Milling and Baking Test Results
for Hard Winter Wheat
Harvested in 2015

66th 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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2015

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 2015 Testing Program

Founded in 1949, this is the **66th** 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 25 entries this year were grown in special locations and submitted for small-scale testing by eight 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 cooperators (17 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 and Dr. Mike Tilley's Group in Manhattan, KS, as well as tortilla data generated by Texas A&M University. Methods used to evaluate wheat lines are listed in Appendix A.

2015 WQC HWW Entries & Breeding Programs

Breeding Programs	Entry Number	Sample Identification
KANSAS-HAYS	15-2401	Jagalene (CC01)
	15-2402	Danby (IC)
	15-2403	KS11HW39-5
NEBRASKA	15-2404	Jagalene (CC04)
	15-2405	NE10589
WESTBRED	15-2406	Jagalene (CC06)
	15-2407	BZ9W09-2075
	15-2408	HV9W10-1002
COLORADO	15-2409	Jagalene (CC09)
	15-2410	Byrd (IC)
	15-2411	CO11D1397
	15-2412	CO11D1539
	15-2413	CO11D1767
OKLAHOMA	15-2414	Jagalene (CC14)
	15-2415	Gallagher (IC)
	15-2416	OK11D25056
	15-2417	OK13625
	15-2418	OK10728W
MONTANA	15-2419	Jagalene (CC19)
	15-2420	Yellowstone (IC)
	15-2421	MTS1224
	15-2422	MT1265
SOUTH DAKOTA	15-2423	Ideal (IC)
	15-2424	SD10257-2

LIMAGRAIN	15-2425	LCH13DH-20-87
	15-2426*	Jagalene (CC09)
COMMON CHECK	15-2427	Jagalene (CC01)
	15-2428	Jagalene (CC04)
	15-2429	Jagalene (CC06)
	15-2430	Jagalene (CC09)
	15-2431	Jagalene (CC14)
	15-2432	Jagalene (CC19)

* The common check shared with the sample 15-2409 for statistical analysis of the Limagrain line.

CC = Common Check and IC = Internal Check

2015 Wheat Classification Results from GIPSA

GIPSA Wheat Market Classification

ID	Sample ID	CL	DKG	TW	M	ODOR	HT	DKT	FM	SHBN	DEF	CCL	WOCL	GRADE
15-2401	Jagalene (CC01)	HRW	0.01	62.2	N/A	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
15-2402	Danby (IC)	HDWH	0.02	64.1	N/A	OK	0.0	0.3	0.0	0.2	0.5	0.0	0.0	U.S. NO. 1 HDWH DKG 0.0%
15-2403	KS11HW39-5	HDWH	0.00	63.4	N/A	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	U.S. NO. 1 HDWH DKG 0.0%
15-2404	Jagalene (CC04)	HRW	0.00	60.1	N/A	OK	0.0	0.4	0.0	0.8	1.2	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
15-2405	NE10589	HRW	0.00	58.3	N/A	OK	0.0	1.7	0.0	0.3	2.0	0.0	0.2	U.S. NO. 2 HRW DKG 0.0%
15-2406	Jagalene (CC06)	HRW	0.00	63.8	N/A	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
15-2407	BZ9W09-2075	HRW	0.00	62.8	N/A	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
15-2408	HV9W10-1002	HRW	0.00	60.6	N/A	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
15-2409	Jagalene (CC09)	HRW	0.00	62.3	N/A	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
15-2410	Byrd (IC)	HRW	0.05	58.1	N/A	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 2 HRW DKG 0.1%
15-2411	CO11D1397	HRW	0.05	58.4	N/A	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	U.S. NO. 2 HRW DKG 0.1%
15-2412	CO11D1539	HRW	0.01	61.2	N/A	OK	0.0	0.2	0.0	0.1	0.3	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
15-2413	CO11D1767	HRW	0.06	59.0	N/A	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 2 HRW DKG 0.1%
15-2414	Jagalene (CC14)	HRW	0.04	59.0	N/A	OK	0.0	0.0	0.0	3.9	3.9	0.0	0.0	U.S. NO. 2 HRW DKG 0.0%
15-2415	Gallagher (IC)	HRW	0.00	62.3	N/A	OK	0.0	0.1	0.0	1.7	1.8	0.0	0.2	U.S. NO.1 HRW DKG 0.0%
15-2416	OK11D25056	HRW	0.00	60.3	N/A	OK	0.0	0.0	0.0	2.3	2.3	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
15-2417	OK13625	HRW	0.00	62.2	N/A	OK	0.0	0.1	0.0	1.0	1.1	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
15-2418	OK10728W	HDWH	0.00	56.7	N/A	OK	0.0	0.1	0.0	3.8	3.9	0.0	2.6	U.S. NO. 3 HDWH DKG 0.0%
15-2419	Jagalene (CC19)	HRW	0.00	57.5	N/A	OK	0.0	0.0	0.0	0.6	0.6	0.0	1.3	U.S. NO. 3 HRW DKG 0.0%
15-2420	Yellowstone (IC)	HRW	0.00	57.5	N/A	OK	0.0	0.0	0.0	0.5	0.5	0.0	0.0	U.S. NO.3 HRW DKG 0.0%
15-2421	MTS1224	HRW	0.00	57.4	N/A	OK	0.0	0.2	0.0	2.2	2.4	0.0	0.0	U.S. NO. 3 HRW DKG 0.0%
15-2422	MT1265	HRW	0.01	56.5	N/A	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	U.S. NO.3 HRW DKG 0.0%
15-2423	Ideal (IC)	HRW	0.00	63.9	N/A	OK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
15-2424	SD10257-2	HRW	0.01	63.0	N/A	OK	0.0	0.5	0.0	0.1	0.6	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
15-2425	LCH13DH-20-87	HRW	0.00	62.6	N/A	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	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

15-2401	Jagalene (CC01)
15-2402	Danby (IC)
15-2403	KS11HW39-5

Description of Test Plots and Breeder Entries

Kansas-Hays - Gourong Zhang

The samples submitted were grown at Hays experimental station in 2015. The field has sandy-loam soil. Test plots were not irrigated, not fertilized, and not sprayed with fungicide. We had a dry spring season. Later, the precipitation in early May relieved the drought condition and made the plants grow very well. But, plenty of precipitation also favored disease development and both stripe rust and leaf rust was very severe this year. Leaf rust came up at the late stage and did not affect yield very much. The common check Jagalene was moderately susceptible to stripe rust. Local check Danby had intermediate reaction to stripe rust. The breeder entry Joe showed resistance to both stripe rust and leaf rust. In general, the yield level of our test plots was above normal.

Jagalene (common check)

Danby (local check)

Joe (KS11HW39-5-4)

Joe is a hard white winter wheat variety, released in 2015. It is derived from a two-way cross of KS04HW101-3/KS04HW119-3. Joe has competitive yield potential and it performed well in both eastern and western Kansas in the last three years. Joe has very good resistance to the three most important diseases in western Kansas, wheat streak mosaic virus, stripe rust, and leaf rust. Joe has an average test weight, good milling quality, and above average baking quality.
Joe is medium late and medium tall. It has good straw strength and good grain shattering tolerance.

