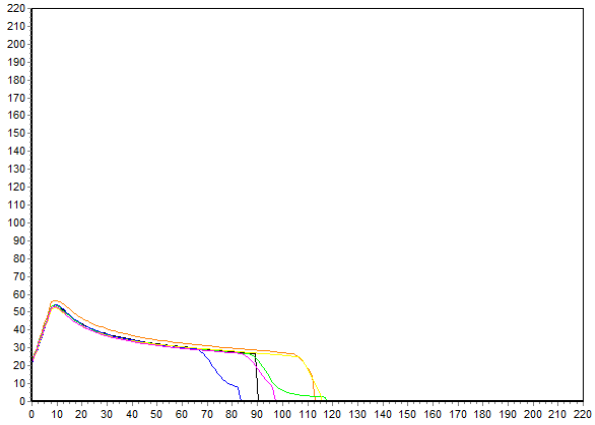
2013 (Small Scale) Samples – Limagrain



13-2401, Check Blend (check)
P (mm H_20) = 76, L (mm) = 105, W ($10E^{-4}J$) = 259



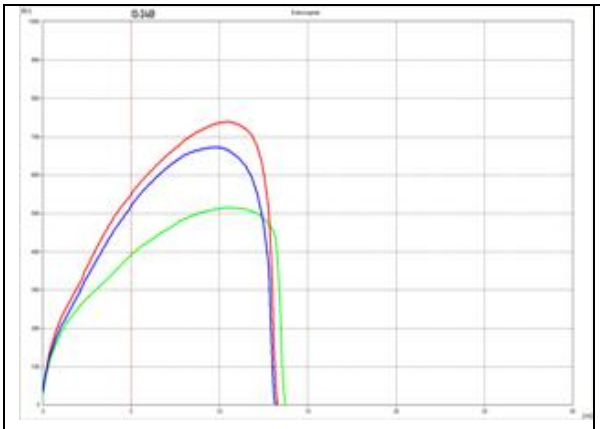
13-2402, LCH08-80
P (mm H_20) = 50, L (mm) = 178, W ($10E^{-4}J$) = 221



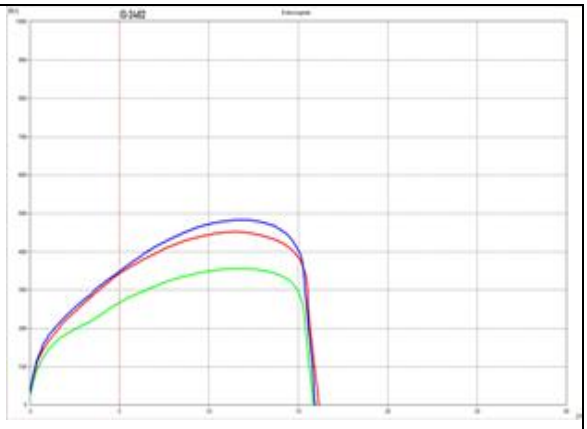
13-2403, LCS Mint
P (mm H_20) = 59, L (mm) = 90, W ($10E^{-4}J$) = 205

Physical Dough Tests - Extensigraph

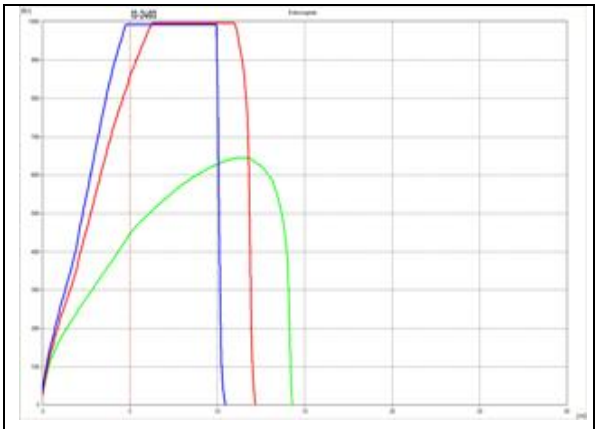
2013 (Small Scale) Samples – Limagrain



13-2401 Check Blend (check)
R (BU) = 553, E (mm) = 133, W (cm^2) = 127
Rmax (BU) = 739, Ratio = 4.16 at 90 min



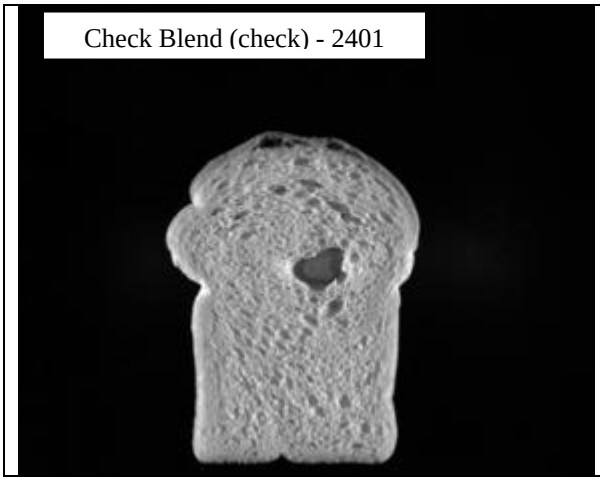
13-2402 LCH08-80
R (BU) = 345, E (mm) = 163, W (cm^2) = 100,
Rmax (BU) = 452, Ratio = 2.12 at 90 min

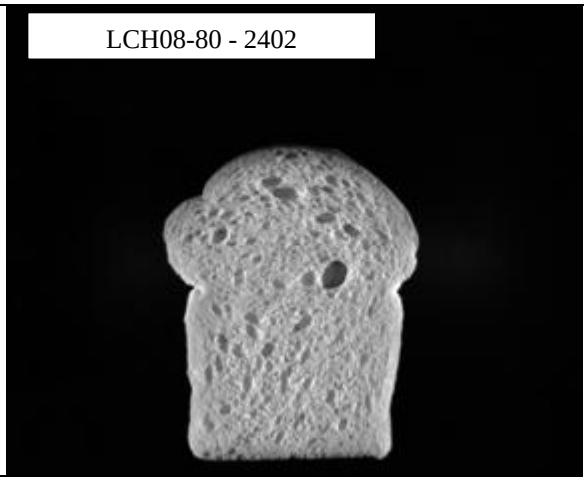


13-2403 LCS Mint
R (BU) = 864, E (mm) = 122, W (cm^2) = 160
Rmax (BU) = 997, Ratio = 7.1 at 90 min

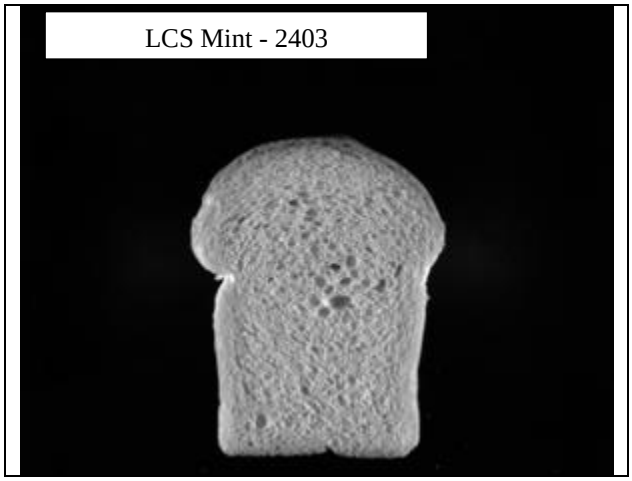
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Limagrain: C-Cell Bread Images and Analysis for 2013 (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	5978	151	4244	0.431	1.753	4.301	1.683	-17.63
2402	5837	153	4123	0.432	1.789	3.948	1.675	5.55



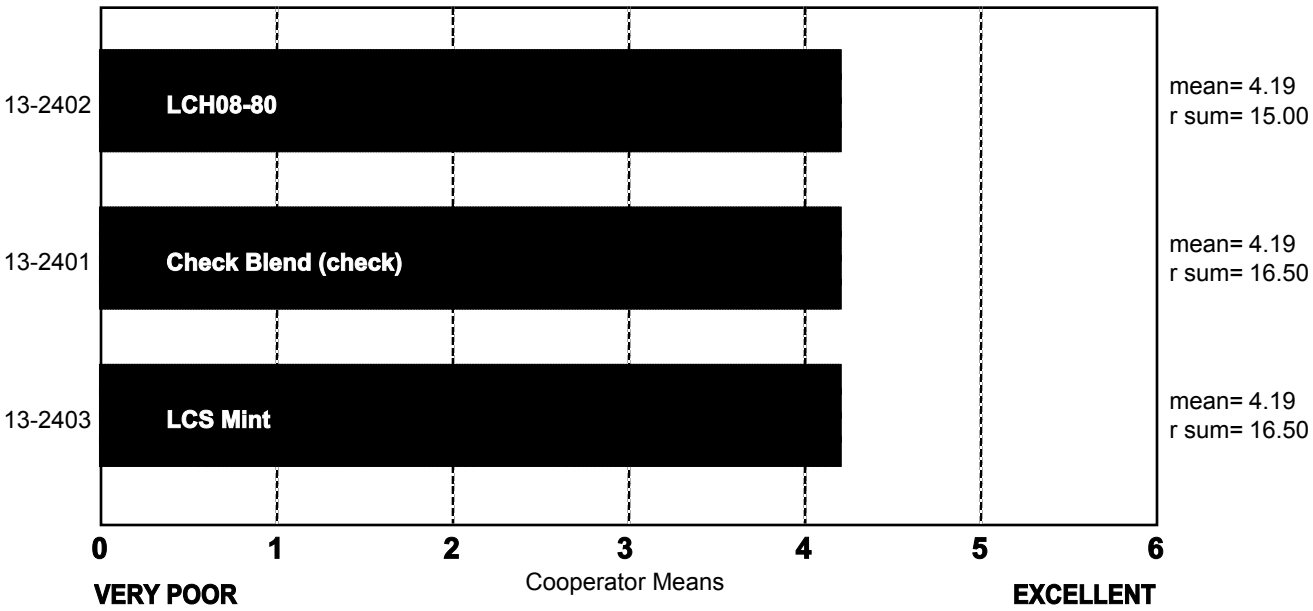
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2403	5973	151	4353	0.421	1.706	1.182	1.648	-19.25

SPONGE CHARACTERISTICS

(Small Scale) Limagrain

ncoop= 8
chisq= 0.19
chisqc= -0.27
cvchisq= 5.99
crdiff=

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

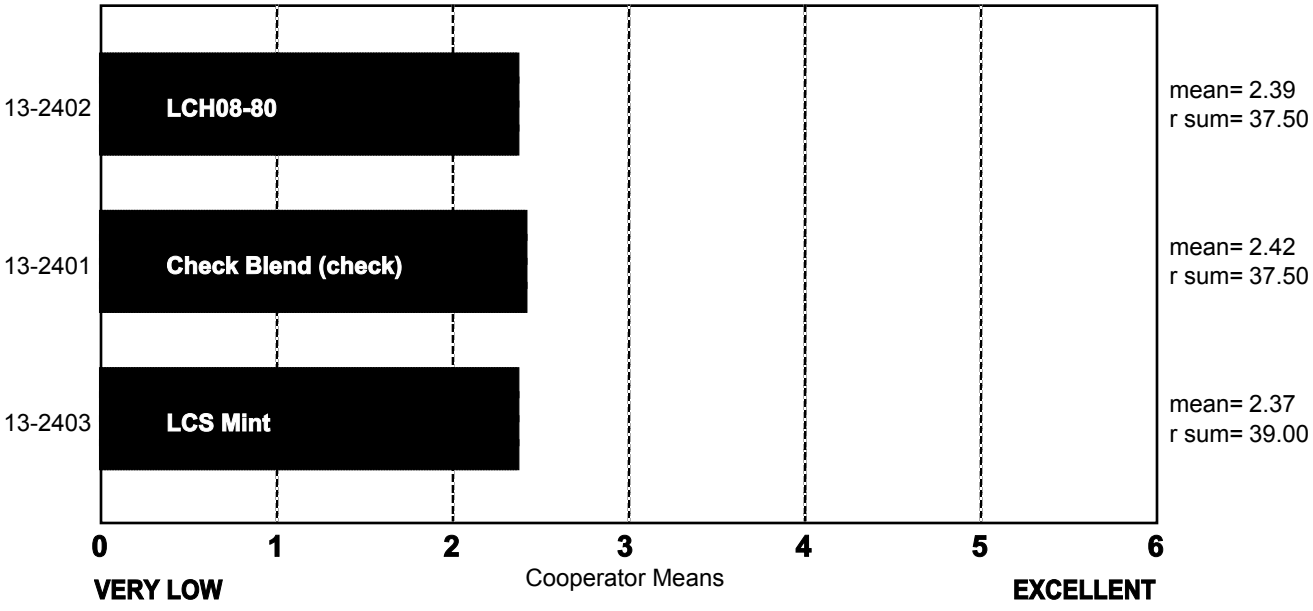


BAKE ABSORPTION

(Small Scale) Limagrain

ncoop= 19
chisq= 0.08
chisqc= 0.16
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) Limagrain

	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	Coop. R	Coop. S
13-2401 Check Blend (check)	**56.0**	**58.0**	**60.0**	**59.0**	**58.5**	**59.1**	**55.8**	**63.0**	**58.7**	**55.8**	**63.8**	**60.0**	**60.0**	**53.1**	**62.5**	**60.0**	**68.4**	**61.2**	**55.8**
13-2402 LCH08-80	**57.0**	**59.0**	**60.0**	**59.0**	**58.5**	**60.0**	**55.7**	**65.0**	**59.4**	**55.7**	**64.8**	**61.3**	**59.0**	**53.1**	**59.8**	**58.0**	**68.2**	**62.7**	**55.7**
13-2403 LCS Mint	**57.0**	**59.0**	**60.0**	**59.0**	**57.5**	**60.8**	**53.4**	**65.0**	**59.1**	**53.4**	**63.0**	**61.3**	**60.5**	**51.7**	**59.5**	**59.0**	**67.4**	**62.4**	**53.4**

BAKE MIX TIME, ACTUAL

(Small Scale) Limagrain

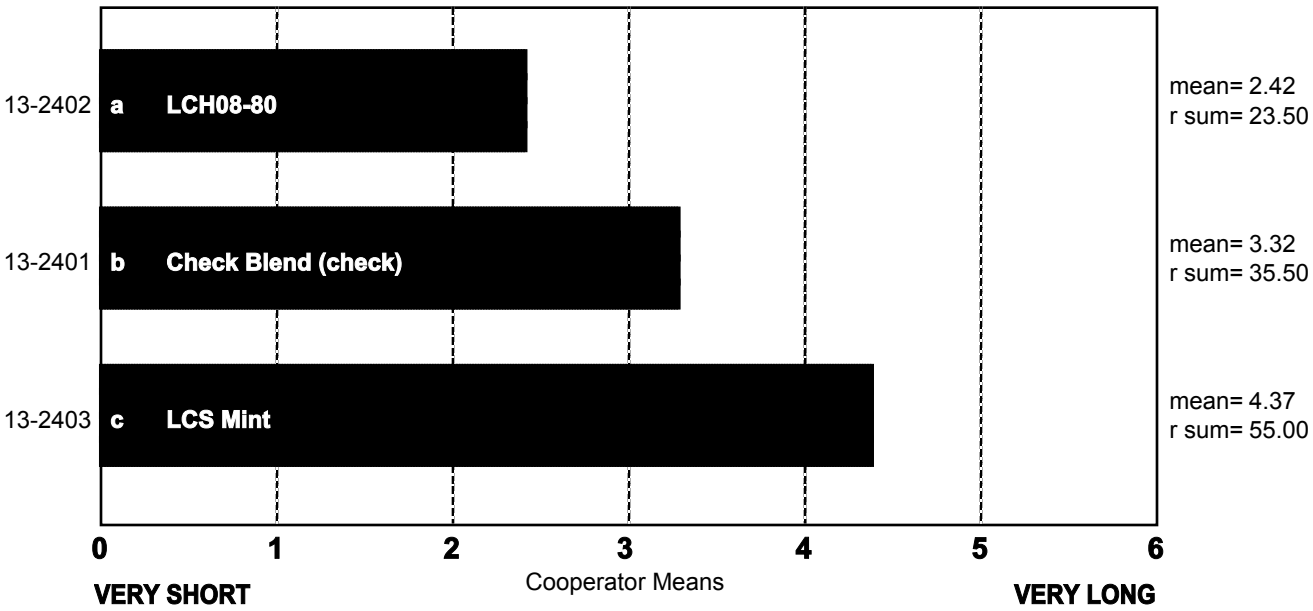
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2401 Check Blend (check)	**7.0**	**7.0**	**3.0**	**14.0**	**17.0**	**4.3**	**8.0**	**3.8**	**4.3**	**6.0**	**4.2**	**5.3**	**3.3**	**3.3**	**5.0**	**4.0**	**4.9**	**3.9**	**12.0**
13-2402 LCH08-80	**7.0**	**3.0**	**3.0**	**15.0**	**13.0**	**3.5**	**6.0**	**2.3**	**3.0**	**5.0**	**3.3**	**5.5**	**2.6**	**2.0**	**3.8**	**4.0**	**3.3**	**2.9**	**7.0**
13-2403 LCS Mint	**12.0**	**11.0**	**9.0**	**25.0**	**20.0**	**4.8**	**9.0**	**4.8**	**4.5**	**9.0**	**5.0**	**7.0**	**3.3**	**3.3**	**7.0**	**5.0**	**5.9**	**4.9**	**14.0**

BAKE MIX TIME

(Small Scale) Limagrain

ncoop= 19
chisq= 26.61
chisqc= 32.10
cvchisq= 5.99
crdiff= 4.61

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

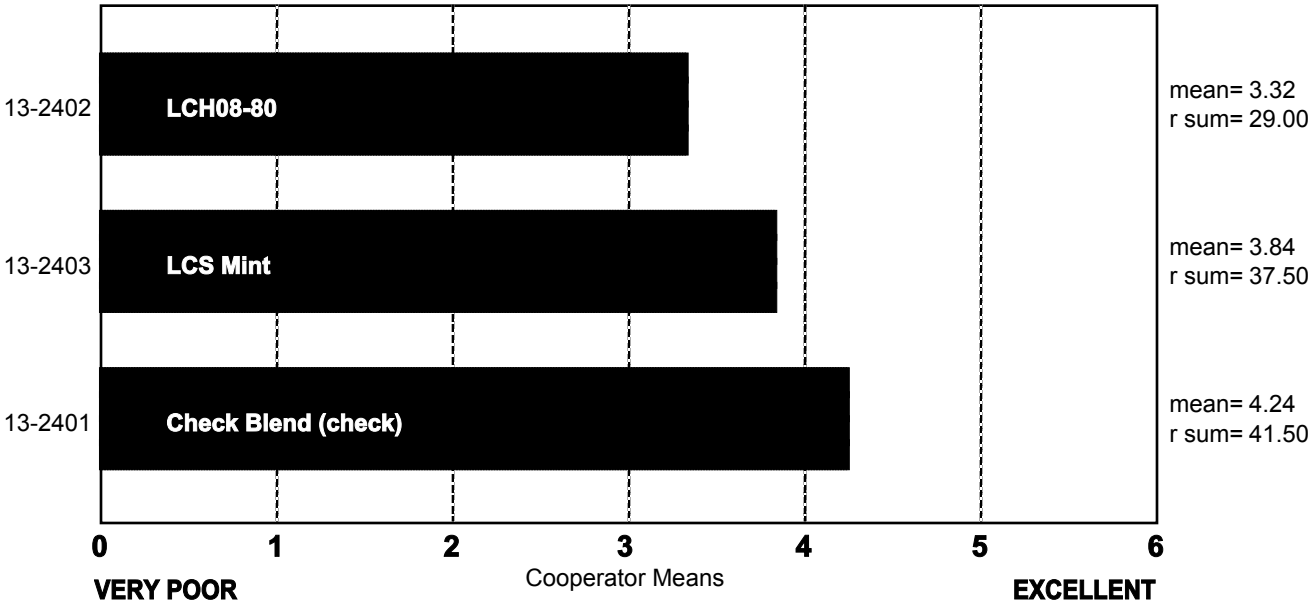


MIXING TOLERANCE

(Small Scale) Limagrain

ncoop= 18
chisq= 4.53
chisqc= 5.72
cvchisq= 5.99
crdiff=

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

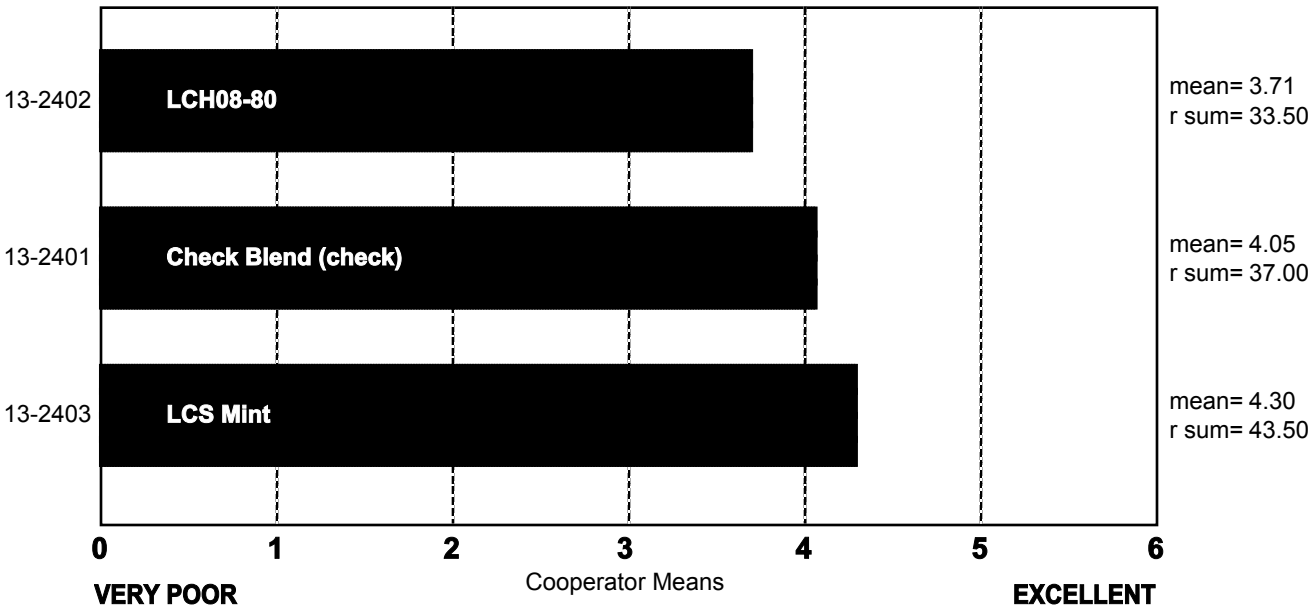


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Limagrain

ncoop= 19
chisq= 2.71
chisqc= 4.04
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) Limagrain

	Sticky	Wet	Tough	Good	Excellent
13-2401 Check Blend (check)	**2**	**1**	**5**	**9**	**2**
13-2402 LCH08-80	**4**	**4**	**3**	**6**	**2**
13-2403 LCS Mint	**0**	**0**	**4**	**11**	**4**

Frequency Table

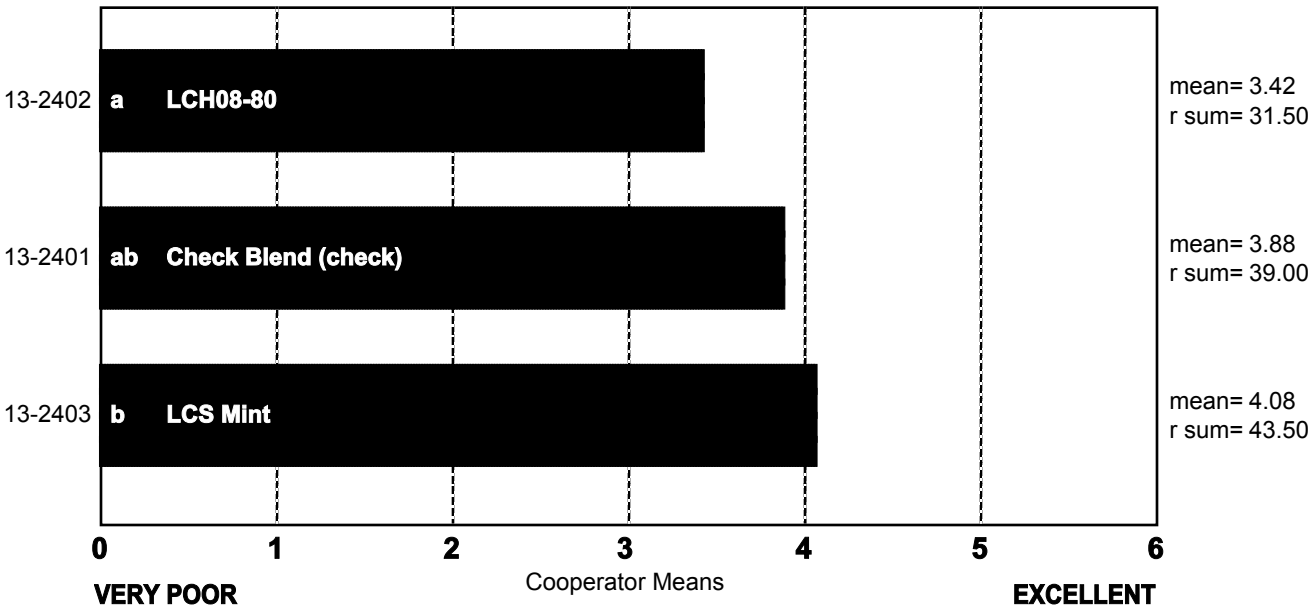
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Limagrain

ncoop= 19
chisq= 3.87
chisqc= 6.00
cvchisq= 5.99
crdiff= 9.46

Variety order by rank sum.

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Limagrain

	Sticky	Wet	Tough	Good	Excellent
13-2401 Check Blend (check)	**1**	**1**	**2**	**11**	**4**
13-2402 LCH08-80	**2**	**3**	**3**	**9**	**2**
13-2403 LCS Mint	**0**	**1**	**1**	**16**	**1**

Frequency Table

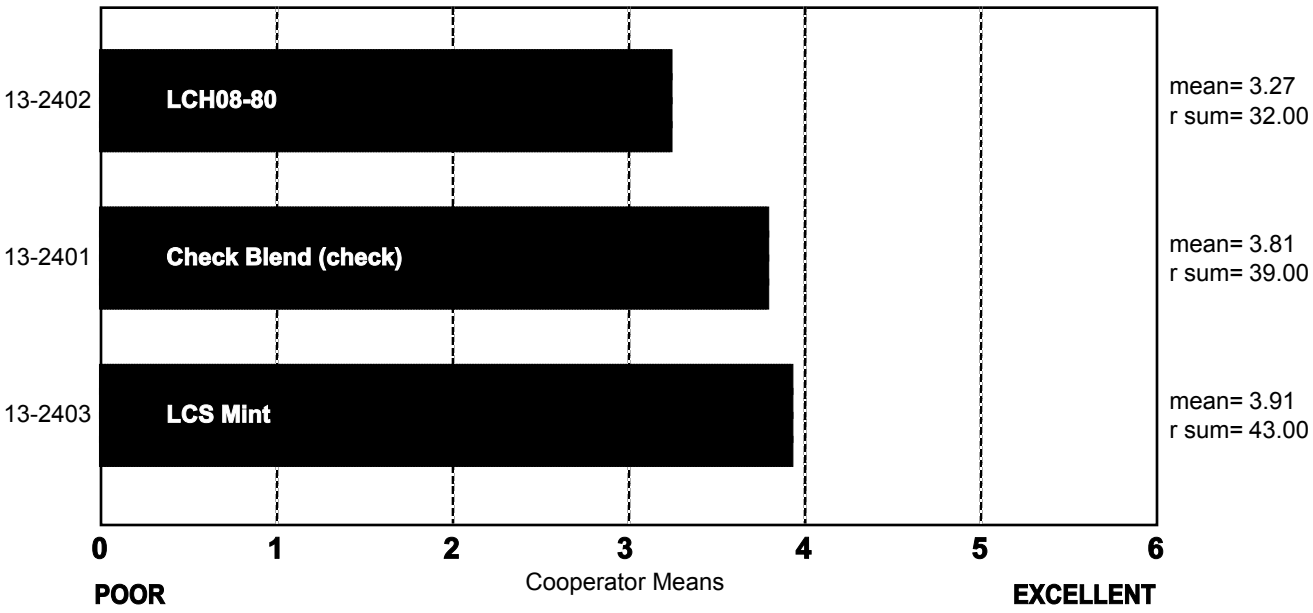
CRUMB GRAIN

(Small Scale) Limagrain

ncoop= 19
chisq= 3.26
chisqc= 5.06
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Limagrain

	Open	Fine	Dense
13-2401 Check Blend (check)	**9**	**7**	**3**
13-2402 LCH08-80	**9**	**6**	**4**
13-2403 LCS Mint	**9**	**8**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Limagrain

	Round	Irregular	Elongated
13-2401 Check Blend (check)	**8**	**8**	**3**
13-2402 LCH08-80	**7**	**9**	**3**
13-2403 LCS Mint	**3**	**11**	**5**

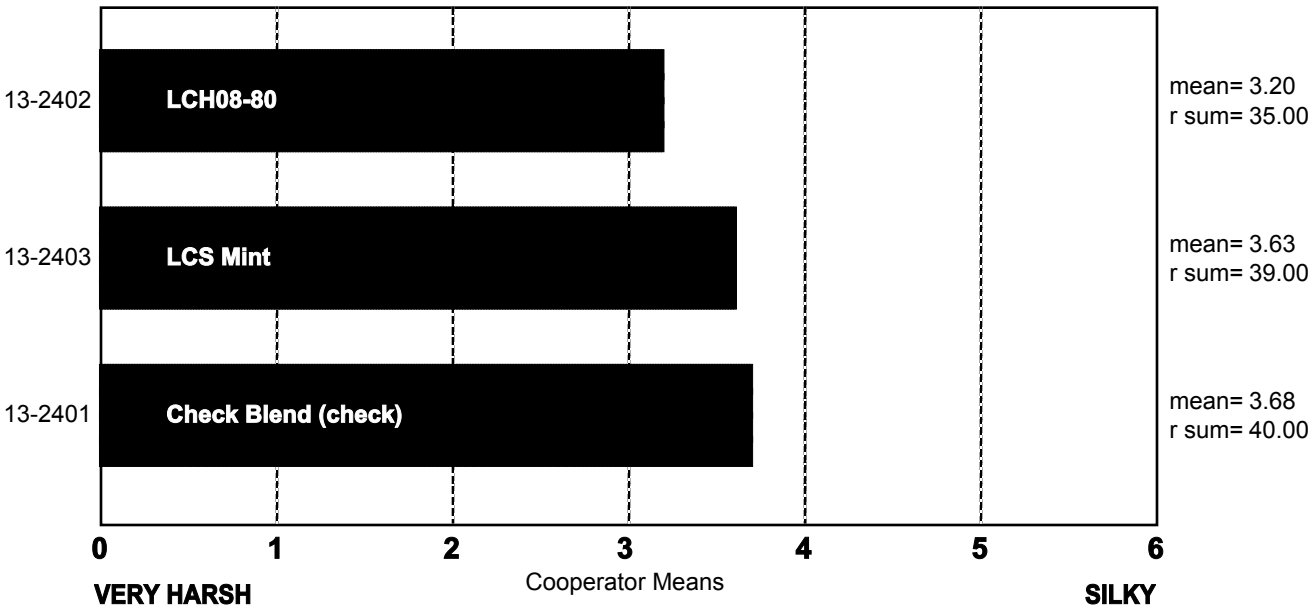
Frequency Table

CRUMB TEXTURE

(Small Scale) Limagrain

ncoop= 19
chisq= 0.74
chisqc= 1.24
cvchisq= 5.99
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Limagrain

	Harsh	Smooth	Silky
13-2401 Check Blend (check)	**4**	**12**	**3**
13-2402 LCH08-80	**8**	**8**	**3**
13-2403 LCS Mint	**5**	**11**	**3**

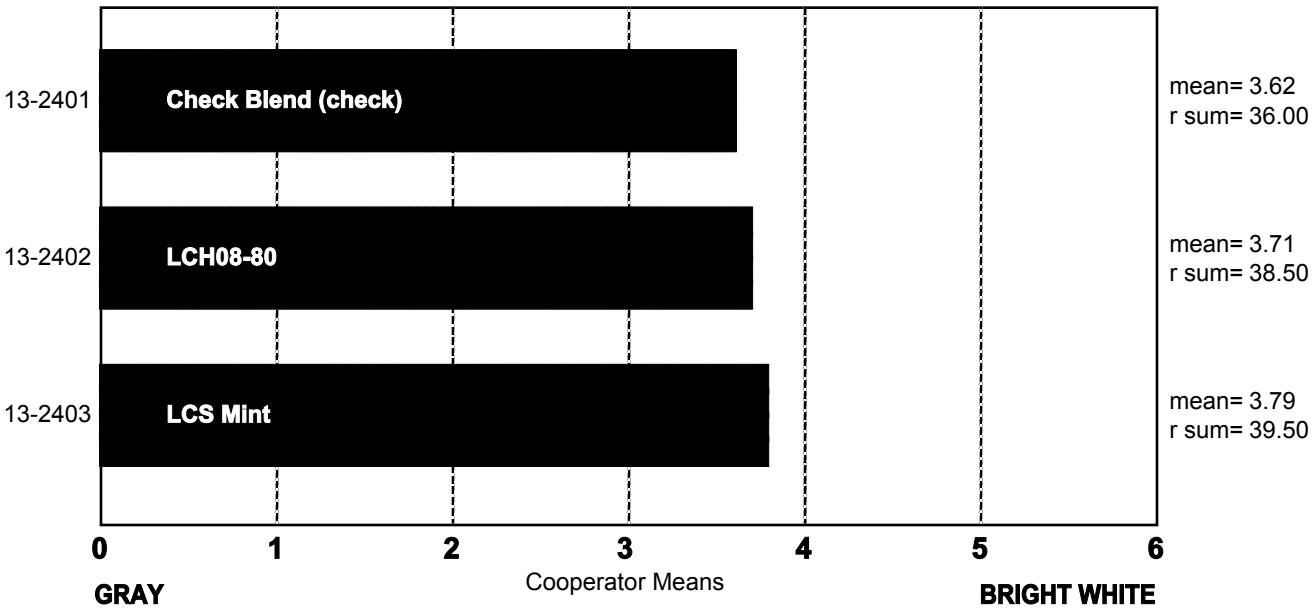
Frequency Table

CRUMB COLOR

(Small Scale) Limagrain

ncoop= 19
chisq= 0.34
chisqc= 0.59
cvchisq= 5.99
crdiff=

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



CRUMB COLOR, DESCRIBED

(Small Scale) Limagrain

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
13-2401 Check Blend (check)	**0**	**0**	**4**	**3**	**9**	**2**	**1**
13-2402 LCH08-80	**0**	**0**	**5**	**3**	**6**	**4**	**1**
13-2403 LCS Mint	**0**	**1**	**1**	**5**	**9**	**2**	**1**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Limagrain

	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	Coop. R	Coop. S
13-2401 Check Blend (check)	**413.0**	**465.5**	**130.0**	**481.5**	**463.5**	**140.8**	**462.0**	**137.3**		**448.8**	**126.5**	**141.7**		**128.4**	**153.1**	**487.8**	**155.5**	**139.8**	**451.0**
13-2402 LCH08-80	**412.0**	**464.3**	**130.0**	**482.2**	**459.8**	**140.7**	**460.0**	**136.6**		**448.9**	**126.9**	**145.5**		**129.9**	**149.5**	**487.7**	**154.4**	**141.0**	**447.5**
13-2403 LCS Mint	**411.0**	**465.7**	**130.0**	**480.9**	**462.9**	**140.7**	**466.0**	**135.5**		**450.1**	**126.7**	**143.4**		**126.8**	**149.0**	**481.9**	**151.8**	**141.0**	**454.0**

LOAF VOLUME, ACTUAL

(Small Scale) Limagrain

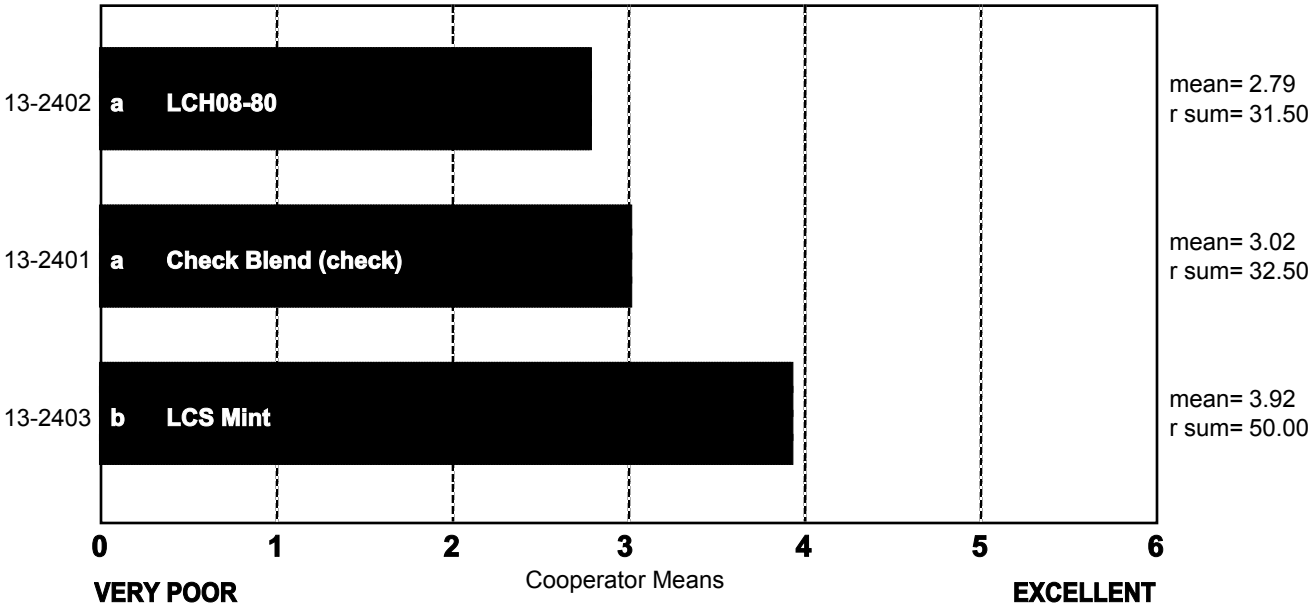
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2401 Check Blend (check)	**2675**	**2600**	**935**	**3045**	**2700**	**900**	**2250**	**868**	**790**	**2525**	**785**	**810**	**710**	**650**	**810**	**2425**	**963**	**769**	**2525**
13-2402 LCH08-80	**2750**	**2638**	**950**	**3045**	**2700**	**830**	**2150**	**865**	**730**	**2550**	**780**	**815**	**695**	**625**	**765**	**2150**	**993**	**736**	**2475**
13-2403 LCS Mint	**2850**	**2738**	**1000**	**3015**	**2650**	**1040**	**2200**	**968**	**940**	**2540**	**820**	**884**	**835**	**730**	**800**	**2625**	**938**	**794**	**2450**

LOAF VOLUME

(Small Scale) Limagrain

ncoop= 19
chisq= 11.39
chisqc= 16.04
cvchisq= 5.99
crdiff= 8.23

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

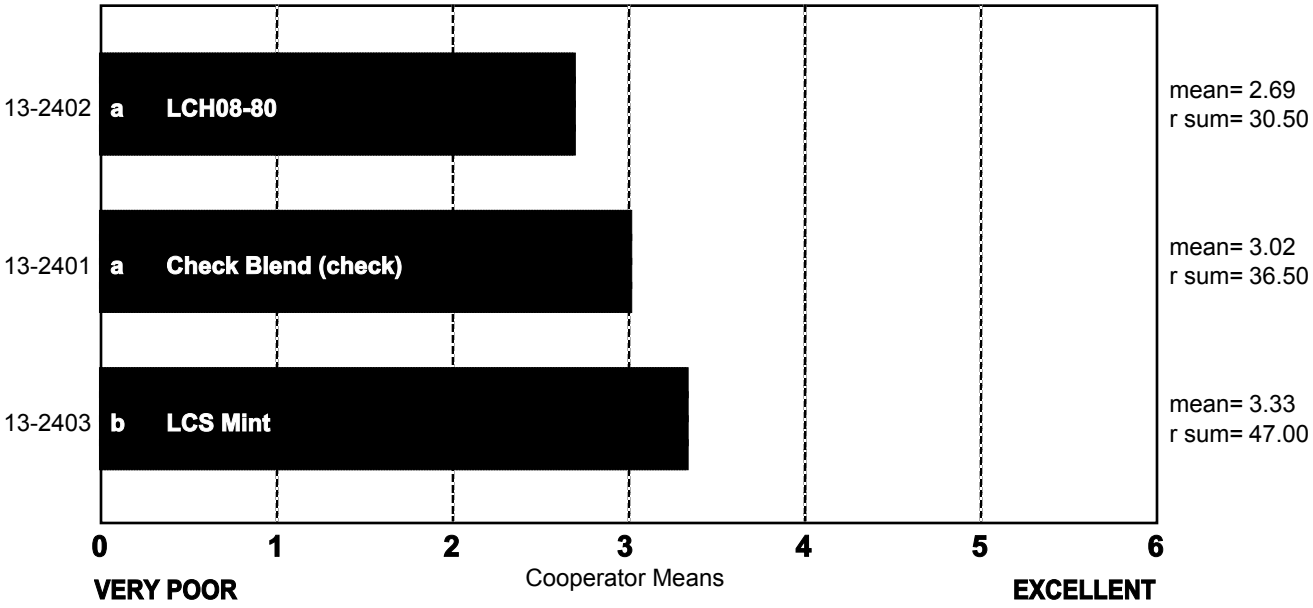


OVERALL BAKING QUALITY

(Small Scale) Limagrain

ncoop= 19
chisq= 7.34
chisqc= 9.79
cvchisq= 5.99
crdiff= 9.58

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



COOPERATOR'S COMMENTS
(Small Scale) Limagrain

COOP. **13-2401 Check Blend (check)**

A. Slightly open grain, bright interior, lowest protein group, shortest mix, lowest volume.
B. Low absorption, avg. mix, avg. volume, yellow crumb, sl. open grain.
C. Small volume, slightly below average performance.
D. Absorption was sl. below average; mix time was sl. below average, fairly tight, variable grain, very good volume.
E. No comment.
F. Cap.
G. No comment.
H. No comment.
I. No comment.
J. Low absorption, excellent dough, good volume, white in color.
K. No comment.
L. Lower absorption, normal mix time, slight sticky & weak dough, mid-high OS & volume, creamy crumb, open & elongated cells, smooth & resilient texture.
M. Unacceptable, low protein, poorer gluten strength.
N. At mixing dough was smooth, soft and pliable with body. At panning, no gas, no elasticity, pliable dough, poor moulding.
O. Absorption good for protein, good out of mix & pan, questionable crumb grain with poor quality exterior (double break, shell top, ragged break).
P. Short mix time, good grain, yellow crumb, low volume.
Q. Good dough properties and very good volume performance, crumb average.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. Break and shred.

COOP. **13-2402 LCH08-80**

A. Slightly open grain, bright interior, lowest protein group, shortest mix, lowest volume.
B. Low absorption, short mix, avg. volume, yellow crumb, sl. open grain.
C. Tacky, poor mix tolerance, slightly below average performance.
D. Average absorption and mix time, interior scores were good, volume was very good.
E. No comment.
F. Cap.
G. No comment.
H. No comment.
I. No comment.
J. Low absorption, excellent dough, good volume, dense grain, white in color.
K. No comment.
L. Normal absorption and mix time, slight sticky & strong dough, mid-high OS & volume, yellow crumb, open & irregular cells, slightly harsh & resilient texture.
M. Very low protein, weak, unacceptable bread flour.

N. At mixing dough felt rubbery. At panning dough had little gas, no strength, was pliable yet dense, poor moulding, outside of the loaf dried in moulder.
O. Low absorption, low scores for tolerance and at pan, poor quality exterior, good mix time, yellow crumb color, rated lower than the check.
P. Low absorption, short mix time, poor tolerance, sticky dough, dense grain, yellow crumb, poor volume.
Q. Good volume performance for protein.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. Break and shred.

COOP. 13-2403 LCS Mint

A. Slightly open grain, bright interior, lowest protein group, shortest mix, lowest volume.
B. Low absorption, slightly above average mix, good volume, creamy crumb, good grain.
C. Lively dough, good baking performance.
D. Low farinograph absorption, strong dough strength, above average interior scores.
E. Low absorption, poor texture, body, crumb strength.
F. Excellent externals.
G. No comment.
H. No comment.
I. No comment.
J. Very low absorption, good dough, dense grain, good volume, white in color.
K. No comment.
L. Lower absorption, longer mix time, slight sticky & strong dough, higher OS & volume, creamy crumb, fine & elongated cells, smooth/silky & resilient texture.
M. Very low protein, acceptable for low protein.
N. At mixing dough felt rubbery. At panning dough had little gas, no resistance/ pliable, poor moulding, outside of the loaf dried in moulder.
O. Low absorption, long mix time, excellent out of mixer, good at pan, satisfactory crumb grain, yellow crumb color, rated higher than the check.
P. Excellent dough, good grain, good volume.
Q. Good dough properties and very good volume performance, crumb was average.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. Break and shred.

Notes: **A, B, C, D, E, J, P and S** conducted sponge and dough bake tests

KANSAS-HAYS

13-2404	Danby (check)
13-2405	Oakley CL
13-2406	KS10HW78-1

Description of Test Plots and Breeder Entries

Kansas-Hays - Gourong Zhang

The samples submitted were grown at Hays experimental station in 2013. The field is sandy-loam soil and not fertilized. Yield levels were above average and there was little disease pressure.

Danby (Check)

Oakley CL

Oakley CL is a hard red winter wheat variety and was released in 2013. It is selected from a three-way cross of Above/Danby//KS03HW10. Oakley CL is a one-gene Clearfield wheat. Oakley CL has performed well in western Kansas, especially in northwestern Kansas, where it yielded over 5% more than Danby in the last two years. Oakley CL has very good resistance to wheat streak mosaic virus and stripe rust. It has the *Wsm2* gene for wheat streak mosaic virus resistance. It is resistance to both 2010 and 2012 races of stripe rust.
Oakley CL has good milling and baking quality. It has good mixing tolerance and longer mixing time. Its test weight is about the average (60 lb/bu).
Oakley CL is medium late and medium tall. It has good straw strength and good tolerance to grain shattering and pre-harvest sprouting.

KS10HW78-1

KS10HW78-1 is a hard white winter wheat breeding line and derived from a cross of KS03HW12-1/KS01HW152-6. KS10HW78-1 has good yield potential in the dry-land locations. KS10HW78-1 has good disease resistance package. It is resistant to 2012 stripe rust race, wheat streak mosaic virus, soilborn mosaic virus, and Hessian fly. KS10HW78-1 has very good tolerance to pre-harvest sprouting.
KS10HW78-1 has good test weight and milling quality. Its baking quality is about average.
KS10HW78-1 is early and medium short. It has good straw strength and good tolerance to grain shattering.

Kansas-Hays: 2013 (Small-Scale) Samples

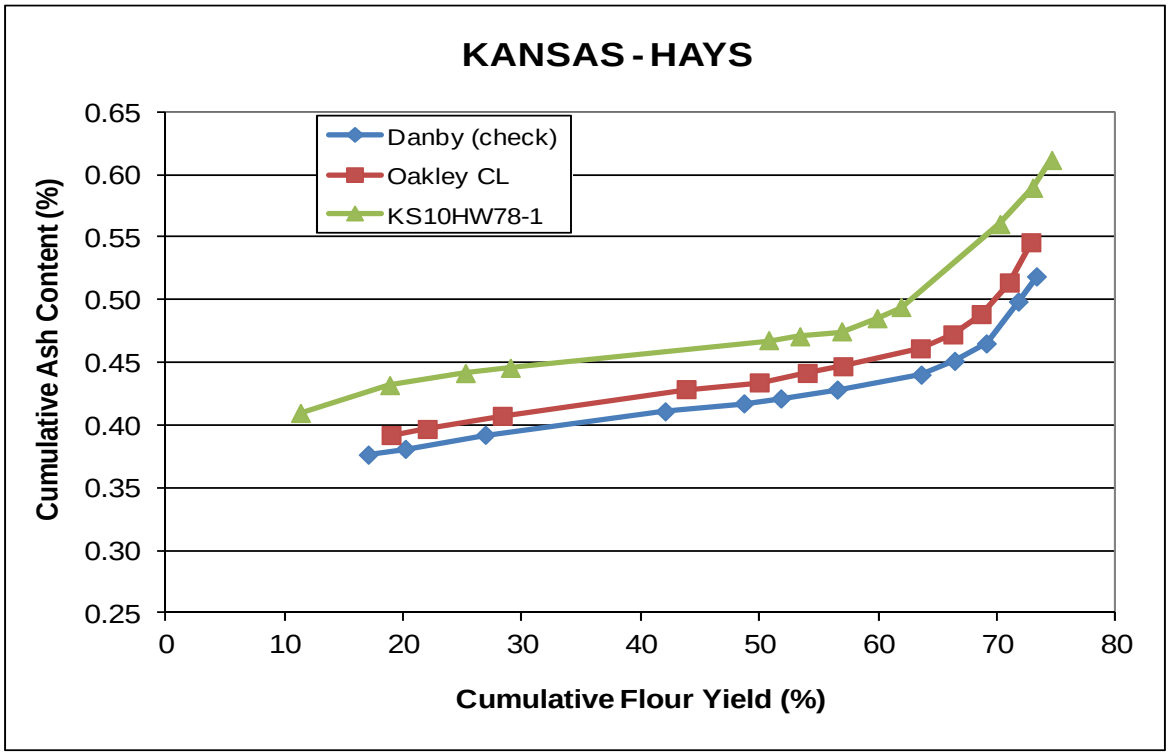
Test entry number	13-2404	13-2405	13-2406
Sample identification	**Danby (check)**	**Oakley CL**	**KS10HW78-1**
Wheat Data			
GIPSA classification	1 HDWH	2 HRW	2 HDWH
Test weight (lb/bu)	61.9	59.0	60.8
Hectoliter weight (kg/hl)	81.4	77.6	80.0
1000 kernel weight (gm)	25.6	26.1	26.7
Wheat kernel size (Rotap)			
Over 7 wire (%)	22.6	36.2	29.5
Over 9 wire (%)	75.8	62.6	69.7
Through 9 wire (%)	1.6	1.1	0.8
Single kernel (skcs)[a]			
Hardness (avg /s.d)	79.3/17.4	85.6/14.8	83.3/15.5
Weight (mg) (avg/s.d)	25.6/7.8	26.1/7.1	26.7/8.3
Diameter (mm)(avg/s.d)	2.46/0.27	2.53/0.30	2.56/0.30
Moisture (%) (avg/s.d)	11.7/0.3	11.3/0.3	11.2/0.3
SKCS distribution	02-03-09-86-01	00-01-03-96-01	01-01-05-93-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	14.2	15.4	14.3
Wheat ash (12% mb)	1.33	1.49	1.40
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	73.4	72.8	74.4
Quadrumat Sr. Mill	70.8	71.0	73.8
Flour moisture (%)	12.0	11.9	11.5
Flour protein (14% mb)	12.8	14.1	13.0
Flour ash (14% mb)	0.51	0.57	0.53
Rapid Visco-Analyser			
Peak time (min)	6.5	6.3	6.4
Peak viscosity (RVU)	252.9	201.5	252.9
Breakdown (RVU)	88.6	43.4	79.4
Final viscosity at 13 min (RVU)	270.6	278.8	292.2
Minolta color meter			
L*	92.60	91.62	91.76
a*	-2.30	-2.18	-2.03
b*	9.82	10.80	9.88
PPO	0.703	0.188	0.647
Falling number (sec)	550	612	558
Damaged Starch			
(AI%)	95.37	96.23	96.53
(AACC76-31)	5.80	6.45	6.69

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

Kansas-Hays: Physical Dough Tests and Gluten Analysis For 2013 (Small-Scale) Samples

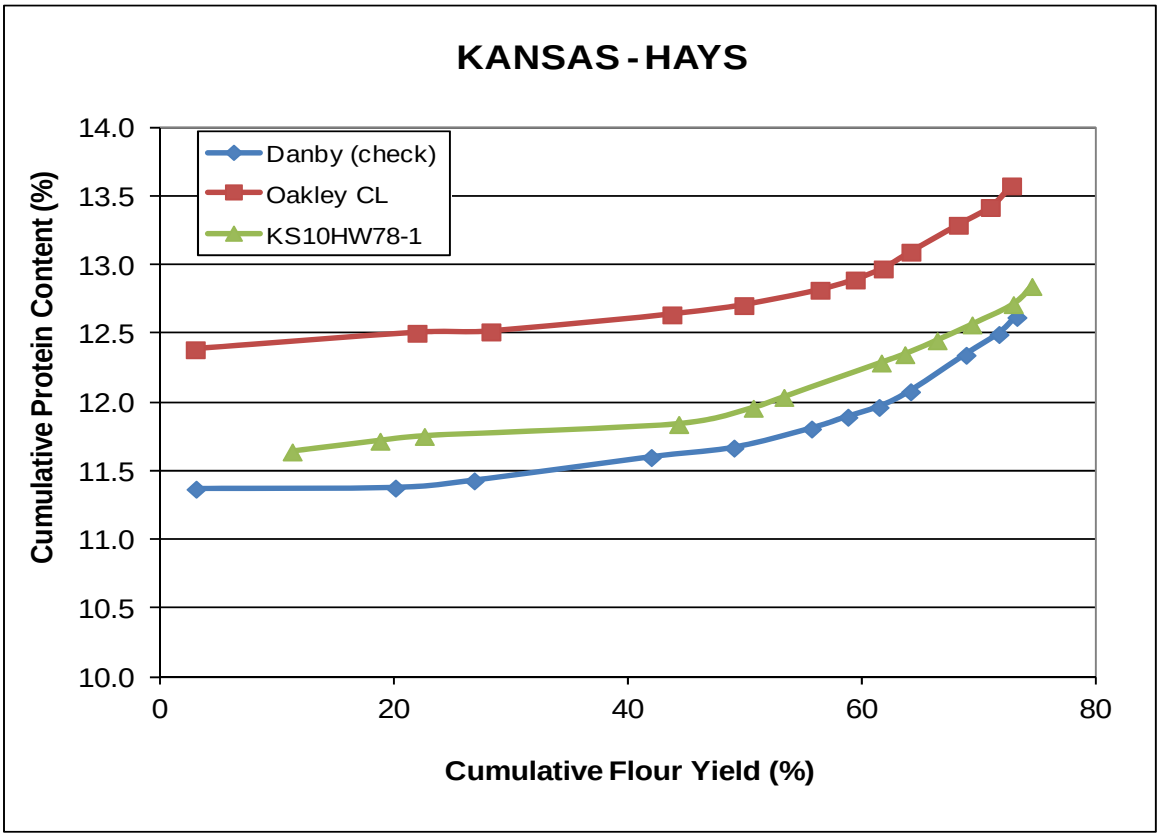
Test Entry Number	13-2404	13-2405	13-2406
Sample Identification	Danby (check)	Oakley CL	KS10HW78-1
MIXOGRAPH			
Flour Abs (% as-is)	65.6	68.8	67.5
Flour Abs (14% mb)	63.3	66.4	64.6
Mix Time (min)	3.0	4.3	2.8
Mix tolerance (0-6)	2	4	2
FARINOGRAPH			
Flour Abs (% as-is)	62.8	64.9	67.7
Flour Abs (14% mb)	60.5	62.5	64.9
Development time (min)	6.7	8.0	6.7
Mix stability (min)	11.4	27.1	17.1
Mix Tolerance Index (FU)	28	15	15
Breakdown time (min)	12.3	19.0	12.5
ALVEOGRAPH			
P(mm): Tenacity	67	81	105
L(mm): Extensibility	183	194	125
G(mm): Swelling index	30.1	31.0	24.9
W(10^{-4} J): strength (curve area)	325	475	376
P/L: curve configuration ratio	0.37	0.42	0.84
Ie(P_{200}/P): elasticity index	55.4	62.1	54.4
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	235/388/404	385/572/686	268/397/517
Extensibility (mm at 45/90/135 min)	164/162/149	177/165/154	159/157/149
Energy (cm^2 at 45/90/135 min)	73/116/110	137/192/201	78/116/133
Resist $_{max}$ (BU at 45/90/135min)	327/542/579	598/941/998	370/559/688
Ratio (at 45/90/135 min)	1.43/2.39/2.72	2.17/3.47/4.46	1.69/2.54/3.48
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+9, 5+10	2*,7+9, 5+10
%IPP	49.09	51.55	46.57
SEDIMENTATION TEST			
Volume (ml)	63.0	68.3	51.5

Kansas-Hays: Cumulative Ash Curves



Danby (check)					Oakley CL					KS10HW78-1				
Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash
2M	17.05	0.38	17.05	0.38	2M	18.97	0.39	18.97	0.39	2M	11.34	0.41	11.34	0.41
1M Red	3.13	0.41	20.17	0.38	1M Red	3.06	0.43	22.02	0.40	1M	7.51	0.47	18.85	0.43
1M	6.73	0.43	26.91	0.39	1M	6.31	0.44	28.33	0.41	1BK	6.37	0.47	25.23	0.44
3M	15.13	0.44	42.04	0.41	3M	15.48	0.47	43.81	0.43	1M Red	3.79	0.47	29.01	0.45
1BK	6.64	0.46	48.67	0.42	1BK	6.15	0.47	49.96	0.43	3M	21.75	0.50	50.76	0.47
Grader	3.11	0.48	51.78	0.42	2BK	4.05	0.53	54.00	0.44	Grader	2.62	0.53	53.38	0.47
2BK	4.75	0.51	56.53	0.43	Grader	3.01	0.54	57.01	0.45	2BK	3.52	0.53	56.90	0.47
4M	7.07	0.54	63.60	0.44	4M	6.52	0.59	63.53	0.46	3BK	2.98	0.68	59.88	0.49
3BK	2.81	0.70	66.41	0.45	3BK	2.73	0.73	66.26	0.47	FILTER FLR	2.01	0.76	61.90	0.49
FILTER FLR	2.67	0.81	69.08	0.46	FILTER FLR	2.39	0.94	68.64	0.49	4M	8.33	1.05	70.22	0.56
5M	2.69	1.36	71.77	0.50	5M	2.37	1.24	71.02	0.51	5M	2.76	1.33	72.99	0.59
BRAN FLR	1.53	1.46	73.30	0.52	BRAN FLR	1.82	1.80	72.84	0.55	BRAN FLR	1.59	1.63	74.58	0.61
Filter Bran	1.13	2.01	74.43	0.54	Filter Bran	1.10	2.15	73.93	0.57	Filter Bran	1.44	2.05	76.02	0.64
Red Dog	2.51	2.37	76.94	0.60	Red Dog	2.38	2.74	76.32	0.64	Red Dog	1.86	2.77	77.88	0.69
Red Shorts	0.70	3.13	77.64	0.62	Break Shorts	3.06	3.30	79.38	0.74	Break Shorts	2.88	3.09	80.76	0.77
Break Shorts	3.19	3.15	80.83	0.72	Red Shorts	0.40	3.45	79.78	0.75	Red Shorts	0.26	3.47	81.02	0.78
Bran	19.17	4.14	100.0	1.38	Bran	20.22	4.52	100.00	1.52	Bran	18.98	4.41	100.00	1.47
Wheat		1.30					1.46					1.37		
St. Grd. Fl.		0.51					0.57					0.53		

Kansas-Hays: Cumulative Protein Curves

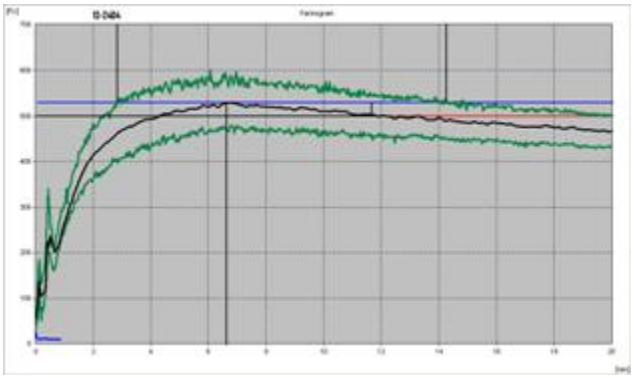


Danby (check)					Oakley CL					KS10HW78-1				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1M Red	3.13	11.37	3.13	11.37	1M Red	3.06	12.38	3.06	12.38	2M	11.34	11.64	11.34	11.64
2M	17.05	11.38	20.17	11.38	2M	18.97	12.52	22.02	12.50	1M	7.51	11.83	18.85	11.72
1M	6.73	11.58	26.91	11.43	1M	6.31	12.55	28.33	12.51	1M Red	3.79	11.92	22.64	11.75
3M	15.13	11.90	42.04	11.60	3M	15.48	12.86	43.81	12.64	3M	21.75	11.93	44.39	11.84
4M	7.07	12.08	49.11	11.67	1BK	6.15	13.18	49.96	12.70	1BK	6.37	12.78	50.76	11.96
1BK	6.64	12.84	55.74	11.81	4M	6.52	13.67	56.48	12.82	Grader	2.62	13.56	53.38	12.04
Grader	3.11	13.42	58.85	11.89	Grader	3.01	14.29	59.48	12.89	4M	8.33	13.89	61.71	12.29
FILTER FLR	2.67	13.55	61.52	11.96	FILTER FLR	2.39	14.97	61.87	12.97	FILTER FLR	2.01	14.23	63.72	12.35
5M	2.69	14.67	64.21	12.08	5M	2.37	16.28	64.24	13.09	5M	2.76	14.78	66.48	12.45
2BK	4.75	15.95	68.95	12.34	2BK	4.05	16.41	68.29	13.29	3BK	2.98	15.14	69.46	12.56
3BK	2.81	16.19	71.77	12.49	3BK	2.73	16.66	71.02	13.42	2BK	3.52	15.62	72.99	12.71
BRAN FLR	1.53	18.46	73.30	12.62	BRAN FLR	1.82	19.69	72.84	13.58	BRAN FLR	1.59	18.90	74.58	12.84
Break Shorts	3.19	16.93	76.49	12.80	Break Shorts	3.06	17.91	75.90	13.75	Break Shorts	2.88	15.99	77.46	12.96
Red Dog	2.51	16.55	79.00	12.92	Red Dog	2.38	16.53	78.28	13.83	Red Dog	1.86	15.25	79.32	13.01
Red Shorts	0.70	15.74	79.70	12.94	Red Shorts	0.40	16.54	78.68	13.85	Red Shorts	0.26	15.94	79.58	13.02
Filter Bran	1.13	13.71	80.83	12.95	Filter Bran	1.10	15.20	79.78	13.87	Filter Bran	1.44	14.43	81.02	13.05
Bran	19.17	17.72	100.00	13.87	Bran	20.22	16.73	100.00	14.45	Bran	18.98	17.94	100.00	13.98
Wheat		13.9					15.1					13.9		
St. Grd. Fl		12.8					14.1					13.0		

