Milling and Baking Test Results
for Hard Winter Wheat
Harvested in 2014

65th 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, Bayer CropScience LP, 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.

The Wheat Quality Council (WQC) provides funds for the program with great effort and support from collaborators who run bake tests.

Downloading or printing of this report is available through the 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:

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2014

Milling and Baking Test Results for

Hard Winter Wheats

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The MISSION
of the WHEAT QUALITY COUNCIL:

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

The GOAL
of the WHEAT QUALITY COUNCIL:

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

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Description of the 2014 Testing Program

Founded in 1949, this is the **65th** 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 (including common check and internal check) 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.

A total of 29 entries this year were grown in special locations and submitted for small-scale testing by nine 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 artisan bread, 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, tortilla data generated by Texas A&M University, and artisan bread quality data from Farm To Market Bread Company, Kansas City, MO. Methods used to evaluate wheat lines are listed in Appendix A.

2014 WQC Hard Winter Wheat Entries

	Test Entry Number	Sample Identification
KANSAS-HAYS	14-2401	Jagalene (CC)
	14-2402	Danby (IC)
	14-2403	KS11HW15-4
	14-2404	KS11W39-5
TEXAS-AMARILLO	14-2405	Jagalene (CC)
	14-2406	TAM 111 (IC)
	14-2407	TX08A001249
	14-2408	TX09A001194
	14-2409	TX09D1172
COLORADO	14-2410	Jagalene (CC)
	14-2411	Byrd (IC)
	14-2412	CO11D174
	14-2413	CO11D446
NEBRASKA	14-2414	Jagalene (CC)
	14-2415	Camelot (IC)
	14-2416	NE07531
	14-2417	NE09521
MONTANA	14-2418	Jagalene (CC)
	14-2419	Yellowstone (IC)
	14-2420	MT1078
	14-2421	MT1138
OKLAHOMA	14-2422	Jagalene (CC)
	14-2423	Ruby Lee (IC)
	14-2424	OK09125
	14-2425	OK10126
KANSAS-MANHATTAN	14-2426	Jagalene (CC)
	14-2427	KanMark
AGRIPRO	14-2428	06BC722#25
	14-2429	06BC796#68
	14-2430*	Jagalene (CC)

* Shared common check. bake data for sample 14-2426 used for statistical evaluation of Syngenta lines.

CC = Common Check and IC = Internal Check

2014 Wheat Classification Results from GIPSA

GIPSA Wheat Market Classification

ID	CL	DKG	TW	M	ODOR	HT	DKT	FM	SHBN	DEF	CCL	WOCL	VARIETY	GRADE
14-2401	HRW	0.02	58.7	13.1	OK	0.0	0.2	0.1	0.6	0.9	0.0	0.4	JAGALENE	U.S. NO. 2 HRW DKG 0.0%
14-2402	HDWH	0.01	62.1	12.8	OK	0.0	0.1	0.0	0.2	0.3	0.0	0.0	DANBY	U.S. NO. 1 HDWH DKG 0.0%
14-2403	HDWH	0.00	60.8	12.9	OK	0.0	0.3	0.0	0.2	0.5	0.0	0.0	KS11HW154-4	U. S. NO. 1 HDWH DKG 0.0%
14-2404	HDWH	0.00	60.4	12.7	OK	0.0	0.3	0.0	0.3	0.6	0.0	0.0	KS11HW39-5	U. S. NO. 1 HDWH DKG 0.9%
14-2405	HRW	0.00	60.7	11.9	OK	0.0	0.2	0.0	0.1	0.3	0.0	0.0	JAGALENE	U. S. NO. 1 HRW DKG 0.0%
14-2406	HRW	0.04	61.6	11.9	OK	0.0	0.4	0.0	0.1	0.5	0.0	0.0	TAM 111	U. S. NO. 1 HRW DKG 0.0%
14-2407	HRW	0.00	61.8	11.8	OK	0.0	0.0	0.0	0.8	0.8	0.0	0.0	TX 08A001249	U. S. NO. 1 HRW DKG 0.0%
14-2408	HRW	0.00	61.5	11.8	OK	0.0	0.1	0.0	0.3	0.4	0.0	0.0	TX 09A001194	U. S. NO. 1 HRW DKG 0.0%
14-2409	HRW	0.01	61.4	11.8	OK	0.0	0.5	0.0	0.3	0.8	0.0	0.0	TX 09D1172	U. S. NO. 1 HRW DKG 0.0%
14-2410	HRW	0.00	62.0	9.9	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	JAGALENE	U. S. NO. 1 HRW DKG 0.0%
14-2411	HRW	0.00	61.6	10.9	OK	0.0	1.1	0.0	0.4	1.5	0.0	0.0	BYRD	U. S. NO. 1 HRW DKG 0.0%
14-2412	HRW	0.00	60.0	9.9	OK	0.0	0.0	0.0	0.6	0.6	0.0	0.0	CO11D174	U. S. NO. 1 HRW DKG 0.0%
14-2413	HRW	0.01	59.3	10.0	OK	0.0	0.0	0.0	0.8	0.8	0.0	0.0	C011D446	U. S. NO. 2 HRW DKG 0.0%
14-2414	HRW	0.00	61.0	12.6	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	JAGALENE	U. S. NO. 1 HRW DKG 0.0%
14-2415	HRW	0.01	60.6	12.6	OK	0.0	0.1	0.0	0.2	0.3	0.0	0.0	CAMELOT	U. S. NO. 1 HRW DKG 0.0%
14-2416	HRW	0.00	61.6	11.7	OK	0.0	0.0	0.0	0.5	0.5	0.0	0.0	NEO7531	U. S. NO. 1 HRW DKG 0.0%
14-2417	HRW	0.00	61.2	12.2	OK	0.0	0.1	0.0	0.4	0.5	0.0	0.1	NEO9521	U. S. NO. 1 HRW DKG 0.0%
14-2418	HRW	0.00	63.1	11.8	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.2	JAGALENE	U. S. NO. 1 HRW DKG 0.0%
14-2419	HRW	0.03	61.1	12.5	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	YELLOWSTONE	U. S. NO. 1 HRW DKG 0.0%
14-2420	HRW	0.00	61.7	11.8	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	MT 1078	U. S. NO. 1 HRW DKG 0.0%
14-2421	HRW	0.01	61.9	12.4	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	MT1138	U. S. NO. 1 HRW DKG 0.0%
14-2422	HRW	0.00	60.9	12.7	OK	0.0	0.1	0.0	0.7	0.8	0.0	2.7	JAGALENE	U. S. NO. 1 HRW DKG 0.0%
14-2423	HRW	0.00	60.5	12.8	OK	0.0	0.1	0.0	0.3	0.4	0.0	0.0	RUBY LEE	U. S. NO. 1 HRW DKG 0.0%
14-2424	HRW	0.00	59.4	12.6	OK	0.0	0.0	0.0	0.6	0.6	0.0	0.0	OK09125	U. S. NO. 2 HRW DKG 0.0%
14-2425	HRW	0.00	59.9	12.6	OK	0.0	0.0	0.0	0.5	0.5	0.0	0.0	OK10126	U. S. NO. 2 HRW DKG 0.0%
14-2426	HRW	0.00	58.0	12.0	OK	0.0	0.3	0.0	0.2	0.5	0.0	0.0	JAGALENE	U. S. NO. 2 HRW DKG 0.0%
14-2427	HRW	0.00	60.1	12.1	OK	0.0	0.2	0.0	0.1	0.3	0.0	0.0	KANMARK	U.S. NO. 1 HRW DKG 0.0%
14-2428	HRW	0.00	63.0	13.1	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	06BC722 #25	U. S. NO. 1 HRW DKG 0.0%
14-2429	HRW	0.00	62.4	12.8	OK	0.0	0.6	0.0	0.0	0.6	0.0	0.0	06BC796 #68	U. S. NO. 1 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

KANSAS-HAYS

14-2401	Jagalene (CC01)
14-2402	Danby (IC)
14-2403	KS11HW15-4
14-2404	KS11W39-5

Description of Test Plots and Breeder Entries

Kansas-Hays - Gourong Zhang

The samples submitted were grown at Hays experimental station in the 2014 crop year. The field has sandy-loam soil. Test plots were not irrigated and not fertilized. We got cold winter and extremely dry spring season (the total precipitation was 1.9 inches from March to May) in the 2014 crop year. There was little disease pressure though. Yield level was below average.

Jagalene (common check)

Danby (Local check)

KS11HW39-5

KS11HW39-5 is a hard white winter wheat breeding line. It is derived from a two-way cross of KS04HW101-3/KS04HW119-3. KS11HW39-5 has competitive yield potential and performed well in both eastern and western Kansas in the last two years. KS11HW39-5 has very good resistance to the three most important diseases in western Kansas, wheat streak mosaic virus, stripe rust, and leaf rust.

KS11HW39-5 has good baking quality with good mixing tolerance and good loaf volume. It has an average test weight.

KS11HW39-5 is medium late and medium tall. It has average straw strength and good tolerance to grain shattering.

KS11HW15-4

KS11HW15-4 is a hard white winter wheat breeding line and derived from a two-way cross of KS04HW101-3/RonL. KS11HW15-4 has good yield potential in the dry-land locations. KS11HW15-4 has good resistance to wheat streak mosaic virus, stripe rust, leaf rust, and Hessian fly.

KS11HW15-4 has good test weight and it also has good milling and baking quality.

KS11HW15-4 is medium late and has a medium height. It has below average straw strength and good tolerance to grain shattering.

Kansas-Hays: 2014 (Small-Scale) Samples

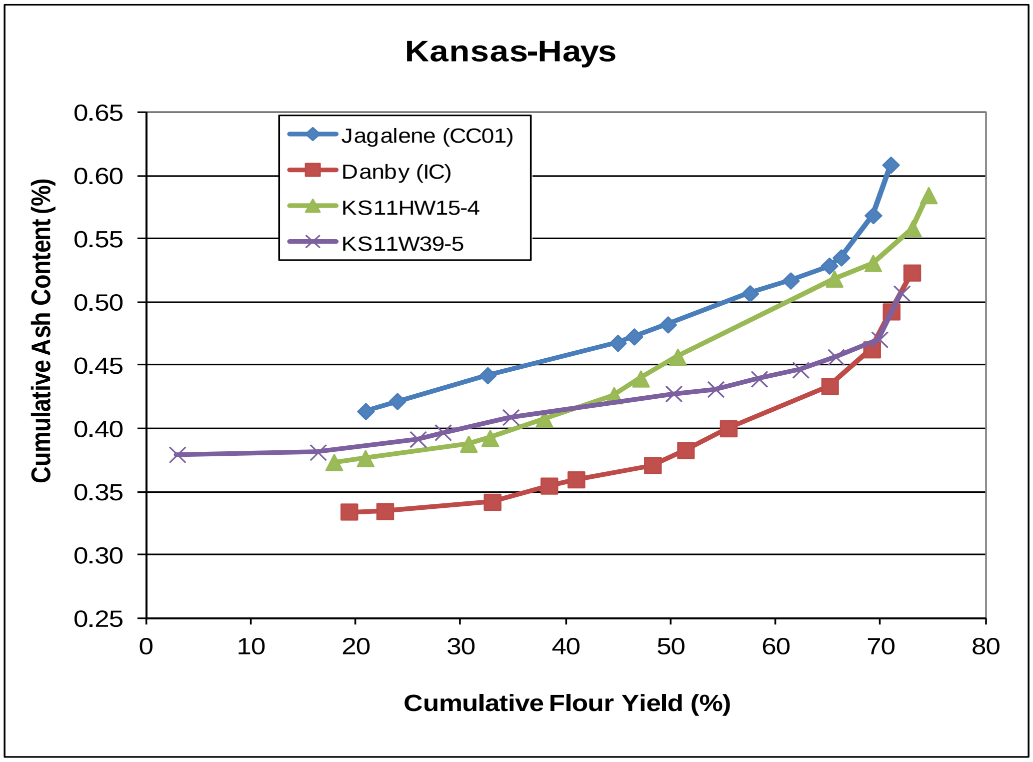
Test entry number	14-2401	14-2402	14-2403	14-2404
Sample identification	**Jagalene (CC01)**	**Danby (CI)**	**KS11HW154**	**KS11W39-5**
Wheat Data				
GIPSA classification	2 HRW	1 HDWH	1 HDWH	1 HDWH
Test weight (lb/bu) **Hectoliter weight (kg/hl)**	58.2 76.6	62.0 81.5	60.6 79.7	60.1 79.1
1000 kernel weight (gm)	30.2	29.7	32.9	32.8
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 65.3 34.3 0.4	 51.6 48.2 0.2	 68.8 31.2 0.0	 68.4 31.5 0.1
Single kernel (skcs)[a] Hardness (avg /s.d) Weight (mg) (avg/s.d) Diameter (mm)(avg/s.d) Moisture (%) (avg/s.d) SKCS distribution Classification	 75.1/17.3 30.2/8.4 2.71/0.36 13.1/0.4 01-06-12-81-01 Hard	 58.4/16.4 29.7/7.6 2.56/0.27 12.5/0.4 05-18-29-48-01 Hard	 59.1/17.2 32.9/9.0 2.69/0.32 12.7/0.4 08-14-26-52-02 Hard	 55.7/17.5 32.8/9.7 2.67/0.34 12.6/0.4 11-17-27-45-03 Mixed
Wheat protein (12% mb) **Wheat ash (12% mb)**	15.4 1.67	14.5 1.48	14.5 1.53	14.4 1.56
Milling and Flour Quality Data				
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 71.8 67.4	 73.5 68.0	 73.4 67.7	 72.6 68.0
Flour moisture (%) **Flour protein (14% mb)** **Flour ash (14% mb)**	13.2 14.3 0.61	12.9 13.4 0.49	12.2 13.2 0.50	12.4 12.8 0.47
Rapid Visco-Analyser Peak time (min) Peak viscosity (RVU) Breakdown (RVU) Final viscosity at 13 min (RVU)	 6.1 200.6 73.4 247.3	 6.2 248.1 117.8 234.0	 6.1 224.3 91.5 247.7	 6.2 230.4 91.3 255.1
Minolta color meter L* a* b* **PPO**	 92.11 -1.40 9.11 0.659	 92.78 -1.34 7.62 0.730	 92.11 -1.43 8.72 0.730	 92.43 -1.48 8.63 0.771
Falling number (sec)	569	490	573	507
Damaged Starch (AI%) (AACC76-31)	 96.44 6.62	 94.37 5.08	 95.24 5.70	 94.41 5.10

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

Kansas-Hays: Physical Dough Tests and Gluten Analysis
For 2014 (Small-Scale) Samples

Test Entry Number	14-2401	14-2402	14-2403	14-2404
Sample Identification	**Jagalene (CC01)**	**Danby (IC)**	**KS11HW15-4**	**KS11W39-5**
MIXOGRAPH				
Flour Abs (% as-is)	68.0	65.6	66.4	65.5
Flour Abs (14% mb)	66.6	64.2	64.2	63.6
Mix Time (min)	5.0	3.3	3.5	3.4
Mix tolerance (0-6)	5	1	1	1
FARINOGRAPH				
Flour Abs (% as-is)	62.6	60.4	61.4	59.3
Flour Abs (14% mb)	61.2	59.0	59.2	57.4
Development time (min)	28.7	10.7	8.7	9.9
Mix stability (min)	31.6	17.1	10.3	19.0
Mix Tolerance Index (FU)	7	13	27	18
Breakdown time (min)	36.9	21.0	14.1	22.1
ALVEOGRAPH				
P(mm): Tenacity	94	49	56	53
L(mm): Extensibility	120	177	196	218
G(mm): Swelling index	24.4	29.6	31.2	32.9
W(10^{-4} J): strength (curve area)	448	250	310	308
P/L: curve configuration ratio	0.78	0.28	0.29	0.24
Ie(P_{200}/P): elasticity index	71.1	58.5	58.0	55.2
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	509/608/619	215/281/298	286/368/392	305/399/431
Extensibility (mm at 45/90/135 min)	188/171/171	178/192/196	171/169/178	175/181/186
Energy (cm^2 at 45/90/135 min)	211/218/223	82/113/123	94/123/136	108/148/161
Resist $_{max}$ (BU at 45/90/135min)	910/998/998	355/441/469	416/555/579	473/634/663
Ratio (at 45/90/135 min)	2.71/3.55/3.61	1.20/1.46/1.52	1.67/2.17/2.21	1.74/2.21/2.32
PROTEIN ANALYSIS				
HMW-GS Composition	1/2*, 17+18, 5+10	1/2*, 7+9, 5+10	2*, 7+8, 5+10	2*, 7+8, 5+10
%IPP	53.73	43.93	43.11	42.12
SEDIMENTATION TEST				
Volume (ml)	67.5	66.5	61.6	63.3

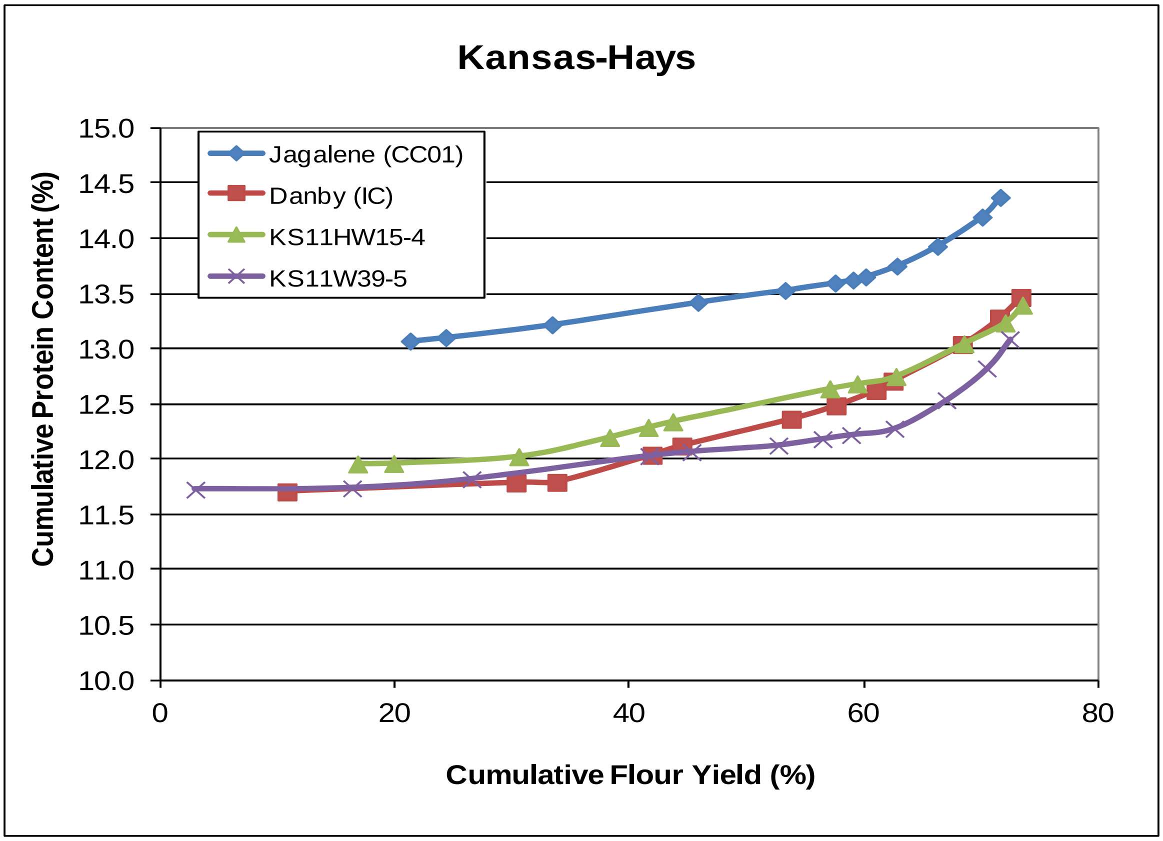
Kansas-Hays: Cumulative Ash Curves



Jagalene (CC01)					Danby (IC)				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	20.86	0.41	20.86	0.41	2M	19.28	0.33	19.28	0.33
1M Red	3.00	0.48	23.87	0.42	1M Red	3.42	0.34	22.70	0.33
1M	8.60	0.50	32.47	0.44	1M	10.23	0.36	32.93	0.34
3M	12.39	0.53	44.87	0.47	2BK	5.40	0.43	38.33	0.35
Grader	1.56	0.62	46.43	0.47	Grader	2.57	0.43	40.90	0.36
2BK	3.21	0.62	49.64	0.48	1BK	7.28	0.44	48.19	0.37
4M	7.82	0.66	57.46	0.51	3BK	3.15	0.56	51.34	0.38
1BK	3.88	0.67	61.34	0.52	FILTER FLR	4.07	0.62	55.41	0.40
3BK	3.68	0.72	65.02	0.53	3M	9.66	0.63	65.07	0.43
FILTER FLR	1.13	0.91	66.15	0.54	4M	4.00	0.93	69.07	0.46
5M	3.05	1.29	69.20	0.57	5M	1.86	1.61	70.93	0.49
BRAN FLR	1.67	2.26	70.87	0.61	BRAN FLR	1.97	1.63	72.90	0.52
Break Shorts	2.32	4.20	73.19	0.72	Break Shorts	2.09	3.55	74.99	0.61
Red Dog	2.13	3.06	75.32	0.79	Red Dog	1.51	2.62	76.49	0.65
Red Shorts	0.24	4.49	75.56	0.80	Red Shorts	0.12	3.72	76.61	0.65
Filter Bran	6.60	3.50	82.16	1.02	Filter Bran	4.77	2.03	81.39	0.73
Bran	17.84	5.91	100.0	1.89	Bran	18.61	5.28	100.0	1.58
Wheat		1.63					1.45		
St. Grd. Fl.		0.61					0.49		

KS11HW15-4					KS11W39-5				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	17.84	0.37	17.84	0.37	1M Red	2.92	0.38	2.92	0.38
1M Red	2.99	0.39	20.83	0.38	2M	13.40	0.38	16.32	0.38
1M	9.83	0.41	30.66	0.39	1M	9.52	0.41	25.85	0.39
Grader	2.04	0.46	32.70	0.39	Grader	2.38	0.46	28.22	0.40
2BK	5.16	0.50	37.86	0.41	1BK	6.46	0.46	34.68	0.41
1BK	6.64	0.53	44.50	0.43	3M	15.52	0.47	50.20	0.43
FILTER FLR	2.55	0.67	47.06	0.44	2BK	4.00	0.48	54.20	0.43
3BK	3.52	0.69	50.58	0.46	FILTER FLR*	4.15	0.55	58.34	0.44
3M	14.92	0.73	65.50	0.52	4M	3.95	0.55	62.29	0.45
4M	3.68	0.75	69.18	0.53	3BK	3.37	0.65	65.66	0.46
5M	3.77	1.06	72.95	0.56	5M	4.15	0.69	69.81	0.47
BRAN FLR	1.52	1.83	74.47	0.58	BRAN FLR	2.12	1.71	71.93	0.51
Break Shorts	1.84	4.41	76.31	0.68	Break Shorts	2.41	4.11	74.34	0.62
Red Dog	2.79	1.77	79.10	0.72	Red Dog	3.56	2.03	77.90	0.69
Red Shorts	0.25	4.24	79.35	0.73	Red Shorts	0.42	4.47	78.32	0.71
Filter Bran	3.62	2.36	82.98	0.80	Filter Bran	3.19	2.58	81.50	0.78
Bran	17.02	5.66	100.0	1.63	Bran	18.50	5.57	100.00	1.67
		1.49					1.53		
		0.50					0.47		

Kansas-Hays: Cumulative Protein Curves



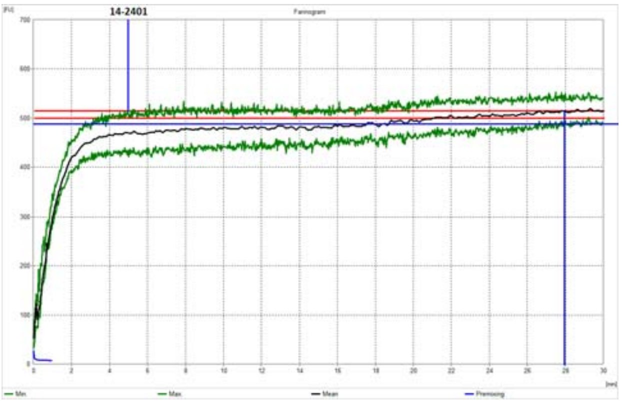
Jagalene (CC01)					Danby (IC)				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
2M	21.31	13.07	21.31	13.07	1M	10.79	11.71	10.79	11.71
1M Red	3.03	13.33	24.34	13.10	2M	19.54	11.83	30.33	11.79
1M	9.07	13.53	33.41	13.22	1M Red	3.48	11.84	33.82	11.79
3M	12.44	13.96	45.85	13.42	1BK	8.13	13.06	41.94	12.04
4M	7.44	14.19	53.29	13.53	Grader	2.54	13.50	44.48	12.12
1BK	4.26	14.44	57.55	13.60	3M	9.33	13.52	53.81	12.36
Grader	1.53	14.63	59.08	13.62	FILTER FLR	3.83	14.20	57.64	12.48
FILTER FLR	1.08	15.21	60.16	13.65	4M	3.40	14.99	61.04	12.62
5M	2.67	15.96	62.83	13.75	5M	1.46	16.18	62.50	12.71
2BK	3.45	17.18	66.28	13.93	2BK	5.91	16.55	68.40	13.04
3BK	3.82	18.80	70.09	14.19	3BK	3.16	18.46	71.57	13.28
BRAN FLR	1.54	22.44	71.64	14.37	BRAN FLR	1.83	20.78	73.39	13.47
Break Shorts	2.35	17.84	73.98	14.48	Break Shorts	2.05	17.88	75.44	13.59
Red Dog	1.79	16.79	75.77	14.54	Red Dog	1.15	15.20	76.60	13.61
Red Shorts	0.20	15.45	75.96	14.54	Red Shorts	0.09	15.44	76.69	13.61
Filter Bran	6.42	16.76	82.38	14.71	Filter Bran	4.52	16.73	81.21	13.79
Bran	17.62	16.85	100.00	15.09	Bran	18.79	18.27	100.00	14.63
Wheat		15.07					14.20		
St. Grd. Fl		14.29					13.35		

KS11HW15-4					KS11W39-5				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
2M	16.82	11.96	16.82	11.96	1M Red	2.99	11.73	2.99	11.73
1M Red	3.07	11.99	19.90	11.96	2M	13.36	11.74	16.35	11.74
1M	10.67	12.14	30.57	12.02	1M	10.20	11.95	26.55	11.82
1BK	7.75	12.88	38.31	12.20	3M	15.15	12.40	41.69	12.03
4M	3.30	13.35	41.61	12.29	4M	3.61	12.48	45.31	12.07
Grader	2.09	13.36	43.71	12.34	1BK	7.41	12.49	52.72	12.12
3M	13.39	13.61	57.09	12.64	FILTER FLR*	3.76	13.00	56.48	12.18
FILTER FLR	2.34	13.78	59.44	12.68	Grader	2.43	13.07	58.91	12.22
5M	3.30	13.96	62.74	12.75	5M	3.71	13.18	62.61	12.28
2BK	5.80	16.25	68.54	13.05	2BK	4.43	16.19	67.05	12.54
3BK	3.51	16.92	72.05	13.23	3BK	3.43	18.43	70.48	12.82
BRAN FLR	1.48	21.25	73.53	13.40	BRAN FLR	1.97	22.53	72.45	13.09
Break Shorts	1.94	17.58	75.47	13.50	Break Shorts	2.43	17.44	74.88	13.23
Red Dog	2.41	14.18	77.88	13.52	Red Dog	3.09	15.02	77.97	13.30
Red Shorts	0.21	15.59	78.09	13.53	Red Shorts	0.34	16.05	78.31	13.31
Filter Bran	3.37	16.72	81.46	13.66	Filter Bran	2.84	15.48	81.15	13.39
Bran	18.54	19.24	100.00	14.70	Bran	18.85	16.86	100.00	14.04
		14.16					14.05		
		13.17					12.80		

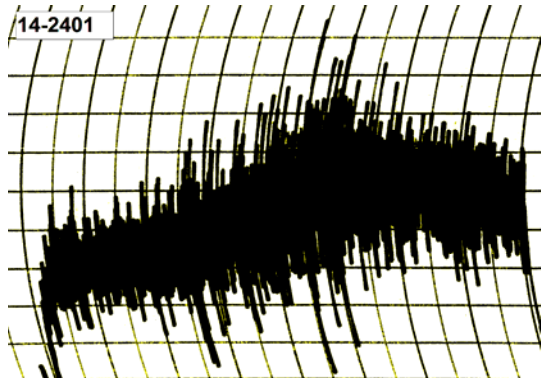
Physical Dough Tests

2014 (Small Scale) Samples - Kansas-Hays

Farinograms **Mixograms**

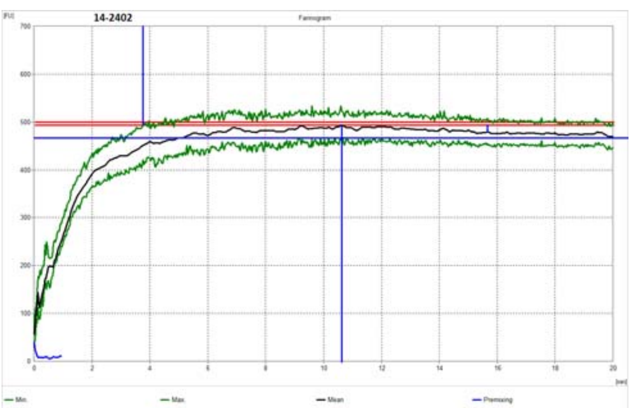


Water abs = 61.2%, Peak time = 28.7 min,
Mix stab = 31.6 min, MTI = 7 FU

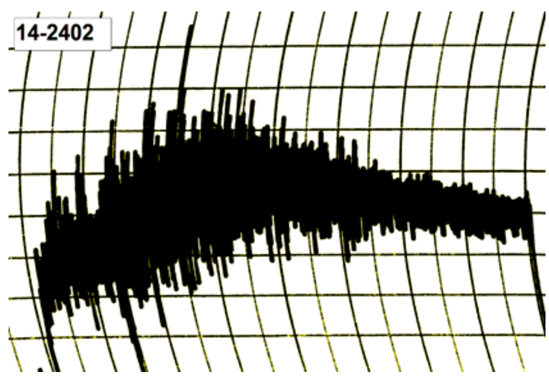


Water abs = 66.6%
Mix time = 5.0 min

14-2404, Jagalene (CC01)



Water abs = 59.0%, Peak time = 10.7 min,
Mix stab = 17.1 min, MTI = 13 FU



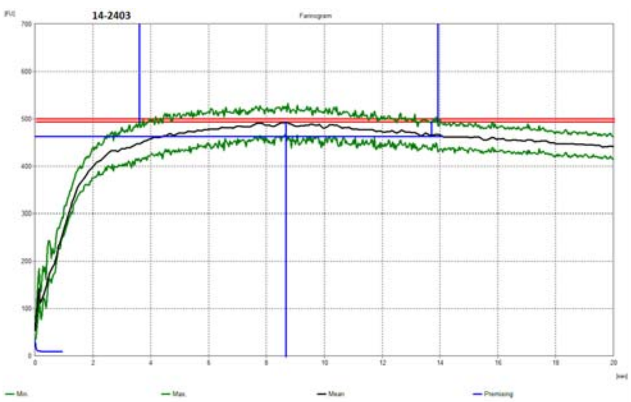
Water abs = 64.2%
Mix time = 3.3 min

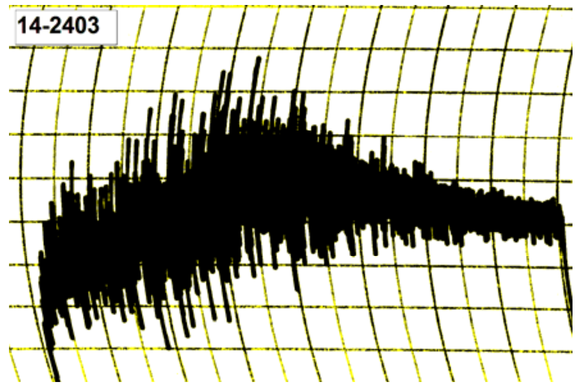
14-2402, Danby (IC)

Physical Dough Tests

2014 (Small Scale) Samples - Kansas-Hays (continued)

Farinograms | **Mixograms**

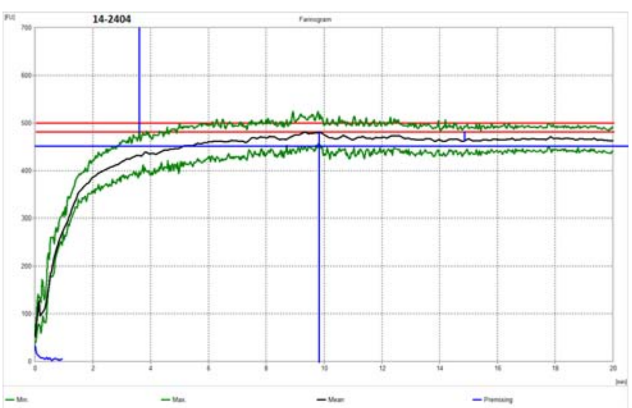


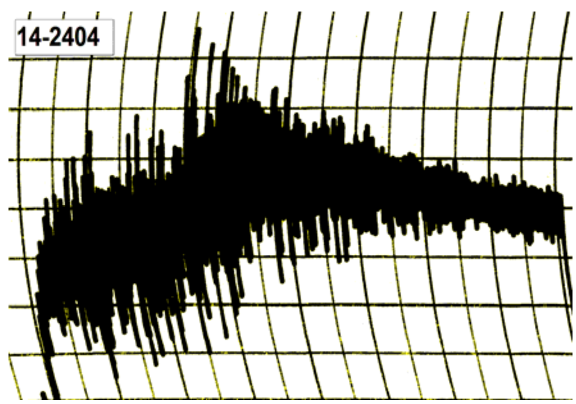


Water abs= 59.2%, Peak time = 8.7 min,
Mix stab = 10.3 min, MTI = 27 FU

Water abs = 64.2%
Mix time = 3.5 min

14-2403, KS11HW15-4





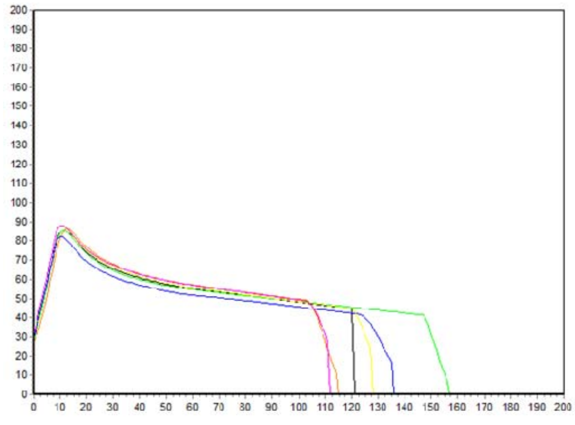
Water abs= 57.4%, Peak time = 9.9 min,
Mix stab = 19.0 min, MTI = 18 FU

Water abs = 63.6%
Mix time = 3.4 min

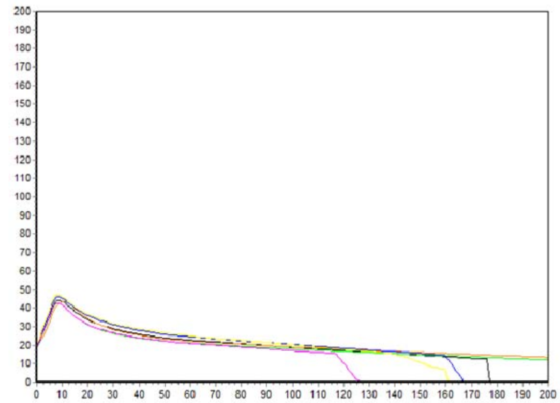
14-2404, KS11W39-5

Physical Dough Tests - Alveograph

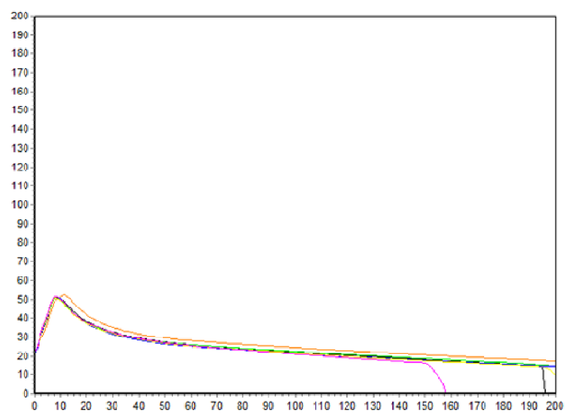
2014 (Small Scale) Samples – Kansas-Hays



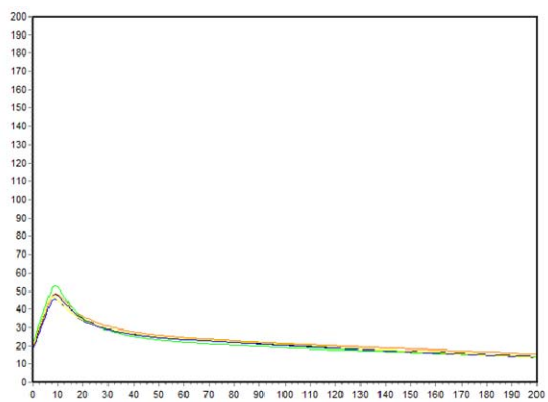
14-2401, Jagalene (CC01)
P(mm $H_2$0)=94, L(mm)=120, W(10E^{-4} J)=448



14-2402, Danby (IC)
P(mm $H_2$0)=49, L(mm)=177, W(10E^{-4} J)=250



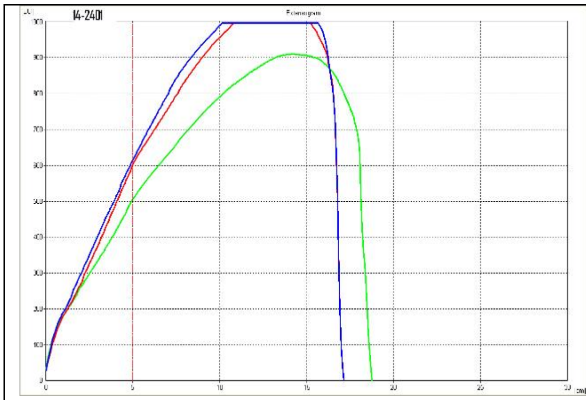
14-2403, KS11HW15-4
P(mm $H_2$0)=56, L(mm)=196, W(10E^{-4} J)=310



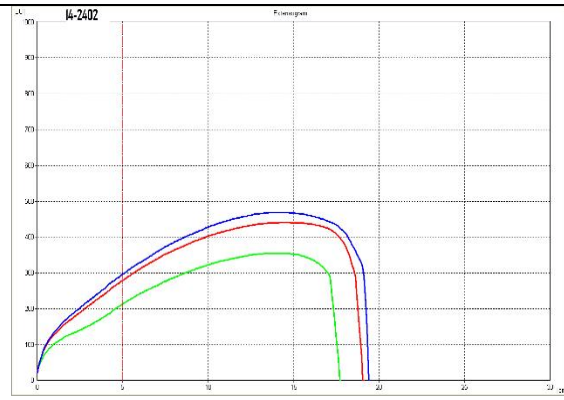
14-2404, KS11W39-5
P(mm $H_2$0)=53, L(mm)=218, W(10E^{-4} J)=308

Physical Dough Tests - Extensigraph

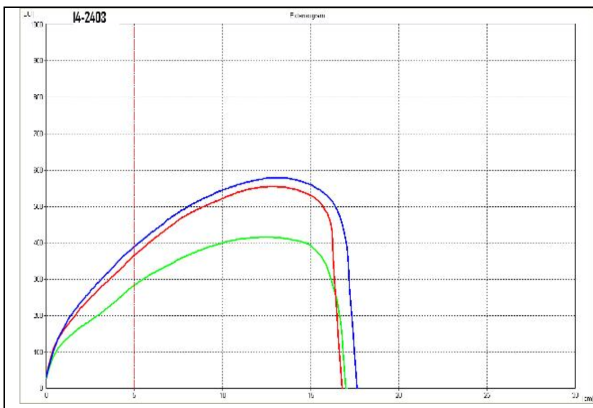
2014 (Small Scale) Samples – Kansas-Hays



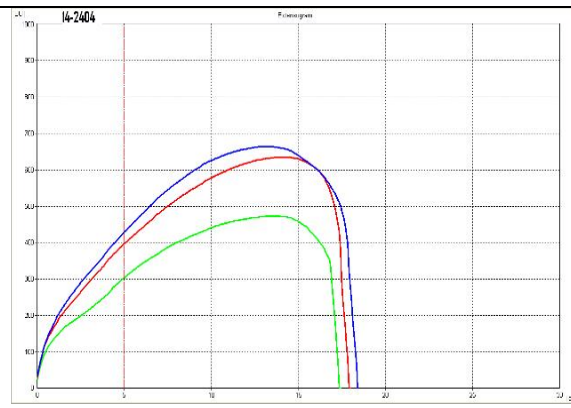
14-2401, Jagalene (CC01)
R (BU) = 608, E (mm) =171, W (cm^2) = 217
Rmax (BU) = 998, Ratio = 3.55 at 90 min



14-2402, Danby (IC)
R (BU) = 281, E (mm) =192, W (cm^2) = 113
Rmax (BU) = 441, Ratio = 1.46 at 90 min



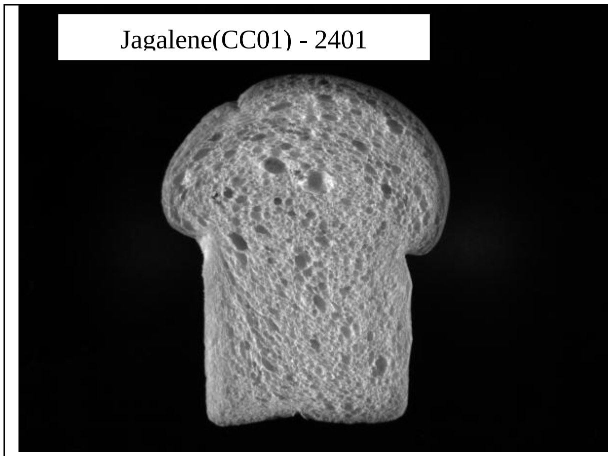
14-2403, KS11HW15-4
R (BU) = 368, E (mm) =169, W (cm^2) = 123
Rmax (BU) = 555, Ratio = 2.17 at 90 min

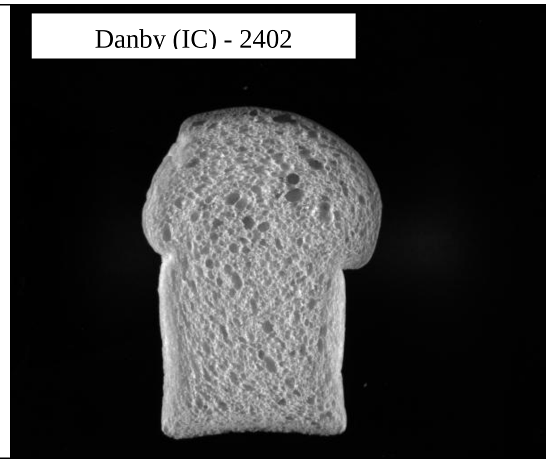


14-2404, KS11W39-5
R (BU) = 399, E (mm) =181, W (cm^2) = 148
Rmax (BU) = 634, Ratio = 2.21 at 90 min

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 2014 (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	7387	137.7	4482	0.443	2.080	3.985	1.698	-23.50
2402	6806	145.5	3972	0.454	2.225	3.268	1.598	-17.15

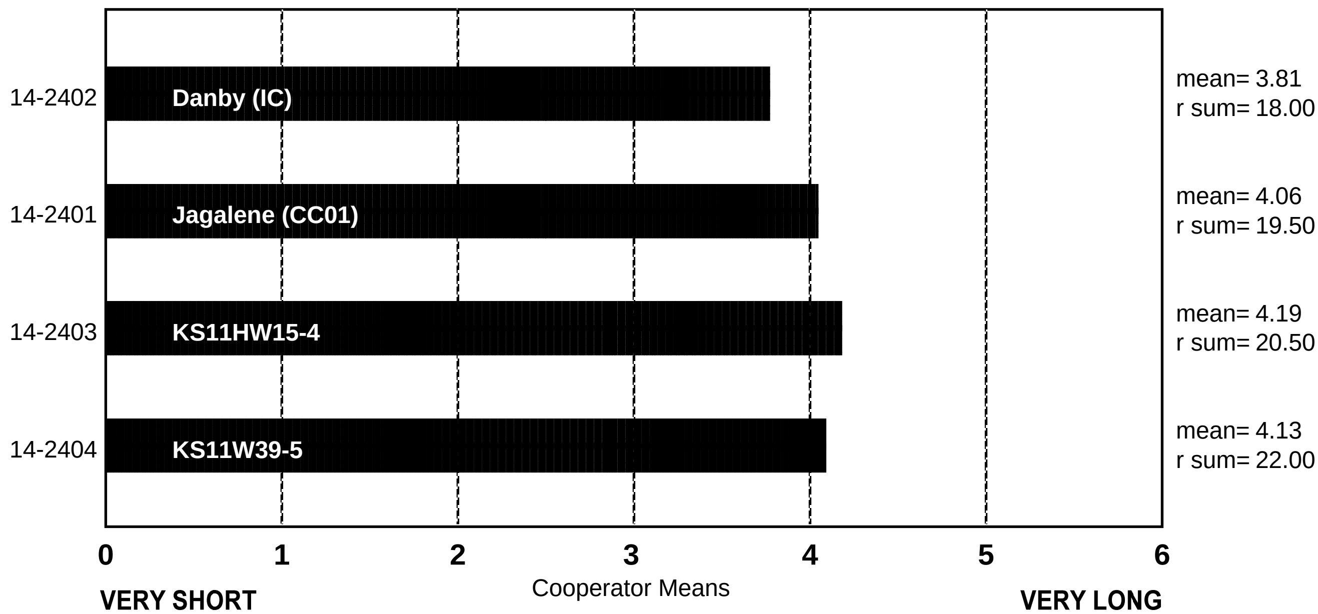
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2403	7012	147.4	4361	0.441	2.069	2.437	1.648	-19.18
2404	6944	150.0	4448	0.442	2.036	4.033	1.665	-20.93

SPONGE CHARACTERISTICS

(Small Scale) Kansas-Hays

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

ncoop= 8
chisq= 0.64
chisqc= 1.55
cvchisq= 7.82
crdiff=

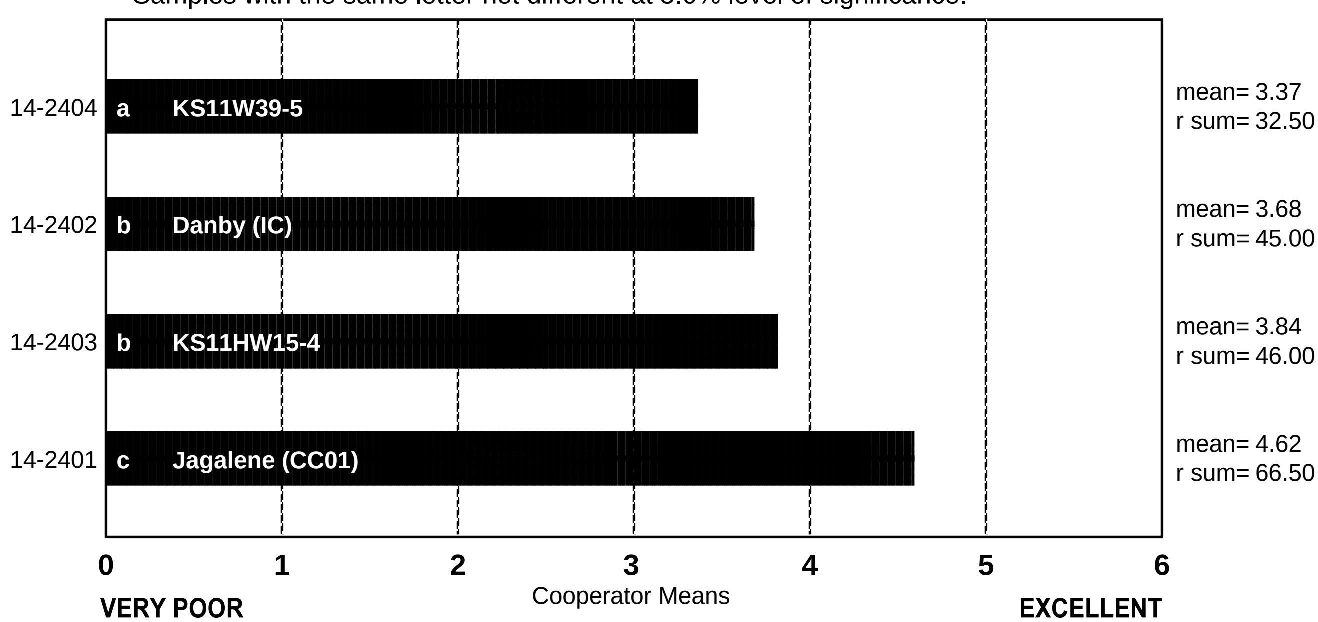


BAKE ABSORPTION

(Small Scale) Kansas-Hays

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

ncoop= 19
chisq= 18.77
chisqc= 27.65
cvchisq= 7.82
crdiff= 9.70



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
14-2401 Jagalene (CC01)	61.7	66.4	65.2	68.2	62.5	67.5	64.0	61.2	60.0	67.4	64.0	67.1	62.6	65.9	69.0	61.0	62.5	65.6	63.0
14-2402 Danby (IC)	57.2	62.8	63.8	67.9	62.0	65.5	62.5	59.0	60.0	67.3	64.0	63.3	60.4	63.2	66.0	59.0	60.5	63.4	60.0
14-2403 KS11HW15-4	59.1	62.8	63.7	67.0	60.5	65.5	62.5	59.2	59.0	66.1	64.0	63.5	61.4	64.1	66.0	59.0	61.5	64.4	61.0
14-2404 KS11W39-5	56.6	63.4	63.2	66.3	60.5	65.0	61.0	57.4	59.0	65.8	63.0	61.8	59.3	63.6	66.0	59.0	59.5	62.3	59.0

BAKE MIX TIME, ACTUAL

(Small Scale) Kansas-Hays

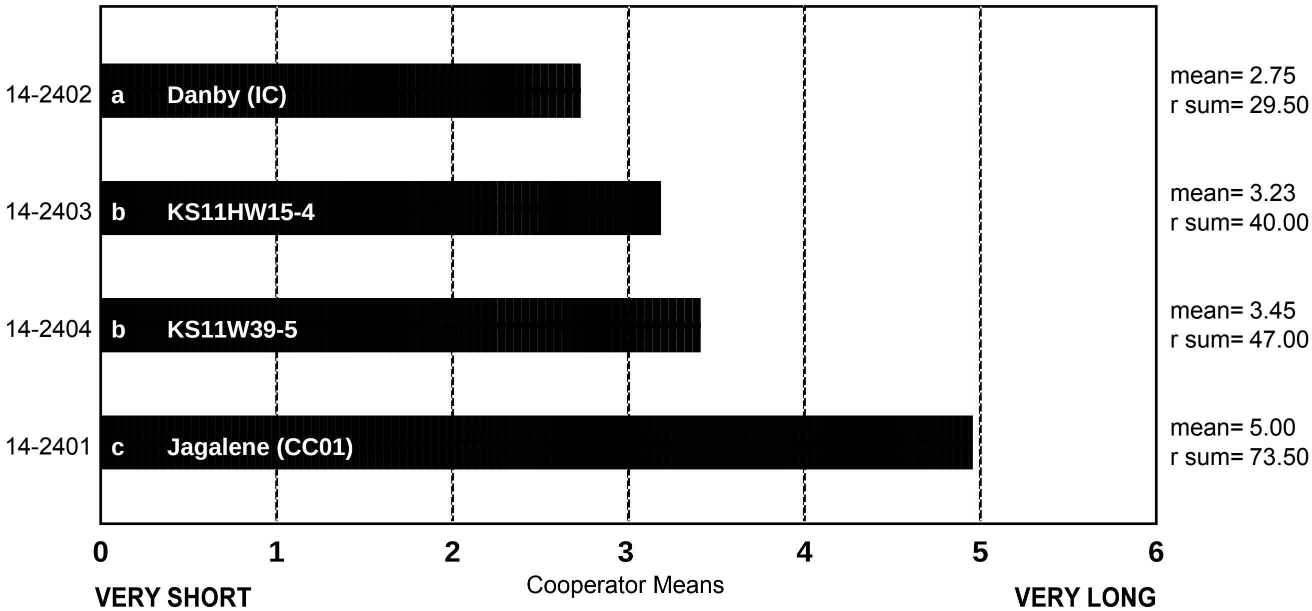
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2401 Jagalene (CC01)	**4.0**	**6.0**	**5.0**	**4.4**	**6.1**	**4.0**	**30.0**	**18.0**	**20.0**	**6.0**	**9.0**	**8.3**	**9.5**	**5.0**	**6.2**	**25.0**	**12.0**	**18.0**	**13.0**
14-2402 Danby (IC)	**2.5**	**3.0**	**2.2**	**3.9**	**3.5**	**2.4**	**11.0**	**5.0**	**11.0**	**5.0**	**9.0**	**3.8**	**7.0**	**3.0**	**3.0**	**25.0**	**7.0**	**7.0**	**4.0**
14-2403 KS11HW15-4	**2.8**	**3.8**	**3.2**	**4.0**	**4.2**	**2.7**	**15.0**	**5.0**	**10.0**	**6.5**	**9.0**	**4.4**	**6.0**	**3.5**	**3.5**	**24.0**	**10.0**	**6.0**	**5.0**
14-2404 KS11W39-5	**2.8**	**3.8**	**2.3**	**4.4**	**4.3**	**2.8**	**24.0**	**8.0**	**10.0**	**5.5**	**9.0**	**4.5**	**8.0**	**3.4**	**3.5**	**25.0**	**10.0**	**9.0**	**6.0**

BAKE MIX TIME

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 33.36
chisqc= 39.37
cvchisq= 7.82
crdiff= 8.40

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

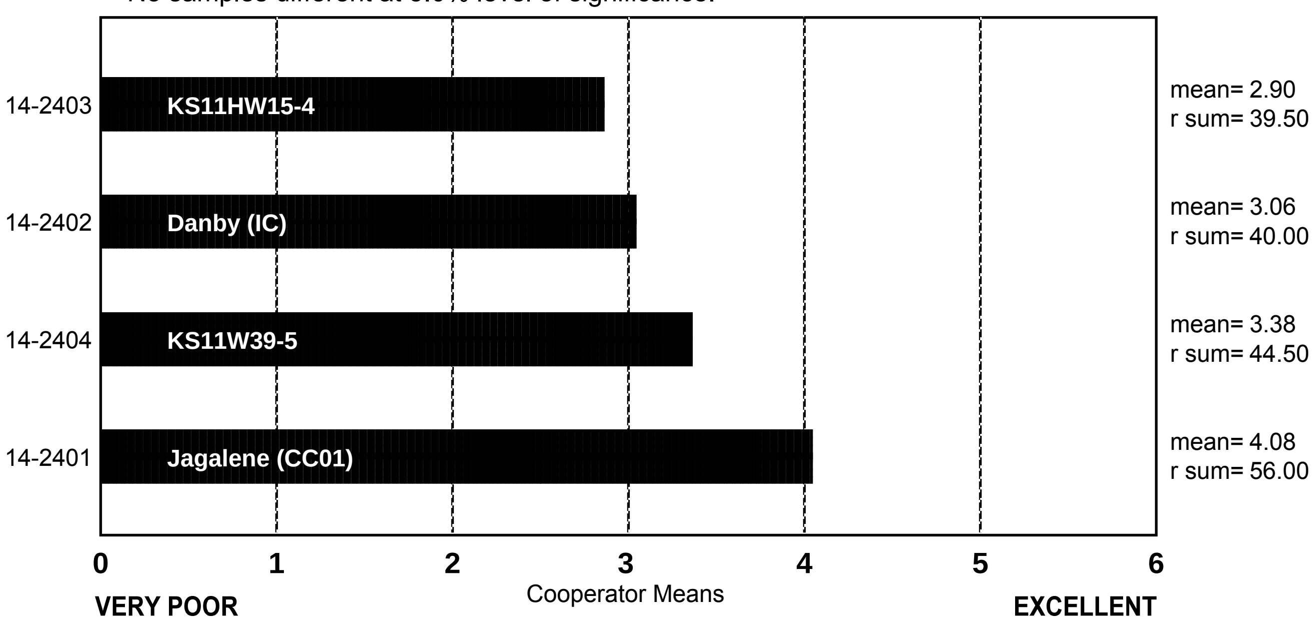


MIXING TOLERANCE

(Small Scale) Kansas-Hays

ncoop= 18
chisq= 5.88
chisqc= 7.20
cvchisq= 7.82
crdiff=

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

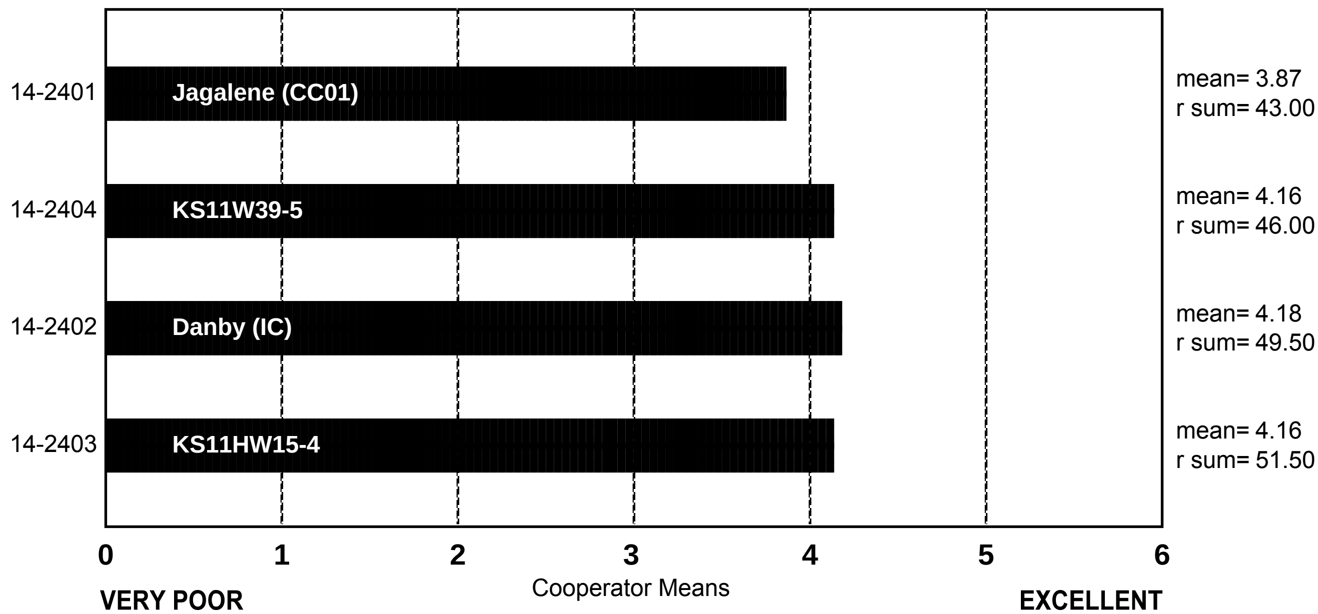


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 1.34
chisqc= 2.04
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Kansas-Hays

	Sticky	Wet	Tough	Good	Excellent
14-2401 Jagalene (CC01)	1	0	7	11	0
14-2402 Danby (IC)	2	1	2	13	1
14-2403 KS11HW15-4	4	0	1	13	1
14-2404 KS11W39-5	2	2	1	12	2

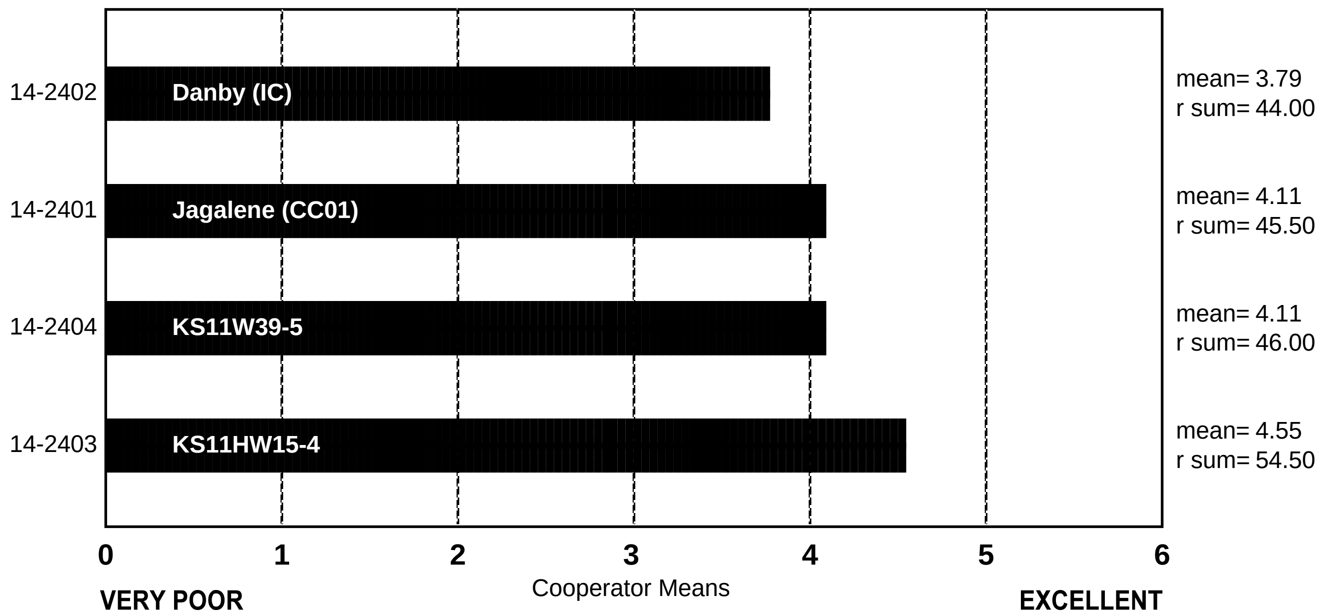
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 2.13
chisqc= 2.61
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Kansas-Hays

	Sticky	Wet	Tough	Good	Excellent
14-2401 Jagalene (CC01)	**1**	**1**	**6**	**8**	**3**
14-2402 Danby (IC)	**2**	**4**	**0**	**11**	**2**
14-2403 KS11HW15-4	**1**	**0**	**2**	**13**	**3**
14-2404 KS11W39-5	**2**	**3**	**0**	**13**	**1**

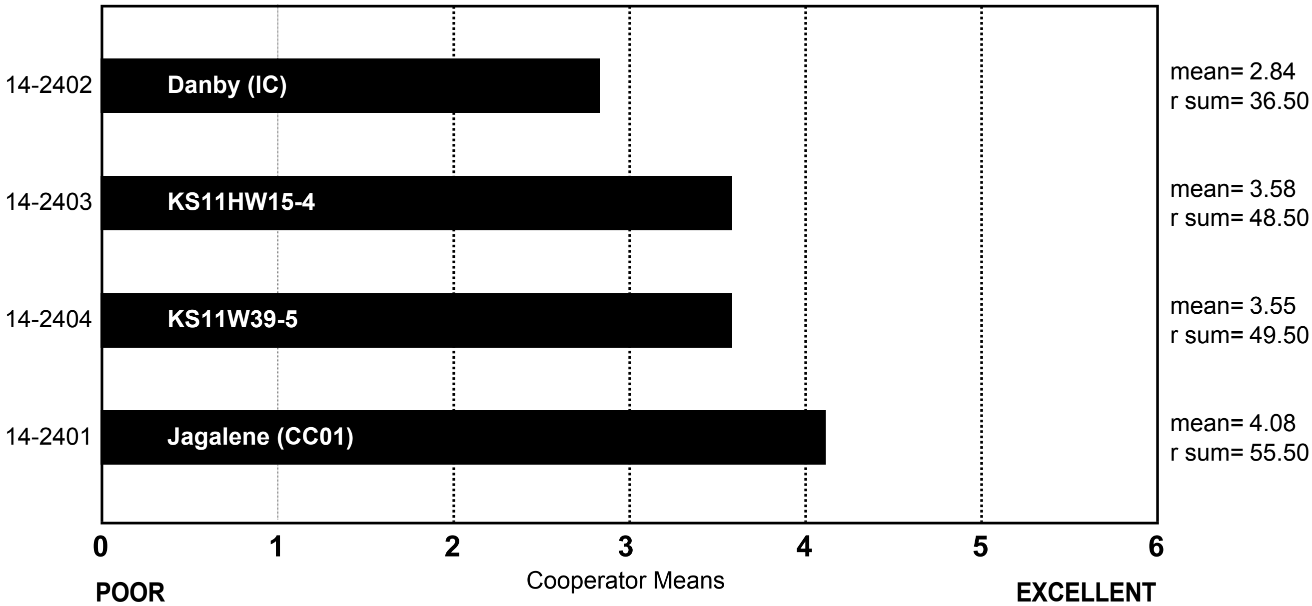
Frequency Table

CRUMB GRAIN

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 6.00
chisqc= 7.40
cvchisq= 7.82
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Kansas-Hays

	Open	Fine	Dense
14-2401 Jagalene (CC01)	8	10	1
14-2402 Danby (IC)	15	4	0
14-2403 KS11HW15-4	11	8	0
14-2404 KS11W39-5	12	6	1

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Kansas-Hays

	Round	Irregular	Elongated
14-2401 Jagalene (CC01)	**4**	**6**	**9**
14-2402 Danby (IC)	**11**	**5**	**3**
14-2403 KS11HW15-4	**5**	**8**	**6**
14-2404 KS11W39-5	**2**	**10**	**7**

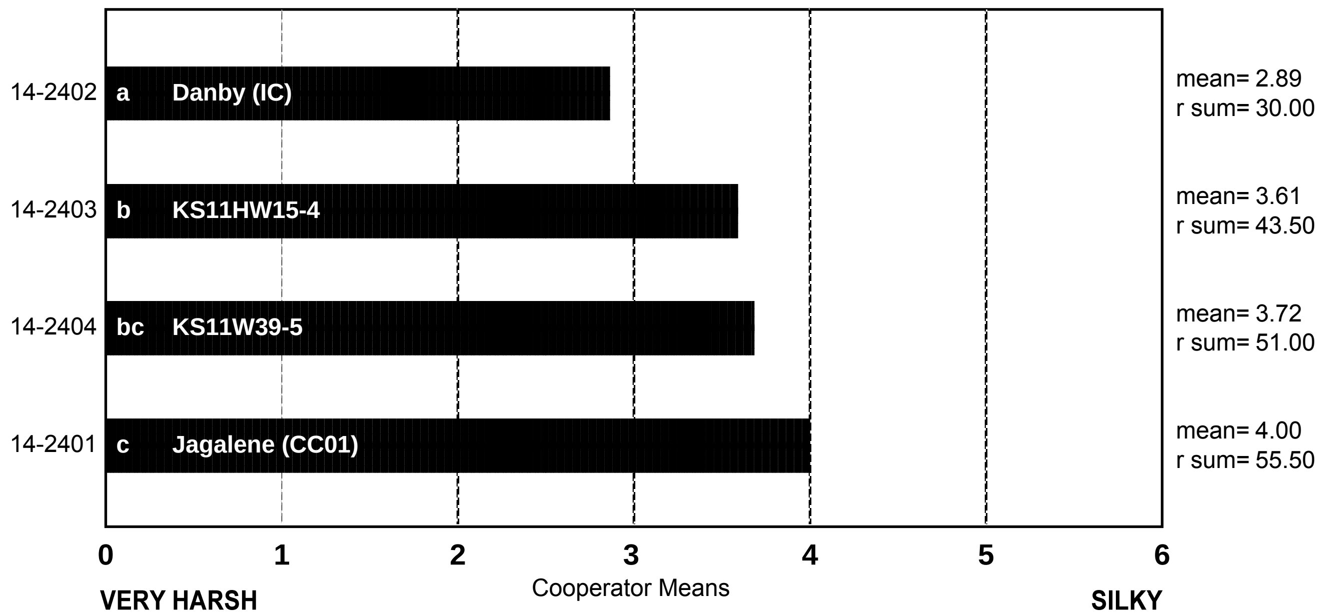
Frequency Table

CRUMB TEXTURE

(Small Scale) Kansas-Hays

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

ncoop= 18
chisq= 12.45
chisqc= 19.83
cvchisq= 7.82
crdiff= 10.08



CRUMB TEXTURE, DESCRIBED

(Small Scale) Kansas-Hays

	Harsh	Smooth	Silky
14-2401 Jagalene (CC01)	**5**	**10**	**3**
14-2402 Danby (IC)	**12**	**5**	**1**
14-2403 KS11HW15-4	**8**	**7**	**3**
14-2404 KS11W39-5	**5**	**10**	**3**

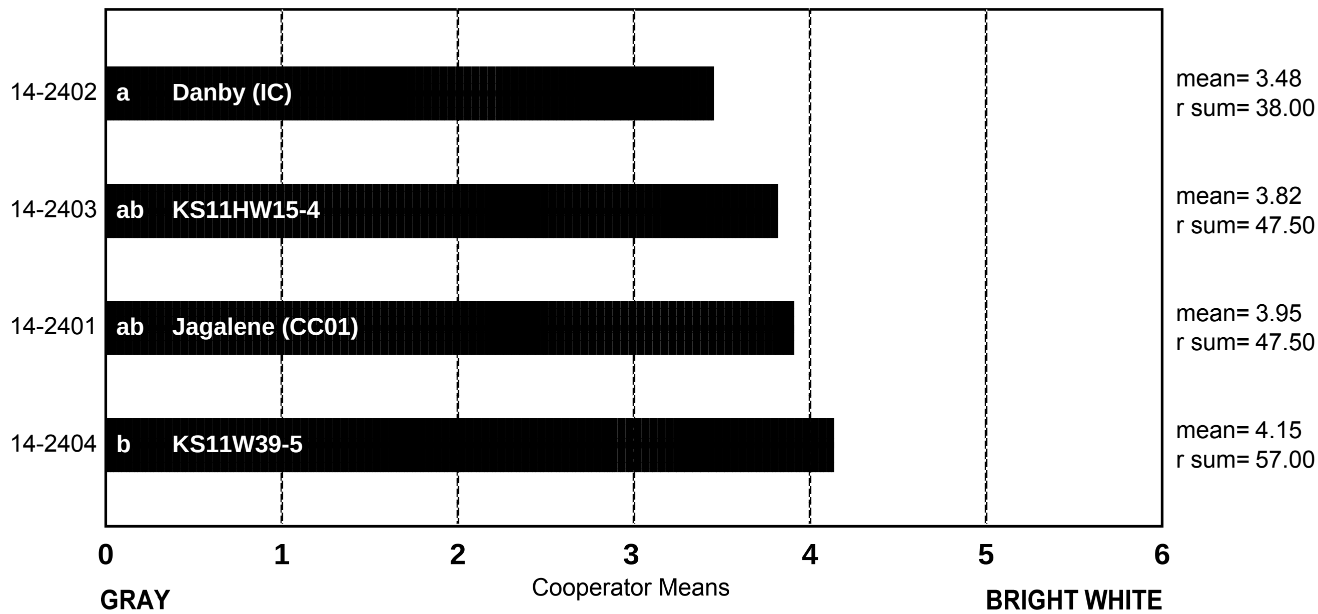
Frequency Table

CRUMB COLOR

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 5.70
chisqc= 9.50
cvchisq= 7.82
crdiff= 11.60

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



CRUMB COLOR, DESCRIBED

(Small Scale) Kansas-Hays

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
14-2401 Jagalene (CC01)	1	0	1	0	13	3	1
14-2402 Danby (IC)	1	0	2	6	7	3	0
14-2403 KS11HW15-4	1	0	1	2	12	3	0
14-2404 KS11W39-5	0	0	1	2	9	7	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
14-2401 Jagalene (CC01)	**130.9**	**141.6**	**142.6**	**155.8**	**138.3**	**141.3**	**462.7**	**462.4**	**413.0**	**728.3**	**134.0**	**147.8**	**462.8**	**133.9**	**137.3**	**477.1**	**455.0**	**447.3**	**485.7**
14-2402 Danby (IC)	**128.7**	**140.9**	**145.0**	**155.3**	**139.1**	**141.4**	**460.6**	**467.8**	**412.0**	**741.2**	**134.0**	**150.6**	**455.0**	**136.6**	**136.6**	**477.6**	**446.0**	**448.3**	**492.3**
14-2403 KS11HW15-4	**129.3**	**137.5**	**143.9**	**155.7**	**136.5**	**140.9**	**463.1**	**466.0**	**414.0**	**649.6**	**134.0**	**148.8**	**454.8**	**137.4**	**135.5**	**490.0**	**455.0**	**450.1**	**492.4**
14-2404 KS11W39-5	**127.7**	**141.0**	**143.2**	**156.6**	**136.7**	**138.7**	**464.7**	**467.1**	**412.0**	**692.1**	**134.0**	**149.8**	**459.8**	**137.2**	**140.7**	**488.0**	**458.0**	**449.9**	**488.9**

LOAF VOLUME, ACTUAL

(Small Scale) Kansas-Hays

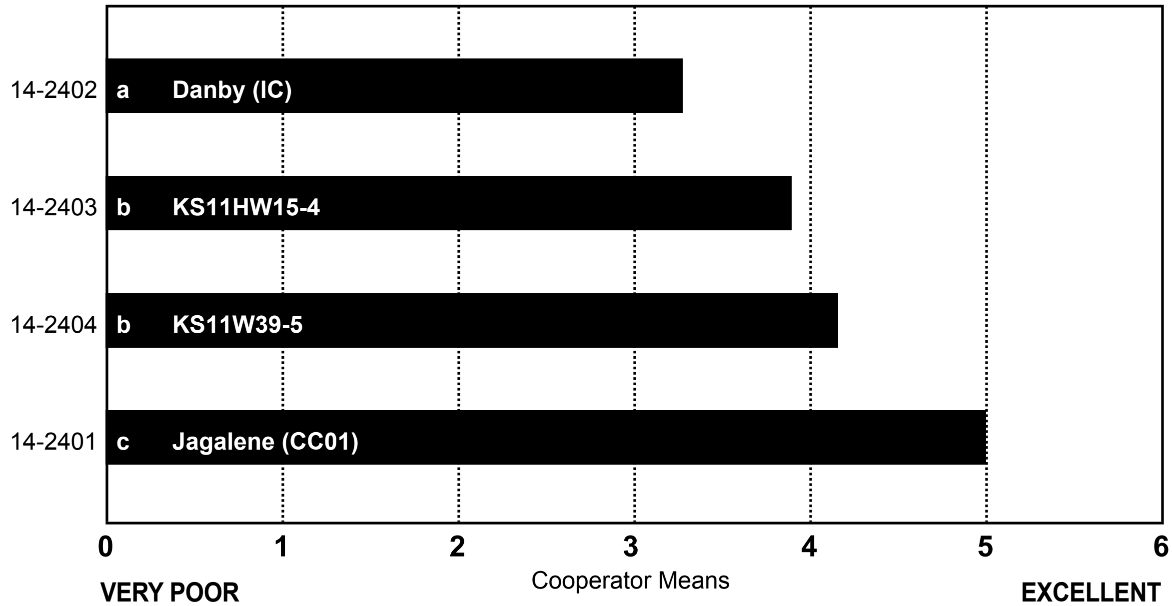
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2401 Jagalene (CC01)	**920**	**1305**	**1165**	**1050**	**1000**	**975**	**2800**	**2725**	**3150**	**4055**	**1110**	**1020**	**2250**	**1044**	**1045**	**3104**	**2300**	**2550**	**2600**
14-2402 Danby (IC)	**660**	**945**	**845**	**1113**	**1038**	**785**	**2500**	**2138**	**2800**	**4730**	**915**	**935**	**2525**	**932**	**1120**	**2750**	**2225**	**2500**	**2113**
14-2403 KS11HW15-4	**705**	**1135**	**985**	**1058**	**1025**	**835**	**2600**	**2438**	**2925**	**4230**	**943**	**975**	**2700**	**890**	**1093**	**2780**	**2400**	**2550**	**2488**
14-2404 KS11W39-5	**720**	**1145**	**1010**	**1075**	**1023**	**985**	**2650**	**2400**	**2875**	**4305**	**940**	**985**	**2750**	**921**	**1073**	**2956**	**2300**	**2500**	**2463**

LOAF VOLUME

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 13.29
chisqc= 17.79
cvchisq= 7.82
crdiff= 11.77

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



mean= 3.26
r sum= 33.00

mean= 3.86
r sum= 47.00

mean= 4.12
r sum= 48.00

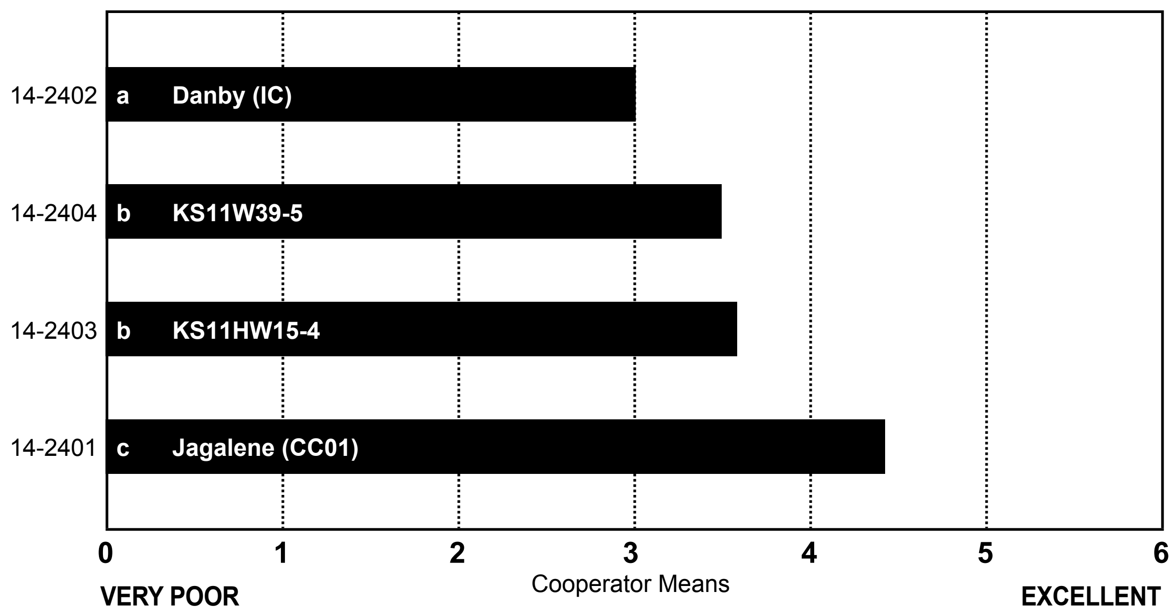
mean= 4.96
r sum= 62.00

OVERALL BAKING QUALITY

(Small Scale) Kansas-Hays

ncoop= 19
chisq= 19.44
chisqc= 21.35
cvchisq= 7.82
crdiff= 12.38

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



mean= 2.99
r sum= 30.50

mean= 3.47
r sum= 46.00

mean= 3.57
r sum= 48.00

mean= 4.41
r sum= 65.50

COOPERATOR'S COMMENTS
(Small Scale) Kansas - Hays

COOP. **14-2401 Jagalene (CC01)**

A. Nice gas retention, smooth and elastic, nice oven spring.
B. Nice dough out of mixer, excellent loaf externals.
C. No comment.
D. Good dough properties and crumb grain.
E. Normal absorption & mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, fine elongated cells, very smooth & resilient texture.
F. Very good protein and bread.
G. No comment.
H. Average absorption, long mix, high volume, creamy, open grain.
I. Long mix, tough and bucky, very open grain.
J. No comment.
K. Great bake quality, best sample of set, nice grain.
L. Flour protein excellent, good dough strength, absorption and loaf volume high, crumb grain satisfactory, long mix time, strong mixograph.
M. No comment.
N. 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
O. No comment.
P. Strong mixing doughs, above average interior scores, excellent volume.
Q. Open thick cells.
R. Long mix time, tough dough, good volume, open grain.
S. High absorption, long mix time, good grain, good volume.

COOP. **14-2402 Danby (IC)**

A. Short mixer, elastic yet slightly flat, no oven spring.
B. Short mix time, cap.
C. No comment.
D. Weaker dough but good loaf volume performance.
E. Normal absorption, little short mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, open & elongated cells, smooth & resilient texture.
F. Weaker gluten and poor baker.
G. No comment.
H. Low absorption, short mix, very low volume, dull, open grain, very flat.
I. Worst of set, squatty and dull, lowest volume.
J. No comment.
K. Very poor bake performance, worst sample of set, poor tolerance.
L. Bold break and shred, beautiful loaf exterior, good flour protein, excellent at pan, good absorption, good crumb grain and loaf volume.
M. No comment.
N. 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
O. No comment.

P. Very open, irregular grain, harsh texture, low volume.
Q. No comment.
R. Excellent mix time, excellent dough, open grain.
S. Average absorption, short mix time, open grain, yellow crumb, very low volume.

COOP. 14-2403 KS11HW15-4

A. Weaker dough.
B. Rough break.
C. No comment.
D. Weaker dough but good loaf volume performance.
E. Low low water absorption, normal mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, open & elongated cells, smooth & resilient texture.
F. Very poor mixing tolerance and poor bread.
G. No comment.
H. Low absorption, short mix, low volume, creamy, open grain, flat.
I. Slightly short mix for protein, good and pliable out of mixer, good volume.
J. No comment.
K. Marginal bake performance, poor grain and low volumes.
L. Very nice experimental, similar to check 2402 with above satisfactory crumb grain and loaf volume, nice dough strength at pan.
M. No comment.
N. 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
O. No comment.
P. Very open, irregular grain, harsh texture, low volume.
Q. Good bake.
R. Good mix time, excellent dough, good volume, open grain.
S. Average absorption, short mix time, good grain, low volume.

COOP. 14-2404 KS11W39-5

A. Pliable, gas retention not great, little oven spring, reflects mixograph results.
B. Nice loaf externals.
C. No comment.
D. Weaker dough but good loaf volume performance.
E. Low water absorption, normal mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, fine & elongated cells, very smooth & resilient texture.
F. Weaker gluten, good volume.
G. No comment.
H. Low absorption, average mix, low volume, dull, open grain, flat.
I. Good interior, average volume, slightly short mix.
J. No comment.
K. Poor bake performance, only slightly better than 2402.
L. Overall similar to 2403, good dough strength at pan, good mix time, nice crumb grain and loaf volume, however lower bake absorption.
M. No comment.
N. 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

O. No comment.
P. Open, thick cell walls, irregular grain, harsh texture, good volume.
Q. Good stability.
R. Good mix time, excellent dough, good volume, fine grain.
S. Average mix time, good grain, white crumb, low volume.

Notes: **G, H, I, K, P, Q, R and S** conducted sponge and dough bake tests

Texas-Amarillo

14-2405	Jagalene (CC05)
14-2406	TAM 111 (IC)
14-2407	TX08A001249
14-2408	TX09A001194
14-2409	TX09D1172

Description of Test Plots and Breeder Entries

Texas-Amarillo - Jackie Rudd and Amir Ibrahim

Texas AgriLife Research, Amarillo

The Wheat Quality Council samples submitted by Texas AgriLife Research were harvested from irrigated strips planted adjacent to our irrigated yield trials at Bushland (near Amarillo in the Texas Panhandle). We fertilized for a yield goal of 100 bu/a. The grain yields of TAM 111, TX08A001249, TX09A001194, and TX09D1172 were 75, 82, 76, and 77 bu/a respectively. There was a spring freeze in March that set the crop back some, but all of these lines recovered and had a fairly normal yield. The crop was flood irrigated four times from early March to early May.
The three experimental lines described below are all from a similar pedigree and have similar performance. The quality data from this WQC trial will be important criteria to help us decide which of the three lines to release.

JAGALENE (Common Check)
Quality check

TAM 111 (Internal Check)

TAM 111 (TX95A3091), a hard red winter wheat from the cross
TAM 107//TX78V3620/CTK78/3/TX87V1233, was released in 2002 and licensed to AgriPro Wheat. It has good yield under dryland and irrigated conditions in High Plains of Texas, panhandle of Oklahoma, western Kansas, and eastern Colorado.

TX08A001249

TAM 112/TX98D1158 (TAM 303 sibling)
This hard red winter wheat experimental was selected from the TAM Wheat Improvement Program in Amarillo. It is resistant to greenbug and wheat curl mite, intermediately resistant to leaf rust (Lr21 and Lr39), resistant to stem rust (Amigo 1A1R), and susceptible to stripe rust. It has performed well throughout Texas and the southern High Plains of the U.S. The test weight is good and it generally has strong dough strength.

TX09A001194

TAM 112/TAM 303
This hard red winter wheat experimental was selected from the TAM Wheat Improvement Program in Amarillo. It is resistant to greenbug and wheat curl mite, intermediately resistant to leaf rust (Lr21 and Lr39), resistant to stem rust (Amigo 1A1R), and susceptible to stripe rust. It also has resistance to wheat soil borne and is tolerant to acid soils. It has performed well

throughout central and north Texas and south-central Oklahoma. The test weight is good, seed size is above average and it generally has medium-strong dough strength.

TX09D1172

TAM 303/TAM 112
This hard red winter wheat experimental was selected from the TAM Wheat Improvement Program in College Station. It is resistant to greenbug and wheat curl mite, intermediately resistant to leaf rust (Lr21 and Lr39), resistant to stem rust (Amigo 1A1R), and susceptible to stripe rust. It has performed well throughout south, central, and the High Plains of Texas. It was one of the highest yielding lines in the 2013 SRPN. The test weight is good, seed size is above average and it generally has medium dough strength.