Kansas-Hays: 2015 (Small-Scale) Samples

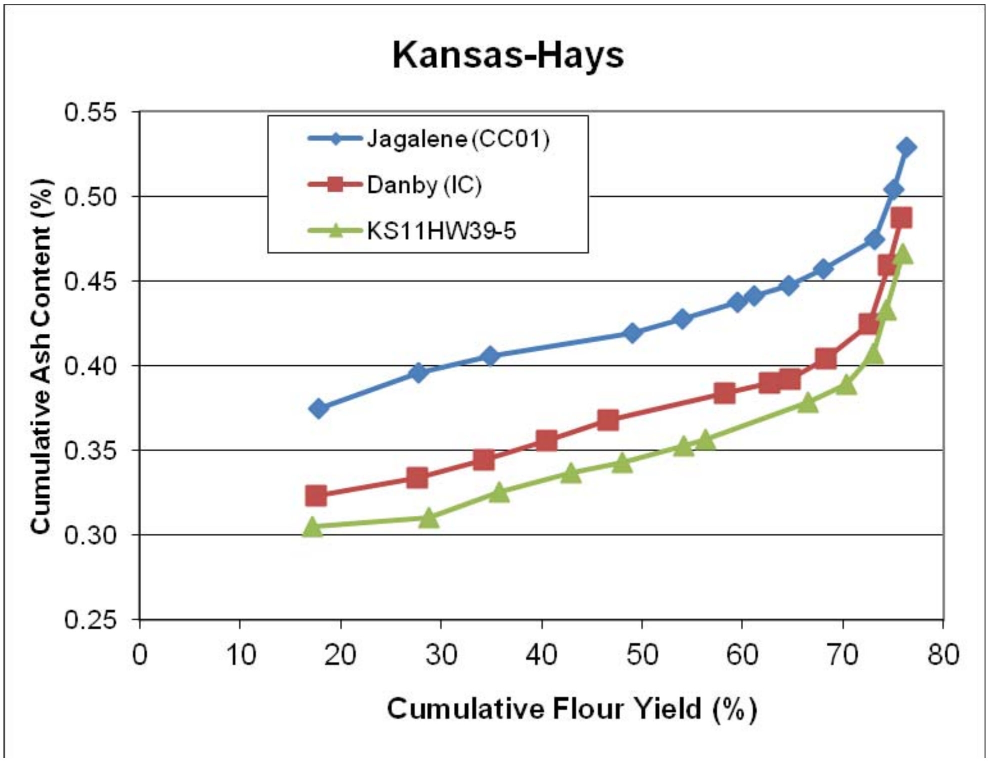
Test entry number	15-2401	15-2402	15-2403
Sample identification	**Jagalene (CC01)**	**Danby (IC)**	**KS11HW39-5**
Wheat Data			
GIPSA classification	1 HRW	1 HDWH	1 HDWH
Test weight (lb/bu) **Hectoliter weight (kg/hl)**	62.2 81.8	64.1 84.2	63.4 83.3
1000 kernel weight (gm)	28.7	30.3	34.4
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 57.1 41.2 1.0	 70.5 29.3 0.2	 84.4 15.6 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	 77.1/15.4 28.7/8.4 2.60/0.33 10.1/0.4 00-02-11-87-01 Hard	 72.8/14.8 30.3/7.2 2.61/0.31 11.1/0.4 01-04-12-83-01 Hard	 69.2/13.5 34.4/8.7 2.68/0.37 10.5/0.4 00-03-19-78-01 Hard
Wheat protein (12% mb) **Wheat ash (12% mb)**	12.2 1.43	12.5 1.47	12.9 1.46
Milling and Flour Quality Data			
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 71.8 68.7	 73.5 68.3	 73.4 67.7
Flour moisture (%) **Flour protein (14% mb)** **Flour ash (14% mb)**	12.4 11.0 0.52	12.4 11.3 0.49	12.8 11.5 0.49
Rapid Visco-Analyser Peak time (min) Peak viscosity (RVU) Breakdown (RVU) Final viscosity at 13 min (RVU)	 6.0 164.1 57.6 211.4	 6.1 233.0 103.5 228.1	 6.1 216.6 76.6 254.8
Minolta color meter L* a* b* **PPO**	 91.42 -1.60 10.63 0.481	 92.12 -1.39 8.60 0.574	 91.58 -1.35 9.36 0.553
Falling number (sec)	476	479	492
Damaged Starch (AI%) (AACC76-31)	 98.19 8.09	 95.91 6.20	 97.15 7.19

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

Kansas-Hays: Physical Dough Tests and Gluten Analysis For 2015 (Small-Scale) Samples

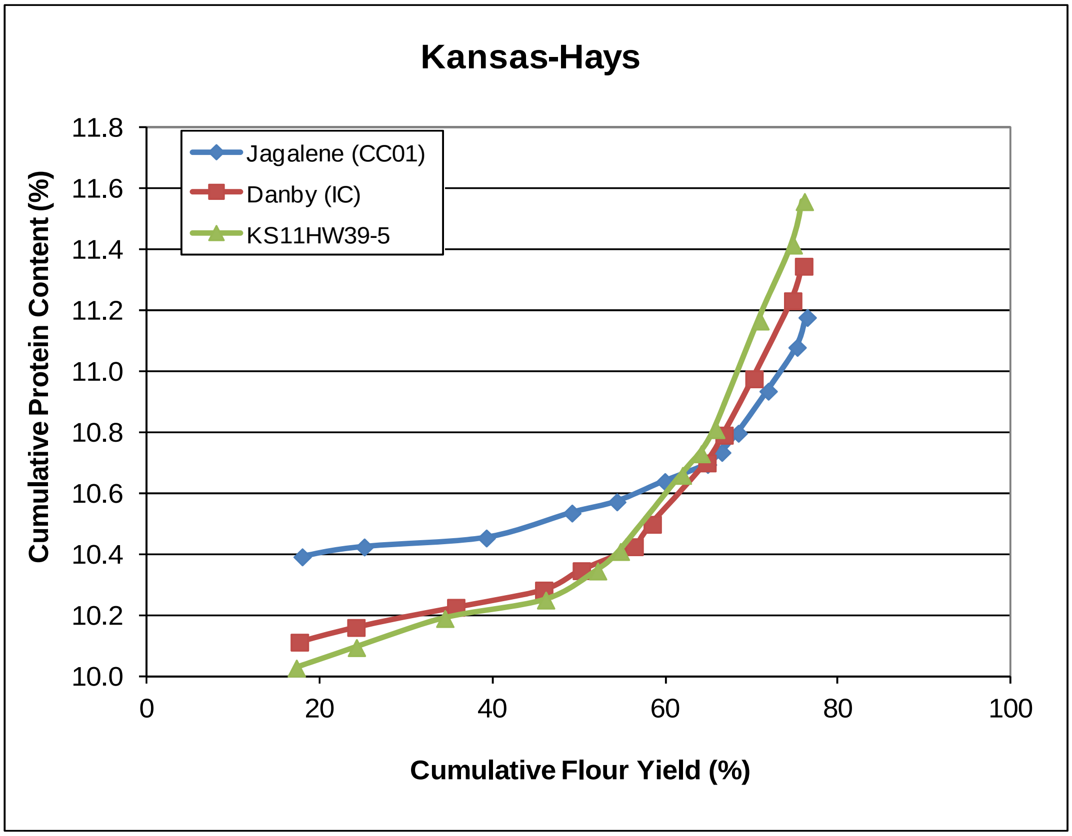
Test Entry Number	15-2401	15-2402	15-2403
Sample Identification	**Jagalene (CC01)**	**Danby (IC)**	**KS11HW39-5**
MIXOGRAPH			
Flour Abs (% as-is)	66.6	65.6	65.6
Flour Abs (14% mb)	64.8	63.8	64.2
Mix Time (min)	3.4	2.6	3.1
Mix tolerance (0-6)	4	2	1
FARINOGRAPH			
Flour Abs (% as-is)	64.8	65.6	63.5
Flour Abs (14% mb)	63.0	63.8	62.1
Development time (min)	5.3	4.4	5.7
Mix stability (min)	9.0	7.9	7.1
Mix Tolerance Index (FU)	27	24	27
Breakdown time (min)	11.0	11.0	11.2
ALVEOGRAPH			
P(mm): Tenacity	122	87	76
L(mm): Extensibility	77	104	95
G(mm): Swelling index	19.5	22.7	21.7
W(10^{-4} J): strength (curve area)	332	264	209
P/L: curve configuration ratio	1.58	0.84	0.80
Ie(P_{200}/P): elasticity index	56.3	50.6	47.6
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	394/465/470	200/229/261	180/271/317
Extensibility (mm at 45/90/135 min)	135/141/135	157/177/176	168/169/155
Energy (cm^2 at 45/90/135 min)	89/113/105	57/77/88	55/85/87
Resist $_{max}$ (BU at 45/90/135min)	499/627/595	260/308/364	236/366/414
Ratio (at 45/90/135 min)	2.92/3.30/3.48	1.27/1.29/1.49	1.07/1.60/2.05
PROTEIN ANALYSIS			
HMW-GS Composition	2*,1, 17+18, 5+10	2*,1, 7+9, 5+10	2*,1, 7+9, 5+10
%IPP	49.54	42.31	42.92
SEDIMENTATION TEST			
Volume (ml)	47.1	48.1	43.4

Kansas-Hays: Cumulative Ash Curves



Jagalene (CC01)					Danby (IC)					KS11HW39-5				
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	17.82	0.37	17.82	0.37	2M	17.50	0.32	17.50	0.32	2M	17.15	0.30	17.15	0.30
1M	9.92	0.43	27.74	0.40	1M Red	10.18	0.35	27.68	0.33	1M	11.67	0.32	28.82	0.31
1M Red	7.18	0.44	34.92	0.41	1BK	6.55	0.39	34.23	0.34	1M Red	6.96	0.39	35.77	0.33
3M	14.12	0.45	49.04	0.42	3M	6.33	0.42	40.56	0.36	1BK	7.19	0.39	42.96	0.34
1BK	4.95	0.51	53.99	0.43	1M	6.10	0.45	46.66	0.37	2BK	5.12	0.40	48.08	0.34
FILTER FLR	5.55	0.54	59.54	0.44	Grader	11.55	0.45	58.21	0.38	FILTER FLR	6.02	0.43	54.10	0.35
Grader	1.65	0.56	61.19	0.44	4M	4.47	0.47	62.68	0.39	Grader	2.17	0.45	56.27	0.36
2BK	3.35	0.56	64.54	0.45	FILTER FLR	2.10	0.47	64.78	0.39	3M	10.23	0.50	66.50	0.38
3BK	3.46	0.65	68.00	0.46	2BK	3.47	0.62	68.25	0.40	3BK	3.85	0.57	70.36	0.39
4M	5.20	0.70	73.20	0.47	3BK	4.36	0.75	72.61	0.42	4M	2.62	0.90	72.98	0.41
5M	1.91	1.64	75.11	0.50	5M	1.99	1.73	74.60	0.46	BRAN FLR	1.29	1.89	74.27	0.43
BRAN FLR	1.17	2.13	76.28	0.53	BRAN FLR	1.27	2.12	75.87	0.49	5M	1.68	1.93	75.95	0.47
Break Shorts	2.73	3.25	79.01	0.62	Break Shorts	2.71	3.34	78.58	0.59	Break Shorts	2.96	3.35	78.91	0.57
Red Dog	1.32	3.54	80.33	0.67	Red Dog	1.49	2.56	80.07	0.62	Red Dog	1.35	2.59	80.26	0.61
Red Shorts	0.23	2.52	80.56	0.68	Red Shorts	0.24	3.46	80.31	0.63	Red Shorts	0.22	3.57	80.48	0.62
Filter Bran	2.98	1.10	83.54	0.69	Filter Bran	2.71	1.21	83.02	0.65	Filter Bran	2.92	1.39	83.40	0.64
Bran	16.46	5.56	100.0	1.49	Bran	16.98	5.59	100.0	1.49	Bran	16.60	5.60	100.0	1.47
Wheat		1.40					1.43					1.43		
St. Grd. Fl.		0.52					0.49					0.49		