Physical Dough Tests

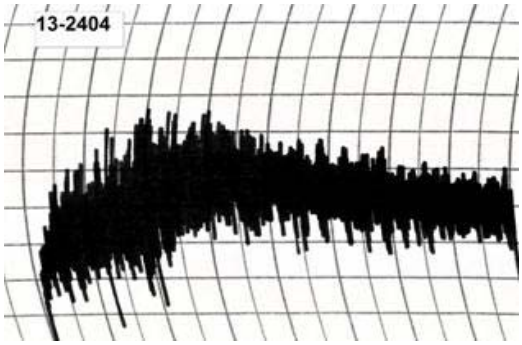
2013 (Small Scale) Samples - Kansas-Hays

Farinograms



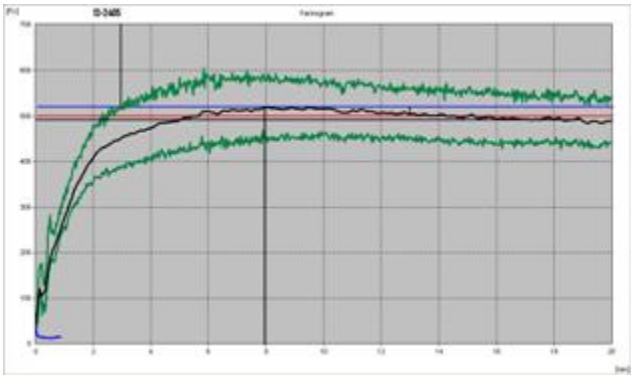
Water abs = 60.5%, Peak time = 6.7 min,
Mix stab = 11.4 min, MTI = 28 FU

Mixograms

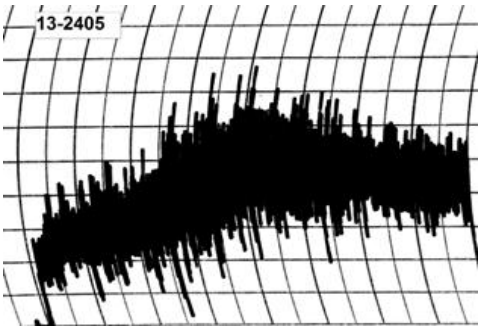


Water abs = 63.3%
Mix time = 3.0 min

13-2404, Danby (check)



Water abs = 62.5%, Peak time = 8.0 min,
Mix stab = 27.1 min, MTI = 15 FU



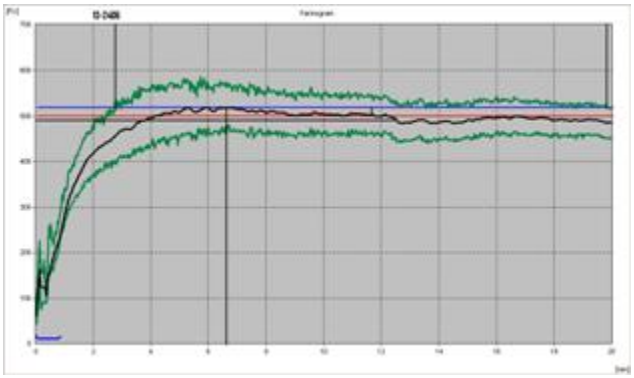
Water abs = 66.4%
Mix time = 4.3 min

13-2405, Oakley CL

Physical Dough Tests

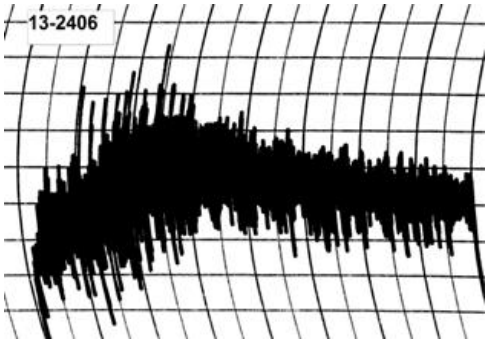
2013 (Small Scale) Samples - Kansas-Hays (continued)

Farinograms



Water abs= 64.9%, Peak time = 6.7 min,
Mix stab = 17.1 min, MTI = 15 FU

Mixograms

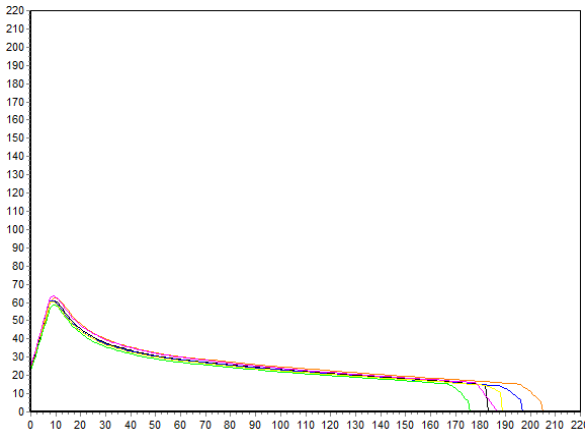


Water abs = 64.6%
Mix time = 2.8 min

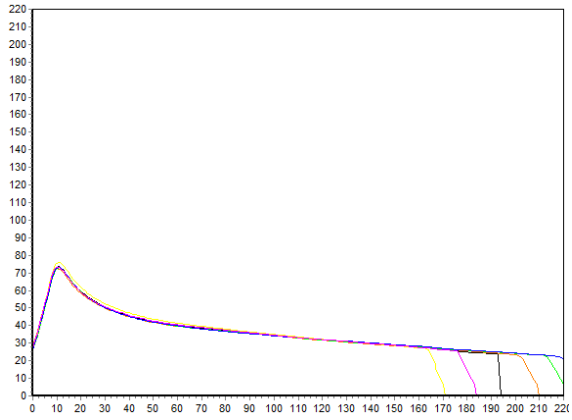
13-2406, KS10HW78-1

Physical Dough Tests - Alveograph

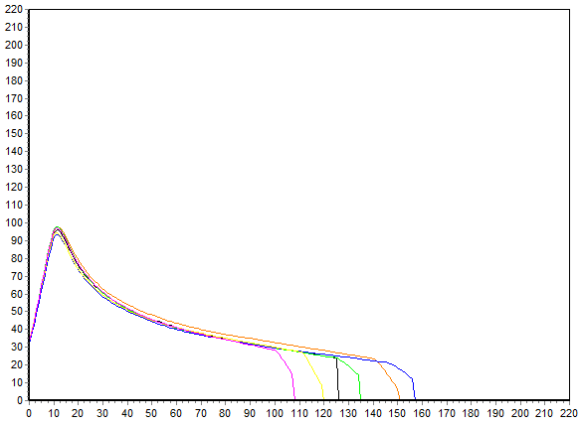
2013 (Small Scale) Samples – Kansas-Hays



13-2404, Danby (check)
P(mm H_20)=67, L(mm)=183, W($10E^{-4}$ J)=325



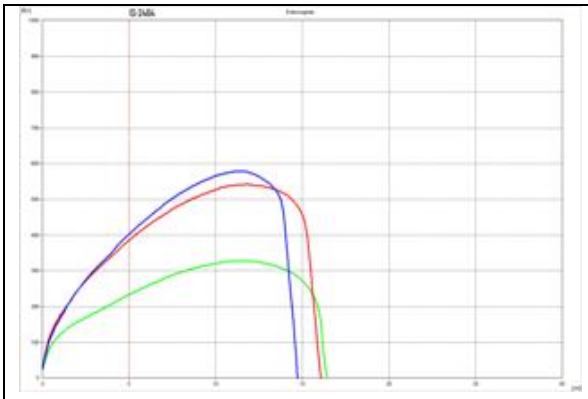
13-2405, Oakley CL
P(mm H_20)=81, L(mm)=194, W($10E^{-4}$ J)=475



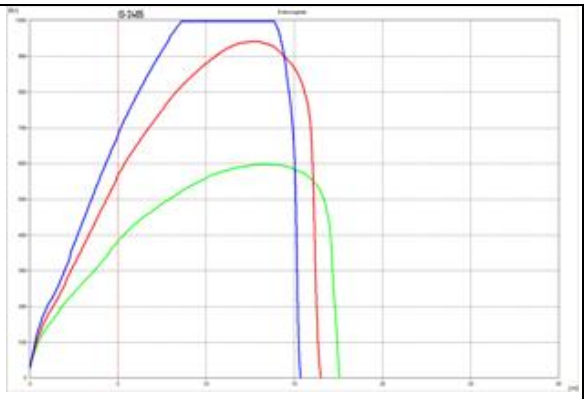
13-2406, KS10HW78-1
P(mm H_20)=105, L(mm)=125, W($10E^{-4}$ J)=376

Physical Dough Tests - Extensigraph

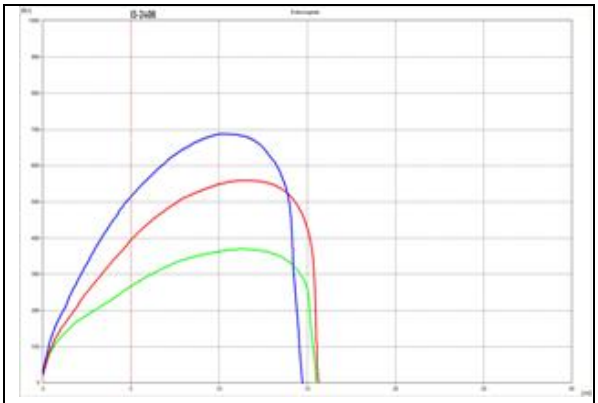
2013 (Small Scale) Samples – Kansas-Hays



13-2404, Danby (check)
R (BU) = 388, E (mm) =162 W (cm^2) = 116
Rmax (BU) = 542, Ratio = 2.39 at 90 min



13-2405, Oakley CL
R (BU) = 572, E (mm) =165, W (cm^2) = 192
Rmax (BU) = 941, Ratio = 3.47 at 90 min



13-2406, KS10HW78-1
R (BU) = 397, E (mm) =157, W (cm^2) = 116
Rmax (BU) = 559, Ratio = 2.54 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Kansas-Hays: C-Cell Bread Images and Analysis for 2013 (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	6174	151.7	3942	0.445	2.039	2.611	1.605	-20.43
2405	6821	146.1	4537	0.430	1.893	1.188	1.673	-17.88

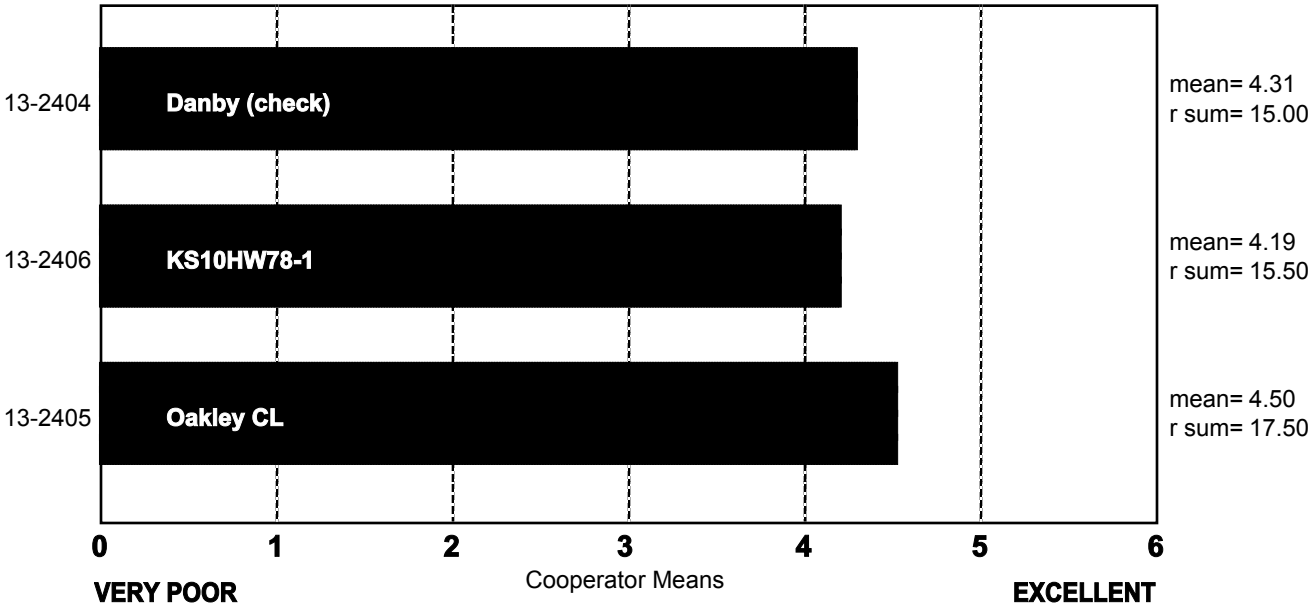
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2406	5806	146.9	3755	0.439	1.937	2.981	1.643	-22.75

SPONGE CHARACTERISTICS

(Small Scale) Kansas-Hays

ncoop= 8
chisq= 0.44
chisqc= -0.78
cvchisq= 5.99
crdiff=

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

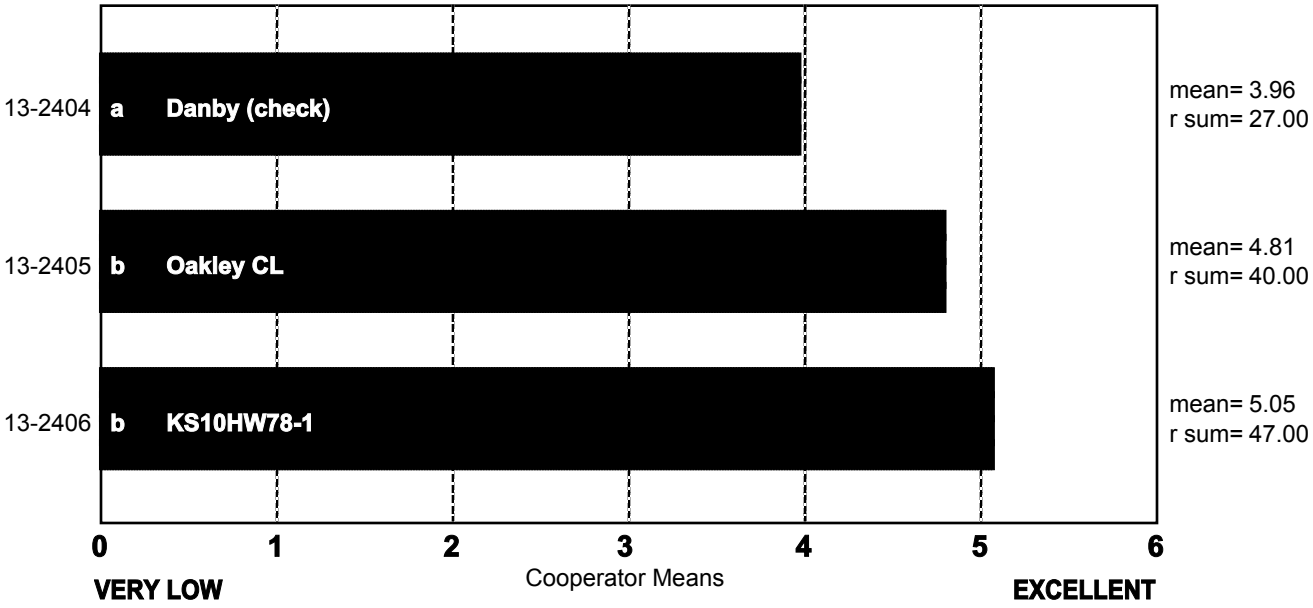


BAKE ABSORPTION

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 10.84
chisqc= 14.98
cvchisq= 5.99
crdiff= 8.50

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) Kansas-Hays

	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	Coop. R	Coop. S
13-2404 Danby (check)	**59.0**	**63.0**	**63.0**	**65.0**	**62.5**	**62.2**	**60.5**	**68.0**	**62.7**	**60.5**	**69.4**	**63.8**	**64.5**	**56.2**	**61.4**	**63.0**	**70.3**	**65.5**	**60.5**
13-2405 Oakley CL	**60.0**	**66.0**	**64.0**	**64.0**	**62.0**	**66.8**	**62.5**	**71.0**	**64.6**	**62.5**	**69.6**	**64.8**	**67.0**	**58.1**	**66.3**	**63.0**	**73.6**	**68.6**	**62.5**
13-2406 KS10HW78-1	**60.0**	**65.0**	**64.0**	**65.0**	**61.5**	**62.9**	**64.9**	**70.0**	**63.0**	**64.9**	**73.3**	**66.5**	**67.0**	**60.0**	**62.8**	**68.0**	**71.7**	**67.5**	**64.9**

BAKE MIX TIME, ACTUAL

(Small Scale) Kansas-Hays

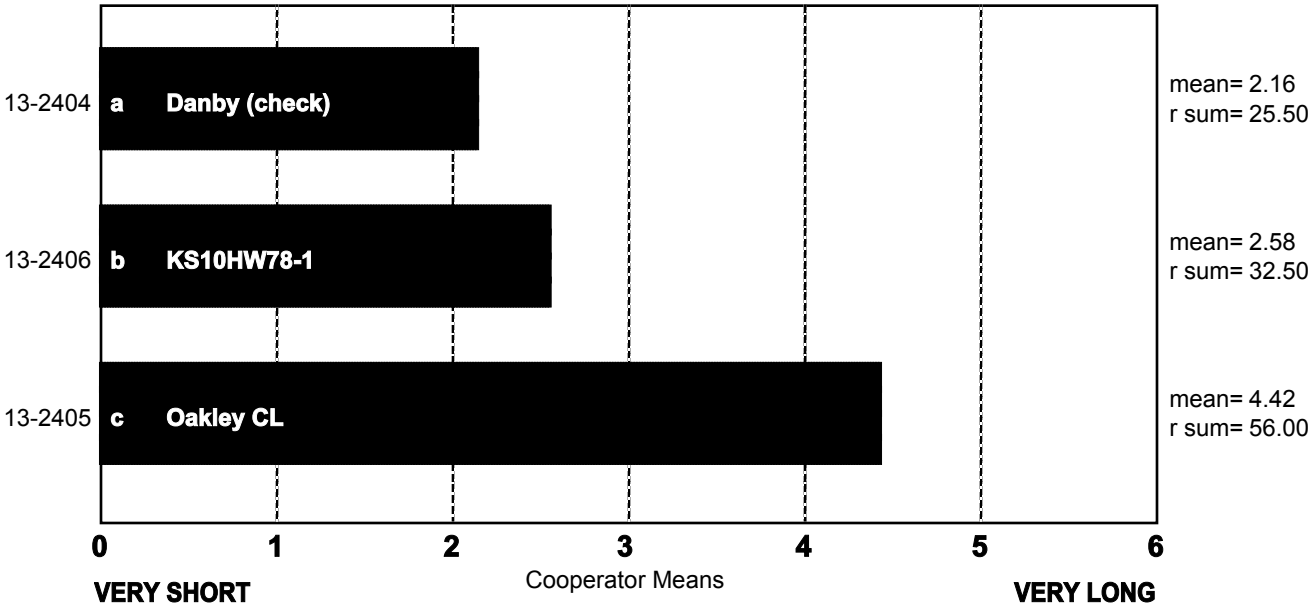
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2404 Danby (check)	**8.0**	**5.0**	**3.0**	**11.0**	**13.0**	**2.5**	**9.0**	**2.3**	**2.3**	**5.0**	**2.5**	**4.3**	**2.2**	**1.5**	**3.5**	**4.0**	**2.3**	**3.0**	**8.0**
13-2405 Oakley CL	**20.0**	**16.0**	**9.0**	**25.0**	**30.0**	**4.5**	**10.0**	**4.5**	**4.0**	**10.0**	**3.3**	**6.5**	**3.6**	**2.5**	**6.8**	**10.0**	**5.2**	**4.8**	**13.0**
13-2406 KS10HW78-1	**12.0**	**5.0**	**3.0**	**15.0**	**14.0**	**3.0**	**8.5**	**2.5**	**3.0**	**5.0**	**3.2**	**3.6**	**2.7**	**1.5**	**3.6**	**4.0**	**3.1**	**2.8**	**10.0**

BAKE MIX TIME

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 26.87
chisqc= 32.41
cvchisq= 5.99
crdiff= 4.48

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

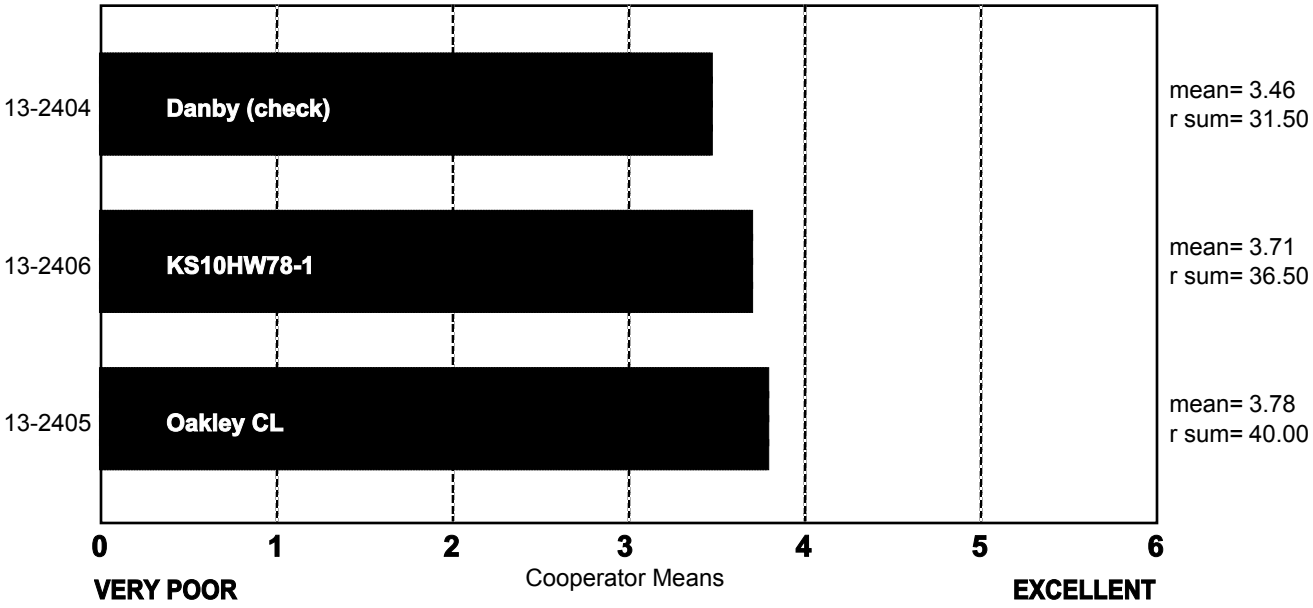


MIXING TOLERANCE

(Small Scale) Kansas-Hays

ncoop= 18
chisq= 2.03
chisqc= 2.65
cvchisq= 5.99
crdiff=

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

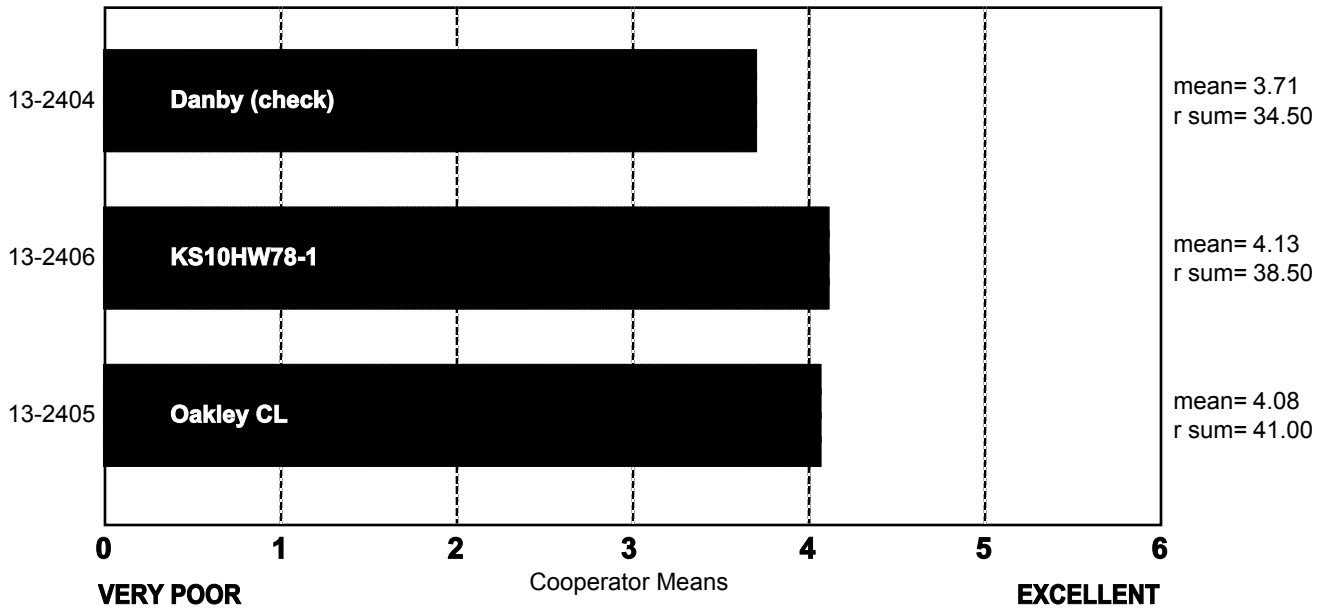


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 1.13
chisqc= 1.76
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) Kansas-Hays

	Sticky	Wet	Tough	Good	Excellent
13-2404 Danby (check)	**2**	**6**	**1**	**10**	**0**
13-2405 Oakley CL	**1**	**1**	**6**	**9**	**2**
13-2406 KS10HW78-1	**3**	**1**	**1**	**13**	**1**

Frequency Table

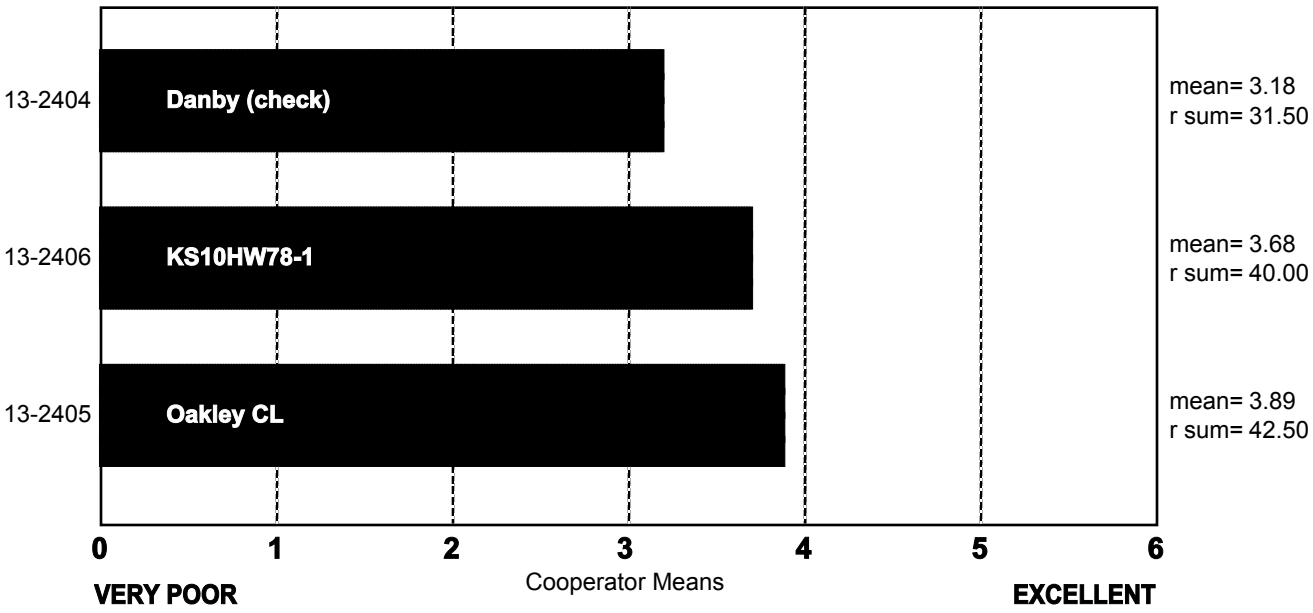
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 3.50
chisqc= 4.09
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) Kansas-Hays

	Sticky	Wet	Tough	Good	Excellent
13-2404 Danby (check)	**4**	**5**	**1**	**8**	**1**
13-2405 Oakley CL	**1**	**1**	**6**	**9**	**2**
13-2406 KS10HW78-1	**0**	**5**	**0**	**12**	**2**

Frequency Table

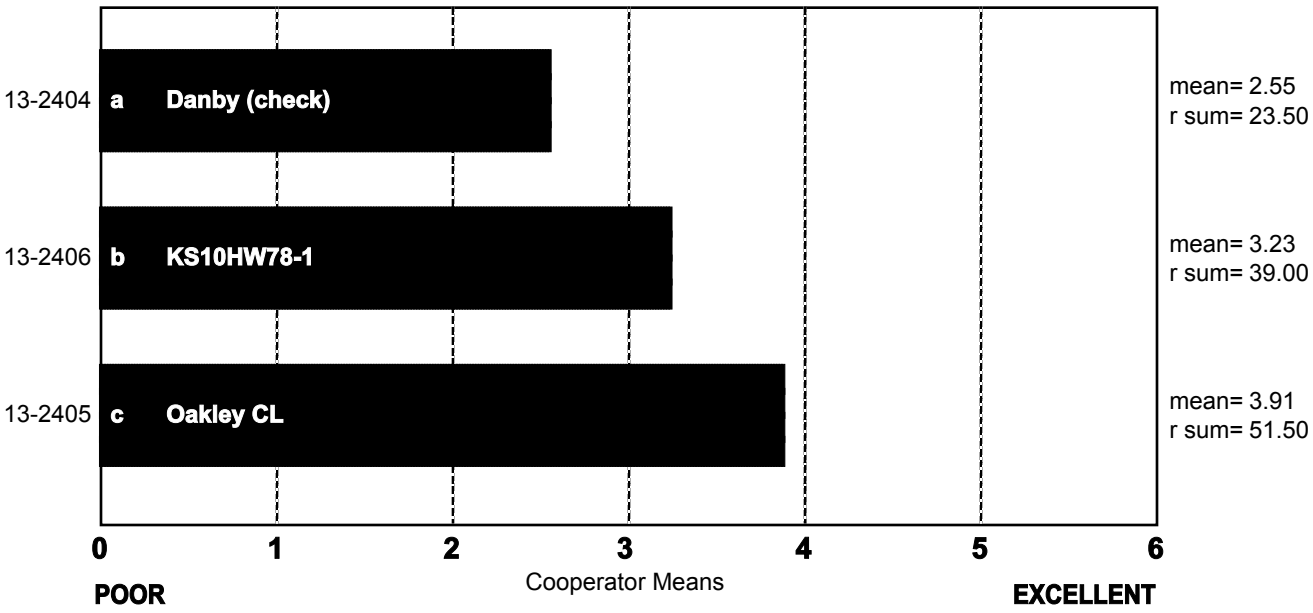
CRUMB GRAIN

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 20.71
chisqc= 24.59
cvchisq= 5.99
crdiff= 7.00

Variety order by rank sum.

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Kansas-Hays

	Open	Fine	Dense
13-2404 Danby (check)	**14**	**2**	**3**
13-2405 Oakley CL	**9**	**8**	**2**
13-2406 KS10HW78-1	**13**	**2**	**4**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Kansas-Hays

	Round	Irregular	Elongated
13-2404 Danby (check)	**14**	**3**	**2**
13-2405 Oakley CL	**3**	**8**	**8**
13-2406 KS10HW78-1	**14**	**4**	**1**

Frequency Table

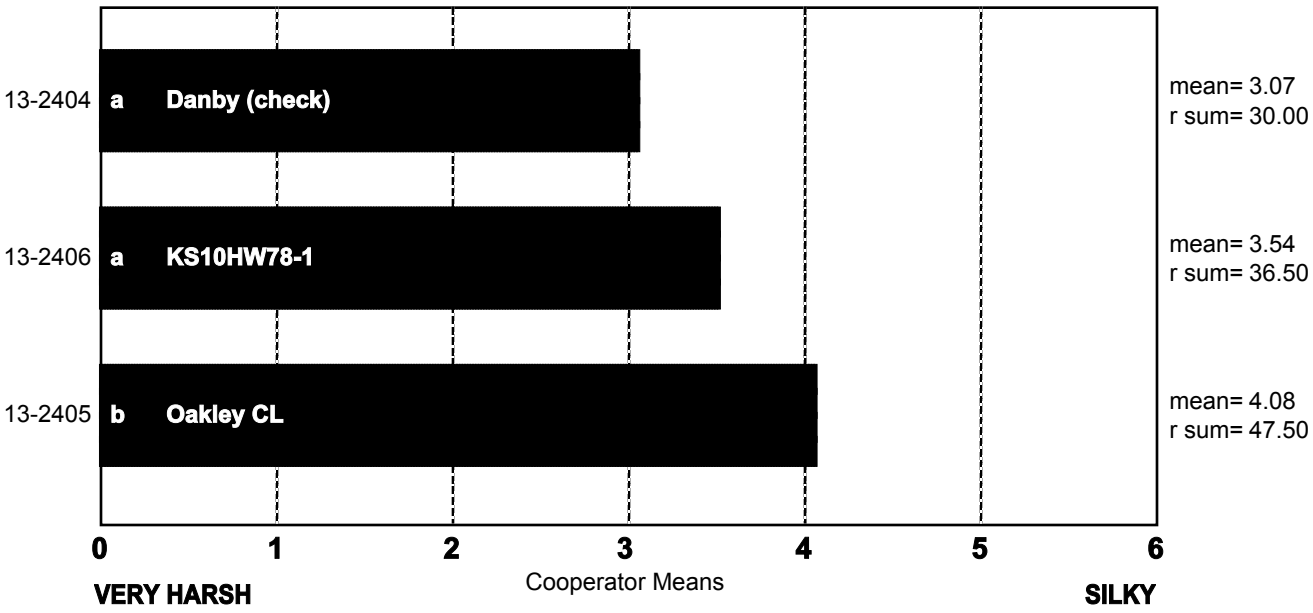
CRUMB TEXTURE

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 8.24
chisqc= 11.18
cvchisq= 5.99
crdiff= 9.26

Variety order by rank sum.

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Kansas-Hays

	Harsh	Smooth	Silky
13-2404 Danby (check)	**12**	**4**	**3**
13-2405 Oakley CL	**2**	**13**	**4**
13-2406 KS10HW78-1	**6**	**10**	**3**

Frequency Table

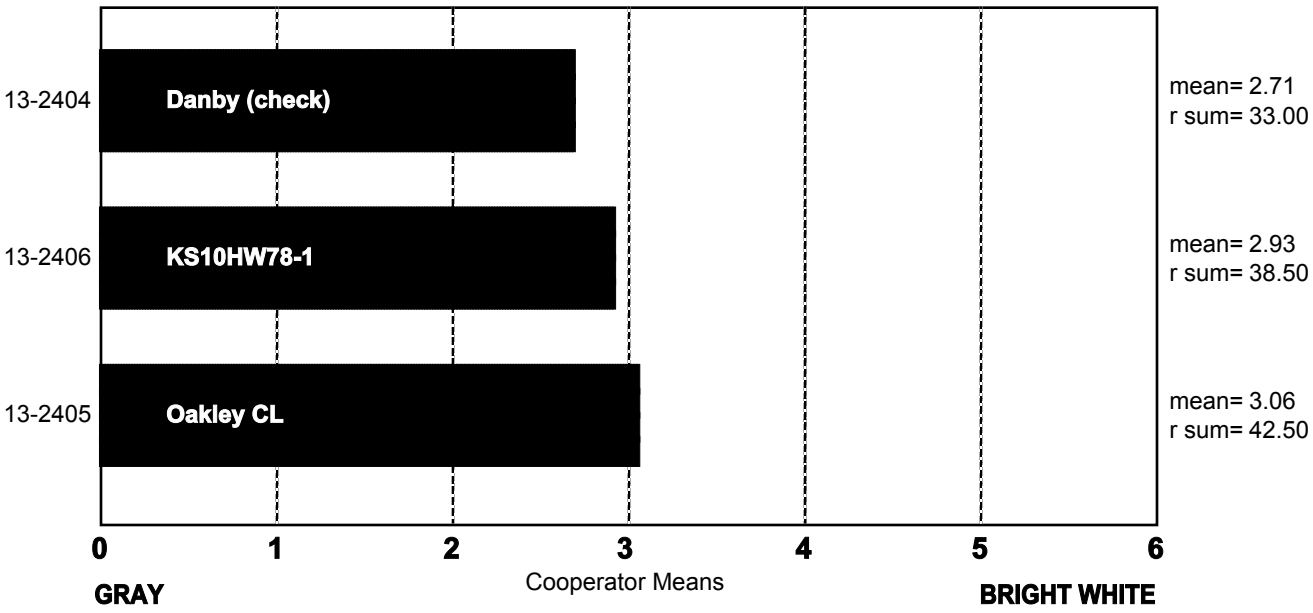
CRUMB COLOR

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 2.39
chisqc= 4.92
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Kansas-Hays

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
13-2404 Danby (check)	**0**	**5**	**4**	**0**	**8**	**2**	**0**
13-2405 Oakley CL	**0**	**1**	**8**	**1**	**8**	**1**	**0**
13-2406 KS10HW78-1	**0**	**2**	**7**	**2**	**7**	**1**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Kansas-Hays

	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	Coop. R	Coop. S
13-2404 Danby (check)	**409.0**	**466.1**	**130.0**	**481.2**	**458.9**	**147.5**	**458.0**	**140.7**		**452.9**	**132.5**	**141.4**		**135.1**	**148.5**	**488.8**	**157.2**	**141.7**	**447.5**
13-2405 Oakley CL	**412.0**	**464.8**	**130.0**	**487.5**	**465.3**	**147.3**	**454.0**	**143.0**		**449.5**	**135.4**	**143.9**		**132.9**	**152.8**	**482.4**	**158.3**	**139.4**	**448.5**
13-2406 KS10HW78-1	**416.0**	**464.6**	**130.0**	**480.3**	**463.0**	**147.0**	**449.0**	**142.8**		**449.2**	**137.9**	**146.9**		**136.9**	**150.7**	**487.0**	**159.8**	**141.0**	**448.0**

LOAF VOLUME, ACTUAL

(Small Scale) Kansas-Hays

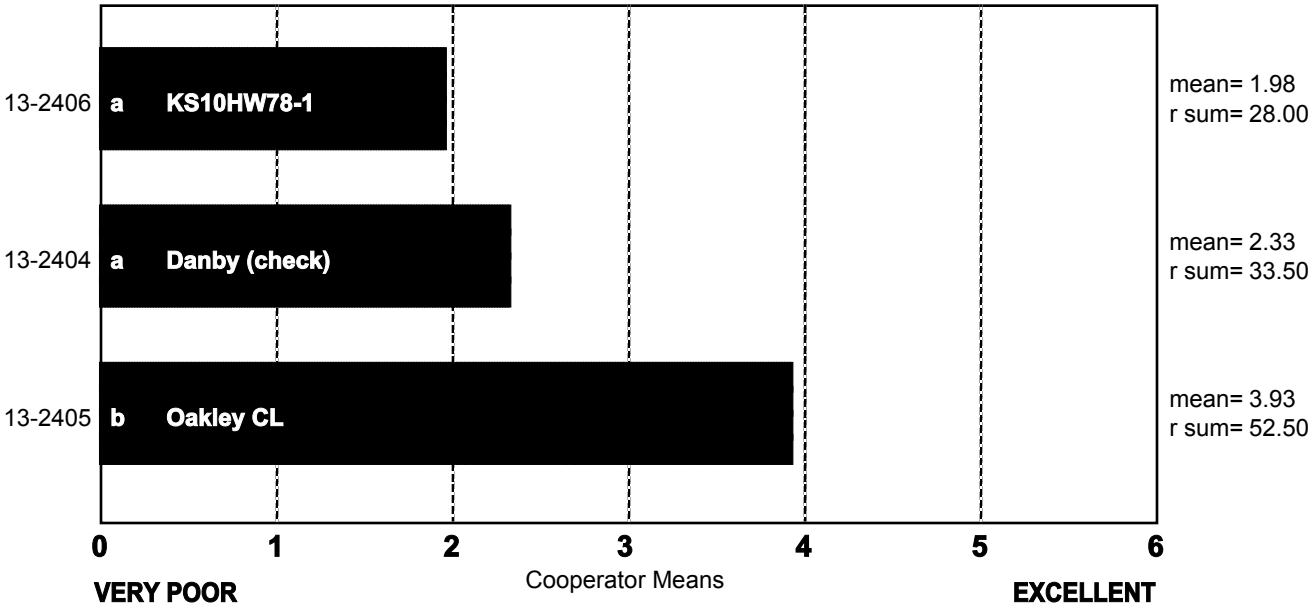
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2404 Danby (check)	**2750**	**2338**	**920**	**2883**	**2600**	**715**	**2300**	**950**	**695**	**2400**	**840**	**830**	**705**	**620**	**855**	**2338**	**958**	**734**	**2675**
13-2405 Oakley CL	**3025**	**2588**	**1025**	**3104**	**2600**	**915**	**2850**	**1058**	**970**	**2450**	**890**	**923**	**890**	**720**	**945**	**2488**	**1080**	**894**	**2650**
13-2406 KS10HW78-1	**2875**	**2363**	**870**	**2897**	**2475**	**790**	**2225**	**893**	**825**	**2275**	**825**	**786**	**730**	**640**	**800**	**2213**	**960**	**716**	**2375**

LOAF VOLUME

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 17.39
chisqc= 21.67
cvchisq= 5.99
crdiff= 7.54

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

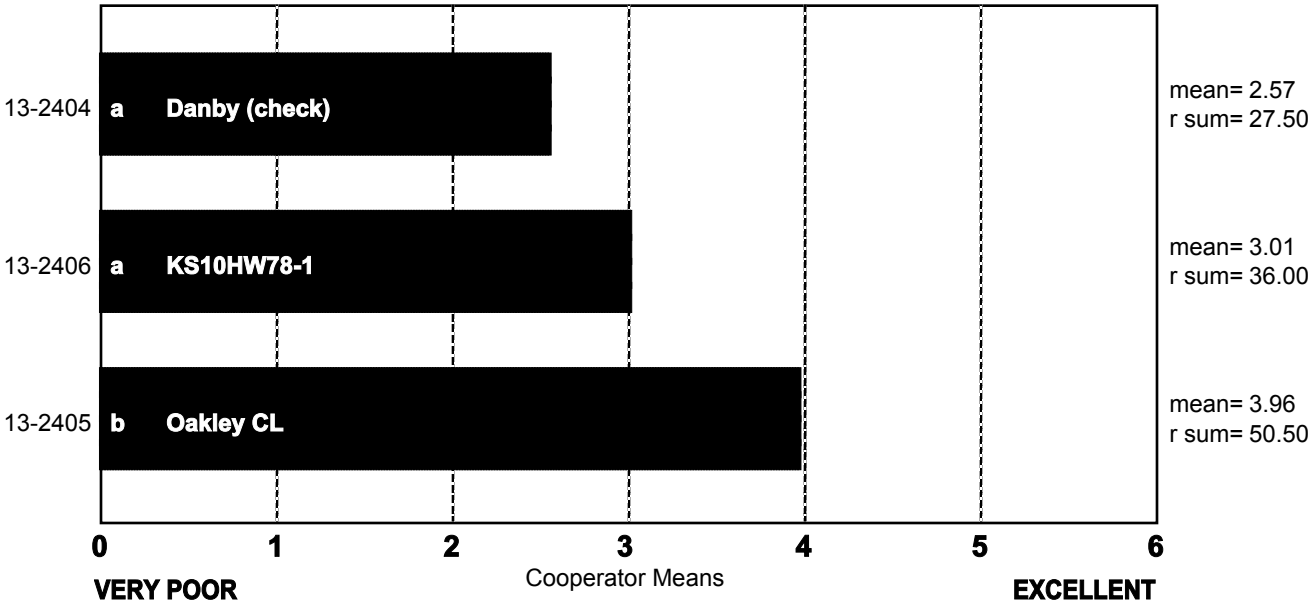


OVERALL BAKING QUALITY

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 14.24
chisqc= 15.91
cvchisq= 5.99
crdiff= 9.26

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



COOPERATOR'S COMMENTS
(Small Scale) Kansas - Hays

COOP. **13-2404 Danby (check)**

A. Open grain, creamy crumb, short mix for protein level, average volume.
B. Above average absorption, short mix, very low volume, very yellow, harsh texture, flat, open grain.
C. Poor grain, irregular crumb, tacky, poor baking performance.
D. Yellow crumb color, thick cell walls, average volume.
E. Poor grain, texture, and crumb strength.
F. Very short mix time.
G. No comment.
H. No comment.
I. No comment.
J. Excellent dough, lower volume, open grain.
K. Poor color.
L. Normal absorption & mix time, slight sticky & strong dough, mid-high OS & volume, slightly yellow crumb, slightly open & elongated cells, smooth & resilient texture.
M. Good protein, weak and baked poorly.
N. At mixing dough was nice, smooth, soft yet slightly tough; short mixer. At panning, no gas, pliable and slightly weak, poor moulding, outside of the loaf dried in moulder. Slightly over fermented possibly.
O. Poor exterior look (yellow crust, rough break), good at pan, questionable crumb, yellow crumb color.
P. Good absorption, short mix time, open grain, dk yellow crumb, poor volume.
Q. Poor crumb grain.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. Break and shred.

COOP. **13-2405 Oakley CL**

A. Open grain, creamy crumb, long mix, tough dough, average volume.
B. High absorption, long mix, avg. volume, yellow crumb, open grain.
C. Lively, strong, excellent baking performance.
D. Very strong dough, slightly variable grain, excellent volume.
E. No comment.
F. No comment.
G. Very good.
H. No comment.
I. No comment.
J. High absorption, good dough, lower volume, good grain rating.
K. No comment.
L. Normal absorption and mix time, slight sticky & strong dough, much higher OS & volume, slight yellow crumb, open & elongated cells, smooth & resilient texture.
M. Excellent protein, acceptable baking quality.

N. At mixing dough was wet. At panning dough was pliable, weak, and limp; nice moisture with little gas.
O. Highest flour protein, absorption, tolerance, out of mixer & at pan; above satisfactory crumb grain, yellow crumb color, good loaf volume, rated higher than the check.
P. Good absorption, good grain, yellow crumb.
Q. Nice crumb grain.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. Break and shred.

COOP. 13-2406 KS10HW78-1

A. Open grain, creamy crumb, average mix, and average volume.
B. High absorption, short mix, very low volume, yellow crumb, open grain, flat.
C. Very small, poor grain, poor baking performance. Worst of the set.
D. Open, irregular, thick cell walls, average volume.
E. Poor volume, grain, texture, crumb strength.
F. No comment.
G. Open grain.
H. No comment.
I. No comment.
J. Very high absorption, sticky at first but excellent dough out of mixer, low volume, open grain, dull color.
K. Excellent baking absorption.
L. Higher absorption, normal mix time, strong dough, fair-high OS & volume, yellow crumb, open & round cells, slightly harsh & resilient texture.
M. Very good protein, weak and poor baking quality.
N. Tacky during mixing yet dense, short mixer. At panning dough was moist, no gas, pliable/weak and limp. Slightly over fermented possibly.
O. Good flour protein, medium mix time, dough was good out of mixer, weaker at pan, questionable crumb grain with yellow crumb color, similar to check/rated lower than Oakley CL.
P. Very high absorption, short mix time, poor tolerance, wet dough, dense grain, dk yellow crumb, poor volume.
Q. Poor crumb grain.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. No comment.

Notes: **A, B, C, D, E, J, P and S** conducted sponge and dough bake tests

SOUTH DAKOTA

13-2407	Lyman (check)
13-2408	SD08200
13-2409	SD09192

Description of Test Plots and Breeder Entries

South Dakota - Melanie Caffe

Test plots
For the 2013 WQC Trials, South Dakota State University submitted Lyman as a check along with two experimental breeding lines, SD09192 and SD08200. Samples combining equal amounts of seed were composited from Brookings, Dakota Lakes, and Winner, SD. Sample plots were approximately 5 ft. wide by 250 ft. long at each location. Plots at Brookings were irrigated in the fall. Plots at Winner and Dakota Lakes didn't emerge in the fall.

Lyman (Check)
Released in 2008, and 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 agronomic performance. Lyman has above average disease resistance, including leaf and stem rust resistance, and it is among the most resistant winter wheat varieties for Fusarium head blight. Lyman has a tendency to lodge under high moisture conditions, similar to Arapahoe, and is rated as having excellent milling and satisfactory baking quality.

SD08200
SD08200 is a hard red winter wheat breeding line with the pedigree Wesley/KS91048-L-2-1//NE93613/Wendy. This breeding line is a white-chaff type, heading about 3 days later than Wesley. SD08200 is taller than Wesley but shorter than Overland. This breeding line was evaluated in the South Dakota Crop Performance Trial (CPT) and in the NRPN in 2012 and 2013. In the 2012 NRPN, SD08200 ranked 3rd for average grain yield among 34 entries evaluated, and in the 2013 NRPN, it ranked 11th for average grain yield among 37 entries tested. In the 2013 CPT which included 13 locations throughout South Dakota, SD08200 had the highest average grain yield among 36 entries evaluated in the trial. SD08200 exhibits a good level of resistance to the prevalent races of leaf rust, and it is moderately resistant to stem rust, and moderately susceptible to stripe rust and Fusarium head blight.

SD09192
SD09192 is a hard red winter wheat breeding line with the pedigree Harding/Trego//Trego/Wendy. This breeding line is a white-chaff type with excellent yield potential. It is a mid-maturity breeding line, heading about the same as Wesley, but about one day earlier than Overland. SD09192 is taller than Wesley and Overland but shorter than Jerry. SD09192 has been evaluated in the South Dakota Crop Performance Trial (CPT) and in the NRPN in 2012 and 2013. In both 2012 and 2013 CPT, SD09192 average yield was higher than the trial average at both east and west river locations. In the 2012 NRPN, SD09192 ranked 1st for average grain yield among 34 entries tested, and in the 2013 NRPN, it ranked 2nd among 37 entries tested. SD09192 is resistant to most prevalent leaf rust races, moderately resistant to stem rust and stripe rust, and moderately susceptible to Fusarium head blight.

South Dakota: 2013 (Small-Scale) Samples

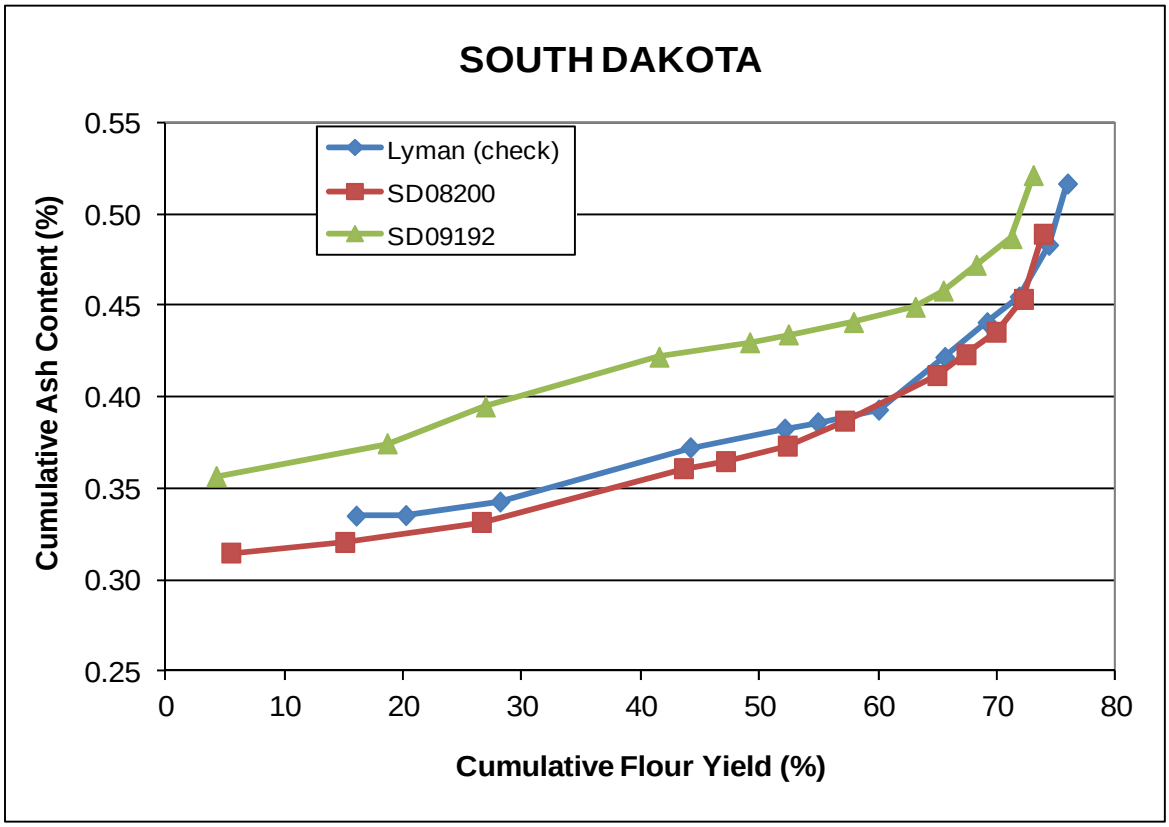
Test entry number	13-2407	13-2408	13-2409
Sample identification	**Lyman (check)**	**SD08200**	**SD09192**
Wheat Data			
GIPSA classification	2 HRW	2HRW	2HRW
Test weight (lb/bu)	59.1	57.8	58.1
Hectoliter weight (kg/hl)	77.8	76.1	76.5
1000 kernel weight (gm)	34.1	30.2	31.7
Wheat kernel size (Rotap)			
Over 7 wire (%)	75.0	58.5	62.4
Over 9 wire (%)	25.0	40.5	37.0
Through 9 wire (%)	0.0	1.0	0.6
Single kernel (skcs)[a]			
Hardness (avg /s.d)	58.7/14.2	55.2/17.9	60.3/17.7
Weight (mg) (avg/s.d)	34.1/8.3	30.2/10.4	31.7/8.8
Diameter (mm)(avg/s.d)	2.74/0.33	2.63/0.36	2.66/0.33
Moisture (%) (avg/s.d)	12.3/0.3	11.6/0.4	12.5/0.5
SKCS distribution	02-18-30-50-01	10-19-31-40-02	06-12-30-52-02
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	15.1	14.1	14.2
Wheat ash (12% mb)	1.64	1.70	1.76
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	75.9	73.8	73.0
Quadrumat Sr. Mill	73.9	71.0	71.0
Flour moisture (%)	13.2	12.1	12.7
Flour protein (14% mb)	13.8	12.9	12.6
Flour ash (14% mb)	0.49	0.47	0.52
Rapid Visco-Analyser			
Peak time (min)	6.2	6.2	6.3
Peak viscosity (RVU)	204.3	206.2	255.2
Breakdown (RVU)	57.8	65.1	88.0
Final viscosity at 13 min (RVU)	271.5	261.8	295.8
Minolta color meter			
L*	92.07	92.22	92.0492.33
a*	-2.23	-1.89	-2.13
b*	9.92	8.33	9.58
PPO	0.769	0.863	0.784
Falling number (sec)	505	454	467
Damaged Starch			
(AI%)	94.78	94.73	94.85
(AACC76-31)	5.37	5.33	5.42

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

South Dakota: Physical Dough Tests and Gluten Analysis For 2013 (Small-Scale) Samples

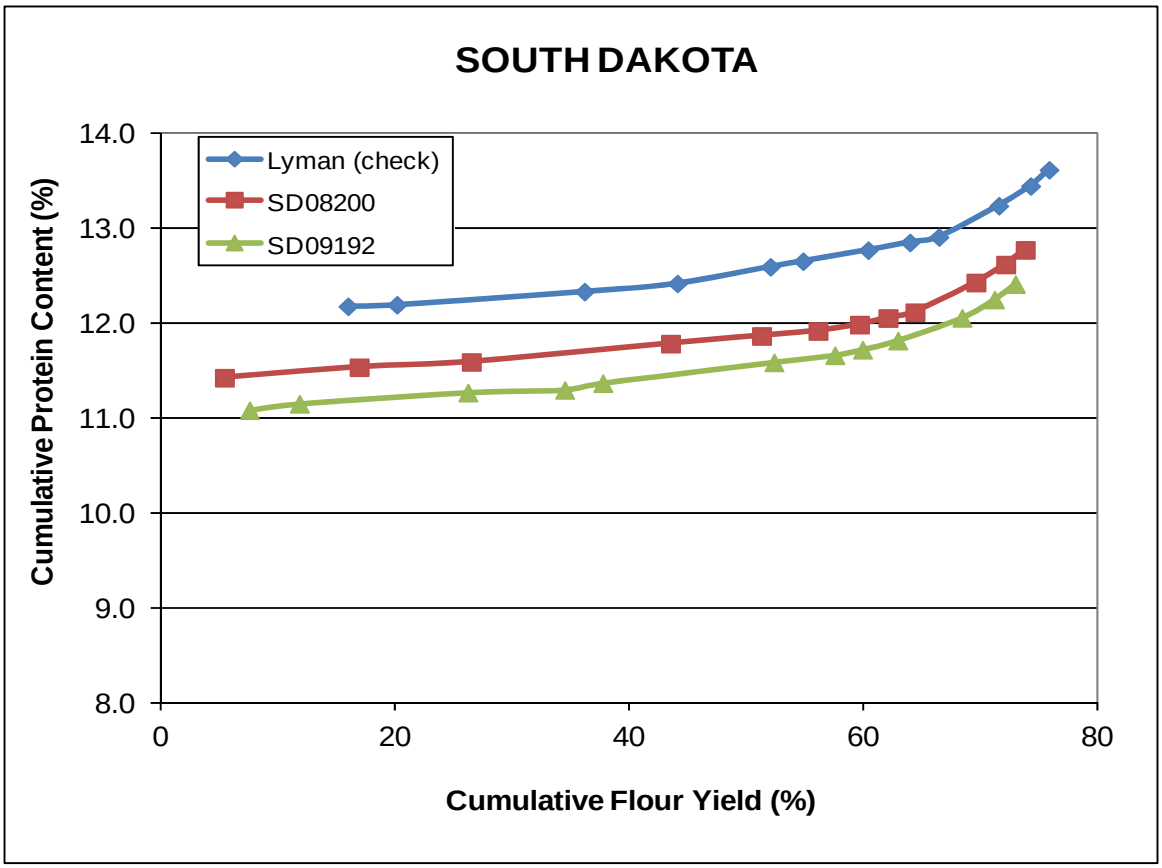
Test Entry Number	13-2407	13-2408	13-2409
Sample Identification	Lyman (check)	SD08200	SD09192
MIXOGRAPH			
Flour Abs (% as-is)	65.9	64.7	63.4
Flour Abs (14% mb)	64.9	62.5	61.9
Mix Time (min)	4.4	6.5	6.0
Mix tolerance (0-6)	4	4	5
FARINOGRAPH			
Flour Abs (% as-is)	60.7	57.6	57.4
Flour Abs (14% mb)	59.7	55.4	55.9
Development time (min)	8.3	9.9	8.7
Mix stability (min)	22.1	28.5	28.4
Mix Tolerance Index (FU)	7	5	12
Breakdown time (min)	24.2	30.0	30.0
ALVEOGRAPH			
P(mm): Tenacity	75	75	69
L(mm): Extensibility	169	124	126
G(mm): Swelling index	28.9	24.8	25.0
W(10^{-4} J): strength (curve area)	427	379	331
P/L: curve configuration ratio	0.44	0.60	0.55
Ie(P_{200}/P): elasticity index	65.7	72.5	66.7
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	372/585/686	660/1000/993	535/837/831
Extensibility (mm at 45/90/135 min)	160/154/156	153/140/144	160/147/132
Energy (cm^2 at 45/90/135 min)	111/168/203	192/204/208	175/204/174
Resist $_{max}$ (BU at 45/90/135min)	556/882/997	1000/1000/993	897/993/997
Ratio (at 45/90/135 min)	2.33/3.79/4.40	4.32/7.13/6.91	3.34/5.68/6.31
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+9, 5+10	2*, 7+9, 5+10
%IPP	45.62	47.20	48.73
SEDIMENTATION TEST			
Volume (ml)	65.4	68.0	68.0

South Dakota: Cumulative Ash Curves



Lyman (check)					SD08200					SD09192				
Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash
2M	16.04	0.33	16.04	0.33	1M Red	5.49	0.31	5.49	0.31	1M Red	4.26	0.36	4.26	0.36
1M Red	4.17	0.34	20.21	0.34	1M	9.58	0.32	15.08	0.32	2M	14.39	0.38	18.65	0.37
1M	7.93	0.36	28.14	0.34	2M	11.50	0.35	26.58	0.33	1M	8.27	0.44	26.92	0.39
3M	16.02	0.42	44.17	0.37	3M	17.01	0.41	43.59	0.36	3M	14.61	0.47	41.53	0.42
1BK	7.94	0.44	52.11	0.38	Grader	3.54	0.41	47.13	0.36	1BK	7.63	0.47	49.17	0.43
Grader	2.79	0.45	54.90	0.39	2BK	5.21	0.45	52.34	0.37	Grader	3.26	0.50	52.42	0.43
2BK	5.12	0.47	60.02	0.39	4M	4.82	0.53	57.15	0.39	2BK	5.48	0.51	57.90	0.44
4M	5.57	0.73	65.58	0.42	1BK	7.77	0.60	64.93	0.41	4M	5.20	0.54	63.10	0.45
FILTER FLR	3.56	0.79	69.14	0.44	FILTER FLR	2.44	0.73	67.37	0.42	FILTER FLR	2.36	0.69	65.46	0.46
3BK	2.71	0.81	71.85	0.45	3BK	2.54	0.76	69.91	0.44	3BK	2.77	0.80	68.24	0.47
5M	2.49	1.30	74.34	0.48	5M	2.30	1.00	72.21	0.45	5M	3.02	0.82	71.25	0.49
BRAN FLR	1.58	2.09	75.92	0.52	BRAN FLR	1.67	2.03	73.88	0.49	BRAN FLR	1.79	1.90	73.04	0.52
Filter Bran	1.31	2.51	77.23	0.55	Filter Bran	1.10	2.20	74.98	0.51	Filter Bran	1.10	2.12	74.13	0.54
Red Dog	1.80	3.38	79.03	0.61	Red Dog	2.22	3.22	77.20	0.59	Red Dog	2.67	2.74	76.81	0.62
Break Shorts	2.56	4.63	81.59	0.74	Break Shorts	3.05	4.73	80.26	0.75	Break Shorts	2.94	4.59	79.75	0.77
Red Shorts	0.44	4.66	82.03	0.76	Red Shorts	0.61	4.82	80.87	0.78	Red Shorts	0.69	4.88	80.44	0.80
Bran	17.97	5.79	100.00	1.67	Bran	19.13	6.08	100.00	1.79	Bran	19.56	5.87	100.00	1.79
Wheat		1.60					1.66					1.72		
St. Grd. Fl.		0.49					0.47					0.52		