Texas-Amarillo: 2014 (Small-Scale) Samples

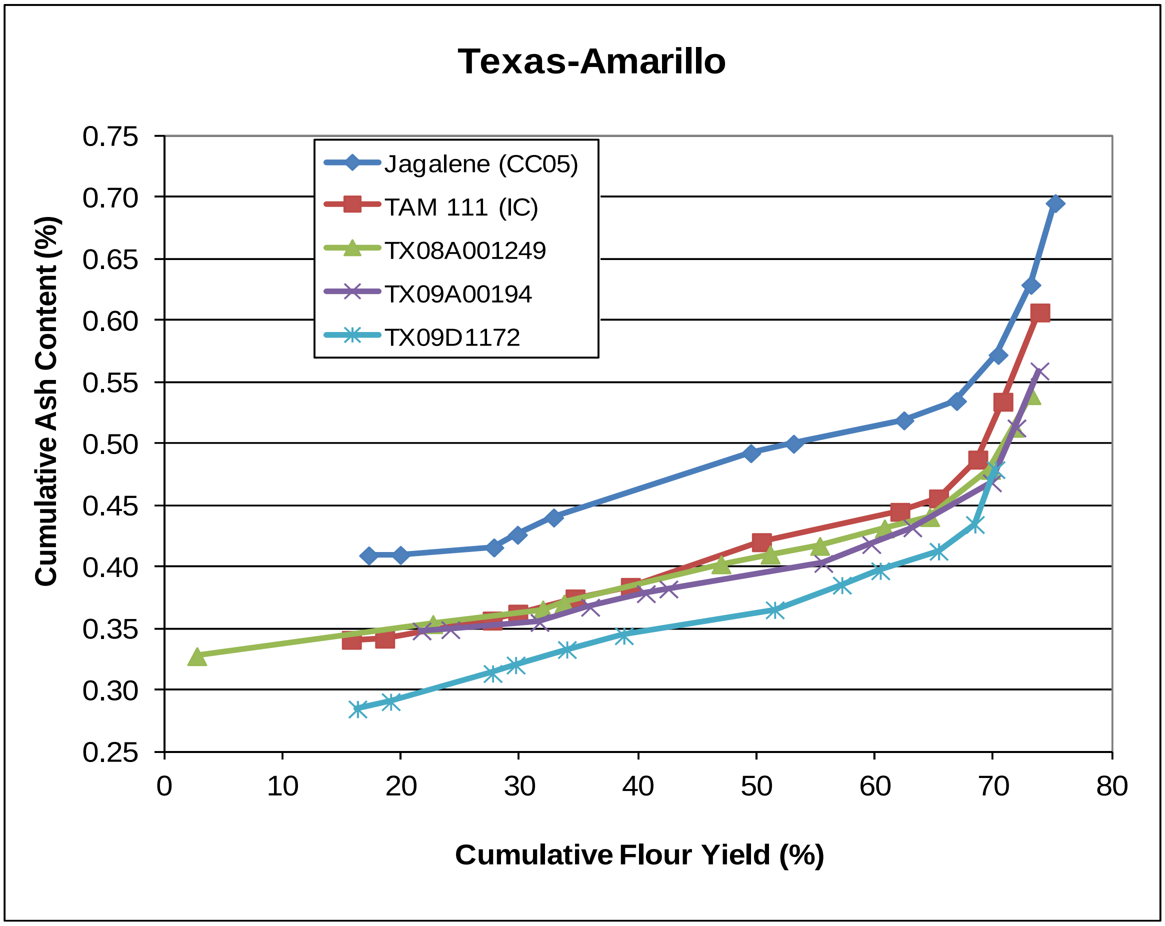
Test entry number	14-2405	14-2406	14-2407	14-2408	14-2409
Sample identification	Jagalene (CC05)	TAM 111 (IC)	TX08A001249	TX09A001194	TX09D1172
Wheat Data					
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW	1 HRW
Test weight (lb/bu) Hectoliter weight (kg/hl)	60.4 79.5	61.7 81.1	61.7 81.1	61.4 80.7	61.1 80.4
1000 kernel weight (gm)	34.0	38.1	32.2	36.4	33.5
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 78.8 21.2 0.0	 88.0 12.0 0.0	 69.3 30.2 0.5	 82.2 17.7 0.1	 77.1 22.8 0.1
Single kernel (skcs)[a] Hardness (avg /s.d) Weight (mg) (avg/s.d) Diameter (mm)(avg/s.d) Moisture (%) (avg/s.d) SKCS distribution Classification	 61.3/16.6 34.0/8.4 2.81/0.29 11.7/0.3 05-11-29-55-01 Hard	 55.4/13.7 38.1/8.0 2.87/0.31 11.8/0.3 03-21-36-40-01 Hard	 60.2/12.3 32.2/7.8 2.64/0.31 11.8/0.3 02-09-35-54-01 Hard	 58.3/13.7 36.4/8.8 2.77/0.35 11.8/0.3 02-16-35-47-01 Hard	 62.5/14.6 33.5/7.1 2.71/0.30 11.9/0.3 03-11-25-61-01 Hard
Wheat protein (12% mb) Wheat ash (12% mb)	15.6 1.80	15.3 1.90	14.2 1.66	14.8 1.79	15.7 1.83
Milling and Flour Quality Data					
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 74.7 68.7	 72.8 68.2	 73.1 67.6	 73.0 66.2	 69.8 67.8
Flour moisture (%) Flour protein (14% mb) Flour ash (14% mb)	13.0 14.7 0.66	11.8 13.8 0.57	12.3 12.8 0.51	12.1 13.5 0.52	11.7 14.3 0.49
Rapid Visco-Analyser Peak time (min) Peak viscosity (RVU) Breakdown (RVU) Final viscosity at 13 min (RVU)	 6.1 175.0 63.6 216.0	 6.2 202.7 70.8 249.0	 6.2 221.6 89.5 243.3	 6.1 198.3 78.7 225.0	 5.9 177.4 75.5 200.8
Minolta color meter L* a* b* PPO	 91.13 -1.11 8.54 0.428	 92.08 -1.13 8.30 0.623	 91.64 -0.90 8.09 0.562	 91.84 -1.07 8.33 0.620	 91.90 -1.57 9.96 0.515
Falling number (sec)	512	531	532	482	435
Damaged Starch (AI%) (AACC76-31)	 98.09 8.00	 96.15 6.39	 97.61 7.59	 97.17 7.21	 96.01 6.28

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

Texas-Amarillo: Physical Dough Tests and Gluten Analysis For 2014 (Small-Scale) Samples

Test Entry Number	14-2405	14-2406	14-2407	14-2408	14-2409
Sample Identification	Jagalene (CC05)	TAM 111 (IC)	TX08A001249	TX09A001194	TX09D1172
MIXOGRAPH					
Flour Abs (% as-is)	71.5	69.0	70.0	70.5	69.7
Flour Abs (14% mb)	69.4	66.0	67.7	68.3	66.8
Mix Time (min)	43.9	2.1	5.0	3.9	3.1
Mix tolerance (0-6)	4	2	5	4	2
FARINOGRAPH					
Flour Abs (% as-is)	67.6	64.6	67.7	67.5	66.0
Flour Abs (14% mb)	65.5	61.7	65.4	65.3	63.1
Development time (min)	12.9	6.4	8.4	10.0	9.3
Mix stability (min)	20.2	10.6	21.8	19.5	14.7
Mix Tolerance Index (FU)	7	22	16	10	12
Breakdown time (min)	24.5	11.9	24.0	22.0	21.0
ALVEOGRAPH					
P(mm): Tenacity	125	72	134	115	78
L(mm): Extensibility	106	141	89	107	159
G(mm): Swelling index	22.9	26.4	21.0	23.0	28.1
W(10^{-4} J): strength (curve area)	508	277	441	401	359
P/L: curve configuration ratio	1.18	0.51	1.51	1.07	0.49
Ie(P_{200}/P): elasticity index	69.2	53.1	62.8	58.5	58.0
EXTENSIGRAPH					
Resist (BU at 45/90/135 min)	422/485/418	271/284/309	463/651/741	353/486/490	265/343/396
Extensibility (mm at 45/90/135 min)	171/168/181	194/206/309	154/143/139	147/152/141	176/174/162
Energy (cm^2 at 45/90/135 min)	154/161/168	100/113/112	130/167/173	92/133/118	91/117/120
Resist $_{max}$ (BU at 45/90/135min)	729/774/774	367/392/415	689/962/1000	483/685/680	389/520/556
Ratio (at 45/90/135 min)	2.47/2.89/2.31	1.40/1.38/1.60	3.02/4.56/5.32	2.41/3.19/3.48	1.51/1.97/2.45
PROTEIN ANALYSIS					
HMW-GS Composition	1/2*, 17+18, 5+10	2*, 7+9, 2+12	2*, 7+8, 5+10	2*, 7+8, 5+10	2*, 7+8, 5+10
%IPP	50.22	42.27	47.60	44.87	41.33
SEDIMENTATION TEST					
Volume (ml)	63.7	53.8	66.0	66.5	65.1

Texas-Amarillo: Cumulative Ash Curves



Jagalene (CC05)				
Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash
2M	17.20	0.41	17.20	0.41
1M Red	2.67	0.41	19.87	0.41
1M	7.89	0.43	27.76	0.42
Grader	1.99	0.57	29.76	0.43
2BK	3.06	0.58	32.81	0.44
3M	16.63	0.60	49.44	0.49
1BK	3.61	0.60	53.05	0.50
FILTER FLR	9.31	0.63	62.36	0.52
3BK	4.44	0.76	66.81	0.53
4M	3.51	1.29	70.31	0.57
5M	2.77	2.07	73.08	0.63
BRAN FLR	2.05	3.06	75.14	0.70
Break Shorts	2.58	4.50	77.71	0.82
Red Dog	1.80	2.54	79.52	0.86
Red Shorts	0.16	3.43	79.68	0.87
Filter Bran	4.23	1.80	83.91	0.91
Bran	16.09	6.19	100.0	1.76
Wheat		1.76		
St. Grd. Fl.		0.66		

TAM 111 (IC)				
Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash
2M	15.74	0.34	15.74	0.34
1M Red	2.81	0.35	18.56	0.34
1M	9.07	0.39	27.63	0.36
Grader	2.16	0.43	29.79	0.36
2BK	4.83	0.45	34.61	0.37
1BK	4.68	0.45	39.29	0.38
3M	11.06	0.55	50.35	0.42
FILTER FLR	11.68	0.55	62.03	0.44
3BK	3.27	0.66	65.30	0.46
4M	3.30	1.11	68.60	0.49
5M	2.12	2.05	70.72	0.53
BRAN FLR	3.12	2.25	73.84	0.61
Break Shorts	2.50	4.01	76.34	0.72
Red Dog	1.46	2.42	77.80	0.75
Red Shorts	0.04	3.75	77.83	0.75
Filter Bran	3.88	2.32	81.71	0.83
Bran	18.29	6.29	100.0	1.82
		1.85		
		0.57		

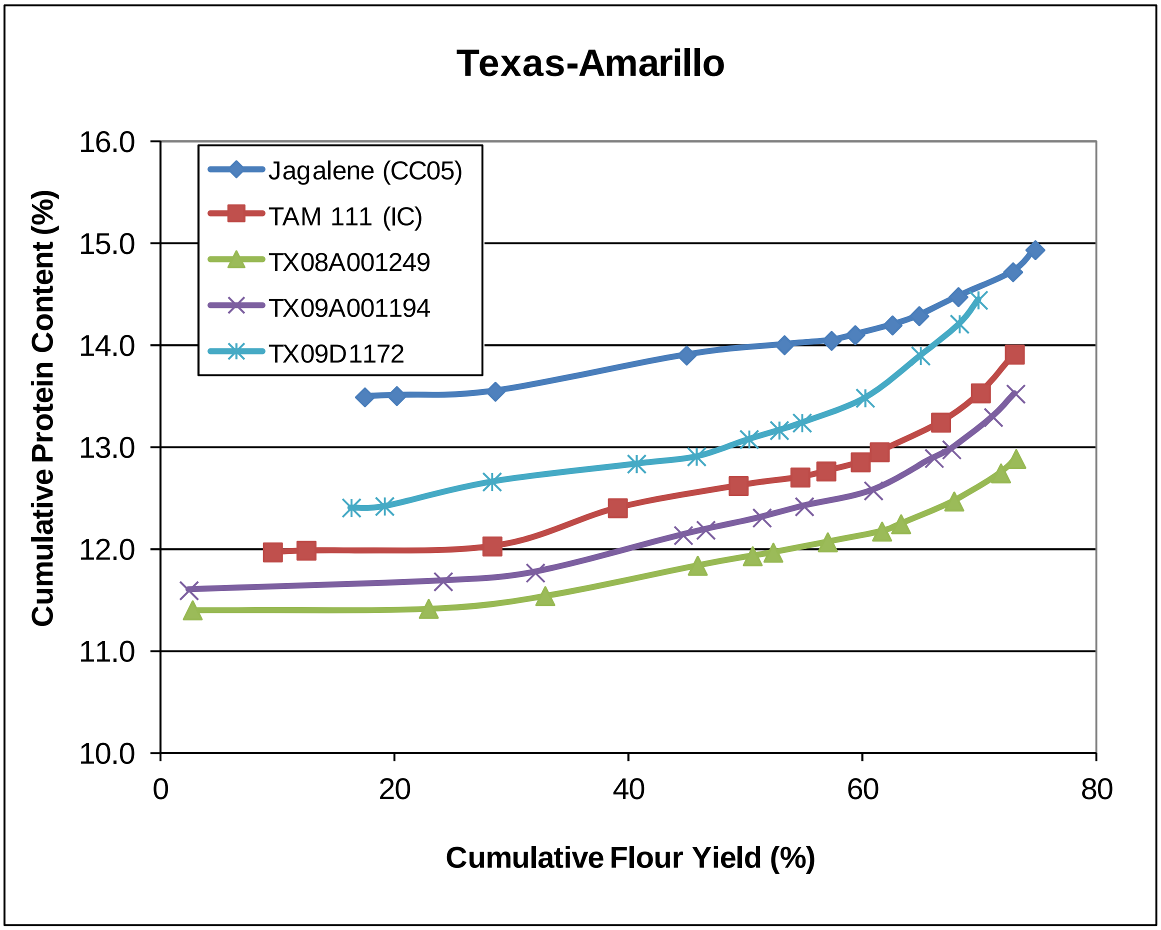
TX08A001249				
Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash
1M Red	2.70	0.33	2.70	0.33
2M	19.92	0.36	22.62	0.35
1M	9.28	0.39	31.89	0.37
Grader	1.80	0.46	33.69	0.37
3M	13.24	0.48	46.93	0.40
2BK	4.15	0.50	51.08	0.41
1BK	4.18	0.50	55.26	0.42
FILTER FLR	5.46	0.57	60.72	0.43
3BK	3.82	0.59	64.54	0.44
4M	5.13	0.96	69.67	0.48
5M	2.00	1.70	71.68	0.51
BRAN FLR	1.41	1.88	73.09	0.54
Break Shorts	2.80	3.94	75.89	0.66
Red Dog	1.21	2.40	77.10	0.69
Red Shorts	0.03	4.06	77.13	0.69
Filter Bran	5.39	1.72	82.52	0.76
Bran	17.48	5.31	100.0	1.56
		1.62		
		0.51		

Texas-Amarillo: Cumulative Ash Curves (continued)

TX09A001194					TX09D1172				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	21.67	0.35	21.67	0.35	2M	16.26	0.28	16.26	0.28
1M Red	2.42	0.36	24.09	0.35	1M Red	2.81	0.32	19.06	0.29
1M	7.53	0.37	31.62	0.35	1M	8.60	0.36	27.66	0.31
1BK	4.27	0.46	35.90	0.37	Grader	1.94	0.42	29.60	0.32
2BK	4.70	0.46	40.59	0.38	2BK	4.32	0.42	33.93	0.33
Grader	1.91	0.46	42.50	0.38	1BK	4.81	0.42	38.73	0.34
3M	13.07	0.47	55.57	0.40	3M	12.73	0.43	51.46	0.37
FILTER FLR	4.05	0.63	59.62	0.42	4M	5.67	0.57	57.13	0.39
3BK	3.47	0.67	63.08	0.43	3BK	3.24	0.60	60.37	0.40
4M	6.71	0.81	69.79	0.47	FILTER FLR	4.92	0.61	65.29	0.41
BRAN FLR	2.07	2.01	71.87	0.51	5M	3.06	0.90	68.36	0.43
5M	1.94	2.27	73.81	0.56	BRAN FLR	1.74	2.23	70.10	0.48
Break Shorts	2.78	4.22	76.59	0.69	Break Shorts	2.52	4.28	72.63	0.61
Red Dog	1.64	2.83	78.23	0.74	Red Dog	3.36	2.17	75.98	0.68
Red Shorts	0.05	3.84	78.27	0.74	Red Shorts	0.36	4.24	76.35	0.70
Filter Bran	4.18	1.71	82.45	0.79	Filter Bran	6.88	2.08	83.23	0.81
Bran	17.55	5.97	100.0	1.70	Bran	16.77	6.66	100.0	1.79

Wheat		1.75					1.79		
St. Grd. Fl.		0.52					0.49		

Texas-Amarillo: Cumulative Protein Curves



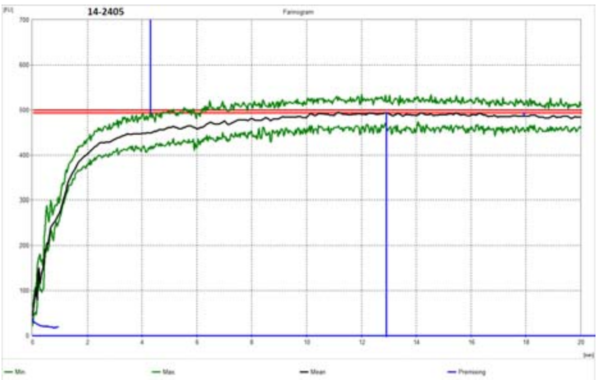
Jagalene (CC05)					TAM 111 (IC)					TX08A001249				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
2M	17.47	13.49	17.47	13.49	1M	9.60	11.97	9.60	11.97	1M Red	2.75	11.40	2.75	11.40
1M Red	2.73	13.58	20.19	13.51	1M Red	2.87	12.04	12.47	11.99	2M	20.17	11.42	22.92	11.42
1M	8.43	13.65	28.62	13.55	2M	15.88	12.06	28.35	12.03	1M	9.96	11.83	32.87	11.54
3M	16.34	14.52	44.96	13.90	3M	10.72	13.40	39.07	12.41	3M	13.03	12.59	45.90	11.84
FILTER FLR	8.36	14.55	53.31	14.00	FILTER FLR	10.31	13.44	49.39	12.62	1BK	4.69	12.85	50.60	11.93
1BK	4.03	14.61	57.34	14.05	1BK	5.28	13.48	54.67	12.71	Grader	1.76	12.95	52.36	11.97
Grader	2.02	15.69	59.36	14.10	Grader	2.22	14.25	56.89	12.77	FILTER FLR	4.66	13.22	57.02	12.07
4M	3.18	15.98	62.54	14.20	4M	2.94	14.59	59.82	12.85	4M	4.63	13.46	61.65	12.17
5M	2.29	16.77	64.83	14.29	5M	1.63	16.61	61.45	12.95	5M	1.63	15.00	63.28	12.25
2BK	3.34	18.10	68.17	14.48	2BK	5.24	16.64	66.69	13.24	2BK	4.54	15.57	67.82	12.47
3BK	4.67	18.28	72.85	14.72	3BK	3.40	19.19	70.09	13.53	3BK	3.99	17.44	71.81	12.75
BRAN FLR	1.90	23.24	74.75	14.94	BRAN FLR	2.90	23.07	72.99	13.91	BRAN FLR	1.31	20.68	73.12	12.89
Break Shorts	2.71	18.04	77.46	15.05	Break Shorts	2.62	17.56	75.61	14.04	Break Shorts	2.87	16.87	75.99	13.04
Red Dog	1.51	17.33	78.96	15.09	Red Dog	1.14	17.35	76.74	14.09	Red Dog	0.99	14.98	76.97	13.06
Red Shorts	0.13	15.83	79.09	15.09	Red Shorts	0.03	16.15	76.77	14.09	Red Shorts	0.02	15.44	77.00	13.06
Filter Bran	3.79	14.97	82.89	15.08	Filter Bran	3.45	15.43	80.22	14.14	Filter Bran	4.87	13.90	81.87	13.11
Bran	17.11	18.38	100.00	15.65	Bran	19.78	18.61	100.00	15.03	Bran	18.13	17.65	100.00	13.94
Wheat		15.24					14.92					13.86		
St. Grd. Fl		14.71					13.78					12.77		

Texas-Amarillo: Cumulative Protein Curves (continued)

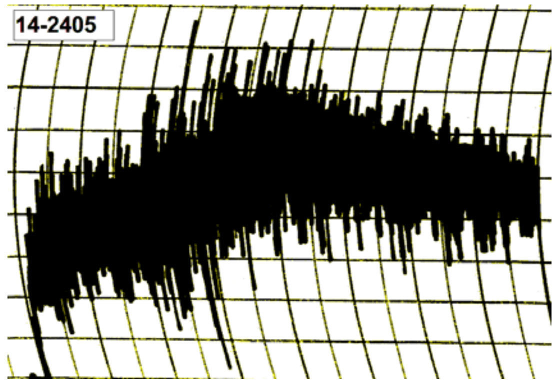
TX09A001194					TX09D1172				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1M Red	2.44	11.60	2.44	11.60	2M	16.32	12.41	16.32	12.41
2M	21.72	11.69	24.16	11.68	1M Red	2.84	12.51	19.16	12.42
1M	7.88	12.03	32.04	11.77	1M	9.17	13.16	28.33	12.66
3M	12.64	13.07	44.68	12.14	3M	12.35	13.24	40.69	12.84
Grader	1.92	13.39	46.60	12.19	4M	5.12	13.47	45.81	12.91
1BK	4.80	13.48	51.41	12.31	FILTER FLR	4.49	14.81	50.30	13.08
FILTER FLR	3.62	13.99	55.03	12.42	5M	2.57	14.88	52.88	13.17
4M	5.90	14.03	60.93	12.57	Grader	1.95	15.23	54.83	13.24
2BK	5.19	16.62	66.12	12.89	1BK	5.40	15.96	60.23	13.48
5M	1.49	16.74	67.61	12.98	2BK	4.73	19.17	64.96	13.90
3BK	3.57	19.32	71.17	13.29	3BK	3.32	20.30	68.28	14.21
BRAN FLR	1.91	22.07	73.08	13.52	BRAN FLR	1.61	24.40	69.89	14.44
Break Shorts	2.90	17.99	75.99	13.69	Break Shorts	2.57	18.33	72.46	14.58
Red Dog	1.29	15.98	77.28	13.73	Red Dog	2.80	16.21	75.26	14.64
Red Shorts	0.04	15.55	77.31	13.73	Red Shorts	0.29	16.69	75.55	14.65
Filter Bran	3.91	14.81	81.22	13.79	Filter Bran	6.50	15.06	82.05	14.68
Bran	18.78	19.31	100.00	14.82	Bran	17.95	18.74	100.00	15.41
Wheat		14.42					15.30		
St. Grd. Fl		13.48					14.33		

Physical Dough Tests
2014 (Small Scale) Samples - Texas-Amarillo

Farinograms **Mixograms**

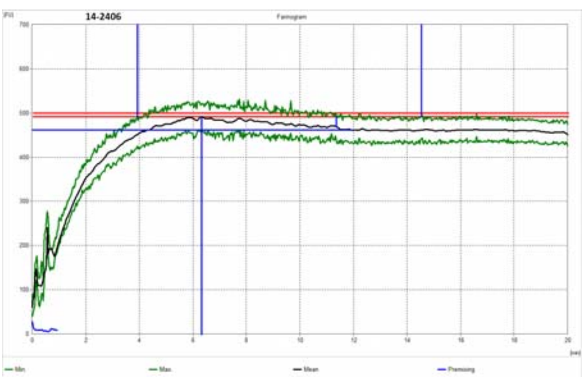


Water abs = 65.5%, Peak time = 12.9 min,
Mix stab = 20.2 min, MTI = 7 FU

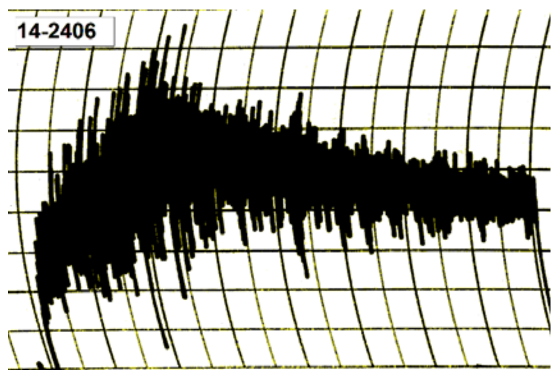


Water abs = 69.4%
Mix time = 3.9 min

14-2405, Jagalene (CC05)



Water abs = 61.7%, Peak time = 6.4 min,
Mix stab = 10.6 min, MTI = 22 FU



Water abs = 66.0%
Mix time = 2.1 min

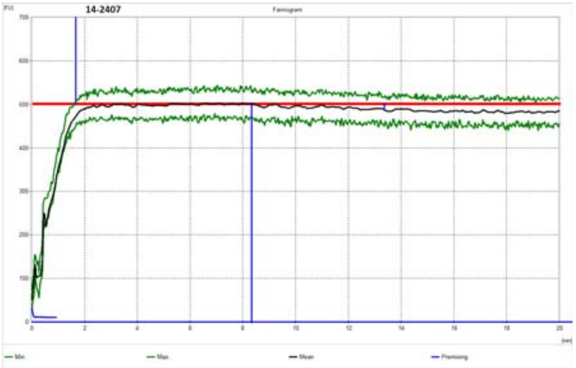
14-2406, TAM 111 (IC)

Physical Dough Tests

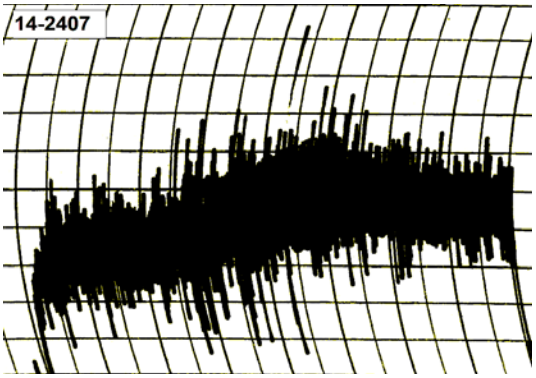
2014 (Small Scale) Samples - Texas-Amarillo (continued)

Farinograms

Mixograms

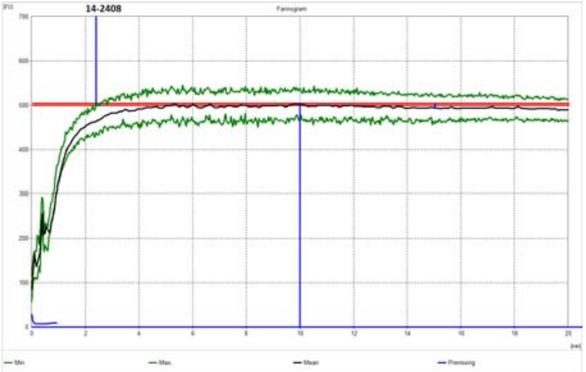


Water abs= 65.4%, Peak time = 8.4 min,
Mix stab = 21.8 min, MTI = 16 FU

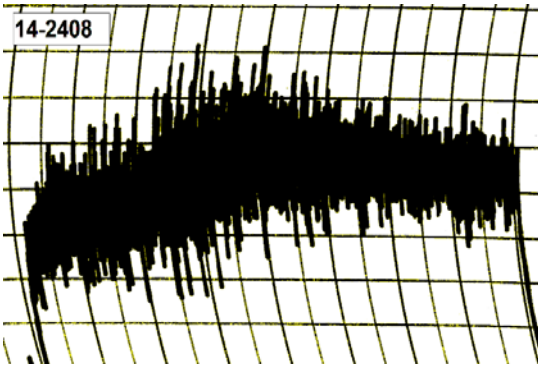


Water abs = 67.7%
Mix time = 5.0 min

14-2407, TX08A001249



Water abs= 65.3%, Peak time = 10.0 min,
Mix stab = 19.5 min, MTI = 10 FU



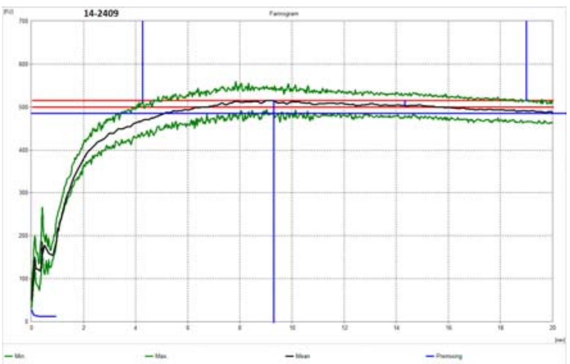
Water abs = 68.3%
Mix time = 3.9 min

14-2408, TX09A001194

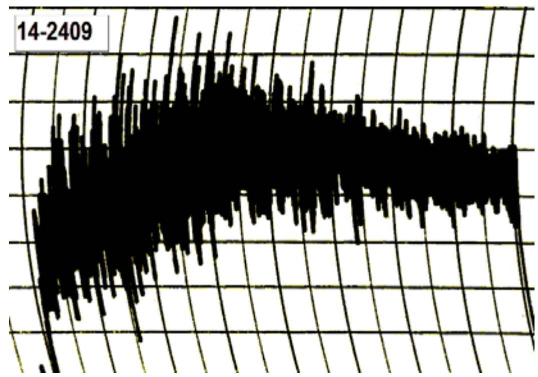
Physical Dough Tests

2014 (Small Scale) Samples - Texas-Amarillo (continued)

Farinograms | **Mixograms**



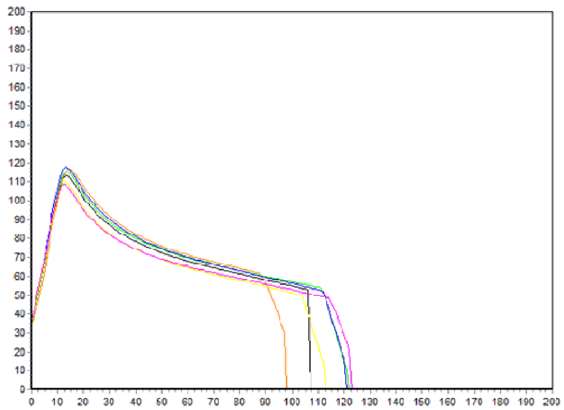
Water abs= 63.1%, Peak time = 9.3 min,
Mix stab = 14.7 min, MTI = 12 FU



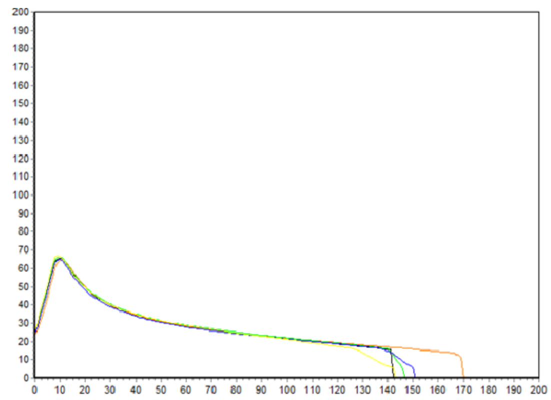
Water abs = 66.8%
Mix time = 3.1 min

14-2409, TX09D1172

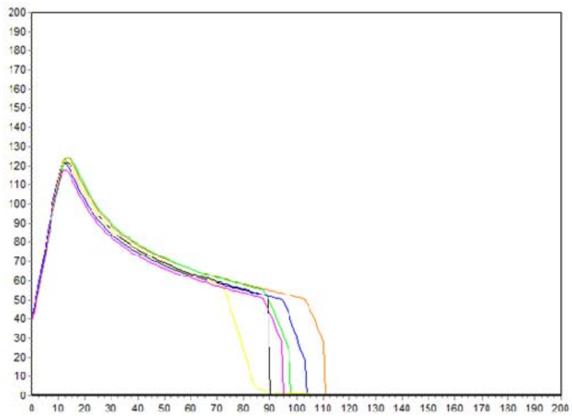
Physical Dough Tests - Alveograph
2014 (Small Scale) Samples – Texas-Amarillo



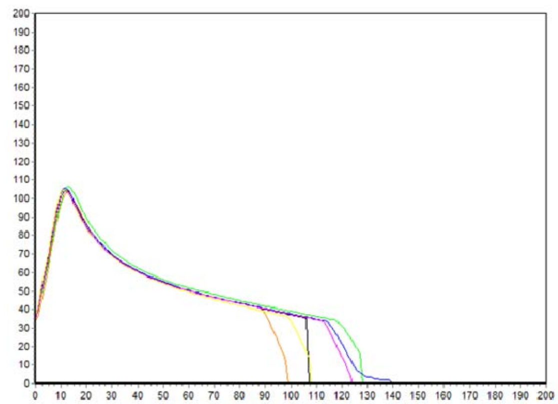
14-2405, Jagalene (CC05)
P(mm H_20)=125, L(mm)=106, W(10E^{-4} J)=508



14-2406, TAM 111 (IC)
P(mm H_20)=72, L(mm)=141, W(10E^{-4} J)=277



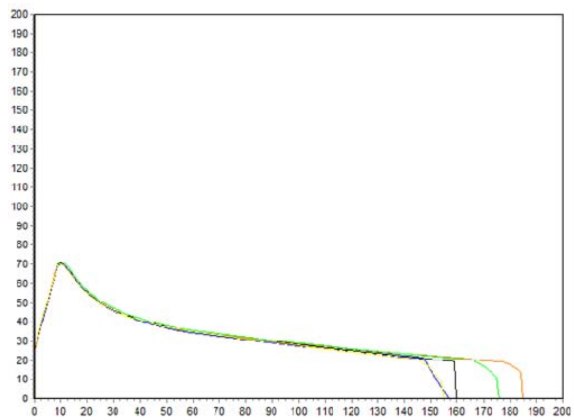
14-2407, TX08A001249
P(mm H_20)=134, L(mm)=89, W(10E^{-4} J)=441



14-2408, TX09A00194
P(mm H_20)=115, L(mm)=107, W(10E^{-4} J)=401

Physical Dough Tests - Alveograph

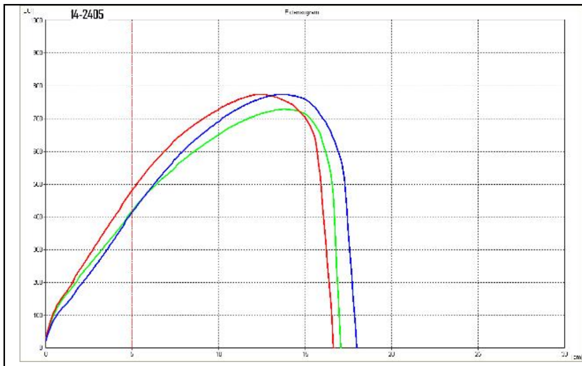
2014 (Small Scale) Samples – Texas-Amarillo (continued)



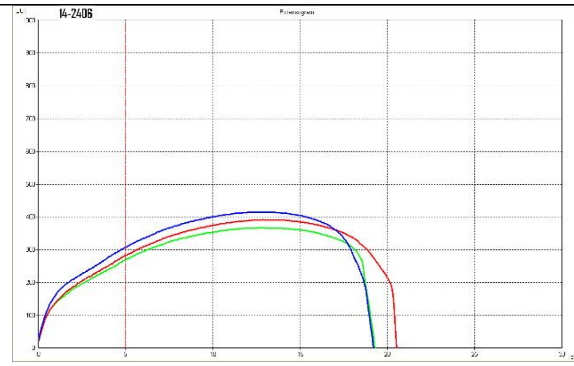
14-2409, SD09192

P(mm $H_2$0)=78, L(mm)=159, W(10E^{-4} J)=359

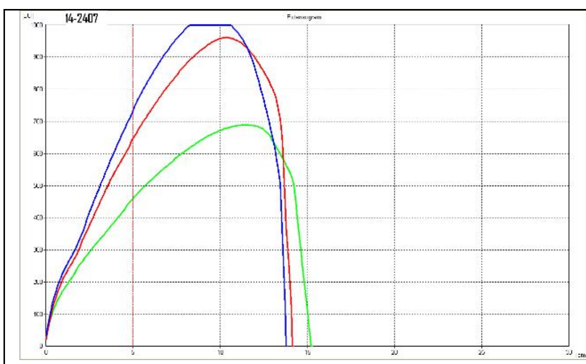
Physical Dough Tests - Extensigraph
2014 (Small Scale) Samples – Texas-Amarillo



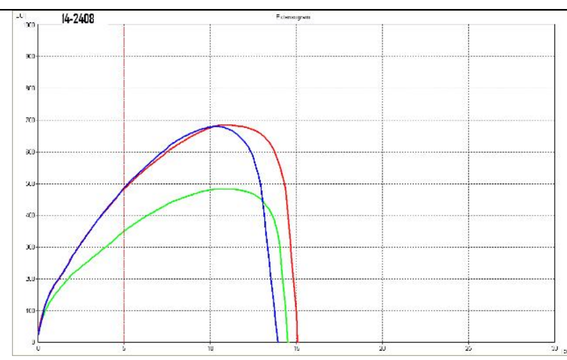
14-2405 Jagalene (CC05)
R (BU) = 485, E (mm) =168, W (cm^2) = 161
Rmax (BU) = 774, Ratio = 2.89 at 90 min



14-2406 TAM 111 (IC)
R (BU) = 284, E (mm) =206, W (cm^2) = 113
Rmax (BU) = 392, Ratio = 1.38 at 90 min



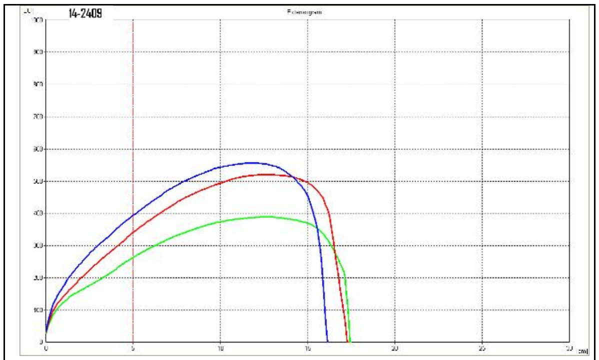
14-2407 TX08A001249
R (BU) = 651, E (mm) =143, W (cm^2) = 167
Rmax (BU) = 962, Ratio = 4.56 at 90 min



14-2408 TX09A001194
R (BU) = 486, E (mm) =152, W (cm^2) = 133
Rmax (BU) = 685, Ratio = 3.19 at 90 min

Physical Dough Tests - Extensigraph

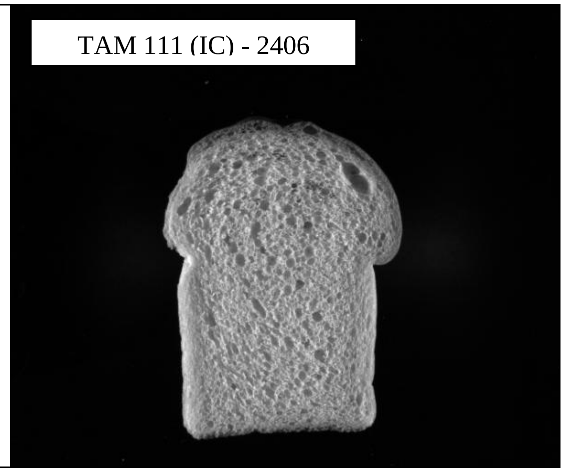
2014 (Small Scale) Samples – Texas-Amarillo (continued)



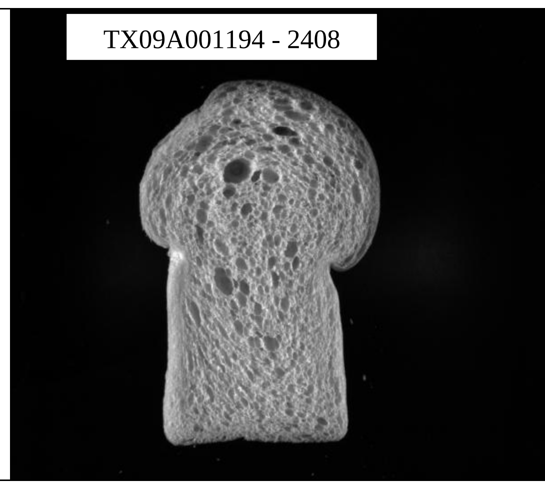
14-2409 TX09D1172
R (BU) = 343, E (mm) =174, W (cm^2) = 117
Rmax (BU) = 520, Ratio = 1.97 at 90 min

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.

Texas-Amarillo: C-Cell Bread Images and Analysis for 2014 (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})
2405	6961	126.9	4082	0.448	2.181	7.820	1.698	-20.10
2406	6340	140.9	3803	0.449	2.072	2.311	1.595	-11.48



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	6861	136.3	3901	0.457	2.147	2.618	1.705	-21.50
2408	6948	134.9	3882	0.459	2.256	2.005	1.708	-20.28

Texas-Amarillo: C-Cell Bread Images and Analysis for 2014 (Small-Scale) Samples (continued)

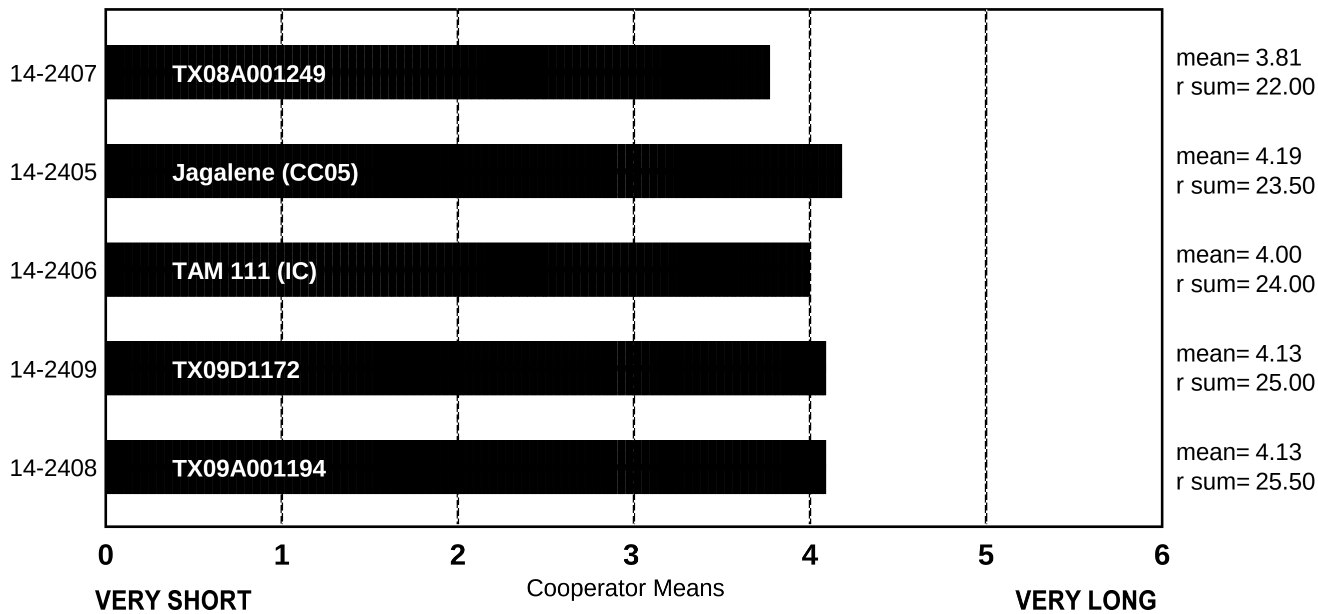
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2409	6948	139.7	4132	0.450	2.196	3.945	1.685	-22.58

SPONGE CHARACTERISTICS

(Small Scale) Texas-Amarillo

ncoop= 8
chisq= 0.38
chisqc= 0.70
cvchisq= 9.49
crdiff=

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

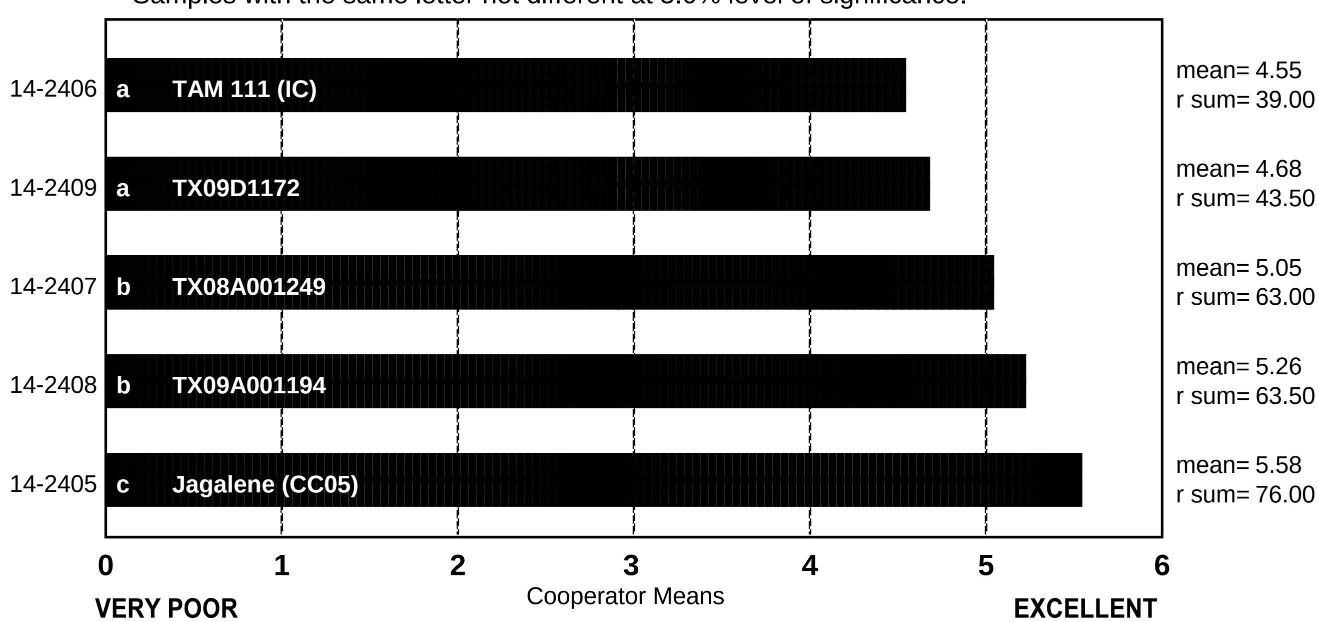


BAKE ABSORPTION

(Small Scale) Texas-Amarillo

ncoop= 19
chisq= 19.91
chisqc= 31.52
cvchisq= 9.49
crdiff= 12.22

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Texas-Amarillo

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2405 Jagalene (CC05)	65.3	68.3	65.9	72.9	65.5	71.0	66.0	65.5	61.0	74.2	64.0	68.6	67.6	69.3	71.0	65.0	67.5	70.6	66.0
14-2406 TAM 111 (IC)	60.0	65.4	64.5	68.5	62.0	68.5	63.5	61.7	60.0	74.2	64.0	65.7	64.6	65.2	68.0	61.0	64.5	67.6	63.0
14-2407 TX08A001249	64.8	65.3	63.0	67.1	65.5	68.0	65.5	65.4	59.0	73.3	63.0	67.4	67.7	67.9	70.0	65.0	68.0	70.7	66.0
14-2408 TX09A001194	64.4	65.0	64.0	68.4	65.0	68.0	66.0	65.3	60.0	73.2	64.0	67.5	67.5	68.4	70.0	65.0	67.5	70.5	65.0
14-2409 TX09D1172	61.4	65.6	65.5	67.5	64.0	68.5	64.5	63.1	61.0	69.9	64.0	66.8	66.0	66.7	69.0	63.0	66.0	69.0	64.0

BAKE MIX TIME, ACTUAL

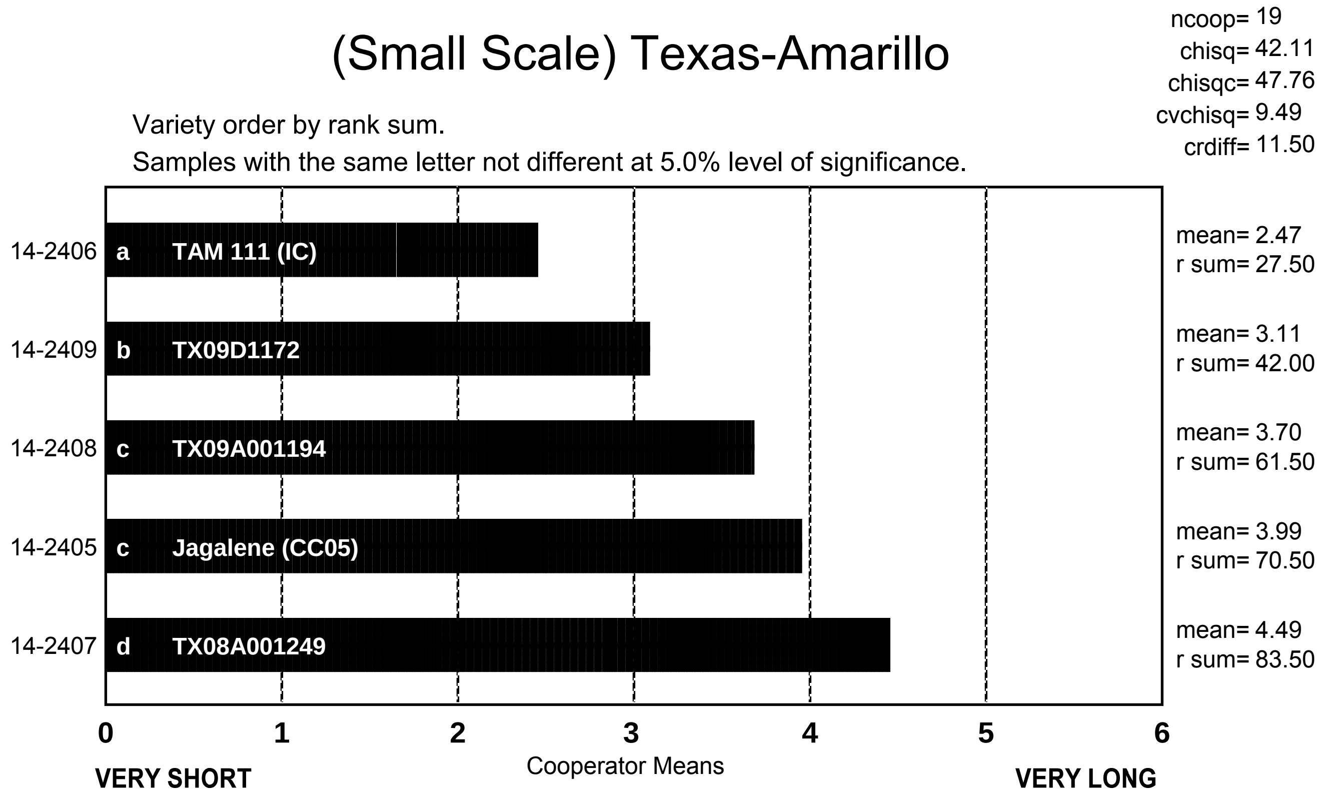
(Small Scale) Texas-Amarillo

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2405 Jagalene (CC05)	3.3	4.5	3.3	4.0	4.5	3.4	24.0	7.0	16.0	6.0	9.0	5.3	7.5	3.9	4.3	25.0	11.0	8.0	7.0
14-2406 TAM 111 (IC)	2.0	3.0	2.2	4.3	2.6	2.2	13.0	5.0	8.0	5.0	9.0	3.0	6.5	2.2	2.3	24.0	9.0	5.0	4.0
14-2407 TX08A001249	3.8	5.0	3.5	4.8	5.7	3.3	30.0	8.0	20.0	8.0	9.0	6.0	9.0	4.9	5.3	25.0	8.5	10.5	8.0
14-2408 TX09A001194	3.0	3.8	3.0	4.0	4.7	2.7	21.0	6.0	20.0	6.0	9.0	4.8	8.0	3.7	3.5	20.0	12.0	7.0	7.0
14-2409 TX09D1172	2.3	3.3	2.3	5.4	3.6	2.3	21.0	6.0	11.0	5.0	9.0	4.0	7.0	2.9	2.8	25.0	8.0	6.5	6.0

BAKE MIX TIME

(Small Scale) Texas-Amarillo

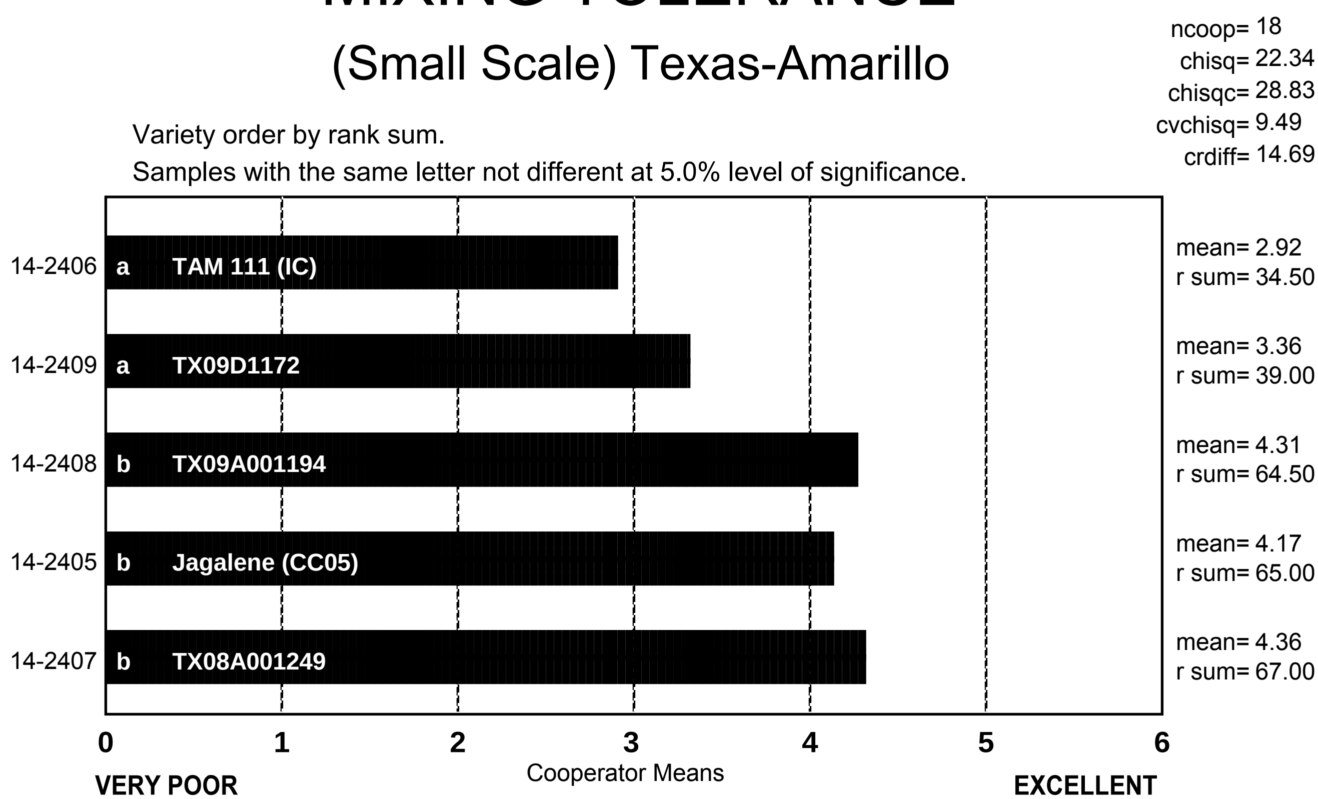
Variety order by rank sum.
Samples with the same letter not different at 5.0% level of significance.



MIXING TOLERANCE

(Small Scale) Texas-Amarillo

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

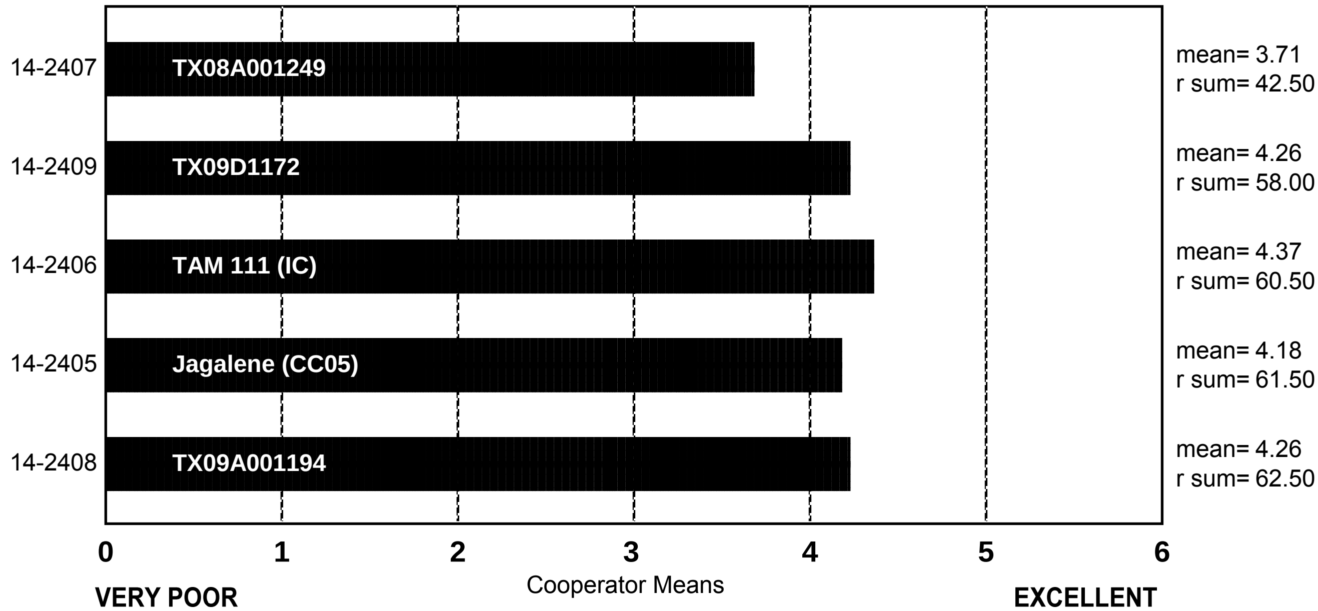


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Texas-Amarillo

ncoop= 19
chisq= 5.77
chisqc= 8.00
cvchisq= 9.49
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Texas-Amarillo

	Sticky	Wet	Tough	Good	Excellent
14-2405 Jagalene (CC05)	**2**	**0**	**3**	**12**	**2**
14-2406 TAM 111 (IC)	**1**	**0**	**4**	**13**	**1**
14-2407 TX08A001249	**0**	**1**	**10**	**8**	**0**
14-2408 TX09A001194	**0**	**0**	**4**	**14**	**1**
14-2409 TX09D1172	**1**	**2**	**1**	**15**	**0**

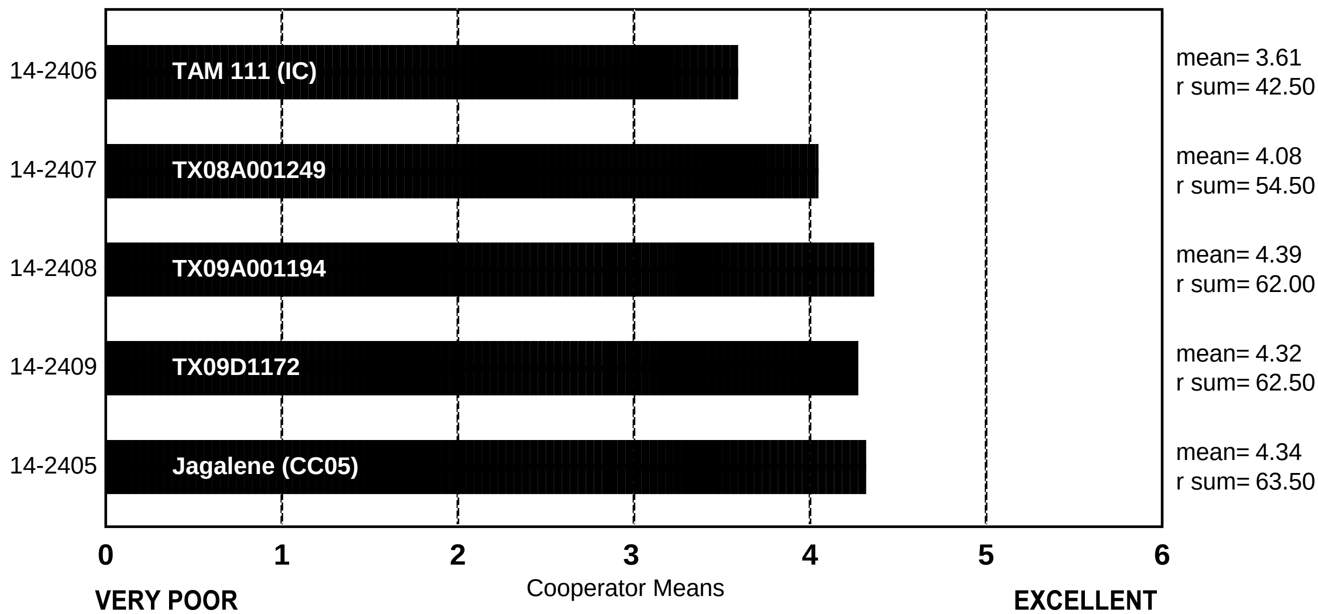
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Texas-Amarillo

ncoop= 19
chisq= 6.61
chisqc= 8.75
cvchisq= 9.49
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Texas-Amarillo

	Sticky	Wet	Tough	Good	Excellent
14-2405 Jagalene (CC05)	1	1	2	12	3
14-2406 TAM 111 (IC)	2	5	1	11	0
14-2407 TX08A001249	0	1	9	7	2
14-2408 TX09A001194	0	0	7	11	1
14-2409 TX09D1172	1	1	1	13	3

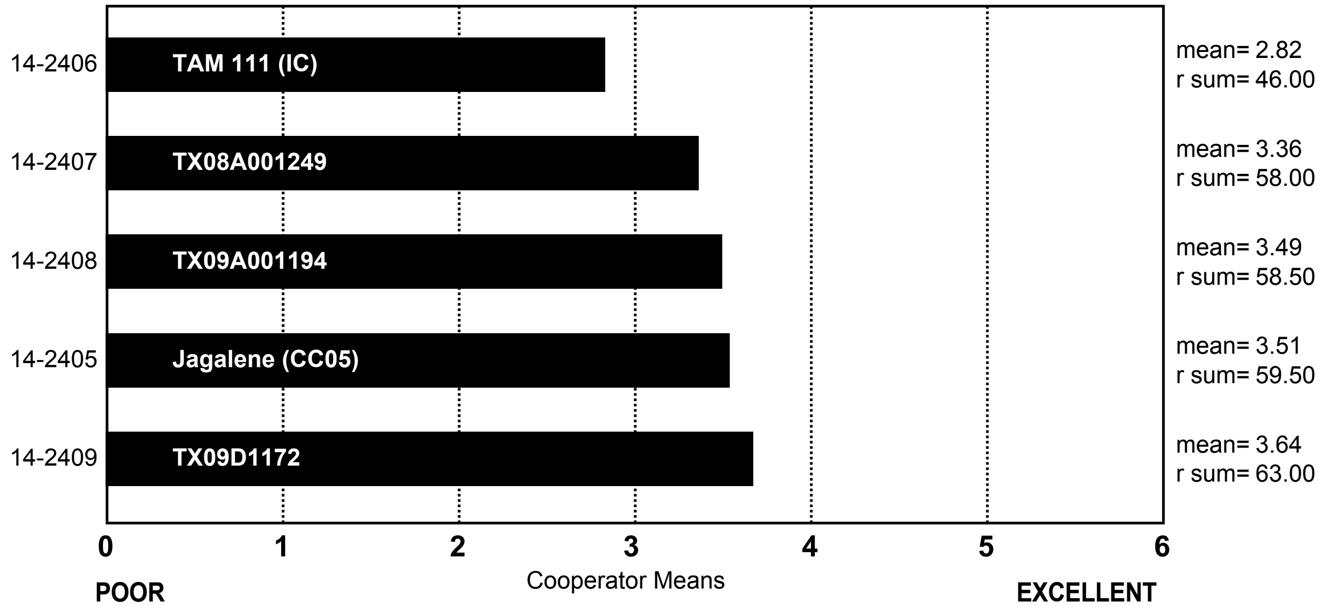
Frequency Table

CRUMB GRAIN

(Small Scale) Texas-Amarillo

ncoop= 19
chisq= 3.51
chisqc= 4.38
cvchisq= 9.49
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Texas-Amarillo

	Open	Fine	Dense
14-2405 Jagalene (CC05)	9	9	1
14-2406 TAM 111 (IC)	10	5	4
14-2407 TX08A001249	9	9	1
14-2408 TX09A001194	12	6	1
14-2409 TX09D1172	10	9	0

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Texas-Amarillo

	Round	Irregular	Elongated
14-2405 Jagalene (CC05)	**6**	**8**	**5**
14-2406 TAM 111 (IC)	**12**	**5**	**2**
14-2407 TX08A001249	**5**	**8**	**6**
14-2408 TX09A001194	**7**	**5**	**7**
14-2409 TX09D1172	**5**	**9**	**5**

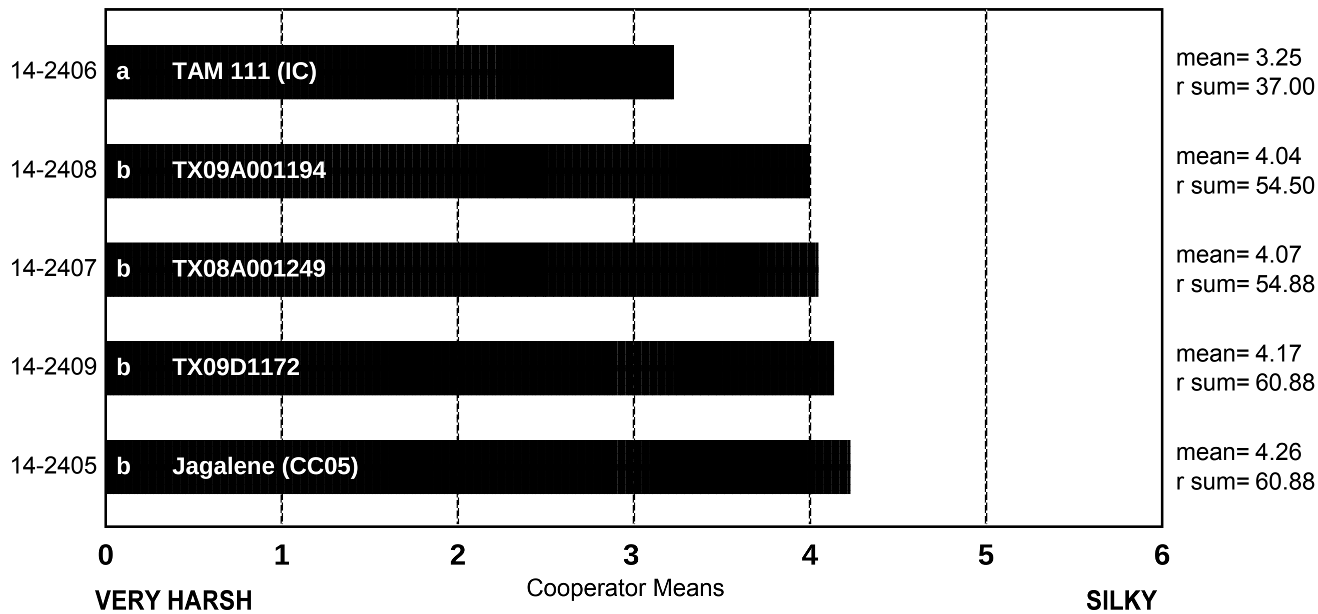
Frequency Table

CRUMB TEXTURE

(Small Scale) Texas-Amarillo

ncoop= 18
chisq= 4.05
chisqc= 23.09
cvchisq= 9.49
crdiff= 13.27

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Texas-Amarillo

	Harsh	Smooth	Silky
14-2405 Jagalene (CC05)	0	13	5
14-2406 TAM 111 (IC)	9	7	2
14-2407 TX08A001249	3	11	4
14-2408 TX09A001194	4	10	4
14-2409 TX09D1172	4	10	4

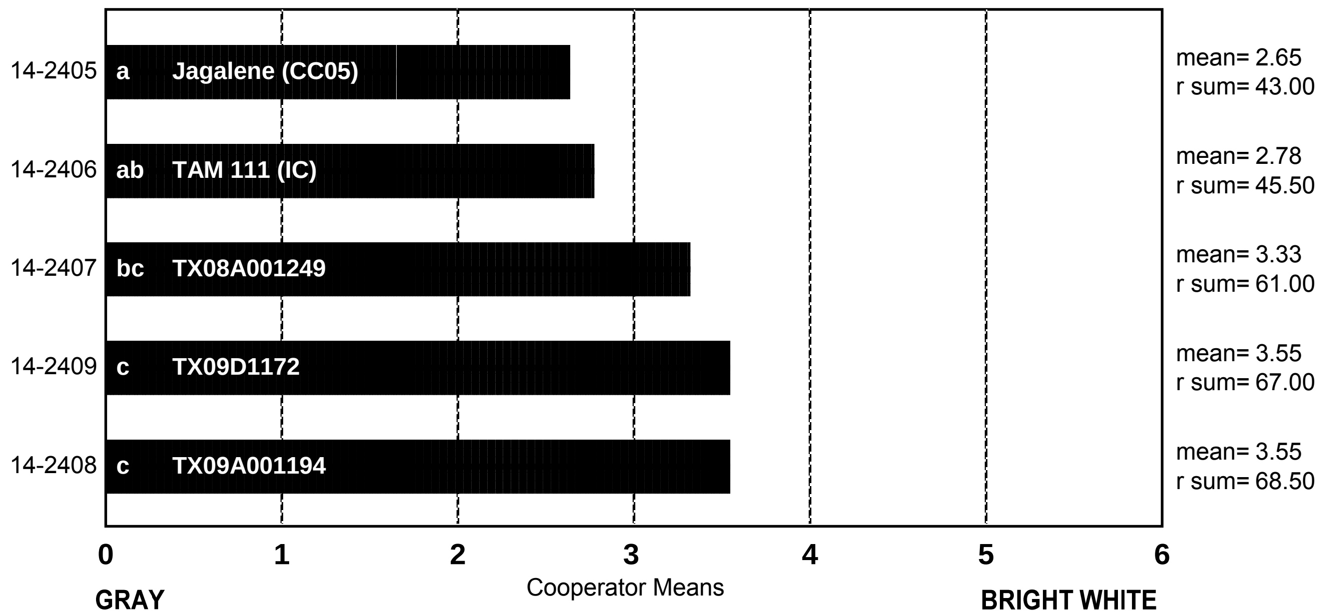
Frequency Table

CRUMB COLOR

(Small Scale) Texas-Amarillo

ncoop= 19
chisq= 12.14
chisqc= 15.22
cvchisq= 9.49
crdiff= 16.05

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



CRUMB COLOR, DESCRIBED

(Small Scale) Texas-Amarillo

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
14-2405 Jagalene (CC05)	**7**	**0**	**2**	**5**	**4**	**1**	**0**
14-2406 TAM 111 (IC)	**4**	**0**	**6**	**4**	**5**	**0**	**0**
14-2407 TX08A001249	**3**	**0**	**2**	**7**	**5**	**1**	**1**
14-2408 TX09A001194	**4**	**0**	**1**	**3**	**8**	**1**	**2**
14-2409 TX09D1172	**0**	**0**	**3**	**4**	**10**	**2**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Texas-Amarillo

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2405 Jagalene (CC05)	132.7	141.6	145.0	161.0	141.2	146.3	460.3	458.5	413.0	734.3	134.0	150.9	464.4	134.4	143.0	485.1	447.0	450.1	480.9
14-2406 TAM 111 (IC)	133.7	143.7	146.0	157.6	140.1	144.8	460.7	464.6	413.0	723.7	134.0	152.2	456.5	138.5	142.8	488.8	448.0	453.0	487.8
14-2407 TX08A001249	132.6	142.3	143.2	156.9	141.4	141.6	458.7	462.9	417.0	759.4	134.0	153.5	460.1	136.6	137.9	478.7	449.0	443.4	484.9
14-2408 TX09A001194	133.1	140.7	144.8	155.7	138.6	143.0	453.9	459.9	412.0	758.4	134.0	152.7	455.8	137.0	136.7	482.6	451.0	445.8	483.7
14-2409 TX09D1172	131.6	143.8	146.9	155.2	137.5	140.7	458.2	462.9	412.0	731.0	134.0	150.9	456.0	137.8	139.1	474.2	450.0	446.5	483.6

LOAF VOLUME, ACTUAL

(Small Scale) Texas-Amarillo

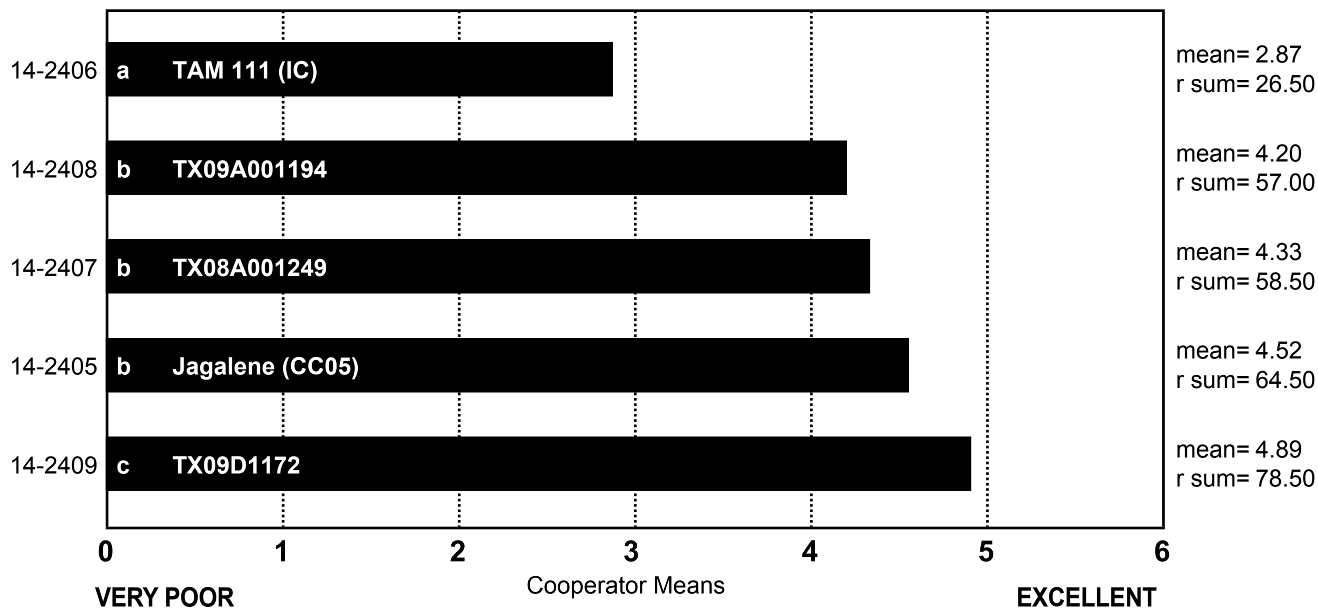
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2405 Jagalene (CC05)	**865**	**1195**	**1025**	**1038**	**1010**	**970**	**2700**	**2700**	**3150**	**4430**	**948**	**1055**	**2375**	**982**	**1118**	**3045**	**2325**	**2525**	**2525**
14-2406 TAM 111 (IC)	**610**	**985**	**870**	**1015**	**903**	**760**	**2500**	**2263**	**2650**	**3555**	**815**	**1000**	**2350**	**837**	**875**	**2839**	**2300**	**2450**	**2400**
14-2407 TX08A001249	**880**	**1200**	**950**	**963**	**970**	**930**	**2650**	**2450**	**3000**	**4405**	**958**	**1050**	**2350**	**898**	**1058**	**3104**	**2475**	**2480**	**2500**
14-2408 TX09A001194	**840**	**1165**	**960**	**1025**	**950**	**950**	**2800**	**2488**	**2900**	**4205**	**958**	**1020**	**2400**	**880**	**1015**	**3104**	**2250**	**2480**	**2550**
14-2409 TX09D1172	**860**	**1275**	**1035**	**1003**	**1050**	**1025**	**2700**	**2600**	**3100**	**4005**	**1085**	**1075**	**2500**	**931**	**1098**	**3104**	**2600**	**2500**	**2663**

LOAF VOLUME

(Small Scale) Texas-Amarillo

ncoop= 19
chisq= 30.55
chisqc= 38.95
cvchisq= 9.49
crdiff= 12.43

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

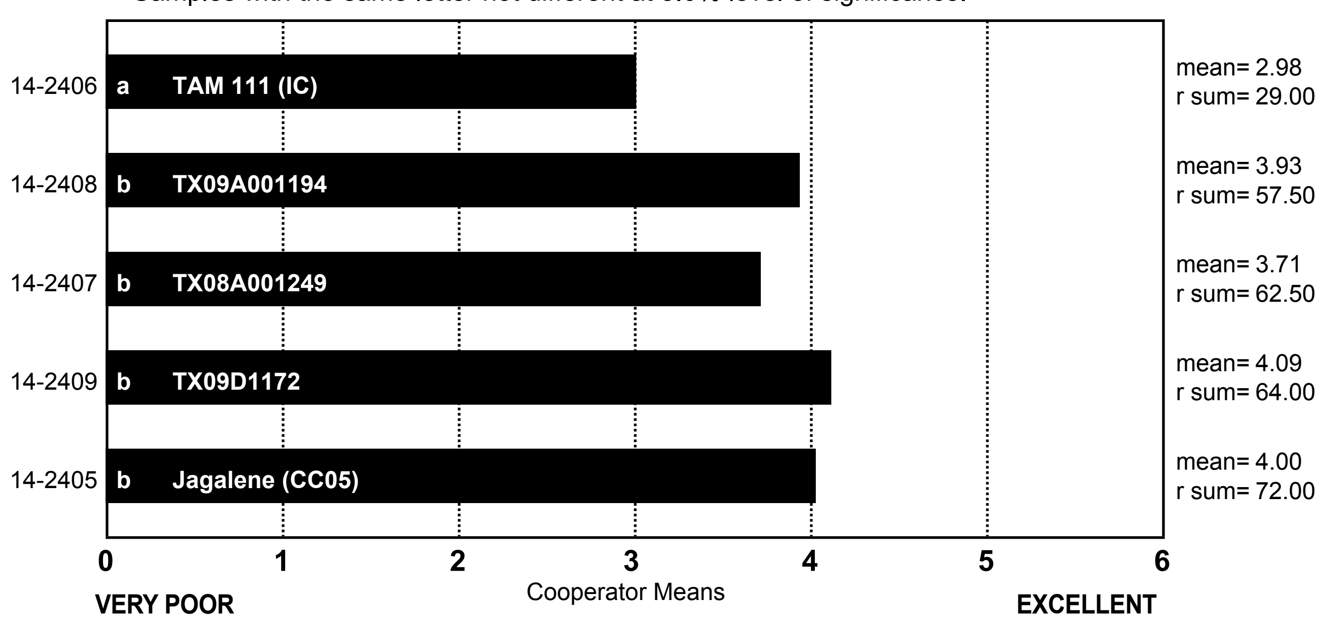


OVERALL BAKING QUALITY

(Small Scale) Texas-Amarillo

ncoop= 19
chisq= 22.92
chisqc= 25.39
cvchisq= 9.49
crdiff= 15.58

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



COOPERATOR'S COMMENTS
(Small Scale) Texas-Amarillo

COOP. 14-2405 Jagalene (CC05)

A. High flour protein, nice feel to dough, elastic and pliable, nice gas retention, nice oven spring.
B. Grey dough, dark crust, grey crumb color.
C. 2 large holes.
D. No comment.
E. Normal water absorption & mix time, slight sticky & strong dough, very high OS & volume, yellow crumb, fine elongated cells, smooth & resilient texture.
F. Excellent protein and absorption, strong farinograph, acceptable bread.
G. No comment.
H. High absorption, average mix, high volume, dull, open grain.
I. Strong dough, good volume, very open grain.
J. Long hydration on mixing.
K. Gassy dough handling, soft on make up, gray crumb color, open grain.
L. High flour protein and bake absorption, good dough at pan, high loaf volume, crumb grain more open/questionable.
M. Dark.
N. 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
O. No comment.
P. Strong mixing dough, tight, consistent grain, very good volume.
Q. Brittle crust, doubled bread and shred.
R. Good mix time, excellent dough, good volume, fine grain.
S. Very high absorption, average volume.

COOP. 14-2406 TAM 111 (IC)

A. Shorter mix time, weak, limp, flat dough, lower loaf volume, gray/yellow color, poor crumb structure.
B. Short mix time.
C. 2 large holes.
D. Good water absorption.
E. Normal absorption, short mix time, slight sticky & strong dough, high OS & volume, gray yellow crumb, open irregular cells, harsh & hard resilient texture.
F. Weaker, short, poor volume, gray/dull bread.
G. No comment.
H. Slightly above average absorption, short mix, very low volume, dull, open grain, flat.
I. Dry sponge, squatty loaf, yellow interior, short mix.
J. No comment.
K. Very poor bake performance, worst of set, very low volume and poor tolerance.
L. Good flour protein, lower crumb grain score but good bake absorption, good at pan with excellent loaf volume.
M. No comment.

N. 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
O. No comment.
P. Slightly low volume, good dough feel, above average interior scores.
Q. Slight wild break and shred.
R. Low mix time of 5 minutes, excellent dough, average volume with a dense grain.
S. High absorption, short mix time, open grain, low volume.

COOP. 14-2407 TX08A001249

A. High bake absorption, nice gas retention and elasticity, nice oven spring.
B. Excellent loaf externals.
C. No comment.
D. Good dough properties.
E. Normal water absorption and mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, little open & elongated cells, smooth & resilient texture.
F. Very good absorption for protein, stronger dough with good baking quality.
G. No comment.
H. High absorption, average mix, low volume, creamy, open grain.
I. Tough and bucky dough, very open grain, good volume.
J. No comment.
K. Great bake quality, similar to 2409.
L. High score for bake absorption, dough strength and loaf volume with satisfactory crumb grain.
M. No comment.
N. 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
O. No comment.
P. Very good strength and absorption, above average interiors and excellent volume. Nice bake.
Q. Dry at sponge and make up, poor cell structure.
R. Longer mix time of 10 minutes, dough was tough, bread had excellent oven spring but couldn't hold it at volume test, good grain score.
S. Very high absorption, open grain, average volume.

COOP. 14-2408 TX09A001194

A. Weak, very pliable yet retained gas, nice oven spring.
B. Grey dough, grey crumb color, rough break.
C. No comment.
D. Good dough properties.
E. Normal water absorption and mix time, slight sticky & strong dough, very high OS & volume, dim creamy crumb, little open & elongated cells, smooth & resilient texture.
F. Good absorption, overall acceptable HRW.
G. No comment.
H. High absorption, average mix, low volume, creamy, open grain.
I. Tough and bucky dough, very open grain, good volume.
J. No comment.
K. Good bake quality.
L. Flour protein excellent, good dough strength, absorption and loaf volume high, crumb grain satisfactory, medium bake mix time.

M. No comment.
N. 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
O. No comment.
P. Slightly open grain, excellent volume, bright crumb color.
Q. Thick, dark crust.
R. Excellent mix time, good dough, bread had excellent oven spring but couldn't hold it at volume test, open grain.
S. High absorption, open grain, average volume.

COOP. 14-2409 TX09D1172

A. High flour protein, smooth, elastic, dense, nice gas retention, full body, little oven spring.
B. Rough break.
C. No comment.
D. Good dough properties and grain, volume performance down for protein level.
E. Normal water absorption and mix time, slight sticky & strong dough, very high OS & volume, yellow crumb, fine & elongated cells, very smooth & resilient texture.
F. Very good protein and bread.
G. No comment.
H. Slightly above average absorption, average mix, average volume, creamy, open grain.
I. Shortest mix, excellent volume.
J. No comment.
K. Great bake quality, best of set.
L. Flour protein excellent, excellent dough at pan, high loaf volume with satisfactory crumb grain.
M. No comment.
N. 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
O. No comment.
P. Good strength and absorption, slightly open grain, excellent volume.
Q. No comment.
R. Excellent mix time, good dough, bread had excellent oven spring but couldn't hold it at volume test, open grain.
S. High absorption, average mix time, open grain, high volume.

Notes: **G, H, I, K, P, Q, R and S** conducted sponge and dough bake tests

COLORADO

14-2410	Jagalene (CC10)
14-2411	Byrd (IC)
14-2412	CO11D174
14-2413	CO11D446

Description of Test Plots and Breeder Entries

Colorado – Scott Haley

Growing Location & Conditions

The Wheat Quality Council samples from Colorado originated from strip increases grown under nonirrigated conditions at the USDA-ARS Central Great Plains Research Station at Akron, CO. The field with the strip increases, and adjacent breeding and extension trials, was fertilized with a pre-plant application of 50 lbs N (applied as 46-0-0). The planting date was 9/30/13 and the harvest date was 7/21/14.