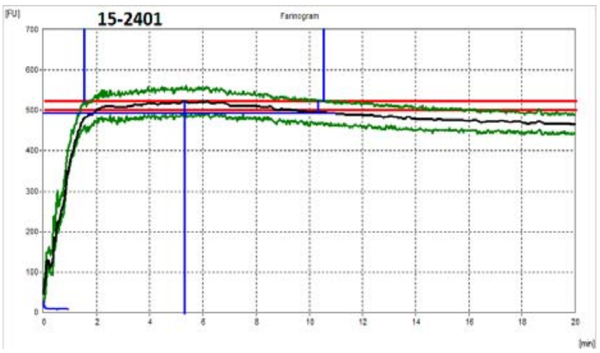
Kansas-Hays: Cumulative Protein Curves

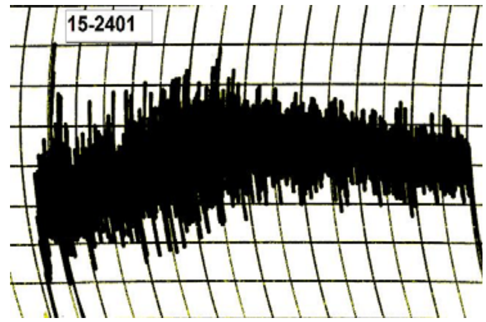


Jagalene (CC01)					Danby (IC)					KS11HW39-5				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
2M	17.82	10.39	17.82	10.39	2M	17.50	10.11	17.50	10.11	2M	17.15	10.03	17.15	10.03
1M Red	7.18	10.50	25.00	10.42	1M Red	6.55	10.29	24.05	10.16	1M Red	6.96	10.26	24.10	10.09
3M	14.12	10.51	39.12	10.45	3M	11.55	10.36	35.61	10.23	3M	10.23	10.41	34.34	10.19
1M	9.92	10.86	49.04	10.53	1M	10.18	10.48	45.78	10.28	1M	11.67	10.43	46.01	10.25
4M	5.20	10.92	54.24	10.57	4M	4.36	11.01	50.14	10.35	FILTER FLR	6.02	11.08	52.02	10.34
FILTER FLR	5.55	11.29	59.79	10.64	FILTER FLR	6.10	11.07	56.24	10.42	4M	2.62	11.67	54.65	10.41
1BK	4.95	11.37	64.74	10.69	Grader	2.10	12.47	58.34	10.50	1BK	7.19	12.56	61.83	10.66
Grader	1.65	12.28	66.39	10.73	1BK	6.33	12.55	64.67	10.70	Grader	2.17	12.75	64.01	10.73
5M	1.91	12.99	68.30	10.80	5M	1.99	13.75	66.66	10.79	5M	1.68	13.82	65.69	10.81
3BK	3.46	13.66	71.76	10.93	3BK	3.47	14.53	70.13	10.97	2BK	5.12	15.73	70.81	11.16
2BK	3.35	14.15	75.11	11.08	2BK	4.47	15.24	74.60	11.23	3BK	3.85	15.99	74.66	11.41
BRAN FLR	1.17	17.47	76.28	11.18	BRAN FLR	1.27	17.98	75.87	11.34	BRAN FLR	1.29	19.83	75.95	11.56
Break Shorts	2.73	15.47	79.01	11.32	Break Shorts	2.71	16.12	78.58	11.51	Break Shorts	2.96	15.61	78.91	11.71
Red Dog	1.32	13.29	80.33	11.36	Red Dog	1.49	13.82	80.07	11.55	Red Dog	1.35	13.49	80.26	11.74
Red Shorts	0.23	12.96	80.56	11.36	Red Shorts	0.24	13.39	80.31	11.56	Red Shorts	0.22	13.88	80.48	11.74
Filter Bran	2.98	10.70	83.54	11.34	Filter Bran	2.71	11.07	83.02	11.54	Filter Bran	2.92	12.05	83.40	11.75
Bran	16.46	16.33	100.00	12.16	Bran	16.98	17.48	100.00	12.55	Bran	16.60	19.27	100.00	13.00
Wheat		11.90					12.18					12.60		
St. Grd. Fl		11.16					11.22					11.61		

Physical Dough Tests
2015 (Small Scale) Samples - Kansas-Hays

Farinograms | **Mixograms**

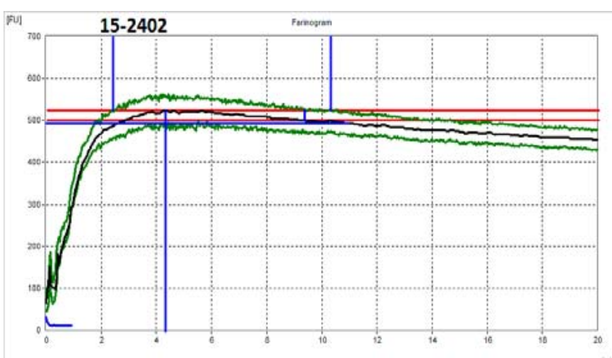


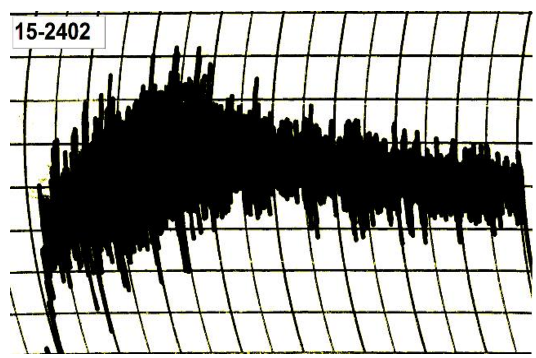


Water abs = 63.0%, Peak time = 5.3 min,
Mix stab =9.0 min, MTI = 27 FU

Water abs = 64.8%
Mix time = 3.4 min

15-2401, Jagalene (CC01)





Water abs = 63.8%, Peak time = 4.4 min,
Mix stab = 7.9 min, MTI = 24 FU

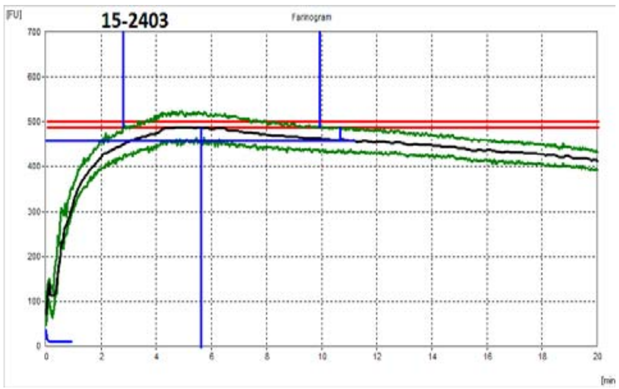
Water abs = 63.8%
Mix time = 2.3 min

15-2402, Danby (IC)

Physical Dough Tests

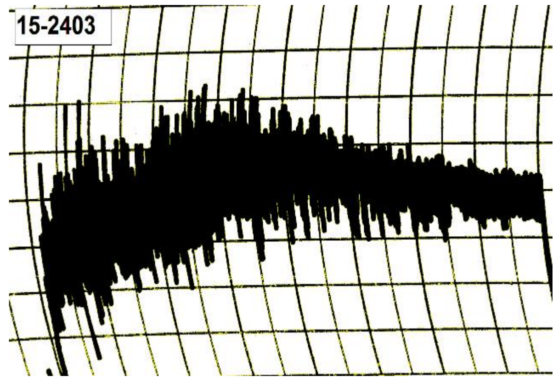
2015 (Small Scale) Samples - Kansas-Hays (continued)