South Dakota: Cumulative Protein Curves

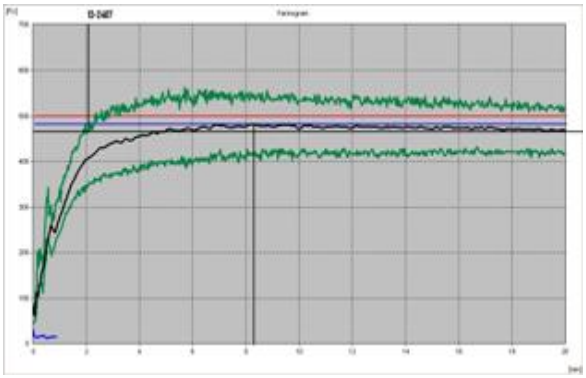


Lyman (check)					SD08200					SD09192				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
2M	16.04	12.18	16.04	12.18	1M Red	5.49	11.42	5.49	11.42	1BK	7.63	11.08	7.63	11.08
1M Red	4.17	12.25	20.21	12.19	2M	11.50	11.59	16.99	11.53	1M Red	4.26	11.27	11.89	11.15
3M	16.02	12.51	36.24	12.33	1M	9.58	11.69	26.58	11.59	2M	14.39	11.36	26.28	11.27
1M	7.93	12.80	44.17	12.42	3M	17.01	12.08	43.59	11.78	1M	8.27	11.38	34.55	11.29
1BK	7.94	13.57	52.11	12.59	1BK	7.77	12.32	51.36	11.86	Grader	3.26	12.12	37.81	11.37
Grader	2.79	13.75	54.90	12.65	4M	4.82	12.47	56.18	11.91	3M	14.61	12.15	52.42	11.58
4M	5.57	13.92	60.46	12.77	Grader	3.54	13.05	59.72	11.98	4M	5.20	12.41	57.62	11.66
FILTER FLR	3.56	14.21	64.02	12.85	FILTER FLR	2.44	13.75	62.16	12.05	FILTER FLR	2.36	13.16	59.98	11.72
5M	2.49	14.39	66.51	12.90	5M	2.30	13.78	64.46	12.11	5M	3.02	13.72	63.00	11.81
2BK	5.12	17.51	71.63	13.23	2BK	5.21	16.29	69.67	12.43	2BK	5.48	14.79	68.48	12.05
3BK	2.71	18.94	74.34	13.44	3BK	2.54	17.83	72.21	12.62	3BK	2.77	17.05	71.25	12.25
BRAN FLR	1.58	21.66	75.92	13.61	BRAN FLR	1.67	19.42	73.88	12.77	BRAN FLR	1.79	18.87	73.04	12.41
Break Shorts	2.56	17.96	78.48	13.75	Break Shorts	3.05	16.69	76.94	12.93	Break Shorts	2.94	16.63	75.97	12.57
Red Dog	1.80	16.67	80.28	13.82	Red Dog	2.22	16.01	79.15	13.01	Red Dog	2.67	16.15	78.65	12.69
Red Shorts	0.44	16.13	80.72	13.83	Red Shorts	0.61	15.65	79.77	13.03	Red Shorts	0.69	15.52	79.34	12.72
Filter Bran	1.31	14.74	82.03	13.85	Filter Bran	1.10	14.10	80.87	13.05	Filter Bran	1.10	13.31	80.44	12.73
Bran	17.97	17.70	100.00	14.54	Bran	19.13	17.43	100.00	13.88	Bran	19.56	16.31	100.00	13.43
Wheat		14.7					13.7					13.8		
St. Grd. Fl		13.8					12.9					12.6		

Physical Dough Tests

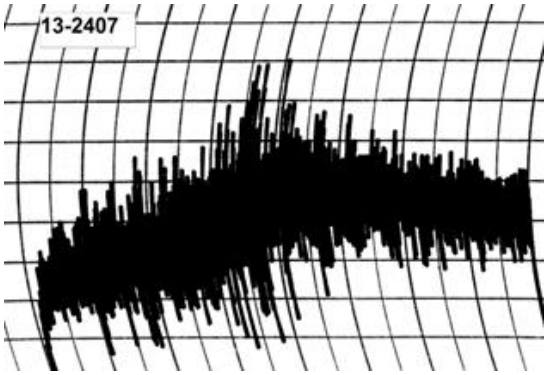
2013 (Small Scale) Samples - South Dakota

Farinograms



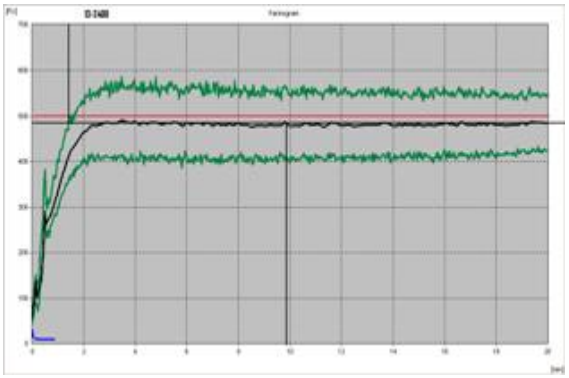
Water abs = 59.7%, Peak time = 8.3 min,
Mix stab = 22.1 min, MTI = 7 FU

Mixograms

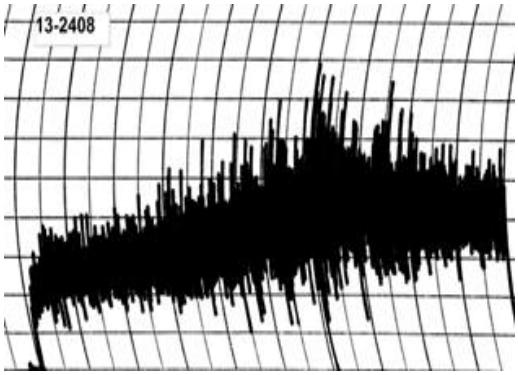


Water abs = 64.9%
Mix time = 4.4 min

13-2407, Lyman (check)



Water abs = 55.4%, Peak time = 9.9 min,
Mix stab = 28.5 min, MTI = 5 FU



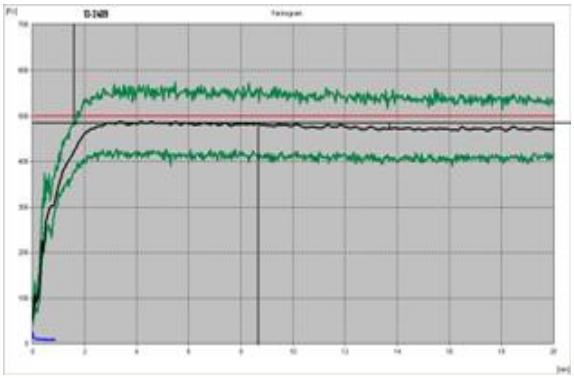
Water abs = 62.5%
Mix time = 6.5 min

13-2408, SD08200

Physical Dough Tests

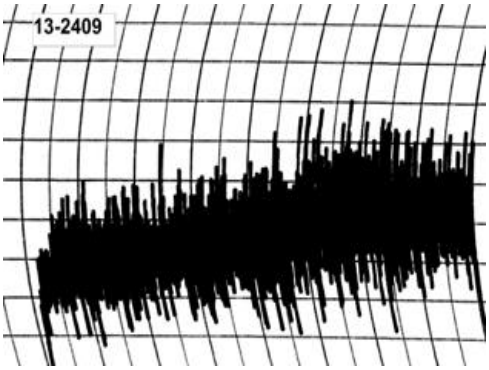
2013 (Small Scale) Samples - South Dakota (continued)

Farinograms



Water abs= 55.9%, Peak time = 8.7 min,
Mix stab = 28.4 min, MTI = 12 FU

Mixograms

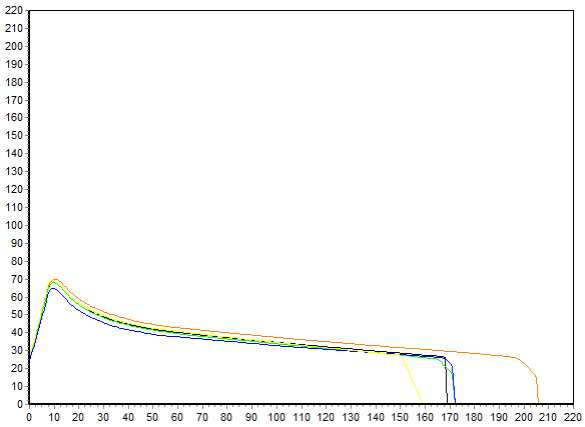


Water abs = 61.9%
Mix time = 6.0 min

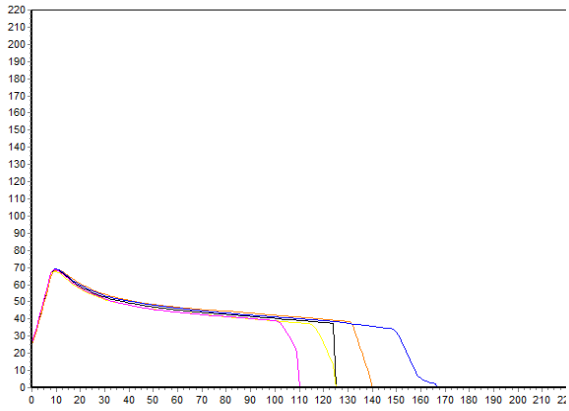
13-2409, SD09192

Physical Dough Tests - Alveograph

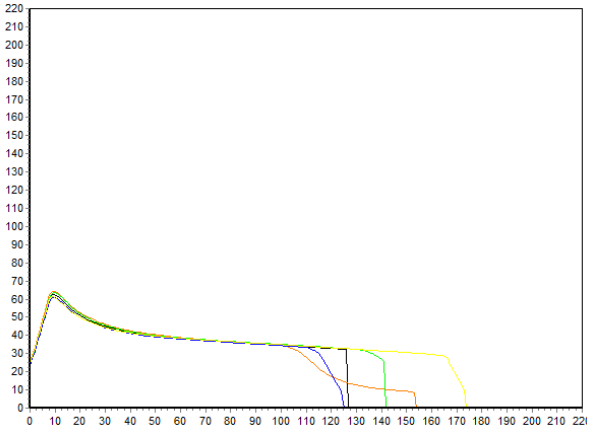
2013 (Small Scale) Samples – South Dakota



13-2407, Lyman (check)
P(mm H_20)=75, L(mm)=169, W(10E^{-4} J)=427



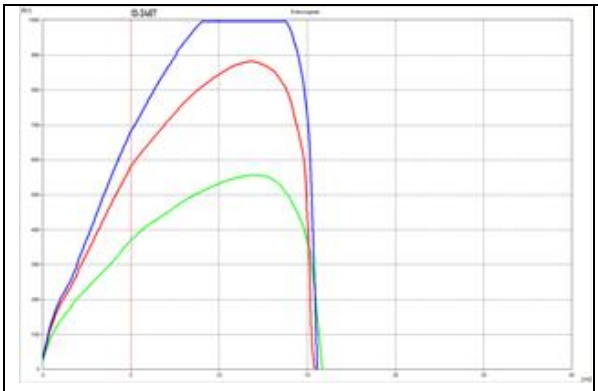
13-2408, SD08200
P(mm H_20)=75, L(mm)=124, W(10E^{-4} J)=379



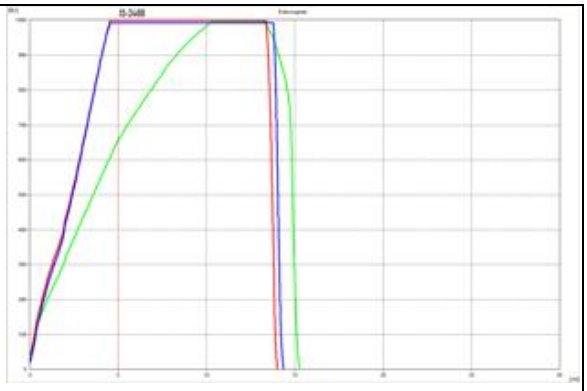
13-2409, SD09192
P(mm H_20)=69, L(mm)=126, W(10E^{-4} J)=331

Physical Dough Tests - Extensigraph

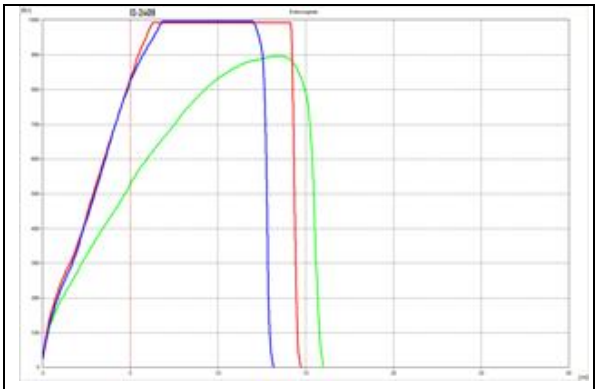
2013 (Small Scale) Samples – South Dakota



13-2407 Lyman (check)
R (BU) = 585, E (mm) =154, W (cm^2) = 168
Rmax (BU) = 882, Ratio = 3.8 at 90 min



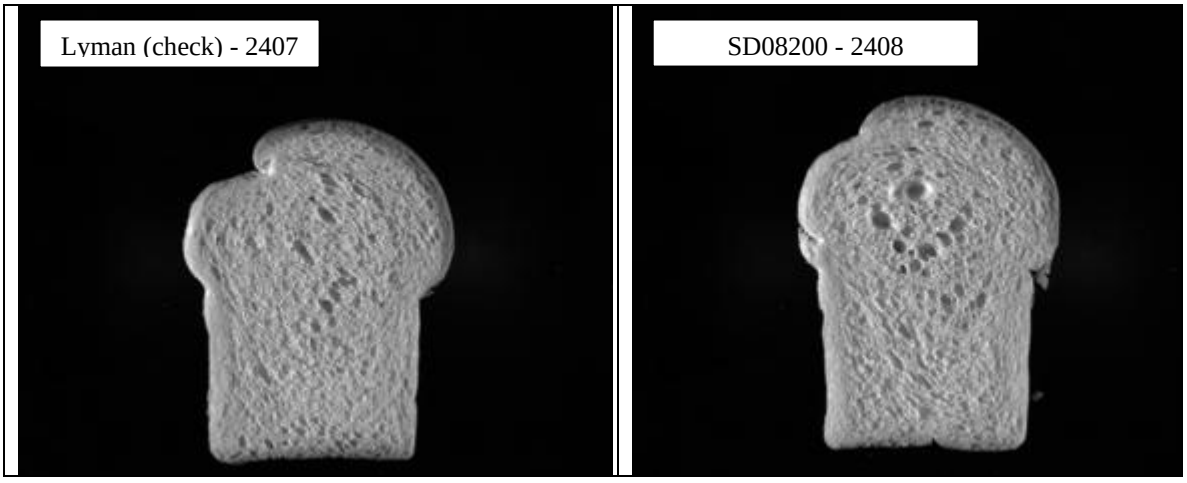
13-2408 SD08200
R (BU) = 1000, E (mm) =140, W (cm^2) = 204
Rmax (BU) = 1000, Ratio = 7.1 at 90 min



13-2409 SD09192
R (BU) = 837, E (mm) =147, W (cm^2) = 204
Rmax (BU) = 993, Ratio = 5.7 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

South Dakota: C-Cell Bread Images and Analysis for 2013 (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})
2407	6642	149.2	4445	0.432	1.900	0.803	1.683	-16.13
2408	6942	148.6	4401	0.442	1.974	6.947	1.690	-21.75

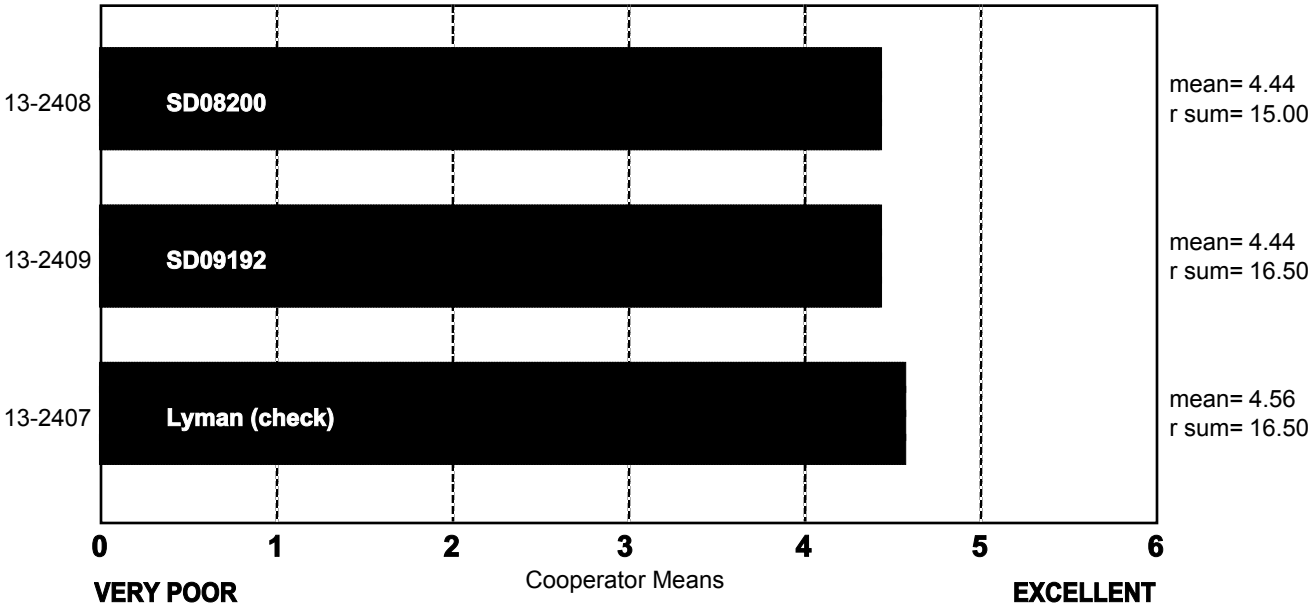
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2409	7507	146.4	4749	0.444	2.060	7.478	1.713	-28.50

SPONGE CHARACTERISTICS

(Small Scale) South Dakota

ncoop= 8
chisq= 0.19
chisqc= -0.32
cvchisq= 5.99
crdiff=

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

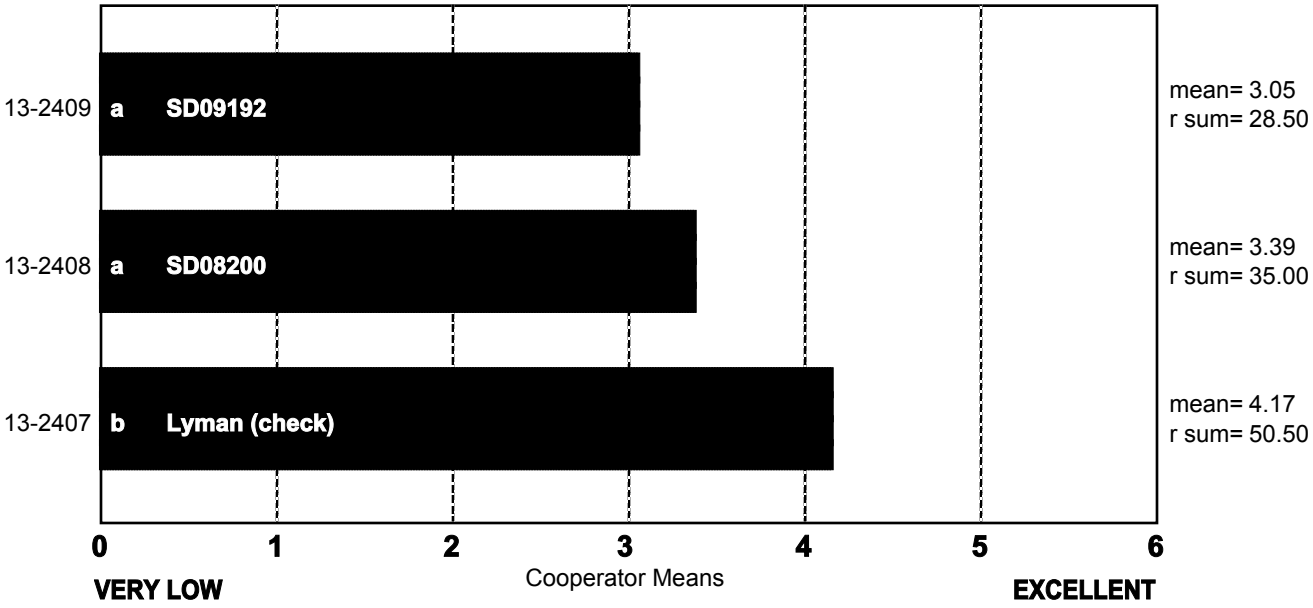


BAKE ABSORPTION

(Small Scale) South Dakota

ncoop= 19
chisq= 13.45
chisqc= 19.65
cvchisq= 5.99
crdiff= 7.38

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) 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	Coop. R	Coop. S
13-2407 Lyman (check)	**60.0**	**65.0**	**64.0**	**61.0**	**60.5**	**65.2**	**59.7**	**68.0**	**64.2**	**59.7**	**65.3**	**64.5**	**65.5**	**56.7**	**64.7**	**61.0**	**72.2**	**66.1**	**59.7**
13-2408 SD08200	**59.0**	**62.0**	**63.0**	**59.0**	**58.5**	**64.7**	**55.4**	**67.0**	**62.9**	**55.4**	**65.0**	**63.5**	**63.5**	**53.5**	**62.5**	**58.0**	**71.9**	**64.9**	**55.4**
13-2409 SD09192	**59.0**	**63.0**	**63.0**	**59.0**	**59.0**	**63.5**	**55.9**	**65.0**	**62.4**	**55.9**	**64.3**	**64.0**	**62.5**	**54.4**	**61.2**	**57.0**	**72.7**	**63.9**	**55.9**

BAKE MIX TIME, ACTUAL

(Small Scale) South Dakota

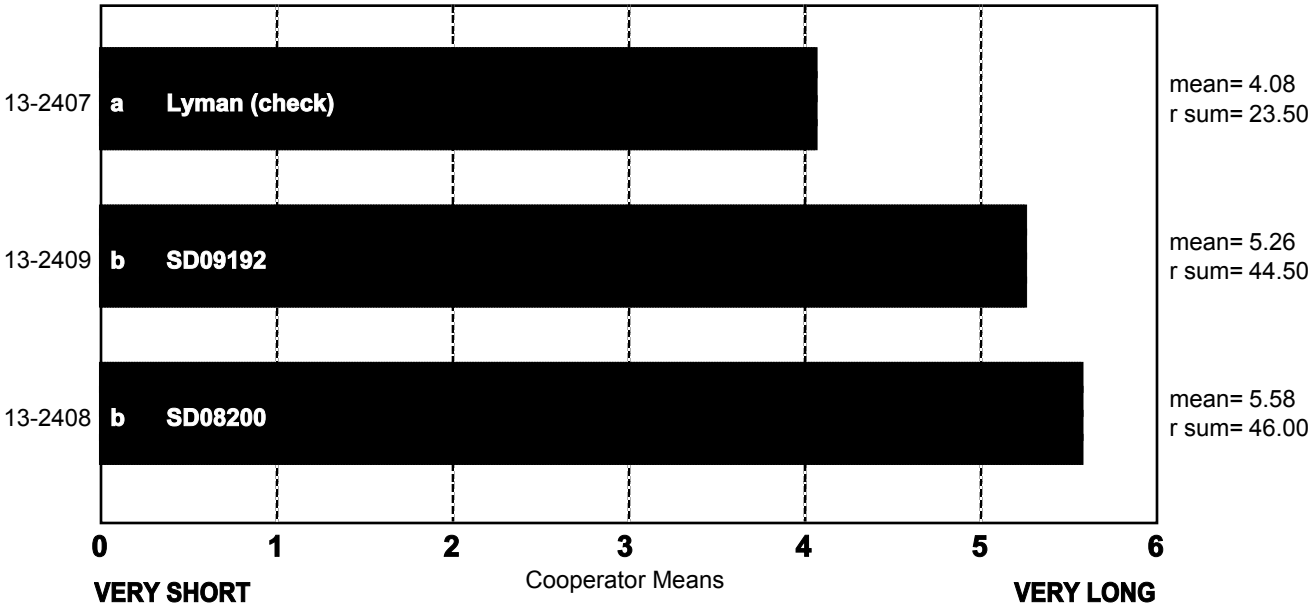
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2407 Lyman (check)	**20.0**	**12.0**	**6.0**	**25.0**	**30.0**	**4.5**	**7.0**	**4.3**	**3.5**	**10.0**	**4.0**	**5.8**	**3.8**	**1.8**	**5.5**	**8.0**	**4.6**	**4.4**	**12.0**
13-2408 SD08200	**20.0**	**60.0**	**9.0**	**25.0**	**30.0**	**7.3**	**8.0**	**8.0**	**6.2**	**17.0**	**5.0**	**9.8**	**5.0**	**3.8**	**11.0**	**14.0**	**10.6**	**6.5**	**15.0**
13-2409 SD09192	**20.0**	**60.0**	**9.0**	**25.0**	**30.0**	**7.3**	**8.0**	**4.0**	**6.3**	**16.0**	**5.3**	**9.7**	**5.1**	**3.5**	**10.0**	**19.0**	**8.4**	**6.5**	**15.0**

BAKE MIX TIME

(Small Scale) South Dakota

ncoop= 19
chisq= 16.66
chisqc= 23.02
cvchisq= 5.99
crdiff= 6.20

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

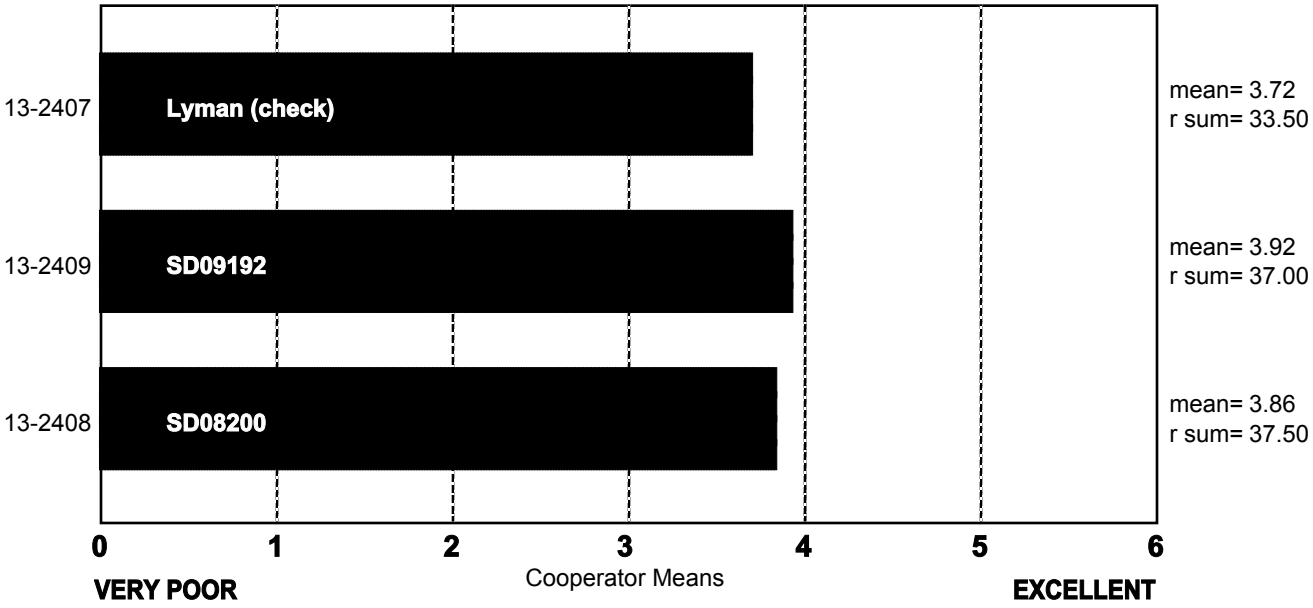


MIXING TOLERANCE

(Small Scale) South Dakota

ncoop= 18
chisq= 0.53
chisqc= 0.75
cvchisq= 5.99
crdiff=

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



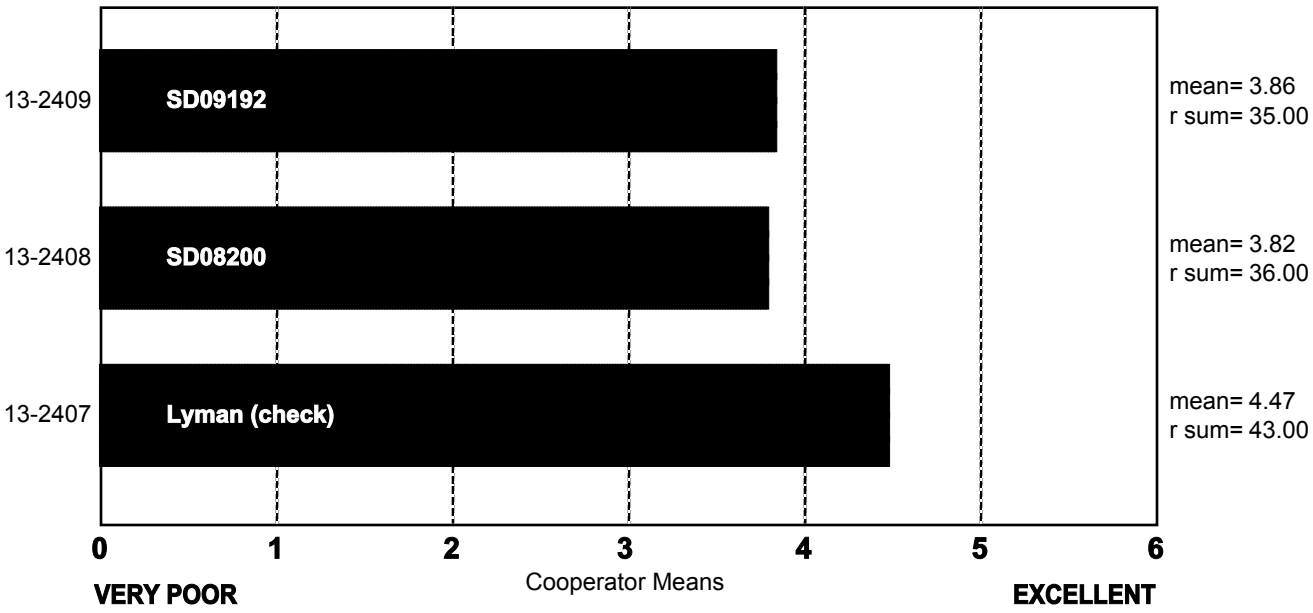
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) South Dakota

ncoop= 19
chisq= 2.00
chisqc= 3.17
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
13-2407 Lyman (check)	**1**	**2**	**3**	**8**	**5**
13-2408 SD08200	**1**	**0**	**10**	**5**	**3**
13-2409 SD09192	**0**	**0**	**10**	**4**	**5**

Frequency Table

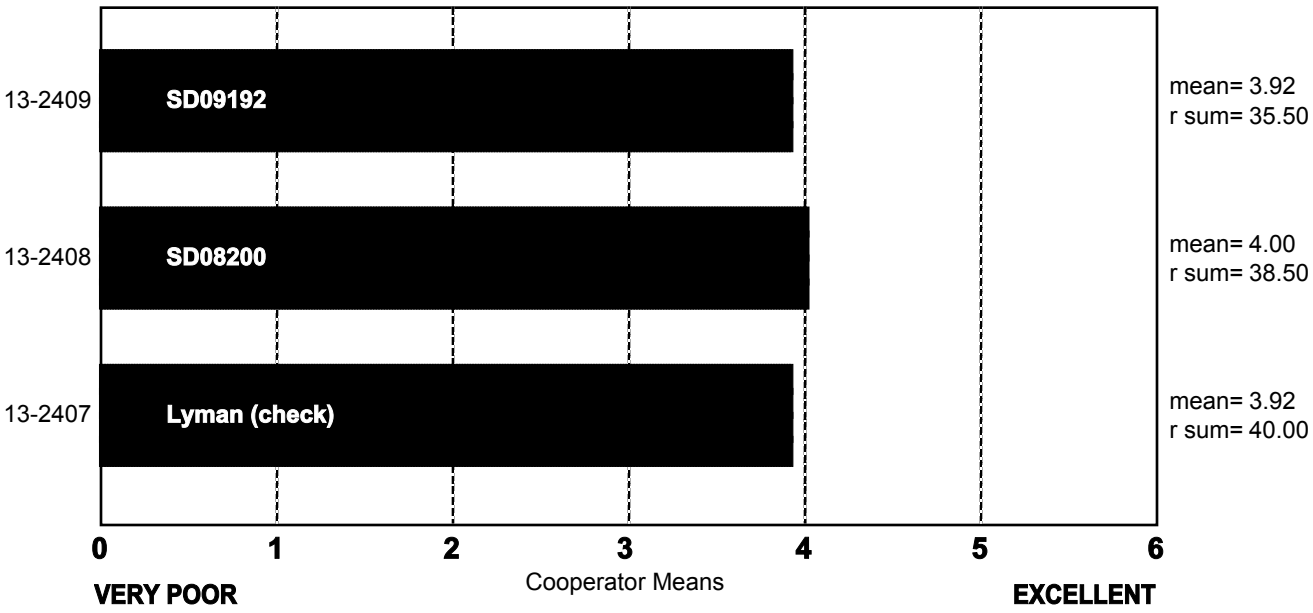
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) South Dakota

ncoop= 19
chisq= 0.55
chisqc= 0.95
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
13-2407 Lyman (check)	**0**	**2**	**4**	**11**	**2**
13-2408 SD08200	**0**	**0**	**11**	**4**	**4**
13-2409 SD09192	**1**	**0**	**10**	**5**	**3**

Frequency Table

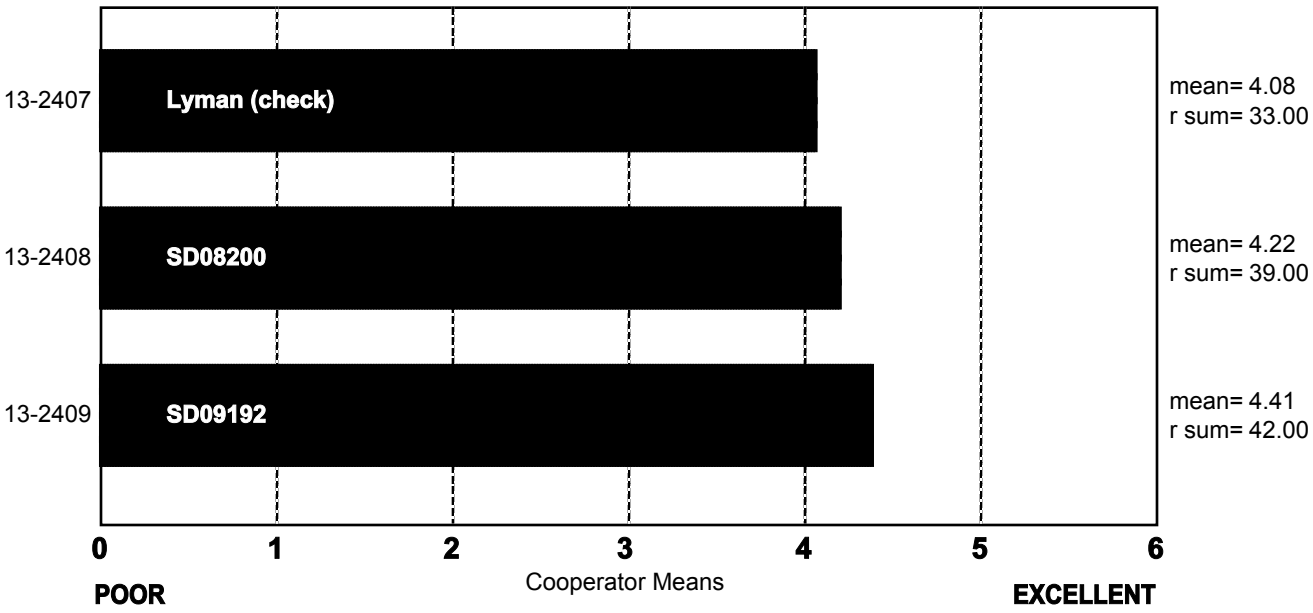
CRUMB GRAIN

(Small Scale) South Dakota

ncoop= 19
chisq= 2.21
chisqc= 3.17
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
13-2407 Lyman (check)	**8**	**9**	**2**
13-2408 SD08200	**8**	**8**	**3**
13-2409 SD09192	**8**	**11**	**0**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) South Dakota

	Round	Irregular	Elongated
13-2407 Lyman (check)	**2**	**11**	**6**
13-2408 SD08200	**3**	**10**	**6**
13-2409 SD09192	**2**	**5**	**12**

Frequency Table

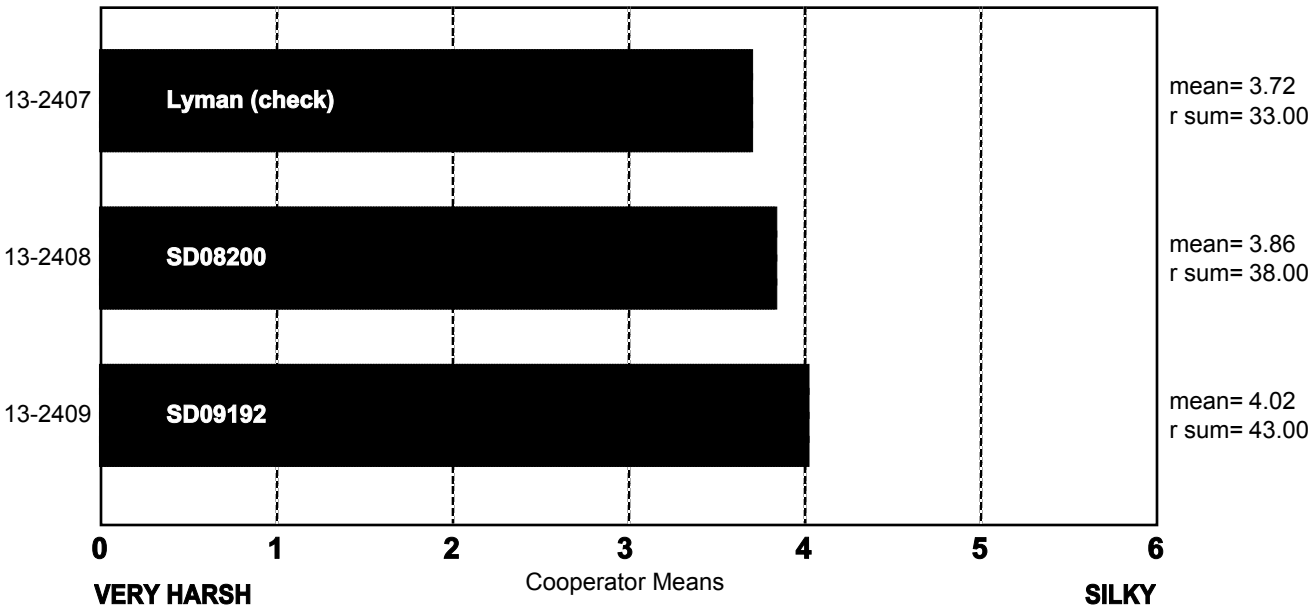
CRUMB TEXTURE

(Small Scale) South Dakota

ncoop= 19
chisq= 2.63
chisqc= 3.77
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
13-2407 Lyman (check)	**3**	**14**	**2**
13-2408 SD08200	**3**	**12**	**4**
13-2409 SD09192	**4**	**11**	**4**

Frequency Table

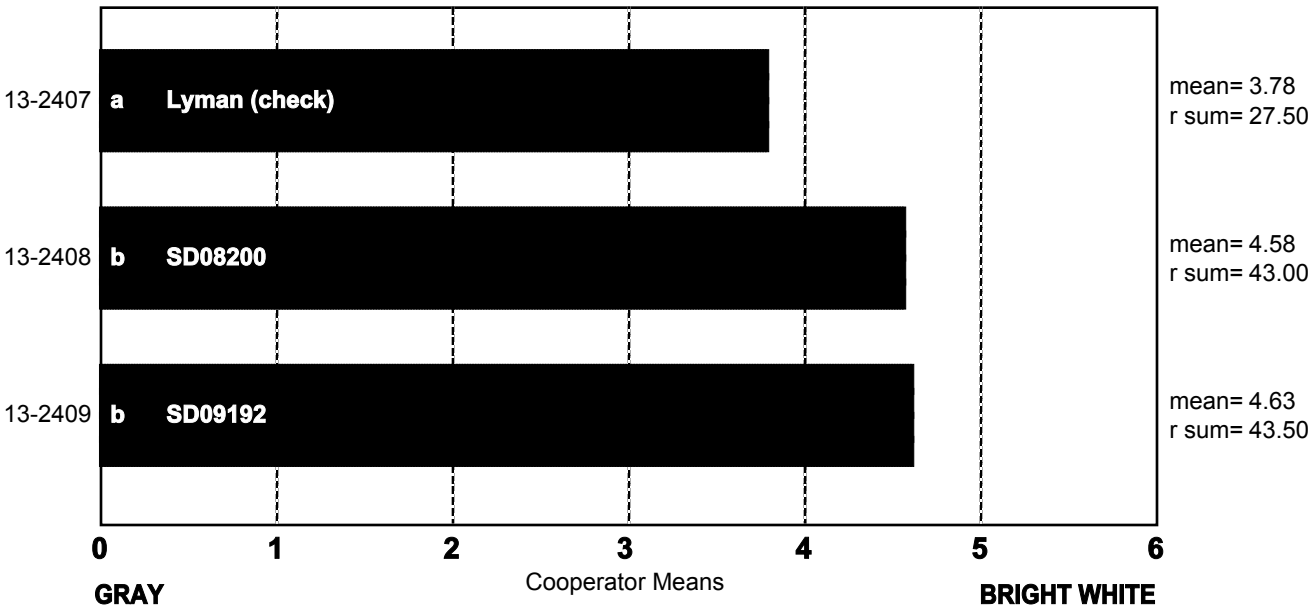
CRUMB COLOR

(Small Scale) South Dakota

ncoop= 19
chisq= 8.71
chisqc= 12.98
cvchisq= 5.99
crdiff= 8.54

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
13-2407 Lyman (check)	**0**	**0**	**1**	**2**	**13**	**3**	**0**
13-2408 SD08200	**0**	**0**	**0**	**2**	**7**	**7**	**3**
13-2409 SD09192	**0**	**0**	**0**	**1**	**7**	**9**	**2**

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	Coop. R	Coop. S
13-2407 Lyman (check)	**410.0**	**461.5**	**130.0**	**488.5**	**466.6**	**144.7**	**464.0**	**137.9**		**456.0**	**131.4**	**144.3**		**131.3**	**151.8**	**484.6**	**157.1**	**140.0**	**444.5**
13-2408 SD08200	**413.0**	**467.4**	**130.0**	**488.1**	**456.6**	**143.7**	**471.0**	**136.7**		**457.5**	**129.5**	**140.5**		**124.5**	**147.6**	**482.0**	**152.5**	**139.6**	**456.0**
13-2409 SD09192	**411.0**	**466.8**	**130.0**	**492.1**	**464.5**	**141.3**	**468.0**	**139.1**		**452.0**	**128.5**	**140.3**		**126.6**	**145.4**	**487.8**	**152.0**	**137.8**	**457.5**

LOAF VOLUME, ACTUAL

(Small Scale) South Dakota

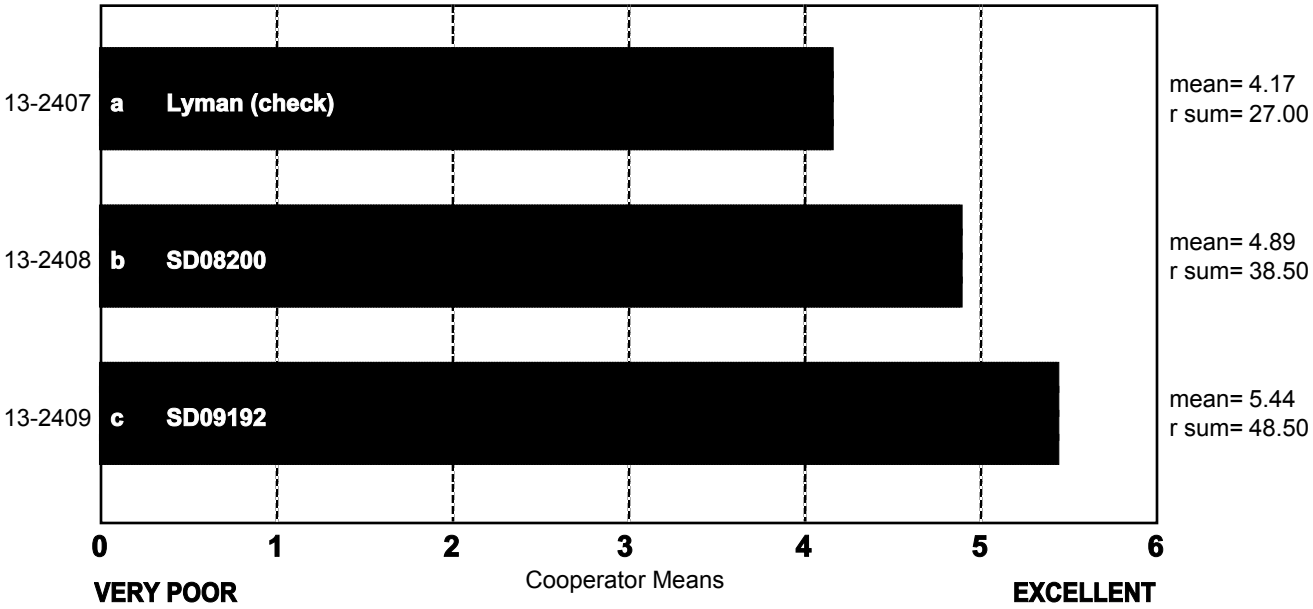
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2407 Lyman (check)	**3100**	**2663**	**1025**	**3045**	**2625**	**980**	**2950**	**1078**	**975**	**2500**	**955**	**898**	**930**	**760**	**915**	**2613**	**1125**	**824**	**2675**
13-2408 SD08200	**3100**	**2725**	**1015**	**3045**	**2700**	**1190**	**2725**	**1095**	**1300**	**2500**	**990**	**939**	**1030**	**850**	**955**	**2600**	**1030**	**906**	**2475**
13-2409 SD09192	**3100**	**3025**	**1040**	**3104**	**2725**	**1255**	**2725**	**1148**	**1250**	**2700**	**905**	**954**	**1025**	**845**	**1005**	**2788**	**1135**	**967**	**2550**

LOAF VOLUME

(Small Scale) South Dakota

ncoop= 19
chisq= 12.18
chisqc= 17.81
cvchisq= 5.99
crdiff= 7.74

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

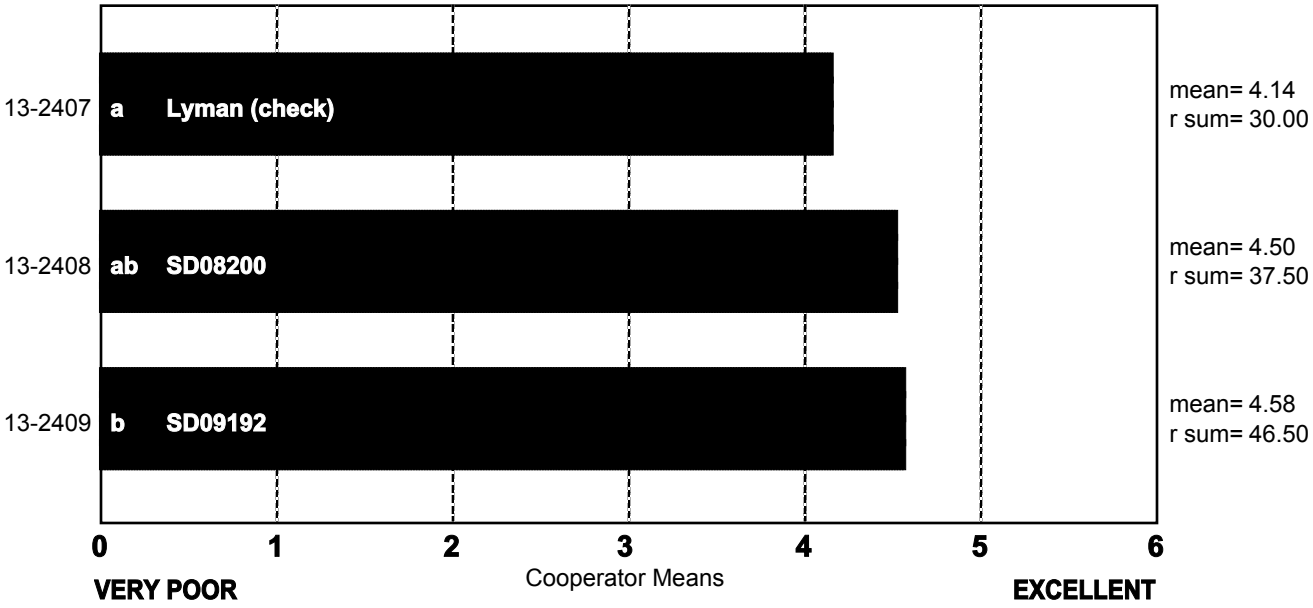


OVERALL BAKING QUALITY

(Small Scale) South Dakota

ncoop= 19
chisq= 7.18
chisqc= 8.95
cvchisq= 5.99
crdiff= 10.06

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. **13-2407 Lyman (check)**

A. Very tough dough, excellent volume, very open grain, slightly dull interior, harsh.
B. High absorption, above average mix, above average volume, creamy crumb, good grain.
C. Strong, large volume, excellent baking performance.
D. Very strong dough, slightly open, irregular grain, very good volume.
E. No comment.
F. No comment.
G. Very good.
H. No comment.
I. No comment.
J. Good dough, good volume and grain rating.
K. No comment.
L. Normal absorption & mix time, slight sticky & strong dough, much higher OS & volume, creamy crumb, slightly open & elongated cells, smooth & resilient texture.
M. Excellent protein, acceptable to poor baking.
N. Tacky during mixing; short mixer. At panning, nice moisture, no gas, pliable/weak, limp dough.
O. Best set; good flour protein, good absorption, long mix time, satisfactory crumb grain, creamy crumb color, good loaf volume.
P. Excellent dough, good grain, good volume.
Q. Nice overall performance and very good crumb grain.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. Break and shred.

COOP. **13-2408 SD08200**

A. Very tough dough, excellent volume, very open grain, slightly dull interior, harsh.
B. Slightly above average absorption, extremely long mix, high volume, bright white, fine grain.
C. Underdeveloped, good crumb, white, excellent mix tolerance, excellent baking performance.
D. Farinograph absorption was low, slightly open, variable grain, very good volume.
E. No comment.
F. No comment.
G. Very good.
H. No comment.
I. No comment.
J. Low absorption, good dough, good volume with a dense grain rating, white in color.
K. Good color.
L. Normal absorption, much longer mix time, slight sticky & strong dough, much higher OS & volume, creamy crumb, fine & elongated cells, silky & resilient texture.
M. Good protein, longer mixing, baked well with bright color.
N. Smooth rubbery dough, slightly tough at mixing. At panning dough had nice moisture, little gas, was elastic/pliable. Poor moulding, larger loaf volume.

O. Good flour protein, long mix time, excellent at pan, excellent crumb grain, creamy color, good loaf volume, rated higher than the check.
P. Low absorption, tolerant to mixing, tough dough, good grain, good volume.
Q. Great dough strength and overall good performance.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. Break and shred.

COOP. 13-2409 SD09192

A. Very tough dough, excellent volume, very open grain, slightly dull interior, harsh.
B. Slightly above average absorption, extremely long mix, very high volume, bright white, slightly open grain.
C. Underdeveloped, good crumb, white, excellent mix tolerance, excellent baking performance. Best of the set.
D. Good crumb color, tight, consistent grain, and excellent volume.
E. No comment.
F. Huge loaf!
G. No comment.
H. No comment.
I. No comment.
J. Low absorption, dough was bucky, excellent volume with a good grain rating, white in color.
K. Fair crumb.
L. Normal absorption, much longer mix time, slightly sticky & strong dough, much higher OS & volume, creamy crumb, slightly open & elongated cells, smooth & resilient texture.
M. Good protein, longer mixing, baked well with good color.
N. At mixing dough was moist at first but then felt tough and dry at the end (slow water uptake?). At panning dough had nice moisture, little gas, elastic/pliable with body. Poor moulding, larger loaf volume.
O. Good flour protein, long mix time, excellent at pan, excellent crumb grain, creamy color, good loaf volume, rated higher than the check.
P. Very low absorption, long mix time, very tolerant to mixing, tough dough, very fine grain, silky, white crumb, high volume. Overall nice sample.
Q. Great overall performance. BEST OF SHOW.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. Break and shred.

Notes: **A, B, C, D, E, J, P and S** conducted sponge and dough bake tests

AGRIPRO

13-2410	Postrock (check)
13-2411	04BC574-2

Description of Test Plots and Breeder Entries

Agripro - Jon Rich

Postrock(check)

It is a hard red winter wheat adapted to Kansas and southern Nebraska. Postrock was released in 2006. Postrock was on 8% of the acres in Kansas in 2010. In 2013 it was on 4% of the acres. We continue to use Postrock as a check because it has above average protein concentration with good milling and baking properties.

04BC574-2

04BC574-2 is a hard red winter wheat that was developed from the cross BC991149-11/00x0090-4. The single cross was made in the Spring of 2004. BC991149-11 is an experimental line developed at Kansas State University from the cross KS89180B-2-1-1/CM75113,F1//X920750-A-11-2. 00x0090-4 is an Agripro experimental line developed from the cross W95-091/W98-183. Both W95-091 and W98-183 are Agripro experimental lines. 04BC574-2 is best adapted to the western hi-plains of Kansas, Colorado, Nebraska, Oklahoma and Texas. 04BC574-2 has a very good disease resistant package. 04BC574-2 is moderately resistant to both leaf and stripe rust. 04BC574-2 has SBMV and BYDV resistance and has also shown to do very well in low Ph situations. It is a later maturing line averaging about 1-2 days later than Jagalene. This line is currently being tested in Syngenta Cereals yield trials as well as State performance trials. If testing goes as planned certified seed would be available in the Fall of 2015.

04BC574-2 has acceptable protein levels. This is a long mixing, strong gluten line that bakes very well. Crumb grain is very good as well as color and texture.