Growing conditions included: slightly delayed planting due to heavy mid-September rain (2.5"), planting into excellent moisture, good fall establishment and growth, relatively cold winter temperatures (often with good snow cover though), unbeliebably windy conditions throughout the winter and spring, good early spring precipitation, moderate drought stress symptoms appearing by early-boot stage relieved by excellent early-May precipitation, excellent late-May and early-June precipitation, adequate and regular precipitation throughout grain-filling. Stripe rust, Septoria, and Bird-cherry oat aphids were present at relatively low levels and no other significant disease or insect problems were observed.

Grain yields of the adjacent state variety extension trial (UVPT) were quite good, averaging 61.7 bu/a (49.8-70.5 bu/a range) with an average test weight of 59.3 lb/bu (58.9-63.5 lb/bu range). Average grain protein content (12% moisture basis) from the group of four strips harvested for the WQC was 12.0%. The cultivar Byrd was the top performing entry in the UVPT at 70.5 bu/a grain yield and 59.5 lb/bu test weight.

Jagalene (check) – common check

Byrd (check) – local check

Byrd is a hard red winter wheat (HRW) released by Colorado State University in 2011. Byrd was tested in the 2010 WQC sample set under experimental number CO06424 and has been included as our check since 2012. Byrd has shown good milling and baking quality characteristics and likely will soon displace Hatcher as the most widely grown wheat cultivar in Colorado. Byrd is marketed by the Colorado Wheat Research Foundation (CWRF) under the PlainsGold Brand.

CO11D174

CO11D174 is a doubled-haploid hard red winter wheat experimental line from the cross TAM 112/Byrd made in 2009. CO11D174 is similar to Byrd in many respects. It is medium-height and medium-maturity and has a medium-long coleoptile, average straw strength, and average test weight. CO11D174 is moderately susceptible to stripe rust, susceptible to leaf rust and stem rust, susceptible to Hessian fly and all biotypes of Russian wheat aphid, and resistant to wheat soilborne mosaic virus and the wheat curl mite (resistance from TAM 112). The reaction of CO11D174 to Fusarium head blight is not known. Across 26 site-years in the CSU Elite Trial (2013 and 2014) and UVPT (2014), CO11D174 was the highest yielding entry tested, approximately 7% higher yielding than Byrd. In the 2014 Southern Regional Performance Nursery (SRPN), CO11D174 was also the highest yielding entry. CO11D174 has shown good overall milling and baking properties in tests conducted in the CSU Wheat Quality Lab. Individual milling and baking properties of CO11D174 are very similar to Byrd, though CO11D174 has slightly greater SKCS kernel weight (29.3 vs. 27.7 grams/1000) and diameter (2.58 vs. 2.49 mm), slightly lower Brabender quadrumat senior flour yield (69.9 vs. 72.0%), and slightly shorter mixograph mixing time (5.3 vs. 6.6 minutes). CO11D174 is on foundation seed increase in 2015 with the intent to release as a new cultivar in fall 2015.

CO11D446

CO11D446 is a doubled-haploid hard red winter wheat experimental line from the cross CO050270/Byrd made in 2009. CO050270 is an experimental line from CSU with the pedigree Hatcher/NW97S295. CO11D446 is medium-short and medium-early and has a medium length coleoptile, average straw strength, and average test weight. CO11D446 is moderately resistant to stripe rust, susceptible to leaf rust and stem rust, susceptible to Hessian fly and all biotypes of Russian wheat aphid, and resistant to wheat soilborne mosaic virus and the wheat curl mite (resistance from TAM 112). The reaction of CO11D446 to Fusarium head blight is not known. Across 26 site-years in the CSU Elite Trial (2013 and 2014) and UVPT (2014), CO11D446 was about 1 bu/a lower yielding than Byrd. In the 2014 Southern Regional Performance Nursery (SRPN), CO11D446 was the second highest yielding entry. CO11D446 has shown very good overall milling and baking properties in tests conducted in the CSU Wheat Quality Lab. Individual milling and baking properties of CO11D446 are similar to Byrd, though CO11D446 has slightly lower Brabender quadrumat senior flour yield (70.3 vs. 72.0%) and longer mixograph (7.2 vs. 5.7 minutes) and pup-loaf bake (6.6 vs. 5.2 minutes) mixing time. CO11D446 is on breeder seed increase in 2015 and the earliest possible release would be fall 2016.

Colorado: 2014 (Small-Scale) Samples

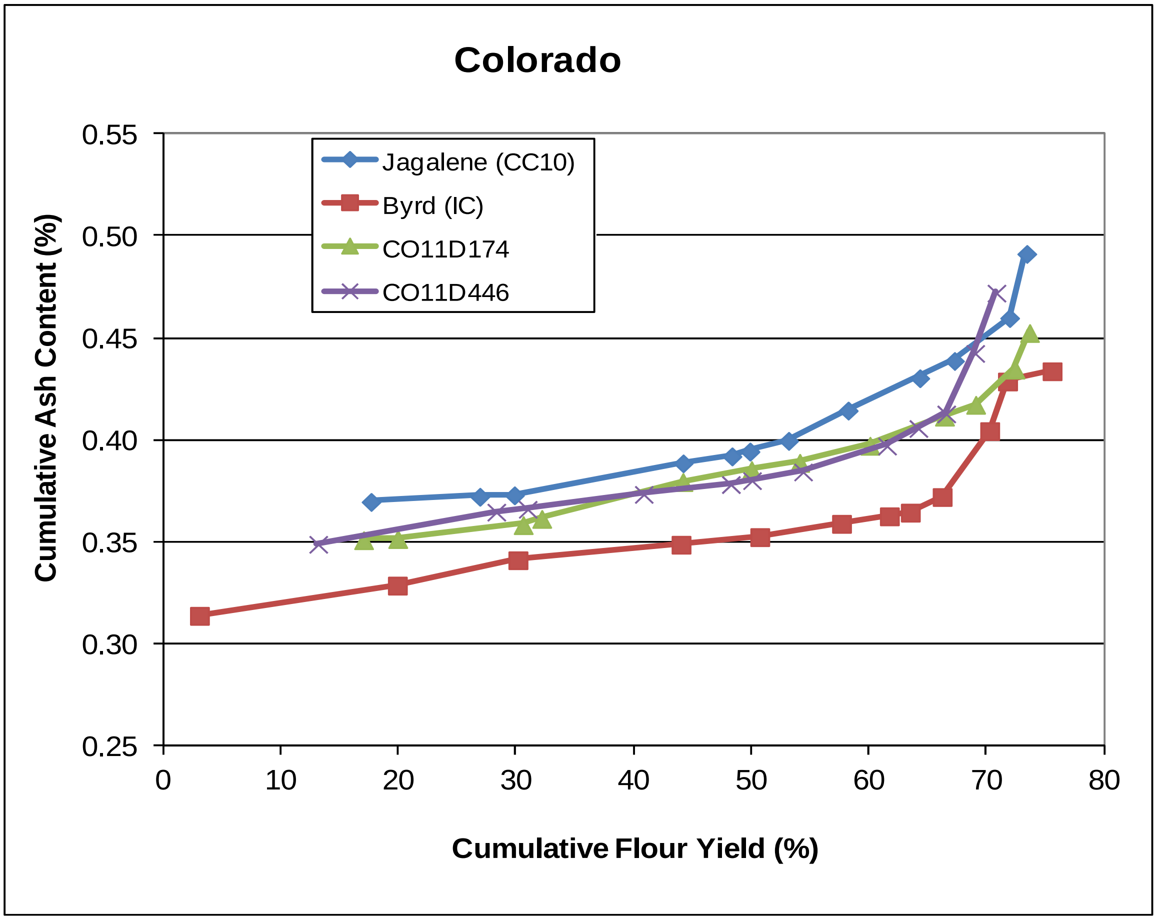
Test entry number	14-2410	14-2411	14-2412	14-2413
Sample identification	Jagalene (CC10)	Bryd (IC)	CO11D174	CO11D446
Wheat Data				
GIPSA classification	1 HRW	1 HRW	1 HRW	2 HRW
Test weight (lb/bu) Hectoliter weight (kg/hl)	62.0 81.5	61.6 81.0	60.1 79.1	59.2 77.9
1000 kernel weight (gm)	30.5	31.1	28.6	30.1
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 65.3 34.7 0.0	 70.9 28.7 0.4	 59.5 40.0 0.5	 58.7 40.5 0.8
Single kernel (skcs)[a] Hardness (avg /s.d) Weight (mg) (avg/s.d) Diameter (mm)(avg/s.d) Moisture (avg/s.d) SKCS distribution Classification	 68.5/16.1 30.5/7.2 2.69/0.31 9.1/0.6 02-07-17-74-01 Hard	 57.6/17.3 31.1/9.1 2.61/0.35 10.8/0.6 08-14-31-47-02 Hard	 61.8/16.3 28.6/6.5 2.54/0.31 9.5/0.6 05-10-26-59-01 Hard	 59.7/17.3 30.1/8.3 2.52/0.33 9.8/0.5 05-20-26-49-01 Hard
Wheat protein (12% mb) Wheat ash (12% mb)	13.0 1.49	12.6 1.53	12.7 1.53	12.0 1.48
Milling and Flour Quality Data				
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 73.6 69.6	 75.4 72.7	 73.5 70.5	 71.2 71.3
Flour moisture (%) Flour protein (14% mb) Flour ash (14% mb)	11.9 11.8 0.44	12.5 11.1 0.41	13.1 11.3 0.43	12.0 10.6 0.45
Rapid Visco-Analyser Peak Time (min) Peak Viscosity (RVU) Breakdown (RVU) Final Viscosity at 13 min (RVU)	 6.2 203.0 64.3 258.5	 6.0 229.0 95.2 256.3	 6.3 266.4 98.3 299.8	 6.1 237.7 83.8 290.8
Minolta color meter L* a* b* **PPO value**	 92.62 -1.88 10.14 0.600	 92.83 -1,79 9.87 0.597	 93.14 -1.75 9.46 0.770	 92.82 -1.83 9.80 0.701
Falling number (sec)	518	513	559	486
Damaged Starch (AI%) (AACC76-31)	 96.93 7.02	 95.87 6.17	 95.46 5.87	 95.72 6.06

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

Colorado: Physical Dough Tests and Gluten Analysis
For 2014 (Small-Scale) Samples

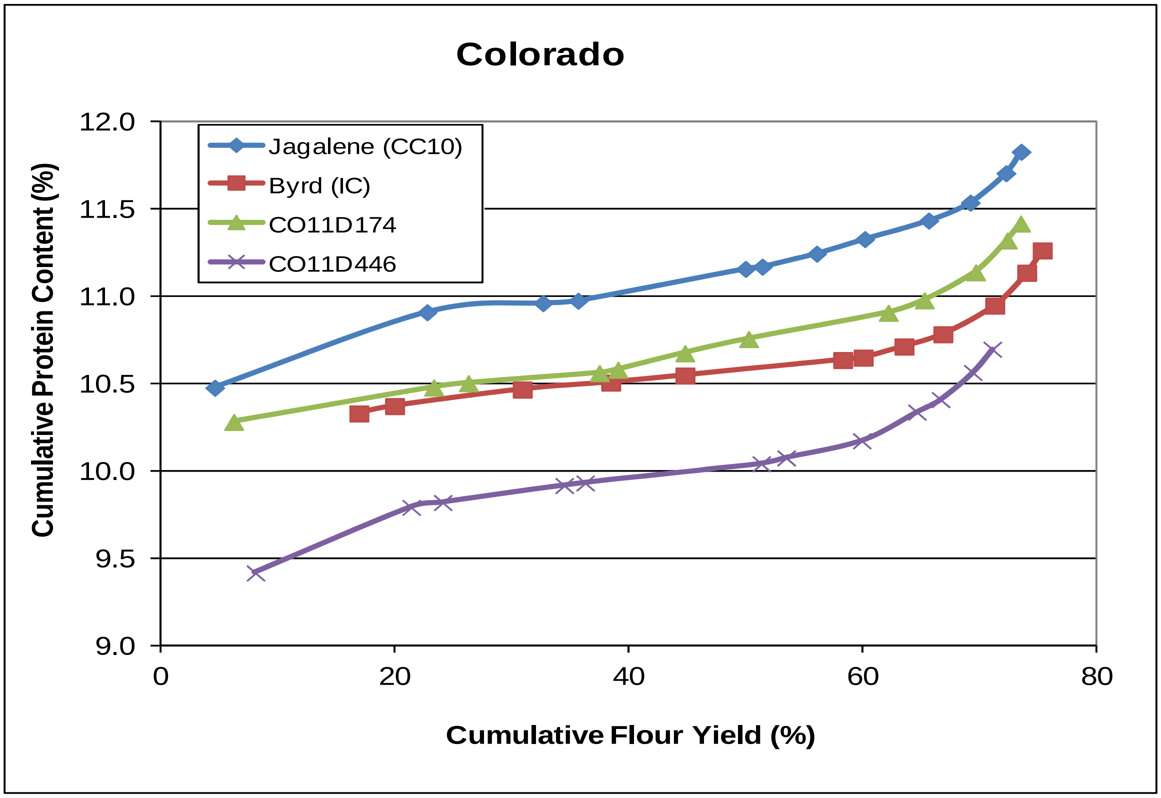
Test Entry Number	14-2410	14-2411	14-2412	14-2413
Sample Identification	Jagalene (CC10)	Byrd (IC)	CO11D174	CO11D446
MIXOGRAPH				
Flour Abs (% as-is)	65.4	63.4	62.9	62.8
Flour Abs (14% mb)	62.8	61.2	61.4	60.7
Mix Time (min)	4.2	5.6	6.0	7.0
Mix tolerance (0-6)	3	4	4	5
FARINOGRAPH				
Flour Abs (% as-is)	59.4	55.6	57.2	55.8
Flour Abs (14% mb)	56.8	53.4	55.7	53.7
Development time (min)	5.8	2.7	10.3	2.7
Mix stability (min)	15.5	17.3	30.7	14.4
Mix Tolerance Index (FU)	17	20	0	27
Breakdown time (min)	17.7	12.9	32.0	8.5
ALVEOGRAPH				
P(mm): Tenacity	64	56	80	60
L(mm): Extensibility	133	95	100	78
G(mm): Swelling index	25.7	21.7	22.3	19.7
W(10^{-4} J): strength (curve area)	301	218	307	197
P/L: curve configuration ratio	0.48	0.59	0.80	0.77
Ie(P_{200}/P): elasticity index	64.9	68.2	64.9	68.1
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	399/579/612	531/740/767	540/818/959	549/925/992
Extensibility (mm at 45/90/135 min)	140/139/147	149/140/136	130/133/122	144/118/118
Energy (cm^2 at 45/90/135 min)	98/138/160	151/183/174	118/179/168	142/156/159
Resist $_{max}$ (BU at 45/90/135 min)	556/808/893	826/996/997	701/998/997	804/993/992
Ratio (at 45/90/135 min)	2.85/4.16/4.16	3.55/5.28/5.65	4.15/6.15/7.84	3.82/7.83/8.40
PROTEIN ANALYSIS				
HMW-GS Composition	1/2*, 17+18, 5+10	2*, 7+8, 5+10	2*, 7+8, 5+10	2*, 7+8, 5+10
%IPP	49.52	50.10	50.51	52.61
SEDIMENTATION TEST				
Volume (ml)	60.4	61.6	65.5	59.7

Colorado: Cumulative Ash Curves



Jagalene (CC10)					Byrd (IC)					CO11D174					CO11D446				
Mill	Strm-yld	Ash	Cumul (14%)		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	Streams	(14%mb)		Yield	Ash
2M	17.63	0.37	17.63	0.37	1M Red	3.04	0.31	3.04	0.31	2M	16.99	0.35	16.99	0.35	2M	13.1	0.35	13.1	0.35
1M	9.24	0.38	26.87	0.37	2M	16.82	0.33	19.86	0.33	1M Red	2.90	0.36	19.90	0.35	3M	15.1	0.38	28.3	0.37
1M Red	2.94	0.38	29.81	0.37	1M	10.25	0.37	30.11	0.34	1M	10.66	0.37	30.56	0.36	1M Red	2.7	0.38	30.9	0.37
3M	14.34	0.42	44.15	0.39	3M	13.86	0.37	43.97	0.35	Grader	1.57	0.42	32.13	0.36	1M	9.9	0.40	40.8	0.37
1BK	4.15	0.43	48.30	0.39	1BK	6.69	0.38	50.66	0.35	3M	12.00	0.43	44.13	0.38	1BK	7.4	0.41	48.2	0.38
Grader	1.53	0.47	49.83	0.39	4M	6.94	0.41	57.60	0.36	1BK	5.83	0.43	49.96	0.39	Grader	1.8	0.43	50.0	0.38
2BK	3.28	0.48	53.11	0.40	2BK	4.07	0.41	61.67	0.36	2BK	4.09	0.43	54.05	0.39	2BK	4.3	0.43	54.3	0.38
4M	5.07	0.57	58.17	0.41	Grader	1.78	0.43	63.45	0.36	4M	5.96	0.47	60.02	0.40	FILTER FLR	7.1	0.49	61.5	0.40
FILTER FLR	6.09	0.58	64.26	0.43	3BK	2.71	0.55	66.16	0.37	FILTER FLR	6.34	0.55	66.35	0.41	3BK	2.7	0.60	64.1	0.41
3BK	2.95	0.62	67.21	0.44	5M	4.04	0.93	70.20	0.40	3BK	2.65	0.56	69.00	0.42	4M	2.4	0.61	66.5	0.41
5M	4.69	0.76	71.89	0.46	BRAN FLR	1.51	1.56	71.71	0.43	5M	3.35	0.79	72.35	0.43	5M	2.5	1.24	69.0	0.44
BRAN FLR	1.46	2.04	73.35	0.49	FILTER FLR	3.79	0.53	75.50	0.43	BRAN FLR	1.23	1.51	73.58	0.45	BRAN FLR	1.8	1.60	70.8	0.47
Break Shorts	1.80	3.62	75.15	0.57	Break Shorts	1.40	3.55	76.91	0.49	Break Shorts	1.47	3.46	75.05	0.51	Break Shorts	1.7	3.58	72.5	0.54
Red Dog	2.33	2.25	77.48	0.62	Red Dog	1.16	2.51	78.07	0.52	Red Dog	1.51	2.48	76.56	0.55	Red Dog	1.0	2.80	73.4	0.57
Red Shorts	0.57	4.24	78.05	0.64	Red Shorts	0.09	3.61	78.16	0.52	Red Shorts	0.22	3.74	76.78	0.56	Red Shorts	0.1	3.67	73.5	0.58
Filter Bran	5.67	1.95	83.72	0.73	Filter Bran	3.74	3.12	81.89	0.64	Filter Bran	6.20	2.28	82.98	0.69	Filter Bran	5.5	2.03	79.0	0.68
Bran	16.28	5.40	100.0	1.49	Bran	18.11	5.83	100.0	1.58	Bran	17.02	5.42	100.0	1.49	Bran	21.0	5.67	100.0	1.73
Wheat		1.45					1.49					1.49					1.45		
St. Grd. Fl.		0.44					0.41					0.43					0.45		

Colorado: Cumulative Protein Curves



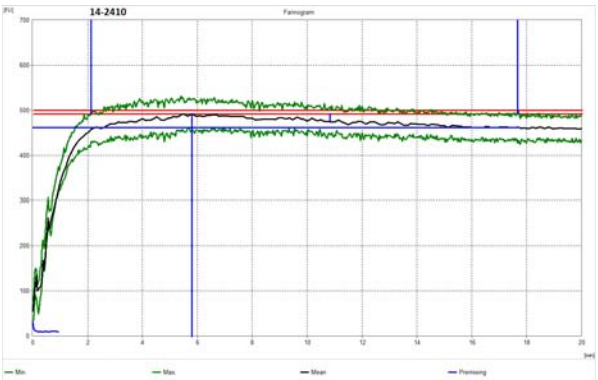
Jagalene (CC10)					Byrd (IC)					CO11D174					CO11D446				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1BK	4.67	10.47	4.67	10.47	2M	16.98	10.33	16.98	10.33	1BK	6.29	10.28	6.29	10.28	1BK	8.15	9.41	8.15	9.41
2M	18.14	11.02	22.81	10.91	1M Red	3.05	10.60	20.03	10.37	2M	17.08	10.55	23.37	10.48	2M	13.30	10.02	21.45	9.79
1M	9.89	11.08	32.70	10.96	1M	10.91	10.64	30.94	10.46	1M Red	2.97	10.69	26.34	10.50	1M Red	2.70	10.04	24.14	9.82
1M Red	3.00	11.12	35.70	10.97	1BK	7.56	10.67	38.51	10.50	1M	11.19	10.69	37.52	10.56	1M	10.38	10.14	34.53	9.92
3M	14.30	11.61	50.01	11.15	4M	6.34	10.79	44.84	10.54	Grader	1.59	11.04	39.11	10.58	Grader	1.79	10.21	36.32	9.93
Grader	1.44	11.62	51.45	11.17	3M	13.48	10.93	58.32	10.63	4M	5.72	11.32	44.83	10.67	3M	15.05	10.31	51.36	10.04
4M	4.64	12.07	56.09	11.24	Grader	1.75	11.09	60.07	10.65	FILTER FLR	5.45	11.42	50.28	10.75	4M	2.13	10.88	53.49	10.07
5M	4.11	12.46	60.20	11.32	FILTER FLR	3.48	11.81	63.55	10.71	3M	11.94	11.54	62.21	10.90	FILTER FLR	6.46	10.98	59.95	10.17
FILTER FLR	5.47	12.60	65.67	11.43	5M	3.33	12.12	66.88	10.78	5M	3.08	12.41	65.29	10.97	2BK	4.71	12.42	64.66	10.33
2BK	3.55	13.42	69.22	11.53	2BK	4.43	13.41	71.31	10.94	2BK	4.38	13.53	69.68	11.14	5M	2.02	12.71	66.69	10.41
3BK	3.05	15.53	72.27	11.70	3BK	2.74	16.05	74.05	11.13	3BK	2.70	16.01	72.38	11.32	3BK	2.75	14.33	69.43	10.56
BRAN FLR	1.30	18.66	73.57	11.82	BRAN FLR	1.33	18.40	75.38	11.26	BRAN FLR	1.14	17.57	73.52	11.41	BRAN FLR	1.67	16.22	71.10	10.69
Break Shorts	1.79	16.29	75.36	11.93	Break Shorts	1.33	15.62	76.71	11.34	Break Shorts	1.46	15.46	74.98	11.49	Break Shorts	1.69	15.37	72.78	10.80
Red Dog	1.97	15.16	77.33	12.01	Red Dog	0.89	13.68	77.60	11.36	Red Dog	1.34	14.34	76.32	11.54	Red Dog	0.74	14.23	73.53	10.84
Red Shorts	0.44	15.67	77.77	12.03	Red Shorts	0.06	13.07	77.66	11.36	Red Shorts	0.18	13.69	76.50	11.55	Red Shorts	0.10	13.77	73.63	10.84
Filter Bran	5.24	13.65	83.01	12.14	Filter Bran	3.42	14.87	81.08	11.51	Filter Bran	5.66	13.98	82.16	11.72	Filter Bran	4.86	13.39	78.49	11.00
Bran	16.99	15.52	100.00	12.71	Bran	18.92	16.86	100.00	12.52	Bran	17.84	15.55	100.00	12.40	Bran	21.51	15.27	100.00	11.92
Wheat		12.68					12.30					12.38					11.68		
St. Grd. Fl		11.79					11.07					11.31					10.62		

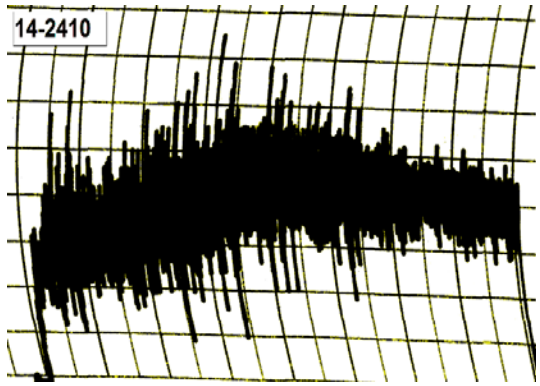
Physical Dough Tests

2014 (Small Scale) Samples – Colorado

Farinograms

Mixograms

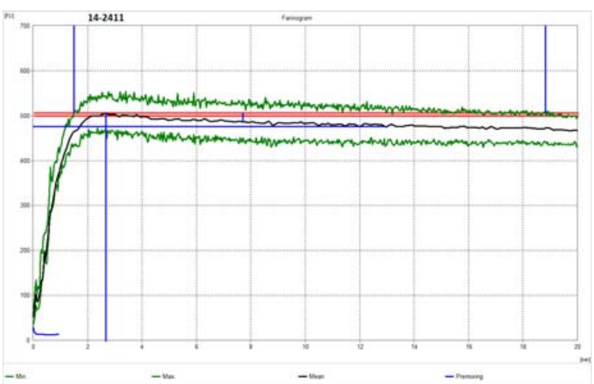


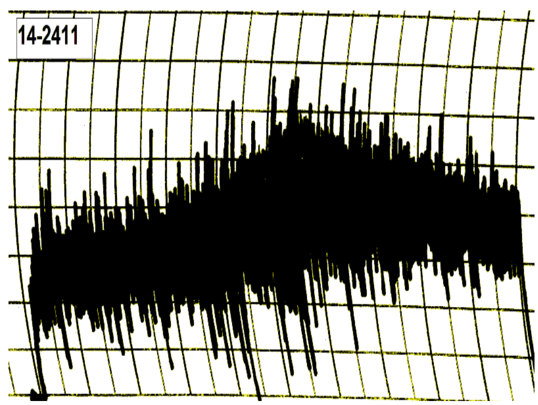


Water abs = 56.8%, Peak time = 5.8 min,
Mix stab = 15.5 min, MTI = 17 FU

Water abs = 62.8%
Mix time = 4.1 min

14-2410, Jagalene (CC10)





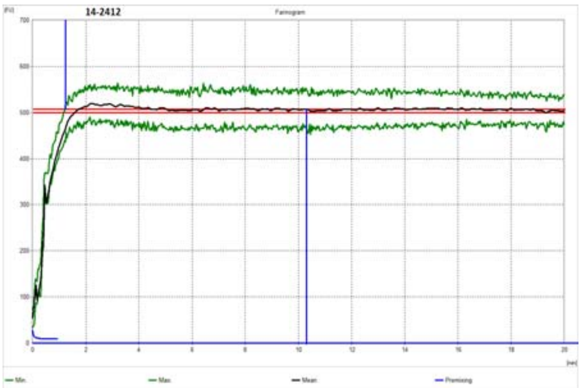
Water abs = 53.4%, Peak time = 2.7 min,
Mix stab = 17.3 min, MTI = 20 FU

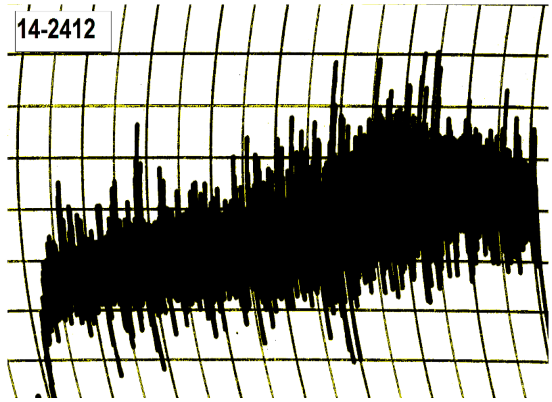
Water abs = 61.2%
Mix time = 5.6 min

14-2411, Byrd (IC)

Physical Dough Tests

2014 (Small Scale) Samples – Colorado

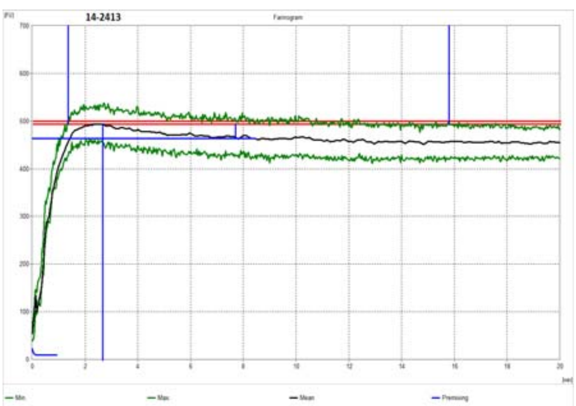


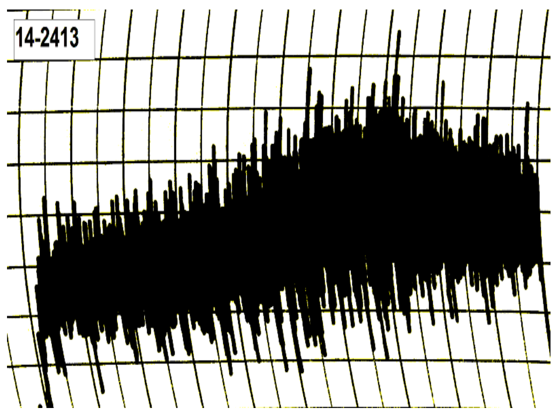


Water abs = 55.7%, Peak time = 10.3 min,
Mix stab = 30.7 min, MTI = 0 FU

Water abs = 61.4%
Mix time = 6.0 min

14-2412, CO11D174



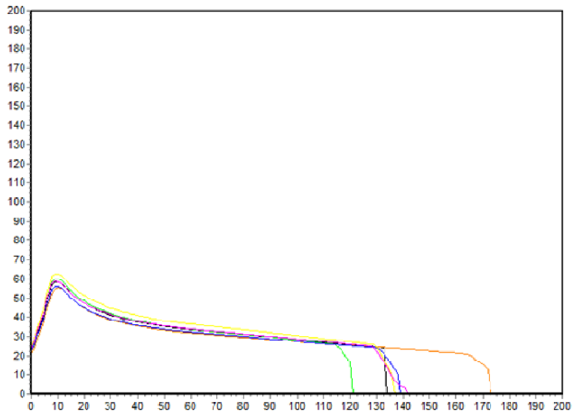


Water abs = 53.7%, Peak time = 2.7 min,
Mix stab = 14.4 min, MTI = 27 FU

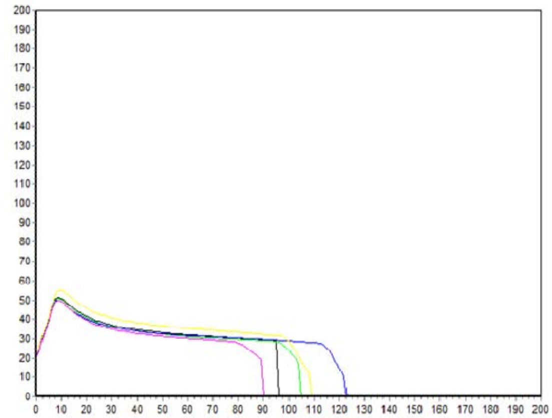
Water abs = 60.7%
Mix time = 7.0 min

14-2413, CO11D446

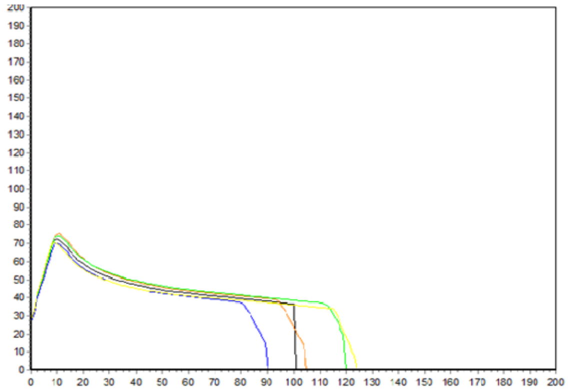
Physical Dough Tests - Alveograph
2014 (Small Scale) Samples – Colorado



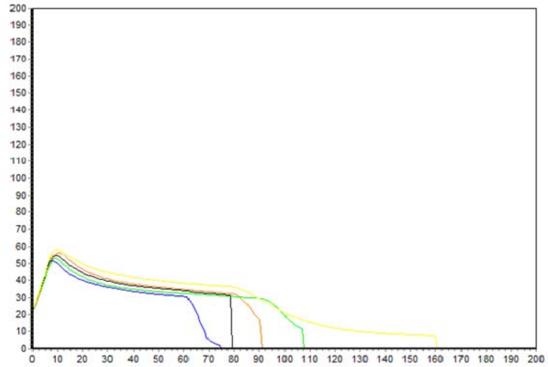
14-2410, Jagalene (CC10)
P (mm $H_2$0) = 64, L (mm) = 133, W ($10E^{-4}$J) = 301



14-2411, Byrd (IC)
P (mm $H_2$0) = 56, L (mm) = 95, W ($10E^{-4}$J) = 218

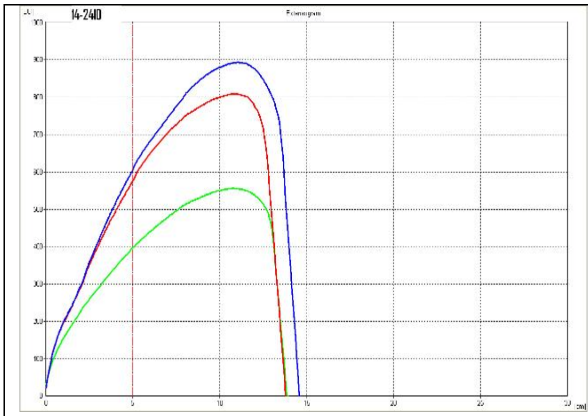


14-2412, CO11D174
P (mm $H_2$0) = 80, L (mm) = 100, W ($10E^{-4}$J) = 307

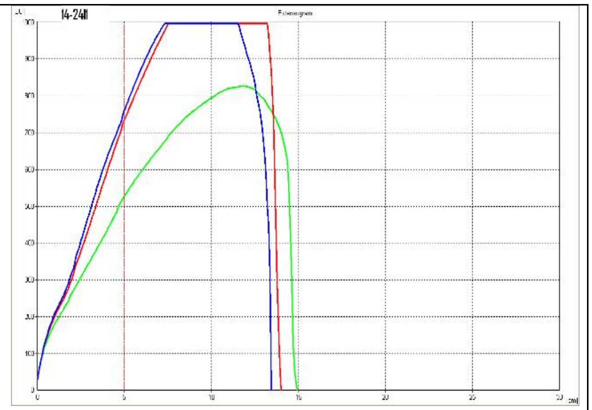


14-2413, CO11D446
P (mm $H_2$0) = 60, L (mm) = 78, W ($10E^{-4}$J) = 197

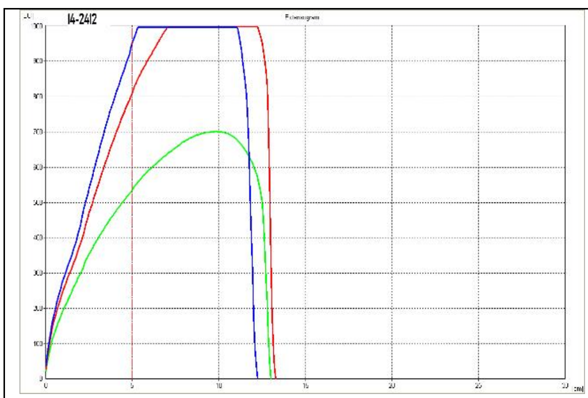
Physical Dough Tests - Extensigraph
2014 (Small Scale) Samples – Colorado



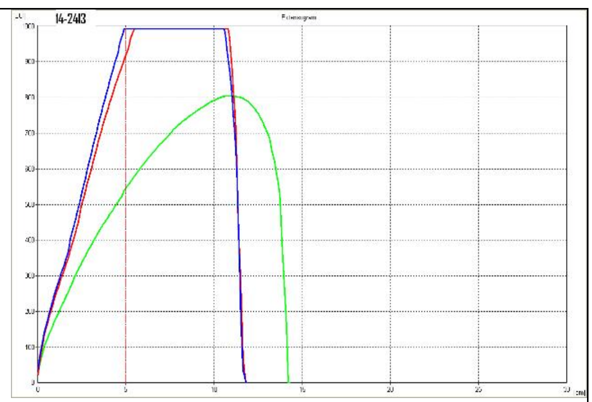
14-2410 Jagalene (CC10)
R (BU) = 579, E (mm) = 139, W (cm^2) = 138
Rmax (BU) = 808, Ratio = 4.16 at 90 min



14-2411 Byrd (IC)
R (BU) = 740, E (mm) = 140, W (cm^2) = 183,
Rmax (BU) = 996, Ratio = 5.28 at 90 min



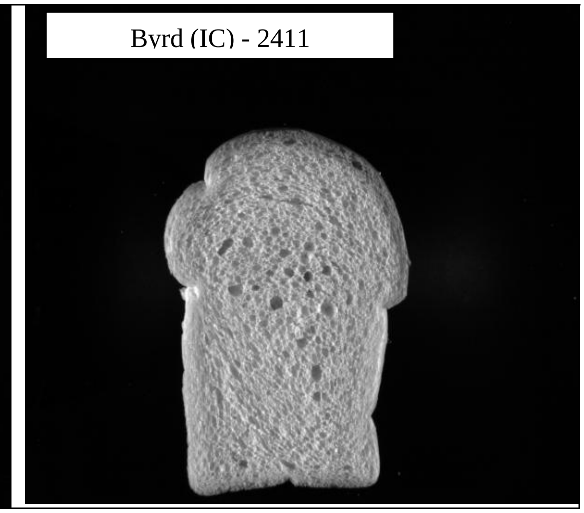
14-2412 CO11D174
R (BU) = 818, E (mm) = 133, W (cm^2) = 179
Rmax (BU) = 998, Ratio = 6.15 at 90 min



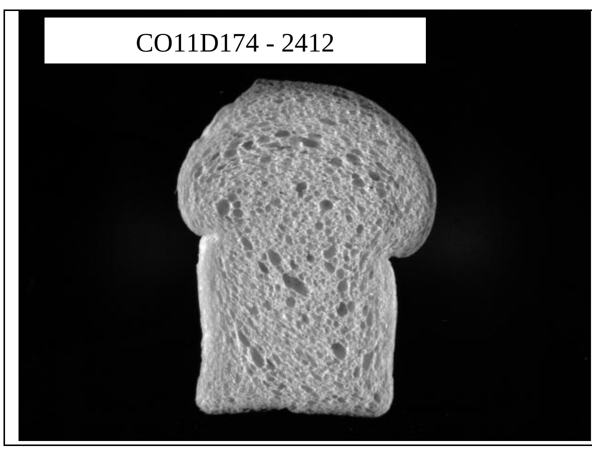
14-2413 CO11D446
R (BU) = 925, E (mm) = 118, W (cm^2) = 156,
Rmax (BU) = 993, Ratio = 7.83 at 90 min

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.

Colorado: C-Cell Bread Images and Analysis for 2014 (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	6859	146.4	4327	0.44	2.027	2.140	1.643	-22.28
2411	6724	147.4	4294	0.436	1.881	1.885	1.620	-17.08



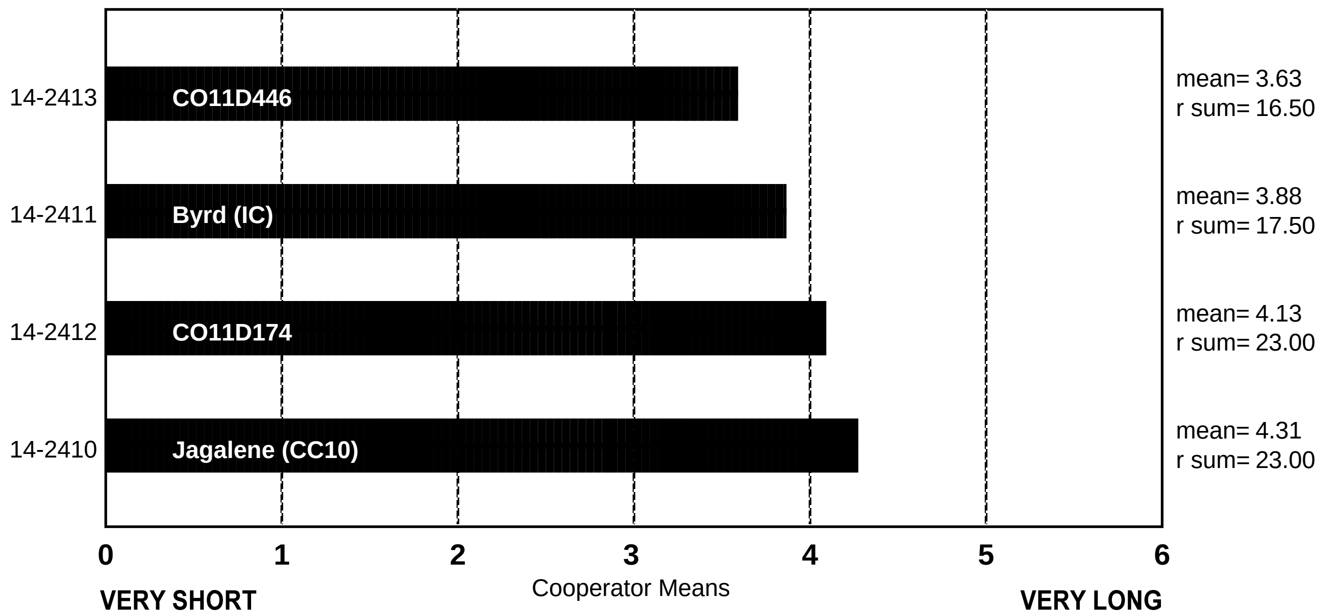
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2412	7135	148.8	4267	0.452	2.116	3.249	1.638	-25.10
2413	6750	149.8	4239	0.442	1.960	1.970	1.648	29.55

SPONGE CHARACTERISTICS

(Small Scale) Colorado

ncoop= 8
chisq= 2.74
chisqc= 5.76
cvchisq= 7.82
crdiff=

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

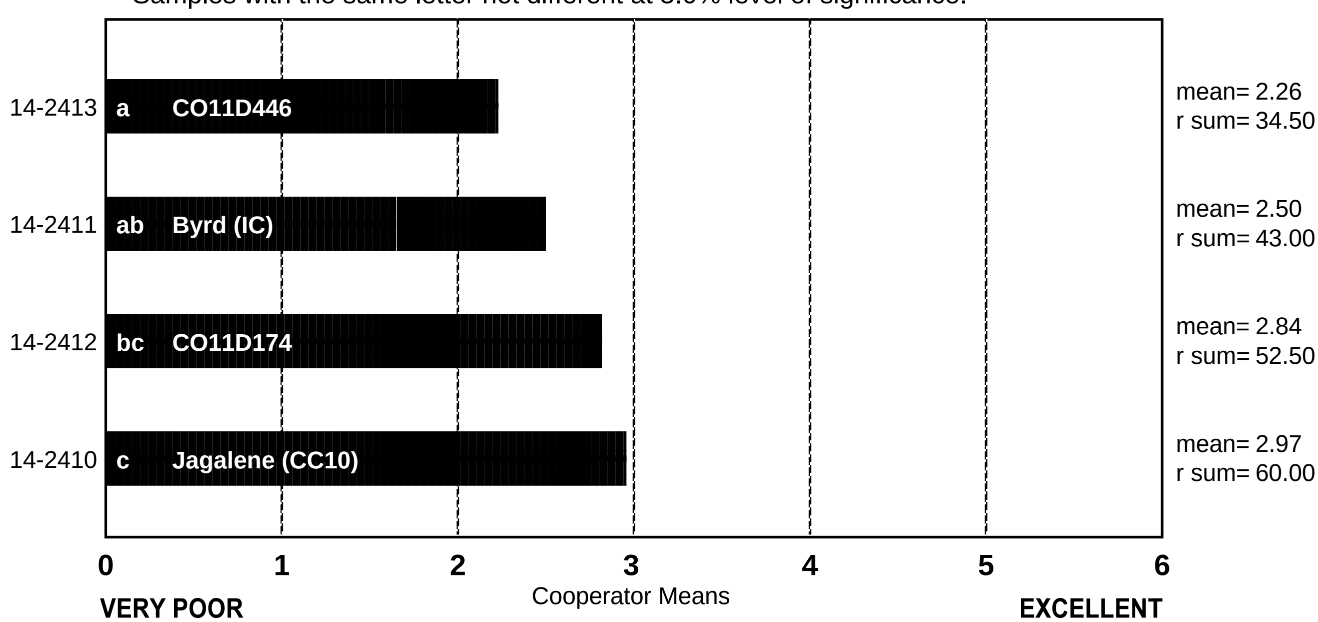


BAKE ABSORPTION

(Small Scale) Colorado

ncoop= 19
chisq= 11.70
chisqc= 17.37
cvchisq= 7.82
crdiff= 11.23

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Colorado

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2410 Jagalene (CC10)	**56.8**	**62.7**	**61.5**	**64.1**	**60.5**	**62.0**	**60.0**	**56.8**	**58.0**	**65.1**	**62.0**	**62.1**	**59.4**	**63.0**	**65.0**	**58.0**	**59.5**	**62.4**	**59.0**
14-2411 Byrd (IC)	**56.2**	**61.7**	**60.3**	**64.5**	**60.8**	**61.5**	**54.5**	**53.4**	**57.0**	**60.7**	**60.0**	**59.5**	**55.6**	**61.0**	**63.0**	**56.0**	**55.5**	**58.5**	**56.0**
14-2412 CO11D174	**57.1**	**62.4**	**60.8**	**66.0**	**60.0**	**61.0**	**60.5**	**55.7**	**57.0**	**59.9**	**61.0**	**62.2**	**57.2**	**61.2**	**63.0**	**58.0**	**57.0**	**60.2**	**57.0**
14-2413 CO11D446	**54.7**	**61.1**	**59.7**	**62.9**	**60.0**	**60.0**	**55.0**	**53.7**	**57.0**	**61.3**	**60.0**	**60.6**	**55.8**	**60.9**	**63.0**	**56.0**	**56.0**	**58.8**	**56.0**

BAKE MIX TIME, ACTUAL

(Small Scale) Colorado

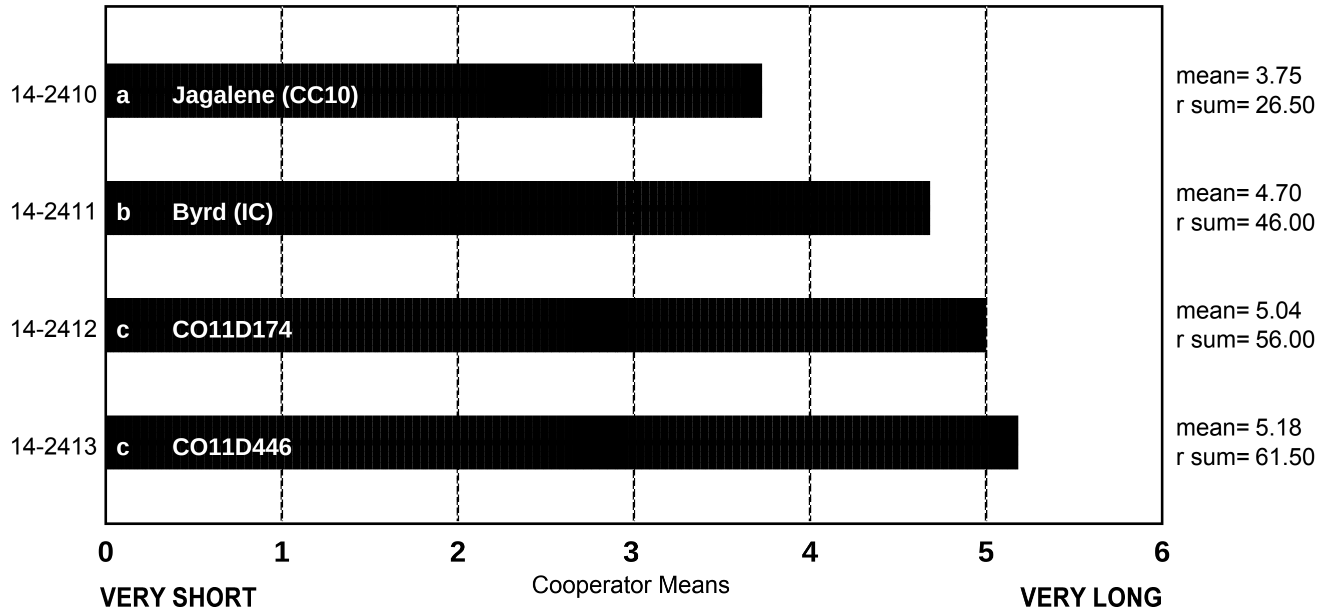
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2410 Jagalene (CC10)	**3.5**	**4.0**	**3.2**	**6.3**	**4.8**	**3.1**	**21.0**	**6.0**	**11.0**	**5.0**	**9.0**	**6.3**	**7.0**	**4.1**	**3.8**	**22.0**	**11.0**	**8.5**	**5.0**
14-2411 Byrd (IC)	**4.5**	**6.3**	**4.5**	**6.4**	**7.6**	**4.0**	**30.0**	**6.0**	**18.0**	**7.5**	**9.0**	**8.5**	**6.0**	**5.4**	**6.0**	**25.0**	**12.0**	**8.0**	**6.0**
14-2412 CO11D174	**4.5**	**6.3**	**4.5**	**7.4**	**8.5**	**4.1**	**30.0**	**15.0**	**20.0**	**6.0**	**9.0**	**9.0**	**7.0**	**6.0**	**6.0**	**25.0**	**11.0**	**15.0**	**10.0**
14-2413 CO11D446	**4.5**	**7.0**	**5.2**	**7.7**	**9.2**	**4.4**	**30.0**	**12.0**	**20.0**	**8.0**	**9.0**	**10.0**	**7.0**	**4.9**	**7.8**	**25.0**	**14.0**	**11.5**	**12.0**

BAKE MIX TIME

(Small Scale) Colorado

ncoop= 19
chisq= 22.47
chisqc= 32.84
cvchisq= 7.82
crdiff= 8.84

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

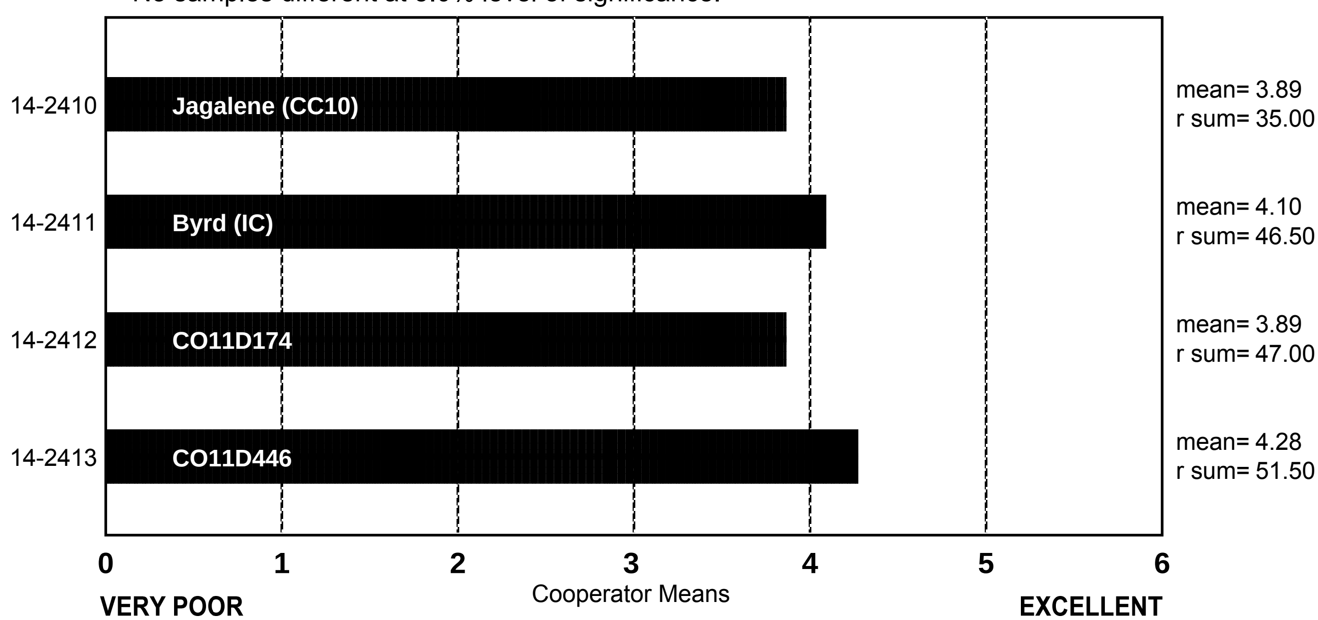


MIXING TOLERANCE

(Small Scale) Colorado

ncoop= 18
chisq= 4.95
chisqc= 6.36
cvchisq= 7.82
crdiff=

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

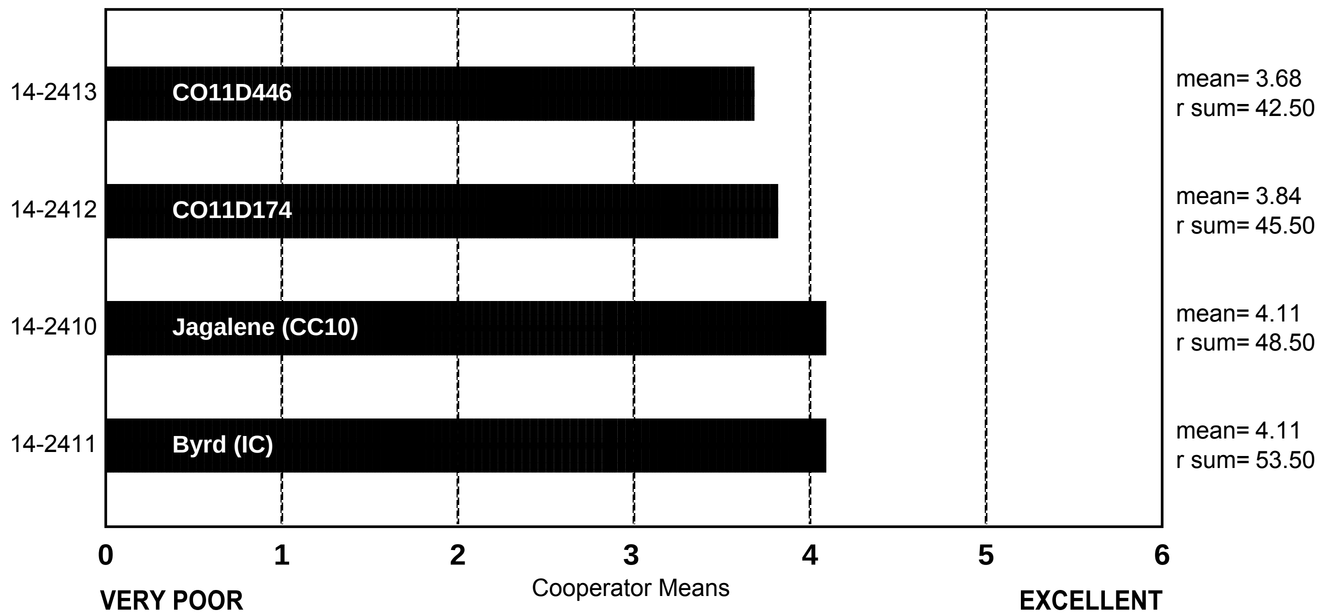


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Colorado

ncoop= 19
chisq= 2.08
chisqc= 2.81
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Colorado

	Sticky	Wet	Tough	Good	Excellent
14-2410 Jagalene (CC10)	2	2	2	12	1
14-2411 Byrd (IC)	1	2	4	8	4
14-2412 CO11D174	2	0	7	9	1
14-2413 CO11D446	1	2	10	6	0

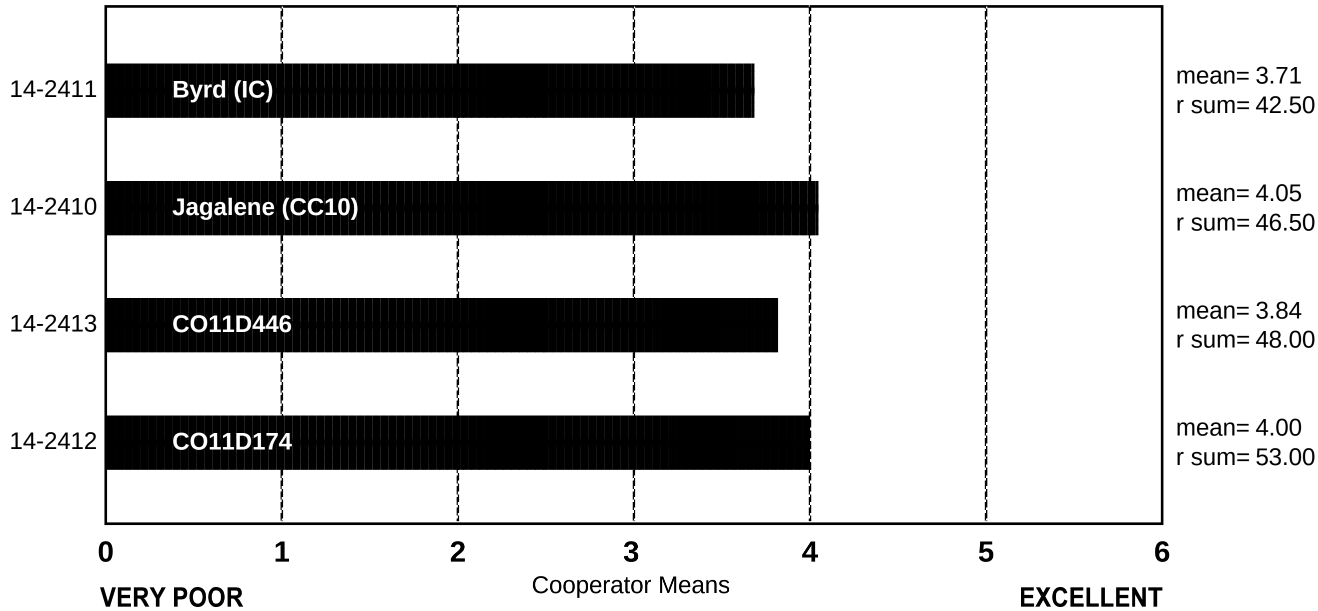
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Colorado

ncoop= 19
chisq= 1.78
chisqc= 2.35
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Colorado

	Sticky	Wet	Tough	Good	Excellent
14-2410 Jagalene (CC10)	**0**	**3**	**1**	**14**	**1**
14-2411 Byrd (IC)	**2**	**3**	**3**	**9**	**2**
14-2412 CO11D174	**1**	**0**	**4**	**14**	**0**
14-2413 CO11D446	**1**	**3**	**5**	**9**	**1**

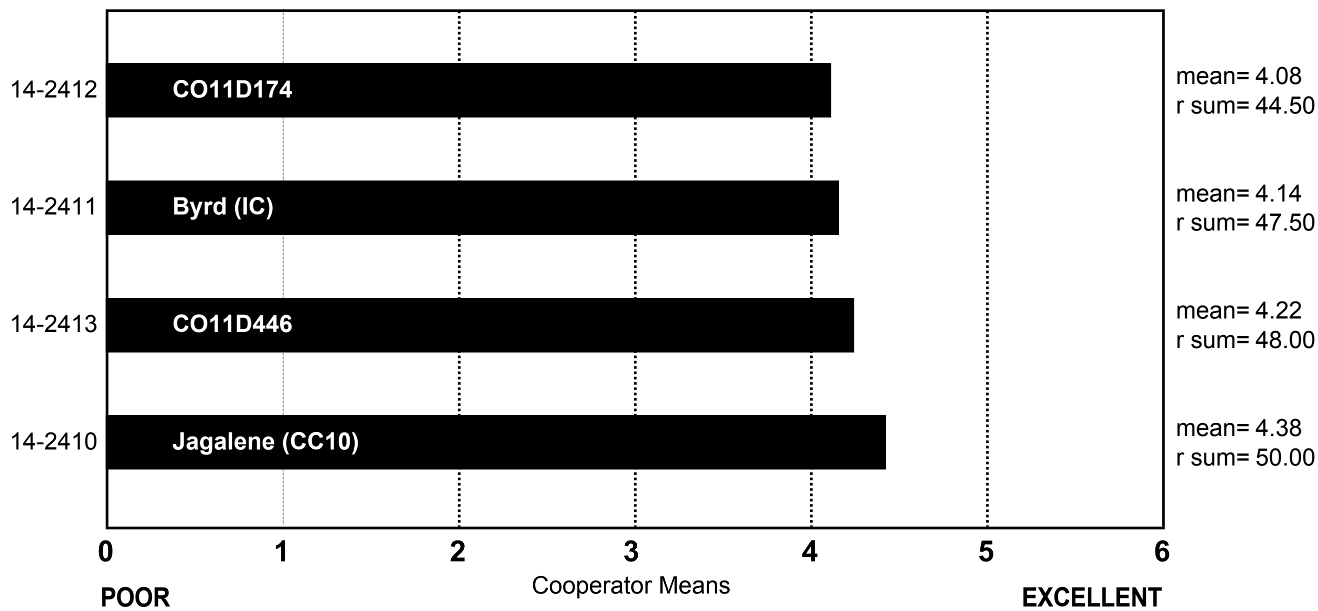
Frequency Table

CRUMB GRAIN

(Small Scale) Colorado

ncoop= 19
chisq= 0.49
chisqc= 0.65
cvchisq= 7.82
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Colorado

	Open	Fine	Dense
14-2410 Jagalene (CC10)	5	11	3
14-2411 Byrd (IC)	6	11	2
14-2412 CO11D174	7	11	1
14-2413 CO11D446	5	13	1

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Colorado

	Round	Irregular	Elongated
14-2410 Jagalene (CC10)	**3**	**8**	**8**
14-2411 Byrd (IC)	**4**	**6**	**9**
14-2412 CO11D174	**4**	**10**	**5**
14-2413 CO11D446	**2**	**7**	**10**

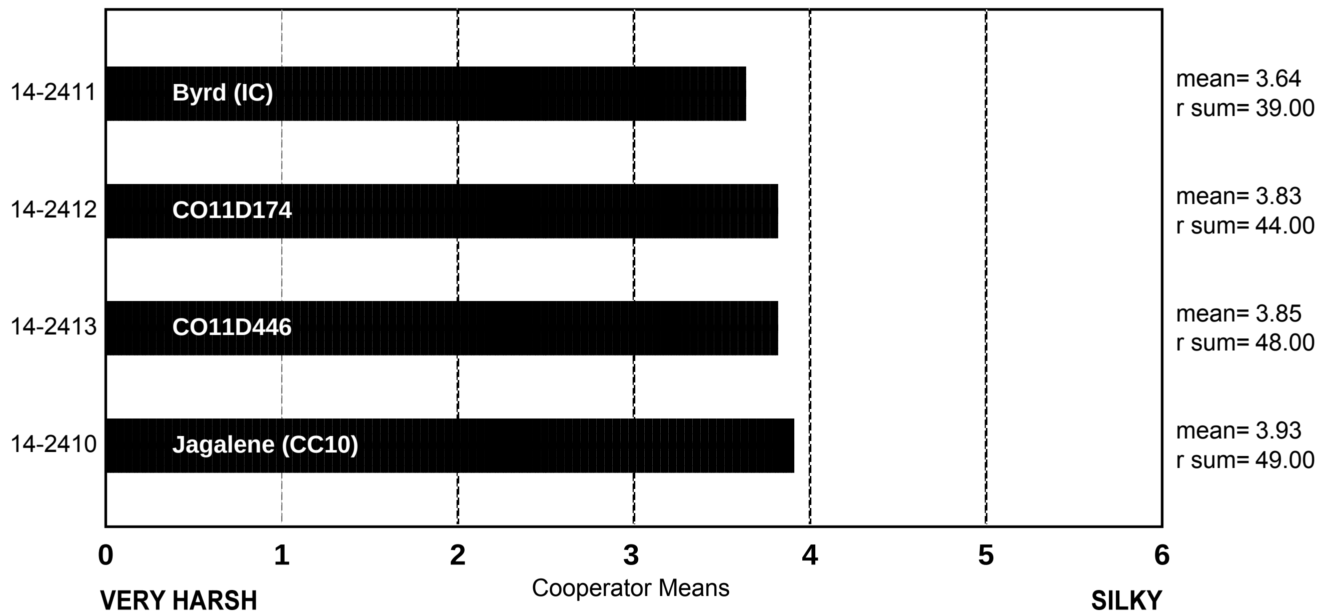
Frequency Table

CRUMB TEXTURE

(Small Scale) Colorado

ncoop= 18
chisq= 2.07
chisqc= 3.32
cvchisq= 7.82
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Colorado

	Harsh	Smooth	Silky
14-2410 Jagalene (CC10)	4	10	4
14-2411 Byrd (IC)	8	8	2
14-2412 CO11D174	5	9	4
14-2413 CO11D446	3	12	3

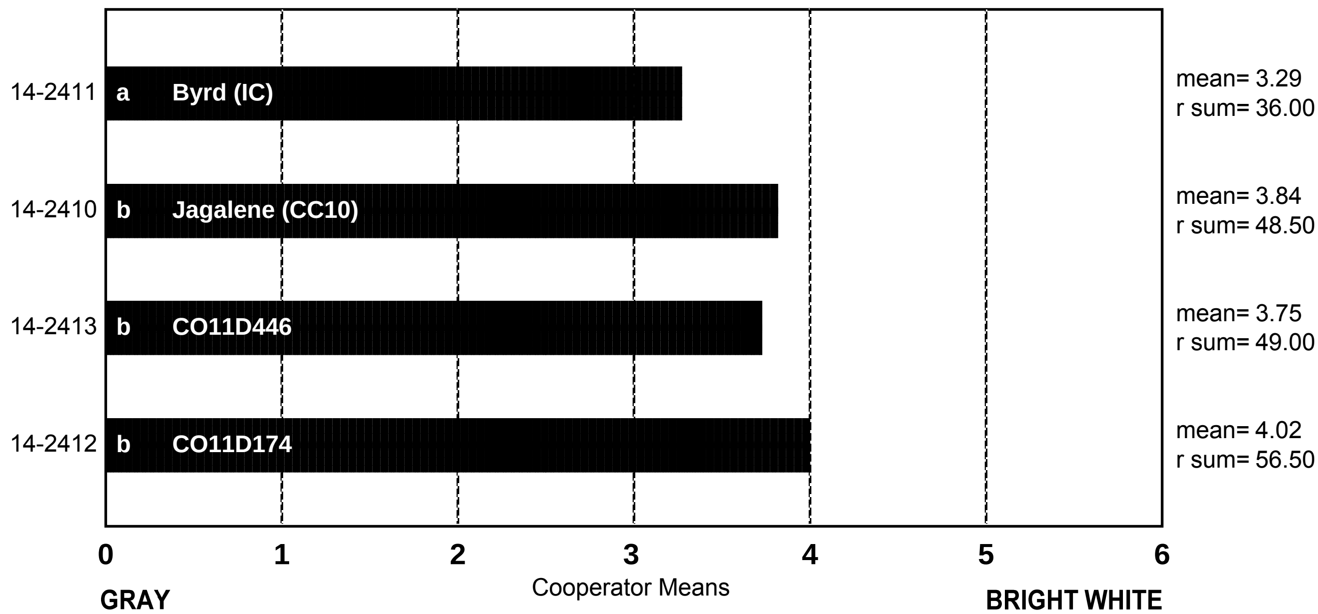
Frequency Table

CRUMB COLOR

(Small Scale) Colorado

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

ncoop= 19
chisq= 6.84
chisqc= 13.97
cvchisq= 7.82
crdiff= 9.98



CRUMB COLOR, DESCRIBED

(Small Scale) Colorado

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
14-2410 Jagalene (CC10)	**0**	**0**	**3**	**1**	**12**	**2**	**1**
14-2411 Byrd (IC)	**0**	**0**	**6**	**2**	**9**	**2**	**0**
14-2412 CO11D174	**0**	**0**	**2**	**2**	**10**	**4**	**1**
14-2413 CO11D446	**0**	**0**	**3**	**2**	**12**	**2**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Colorado

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2410 Jagalene (CC10)	126.6	138.6	141.3	151.9	136.5	135.5	463.2	464.8	414.0	726.7	134.0	147.7	461.7	135.6	137.8	472.2	455.0	453.5	485.6
14-2411 Byrd (IC)	125.1	136.8	139.3	152.0	134.3	136.5	466.4	466.6	415.0	734.7	134.0	145.2	464.8	138.2	140.2	474.0	454.0	452.7	485.3
14-2412 CO11D174	127.0	137.3	139.8	154.7	135.6	134.2	457.7	465.7	412.0	712.0	134.0	148.9	459.6	138.5	142.1	457.8	462.0	449.4	485.3
14-2413 CO11D446	126.1	138.3	139.4	153.8	134.9	135.6	458.8	467.3	412.0	708.4	134.0	146.4	457.9	136.6	139.4	485.1	460.0	450.5	485.4

LOAF VOLUME, ACTUAL

(Small Scale) Colorado

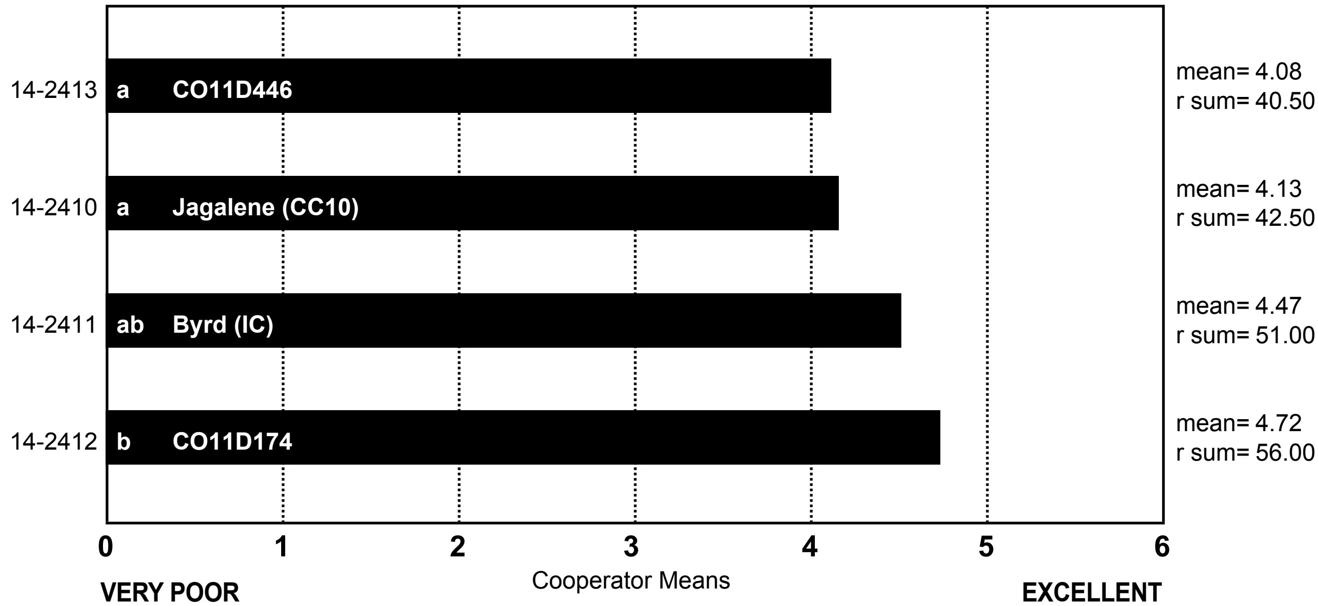
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2410 Jagalene (CC10)	**730**	**1135**	**1020**	**948**	**973**	**885**	**2700**	**2600**	**3050**	**4350**	**943**	**1095**	**2525**	**878**	**925**	**3104**	**2350**	**2550**	**2550**
14-2411 Byrd (IC)	**845**	**1160**	**1095**	**975**	**953**	**925**	**2775**	**2600**	**3050**	**4130**	**963**	**925**	**2550**	**882**	**963**	**3104**	**2100**	**2600**	**2750**
14-2412 CO11D174	**730**	**1215**	**1115**	**1085**	**1008**	**970**	**2900**	**2563**	**3100**	**4005**	**980**	**1025**	**2475**	**868**	**1073**	**3104**	**2350**	**2550**	**2638**
14-2413 CO11D446	**705**	**1120**	**1015**	**965**	**975**	**815**	**2825**	**2550**	**3150**	**4130**	**928**	**935**	**2550**	**861**	**945**	**3104**	**2225**	**2475**	**2638**

LOAF VOLUME

(Small Scale) Colorado

ncoop= 19
chisq= 5.01
chisqc= 8.27
cvchisq= 7.82
crdiff= 11.80

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

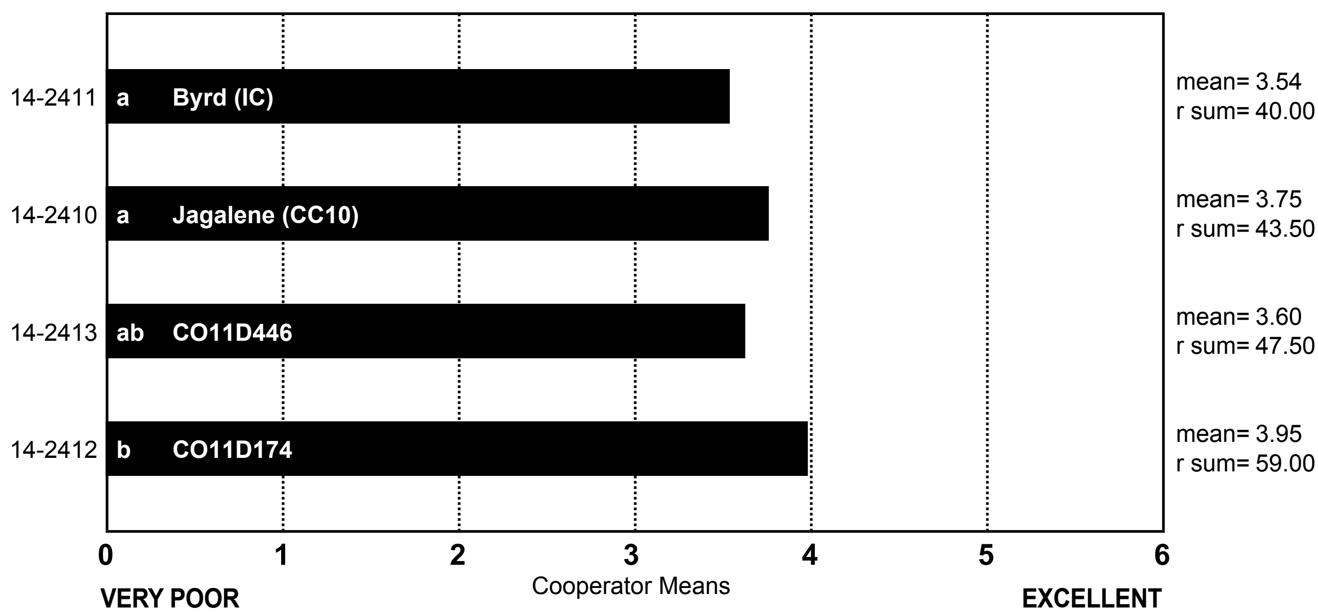


OVERALL BAKING QUALITY

(Small Scale) Colorado

ncoop= 19
chisq= 6.46
chisqc= 8.35
cvchisq= 7.82
crdiff= 13.34

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



COOPERATOR'S COMMENTS
(Small Scale) Colorado

COOP. 14-2410 Jagalene (CC10)

A. Rubbery, elastic/pliable, slight body to dough.
B. Excellent loaf externals.
C. No comment.
D. Good dough.
E. Low water absorption, normal mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, fine elongated cells, smooth & resilient texture.
F. Overall acceptable line.
G. No comment.
H. Low absorption, average mix, average volume, yellow, open grain.
I. Low protein, shortest mix, good out of mixer.
J. No comment.
K. Good bake performance, slightly low volume.
L. Amazing and excellent loaf volume for the protein, excellent crumb grain.
M. No comment.
N. 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
O. No comment.
P. Low absorption, open, irregular grain, excellent volume.
Q. Tough and bucky.
R. Excellent mix time, excellent dough, great volume, dense grain.
S. Short mix time, average volume.

COOP. 14-2411 Byrd (IC)

A. Lower bake absorption, smooth, elastic/pliable, moist, nice oven spring.
B. Long time to pick-up, excellent loaf externals.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Low water absorption, long mix time, slight sticky & weak dough, very high OS & volume, yellow crumb, open & elongated cells, smooth & resilient texture.
F. Good volume for protein, yellow crumb.
G. No comment.
H. Low absorption, average mix, average volume, dull, open grain.
I. Long mix, good volume, slightly dull.
J. No comment.
K. Very dense grain, slightly tough at make up.
L. Lower bake absorption, long mix time, satisfactory crumb grain, yellow crumb color.
M. No comment.
N. 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

O. No comment.
P. Very low absorption, very strong doughs, good interiors and volume.
Q. Thick, dark crust, yellow crumb color.
R. Excellent mix time, dough was excellent, excellent volume, good crumb score.
S. Very low absorption, average mix time, very fine grain, very high volume.

COOP. 14-2412 CO11D174

A. Rubbery, elastic with little oven spring.
B. Long time to pick-up, right side break.
C. 1 large hole.
D. Good dough properties and bake performance for protein level.
E. Low water absorption, long mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, fine & elongated cells, very smooth & resilient texture.
F. Good volume for protein.
G. No comment.
H. Low absorption, long mix, average volume, dull, open grain.
I. Very long mix, tough and bucky dough, slightly dull.
J. Low absorption but overall fairly good quality.
K. Great bake performance, best of set.
L. Good bake absorption, good dough at pan, satisfactory crumb grain, yellow crumb color, with long mix time, amazing loaf volume for the protein.
M. No comment.
N. 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
O. No comment.
P. Low absorption, slightly open grain, excellent volume.
Q. Rough texture.
R. Long mix time, dough was good, excellent volume, good grain score.
S. Very low absorption, good grain, good volume.

COOP. 14-2413 CO11D446

A. Lower flour protein and low bake absorption, went from dense and rubbery at mixing to very pliable at panning.
B. Long time to pick-up, rough break.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Low water absorption, long mix time, slight sticky & strong dough, very high OS & volume, yellow crumb, open & elongated cells, smooth & resilient texture.
F. Low protein and loaf volume.
G. No comment.
H. Low absorption, above average mix, average volume, dull, open grain.
I. Very long mix, tough and bucky dough, slightly dull.

J. No comment.
K. Good bake performance, slightly better than check.
L. Good crust color, good dough at pan, excellent crumb grain with high loaf volume, nice mixograph, long mix time.
M. No comment.
N. 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
O. No comment.
P. Very low absorption, good interior scores, excellent volume.
Q. Thick crust, light colored crust, shelled break and shred.
R. Long mix time, dough was good, average volume, good grain score.
S. Very low absorption, long mix time, fine grain, good volume.

Notes: **G, H, I, K, P, Q, R and S** conducted sponge and dough bake tests

NEBRASKA

14-2414	Jagalene (CC14)
14-2415	Camelot (IC)
14-2416	NE07531
14-2417	NE09521

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 2013-2014 growing season would be considered being much better than in the previous years. Sidney was planted and then had a heavy rain which hurt emergence. Stands were further reduced by some winterklling, but that did not affect our advanced lines. North Platte had good growing conditions throughout the year, but was affected by Cephalosproium stripe (a relatively rare soil borne disease). Mead had excellent yields, but heavy rains throughout grainfill. While leaf rust was present, the main disease was bacterial streak which cannot be controlled by fungicides.

Data from the State Variety Trial:

	Mead	N.Plattte	Sidney
	Yield	Yield	Yield
	Bu/a	Bu/a	Bu/a
NE09521	55	41	44
Camelot	53	36	48
NE07531	43	45	40
Nursery mean	**49**	44	40
LSD (P=.05%)	**5**	8	8

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.

NE07531

NE07531 is derived from the cross HBA142A/HBZ//Ale (=HBK0630-4-5)/3/NE98574 (=CO850267/Rawhide)/4/Hallam. The HB… lines were lines gifted to Kansas State University by Pioneer when Pioneer reduced its hard red winter wheat breeding effort. NE07531 is a moderately tall, semi-dwarf with average straw strength. It is moderately resistant to stem, leaf, and stripe rust, wheat soilborne mosaic virus, and acid soils. It is susceptible to wheat streak and triticum mosaic virus, and Hessian fly. It was tested in the NRPN in 2010 and 2011 (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). NE07531 seems best suited for south central and southwestern Nebraska, though it may also have potential for irrigated production in western Nebraska. 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), NE07531 is considered as being moderately resistant for scab reaction and susceptible for DON accumulation.

Camelot (Internal Check)

The internal 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.