Farinograms



Water abs= 62.1%, Peak time = 5.7 min,
Mix stab = 7.1 min, MTI = 27 FU

Mixograms

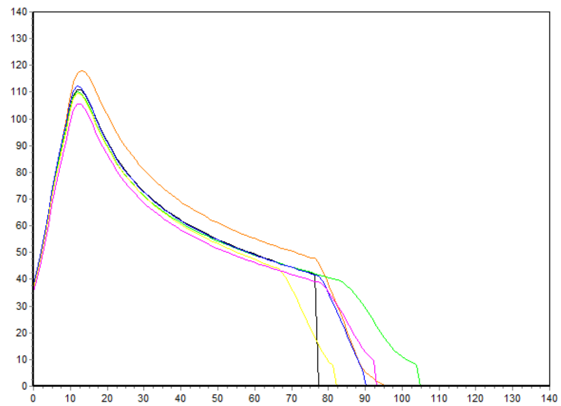


Water abs = 64.2%
Mix time = 3.2 min

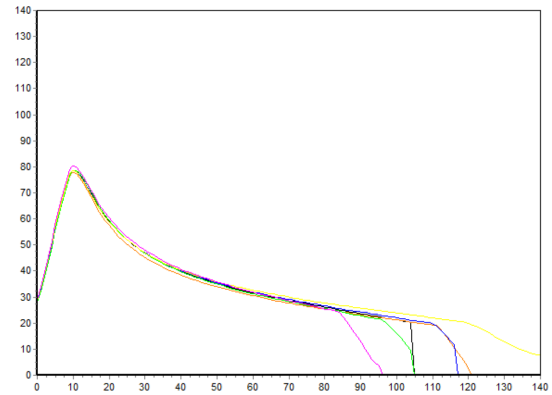
15-2403, KS11HW39-5

Physical Dough Tests - Alveograph

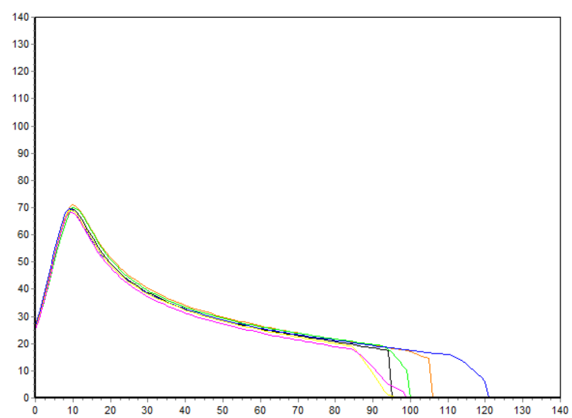
2015 (Small Scale) Samples – Kansas-Hays



15-2401, Jagalene (CC01)
P(mm H_20)=122, L(mm)=77, W(10E^{-4} J)=332



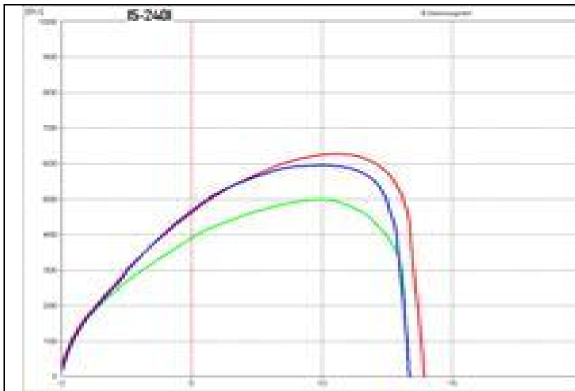
15-2402, Danby (IC)
P(mm H_20)=87, L(mm)=104, W(10E^{-4} J)=264



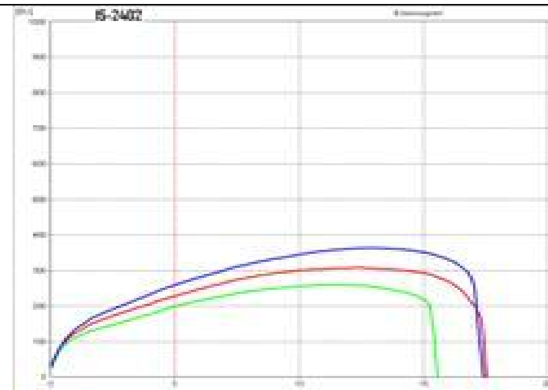
15-2403, KS11HW39-5
P(mm H_20)=76, L(mm)=95, W(10E^{-4} J)=209

Physical Dough Tests - Extensigraph

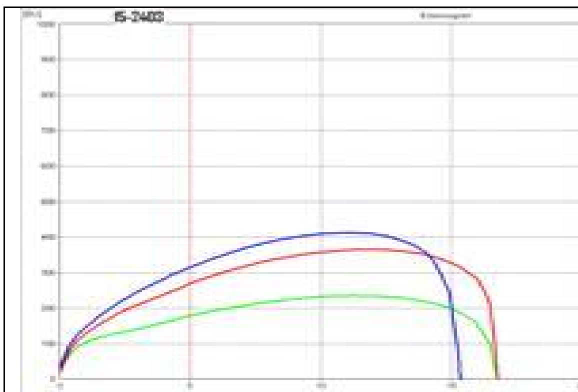
2015 (Small Scale) Samples – Kansas-Hays



15-2401, Jagalene (CC01)
R (BU) = 468, E (mm) =142, W (cm^2) = 113
Rmax (BU) = 627, Ratio = 3.3 at 90 min



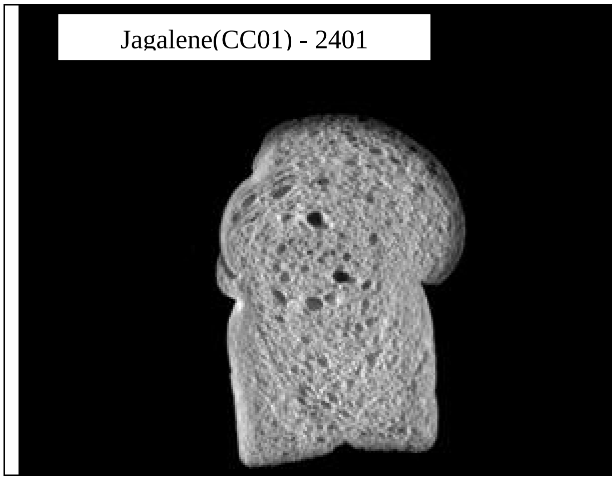
15-2402, Danby (IC)
R (BU) = 229, E (mm) =177, W (cm^2) = 77
Rmax (BU) = 308, Ratio = 1.3 at 90 min

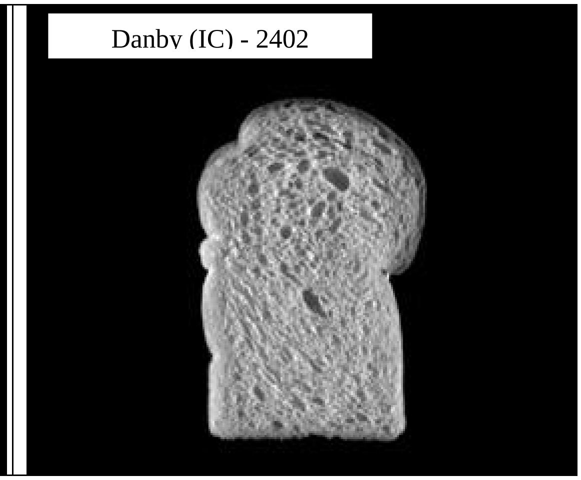


15-2403, KS11HW39-5
R (BU) = 271, E (mm) = 169, W (cm^2) = 85
Rmax (BU) = 366, Ratio = 1.6 at 90 min

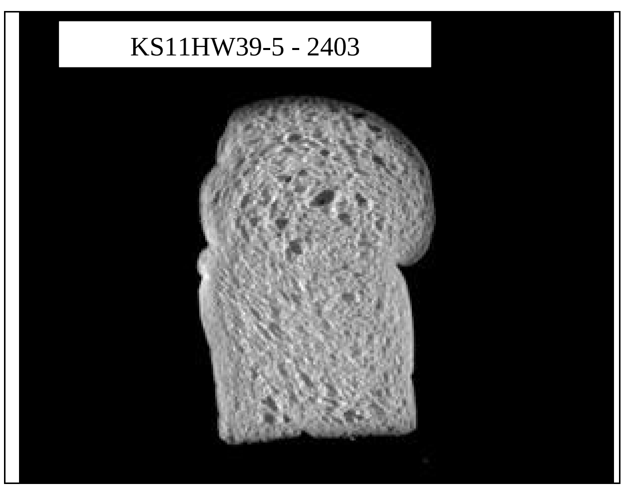
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Kansas-Hays: C-Cell Bread Images and Analysis for 2015 (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	6271	141.9	4048	0.436	1.910	3.990	1.665	-21.95
2402	6004	145.5	3633	0.452	2.145	1.417	1.603	-11.60