Agripro: 2013 (Small-Scale) Samples

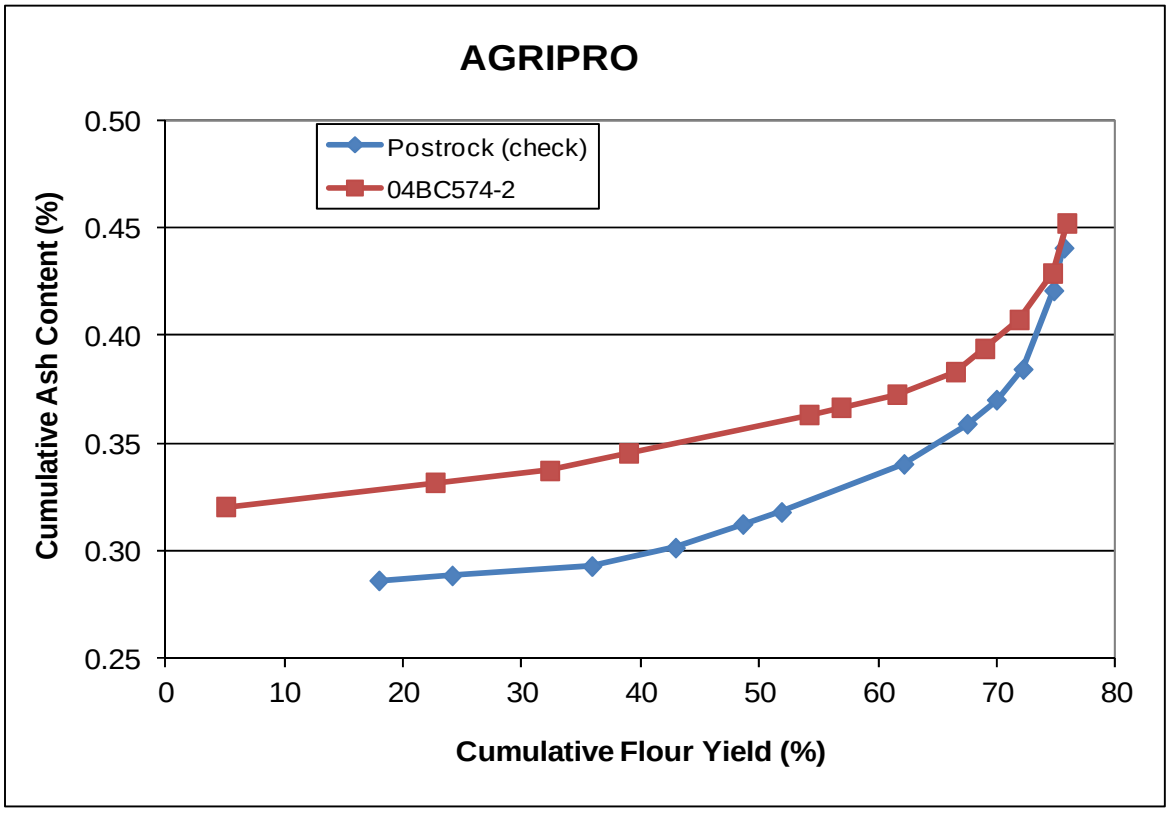
Test entry number	13-2410	13-2411
Sample identification	**Postrock (check)**	**04BC574-2**
Wheat Data		
GIPSA classification	1 HRW	1 HRW
Test weight (lb/bu)	61.5	61.2
Hectoliter weight (kg/hl)	80.9	80.5
1000 kernel weight (gm)	29.2	32.2
Wheat kernel size (Rotap)		
Over 7 wire (%)	73.2	85.7
Over 9 wire (%)	26.8	14.3
Through 9 wire (%)	0.0	0.0
Single kernel (skcs)[a]		
Hardness (avg /s.d)	50.9/15.0	66.4/15.3
Weight (mg) (avg/s.d)	29.2/5.8	32.2/5.3
Diameter (mm)(avg/s.d)	2.75/0.25	2.80/0.28
Moisture (%) (avg/s.d)	10.1/0.4	10.5/0.3
SKCS distribution	09-31-32-28-02	02-05-24-69-01
Classification	Hard	Hard
Wheat protein (12% mb)	13.4	12.8
Wheat ash (12% mb)	1.48	1.44
Milling and Flour Quality Data		
Flour yield (%, str. grade)		
Miag Multomat Mill	75.7	75.9
Quadrumat Sr. Mill	72.9	74.2
Flour moisture (%)	12.2	12.5
Flour protein (14% mb)	12.0	11.2
Flour ash (14% mb)	0.42	0.44
Rapid Visco-Analyser		
Peak time (min)	6.1	6.2
Peak viscosity (RVU)	218.4	221.0
Breakdown (RVU)	63.2	60.8
Final viscosity at 13 min (RVU)	288.4	292.2
Minolta color meter		
L*	92.76	92.66
a*	-2.29	-2.23
b*	10.01	9.94
PPO	0.521	0.357
Falling number (sec)	442	501
Damaged Starch		
(AI%)	94.40	95.85
(AACC76-31)	5.10	6.16

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

Agripro: Physical Dough Tests and Gluten Analysis For 2013 (Small-Scale) Samples

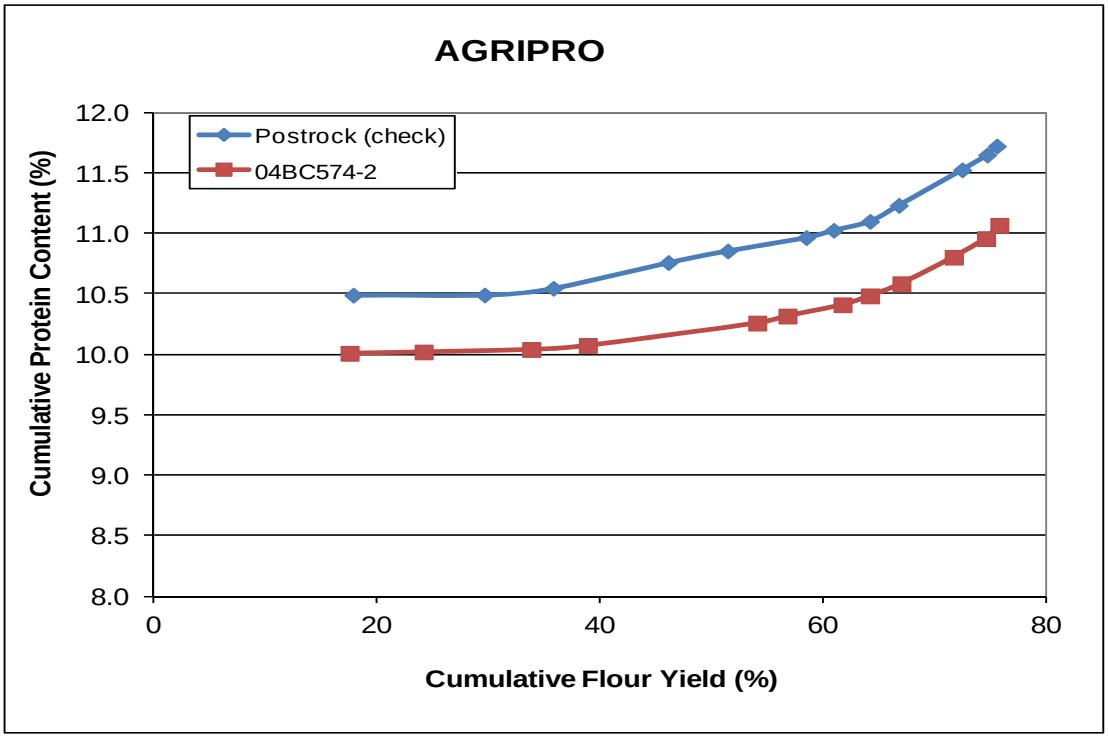
Test Entry Number	13-2410	13-2411
Sample Identification	Postrock (check)	04BC574-2
MIXOGRAPH		
Flour Abs (% as-is)	60.9	62.4
Flour Abs (14% mb)	58.9	60.6
Mix Time (min)	2.9	9.0
Mix tolerance (0-6)	1	5
FARINOGRAPH		
Flour Abs (% as-is)	57.8	59.4
Flour Abs (14% mb)	55.7	57.7
Development time (min)	5.0	2.9
Mix stability (min)	12.1	16.2
Mix Tolerance Index (FU)	32	245
Breakdown time (min)	10.0	8.6
ALVEOGRAPH		
P(mm): Tenacity	38	97
L(mm): Extensibility	218	79
G(mm): Swelling index	32.9	19.8
W(10^{-4} J): strength (curve area)	230	332
P/L: curve configuration ratio	0.17	1.23
Ie(P_{200}/P): elasticity index	57.8	73.1
EXTENSIGRAPH		
Resist (BU at 45/90/135 min)	234/312/329	702/991/987
Extensibility (mm at 45/90/135 min)	178/182/183	125/104/88
Energy (cm^2 at 45/90/135 min)	84/116/122	142/138/111
Resist $_{max}$ (BU at 45/90/135min)	355/493/516	934/991/988
Ratio (at 45/90/135 min)	1.32/1.71/1.80	5.64/9.53/11.27
PROTEIN ANALYSIS		
HMW-GS Composition	2*, 7+8, 5+10	2*, 7+8, 5+10
%IPP	42.55	61.03
SEDIMENTATION TEST		
Volume (ml)	49.5	58.0

Agripro: Cumulative Ash Curves



Postrock (check)					04BC574-2				
Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash
2M	17.96	0.29	17.96	0.29	1M Red	5.06	0.32	5.06	0.32
1M Red	6.16	0.30	24.12	0.29	2M	17.63	0.33	22.69	0.33
1M	11.76	0.30	35.88	0.29	1M	9.64	0.35	32.33	0.34
1BK	7.04	0.35	42.92	0.30	1BK	6.64	0.39	38.97	0.35
2BK	5.67	0.40	48.59	0.31	3M	15.19	0.41	54.16	0.36
Grader	3.25	0.40	51.84	0.32	Grader	2.70	0.43	56.86	0.37
3M	10.31	0.45	62.15	0.34	2BK	4.70	0.45	61.56	0.37
4M	5.32	0.58	67.47	0.36	4M	4.93	0.51	66.49	0.38
FILTER FLR	2.46	0.68	69.93	0.37	FILTER FLR	2.46	0.68	68.96	0.39
3BK	2.24	0.83	72.17	0.38	3BK	2.89	0.73	71.85	0.41
5M	2.59	1.44	74.76	0.42	5M	2.82	0.98	74.66	0.43
BRAN FLR	0.86	2.15	75.63	0.44	BRAN FLR	1.19	1.90	75.86	0.45
Break Shorts	2.58	3.96	78.21	0.56	Break Shorts	2.33	3.87	78.19	0.55
Red Dog	2.22	2.71	80.43	0.62	Red Dog	1.95	2.58	80.14	0.60
Red Shorts	0.36	4.11	80.78	0.63	Red Shorts	0.30	4.29	80.44	0.62
Filter Bran	1.30	2.15	82.08	0.66	Filter Bran	1.79	1.63	82.22	0.64
Bran	17.92	5.46	100.00	1.52	Bran	17.78	5.01	100.00	1.42
Wheat		1.45					1.41		
St. Grd. Fl.		0.42					0.44		

Agripro: Cumulative Protein Curves

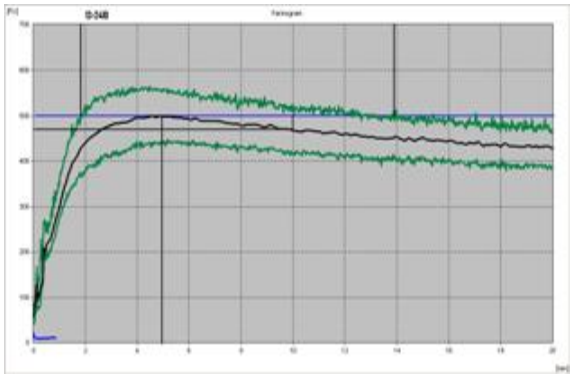


Postrock (check)					04BC574-2				
Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein	Mill Streams	Strm-yld (14%mb)	Protein	Cumulative (14%) Yield	Protein
2M	17.96	10.49	17.96	10.49	2M	17.63	10.01	17.63	10.01
1M	11.76	10.49	29.72	10.49	1BK	6.64	10.05	24.27	10.02
1M Red	6.16	10.81	35.88	10.55	1M	9.64	10.09	33.91	10.04
3M	10.31	11.50	46.19	10.76	1M Red	5.06	10.29	38.97	10.07
4M	5.32	11.69	51.51	10.86	3M	15.19	10.74	54.16	10.26
1BK	7.04	11.78	58.55	10.97	Grader	2.70	11.48	56.86	10.32
FILTER FLR	2.46	12.46	61.01	11.03	4M	4.93	11.48	61.80	10.41
Grader	3.25	12.48	64.26	11.10	FILTER FLR	2.46	12.32	64.26	10.48
5M	2.59	14.52	66.85	11.23	5M	2.82	12.89	67.08	10.59
2BK	5.67	14.98	72.52	11.53	2BK	4.70	13.93	71.77	10.80
3BK	2.24	15.65	74.76	11.65	3BK	2.89	14.78	74.66	10.96
BRAN FLR	0.86	18.06	75.63	11.72	BRAN FLR	1.19	17.94	75.86	11.07
Break Shorts	2.58	16.86	78.21	11.89	Break Shorts	2.33	16.05	78.19	11.22
Red Dog	2.22	15.70	80.43	12.00	Red Dog	1.95	15.19	80.14	11.31
Red Shorts	0.36	15.60	80.78	12.01	Red Shorts	0.30	15.69	80.44	11.33
Filter Bran	1.30	14.45	82.08	12.05	Filter Bran	1.79	12.66	82.22	11.36
Bran	17.92	17.78	100.00	13.08	Bran	17.78	15.83	100.00	12.15
Wheat		13.1					12.5		
St. Grd. Fl		12.0					11.2		

Physical Dough Tests

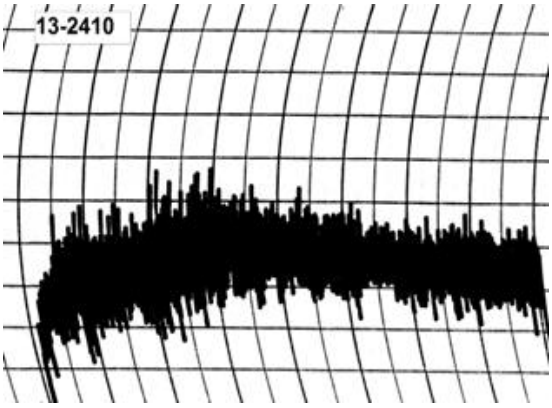
2013 (Small Scale) Samples - Agripro

Farinograms



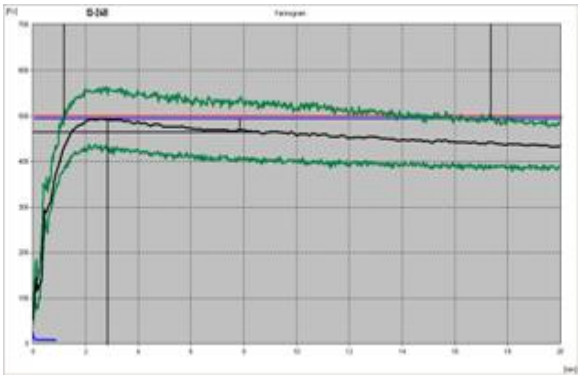
Water abs = 55.7%, Peak time = 5.0 min,
Mix stab = 12.1 min, MTI = 32 FU

Mixograms

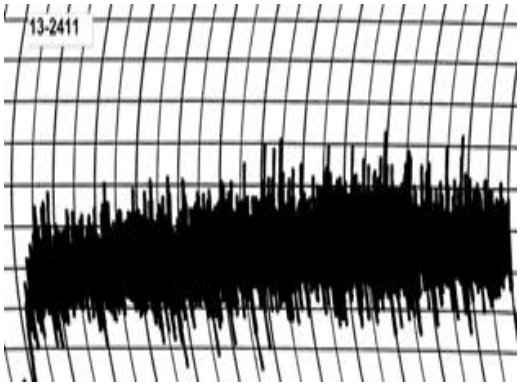


Water abs = 58.9%
Mix time = 2.9 min

13-2410, Postrock (check)



Water abs = 57.7%, Peak time = 2.9 min,
Mix stab = 16.2 min, MTI = 25 FU

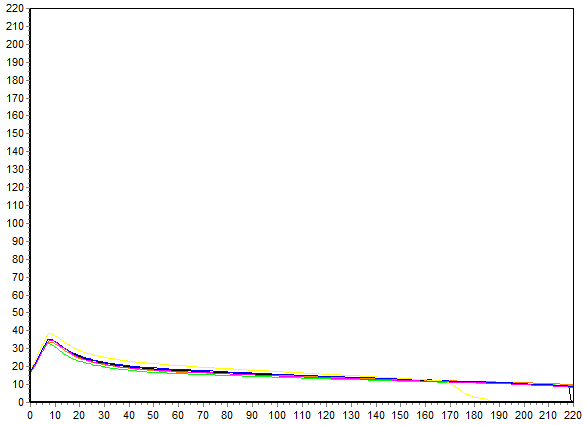


Water abs = 60.6%
Mix time = 9.0 min

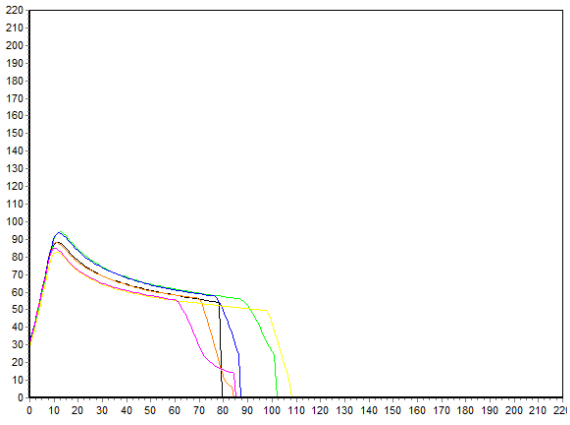
13-2411, 04BC574-2

Physical Dough Tests - Alveograph

2013 (Small Scale) Samples – Agripro



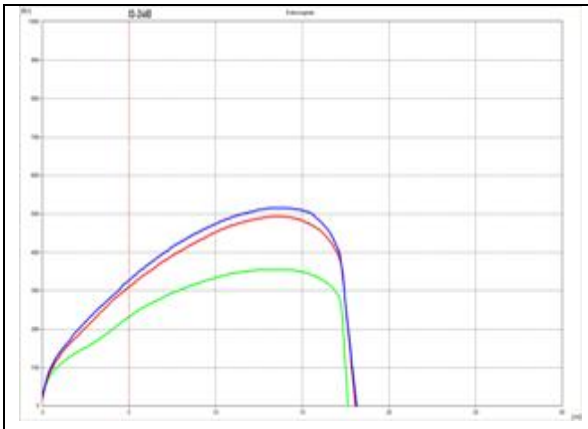
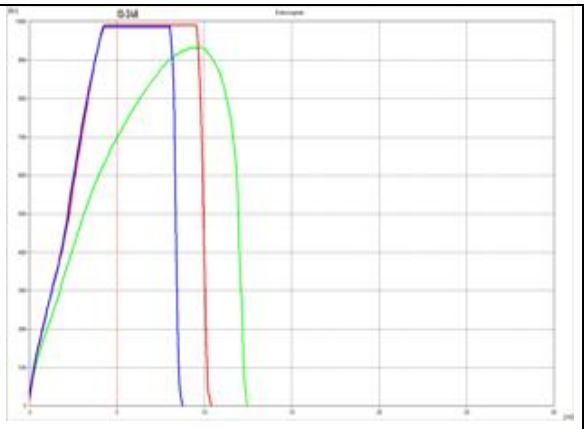
13-2410, Postrock (check)
P(mm H_20)=38, L(mm)=218, W($10E^{-4}$ J)=230



13-2411, 04BC574-2
P(mm H_20)=97, L(mm)=79, W($10E^{-4}$ J)=332

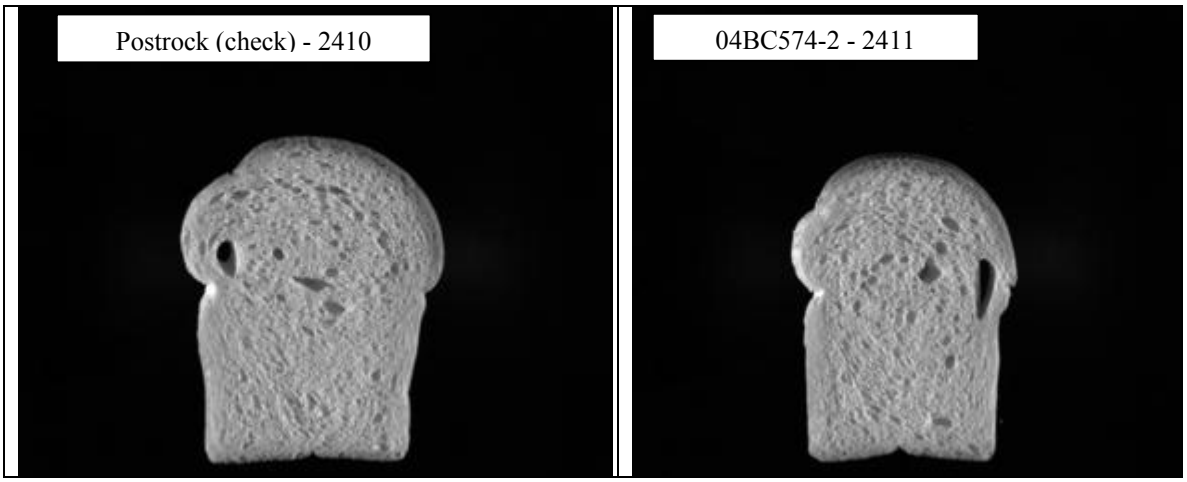
Physical Dough Tests - Extensigraph

2013 (Small Scale) Samples – Agripro

	
13-2410, Postrock (check) R (BU) = 312, E (mm) =182, W (cm^2) = 116 Rmax (BU) = 493, Ratio = 1.71 at 90 min	**13-2411, 04BC574-2** R (BU) = 991, E (mm) =104, W (cm^2) = 138 Rmax (BU) = 991, Ratio = 9.53 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Agripro: C-Cell Bread Images and Analysis for 2013 (Small-Scale) Samples



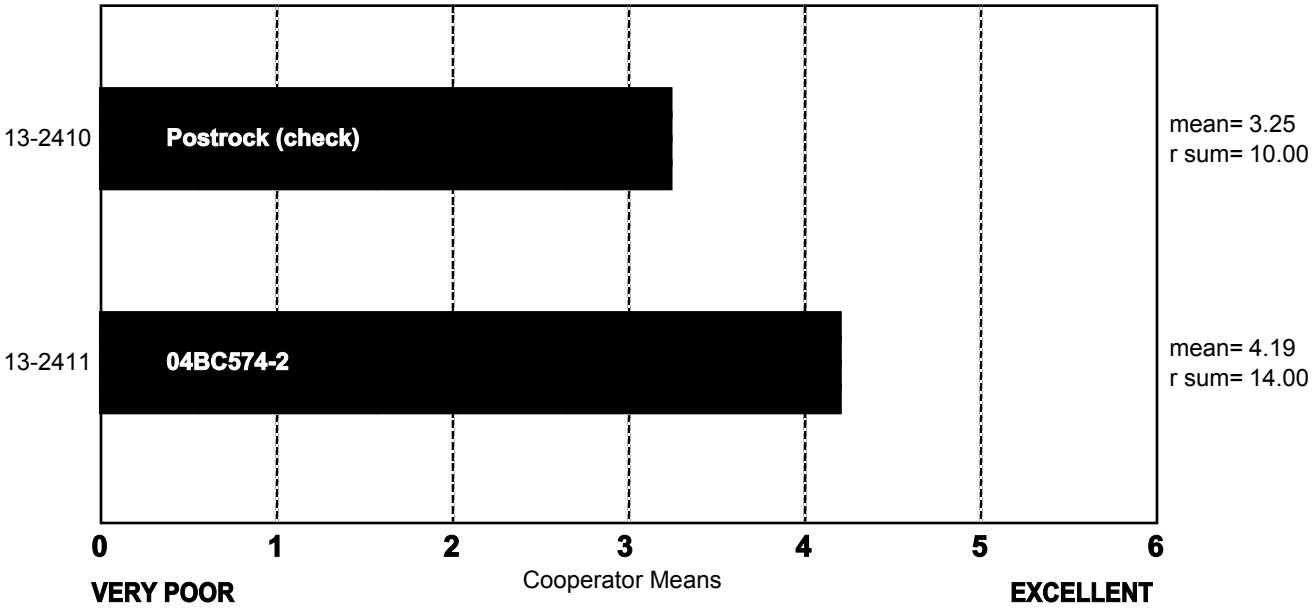
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2410	6222	151.3	4885	0.425	1.787	7.678	1.640	-22.70
2411	5882	151.6	4125	0.430	1.740	8.526	1.663	-23.05

SPONGE CHARACTERISTICS

(Small Scale) Agripro

ncoop= 8
chisq= 2.00
chisqc= -5.33
cvchisq= 3.84
crdiff=

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

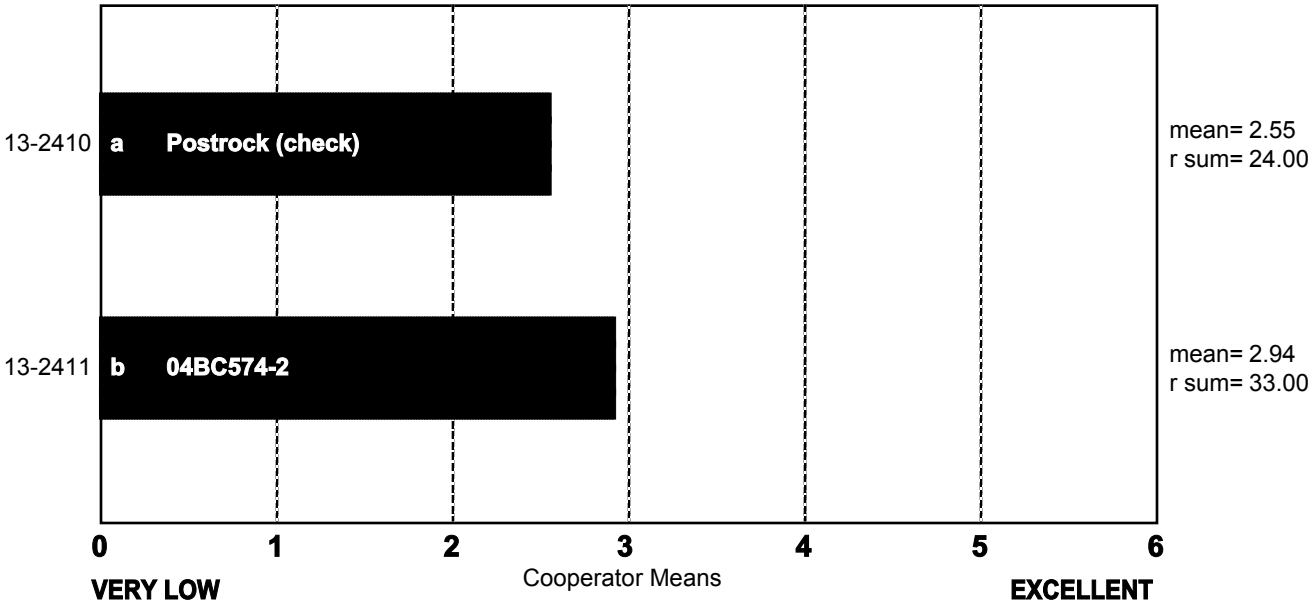


BAKE ABSORPTION

(Small Scale) Agripro

ncoop= 19
chisq= 4.26
chisqc= 6.23
cvchisq= 3.84
crdiff= 6.38

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) Agripro

	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	Coop. R	Coop. S
13-2410 Postrock (check)	**58.0**	**61.0**	**62.0**	**59.0**	**57.0**	**62.7**	**55.7**	**63.0**	**61.5**	**55.7**	**64.1**	**61.0**	**60.5**	**51.7**	**57.7**	**58.0**	**69.6**	**60.7**	**55.7**
13-2411 04BC574-2	**57.0**	**61.0**	**60.0**	**60.0**	**57.0**	**63.1**	**57.7**	**64.0**	**60.3**	**57.7**	**66.6**	**62.3**	**61.5**	**56.2**	**60.9**	**59.0**	**70.3**	**62.6**	**57.7**

BAKE MIX TIME, ACTUAL

(Small Scale) Agripro

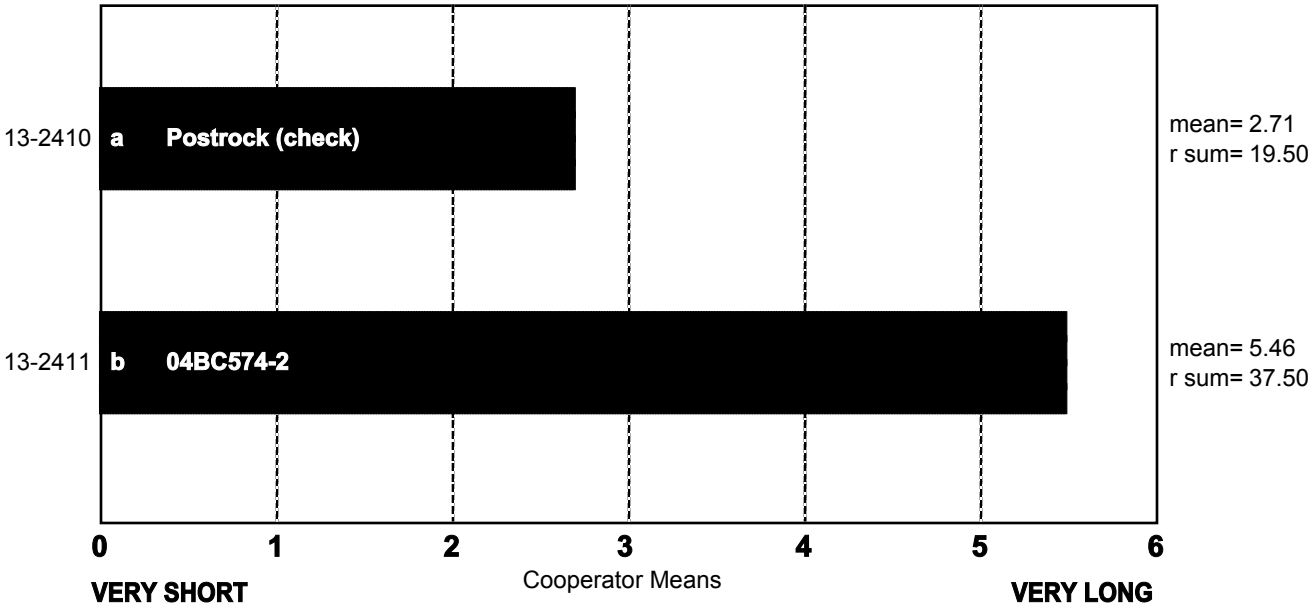
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2410 Postrock (check)	**8.0**	**5.0**	**6.0**	**12.0**	**17.0**	**3.8**	**6.0**	**3.3**	**3.2**	**4.0**	**3.3**	**4.1**	**2.5**	**1.8**	**3.8**	**4.0**	**4.3**	**2.9**	**9.0**
13-2411 04BC574-2	**20.0**	**25.0**	**9.0**	**25.0**	**30.0**	**8.0**	**6.5**	**8.5**	**7.0**	**10.5**	**7.3**	**10.8**	**5.8**	**4.0**	**11.8**	**14.0**	**10.1**	**7.5**	**12.0**

BAKE MIX TIME

(Small Scale) Agripro

ncoop= 19
chisq= 17.05
chisqc= 18.00
cvchisq= 3.84
crdiff= 2.10

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

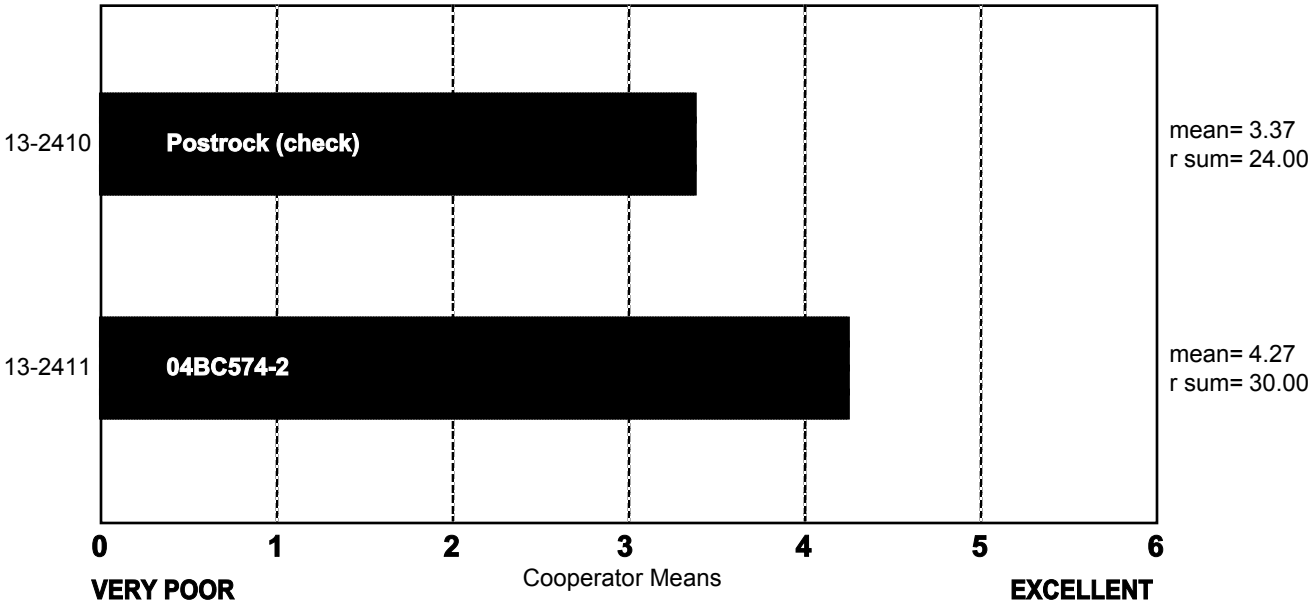


MIXING TOLERANCE

(Small Scale) Agripro

ncoop= 18
chisq= 2.00
chisqc= 2.25
cvchisq= 3.84
crdiff=

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

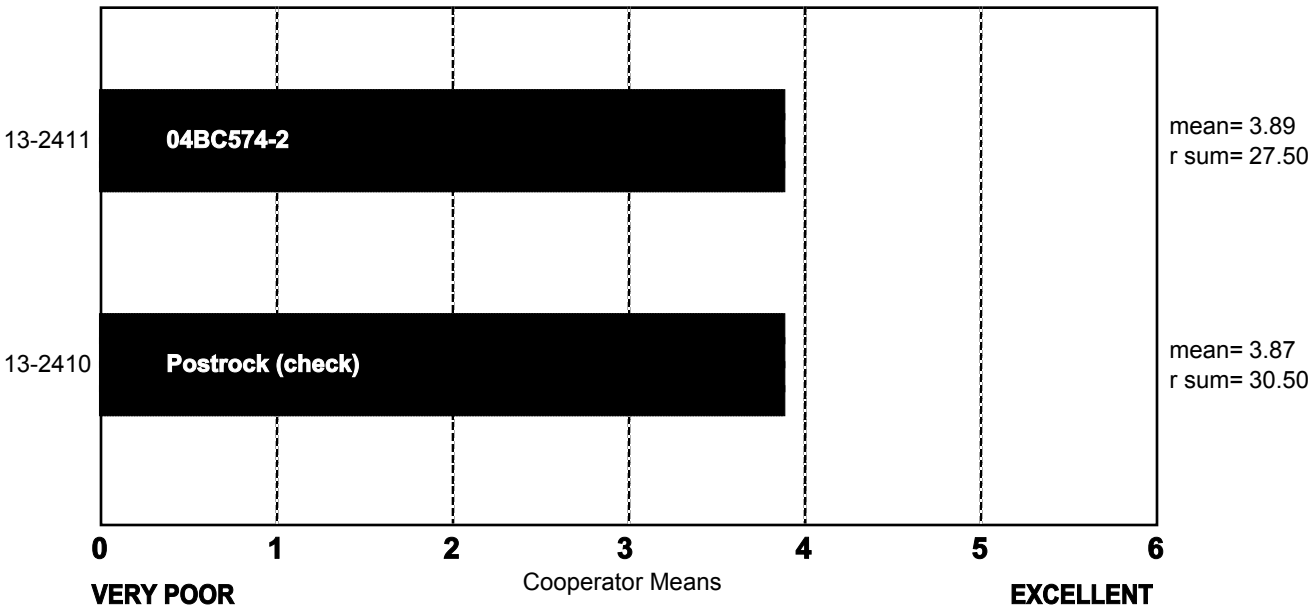


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Agripro

ncoop= 19
chisq= 6.53
chisqc= 1.80
cvchisq= 3.84
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Agripro

	Sticky	Wet	Tough	Good	Excellent
13-2410 Postrock (check)	**6**	**5**	**0**	**6**	**2**
13-2411 04BC574-2	**2**	**0**	**12**	**3**	**2**

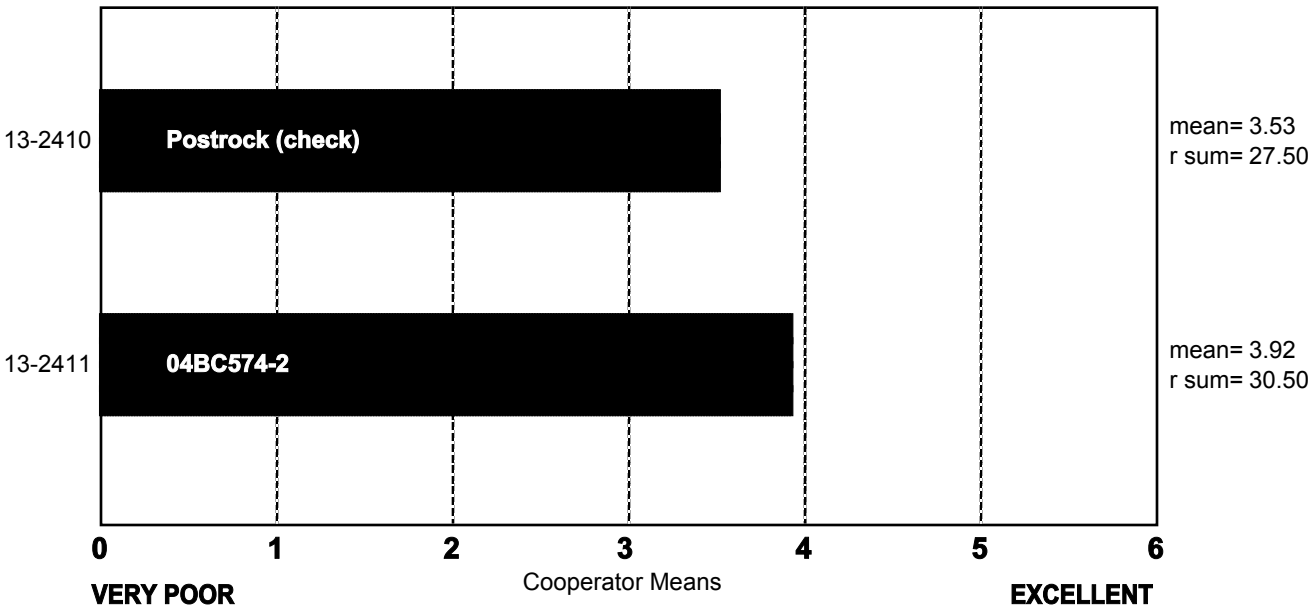
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Agripro

ncoop= 19
chisq= 6.53
chisqc= 0.82
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) Agripro

	Sticky	Wet	Tough	Good	Excellent
13-2410 Postrock (check)	**1**	**5**	**0**	**12**	**1**
13-2411 04BC574-2	**2**	**0**	**7**	**9**	**1**

Frequency Table

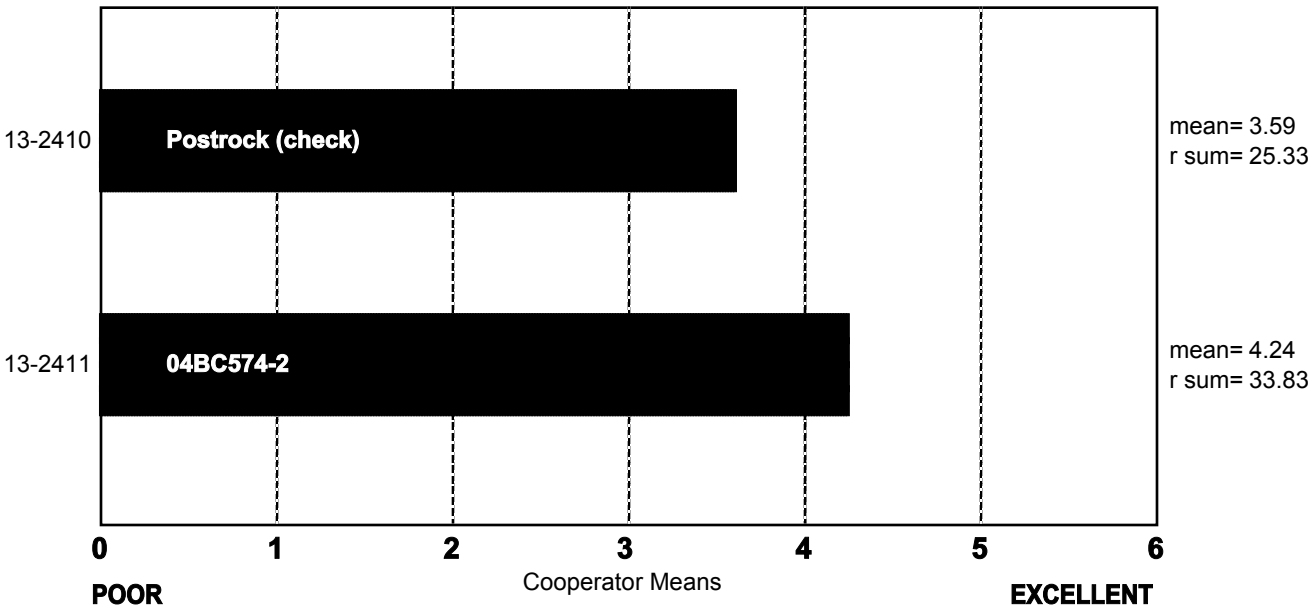
CRUMB GRAIN

(Small Scale) Agripro

ncoop= 19
chisq= 17.05
chisqc= -36.12
cvchisq= 3.84
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Agripro

	Open	Fine	Dense
13-2410 Postrock (check)	**8**	**3**	**8**
13-2411 04BC574-2	**6**	**11**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Agripro

	Round	Irregular	Elongated
13-2410 Postrock (check)	**9**	**5**	**5**
13-2411 04BC574-2	**3**	**6**	**10**

Frequency Table

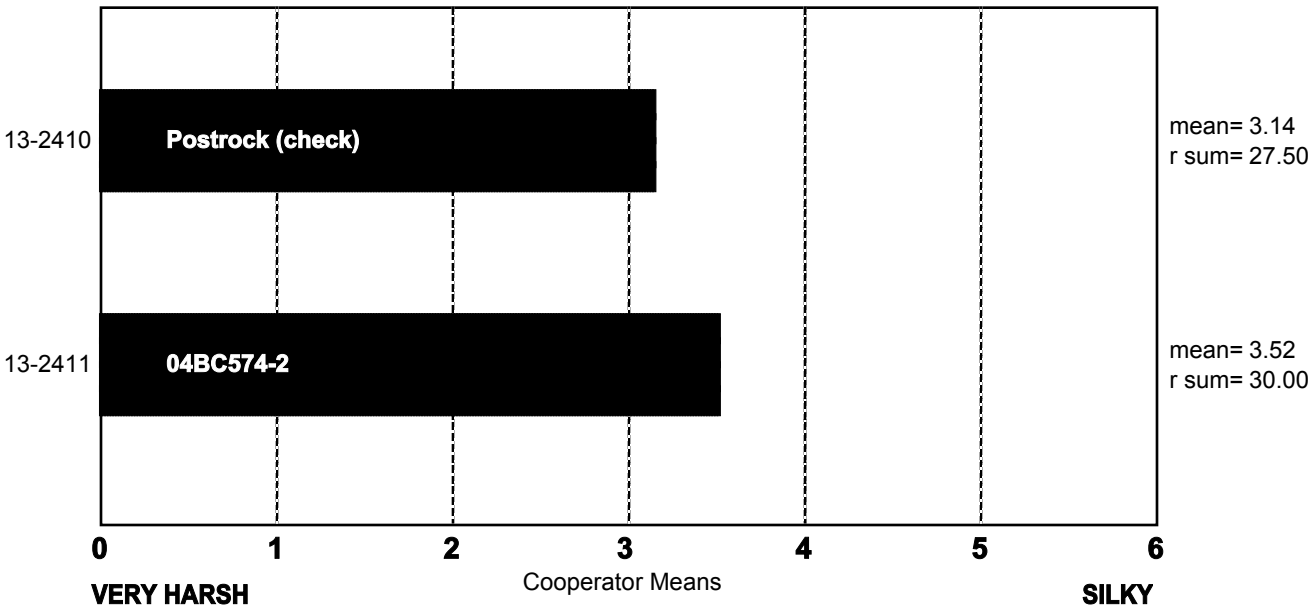
CRUMB TEXTURE

(Small Scale) Agripro

ncoop= 19
chisq= 3.34
chisqc= 0.78
cvchisq= 3.84
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Agripro

	Harsh	Smooth	Silky
13-2410 Postrock (check)	**9**	**8**	**2**
13-2411 04BC574-2	**8**	**9**	**2**

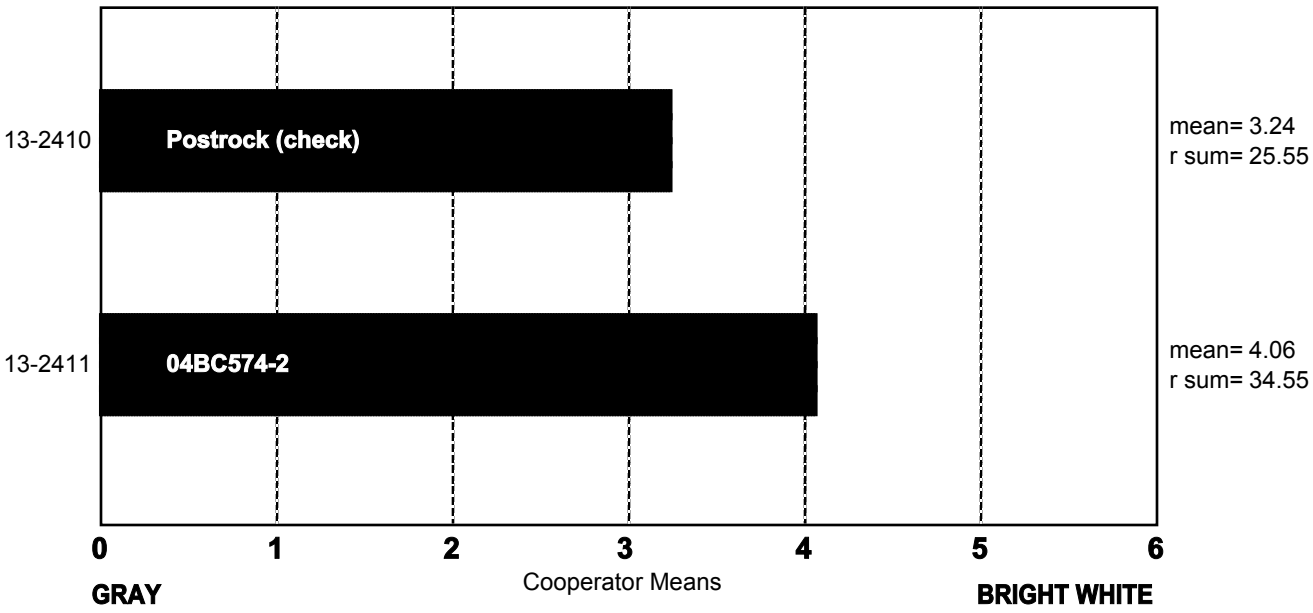
Frequency Table

CRUMB COLOR

(Small Scale) Agripro

ncoop= 19
chisq= 23.37
chisqc= -2.89
cvchisq= 3.84
crdiff=

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



CRUMB COLOR, DESCRIBED

(Small Scale) Agripro

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
13-2410 Postrock (check)	**0**	**0**	**8**	**2**	**7**	**1**	**1**
13-2411 04BC574-2	**0**	**0**	**1**	**4**	**9**	**3**	**2**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Agripro

	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	Coop. R	Coop. S
13-2410 Postrock (check)	**413.0**	**464.8**	**130.0**	**486.4**	**463.0**	**147.6**	**470.0**	**137.8**		**454.7**	**129.6**	**142.5**		**131.1**	**147.0**	**484.3**	**152.5**	**140.0**	**449.0**
13-2411 04BC574-2	**414.0**	**467.8**	**130.0**	**491.9**	**470.4**	**142.5**	**475.0**	**140.2**		**453.8**	**131.3**	**139.9**		**128.2**	**149.5**	**486.3**	**155.1**	**140.0**	**448.5**

LOAF VOLUME, ACTUAL

(Small Scale) Agripro

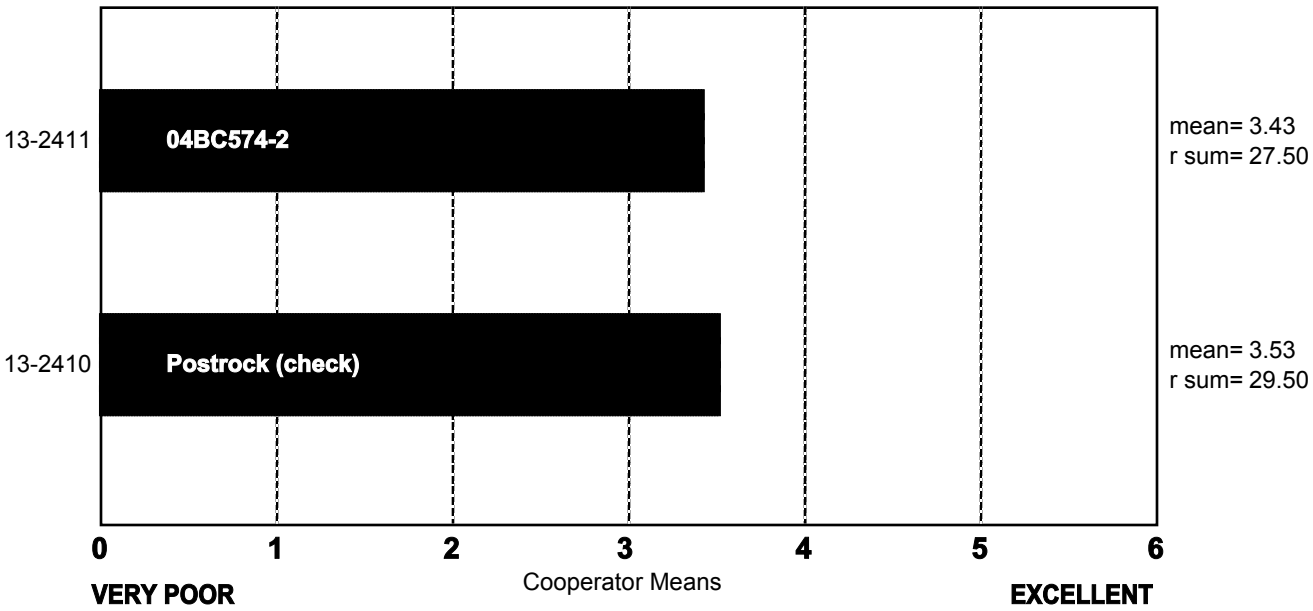
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2410 Postrock (check)	**3100**	**2725**	**1000**	**2986**	**2850**	**825**	**2475**	**983**	**910**	**2525**	**855**	**839**	**855**	**675**	**840**	**2350**	**1033**	**854**	**2650**
13-2411 04BC574-2	**2850**	**2575**	**960**	**3104**	**2550**	**985**	**2300**	**915**	**920**	**2475**	**855**	**836**	**885**	**745**	**790**	**2513**	**1003**	**797**	**2275**

LOAF VOLUME

(Small Scale) Agripro

ncoop= 19
chisq= 0.21
chisqc= 0.29
cvchisq= 3.84
crdiff=

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

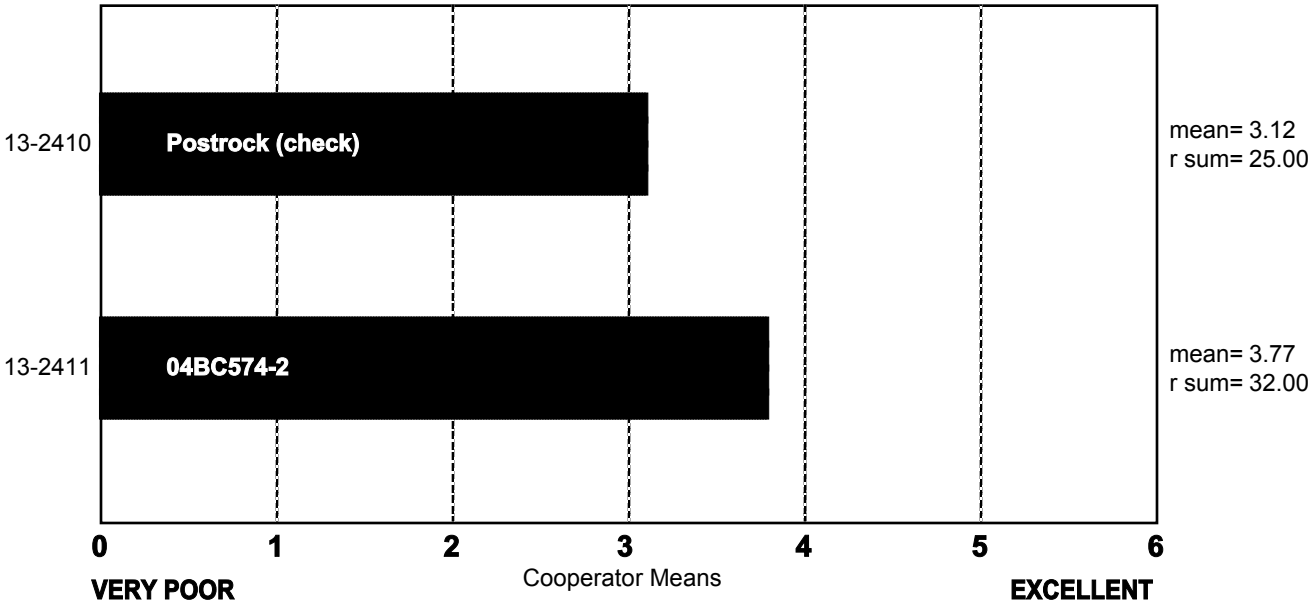


OVERALL BAKING QUALITY

(Small Scale) Agripro

ncoop= 19
chisq= 2.58
chisqc= 2.88
cvchisq= 3.84
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Agripro

COOP. **13-2410 Postrock (check)**

A. Open grain, bright interior, excellent volume, and short mix, slightly sticky out of mixer.
B. Average absorption, short mix, high volume, yellow crumb, slightly open grain.
C. Good baking performance.
D. Low absorption, dough was slack and wet, good interior scores, good volume.
E. Low absorption, poor crumb strength.
F. Very weak dough.
G. No comment.
H. No comment.
I. No comment.
J. Low absorption, good dough, good volume with a dense grain rating.
K. No comment.
L. Lower absorption, normal mix time, slight sticky & weak dough, higher OS & volume, yellow crumb, dense & round cells, slightly harsh & resilient texture.
M. Low absorption for protein, overall weaker with poorer bread baking qualities.
N. Moist/tacky dough, short mixer. At panning dough was weak/pliable with nice moisture. Poor moulding.
O. Low bake absorption, poor tolerance, short/medium mix time, satisfactory crumb grain with yellow crumb color.
P. Low absorption, short mix time, sticky dough, dense grain, harsh, yellow crumb, poor volume.
Q. No comment.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. Break and shred.

COOP. **13-2411 04BC574-2**

A. Open grain, bright interior, average volume, and tough dough.
B. Average absorption, long mix, average volume, creamy crumb, slightly open grain.
C. Underdeveloped, average baking performance.
D. Tight, consistent, smooth grain, excellent volume.
E. Low absorption and volume.
F. Best crumb and color of all samples.
G. No comment.
H. No comment.
I. No comment.
J. Bucky dough, good volume and grain rating, white in color.
K. No comment.
L. Normal absorption, much longer mix time, slight sticky & strong dough, mid-high OS & volume, slightly yellow crumb, fine & elongated cells, smooth & resilient texture.
M. Lower protein, very long mixing with good bread baking quality.
N. Moist/tacky dough then turned dry and tough (slow water uptake?). At panning dough was moist, elastic and nice.

O. Low bake absorption, good tolerance, very long mix time, excellent dough out of mixer, crumb grain slightly lower than check, yellow crumb color.
P. Tolerant to mixing, tough dough, fine grain, white crumb, average volume.
Q. Great dough performance.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. No comment.

Notes: **A, B, C, D, E, J, P and S** conducted sponge and dough bake tests

NEBRASKA

13-2412	Millennium (check)
13-2413	NE09521
13-2414	NE08499

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 2012-2013 would be considered as an extremely dry start in western NE which became progressively worse (e.g. drier) as the season progressed. The breeding nurseries were lost at Sidney (good emergence, but freeze damage in the early spring) and North Platte (too dry for emergence anytime during the seaons). The quality increases however survived and finished under drought. The eastern site was better with good emergence and adequate moistures throughout the season. The season would be considered slightly later than normal.
Hence the western samples were affected by drought stress and possibly heart stress (which tends to shorten the Mixograph mixing times and reduce Mixograph tolerance scores). The eastern site would be considered normal. The main diseases present were bacterial streak and leaf rust at Mead. Due to drought, the western sites were relatively disease free.

Data from the State Variety Trial:

Line	Mead	North Platte	Sidney
	bu/a	bu/a	bu/a
NE09521	90	43	58
NE08499	84	46	58
Millennium	NT	34*	36*
Nursery Mean	**85**	**40**	**59**
LSD (p=0.05)	8	7	14

Data from the State Variety Trial
* Low yields were due to low quality seed and poor emergence

Lines submitted for testing:

NE09521: The pedigree of NE09521 is OK96717-99-6755/NI01824//NE00564 where the pedigree of OK96717-99-6755 is Abilene/2180//Chisholm, the pedigree of NI01824 is Intensivnaja/NE92458 (=PL83201/Redland)//VBF0168), and the pedigree of NE00564 is T81/NE91635 (=NE82671/NE82599).
NE09521 is a moderately early, moderately tall, semi-dwarf wheat with average straw strength. It is moderately resistant to resistant to wheat stem rust; moderately resistant to

moderately susceptible to stripe rust and wheat soilborne mosaic virus; moderately susceptible to leaf rust and barley yellow dwarf virus; and susceptible to Hessian fly, greenbug, bacterial leaf streak, and wheat streak mosaic virus. It was tested in the SRPN in 2012 and 2013 (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). Based upon the data we have collected so far, NE09521 seems to be adapted to the Northcentral and Northern High Plains and best suited for production in eastern Nebraska and states south and west of Nebraska where disease resistance is less needed. Based upon our end-use quality data to date, NE09521 would be lower in test weight and have average end-use quality. This line is being considered for release to certified seed producers in 2015. Compared to Wesley (moderately susceptible to susceptible for scab reaction and susceptible for DON accumulation) and Overland (moderately resistance to scab reaction and moderately resistant for DON accumulation), NE09521 is considered as being moderately resistant for scab reaction and susceptible for DON accumulation.

NE08499: The pedigree of NE08499 is CDL 91185-1/NE99469 where CDL 91185-1 is a line created by the late Dr. Don McVey to couple excellent stem rust resistance with winterhardiness and NE99469 has the pedigree NE97V106/Pronghorn sib//Karl 92. NE08499 is a medium late, medium tall semi-dwarf wheat, with average straw strength and good winterhardiness. It is moderately resistant to stripe rust, bacterial leaf streak, and barley yellow dwarf virus; moderately resistant to moderately susceptible to stem rust; moderately susceptible to leaf rust and wheat soilborne mosaic virus; and susceptible to Hessian fly, wheat streak mosaic virus, and greenbug. It was tested in the SRPN in 2012 and in the NRPN in 2013 (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). Based upon the data we have collected so far, NE08499 seems to be best adapted and best suited for production in eastern and central Nebraska and the Northcentral High Plains. Based upon our end-use quality data to date, NE08499 would be considered as having average, acceptable end-use quality. This line is on the4 bubble for release and if released would be available for release to certified seed producers in 2015. Compared to Wesley (moderately susceptible to susceptible for scab reaction and susceptible for DON accumulation) and Overland (moderately resistance to scab reaction and moderately resistant for DON accumulation), NE08499 is considered as being moderately resistant for scab reaction and moderately resistant for DON accumulation.

Millennium: The milling and baking check cultivar. It is a popular older cultivar with acceptable end use quality, excellent disease resistance and tolerance, and was broadly adapted in Nebraska. Hence is considered quite stable for end-use quality.

Nebraska: 2013 (Small-Scale) Samples

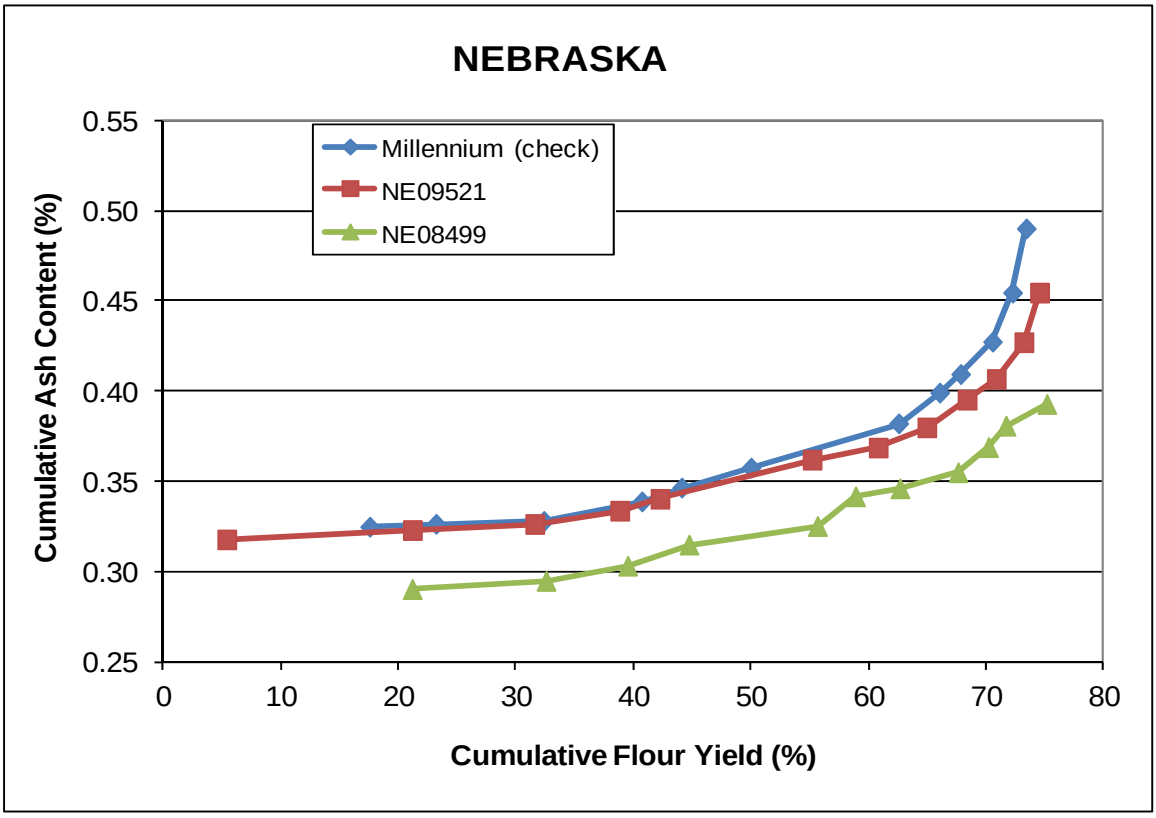
Test entry number	13-2412	13-2413	13-2414
Sample identification	**Millennium (check)**	**NE09521**	**NE08499**
Wheat Data			
GIPSA classification	1 HRW	2 HRW	1 HRW
Test weight (lb/bu)	61.9	59.7	59.9
Hectoliter weight (kg/hl)	81.4	78.6	78.8
1000 kernel weight (gm)	32.3	31.9	27.3
Wheat kernel size (Rotap)			
Over 7 wire (%)	76.2	74.7	59.6
Over 9 wire (%)	23.7	25.2	39.5
Through 9 wire (%)	0.1	0.1	0.9
Single kernel (skcs)[a]			
Hardness (avg /s.d)	63.1/15.1	57.3/16.0	65.8/20.2
Weight (mg) (avg/s.d)	32.3/7.5	31.9/8.3	27.3/7.7
Diameter (mm)(avg/s.d)	2.70/0.29	2.71/0.33	2.55/0.31
Moisture (%) (avg/s.d)	11.2/0.4	11.1/0.4	10.9/0.4
SKCS distribution	02-08-28-62-01	06-18-30-46-02	08-09-16-67-02
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	11.8	12.3	14.0
Wheat ash (12% mb)	1.79	1.45	1.54
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	73.4	74.6	72.7
Quadrumat Sr. Mill	72.6	72.1	71.7
Flour moisture (%)	11.5	12.0	13.7
Flour protein (14% mb)	10.8	11.0	12.6
Flour ash (14% mb)	0.48	0.43	0.46
Rapid Visco-Analyser			
Peak Time (min)	6.2	6.3	6.3
Peak Viscosity (RVU)	231.6	246.0	233.7
Breakdown (RVU)	60.8	56.3	51.3
Final Viscosity at 13 min (RVU)	293.2	312.3	311.4
Minolta color meter			
L*	92.45	92.59	92.04
a*	-2.19	-2.10	-1.98
b*	9.02	8.71	9.20
PPO	0.501	0.314	0.602
Falling number (sec)	464	453	526
Damaged Starch			
(AI%)	95.61	94.98	94.69
(AACC76-31)	5.97	5.51	5.30

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

Nebraska: Physical Dough Tests and Gluten Analysis For 2013 (Small-Scale) Samples

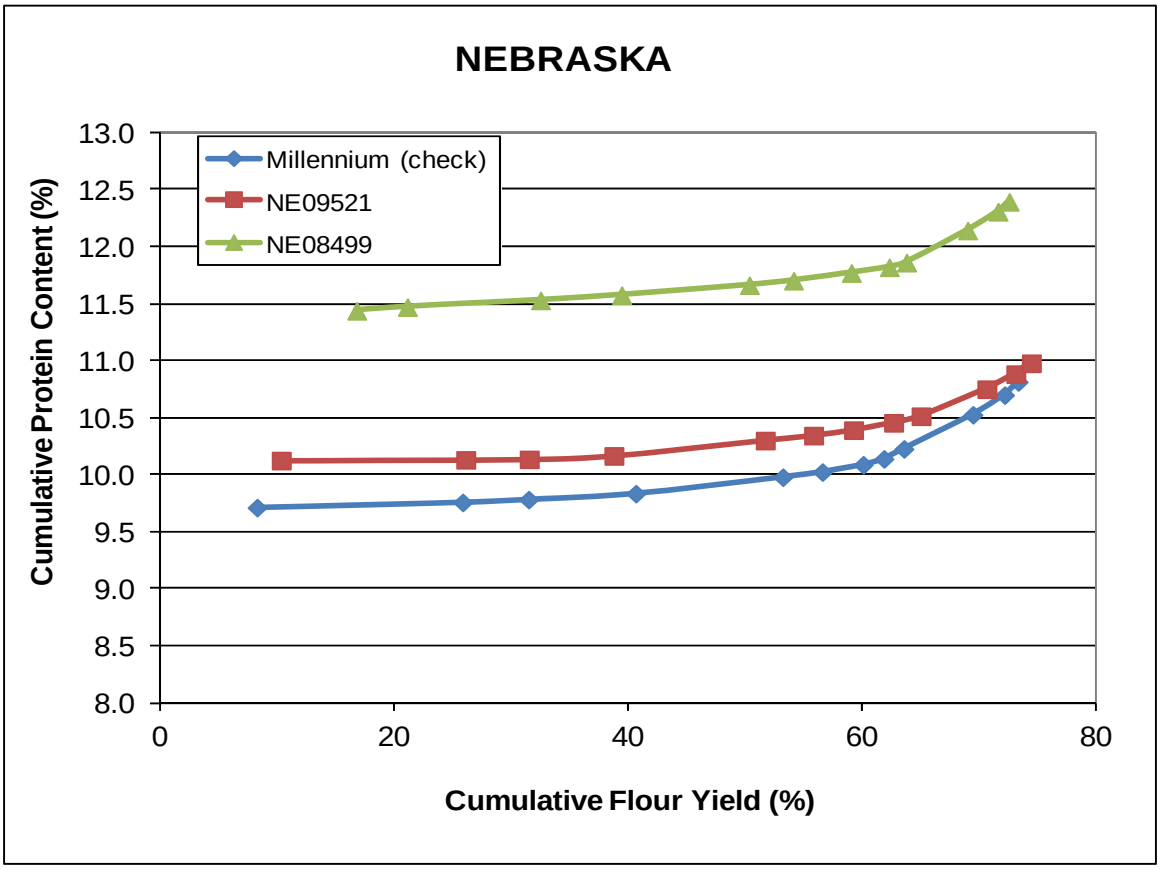
Test Entry Number	13-2412	13-2413	13-2414
Sample Identification	Millennium (check)	NE09521	NE08499
MIXOGRAPH			
Flour Abs (% as-is)	63.2	64.2	65.6
Flour Abs (14% mb)	59.9	61.4	62.9
Mix Time (min)	2.6	3.8	4.8
Mix tolerance (0-6)	2	3	4
FARINOGRAPH			
Flour Abs (% as-is)	59.7	59.0	59.9
Flour Abs (14% mb)	56.4	56.2	57.2
Development time (min)	4.7	6.5	4.5
Mix stability (min)	9.3	18.9	7.9
Mix Tolerance Index (FU)	37	24	48
Breakdown time (min)	9.0	14.8	7.6
ALVEOGRAPH			
P(mm): Tenacity	47	55	58
L(mm): Extensibility	178	188	177
G(mm): Swelling index	29.7	30.5	29.6
W(10^{-4} J): strength (curve area)	217	321	345
P/L: curve configuration ratio	0.26	0.29	0.33
Ie(P_{200}/P): elasticity index	52.9	60.6	64.3
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	242/284/280	306/404/473	431/646/676
Extensibility (mm at 45/90/135 min)	169/185/181	159/164/156	150/147/143
Energy (cm^2 at 45/90/135 min)	77/102/99	92/136/149	119/169/140
Resist $_{max}$ (BU at 45/90/135 min)	334/405/417	455/690/781	614/931/988
Ratio (at 45/90/135 min)	4.93/6.67/7.24	10.50/12.06/14.22	6.80/8.04/8.64
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+8, 5+10	2*, 7+8/7+9, 5+10	2*, 7+8/7+9, 5+10
%IPP	48.43	52.61	54.33
SEDIMENTATION TEST			
Volume (ml)	39.7	54.9	63.2