Jagalene (Common Check)

Nebraska: 2014 (Small-Scale) Samples

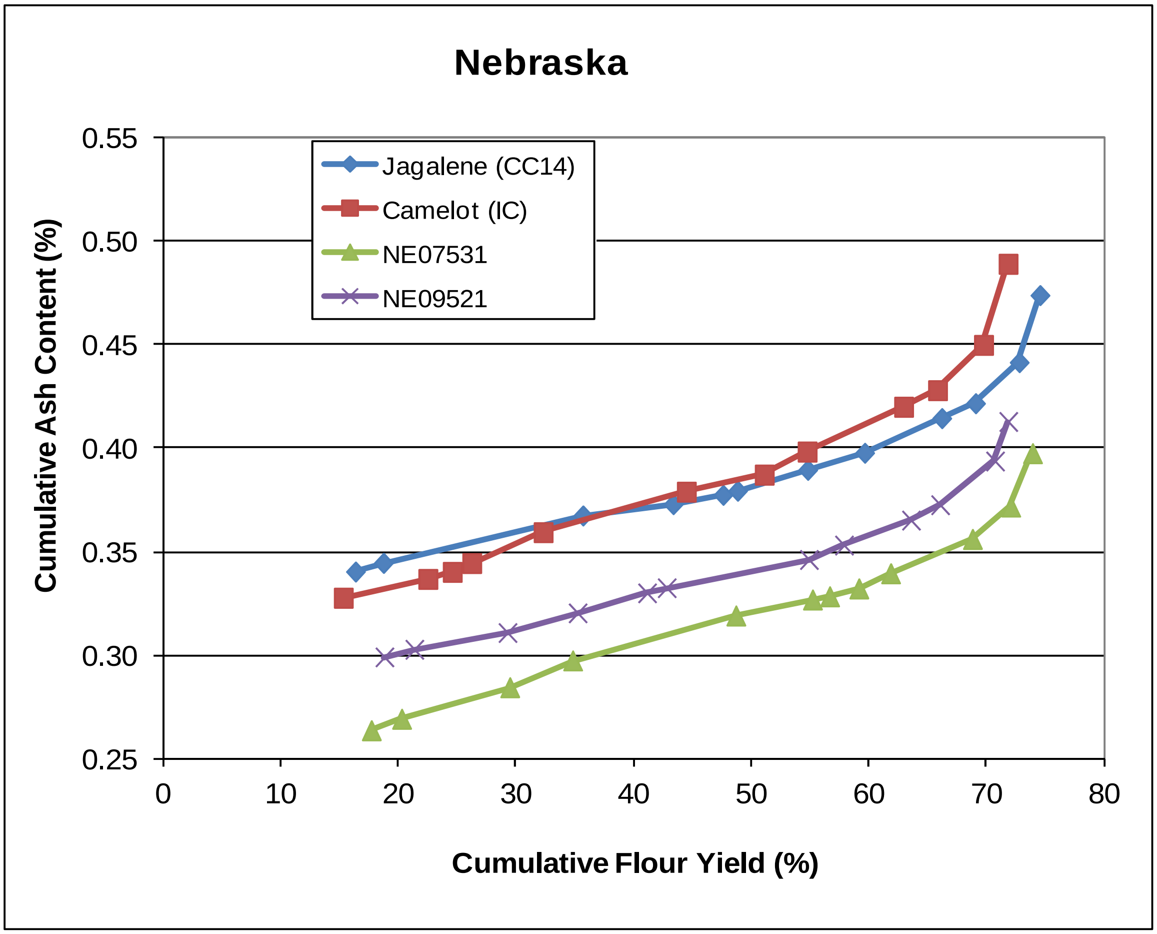
Test entry number	14-2414	14-2415	14-2416	14-2417
Sample identification	**Jagalene (CC14)**	**Camelot (IC)**	**NE07531**	**NE09521**
Wheat Data				
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW
Test weight (lb/bu) **Hectoliter weight (kg/hl)**	60.8 80.0	60.5 79.6	61.6 81.0	61.1 80.4
1000 kernel weight (gm)	33.5	36.1	32.7	32.8
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 76.0 23.6 0.4	 84.1 15.8 0.1	 77.3 22.6 0.1	 72.8 26.8 0.4
Single kernel (skcs)[a] Hardness (avg /s.d) Weight (mg) (avg/s.d) Diameter (mm)(avg/s.d) Moisture (%) (avg/s.d) SKCS distribution Classification	 62.5/17.6 33.5/9.4 2.80/0.36 12.3/0.5 05-12-25-58-01 Hard	 59.7/16.7 36.1/8.9 2.86/0.32 12.5/0.4 06-11-30-53-02 Hard	 58.0/17.1 32.7/8.3 2.71/0.37 11.5/0.4 04-19-33-44-01 Hard	 61.5/16.4 32.8/9.4 2.69/0.35 11.9/0.5 05-09-26-60-01 Hard
Wheat protein (12% mb) **Wheat ash (12% mb)**	14.2 1.51	14.5 1.62	13.3 1.41	13.1 1.39
Milling and Flour Quality Data				
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 74.1 71.5	 72.0 66.6	 74.6 71.1	 71.9 68.9
Flour moisture (%) **Flour protein (14% mb)** **Flour ash (14% mb)**	11.9 12.7 0.43	12.8 12.9 0.45	12.5 11.8 0.36	11.3 11.9 0.39
Rapid Visco-Analyser Peak Time (min) Peak Viscosity (RVU) Breakdown (RVU) Final Viscosity at 13 min (RVU)	 6.1 199.8 69.4 245.8	 6.2 181.8 53.1 239.3	 6.3 235.5 72.4 290.6	 6.2 208.2 71.8 247.9
Minolta color meter L* a* b* **PPO**	 92.34 -1.72 10.01 0.511	 92.46 -1.10 7.55 0.612	 92.83 -1.75 9.62 0.661	 92.90 -1.42 8.43 0.221
Falling number (sec)	481	482	506	471
Damaged Starch (AI%) (AACC76-31)	 96.23 6.45	 94.70 5.31	 95.35 5.78	 95.09 5.59

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

Nebraska: Physical Dough Tests and Gluten Analysis
For 2014 (Small-Scale) Samples

Test Entry Number	14-2414	14-2415	14-2416	14-2417
Sample Identification	Jagalene (CC14)	Camelot (IC)	NE07531	NE09521
MIXOGRAPH				
Flour Abs (% as-is)	67.2	66.7	64.9	66.0
Flour Abs (14% mb)	64.3	64.5	62.9	63.0
Mix Time (min)	5.5	3.3	4.5	4.0
Mix tolerance (0-6)	5	3	4	4
FARINOGRAPH				
Flour Abs (% as-is)	58.0	57.7	56.8	59.8
Flour Abs (14% mb)	55.1	55.5	54.7	56.6
Development time (min)	10.2	8.0	8.4	8.0
Mix stability (min)	26.3	11.7	26.8	19.1
Mix Tolerance Index (FU)	8	23	13	20
Breakdown time (min)	28.0	14.1	28.5	16.0
ALVEOGRAPH				
P(mm): Tenacity	70	61	56	57
L(mm): Extensibility	110	165	117	157
G(mm): Swelling index	23.3	28.6	24.1	27.9
W(10^{-4} J): strength (curve area)	319	337	248	308
P/L: curve configuration ratio	0.64	0.37	0.48	0.36
Ie(P_{200}/P): elasticity index	71.8	65.1	64.5	63.7
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	618/924/902	344/411/422	442/623/674	377/442/554
Extensibility (mm at 45/90/135 min)	157/127/135	188/195/188	169/148/147	164/170/169
Energy (cm^2 at 45/90/135 min)	192/174/184	139/174/172	149/174/182	124/161/194
Resist $_{max}$ (BU at 45/90/135 min)	982/993/1000	561/689/724	709/946/999	600/785/920
Ratio (at 45/90/135 min)	3.93/7.26/6.71	1.83/2.11/2.25	2.61/4.21/4.58	2.31/2.60/3.27
PROTEIN ANALYSIS				
HMW-GS Composition	1/2*, 17+18, 5+10	NULL, 7+9, 5+10	2*, 7+9, 5+10	1, 7+8, 5+10
%IPP	51.80	43.69	48.14	46.58
SEDIMENTATION TEST				
Volume (ml)	68.9	67.0	69.6	65.9

Nebraska: Cumulative Ash Curves



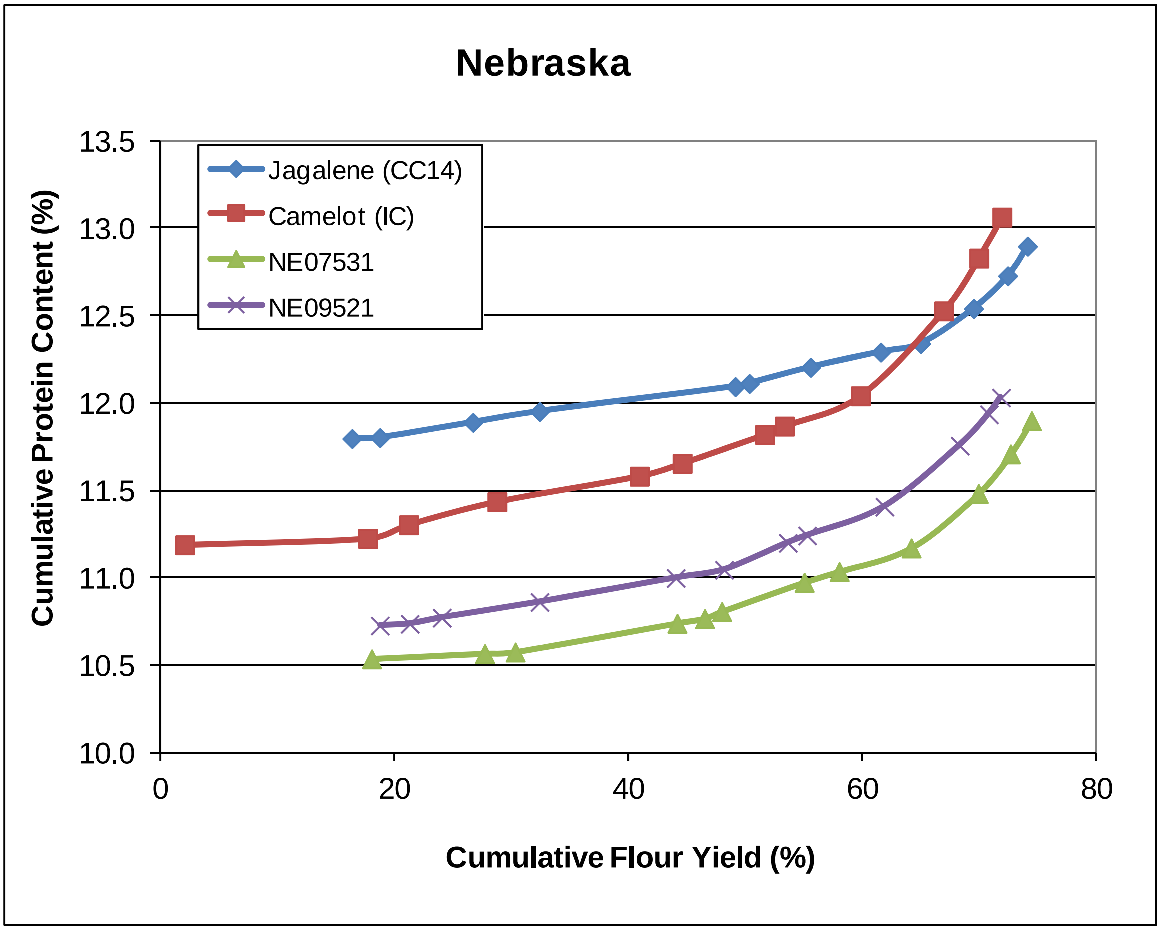
Jagalene (CC14)				
Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash
2M	16.30	0.34	16.30	0.34
1M Red	2.38	0.37	18.68	0.34
3M	16.95	0.39	35.63	0.37
1M	7.67	0.40	43.30	0.37
2BK	4.24	0.42	47.53	0.38
Grader	1.23	0.46	48.77	0.38
4M	5.96	0.47	54.73	0.39
1BK	4.84	0.49	59.57	0.40
FILTER FLR	6.55	0.57	66.12	0.41
3BK	2.87	0.59	68.99	0.42
5M	3.71	0.81	72.70	0.44
BRAN FLR	1.76	1.81	74.47	0.47
Break Shorts	1.80	3.86	76.27	0.55
Red Dog	2.25	2.80	78.51	0.62
Red Shorts	0.32	4.11	78.83	0.63
Filter Bran	2.55	3.04	81.38	0.71
Bran	18.62	5.69	100.0	1.64
Wheat		1.48		
St. Grd. Fl.		0.43		

Camelot (IC)				
Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash
2M	15.27	0.33	15.27	0.33
1M	7.18	0.36	22.45	0.34
1M Red	2.08	0.38	24.53	0.34
Grader	1.65	0.41	26.18	0.34
1BK	6.07	0.42	32.25	0.36
3M	12.17	0.43	44.42	0.38
2BK	6.62	0.44	51.04	0.39
4M	3.65	0.55	54.69	0.40
FILTER FLR	8.19	0.56	62.88	0.42
3BK	2.89	0.60	65.77	0.43
5M	3.91	0.82	69.67	0.45
BRAN FLR	2.08	1.80	71.76	0.49
Break Shorts	2.03	3.77	73.79	0.58
Red Dog	2.08	2.19	75.87	0.62
Red Shorts	0.32	3.89	76.19	0.64
Filter Bran	4.09	1.82	80.28	0.70
Bran	19.72	5.78	100.0	1.70
		1.59		
		0.45		

NE07531				
Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash
2M	17.65	0.26	17.65	0.26
1M Red	2.58	0.31	20.22	0.27
1M	9.19	0.32	29.41	0.28
2BK	5.35	0.37	34.76	0.30
3M	13.86	0.37	48.63	0.32
1BK	6.51	0.38	55.14	0.33
Grader	1.46	0.39	56.59	0.33
4M	2.48	0.42	59.08	0.33
3BK	2.70	0.50	61.78	0.34
FILTER FLR	6.95	0.50	68.73	0.36
5M	3.26	0.70	71.99	0.37
BRAN FLR	1.85	1.40	73.84	0.40
Break Shorts	1.72	3.55	75.56	0.47
Red Dog	1.85	2.33	77.41	0.51
Red Shorts	0.41	3.76	77.82	0.53
Filter Bran	4.58	2.10	82.40	0.62
Bran	17.60	5.05	100.0	1.40
		1.37		
		0.36		

NE09521				
Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash
2M	18.8	0.30	18.8	0.30
1M Red	2.5	0.33	21.3	0.30
1M	7.9	0.33	29.2	0.31
1BK	6.0	0.37	35.2	0.32
2BK	5.9	0.39	41.1	0.33
Grader	1.7	0.39	42.8	0.33
3M	12.1	0.39	54.8	0.35
4M	3.0	0.48	57.8	0.35
FILTER FLR	5.7	0.49	63.5	0.37
3BK	2.5	0.56	66.0	0.37
5M	4.7	0.69	70.7	0.39
BRAN FLR	1.1	1.62	71.8	0.41
Break Shorts	2.1	3.72	73.9	0.51
Red Dog	2.3	2.03	76.2	0.55
Red Shorts	0.4	3.78	76.6	0.57
Filter Bran	6.8	3.12	83.4	0.78
Bran	16.6	5.18	100.0	1.51
		1.35		
		0.39		

Nebraska: Cumulative Protein Curves



Jagalene (CC14)				
Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein
2M	16.41	11.80	16.41	11.80
1M Red	2.39	11.84	18.79	11.80
1M	7.94	12.10	26.74	11.89
4M	5.69	12.25	32.43	11.95
3M	16.72	12.37	49.15	12.09
Grader	1.21	12.84	50.36	12.11
1BK	5.23	13.10	55.59	12.21
FILTER FLR	5.99	13.10	61.57	12.29
5M	3.42	13.22	64.99	12.34
2BK	4.52	15.42	69.51	12.54
3BK	2.91	17.19	72.43	12.73
BRAN FLR	1.70	20.16	74.13	12.90
Break Shorts	1.79	16.80	75.92	12.99
Red Dog	1.96	15.87	77.88	13.06
Red Shorts	0.27	15.12	78.15	13.07
Filter Bran	2.33	14.87	80.48	13.12
Bran	19.52	17.73	100.00	14.02
Wheat		13.89		
St. Grd. Fl		12.66		

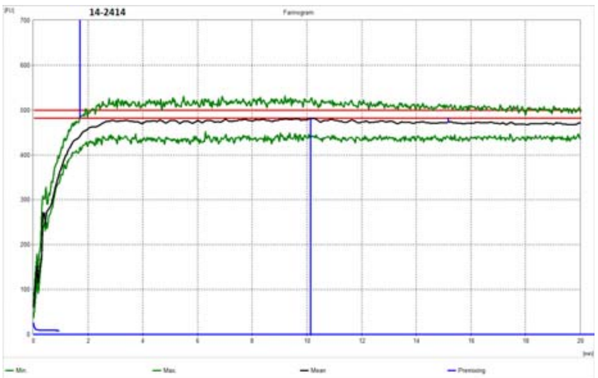
Camelot (IC)				
Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein
1M Red	2.13	11.19	2.13	11.19
2M	15.63	11.23	17.75	11.23
4M	3.50	11.70	21.26	11.30
1M	7.54	11.81	28.80	11.44
3M	12.17	11.93	40.96	11.58
5M	3.67	12.47	44.63	11.66
FILTER FLR	7.04	12.87	51.67	11.82
Grader	1.69	13.34	53.36	11.87
1BK	6.50	13.46	59.85	12.04
2BK	7.12	16.62	66.97	12.53
3BK	3.00	19.59	69.97	12.83
BRAN FLR	1.98	21.36	71.94	13.06
Break Shorts	2.10	16.75	74.04	13.17
Red Dog	1.87	14.64	75.92	13.21
Red Shorts	0.28	15.22	76.19	13.21
Filter Bran	3.57	13.59	79.77	13.23
Bran	20.23	17.21	100.00	14.03
		14.16		
		12.89		

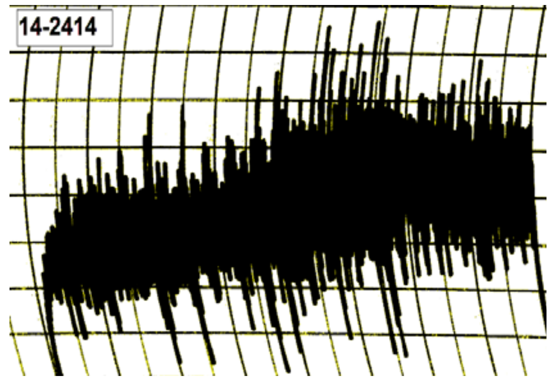
NE07531				
Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein
2M	18.09	10.54	18.09	10.54
1M	9.65	10.62	27.74	10.57
1M Red	2.61	10.67	30.35	10.58
3M	13.83	11.10	44.18	10.74
4M	2.35	11.27	46.54	10.77
Grader	1.46	12.09	48.00	10.81
1BK	7.05	12.11	55.05	10.97
5M	2.99	12.17	58.04	11.04
FILTER FLR	6.15	12.45	64.19	11.17
2BK	5.74	14.97	69.93	11.48
3BK	2.75	17.47	72.67	11.71
BRAN FLR	1.79	19.61	74.47	11.90
Break Shorts	1.76	16.71	76.22	12.01
Red Dog	1.63	14.99	77.86	12.07
Red Shorts	0.34	14.87	78.19	12.09
Filter Bran	3.96	13.44	82.15	12.15
Bran	17.85	17.79	100.00	13.16
		12.99		
		11.80		

NE09521				
Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein
2M	18.79	10.73	18.79	10.73
1M Red	2.55	10.81	21.34	10.74
4M	2.74	11.05	24.09	10.77
1M	8.35	11.12	32.44	10.86
3M	11.63	11.38	44.07	11.00
5M	4.14	11.55	48.21	11.05
FILTER FLR	5.44	12.56	53.65	11.20
Grader	1.66	12.61	55.30	11.24
1BK	6.60	12.79	61.90	11.41
2BK	6.44	15.12	68.34	11.76
3BK	2.49	16.84	70.83	11.94
BRAN FLR	1.04	18.55	71.87	12.03
Break Shorts	2.15	15.98	74.02	12.15
Red Dog	1.96	14.02	75.98	12.19
Red Shorts	0.36	14.58	76.34	12.21
Filter Bran	6.44	15.71	82.78	12.48
Bran	17.22	15.37	100.00	12.98
		12.80		
		11.89		

Physical Dough Tests
2014 (Small Scale) Samples – Nebraska

Farinograms | **Mixograms**

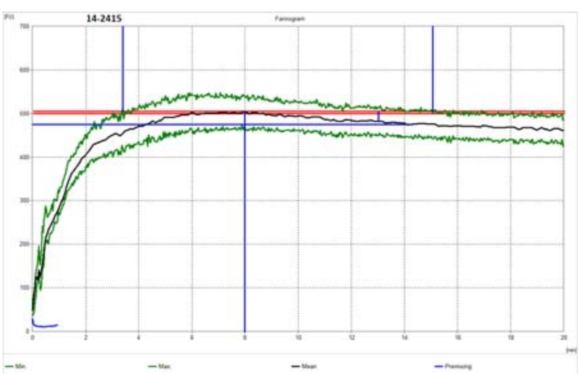


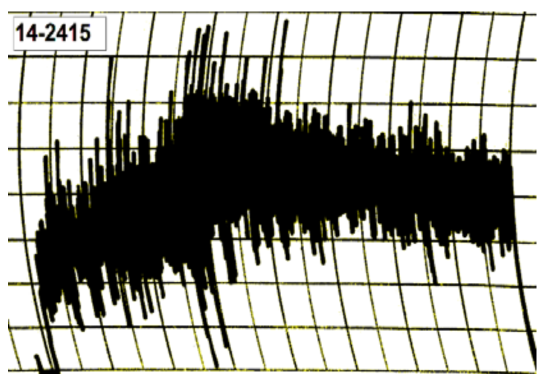


Water abs = 55.1%, Peak time = 10.2 min,
Mix stab = 26.3 min, MTI = 8 FU

Water abs = 64.3%
Mix time = 5.5 min

14-2414, Jagalene (CC14)





Water abs = 55.5%, Peak time = 8.0 min,
Mix stab = 11.7 min, MTI = 23 FU

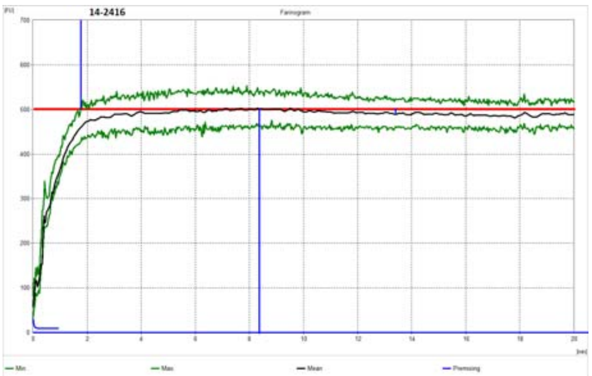
Water abs = 64.5%
Mix time = 3.3 min

14-2415, Camelot (IC)

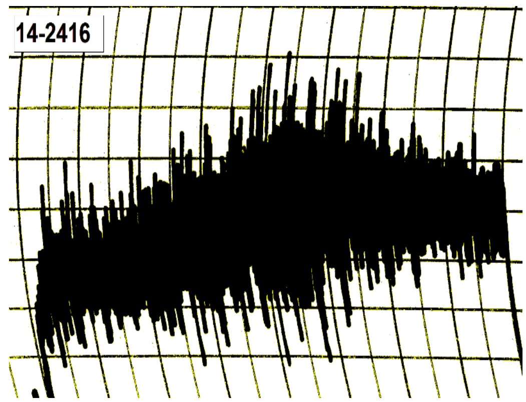
Physical Dough Tests

2014 (Small Scale) Samples – Nebraska (continued)

Farinograms | **Mixograms**

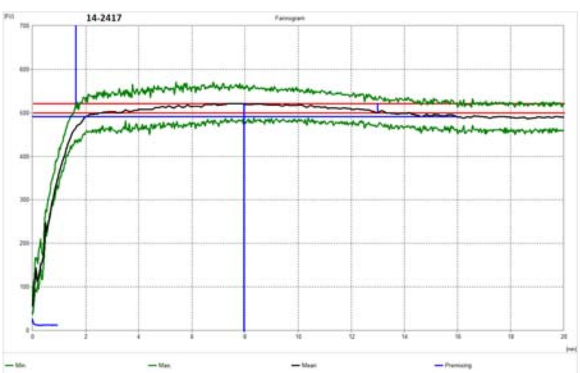


Water abs. = 54.7%, Peak time = 8.4 min,
Mix stab = 26.8 min, MTI = 13 FU

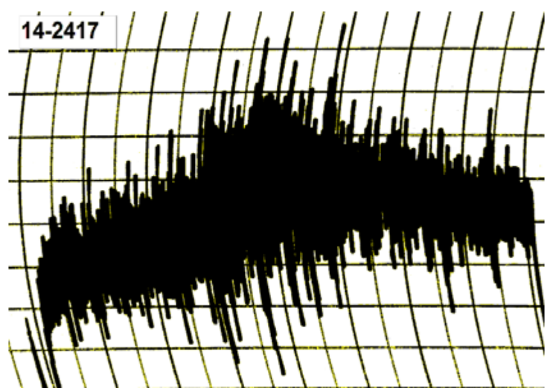


Water abs = 62.9%
Mix time = 4.5 min

14-2416, NE07531



Water abs. = 56.6%, Peak time = 8.0 min,
Mix stab = 19.1 min, MTI = 20 FU

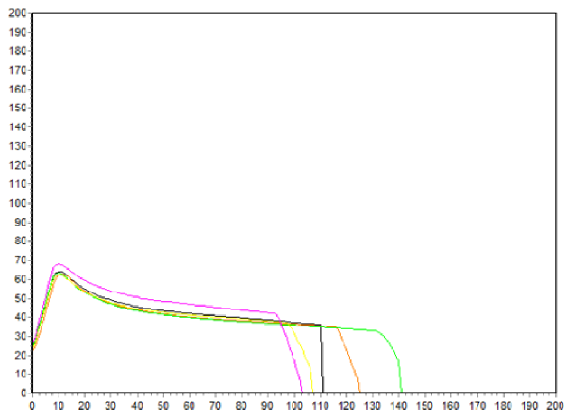


Water abs = 63.0%
Mix time = 4.0 min

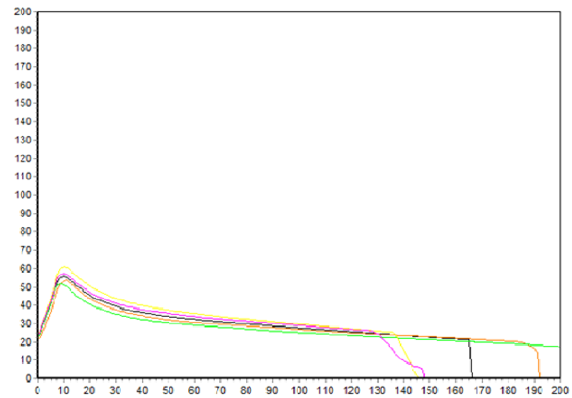
14-2417, NE089521

Physical Dough Tests - Alveograph

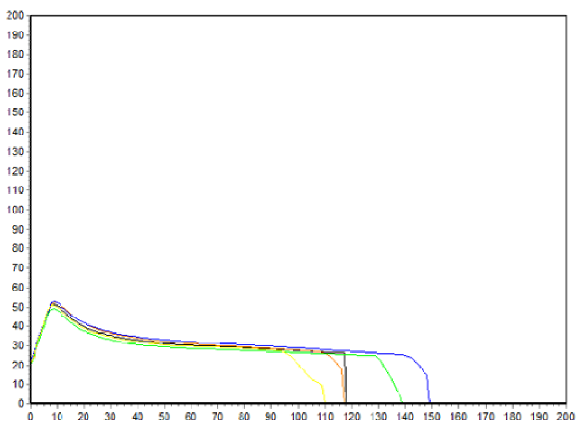
2014 (Small Scale) Samples – Nebraska



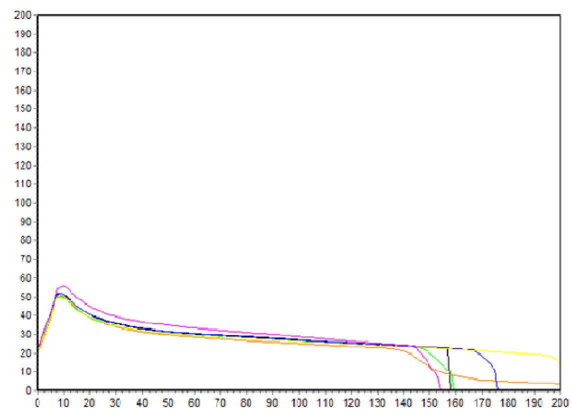
14-2414, Jagalene (CC14)
P (mm H_20) = 70, L (mm) = 110, W ($10E^{-4}J$) = 319



14-2415, Camelot (IC)
P (mm H_20) = 61, L (mm) = 165, W ($10E^{-4}J$) = 337



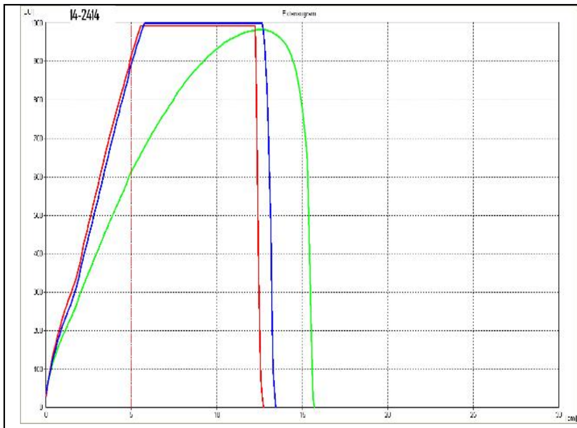
14-2416, NE07531
P (mm H_20) = 56, L (mm) = 117, W ($10E^{-4}J$) = 248



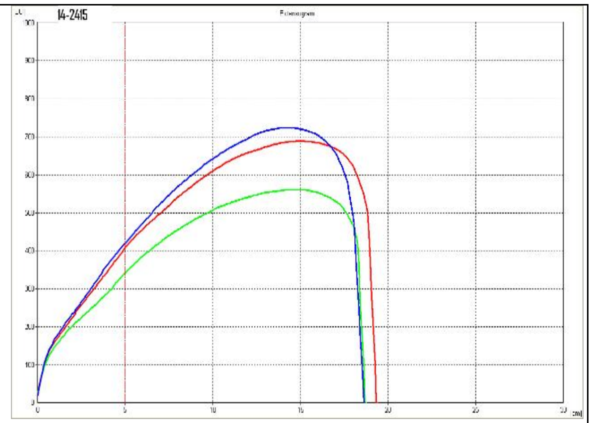
14-2417, NE09521
P (mm H_20) = 57, L (mm) = 157, W ($10E^{-4}J$) = 308

Physical Dough Tests - Extensigraph

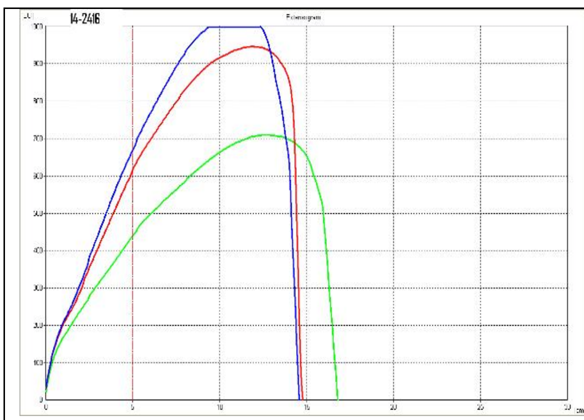
2014 (Small Scale) Samples – Nebraska



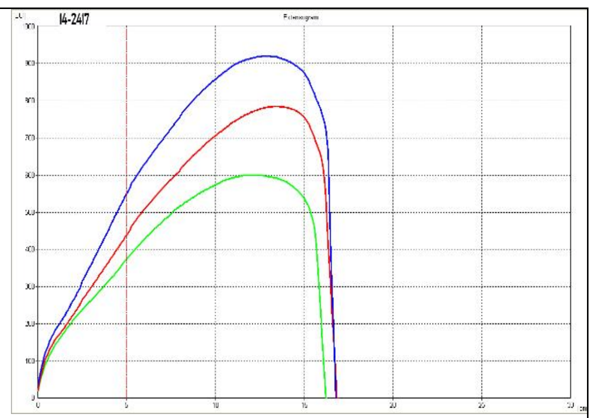
14-2414, Jagalene (CC14)
R (BU) = 924, E (mm) = 127, W (cm^2) = 174
Rmax (BU) = 993, Ratio = 7.26 at 90 min



14-2415, Camelot (IC)
R (BU) = 411, E (mm) = 194, W (cm^2) = 174
Rmax (BU) = 689, Ratio = 2.11 at 90 min



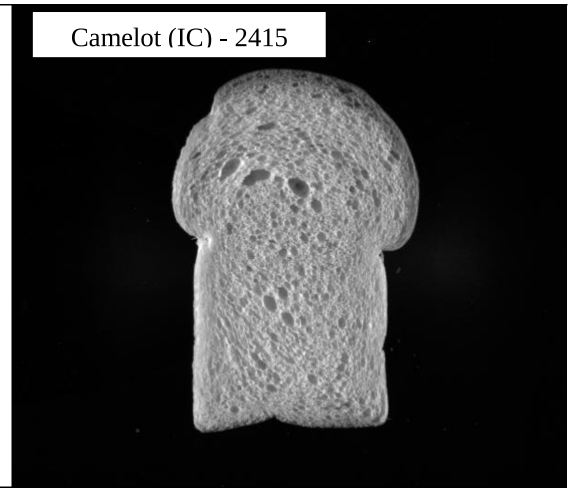
14-2416, NE07531
R (BU) = 623, E (mm) = 148, W (cm^2) = 174
Rmax (BU) = 946, Ratio = 4.21 at 90 min



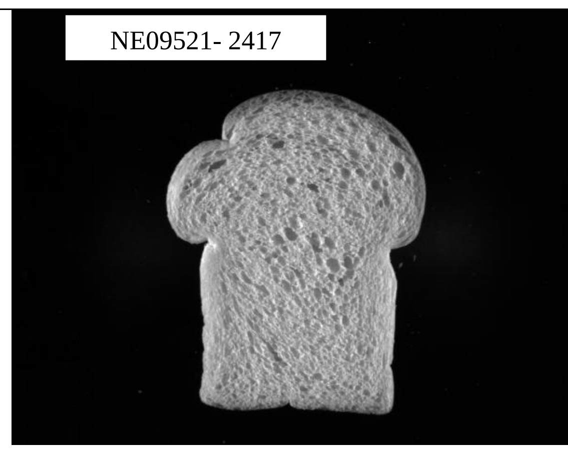
14-2417, NE09521
R (BU) = 442, E (mm) = 170, W (cm^2) = 161
Rmax (BU) = 785, Ratio = 2.60 at 90 min

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 2014 (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})
2414	7358	143.4	4445	0.447	2.144	6.805	1.680	-20.9
2415	6720	149.4	4490	0.430	1.837	2.457	1.653	-20.55



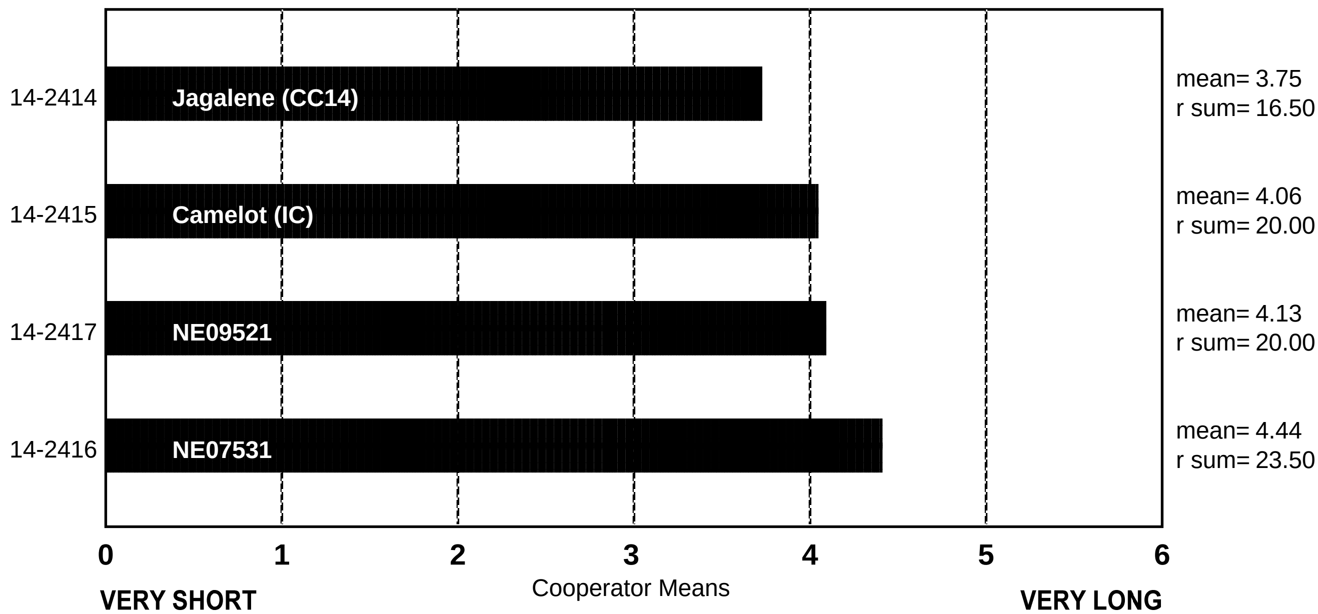
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2416	7020	150.6	4494	0.439	2.010	1.864	1.678	-23.10
2417	6716	152.0	4282	0.442	2.010	1.866	1.650	-24.83

SPONGE CHARACTERISTICS

(Small Scale) Nebraska

ncoop= 8
chisq= 1.84
chisqc= 4.45
cvchisq= 7.82
crdiff=

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

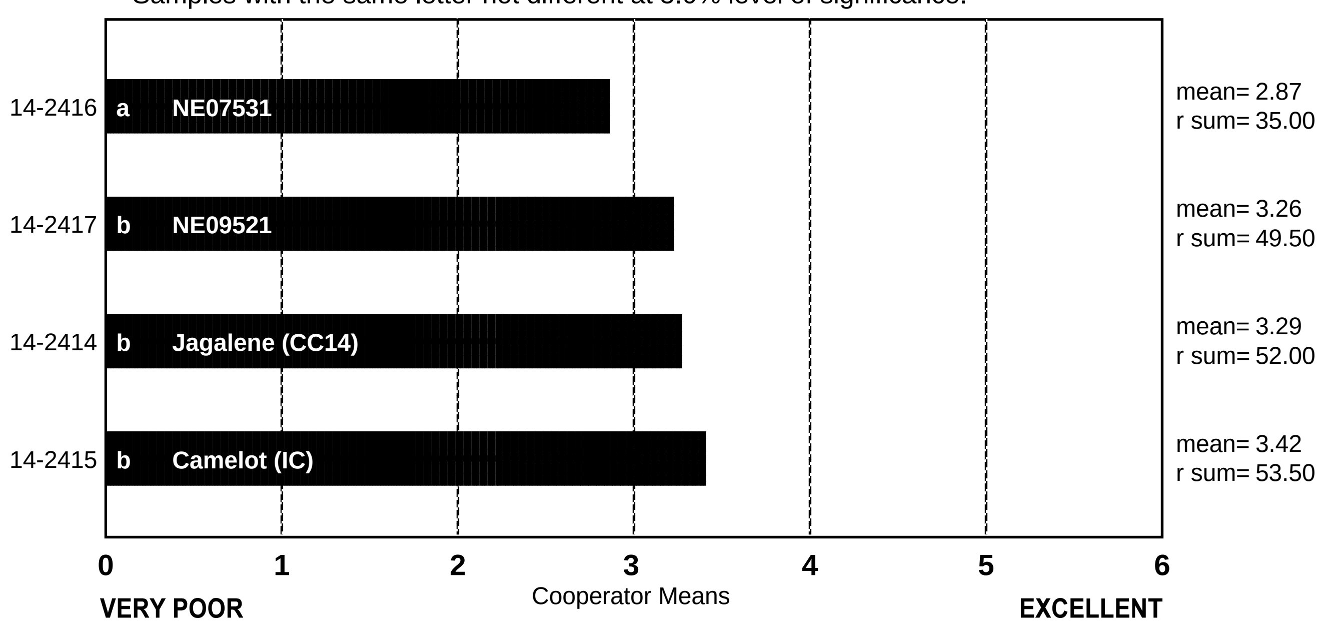


BAKE ABSORPTION

(Small Scale) Nebraska

ncoop= 19
chisq= 6.84
chisqc= 10.74
cvchisq= 7.82
crdiff= 11.80

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
14-2414 Jagalene (CC14)	**56.6**	**64.5**	**63.0**	**66.8**	**62.0**	**63.5**	**58.0**	**55.1**	**59.0**	**65.6**	**63.0**	**61.8**	**58.0**	**64.5**	**66.0**	**57.0**	**58.0**	**61.0**	**58.0**
14-2415 Camelot (IC)	**58.1**	**64.5**	**63.2**	**67.8**	**61.0**	**64.6**	**59.5**	**55.5**	**59.0**	**62.6**	**63.0**	**63.5**	**57.7**	**64.4**	**67.0**	**58.0**	**57.5**	**60.7**	**58.0**
14-2416 NE07531	**56.2**	**64.1**	**61.9**	**65.3**	**61.0**	**61.0**	**59.0**	**54.7**	**58.0**	**62.0**	**62.0**	**62.7**	**56.8**	**63.1**	**65.0**	**56.0**	**57.0**	**69.8**	**57.0**
14-2417 NE09521	**57.0**	**62.9**	**61.8**	**65.1**	**62.0**	**64.0**	**60.0**	**56.6**	**58.0**	**65.8**	**62.0**	**60.7**	**59.7**	**62.9**	**65.0**	**58.0**	**59.5**	**62.7**	**60.0**

BAKE MIX TIME, ACTUAL

(Small Scale) Nebraska

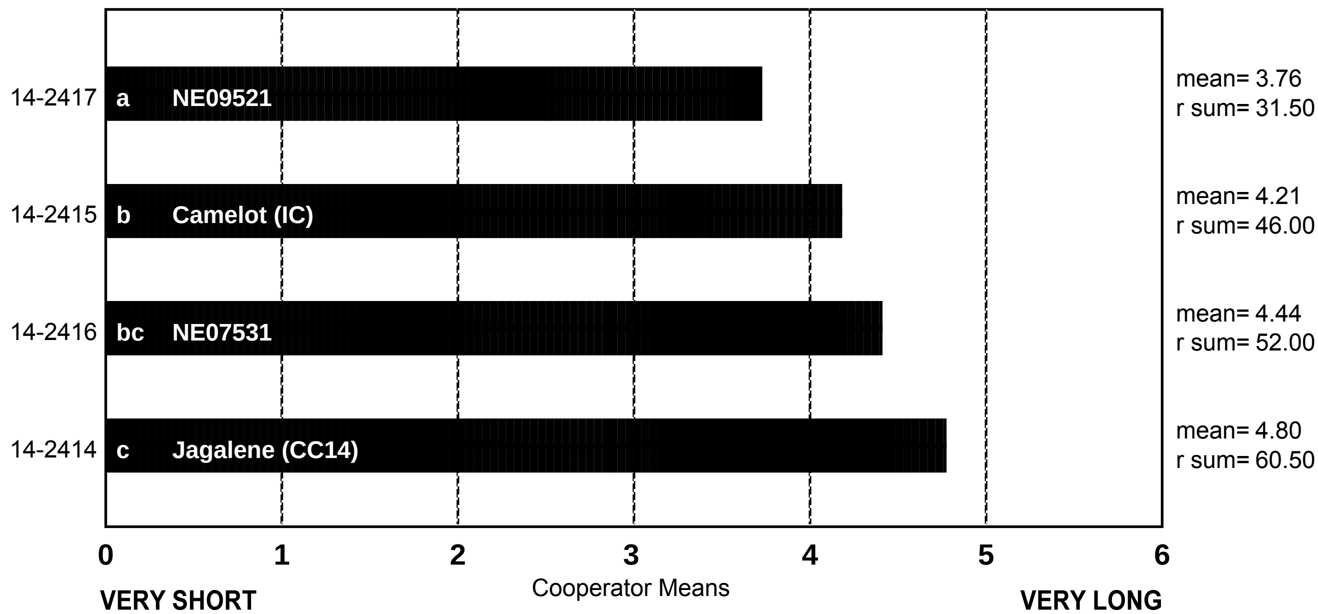
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2414 Jagalene (CC14)	**4.5**	**5.8**	**4.3**	**6.6**	**6.0**	**3.8**	**30.0**	**9.0**	**20.0**	**8.0**	**9.0**	**8.5**	**9.0**	**4.9**	**5.8**	**25.0**	**8.0**	**13.0**	**8.0**
14-2415 Camelot (IC)	**3.3**	**4.5**	**3.3**	**6.0**	**4.0**	**3.1**	**30.0**	**13.0**	**20.0**	**7.0**	**9.0**	**5.9**	**6.0**	**3.3**	**4.5**	**25.0**	**10.0**	**8.0**	**9.0**
14-2416 NE07531	**3.8**	**5.3**	**4.0**	**5.6**	**6.3**	**3.6**	**30.0**	**5.0**	**20.0**	**6.0**	**9.0**	**8.5**	**8.0**	**4.9**	**5.3**	**25.0**	**11.5**	**10.0**	**8.0**
14-2417 NE09521	**3.3**	**4.3**	**3.3**	**4.4**	**4.9**	**2.9**	**20.0**	**8.0**	**15.0**	**6.5**	**9.0**	**5.1**	**6.5**	**3.5**	**3.8**	**25.0**	**10.0**	**8.0**	**6.0**

BAKE MIX TIME

(Small Scale) Nebraska

ncoop= 19
chisq= 14.13
chisqc= 20.50
cvchisq= 7.82
crdiff= 10.90

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

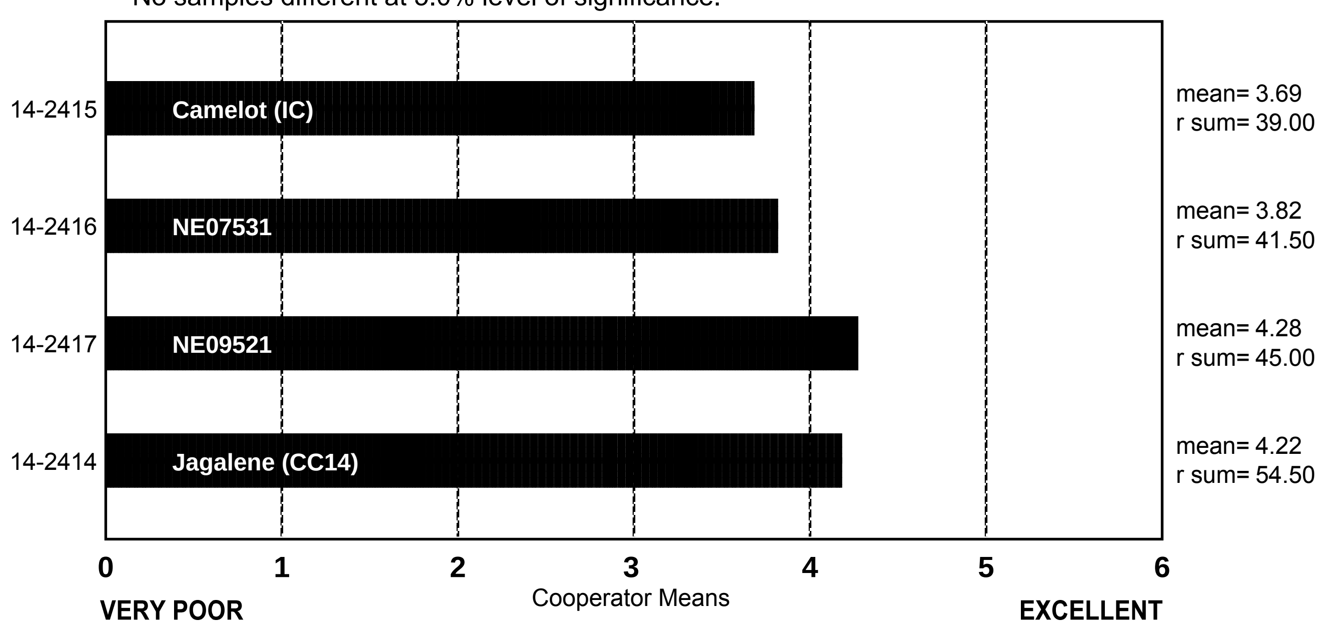


MIXING TOLERANCE

(Small Scale) Nebraska

ncoop= 18
chisq= 4.62
chisqc= 6.20
cvchisq= 7.82
crdiff=

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

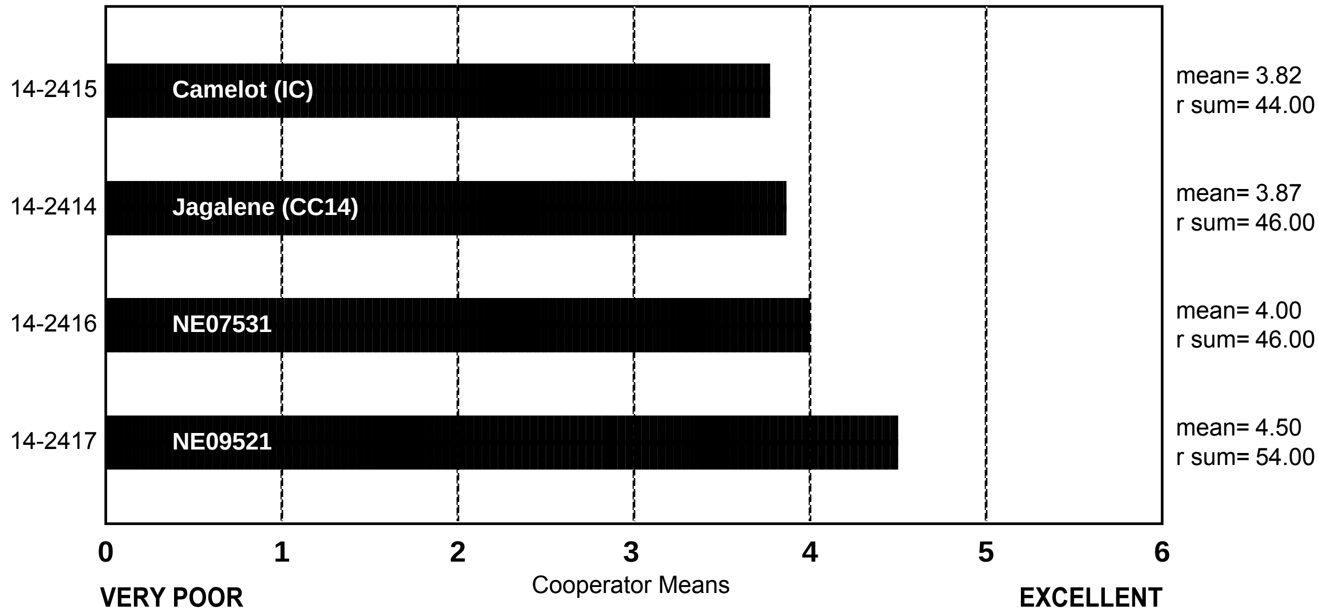


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Nebraska

ncoop= 19
chisq= 1.86
chisqc= 2.79
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
14-2414 Jagalene (CC14)	**0**	**3**	**6**	**9**	**1**
14-2415 Camelot (IC)	**0**	**4**	**6**	**8**	**1**
14-2416 NE07531	**1**	**2**	**4**	**9**	**3**
14-2417 NE09521	**0**	**1**	**5**	**11**	**2**

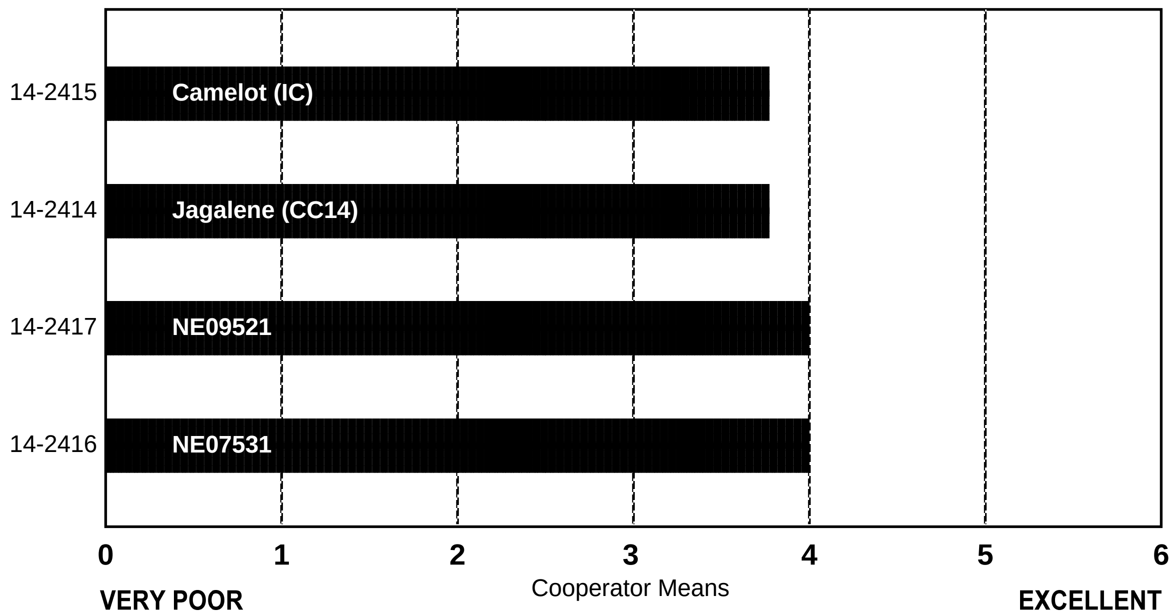
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Nebraska

ncoop= 19
chisq= 0.06
chisqc= 0.09
cvchisq= 7.82
crdiff=

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



mean= 3.82
r sum= 46.50

mean= 3.82
r sum= 47.50

mean= 4.03
r sum= 47.50

mean= 4.00
r sum= 48.50

DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
14-2414 Jagalene (CC14)	0	2	6	9	2
14-2415 Camelot (IC)	0	2	6	8	3
14-2416 NE07531	1	1	5	11	1
14-2417 NE09521	1	1	4	11	2

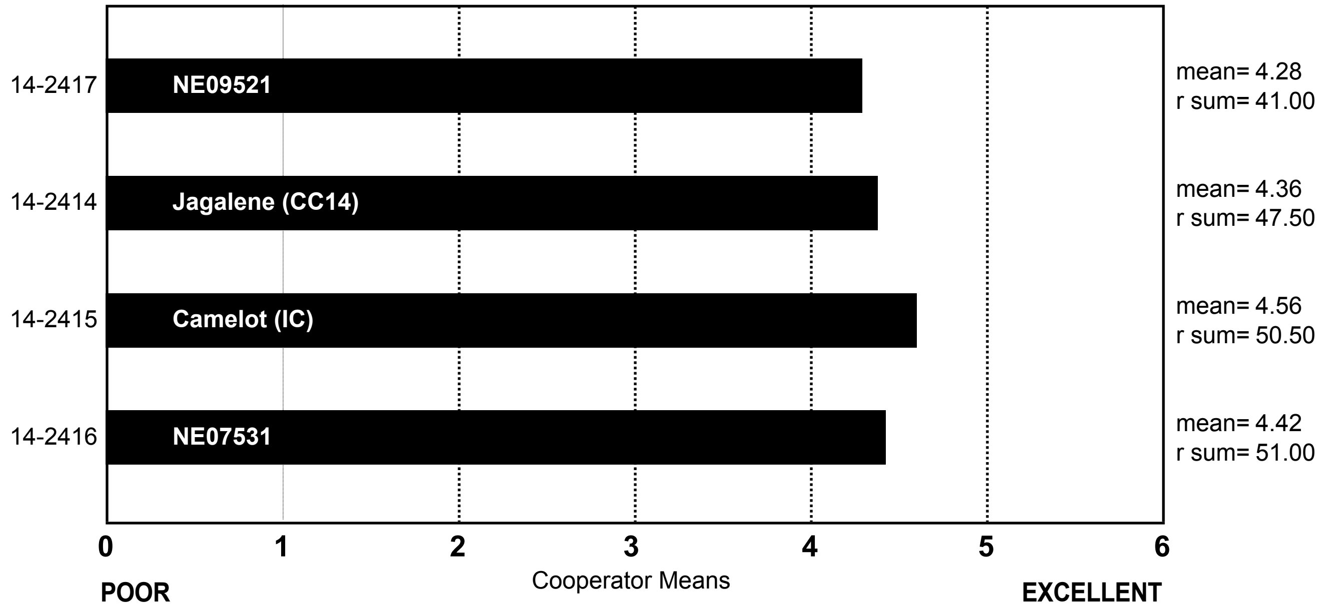
Frequency Table

CRUMB GRAIN

(Small Scale) Nebraska

ncoop= 19
chisq= 2.01
chisqc= 2.54
cvchisq= 7.82
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Nebraska

	Open	Fine	Dense
14-2414 Jagalene (CC14)	7	10	2
14-2415 Camelot (IC)	4	11	4
14-2416 NE07531	5	14	0
14-2417 NE09521	7	10	2

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Nebraska

	Round	Irregular	Elongated
14-2414 Jagalene (CC14)	**1**	**9**	**9**
14-2415 Camelot (IC)	**3**	**4**	**12**
14-2416 NE07531	**3**	**8**	**8**
14-2417 NE09521	**7**	**6**	**6**

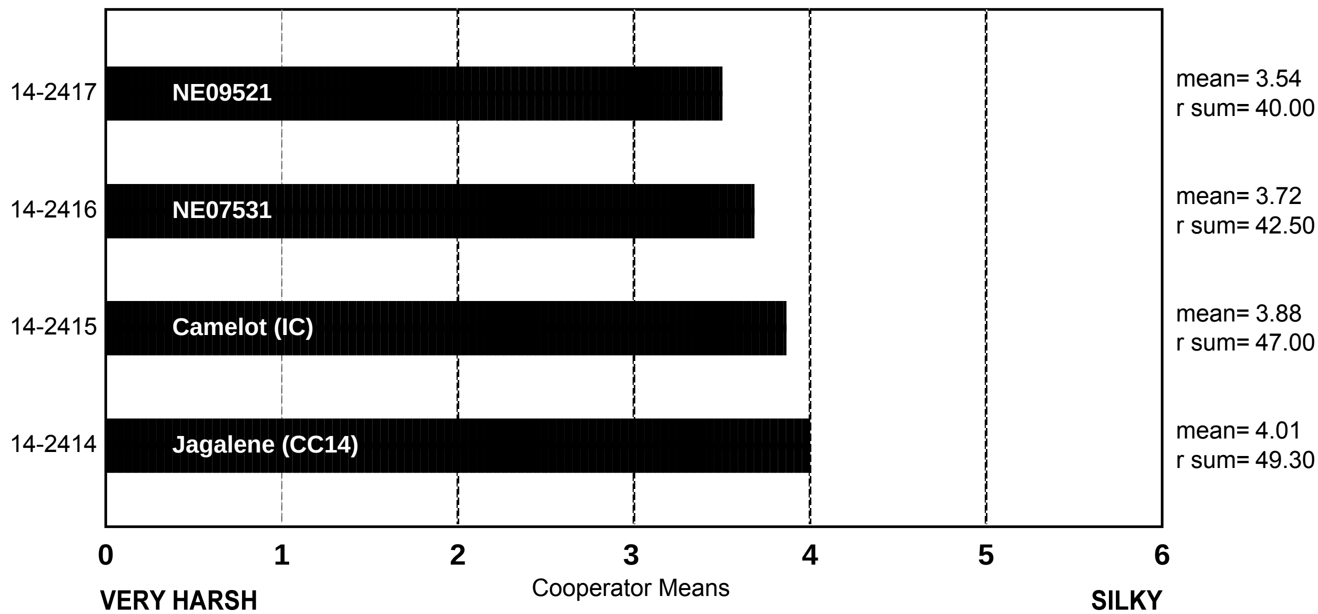
Frequency Table

CRUMB TEXTURE

(Small Scale) Nebraska

ncoop= 18
chisq= -1.81
chisqc= 3.77
cvchisq= 7.82
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Nebraska

	Harsh	Smooth	Silky
14-2414 Jagalene (CC14)	**3**	**11**	**3**
14-2415 Camelot (IC)	**5**	**9**	**4**
14-2416 NE07531	**6**	**9**	**3**
14-2417 NE09521	**7**	**9**	**2**

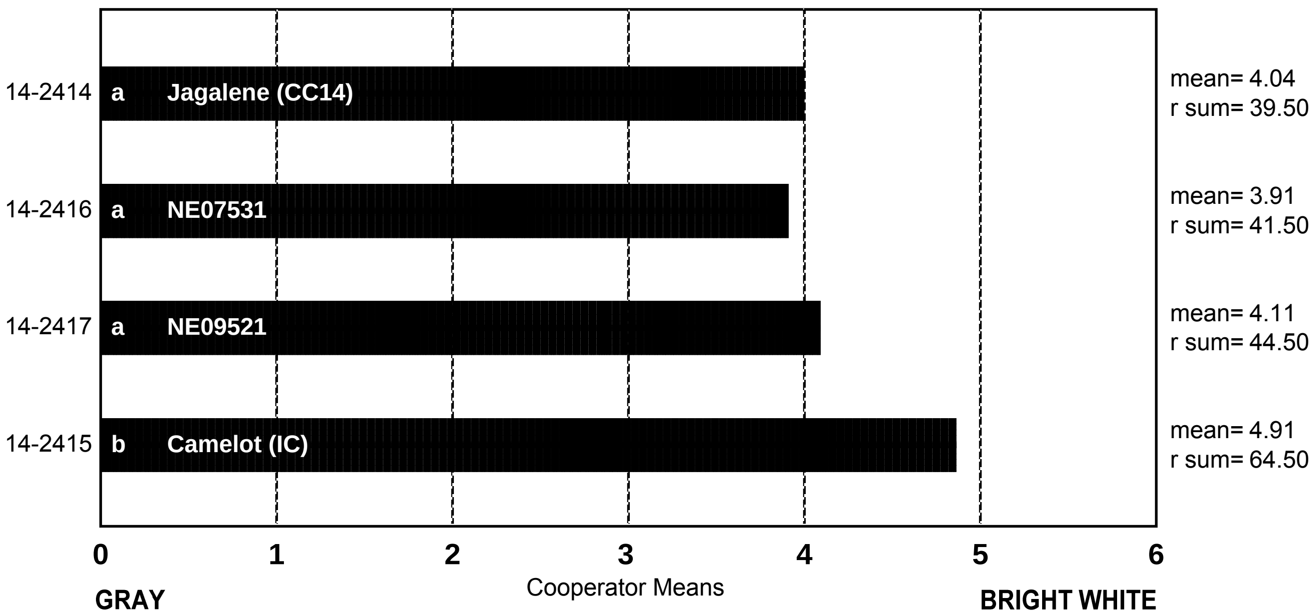
Frequency Table

CRUMB COLOR

(Small Scale) Nebraska

ncoop= 19
chisq= 12.57
chisqc= 19.26
cvchisq= 7.82
crdiff= 10.79

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



CRUMB COLOR, DESCRIBED

(Small Scale) Nebraska

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
14-2414 Jagalene (CC14)	0	0	1	1	14	3	0
14-2415 Camelot (IC)	0	0	0	0	5	9	5
14-2416 NE07531	0	0	2	2	11	4	0
14-2417 NE09521	0	0	0	2	13	4	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
14-2414 Jagalene (CC14)	**126.7**	**139.8**	**143.2**	**155.5**	**136.1**	**137.7**	**462.7**	**466.5**	**414.0**	**700.9**	**134.0**	**147.1**	**461.9**	**136.4**	**138.9**	**492.2**	**460.0**	**452.3**	**481.9**
14-2415 Camelot (IC)	**127.8**	**142.9**	**143.2**	**158.3**	**137.1**	**139.2**	**468.2**	**465.8**	**418.0**	**721.0**	**134.0**	**149.5**	**457.2**	**137.8**	**144.0**	**498.5**	**457.0**	**457.0**	**477.8**
14-2416 NE07531	**126.0**	**142.1**	**142.4**	**154.9**	**137.0**	**137.5**	**463.9**	**468.7**	**419.0**	**721.6**	**134.0**	**153.4**	**461.6**	**137.4**	**140.1**	**489.5**	**460.0**	**450.6**	**485.3**
14-2417 NE09521	**126.5**	**142.9**	**144.4**	**154.9**	**137.3**	**141.7**	**465.7**	**468.4**	**414.0**	**732.8**	**134.0**	**148.9**	**461.9**	**140.0**	**148.6**	**483.9**	**454.0**	**449.2**	**484.2**

LOAF VOLUME, ACTUAL

(Small Scale) Nebraska

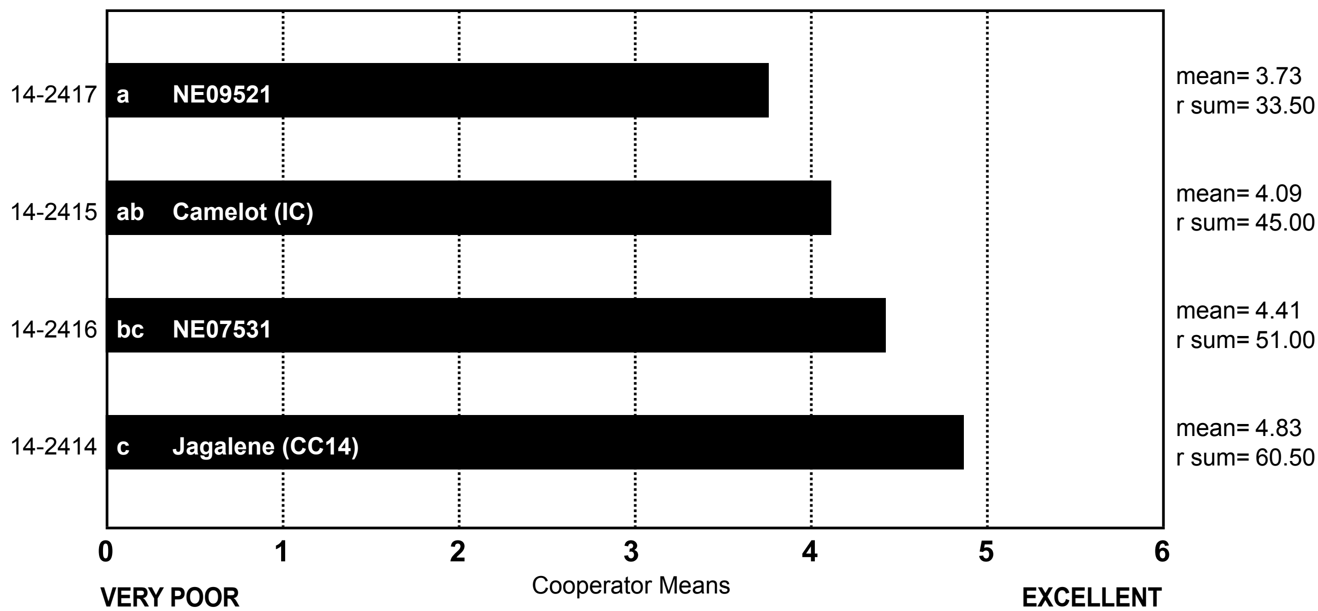
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2414 Jagalene (CC14)	**875**	**1245**	**1005**	**960**	**993**	**1020**	**2800**	**2638**	**3150**	**4080**	**1200**	**1080**	**2475**	**970**	**1015**	**3104**	**2200**	**2500**	**2713**
14-2415 Camelot (IC)	**765**	**1060**	**1010**	**905**	**958**	**865**	**2775**	**2475**	**3000**	**4055**	**918**	**980**	**2650**	**905**	**1020**	**3104**	**2225**	**2475**	**2613**
14-2416 NE07531	**725**	**1190**	**1035**	**995**	**968**	**885**	**2800**	**2500**	**3000**	**4305**	**963**	**975**	**2500**	**924**	**983**	**3104**	**2325**	**2530**	**2638**
14-2417 NE09521	**715**	**1045**	**930**	**1003**	**1015**	**760**	**2700**	**2350**	**2700**	**4280**	**963**	**975**	**2475**	**861**	**960**	**3104**	**2225**	**2430**	**2538**

LOAF VOLUME

(Small Scale) Nebraska

ncoop= 19
chisq= 12.11
chisqc= 16.44
cvchisq= 7.82
crdiff= 11.88

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

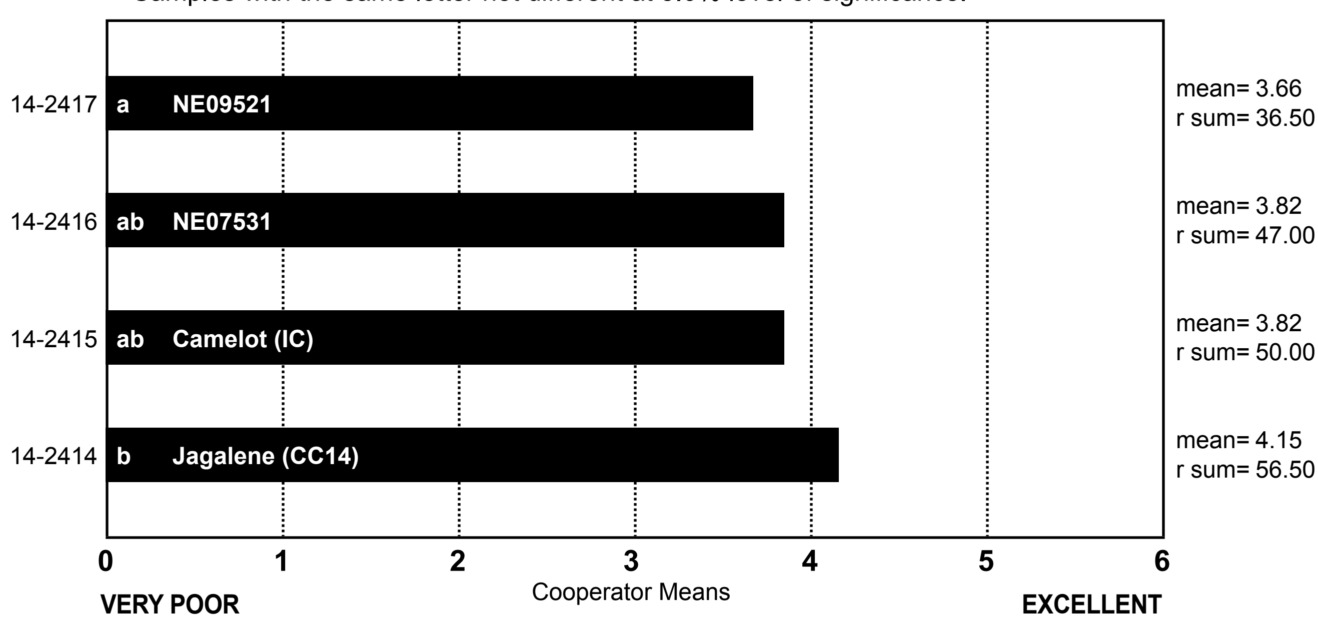


OVERALL BAKING QUALITY

(Small Scale) Nebraska

ncoop= 19
chisq= 6.58
chisqc= 7.87
cvchisq= 7.82
crdiff= 13.94

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. **14-2414 Jagalene (CC14)**

A. Smooth, soft, elastic, nice gas retention, nice oven spring.
B. Excellent loaf externals.
C. No comment.
D. Good dough properties.
E. Normal water absorption and mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, fine elongated cells, very smooth & resilient texture.
F. Very good baker, good crumb and loaf volume, stronger gluten.
G. No comment.
H. Low absorption, slightly above average mix, average volume, dull, open grain.
I. Long mix, strong dough, excellent break and shred.
J. No comment.
K. Best of set, very good volume, slightly underdeveloped on short mix.
L. Bold break and shred, beautiful loaf exterior, good flour protein, excellent at pan, above satisfactory crumb grain with high loaf volume, strong mixograph.
M. No comment.
N. 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
O. No comment.
P. Very low absorption, fairly tight grain, excellent volume.
Q. No comment.
R. Long mix time, dough was good, good volume, excellent dense grain rating.
S. Average in most categories, high volume.

COOP. **14-2415 Camelot (IC)**

A. Smooth, soft, elastic, nice gas retention, full body, good crumb structure and texture.
B. Very nice crumb grain.
C. No comment.
D. Low volume performance for protein level.
E. Low water absorption, normal mix time, slight sticky & strong dough, very high OS & volume, white crumb, fine & elongated cells, very smooth & resilient texture.
F. Poor loaf volume for protein, good color.
G. No comment.
H. Low absorption, above average mix, low volume, white, open grain.
I. Long mix, bright interior, tough dough.
J. No comment.
K. Acceptable bake performance, low volume.
L. Nice break and shred, good crust color, shorter mix time with above satisfactory crumb grain, creamy crumb color and good loaf volume.
M. No comment.
N. 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

O. No comment.
P. Very low absorption, above average interior scores, excellent volume, very bright crumb color.
Q. Thick cells.
R. Excellent mix time, dough was tough, excellent dense grain rating.
S. Very fine grain, bright white crumb, good volume.

COOP. 14-2416 NE07531

A. Smooth, soft, elastic, nice. Good crumb structure and texture.
B. Excellent loaf externals.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Low water absorption, normal mix time, slight sticky & strong dough, very high OS & volume, little yellow crumb, fine & elongated cells, smooth & resilient texture.
F. Poorer absorption for protein.
G. No comment.
H. Low absorption, short mix, average volume, dull, open grain.
I. Long mix, strong dough, excellent volume, good at make up, slightly open grain.
J. No comment.
K. Good bake performance.
L. Nice break and shred, good crust color, long mix time, above satisfactory crumb grain, creamy crumb color and good loaf volume, excellent dough at pan, strong mixograph.
M. No comment.
N. 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
O. No comment.
P. Very low absorption, tight, streaky grain, excellent volume.
Q. Low absorption.
R. Longer mix time, dough was good, lower volume with a good grain rating.
S. Very low absorption, good grain, good volume.

COOP. 14-2417 NE09521

A. Smooth, soft, and elastic dough, nice gas retention, little oven spring.
B. Somewhat slack at pan, nice loaf externals.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Normal water absorption and mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, little open & elongated cells, smooth & resilient texture.
F. Poor loaf volume and crumb characteristics.
G. No comment.
H. Low absorption, average mix, very low volume, dull, open grain.
I. Good mix and make up, slightly creamy, shorter volume, slightly open grain.
J. No comment.
K. Good bake performance.
L. Lower bake absorption, satisfactory crumb grain with creamy crumb color, high loaf volume, nice strong mixograph.
M. No comment.

N. 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
O. No comment.
P. Low absorption, tight, consistent smooth grain, excellent volume.
Q. Dry at make up, excessive break and shred.
R. Excellent mix time, dough was excellent, bread had an average volume with a dense grain.
S. Average absorption, average mix time, very fine grain, average volume.

Notes: **G, H, I, K, P, Q, R and S** conducted sponge and dough bake tests

MONTANA

14-2418	Jagalene (CC18)
14-2419	Yellowstone (IC)
14-2420	MT1078
14-2421	MT1138

,Description of Test Plots and Breeder Entries

Montana - Phil Bruckner/Jim Berg

The Post Agronomy Farm, west of Bozeman, had a 17% increase in average rainfall for the 2014 crop year (18.6in versus 15.9in for the 57yr average). There was normal snow cover during winter months and no winterkill was observed. Heading (June 14) was earlier than average by 6 days. Temperatures from March to August (except June) were slightly above average with above average moisture recorded in March and June and below average moisture in April, May, and July, Average August temperatures, with above average moisture delayed harvest until August 15, about 2 days later 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 = 100 bu/a, range 88-113) and test weights (x = 62.6 lb/bu, range 57.8-62.6) which were both above recent averages. Proteins were about average at 13.2%.

Jagalene (Common check) – was grown on 1.6% (41,100 acres) of the Montana winter wheat acreage in 2014.

Yellowstone (MT Internal 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 19.8% of the acreage (494,000 acres) in 2014.

MT1078 – a hollow stemmed hard red winter wheat line with the pedigree (Karl 92/UT190, MT02113)//(MTS0359, Rampart/Mironovskaja 61). MT1078 has above average yield and below average test weight and protein. Over 49 location-years, yield of MT1078 was 0.7 bu/a lower than Yellowstone. MT1078 has low winter hardiness and would not be suited for eastern Montana and western North Dakota. MT1078 has medium heading date and is shorter (2.3in less) in height than Yellowstone. MT1078 is moderately resistant to stem rust (Yellowstone is susceptible) and moderately resistant to stripe rust.

MT1078 is a high PPO line with below average flour yield and flour protein in MSU tests. Ash is good and similar to Jagalene. Mix times are long, similar to most Montana varieties. Mixing tolerance is above average. Mix and bake absorption is average. Loaf volume is excellent, exceeding both Jagalene and Yellowstone

MT1138 – a hollow stemmed hard red winter wheat line with the pedigree (059E//Jagger/Pecos, W99-194)/3/2*Yellowstone. MT1138 is similar to Yellowstone. MT1138 has above average yield and average test weight and protein. Over 27 location-years, yield of MT1090 was 2 bu/a higher than Yellowstone. MT1138 has winter hardiness similar to Yellowstone. MT1138 has medium heading date (0.6da earlier than Yellowstone). Though MT1138 is taller (0.7in) in height than Yellowstone, it has good lodging resistance. MT1138 is moderately susceptible to stem rust (Yellowstone is susceptible) and resistant to stripe rust.

MT1138 is a high PPO line with average flour yield and flour protein in MSU tests. Ash is average and similar to Yellowstone. Mix times are long, similar to Yellowstone. Mixing tolerance is above average. Mix and bake absorption is average. Loaf volume is good, exceeding Yellowstone.

Montana: 2014 (Small-Scale) Samples

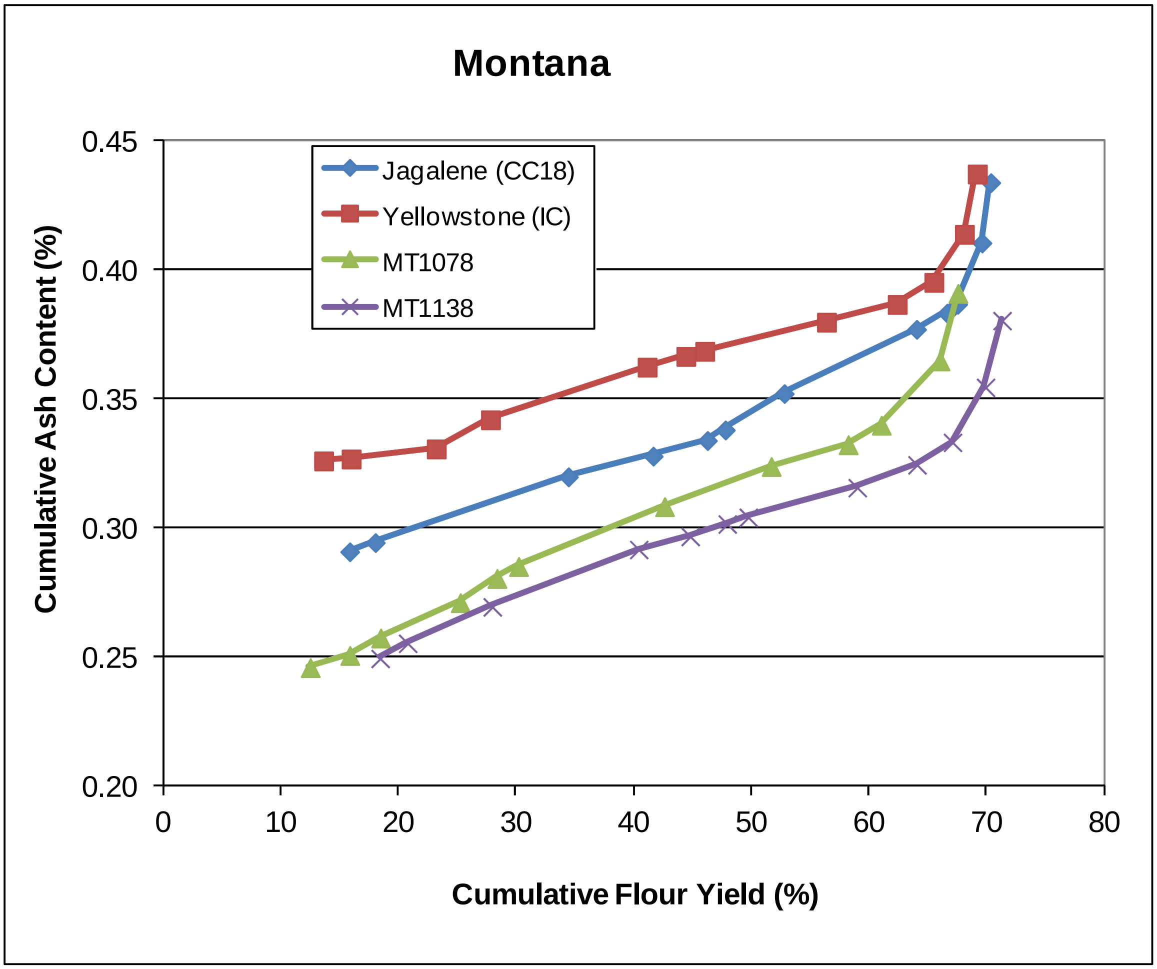
Test entry number	14-2418	14-2419	14-2420	14-2421
Sample identification	**Jagalene (CC18)**	**Yellowstone (IC)**	**MT1078**	**MT1138**
Wheat Data				
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW
Test weight (lb/bu) **Hectoliter weight (kg/hl)**	63.2 83.1	61.6 81.0	61.9 81.4	62.1 81.7
1000 kernel weight (gm)	39.7	38.2	42.4	42.2
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 91.1 8.9 0.0	 89.6 10.4 0.0	 95.9 4.1 0.0	 97.7 2.3 0.0
Single kernel (skcs)[a] Hardness (avg /s.d) Weight (mg) (avg/s.d) Diameter (mm)(avg/s.d) Moisture (%) (avg/s.d) SKCS distribution Classification	 59.7/12.9 39.7/7.1 2.98/0.29 11.0/0.3 02-12-38-48-01 Hard	 64.6/15.0 38.2/8.2 2.81/0.36 12.0/0.3 03-10-22-65-01 Hard	 58.4/12.6 42.4/7.1 2.91/0.31 11.2/0.3 02-11-41-46-01 Hard	 62.3/11.5 42.2/6.3 2.95/0.34 11.9/0.2 01-06-31-62-01 Hard
Wheat protein (12% mb) **Wheat ash (12% mb)**	13.6 1.45	12.0 1.49	12.3 1.37	12.7 1.36
Milling and Flour Quality Data				
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 70.6 69.8	 69.4 70.3	 67.5 67.2	 70.3 69.7
Flour moisture (%) **Flour protein (14% mb)** **Flour ash (14% mb)**	12.0 12.1 0.42	12.7 10.8 0.42	12.9 10.8 0.40	13.3 11.4 0.37
Rapid Visco-Analyser Peak Time (min) Peak Viscosity (RVU) Breakdown (RVU) Final Viscosity at 13 min (RVU)	 6.3 197.1 62.7 239.8	 6.3 238.1 71.9 284.2	 6.2 225.7 74.7 268.3	 6.2 229.3 80.1 262.4
Minolta color meter L* a* b* **PPO**	 92.49 -1.59 8.89 0.527	 92.77 -1.51 8.64 0.368	 92.81 -1.46 8.19 0.517	 92.82 -1.62 8.86 0.479
Falling number (sec)	423	452	380	451
Damaged Starch (AI%) (AACC76-31)	 96.40 6.58	 95.75 6.08	 96.25 6.47	 95.79 6.12

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

Montana: Physical Dough Tests and Gluten Analysis
For 2014 (Small-Scale) Samples

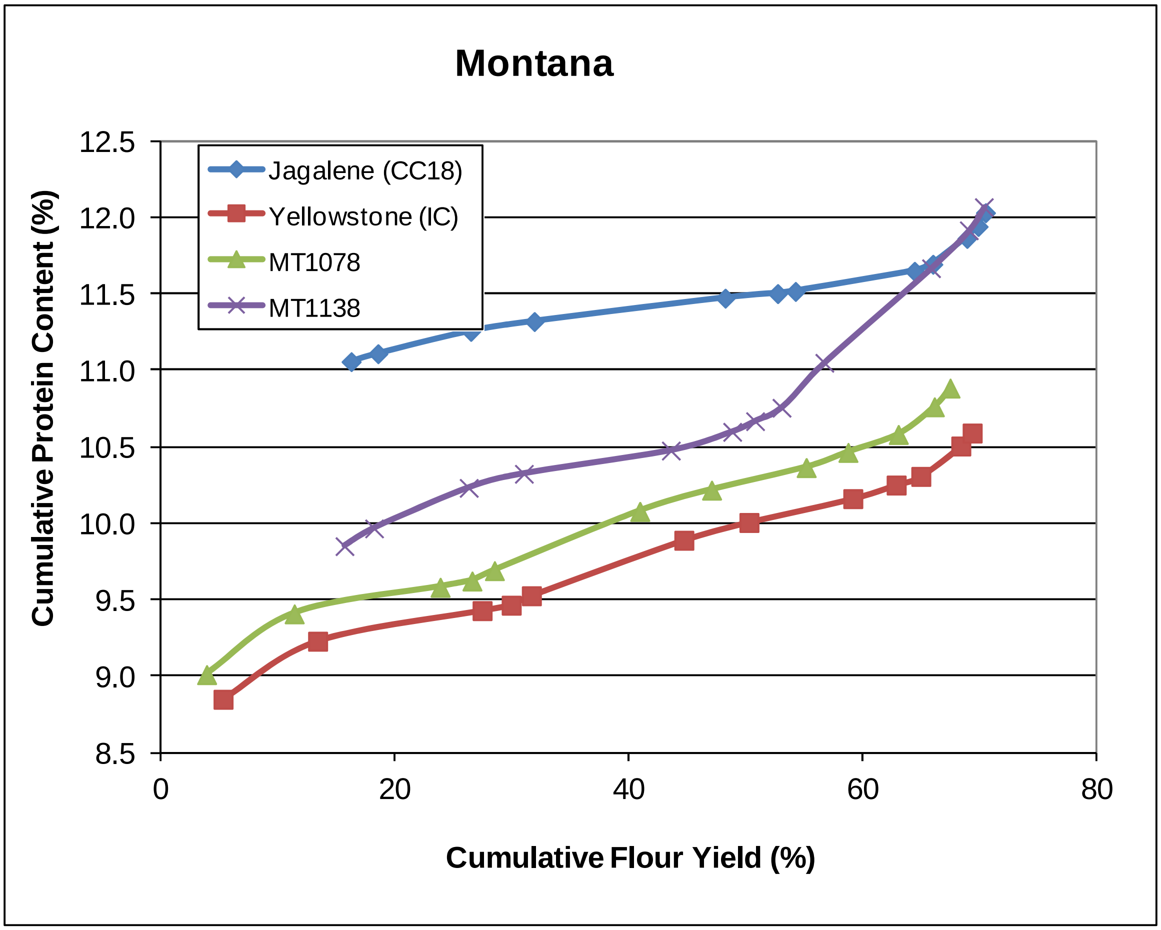
Test Entry Number	14-2418	14-2419	14-2420	14-2421
Sample Identification	Jagalene (CC18)	Yellowstone (IC)	MT1078	MT1138
MIXOGRAPH				
Flour Abs (% as-is)	65.4	62.8	62.4	63.0
Flour Abs (14% mb)	62.9	61.2	60.9	61.8
Mix Time (min)	3.5	8.1	6.5	6.5
Mix tolerance (0-6)	3	5	4	4
FARINOGRAPH				
Flour Abs (% as-is)	62.4	59.8	59.6	60.1
Flour Abs (14% mb)	59.9	58.2	58.1	58.8
Development time (min)	6.5	2.8	3.0	3.0
Mix stability (min)	11.8	10.9	11.3	11.2
Mix Tolerance Index (FU)	21	20	22	15
Breakdown time (min)	14.3	11.6	9.9	11.6
ALVEOGRAPH				
P(mm): Tenacity	81	90	100	93
L(mm): Extensibility	111	77	76	92
G(mm): Swelling index	23.5	19.5	19.4	21.4
W(10^{-4} J): strength (curve area)	339	295	330	357
P/L: curve configuration ratio	0.73	1.17	1.62	1.01
Ie(P_{200}/P): elasticity index	68.1	70.4	72.2	71.1
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	367/492/494	808/993/983	587/944/997	711/895/770
Extensibility (mm at 45/90/135 min)	144/148/142	111/101/95	130/108/106	127/113/97
Energy (cm^2 at 45/90/135 min)	95/137/121	135/135/128	127/137/136	140/141/104
Resist $_{max}$ (BU at 45/90/135 min)	525/769/697	974/993/983	782/998/998	860/996/921
Ratio (at 45/90/135 min)	2.54/3.33/3.49	7.28/9.83/10.39	4.53/8.73/9.40	5.58/7.92/7.96
PROTEIN ANALYSIS				
HMW-GS Composition	1/2*, 17+18, 5+10	1, 7+8, 5+10	1, 7+8, 5+10	1, 7+8, 5+10
%IPP	49.33	52.53	52.66	50.87
SEDIMENTATION TEST				
Volume (ml)	63.9	65.4	63.0	67.7