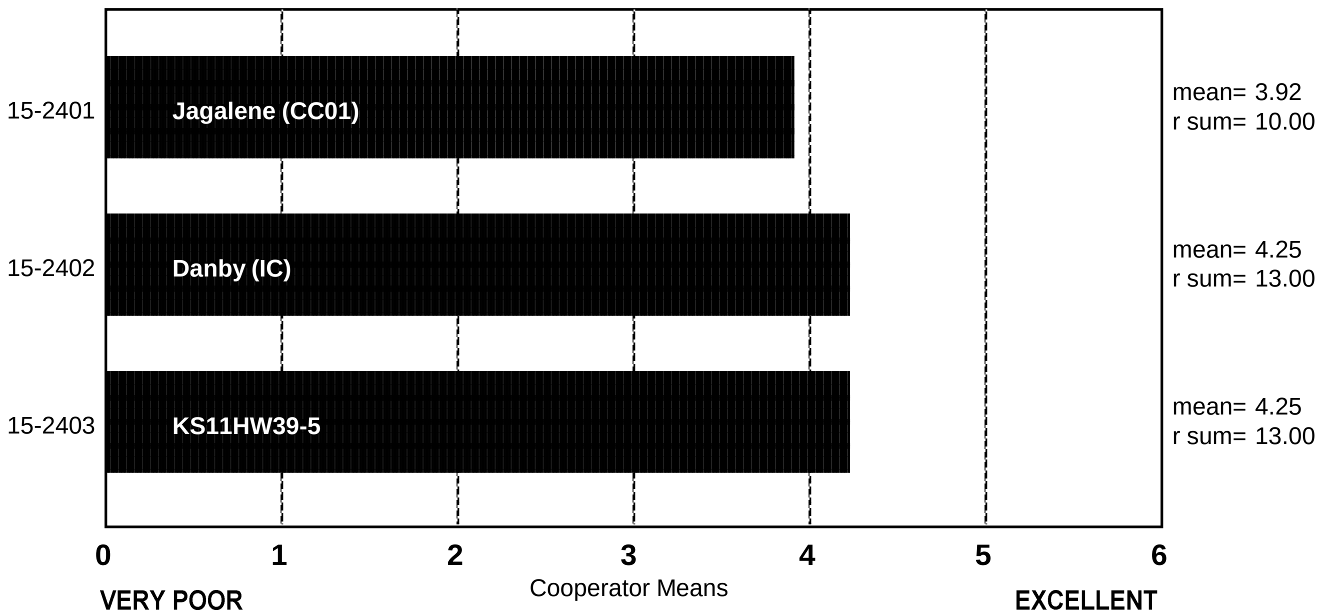
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2403	6413	146.6	4030	0.447	1.998	2.642	1.643	-26.58

SPONGE CHARACTERISTICS

(Small Scale) Kansas-Hays

ncoop= 6
chisq= 1.00
chisqc= 2.00
cvchisq= 5.99
crdiff=

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

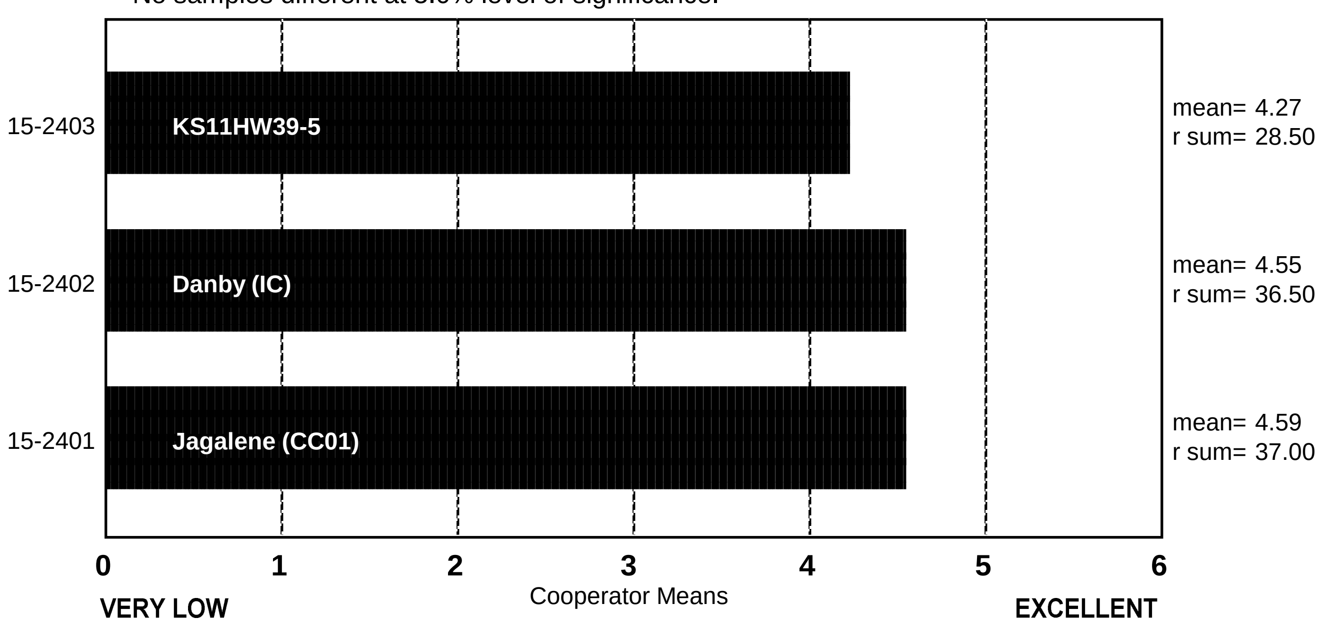


BAKE ABSORPTION

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 2.68
chisqc= 4.23
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) 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. O
15-2401 Jagalene (CC01)	**66.7**	**69.0**	**57.0**	**60.0**	**65.3**	**65.5**	**68.8**	**62.3**	**63.2**	**63.0**	**71.1**	**60.8**	**62.0**	**63.9**	**63.0**	**59.0**	**63.1**
15-2402 Danby (IC)	**65.7**	**68.0**	**57.0**	**61.0**	**64.0**	**65.3**	**67.3**	**62.3**	**63.5**	**63.8**	**71.9**	**61.2**	**63.0**	**62.9**	**63.8**	**61.0**	**64.0**
15-2403 KS11HW39-5	**65.4**	**68.0**	**58.0**	**60.0**	**64.1**	**64.0**	**69.3**	**61.7**	**63.4**	**62.1**	**69.5**	**61.6**	**61.0**	**61.3**	**62.1**	**60.0**	**62.7**

BAKE MIX TIME, ACTUAL

(Small Scale) Kansas-Hays

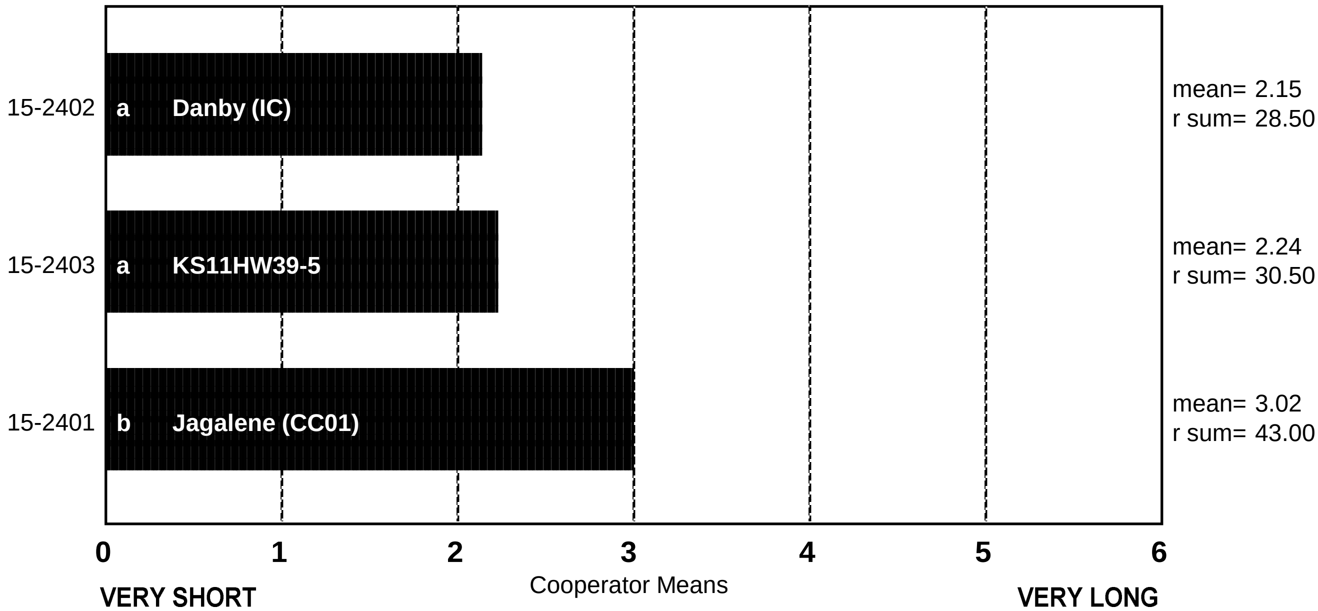
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2401 Jagalene (CC01)	**3.4**	**3.8**	**7.0**	**6.0**	**4.0**	**3.9**	**4.1**	**4.3**	**3.0**	**7.0**	**4.0**	**4.0**	**8.0**	**4.5**	**4.0**	**4.0**	**5.0**
15-2402 Danby (IC)	**2.6**	**2.5**	**6.0**	**6.0**	**2.9**	**3.8**	**2.5**	**3.0**	**2.1**	**5.3**	**3.0**	**2.3**	**12.0**	**3.5**	**3.0**	**4.0**	**5.0**
15-2403 KS11HW39-5	**3.1**	**2.5**	**6.0**	**6.0**	**2.8**	**3.8**	**2.8**	**3.3**	**2.2**	**5.3**	**3.0**	**2.5**	**11.0**	**3.3**	**4.0**	**4.0**	**6.0**

BAKE MIX TIME

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 7.26
chisqc= 10.74
cvchisq= 5.99
crdiff= 7.78