Nebraska: Cumulative Ash Curves



Millennium (check)					NE09521					NE08499				
Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash
2M	17.57	0.32	17.57	0.32	1M Red	5.43	0.32	5.43	0.32	2M	16.86	0.29	16.86	0.29
1M Red	5.64	0.33	23.21	0.33	2M	15.78	0.32	21.20	0.32	1M Red	4.33	0.31	21.19	0.29
1M	9.17	0.33	32.38	0.33	1M	10.40	0.33	31.61	0.33	1M	11.38	0.32	32.57	0.30
1BK	8.34	0.38	40.72	0.34	1BK	7.23	0.37	38.84	0.33	1BK	6.93	0.37	39.50	0.31
Grader	3.38	0.44	44.10	0.35	Grader	3.42	0.42	42.25	0.34	2BK	5.22	0.40	44.72	0.33
2BK	5.90	0.44	49.99	0.36	3M	12.94	0.43	55.19	0.36	3M	10.92	0.41	55.65	0.34
3M	12.56	0.48	62.55	0.38	2BK	5.62	0.43	60.81	0.37	Grader	3.24	0.42	58.89	0.35
4M	3.49	0.70	66.04	0.40	4M	4.13	0.54	64.95	0.38	4M	3.77	0.49	62.66	0.35
FILTER FLR	1.78	0.79	67.82	0.41	FILTER FLR	3.42	0.69	68.37	0.40	FILTER FLR	4.94	0.55	67.60	0.37
3BK	2.71	0.88	70.53	0.43	3BK	2.48	0.72	70.85	0.41	3BK	2.60	0.69	70.19	0.38
5M	1.70	1.58	72.24	0.45	5M	2.35	1.04	73.20	0.43	5M	1.48	0.96	71.68	0.39
BRAN FLR	1.16	2.70	73.40	0.49	BRAN FLR	1.33	1.97	74.53	0.45	Filter Bran	3.47	1.89	75.15	0.46
Break Shorts	2.49	4.58	75.89	0.62	Filter Bran	1.80	2.21	76.33	0.50	BRAN FLR	0.96	1.97	76.11	0.48
Red Dog	1.78	3.31	77.68	0.69	Red Dog	1.98	2.54	78.31	0.55	Red Dog	1.84	2.44	77.95	0.53
Red Shorts	0.27	4.71	77.95	0.70	Break Shorts	2.53	3.75	80.84	0.65	Break Shorts	2.70	3.77	80.65	0.64
Filter Bran	2.90	2.16	80.85	0.75	Red Shorts	0.32	4.14	81.16	0.66	Red Shorts	0.28	4.19	80.93	0.65
Bran	19.15	6.20	100.00	1.80	Bran	18.84	5.01	100.00	1.48	Bran	19.07	5.18	100.00	1.51
Wheat		1.75					1.42					1.50		
St. Grd. Fl.		0.48					0.43					0.46		

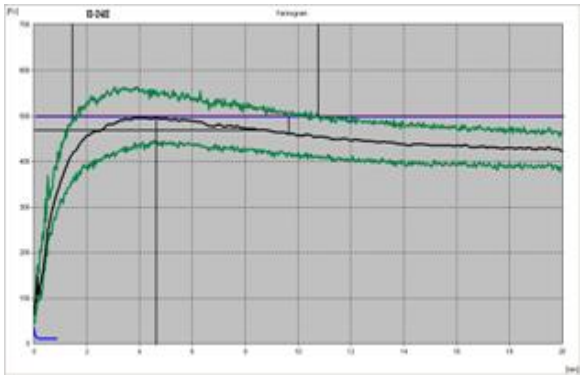
Nebraska: Cumulative Protein Curves



Millennium (check)					NE09521					NE08499				
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
1BK	8.34	9.71	8.34	9.71	1M	10.40	10.13	10.40	10.13	2M	16.86	11.44	16.86	11.44
2M	17.57	9.78	25.91	9.76	2M	15.78	10.14	26.18	10.13	1M Red	4.33	11.59	21.19	11.47
1M Red	5.64	9.90	31.55	9.78	1M Red	5.43	10.16	31.61	10.14	1M	11.38	11.64	32.57	11.53
1M	9.17	10.01	40.72	9.83	1BK	7.23	10.30	38.84	10.17	1BK	6.93	11.79	39.50	11.57
3M	12.56	10.45	53.28	9.98	3M	12.94	10.71	51.78	10.30	3M	10.92	11.98	50.43	11.66
Grader	3.38	10.74	56.66	10.02	4M	4.13	10.88	55.91	10.34	4M	3.77	12.23	54.20	11.70
4M	3.49	11.12	60.15	10.09	Grader	3.42	11.17	59.33	10.39	FILTER FLR	4.94	12.51	59.14	11.77
FILTER FLR	1.78	11.87	61.93	10.14	FILTER FLR	3.42	11.58	62.75	10.46	Grader	3.24	12.73	62.38	11.82
5M	1.70	13.41	63.63	10.23	5M	2.35	12.05	65.10	10.51	5M	1.48	13.60	63.86	11.86
2BK	5.90	13.76	69.53	10.53	2BK	5.62	13.50	70.72	10.75	2BK	5.22	15.57	69.08	12.14
3BK	2.71	15.13	72.24	10.70	3BK	2.48	14.63	73.20	10.88	3BK	2.60	16.69	71.68	12.31
BRAN FLR	1.16	17.96	73.40	10.81	BRAN FLR	1.33	16.22	74.53	10.98	BRAN FLR	0.96	18.82	72.64	12.39
Break Shorts	2.49	16.39	75.89	11.00	Break Shorts	2.53	15.14	77.06	11.11	Break Shorts	2.70	16.30	75.34	12.53
Red Dog	1.78	15.04	77.68	11.09	Red Dog	1.98	13.80	79.04	11.18	Red Dog	1.84	15.58	77.18	12.60
Red Shorts	0.27	15.41	77.95	11.11	Red Shorts	0.32	14.34	79.36	11.19	Red Shorts	0.28	15.33	77.46	12.61
Filter Bran	2.90	13.32	80.85	11.18	Filter Bran	1.80	13.92	81.16	11.25	Filter Bran	3.47	13.50	80.93	12.65
Bran	19.15	16.71	100.00	12.24	Bran	18.84	15.66	100.00	12.08	Bran	19.07	16.08	100.00	13.31
Wheat		11.5					12.0					13.7		
St. Grd. Fl		10.8					11.0					12.6		

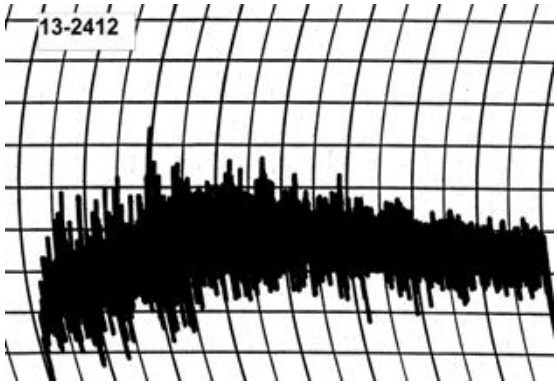
Physical Dough Tests
2013 (Small Scale) Samples – Nebraska

Farinograms



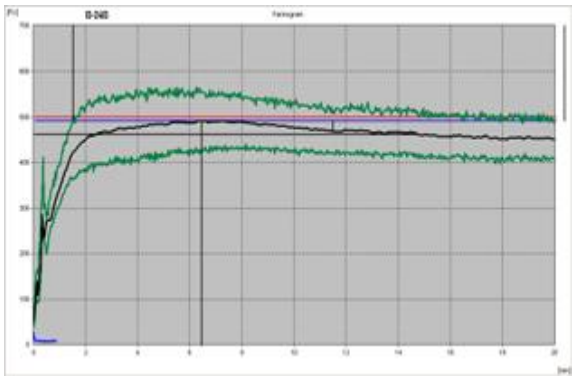
Water abs = 56.4%, Peak time = 4.7 min,
Mix stab = 9.3 min, MTI = 37 FU

Mixograms

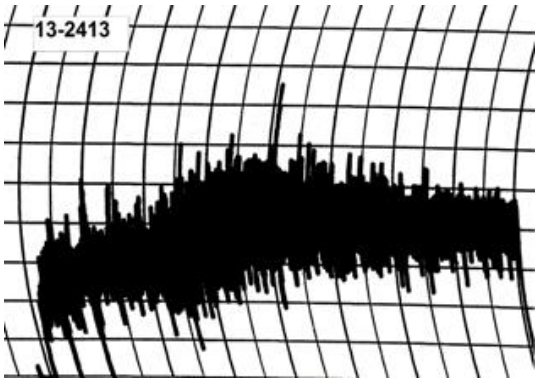


Water abs = 59.9%
Mix time = 2.6 min

13-2412, Millennium (check)



Water abs = 56.2%, Peak time = 6.5 min,
Mix stab = 18.9 min, MTI = 24 FU



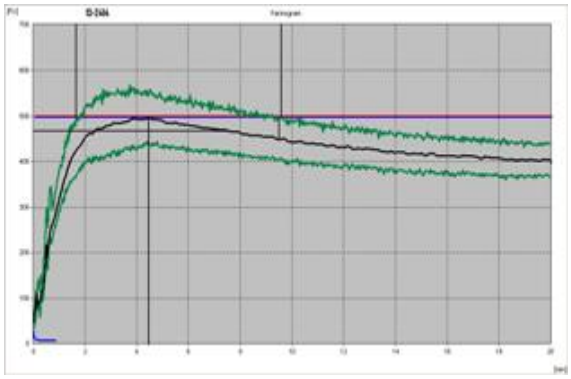
Water abs = 61.4%
Mix time = 3.8 min

13-2413, NE09521

Physical Dough Tests

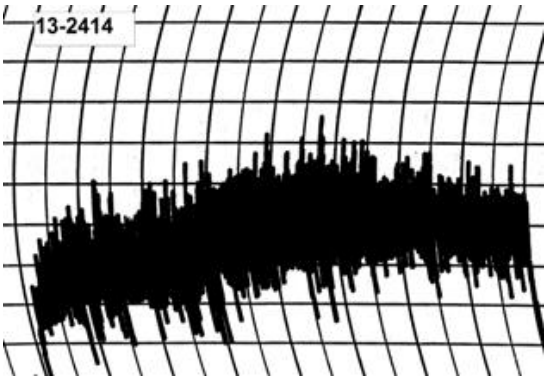
2013 (Small Scale) Samples – Nebraska (continued)

Farinograms



Water abs. = 57.2%, Peak time = 4.5 min,
Mix stab = 7.9 min, MTI = 48 FU

Mixograms

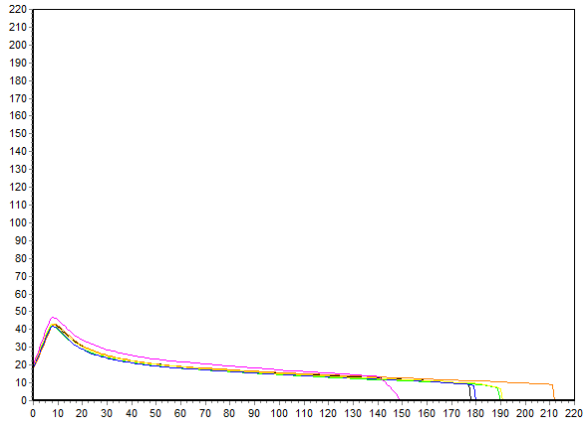


Water abs = 62.9%
Mix time = 4.8 min

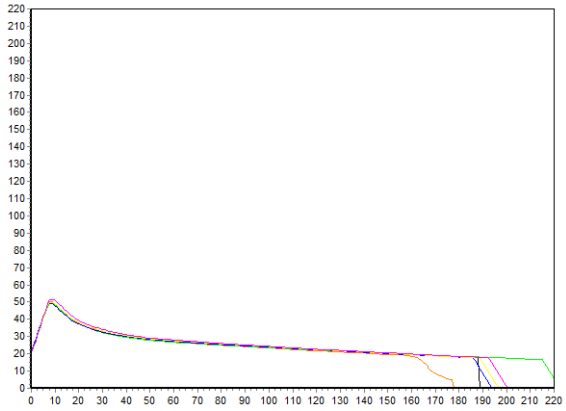
13-2414, NE08499

Physical Dough Tests - Alveograph

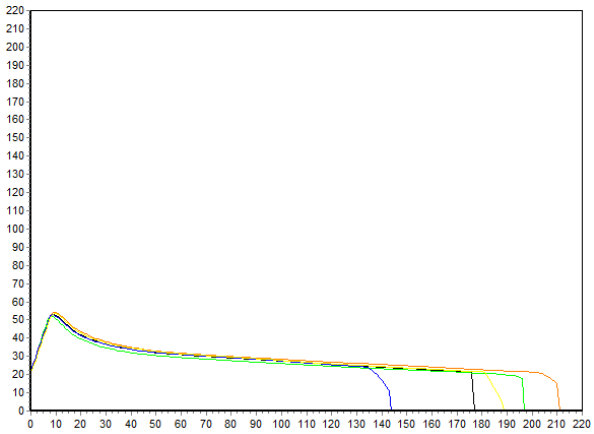
2013 (Small Scale) Samples – Nebraska



13-2412, Millennium (check)
P (mm H_20) = 47, L (mm) = 178, W ($10E^{-4}J$) = 217



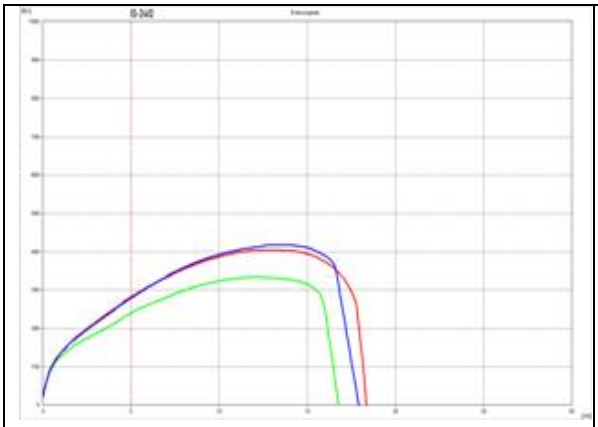
13-2413, NE09521
P (mm H_20) = 55, L (mm) = 188, W ($10E^{-4}J$) = 321



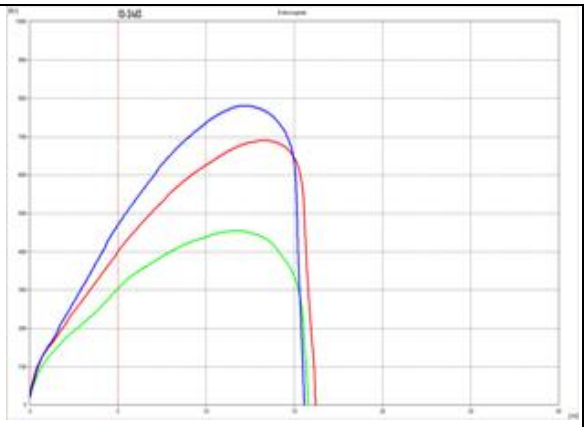
13-2414, NE08499
P (mm H_20) = 58, L (mm) = 177, W ($10E^{-4}J$) = 345

Physical Dough Tests - Extensigraph

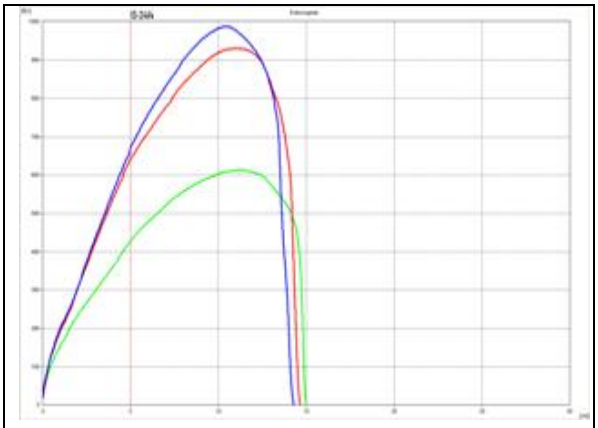
2013 (Small Scale) Samples – Nebraska



13-2412, Millennium (check)
R (BU) = 284, E (mm) = 185, W (cm^2) = 102
Rmax (BU) = 405, Ratio = 1.54 at 90 min



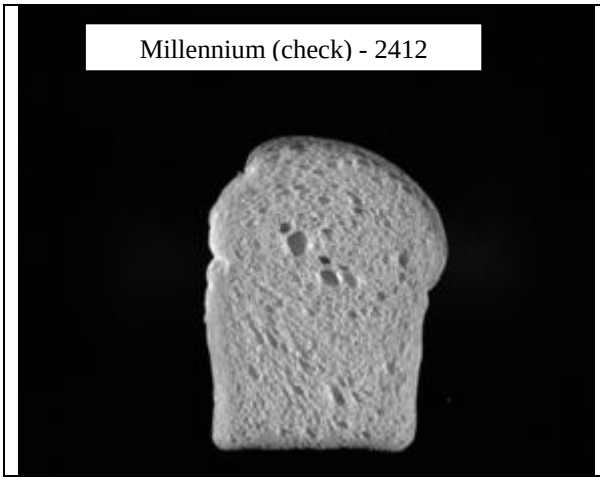
13-2413, NE09521
R (BU) = 404, E (mm) = 164, W (cm^2) = 136
Rmax (BU) = 690, Ratio = 2.47 at 90 min



13-2414, NE08499
R (BU) = 646, E (mm) = 147, W (cm^2) = 169
Rmax (BU) = 931, Ratio = 4.41 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Nebraska: C-Cell Bread Images and Analysis for 2013 (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})
2412	5885	153	4236	0.426	1.736	1.658	1.648	-20.90
2413	6406	154	4361	0.433	1.877	6.307	1.653	-22.88

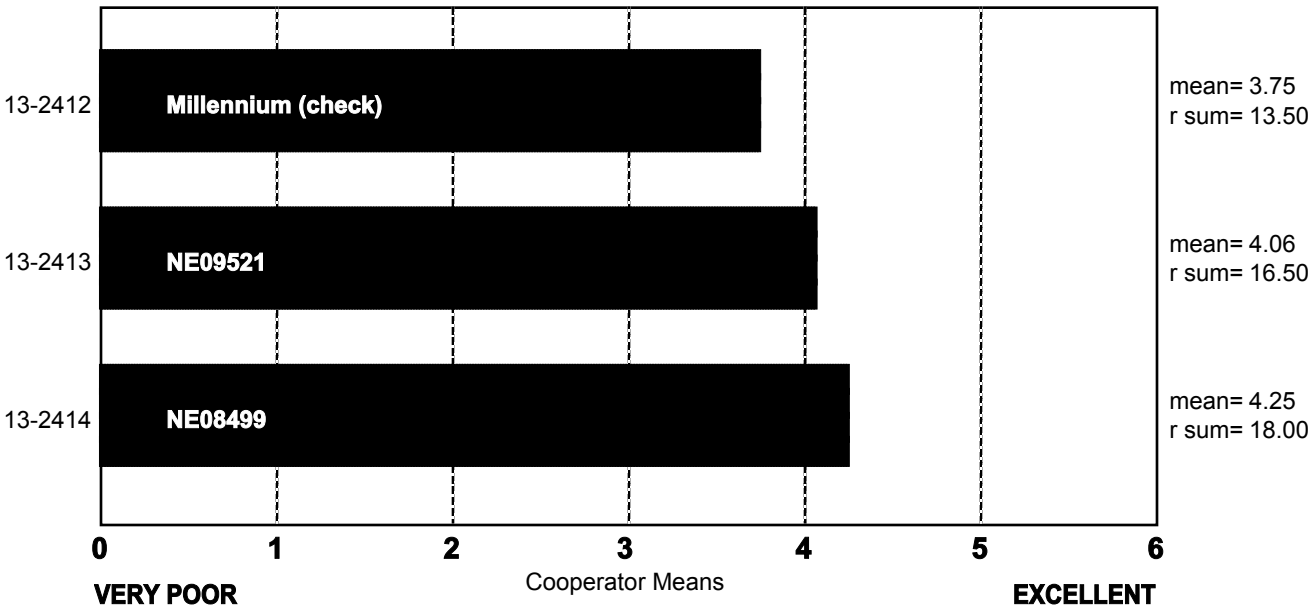
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2414	6618	144	4335	0.443	1.958	10.259	1.678	-24.80

SPONGE CHARACTERISTICS

(Small Scale) Nebraska

ncoop= 8
chisq= 1.31
chisqc= -2.63
cvchisq= 5.99
crdiff=

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

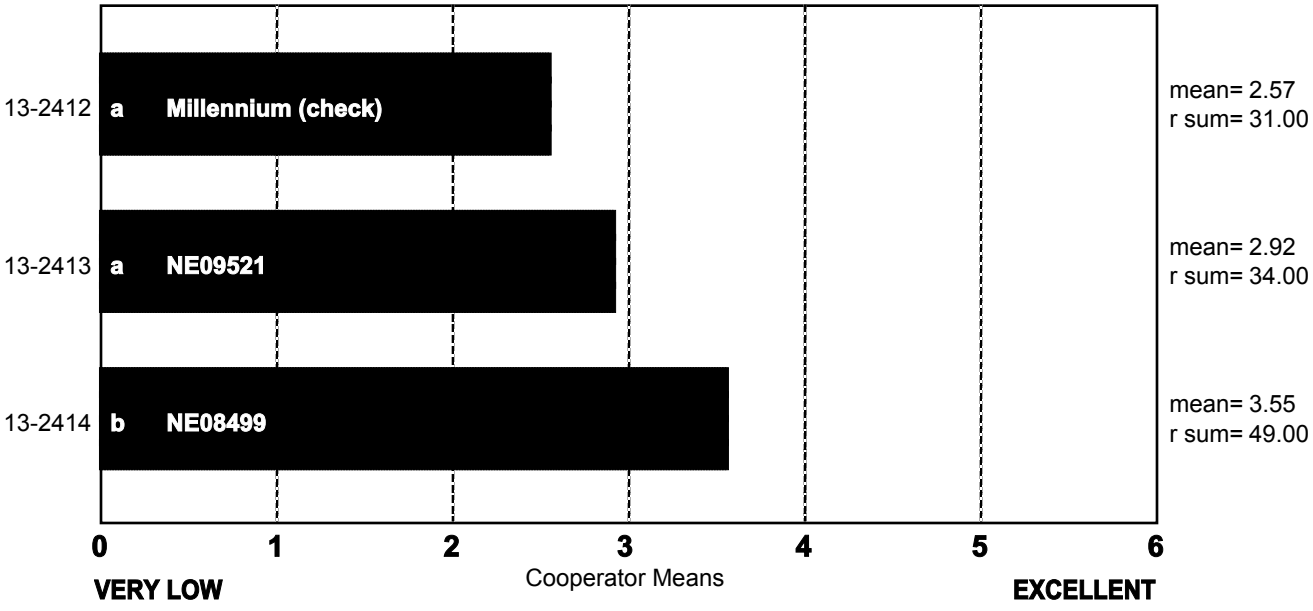


BAKE ABSORPTION

(Small Scale) Nebraska

ncoop= 19
chisq= 9.79
chisqc= 15.83
cvchisq= 5.99
crdiff= 7.71

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) 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	Coop. R	Coop. S
13-2412 Millennium (check)	**57.0**	**61.0**	**60.0**	**59.0**	**57.5**	**59.7**	**56.4**	**65.0**	**59.7**	**56.4**	**67.9**	**62.0**	**61.5**	**53.1**	**58.4**	**60.0**	**67.7**	**63.1**	**56.4**
13-2413 NE09521	**57.0**	**60.0**	**60.0**	**59.0**	**58.5**	**61.2**	**56.2**	**66.0**	**60.0**	**56.2**	**65.9**	**62.0**	**62.5**	**53.4**	**60.9**	**59.0**	**68.2**	**64.3**	**56.2**
13-2414 NE08499	**59.0**	**63.0**	**63.0**	**60.0**	**59.5**	**65.2**	**57.2**	**68.0**	**62.4**	**57.2**	**67.7**	**63.8**	**64.5**	**55.0**	**62.0**	**60.0**	**70.9**	**65.8**	**57.2**

BAKE MIX TIME, ACTUAL

(Small Scale) Nebraska

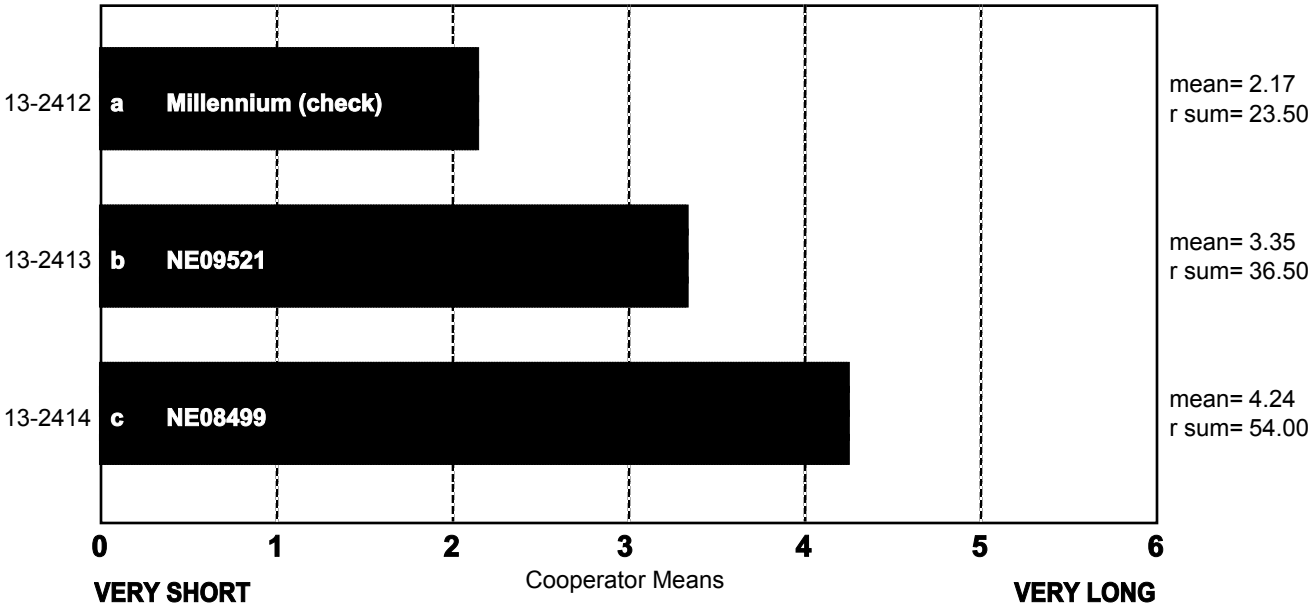
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2412 Millennium (check)	**8.0**	**3.0**	**6.0**	**9.0**	**13.0**	**3.3**	**5.5**	**2.3**	**3.2**	**4.0**	**4.3**	**3.9**	**2.6**	**1.5**	**3.8**	**4.0**	**3.4**	**2.6**	**6.0**
13-2413 NE09521	**19.0**	**6.0**	**6.0**	**18.0**	**23.0**	**3.8**	**8.0**	**3.0**	**3.2**	**6.0**	**3.5**	**4.5**	**2.9**	**2.3**	**5.4**	**4.0**	**4.8**	**3.8**	**8.0**
13-2414 NE08499	**20.0**	**12.0**	**6.0**	**25.0**	**30.0**	**4.8**	**5.0**	**4.5**	**4.3**	**7.0**	**5.0**	**5.9**	**3.4**	**2.8**	**6.5**	**7.0**	**5.7**	**4.8**	**11.0**

BAKE MIX TIME

(Small Scale) Nebraska

ncoop= 19
chisq= 24.66
chisqc= 28.39
cvchisq= 5.99
crdiff= 6.02

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

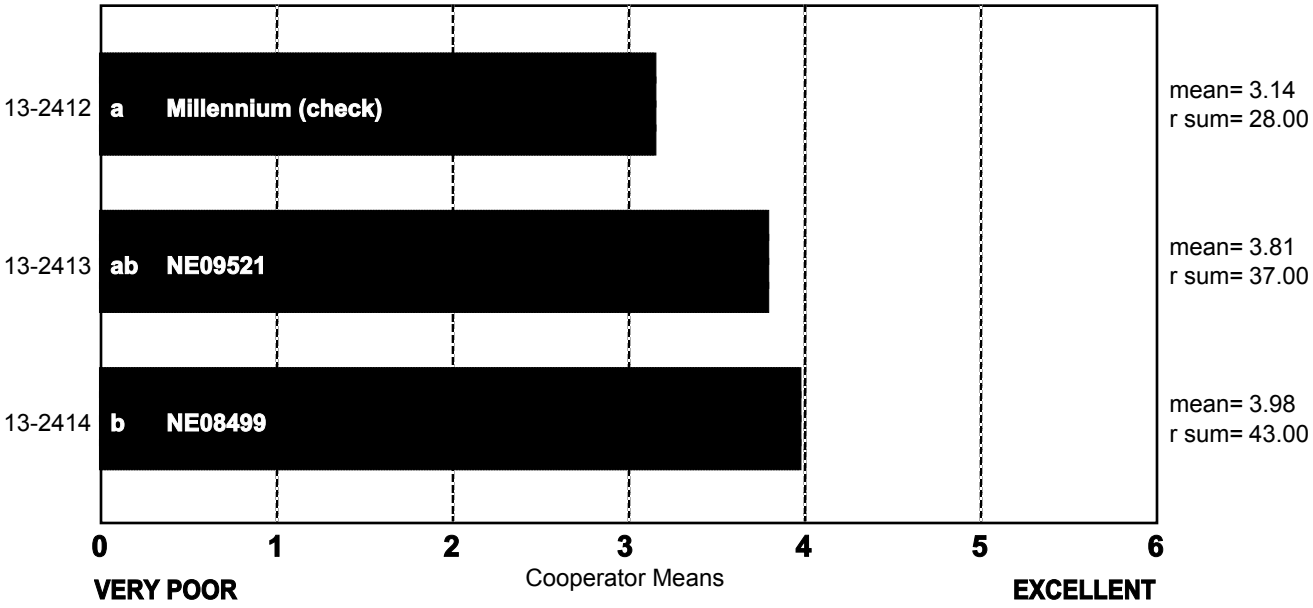


MIXING TOLERANCE

(Small Scale) Nebraska

ncoop= 18
chisq= 6.33
chisqc= 8.29
cvchisq= 5.99
crdiff= 9.62

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



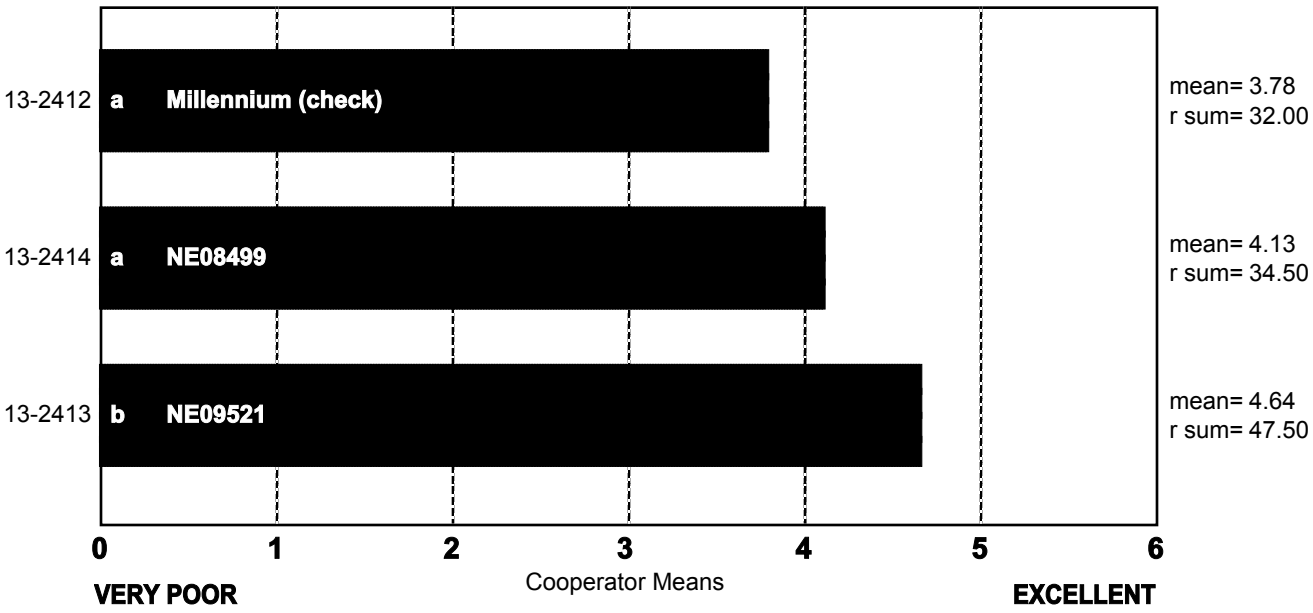
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Nebraska

ncoop= 19
chisq= 7.29
chisqc= 10.65
cvchisq= 5.99
crdiff= 9.01

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) Nebraska

	Sticky	Wet	Tough	Good	Excellent
13-2412 Millennium (check)	**5**	**1**	**2**	**9**	**2**
13-2413 NE09521	**0**	**1**	**1**	**12**	**5**
13-2414 NE08499	**1**	**1**	**4**	**11**	**2**

Frequency Table

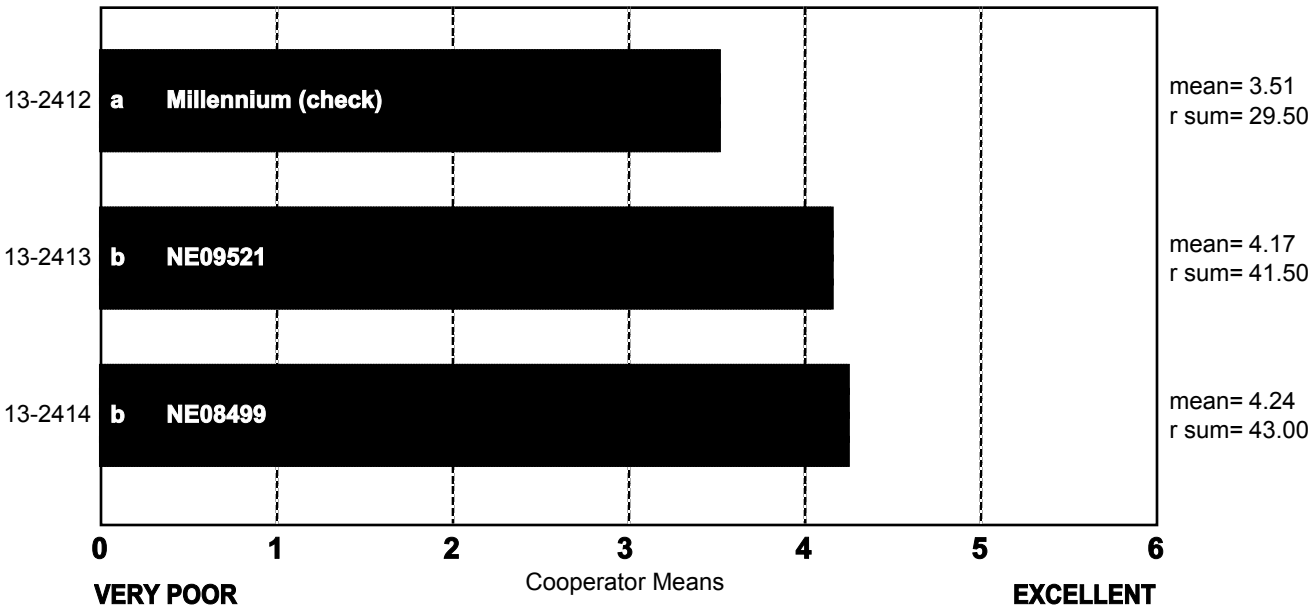
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Nebraska

ncoop= 19
chisq= 5.76
chisqc= 9.95
cvchisq= 5.99
crdiff= 8.40

Variety order by rank sum.

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
13-2412 Millennium (check)	**2**	**4**	**1**	**10**	**2**
13-2413 NE09521	**0**	**4**	**1**	**11**	**3**
13-2414 NE08499	**1**	**3**	**3**	**8**	**4**

Frequency Table

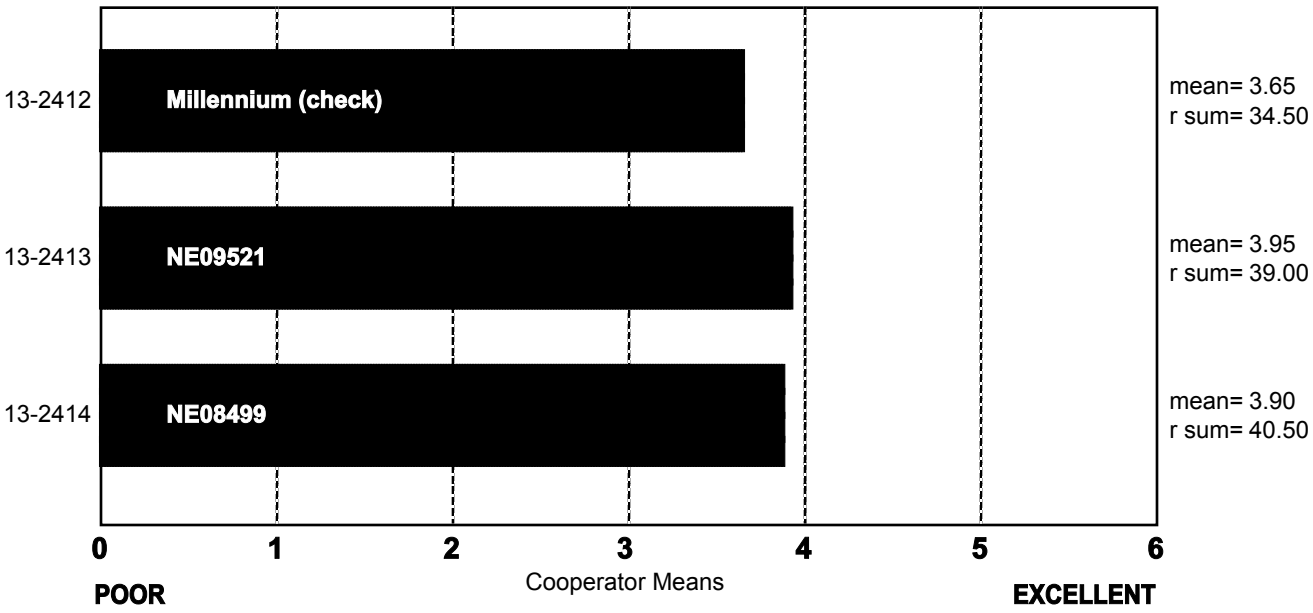
CRUMB GRAIN

(Small Scale) Nebraska

ncoop= 19
chisq= 1.03
chisqc= 1.56
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Nebraska

	Open	Fine	Dense
13-2412 Millennium (check)	**6**	**8**	**5**
13-2413 NE09521	**7**	**10**	**2**
13-2414 NE08499	**12**	**6**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Nebraska

	Round	Irregular	Elongated
13-2412 Millennium (check)	**10**	**7**	**2**
13-2413 NE09521	**2**	**9**	**8**
13-2414 NE08499	**3**	**11**	**5**

Frequency Table

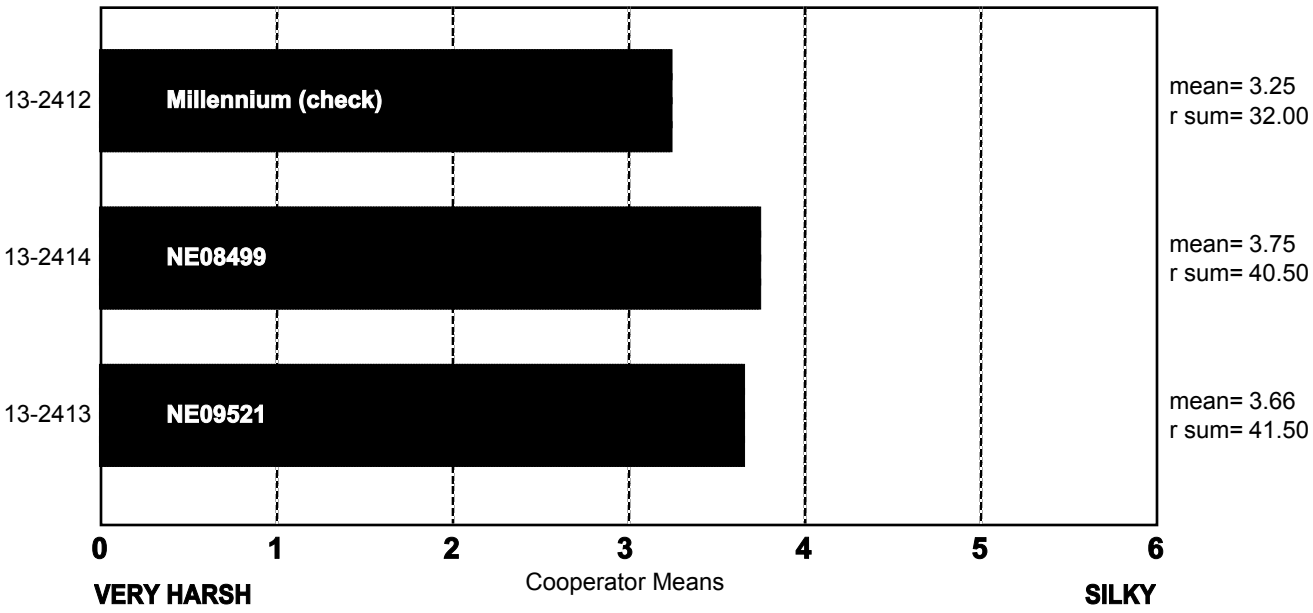
CRUMB TEXTURE

(Small Scale) Nebraska

ncoop= 19
chisq= 2.87
chisqc= 3.96
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
13-2412 Millennium (check)	**9**	**8**	**2**
13-2413 NE09521	**3**	**13**	**3**
13-2414 NE08499	**4**	**14**	**1**

Frequency Table

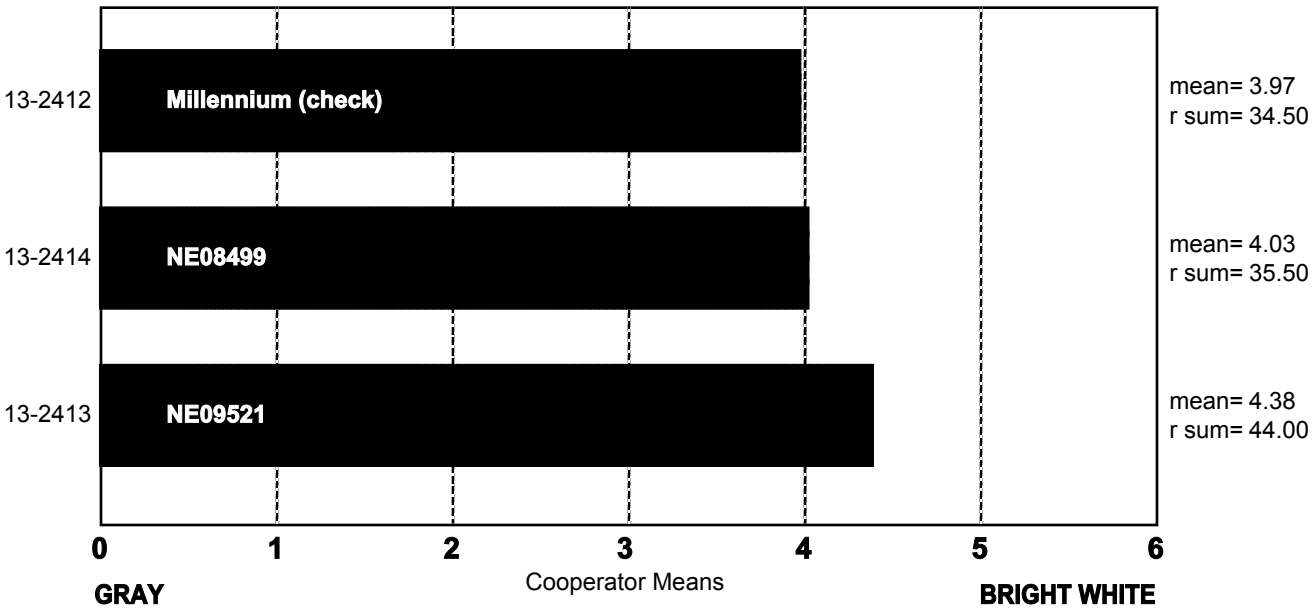
CRUMB COLOR

(Small Scale) Nebraska

ncoop= 19
chisq= 2.87
chisqc= 4.54
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED

(Small Scale) Nebraska

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
13-2412 Millennium (check)	**0**	**0**	**2**	**3**	**11**	**1**	**2**
13-2413 NE09521	**0**	**0**	**0**	**2**	**8**	**7**	**2**
13-2414 NE08499	**0**	**0**	**0**	**6**	**8**	**5**	**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	Coop. R	Coop. S
13-2412 Millennium (check)	**417.0**	**463.9**	**130.0**	**489.2**	**463.7**	**145.0**	**474.0**	**142.1**		**454.8**	**131.7**	**140.2**		**131.1**	**145.6**	**489.9**	**155.8**	**140.6**	**444.0**
13-2413 NE09521	**413.0**	**464.0**	**130.0**	**493.1**	**467.2**	**144.7**	**562.0**	**139.4**		**452.8**	**127.7**	**141.1**		**127.7**	**149.9**	**485.6**	**151.2**	**141.0**	**442.0**
13-2414 NE08499	**413.0**	**465.3**	**130.0**	**492.1**	**463.3**	**146.3**	**462.0**	**138.9**		**453.3**	**129.8**	**141.7**		**128.6**	**149.8**	**481.1**	**156.2**	**141.2**	**445.5**

LOAF VOLUME, ACTUAL

(Small Scale) Nebraska

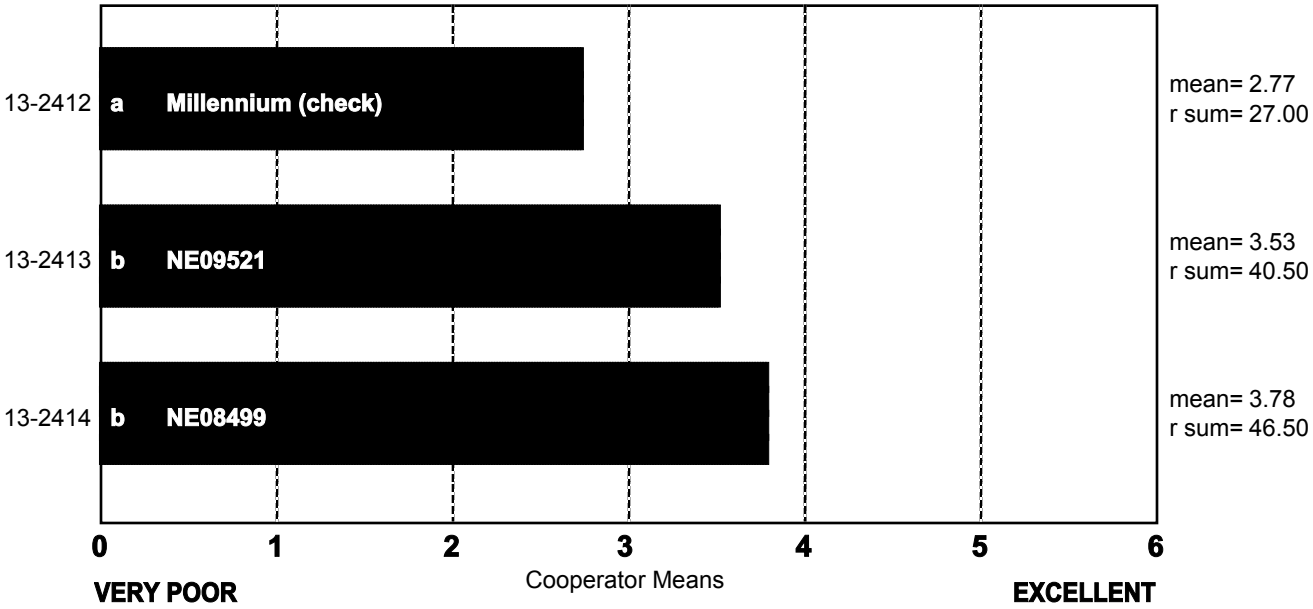
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2412 Millennium (check)	**2875**	**2575**	**925**	**3045**	**2725**	**750**	**2225**	**865**	**825**	**2380**	**850**	**850**	**755**	**605**	**770**	**2313**	**970**	**726**	**2350**
13-2413 NE09521	**2850**	**2500**	**980**	**3074**	**2750**	**885**	**2525**	**925**	**850**	**2450**	**900**	**808**	**780**	**725**	**850**	**2450**	**1003**	**783**	**2450**
13-2414 NE08499	**3150**	**2563**	**1005**	**3104**	**2750**	**875**	**2400**	**998**	**1100**	**2450**	**885**	**876**	**855**	**780**	**875**	**2550**	**1113**	**764**	**2425**

LOAF VOLUME

(Small Scale) Nebraska

ncoop= 19
chisq= 10.50
chisqc= 13.76
cvchisq= 5.99
crdiff= 8.96

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

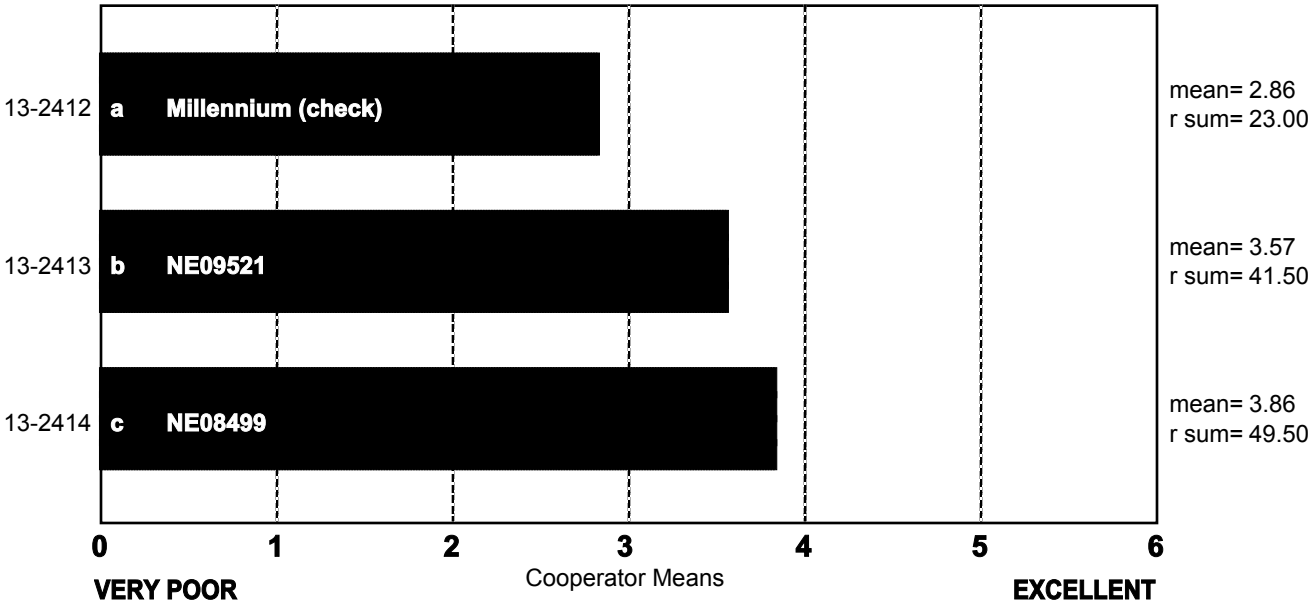


OVERALL BAKING QUALITY

(Small Scale) Nebraska

ncoop= 19
chisq= 19.45
chisqc= 21.74
cvchisq= 5.99
crdiff= 7.95

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. **13-2412 Millennium (check)**

A. Slightly open, bright interior, average volume, short mix, good pliable dough.
B. Average absorption, short mix, average volume, creamy crumb, slightly open grain.
C. Tacky, small volume, poor mix tolerance. Poor baking performance.
D. Weak mixing time, good interior scores, and good crumb color.
E. Low absorption, poor texture, body, and crumb strength.
F. No comment.
G. Short texture.
H. No comment.
I. No comment.
J. Low mix time, excellent dough, lower volume with a good grain rating.
K. No comment.
L. Normal absorption & mix time, slight sticky & strong dough, mid-high OS & volume, dim yellow crumb, dense & round cells, slightly harsh & resilient texture.
M. Low protein, weak and poorer baking quality.
N. Short mixer, dough felt dry at mixing. At panning dough had nice moisture yet limp/pliable/weak. Poor moulding.
O. Low bake absorption, good mix time, good at pan, satisfactory crumb grain, and creamy color.
P. Short mix time, poor tolerance, sticky dough, dense grain, poor volume.
Q. No comment.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. No comment.

COOP. **13-2413 NE09521**

A. Slightly open, bright interior, average volume, long mix for low protein, good dough.
B. Average absorption, average mix, below average volume, creamy crumb, slightly open grain, flat.
C. Slightly small volume, white crumb, average baking performance.
D. Slightly open, variable grain, excellent volume.
E. No comment.
F. Rough break and shred.
G. No comment.
H. No comment.
I. No comment.
J. Excellent dough, good volume and grain rating.
K. No comment.
L. Normal absorption and mix time, slight sticky & strong dough, mid-high OS & volume, creamy crumb, fine & elongated cells, smooth & resilient texture.
M. Acceptable to poor.
N. Smooth pliable dough at mixing. Moist pliable/weak and limp dough with no gas at panning stage.

O. Higher bake absorption than the check, good mix time, excellent dough at mix and pan, excellent crumb grain, creamy, good loaf volume; rated better than the check.
P. Short mix time, fine grain.
Q. Good volume performance for protein.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. No comment.

COOP. 13-2414 NE08499

A. Open grain, slightly creamy, tough strong dough, and excellent volume.
B. Slightly above average absorption, above average mix, average volume, dull crumb, slightly open grain, slightly flat.
C. Good baking performance.
D. Very strong mixing dough.
E. Poor crumb strength.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Good dough, good volume and grain rating.
K. No comment.
L. Normal absorption & mix time, slightly sticky & strong dough, much higher OS & volume, creamy crumb, slightly open & elongated cells, smooth & resilient texture.
M. Good protein, acceptable to good baker.
N. At mixing; smooth, dense dough. Moist, elastic, slightly pliable dough at panning. Poor moulding.
O. Higher bake absorption than the check, good mix time, excellent dough at mix & pan, satisfactory crumb grain, creamy, good loaf volume; rated better than the check.
P. Average absorption and mix time, excellent dough, good grain, average volume.
Q. Good volume performance for protein.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. No comment.

Notes: **A, B, C, D, E, J, P and S** conducted sponge and dough bake tests

MONTANA

13-2415	Yellowstone (check)
13-2416	MT1090
13-2417	MTW08168

Description of Test Plots and Breeder Entries

Montana - Phil Bruckner/Jim Berg

The Post Agronomy Farm (6mi west of Bozeman) had a 30% decrease in average rainfall for the 2013 crop year (11.0in versus 15.8in for the 56yr average). There was reduced snow cover during winter months but no winterkill was observed. Heading (June 13) was earlier than average by 7 days. Average temperatures from March to August (except April and July) were above average with below average moisture recorded in each of those months (except May and June). Above average August temperatures allowed us to harvest August 8, about 5 days earlier than our normal mid-August harvest. Stripe rust was negligible.

The Montana Intrastate Winter Wheat Test (varieties and elite lines) which includes lines grown in the WQC drill strips had yields (x = 86 bu/a, range 74-98) and test weights (x = 59.9 lb/bu, range 57.8-62.6) which were below recent averages. Proteins were higher than average at 14.5%.

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 has been the leading winter wheat variety planted in Montana since 2012, with 23.5% of the acreage (516,800 acres) in 2013.

MT1090 – a hollow stemmed hard red winter wheat line with the pedigree Reeder/6*Yellowstone. MT1090 is most similar to Yellowstone. MT1090 has above average yield and average test weight and protein. Over 29 location-years, yield of MT1090 was 2 bu/a higher than Yellowstone. MT1090 has good yield under winter-kill conditions. MT1090 has medium heading date and is similar in height to Yellowstone. MT1090 is moderately susceptible to stem rust (Yellowstone is susceptible) and resistant to stripe rust (similar to Yellowstone). Milling and baking characteristics were above average and similar to Yellowstone in Montana tests.

MTW08168 (WB3768)
It is a white-chaffed hard white winter wheat developed by the Montana Agricultural Experiment Station and licensed exclusively to WestBred/Monsanto in 2013. WB3768 was derived from a composite of two F_1 crosses with a common white seeded experimental parent, MTW0047 (=Judith/PI262605//S86-740), to 2*MT9982 (Yellowstone sib) and MT9982/MT9989 (= Judith/Arapahoe). WB3768 is a high yielding variety similar to Yellowstone. WB3768 is similar to Yellowstone for most agronomic traits with the exception of higher test weight and later heading date and maturity. WB3768 is 1.8 inches taller than Yellowstone. Like Yellowstone, WB3768 is resistant to prevalent races of stem rust, but susceptible to stem and leaf rust. WB3768 has acceptable milling and baking quality. WB3768 is a low PPO cultivar with favorable Asian noodle color stability and noodle score in Montana tests.