Montana: Cumulative Ash Curves



Jagalene (CC18)					Yellowstone (IC)					MT1078					MT1138				
Mill	Strm-yld	Ash	Cumul (14%)		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	Streams	(14%mb)		Yield	Ash
2M	15.81	0.29	15.81	0.29	2M	13.59	0.33	13.59	0.33	2M	12.46	0.25	12.46	0.25	2M	18.4	0.25	18.4	0.25
1M Red	2.18	0.32	17.99	0.29	1M Red	2.34	0.33	15.93	0.33	1BK	3.35	0.27	15.82	0.25	1M Red	2.3	0.30	20.7	0.26
3M	16.41	0.35	34.40	0.32	1M	7.24	0.34	23.17	0.33	1M Red	2.63	0.30	18.44	0.26	1M	7.2	0.31	27.9	0.27
1M	7.20	0.37	41.59	0.33	1BK	4.60	0.40	27.77	0.34	1M	6.76	0.31	25.21	0.27	3M	12.4	0.34	40.4	0.29
1BK	4.61	0.39	46.21	0.33	3M	13.32	0.41	41.09	0.36	2BK	3.11	0.36	28.32	0.28	1BK	4.4	0.34	44.8	0.30
Grader	1.52	0.46	47.73	0.34	2BK	3.28	0.42	44.37	0.37	Grader	1.84	0.36	30.16	0.29	2BK	3.1	0.37	47.9	0.30
4M	5.01	0.49	52.74	0.35	Grader	1.61	0.42	45.99	0.37	3M	12.41	0.37	42.57	0.31	Grader	1.8	0.37	49.7	0.30
FILTER FLR	11.24	0.49	63.98	0.38	FILTER FLR	10.34	0.43	56.33	0.38	FILTER FLR	9.06	0.40	51.63	0.32	FILTER FLR	9.3	0.38	58.9	0.32
2BK	2.59	0.54	66.57	0.38	4M	6.00	0.45	62.33	0.39	4M	6.55	0.40	58.17	0.33	4M	5.1	0.43	64.0	0.32
3BK	0.91	0.64	67.48	0.39	3BK	3.12	0.57	65.46	0.40	3BK	2.82	0.50	60.99	0.34	3BK	3.0	0.52	67.0	0.33
5M	2.06	1.19	69.54	0.41	5M	2.59	0.89	68.05	0.41	5M	4.99	0.67	65.98	0.37	5M	2.8	0.86	69.8	0.35
BRAN FLR	0.75	2.61	70.29	0.43	BRAN FLR	1.10	1.89	69.14	0.44	BRAN FLR	1.52	1.52	67.50	0.39	BRAN FLR	1.4	1.67	71.2	0.38
Break Shorts	3.09	3.79	73.38	0.58	Break Shorts	2.61	3.60	71.75	0.55	Break Shorts	2.80	2.88	70.30	0.49	Break Shorts	3.0	3.19	74.2	0.49
Red Dog	1.35	2.78	74.72	0.62	Red Dog	1.50	2.41	73.26	0.59	Red Dog	2.02	1.82	72.32	0.53	Red Dog	1.2	2.25	75.5	0.52
Red Shorts	0.09	4.41	74.81	0.62	Red Shorts	0.09	4.43	73.35	0.60	Red Shorts	0.11	3.40	72.43	0.53	Red Shorts	0.2	3.85	75.6	0.53
Filter Bran	9.18	1.43	83.99	0.71	Filter Bran	9.12	1.57	82.48	0.70	Filter Bran	6.90	0.93	79.33	0.57	Filter Bran	7.5	1.16	83.1	0.59
Bran	16.01	5.60	100.0	1.49	Bran	17.52	5.74	100.0	1.59	Bran	20.67	4.80	100.0	1.44	Bran	16.9	5.47	100.0	1.41
Wheat		1.41					1.45					1.33					1.32		
St. Grd. Fl.		0.42					0.42					0.40					0.37		

Montana: Cumulative Protein Curves



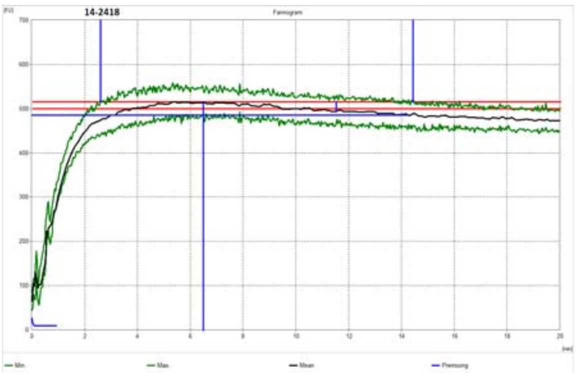
Jagalene (CC18)					Yellowstone (IC)					MT1078					MT1138				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
2M	16.32	11.06	16.32	11.06	1BK	5.38	8.85	5.38	8.85	1BK	3.97	9.01	3.97	9.01	2M	15.75	9.85	15.75	9.85
1M Red	2.29	11.48	18.61	11.11	1M	8.08	9.48	13.45	9.23	1M	7.48	9.62	11.45	9.41	1M Red	2.53	10.69	18.28	9.97
1M	7.93	11.60	26.54	11.26	2M	14.06	9.62	27.51	9.43	2M	12.47	9.74	23.92	9.58	1M	8.09	10.83	26.37	10.23
1BK	5.43	11.63	31.97	11.32	1M Red	2.48	9.86	29.99	9.47	1M Red	2.72	9.98	26.64	9.62	4M	4.71	10.84	31.08	10.33
3M	16.31	11.77	48.27	11.47	Grader	1.73	10.59	31.72	9.53	Grader	1.92	10.63	28.56	9.69	3M	12.55	10.85	43.64	10.48
4M	4.48	11.83	52.75	11.50	3M	13.03	10.77	44.75	9.89	3M	12.42	10.97	40.98	10.08	1BK	5.24	11.62	48.88	10.60
Grader	1.52	12.00	54.27	11.52	4M	5.56	10.94	50.31	10.01	4M	6.14	11.15	47.12	10.22	Grader	1.95	12.41	50.83	10.67
FILTER FLR	10.18	12.35	64.45	11.65	FILTER FLR	8.87	11.05	59.18	10.16	FILTER FLR	8.08	11.23	55.20	10.37	5M	2.26	12.73	53.09	10.76
5M	1.57	13.59	66.02	11.70	2BK	3.71	11.68	62.89	10.25	2BK	3.57	11.99	58.77	10.47	2BK	3.66	15.32	56.75	11.05
2BK	2.91	15.70	68.93	11.86	5M	2.11	11.98	65.00	10.31	5M	4.30	12.19	63.07	10.58	FILTER FLR	9.12	15.52	65.87	11.67
3BK	0.96	17.56	69.89	11.94	3BK	3.42	14.29	68.41	10.51	3BK	3.08	14.46	66.15	10.76	3BK	3.23	16.98	69.10	11.92
BRAN FLR	0.63	22.04	70.52	12.03	BRAN FLR	0.97	16.59	69.38	10.59	BRAN FLR	1.35	16.91	67.50	10.89	BRAN FLR	1.28	20.23	70.38	12.07
Break Shorts	3.14	18.05	73.66	12.29	Break Shorts	2.75	16.08	72.13	10.80	Break Shorts	3.00	16.48	70.49	11.12	Break Shorts	2.83	13.21	73.21	12.11
Red Dog	1.00	15.92	74.66	12.34	Red Dog	1.17	16.12	73.30	10.89	Red Dog	1.64	16.03	72.13	11.24	Red Dog	0.94	14.86	74.14	12.15
Red Shorts	0.06	16.12	74.72	12.34	Red Shorts	0.07	14.94	73.37	10.89	Red Shorts	0.08	15.10	72.21	11.24	Red Shorts	0.11	14.38	74.26	12.15
Filter Bran	8.40	12.81	83.13	12.39	Filter Bran	8.18	11.31	81.54	10.93	Filter Bran	6.24	12.47	78.45	11.34	Filter Bran	7.36	11.72	81.62	12.11
Bran	16.87	18.15	100.00	13.36	Bran	18.46	16.23	100.00	11.91	Bran	21.55	16.89	100.00	12.53	Bran	18.38	16.70	100.00	12.96
Wheat		13.25					11.72					12.02					12.37		
St. Grd. Fl		12.06					10.83					10.76					11.38		

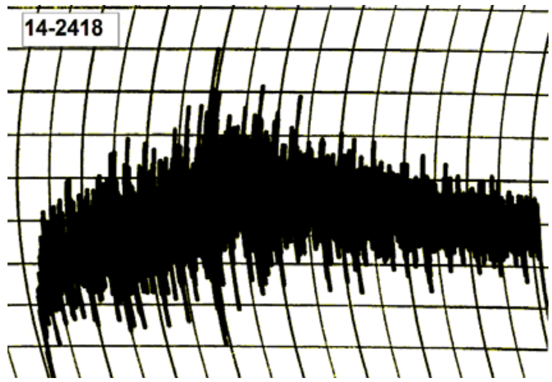
Physical Dough Tests

2014 (Small Scale) Samples – Montana

Farinograms

Mixograms

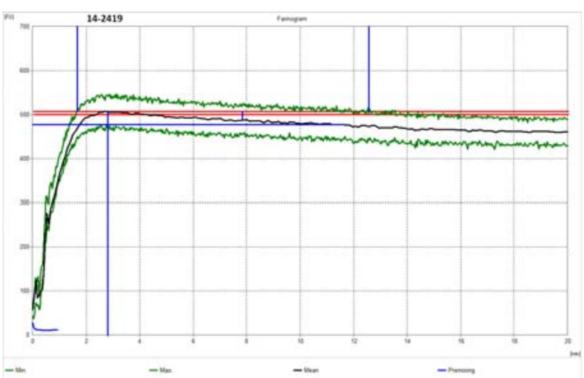


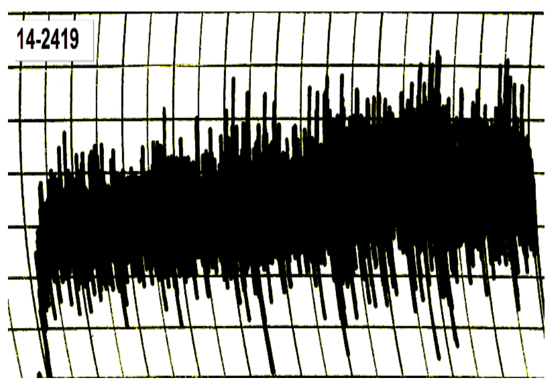


Water abs = 59.9%, Peak time = 6.5 min,
Mix stab = 11.8 min, MTI = 21 FU

Water abs = 62.9%
Mix time = 3.5 min

14-2418, Jagalene (CC14)





Water abs = 58.2%, Peak time = 2.8 min,
Mix stab = 10.9 min, MTI = 21 FU

Water abs = 61.2%
Mix time = 8.1 min

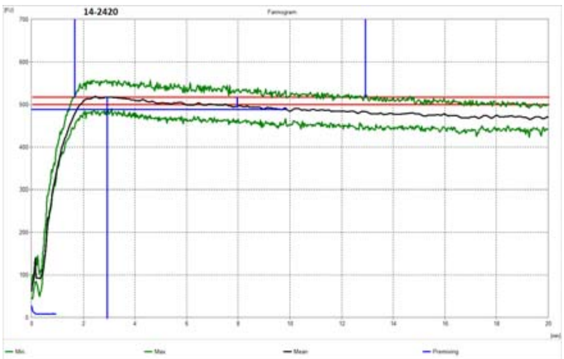
14-2419, Yellowstone (IC)

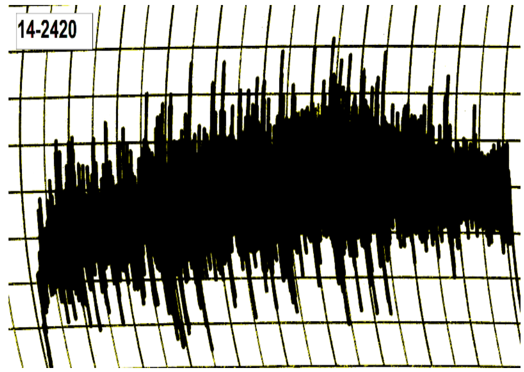
Physical Dough Tests

2014 (Small Scale) Samples – Montana (continued)

Farinograms

Mixograms

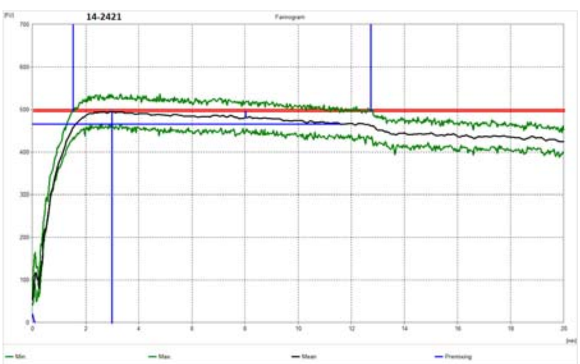


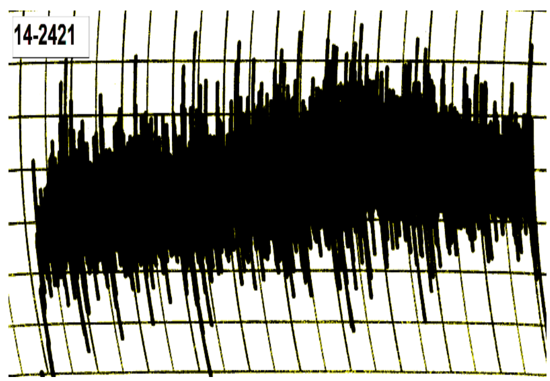


Water abs. = 58.1%, Peak time = 3.0 min,
Mix stab = 11.3 min, MTI = 22 FU

Water abs = 60.9%
Mix time = 6.5 min

14-2420, MT1078





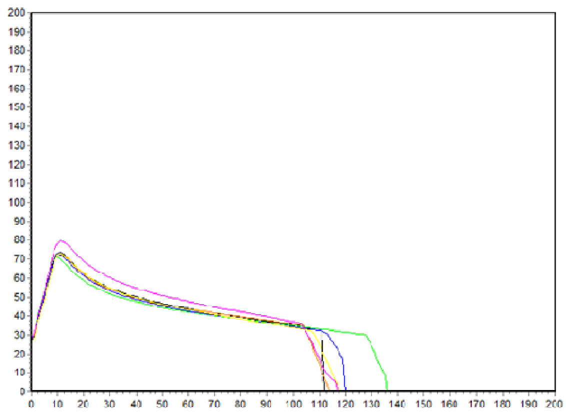
Water abs. = 58.8%, Peak time = 3.0 min,
Mix stab = 11.2 min, MTI = 15 FU

Water abs = 61.8%
Mix time = 6.5 min

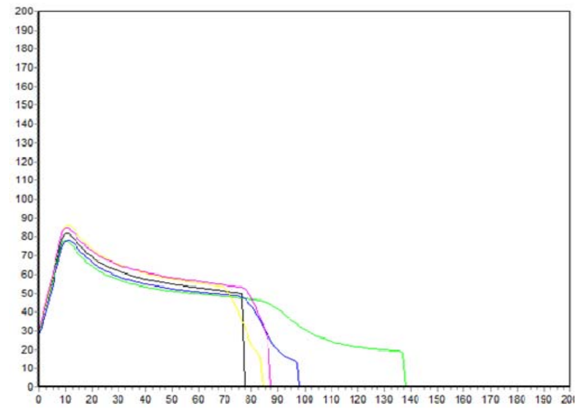
14-2421, MT1138

Physical Dough Tests - Alveograph

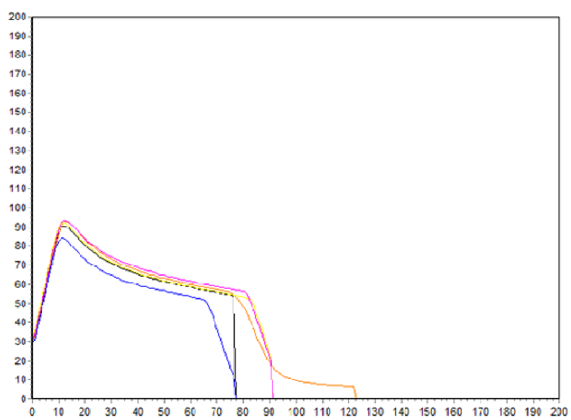
2014 (Small Scale) Samples – Montana



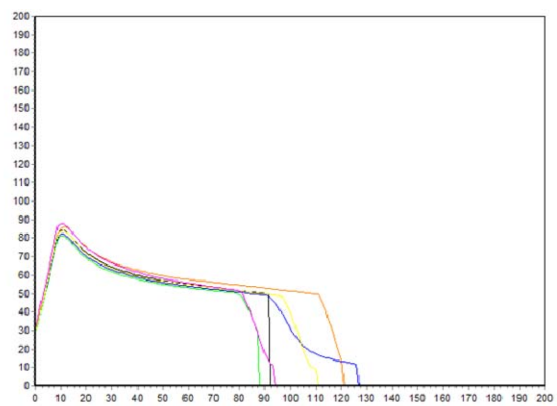
14-2418, Jagalene (CC18)
P (mm $H_2$0) = 81, L (mm) = 111, W ($10E^{-4}$J) = 339



14-2419, Yellowstone (IC)
P (mm $H_2$0) = 90, L (mm) = 77, ($10E^{-4}$J) = 295

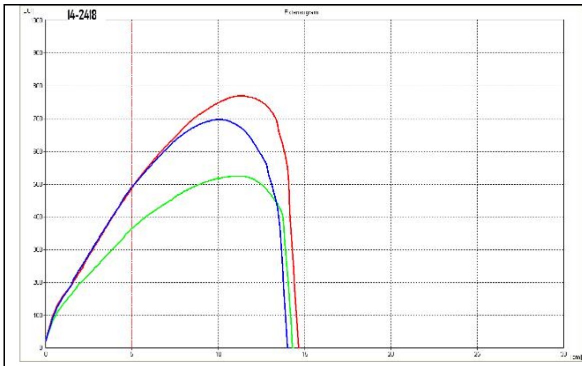


14-2420, MT1078
P (mm $H_2$0) = 100, L (mm) = 76 W ($10E^{-4}$J) = 330

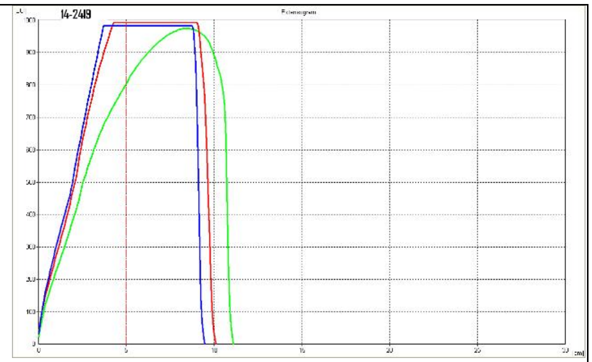


14-2421, MT1138
P (mm $H_2$0) = 93, L (mm) = 92, ($10E^{-4}$J) = 357

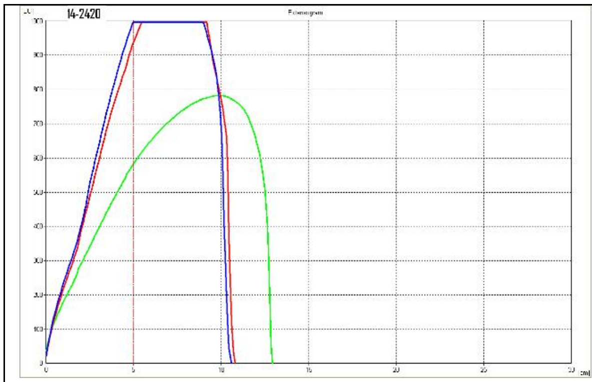
Physical Dough Tests - Extensigraph
2014 (Small Scale) Samples – Montana



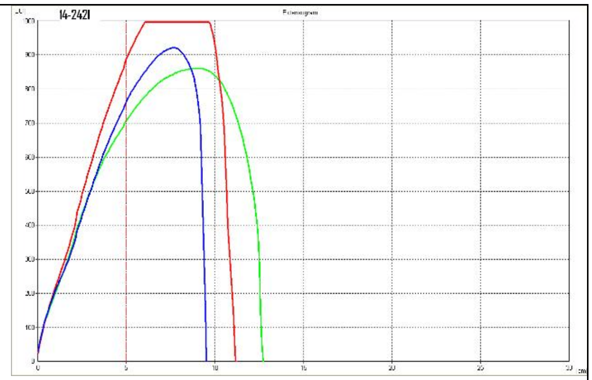
14-2418, Jagalene (CC18)
R (BU) = 492, E (mm) = 1489, W (cm^2) = 137
Rmax (BU) = 769, Ratio = 3.33 at 90 min



14-2419, Yellowstone (IC)
R (BU) = 993, E (mm) = 101, W (cm^2) = 135
Rmax (BU) = 993, Ratio = 9.83 at 90 min



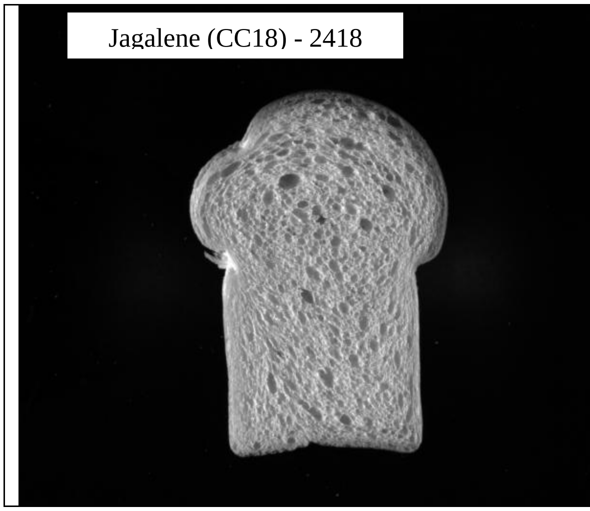
14-2420, MT1078
R (BU) = 944, E (mm) = 108, W (cm^2) = 137
Rmax (BU) = 998, Ratio = 8.73 at 90 min

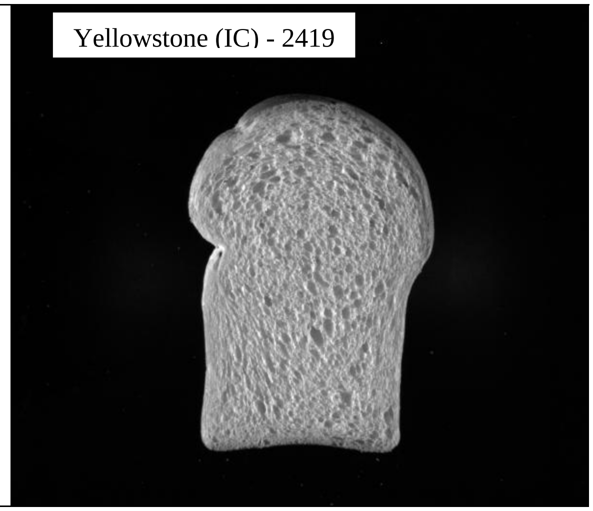


14-2421, MT1138
R (BU) = 895, E (mm) = 113, W (cm^2) = 141
Rmax (BU) = 996, Ratio = 7.92 at 90 min

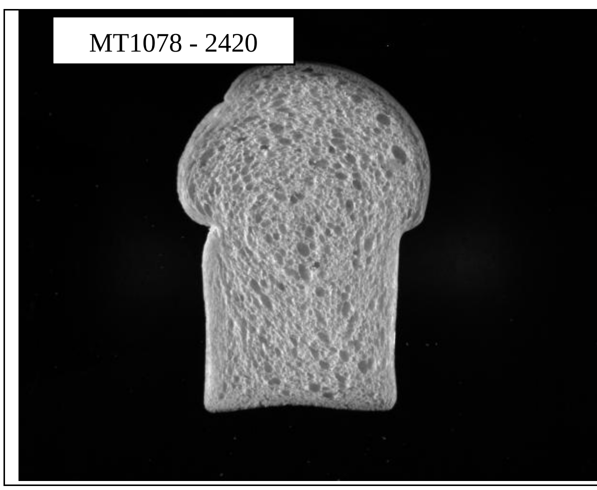
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Montana: C-Cell Bread Images and Analysis for 2014 (Small-Scale) Samples


Jagalene (CC18) - 2418


Yellowstone (IC) - 2419

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	6351	144.7	3892	0.444	2.114	1.115	1.720	-19.80
2419	6468	149.1	3847	0.448	2.128	0.703	1.770	-13.05


MT1078 - 2420


MT1138 - 2421

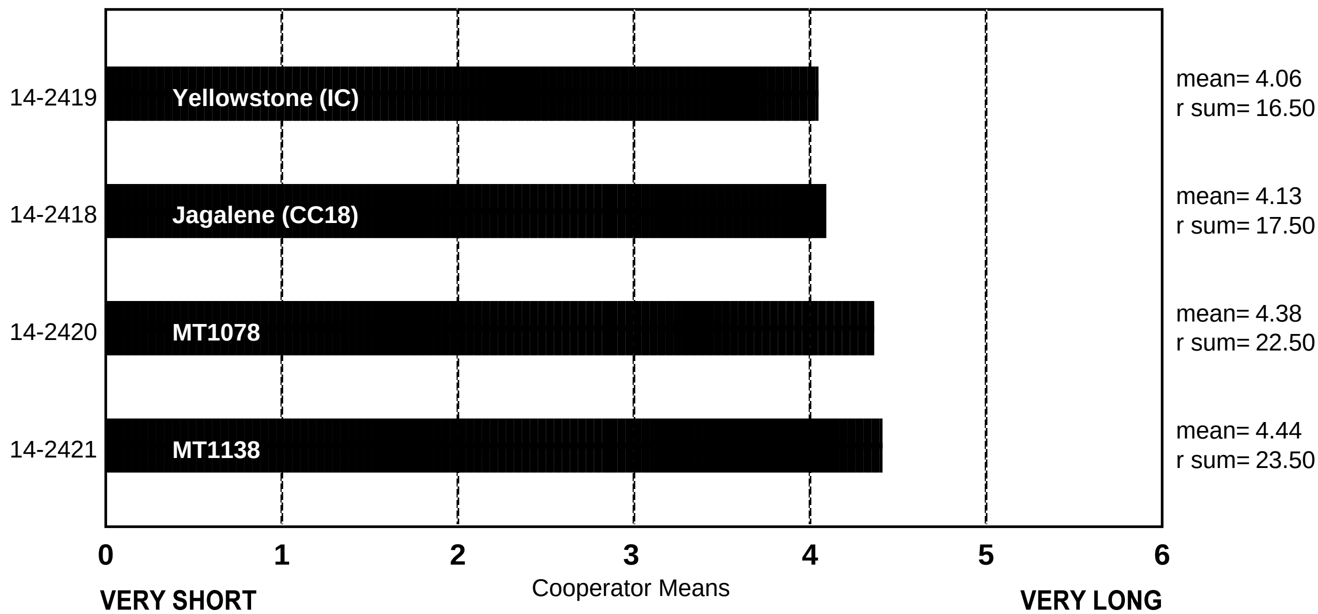
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2420	6709	145.1	4044	0.447	2.122	1.043	1.680	-11.50
2421	6667	147.6	3814	0.455	2.245	7.462	1.755	-16.25

SPONGE CHARACTERISTICS

(Small Scale) Montana

ncoop= 8
chisq= 2.78
chisqc= 7.40
cvchisq= 7.82
crdiff=

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

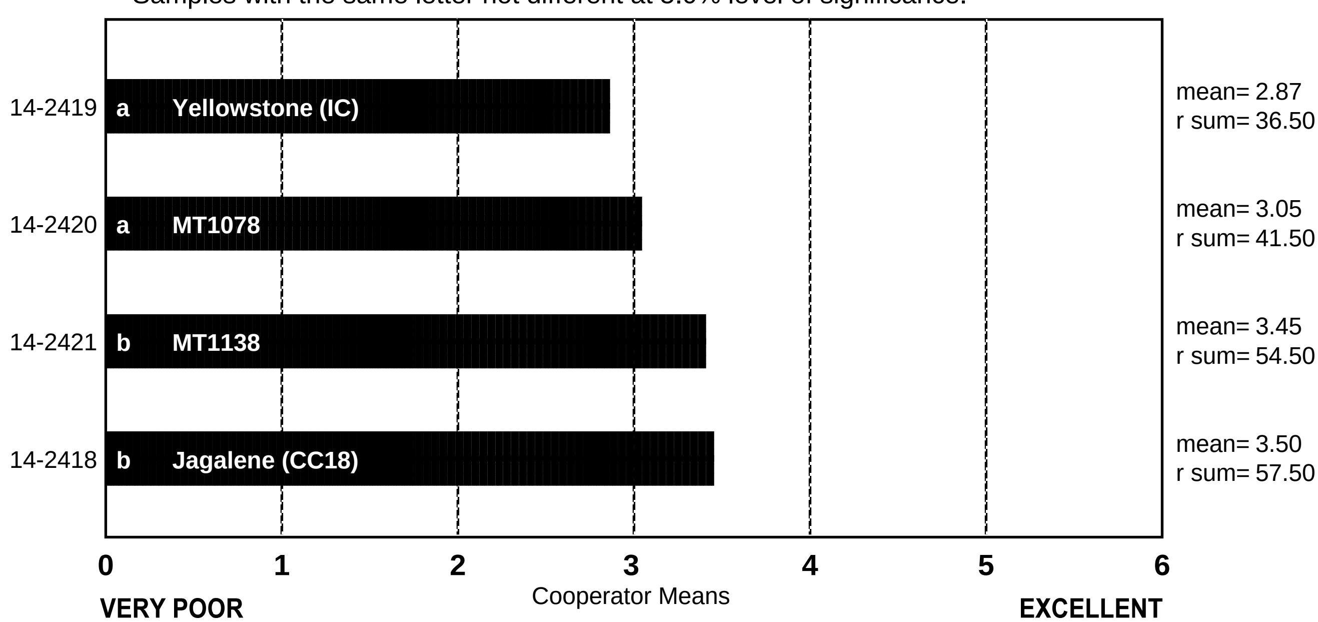


BAKE ABSORPTION

(Small Scale) Montana

ncoop= 19
chisq= 9.66
chisqc= 16.84
cvchisq= 7.82
crdiff= 10.43

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) 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
14-2418 Jagalene (CC18)	59.6	63.5	62.1	63.9	62.0	62.5	60.0	59.9	58.0	68.0	62.0	61.2	62.4	62.9	65.0	59.0	62.5	65.4	62.0
14-2419 Yellowstone (IC)	59.5	60.6	60.3	63.1	61.0	60.0	58.0	58.2	57.0	64.9	60.0	59.1	59.8	61.4	63.0	59.0	60.0	62.8	60.0
14-2420 MT1078	60.1	61.8	59.9	63.8	61.0	62.0	59.0	58.1	57.0	64.5	60.0	61.2	59.6	60.8	63.0	59.0	59.5	62.6	60.0
14-2421 MT1138	60.3	63.0	60.9	66.3	62.0	62.0	58.5	58.8	57.0	64.7	61.0	60.5	60.1	62.0	64.0	59.0	60.0	63.1	60.0

BAKE MIX TIME, ACTUAL

(Small Scale) Montana

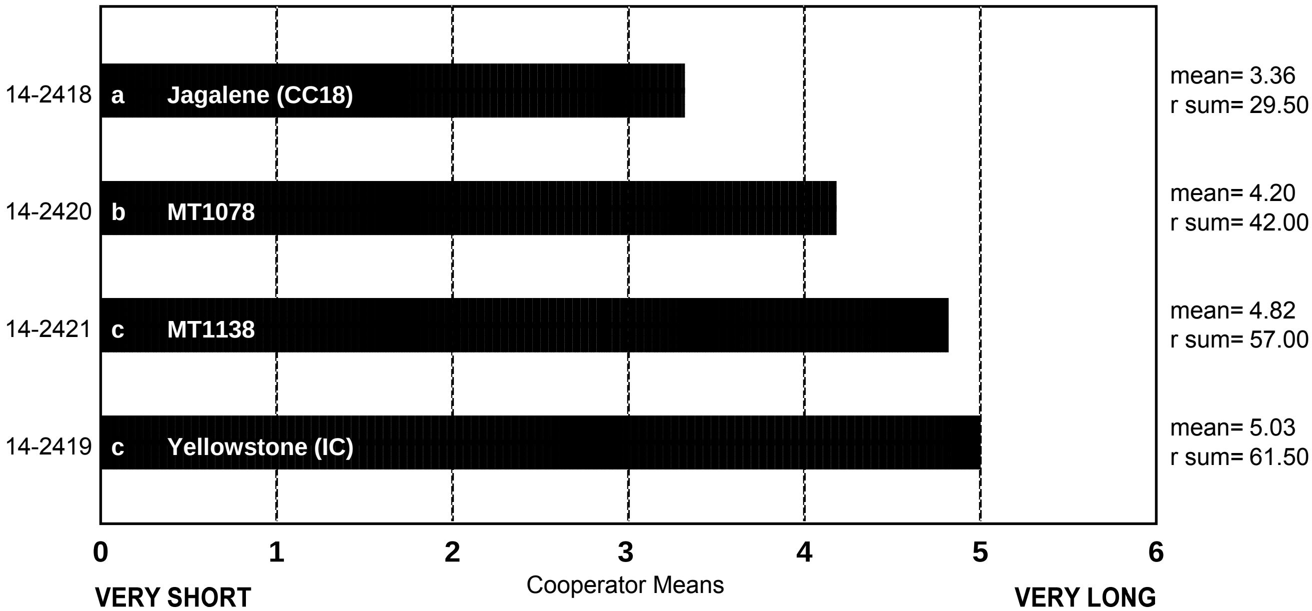
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2418 Jagalene (CC18)	3.3	3.5	3.0	6.2	4.3	2.5	16.0	14.0	8.0	7.0	9.0	4.4	5.0	3.5	3.0	20.0	8.0	6.0	5.0
14-2419 Yellowstone (IC)	6.0	8.0	6.3	7.9	9.5	4.3	30.0	8.0	20.0	6.0	9.0	9.8	5.5	5.6	7.5	25.0	12.0	9.0	14.0
14-2420 MT1078	5.0	5.3	4.5	6.7	7.3	3.7	19.0	8.0	14.0	6.0	9.0	8.0	6.0	4.5	5.3	21.0	10.0	6.0	8.0
14-2421 MT1138	4.5	6.5	5.3	6.5	8.6	4.1	30.0	11.0	20.0	5.0	9.0	8.3	6.0	4.2	6.3	25.0	11.0	10.0	14.0

BAKE MIX TIME

(Small Scale) Montana

ncoop= 19
chisq= 20.23
chisqc= 26.87
cvchisq= 7.82
crdiff= 10.35

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

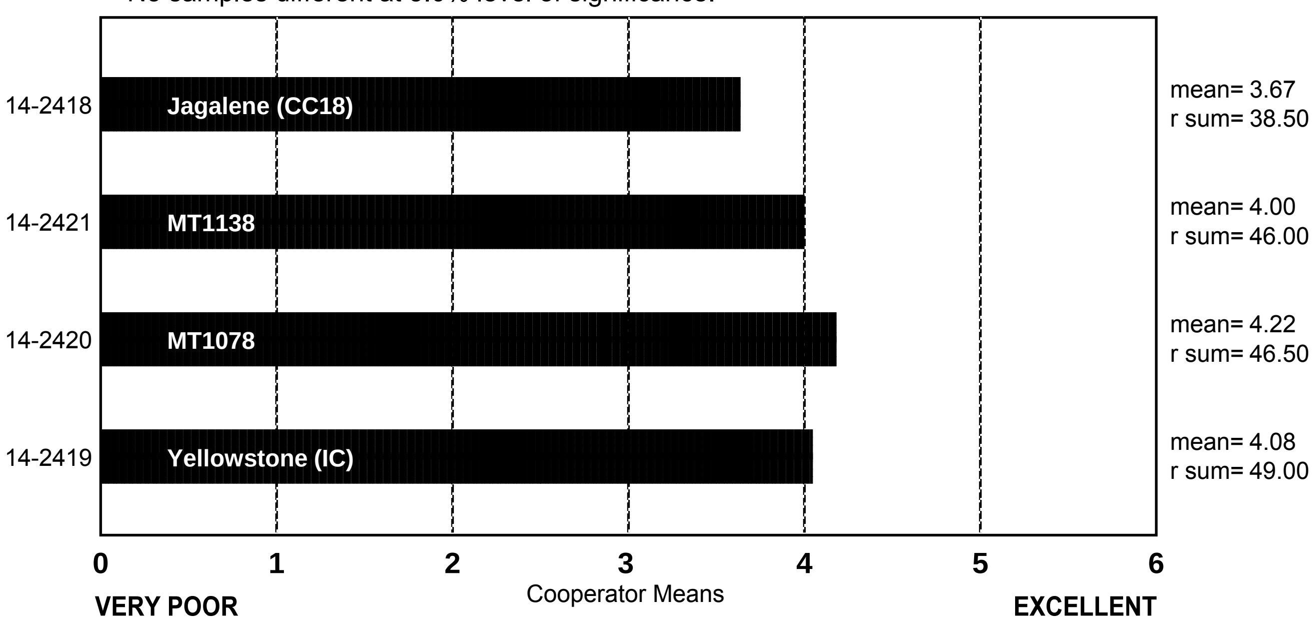


MIXING TOLERANCE

(Small Scale) Montana

ncoop= 18
chisq= 2.05
chisqc= 3.15
cvchisq= 7.82
crdiff=

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

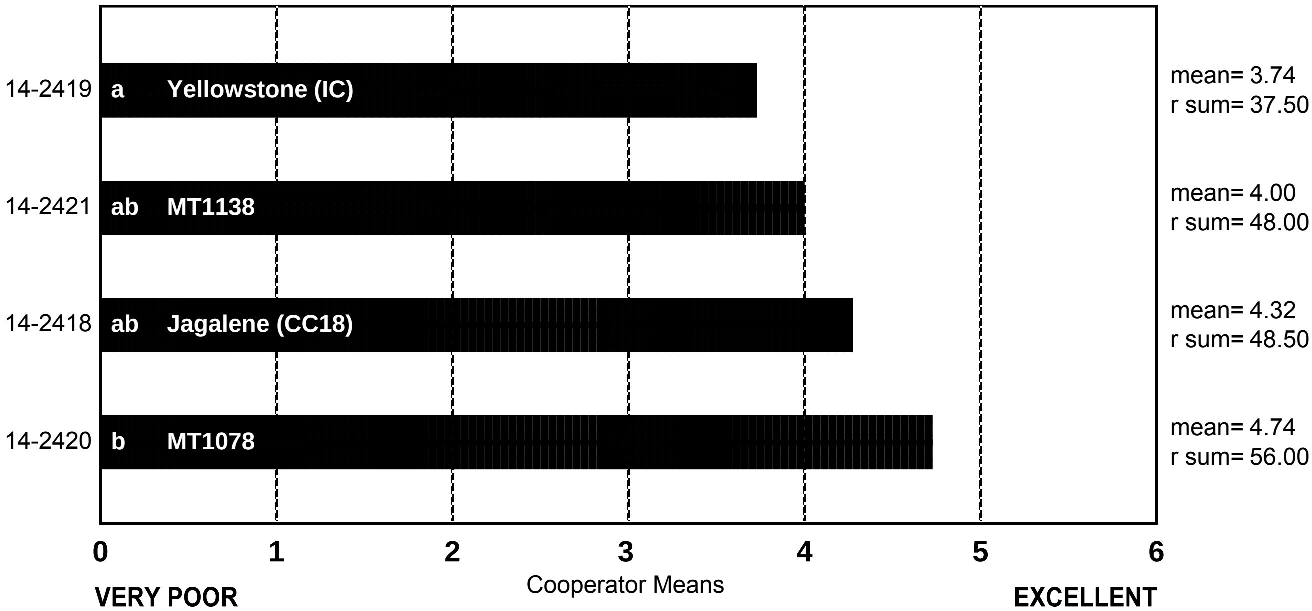


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Montana

ncoop= 19
chisq= 5.48
chisqc= 7.83
cvchisq= 7.82
crdiff= 12.75

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Montana

	Sticky	Wet	Tough	Good	Excellent
14-2418 Jagalene (CC18)	**2**	**2**	**0**	**13**	**2**
14-2419 Yellowstone (IC)	**3**	**0**	**6**	**9**	**1**
14-2420 MT1078	**2**	**0**	**3**	**11**	**3**
14-2421 MT1138	**1**	**1**	**8**	**6**	**3**

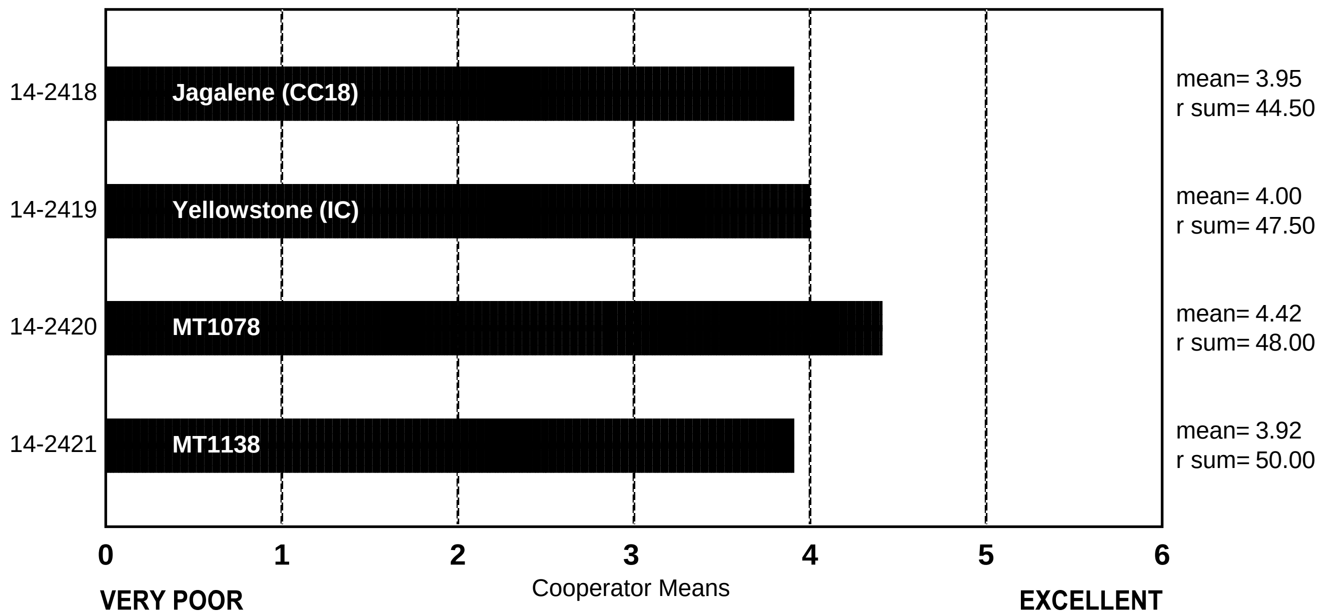
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Montana

ncoop= 19
chisq= 0.49
chisqc= 0.71
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Montana

	Sticky	Wet	Tough	Good	Excellent
14-2418 Jagalene (CC18)	3	4	0	11	1
14-2419 Yellowstone (IC)	1	1	8	8	1
14-2420 MT1078	1	0	2	13	3
14-2421 MT1138	0	2	7	9	1

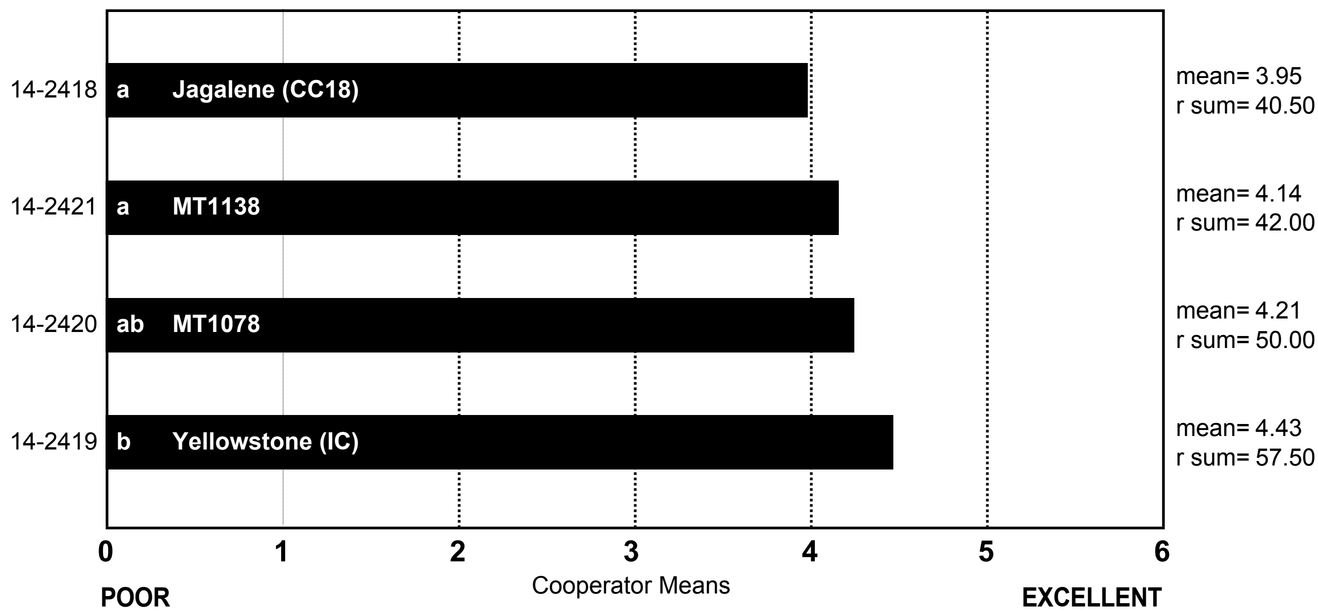
Frequency Table

CRUMB GRAIN

(Small Scale) Montana

ncoop= 19
chisq= 5.86
chisqc= 8.18
cvchisq= 7.82
crdiff= 12.85

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Montana

	Open	Fine	Dense
14-2418 Jagalene (CC18)	**9**	**9**	**1**
14-2419 Yellowstone (IC)	**2**	**12**	**5**
14-2420 MT1078	**5**	**12**	**2**
14-2421 MT1138	**4**	**11**	**4**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Montana

	Round	Irregular	Elongated
14-2418 Jagalene (CC18)	**5**	**9**	**5**
14-2419 Yellowstone (IC)	**4**	**3**	**12**
14-2420 MT1078	**6**	**5**	**8**
14-2421 MT1138	**3**	**9**	**7**

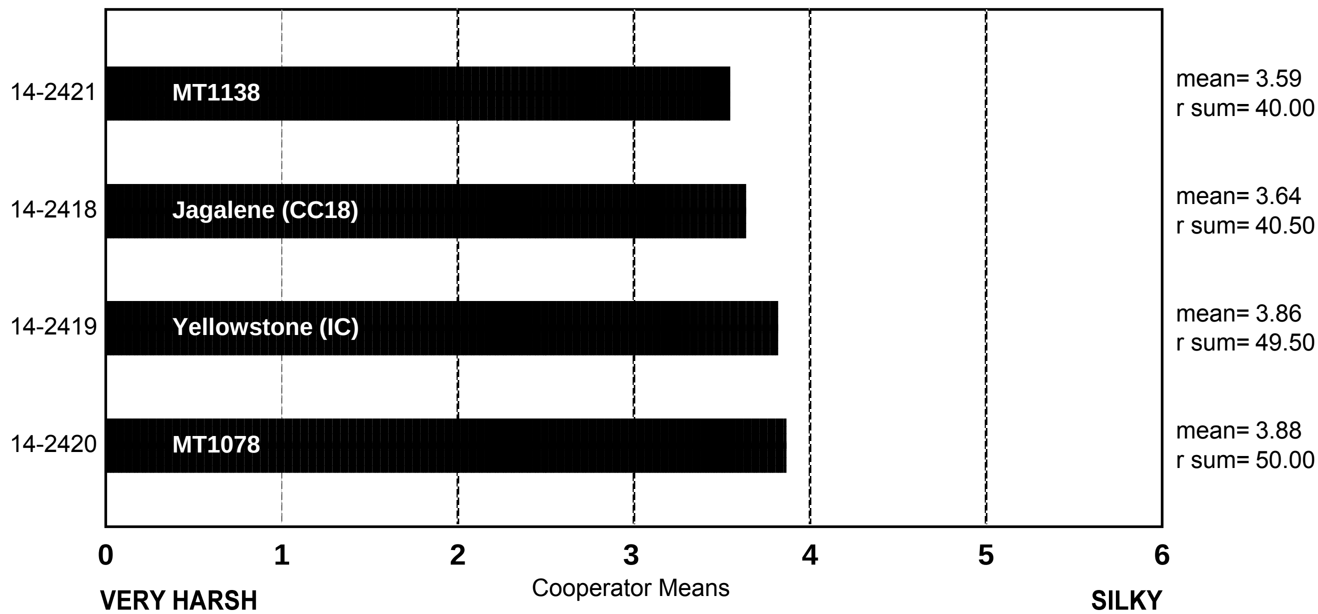
Frequency Table

CRUMB TEXTURE

(Small Scale) Montana

ncoop= 18
chisq= 3.02
chisqc= 5.43
cvchisq= 7.82
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Montana

	Harsh	Smooth	Silky
14-2418 Jagalene (CC18)	3	13	2
14-2419 Yellowstone (IC)	4	9	5
14-2420 MT1078	4	9	5
14-2421 MT1138	6	10	2

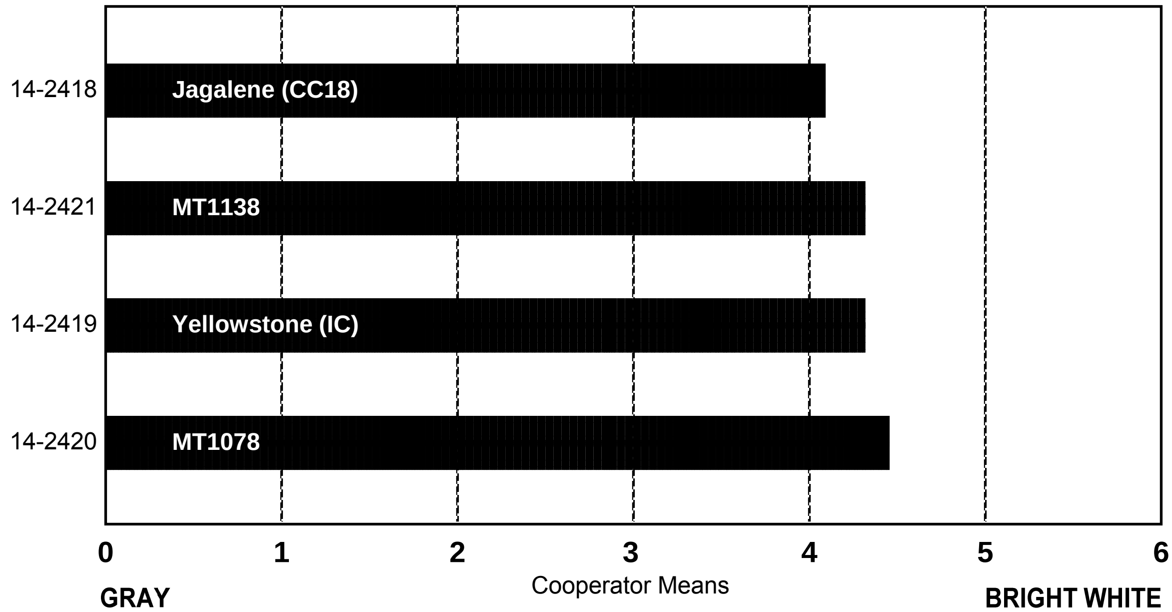
Frequency Table

CRUMB COLOR

(Small Scale) Montana

ncoop= 19
chisq= 0.71
chisqc= 1.34
cvchisq= 7.82
crdiff=

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



mean= 4.13
r sum= 43.50

mean= 4.34
r sum= 48.00

mean= 4.34
r sum= 49.00

mean= 4.46
r sum= 49.50

CRUMB COLOR, DESCRIBED

(Small Scale) Montana

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
14-2418 Jagalene (CC18)	**0**	**0**	**0**	**2**	**10**	**6**	**1**
14-2419 Yellowstone (IC)	**0**	**0**	**1**	**0**	**10**	**7**	**1**
14-2420 MT1078	**0**	**0**	**0**	**0**	**13**	**4**	**2**
14-2421 MT1138	**0**	**0**	**2**	**0**	**9**	**6**	**2**

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
14-2418 Jagalene (CC18)	**128.7**	**142.1**	**144.2**	**154.2**	**136.8**	**139.8**	**462.8**	**465.3**	**420.0**	**724.2**	**134.0**	**147.2**	**453.4**	**137.6**	**136.3**	**486.5**	**449.0**	**450.3**	**485.2**
14-2419 Yellowstone (IC)	**129.1**	**136.5**	**141.3**	**153.4**	**136.1**	**136.7**	**469.6**	**466.9**	**413.0**	**736.6**	**134.0**	**145.9**	**463.6**	**140.7**	**143.6**	**488.1**	**456.0**	**452.2**	**487.4**
14-2420 MT1078	**128.6**	**138.2**	**141.4**	**152.2**	**138.4**	**139.2**	**462.5**	**465.0**	**412.0**	**741.4**	**134.0**	**147.3**	**462.8**	**140.5**	**142.2**	**477.1**	**455.0**	**448.6**	**482.9**
14-2421 MT1138	**129.0**	**137.8**	**140.5**	**152.4**	**137.8**	**136.9**	**461.8**	**466.6**	**415.0**	**740.0**	**134.0**	**146.4**	**462.8**	**139.2**	**136.7**	**480.2**	**454.0**	**446.6**	**484.9**

LOAF VOLUME, ACTUAL

(Small Scale) Montana

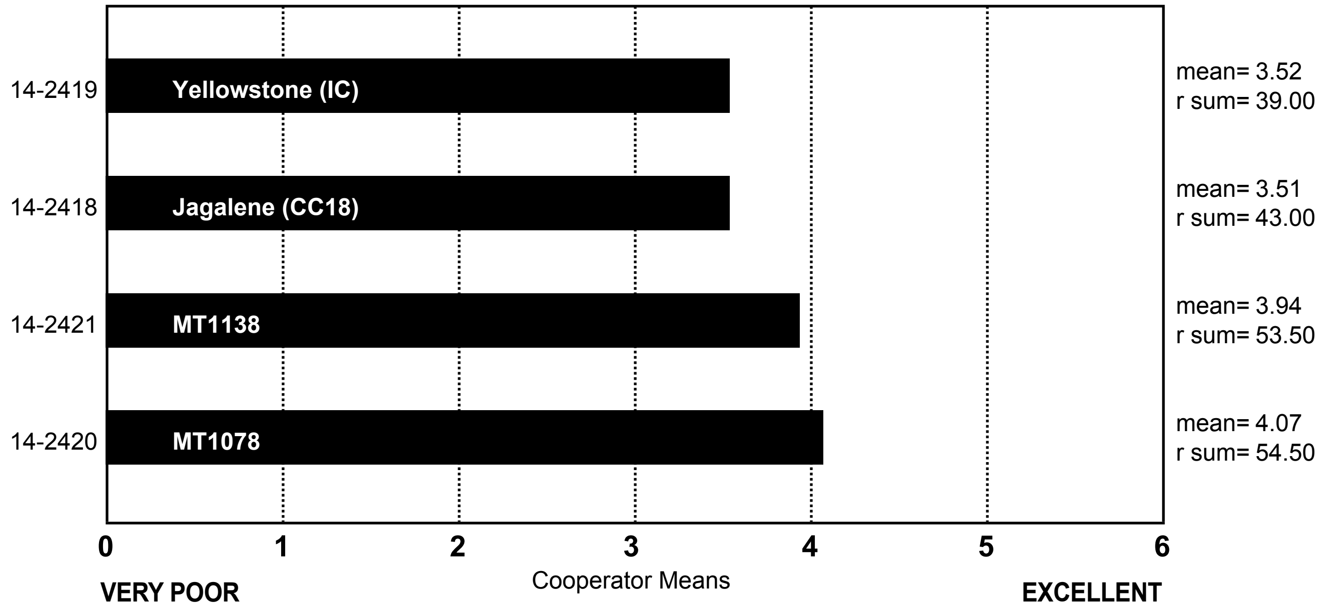
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2418 Jagalene (CC18)	**755**	**1080**	**980**	**980**	**993**	**815**	**2675**	**2575**	**2900**	**3930**	**955**	**930**	**2375**	**890**	**885**	**2956**	**1950**	**2450**	**2613**
14-2419 Yellowstone (IC)	**670**	**1045**	**895**	**950**	**953**	**860**	**2650**	**2463**	**3000**	**2955**	**965**	**900**	**2425**	**808**	**843**	**3104**	**1900**	**2430**	**2600**
14-2420 MT1078	**755**	**1165**	**980**	**995**	**965**	**865**	**2825**	**2450**	**3050**	**4205**	**978**	**960**	**2375**	**806**	**968**	**3074**	**2125**	**2480**	**2550**
14-2421 MT1138	**675**	**1090**	**985**	**990**	**960**	**890**	**2700**	**2325**	**3100**	**3180**	**960**	**945**	**2400**	**862**	**988**	**3104**	**2125**	**2525**	**2613**

LOAF VOLUME

(Small Scale) Montana

ncoop= 19
chisq= 5.61
chisqc= 7.72
cvchisq= 7.82
crdiff=

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

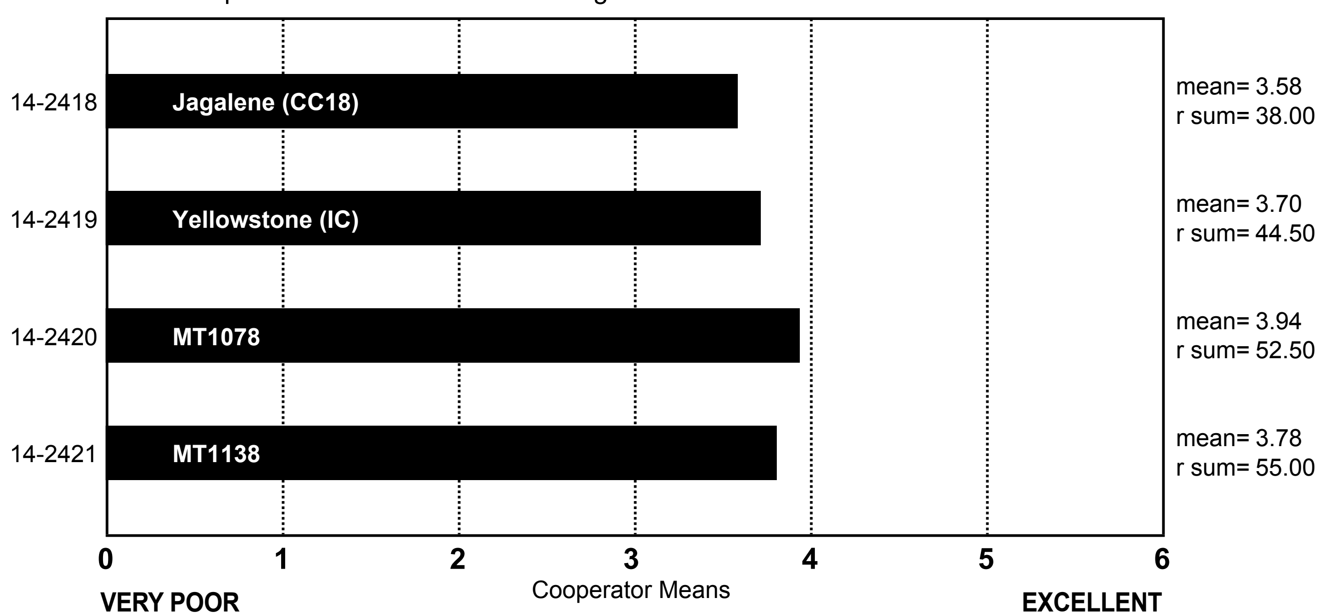


OVERALL BAKING QUALITY

(Small Scale) Montana

ncoop= 19
chisq= 5.70
chisqc= 6.94
cvchisq= 7.82
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Montana

COOP. 14-2418 Jagalene (CC18)

A. Poor dough performance, okay oven spring.
B. Nice loaf externals.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Normal water absorption and mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, little open elongated cells, smooth & resilient texture.
F. Weaker gluten, poor loaf volume for protein.
G. No comment.
H. Average absorption, above average mix, average volume, white, open grain.
I. Short mix, average volume and protein, slightly dull, open grain.
J. No comment.
K. Good bake performance, slightly low volume.
L. Good flour protein, good bake absorption and mix time, excellent dough at pan, good crumb grain and loaf volume.
M. No comment.
N. 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
O. No comment.
P. Sticky doughs, above average interior scores, good volume.
Q. Shelled, capped break and shred.
R. Excellent mix time and dough, good oven spring but didn't hold it at volume test, bread had average volume with an open grain, bright white in color.
S. Short mix time, good grain, good volume.

COOP. 14-2419 Yellowstone (IC)

A. Lower flout protein, long mixer, good dough performance however, low loaf volume.
B. Long mix time, rough break.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Normal water absorption, very long mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, fine & elongated cells, very smooth & resilient texture.
F. Low protein, tough dough with good bread quality.
G. No comment.
H. Low absorption, average mix, low volume, white, open grain.
I. Tough and bucky, excellent volume, low protein.
J. No comment.
K. Great volume, best cell structure, short mix was underdeveloped.
L. Lower flour protein, long mix time but good dough strength with excellent crumb grain, nice strong mixograph.
M. No comment.
N. 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

O. No comment.
P. Very tight, consistent grain, silky texture, excellent volume.
Q. Poor volume.
R. Dough was good, lower volume, good dense grain.
S. Average absorption, long mix time, fine grain, good volume.

COOP. 14-2420 MT1078

A. Lower flour protein, longer mixer, smooth and pliable, nice oven spring.
B. Excellent loaf externals.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Low water absorption, long mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, fine & elongated cells, smooth & resilient texture.
F. Low protein but baked well.
G. No comment.
H. Low absorption, average mix, low volume, creamy, open grain.
I. Slightly stronger dough, dull interior, good out of mixer, good volume.
J. No comment.
K. Good bake performance and volumes.
L. Very similar to 2419, excellent crumb grain, creamy color with excellent loaf volume, nice mixograph.
M. No comment.
N. 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
O. No comment.
P. Tight, consistent grain, silky texture, good volume, good crumb color.
Q. Slight wild break and shred.
R. Dough was good, lower volume, good dense grain.
S. Average absorption, open grain, average volume.

COOP. 14-2421 MT1138

A. Elastic/pliable.
B. Rough break.
C. 1 large hole.
D. Good dough properties and bake performance for protein level.
E. Normal absorption, long mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, fine & elongated cells, smooth & resilient texture.
F. Very good crumb characteristics with acceptable volume.
G. No comment.
H. Low absorption, slightly above average mix, very low volume, creamy, open grain.
I. Tough and bucky, long mix, excellent volume, slightly open grain.
J. Overall poor performance.
K. Good bake performance and volumes.
L. Similar to 2420, long mix time but good dough with satisfactory crumb grain, creamy crumb color, nice mixograph.
M. No comment.

N. 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
O. No comment.
P. Tight, streaky grain, excellent volume.
Q. Slight wild break and shred.
R. Higher mix time, good dough, good volume with a dense grain and a bright white color.
S. Average absorption, long mix time, very fine grain, white crumb, good volume.

Notes: **G, H, I, K, P, Q, R and S** conducted sponge and dough bake tests

OKLAHOMA

14-2422	Jagalene (CC22)
14-2423	Ruby Lee (IC)
14-2424	OK09125
14-2425	OK10126

Description of Test Plots and Breeder Entries

Oklahoma - Brett Carver

Grain samples for the 2014 WQC hard winter wheat evaluation program were produced in Oklahoma at the North Central Agronomy Research Station at Lahoma (near Enid, OK). No supplemental irrigation is available at this location. Chronic drought throughout the spring eliminated any need for fungicides, and the drought reduced grain yields to levels much lower than anticipated when pre-plant fertilizer applications occurred. The enhanced nitrogen availability elevated protein levels about one percentage unit above normal.

Entries included in the Oklahoma set include the standard check, Jagalene, produced alongside the two experimentals and local check, Ruby Lee. Over the past two years, acres of Ruby Lee have increased in Oklahoma second only to Gallagher. It has been evaluated in the WQC program every year since 2009 except for 2011. Both experimental entries are currently under multi-year evaluation in the USDA-ARS Southern Regional Performance Nursery.

14-2423 **Ruby Lee**

This variety has become a local favorite in junior wheat show contests, owing to its reliable milling and baking excellence. That seems a little odd, given one of its parents (KS94U275/OK94P549) is Endurance, a variety that rarely made it past the visual exam in the wheat show to even qualify for baking. Ruby Lee was released in 2011 and positioned as an alternative to Billings east of the Oklahoma panhandle in non-acidic areas. For every acre of Duster replaced with Ruby Lee, the state's wheat crop gets a 20% boost in kernel size with no decline in test weight. And, Ruby Lee throws a fresh-baked cow pie in the face of false claims that good grazing wheats can't make good quality. Relative to Billings, Ruby Lee has better cold and drought tolerance, greater tolerance to Hessian fly and barley yellow dwarf, wider adaptation, but inferior protection against stripe rust.

14-2424 **OK09125**

This HRW candidate from the cross, TAM 303/Overley, is in its final year of variety trial testing in Oklahoma as an experimental, and second year of foundation seed production. A release decision will not be rendered until late spring 2015. OK09125 maintained a statewide 4 to 7% yield advantage over Gallagher and Iba in 2012 and 2013, but could not out-perform Iba in 2014. Its strengths lie in grazing tenacity and yield after grazing, avoidance of physiological leaf spot, and tolerance to barley yellow dwarf and soil acidity. Main weaknesses include test weight (about average but at times humiliating), shattering tendency (its greatest vulnerability) with early maturity, and moderate reaction to spot blotch. Several years of quality evaluations point to good water absorption and very good dough strength based on mixograph, farinograph, and alveograph tests. Crumb scores have been average to above-average. No other OSU experimental can claim pushing its perpetrator to the ends of ecstasy and anguish in a single breath.

***14-2425* OK10126**

This HRW candidate comes with a completely different portfolio than OK09125. Its parentage is OK Bullet/OK98680 reseln, in which OK98580 resulted from a cross of an Odessa variety with Mesa. OK10126 has a very high yield ceiling with excellent straw strength. If ever released, it would be pushed toward the more intensively managed acres that typically are not subjected to grazing, or acres not planted early. An inclination to late winter freeze damage confirms its parentage. OK10126 is the proud carrier of *Lr34r* (not *Lr34-Dr*), *Rht8*, and *Wx-B1b*. Its stripe rust resistance appears to extend well beyond *Lr34/Yr18*, however. Leaf hygiene is outstanding in the absence of a severe infection of barley yellow dwarf or powdery mildew. We are particularly intrigued by what appears to be an unusually high insoluble fiber content relative to U.S. commercial whole-wheat flours. Most notably, OK10126 can produce flour with very high protein content, another signal of its OK Bullet lineage. As for protein quality, dough strength and bake tests indicate that everything in this berry is copacetic.

Oklahoma: 2014 (Small-Scale) Samples

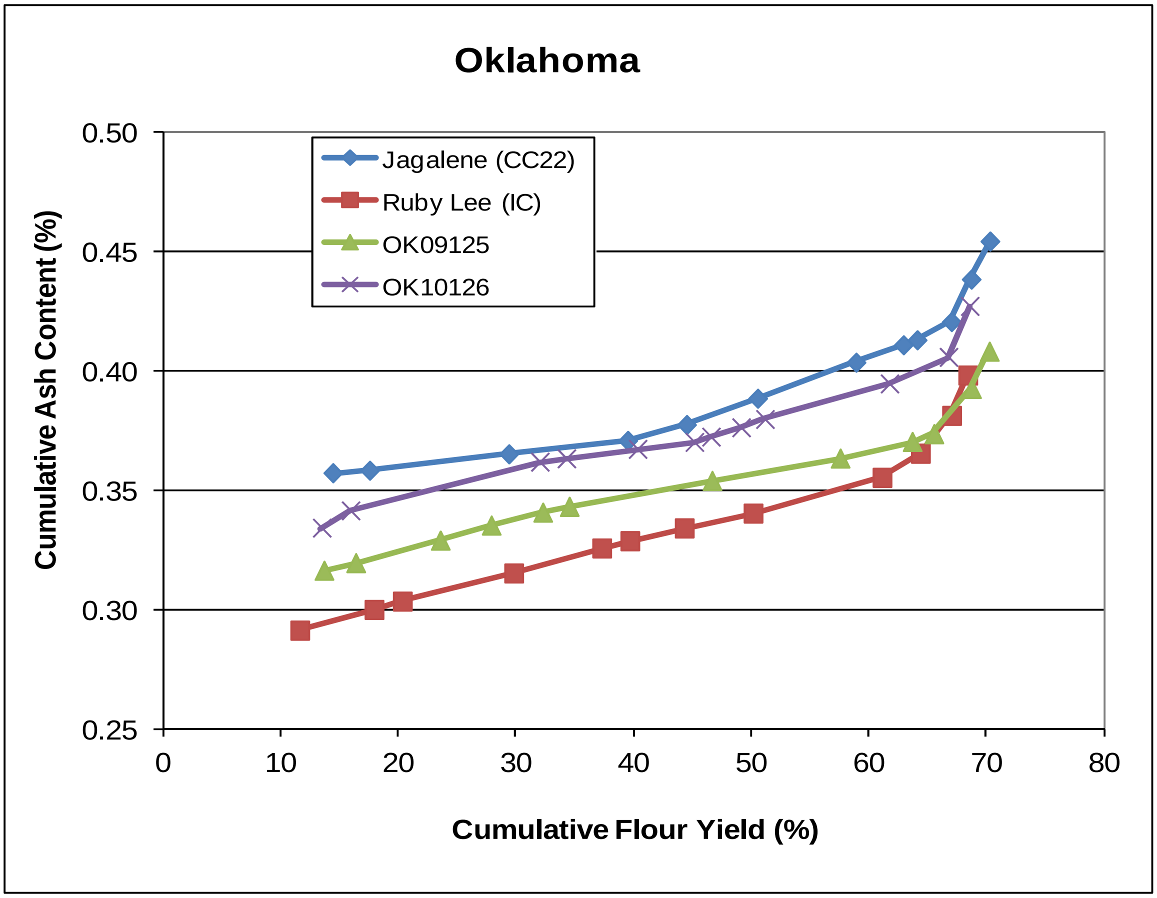
Test entry number	14-2422	14-2423	14-2424	14-2425
Sample identification	**Jagalene (CC22)**	**Ruby Lee (IC)**	**OK09125**	**OK10126**
Wheat Data				
GIPSA classification	1 HRW	1 HRW	2 HRW	2 HRW
Test weight (lb/bu) **Hectoliter weight (kg/hl)**	60.8 80.0	60.3 79.3	59.3 78.0	59.8 78.7
1000 kernel weight (gm)	28.1	30.9	30.0	27.1
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 47.4 52.6 0.0	 63.7 36.2 0.1	 62.2 37.6 0.2	 46.7 53.0 0.3
Single kernel (skcs)[a] Hardness (avg /s.d) Weight (mg) (avg/s.d) Diameter (mm)(avg/s.d) Moisture (%) (avg/s.d) SKCS distribution Classification	 67.7/16.1 28.1/7.1 2.59/0.30 12.2/0.3 02-05-16-77-01 Hard	 46.1/13.4 30.9/8.0 2.63/0.3 12.4/0.3 15-32-38-15-03 Mixed	 54.4/12.8 30.0/8.5 2.63/0.33 12.2/0.3 06-18-41-35-02 Hard	 69.0/14.0 27.1/7.3 2.56/0.27 12.0/0.3 01-05-15-79-01 Hard
Wheat protein (12% mb) **Wheat ash (12% mb)**	13.8 1.03	13.6 1.10	13.1 1.08	13.7 1.08
Milling and Flour Quality Data				
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 71.4 70.8	 69.6 68.5	 69.9 71.3	 70.2 68.3
Flour moisture (%) **Flour protein (14% mb)** **Flour ash (14% mb)**	13.5 12.6 0.45	12.3 12.3 0.40	13.3 11.7 0.39	13.1 12.4 0.43
Rapid Visco-Analyser Peak Time (min) Peak Viscosity (RVU) Breakdown (RVU) Final Viscosity at 13 min (RVU)	 5.9 213.3 77.3 258.3	 6.0 249.1 87.3 298.5	 6.1 236.8 74.8 296.7	 5.9 241.5 110.1 232.3
Minolta color meter L* a* b* **PPO**	 92.27 -1.97 10.58 0.647	 92.38 -1.53 7.81 0.881	 92.72 -1.99 9.49 0.735	 92.34 -1.66 9.05 0.683
Falling number (sec)	558	590	531	548
Damaged Starch (AI%) (AACC76-31)	 96.48 6.65	 93.63 4.58	 94.92 5.47	 96.58 6.47

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

Oklahoma: Physical Dough Tests and Gluten Analysis For 2014 (Small-Scale) Samples

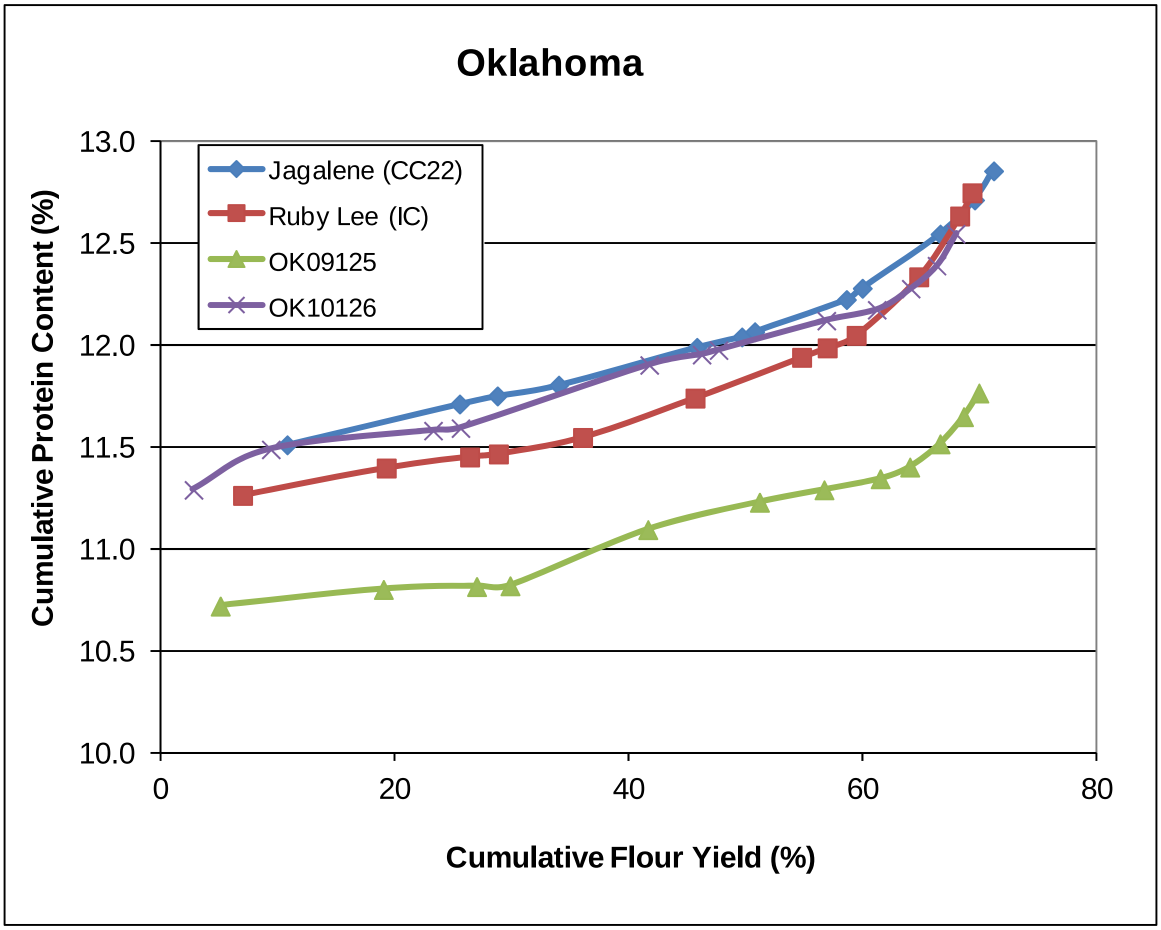
Test Entry Number	14-2422	14-2423	14-2424	14-2425
Sample Identification	Jagalene (CC22)	Ruby Lee (IC)	OK09125	OK10126
MIXOGRAPH				
Flour Abs (% as-is)	65.0	66.2	63.7	65.3
Flour Abs (14% mb)	64.1	64.1	62.6	64.0
Mix Time (min)	4.9	4.5	4.3	5.0
Mix tolerance (0-6)	4	4	4	5
FARINOGRAPH				
Flour Abs (% as-is)	60.3	58.8	59.2	61.4
Flour Abs (14% mb)	59.4	56.6	58.2	60.0
Development time (min)	20.7	18.5	21.4	23.6
Mix stability (min)	28.5	35.5	32.3	25.0
Mix Tolerance Index (FU)	3	5	5	8
Breakdown time (min)	36.0	38.0	39.8	33.0
ALVEOGRAPH				
P(mm): Tenacity	73	61	63	80
L(mm): Extensibility	152	156	166	140
G(mm): Swelling index	27.4	27.8	28.7	26.3
W(10^{-4} J): strength (curve area)	401	328	348	401
P/L: curve configuration ratio	0.48	0.39	0.38	0.57
Ie(P_{200}/P): elasticity index	67.3	63.1	62.1	64.5
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	414/541/641	439/614/662	413/548/571	448/532/587
Extensibility (mm at 45/90/135 min)	160/174/159	183/165/162	169/174/167	164/166/169
Energy (cm^2 at 45/90/135 min)	130/200/199	163/203/211	133/203/196	143/181/202
Resist $_{max}$ (BU at 45/90/135 min)	633/932/999	694/999/1000	602/935/951	688/885/980
Ratio (at 45/90/135 min)	2.59/3.11/4.04	2.40/3.72/4.08	2.45/3.16/3.42	2.74/3.20/3.48
PROTEIN ANALYSIS				
HMW-GS Composition	1/2*, 17+18, 5+10	2*, 7+8, 2+12	1, 17+18, 5+10	1, 7+8, 5+10
%IPP	48.07	46.47	44.49	48.39
SEDIMENTATION TEST				
Volume (ml)	67.4	71.4	69.2	64.1

Oklahoma: Cumulative Ash Curves



Jagalene (CC22)					Ruby Lee (IC)					OK09125					OK10126				
Mill	Strm-yld	Ash	Cumul (14%)		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	Streams	(14%mb)		Yield	Ash
2M	14.37	0.36	14.37	0.36	2M	11.57	0.29	11.57	0.29	2M	13.62	0.32	13.62	0.32	2M	13.4	0.33	13.4	0.33
1M Red	3.13	0.36	17.50	0.36	1M	6.32	0.32	17.88	0.30	1M Red	2.70	0.34	16.32	0.32	1BK	2.5	0.38	15.9	0.34
3M	11.83	0.38	29.33	0.37	1M Red	2.40	0.33	20.28	0.30	1M	7.18	0.35	23.51	0.33	3M	16.1	0.38	32.0	0.36
1M*	10.10	0.39	39.43	0.37	3M	9.47	0.34	29.75	0.32	1BK	4.33	0.37	27.84	0.34	1M Red	2.3	0.38	34.2	0.36
1BK	5.01	0.43	44.44	0.38	4M	7.48	0.37	37.23	0.33	2BK	4.38	0.38	32.22	0.34	1M	6.0	0.39	40.3	0.37
2BK	6.04	0.47	50.48	0.39	Grader	2.38	0.38	39.61	0.33	Grader	2.25	0.38	34.47	0.34	4M	4.8	0.39	45.1	0.37
FILTER FLR	8.35	0.49	58.83	0.40	2BK	4.62	0.38	44.24	0.33	3M	12.14	0.38	46.60	0.35	Grader	1.4	0.44	46.5	0.37
4M	4.03	0.52	62.86	0.41	1BK	5.85	0.39	50.09	0.34	FILTER FLR	10.88	0.40	57.49	0.36	2BK	2.6	0.45	49.1	0.38
Grader	1.17	0.53	64.03	0.41	FILTER FLR	10.96	0.42	61.05	0.36	4M	6.13	0.44	63.61	0.37	3BK	2.0	0.46	51.1	0.38
3BK	2.90	0.59	66.94	0.42	3BK	3.25	0.56	64.31	0.37	3BK	1.84	0.49	65.45	0.37	FILTER FLR	10.6	0.47	61.7	0.39
BRAN FLR	1.69	1.14	68.63	0.44	5M	2.65	0.77	66.96	0.38	5M	3.20	0.78	68.65	0.39	5M	5.0	0.54	66.7	0.41
5M	1.58	1.14	70.21	0.45	BRAN FLR	1.38	1.22	68.34	0.40	BRAN FLR	1.51	1.12	70.16	0.41	BRAN FLR	1.8	1.22	68.5	0.43
Break Shorts	1.68	1.97	71.89	0.49	Break Shorts	4.85	2.87	73.19	0.56	Break Shorts	3.34	2.57	73.50	0.51	Break Shorts	3.2	2.17	71.7	0.50
Red Dog	1.35	2.24	73.24	0.52	Red Dog	2.01	1.55	75.20	0.59	Red Dog	1.74	1.78	75.24	0.54	Red Dog	2.1	1.44	73.8	0.53
Red Shorts	0.14	3.07	73.38	0.53	Red Shorts	0.28	2.86	75.48	0.60	Red Shorts	0.16	2.89	75.40	0.54	Red Shorts	0.1	2.67	73.9	0.53
Filter Bran	8.96	1.32	82.34	0.61	Filter Bran	8.78	1.35	84.26	0.68	Filter Bran	7.48	1.07	82.88	0.59	Filter Bran	6.9	0.89	80.8	0.56
Bran	17.66	3.46	100.0	1.12	Bran	15.74	3.81	100.0	1.17	Bran	17.12	3.61	100.0	1.11	Bran	19.2	3.43	100.0	1.11
Wheat		1.00					1.08					1.06					1.05		
St. Grd. Fl.		0.45					0.40					0.39					0.43		

Oklahoma: Cumulative Protein Curves

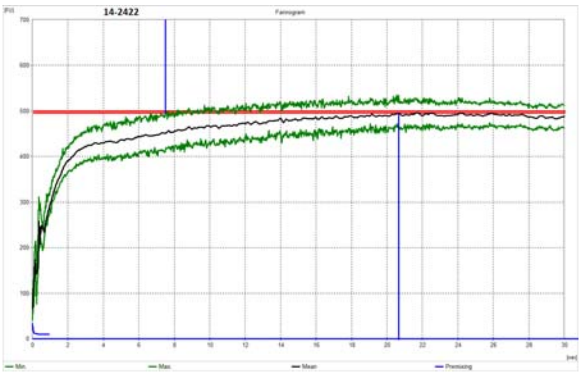


Jagalene (CC22)					Ruby Lee (IC)				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1M*	10.84	11.51	10.84	11.51	1M	7.04	11.26	7.04	11.26
2M	14.73	11.86	25.58	11.71	2M	12.27	11.47	19.32	11.40
1M Red	3.23	12.06	28.81	11.75	1BK	7.13	11.60	26.44	11.45
1BK	5.24	12.09	34.04	11.80	1M Red	2.45	11.63	28.90	11.47
3M	11.81	12.52	45.85	11.99	4M	7.20	11.87	36.10	11.55
4M	3.84	12.65	49.69	12.04	3M	9.60	12.47	45.70	11.74
Grader	1.11	13.22	50.80	12.06	FILTER FLR	9.11	12.94	54.81	11.94
FILTER FLR	7.84	13.24	58.63	12.22	5M	2.18	13.16	56.99	11.99
5M	1.36	14.68	59.99	12.28	Grader	2.48	13.46	59.47	12.05
2BK	6.65	14.94	66.64	12.54	2BK	5.35	15.52	64.81	12.33
3BK	2.95	16.49	69.59	12.71	3BK	3.50	18.17	68.31	12.63
BRAN FLR	1.62	18.98	71.21	12.85	BRAN FLR	1.06	20.06	69.37	12.75
Break Shorts	1.74	14.45	72.95	12.89	Break Shorts	4.82	17.67	74.19	13.07
Red Dog	1.07	15.65	74.02	12.93	Red Dog	1.60	14.25	75.79	13.09
Red Shorts	0.11	14.53	74.13	12.93	Red Shorts	0.21	14.49	76.00	13.09
Filter Bran	8.64	14.14	82.76	13.06	Filter Bran	7.66	13.33	83.66	13.12
Bran	17.24	16.61	100.00	13.67	Bran	16.34	16.45	100.00	13.66
Wheat		13.50					13.33		
St. Grd. Fl		12.61					12.45		

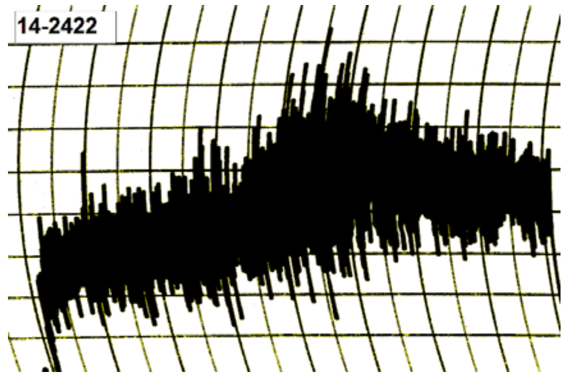
OK09125					OK10126				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1BK	5.14	10.72	5.14	10.72	1BK	2.86	11.29	2.86	11.29
2M	13.94	10.83	19.07	10.80	1M	6.60	11.57	9.46	11.49
1M	7.97	10.85	27.04	10.81	2M	13.86	11.64	23.32	11.58
1M Red	2.86	10.85	29.89	10.82	1M Red	2.35	11.71	25.66	11.59
3M	11.77	11.79	41.67	11.09	3M	16.12	12.39	41.79	11.90
FILTER FLR	9.54	11.82	51.21	11.23	4M	4.47	12.43	46.26	11.95
4M	5.51	11.85	56.72	11.29	Grader	1.45	12.69	47.71	11.97
2BK	4.80	11.99	61.52	11.34	FILTER FLR	9.21	12.87	56.92	12.12
5M	2.52	12.80	64.05	11.40	5M	4.31	12.88	61.23	12.17
Grader	2.59	14.33	66.64	11.51	2BK	2.90	14.46	64.13	12.28
3BK	2.01	16.07	68.64	11.65	3BK	2.21	15.67	66.34	12.39
BRAN FLR	1.31	17.82	69.96	11.76	BRAN FLR	1.64	18.88	67.97	12.54
Break Shorts	3.50	15.47	73.46	11.94	Break Shorts	3.33	15.64	71.30	12.69
Red Dog	1.32	14.06	74.79	11.98	Red Dog	1.79	15.46	73.09	12.76
Red Shorts	0.11	14.36	74.90	11.98	Red Shorts	0.09	15.36	73.19	12.76
Filter Bran	6.64	13.14	81.54	12.08	Filter Bran	6.38	12.93	79.56	12.77
Bran	18.46	16.75	100.00	12.94	Bran	20.44	17.22	100.00	13.68
		12.78					13.39		
		11.71					12.41		