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

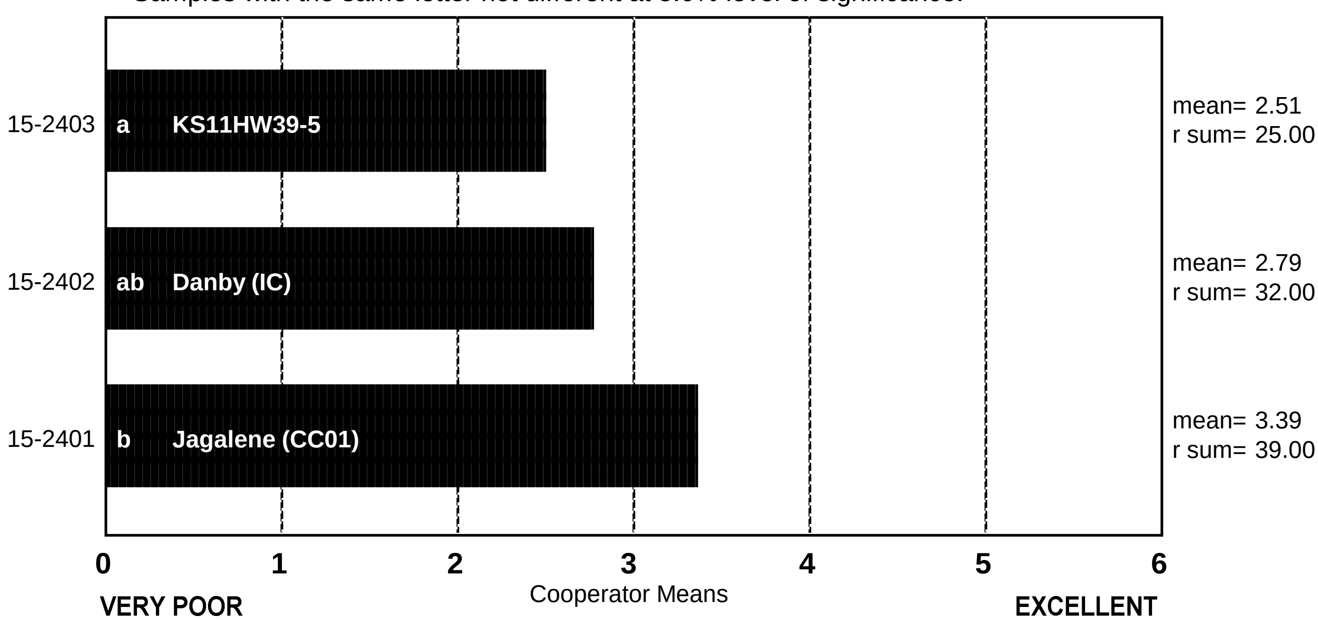


MIXING TOLERANCE

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 6.13
chisqc= 8.71
cvchisq= 5.99
crdiff= 8.53

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

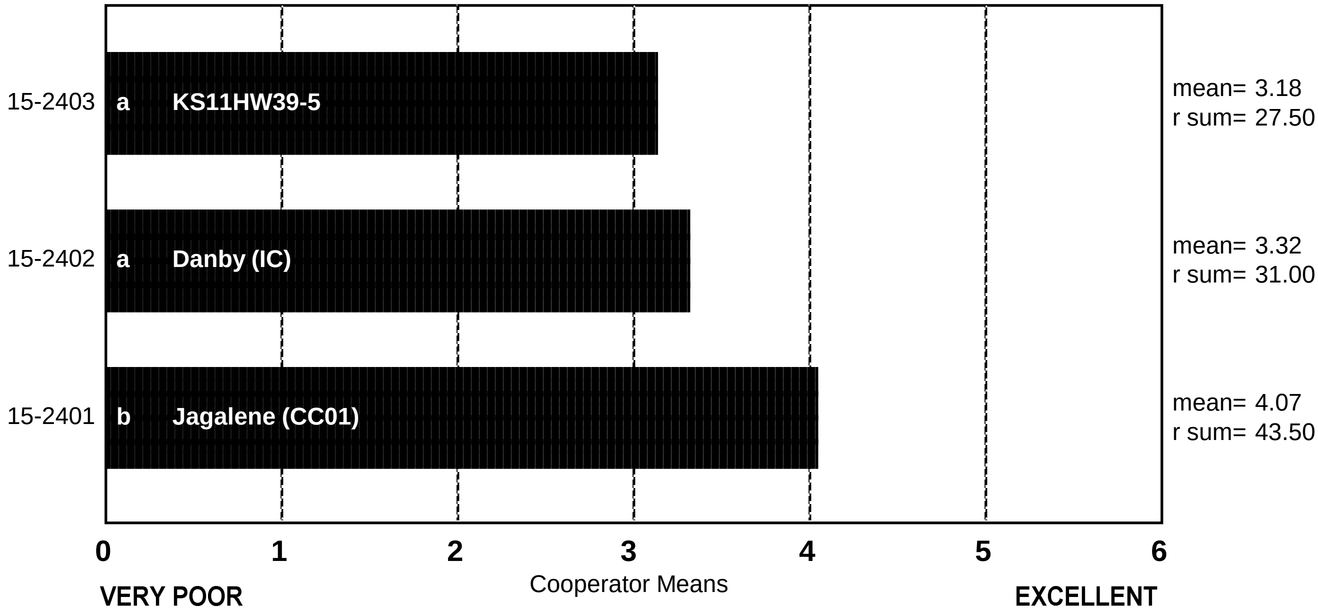


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 8.32
chisqc= 10.88
cvchisq= 5.99
crdiff= 8.83

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) Kansas-Hays

	Sticky	Wet	Tough	Good	Excellent
15-2401 Jagalene (CC01)	2	1	2	11	1
15-2402 Danby (IC)	4	0	2	10	1
15-2403 KS11HW39-5	6	3	1	7	0

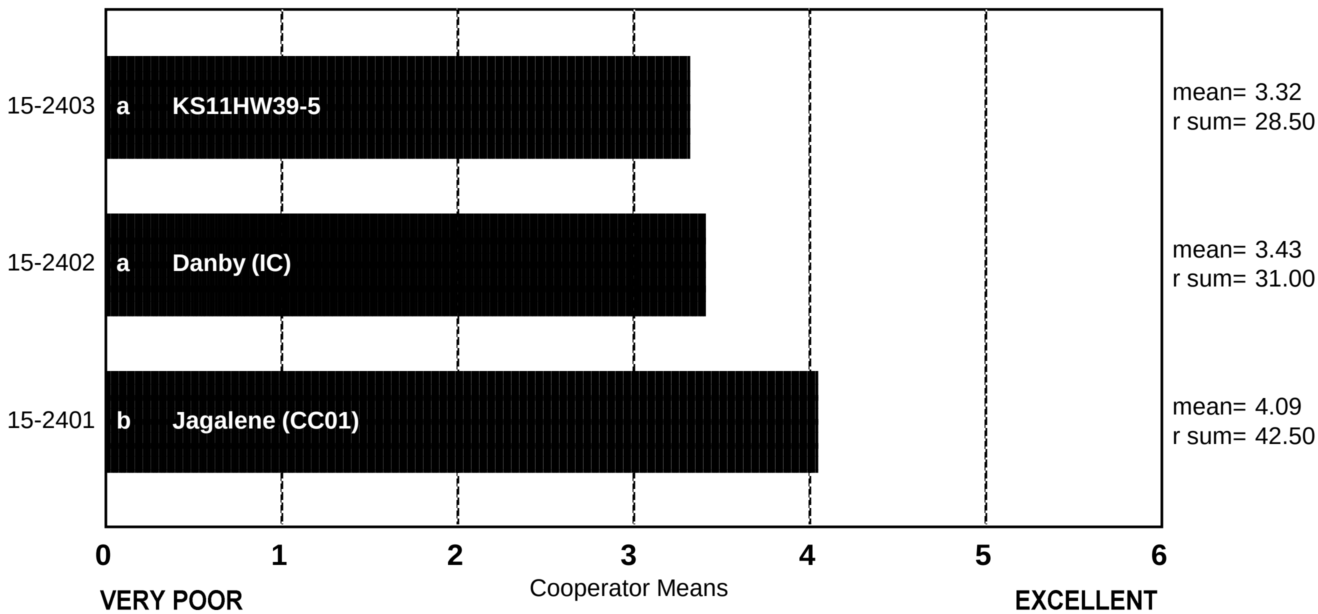
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 6.56
chisqc= 9.29
cvchisq= 5.99
crdiff= 8.77

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Kansas-Hays

	Sticky	Wet	Tough	Good	Excellent
15-2401 Jagalene (CC01)	**1**	**2**	**1**	**13**	**0**
15-2402 Danby (IC)	**3**	**2**	**1**	**11**	**0**
15-2403 KS11HW39-5	**5**	**2**	**1**	**9**	**0**