Montana: 2013 (Small-Scale) Samples

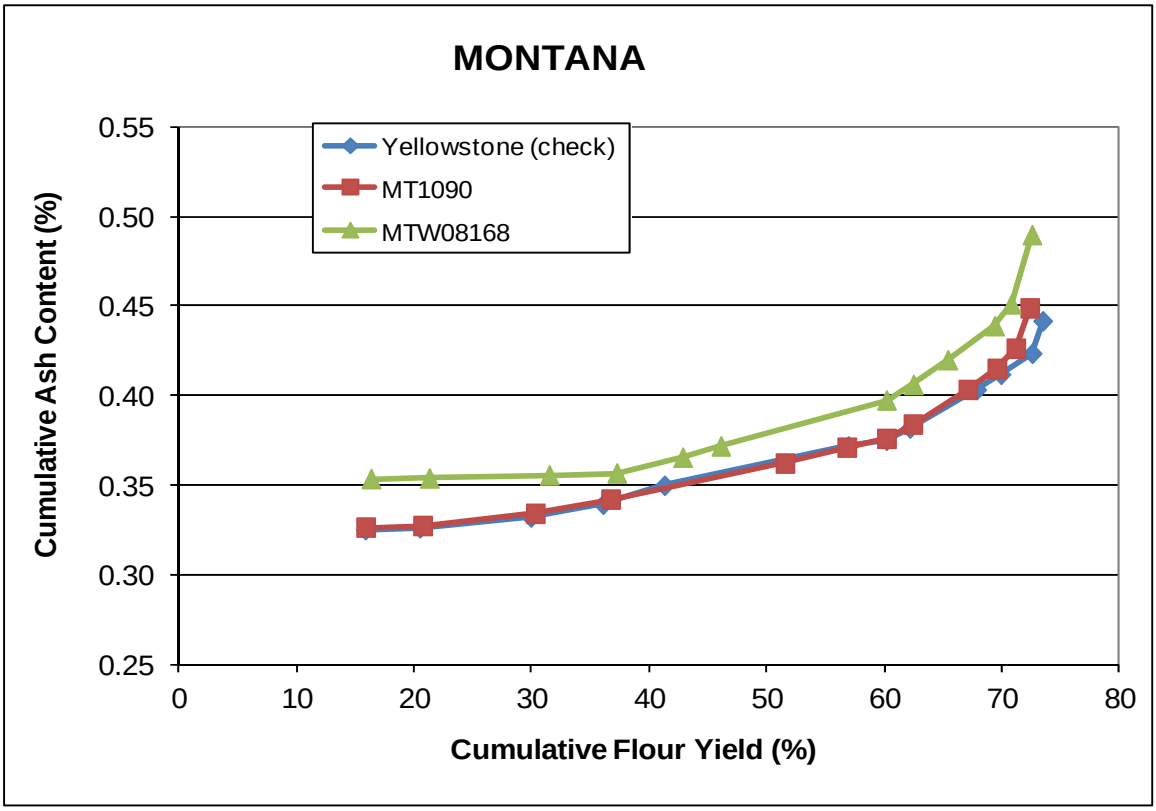
Test entry number	13-2415	13-2416	13-2417
Sample identification	**Yellowstone (check)**	**MT1090**	**MTW08168**
Wheat Data			
GIPSA classification	1 HRW	2 HRW	2 HDWH
Test weight (lb/bu)	62.1	59.8	59.7
Hectoliter weight (kg/hl)	81.7	78.7	78.6
1000 kernel weight (gm)	33.1	29.0	27.3
Wheat kernel size (Rotap)			
Over 7 wire (%)	80.9	60.9	49.9
Over 9 wire (%)	19.1	39.0	50.0
Through 9 wire (%)	0.0	0.1	0.1
Single kernel (skcs)[a]			
Hardness (avg /s.d)	71.2/12.9	72.7/14.3	72.7/14.4
Weight (mg) (avg/s.d)	33.1/7.9	29.0/6.6	27.3/6.7
Diameter (mm)(avg/s.d)	2.75/0.36	2.63/0.31	2.49/0.27
Moisture (%) (avg/s.d)	9.5/0.4	9.2/0.5	8.8/0.6
SKCS distribution	01-04-11-84-01	00-04-12-84-01	01-03-11-85-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	13.1	13.9	15.0
Wheat ash (12% mb)	1.49	1.54	1.64
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	73.5	72.4	72.6
Quadrumat Sr. Mill	72.5	71.4	70.7
Flour moisture (%)	12.4	12.7	13.2
Flour protein (14% mb)	11.8	13.1	13.6
Flour ash (14% mb)	0.44	0.45	0.51
Rapid Visco-Analyser			
Peak Time (min)	6.4	6.5	6.5
Peak Viscosity (RVU)	231.6	246.0	233.7
Breakdown (RVU)	60.8	56.3	51.3
Final Viscosity at 13 min (RVU)	293.2	312.3	311.4
Minolta color meter			
L*	92.36	92.09	91.82
a*	-2.25	-2.36	-2.40
b*	9.74	10.44	11.23
PPO	0.303	0.501	0.195
Falling number (sec)	470	491	609
Damaged Starch			
(AI%)	95.69	95.66	95.39
(AACC76-31)	6.04	6.02	5.81

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

Montana: Physical Dough Tests and Gluten Analysis For 2013 (Small-Scale) Samples

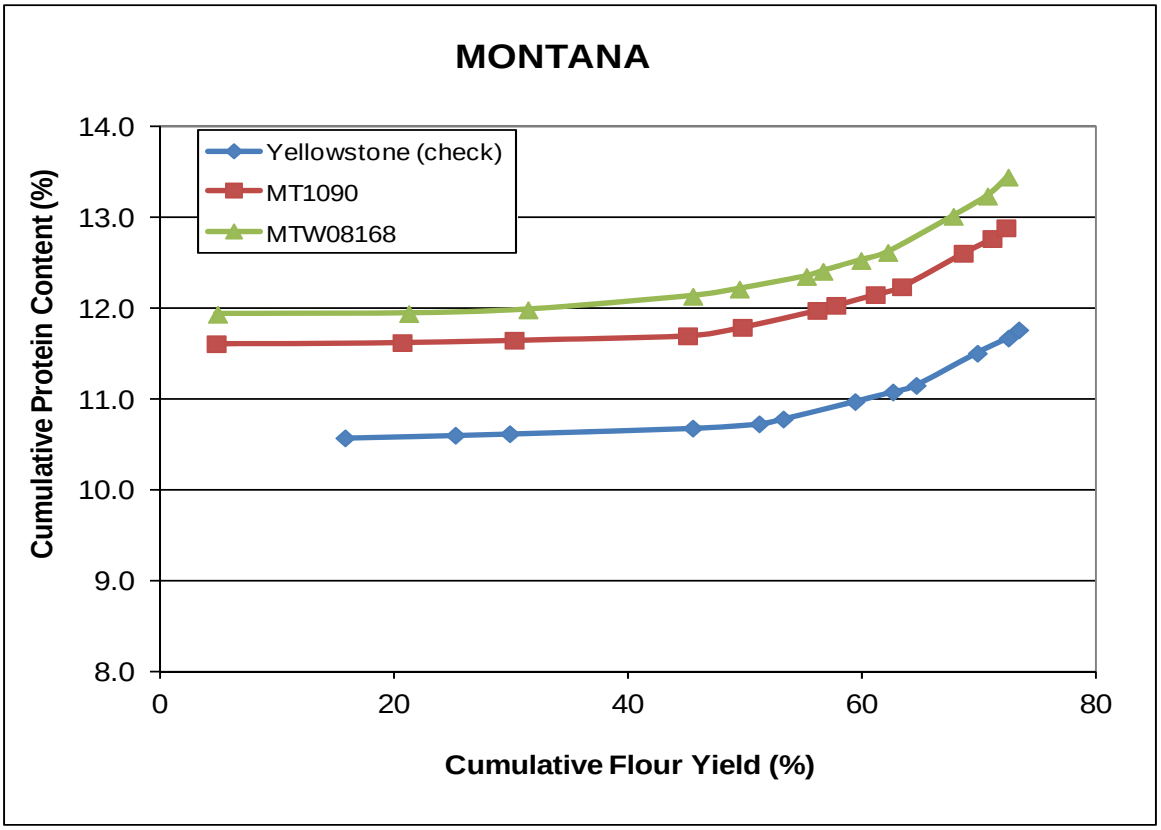
Test Entry Number	13-2415	13-2416	13-2417
Sample Identification	Yellowstone (check)	MT1090	MTW08168
MIXOGRAPH			
Flour Abs (% as-is)	64.5	65.2	66.6
Flour Abs (14% mb)	62.7	63.7	65.7
Mix Time (min)	6.6	10.0	5.8
Mix tolerance (0-6)	5	5	4
FARINOGRAPH			
Flour Abs (% as-is)	61.5	61.5	61.9
Flour Abs (14% mb)	59.7	60.0	61.0
Development time (min)	5.7	6.2	7.5
Mix stability (min)	15.0	26.0	20.1
Mix Tolerance Index (FU)	25	10	19
Breakdown time (min)	11.1	19.9	16.3
ALVEOGRAPH			
P(mm): Tenacity	95	99	104
L(mm): Extensibility	94	97	120
G(mm): Swelling index	21.6	21.9	24.4
W(10^{-4} J): strength (curve area)	367	417	501
P/L: curve configuration ratio	1.01	1.02	0.87
Ie(P_{200}/P): elasticity index	69.7	74.9	73.1
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	673/859/845	994/987/982	851/972/946
Extensibility (mm at 45/90/135 min)	137/129/117	95/82/69	125/121/110
Energy (cm^2 at 45/90/135 min)	153/171/149	122/109/86	156/164/140
Resist $_{max}$ (BU at 45/90/135 min)	905/995/998	997/987/982	981/999/999
Ratio (at 45/90/135 min)	4.93/6.67/7.24	10.5/12.1/14.2	6.8/8.0/8.6
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+8, 5+10	2*, 7+8, 5+10	1, 7+8, 5+10
%IPP	58.28	60.19	58.92
SEDIMENTATION TEST			
Volume (ml)	69.7	70.4	61.5

Montana: Cumulative Ash Curves



Yellowstone (check)					MT1090					MTW08168				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	15.84	0.33	15.84	0.33	2M	15.88	0.33	15.88	0.33	2M	16.34	0.35	16.34	0.35
1M Red	4.65	0.33	20.49	0.33	1M Red	4.84	0.33	20.72	0.33	1M Red	4.95	0.35	21.30	0.35
1M	9.43	0.35	29.93	0.33	1M	9.59	0.35	30.31	0.33	1M	10.20	0.36	31.50	0.36
1BK	6.13	0.37	36.06	0.34	1BK	6.40	0.38	36.71	0.34	1BK	5.74	0.36	37.24	0.36
2BK	5.23	0.42	41.29	0.35	3M	14.83	0.41	51.53	0.36	2BK	5.60	0.42	42.84	0.37
3M	15.64	0.43	56.92	0.37	2BK	5.26	0.46	56.79	0.37	Grader	3.25	0.45	46.09	0.37
Grader	3.23	0.43	60.16	0.37	Grader	3.37	0.46	60.16	0.38	3M	14.08	0.48	60.17	0.40
FILTER FLR	2.00	0.59	62.16	0.38	FILTER FLR	2.26	0.60	62.42	0.38	FILTER FLR	2.29	0.63	62.46	0.41
4M	5.68	0.64	67.84	0.40	4M	4.67	0.66	67.08	0.40	3BK	2.93	0.71	65.39	0.42
5M	2.06	0.69	69.90	0.41	3BK	2.47	0.73	69.56	0.42	4M	3.98	0.75	69.36	0.44
3BK	2.65	0.73	72.56	0.42	5M	1.61	0.91	71.17	0.43	5M	1.41	1.05	70.78	0.45
BRAN FLR	0.89	1.92	73.45	0.44	BRAN FLR	1.18	1.80	72.35	0.45	BRAN FLR	1.76	2.04	72.54	0.49
Filter Bran	1.48	2.05	74.93	0.47	Red Dog	2.49	2.58	74.84	0.52	Break Shorts	2.72	4.03	75.25	0.62
Red Dog	3.34	2.17	78.28	0.55	Filter Bran	2.61	2.69	77.46	0.59	Red Dog	2.79	2.85	78.04	0.70
Break Shorts	2.73	4.15	81.01	0.67	Break Shorts	2.66	3.98	80.12	0.71	Red Shorts	0.49	4.50	78.54	0.72
Red Shorts	0.61	4.48	81.61	0.70	Red Shorts	0.50	4.49	80.61	0.73	Filter Bran	1.86	1.99	80.40	0.75
Bran	18.39	5.10	100.00	1.51	Bran	19.39	5.30	100.00	1.62	Bran	19.60	5.18	100.00	1.62
Wheat		1.46					1.51					1.60		
St. Grd. Fl.		0.44					0.45					0.52		

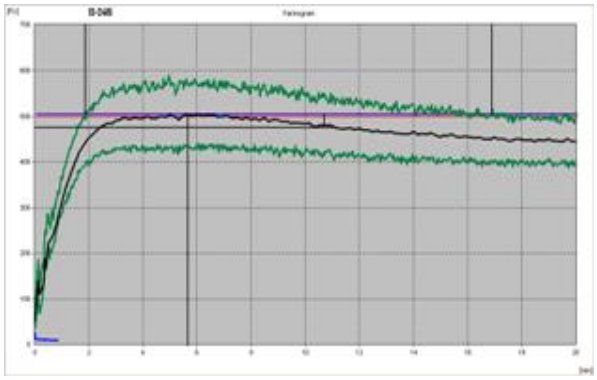
Montana: Cumulative Protein Curves



Yellowstone (check)					MT1090					MTW08168				
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
2M	15.84	10.57	15.84	10.57	1M Red	4.84	11.61	4.84	11.61	1M Red	4.95	11.93	4.95	11.93
1M	9.43	10.65	25.28	10.60	2M	15.88	11.62	20.72	11.62	2M	16.34	11.94	21.30	11.94
1M Red	4.65	10.70	29.93	10.61	1M	9.59	11.70	30.31	11.64	1M	10.20	12.07	31.50	11.98
3M	15.64	10.79	45.56	10.68	3M	14.83	11.79	45.14	11.69	3M	14.08	12.46	45.58	12.13
4M	5.68	11.10	51.25	10.72	4M	4.67	12.69	49.80	11.79	4M	3.98	13.10	49.56	12.21
5M	2.06	12.09	53.31	10.78	1BK	6.40	13.42	56.20	11.97	1BK	5.74	13.54	55.30	12.35
1BK	6.13	12.64	59.44	10.97	5M	1.61	13.98	57.81	12.03	5M	1.41	14.62	56.71	12.40
Grader	3.23	13.02	62.68	11.07	Grader	3.37	14.17	61.18	12.15	Grader	3.25	14.62	59.96	12.52
FILTER FLR	2.00	13.41	64.68	11.15	FILTER FLR	2.26	14.58	63.44	12.23	FILTER FLR	2.29	14.93	62.25	12.61
2BK	5.23	15.89	69.90	11.50	2BK	5.26	17.05	68.69	12.60	2BK	5.60	17.43	67.85	13.01
3BK	2.65	16.09	72.56	11.67	3BK	2.47	17.28	71.17	12.76	3BK	2.93	18.40	70.78	13.23
BRAN FLR	0.89	19.05	73.45	11.76	BRAN FLR	1.18	19.96	72.35	12.88	BRAN FLR	1.76	21.84	72.54	13.44
Break Shorts	2.73	15.78	76.18	11.90	Break Shorts	2.66	16.01	75.01	12.99	Break Shorts	2.72	17.42	75.25	13.58
Red Dog	3.34	13.80	79.52	11.98	Red Dog	2.49	15.05	77.50	13.06	Red Dog	2.79	17.12	78.04	13.71
Red Shorts	0.61	15.75	80.13	12.01	Red Shorts	0.50	16.00	78.00	13.08	Red Shorts	0.49	17.43	78.54	13.73
Filter Bran	1.48	12.18	81.61	12.01	Filter Bran	2.61	15.16	80.61	13.15	Filter Bran	1.86	15.89	80.40	13.78
Bran	18.39	17.52	100.00	13.03	Bran	19.39	15.93	100.00	13.69	Bran	19.60	18.19	100.00	14.65
Wheat		12.8					13.6					14.7		
St. Grd. Fl		11.8					13.1					13.6		

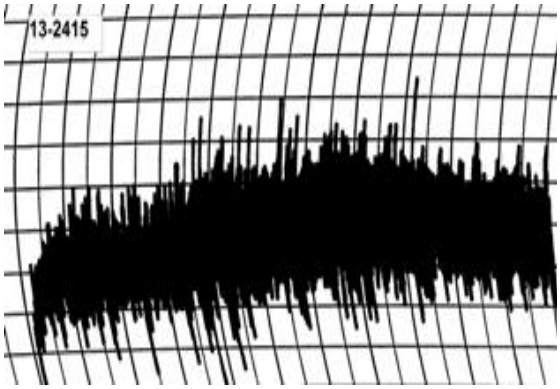
Physical Dough Tests
2013 (Small Scale) Samples – Montana

Farinograms



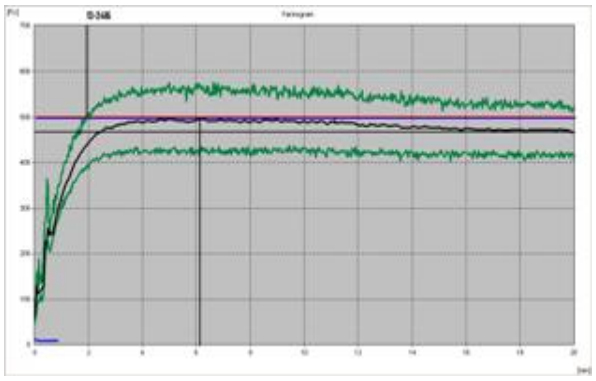
Water abs = 59.7%, Peak time = 5.7 min,
Mix stab = 15.0 min, MTI = 25 FU

Mixograms

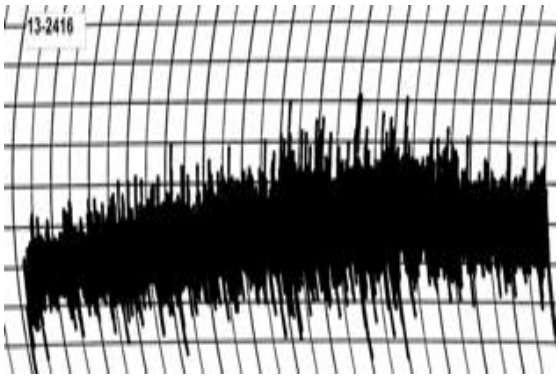


Water abs = 62.7%
Mix time = 6.6 min

13-2415, Yellowstone (check)



Water abs = 60.0%, Peak time = 6.2 min,
Mix stab = 26.0 min, MTI = 10 FU



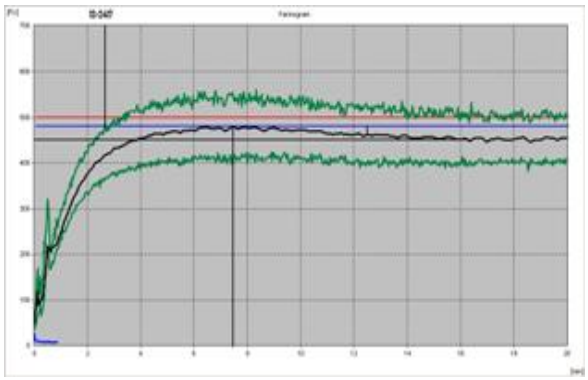
Water abs = 63.7%
Mix time = 10.0 min

13-2416, MT1090

Physical Dough Tests

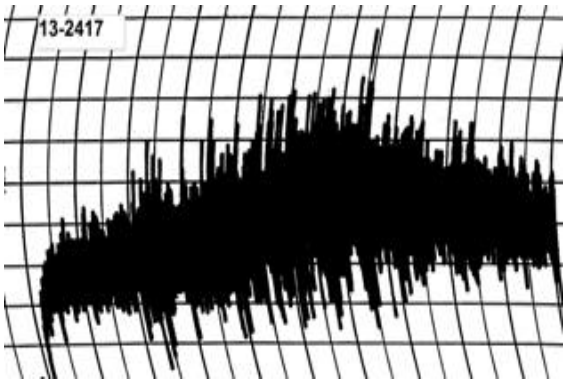
2013 (Small Scale) Samples – Montana (continued)

Farinograms



Water abs. = 61.0%, Peak time = 7.5 min,
Mix stab = 20.1 min, MTI = 19 FU

Mixograms

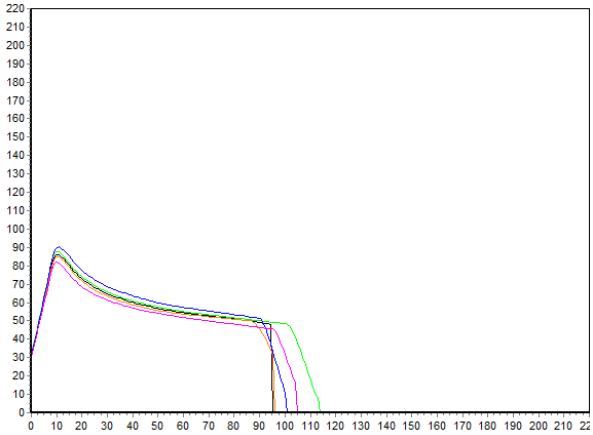


Water abs = 65.7%
Mix time = 5.8 min

13-2417, MTW08168

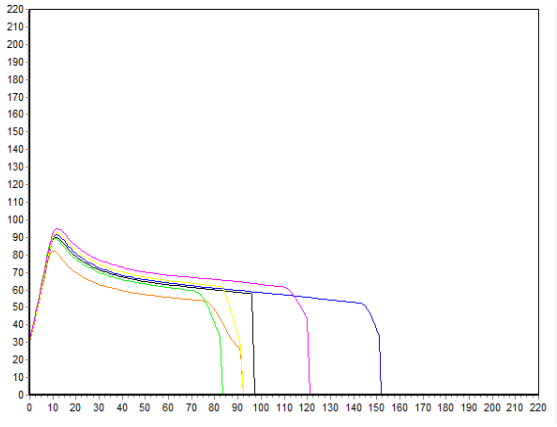
Physical Dough Tests - Alveograph

2013 (Small Scale) Samples – Montana



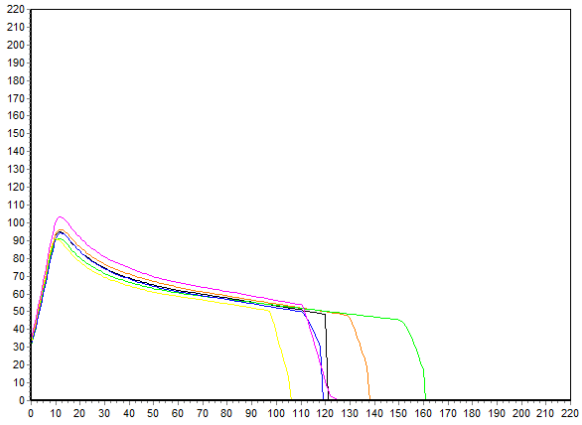
13-2415, Yellowstone (check)

P (mm H_20) = 95, L (mm) = 94, W ($10E^{-4}J$) = 367



13-2416, MT1090

P (mm H_20) = 99, L (mm) = 97, ($10E^{-4}J$) = 417

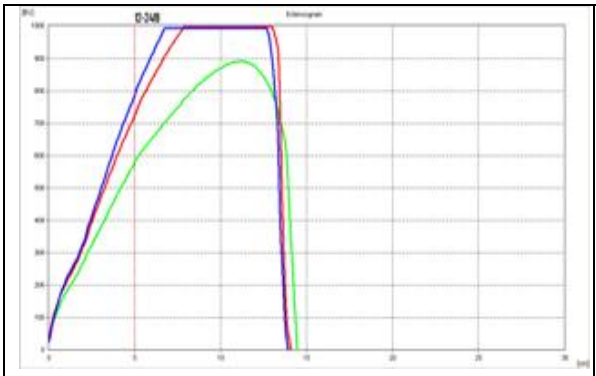


13-2417, MTW08168

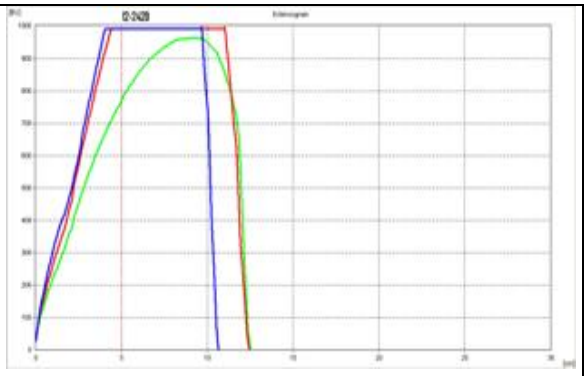
P (mm H_20) = 104, L (mm) = 120, W ($10E^{-4}J$) = 501

Physical Dough Tests - Extensigraph

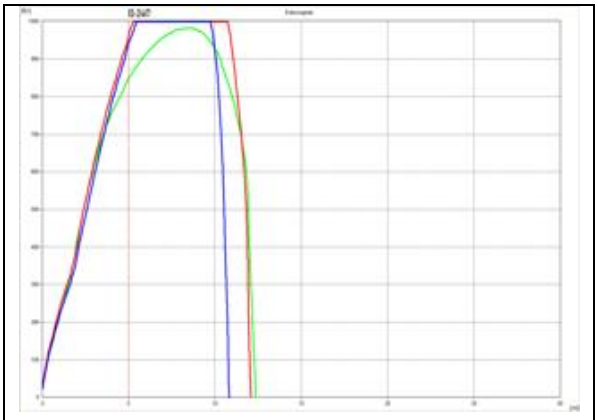
2013 (Small Scale) Samples – Montana



13-2415, Yellowstone (check)
R (BU) = 859, E (mm) = 129, W (cm^2) = 171
Rmax (BU) = 995, Ratio = 6.7 at 90 min



13-2416, MT1090
R (BU) = 987, E (mm) = 82, W (cm^2) = 109
Rmax (BU) = 987, Ratio = 12.1 at 90 min



13-2417, MTW08168
R (BU) = 972, E (mm) = 121, W (cm^2) = 164
Rmax (BU) = 999, Ratio = 8.0 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Montana: C-Cell Bread Images and Analysis for 2013 (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	6546	150	4270	0.440	1.952	7.631	1.675	-22.75
2416	6932	150	4273	0.447	2.085	3.712	1.673	-27.80

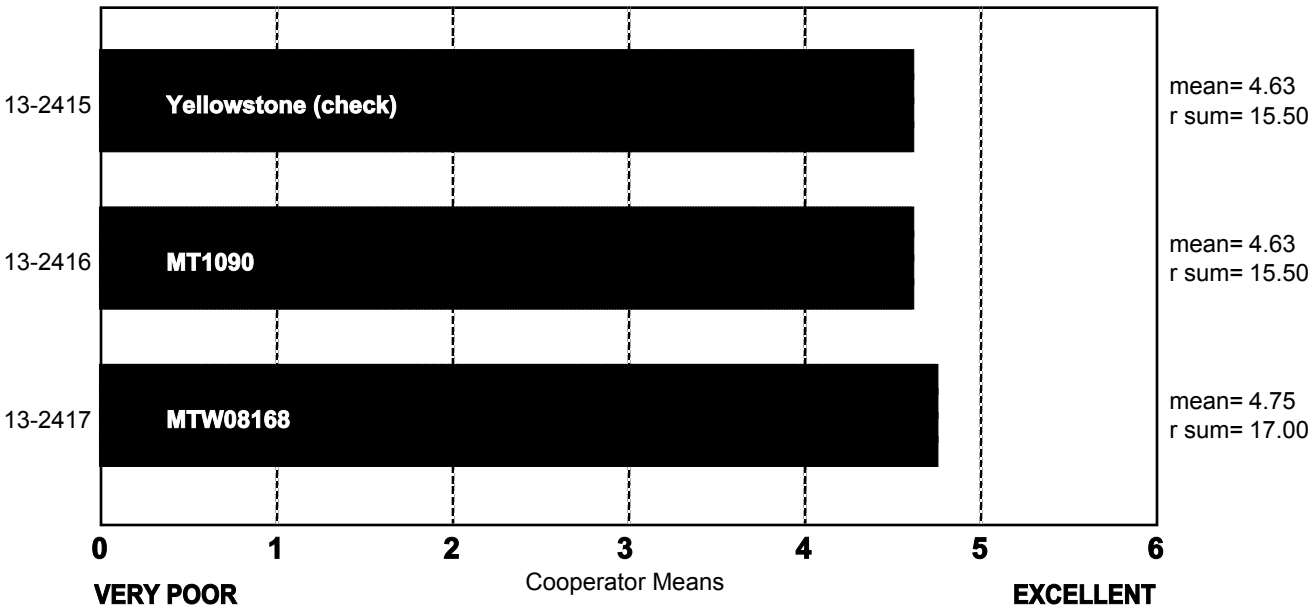
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2417	6854	153	4536	0.434	2.001	10.498	1.703	-34.25

SPONGE CHARACTERISTICS

(Small Scale) Montana

ncoop= 8
chisq= 0.19
chisqc= -0.29
cvchisq= 5.99
crdiff=

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

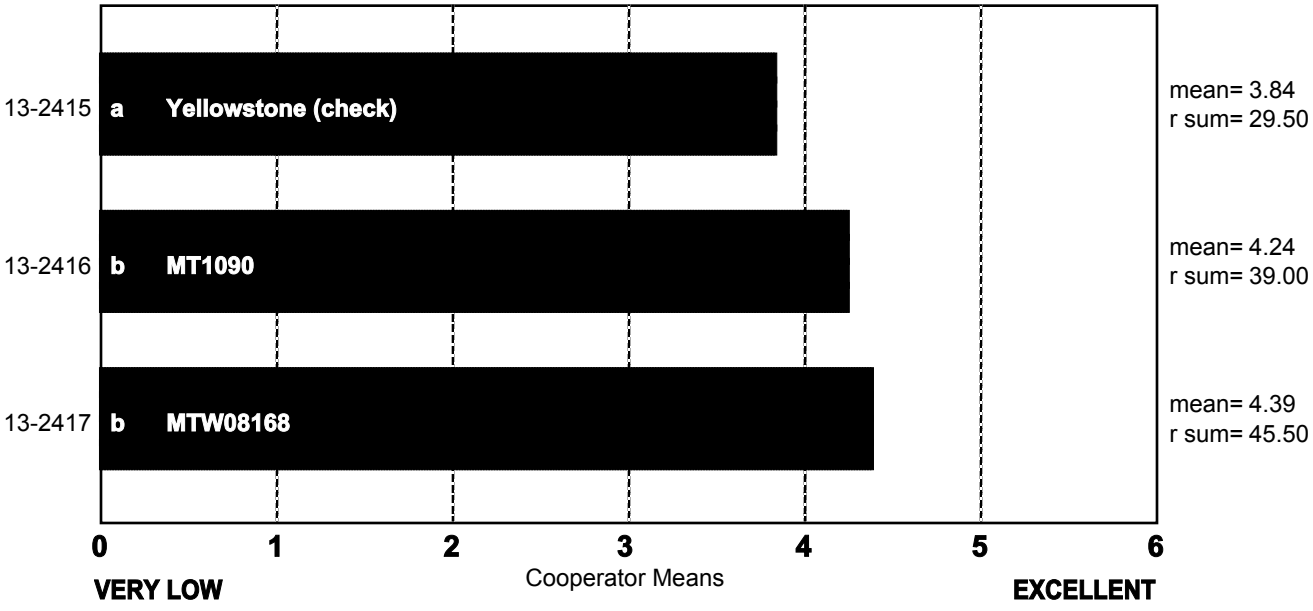


BAKE ABSORPTION

(Small Scale) Montana

ncoop= 19
chisq= 6.82
chisqc= 12.63
cvchisq= 5.99
crdiff= 7.71

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



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	Coop. R	Coop. S
13-2415 Yellowstone (check)	**20.0**	**60.0**	**6.0**	**25.0**	**30.0**	**5.8**	**6.5**	**7.3**	**5.5**	**8.0**	**5.0**	**7.9**	**4.2**	**3.8**	**8.8**	**17.0**	**8.5**	**6.1**	**13.0**
13-2416 MT1090	**20.0**	**60.0**	**9.0**	**25.0**	**30.0**	**7.8**	**9.0**	**8.0**	**7.0**	**17.0**	**7.0**	**10.4**	**5.7**	**3.8**	**11.0**	**21.0**	**9.6**	**6.5**	**14.0**
13-2417 MTW08168	**20.0**	**25.0**	**9.0**	**25.0**	**30.0**	**5.5**	**7.5**	**5.5**	**4.5**	**11.0**	**5.0**	**8.1**	**4.2**	**3.0**	**8.5**	**16.0**	**8.5**	**5.3**	**13.0**

BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Montana

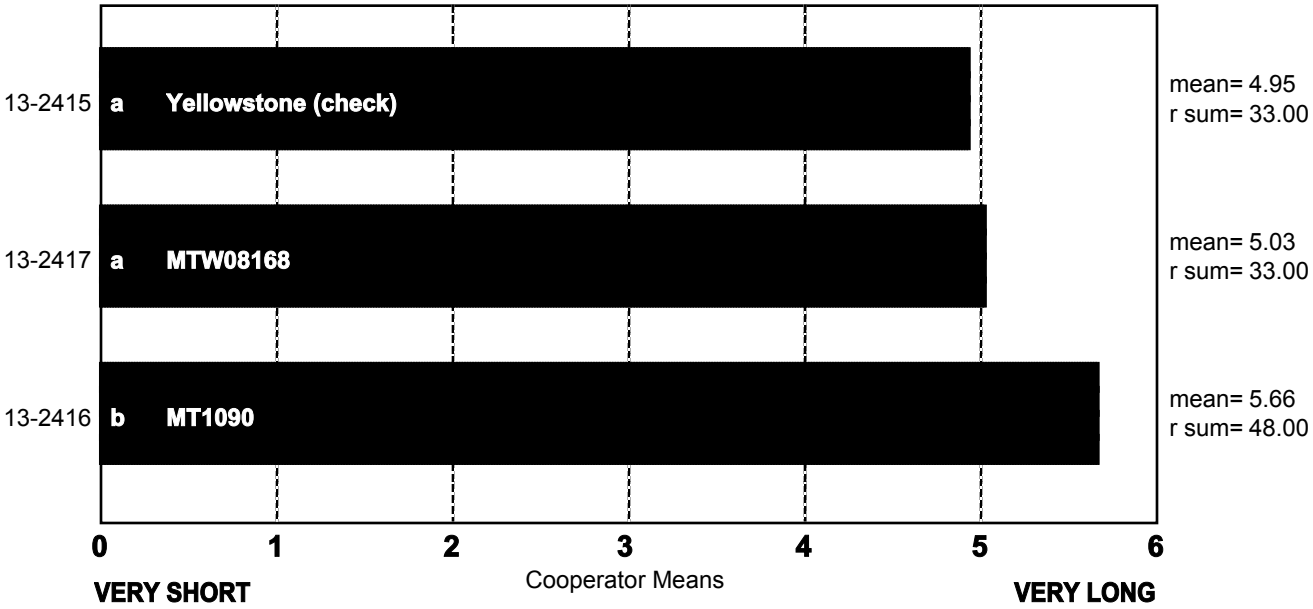
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2415 Yellowstone (check)	**58.0**	**61.0**	**62.0**	**61.0**	**64.0**	**64.5**	**59.7**	**67.0**	**61.2**	**59.7**	**67.7**	**62.4**	**64.0**	**57.4**	**61.9**	**62.0**	**71.8**	**64.7**	**59.7**
13-2416 MT1090	**59.0**	**63.0**	**64.0**	**61.0**	**62.0**	**65.7**	**60.0**	**67.0**	**63.1**	**60.0**	**68.6**	**64.5**	**64.5**	**58.0**	**64.2**	**62.0**	**72.6**	**65.0**	**60.0**
13-2417 MTW08168	**60.0**	**63.0**	**64.0**	**62.0**	**60.0**	**65.7**	**61.0**	**69.0**	**64.0**	**61.0**	**67.5**	**65.8**	**65.0**	**58.6**	**65.8**	**62.0**	**76.8**	**66.6**	**61.0**

BAKE MIX TIME

(Small Scale) Montana

ncoop= 19
chisq= 7.89
chisqc= 13.64
cvchisq= 5.99
crdiff= 6.62

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

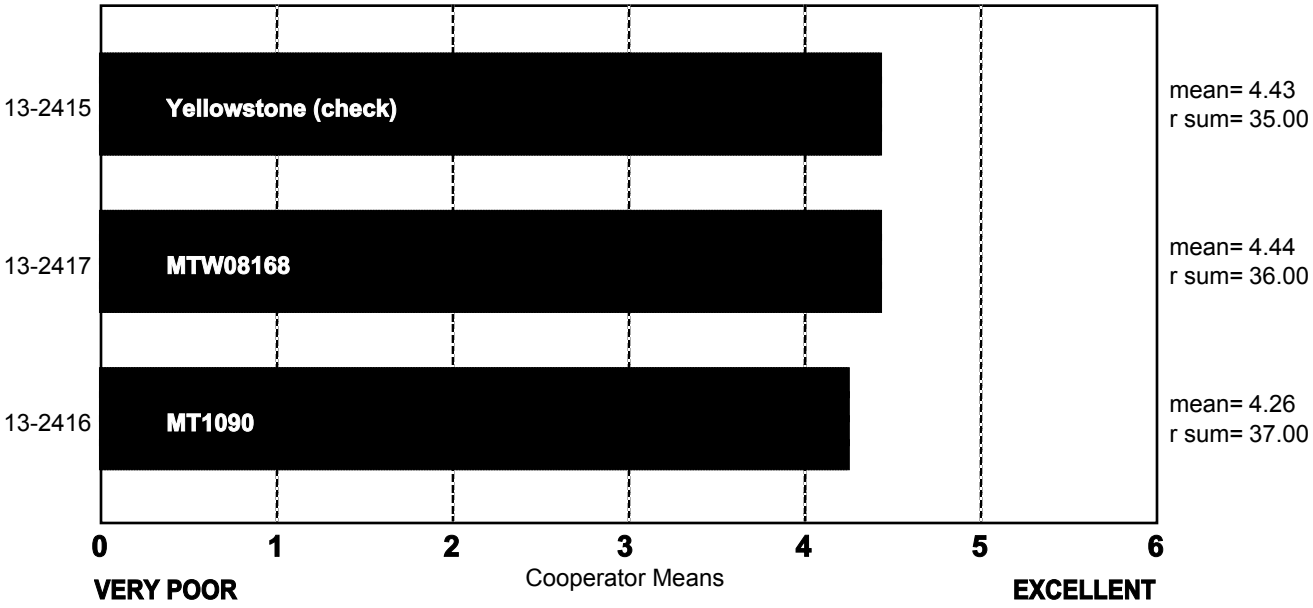


MIXING TOLERANCE

(Small Scale) Montana

ncoop= 18
chisq= 0.11
chisqc= 0.23
cvchisq= 5.99
crdiff=

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



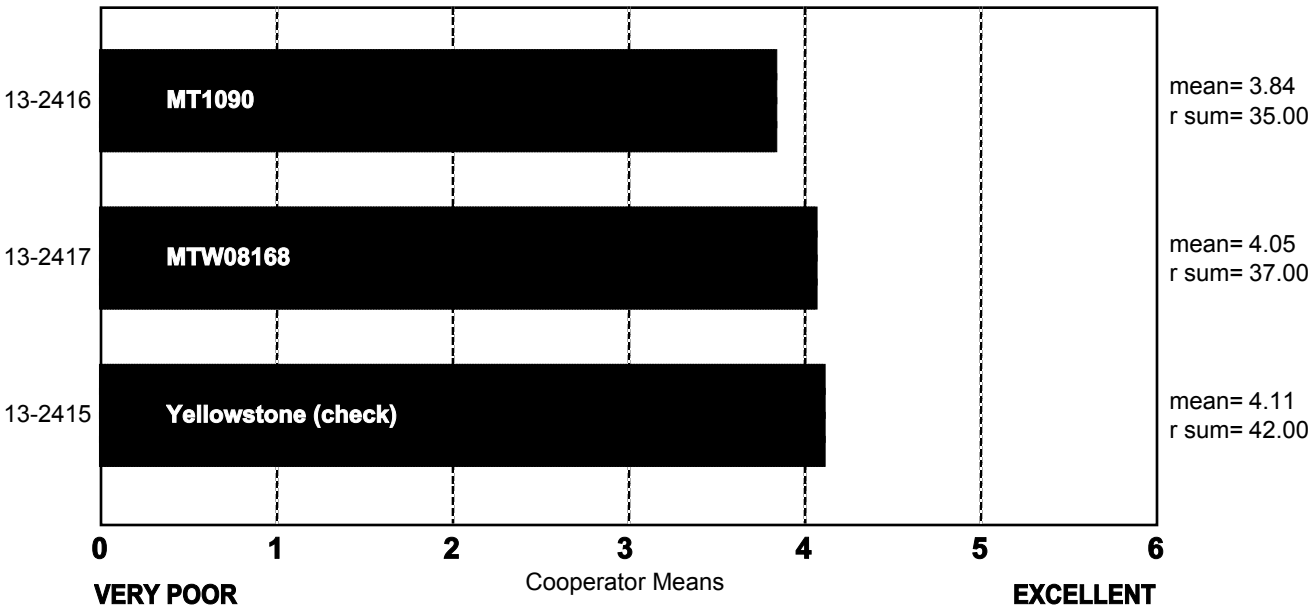
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Montana

ncoop= 19
chisq= 1.37
chisqc= 2.89
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) Montana

	Sticky	Wet	Tough	Good	Excellent
13-2415 Yellowstone (check)	**1**	**0**	**9**	**5**	**4**
13-2416 MT1090	**1**	**0**	**11**	**2**	**5**
13-2417 MTW08168	**1**	**0**	**7**	**7**	**4**

Frequency Table

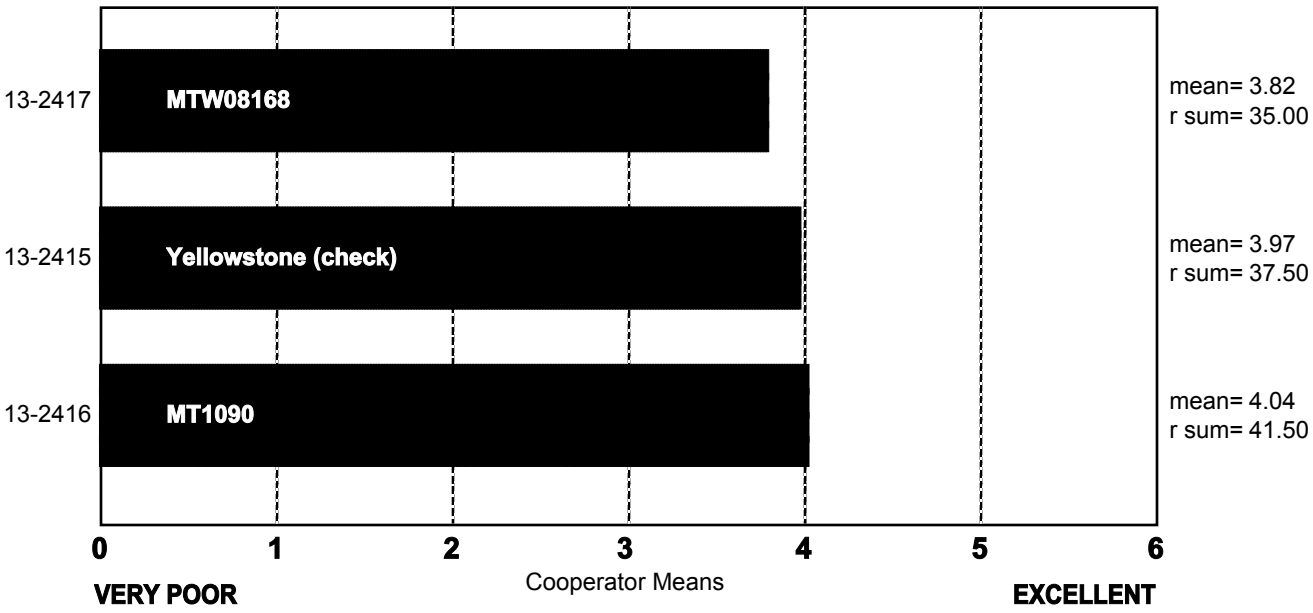
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Montana

ncoop= 19
chisq= 1.13
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) Montana

	Sticky	Wet	Tough	Good	Excellent
13-2415 Yellowstone (check)	**1**	**0**	**8**	**8**	**2**
13-2416 MT1090	**1**	**0**	**9**	**6**	**3**
13-2417 MTW08168	**2**	**0**	**5**	**10**	**2**

Frequency Table

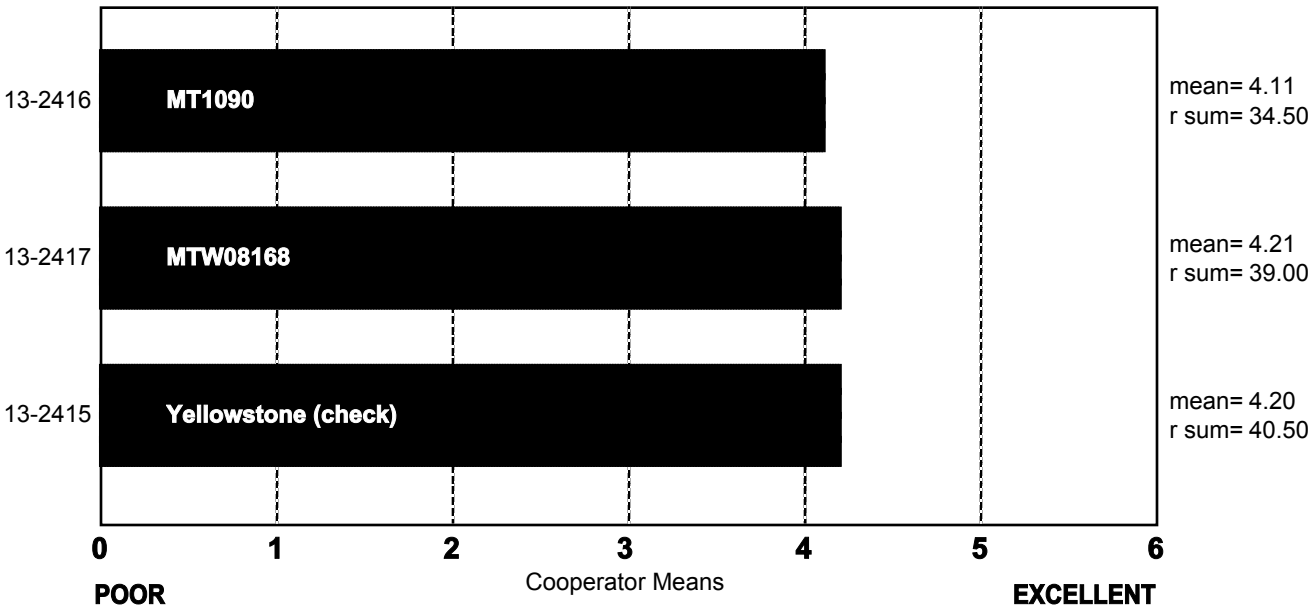
CRUMB GRAIN

(Small Scale) Montana

ncoop= 19
chisq= 1.03
chisqc= 1.56
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED

(Small Scale) Montana

	Open	Fine	Dense
13-2415 Yellowstone (check)	**4**	**13**	**2**
13-2416 MT1090	**9**	**9**	**1**
13-2417 MTW08168	**9**	**9**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Montana

	Round	Irregular	Elongated
13-2415 Yellowstone (check)	**5**	**5**	**9**
13-2416 MT1090	**2**	**11**	**6**
13-2417 MTW08168	**2**	**5**	**12**

Frequency Table

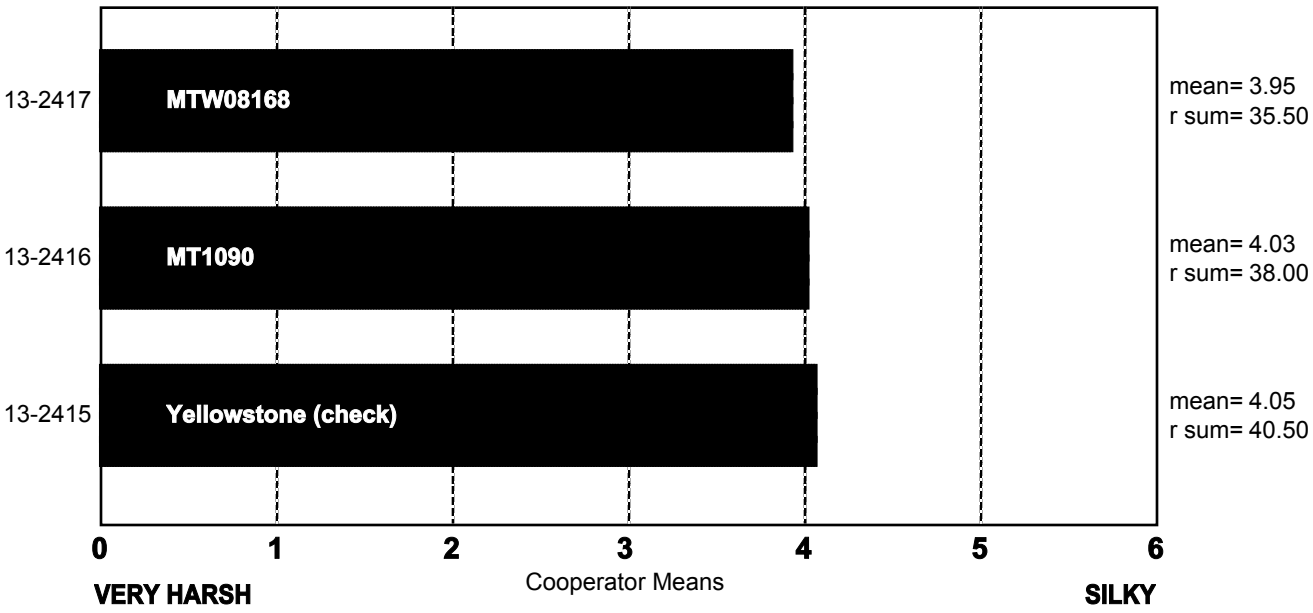
CRUMB TEXTURE

(Small Scale) Montana

ncoop= 19
chisq= 0.66
chisqc= 1.43
cvchisq= 5.99
crdiff=

Variety order by rank sum.

No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Montana

	Harsh	Smooth	Silky
13-2415 Yellowstone (check)	**3**	**11**	**5**
13-2416 MT1090	**1**	**15**	**3**
13-2417 MTW08168	**2**	**13**	**4**

Frequency Table

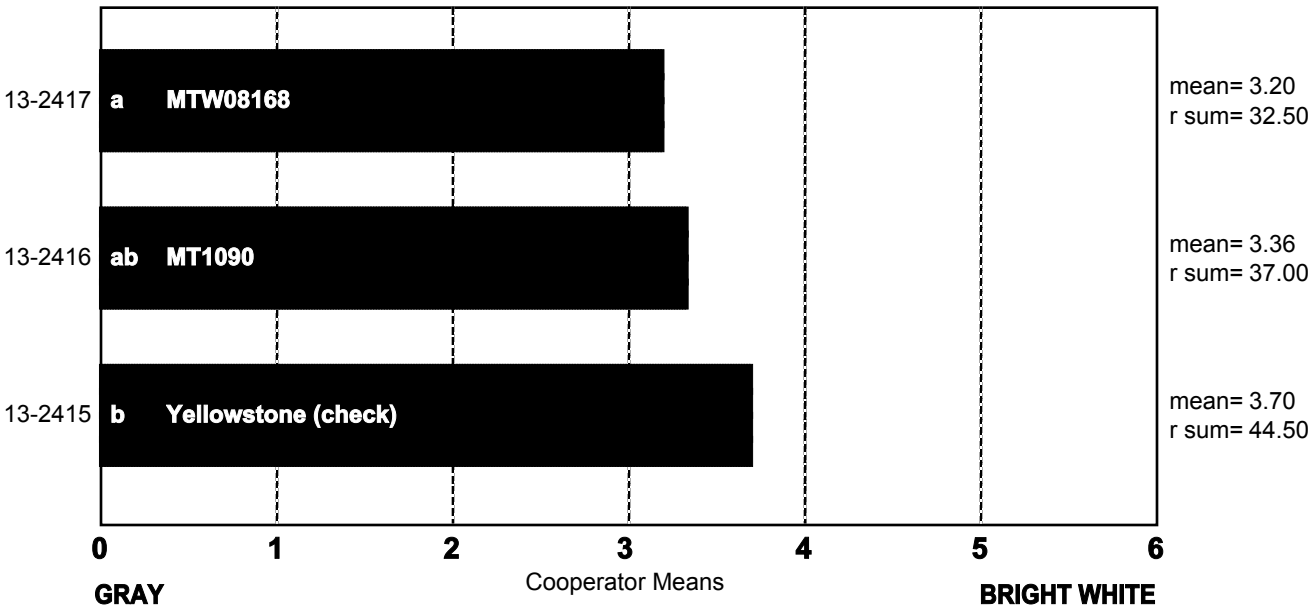
CRUMB COLOR

(Small Scale) Montana

ncoop= 19
chisq= 3.87
chisqc= 6.26
cvchisq= 5.99
crdiff= 9.23

Variety order by rank sum.

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



CRUMB COLOR, DESCRIBED

(Small Scale) Montana

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
13-2415 Yellowstone (check)	**0**	**0**	**3**	**1**	**14**	**0**	**1**
13-2416 MT1090	**0**	**0**	**6**	**2**	**10**	**0**	**1**
13-2417 MTW08168	**0**	**1**	**7**	**1**	**8**	**2**	**0**

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	Coop. R	Coop. S
13-2415 Yellowstone (check)	**413.0**	**471.3**	**130.0**	**487.5**	**463.0**	**145.1**	**459.0**	**144.0**		**452.0**	**132.1**	**142.2**		**131.0**	**149.7**	**482.3**	**158.5**	**139.0**	**448.0**
13-2416 MT1090	**412.0**	**469.7**	**130.0**	**479.8**	**463.5**	**144.5**	**464.0**	**140.1**		**453.2**	**129.0**	**140.9**		**131.8**	**150.6**	**482.9**	**155.0**	**139.2**	**447.0**
13-2417 MTW08168	**415.0**	**467.5**	**130.0**	**487.8**	**473.0**	**146.9**	**454.0**	**148.6**		**455.1**	**133.9**	**143.3**		**131.4**	**153.5**	**480.6**	**158.4**	**140.4**	**446.0**

LOAF VOLUME, ACTUAL

(Small Scale) Montana

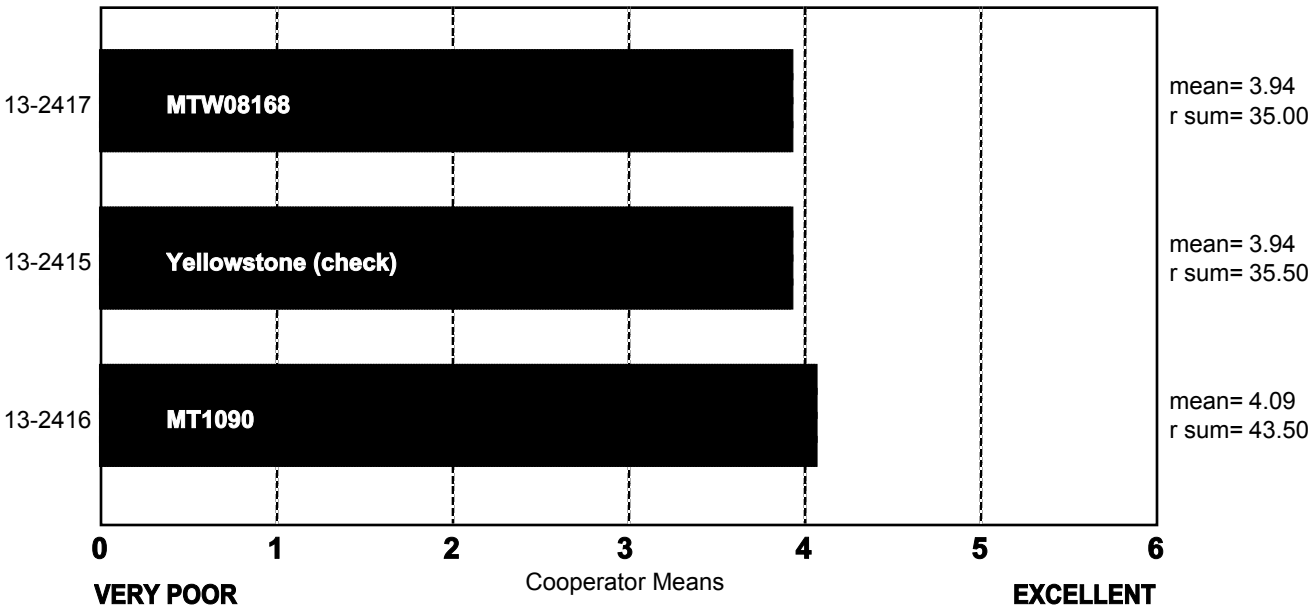
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2415 Yellowstone (check)	**3025**	**2463**	**995**	**3000**	**2675**	**900**	**2325**	**1148**	**1000**	**2450**	**830**	**840**	**885**	**790**	**860**	**2625**	**1073**	**845**	**2225**
13-2416 MT1090	**2850**	**2500**	**1015**	**2986**	**2625**	**1065**	**2475**	**1095**	**1010**	**2460**	**885**	**885**	**955**	**815**	**965**	**2613**	**1080**	**871**	**2400**
13-2417 MTW08168	**3000**	**2500**	**955**	**3162**	**2575**	**950**	**2800**	**1028**	**1010**	**2310**	**960**	**863**	**930**	**795**	**935**	**2525**	**1080**	**824**	**2375**

LOAF VOLUME

(Small Scale) Montana

ncoop= 19
chisq= 2.39
chisqc= 3.14
cvchisq= 5.99
crdiff=

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

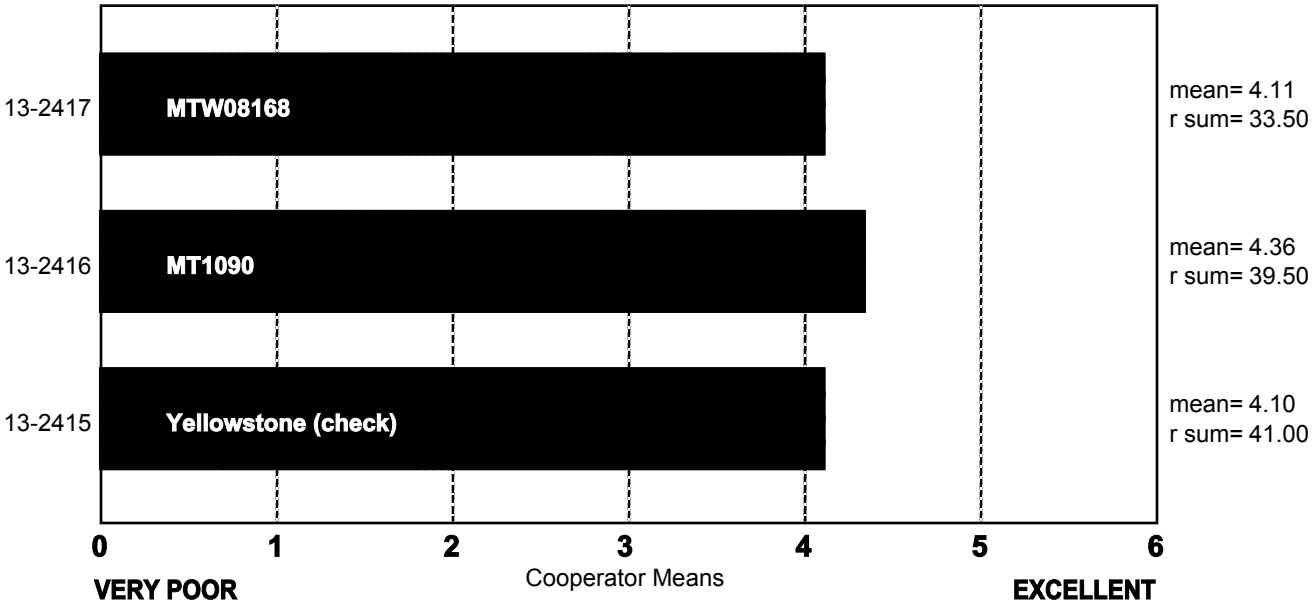


OVERALL BAKING QUALITY

(Small Scale) Montana

ncoop= 19
chisq= 1.66
chisqc= 1.91
cvchisq= 5.99
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Montana

COOP. **13-2415 Yellowstone (check)**

A. Open grain, slightly creamy, tough strong dough, and excellent volume.
B. Average absorption, extremely long mix, low volume, creamy crumb, slightly open grain.
C. Lively, slightly underdeveloped, good baking performance.
D. Excellent interior scores, very strong mixing dough.
E. No comment.
F. Cap.
G. No comment.
H. No comment.
I. No comment.
J. Good dough, good volume and grain rating, white in color.
K. No comment.
L. Normal absorption, longer mix time, slight sticky & strong dough, higher OS & volume, creamy crumb, fine & elongated cells, silky & resilient texture.
M. Slightly above average baker.
N. Nice moisture, smooth, slightly resistant at mixing. At panning, elastic dough with nice body and gas. Poor moulding.
O. Bake absorption on low side & mix time long however dough was excellent out of mix & pan, above satisfactory crumb grain, creamy.
P. Good absorption, long mix time, tolerant to mixing, tough dough, fine grain, good volume. Overall nice sample.
Q. Good overall performance.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. No comment.

COOP. **13-2416 MT1090**

A. Very open grain, yellow interior, very tough dough, bucky, acceptable volume.
B. Above average absorption, extremely long mix, low volume, creamy crumb, open grain.
C. Underdeveloped, excellent mix tolerance, excellent baking performance.
D. Very strong dough, slightly wet dough, very tight, consistent grain, good volume.
E. No comment.
F. Long time to pick-up.
G. No comment.
H. No comment.
I. No comment.
J. Long mix time, bucky dough, average volume, good grain rating, white in color.
K. No comment.
L. Normal absorption, much longer mix time, slight sticky & strong dough, much higher OS & volume, yellow crumb, fine & elongated cells, smooth & resilient texture.
M. Very good protein, very long mixing, good baker.

N. At mixing dough was dry and tough yet smooth. At panning dough was elastic with nice body and nice gas. Poor moulding.
O. Flour protein excellent, bake absorption excellent, long mix time, excellent out of mix & pan, above satisfactory crumb grain, creamy; rated better than the check.
P. Good absorption, very long mix time, tolerant to mixing, tough dough, average grain, yellow crumb, good volume.
Q. Good overall performance.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. No comment.

COOP. 13-2417 MTW08168

A. Very open grain, yellow interior, very tough dough, bucky, acceptable volume.
B. Above average absorption, long mix, low volume, yellow crumb, open grain, slightly flat.
C. Strong, slightly underdeveloped, good baking performance.
D. Strong mixing dough, tight, slightly variable grain, excellent volume.
E. No comment.
F. No comment.
G. Very good. BEST.
H. No comment.
I. No comment.
J. Bucky dough, very low volume, dense grain rating.
K. Poor color.
L. Larger absorption, longer mix time, slightly sticky & strong dough, higher OS & volume, yellow crumb, open & elongated cells, smooth & resilient texture.
M. Very good protein, slightly longer mixing, good baker.
N. At mixing; smooth dough with resistance. Elastic, smooth dough with nice body and gas, slightly bucky at panning.
O. Flour protein excellent, bake absorption excellent, long mix time, excellent out of mix & pan, excellent crumb grain, creamy; rated better than the check.
P. Good absorption, long mix time, tolerant to mixing, tough at make-up, fine grain, average volume.
Q. Nice dough strength.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. Wild break and shred.

Notes: **A, B, C, D, E, J, P and S** conducted sponge and dough bake tests

OKLAHOMA

13-2418	Ruby Lee (check)
13-2419	Doublestop CL+
13-2420	OK09125

Description of Test Plots and Breeder Entries

Oklahoma - Brett Carver

Oklahoma's 2013 WQC grain samples were produced entirely at the North Central Agronomy Research Station at Lahoma (near Enid, OK) with no supplemental irrigation. This is the primary selection site for determining grain-only yield performance among early to late-generation experimental lines. Fungicide was not applied, though various leaf-spotting diseases were present. Harvest occurred at the appropriate time.

Ruby Lee (check)

Released in 2011 and positioned as an alternative to Billings in non-acidic areas, Ruby Lee was previously tested in the 2009 and 2010 WQC evaluations as OK05526 (KS94U275/OK94P549) and as OK05526-RHf in 2012. The breeder-seed source of Ruby Lee was named OK05526-RHf to represent a single-plant F_9 selection from OK05526 with seedling resistance (temperature-sensitive) to Hessian fly. In statewide variety trials Ruby Lee has shown good yield potential and end-use quality consistent with Billings.

Doublestop CL Plus

A 2-gene CLEARFIELD HRW cultivar, Doublestop CL Plus (N91D2308-13/OK03908C//OK03928C) was tested in the 2013 SRPN with the experimental designation OK09915C. Grain yield performance is acceptable, while test weight and quality characteristics are above-average.

OK09125

This HRW candidate with pedigree Overley/TX98D1170 was tested in the 2013 SRPN. It has demonstrated good drought tolerance with below-average test weight.