Physical Dough Tests
2014 (Small Scale) Samples – Oklahoma

Farinograms | **Mixograms**

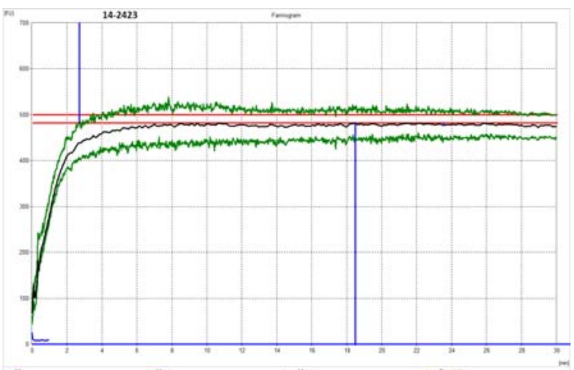


Water abs = 59.4%, Peak time = 20.7 min,
Mix stab = 28.5 min, MTI = 3 FU

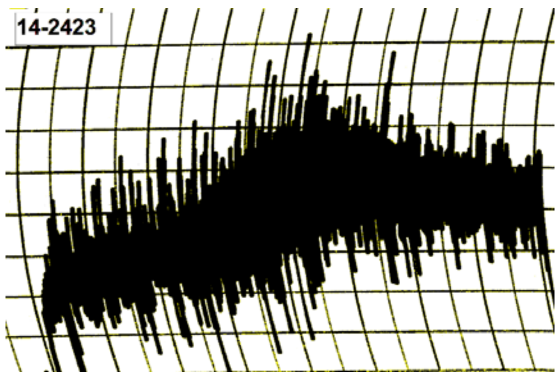


Water abs = 64.1%
Mix time = 4.9 min

14-2422, Jagalene (CC22)



Water abs = 56.6%, Peak time = 18.5 min,
Mix stab = 35.5min, MTI = 5 FU

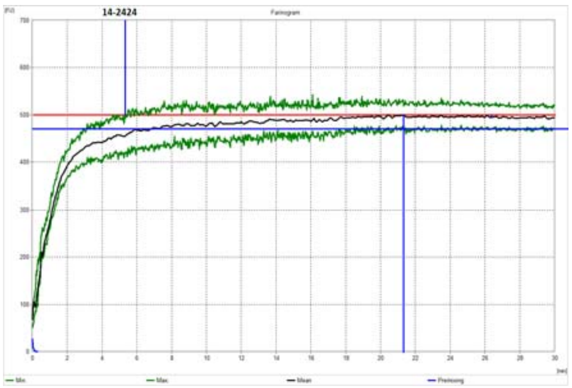


Water abs = 64.1%
Mix time = 4.5 min

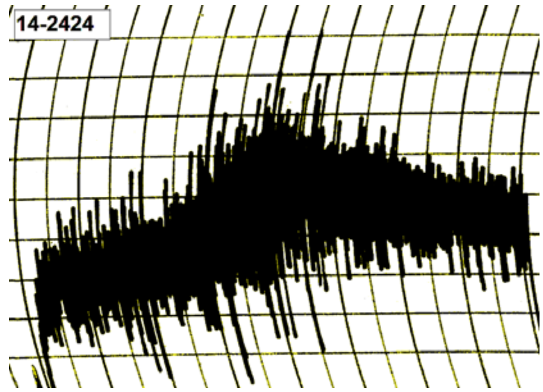
14-2423, Ruby Lee (IC)

Physical Dough Tests
2014 (Small Scale) Samples – Oklahoma (continued)

Farinograms | **Mixograms**

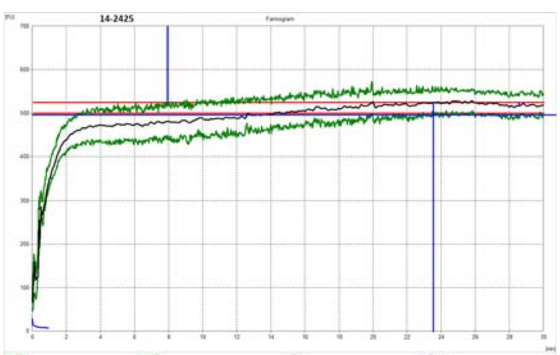


Water abs. = 58.2%, Peak time = 21.4 min,
Mix stab = 32.3 min, MTI = 5 FU

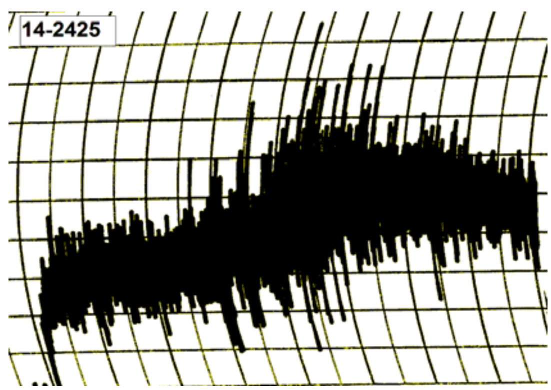


Water abs = 62.6%
Mix time = 4.3 min

14-2424, OK09125



Water abs. = 60.0%, Peak time = 23.6 min,
Mix stab = 25.0 min, MTI = 8 FU

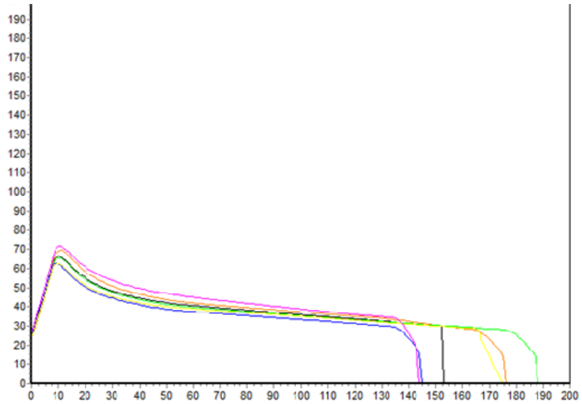


Water abs = 64.0%
Mix time = 5.0 min

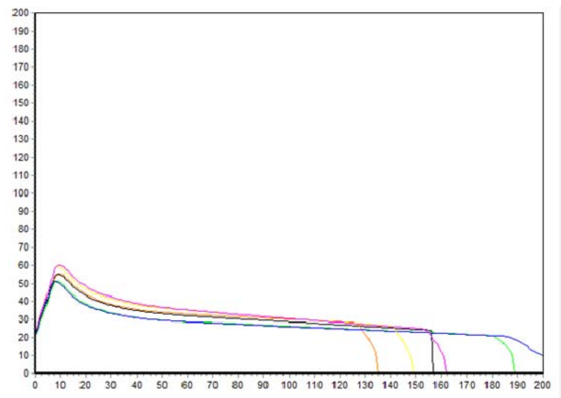
14-2425, OK10126

Physical Dough Tests - Alveograph

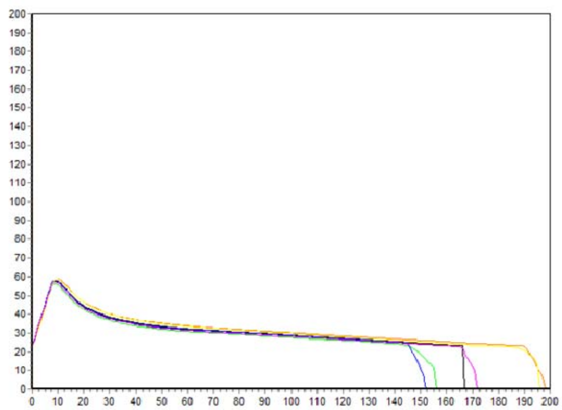
2014 (Small Scale) Samples – Oklahoma



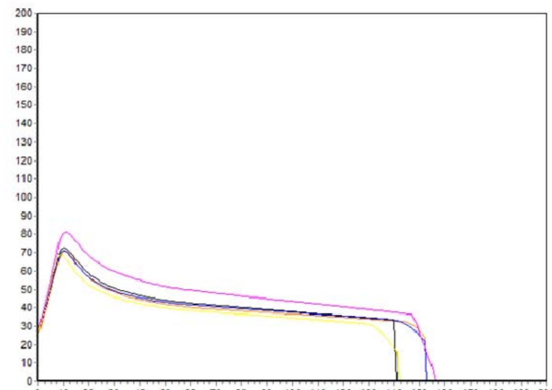
14-2422, Jagalene (CC22)
P (mm H_20) = 73, L (mm) = 152, W ($10E^{-4}J$) = 401



14-2423, Ruby Lee (IC)
P (mm H_20) = 61, L (mm) = 156, W ($10E^{-4}J$) = 328



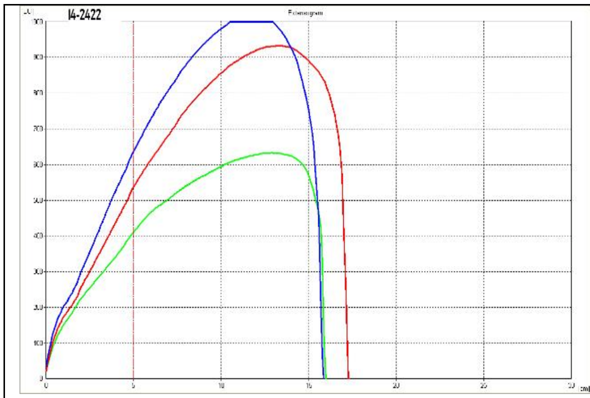
14-2424, OK09125
P (mm H_20) = 63, L (mm) = 166, W ($10E^{-4}J$) = 348



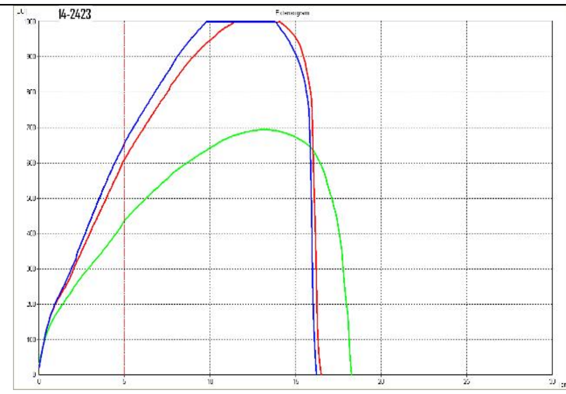
14-2425, OK10126
P (mm H_20) = 80, L (mm) = 140, W ($10E^{-4}J$) = 401

Physical Dough Tests - Extensigraph

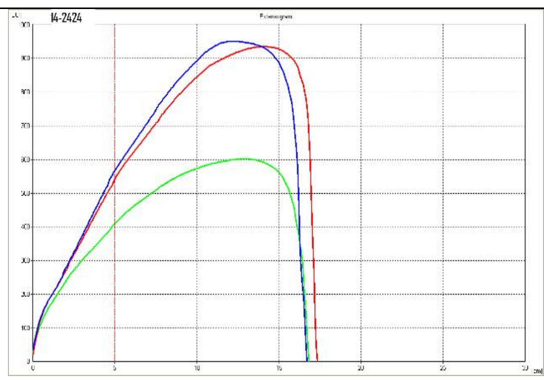
2014 (Small Scale) Samples – Oklahoma



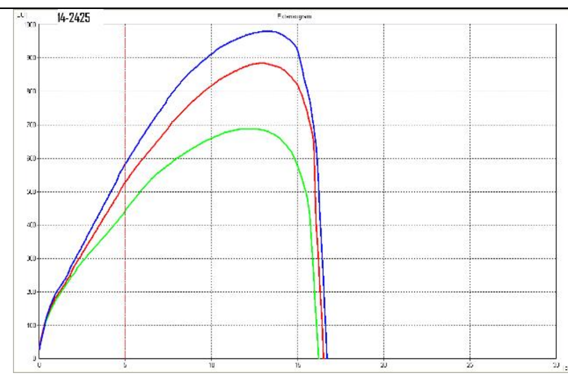
14-2422, Jagalene (CC22)
R (BU) = 541, E (mm) = 174, W (cm^2) = 200
Rmax (BU) = 932, Ratio = 3.11 at 90 min



14-2423, Ruby Lee (IC)
R (BU) = 614, E (mm) = 165, W (cm^2) = 207
Rmax (BU) = 999, Ratio = 3.72 at 90 min



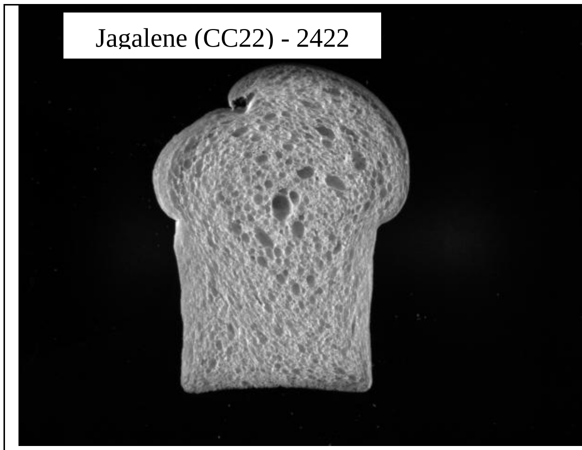
14-2424, OK09125
R (BU) = 548, E (mm) = 174, W (cm^2) = 203
Rmax (BU) = 935, Ratio = 3.16 at 90 min

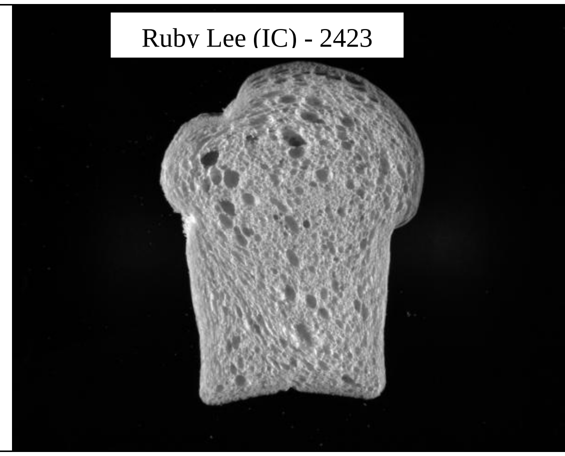


14-2425, OK10126
R (BU) = 532, E (mm) = 166, W (cm^2) = 181
Rmax (BU) = 885, Ratio = 3.20 at 90 min

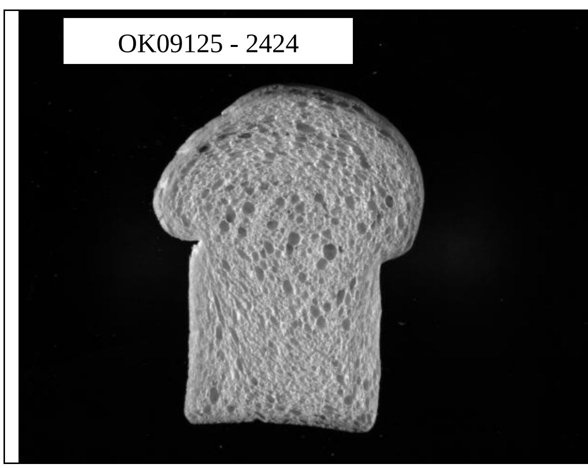
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Oklahoma: C-Cell Bread Images and Analysis for 2014 (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})
2422	7154	145.0	4345	0.444	2.134	1.700	1.713	-17.88
2423	7223	144.4	4460	0.445	2.161	3.548	1.703	-15.23



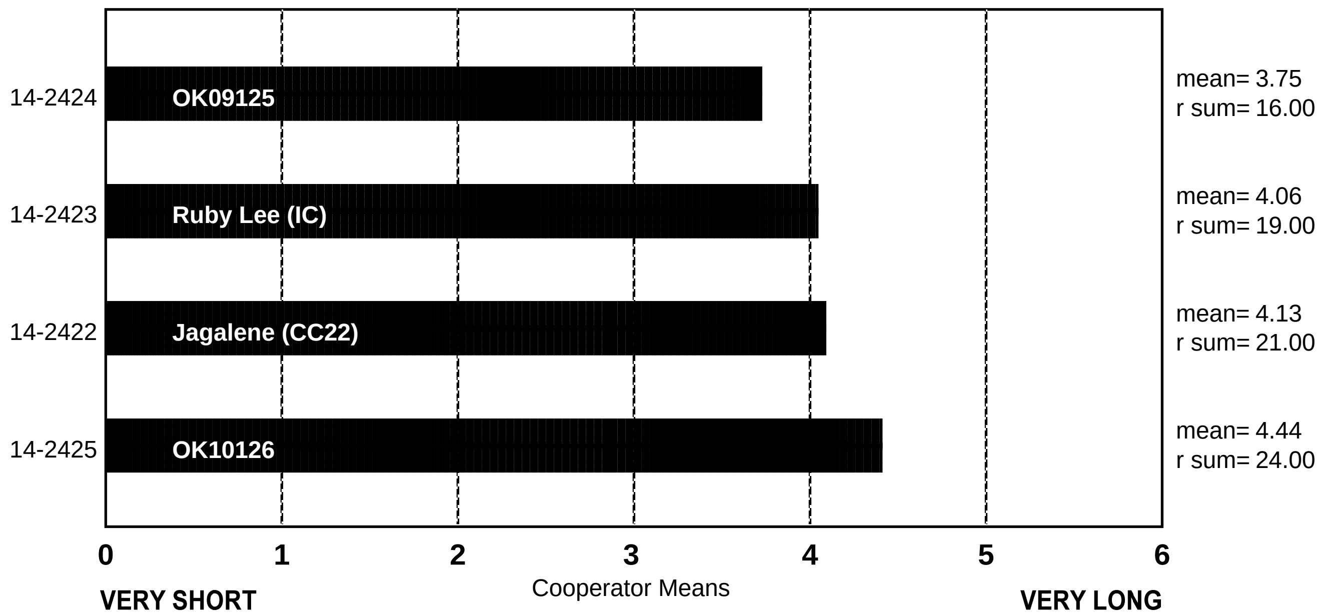
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2424	7192	145.4	4308	0.447	2.196	3.592	1.740	-12.90
2425	6793	136.9	3659	0.465	2.343	4.500	1.660	-13.40

SPONGE CHARACTERISTICS

(Small Scale) Oklahoma

ncoop= 8
chisq= 2.55
chisqc= 6.80
cvchisq= 7.82
crdiff=

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

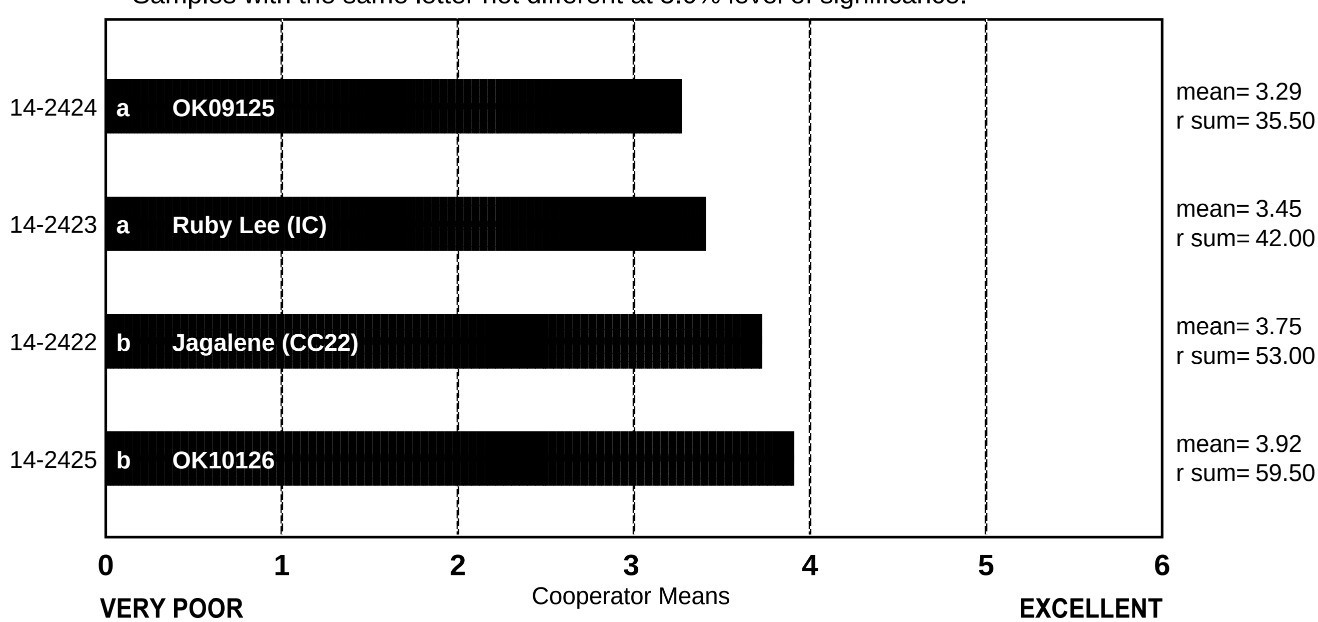


BAKE ABSORPTION

(Small Scale) Oklahoma

ncoop= 19
chisq= 11.01
chisqc= 17.87
cvchisq= 7.82
crdiff= 10.67

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
14-2422 Jagalene (CC22)	60.3	64.6	62.6	66.0	63.0	64.5	59.5	59.4	59.0	64.8	63.0	62.8	60.3	63.9	66.0	59.0	60.5	63.3	60.0
14-2423 Ruby Lee (IC)	57.1	65.0	62.7	65.1	62.0	64.0	62.0	56.6	59.0	62.1	63.0	62.1	58.8	64.3	66.0	58.0	59.0	61.8	59.0
14-2424 OK09125	59.1	63.1	61.4	65.9	61.0	62.0	60.5	58.2	58.0	63.8	61.0	61.6	59.6	62.5	65.0	59.0	59.0	62.2	59.0
14-2425 OK10126	60.0	63.8	62.7	66.5	62.5	63.5	60.0	60.0	59.0	66.2	63.0	62.9	61.4	64.2	66.0	60.0	61.5	64.4	61.0

BAKE MIX TIME, ACTUAL

(Small Scale) Oklahoma

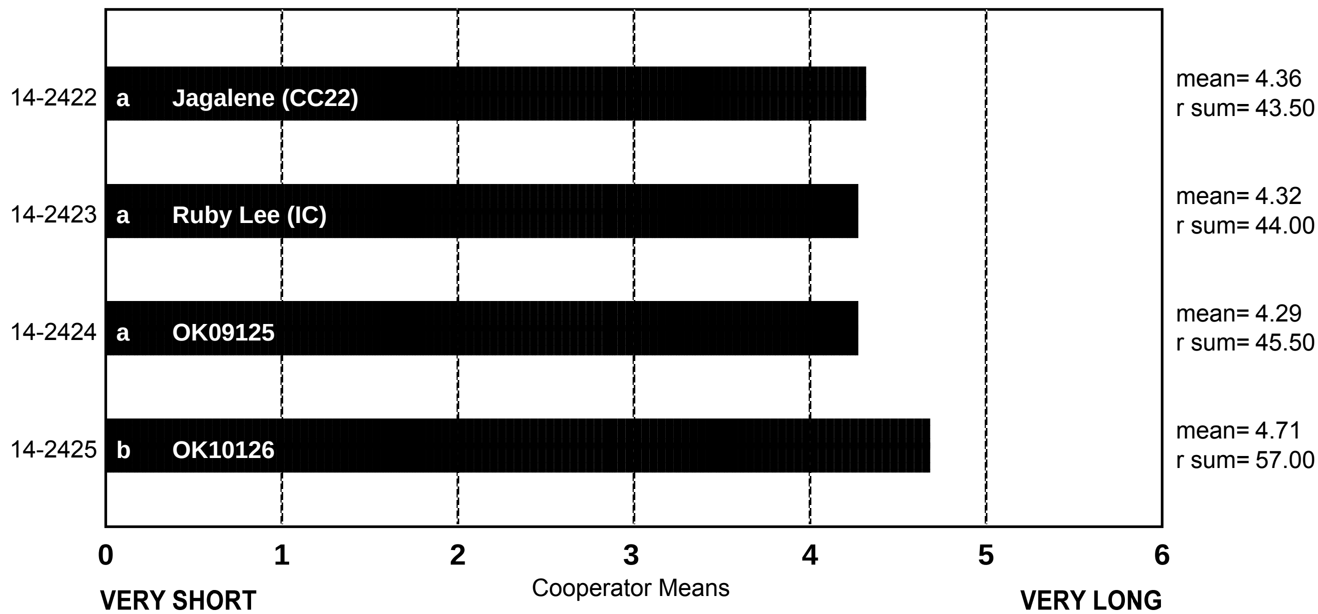
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2422 Jagalene (CC22)	**3.8**	**5.0**	**4.3**	**6.1**	**7.8**	**3.6**	**30.0**	**10.0**	**9.0**	**6.0**	**9.0**	**6.4**	**8.0**	**4.9**	**5.5**	**25.0**	**10.0**	**7.0**	**7.0**
14-2423 Ruby Lee (IC)	**3.8**	**5.5**	**4.0**	**4.8**	**6.4**	**3.4**	**30.0**	**10.0**	**9.0**	**6.0**	**9.0**	**7.0**	**8.5**	**4.5**	**5.0**	**25.0**	**11.0**	**9.0**	**7.0**
14-2424 OK09125	**3.5**	**5.0**	**4.0**	**4.5**	**6.2**	**3.4**	**30.0**	**12.0**	**9.0**	**6.5**	**9.0**	**5.9**	**8.5**	**4.8**	**5.0**	**25.0**	**11.0**	**7.0**	**7.0**
14-2425 OK10126	**4.3**	**6.0**	**4.3**	**6.3**	**9.0**	**3.8**	**30.0**	**14.0**	**13.0**	**8.0**	**9.0**	**7.9**	**7.0**	**5.0**	**5.5**	**25.0**	**11.0**	**7.0**	**13.0**

BAKE MIX TIME

(Small Scale) Oklahoma

ncoop= 19
chisq= 3.87
chisqc= 10.21
cvchisq= 7.82
crdiff= 9.15

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

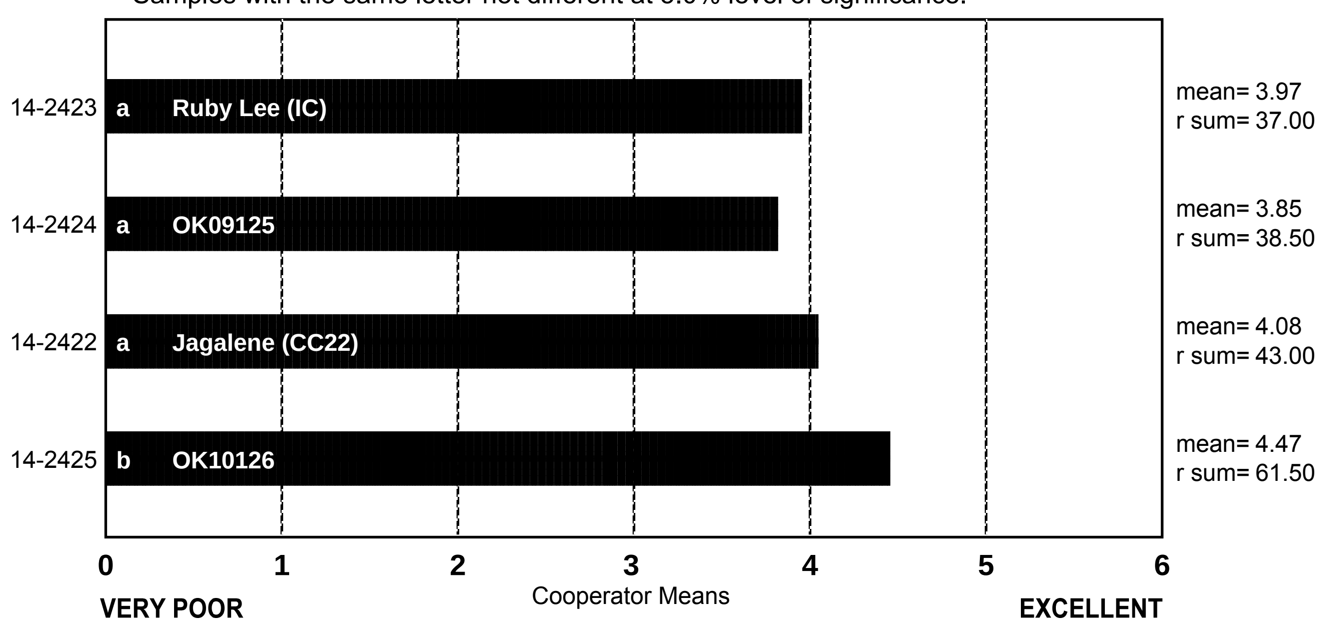


MIXING TOLERANCE

(Small Scale) Oklahoma

ncoop= 18
chisq= 12.75
chisqc= 20.49
cvchisq= 7.82
crdiff= 9.94

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

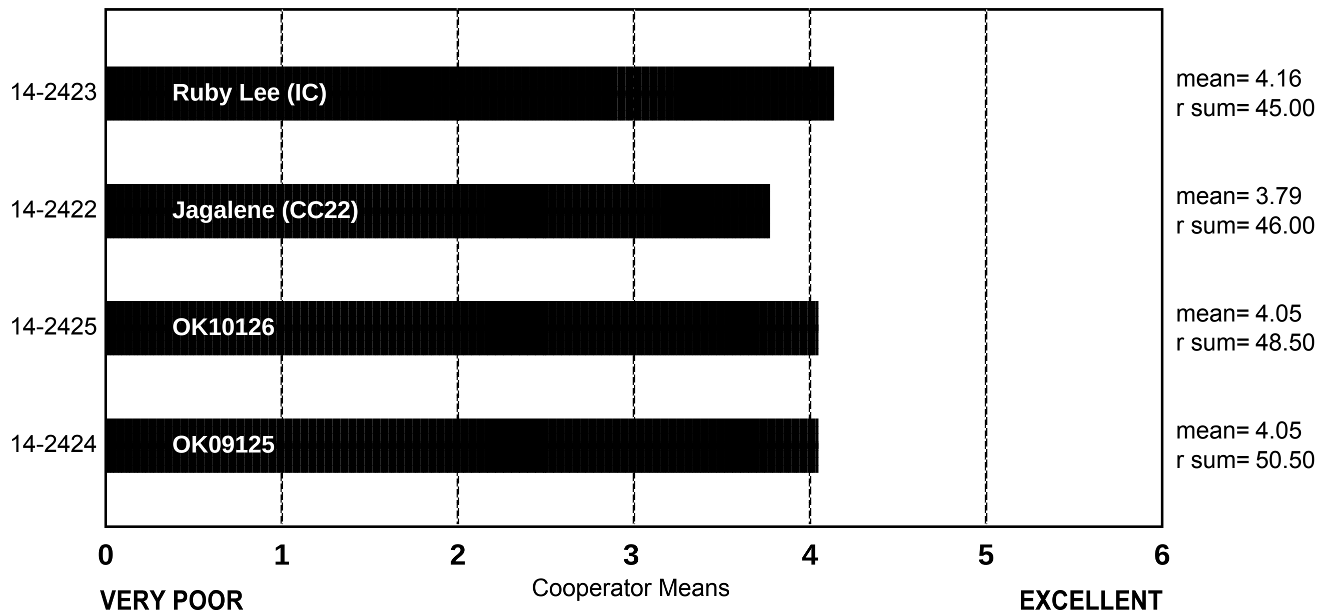


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Oklahoma

ncoop= 19
chisq= 0.58
chisqc= 0.93
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
14-2422 Jagalene (CC22)	**3**	**2**	**2**	**10**	**2**
14-2423 Ruby Lee (IC)	**2**	**3**	**5**	**8**	**1**
14-2424 OK09125	**2**	**1**	**3**	**10**	**3**
14-2425 OK10126	**2**	**1**	**4**	**9**	**3**

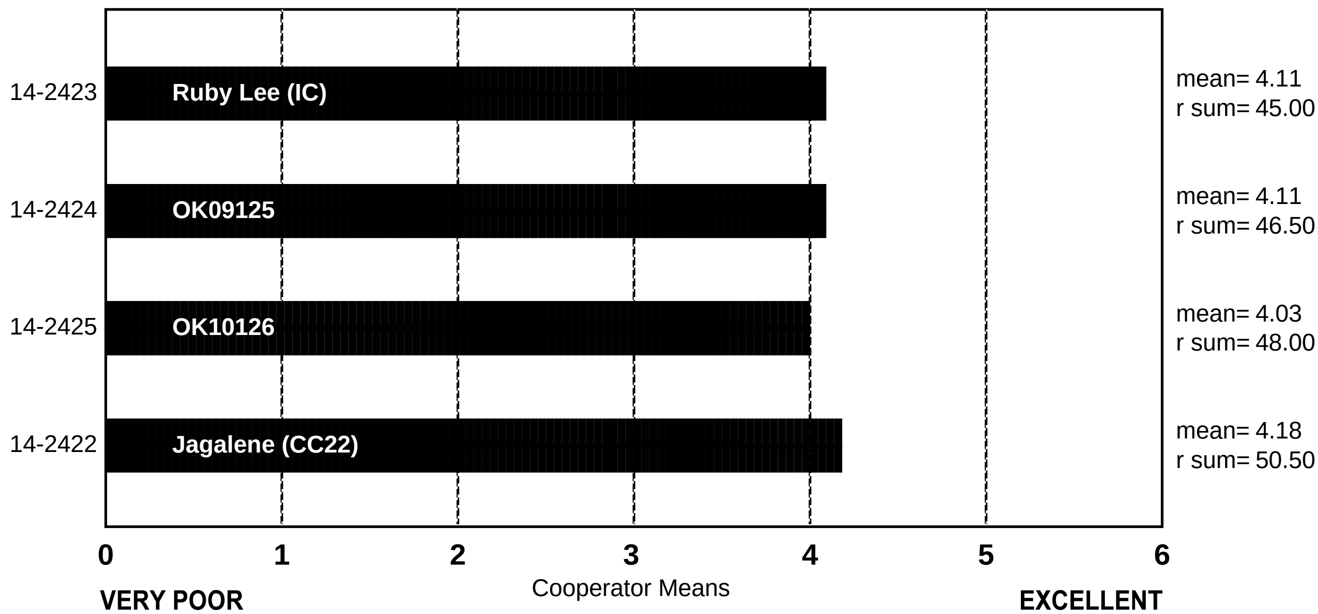
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Oklahoma

ncoop= 19
chisq= 0.52
chisqc= 1.01
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
14-2422 Jagalene (CC22)	1	2	3	11	2
14-2423 Ruby Lee (IC)	1	2	3	12	1
14-2424 OK09125	2	0	4	12	1
14-2425 OK10126	2	1	2	12	2

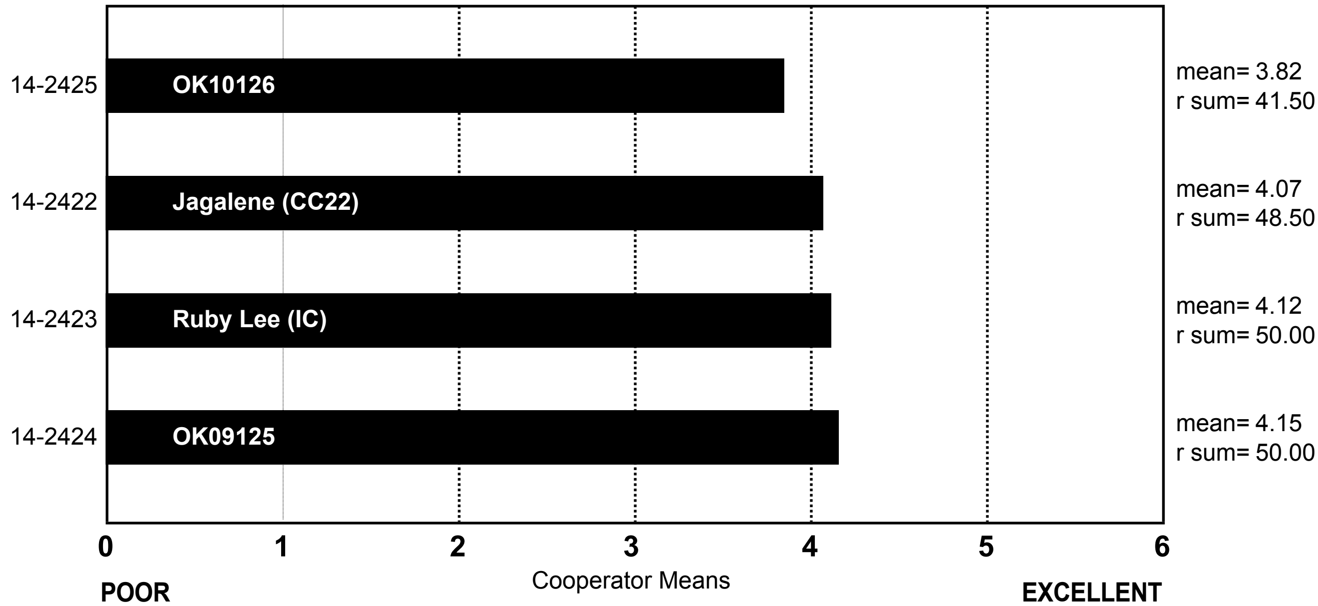
Frequency Table

CRUMB GRAIN

(Small Scale) Oklahoma

ncoop= 19
chisq= 1.56
chisqc= 2.15
cvchisq= 7.82
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Oklahoma

	Open	Fine	Dense
14-2422 Jagalene (CC22)	9	8	2
14-2423 Ruby Lee (IC)	8	10	1
14-2424 OK09125	8	11	0
14-2425 OK10126	10	8	1

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Oklahoma

	Round	Irregular	Elongated
14-2422 Jagalene (CC22)	**6**	**7**	**6**
14-2423 Ruby Lee (IC)	**3**	**9**	**7**
14-2424 OK09125	**3**	**7**	**9**
14-2425 OK10126	**10**	**3**	**6**

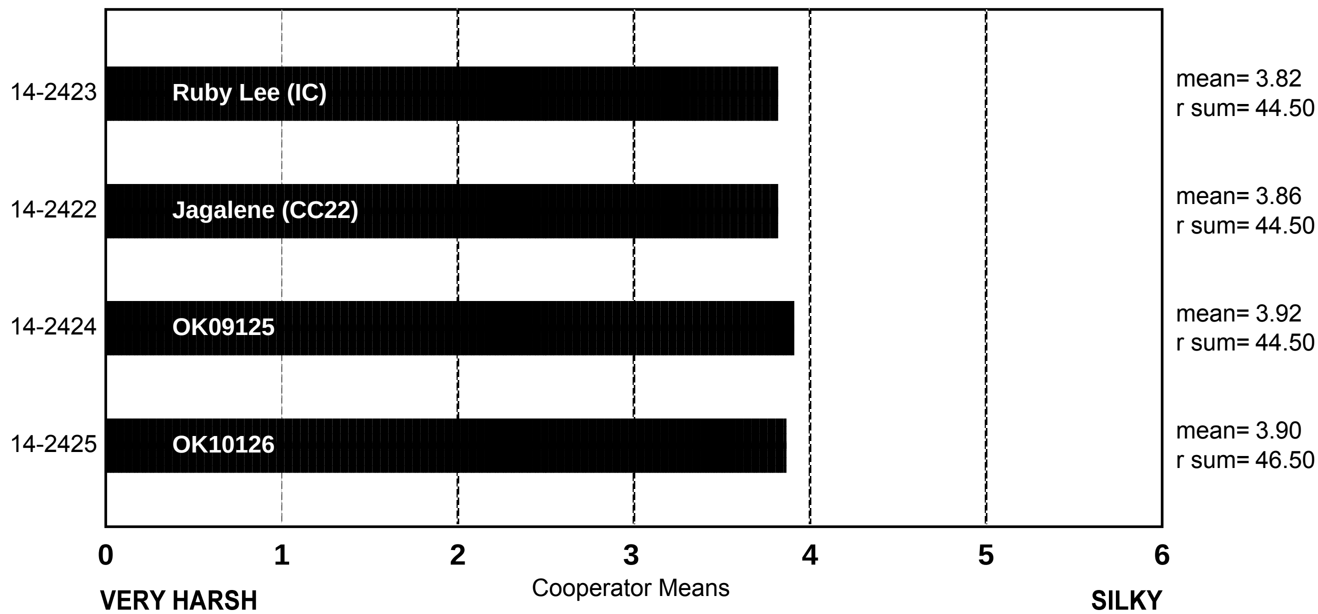
Frequency Table

CRUMB TEXTURE

(Small Scale) Oklahoma

ncoop= 18
chisq= 0.10
chisqc= 0.22
cvchisq= 7.82
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Oklahoma

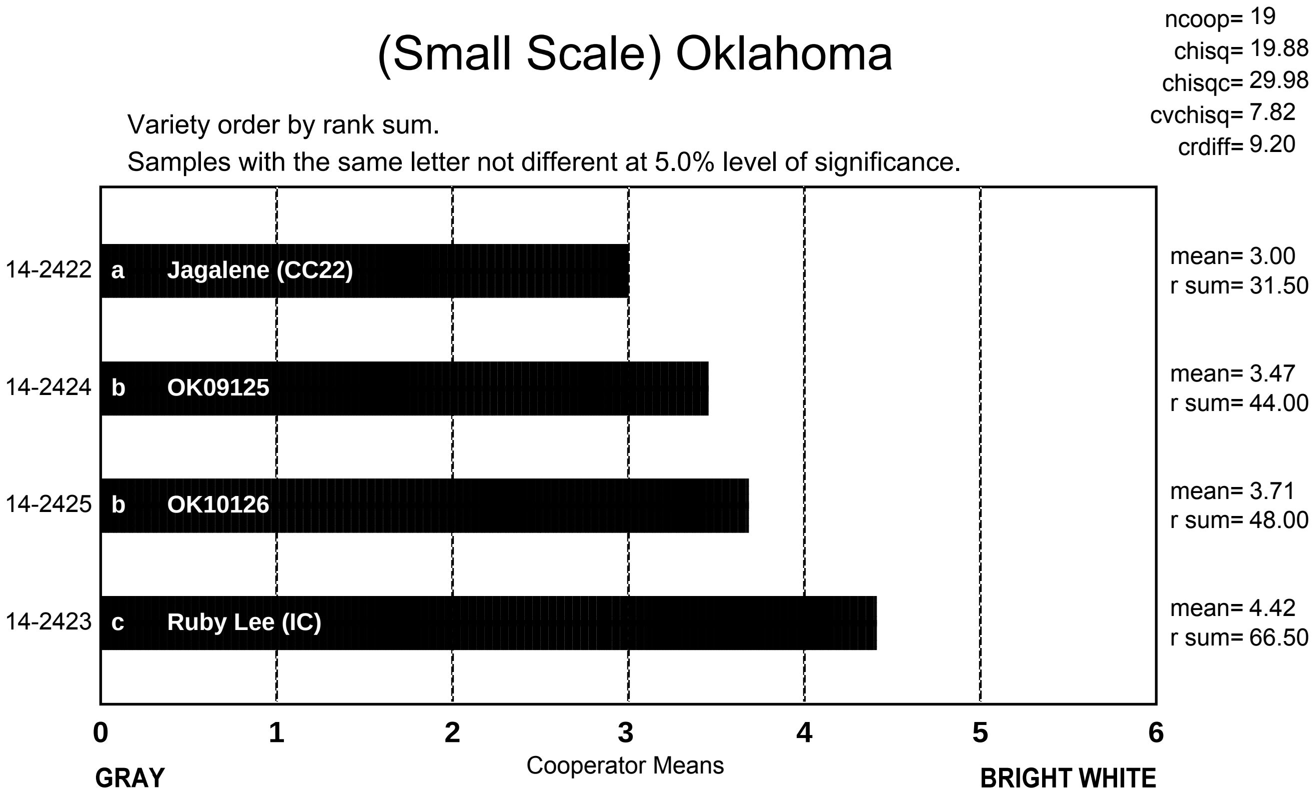
	Harsh	Smooth	Silky
14-2422 Jagalene (CC22)	4	11	2
14-2423 Ruby Lee (IC)	3	12	3
14-2424 OK09125	4	11	2
14-2425 OK10126	4	10	3

Frequency Table

CRUMB COLOR

(Small Scale) Oklahoma

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



CRUMB COLOR, DESCRIBED

(Small Scale) Oklahoma

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
14-2422 Jagalene (CC22)	0	1	8	1	7	2	0
14-2423 Ruby Lee (IC)	0	0	1	0	9	8	1
14-2424 OK09125	0	0	7	0	9	3	0
14-2425 OK10126	1	0	3	3	9	3	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
14-2422 Jagalene (CC22)	130.4	140.3	142.6	154.8	139.7	138.2	462.2	463.5	418.0	738.4	134.0	148.0	459.8	139.2	139.1	489.9	455.0	451.1	486.8
14-2423 Ruby Lee (IC)	129.9	140.1	142.9	155.1	136.0	137.5	454.2	470.5	415.0	720.9	134.0	148.8	461.2	138.1	137.8	490.4	453.0	449.9	487.8
14-2424 OK09125	127.8	141.1	141.7	154.2	137.7	136.8	435.8	466.3	418.0	758.3	134.0	146.5	461.3	139.1	140.2	481.2	452.0	451.9	484.1
14-2425 OK10126	128.4	138.5	142.8	154.1	137.8	136.3	462.1	466.4	412.0	750.8	134.0	148.5	463.9	138.0	136.6	481.0	453.0	447.4	480.7

LOAF VOLUME, ACTUAL

(Small Scale) Oklahoma

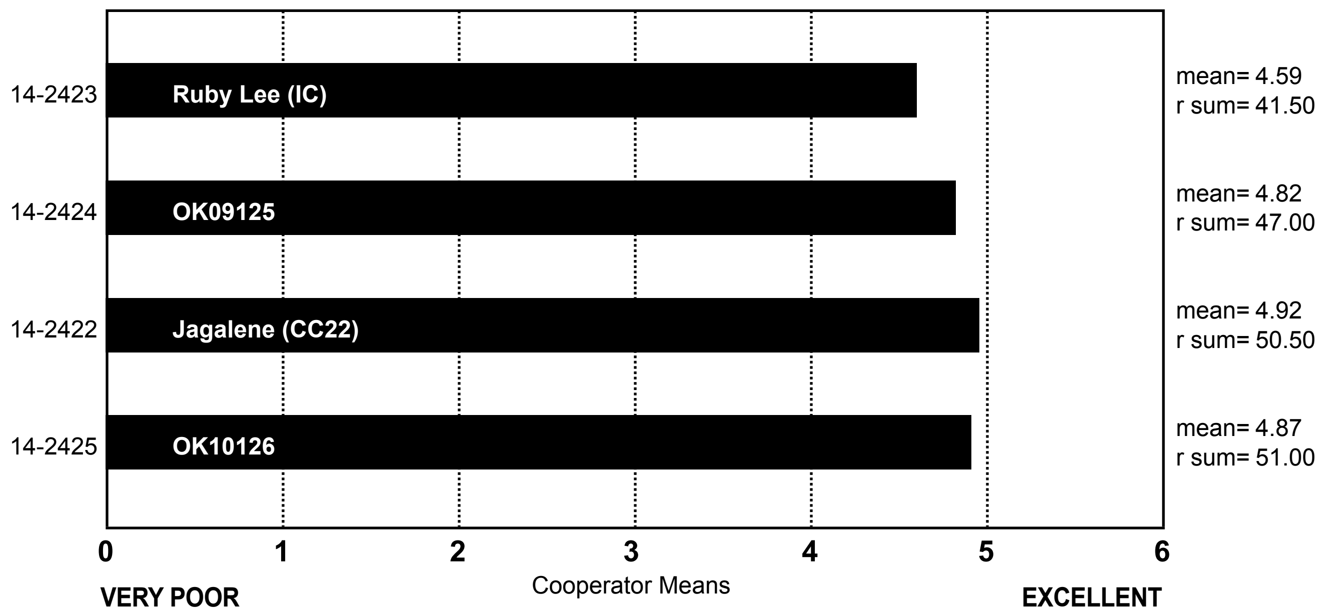
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2422 Jagalene (CC22)	**780**	**1205**	**1135**	**1090**	**1020**	**1030**	**2775**	**2588**	**3000**	**4170**	**1200**	**1025**	**2575**	**912**	**1095**	**3104**	**2450**	**2600**	**2550**
14-2423 Ruby Lee (IC)	**655**	**1125**	**1045**	**1132**	**965**	**945**	**2875**	**2488**	**2750**	**4205**	**1108**	**1025**	**2700**	**856**	**1033**	**3104**	**2500**	**2675**	**2575**
14-2424 OK09125	**715**	**1220**	**1055**	**1128**	**995**	**990**	**2825**	**2638**	**2900**	**4230**	**1200**	**1050**	**2525**	**868**	**1095**	**3104**	**2325**	**2675**	**2475**
14-2425 OK10126	**765**	**1250**	**1075**	**1145**	**1050**	**1025**	**2725**	**2550**	**2800**	**4435**	**1108**	**1020**	**2300**	**962**	**1095**	**3104**	**2475**	**2625**	**2700**

LOAF VOLUME

(Small Scale) Oklahoma

ncoop= 19
chisq= 1.82
chisqc= 2.88
cvchisq= 7.82
crdiff=

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

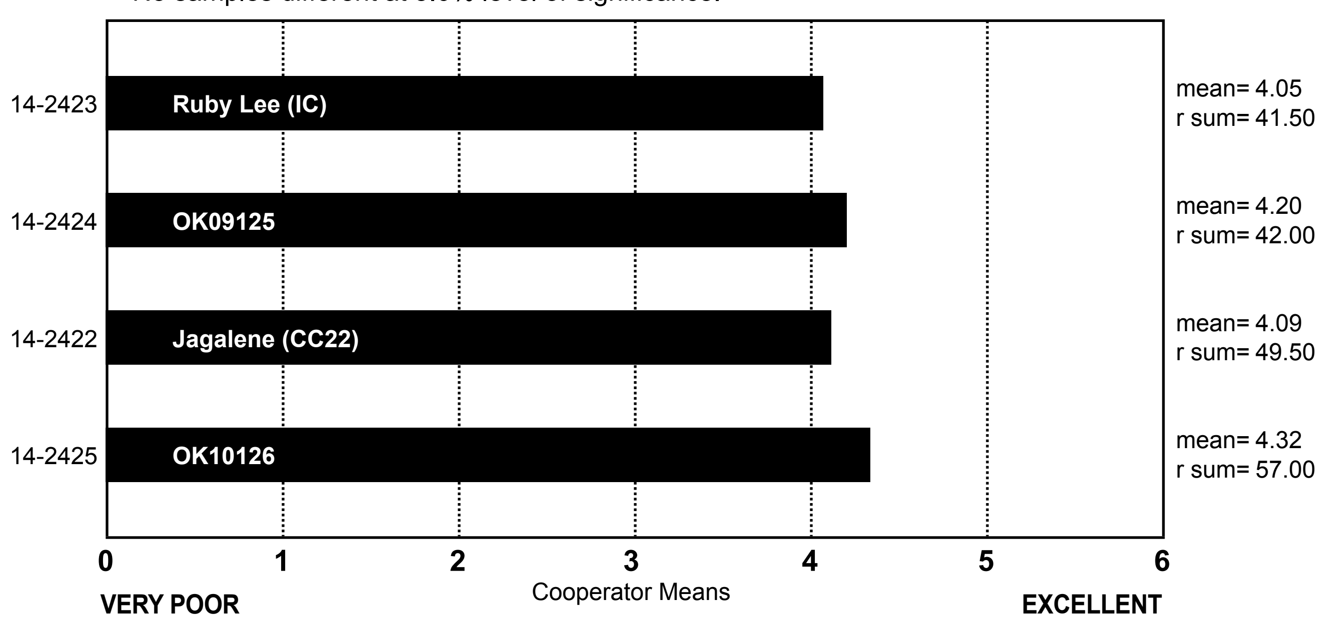


OVERALL BAKING QUALITY

(Small Scale) Oklahoma

ncoop= 19
chisq= 5.07
chisqc= 6.51
cvchisq= 7.82
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Oklahoma

COOP. 14-2422 Jagalene (CC22)

A. Smooth, pliable, little dough strength.
B. Excellent loaf externals.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Normal absorption, long mix time, slight sticky & strong dough, very high OS & volume, yellow crumb, fine elongated cells, smooth & resilient texture.
F. Good baker with slightly yellow color.
G. No comment.
H. Low absorption, slightly above average mix, average volume, yellow, open grain.
I. Average shorter mix, good out of mixer and make up.
J. No comment.
K. Very high volume, great shape.
L. Good flour protein, good bake absorption, long mix time, good dough at pan, Q-S crumb grain, excellent loaf volume.
M. No comment.
N. 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
O. No comment.
P. Good interior scores, excellent volume.
Q. Good bake.
R. Excellent mix time, good dough, good volume, dense grain.
S. Average in most categories, excellent dough characteristics, yellow crumb.

COOP. 14-2423 Ruby Lee (IC)

A. Pliable, nice resistance to dough. Flat, pliable/elastic at panning, lower loaf volume, scratchy, crumb crumbles when pressed.
B. Excellent loaf externals.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Normal absorption and mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, little open & elongated cells, smooth & resilient texture.
F. Very good dough handling, good color, acceptable volume.
G. No comment.
H. Low absorption, slightly above average mix, low volume, creamy, open grain.
I. Lowest volume of set, slightly dull.
J. No comment.
K. Very high volume, great shape.
L. Very similar to 2422, Q-S crumb grain with excellent loaf volume.
M. No comment.
N. 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

O. No comment.
P. Low absorption, bright crumb color, good internal scores and good volume.
Q. Uneven break and shred.
R. Excellent mix time, excellent dough, high volume with a dense grain.
S. Good grain, average volume.

COOP. 14-2424 OK09125

A. Smooth, pliable, nice gas retention, crumb tears when pressure is applied, crumbly.
B. Right side break.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Low water absorption, normal mix time, slight sticky & strong dough, very high OS & volume, yellow crumb, open & elongated cells, smooth & resilient texture.
F. Overall good line.
G. No comment.
H. Low absorption, above average mix, average volume, yellow, open grain.
I. Good volume, slightly dull, good pliable dough.
J. No comment.
K. Very high volume, great shape.
L. Equal to checks, satisfactory crumb grain with excellent loaf volume.
M. No comment.
N. 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
O. No comment.
P. Low absorption, fairly tight grain, excellent volume.
Q. Good structure, texture rough and dry.
R. Excellent mix time, excellent dough, high volume with an above average grain.
S. Average in most categories, yellow crumb, low volume.

COOP. 14-2425 OK10126

A. Nice dough strength and nice gas.
B. Excellent loaf externals.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Normal absorption, long mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, fine & elongated cells, very smooth & resilient texture.
F. Very good loaf volume and color.
G. No comment.
H. Average absorption, above average mix, average volume, yellow, open grain.
I. Average volume and mix, slightly tough, good out of mixer.
J. No comment.
K. Excellent bake performance, great volume and mix tolerance, best of set.
L. Good flour protein with good bake absorption, long mix time and questionable crumb grain but excellent loaf volume.
M. No comment.

N. 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
O. No comment.
P. Very strong dough, slightly open grain, harsh texture, excellent volume.
Q. Good bake.
R. Excellent mix time, excellent dough, high volume with a dense grain.
S. Average absorption, long mix time, good dough, average grain, yellow crumb, high volume.

Notes: **G, H, I, K, P, Q, R and S** conducted sponge and dough bake tests

KANSAS-MANHATTAN

14-2426	Jagalene (CC26)
14-2427	KanMark

Description of Test Plots and Breeder Entries

Kansas-Manhattan - Allan Fritz

KanMark

KanMark (KS030887K-6) is a hard red winter wheat selected from the cross Parula/2*Pastor//G980129W/3/KS970104-3-13. KanMark is yield competitive across the wheat growing regions of Kansas. Its strongest performance has been in western Kansas where it has a yield advantage over TAM-111 which is the mostly popular variety in western Kansas. Its performance suggests that KanMark has good tolerance to drought. KanMark has also been a very strong performer under irrigation. Tables 1, 2 and 3 show the yield performance of KanMark and relevant checks in western Kansas dryland, western Kansas irrigated and central Kansas dryland environments, respectively. KanMark has good resistance to prevalence races of both leaf and stripe rust making it one of very few available commercial varieties adapted to the region that offers protection against both diseases. KanMark's utility in central and eastern Kansas may be limited by its susceptibility to Fusarium head blight. See Table 4 for disease and insect ratings. K-State Quality Lab results indicate that KanMark has good baking quality.

Jagalene

Jagalene is the common check used for the WQC.

Both increases were grown at the K-State Agronomy Farm in Manhattan, KS. They were planted no-till after soybeans. Significant drought stress occurred during the season.

Kansas-Manhattan: 2014 (Small-Scale) Samples

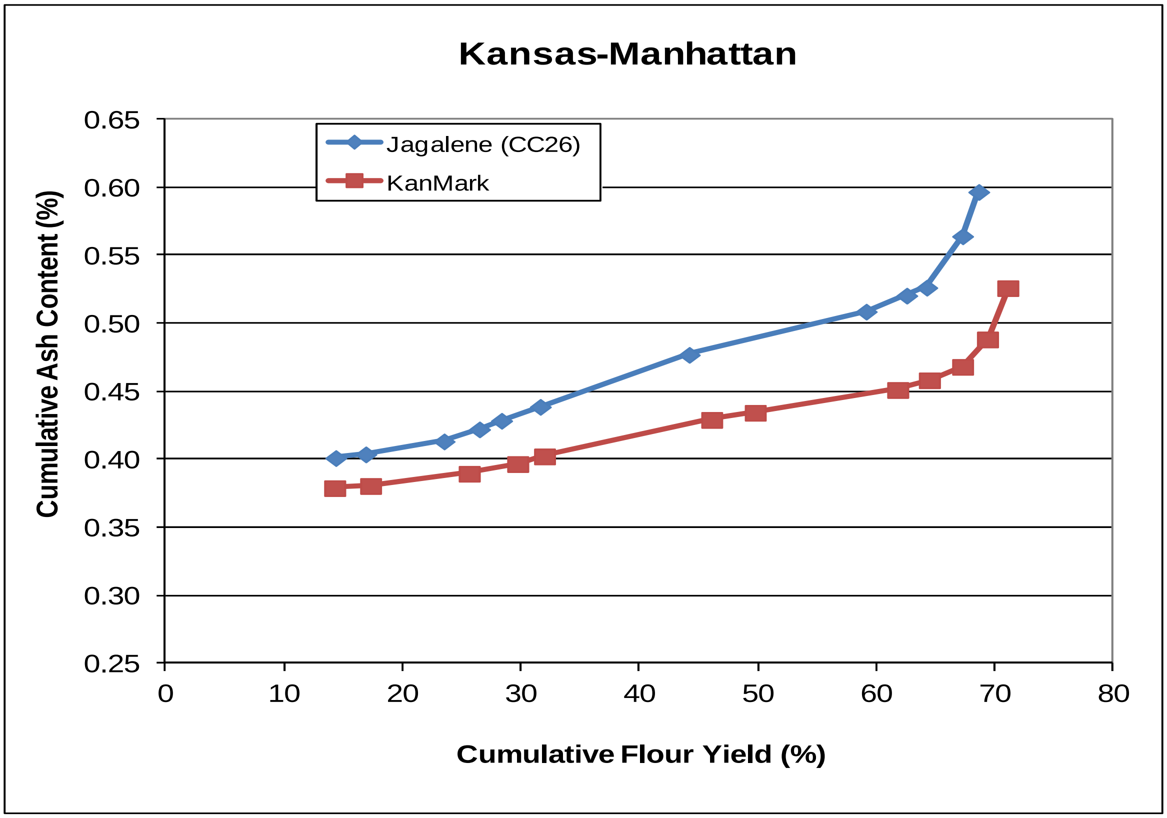
Test entry number	14-2426	14-2427
Sample identification	Jagalene (CC26)	KanMark
Wheat Data		
GIPSA classification	2 HRW	1 HRW
Test weight (lb/bu) Hectoliter weight (kg/hl)	57.8 76.1	60.1 79.1
1000 kernel weight (gm)	31.8	32.3
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 73.8 26.1 0.1	 79.5 20.5 0.0
Single kernel (skcs)[a] Hardness (avg /s.d) Weight (mg) (avg/s.d) Diameter (mm)(avg/s.d) Moisture (%) (avg/s.d) SKCS distribution Classification	 60.6/15.5 31.8/9.2 2.76/0.35 11.9/0.3 04-12-30-54-01 Hard	 56.2/15.2 32.3/8.4 2.77/0.34 11.8/0.3 06-21-29-44-02 Hard
Wheat protein (12% mb) Wheat ash (12% mb)	14.7 1.80	14.5 1.85
Milling and Flour Quality Data		
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 67.1 67.6	 70.5 70.2
Flour moisture (%) Flour protein (14% mb) Flour ash (14% mb)	13.0 13.5 0.55	12.8 13.0 0.48
Rapid Visco-Analyser Peak time (min) Peak viscosity (RVU) Breakdown (RVU) Final viscosity at 13 min (RVU)	 6.2 214.9 77.0 257.6	 6.3 223.4 80.8 248.5
Minolta color meter L* a* b* **PPO**	 91.92 -1.54 9.38 0.559	 92.47 -1.56 8.66 0.693
Falling number (sec)	469	464
Damaged Starch (AI%) (AACC76-31)	 95.30 5.75	 95.05 5.56

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

Kansas-Manhattan: Physical Dough Tests and Gluten Analysis For 2014 (Small-Scale) Samples

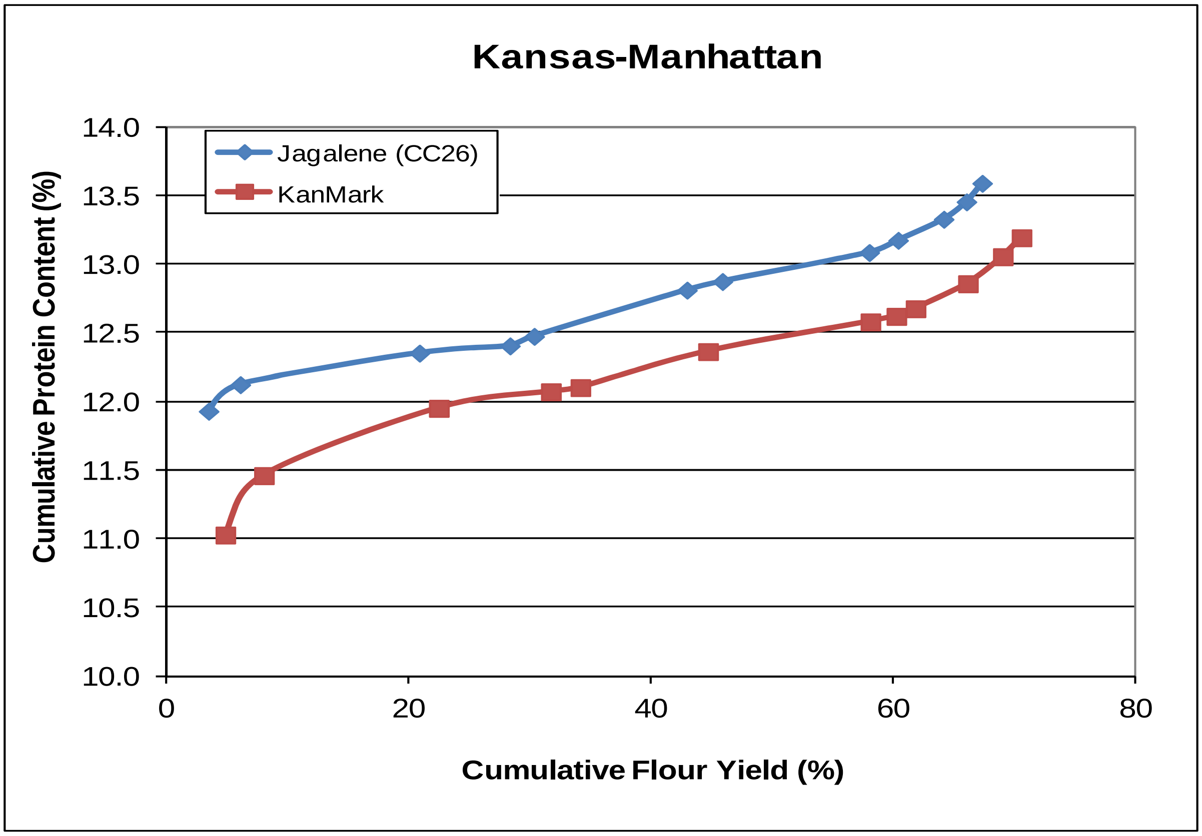
Test Entry Number	**14-2426**	**14-2427**
Sample Identification	**Jagalene (CC26)**	**KanMark**
MIXOGRAPH		
Flour Abs (% as-is)	67.2	66.2
Flour Abs (14% mb)	65.6	64.8
Mix Time (min)	5.6	7.4
Mix tolerance (0-6)	5	5
FARINOGRAPH		
Flour Abs (% as-is)	59.0	58.7
Flour Abs (14% mb)	57.4	57.2
Development time (min)	5.8q	32.7
Mix stability (min)	25.2	48.1
Mix Tolerance Index (FU)	13	4
Breakdown time (min)	21.8	52.4
ALVEOGRAPH		
P(mm): Tenacity	77	75
L(mm): Extensibility	131	110
G(mm): Swelling index	25.5	23.3
W(10^{-4} J): strength (curve area)	381	352
P/L: curve configuration ratio	0.59	0.68
Ie(P_{200}/P): elasticity index	68.0	73.9
EXTENSIGRAPH		
Resist (BU at 45/90/135 min)	568/726/874	751/1000/992
Extensibility (mm at 45/90/135 min)	171/171/149	154/147/123
Energy (cm^2 at 45/90/135 min)	195/228/207	209/206/173
Resist $_{max}$ (BU at 45/90/135min)	928/1000/994	997/1000/992
Ratio (at 45/90/135 min)	3.33/4.25/5.88	4.86/6.80/8.06
PROTEIN ANALYSIS		
HMW-GS Composition	1/2*, 17+18, 5+10	1, 7+8, 5+10
%IPP	54.34	55.77
SEDIMENTATION TEST		
Volume (ml)	67.9	65.5

Kansas-Manhattan: Cumulative Ash Curves



Jagalene (CC26)					KanMark				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	14.43	0.40	14.43	0.40	2M	14.3	0.38	14.3	0.38
1M Red	2.54	0.42	16.96	0.40	1M Red	3.0	0.39	17.4	0.38
1M	6.61	0.44	23.57	0.41	1M	8.3	0.41	25.7	0.39
1BK	2.98	0.49	26.55	0.42	1BK	4.1	0.44	29.8	0.40
Grader	1.86	0.52	28.42	0.43	Grader	2.3	0.48	32.0	0.40
2BK	3.27	0.53	31.69	0.44	3M	14.1	0.49	46.2	0.43
3M	12.57	0.57	44.26	0.48	2BK	3.7	0.50	49.8	0.43
FILTER FLR	14.93	0.60	59.19	0.51	FILTER FLR	12.0	0.52	61.8	0.45
4M	3.42	0.72	62.61	0.52	4M	2.7	0.62	64.5	0.46
3BK	1.69	0.74	64.30	0.53	3BK	2.8	0.70	67.3	0.47
5M	3.03	1.37	67.33	0.56	5M	2.1	1.13	69.4	0.49
BRAN FLR	1.36	2.21	68.69	0.60	BRAN FLR	1.7	2.06	71.1	0.53
Break Shorts	3.70	4.35	72.38	0.79	Break Shorts	1.8	4.08	73.0	0.62
Red Dog	1.50	3.31	73.88	0.84	Red Dog	1.2	3.47	74.2	0.66
Red Shorts	0.09	5.10	73.98	0.85	Red Shorts	0.1	4.12	74.2	0.66
Filter Bran	9.58	1.77	83.56	0.95	Filter Bran	7.2	1.63	81.4	0.75
Bran	16.44	6.03	100.0	1.79	Bran	18.6	6.14	100.0	1.75
Wheat		1.76					1.80		
St. Grd. Fl.		0.55					0.48		

Kansas-Manhattan: Cumulative Protein Curves



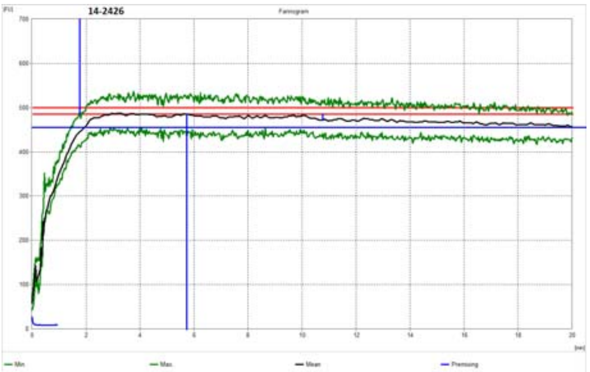
	Jagalene (CC26)					KanMark				
Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein	Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein
1BK	3.54	11.93	3.54	11.93	1BK	4.92	11.03	4.92	11.03
1M Red	2.62	12.38	6.15	12.12	1M Red	3.19	12.13	8.11	11.46
2M	14.78	12.45	20.94	12.35	2M	14.43	12.23	22.53	11.95
1M	7.47	12.55	28.40	12.41	1M	9.24	12.37	31.78	12.07
Grader	2.00	13.46	30.40	12.48	Grader	2.44	12.49	34.21	12.10
FILTER FLR	12.61	13.62	43.01	12.81	FILTER FLR	10.54	13.22	44.75	12.36
4M	2.92	13.80	45.93	12.87	3M	13.40	13.30	58.15	12.58
3M	12.12	13.89	58.05	13.09	4M	2.14	13.72	60.29	12.62
5M	2.39	15.33	60.44	13.17	5M	1.58	14.80	61.87	12.68
2BK	3.76	15.80	64.19	13.33	2BK	4.32	15.46	66.20	12.86
3BK	1.88	17.79	66.07	13.46	3BK	2.87	17.59	69.07	13.06
BRAN FLR	1.30	20.47	67.37	13.59	BRAN FLR	1.55	19.32	70.62	13.19
Break Shorts	4.16	18.22	71.53	13.86	Break Shorts	1.93	16.85	72.55	13.29
Red Dog	1.11	16.82	72.64	13.90	Red Dog	0.85	16.47	73.39	13.33
Red Shorts	0.07	16.71	72.70	13.91	Red Shorts	0.03	15.35	73.43	13.33
Filter Bran	8.33	14.10	81.03	13.93	Filter Bran	6.45	13.93	79.88	13.38
Bran	18.97	18.62	100.00	14.82	Bran	20.12	18.16	100.00	14.34
Wheat		14.40					14.21		
St. Grd. Fl		13.50					12.96		

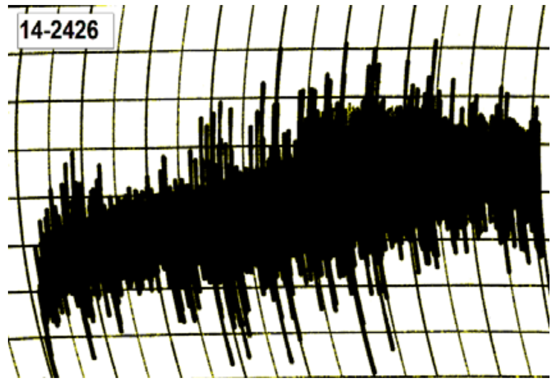
Physical Dough Tests

2014 (Small Scale) Samples - Kansas-Manhattan

Farinograms

Mixograms

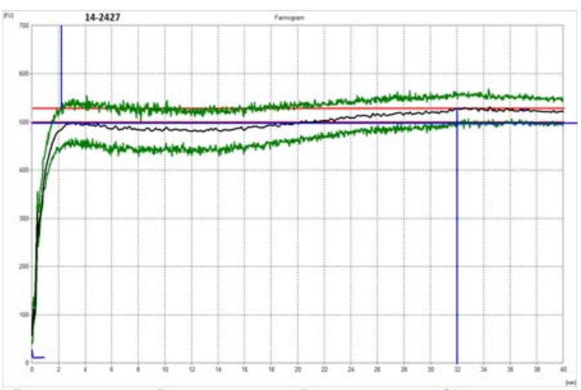


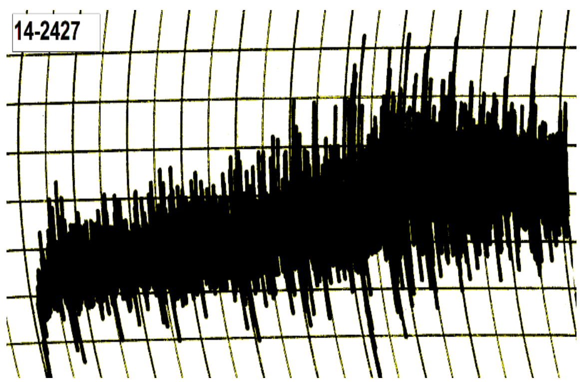


Water abs = 57.4%, Peak time = 5.8 min,
Mix stab = 25.2 min, MTI = 13 FU

Water abs = 65.6%
Mix time = 5.6 min

14-2426, Jagalene (CC26)





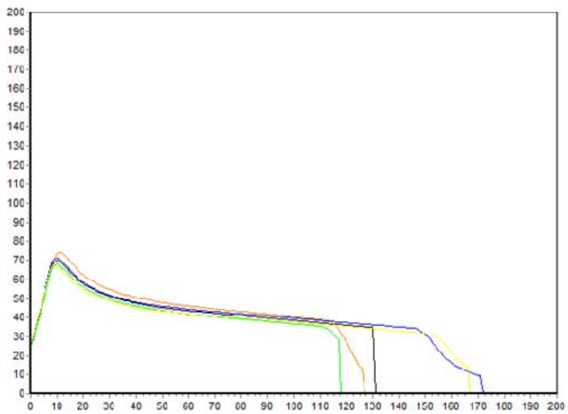
Water abs = 57.2%, Peak time = 32.7 min,
Mix stab = 48.1 min, MTI = 4 FU

Water abs = 64.8%
Mix time = 7.4 min

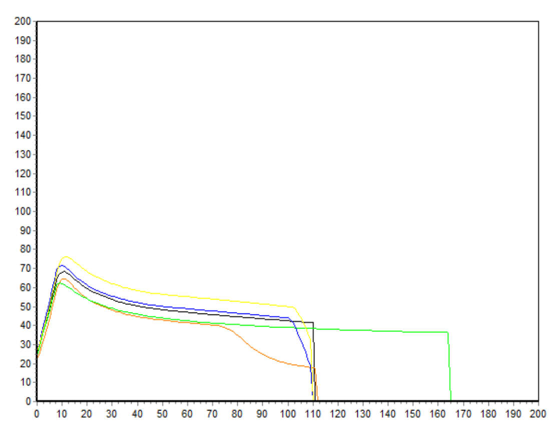
14-2427, KanMark

Physical Dough Tests - Alveograph

2014 (Small Scale) Samples – Kansas-Manhattan



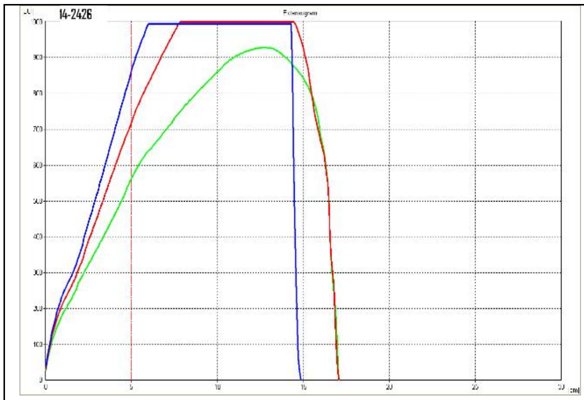
14-2426, Jagalene (CC26)
P(mm H_20)=77, L(mm)=131, W($10E^{-4}$ J)=381

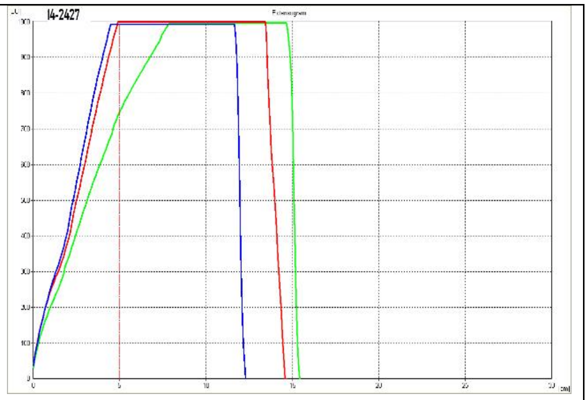


14-2427, KanMark
P(mm H_20)=75, L(mm)=110, W($10E^{-4}$ J)=352

Physical Dough Tests - Extensigraph

2014 (Small Scale) Samples – Kansas-Manhattan

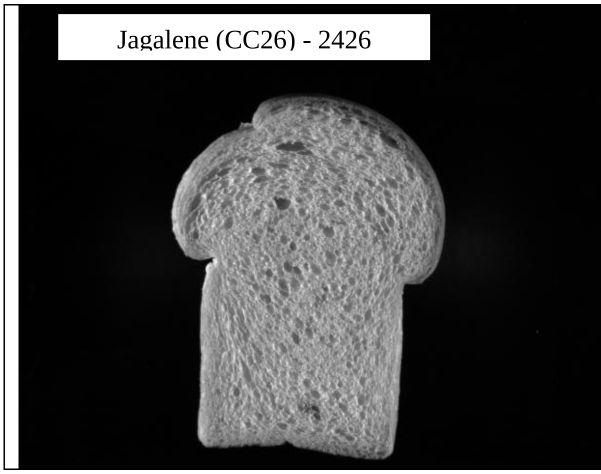
<table>
<tr>
<td>

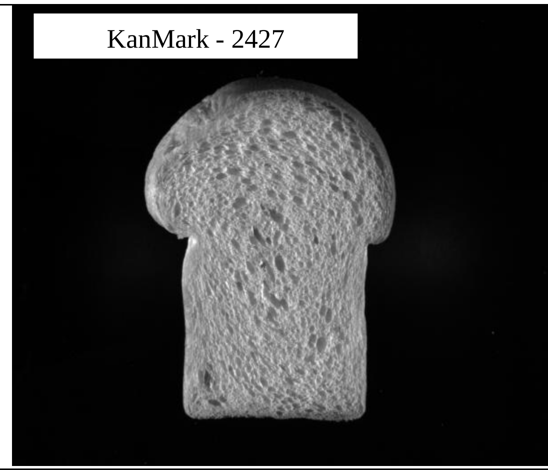
14-2426, Jagalene (CC26)
R (BU) = 726, E (mm) =171, W (cm²) = 228
Rmax (BU) = 1000, Ratio = 4.25 at 90 min</td>
<td>

14-2427, KKAMark
R (BU) = 1000, E (mm) =147, W (cm²) = 206
Rmax (BU) = 1000, Ratio = 6.80 at 90 min</td>
</tr>
</table>

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-Manhattan: C-Cell Bread Images and Analysis for 2014 (Small-Scale) Samples





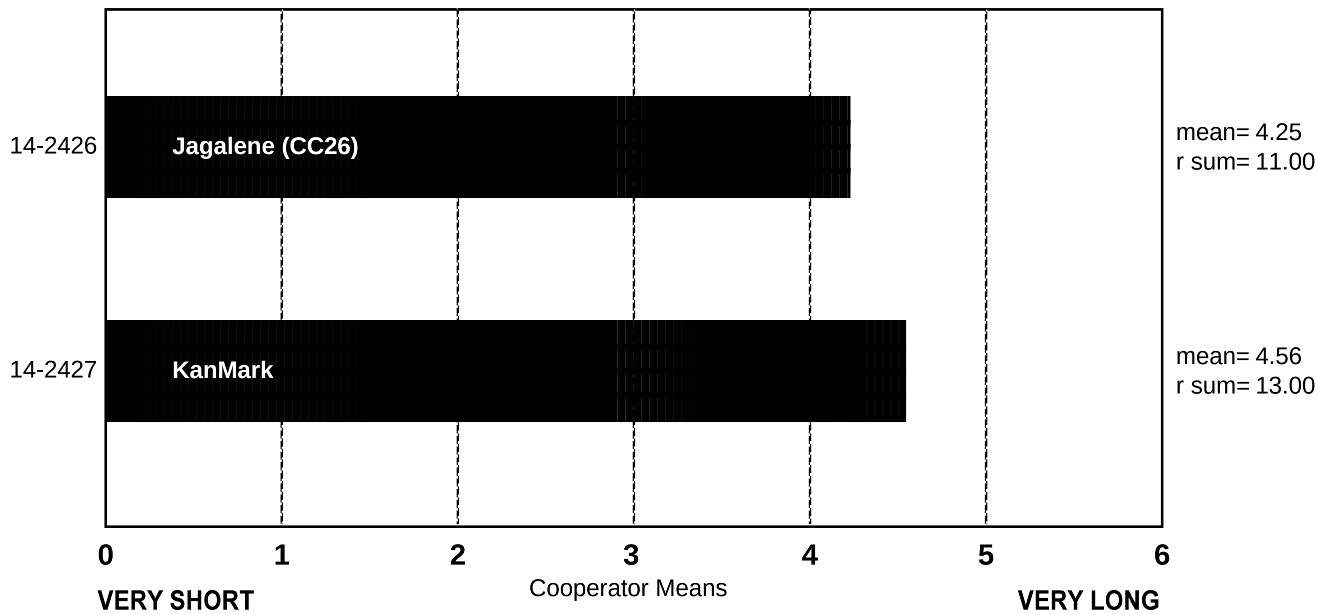
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2426	7380	138.7	4533	0.441	2.061	1.684	1.745	-15.45
2427	7060	139.2	4309	0.439	2.140	1.114	1.735	-18.10

SPONGE CHARACTERISTICS

(Small Scale) Kansas-Manhattan

ncoop= 8
chisq= 0.50
chisqc= 1.00
cvchisq= 3.84
crdiff=

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

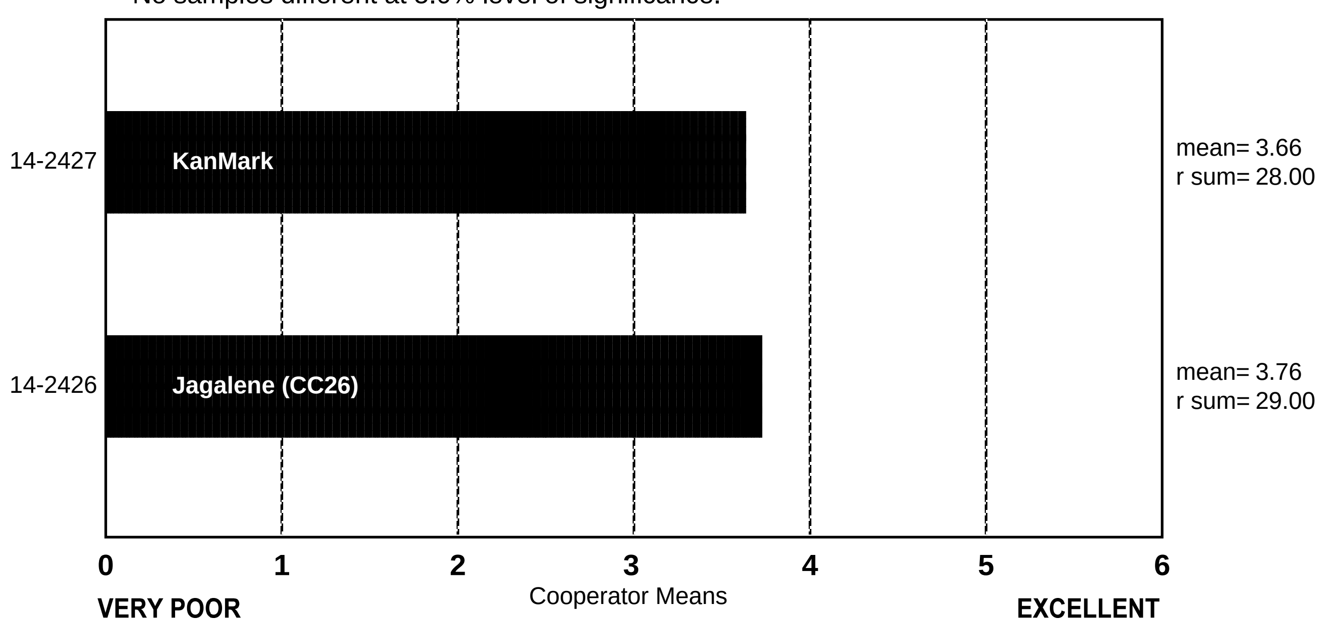


BAKE ABSORPTION

(Small Scale) Kansas-Manhattan

ncoop= 19
chisq= 0.05
chisqc= 0.13
cvchisq= 3.84
crdiff=

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Kansas-Manhattan

	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
14-2426 Jagalene (CC26)	**59.4**	**66.6**	**64.1**	**65.9**	**63.0**	**64.5**	**60.5**	**57.4**	**60.0**	**65.9**	**64.0**	**64.6**	**59.0**	**65.8**	**68.0**	**59.0**	**59.0**	**62.0**	**59.0**
14-2427 KanMark	**58.6**	**66.8**	**63.4**	**66.8**	**63.0**	**64.5**	**57.5**	**57.2**	**59.0**	**65.7**	**64.0**	**63.3**	**58.7**	**64.9**	**66.0**	**59.0**	**58.5**	**61.7**	**59.0**