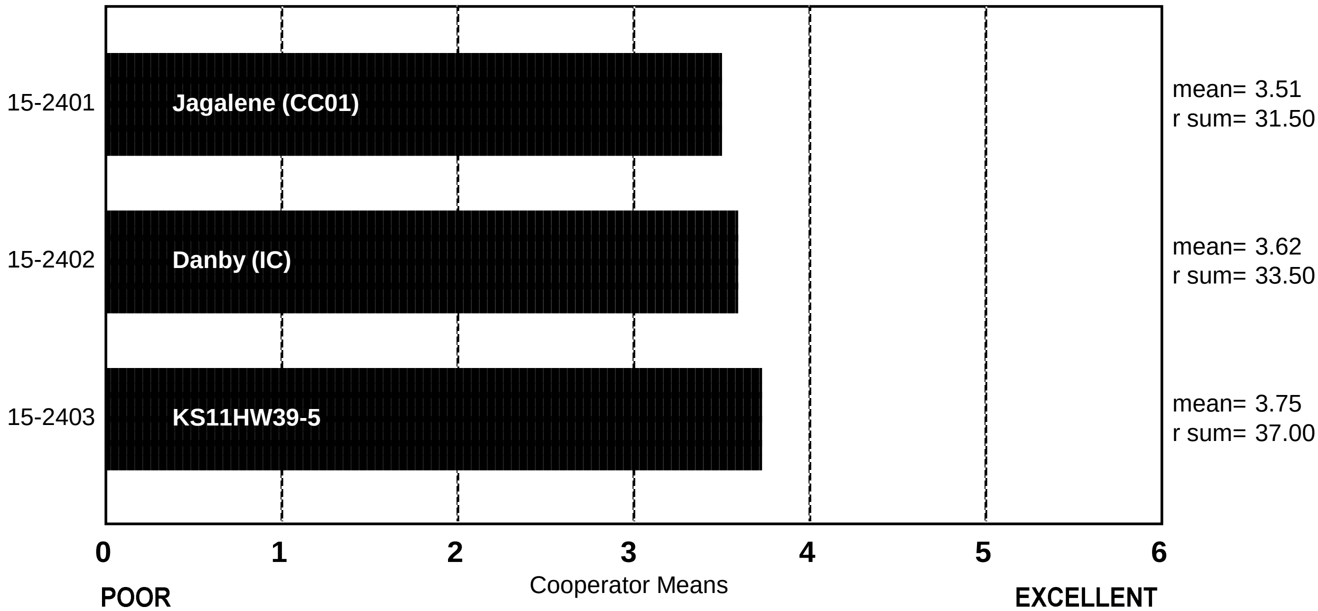
Frequency Table

CRUMB GRAIN

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 0.91
chisqc= 1.35
cvchisq= 5.99
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
15-2401 Jagalene (CC01)	**8**	**6**	**3**
15-2402 Danby (IC)	**9**	**8**	**0**
15-2403 KS11HW39-5	**9**	**7**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Kansas-Hays

	Round	Irregular	Elongated
15-2401 Jagalene (CC01)	**4**	**5**	**8**
15-2402 Danby (IC)	**6**	**7**	**4**
15-2403 KS11HW39-5	**6**	**6**	**5**

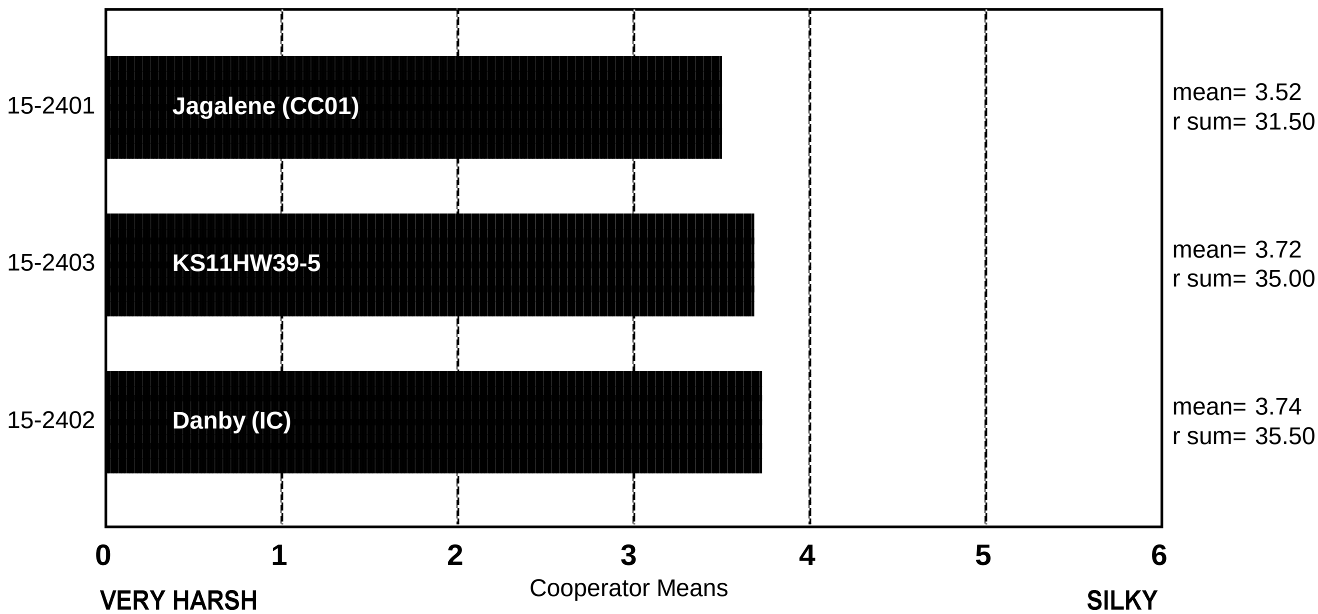
Frequency Table

CRUMB TEXTURE

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 0.56
chisqc= 0.79
cvchisq= 5.99
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Kansas-Hays

	Harsh	Smooth	Silky
15-2401 Jagalene (CC01)	**5**	**10**	**2**
15-2402 Danby (IC)	**5**	**10**	**2**
15-2403 KS11HW39-5	**6**	**9**	**2**

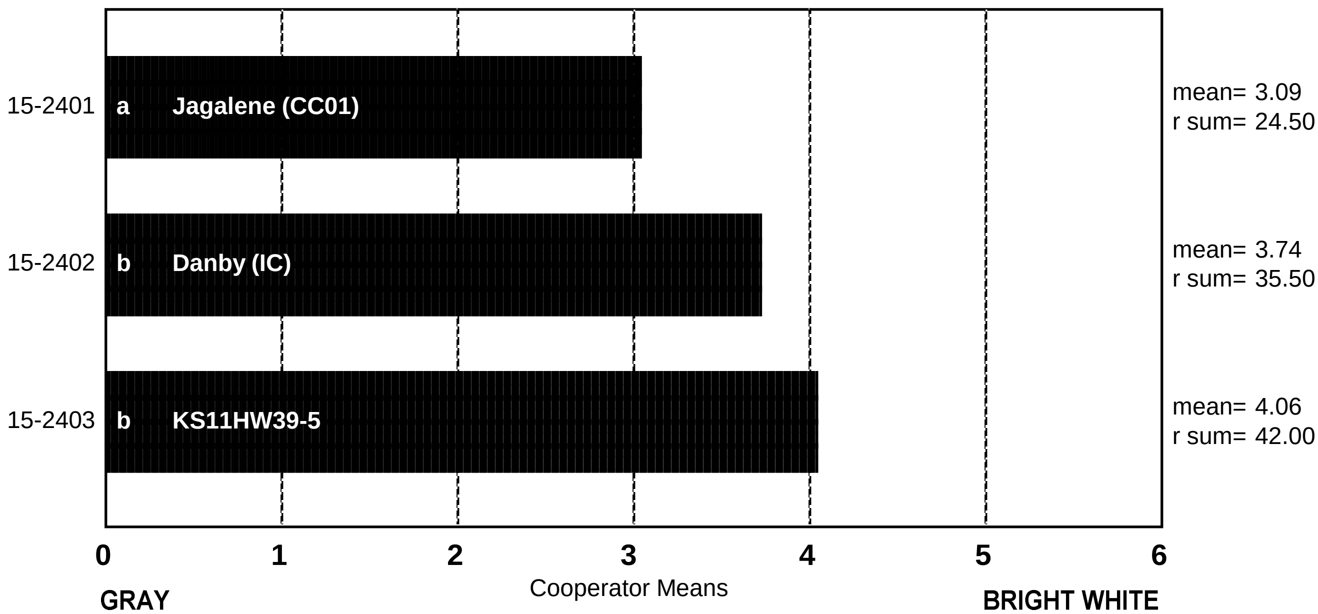
Frequency Table

CRUMB COLOR

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 9.21
chisqc= 15.65
cvchisq= 5.99
crdiff= 6.90

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
15-2401 Jagalene (CC01)	**1**	**0**	**8**	**2**	**5**	**1**	**0**
15-2402 Danby (IC)	**0**	**0**	**2**	**3**	**10**	**1**	**1**
15-2403 KS11HW39-5	**0**	**0**	**0**	**1**	**13**	**2**	**1**