Oklahoma: 2013 (Small-Scale) Samples

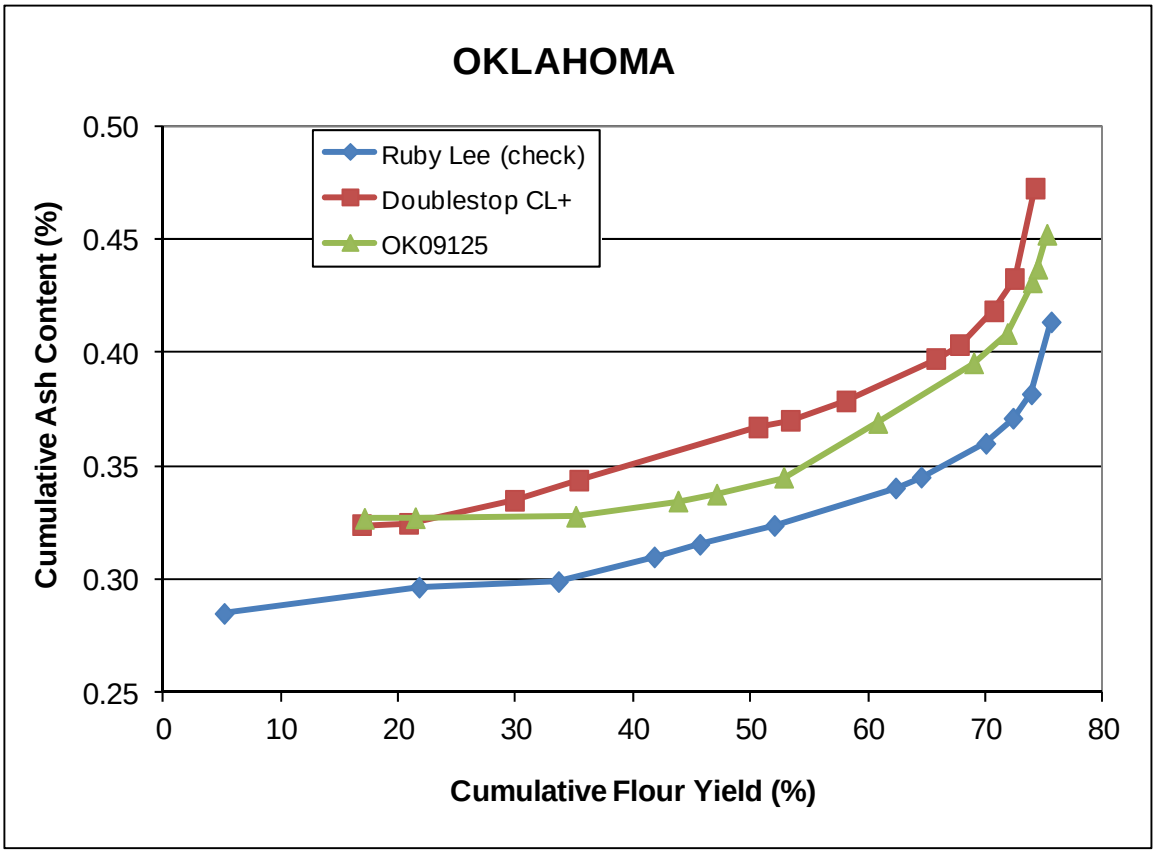
Test entry number	13-2418	13-2419	13-2420
Sample identification	**Ruby Lee (check)**	**Doublestop CL+**	**OK09125**
Wheat Data			
GIPSA classification	1 HRW	1 HRW	2 HRW
Test weight (lb/bu)	60.0	61.9	58.2
Hectoliter weight (kg/hl)	78.9	81.4	76.7
1000 kernel weight (gm)	31.2	31.5	30.0
Wheat kernel size (Rotap)			
Over 7 wire (%)	83.0	76.2	77.3
Over 9 wire (%)	17.0	23.8	22.7
Through 9 wire (%)	0.0	0.0	0.0
Single kernel (skcs)[a]			
Hardness (avg /s.d)	56.4/14.3	77.3/16.0	60.3/16.0
Weight (mg) (avg/s.d)	31.2/6.9	31.5/8.4	30.0/7.3
Diameter (mm)(avg/s.d)	2.76/0.34	2.75/0.31	2.71/0.34
Moisture (%) (avg/s.d)	11.6/0.4	10.9/0.5	11.0/0.5
SKCS distribution	05-18-36-41-01	01-00-08-91-01	04-15-27-54-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	12.1	13.5	11.2
Wheat ash (12% mb)	1.45	1.59	1.47
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	75.0	73.4	75.4
Quadrumat Sr. Mill	72.0	71.8	72.7
Flour moisture (%)	12.9	12.4	12.2
Flour protein (14% mb)	10.9	12.1	10.0
Flour ash (14% mb)	0.39	0.45	0.46
Rapid Visco-Analyser			
Peak Time (min)	6.1	6.3	6.2
Peak Viscosity (RVU)	261.0	256.1	265.8
Breakdown (RVU)	100.9	91.2	97.3
Final Viscosity at 13 min (RVU)	293.3	285.3	296.7
Minolta color meter			
L*	92.23	91.43	91.79
a*	-2.16	-2.24	-2.55
b*	9.10	10.12	9.97
PPO	0.385	0.469	0.467
Falling number (sec)	482	522	459
Damaged Starch			
(AI%)	94.42	95.35	95.38
(AACC76-31)	5.11	5.78	5.80

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

Oklahoma: Physical Dough Tests and Gluten Analysis For 2013 (Small-Scale) Samples

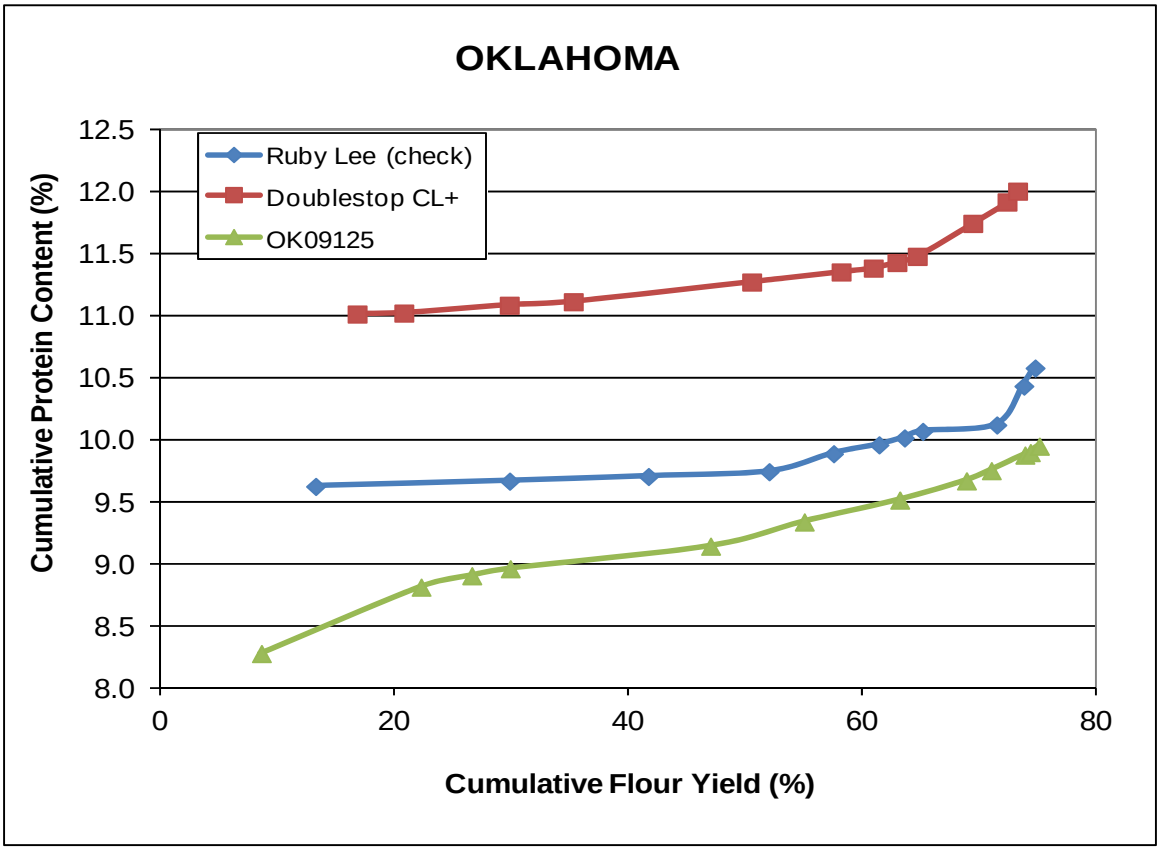
Test Entry Number	13-2418	13-2419	13-2420
Sample Identification	Ruby Lee (check)	Doublestop CL+	OK09125
MIXOGRAPH			
Flour Abs (% as-is)	62.4	64.8	61.2
Flour Abs (14% mb)	61.1	63.0	59.1
Mix Time (min)	4.4	3.5	3.9
Mix tolerance (0-6)	4	4	2
FARINOGRAPH			
Flour Abs (% as-is)	57.3	61.7	56.6
Flour Abs (14% mb)	56.0	59.9	54.5
Development time (min)	6.0	5.9	6.8
Mix stability (min)	24.7	18.7	19.4
Mix Tolerance Index (FU)	13	19	17
Breakdown time (min)	19.5	13.1	15.2
ALVEOGRAPH			
P(mm): Tenacity	73	76	61
L(mm): Extensibility	124	139	128
G(mm): Swelling index	24.8	26.2	25.2
W(10^{-4} J): strength (curve area)	320	319	257
P/L: curve configuration ratio	0.59	0.55	0.48
Ie(P_{200}/P): elasticity index	63.1	56.4	59.0
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	456/612/643	353/498/536	388/659/805
Extensibility (mm at 45/90/135 min)	167/157/150	164/170/158	165/151/125
Energy (cm^2 at 45/90/135 min)	156/185/185	114/176/166	125/185/163
Resist $_{max}$ (BU at 45/90/135 min)	730/960/999	534/820/844	570/987/999
Ratio (at 45/90/135 min)	2.74/3.91/4.30	2.16/2.93/3.39	2.35/4.37/6.43
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+8, 2+12	2*, 7+8, 2+12	1, 17+18, 5+10
%IPP	49.82	42.19	43.70
SEDIMENTATION TEST			
Volume (ml)	56.8	54.5	40.2

Oklahoma: Cumulative Ash Curves



Ruby Lee (check)					Doublestop CL+					OK09125				
Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash	Mill Streams	Strm-yld (14%mb)	Ash	Cumul (14%) Yield	Ash
1M Red	5.19	0.28	5.19	0.28	2M	16.88	0.32	16.88	0.32	2M	17.12	0.33	17.12	0.33
2M	16.58	0.30	21.77	0.30	1M Red	4.00	0.33	20.89	0.32	1M Red	4.33	0.33	21.46	0.33
1M	11.87	0.30	33.64	0.30	1M	9.01	0.36	29.90	0.33	1M	13.65	0.33	35.11	0.33
1BK	8.15	0.35	41.79	0.31	1BK	5.47	0.39	35.37	0.34	1BK	8.71	0.36	43.81	0.33
Grader	3.89	0.38	45.68	0.32	3M	15.25	0.42	50.62	0.37	Grader	3.29	0.38	47.11	0.34
2BK	6.34	0.38	52.01	0.32	Grader	2.75	0.42	53.37	0.37	2BK	5.70	0.41	52.81	0.34
3M	10.32	0.42	62.34	0.34	2BK	4.74	0.47	58.11	0.38	3M	8.01	0.53	60.82	0.37
FILTER FLR	2.18	0.48	64.51	0.34	4M	7.64	0.54	65.75	0.40	FILTER FLR	8.16	0.59	68.98	0.40
4M	5.51	0.54	70.02	0.36	FILTER FLR	2.01	0.60	67.77	0.40	3BK	2.87	0.72	71.85	0.41
3BK	2.31	0.71	72.33	0.37	3BK	2.93	0.76	70.70	0.42	4M	2.13	1.20	73.97	0.43
5M	1.56	0.88	73.89	0.38	5M	1.74	1.01	72.44	0.43	5M	0.47	1.39	74.44	0.44
Filter Bran	1.69	1.80	75.58	0.41	Filter Bran	1.76	2.11	74.21	0.47	BRAN FLR	0.77	1.89	75.21	0.45
BRAN FLR	0.96	1.86	76.53	0.43	BRAN FLR	0.91	2.20	75.11	0.49	Filter Bran	3.23	2.08	78.44	0.52
Red Dog	2.51	2.11	79.05	0.48	Red Dog	3.42	2.45	78.53	0.58	Red Dog	0.99	3.34	79.44	0.55
Break Shorts	2.53	3.84	81.57	0.59	Break Shorts	3.05	4.17	81.58	0.71	Break Shorts	2.52	3.79	81.95	0.65
Red Shorts	0.45	4.01	82.02	0.61	Red Shorts	0.54	4.63	82.12	0.74	Red Shorts	0.11	4.31	82.06	0.66
Bran	17.98	5.45	100.00	1.48	Bran	17.88	5.53	100.00	1.60	Bran	17.94	5.27	100.00	1.48
Wheat		1.41					1.55					1.44		
St. Grd. Fl.		0.39					0.45					0.46		

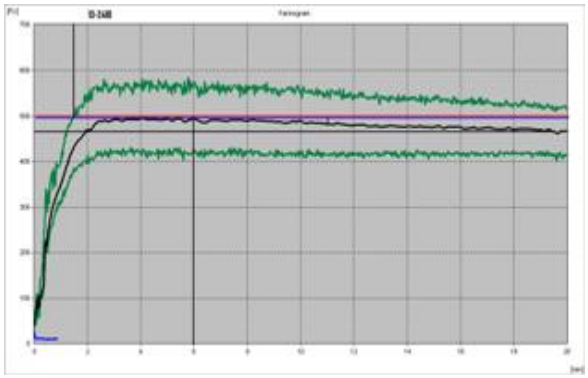
Oklahoma: Cumulative Protein Curves



Ruby Lee (check)					Doublestop CL+					OK09125				
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	5.19	9.62	5.19	9.62	2M	16.88	11.01	16.88	11.01	1BK	8.71	8.28	8.71	8.28
1BK	8.15	9.69	13.34	9.67	1M Red	4.00	11.05	20.89	11.02	1M	13.65	9.15	22.36	8.81
2M	16.58	9.73	29.92	9.70	1M	9.01	11.23	29.90	11.08	1M Red	4.33	9.38	26.69	8.90
1M	11.87	9.84	41.79	9.74	1BK	5.47	11.26	35.37	11.11	Grader	3.29	9.42	29.98	8.96
3M	10.32	10.47	52.11	9.89	3M	15.25	11.64	50.62	11.27	2M	17.12	9.46	47.11	9.14
4M	5.51	10.63	57.62	9.96	4M	7.64	11.89	58.26	11.35	3M	8.01	10.49	55.11	9.34
Grader	3.89	10.84	61.50	10.01	Grader	2.75	12.04	61.02	11.38	FILTER FLR	8.16	10.70	63.28	9.51
FILTER FLR	2.18	11.54	63.68	10.07	FILTER FLR	2.01	12.81	63.03	11.43	2BK	5.70	11.38	68.98	9.67
5M	1.56	12.26	65.24	10.12	5M	1.74	13.25	64.77	11.48	4M	2.13	12.42	71.10	9.75
2BK	6.34	13.66	71.57	10.43	2BK	4.74	15.37	69.51	11.74	3BK	2.87	12.99	73.97	9.88
3BK	2.31	15.08	73.89	10.58	3BK	2.93	16.01	72.44	11.91	5M	0.47	13.03	74.44	9.90
BRAN FLR	0.96	16.78	74.84	10.66	BRAN FLR	0.91	18.95	73.35	12.00	BRAN FLR	0.77	14.90	75.21	9.95
Break Shorts	2.53	15.03	77.37	10.80	Break Shorts	3.05	15.99	76.40	12.16	Break Shorts	2.52	14.07	77.73	10.08
Red Dog	2.51	13.38	79.89	10.88	Red Dog	3.42	14.80	79.82	12.27	Red Dog	0.99	12.54	78.72	10.11
Red Shorts	0.45	14.59	80.34	10.90	Red Shorts	0.54	15.48	80.36	12.30	Red Shorts	0.11	13.96	78.83	10.12
Filter Bran	1.69	11.92	82.02	10.92	Filter Bran	1.76	14.28	82.12	12.34	Filter Bran	3.23	11.48	82.06	10.17
Bran	17.98	14.91	100.00	11.64	Bran	17.88	17.65	100.00	13.29	Bran	17.94	15.14	100.00	11.06
Wheat		11.8					13.2					10.9		
St. Grd. Fl		10.9					12.1					10.0		

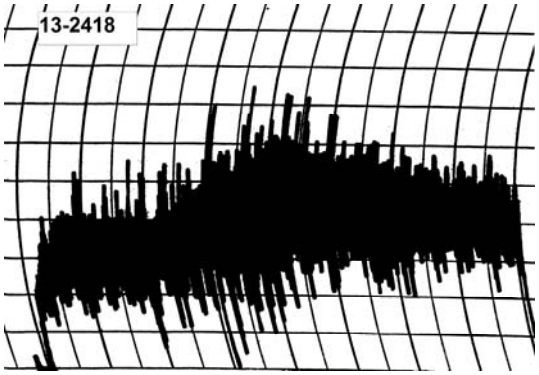
Physical Dough Tests
2013 (Small Scale) Samples – Oklahoma

Farinograms



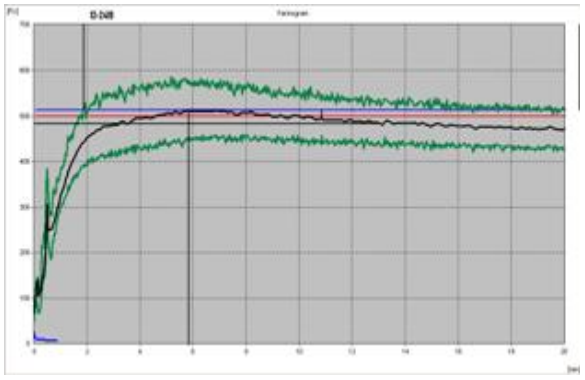
Water abs = 56.0%, Peak time = 6.0 min,
Mix stab = 24.7 min, MTI = 13 FU

Mixograms

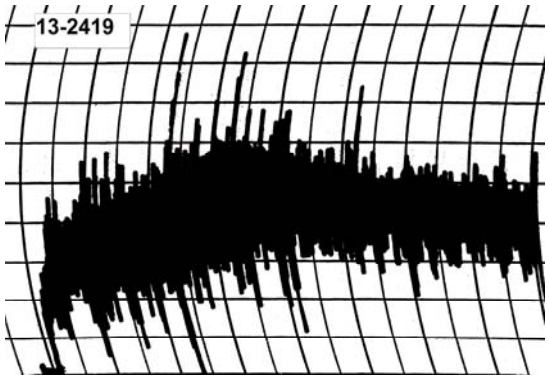


Water abs = 61.1%
Mix time = 4.4 min

13-2418, Ruby Lee (check)



Water abs = 59.9%, Peak time = 5.9 min,
Mix stab = 18.7 min, MTI = 19 FU



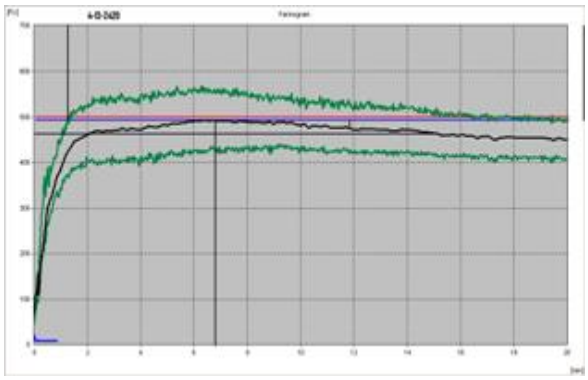
Water abs = 63.0%
Mix time = 3.5 min

13-2419, Doublestop CL+

Physical Dough Tests

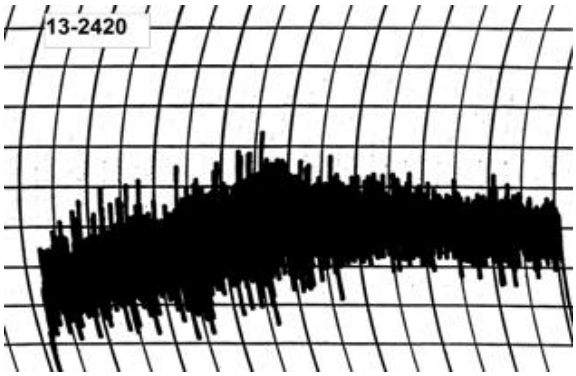
2013 (Small Scale) Samples – Oklahoma (continued)

Farinograms



Water abs. = 54.5%, Peak time = 6.8 min,
Mix stab = 19.4 min, MTI = 17 FU

Mixograms

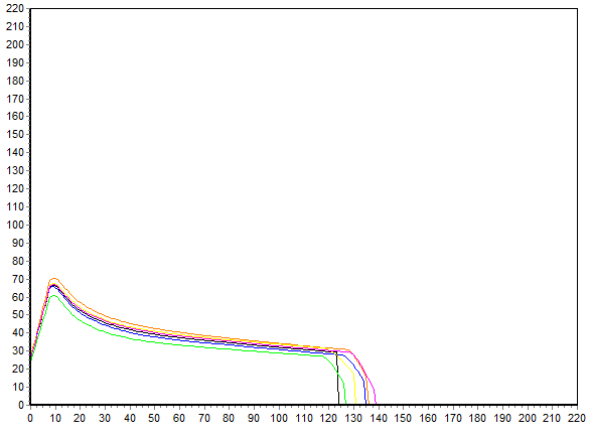


Water abs = 59.1%
Mix time = 3.9 min

13-2420, OK09125

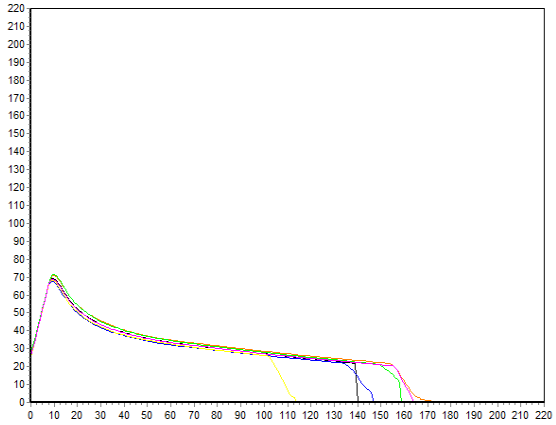
Physical Dough Tests - Alveograph

2013 (Small Scale) Samples – Oklahoma



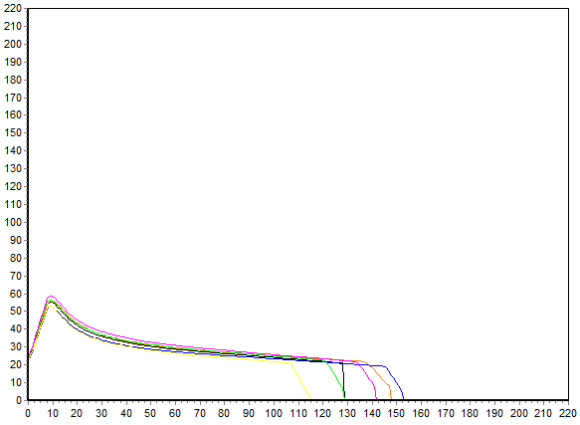
13-2418, Ruby Lee (check)

P (mm H_20) = 73, L (mm) = 124, W ($10E^{-4}J$) = 320



13-2419, Doublestop CL+

P (mm H_20) = 76, L (mm) = 139, W ($10E^{-4}J$) = 319

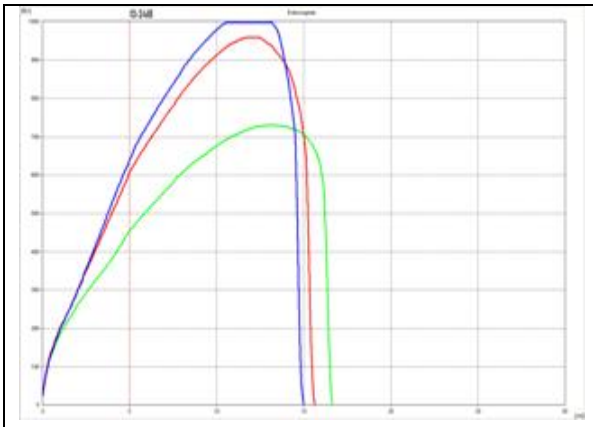


13-2420, OK09125

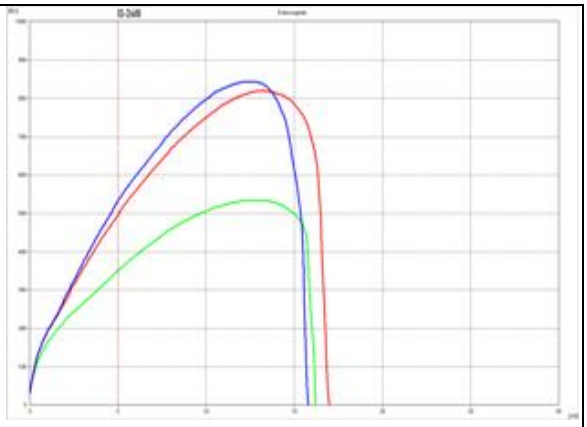
P (mm H_20) = 61, L (mm) = 128, W ($10E^{-4}J$) = 257

Physical Dough Tests - Extensigraph

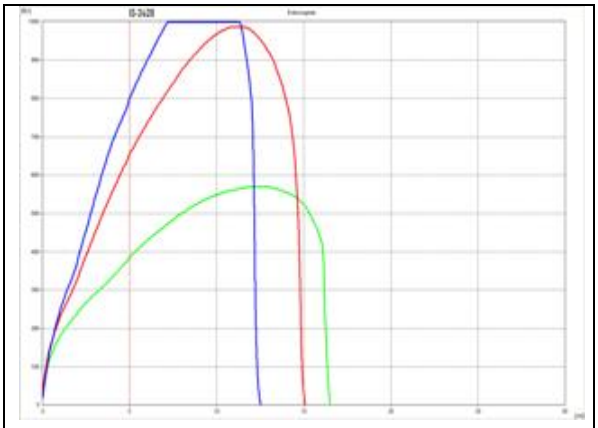
2013 (Small Scale) Samples – Oklahoma



13-2418, Ruby Lee (check)
R (BU) = 612, E (mm) = 157, W (cm^2) = 185
Rmax (BU) = 960, Ratio = 3.9 at 90 min



13-2419, Doublestop CL+
R (BU) = 498, E (mm) = 170, W (cm^2) = 176
Rmax (BU) = 820, Ratio = 2.9 at 90 min



13-2420, OK09125
R (BU) = 659, E (mm) = 151, W (cm^2) = 185
Rmax (BU) = 987, Ratio = 4.4 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Oklahoma: C-Cell Bread Images and Analysis for 2013 (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	6356	150	4084	0.441	2.024	6.004	1.673	-25.85
2419	6669	150	4081	0.437	1.811	5.601	1.643	-24.18

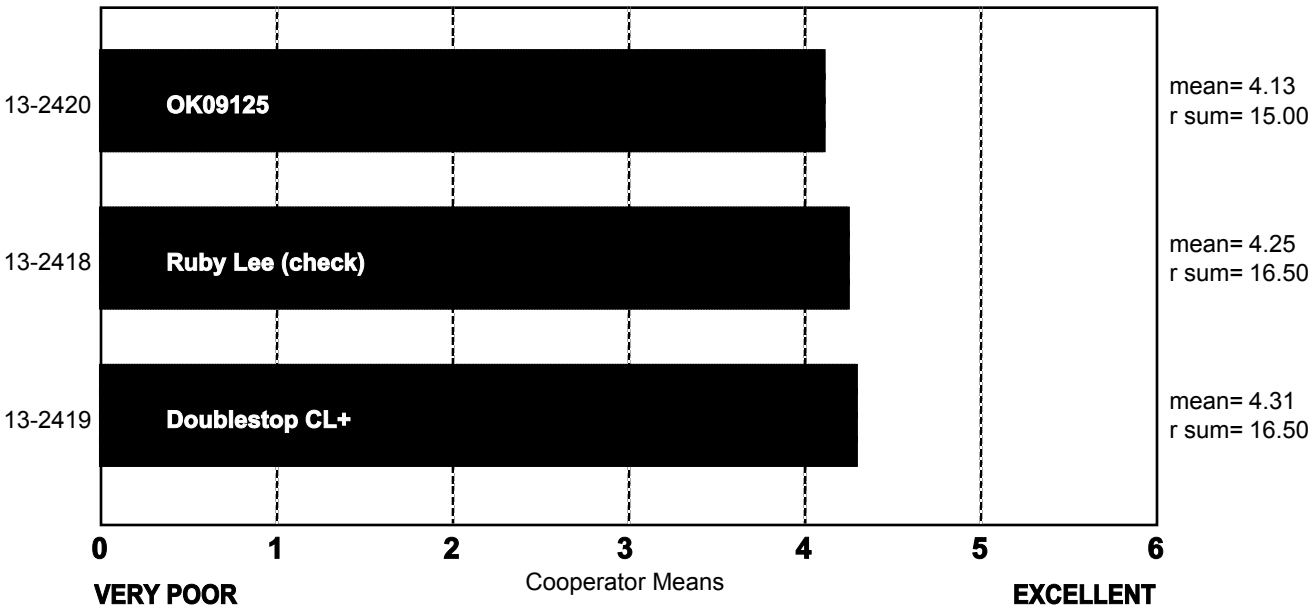
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2420	5976	151	4081	0.437	1.811	5.601	1.643	-24.18

SPONGE CHARACTERISTICS

(Small Scale) Oklahoma

ncoop= 8
chisq= 0.19
chisqc= -0.33
cvchisq= 5.99
crdiff=

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

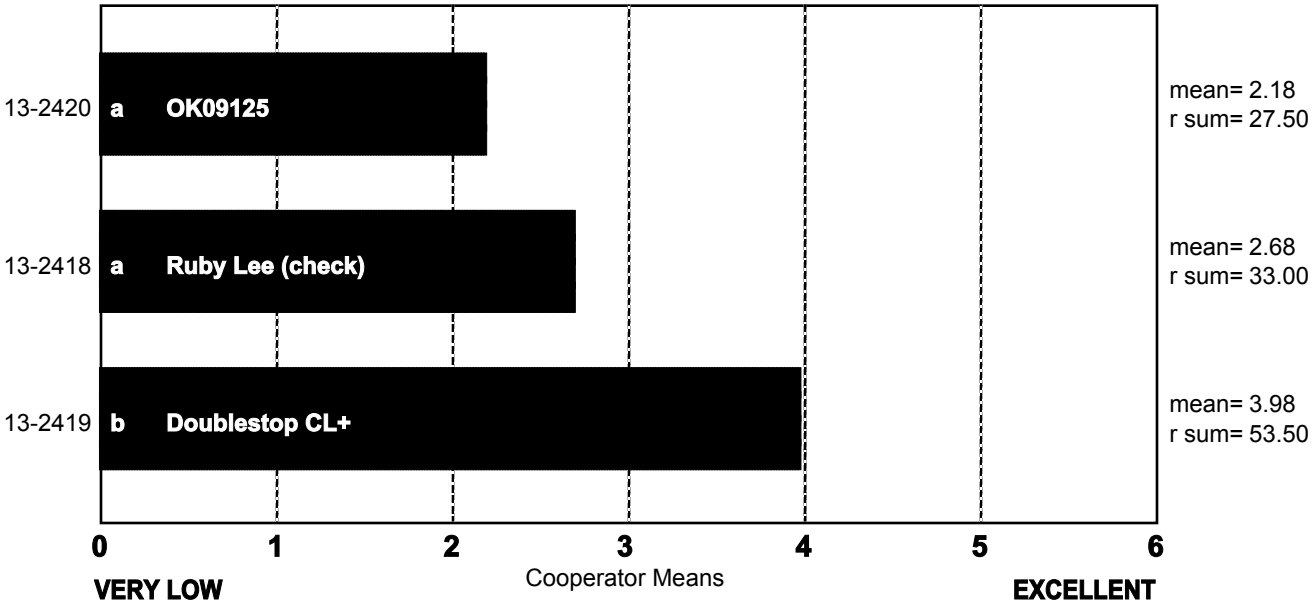


BAKE ABSORPTION

(Small Scale) Oklahoma

ncoop= 19
chisq= 19.76
chisqc= 24.62
cvchisq= 5.99
crdiff= 6.83

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	Coop. R	Coop. S
13-2418 Ruby Lee (check)	**57.0**	**59.0**	**60.0**	**59.0**	**58.5**	**61.7**	**56.0**	**64.0**	**59.9**	**56.0**	**64.1**	**61.5**	**62.5**	**56.0**	**60.4**	**57.0**	**71.8**	**62.3**	**56.0**
13-2419 Doublestop CL+	**58.0**	**62.0**	**62.0**	**61.0**	**60.0**	**62.2**	**59.9**	**67.0**	**61.6**	**59.9**	**68.9**	**63.3**	**66.0**	**58.6**	**61.9**	**62.0**	**72.3**	**64.7**	**59.9**
13-2420 OK09125	**56.0**	**58.0**	**60.0**	**59.0**	**57.5**	**59.1**	**54.5**	**64.0**	**58.5**	**54.5**	**62.9**	**61.3**	**60.0**	**53.7**	**59.6**	**57.0**	**68.5**	**61.3**	**54.5**

BAKE MIX TIME, ACTUAL

(Small Scale) Oklahoma

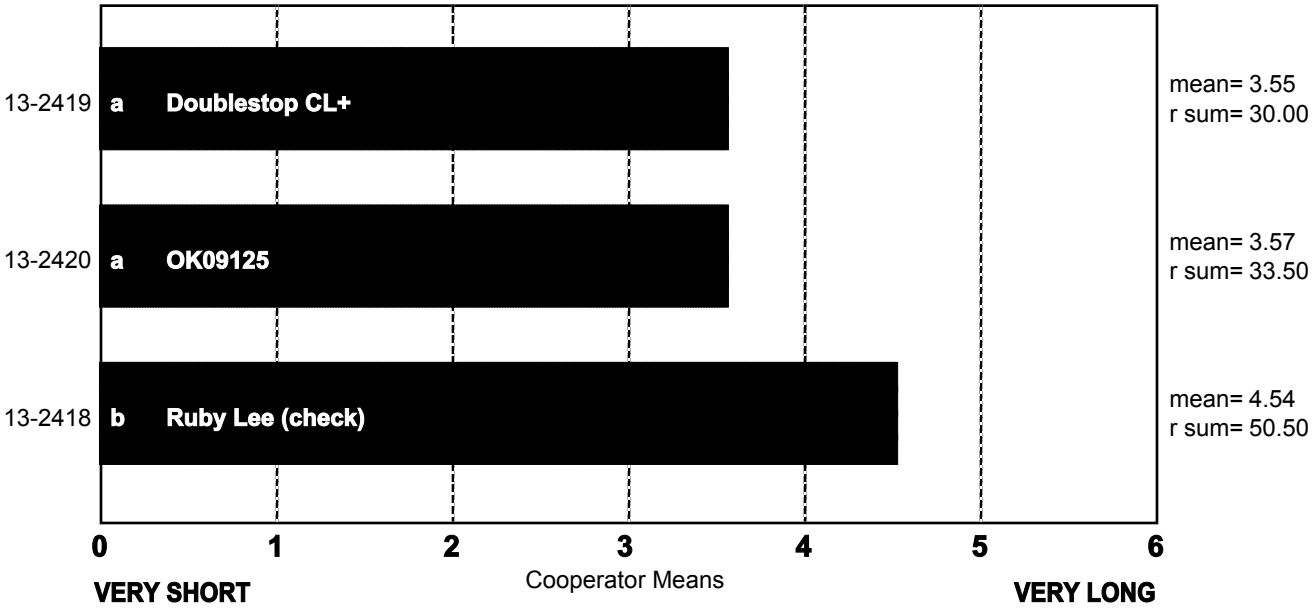
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2418 Ruby Lee (check)	**20.0**	**15.0**	**6.0**	**25.0**	**30.0**	**5.0**	**8.5**	**4.0**	**5.0**	**6.0**	**4.3**	**7.3**	**4.1**	**2.8**	**8.0**	**8.0**	**7.0**	**4.4**	**13.0**
13-2419 Doublestop CL+	**20.0**	**7.0**	**6.0**	**25.0**	**30.0**	**3.8**	**8.0**	**3.3**	**3.5**	**5.0**	**4.2**	**4.5**	**2.8**	**2.3**	**5.0**	**4.0**	**4.1**	**3.2**	**8.0**
13-2420 OK09125	**14.0**	**9.0**	**6.0**	**17.0**	**13.0**	**4.3**	**8.0**	**3.5**	**4.0**	**4.0**	**4.3**	**5.8**	**3.3**	**2.5**	**5.0**	**4.0**	**5.3**	**3.9**	**13.0**

BAKE MIX TIME

(Small Scale) Oklahoma

ncoop= 19
chisq= 12.66
chisqc= 18.50
cvchisq= 5.99
crdiff= 7.61

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

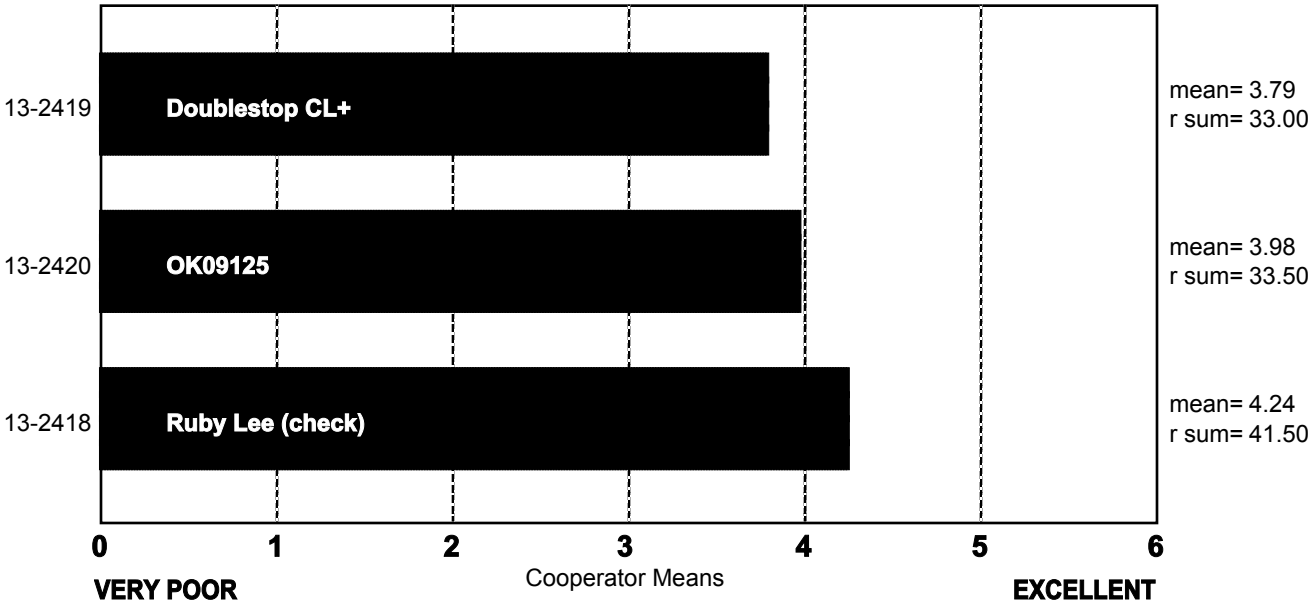


MIXING TOLERANCE

(Small Scale) Oklahoma

ncoop= 18
chisq= 2.53
chisqc= 3.87
cvchisq= 5.99
crdiff=

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



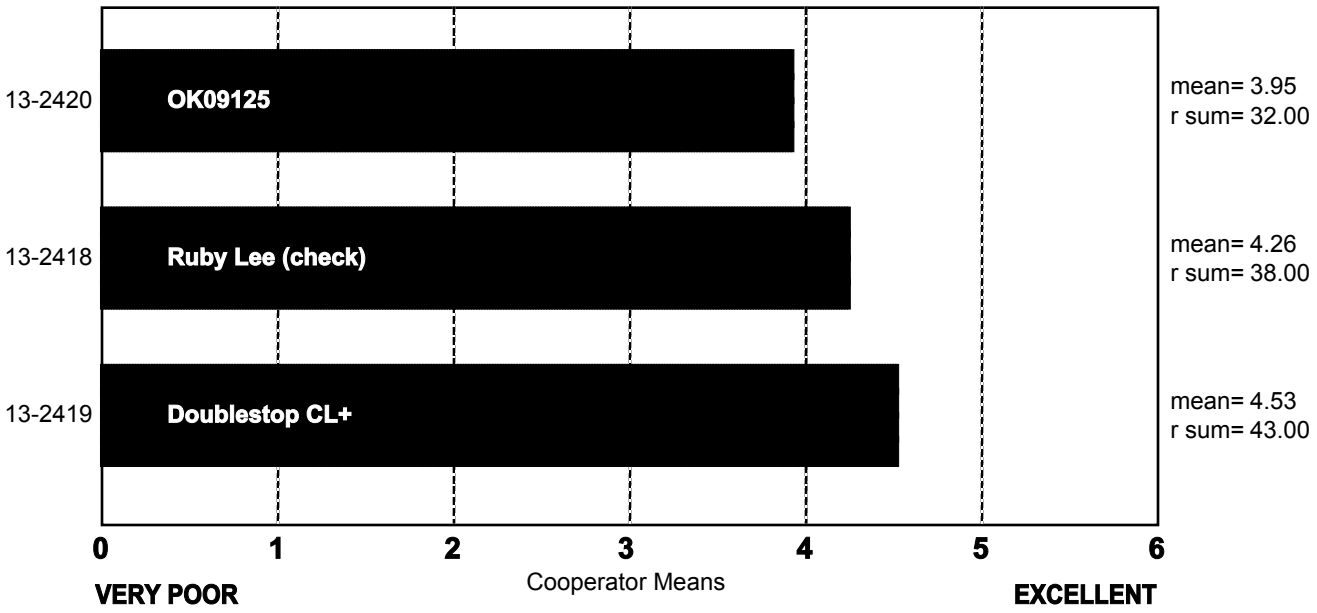
DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Oklahoma

ncoop= 19
chisq= 87.97
chisqc= ?
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) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
13-2418 Ruby Lee (check)	**0**	**1**	**6**	**8**	**4**
13-2419 Doublestop CL+	**0**	**1**	**2**	**12**	**4**
13-2420 OK09125	**3**	**4**	**1**	**9**	**2**

Frequency Table

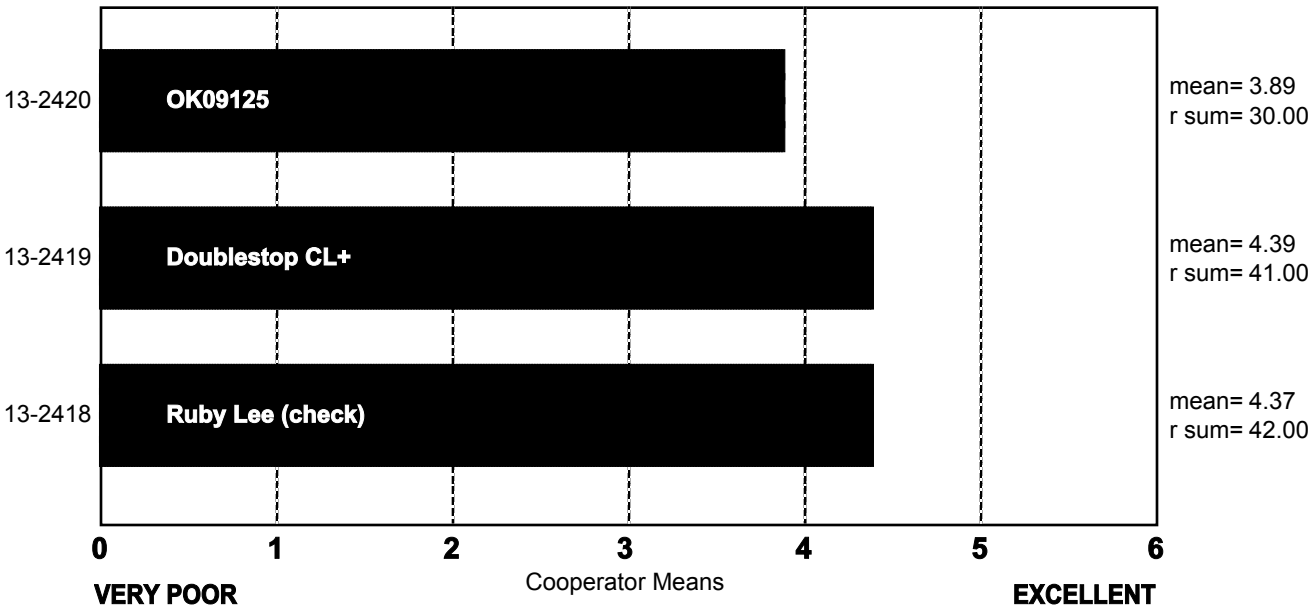
DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Oklahoma

ncoop= 19
chisq= 89.45
chisqc= ?
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) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
13-2418 Ruby Lee (check)	**0**	**0**	**4**	**11**	**4**
13-2419 Doublestop CL+	**0**	**1**	**2**	**13**	**3**
13-2420 OK09125	**2**	**2**	**1**	**13**	**1**

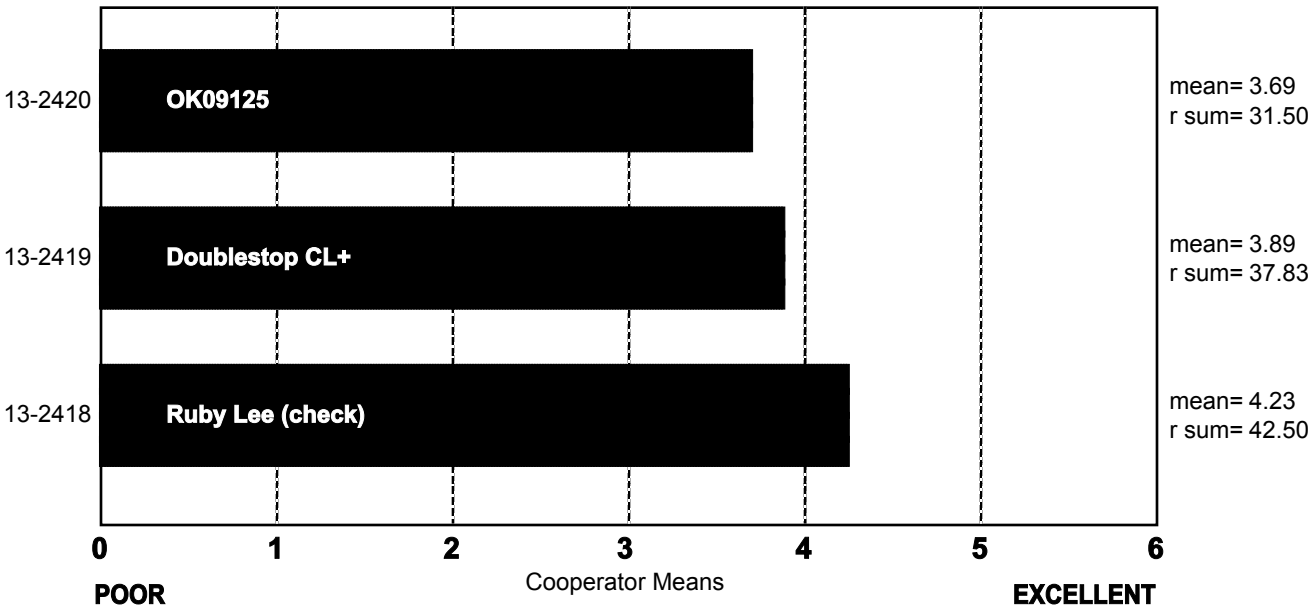
Frequency Table

CRUMB GRAIN

(Small Scale) Oklahoma

ncoop= 19
chisq= 88.65
chisqc= ?
cvchisq= 5.99
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Oklahoma

	Open	Fine	Dense
13-2418 Ruby Lee (check)	**6**	**11**	**2**
13-2419 Doublestop CL+	**12**	**6**	**1**
13-2420 OK09125	**9**	**8**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Oklahoma

	Round	Irregular	Elongated
13-2418 Ruby Lee (check)	**3**	**8**	**8**
13-2419 Doublestop CL+	**4**	**8**	**7**
13-2420 OK09125	**6**	**7**	**6**

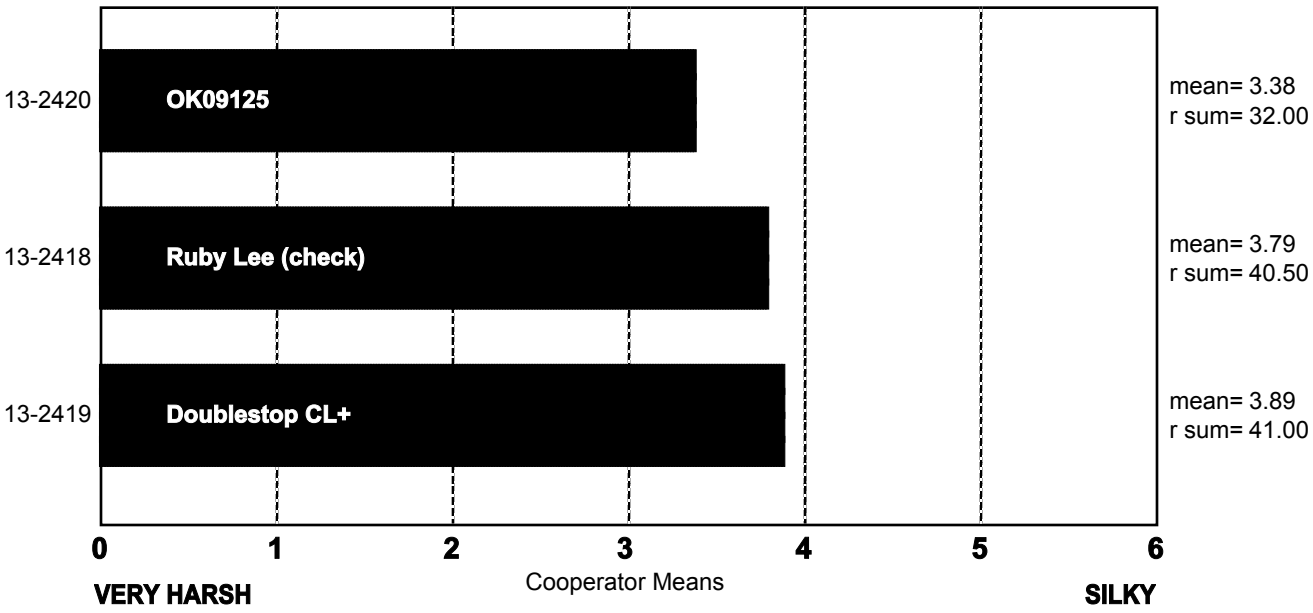
Frequency Table

CRUMB TEXTURE

(Small Scale) Oklahoma

ncoop= 19
chisq= 87.87
chisqc= ?
cvchisq= 5.99
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Oklahoma

	Harsh	Smooth	Silky
13-2418 Ruby Lee (check)	**4**	**12**	**3**
13-2419 Doublestop CL+	**5**	**10**	**4**
13-2420 OK09125	**6**	**11**	**2**

Frequency Table

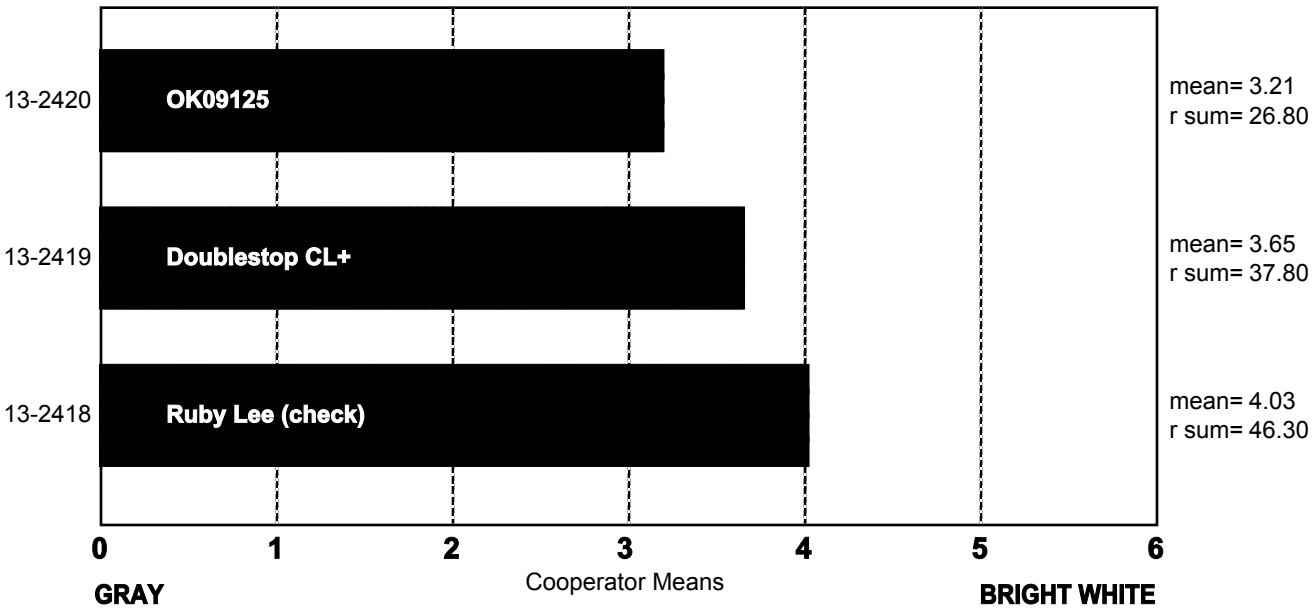
CRUMB COLOR

(Small Scale) Oklahoma

ncoop= 19
chisq= 95.01
chisqc= ?
cvchisq= 5.99
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
13-2418 Ruby Lee (check)	**0**	**0**	**2**	**1**	**11**	**3**	**2**
13-2419 Doublestop CL+	**0**	**0**	**4**	**1**	**11**	**3**	**0**
13-2420 OK09125	**0**	**0**	**5**	**6**	**8**	**0**	**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	Coop. R	Coop. S
13-2418 Ruby Lee (check)	**412.0**	**467.9**	**130.0**	**490.2**	**467.8**	**142.6**	**456.0**	**136.3**		**453.4**	**131.5**	**140.7**		**128.6**	**148.1**	**481.3**	**155.6**	**141.2**	**445.0**
13-2419 Doublestop CL+	**413.0**	**463.1**	**130.0**	**482.6**	**469.9**	**142.0**	**461.0**	**143.6**		**447.8**	**134.3**	**141.2**		**131.0**	**149.8**	**480.1**	**157.9**	**138.1**	**442.0**
13-2420 OK09125	**413.0**	**464.7**	**130.0**	**487.5**	**469.5**	**140.4**	**465.0**	**142.2**		**449.6**	**130.4**	**139.7**		**128.1**	**148.4**	**482.7**	**157.4**	**140.8**	**445.0**

LOAF VOLUME, ACTUAL

(Small Scale) Oklahoma

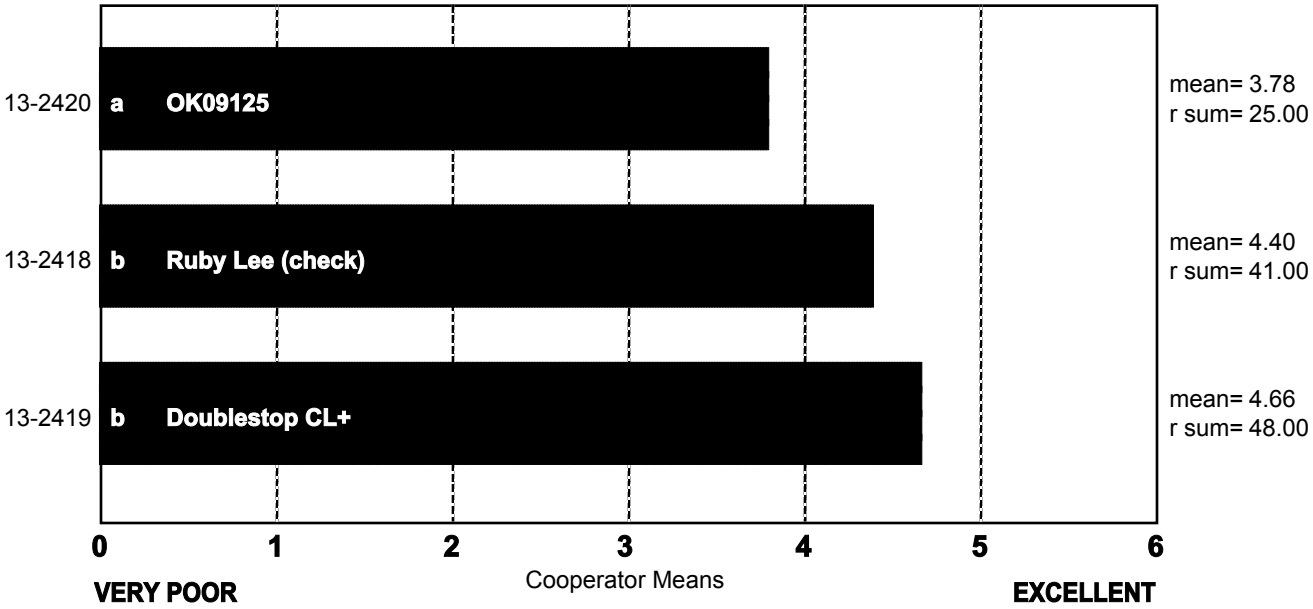
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
13-2418 Ruby Lee (check)	**3150**	**2713**	**1000**	**2986**	**2800**	**1100**	**2725**	**1078**	**1100**	**2525**	**895**	**893**	**960**	**790**	**850**	**2675**	**1025**	**804**	**2425**
13-2419 Doublestop CL+	**3150**	**2700**	**1015**	**2868**	**2775**	**1170**	**2750**	**1063**	**1200**	**2550**	**925**	**916**	**1005**	**825**	**905**	**2813**	**1098**	**830**	**2700**
13-2420 OK09125	**2900**	**2663**	**930**	**2809**	**2725**	**1020**	**2600**	**998**	**900**	**2540**	**840**	**886**	**870**	**750**	**785**	**2500**	**1013**	**776**	**2550**

LOAF VOLUME

(Small Scale) Oklahoma

ncoop= 19
chisq= 14.63
chisqc= 18.53
cvchisq= 5.99
crdiff= 8.17

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

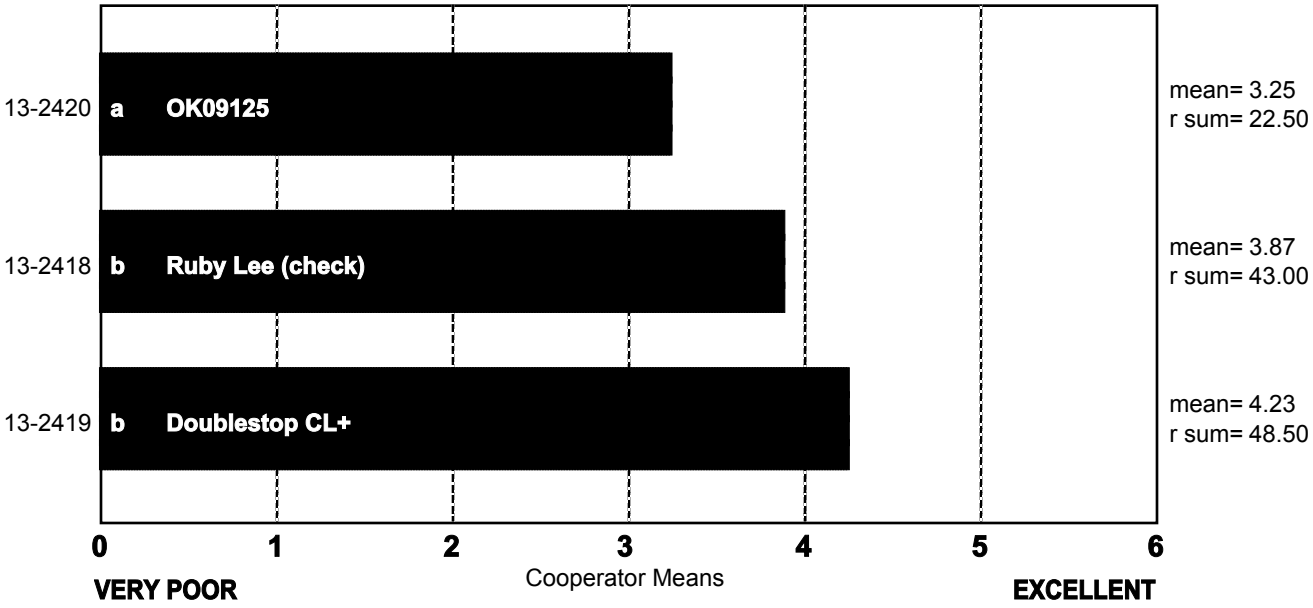


OVERALL BAKING QUALITY

(Small Scale) Oklahoma

ncoop= 19
chisq= 19.76
chisqc= 23.11
cvchisq= 5.99
crdiff= 7.44

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. **13-2418 Ruby Lee (check)**

A. Slightly open grain, bright interior, very tough dough, excellent volume, lower protein.
B. Low absorption, above average mix, high volume, creamy crumb, slightly open grain.
C. Strong, good baking performance.
D. Fairly tight, slightly variable grain, good volume.
E. No comment.
F. Excellent externals.
G. Very good.
H. No comment.
I. No comment.
J. Low absorption, bucky dough, good volume and grain rating.
K. No comment.
L. Normal absorption, longer mix time, slight sticky & strong dough, much higher OS & volume, creamy crumb, fine & elongated cells, silky & resilient texture.
M. Low protein, baked very well for protein.
N. Elastic, smooth dough with nice moisture at mixing. At panning, dough was moist, elastic yet slightly pliable.
O. Long mix time, excellent dough out of mix & pan, satisfactory crumb grain, creamy.
P. Very low absorption, tough dough, fine grain, good volume.
Q. Good volume performance for protein.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. Wild break & shred, light crust color.

COOP. **13-2419 Doublestop CL+**

A. Open grain, slightly creamy, excellent volume, very tough & bucky.
B. Above average absorption, average mix, high volume, white crumb, open grain.
C. Large volume, excellent baking performance, strong.
D. Slightly open, round cell structure, average volume.
E. No comment.
F. Excellent externals.
G. Very good.
H. No comment.
I. No comment.
J. Good dough, excellent volume, with a dense grain rating.
K. No comment.
L. Normal absorption and mix time, slight sticky & strong dough, much higher OS & volume, slightly yellow crumb, slightly open & elongated cells, smooth & resilient texture.
M. Acceptable protein with slightly above average baking.
N. At mixing dough was smooth, elastic yet slightly pliable. At panning dough was moist, pliable and limp with little gas. Larger loaf volume.

O. Good mix time, excellent dough out of mix & pan, satisfactory crumb grain, creamy, good loaf volume; rated higher than the check.
P. Good absorption, short mix time, excellent dough, fine grain, and very high volume. Overall nice sample.
Q. Good volume performance for protein.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. No comment.

COOP. 13-2420 OK09125

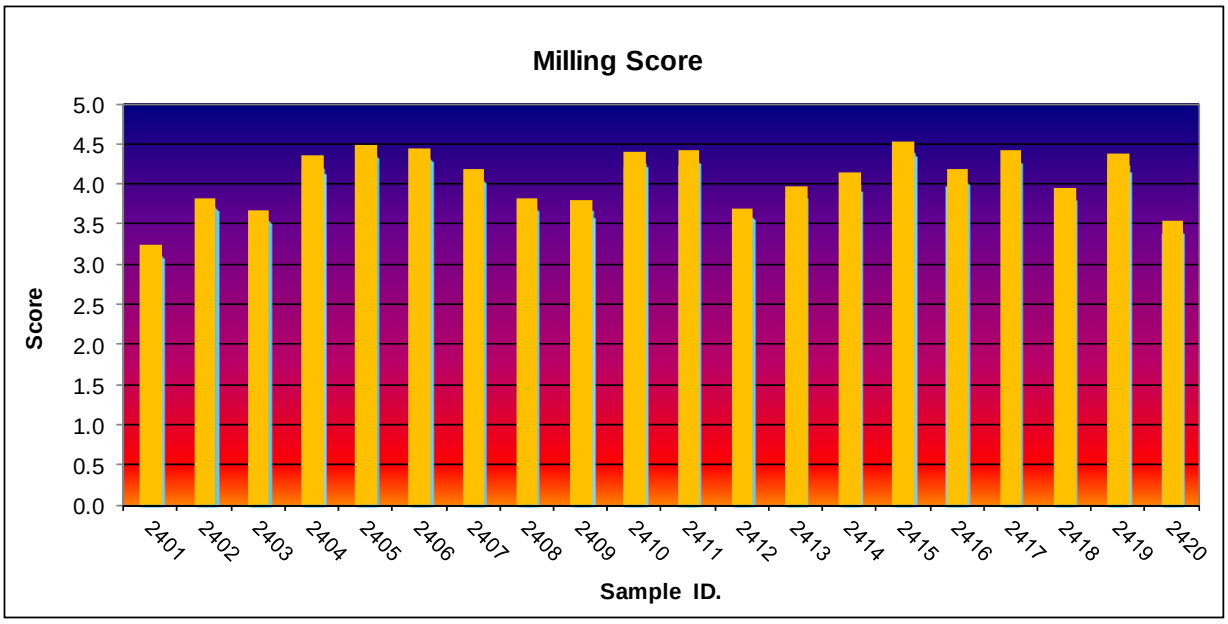
A. Low protein, pliable dough out of mixer, good volume, slightly creamy interior, slightly open grain.
B. Low absorption, average mix, above average volume, creamy crumb, open grain.
C. Tacky, poor baking performance.
D. Low absorption, above average interior scores, low volume.
E. No comment.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Low absorption, good dough, good volume with a good grain rating.
K. No comment.
L. Normal absorption & mix time, slightly sticky & weak dough, higher OS & volume, yellow crumb, fine & elongated cells, smooth & resilient texture.
M. Unacceptable low protein, below average baking.
N. At mixing dough was smooth and elastic yet slightly pliable. At panning, dough was moist, pliable and slightly limp.
O. Good mix time, good dough out of mix & pan, questionable/satisfactory crumb grain, dull color, low loaf volume; rated lower than the check.
P. Very low absorption, short mix time, wet dough, average grain, yellow crumb, average volume.
Q. Good volume performance for protein.
R. Absorption (0.15)+Mix time (0.1)+Tolerance (0.1)+Mixer (0.1)+Make Up (0.1)+Grain (0.1)+Texture (0.1)+Color (0.05)+Volume (0.2)=Overall
S. No comment.