BAKE MIX TIME, ACTUAL

(Small Scale) Kansas-Manhattan

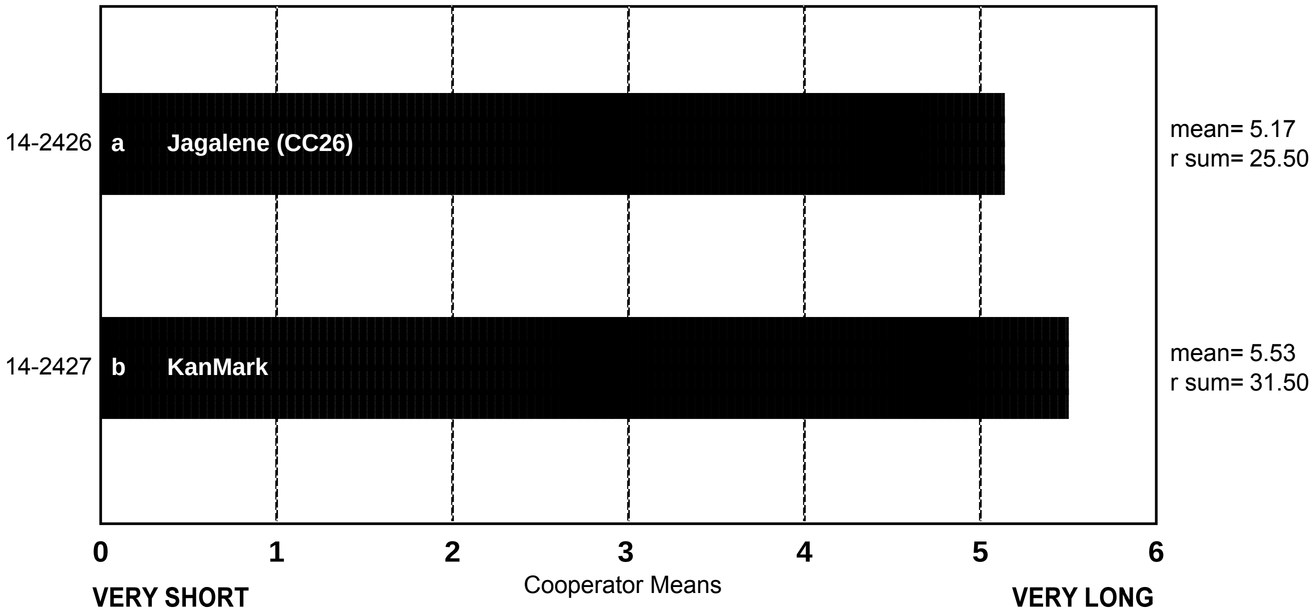
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2426 Jagalene (CC26)	**4.8**	**6.8**	**4.5**	**7.5**	**8.6**	**4.1**	**30.0**	**9.0**	**20.0**	**7.0**	**9.0**	**8.5**	**7.5**	**5.6**	**7.8**	**25.0**	**11.5**	**13.0**	**12.0**
14-2427 KanMark	**6.0**	**9.0**	**6.3**	**6.9**	**10.3**	**5.1**	**30.0**	**28.0**	**20.0**	**7.0**	**9.0**	**10.6**	**8.0**	**7.0**	**9.3**	**25.0**	**12.0**	**17.0**	**28.0**

BAKE MIX TIME

(Small Scale) Kansas-Manhattan

ncoop= 19
chisq= 1.89
chisqc= 4.50
cvchisq= 3.84
crdiff= 4.37

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

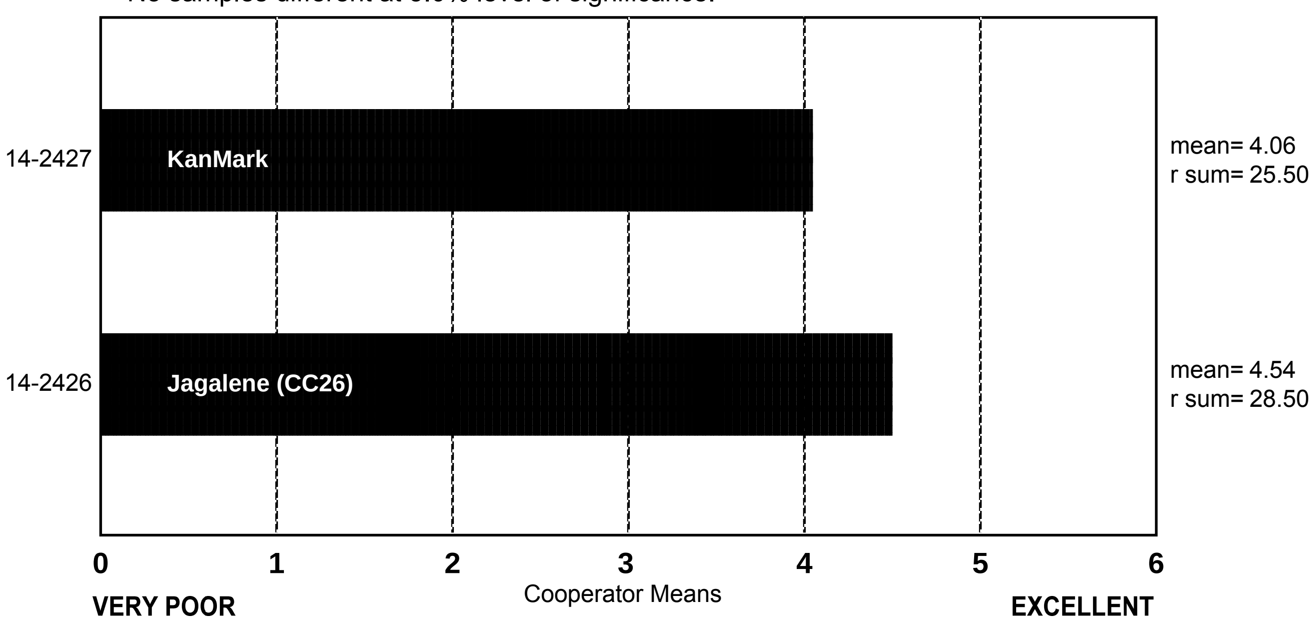


MIXING TOLERANCE

(Small Scale) Kansas-Manhattan

ncoop= 18
chisq= 0.50
chisqc= 0.90
cvchisq= 3.84
crdiff=

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

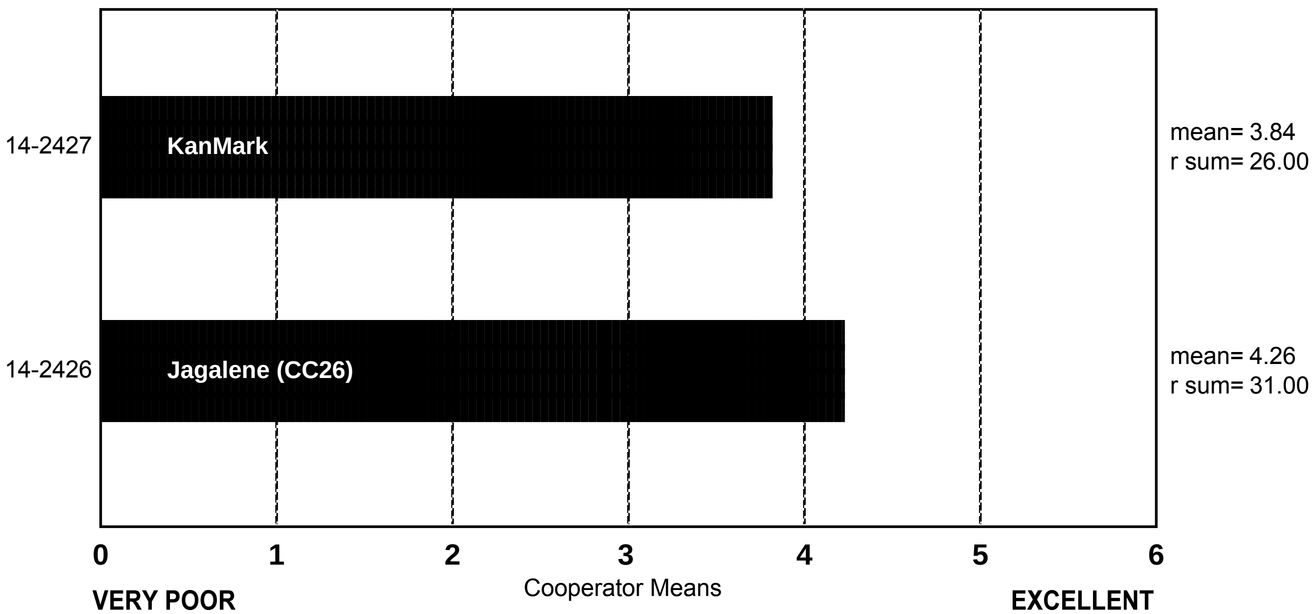


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Kansas-Manhattan

ncoop= 19
chisq= 1.32
chisqc= 2.08
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) Kansas-Manhattan

	Sticky	Wet	Tough	Good	Excellent
14-2426 Jagalene (CC26)	1	1	8	7	2
14-2427 KanMark	2	2	8	4	3

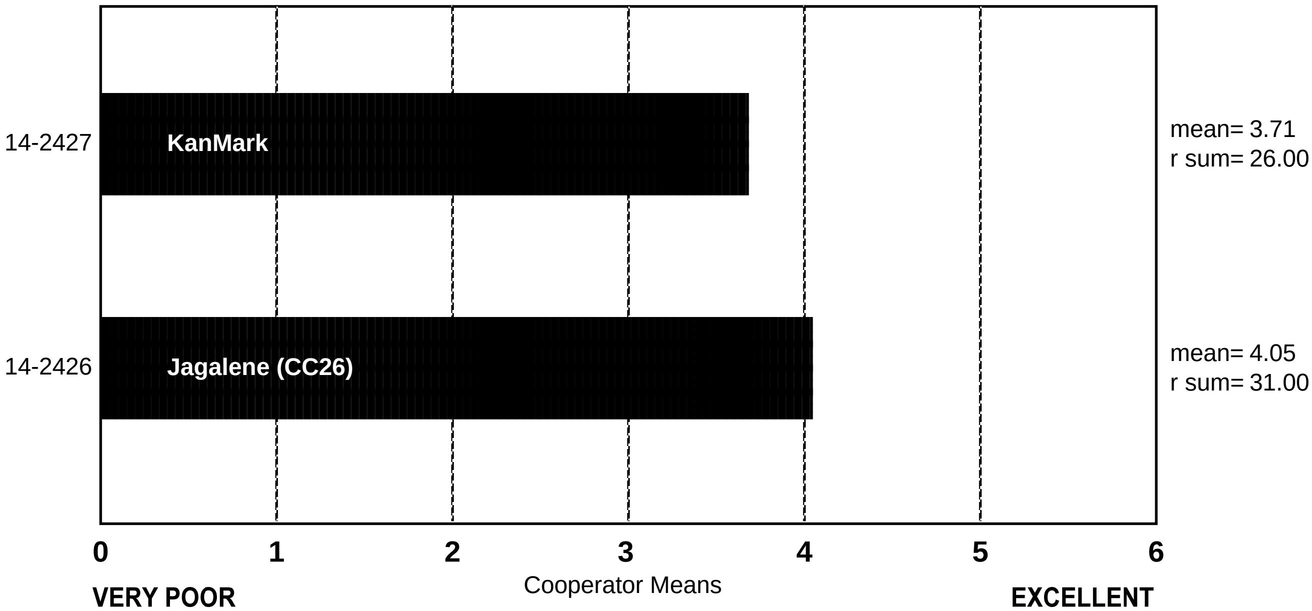
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Kansas-Manhattan

ncoop= 19
chisq= 1.32
chisqc= 2.78
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) Kansas-Manhattan

	Sticky	Wet	Tough	Good	Excellent
14-2426 Jagalene (CC26)	1	0	7	10	1
14-2427 KanMark	1	3	9	6	0

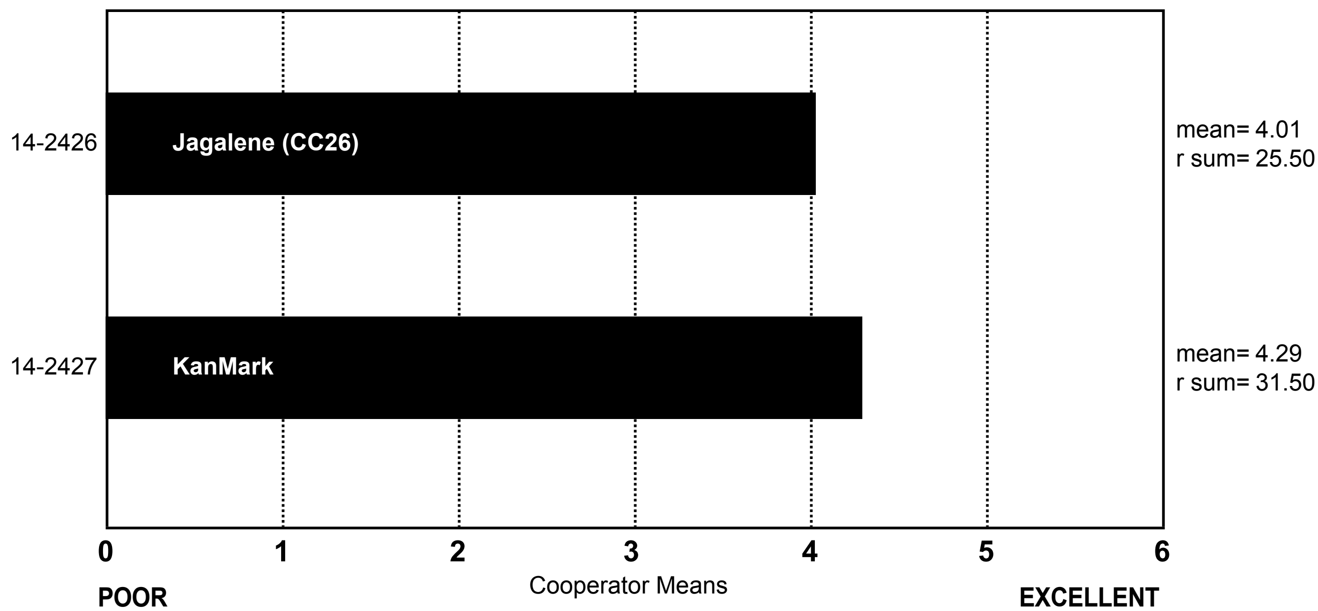
Frequency Table

CRUMB GRAIN

(Small Scale) Kansas-Manhattan

ncoop= 19
chisq= 1.89
chisqc= 2.57
cvchisq= 3.84
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Kansas-Manhattan

	Open	Fine	Dense
14-2426 Jagalene (CC26)	8	9	2
14-2427 KanMark	8	9	2

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Kansas-Manhattan

	Round	Irregular	Elongated
14-2426 Jagalene (CC26)	**2**	**7**	**10**
14-2427 KanMark	**4**	**4**	**11**

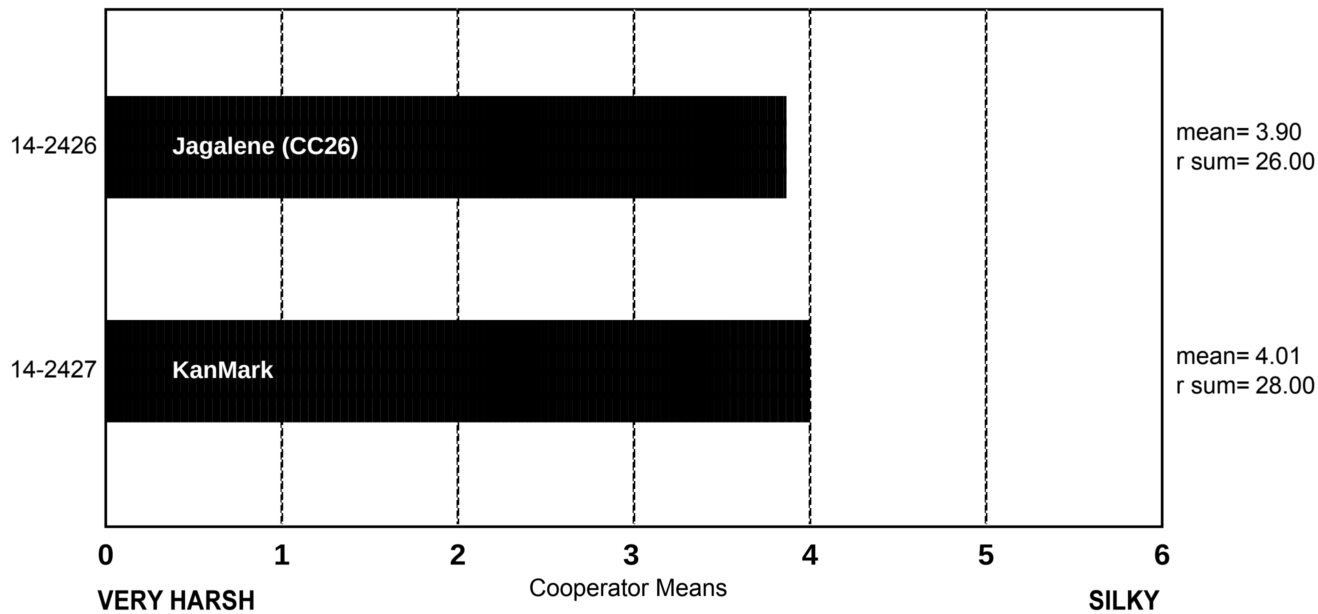
Frequency Table

CRUMB TEXTURE

(Small Scale) Kansas-Manhattan

ncoop= 18
chisq= 0.22
chisqc= 2.00
cvchisq= 3.84
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Kansas-Manhattan

	Harsh	Smooth	Silky
14-2426 Jagalene (CC26)	4	11	3
14-2427 KanMark	4	9	4

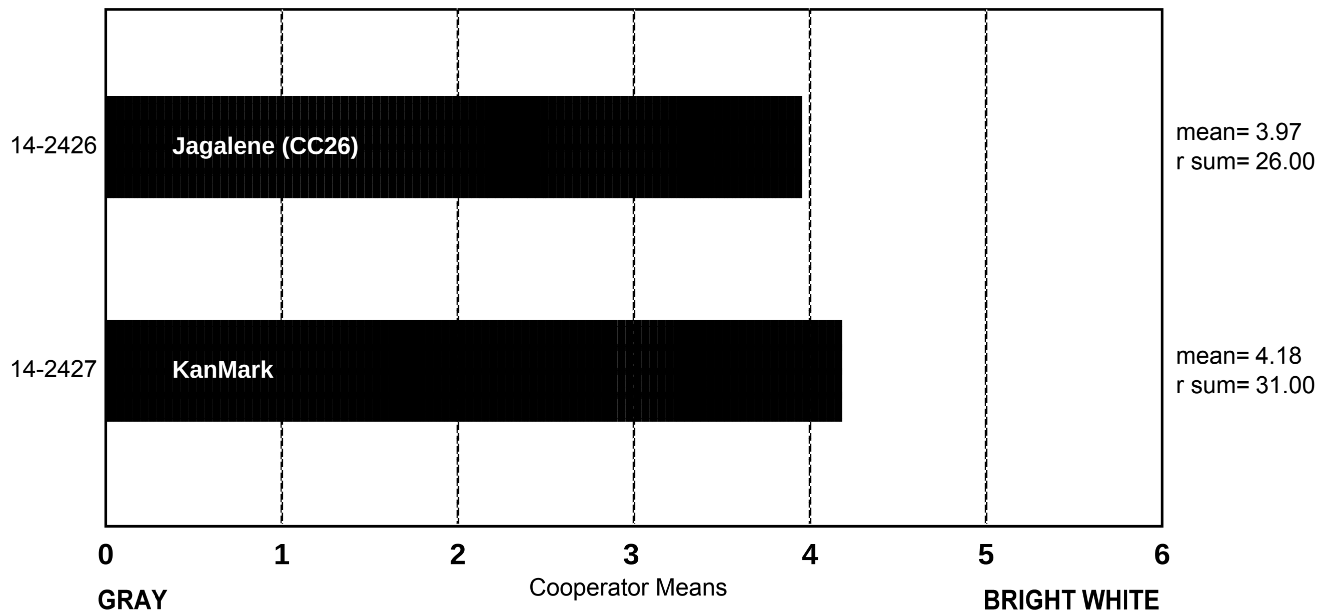
Frequency Table

CRUMB COLOR

(Small Scale) Kansas-Manhattan

ncoop= 19
chisq= 1.32
chisqc= 2.08
cvchisq= 3.84
crdiff=

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



CRUMB COLOR, DESCRIBED

(Small Scale) Kansas-Manhattan

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
14-2426 Jagalene (CC26)	1	0	2	2	10	4	0
14-2427 KanMark	0	0	3	2	4	10	0

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Kansas-Manhattan

	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
14-2426 Jagalene (CC26)	**127.5**	**139.9**	**143.4**	**154.2**	**137.9**	**139.2**	**463.5**	**467.5**	**418.0**	**730.6**	**134.0**	**149.1**	**465.6**	**138.4**	**135.5**	**484.5**	**460.0**	**449.3**	**488.2**
14-2427 KanMark	**124.3**	**139.1**	**143.1**	**152.8**	**138.6**	**137.7**	**465.3**	**470.3**	**412.0**	**744.5**	**134.0**	**147.7**	**463.2**	**136.9**	**139.1**	**478.7**	**462.0**	**453.7**	**484.9**

LOAF VOLUME, ACTUAL

(Small Scale) Kansas-Manhattan

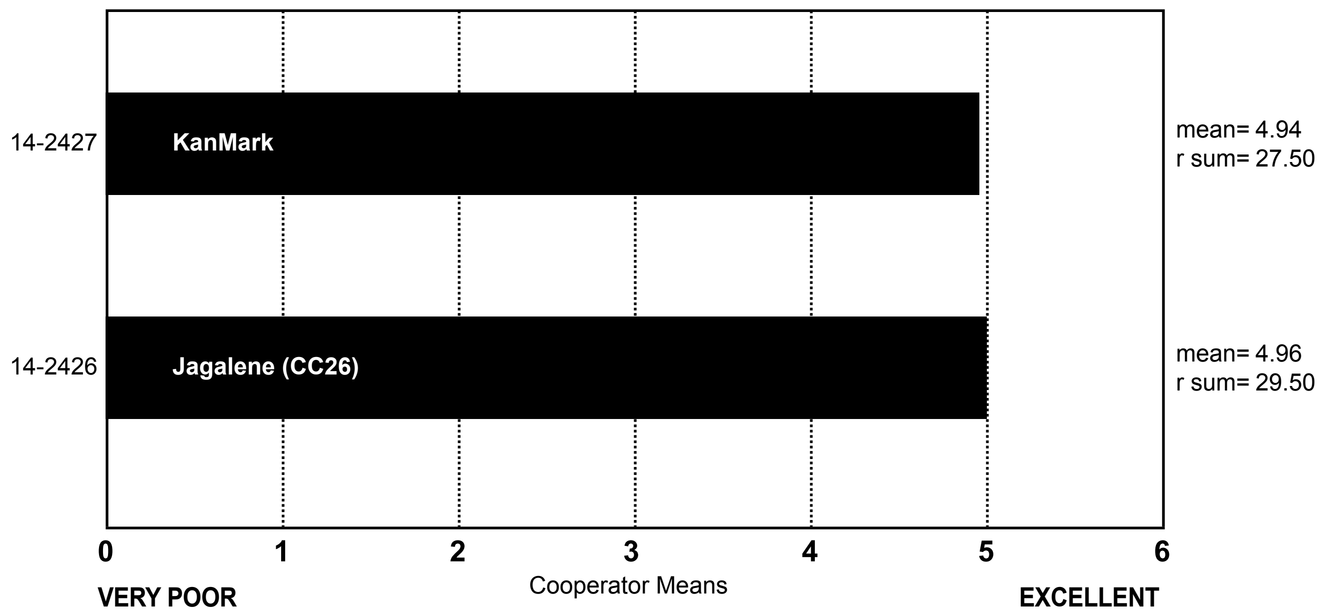
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2426 Jagalene (CC26)	**825**	**1240**	**1095**	**1105**	**1038**	**965**	**2800**	**2563**	**3000**	**4280**	**1200**	**1075**	**2475**	**1001**	**1023**	**3104**	**2225**	**2650**	**2750**
14-2427 KanMark	**960**	**1325**	**1100**	**1035**	**968**	**1050**	**2850**	**2500**	**3050**	**3780**	**1200**	**1095**	**2300**	**985**	**1033**	**3104**	**2000**	**2675**	**2838**

LOAF VOLUME

(Small Scale) Kansas-Manhattan

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.

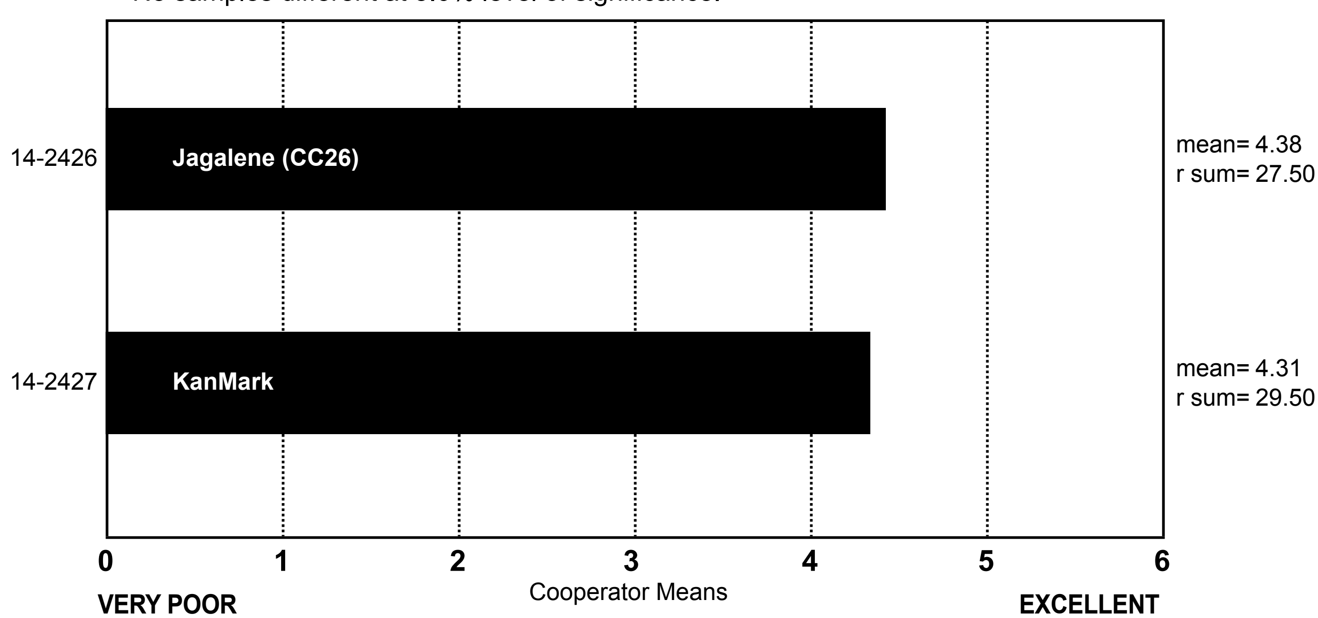


OVERALL BAKING QUALITY

(Small Scale) Kansas-Manhattan

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.



COOPERATOR'S COMMENTS
(Small Scale) Kansas-Manhattan

COOP. **14-2426 Jagalene (CC26)**

A. Smooth, pliable, nice resistance/body, nice gas, full body, elastic, nice oven spring.
B. Long time to pick-up, excellent loaf externals.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Normal absorption, long mix time, slight sticky & strong dough, very high OS & volume, little yellow crumb, fine elongated cells, very smooth & resilient texture.
F. Overall acceptable line.
G. No comment.
H. Low absorption, slightly above average mix, average volume, yellow, open grain.
I. Tough and bucky dough, very open grain, good volume.
J. No comment.
K. Excellent bake performance, great volume.
L. Excellent absorption, dough strength at mix and pan, crumb grain and loaf volume. Strong mixograph.
M. Off flavor.
N. 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
O. No comment.
P. Good strength, open, irregular grain, harsh texture, good volume.
Q. Open cell structure, weak crumb.
R. Long mix time, dough was tough, excellent volume with a dense grain.
S. Long mix time, tough dough, good grain, very high volume.

COOP. **14-2427 KanMark**

A. Long mixer, great volume, good crumb structure.
B. Extremely long mix time, excellent loaf externals.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Normal absorption, very long mix time, slight sticky & strong dough, very high OS & volume, creamy crumb, fine & elongated cells, very smooth & resilient texture.
F. Longer mixing, very good loaf volume with good color.
G. No comment.
H. Low absorption, extremely long mix, average volume, white, open grain.
I. Tough and bucky dough, very open grain, good volume.
J. No comment.
K. Excellent bake performance, strong mix tolerance, short mix underdeveloped.
L. Excellent sample, excellent dough, perfect crumb grain, creamy color with high loaf volume.
M. No comment.
N. 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
O. No comment.

P. Good crumb color, tight, consistent grain, excellent volume.
Q. Low absorption, light crust color, shelled break and shred.
R. Long mix time, dough was tough, excellent volume with a dense grain.
S. Extremely long mix time, tough dough, very fine grain, white crumb, very high volume, best overall.

Notes: **G, H, I, K, P, Q, R and S** conducted sponge and dough bake tests

AGRIPRO

14-2428	06BC722#25
14-2429	06BC796#68
14-2430	Jagalene (CC26)

Description of Test Plots and Breeder Entries

Agripro (Syngenta) - Jon Rich

Increase strips were planted on 10/28/13 at our location in Junction City, KS. An early winter prevented good plant development going into the winter. All increases had 80lbs of 11-52-0 applied with the planter with 70lbs of N applied prior to planting. An additional 40lbs of N was applied in the spring prior to joining.

06BC722#25

06BC722#25 is a double haploid line that was developed from the 3-way cross 06BC518/Duster made in the Fall of 2006. 06BC518 is a cross between WGRC42 and Jagalene. WGRC42 was a Hessian Fly germplasm release developed at the Wheat Genetics Resource Center at Kansas State University. The pedigree is KARL-92/(TR.DN)PI-94641//JAGGER*2/KARL-92; KARL-92/(TR.DN)PI-94641//2*JAGGER. The major gene is Hdic conferring Biotype L resistance to Hessian Fly. Jagalene a cross between Jagger and Abilene was released in 2003. Duster an Oklahoma State University release in 2006 was selected from a double cross, W0405/ NE78488//W7469C/TX81V6187, made within the former Pioneer HRW-wheat breeding program.

06BC722#25 is a hard red winter wheat broadly adapted to the major growing regions of Oklahoma, Kansas, Colorado and Nebraska. 06BC722#25 will be targeted for both irrigated and dry land situations. It is moderately resistant to leaf rust and stripe rust and resistant to Hessian fly. It is very tolerant to acid soils and resistant to Soil-borne Mosaic Virus. It also has intermediate reaction to Barley Yellow Dwarf Virus with very good straw strength. Milling and baking data compiled over three years indicates a line with excellent milling properties compared to Jagalene but slightly below Jagalene in baking properties. Baking is comparable to SY Wolf and Postrock.

06BC796#68

06BC796#68 is a double haploid line that was developed from the cross 06BC308/NE03458 made in the Fall of 2006. 06BC308 is a cross between BC98337-10-53 and CDC FALCON. BC98337-10-53 was a line developed at Kansas State University from the cross X920709B-5-2/WGRC10//OGALLALA. CDC Falcon was developed and released in 1998 by the Crop Development Centre, University of Saskatchewan. The pedigree for CDC Falcon is Norstar ´ 2/Vona//Abilene. NE03458 was a line developed by University of Nebraska from the cross NE95544 (=MCVEY 78015/NE88521)/W91-348//MILLENNIUM which was tested in the NRPN in 2006 and 2007.

06BC796#68 is a hard red winter wheat that will be targeted for irrigated production in the high plains regions of Kansas, Colorado and Nebraska. This is a shorter, later maturing line with excellent straw strength and top end yield potential. It is moderately susceptible to stripe rust but moderately resistant to leaf rust. It is intolerant to low pH soils. Milling and baking data compiled over three years have shown acceptable quality but not an improvement over Jagalene. Baking is comparable to SY Wolf.

Agripro: 2014 (Small-Scale) Samples

Test entry number	14-2428	14-2429	14-2430
Sample identification	**06BC722#25**	**06BC796#68**	**Jagalene (CC26)**
Wheat Data			
GIPSA classification	1 HRW	1 HRW	2 HRW
Test weight (lb/bu) **Hectoliter weight (kg/hl)**	63.0 82.8	62.3 81.9	57.8 76.1
1000 kernel weight (gm)	34.1	37.9	31.8
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 84.6 15.4 0.0	 94.3 5.7 0.0	 73.8 26.1 0.1
Single kernel (skcs)[a] Hardness (avg /s.d) Weight (mg) (avg/s.d) Diameter (mm)(avg/s.d) Moisture (%) (avg/s.d) SKCS distribution Classification	 78.9/14.3 34.1/6.1 2.82/0.26 12.7/0.3 00-02-07-91-01 Hard	 75.5/14.2 37.9/6.7 3.02/0.27 12.5/0.3 00-01-12-87-01 Hard	 60.6/15.5 31.8/9.2 2.76/0.35 11.9/0.3 04-12-30-54-01 Hard
Wheat protein (12% mb) **Wheat ash (12% mb)**	14.7 1.83	13.8 1.81	14.7 1.80
Milling and Flour Quality Data			
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 71.3 65.9	 66.1 62.5	 67.1 67.6
Flour moisture (%) **Flour protein (14% mb)** **Flour ash (14% mb)**	12.5 12.5 0.58	12.9 11.3 0.51	13.0 13.5 0.55
Rapid Visco-Analyser Peak time (min) Peak viscosity (RVU) Breakdown (RVU) Final viscosity at 13 min (RVU)	 6.1 217.7 86.7 245.2	 6.1 271.0 110.0 291.1	 6.2 214.9 77.0 257.6
Minolta color meter L* a* b* **PPO**	 91.95 -1.19 8.15 0.502	 92.23 -1.20 7.90 0.516	 91.92 -1.54 9.38 0.559
Falling number (sec)	526	477	469
Damaged Starch (AI%) (AACC76-31)	 97.55 7.53	 97.39 7.40	 95.30 5.75

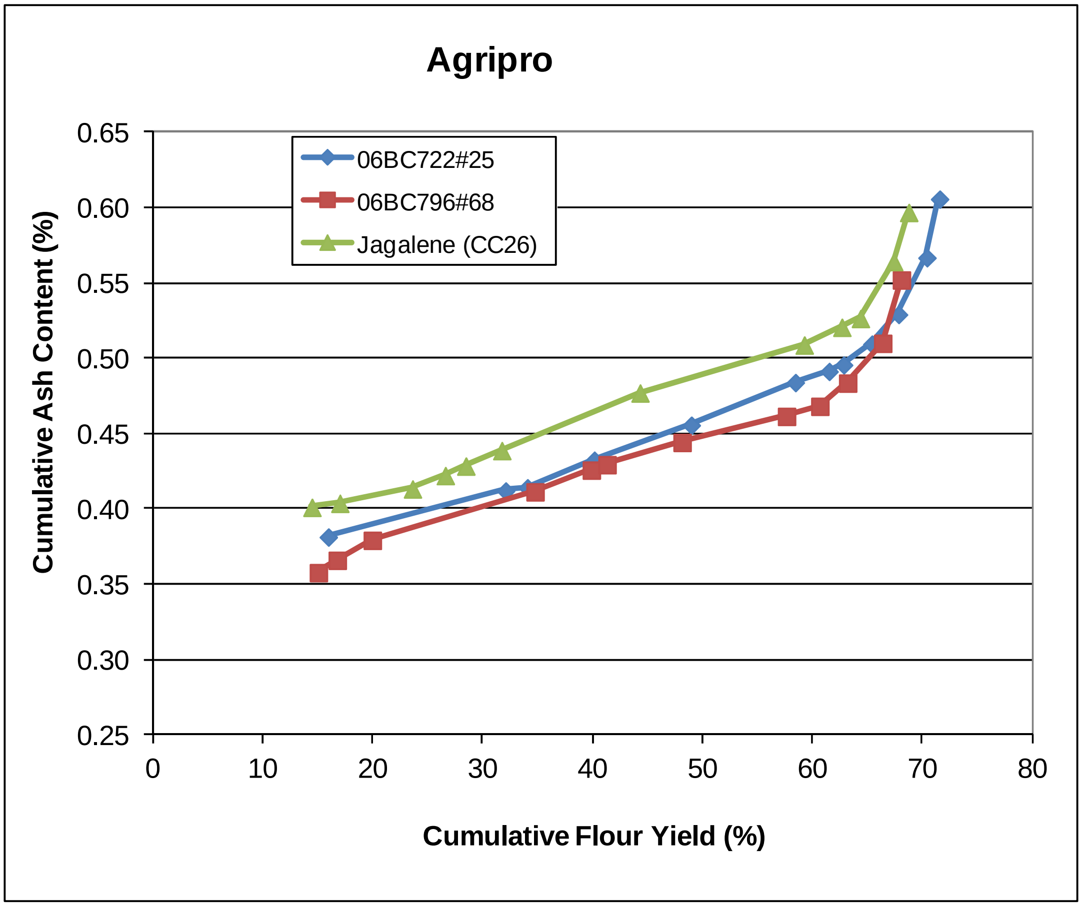
[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Agripro: Physical Dough Tests and Gluten Analysis For 2014 (Small-Scale) Samples

Test Entry Number	14-2428	14-2429	14-2430
Sample Identification	06BC722#25	06BC796#68	Jagalene (CC26)
MIXOGRAPH			
Flour Abs (% as-is)	65.5	62.9	67.2
Flour Abs (14% mb)	63.4	61.3	65.6
Mix Time (min)	3.5	4.9	5.6
Mix tolerance (0-6)	4	4	5
FARINOGRAPH			
Flour Abs (% as-is)	66.3	66.3	59.0
Flour Abs (14% mb)	64.1	64.7	57.4
Development time (min)	2.0	1.7	5.8
Mix stability (min)	1.9	2.3	25.2
Mix Tolerance Index (FU)	66	61	13
Breakdown time (min)	3.3	3.4	21.8
ALVEOGRAPH			
P(mm): Tenacity	138	150	77
L(mm): Extensibility	56	34	131
G(mm): Swelling index	16.7	13.0	25.5
W(10^{-4} J): strength (curve area)	325	191	381
P/L: curve configuration ratio	2.46	4.41	0.59
Ie(P_{200}/P): elasticity index	64.6	0.0[@]	68.0
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	448/526/511	532/573/574	568/726/874
Extensibility (mm at 45/90/135 min)	135/134/133	102/93/98	171/171/149
Energy (cm^2 at 45/90/135 min)	103/115/112	77/71/73	195/228/207
Resist $_{max}$ (BU at 45/90/135min)	596/683/678	579/602/601	928/1000/994
Ratio (at 45/90/135 min)	3.32/3.94/3.84	5.23/6.19/5.89	3.33/4.25/5.88
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+8, 5+10	2*, 20a+b, 5+10	1/2*, 17+18, 5+10
%IPP	55.04	57.76	54.34
SEDIMENTATION TEST			
Volume (ml)	39.1	36.9	67.9

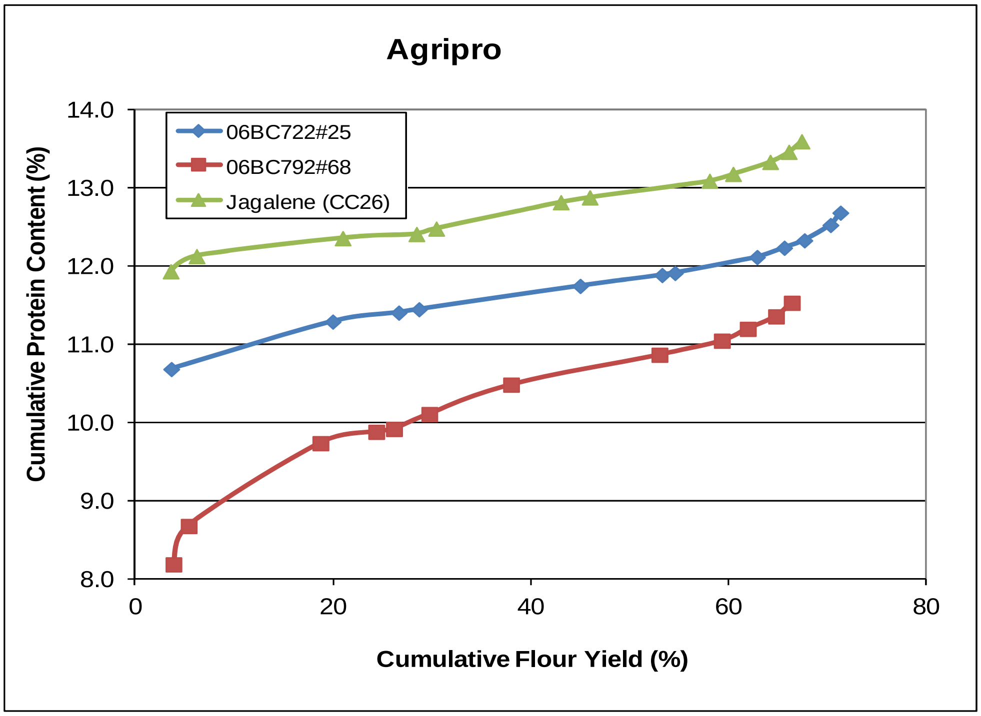
[@] If the extensibility is shorter than 4 cm or less than 200 ml blowing, Ie will be 0.

Agripro: Cumulative Ash Curves



06BC722#25					06BC796#68					Jagalene (CC26)				
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	15.91	0.38	15.91	0.38	2M	15.01	0.36	15.01	0.36	2M	14.43	0.40	14.43	0.40
3M	16.12	0.44	32.04	0.41	1M Red	1.72	0.44	16.74	0.37	1M Red	2.54	0.42	16.96	0.40
1M Red	1.98	0.45	34.01	0.41	1BK	3.19	0.45	19.92	0.38	1M	6.61	0.44	23.57	0.41
1M	6.08	0.54	40.10	0.43	3M	14.79	0.46	34.71	0.41	1BK	2.98	0.49	26.55	0.42
4M	8.82	0.56	48.92	0.46	1M	5.12	0.52	39.83	0.43	Grader	1.86	0.52	28.42	0.43
FILTER FLR	9.47	0.63	58.38	0.48	Grader	1.43	0.53	41.26	0.43	2BK	3.27	0.53	31.69	0.44
1BK	3.06	0.63	61.45	0.49	4M	6.83	0.53	48.09	0.44	3M	12.57	0.57	44.26	0.48
Grader	1.33	0.70	62.77	0.50	FILTER FLR	9.49	0.55	57.58	0.46	FILTER FLR	14.93	0.60	59.19	0.51
2BK	2.56	0.85	65.33	0.51	2BK	3.03	0.60	60.61	0.47	4M	3.42	0.72	62.61	0.52
3BK	2.43	1.06	67.77	0.53	3BK	2.53	0.85	63.14	0.48	3BK	1.69	0.74	64.30	0.53
5M	2.58	1.56	70.35	0.57	5M	3.18	1.03	66.32	0.51	5M	3.03	1.37	67.33	0.56
BRAN FLR	1.15	2.98	71.50	0.61	BRAN FLR	1.70	2.19	68.02	0.55	BRAN FLR	1.36	2.21	68.69	0.60
Break Shorts	3.27	3.42	74.77	0.73	Break Shorts	3.46	2.69	71.48	0.66	Break Shorts	3.70	4.35	72.38	0.79
Red Dog	1.29	2.50	76.06	0.76	Red Dog	1.50	2.53	72.98	0.69	Red Dog	1.50	3.31	73.88	0.84
Red Shorts	0.03	4.61	76.08	0.76	Red Shorts	0.02	3.54	73.01	0.70	Red Shorts	0.09	5.10	73.98	0.85
Filter Bran	7.73	1.13	83.81	0.79	Filter Bran	6.34	1.20	79.34	0.74	Filter Bran	9.58	1.77	83.56	0.95
Bran	16.19	6.97	100.0	1.80	Bran	20.66	5.84	100.0	1.79	Bran	16.44	6.03	100.0	1.79
Wheat		1.79					1.76					1.76		
St. Grd. Fl.		0.58					0.51					0.55		

Agripro: Cumulative Protein Curves



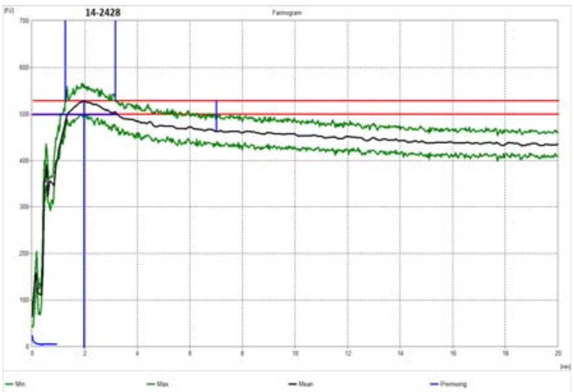
06BC722#25				
Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein
1BK	3.59	10.68	3.59	10.68
2M	16.34	11.42	19.93	11.29
1M	6.67	11.75	26.61	11.40
1M Red	2.05	11.98	28.66	11.44
3M	16.31	12.27	44.97	11.74
4M	8.28	12.64	53.25	11.88
Grader	1.31	12.99	54.56	11.91
FILTER FLR	8.31	13.45	62.86	12.11
2BK	2.75	14.94	65.62	12.23
5M	2.04	15.39	67.65	12.33
3BK	2.64	17.54	70.29	12.52
BRAN FLR	1.00	23.68	71.30	12.68
Break Shorts	3.57	17.59	74.87	12.91
Red Dog	1.03	18.60	75.90	12.99
Red Shorts	0.02	16.07	75.92	12.99
Filter Bran	7.07	13.10	82.99	13.00
Bran	17.01	19.07	100.00	14.03
Wheat		14.37		
St. Grd. Fl		12.48		

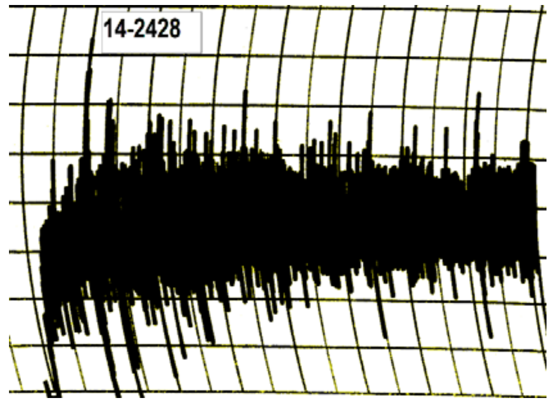
06BC796#68				
Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein
1BK	3.82	8.18	3.82	8.18
Grader	1.53	9.90	5.36	8.67
2M	13.34	10.16	18.69	9.73
1M	5.65	10.36	24.34	9.88
1M Red	1.79	10.40	26.13	9.91
2BK	3.57	11.49	29.70	10.10
FILTER FLR	8.27	11.83	37.98	10.48
3M	15.02	11.83	52.99	10.86
4M	6.31	12.55	59.31	11.04
5M	2.62	14.63	61.93	11.19
3BK	2.86	14.82	64.79	11.35
BRAN FLR	1.59	18.52	66.38	11.53
Break Shorts	3.95	16.69	70.34	11.82
Red Dog	1.21	18.03	71.55	11.92
Red Shorts	0.02	15.88	71.57	11.92
Filter Bran	5.85	12.85	77.42	11.99
Bran	22.58	18.94	100.00	13.56
Wheat		13.44		
St. Grd. Fl		11.34		

Jagalene (CC26)				
Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein
1BK	3.54	11.93	3.54	11.93
1M Red	2.62	12.38	6.15	12.12
2M	14.78	12.45	20.94	12.35
1M	7.47	12.55	28.40	12.41
Grader	2.00	13.46	30.40	12.48
FILTER FLR	12.61	13.62	43.01	12.81
4M	2.92	13.80	45.93	12.87
3M	12.12	13.89	58.05	13.09
5M	2.39	15.33	60.44	13.17
2BK	3.76	15.80	64.19	13.33
3BK	1.88	17.79	66.07	13.46
BRAN FLR	1.30	20.47	67.37	13.59
Break Shorts	4.16	18.22	71.53	13.86
Red Dog	1.11	16.82	72.64	13.90
Red Shorts	0.07	16.71	72.70	13.91
Filter Bran	8.33	14.10	81.03	13.93
Bran	18.97	18.62	100.00	14.82
Wheat		14.40		
St. Grd. Fl		13.50		

Physical Dough Tests
2014 (Small Scale) Samples - Agripro

Farinograms | **Mixograms**

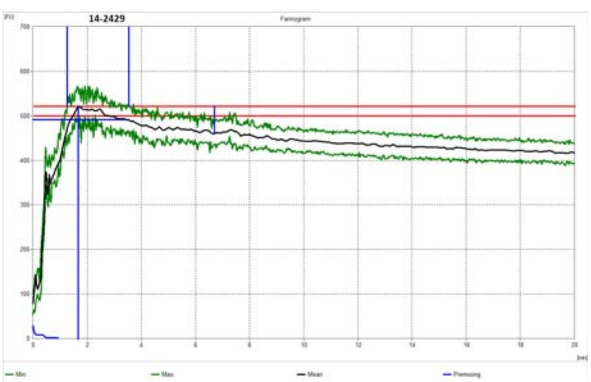


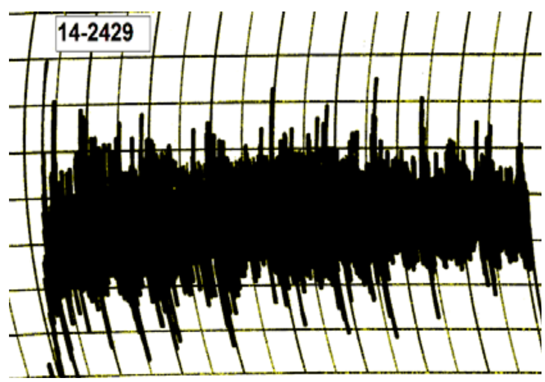


Water abs = 64.1%, Peak time = 2.0 min,
Mix stab = 1.9 min, MTI = 66 FU

Water abs = 63.4%
Mix time = 3.5 min

14-2428, 06BC722#25





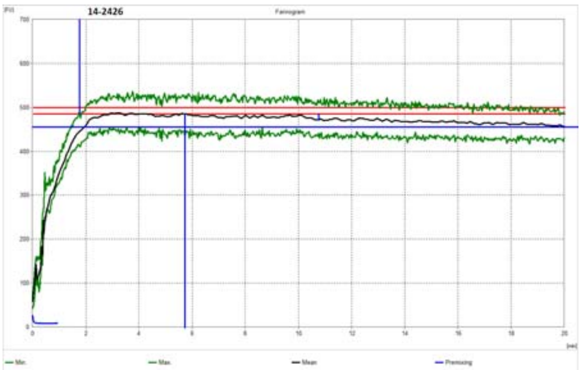
Water abs = 64.7%, Peak time = 1.7 min,
Mix stab = 2.3 min, MTI = 61 FU

Water abs = 61.3%
Mix time = 4.9 min

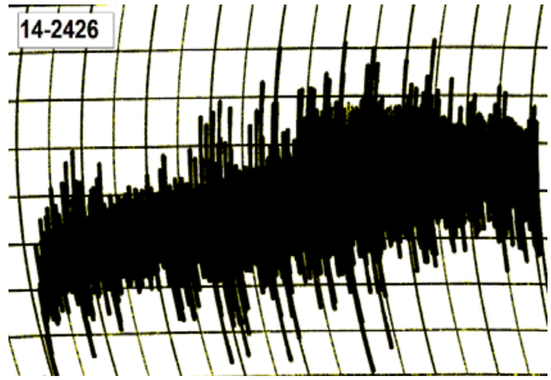
14-2429, 06BC796#68

Physical Dough Tests

2014 (Small Scale) Samples - Agripro (continued)



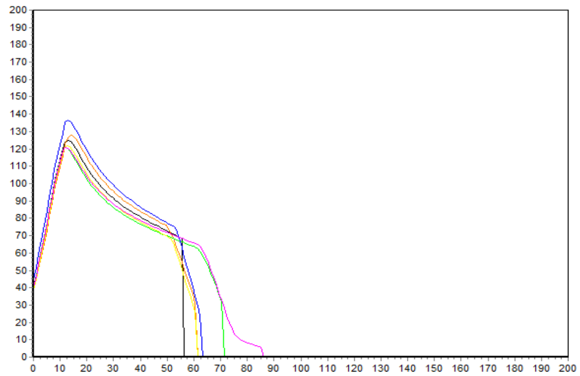
Water abs = 57.4%, Peak time = 5.8 min,
Mix stab = 25.2 min, MTI = 13 FU



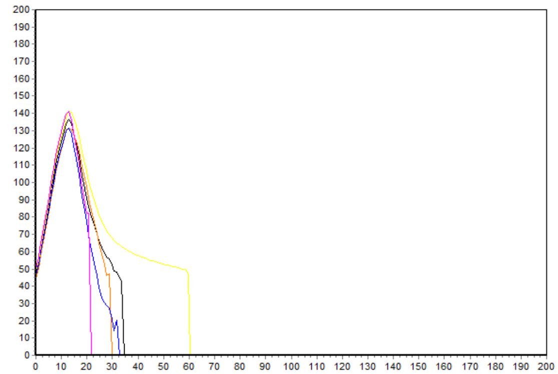
Water abs = 65.6%
Mix time = 5.6 min

14-2430, Jagalene (CC26)

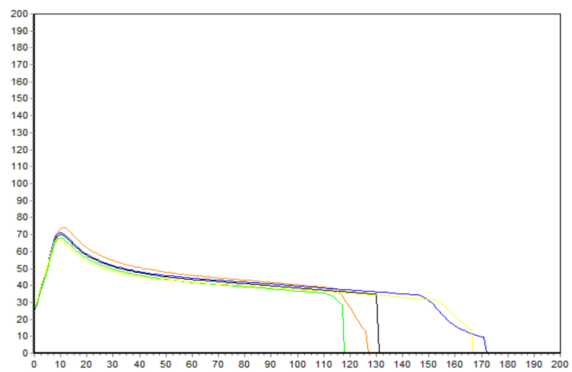
Physical Dough Tests - Alveograph
2014 (Small Scale) Samples – Agripro



14-2428, 06BC722#25
P(mm H_20)=138, L(mm)=56, W($10E^{-4}$ J)=325



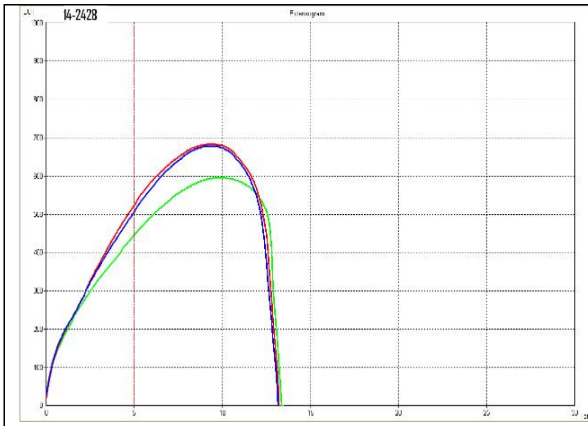
14-2429, 06BC796#68
P(mm H_20)=150, L(mm)=34, W($10E^{-4}$ J)=191



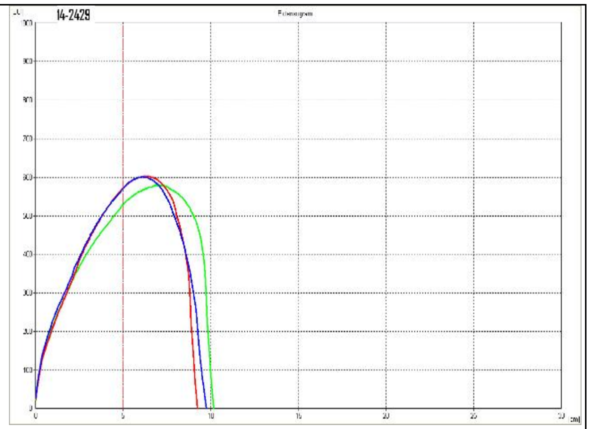
14-2430, Jagalene (CC26)
P(mm H_20)=77, L(mm)=131, W($10E^{-4}$ J)=381

Physical Dough Tests - Extensigraph

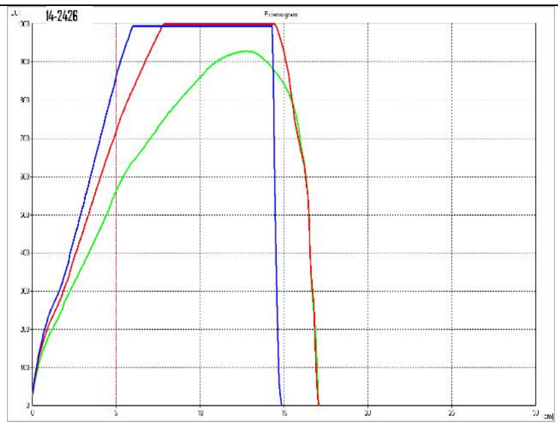
2014 (Small Scale) Samples – Agripro



14-2428, 06BC722#25
R (BU) = 526, E (mm) =134, W (cm^2) = 115
Rmax (BU) = 683, Ratio = 3.94 at 90 min



14-2429, 06BC796#68
R (BU) = 573, E (mm) =93, W (cm^2) = 71
Rmax (BU) = 602, Ratio = 6.19 at 90 min



14-2430, Jagalene (CC26)
R (BU) = 726, E (mm) =171, W (cm^2) = 228
Rmax (BU) = 1000, Ratio = 4.25 at 90 min

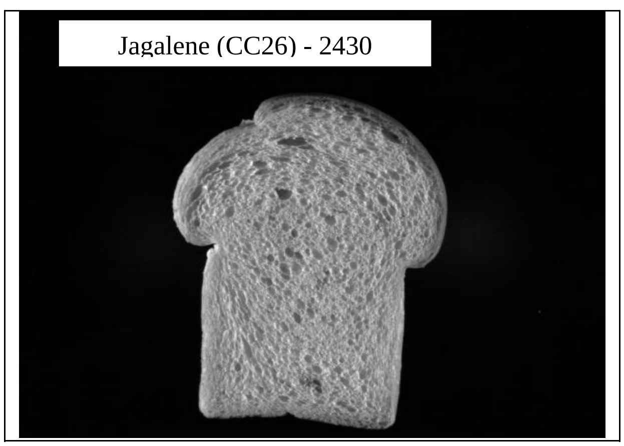
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Agripro: C-Cell Bread Images and Analysis for 2014 (Small-Scale) Samples


06bc722#25 - 2428


06bc796#68 - 2429

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})
2428	6216	141.5	3697	0.450	2.102	1.283	1.650	-19.55
2429	5416	140.1	3239	0.451	1.996	0.872	1.640	-23.23


Jagalene (CC26) - 2430

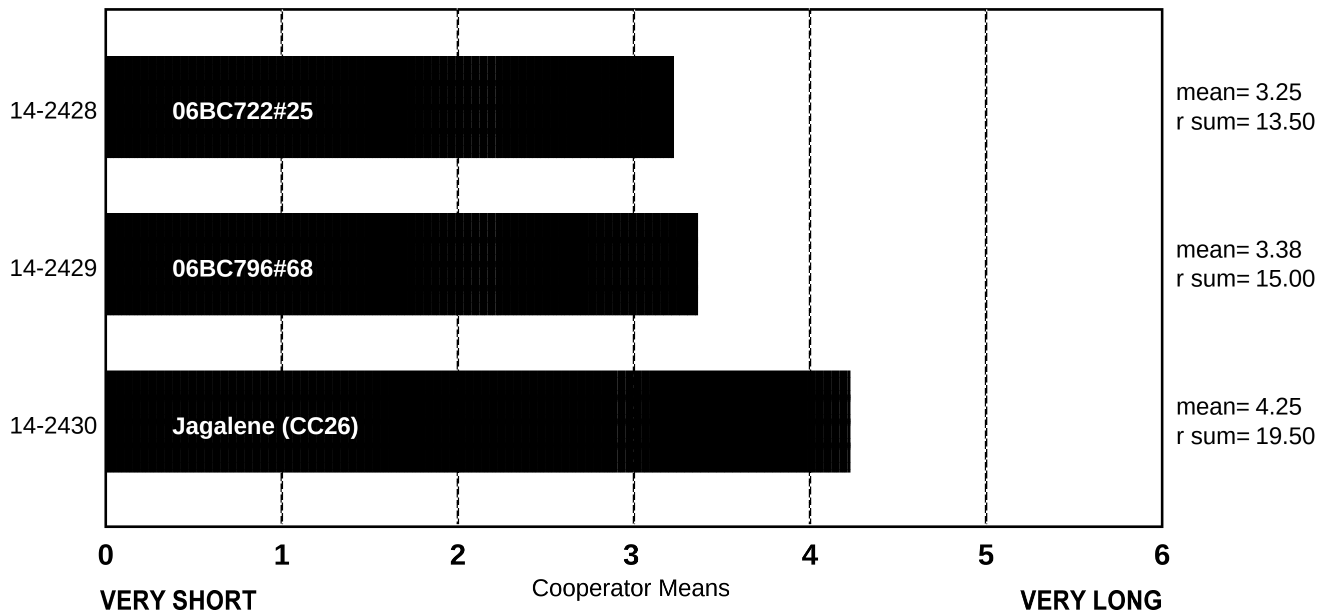
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2430	7380	138.7	4533	0.441	2.061	1.684	1.745	-15.45

SPONGE CHARACTERISTICS

(Small Scale) Agripro

ncoop= 8
chisq= 2.44
chisqc= 3.90
cvchisq= 5.99
crdiff=

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

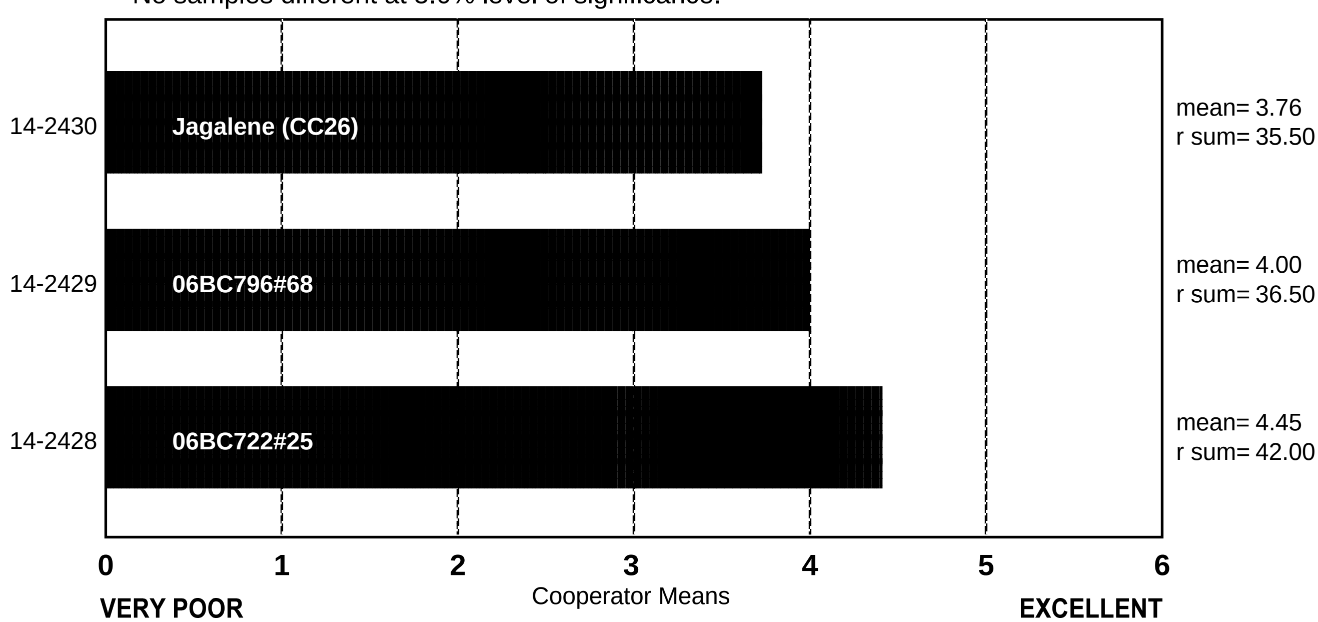


BAKE ABSORPTION

(Small Scale) Agripro

ncoop= 19
chisq= 1.29
chisqc= 1.88
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) 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
14-2428 06BC722#25	**65.4**	**64.1**	**62.6**	**66.3**	**63.0**	**64.5**	**60.5**	**64.1**	**59.0**	**73.7**	**63.0**	**61.6**	**66.3**	**63.6**	**65.0**	**63.0**	**66.5**	**69.3**	**61.0**
14-2429 06BC796#68	**65.4**	**61.4**	**60.5**	**64.3**	**63.0**	**63.5**	**61.0**	**64.7**	**58.0**	**73.3**	**61.0**	**61.1**	**66.3**	**63.8**	**63.0**	**63.0**	**66.5**	**69.3**	**61.0**
14-2430 Jagalene (CC26)	**59.4**	**66.6**	**64.1**	**65.9**	**63.0**	**64.5**	**60.5**	**57.4**	**60.0**	**65.9**	**64.0**	**64.6**	**59.0**	**65.8**	**68.0**	**59.0**	**59.0**	**62.0**	**59.0**

BAKE MIX TIME, ACTUAL

(Small Scale) Agripro

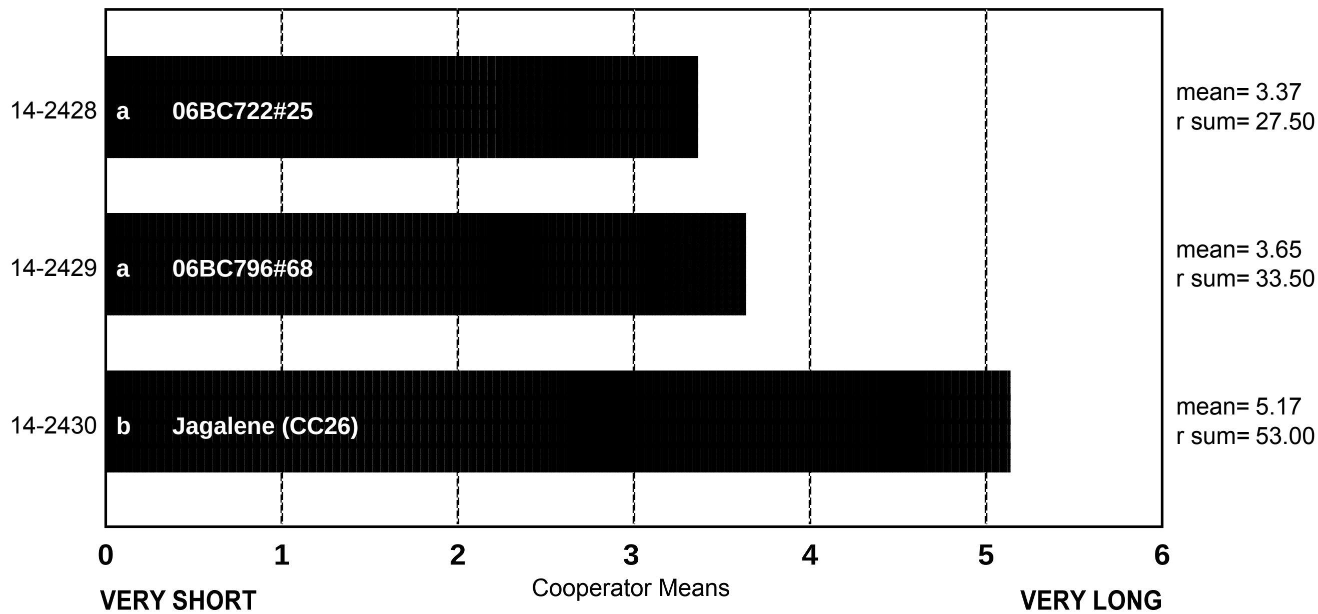
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2428 06BC722#25	**4.0**	**5.0**	**4.3**	**5.5**	**5.9**	**3.5**	**18.0**	**5.0**	**8.0**	**6.0**	**9.0**	**6.3**	**6.5**	**3.2**	**4.3**	**14.0**	**7.0**	**4.0**	**5.0**
14-2429 06BC796#68	**4.3**	**5.5**	**3.3**	**5.6**	**4.9**	**3.7**	**12.0**	**4.0**	**8.0**	**7.5**	**9.0**	**7.0**	**8.0**	**3.9**	**5.3**	**14.0**	**7.0**	**4.5**	**5.0**
14-2430 Jagalene (CC26)	**4.8**	**6.8**	**4.5**	**7.5**	**8.6**	**4.1**	**30.0**	**9.0**	**20.0**	**7.0**	**9.0**	**8.5**	**7.5**	**5.6**	**7.8**	**25.0**	**11.5**	**13.0**	**12.0**

BAKE MIX TIME

(Small Scale) Agripro

ncoop= 19
chisq= 18.71
chisqc= 24.10
cvchisq= 5.99
crdiff= 6.84

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

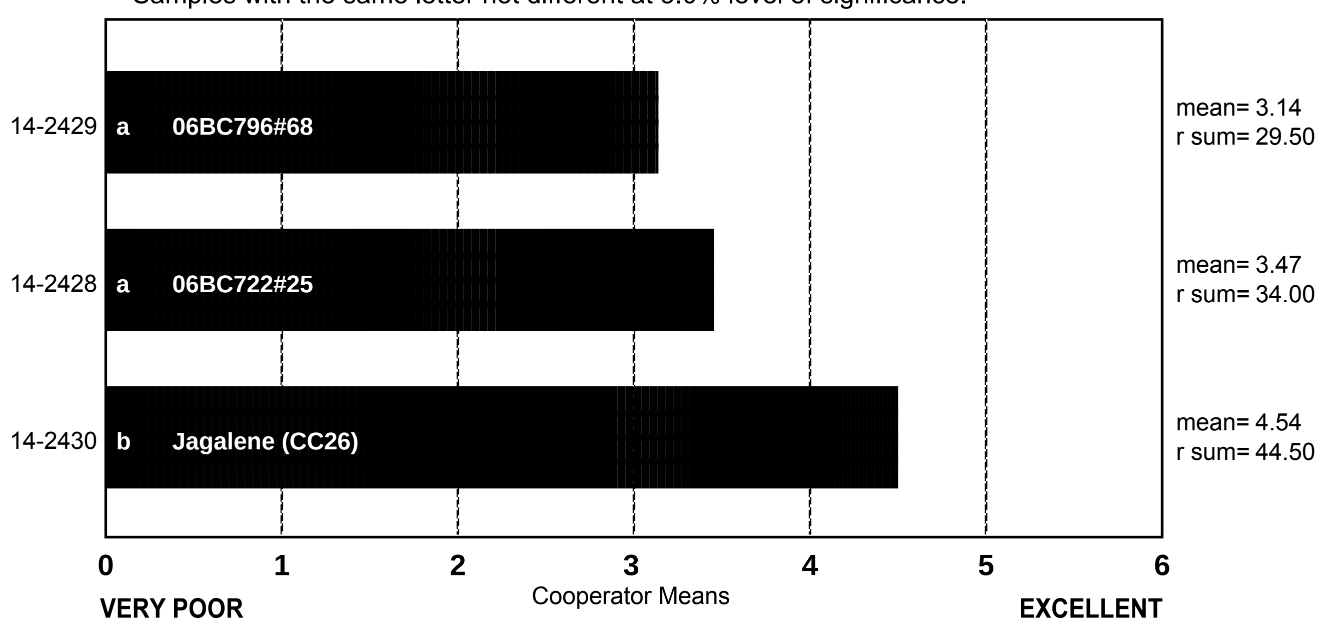


MIXING TOLERANCE

(Small Scale) Agripro

ncoop= 18
chisq= 6.58
chisqc= 9.48
cvchisq= 5.99
crdiff= 8.97

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

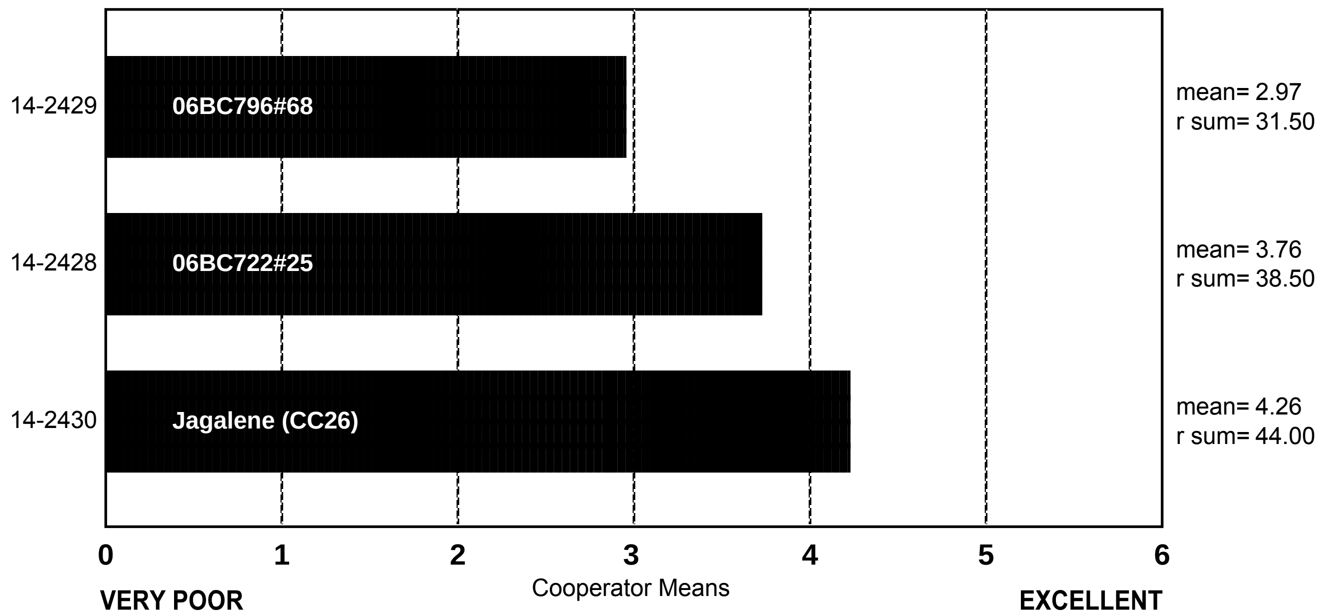


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Agripro

ncoop= 19
chisq= 4.13
chisqc= 5.06
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) Agripro

	Sticky	Wet	Tough	Good	Excellent
14-2428 06BC722#25	2	3	5	8	1
14-2429 06BC796#68	6	2	5	5	1
14-2430 Jagalene (CC26)	1	1	8	7	2

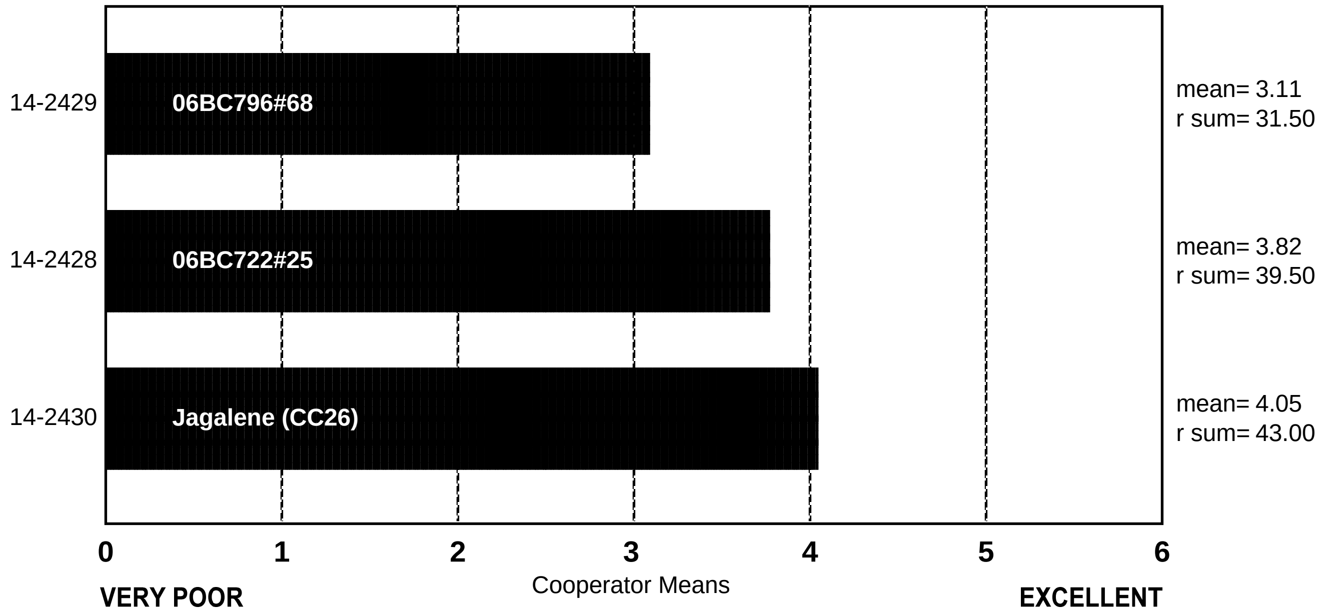
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Agripro

ncoop= 19
chisq= 3.66
chisqc= 4.21
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) Agripro

	Sticky	Wet	Tough	Good	Excellent
14-2428 06BC722#25	**2**	**3**	**3**	**10**	**1**
14-2429 06BC796#68	**2**	**3**	**5**	**8**	**1**
14-2430 Jagalene (CC26)	**1**	**0**	**7**	**10**	**1**

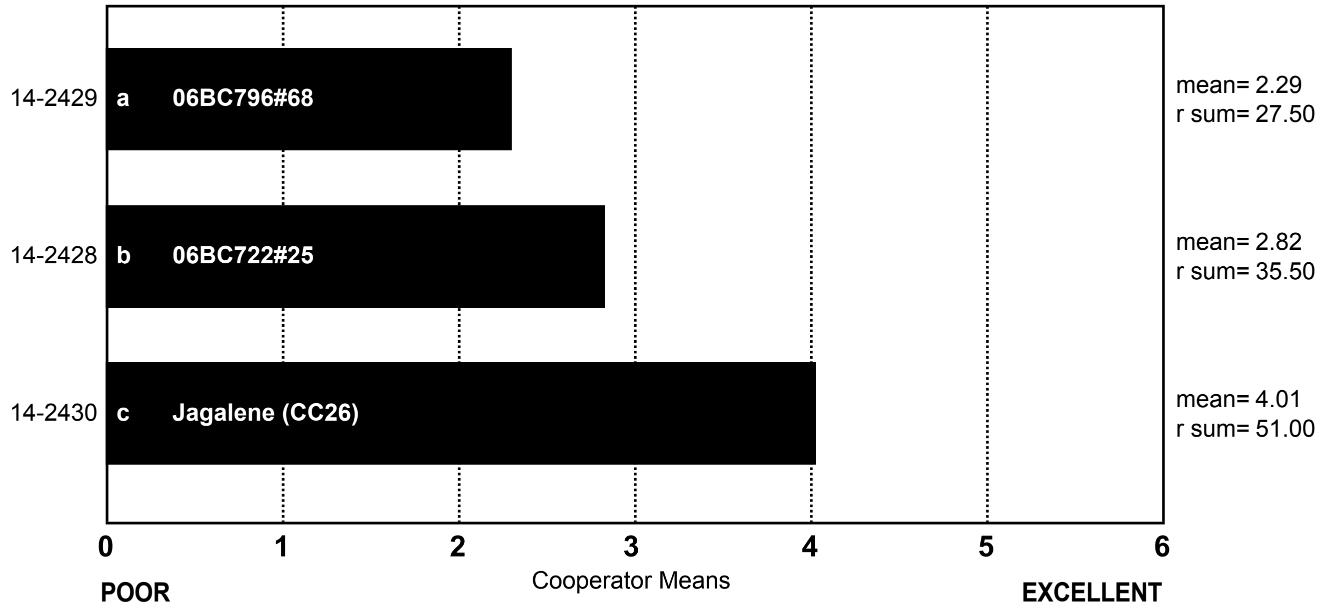
Frequency Table

CRUMB GRAIN

(Small Scale) Agripro

ncoop= 19
chisq= 15.03
chisqc= 19.36
cvchisq= 5.99
crdiff= 7.93

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Agripro

	Open	Fine	Dense
14-2428 06BC722#25	12	3	4
14-2429 06BC796#68	11	3	5
14-2430 Jagalene (CC26)	8	9	2

Frequency Table

CELL SHAPE, DESCRIBED

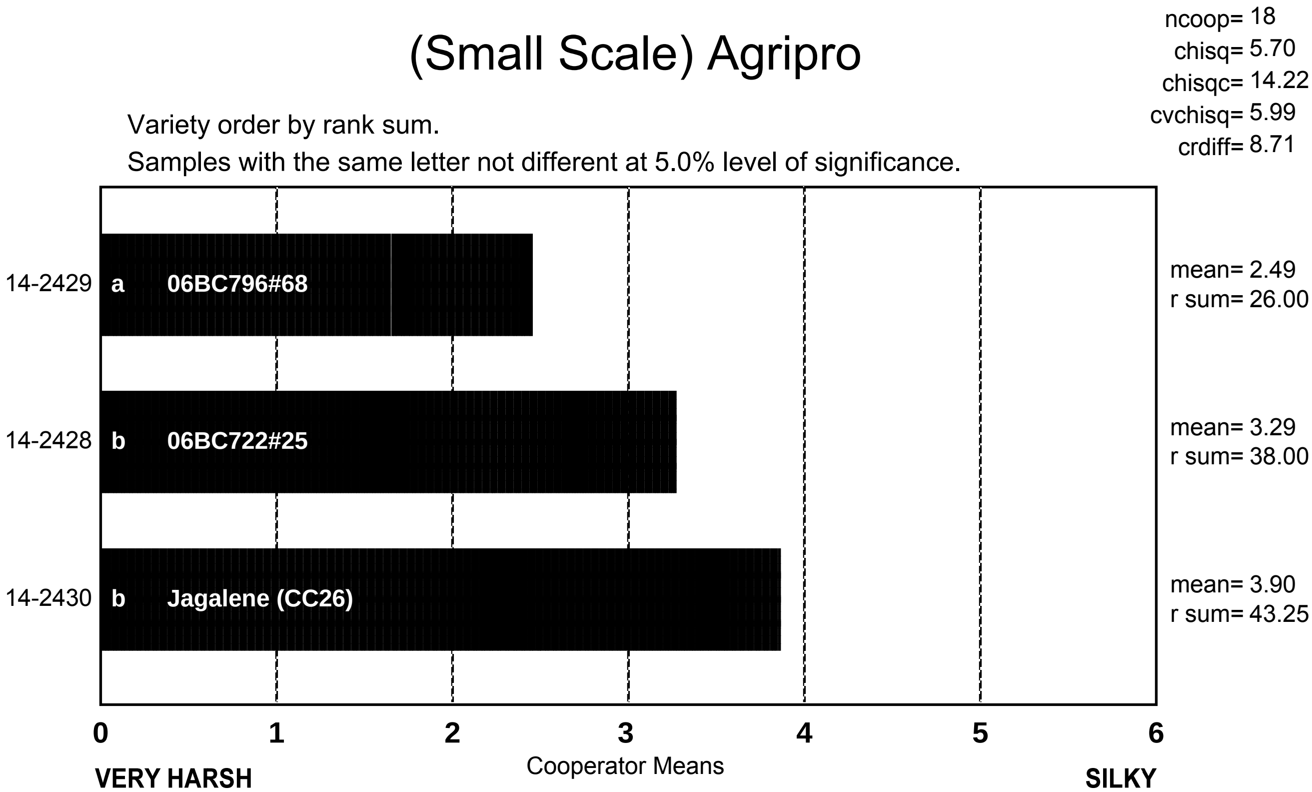
(Small Scale) Agripro

	Round	Irregular	Elongated
14-2428 06BC722#25	**11**	**6**	**2**
14-2429 06BC796#68	**14**	**5**	**0**
14-2430 Jagalene (CC26)	**2**	**7**	**10**

Frequency Table

CRUMB TEXTURE

(Small Scale) Agripro



CRUMB TEXTURE, DESCRIBED

(Small Scale) Agripro

	Harsh	Smooth	Silky
14-2428 06BC722#25	**8**	**8**	**2**
14-2429 06BC796#68	**12**	**5**	**1**
14-2430 Jagalene (CC26)	**4**	**11**	**3**

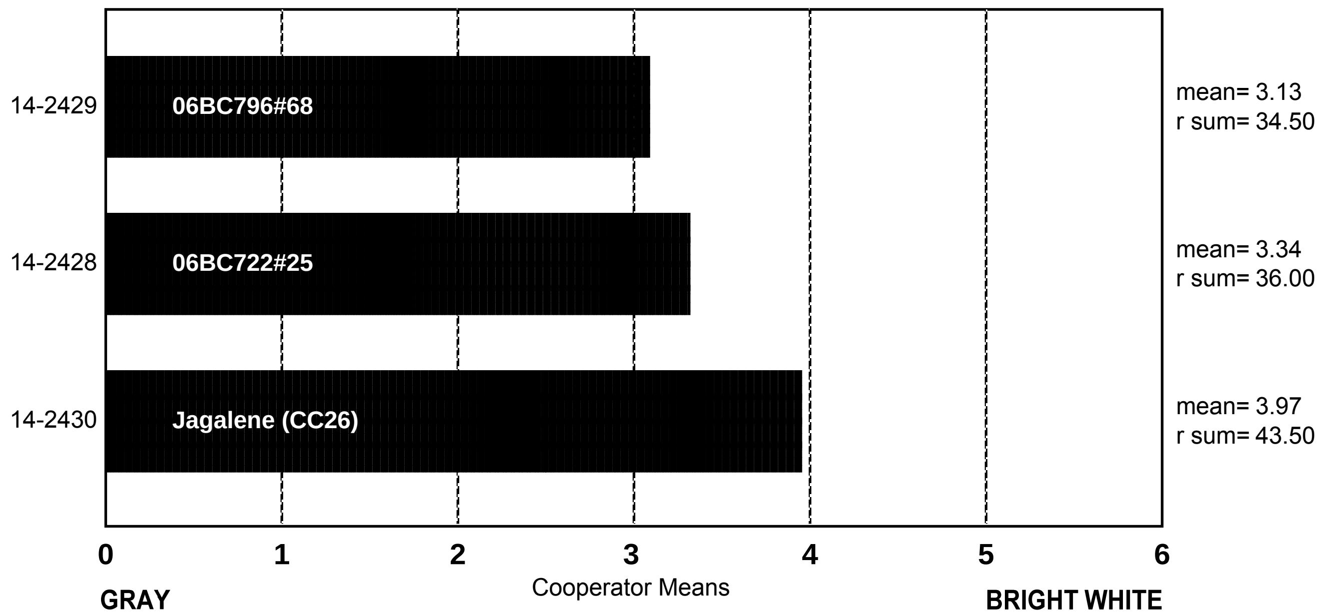
Frequency Table

CRUMB COLOR

(Small Scale) Agripro

ncoop= 19
chisq= 2.45
chisqc= 3.88
cvchisq= 5.99
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
14-2428 06BC722#25	2	1	1	6	5	4	0
14-2429 06BC796#68	3	0	3	3	6	4	0
14-2430 Jagalene (CC26)	1	0	2	2	10	4	0

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
14-2428 06BC722#25	**134.7**	**141.7**	**145.0**	**157.9**	**140.8**	**143.9**	**464.1**	**461.7**	**415.0**	**789.8**	**134.0**	**147.9**	**455.5**	**139.6**	**137.8**	**480.2**	**443.0**	**448.2**	**485.8**
14-2429 06BC796#68	**140.6**	**143.1**	**144.9**	**157.0**	**140.5**	**145.6**	**464.2**	**464.4**	**415.0**	**772.8**	**134.0**	**149.2**	**459.5**	**139.8**	**144.2**	**474.6**	**453.0**	**452.5**	**485.2**
14-2430 Jagalene (CC26)	**127.5**	**139.9**	**143.4**	**154.2**	**137.9**	**139.2**	**463.5**	**467.5**	**418.0**	**730.6**	**134.0**	**149.1**	**465.6**	**138.4**	**135.5**	**484.5**	**460.0**	**449.3**	**488.2**

LOAF VOLUME, ACTUAL

(Small Scale) Agripro

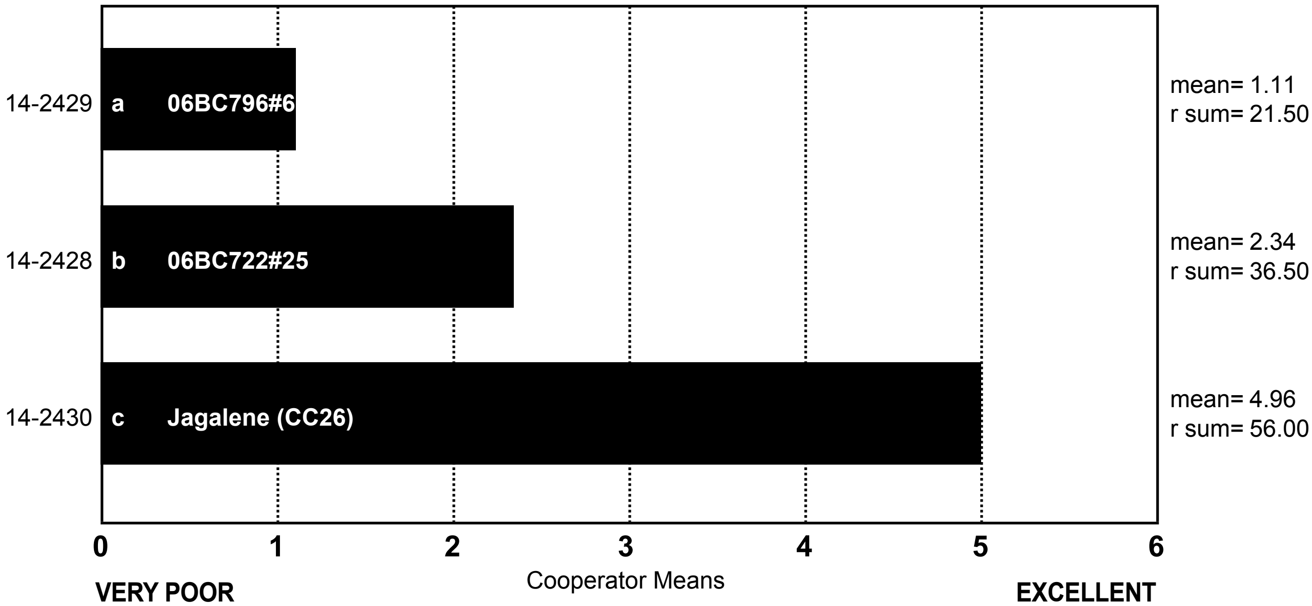
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q	Coop. R	Coop. S
14-2428 06BC722#25	**630**	**965**	**870**	**860**	**928**	**660**	**2475**	**2275**	**2500**	**3430**	**883**	**865**	**2050**	**762**	**915**	**3104**	**2100**	**2225**	**2413**
14-2429 06BC796#68	**415**	**690**	**660**	**675**	**780**	**540**	**2400**	**2100**	**2500**	**2930**	**765**	**700**	**1925**	**698**	**760**	**3015**	**1975**	**2125**	**2238**
14-2430 Jagalene (CC26)	**825**	**1240**	**1095**	**1105**	**1038**	**965**	**2800**	**2563**	**3000**	**4280**	**1200**	**1075**	**2475**	**1001**	**1023**	**3104**	**2225**	**2650**	**2750**

LOAF VOLUME

(Small Scale) Agripro

ncoop= 19
chisq= 31.50
chisqc= 34.70
cvchisq= 5.99
crdiff= 3.61

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

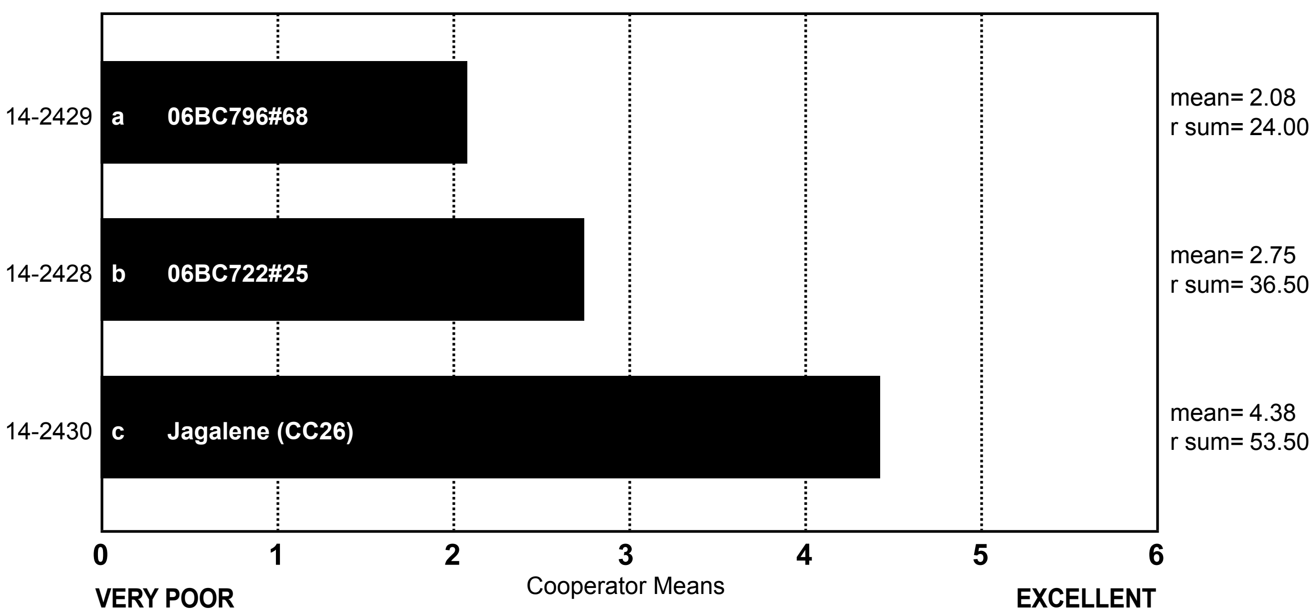


OVERALL BAKING QUALITY

(Small Scale) Agripro

ncoop= 19
chisq= 23.08
chisqc= 25.06
cvchisq= 5.99
crdiff= 7.19

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



COOPERATOR'S COMMENTS
(Small Scale) Agripro

COOP. 14-2428 06BC722#25

A. Very poor sample, comparable to English muffin in structure and texture.
B. OK.
C. No comment.
D. Good dough strength but very poor bread performance.
E. Normal absorption and mix time, slight sticky & strong dough, high OS & volume, yellow crumb, open irregular cells, little harsh & resilient texture.
F. Good protein, no gluten, very weak farinograph!, poor bread.
G. No comment.
H. Above average absorption, short mix, very low volume, dull, open grain.
I. Short mix, low volume, dry sponge.
J. No comment.
K. Lower volume, strong on bench.
L. Good flour protein but weak out of mixer and at pan, questionable crumb grain and lower loaf volume.
M. Off flavor.
N. 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
O. No comment.
P. Good absorption, lower mix time, excellent volume.
Q. Dry at sponge and make up, low stability.
R. Short mix time, dough was slightly wet, low volume with open grain rating.
S. Average absorption, short mix time, average grain, low volume.