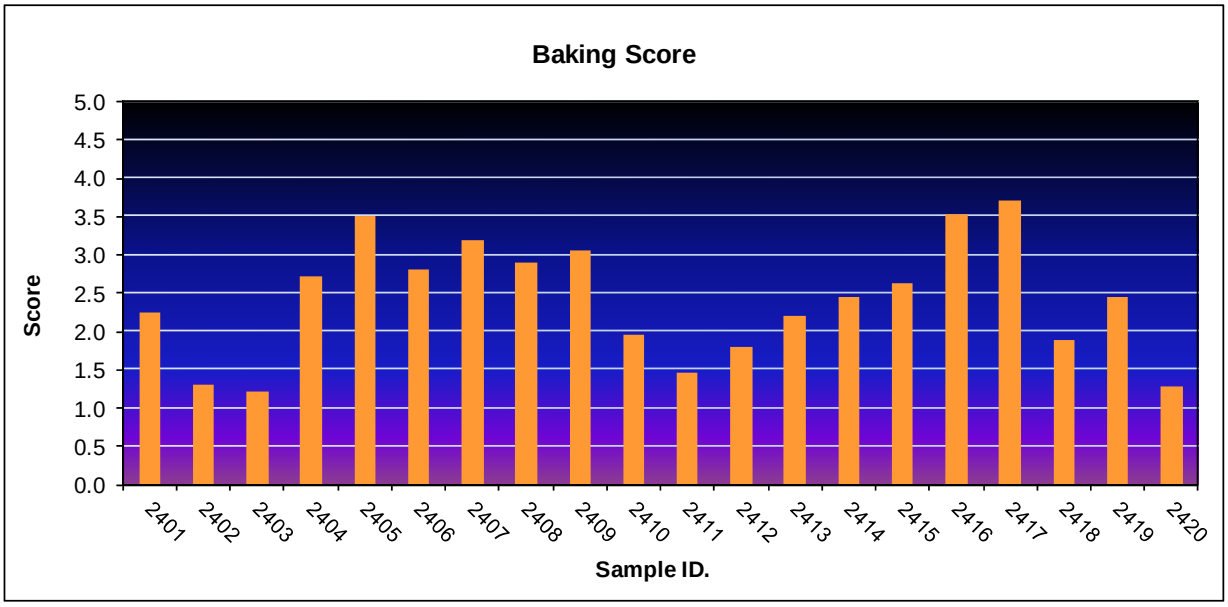
Notes: **A, B, C, D, E, J, P and S** conducted sponge and dough bake tests

2013 WQC Milling and Baking Scores

2013 WQC Milling & Baking Scores

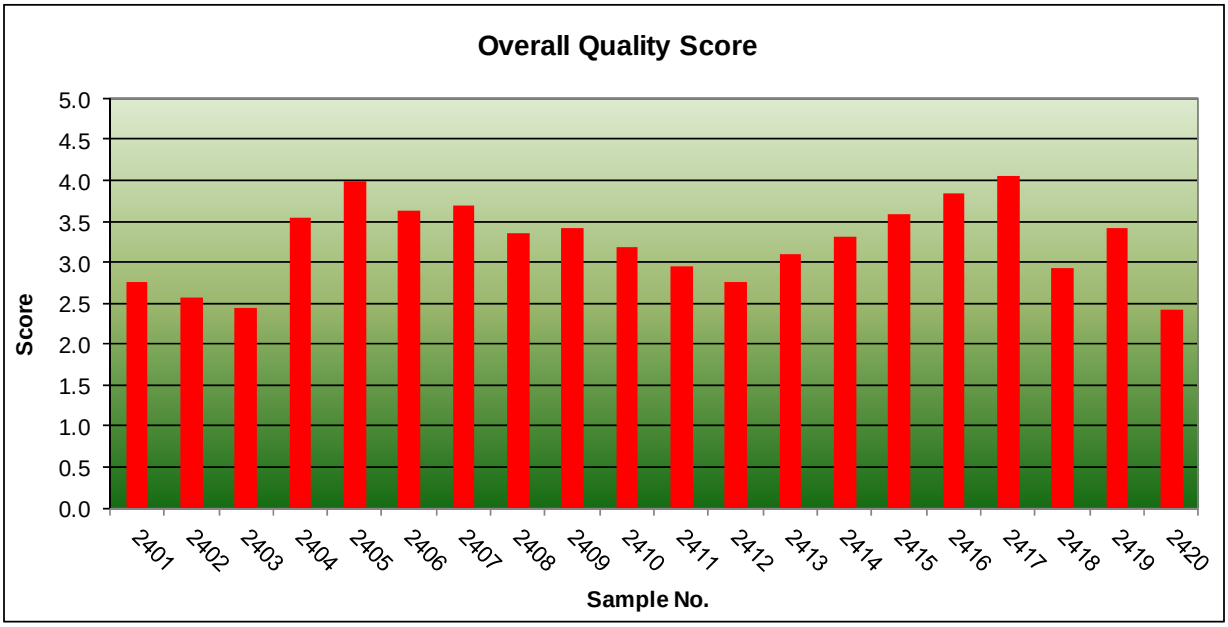
(Based upon HWWQL Quality Data and KSU Milling Data)





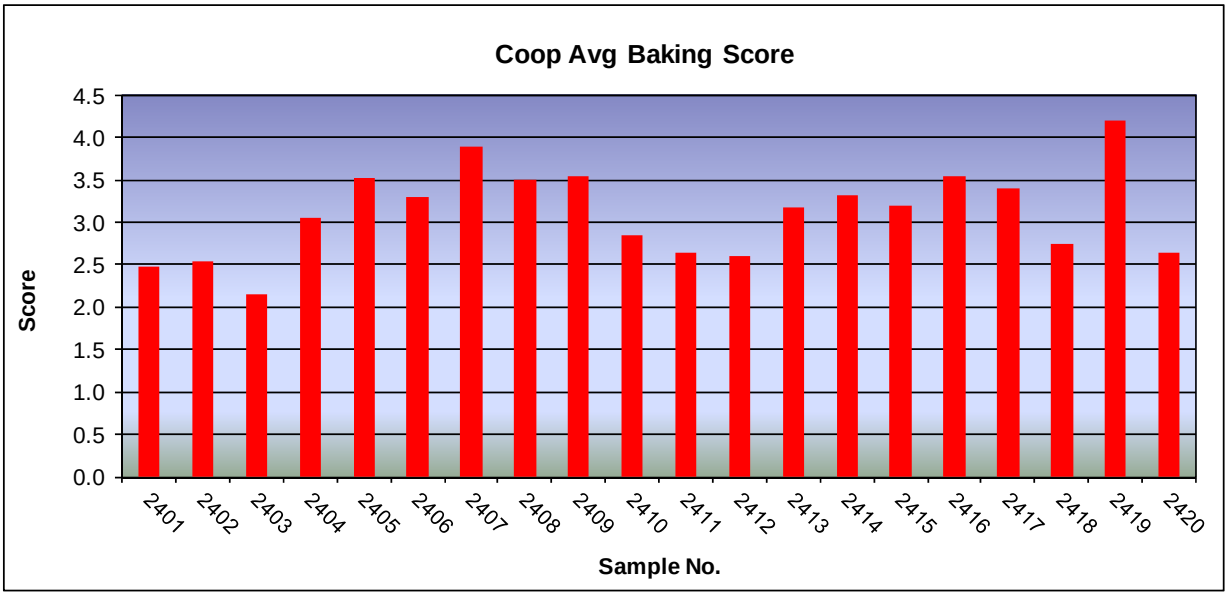
2013 WQC Milling & Baking Scores

(Based upon HWWQL Quality Data and KSU Milling Data)



2013 WQC Baking Scores

(Based upon Average Baking Data of Collaborators Pup-Loaf Straight Dough)



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
2013 WQC Hard Winter Wheat Entries

USDA-ARS Hard Winter Wheat Quality Laboratory
1515 College Avenue
Manhattan, KS 66502

Bradford W. Seabourn, **brad.seabourn@ars.usda.gov**
Richard Chen, **richard.chen@ars.usda.gov**

Alkaline Noodle Quality Report

Objectives: Evaluate alkaline noodle color and cooking characteristics.

Materials: 20 WQC hard winter wheat samples harvested in 2013.

Methods:

PPO (Polyphenol 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 on a tumbling equipment.
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 Noodle was made with 100 g flour, 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 by 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 the boiling distilled water (300 mL).
3. Cook continuously with gentle stirring for 4 min 30 sec or until the core of noodle disappears.
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 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

Texture Profile Analysis (TPA) of Noodle:

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

- **Hardness (N):** maximum peak force during the first compression cycle (first bite) and often substituted by 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.

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

- **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.

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***: 2413 (84.54), 2411(84.38), 2412 (82.89)

- ***Noodle Color*** (*L* value, Higher is better.) ***at 24 hr***: 2413 (73.15), 2411 (72.47), 2417 (71.27)

- ***Delta L*** (Change of *L* value, Lower absolute value is better.)
  2417 (-9.29), 2405 (-10.66), 2406 (-11.26)

- ***PPO*** (Lower is better.): 2405 (0.188), 2417 (0.195), 2415 (0.303)

Table II shows the following:

- ***Hardness***: 2414 (2.687), 2410(2.654), 2402 (2.579)

- ***Springiness***: 2417 (0.986), 2403 (0.982), 2420(0.980)

- ***Chewiness***: 2414 (1.726), 2417 (1.690), 2406 (1.665)

- ***Resilience***: 2405 (0.419), 2417 (0.413), 2407 (0.413)

- ***Cohesiveness***: 2405 (0.689), 2416 (0.682), 2407 (0.680)

- ***Water Uptake***: 2410 (95.96), 2419 (94.60), 2401 (94.56)

- ***Cooking Loss***: 2409 (5.60), 2407 (5.84), 2405 (5.92)

Discussion

The sample 2417 showed the highest *b** value and the third highest brightness noodle color at 24 hr. the lowest delta *L** and the second lowest PPO level, the highest springiness after cooking, and the second highest cohesiveness and r*esilience* in texture. The bright yellow noodle color after 24 hr production and the firmer texture after cooking are considered desirable characteristics for alkaline noodles. Thus, the sample 2417 would be the most favourable for alkaline noodle quality.

The sample 2413 showed the highest brightest noodle color at 0 hr and at 24 hr respectively, softtexture after cooking. Therefore, sample 2413 would be a good noodle flour for white salted noodles (Japanese Udon-type), which are preferred to have a bright, creamy white color, and smooth, soft texture. Sample 2411 showed the second brightest noodle color 0 hr and at 24 hr respectively and the second delta b*.

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
2401	80.64	68.44	-2.33	-0.70	21.98	26.28	-12.21	1.63	4.30	0.590
2402	81.61	70.34	-2.53	-1.22	21.75	25.84	-11.28	1.31	4.10	0.468
2403	80.40	69.04	-2.10	-0.72	22.08	25.03	-11.36	1.39	2.95	0.537
2404	81.24	69.06	-2.96	-1.20	25.21	25.90	-12.18	1.76	0.69	0.703
2405	79.34	68.68	-2.20	-0.95	26.42	27.40	-10.66	1.25	0.98	0.188
2406	82.38	71.12	-2.19	-0.85	21.93	24.24	-11.26	1.35	2.31	0.647
2407	79.79	67.18	-2.33	-0.81	23.73	25.12	-12.61	1.52	1.39	0.769
2408	82.79	67.37	-1.88	-0.78	17.60	23.29	-15.42	1.10	5.69	0.863
2409	81.82	62.49	-2.63	-0.95	21.62	23.11	-19.33	1.68	1.49	0.784
2410	81.46	69.84	-2.65	-1.39	23.10	26.77	-11.62	1.26	3.68	0.521
2411	84.38	72.47	-2.26	-1.61	19.23	25.76	-11.91	0.65	6.53	0.357
2412	82.89	70.38	-2.20	-1.32	19.16	24.50	-12.52	0.89	5.34	0.501
2413	84.54	73.15	-2.57	-1.84	19.34	26.01	-11.40	0.73	6.67	0.314
2414	81.61	69.57	-2.24	-0.95	22.26	24.32	-12.04	1.30	2.06	0.602
2415	82.44	70.94	-2.36	-1.20	21.44	26.46	-11.51	1.16	5.02	0.303
2416	81.79	69.73	-2.38	-1.07	23.14	27.21	-12.06	1.31	4.07	0.501
2417	80.56	71.27	-2.60	-1.50	27.61	30.13	-9.29	1.11	2.52	0.195
2418	82.26	69.52	-2.10	-1.03	19.69	24.74	-12.74	1.08	5.05	0.385
2419	81.05	65.77	-2.16	-0.80	20.37	22.63	-15.28	1.36	2.26	0.469
2420	82.74	68.70	-2.51	-1.18	18.47	22.89	-14.04	1.33	4.43	0.467
Avg	81.78	69.25	-2.36	-1.10	21.80	25.38	-12.53	1.26	3.57	0.510

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

Sample ID	Springiness	Hardness	Chewiness	Resilience	Cohesiveness	Water Uptake (%)	cooking loss(%)
2401	0.975	2.290	1.404	0.359	0.629	94.56	7.00
2402	0.977	2.579	1.552	0.367	0.615	92.04	7.20
2403	0.982	2.465	1.581	0.391	0.654	88.52	6.96
2404	0.975	2.215	1.446	0.408	0.669	93.96	6.96
2405	0.969	2.304	1.538	0.419	0.689	93.20	5.92
2406	0.967	2.552	1.665	0.409	0.675	94.20	7.12
2407	0.977	2.434	1.618	0.413	0.680	88.00	5.84
2408	0.967	2.326	1.528	0.397	0.679	86.76	6.00
2409	0.955	2.558	1.656	0.401	0.678	91.08	5.60
2410	0.973	2.654	1.577	0.333	0.611	95.96	6.40
2411	0.959	2.554	1.574	0.375	0.642	82.52	7.80
2412	0.973	2.476	1.520	0.361	0.631	89.12	7.64
2413	0.963	2.394	1.468	0.365	0.637	89.80	7.72
2414	0.963	2.687	1.726	0.383	0.667	90.28	6.52
2415	0.971	2.338	1.511	0.412	0.665	84.36	6.84
2416	0.975	2.409	1.601	0.411	0.682	80.88	6.24
2417	0.986	2.540	1.690	0.413	0.675	80.56	6.84
2418	0.965	2.480	1.612	0.410	0.674	87.72	6.60
2419	0.975	2.408	1.582	0.410	0.674	94.60	6.28
2420	0.980	2.421	1.539	0.379	0.649	86.44	7.60

TORTILLA BAKING TEST of 2013 WQC SAMPLES

Audrey L. Girard, Tom O. Jondiko, Liyi Yang, Joseph M. Awika
Cereal Quality Lab, Department of Soil and Crop Sciences
Texas A&M University, College Station, TX
(January 2013)

Introduction

Flour tortillas continue to expand into the mainstream of consumers' eating habits. For example, breakfast burritos are continuing to increase in popularity as a portable convenience food that can be eaten on the way to work.

The quality of the tortilla used for wrapping the fillings is of major importance. A tortilla must not crack or break and allow the salsa to create a mess. In many cases, people use tortilla wraps instead of bread because the hot-press type resists moisture uptake, and the wrap can be eaten without worrying about crumbs.

This report includes information on the procedure for production and evaluation as well as data of the 2013 WQC samples. Towards the end are general observations on the relationship between flour properties and tortilla quality.

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	0.6%
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.

↓

PROOF
5 min, 32°C, 70% RH

← Subjective Dough Evaluation

↓

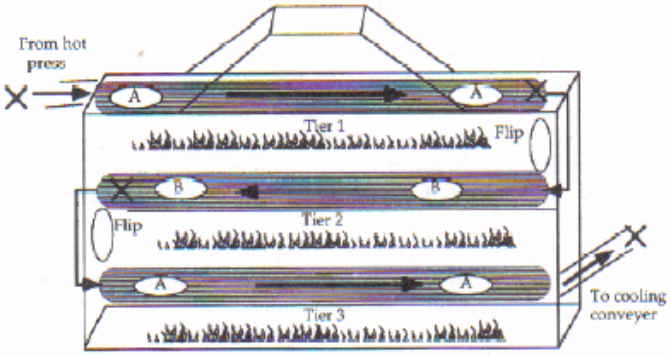
DIVIDE and ROUND
Obtain 43-g dough balls

↓

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, toughness, and 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, and thickness.

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 46 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 2.6 to 3.6 mm.

4. Moisture
Moisture is determined using a two-stage procedure (AACC, Method 44-15A, 2000). This ranges from 25 to 63%.

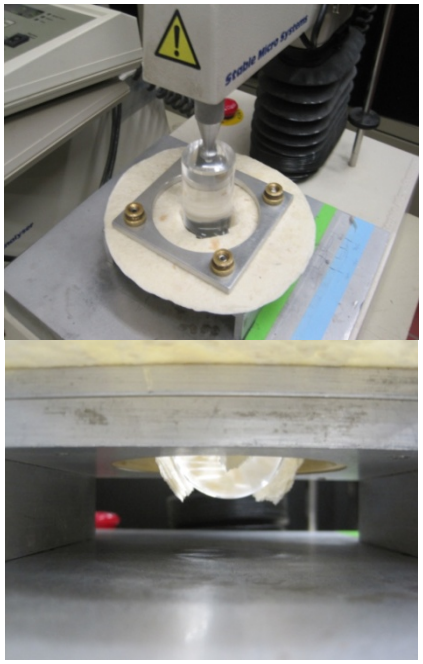
5. Color Values
The color values of lightness (L*), +a* (redness and greenness) and +b* (yellowness and blueness) of tortillas are determined using a handheld colorimeter (model CR-300, Minolta Camera Co., Ltd., Chuo-Ku, Osaka, Japan). L*-values correlate with opacity and are usually greater than 95.

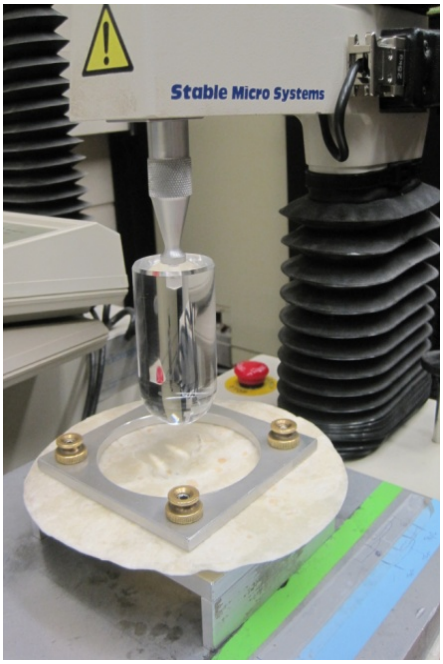
6. Specific Volume
Specific volume (cm^3/g) is calculated: $= \pi * (Diameter/2)^2 * height * 1000/ weight$. This corresponds to fluffiness of the tortilla; desired value is > 1.5 cm^3/g.

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 16^{th} day.

8. Objective rheological test

Extensibility of two tortillas is measured on 0, 4, 8, 12 and 16 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 (The TA-33: 1.5 inch diameter, 3 inch tall rounded end acrylic probe) pushes into the tortilla during the test. Deformation modulus, force, work and distance required to rupture are measured.





WHEAT QUALITY COUNCIL - 2013 DATA WORKSHEET

COOPERATOR NAME:	Audrey, L. Girard, Liyi Yang, T.O. Jondiko, J.M. Awika
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

Special note: The data presented in this report is based on one replication of tortilla processing due to the technical issues of the tortilla hot press oven.

Table 1. Protein content, and mixograph and farinographdata 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 (BU)	Breakdown (min)
2401	10.11	3.90	4	2.5	15.9	16	11.6
2402	10.58	2.90	2	4.3	9.9	32	8.4
2403	10.40	4.90	3	7.7	19.3	12	19.9
2404	12.82	3.00	2	6.7	11.4	28	12.3
2405	14.05	4.30	4	8.0	27.1	15	19.0
2406	12.99	2.80	2	6.7	17.1	15	12.5
2407	13.79	4.40	4	8.3	22.1	7	24.2
2408	12.92	6.50	4	9.9	28.5	5	30.0
2409	12.59	6.00	5	8.7	28.4	12	30.0
2410	11.98	2.90	1	5.0	12.1	32	10.0
2411	11.21	9.00	5	2.9	16.2	25	8.6
2412	10.81	2.60	2	4.7	9.3	37	9.0
2413	11.03	3.80	3	6.5	18.9	24	14.8
2414	12.59	4.80	4	4.5	7.9	48	7.6
2415	11.83	6.60	5	5.7	15.0	25	11.1
2416	13.05	10.00	5	6.2	26.0	10	19.9
2417	13.64	5.80	4	7.5	20.1	19	16.3
2418	10.90	4.40	4	6.0	24.7	13	19.5
2419	12.05	3.50	4	5.9	18.7	19	13.1
2420	10.01	3.90	2	6.8	19.4	17	15.2

*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)
Tortilla Ref.	52.0	10.0	26.9	2.0	2.0	2.0	2.5	2.0
2401	49.8	12.5	25.9	2.0	3.0	3.5	3.0	3.5
2402	50.6	6.0	25.9	2.0	2.0	4.0	2.0	2.0
2403	50.3	13.5	26.4	2.0	3.0	4.0	2.0	4.0
2404	53.3	7.5	26.3	2.0	2.0	4.0	2.0	2.0
2405	56.4	12.0	25.4	2.0	2.0	3.5	2.0	2.0
2406	54.6	8.0	26.7	2.0	2.5	3.0	3.0	4.0
2407	54.9	12.5	27.4	2.0	2.0	4.0	2.0	2.5
2408	52.5	18.0	26.8	2.5	3.0	3.0	4.0	4.0
2409	51.9	14.0	28.1	2.5	2.0	3.0	3.0	3.0
2410	48.9	6.0	27.1	2.0	2.0	3.0	2.0	2.0
2411	50.6	12.5	28.0	2.5	2.5	2.0	4.0	4.5
2412	49.9	7.0	27.4	2.5	3.0	3.0	3.0	3.0
2413	51.4	9.0	28.0	2.5	3.0	2.0	3.0	3.0
2414	52.9	9.0	28.4	3.0	2.0	4.0	3.0	2.0
2415	52.7	13.0	28.0	2.5	2.0	2.5	2.5	3.0
2416	53.7	17.0	27.1	2.5	2.0	4.0	3.0	2.5
2417	55.7	11.0	27.4	2.0	2.0	4.0	2.0	2.0
2418	51.1	10.5	27.8	2.0	2.0	3.0	3.0	2.0
2419	53.0	6.5	27.4	2.0	2.0	3.0	2.0	2.0
2420	49.1	7.5	27.6	2.0	2.0	2.0	3.0	2.5
Descriptors or Scale	record actual absorption		record actual	*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. However, we had to adjust the mixing time to ensure complete gluten formation.

Most of the doughs were generally easy to process (i.e., no excessive stickiness or firmness). Doughs from sample 2402, 2403, 2404, 2407, and 2417 had the highest extensibility scores. Samples2408 and 2411 required more force to extend. Samples 2411 required the most force to flatten and to press (on the stainless steel plate) into a round shape.

Table 3.Physical properties of tortillas.

TEST No.	Moisture	Weight	Thickness	Diameter	Sp. Volume	Lightness *
	%	g	mm	mm	cm^3/g	L-value
Tortilla Ref.	59.6	40.9	2.74	166	1.4	96.6
2401	53.5	40.4	2.62	154	1.2	99.2
2402	56.3	40.4	3.28	167	1.8	100.6
2403	44.7	39.6	3.50	156	1.7	99.3
2404	51.6	39.1	2.84	168	1.6	98.7
2405	47.3	44.5	3.30	158	1.5	97.7
2406	50.4	41.3	3.07	159	1.5	97.3
2407	63.2	41.8	2.95	155	1.3	98.3
2408	59.6	42.2	2.96	147	1.2	96.4
2409	34.8	41.8	3.25	147	1.3	98.0
2410	57.5	39.7	3.15	168	1.8	101.5
2411	47.8	40.0	3.01	125	0.9	101.2
2412	25.3	43.0	3.14	160	1.5	99.8
2413	31.3	45.5	3.07	160	1.4	100.5
2414	32.7	45.4	2.90	162	1.3	98.8
2415	35.7	42.8	3.11	142	1.2	97.9
2416	33.9	45.7	3.10	144	1.1	96.3
2417	32.8	41.7	2.96	158	1.4	97.6
2418	27.6	45.8	3.58	155	1.5	97.8
2419	33.2	42.2	3.38	158	1.6	96.3
2420	31.9	43.2	3.60	157	1.6	97.9
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

Three samples, 2402, 2404, and 2410 produced tortillas of good diameter (at least 165 mm). Samples with >165 mm tortilla diameter had lightness scores >95 and >1.5 cm^3/g specific volume indicating that the dough discs did not shrink back during hot-pressing. Generally, small diameter tortillas (samples 2408, 2409, 2411, 2415, 2416) had corresponding low specific volume and were less fluffy, darker and dense.

Table 4.Texture profile of tortillas measured on day of processing and after 16 days of storage.

TEST No.	*Modulus day 0* (N/mm)	*Force day 0* (N)	*Distance day 0* (mm)	*Work day 0* (N.mm)	*Modulus day 16* (N/mm)	*Force day 16* (N)	*Distance day 16* (mm)	*Work day 16* (N.mm)
Tortilla Ref.	0.8	12.9	26.7	132.2	1.0	9.6	16.0	56.8
2401	1.1	16.3	23.8	151.4	1.1	8.4	12.5	39.4
2402	0.8	9.2	22.4	66.8	0.6	5.2	12.1	23.8
2403	1.0	16.0	25.8	163.7	1.3	12.4	15.2	77.2
2404	0.7	11.8	26.9	122.7	1.0	9.1	15.3	56.2
2405	0.9	19.5	34.8	294.6	0.9	14.2	22.3	141.4
2406	0.9	14.3	26.9	146.0	1.0	10.0	17.1	65.6
2407	0.8	16.0	29.8	200.7	1.1	14.3	21.0	120.9
2408	0.8	15.9	30.3	211.2	1.2	16.5	23.6	185.2
2409	1.1	21.3	27.8	236.3	1.1	15.9	19.4	123.8
2410	0.9	13.9	25.6	135.2	1.1	8.7	13.9	43.7
2411	1.3	21.8	27.1	240.2	1.4	15.6	17.5	117.4
2412	0.9	16.2	28.3	155.1	1.2	10.7	16.2	66.8
2413	0.7	10.5	23.3	86.4	1.3	10.8	14.3	61.2
2414	1.0	20.7	32.9	301.9	1.0	11.9	18.9	89.3
2415	1.1	21.0	31.1	276.2	1.3	17.1	21.4	148.0
2416	1.1	23.3	33.9	353.8	1.2	17.4	22.0	170.3
2417	0.8	13.3	26.8	142.4	0.9	11.5	18.2	81.1
2418	1.1	19.6	29.3	235.8	1.3	12.3	17.3	84.3
2419	0.9	18.3	30.6	206.3	1.1	12.3	17.4	81.2
2420	1.0	18.7	29.2	202.6	1.2	11.9	16.5	74.5
Descriptors or Scale	Determine parameters using texture analyzer on day of processing				Determine parameters using texture analyzer after 12 days of storage			

Tortillas from all the samples had a significant reduction in extensibility (>10 mm) reduction in distance from day 0 to day 16. Samples 2409, 2411, 2415, and 2416 had consistently the highest force, distance and work needed to rupture the tortillas especially after 16 days of storage at room temperature. These were the most extensible (less prone to break) compared to the other samples. However, the diameters of these samples were not satisfactory (<165 mm).

Table 5.Subjective rollability scores, tortilladiameter and sample ratings.

TEST No.	Rollability Scores (RS)				Diameter	Rating*
	4 days	8 days	12 days	16 days	mm	
Tortilla Ref.	4.3	4.5	4.5	3.5	166	Good
2401	4.3	4.3	4.3	3.8	*154*	Poor
2402	4.0	3.0	2.0	1.8	*167*	Poor
2403	5.0	4.3	3.8	3.8	*156*	Poor
2404	5.0	4.8	4.0	3.8	*168*	Good
2405	4.8	4.8	4.8	4.5	*158*	Fair
2406	4.8	4.5	4.0	4.0	*159*	Fair
2407	5.0	4.5	4.5	4.5	*155*	Poor
2408	4.5	4.3	4.3	4.0	*147*	Poor
2409	4.8	4.5	4.0	4.3	*147*	Poor
2410	4.8	4.5	3.3	4.0	*168*	Good
2411	5.0	4.3	3.5	3.8	*125*	Poor
2412	4.0	3.3	2.0	3.0	*160*	Fair
2413	4.8	4.0	3.8	3.3	*160*	Fair
2414	4.5	4.3	4.3	4.3	*162*	Fair
2415	5.0	4.5	4.3	3.9	*142*	Poor
2416	5.0	4.5	4.3	4.3	*144*	Poor
2417	5.0	4.5	4.5	4.0	*158*	Fair
2418	4.0	3.8	3.3	2.8	155	Poor
2419	4.8	4.3	3.5	3.8	*158*	Fair
2420	4.3	3.5	3.0	2.8	157	Poor
Descriptors or Scale	*from* 1 = breaks when rolled to 5 = rolls easily				Record actual	

*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

Only sample 2404 and 2410 tortillas had acceptable diameter and day-16 rollability scores. Samples 2405, 2406, 2412, 2413, 2414, 2417, and 2419 had “fair” ratings (acceptable rollability score but relatively small diameter). Other samples either had very good rollability scores but small diameters (typical of strong flours that cause dough to shrink when hot-pressed) or acceptable diameter but break after 16 days of storage (typical of weak flours) (Figure 1).

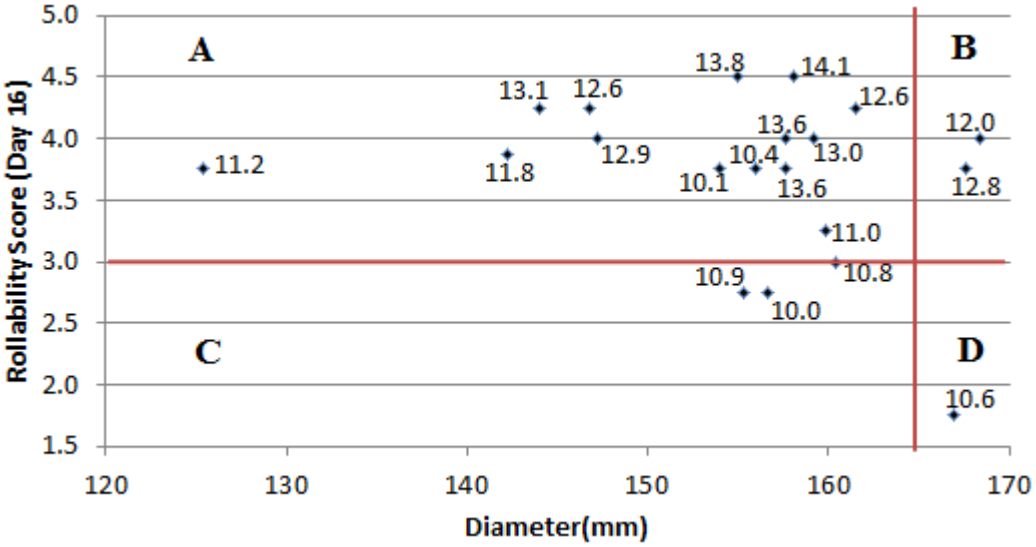


Fig. 1 - Relationship of tortilla diameter, rollability score (day 16), and flour protein content (14% mb; shown as numbers inside the box). Quadrant A: good shelf-stability, poor diameter; B: acceptable diameter and shelf-stability; D: good diameter, poor shelf-stability.

Currently, the characteristics of flour that will give excellent tortilla quality are not completely understood. Waniska et al. (2004) stated that the list of flour properties should include intermediate protein content (10-12%), intermediate protein quality and low levels of starch damage. Sample 2404, which (along with 2410) gave the best tortilla quality, does not fall into this category (i.e., has 12.8% protein and is relatively weak) and seems to be an outlier.

As evident in this year's data, protein content (PC) alone cannot predict tortilla quality. In Figure 1, the shelf-stable samples (rollability score >3) have PC from 10-14%. Protein quality, on the other hand, seems to be a better (but still not perfect) predictor of tortilla quality. Figure 2 shows that samples with longer than 3 min mixograph mixing time generally gave small diameters and good shelf-stability, while two samples in the B quadrant with around 3 min mixing time had tortillas with good diameter and acceptable shelf-stability. Further studies on specific protein and/or gluten components that affect tortilla quality are required to improve the current understanding of the relationships involved.

The work to establish the attributes required for optimum tortilla production will require significant efforts. Bread baking quality has been evaluated for more than 100 years. We think that excellent progress is being made to understand the tortilla baking system, which differs significantly from bread baking.

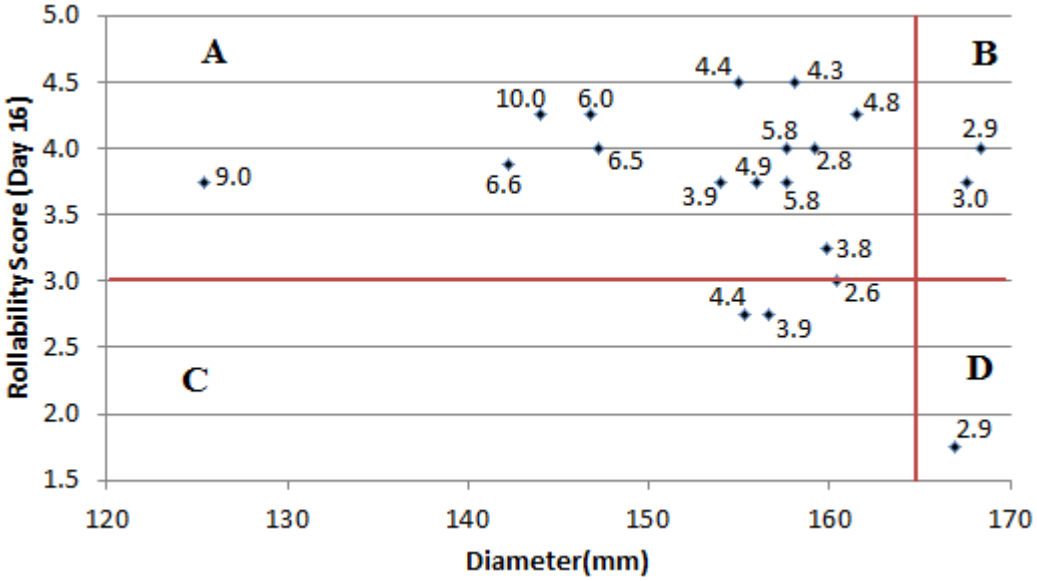


Fig. 2 - Relationship of tortilla diameter, rollability score (day 16) and mixograph mixing time (shown as numbers inside the box). Quadrant A: good shelf-stability, poor diameter; B: acceptable diameter and shelf-stability; D: good diameter, poor shelf-stability.

References:

Jondiko, T. J., Yang, L., Tilley, M., Awika, J. M. Prediction of tortilla quality using multivariate model of kernel, flour and dough properties.2013 AACC International Meeting, Albuquerque, NM.

Serna-Saldivar, S.O., Rooney, L.W., Waniska, R.D. 1988. Wheat flour tortilla production. Cereal Foods World. 33: 855-864.

Waniska, R.D., Cepeda, M., King, B.S., Adams, J.L., Rooney, L.W., Torres, P.I., Lookhart, G.L., Bean, S.R., Wilson, J.D., Bechtel, D.B. 2004. Effects of flour properties on tortilla qualities. Cereal Food World. 49 (4): 237-244.

Waniska, R.D. 1999. Perspectives on flour tortillas. Cereal Foods World. 44:471-473.

2013 WQC HARD WINTER WHEAT FLOUR PROTEIN ANALYSIS

Michael Tilley

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 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

Sample ID	HMW-GS composition	PP/TP	IPP (%)
13-0002401	2*, 7 + 8, 2 + 12	0.715	45.42
13-0002402	null, 7 + 8, 2 + 12	0.701	39.24
13-0002403	1, 7 + 8, 5 + 10	0.720	53.12
13-0002404	2*, 7 + 9, 5 + 10	0.595	49.09
13-0002405	2*, 7 + 9, 5 + 10	0.677	51.55
13-0002406	2*, 7 + 9, 5 + 10	0.574	46.57
13-0002407	2*, 7 + 9, 5 + 10	0.540	45.62
13-0002408	2*, 7 + 9, 5 + 10	0.671	47.20
13-0002409	2*, 7 + 9, 5 + 10	0.649	48.73
13-0002410	2*, 7 + 8, 5 + 10	0.721	42.55
13-0002411	2*, 7 + 8, 5 + 10	0.591	61.03
13-0002412	2*, 7 + 8, 5 + 10	0.607	48.43
13-0002413	2*, 7 + 8/ 7 + 9, 5 + 10	0.692	52.61
13-0002414	2*, 7 + 8/ 7 + 9, 5 + 10	0.621	54.33
13-0002415	2*, 7 + 8, 5 + 10	0.598	58.28
13-0002416	2*, 7 + 8, 5 + 10	0.629	60.19
13-0002417	1, 7 + 8, 5 + 10	0.520	58.92
13-0002418	2*, 7 + 8, 2 + 12	0.844	49.82
13-0002419	2*, 7 + 8, 2 + 12	0.742	42.19
13-0002420	1, 17 + 18, 5 + 10	0.808	43.70

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 Grading	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
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

Stephen Baenziger
University of Nebraska
Dept. of Agronomy and Horticulture
362D Plant Science Building
Lincoln, NE 68583-0915
(402) 472-1538
Pbaenziger1@unl.edu

Brett Carver
Oklahoma State University
Dept. of Plant and Soil Sciences
368 Ag Hall
Stillwater, OK 74078-6028
(405) 744-9580
Brett.carver@okstate.edu

Marla Dale Barnett
Limagrain Cereal Seeds LLC
6414 N Sheridan
Wichita KS 67204
(316) 253-6839
Marla.barnett@limagrain.com

John Rich
Syngenta-Agripro
11783 Ascher Rd
Junction, KS 66441
(785) 210-2108
jon.rich@agripro.com

Phil L. Bruckner/Jim Berg
Montana State University
Dept. of Plant Science and Pathology
407 Leon Johnson Hall
Bozeman, MT 59717
(406) 994-5127
Bruckner@montana.edu

Guorong Zhang
Kansas State University
Ft. Hays Branch Exp. Station
1232 240th Ave.
Hays, KS 67601
(785) 625-3425
gzhang@k-state.edu

Melanie Caffe
South Dakota State University
Dept. of Plant Science
Rm. 113E, Seed Tech Bldg
2380 Research Park Way
Brookings, SD 57006
(605) 688-5334
Melanie.Caffe@sdstate.edu

CREDITS

Baking Collaborators

Address	Collaborator Type	Contact
ADM Milling Co. 100 Paniplus Roadway Olathe, KS 66061	Miller	**Dave Green** (913)491-9400 dave_greeen@admworld.com
American Institute of Baking 1213 Baker's Way Manhattan, KS 66502	Baker	**Toby Moore** (785)537-4750 tmoore@aibonline.org
Bay State Milling Co. P.O. Box 188 55 Franklin Street Winona, MN 55987	Miller	**Terry A. Selleck** (507)452-1770 terry.wn@bsm.com
Cargill Inc. 3794 Williston, Rd., Minnetonka, MN 55345	Miller	**Brian Walker** (952)238-4886 Brian_walker@cargill.com
Cereal Food Processors 701 E. 17th Street Wichita, KS 67214	Miller	**Tim Aschbrenner** (316)267-7311 t.aschbrenner@cerealfood.com
Colorado State University Dept. Soil and Crop Sciences Ft. Collins, CO 80523	Wheat Quality Lab	**John Stromberger** (970)491-2664 jstromb@lamar.colostate.edu
ConAgra Foods ConAgra Drive, 6-108 Omaha, NE 68102	Miller	**Scott Baker** (402)595-5107 scott.baker@conagrafoods.com

CREDITS

Baking Collaborators

Address	Collaborator Type	Contact
General Mill RTC 9931 419 2nd Street Minneapolis, MN 55414	Miller	**Dave Katzke** (776)764-2737 Dave.katzke@genmills.com
Kansas State University Dept of Grain Science Shellenberger Hall Manhattan, KS 66506	Wheat Quality Lab	**Becky Miller** (785)532-6194 beckym@ksu.edu
Limagrain Cereal Seeds LLC 2040 SE Frontage Road Fort Collins, CO 80525	Quality Lab	**Hayley Butler** (970)498-2205 hayley.butler@limagrain.com
Mennel Milling Co. Findlay & Vine Street Fostoria, OH 44830	Miller	**C.J. Lin** (419) 436-5130 Cjlin@mennel.com
North Dakota State Univ. Plant Science Department 1250 Bolley Drive Fargo, ND 58108	Wheat Quality Lab	**Senay Simsek** (701)231-7737 Senay.simsek@ndsu.edu
Syngenta (Agripro) PO Box 30 Berthound, CO 80512-0030	Wheat Quality Lab	**Cathy Butti** (970) 532-3721 cathy.butti@agripro.com
Texas A&M University Soil & Crop Science Dept 2474 TAMU College Station, TX 77843-2472	Wheat Quality Lab	**Joseph Awika** (979) 845-2985 jawika@ag.tamu.edu

CREDITS

Baking Collaborators

Address	Collaborator Type	Contact
Univ. of Nebraska Dept of Agronomy 180 Plant Science Bldg. Lincoln, NE 68583	Wheat Quality Lab	**Lan Xu** (402)472-6243 lxu4@unlnotes.unl.edu
USDA/ARS/HWWQL 1515 College Ave. Manhattan, KS 66502	Wheat Quality Lab	**Margo Caley/Theresa Sutton** (785) 776-2755 margo.caley@ars.usda.gov
USDA/ARS/WQL Harris Hall North Dakota State Univ. Fargo, ND 58105	Wheat Quality Lab	**Jae-Bom Ohm** (701) 239-1377 Jae.ohm@.ars.usda.gov
USDA/ARS/WWQL E-202 FSHN Washington State Univ. Pullman, WA 99614	Wheat Quality Lab	**Doug Engle** (509) 335-4062 doug_engle@wsu.edu
Wheat Marketing Center 1200 NW Naito PRKWY STE 230 Portland, OR 97209	Wheat Quality Lab	**Bon Lee** (503)295-0823 blee@wmcinc.org

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.

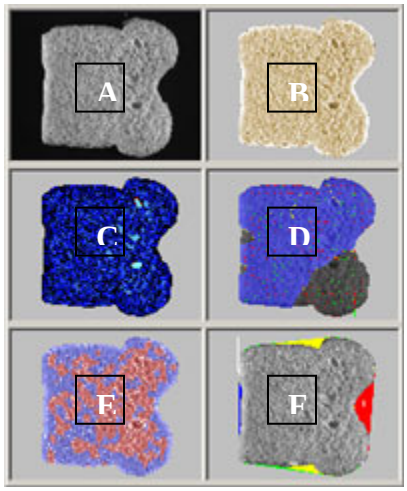
Similarly, cumulative protein curves are determined by arranging millstreams in ascending order of protein content, and tabulating the protein content of the total flour produced with the addition of successive millstreams. Wheat that gives high protein content at low extraction, and a fast rate of protein 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 and Other Information

2013 WQC COLLABORATORS' BAKING TEST PROFILES AND OTHER INFORMATION

Coop	No.	Test Methods	Est. Flour and Dough Wt (g)	Mixing Tolerance	Fermentation time (min)	Oven Temp (F)	Baking Time (min)
A	1	Sponge and dough	600 g flour, 480 g dough	Other	240 min (sponge time) and 45 min (fermentation)	420	20
B	2	Sponge and dough	700 g, 524 g dough	Mixing series	240 min (sponge time) and 60 min (fermentation)	420	20
C	3	Sponge and dough	600 g flour, 160 g dough	Mixing series	240 min	425	16
D	4	Sponge and dough	540 g dough	Mixing series	210 min	430	23
E	5	Sponge and dough	520 g dough		270 min	400	18
F	6	Pup-loaf straight dough	100 g, approx 170 g	Mixograph	90 min	400	25
G	7	Straight dough	700 g flour, 525 g dough	Mixing series	120 min	400	25
H	8	Pup-loaf straight dough	100 g		90 min	401	22
I	9	Pup-loaf straight dough	100 g	Mixograph	90 min	400	25
J	10	Sponge and dough	1000 g flour, 500 g dough	Farinograph	240 min	425	20
K	11	Pup-loaf straight dough	100 g flour, approx 160 g dough	Farinograph	120 min	425	20
L	12	Straight dough	100 g flour, approx. 175 g dough	Farinograph and Mixograph	180 fermentation and 60 min proof time	400	25
M	13	Pop loaf straight	100 g	Mixograph	90 min	400	25
N	14	Pup-loaf straight dough	100 g flour	Farinograph	120 min	390	25
O	15	Pup-loaf straight dough	100 g flour, approx 170 g dough	Mixograph	120 min	420	18
P	16	Sponge and dough	700 g flour, 524 g dough	Farinograph with mixing evalu	240 min (sponge time) and 60 min (fermentation)	420	20
Q	17	Pup-loaf straight dough	100 g flour, approx 175 g dough	Mixograph	90 min	425	21
R	18	Pup-loaf straight dough	200g, 170 g dough	Mixograph	180 min	419	24
S	19	Sponge and dough	700 g flour, 19 oz	Farinograph	180 min (sponge) and 70 min (fermentation)	420	20

APPENDIX B

Hard Winter Wheat Quality Council
Goals for Hard Winter Wheat Breeders

Hard Winter Wheat Quality Council

2013 Technical Board Officers

CHAIR: **Theresa Sutton**, USDA/ARS/CGAHR

VICE CHAIR: **Ron Lindgren**, Foss North America

SECRETARY: **Ron Hobbs**, ADM Milling

MEMBER: **Justin Turner**, Horizon Milling

MEMBER: **Janet Lewis**, Bayer CropScience

2013 Quality Evaluation & Advisory Committee

Brad Seabourn, USDA/ARS/HWWQL

Allan Fritz, Kansas State University

Brian Strouts, American Institute of Baking

Terry Selleck, 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***

CONTACT:
USDA/ARS CGAHR
Hard Winter Wheat Quality Laboratory
1515 College Avenue, Manhattan, KS 66502-2796
VOICE: (785) 776-2751 FAX: (785) 537- 5534 EMAIL: brad.seabourn@ars.usda.gov

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 Ron Lindgren

Feb. 13, 2013

Hard Winter Wheat Quality Council Meeting Minutes
Annual Meeting February 13, 2013

Steve Baenziger moved to accept last year's minutes and Laura McLaughlin seconded.

Officers:

Justin Turner on assignment, moved to bottom of Technical Board list.
Janet Lewis from Bayer nominated as a new Member and elected.

Richard Chen – WQC book has 24 samples

Several different baking tests in book this year.
High ash was reported in some samples.

Shawn Thiele, Operations Manager: KSU Milling update. KSU also milled all the Hard Spring samples with some good help from industry.

Special Presentation: The American Bakers Association made a special presentation to Don Sullins, ADM.

Dave Green gave an update on hard winter wheat quality this year.

Update on Crop Conditions:

MT: good moisture, good snow cover
CO: dry
SD: 66% poor to very poor – not good
NE: tough conditions, no moisture in panhandle. KS line crop has emerged, east crop good
KS: planted acres down and weather is the story. Dry.
OK: Snow cover, 69% poor to very poor, crop stress
TX: Subsoil moisture low, snow in panhandle.

Dave Green Announcements

Motion to Adjourn: Brian Walker and second by Terry Selleck.

Respectfully Submitted by Ron Lindgren, Secretary

A History of WQC Hard Winter Wheat Entries

2012

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
WB-Stout (check)	12-2401	HRW				Westbred
HV9W07-1028	12-2402	HRW				Westbred
Millennium (check)	12-2403	HRW				Nebraska
NW07505	12-2404	HWW				Nebraska
NE06545	12-2405	HRW	yes	Freeman	2012	Nebraska
NE06607	12-2406	HRW				Nebraska
Byrd (check)	12-2407	HRW				Colorado
Snowmass (check)	12-2408	HWW				Colorado
CO07W245	12-2409	HWW	Yes	Antero	2012	Colorado
CO07W722-F5	12-2410	HWW				Colorado
Billings (check)	12-2411	HRW				Oklahoma
Ruby Lee	12-2412	HRW				Oklahoma
Gallagher (OK07214)	12-2413	HRW				Oklahoma
Iba (OK07209)	12-2414	HRW				Oklahoma
OK09634	12-2415	HRW				Oklahoma
Lyman (check)	12-2416	HRW				South Dakota
SD08080	12-2417	HRW				South Dakota
SD06158	12-2418	HRW	yes	Redfield	2013	South Dakota
Yellowstone (check)	12-2419	HRW				Montana
MT08172	12-2420	HRW	yes	Colter	2012	Montana
MT0978	12-2421	HRW				Montana
TAM 111 (check)	12-2422	HRW				Texas
TX07A001505	12-2423	HRW				Texas
TX03A0563-07	12-2424	HRW				Texas

2011

Danby (check)	11-2401	HWW				Kansas-Hays
Tiger	11-2402	HWW	yes			Kansas-Hays
KS08HW35-1	11-2403	HWW	yes	Clara CL	2011	Kansas-Hays
PostRock (check)	11-2404	HRW				AgriPro
SY Wolf	11-2405	HRW	yes			AgriPro
Syngenta Exp 138-45	11-2406	HRW	yes	SY Southwind	2012	AgriPro
Fuller (check)	11-2407	HRW				Kansas-Manhattan
KS020319-7-3	11-2408	HRW	yes	1863	2012	Kansas-Manhattan
KS020633M-13	11-2409	HRW	no			Kansas-Manhattan
McGill (check)	11-2410	HRW				Nebraska
NE05496	11-2411	HRW	no			Nebraska
NE05548	11-2412	HRW	no			Nebraska
NI08708	11-2413	HRW	no			Nebraska
Jagalene (check)	11-2414	HRW				Westbred
HV9W06-509	11-2415	HWW	yes	WB-Grainfield	2012	Westbred
Yellowstone (check)	11-2416	HRW				Montana
MTS0808	11-2417	HRW	yes	Warhorse	2013	Montana
MT0871	11-2418	HRW	no			Montana
Lyman (check)	11-2419	HRW				South Dakota
SD06158	11-2420	HRW	no			South Dakota
SD07184	11-2421	HRW	no			South Dakota

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
2010						
Lyman (check)	10-2401	HRW				SDSU
SD05118-1	10-2402	HRW	yes	Ideal	2011	SDSU
SD06158	10-2403	HRW	no			SDSU
Hatcher (check)	10-2404	HRW				CSU
CO050303-2	10-2405	HRW	yes	Denali	2011	CSU
CO06052	10-2406	HRW	yes	Brawl CL Plus	2011	CSU
CO06424	10-2407	HRW	yes	Byrd	2011	CSU
Millennium (check)	10-2408	HRW				NU
NE03490	10-2409	HRW	no			NU
NE04490	10-2410	HRW	no			NU
Billings (check)	10-2411	HRW				OSU
OK05526	10-2412	HRW	no			OSU
OK05212	10-2413	HRW	yes	Garrison	2011	OSU
OK07231	10-2414	HRW	no			OSU
Smoky Hill (check)	10-2415	HRW				Westbred
HV9W06-262R	10-2416	HRW	no			Westbred
HV9W06-218W	10-2417	HWW	no			Westbred
Yellowstone (check)	10-2418	HRW				MSU
MTS0721	10-2419	HRW	yes	Bearpaw	2011	MSU
TAM 111 (check)	10-2420	HRW				TAMU
TX05A001822	10-2421	HRW	no			TAMU
TX06A001263	10-2422	HRW	no			TAMU
2009						
Smoky Hill (check)	09-2401	HRW				Westbred
Stout (HV9W03-539R)	09-2402	HRW	yes	WB-Stout	2009	Westbred
RonL (check)	09-2403	HWW				KSU-Hays
Tiger	09-2404	HWW	yes			KSU-Hays
Hatcher (check)	09-2405	HRW				CSU
CO04393	09-2406	HRW	no			CSU
CO04499	09-2407	HRW	no			CSU
OK Bullet (check)	09-2408	HRW				OSU
Billings	09-2409	HRW	yes			OSU
OK05526	09-2410	HRW	no			OSU
PostRock (check)	09-2411	HRW				AgriPro
CJ	09-2412	HRW	yes			AgriPro
SY Gold (AP00x0100-51)	09-2413	HRW	yes	SY Gold	2010	AgriPro
Yellowstone (check)	09-2414	HRW				MSU
MT06103	09-2415	HRW	no			MSU
MTS0713	09-2416	HRW	yes	Judee	2011	MSU
TAM 111 (check)	09-2417	HRW				TAMU
TX02A0252	09-2418	HRW	yes	TAM 113	2010	TAMU
Millennium (check)	09-2419	HRW				NU
NE01481	09-2420	HRW	yes	McGill	2010	NU
NI04421	09-2421	HRW	yes	Robidoux	2010	NU

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
2008						
Jagalene (check)	08-2401	HRW				AgriPro
Art	08-2402	HRW	yes			AgriPro
Hawken	08-2403	HRW	yes			AgriPro
NuDakota	08-2404	HRW	yes			AgriPro
Hatcher (check)	08-2405	HRW				CSU
Thunder CL	08-2406	HWW	yes			CSU
CO03W054	08-2407	HWW	yes	Snowmass		CSU
CO03064	08-2408	HRW	no			CSU
Danby (check)	08-2409	HWW				KSU-Hays
Tiger	08-2410	HWW	yes			KSU-Hays
Karl 92 (check)	08-2411	HRW				KSU-Manhattan
KS970093-8-9-#1	08-2412	HRW	yes	Everest	2009	KSU-Manhattan
OK Bullet (check)	08-2413	HRW				OSU
OK03305	08-2414	HRW	yes	Pete	2009	OSU
OK03522	08-2415	HRW	yes	Billings	2009	OSU
OK03825-5403-6	08-2416	HRW				OSU
Tandem (check)	08-2417	HRW	yes	STARS0601W	2006	SDSU
SD05W030	08-2418	HWW	no			SDSU
2007						
Hatcher (check)	07-2401	HRW				CSU
CO03W239	07-2402	HWW	yes	Thunder CL	2008	CSU
CO03W054	07-2403	HWW	yes	Snowmass		CSU
CO02W237	07-2404	HWW	no			CSU
Millennium (check)	07-2405	HRW				NU
NH03614	07-2406	HRW	yes	Settler CL	2008	NU
OK Bullet (check)	07-2407	HRW				OSU
OK00514-05806	07-2408	HRW	no			OSU
OK05737W	07-2409	HWW	no			OSU
OK03522	07-2410	HRW	yes	Billings	2009	OSU
OK02405	07-2411	HRW	no			OSU
Tandem (check)	07-2412	HRW				SDSU
SD98W175-1	07-2413	HRW	no			SDSU
SD01058	07-2414	HRW	no			SDSU
SD0111-9	07-2415	HRW	yes	Lyman	2008	SDSU
SD01273	07-2416	HRW	no			SDSU
Genou (check)	07-2417	HRW				MSU
MT0495	07-2418	HRW	no			MSU
MTS04114	07-2419	HRW	no			MSU

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
2006						
Overley (check)	06-2401	HRW				KSU-Manhattan
Fuller	06-2402	HRW	yes			KSU-Manhattan
KS990498-3-&~2	06-2403	HRW	no			KSU-Manhattan
KS970274-14*9	06-2404	HRW	no			KSU-Manhattan
Overley (check)	06-2405	HRW				Westbred
Smoky Hill	06-2406	HRW	yes			Westbred
Aspen	06-2407	HRW	yes			Westbred
Millennium (check)	06-2408	HRW				NU
NW98S097	06-2409	HRW	yes	Anton	2008	NU
N02Y5117	06-2410	HRW	yes	Mace	2007	NU
NE01643	06-2411	HRW	yes	Overland	2007	NU
NE02584	06-2412	HRW	no			NU
OK Bullet (check)	06-2413	HRW				OSU
Duster	06-2414	HRW	yes			OSU
OK01420	06-2415	HRW	no			OSU
OK02405	06-2416	HRW	no			OSU
OK02522W	06-2417	HWW	yes	OK Rising	2008	OSU
Tandem (check)	06-2418	HRW				SDSU
SD96240-3-1	06-2419	HRW	no			SDSU
SD01122	06-2420	HRW	no			SDSU
SD01W065	06-2421	HWW	no			SDSU
TAM 111 (check)	06-2422	HRW				TAMU
TAM 112	06-2423	HRW	yes			TAMU
TX01A5936	06-2424	HRW	no			TAMU
TX01D3232	06-2425	HRW	yes	TAM 304	2006	TAMU
TX01V5314	06-2426	HRW	yes	TAM 203	2007	TAMU
2005						
Akron (check)	05-2401	HRW				CSU
CO00016	05-2402	HRW	yes	Ripper	2006	CSU
Jagger (check)	05-2403	HRW				KSU-Hays
2137	05-2404	HRW	yes			KSU-Hays
KS03HW6-6	05-2405	HWW	no			KSU-Hays
KS03HW158-1	05-2406	HWW	yes	RonL		KSU-Hays
Jagger (check)	05-2407	HRW				AgriPro
Neosho	05-2408	HRW	yes			AgriPro
W03-20	05-2409	HRW	yes	Postrock	2005	AgriPro
Goodstreak (check)	05-2410	HRW				NU
Infinity CL	05-2411	HRW	yes			NU
OK Bullet (check)	05-2412	HRW				OSU
OK93p656H3299-2c04	05-2413	HRW	yes	Duster	2006	OSU
OK01307	05-2414	HRW	no			OSU
OK03918C	05-2415	HRW	yes	Centerfield	2006	OSU
OK00611W	05-2416	HWW	no			OSU
Tandem (check)	05-2417	HRW				SDSU
Crimson	05-2418	HRW	yes			SDSU
SD97059-2	05-2419	HRW	no			SDSU
SD01W064	05-2420	HWW	no			SDSU

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
2004						
Jagger (check)	04-2401	HRW				KSU-Hays
2137	04-2402	HRW	yes			KSU-Hays
KS02HW34	04-2403	HWW	yes	Danby	2005	KSU-Hays
KS02HW35-5	04-2404	HWW	no			KSU-Hays
KS03HW158	04-2405	HWW	yes	RonL	2006	KSU-Hays
Antelope (check)	04-2406	HRW				NE-USDA-ARS
Arrowsmith	04-2407	HRW	yes			NE-USDA-ARS
NW99L7068	04-2408	HRW	no			NE-USDA-ARS
Millennium (check)	04-2409	HRW				NU
NE99495	04-2410	HRW	yes	NE99495	2005	NU
OK102 (check)	04-2411	HRW				OSU
OK00618W	04-2412	HWW	yes	Guymon	2005	OSU
OK99212	04-2413	HRW	no			OSU
OK00514	04-2414	HRW	yes	OK Bullet	2005	OSU
OK02909C	04-2415	HRW	yes	Okfield	2005	OSU
Tandem (check)	04-2416	HRW				SDSU
SD97W609	04-2417	HWW	yes	Alice	2006	SDSU
SD97538	04-2418	HRW	no			SDSU
SD98102	04-2419	HRW	yes	Darrell	2006	SDSU
2003						
Akron (check)	03-2401	HRW				CSU
CO980607	03-2402	HRW	yes	Hatcher	2004	CSU
CO00D007	03-2403	HRW	yes	Bond CL	2004	CSU
Jagger (check)	03-2404	HRW				KSU-Hays
2137	03-2405	HRW	yes			KSU-Hays
KS01HW152-6	03-2406	HWW	no			KSU-Hays
KS01HW163-4	03-2407	HWW	no			KSU-Hays
KS02HW34	03-2408	HWW	yes	Danby	2005	KSU-Hays
Jagger (check)	03-2409	HRW				KSU-Manhattan
2137	03-2410	HRW	yes			KSU-Manhattan
Overley	03-2411	HRW	yes			KSU-Manhattan
KS940786-6-9	03-2412	HRW	no			KSU-Manhattan
OK 102 (check)	03-2413	HRW				OSU
OK94P549-11	03-2414	HRW	yes	Endurance	2004	OSU
OK98690	03-2415	HRW	yes	Deliver	2004	OSU
Crimson (check)	03-2416	HRW				SDSU
SD97W604	03-2417	HWW	yes	Wendy	2004	SDSU
SD92107-5	03-2418	HRW	no			SDSU

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
2002						
Jagger (check)	02-2401	HRW				AgriPro
Cutter	02-2402	HRW	yes			AgriPro
Dumas	02-2403	HRW	yes			AgriPro
Jagalene	02-2404	HRW	yes			AgriPro
G1878 (check)	02-2405	HRW				Cargill
G980723	02-2406	HRW	no			Cargill
G970252W	02-2407	HWW	no			Cargill
Prowers (check)	02-2408	HRW				CSU
CO980376	02-2409	HRW	no			CSU
CO980607	02-2410	HRW	yes	Hatcher	2004	CSU
CO980630	02-2411	HRW	no			CSU
Jagger (check)	02-2412	HRW				KSU-Manhattan
KS940748-2-2	02-2413	HRW	no			KSU-Manhattan
KS940786-6-7	02-2414	HRW	yes	Overley	2003	KSU-Manhattan
KS940786-6-9	02-2415	HRW	no			KSU-Manhattan
Millennium (check)	02-2416	HRW				NU
NE97V121	02-2417	HRW	no			NU
NE98466	02-2418	HRW	no			NU
NE98471	02-2419	HRW	yes	Hallam	2004	NU
NI98439	02-2420	HRW	no			NU
2174 (check)	02-2421	HRW				OSU
OK102	02-2422	HRW	yes			OSU
OK95548-54	02-2423	HRW	no			OSU
OK95616-56	02-2424	HRW	no			OSU
OK96705-38	02-2425	HRW	no			OSU
OK98699	02-2426	HRW	no			OSU
2001						
Jagger (check)	01-2401	HRW				Cargill
G970380A	01-2402	HRW	no			Cargill
G970209W	01-2403	HWW	no			Cargill
Prowers 99 (check)	01-2404	HRW				CSU
CO970547	01-2405	HRW	no			CSU
Millennium (check)	01-2406	HRW				NU
NE97426	01-2407	HRW	no			NU
NE97465	01-2408	HRW	yes	Goodstreak	2002	NU
NE97638	01-2409	HRW	yes	Empire	2002	NU
NE97669	01-2410	HRW	no			NU
NE97689	01-2411	HRW	yes	Harry	2002	NU
2174 (check)	01-2412	HRW				OSU
OK96717-99-6756	01-2413	HRW	no			OSU
OK97508	01-2414	HRW	yes	Ok102	2002	OSU

Thank you for reviewing this report of 2013 WQC Hard Winter Wheat milling and baking. Please let me know if you have any comments on this report. I can be reached at (785)776-2750 or by email, Richard.chen@ars.usda.gov