COOP. 14-2429 06BC796#68

A. No elasticity, not smooth, no gas retention, flat, very dense and spongy, poor performance overall.
B. Very poor.
C. No comment.
D. Good dough strength but abysmal bread performance.
E. Normal absorption and mix time, slight sticky & strong dough, low OS & volume, yellow crumb, open irregular cells, harsh & hard resilient texture.
F. Very weak farinograph compared to mixograph results, unacceptable bread.
G. No comment.
H. High absorption, short mix, very low volume, creamy, open grain.
I. Short mix, low volume, dry sponge.
J. No comment.
K. Very dry in mix/bench, very small volume.
L. Lower flour protein, lower bake absorption, weak out of mixer but good at pan, poor crumb, low loaf volume.
M. No comment.
N. 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
O. No comment.

P. Good absorption, lower mix time, excellent volume.
Q. Dry at sponge and make up, low stability.
R. Short mix time, dough was slightly wet, low volume with open grain rating.
S. Average absorption, short mix time, sticky/short dough characteristics, open grain, very low volume.

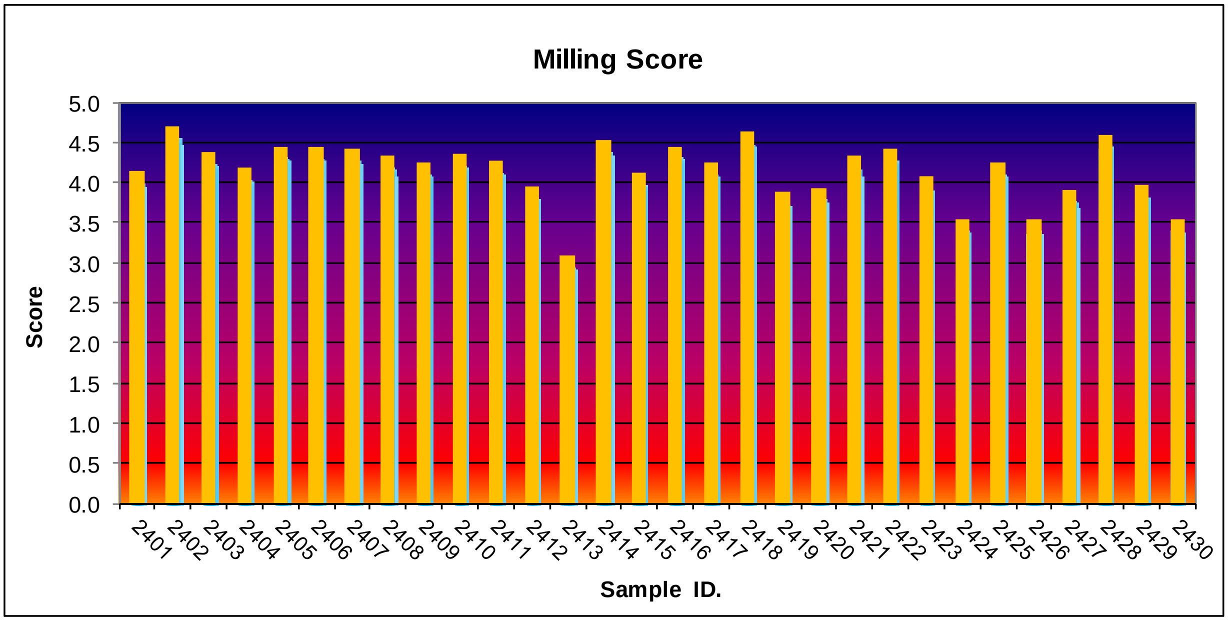
COOP. 14-2430 Jagalene (CC26)

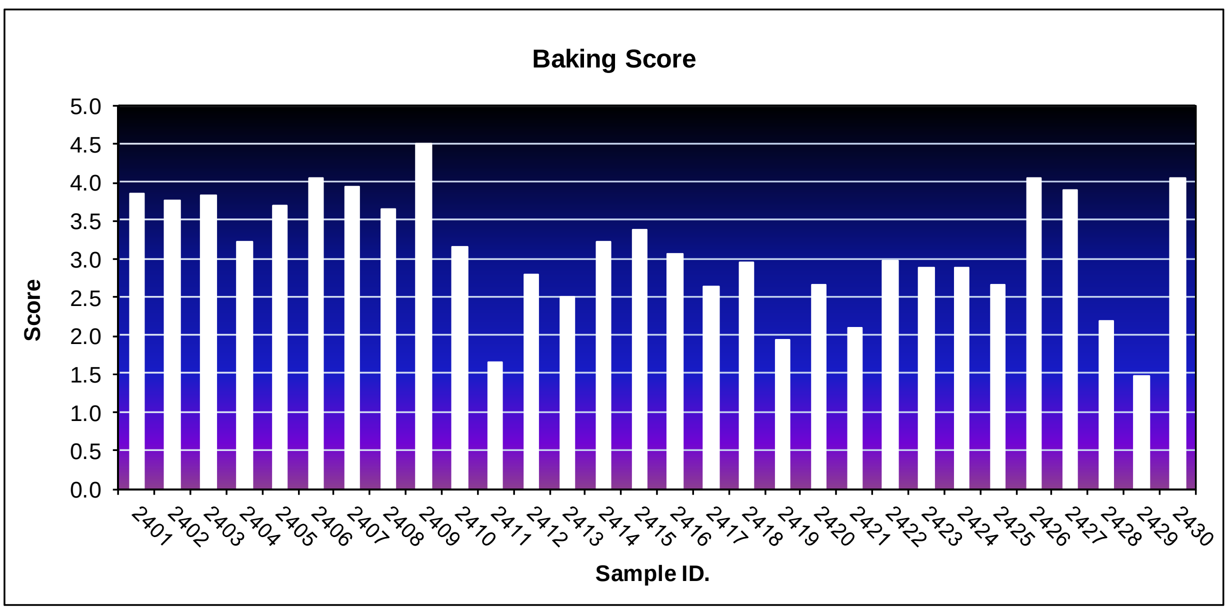
A. Smooth, pliable, nice resistance/body, nice gas, full body, elastic, nice oven spring.
B. Long time to pick-up, excellent loaf externals.
C. No comment.
D. Good dough properties and bake performance for protein level.
E. Normal absorption, long mix time, slight sticky & strong dough, very high OS & volume, little yellow crumb, fine elongated cells, very smooth & resilient texture.
F. Overall acceptable line.
G. No comment.
H. Low absorption, slightly above average mix, average volume, yellow, open grain.
I. Tough and bucky dough, very open grain, good volume.
J. No comment.
K. Excellent bake performance, great volume.
L. Excellent absorption, dough strength at mix and pan, crumb grain and loaf volume. Strong mixograph.
M. No comment.
N. 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
O. No comment.
P. Good strength, open, irregular grain, harsh texture, good volume.
Q. Open cell structure, weak crumb.
R. Long mix time, dough was tough, excellent volume with a dense grain.
S. Long mix time, tough dough, good grain, very high volume.

Notes: **G, H, I, K, P, Q, R and S** conducted sponge and dough bake tests

2014 WQC Milling and Baking Marketing Scores

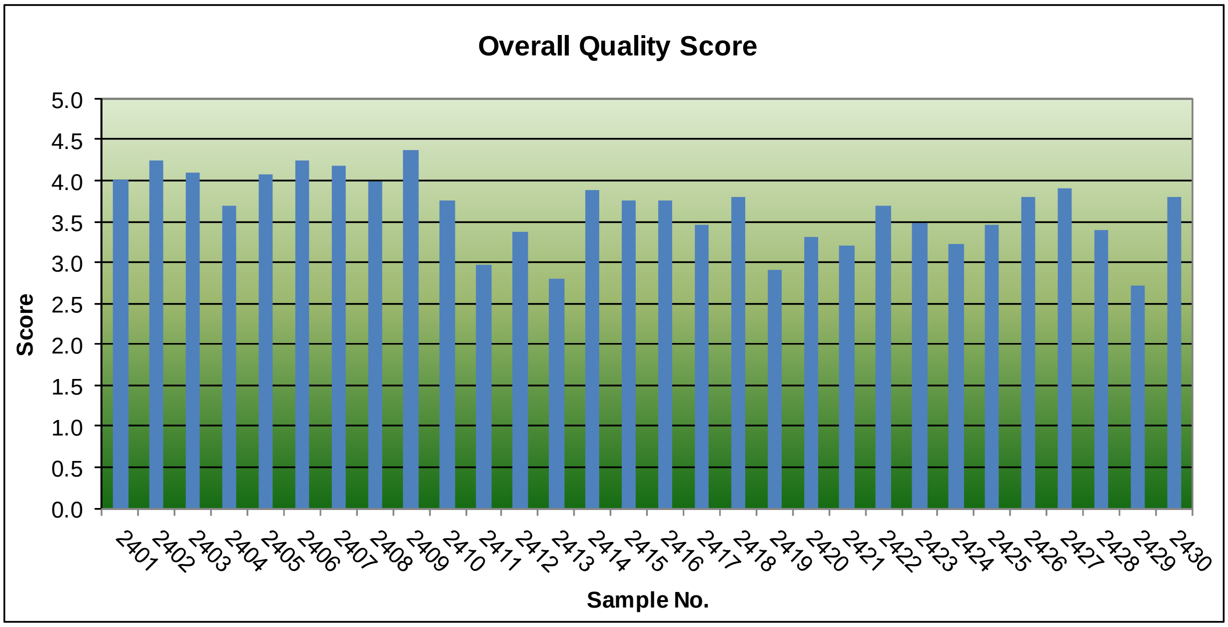
2014 WQC Milling & Baking Marketing Scores
(Based upon HWWQL Quality Data and KSU Milling Data)





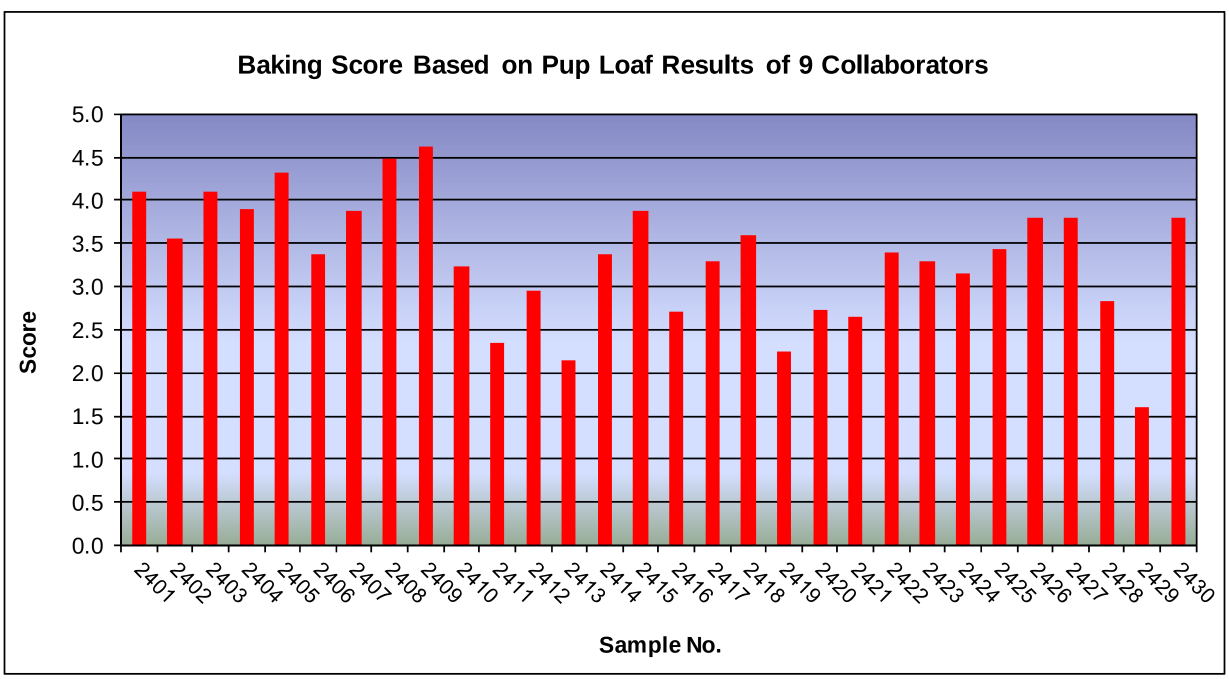
2014 WQC Milling & Baking Marketing Scores

(Based upon HWWQL Quality Data and KSU Milling Data)



2014 WQC Baking Marketing 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
2014 WQC Hard Winter Wheat Entries

USDA-ARS Hard Winter Wheat Quality Laboratory
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Alkaline Noodle Quality Report

Objectives: Evaluate alkaline noodle color and cooking characteristics.

Materials: 29 WQC hard winter wheat samples harvested in 2014.

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 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***: 2429 (84.94), 2412(83.95), 2419 (83.36)

Noodle Color (*L* value, Higher is better.) ***at 24 hr***: 2429 (75.42), 2419 (73.39), 2417 (72.30)

Delta L (Change of *L* value, Lower absolute value is better.)
2429 (-9.52), 2419 (-9.96), 2417 (-10.40)

PPO (Lower is better.): 2417 (0.221), 2419 (0.368), 2405 (0.428)

Table II shows the following:

Hardness: 2403 (2.695), 2419 (2.624), 2426 (2.594)

Springiness: 2425 (1.00), 2402 (0.988), 2419 (0.986)

Chewiness: 2416 (1.757), 2403 (1.742), 2419 (1.729)

Resilience: 2425 (0.432), 2423 (0.430), 2401 (0.429)

Cohesiveness: 2401 (0.701), 2405 (0.700), 2409 (0.699)

Water Uptake: 2406 (89.16), 2402 (87.92), 2404 (86.68)

Cooking Loss: 2425 (4.72), 2405 (5.04), 2423 (5.12)

Discussion

The sample 2419 showed the third highest brightness noodle color at 0 hr and the second highest brightness noodle color at 24 hr. the second lowest delta L^* and the second lowest PPO level, the third highest springiness after cooking, and the second highest hardness and the third highest chewiness in texture. The bright noodle color after 24 hr production and the firmer texture after cooking is considered a desirable characteristic for alkaline noodles. Thus, sample 2419 would be the most favourable for alkaline noodle quality.

Sample 2429 has the highest L-value (brightness) at 0 hr and at 24 hr respectively, and the second lowest springiness , hardness, chewiness, resilience and cohesiveness after cooking. Therefore, sample 2429 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 2417 showed the lowest PPO level, the third brightest noodle color at 24hr and the third lowest delta L*.

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	78.89	64.11	-1.68	-0.29	20.92	23.67	-14.78	1.39	2.76	0.659
2402	80.95	66.71	-1.98	-0.55	19.14	23.28	-14.24	1.44	4.14	0.730
2403	79.90	65.83	-1.84	-0.46	20.56	23.44	-14.07	1.38	2.88	0.730
2404	81.61	69.00	-2.05	-0.85	18.92	23.06	-12.61	1.20	4.14	0.771
2405	75.42	58.44	-0.70	1.31	19.42	22.26	-16.98	2.01	2.84	0.428
2406	77.95	62.36	-0.84	0.99	20.59	24.23	-15.59	1.83	3.64	0.623
2407	78.19	61.60	-0.70	1.61	19.68	24.12	-16.59	2.30	4.44	0.562
2408	79.22	62.12	-0.96	1.35	19.18	24.24	-17.10	2.31	5.06	0.620
2409	77.76	63.79	-1.61	0.14	23.73	25.96	-13.97	1.74	2.23	0.515
2410	82.10	71.67	-2.48	-1.56	21.00	25.25	-10.43	0.93	4.25	0.600
2411	82.47	69.01	-2.21	-1.05	20.64	25.07	-13.46	1.17	4.43	0.597
2412	83.95	70.59	-2.29	-1.27	19.71	24.54	-13.36	1.02	4.84	0.770
2413	82.70	70.53	-2.43	-1.21	21.39	24.95	-12.17	1.22	3.56	0.701
2414	82.18	70.17	-2.34	-1.31	21.37	25.30	-12.01	1.03	3.93	0.511
2415	80.73	69.68	-1.77	-0.62	19.21	23.12	-11.05	1.15	3.91	0.612
2416	82.26	70.86	-2.44	-1.31	21.64	25.44	-11.40	1.13	3.80	0.661
2417	82.70	72.30	-2.04	-1.49	20.53	25.29	-10.40	0.56	4.76	0.221
2418	81.76	69.86	-2.10	-0.85	19.91	24.16	-11.90	1.25	4.25	0.527
2419	83.36	73.39	-1.99	-1.03	19.03	24.02	-9.96	0.97	5.00	0.368
2420	82.43	71.20	-2.01	-0.81	19.27	24.12	-11.23	1.20	4.85	0.517
2421	82.53	71.92	-2.16	-0.96	19.96	23.98	-10.61	1.20	4.02	0.479
2422	79.27	68.15	-2.60	-1.20	24.57	25.87	-11.12	1.40	1.31	0.647
2423	79.79	66.53	-2.08	-0.53	20.59	22.52	-13.27	1.56	1.93	0.881
2424	80.50	69.74	-2.65	-1.46	22.92	25.09	-10.76	1.20	2.17	0.735
2425	80.16	67.63	-2.21	-1.17	21.98	24.06	-12.54	1.05	2.08	0.683
2426	78.92	64.67	-1.95	-0.45	22.88	24.49	-14.26	1.50	1.62	0.559
2427	81.20	69.89	-2.16	-1.13	20.97	23.49	-11.32	1.03	2.52	0.693
2428	82.75	70.09	-1.52	-0.11	18.84	23.58	-12.66	1.41	4.74	0.502
2429	84.94	75.42	-1.57	-0.11	16.63	19.78	-9.52	1.46	3.16	0.516
Avg	80.91	68.18	-1.91	-0.56	20.52	24.08	-12.73	1.34	3.56	0.601

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	0.982	2.356	1.622	0.429	0.701	77.56	5.56
2402	0.988	2.052	1.378	0.420	0.680	87.92	6.12
2403	0.973	2.695	1.742	0.384	0.664	79.88	6.48
2404	0.984	2.299	1.495	0.382	0.661	86.68	6.08
2405	0.967	2.359	1.597	0.427	0.700	82.44	5.04
2406	0.982	2.386	1.587	0.398	0.678	89.16	5.36
2407	0.971	2.399	1.613	0.424	0.691	83.76	5.72
2408	0.984	2.371	1.614	0.422	0.692	85.48	5.40
2409	0.980	2.366	1.620	0.427	0.699	83.36	5.72
2410	0.973	2.488	1.599	0.389	0.660	80.32	6.60
2411	0.975	2.468	1.608	0.393	0.668	79.80	7.64
2412	0.957	2.506	1.610	0.418	0.671	77.88	6.76
2413	0.984	2.400	1.582	0.406	0.670	80.80	6.60
2414	0.986	2.366	1.577	0.422	0.676	78.24	6.48
2415	0.980	2.525	1.685	0.421	0.681	81.68	5.60
2416	1.084	2.430	1.757	0.404	0.667	82.32	6.16
2417	0.967	2.466	1.597	0.402	0.670	76.36	8.12
2418	0.971	2.280	1.518	0.408	0.675	80.36	7.24
2419	0.986	2.624	1.729	0.411	0.678	74.68	7.20
2420	0.955	2.377	1.470	0.390	0.647	74.16	8.56
2421	0.965	2.478	1.589	0.413	0.664	73.76	7.80
2422	0.971	2.337	1.536	0.420	0.677	80.96	5.64
2423	0.984	2.337	1.595	0.430	0.694	82.00	5.12
2424	0.967	2.365	1.538	0.411	0.672	80.84	5.52
2425	1.000	2.420	1.671	0.432	0.691	83.96	4.72
2426	0.975	2.594	1.728	0.421	0.683	77.72	6.60
2427	0.947	2.467	1.567	0.409	0.671	79.12	6.44
2428	0.934	2.194	1.275	0.347	0.622	79.72	7.72
2429	0.947	2.143	1.277	0.364	0.629	77.12	7.44

TORTILLA BAKING TEST of 2014 WQC SAMPLES

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(January 2014)

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 consumed on the drive to work.

The quality of the tortilla used for encasing fillings is of major importance. A tortilla must not crack or break and create a mess. In many cases, people use tortilla wraps instead of bread because the hot-press type of tortilla 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 2014 WQC samples. At the end of the report 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

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.

MIX

PROOF
5 min, 32°C, 70% RH

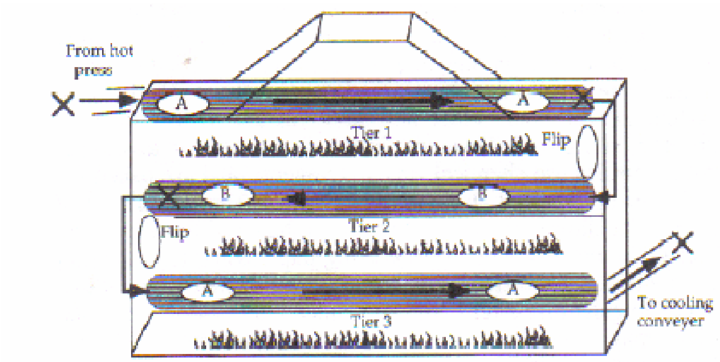
Subjective Dough Evaluation

DIVIDE and ROUND
Obtain 43-g dough balls

PROOF
10 min, 32°C, 70% RH

HOT-PRESS

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



BAKE

Oven temperature = 390^{o}F; baking time = 30 sec

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. These ranged from 30 to 40 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.

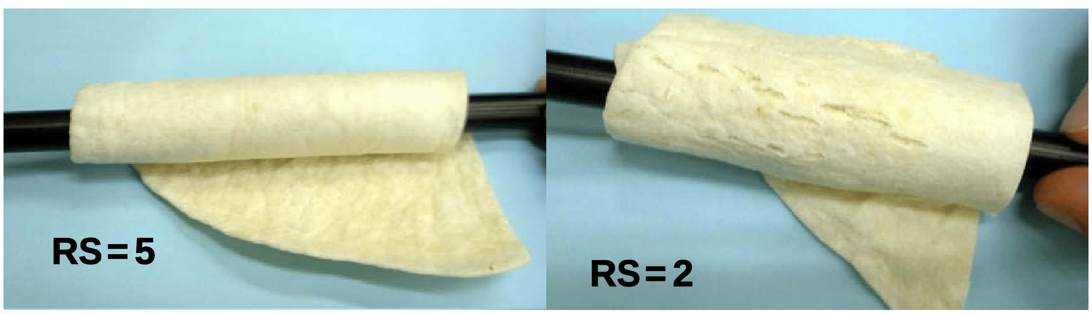
3. Thickness
Ten tortillas are stacked and a digital caliper is used to measure their height. The thickness of one tortilla is calculated by dividing the height of the stack by 10. These ranged from 2.2 to 2.5 mm.

4. Moisture
Moisture is determined using a two-stage procedure (AACC, Method 44-15A, 2000). These ranged from 28 to 36%.

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

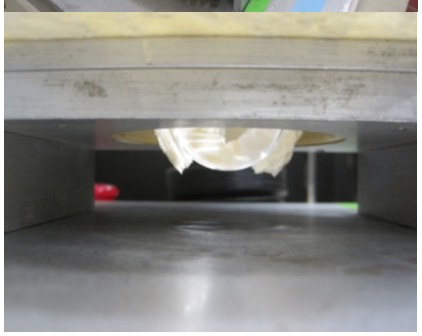
6. Specific Volume
Specific volume (cm^3/g) is calculated: $= \pi * (\text{Diameter}/2)^2 * \text{height} * 1000/ \text{weight}$. This corresponds to fluffiness of the tortilla; desired value is > 1.5 cm^3/g.

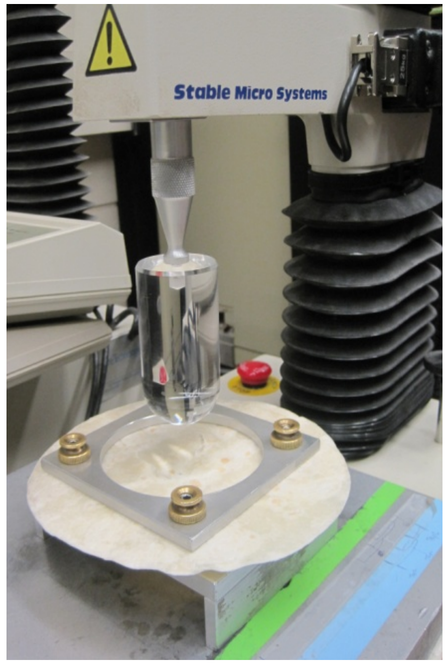
7. Tortilla Rollability Score
Two tortillas are evaluated on 1 and 16 days of storage by wrapping a tortilla around a dowel (1.0 cm diameter). The cracking and breakage of the tortilla is rated using a continuous scale of 1-5 (5 = no cracking, 4 = signs of cracking, but no breaking, 3 = cracking and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



8. Objective rheological test

Extensibility of two tortillas is measured on 1 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 - 2014 DATA WORKSHEET

COOPERATOR NAME:	Audrey L. Girard, 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.

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	14.29	5.00	5	28.7	31.6	7	36.9
2402	13.35	3.30	1	10.7	17.1	13	21
2403	13.17	3.50	1	8.7	10.3	27	14.1
2404	12.80	3.40	1	9.9	19	18	22.1
2405	14.71	3.90	4	12.9	20.2	7	24.5
2406	13.78	2.10	2	6.4	10.6	22	11.9
2407	12.77	5.00	5	8.4	21.8	16	24
2408	13.48	3.90	4	10.0	19.5	10	22
2409	14.33	3.10	2	9.3	14.7	12	21
2410	11.79	4.10	3	5.8	15.5	17	17.7
2411	11.07	5.60	4	2.7	17.3	20	12.9
2412	11.31	6.00	4	10.3	30.7	0	32
2413	10.62	7.00	5	2.7	14.4	27	8.5
2414	12.66	5.50	5	10.2	26.3	8	28
2415	12.89	3.30	3	8.0	11.7	23	14.1
2416	11.80	4.50	4	8.4	26.8	13	28.5
2417	11.89	4.00	4	8.0	19.1	20	16
2418	12.06	3.50	3	6.5	11.8	21	14.3
2419	10.83	8.10	5	2.8	10.9	20	11.6
2420	10.76	6.50	4	3.0	11.3	22	9.9
2421	11.38	6.50	4	3.0	11.2	15	11.6
2422	12.61	4.90	4	20.7	28.5	3	36
2423	12.45	4.50	4	18.5	35.5	5	38
2424	11.71	4.30	4	21.4	32.3	5	39.8
2425	12.41	5.00	5	23.6	25	8	33
2426	13.50	5.60	5	5.8	25.2	13	21.8
2427	12.96	7.40	5	32.7	48.1	4	52.4
2428	12.48	3.50	4	2.0	1.9	66	3.3
2429	11.34	4.90	4	1.7	2.3	61	3.4

*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*** (min)	*Dough Temp* (^{o}C)	*Smooth-ness* (Rating)	*Soft-ness* (Rating)	*Extensi-bility* (Rating)	*Force to Extend* (Rating)	*Press Rating* (Rating)
Tortilla Ref.	52.0	8.0	26.0	2.0	2.0	3.0	2.0	2.0
2401	54.6	10.0	25.4	2.0	2.0	3.0	2.0	3.0
2402	54.4	8.0	26.4	2.0	2.0	4.0	1.0	2.0
2403	53.8	9.0	26.2	2.0	2.0	2.0	2.0	2.0
2404	56.7	9.0	24.8	2.0	2.0	4.0	1.0	2.0
2405	55.3	8.0	25.2	2.0	3.0	2.0	3.0	4.0
2406	53.8	8.0	25.5	2.0	3.0	3.0	2.0	3.0
2407	54.8	9.0	25.3	2.0	3.0	3.0	2.0	3.0
2408	56.1	9.0	25.6	2.0	2.0	2.0	2.0	3.0
2409	52.3	8.0	26.6	2.0	2.5	3.0	3.0	2.5
2410	51.2	8.0	26.1	2.0	2.0	3.0	2.0	2.0
2411	51.6	8.0	25.7	2.0	2.0	3.0	2.0	2.0
2412	50.5	8.0	26.4	2.0	2.0	3.0	2.0	2.0
2413	53.6	8.0	26.1	2.0	2.0	4.0	2.0	2.0
2414	53.9	9.0	26.5	2.0	2.0	3.0	1.5	2.0
2415	52.3	8.0	26.3	2.0	2.0	4.0	1.0	2.0
2416	52.4	8.0	26.2	2.0	2.0	3.0	2.0	2.0
2417	52.7	8.0	26.2	2.0	2.0	3.0	2.0	2.0
2418	50.9	8.0	26.8	2.0	2.0	3.0	2.0	2.0
2419	50.8	9.0	26.0	2.0	2.0	3.0	2.5	2.5
2420	50.8	9.0	25.8	2.0	2.0	3.0	3.0	2.0
2421	51.7	8.0	26.0	2.0	2.0	2.0	3.0	2.0
2422	53.5	8.0	26.3	2.0	2.0	4.0	1.0	2.0
2423	53.3	8.0	26.7	2.0	2.0	3.0	2.0	2.0
2424	52.2	9.0	26.3	2.0	2.0	4.0	1.0	1.0
2425	53.2	9.0	26.0	2.0	2.0	3.0	1.5	1.5
2426	54.9	8.0	26.0	2.0	2.0	4.0	1.0	1.5
2427	54.0	8.0	26.0	2.0	2.0	3.0	2.0	2.0
2428	53.3	9.0	26.0	2.0	2.0	2.5	2.5	3.0
2429	51.6	12.0	26.0	2.0	2.0	2.0	3.0	3.0
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, mixing times were adjusted 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, 2404, 2413, 2415, 2422, 2424, and 2426 had the highest extensibility scores. Samples 2405, 2409, 2420, 2421, and 2429 required more force to extend. Sample 2405 required the most force to flatten and to press on the stainless steel plate.

Table 3. Physical properties of tortillas.

TEST No.	Moisture	Weight	Thickness	Diameter	Sp. Volume	Lightness *
	%	g	mm	mm	cm^3/g	L-value
Tortilla Ref.	28.8	39.9	2.17	164	1.1	71.4
2401	31.4	32.8	2.47	157	1.5	78.7
2402	31.2	29.9	2.10	159	1.4	73.9
2403	30.1	34.6	2.23	155	1.2	77.3
2404	30.8	29.9	2.24	165	1.6	80.9
2405	30.8	32.6	2.34	139	1.1	72.5
2406	30.8	32.1	2.10	156	1.2	76.6
2407	32.3	34.0	2.28	140	1.0	76.1
2408	32.1	31.7	2.20	149	1.2	76.2
2409	31.1	36.4	2.30	146	1.1	77.6
2410	31.4	33.4	2.27	160	1.4	80.8
2411	30.0	32.3	2.18	164	1.4	83.3
2412	31.2	33.1	2.34	151	1.3	83.9
2413	29.9	30.6	2.31	170	1.7	81.9
2414	30.5	30.6	2.25	151	1.3	81.8
2415	28.5	30.3	2.16	166	1.5	82.3
2416	30.5	31.0	2.29	162	1.5	81.9
2417	29.5	31.1	2.32	152	1.4	82.5
2418	30.0	33.4	2.34	161	1.4	82.1
2419	28.5	32.3	2.26	152	1.3	83.4
2420	31.8	32.8	2.27	151	1.2	82.8
2421	32.1	30.8	2.16	155	1.3	83.1
2422	28.8	30.2	2.27	170	1.7	82.0
2423	27.2	31.3	2.23	156	1.4	80.2
2424	35.9	31.6	2.16	163	1.4	82.8
2425	28.5	32.3	2.24	163	1.4	82.1
2426	32.2	31.9	2.22	165	1.5	81.0
2427	34.4	32.9	2.29	157	1.3	83.7
2428	31.6	33.3	2.27	152	1.2	81.2
2429	32.4	30.3	2.33	151	1.4	79.8
Descriptors or Scale	Calculate using two-step method	Record actual weight	Record actual thickness	Record actual diameter	Calculate as = pi*(radius)^2 *thickness *1000/wt	Record actual L-value; 0 = black to 100 = white

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

Five samples, 2404, 2413, 2415, 2422, and 2426 produced tortillas of good diameter (at least 165 mm). Samples with >165 mm tortilla diameter had lightness scores >80 and >1.5 cm^3/g specific volume indicating that the dough discs did not shrink back during hot-pressing. Generally, small diameter tortillas (<156 mm) had corresponding low specific volume and were less fluffy, darker and dense.

Table 4. **Texture profile of tortillas measured 1 and 16 days after processing.**

TEST No.	*Force day 1* (N)	*Distance day 1* (mm)	*Work day 1* (N.mm)	*Force day 16* (N)	*Distance day 16* (mm)	*Work day 16* (N.mm)
Tortilla Ref.	14.4	22.6	134.6	10.4	16.9	69.9
2401	12.6	27.2	163.1	9.2	18.3	67.8
2402	10.4	21.9	97.9	9.6	18.0	65.5
2403	13.7	22.6	132.8	13.4	18.2	87.9
2404	12.1	25.8	135.9	9.9	20.5	78.8
2405	18.6	28.8	233.3	16.5	23.6	144.7
2406	14.5	25.5	156.0	10.8	19.9	73.3
2407	22.0	27.7	266.0	16.1	19.7	127.1
2408	14.0	24.4	133.0	10.7	16.8	62.9
2409	18.2	28.2	231.4	20.7	24.5	217.4
2410	13.0	20.8	102.0	9.8	15.7	52.2
2411	7.2	19.1	55.7	6.3	14.8	35.7
2412	11.7	21.9	95.3	7.8	14.6	47.0
2413	7.6	19.6	61.2	6.9	13.5	33.1
2414	13.3	24.3	132.9	8.8	17.5	60.3
2415	8.4	22.3	79.0	9.4	18.0	65.7
2416	9.3	20.4	72.3	10.9	17.3	74.4
2417	10.9	23.0	115.8	8.8	17.0	53.4
2418	12.1	21.1	96.8	6.7	13.7	33.6
2419	10.6	19.5	76.9	12.3	18.3	77.0
2420	11.5	20.5	91.8	11.2	15.5	66.2
2421	12.2	22.4	107.0	7.8	14.1	40.1
2422	9.7	20.0	74.3	8.7	15.0	43.0
2423	10.4	23.1	97.1	6.5	15.6	37.8
2424	13.3	25.2	139.1	8.6	18.4	55.5
2425	10.9	22.1	98.3	10.1	19.2	69.6
2426	13.6	27.7	163.4	8.2	19.6	66.6
2427	11.3	25.3	124.9	10.2	18.9	79.5
2428	13.7	25.3	142.2	11.5	18.3	79.7
2429	14.0	22.8	121.7	12.6	16.5	76.1
Descriptors or Scale	Determine parameters using texture analyzer 1 day after processing			Determine parameters using texture analyzer 16 days after processing		

Tortillas from nearly all the samples had a significant reduction in extensibility (>10 mm) reduction in distance from day 1 to day 16. Samples 2405, 2407, and 2409 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 (all <165 mm).

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

TEST No.	*Rollability Scores (RS)*		*Diameter*	**Rating***
	1 day	**16 days**	**mm**	
Tortilla Ref.	5.0	5.0	164	Fair
2401	5.0	5.0	157	Fair
2402	5.0	5.0	159	Fair
2403	4.5	5.0	155	Poor
2404	5.0	5.0	165	Good
2405	5.0	5.0	139	Poor
2406	5.0	5.0	156	Poor
2407	5.0	5.0	140	Poor
2408	5.0	5.0	149	Poor
2409	5.0	5.0	146	Poor
2410	5.0	5.0	160	Fair
2411	5.0	4.5	164	Fair
2412	5.0	5.0	151	Poor
2413	4.5	4.0	170	Good
2414	5.0	5.0	151	Poor
2415	5.0	5.0	166	Good
2416	4.5	4.5	162	Fair
2417	4.0	4.5	152	Poor
2418	4.5	5.0	161	Poor
2419	5.0	3.5	152	Poor
2420	5.0	4.5	151	Poor
2421	5.0	5.0	155	Poor
2422	5.0	4.0	170	Good
2423	5.0	5.0	156	Poor
2424	5.0	5.0	163	Fair
2425	5.0	5.0	163	Fair
2426	5.0	5.0	165	Good
2427	5.0	5.0	157	Fair
2428	5.0	5.0	152	Poor
2429	4.5	5.0	151	Poor
Descriptors or Scale	*from* 1 = breaks when rolled to 5 = rolls easily		Record actual diameter	

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

Tortillas from samples 2404, 2413, 2415, 2422, and 2426 had acceptable diameter and day-16 rollability scores. Samples 2401, 2402, 2410, 2411, 2416, 2424, 2425, and 2427 had "fair" ratings (acceptable rollability score but relatively small diameter). All other samples had very good rollability scores but small diameters (typical of strong flours that cause dough to shrink when hot-pressed) (Figure 1).

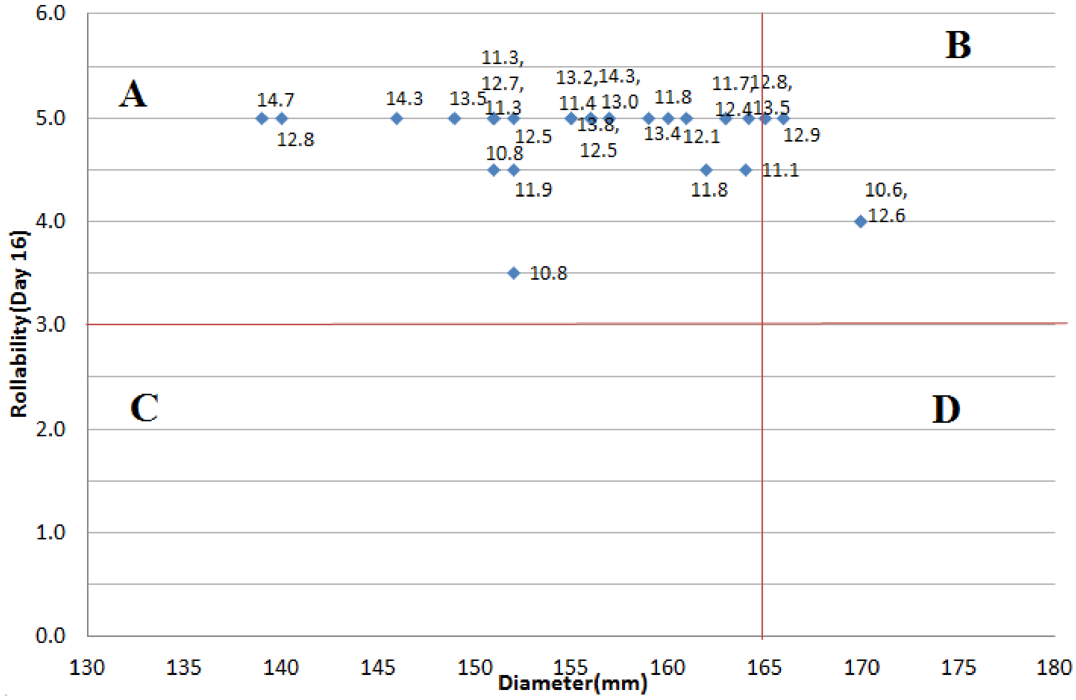


Fig. 1 - Relationship of tortilla diameter, rollability score (day 16), and flour protein content (14% mb; shown as numbers inside the box). Quadrant A: good shelf-stability, poor diameter; B: acceptable diameter and shelf-stability; D: good diameter, poor shelf-stability.

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 2413, 2415, 2422, and 2426) gave the best tortilla quality, does not fall into this category (i.e., has 12.8% protein and is relatively weak). Thus, protein content (PC) alone cannot predict tortilla quality. In Figure 1, the shelf-stable samples (rollability score >3) have PC from 10-15%.

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 as did the sample with 7 min mixing time. Further studies on specific protein and/or gluten components that affect tortilla quality are required to improve the current understanding of the relationships involved.

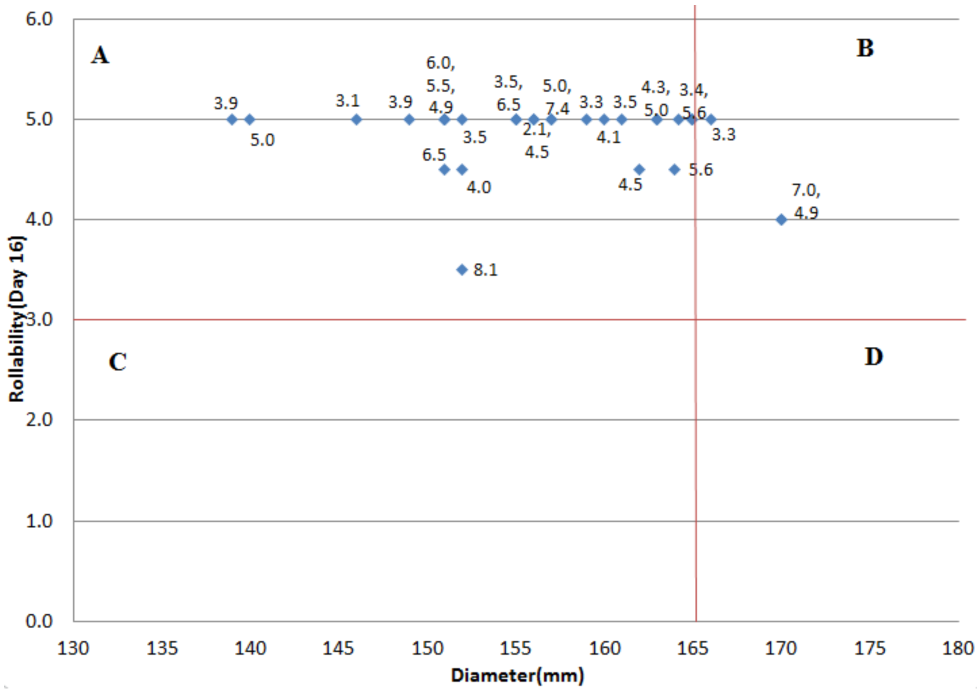


Fig. 2 - Relationship of tortilla diameter, rollability score (day 16) and mixograph mixing time (shown as numbers inside the box). Quadrant A: good shelf-stability, poor diameter; B: acceptable diameter and shelf-stability; D: good diameter, poor shelf-stability.

References:

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ARTISAN BAKING TEST of 2014 WQC SAMPLES

Michel Suas, Mac McConnell and Miyuki Togi
San Francisco Baking Institute
with
Mark Friend, Farm to Market Bread Company

January 2014

Introduction

The artisan bread market is a category that is steadily growing with more and more consumers having an understanding and appreciation for well-made artisan breads. From 1998-2003, U.S. retail sales of specialty/artisan bread increased 23 percent. These breads currently have an 11 percent market share and are expected to lead in product innovation, allowing manufacturers to cater to niche demand according to the Specialty Food Association.

The quality of artisan breads is strongly affected by the quality of the flour because flour is the major ingredient in a very short list of ingredients. Natural flavor of the flour directly influences how the bread will taste. It is also very important for the artisan baker to have flour with the right specifications, because what is suited for artisan baking is different from large manufacturers.

The quality of good artisan bread includes the texture of the crust and of the inner crumb as well as the flavor of the finished product. In this report, we address the unique needs of the artisan baker in the pursuit of quality artisan bread.

This report includes information on the procedure during the test and the evaluation of the 2014 WQC samples. General observations about the flour samples and artisan bread are given.

Bake Testing and Evaluating Staff

Michel Suas is the President and Founder of the San Francisco Baking Institute and is internationally recognized as an industry expert and thought leader. He is a strong advocate of using education to advance the appreciation and craft of artisan baking. The Bread Bakers' guild of America awarded Michel their Golden Baguette in recognition of his enormous contributions to the Guild and the artisan baking industry. Michel has consulted and advised many of the top pioneer artisan bakers.

Miyuki Togi is a baking and pastry instructor at the San Francisco Baking Institute. She joined the institute as an intern and upon completing her internship was promoted to Assistant Instructor. She works in formula and course development and is a driving force in the Institute's decorative displays out of bread, one of which was the 24 foot long centerpiece featuring the Golden Gate Bridge.

Mac McConnell is a bread baking instructor at the San Francisco Baking Institute. Before coming to the Institute he was head baker at the Berkshire Mountain Bakery in Western Massachusetts, a bakery that specializes in highly hydrated whole grain sourdough breads. He most recently taught a master class for the Bread Bakers Guild of American and enjoys deconstructing the complexities of baking and conveying that information to his students.

Mark Friend is president at Farm to Market Bread Company in Kansas City. He trained at both the San Francisco Baking Institute and the American Institute of Baking. Much of his tutelage was under Claudio Cantore, a third generation Italian who grew up among starters and artisan baking. Baking professionals consider Mark one of the leading experts on natural sour starters, and he has lectured on sourdough at the American Institute of Baking and at national conventions. He was instrumental in bringing testing for artisan bread to the Wheat Quality Council.

San Francisco Baking Institute (SFBI) is a world-renowned leader in artisan bread and pastry education. The faculty and staff are experts in their field as professionals, consultants, and educators. Students receive an extraordinary amount of hands-on, "real world" experience with the latest baking equipment and technology, along with an understanding of artisan baking techniques and values. SFBI is the only school in the United States dedicated exclusively to artisan baking.

Procedures to Produce and Evaluate Artisan Bread Using Baguette and Ciabatta Recipes

Formulation

Ingredients	Amount
Wheat flour	100%
Water	68%
Salt	2%
Yeast	0.6%
Malt	1/2%

Processing

All ingredients were mixed first for four minutes average. Second mix differed in length of time due to the need to adjust to the flour.

Small batches of dough with the flour samples were done using the formula above. The hydration was conservative by hand shaping standards. We aimed for a medium/soft consistency and adjusted the hydration for each flour sample accordingly. We mixed to improved stage and removed 1.9 kg of dough for a baguette shape. The remaining dough was scaled and double hydrated for soft consistency and a ciabatta shape. The actual hydration of both the baguette and the ciabatta is charted.

	Baguette	**Ciabatta**
Bulk time	1.5 hr	1.75 hr
Divide weight (kg)	0.350kg	~0.500kg
Rest time	25 minutes	N/A
Final shape	Baguette ~24 inch long	square
Final proof time	1 hr	20 minutes
Bake	450F, 21 minutes with steam	450F, 21 minutes+ 6 minute vent

Subjective Dough Evaluation

The following was used to assess the performance of the wheat variety:

Crust (1-5)

1. thick, tough, hard, chewy
5. thin, crispy, light

Crumb (1-5)

1. very tight uniform cell structure
5. open, regular large gas cells

Flavor (1-5)

1. bland, bitter, lacking any perceivable flavor
5. light, sweet, aromatic, mouth waters

Volume (1-5)

1. small diameter (<2 inch diameter) cuts don't open
5. larger diameter (3 to 4 inch diameter) cuts open strong

Flour Quality for Artisan Bread

- A sweet wheat flour
- Creamy color
- Capable to take lot of water baguette 70% and up; Ciabatta 85 to 90%
- Holding water with minimum starch damage.
- The dough need to have a consistent strength, specially not lost during preferment or final proof.
- Develop very easy on the mixer to minimize over mix, loosing flavor and crumb color.
- Shaping without too much force applied to it.
- Fermentation time average from 3 hours to overnight that stage is important to have dough that will hold the strength.
- All artisan bread is baked with steam. We expect a golden reddish color with nuance, the scoring need to show a good ear.

Final Product Quality

- Thin crust but crispy. Sharp cut on bite not chewy
- Multiple colors on the crust from dark brown to reddish and yellow.
- Crumb open with irregular whole shinny reflection and yellow tone. Sweet flavor and smell moist to the touch holding the shape after pressing down.

Conclusion of Baking Staff

Looking at our evaluation you can notice the sample 18-19-20-22 are the best for artisan Bread production. 19 is the best overall and 22 for a creamy color.
Reminder, Artisan Bread is made with only 4 ingredients; flour, water, salt, and yeast (wild yeast or commercial) . The flour is the most important part for flavor, handling and shelf life. No other conditioners are add to it except malt or vitamin C. On average we are looking for 11-11.5% protein best result with Hard winter wheat. We can handle spring wheat also, that just for reference point.

Editors' Notes

The original results of the artisan bread baking tests show in Table 1 and Table 2 while summary results show in Table 3.

For Table 3 the editors summarized the bake test results of the artisan bread. Crust, crumb, flavor and volume scores were used each ranging 1 to 5 points. The overall baking quality was assigned by the editors ratings of A, B, C, and D corresponding to excellent, good, acceptable, and poor respectively. The protein content and farinograph mix time and mix tolerance index are included in the table to make comparisons during review.

The common check, Jagalene (2401, 2405, 2410, 2414, 2418, 2422, and 2426) ranges in total score from 4 to 16. This wide spread indicates that environment could be an important factor on the artisan bread quality.

Table 1. Results of Artisan Bread Tests

	baker %	**100**	**68**	**2**	**0.6**	**0.5**	171.1				
		Flour	water	salt	yeast	malt					
	kg	**1.268**	**0.862**	**0.025**	**0.008**	**0.006**	2.16924				
					(+/-) water	**Hydration**	**Mix Time minutes**				
	RT	**FT**	**WT**	**DT**	**kg**	**actual %**	**1st speed**	**2nd speed**			
14-1401	57	58	95	77	0.000	68.0	4	3:30			14-1401
14-1402	57	58	95	78	-0.012	67.1	4	2			14-1402
14-1403	57	58	95	79	-0.027	65.9	4	2			14-1403
14-1404	57	58	95	78	-0.027	65.9	4	2			14-1404
14-1405	57	58	87	73	0.100	75.9	4	5:30			14-1405
14-1406	57	58	87	73	0.100	75.9	4	4			14-1406
14-1407	57	58	87	71	0.100	75.9	4	4:30			14-1407
14-1408	57	58	87	72	0.100	75.9	4	4:30			14-1408

baker %	**100.0**	**68.0**	**2.0**	**0.6**	**0.5**	171.1	
	Flour	water	salt	yeast	malt		
kg	**2.075**	**1.411**	**0.041**	**0.012**	**0.010**	3.549	

					(+/-) water	**Hydration**	**Mix Time minutes**		**New**	**DH dough**			**Wet dough hydration**	
	RT	**FT**	**WT**	**DT**	**kg**	**actual %**	**1st speed**	**2nd speed**	**total b%**	**kg**	**kg water**	**extra water**	**Water Baker's %**	
14-1409	55	56	92	77	0.147	75.1	4:30	4	178.2	1.760	0.742	0.150	90.3	14-1409
14-1410	55	56	92	79	0	68.0	4	4	171.1	1.675	0.666	0.130	81.3	14-1410
14-1411	55	56	92	78	-0.066	64.8	4	4:10	167.9	1.596	0.616	0.080	73.2	14-1411
14-1412	55	56	92	79	0	68.0	4	5:15	171.1	1.642	0.653	0.074	75.7	14-1412
14-1413	61	61	78	77	0	68.0	4	5:50	171.1					14-1413
14-1414	61	61	78	77	0.05	70.4	4	5:50	173.5	1.645	0.668	0.100	81.0	14-1414
14-1415	61	61	78	76	0	68.0	4	3:30	171.1	1.640	0.652	0.150	83.6	14-1415
14-1416	61	61	78	76.4	0	68.0	4	5:30	171.1	1.650	0.656	0.100	78.4	14-1416
14-1417	61	61	78	77	0.05	70.4	4	4	173.5	1.690	0.686	0.100	80.7	14-1417
14-1418	61	61	78	76	0.045	70.2	4	4:20	173.3	1.725	0.699	0.100	80.2	14-1418
14-1419	61	61	78	75	-0.01	67.5	4	4:40	170.6	1.635	0.647	0.100	78.0	14-1419
14-1420	61	61	78	80	0.05	70.4	4	7:16	173.5					14-1420
14-1421	61	61	78	80	0.05	70.4	4	10:30	173.5	1.680	0.682	0.050	75.6	14-1421
14-1422	61	61	78	80	0.005	68.2	4	9:22	171.3	1.700	0.677	0.100	78.3	14-1422
14-1423	61	61	78	79	0.055	70.7	4	7	173.8	1.740	0.708	0.150	85.6	14-1423
14-1424	61	61	78	80	0.025	69.2	4	10:30	172.3	1.675	0.673	0.150	84.6	14-1424
14-1425	61	61	74	80	0	68.0	4	11:40	171.1	1.650	0.656	0.079	76.2	14-1425
14-1426	61	61	76	79	0	68.0	4	6	171.1	1.680	0.668	0.082	76.4	14-1426
14-1427	61	61	74	79	-0.06	65.1	4	7	168.2	1.605	0.621	0.070	72.4	14-1427
14-1428	61	61	74	79	0.085	72.1	4:30	3:30	175.2	1.755	0.722	0.100	82.1	14-1428
14-1429	62	62	76	80	0.1	72.8	4	9	175.9	1.770	0.733	0.100	82.8	14-1429
14-1426	61	61	76	79	0	68.0	4	6	171.1	1.680	0.668	0.082	76.4	14-1426

Table 2. Results of Artisan Bread Tests

			Tasting Notes (1-5)				
	Mix Notes	Handling Notes	Crust	Crumb	Flavor	Volume	Extra
14-1401	sticky, little development after second speed	elastic	1	1	1	1	chewy, dry
14-1402	smooth, extensible from mixer	very slack, extensible, gassy, easy to shape	2	3	2	4	chewy, tough
14-1403	could take more water, strong	strong smooth, good to shape	2	3	3	4	tough
14-1404	smooth from mixer	gassy, easy to shape	2	2	3	4	dry, chewy
14-1405	extensible but strong	elastic, shrinks as shaped	1	4	2	3	very chewy
14-1406	very elastic, smooth dough	too extensible, slack, soft	3	4	3	3	tender, cheese-like
14-1407	very elastic, absorbs lots of water	elastic when folded. Strong and easy to shape	2	2	1	2	
14-1408	very elastic, absorbs lots of water	easy to shape, gained extensibility, good balance	3	3	2	4	

			Tasting Notes				
	Mix Notes	Handling Notes	Crust	Crumb	Flavor	Volume	Extra
14-1409	strong, absorbs lots of water, elastic	fluffy, strong like marshmallow	3	4	3	4	tender
14-1410	weak, developed well in second	soft, yet strong, gassy	3	3	4	3	chewy, soft, yellow, sweet
14-1411	weak, gluten developed after some resting	weak, soft, degasses easy, fragile. Took 6 minutes extra baking	1	2	1	2	bitter, bean-like rubbery
14-1412	weak, gluten developed after some resting	weak, soft. Took 6 minutes extra baking	2	2	2	2	dry, tough
14-1413	soft, weak	weak, loose, no gluten pop when shaping	3	1	2	2	
14-1414	weak, not much development in mixer	extensible shaping, nice creamy color	3	1	4	2	
14-1415	good strength	loose in preshape, final shaped great after rest	4	3	4	4	
14-1416	very weak not gaining much strength	holding gas, nice handling	3	2	4	2	
14-1417			5	2	3	3	
14-1418		felt great in preshape, shaped great, holding gas	4	4	4	4	
14-1419	good feel, smooth	good feel	4	3	4	4	
14-1420		sorta loose, but handles well, holds gas	4	4	4	4	like 14-1419
14-1421	very weak not gaining much strength	pasty, no strength, melts under hand, extensible, soft	2	2	1	2	white
14-1422	slow to gain strength	feels good, holds gas, creamy	4	3	4	4	creamy
14-1423	slow to develop, but got strong	weak, loose, no gluten pop, extensible	2	2	2	2	pale crust
14-1424	took long time to develop	holding gas, extensible, but has good body	3	3	3	4	
14-1425	soft, sticky, took a while to develop	soft, extensible, weak	4	2	3	4	
14-1426		weak, feels heavy in preshape, good body and gassy shaping	3	4	3	4	
14-1427	soft dough, less absorbant	soft, weak, decent strength, sorta holding gas	2	3	2	3	
14-1428	very absorbant	elastic in preshape, good strength in final shape	4	3	3	4	tender
14-1429	very absorbant, stiff, took time to develop, didn't gain strength, though thirsty	heavy, extensible, pasty	3	3	2	3	
14-1426		weak, feels heavy in preshape, good body and gassy shaping	3	4	3	4	

Table 3. Summary Results of Artisan Bread

Sample ID	Total Scores[a]	Overall Baking Quality Scores[b]	Poor	Acceptable	Good	Excellent	Protein (%)	Farinograph Mix Time (min)	Farinograph Mix Tol Index
14-2401	4	D	x				14.3	28.7	7
14-2402	11	B			x		13.4	10.7	13
14-2403	12	B			x		13.2	8.7	27
14-2404	11	B			x		12.8	9.9	17
14-2405	10	C		x			14.7	12.9	7
14-2406	13	B			x		13.8	6.4	22
14-2407	7	C		x			12.8	8.4	16
14-2408	12	B			x		13.5	10.0	10
14-2409	14	B			x		14.3	9.3	12
14-2410	13	B			x		11.8	5.8	17
14-2411	6	C		x			11.1	2.7	20
14-2412	8	C		x			11.3	10.3	0
14-2413	8	C		x			10.6	2.7	27
14-2414	10	C		x			12.7	10.2	8
14-2415	15	B			x		12.9	8.0	23
14-2416	11	B			x		11.8	8.4	13
14-2417	13	B			x		11.9	8.0	20
14-2418	16	A				x	12.1	6.5	21
14-2419	15	B			x		10.8	2.8	20
14-2420	16	A				x	10.7	3.0	22
14-2421	7	C		x			11.4	3.0	15
14-2422	15	B			x		12.6	20.7	3
14-2423	8	C		x			12.5	18.5	5
14-2424	13	B			x		11.7	21.4	5
14-2425	13	B			x		12.4	23.6	8
14-2426	14	B			x		13.5	5.8	13
14-2427	10	C		x			13.0	32.7	4
14-2428	14	B			x		12.5	2.0	66
14-2429	11	B			x		11.3	1.7	61
14-2430	14	B			x		13.5	5.8	13

[a]Total scores based on crust, crumb, flavor, and volume, 1 to 5 points each.

[b]A=16-20, B=11-15, C=6-10, and D=1-5

14-2401 Baguette Crumb

14-2402 Baguette Crumb

14-2403 Baguette Crumb

14-2401 Baguette

14-2402 Baguette

14-2401 Baguette

14-2404 Baguette

14-2405 Baguette

14-2406 Baguette

14-2404 Baguette Crumb

14-2405 Baguette Crumb

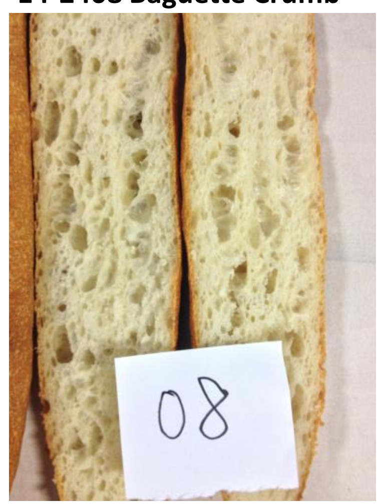
14-2406 Baguette Crumb

14-2407 Baguette

14-2408 Baguette

14-2407 Baguette Crumb

14-2408 Baguette Crumb



14-2410 Baguette

14-2410 Baguette Crumb

14-2410 Ciabatta

14-2409 Baguette

14-2409 Baguette Crumb

14-2409 Ciabatta

14-2412 Baguette

14-2412 Baguette Crumb

14-2412 Ciabatta

14-2411 Baguette

14-2411 Baguette Crumb

14-2411 Ciabatta

14-2414 Baguette

14-2414 Baguette Crumb

14-2414 Ciabatta

14-2413 Baguette

14-2413 Baguette Crumb

14-2413 Ciabatta

14-2416 Baguette

14-2416 Baguette Crumb

14-2416 Ciabatta

14-2415 Baguette

14-2415 Baguette Crumb

14-2415 Ciabatta

14-2418 Baguette

14-2418 Baguette Crumb

14-2418 Ciabatta

14-2417 Baguette

14-2417 Baguette Crumb

14-2417 Ciabatta

14-2420 Baguette

14-2420 Baguette Crumb

14-2420 Ciabatta

14-2419 Baguette Crumb

14-2419 Baguette Crumb

14-2419 Ciabatta

14-2422 Baguette

14-2422 Baguette Crumb

14-2422 Ciabatta

14-2421 Baguette

14-2421 Baguette Crumb

14-2421 Ciabatta

14-2424 Baguette

14-2424 Baguette Crumb

14-2424 Ciabatta

14-2423 Baguette

14-2423 Baguette Crumb

14-2423 Ciabatta

14-2426 Baguette

14-2426 Baguette Crumb

14-2426 Ciabatta

14-2425 Baguette

14-2425 Baguette Crumb

14-2425 Ciabatta

14-2428 Baguette

14-2428 Baguette Crumb

14-2428 Ciabatta

14-2427 Baguette

14-2427 Baguette Crumb

14-2427 Ciabatta

14-2429 Baguette

14-2429 Baguette Crumb

14-2429 Ciabatta

2014 WQC HARD WINTER WHEAT FLOUR PROTEIN ANALYSIS

Michael Tilley

USDA, CGAHR, Manhattan, KS

Procedures

1. Determination of polymeric to monomeric protein ratio

- Protein extraction (Gupta et al, 1993): 20 mg flour + 1 ml 50 mM sodium phosphate buffer, pH 6.9, containing 0.5% SDS, sonicated for 15 sec. Collect the supernatant (contains total protein).
- Filter the supernatant in a 0.45 µm filter and analyze by size-exclusion HPLC (SE-HPLC).
- SE-HPLC using a 300.0 x 7.8 mm BioSep S4000 column at 50°C, with a constant gradient of 50 mM sodium phosphate buffer, pH 7.0, containing 1% SDS, flow rate of 1.0 ml/min for 20 min.
- The chromatograms were manually integrated and the ratio was determined using the areas of the specific peaks.

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

- Protein extraction (Bean et al, 1998): 10 mg flour + 1 ml 50% 1-propanol- vortex for 5 min, centrifuge for 5 min at 12,000 x g. Discard supernatant. Repeat two times.
- 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.

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

Sequential protein extraction:

- 10 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.
- 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.
- 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 HMW-GS and LMW-GS).
- Analyze protein in the supernatant using the Agilent 2100 Bioanalyzer (lab-on-a-chip).

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.

Results of Flour Protein Analysis

Sample ID			HMW-GS composition		
	Polymeric/monomeric	% IPP	Glu A-1	Glu-B1	Glu-D1
WQC 2014-1	0.740	53.73	1/2*	17+18	5+10
WQC 2014-2	0.668	43.93	1/2*	7+9	5+10
WQC 2014-3	0.578	43.11	2*	7+9	5+10
WQC 2014-4	0.610	42.12	2*	7+9	5+10
WQC 2014-5	0.745	50.22	1/2*	17+18	5+10
WQC 2014-6	0.643	42.27	2*	7+9	2+12
WQC 2014-7	0.685	47.60	2*	7+8	5+10
WQC 2014-8	0.665	44.87	2*	7+8	5+10
WQC 2014-9	0.606	41.33	2*	7+8	5+10
WQC 2014-10	0.725	49.52	1/2*	17+18	5+10
WQC 2014-11	0.626	50.10	2*	7+8	5+10
WQC 2014-12	0.701	50.51	2*	7+8	5+10
WQC 2014-13	0.661	52.61	2*	7+8	5+10
WQC 2014-14	0.752	51.80	1/2*	17+18	5+10
WQC 2014-15	0.678	43.69	NULL	7+9	5+10
WQC 2014-16	0.570	48.14	2*	7+9	5+10
WQC 2014-17	0.624	46.58	1	7+8	5+10
WQC 2014-18	0.646	49.33	1/2*	17+18	5+10
WQC 2014-19	0.552	52.53	1	7+8	5+10
WQC 2014-20	0.597	52.66	1	7+8	5+10
WQC 2014-21	0.597	50.87	1	7+8	5+10
WQC 2014-22	0.595	48.07	1/2*	17+18	5+10
WQC 2014-23	0.622	46.47	2*	7+8	2+12
WQC 2014-24	0.635	44.49	1	17+18	5+10
WQC 2014-25	0.630	48.39	1	7+8	5+10
WQC 2014-26	0.696	54.34	1/2*	17+18	5+10
WQC 2014-27	0.614	55.77	1	7+8	5+10
WQC 2014-28	0.594	55.04	2*	7+8	5+10
WQC 2014-29	0.580	57.76	2*	20a+b	5+10

APPENDIX A
Credits and Methods

CREDITS

Milling, Sample Analysis, Ingredients and Report Preparation

Single Kernel Analysis, Kernel Size Distribution, and Test Weight	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
Artisan Bread Evaluation	Farm to Market Bread Company Kansas City, MO 64108
Data Compilation and Final Report	USDA/ARS/HWWQL Manhattan, KS

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USDA/ARS/WQL Harris Hall North Dakota State Univ. Fargo, ND 58105	Wheat Quality Lab	**Linda Dykes** (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.

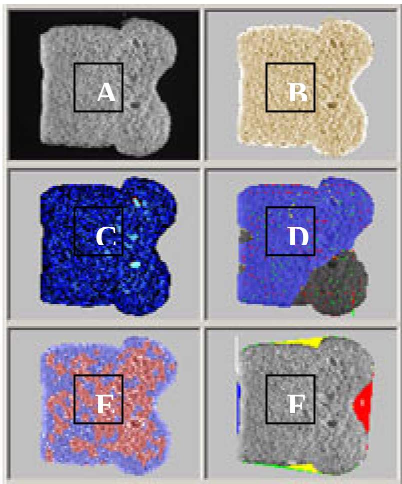
Similarly, cumulative protein curves are determined by arranging millstreams in ascending order of protein content, and tabulating the protein content of the total flour produced with the addition of successive millstreams. Wheat that gives high protein content at low extraction, and a fast rate of protein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

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

<u>Cell Elongation and Orientation</u>: Cell alignment and elongation, circulation and curvature

<u>Dimensions</u>: Sample area, height, breadth, ratios and wrapper length.

<u>Brightness</u>: Sample brightness and cell contrast.

<u>Shape</u>: Various physical features including, break, concavity and roundness.

<u>*Slice Area*</u>: The total area of a product slice (mm^2).

<u>*Slice Brightness:*</u> 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.

<u>*Number of Cells:*</u> 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.

<u>*Wall Thickness:*</u> 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.

<u>*Cell Diameter:*</u> 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

2014 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	Baking Time
A	1	Pup-loaf straight dough	100 g flour	Farinograph	120 min	390	25
B	2	Pup-loaf straight dough	100 g, approx 170 g	Mixograph	90 min	400	25
C	3	Pup-loaf straight dough	100 g	Mixograph	90 min	400	25
D	4	Pup-loaf straight dough	100 g flour, approx 175 g dough	Mixograph	90 min	425	21
E	5	Straight dough	100 g flour, approx. 175 g dough	Farinograph and Mixograph	180 fermentation and 60 min proof time	400	25
F	6	Pop loaf straight	100 g	Mixograph	90 min	400	25
G	7	Sponge and dough	520 g dough	Other (mix to optimum)	270 min	400	18
H	8	Sponge and dough	700 g, 524 g dough	Mixing series	240 min (sponge time) and 60 min (fermentation)	420	20
I	9	Sponge and dough	600 g flour, 480 g dough	Other	240 min (sponge time) and 45 min (fermentation)	420	20
J	10	Pup-loaf straight dough	100 g flour, approx 160 g dough	Farinograph	120 min	425	20
K	11	Sponge and dough	600 g flour, 160 g dough	Mixing series	240 min	425	16
L	12	Pup-loaf straight dough	100 g flour, approx 170 g dough	Mixograph	120 min	420	18
M	13	Straight dough	700 g flour, 525 g dough	Mixing series	120 min	400	25
N	14	Pup-loaf straight dough	200g, 170 g dough	Mixograph	180 min	419	24
O	15	Pup-loaf straight dough	100 g		90 min	401	22
P	16	Sponge and dough	540 g dough	Mixing series	210 min	430	23
Q	17	Sponge and dough	700 g flour, 19 oz	Farinograph	180 min (sponge) and 70 min (fermentation)	420	20
R	18	Sponge and dough	1000 g flour, 500 g dough	Farinograph	240 min	425	20
S	19	Sponge and dough	700 g flour, 524 g dough	Farinograph with mixing evalu	240 min (sponge time) and 60 min (fermentation)	420	20

APPENDIX B

Hard Winter Wheat Quality Council
Goals for Hard Winter Wheat Breeders

Hard Winter Wheat Quality Council

2014 Technical Board Officers

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

VICE CHAIR:

SECRETARY: **Janet Lewis**, Bayer CropScience

MEMBER: Ben Moreno, Monsanto/Westbred

MEMBER: Vance Lamb, ADM Milling

2014 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', <u>not</u> bucky or tough.

APPENDIX C

Hard Red Winter Wheat Quality Targets

RECOMMENDED*
QUALITY TARGETS FOR HARD RED WINTER WHEAT

HWW Quality Targets Committee
Approved February, 2006

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

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

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APPENDIX D

Hard White Wheat Quality Targets
Adopted from PNW for Great Plains

Hard White Wheat Quality Targets

Dual Purpose -- Chinese Noodles and Western Pan Bread

Updated on March 1, 2002 at Hard White Wheat Quality Targets Meeting

Wheat Marketing Center, Portland, Oregon

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

Notes:

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

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

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

(4) Noodle formula: straight-grade flour, 100%; water, 28%; and sodium chloride, 1.2%.
Noodle sizes: 2.5 mm (width) x 1.2 mm (thickness).
Noodle textural measurement: cook 100 g noodles in 1000 ml deionized water for 5 min, rinse in 27^{0}C 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 Justin Turner

Feb. 19, 2014

Hard Winter Wheat Quality Council Meeting Minutes
Annual Meeting February 19, 2014

8:07 AM: Ben H opens this year's meeting
- Review of 2013's minutes: Theresa Sutton, Chair WQC HWW Board.
- Review/corrections to the minutes: passed as is.

Nominations for 2 new members/officers:
- Ben Merino, Westbred/Monsanto, nominated and elected.
- Vance Lamb, Tech/Product services, ADM Milling, nominated and elected.
- **Board for 2014: Chair-Ron Lindgren**
  Vice Chair-Justin Turner
  Secretary-Janet Lewis
  Member-Ben Moreno
  Member-Vance Lamb

Richard Chen, WQC Book: USDA HRW WQC Lab, Manhattan, KS, 20 entries by, 7 breeders, 19 collaborators, 8 run sponge and dough, rest were straight dough.
- Tortilla Bake, Texas A and M.
- History of entries in back of book.

Overview of milling, Shawn Thiele, KSU Mill operations manager.
- Miag repairs, repaired some sifter bearings. Mostly torn down, break rolls, sifters, etc. $18-19K in repair costs.
- Machine failed after 14 samples, at sample 20, airlock down, some delay in milling samples. Samples tempered to 16.5% moisture, 20 hours. Eased off of 3rd break settings, did not grind as hard on reduction rolls this year. Sifted out bran duster and filter stock. Flour streams blended in mixer for 15 minutes.
- Will look at resurfacing of midds rolls this year. Will need to do some rebuilding of airlocks this year.
- Estimated costs for this year close to $18K. Glen Weaver asked about preventative maintenance schedules to reduce costs in future. Shawn will be looking at annual maintenance plan. Machine doesn't run each day/month, not sure about how to calculate hour's usage and parts. No previous maintenance logs available.

Ben Handcock, remarks:
- Board voted to put permanent position on WQC board of trustees from ARS. Brad
  Seabourn would serve the first term.
- Mark Hodges moved that we move forward, motion 2nd. Discussion: motion carries.

- Mark Hodges and Mike Schulte, bread for WQC meeting.
- Good year, have some new members. In attendance are Tom DeZarn, Rich Products; Charlie Moon, Flower's Foods; and Dan Herzog, Gonnella Baking Company.

10 years of quality trends, Mark Hodges:

- What is a normal wheat crop in the last 10 years, 70 mill bu's. to 166 mill bu's in OK, extremes. In last 6 years, moved to a grain shed basis of reporting. Possibly what is accessible vs crop reporting district.
- At least 30% of harvest must be complete before getting sample. Most of samples run through ARS.
- Plainsgrains.org. Provides maps for overview of harvest, quality parameters.
- TW: general trend is up.
- Wheat protein: miller, baker, or producer's crop.
- TKW: widespread this past year, contributed to drought, hard freezes after March,
- Values associated with protein were different in last year.
- W-values, Latin American market
- Variation in production tied to climate and soil conditions, KS, TX, and OK.
- Do not pull white samples, not under contract to review.
- Yield and protein model built by OSU Ag Econ department, 70% correlation by middle of April of harvest.
- Conclusions drawn on end use performance of these? Some recent criticism's to varieties with disease resistance, losing some mixing tolerance, adding more gluten in industry. 70% environment, 30% genetics possibly.
- No till production changes, disease harborage. In last 7 years, farmers have managed wheat production much more intensively, what was crop prior to wheat? May want to look into management of fields more closely, fertilizer management, protein, higher protein and not higher gluten strength.

Update on Crop Conditions:

MT: good snow cover, some is bare, good in north by mountains, survived cold with this. 2-2.1 mill acres of HRW, adequate. Slightly drier to west. 2.8-3.0 mill acres of spring wheat, none planted yet. In May, 5-6 days of cold weather, has freeze out, replant as spring wheat along river bottoms.

CO: crop went in dry, have had good fall moisture, emergence was there but small, minimal snow cover, east of Limon, CO, beginning to break dormancy.

SD: total acres, down from last year planted, 1.2 mill acres HRW. Many of row crops did not get off as timely. Crop into good soil moisture conditions; have had quite a bit of snow cover, 56% good to excellent. Good stand, some areas with little snow cover, close to greening up.

NE: East, crop looks excellent, good soil temps. West, dry, northern part, better. No-till is working well with some wind erosion. Acreage up 6%. Have had little snow, but not enough.

KS: KS down 700K acres this year, 8.8 mill this year. Eastern region, some smaller wheat, good stands, planted late, better moisture in western 1/3 of state, stands looking much better, better with snow. Periods of cold and snow cover. In good shape. Concern may be now with cold temperatures moving forward. Wheat is very brown in central and south central corridor.

OK: down 300K in crop acres this year, much in northern part of state. Have seen winter kill in wheat, panhandle surviving on little moisture, will need moisture in next few weeks for this area to make decent crop. Some concerns in SW area of state with (hollow stem?)

TX: Panhandle to south, very poor conditions, little moisture, some has germinated, but erratic emergence. To the east of high plains, central and NE TX looking good. Overall average to slight above average.

- Brian Walker: variety checks. Decided on Jagalene as uniform check for all locations, however, needed to be fungicide treated. Implemented this year.

Adjourned at 9:14.
Justin Turner, Sec.

APPENDIX F

Historical WQC Hard Winter Wheat Entries from 2001 to 2013

A History of WQC Hard Winter Wheat Entries

2013						
Entry ID	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Check Blend (check)	12-2401	HRW				Limagrain
LCH08-80	12-2402	HRW				Limagrain
lCS Mint	12-2403	HRW				Limagrain
Danby (check)	12-2404	HWW				Kansas-Hays
Oakley CL	12-2405	HRW	yes	Oakley CL	2013	Kansas-Hays
KS10HW78-1	12-2406	HWW				Kansas-Hays
Lyman (check)	12-2407	HRW				South Dakota
SD08200	12-2408	HRW				South Dakota
SD09192	12-2409	HRW				South Dakota
Postorock (check)	12-2410	HRW				Agripro
04BC574-2	12-2411	HRW	yes	SY Monument	2014	Agripro
Millennium (check)	12-2412	HRW				Nebraska
NE09521	12-2413	HRW				Nebraska
NE08499	12-2414	HRW				Nebraska
Yellowstone (check)	12-2415	HRW				Montana
MT1090	12-2416	HRW				Montana
MTW08168	12-2417	HWW	yes	WB3768	2013	Montana
Ruby Lee (check)	12-2418	HRW				Oklahoma
Doublestop CL+	12-2419	HRW	yes	Doublestop CL+	2013	Oklahoma
OK09125	12-2420	HRW				Oklahoma
2012						
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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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
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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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

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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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
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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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
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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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
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

Entry ID	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
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 2014 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