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
15-2401 Jagalene (CC01)	**136.1**	**137.3**	**395.0**		**133.1**	**139.2**	**156.0**	**139.4**	**141.8**	**449.5**	**131.7**			**149.9**	**119.7**	**481.8**	**454.0**
15-2402 Danby (IC)	**136.6**	**136.6**	**401.0**		**131.5**	**140.0**	**152.3**	**141.4**	**148.4**	**447.2**	**128.5**			**149.9**	**112.4**	**484.2**	**452.0**
15-2403 KS11HW39-5	**138.0**	**135.5**	**398.0**		**133.1**	**138.2**	**151.9**	**140.8**	**146.7**	**448.5**	**131.4**			**148.2**	**114.4**	**488.8**	**457.0**

LOAF VOLUME, ACTUAL

(Small Scale) Kansas-Hays

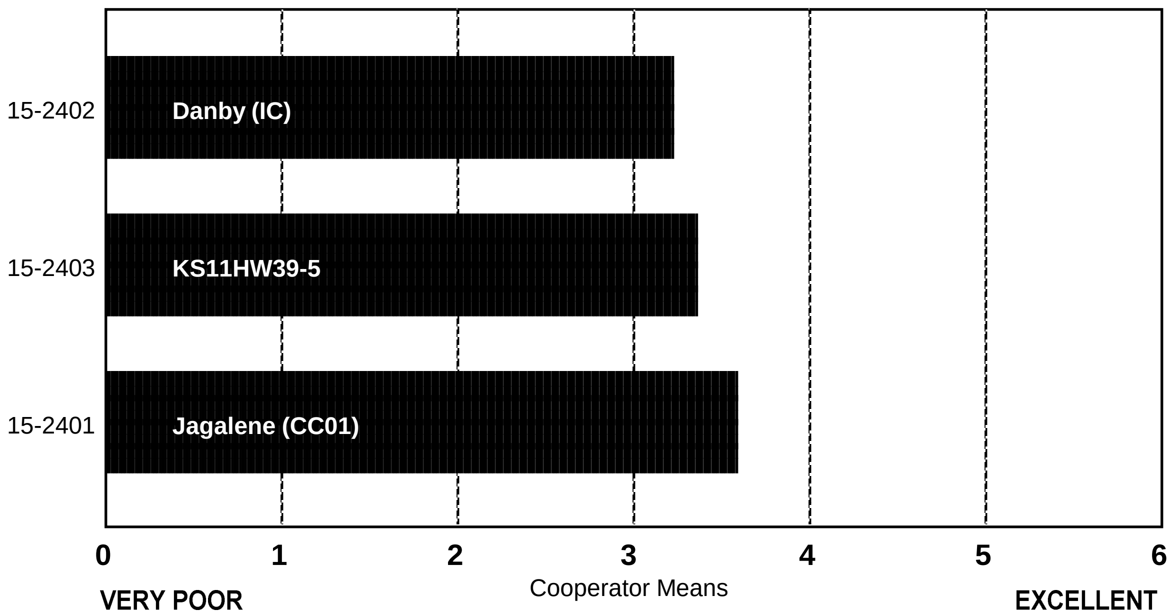
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2401 Jagalene (CC01)	**866**	**868**	**2800**	**940**	**923**	**1004**	**880**	**975**	**760**	**2846**	**960**	**635**	**2691**	**925**	**2550**	**2638**	**2250**
15-2402 Danby (IC)	**857**	**860**	**2600**	**965**	**880**	**1038**	**935**	**885**	**655**	**2790**	**1020**	**790**	**2750**	**945**	**2200**	**2375**	**2000**
15-2403 KS11HW39-5	**830**	**574**	**2600**	**950**	**858**	**943**	**935**	**895**	**730**	**2744**	**970**	**785**	**2691**	**995**	**2450**	**2413**	**2275**

LOAF VOLUME

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 0.38
chisqc= 0.46
cvchisq= 5.99
crdiff=

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



mean= 3.23
r sum= 32.00

mean= 3.37
r sum= 34.50

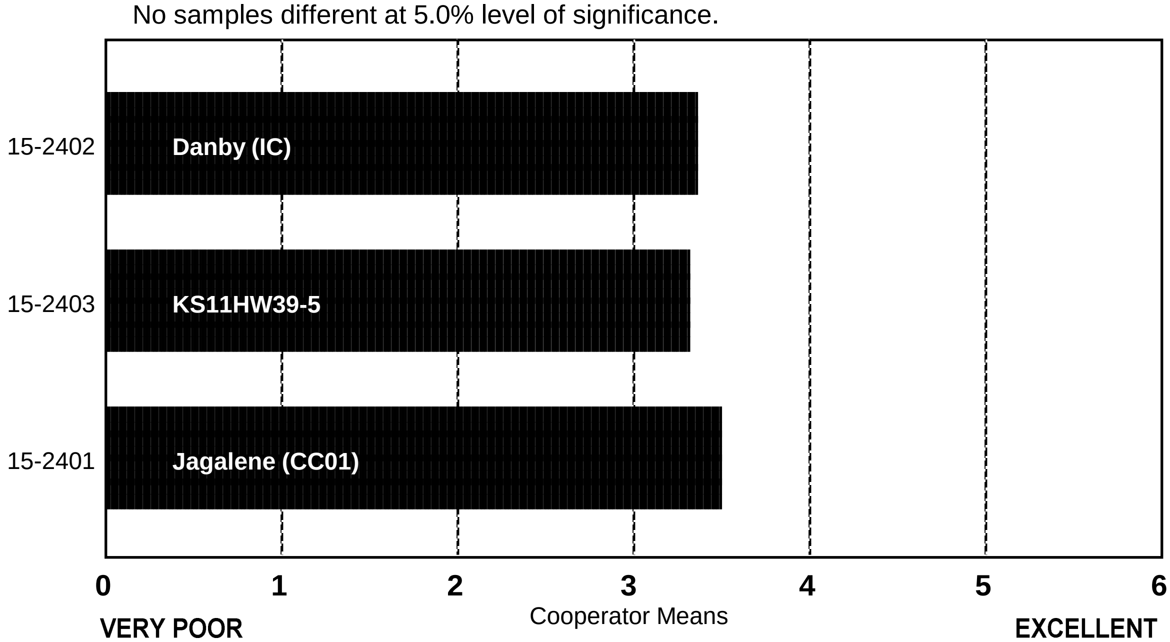
mean= 3.62
r sum= 35.50

OVERALL BAKING QUALITY

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 1.85
chisqc= 2.38
cvchisq= 5.99
crdiff=

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



mean= 3.39
r sum= 31.00

mean= 3.36
r sum= 32.50

mean= 3.52
r sum= 38.50

COOPERATOR'S COMMENTS
(Small Scale) Kansas-Hays

COOP. 15-2401 Jagalene (CC01)

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. Highest water absorption in the set.
F. Normal water absorption and mix time, slight sticky & strong dough, very high volume, yellow crumb, open elongated cells, resilient & smooth texture.
G. Somewhat weaker dough properties but feel was good, absorption was very good, volume and grain average.
H. Slight cap.
I. Poor bread bake, low volume, poor color.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Good rating for bake absorption, out of mixer, mix time, loaf volume and Q-S crumb-nice check.
O. High absorption, low mix time, excellent volume and grain rating.
P. Short mix time, wet and sticky dough, open grain, yellow crumb, good volume.
Q. Slightly sticky at makeup, weak crust.

COOP. 15-2402 Danby (IC)

A. No comment.
B. Satisfactory quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption and mix time, slight sticky & strong dough, very high volume, creamy crumb, open elongated cells, soft resilient & smooth texture.
G. Short mix time but overall strength average, absorption is at a good level, volume is good for protein level, grain average.
H. No comment.
I. Short, weak dough, very poor baker.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Good rating for bake absorption, out of mixer, mix time; excellent loaf volume, Q-S crumb.
O. High absorption, low mix time, bread collapsed before volume reading, good grain rating.
P. Good absorption, short mix time, wet and sticky dough, open grain, low volume.
Q. Sticky and slightly slack at makeup, had to use more dusting flour, very weak crust.

COOP. **15-2403 KS11HW39-5**

A. No comment.
B. Questionable quality overall.
C. No comment.
D. No comment.
E. Weaker dough performance.
F. Normal water absorption and mix time, slight sticky & strong dough, high volume, creamy crumb, open elongated cells, resilient & smooth texture.
G. Short mix time but overall strength average, absorption is at a very good level, volume is good for protein level, grain average.
H. No comment.
I. Short, weak dough, very poor baker.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Experimental has lower bake absorption, shorter mix time, satisfactory crumb grain, excellent loaf volume.
O. Higher absorption, low mix time, slightly slack dough, bread had good volume and grain rating.
P. Good absorption, short mix time, wet and sticky dough, low volume.
Q. Not as bad as 2402.

Notes: **C, D, M, O, P and Q** conducted sponge and dough bake tests

NEBRASKA

15-2404	Jagalene (CC04)
15-2405	NE10589

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 2014-2015 growing season would be considered being very heterogeneous for production. Sidney was planted and then had a very unusual winter with highly fluctuating temperatures leading to more winterkill than normal. Most Nebraska lines fared well. Rains at harvest delayed the harvest and weathered the grain. North Platte had generally good growing good growing conditions throughout the year and produced very good quality grain. Mead had a normal growing season until Flowering at which time we had excessive moisture leading to sever epidemics of stripe (yellow) rust and Fusarium head blight (scab). No fungicides were applied to the grow-outs at Mead, but the seed was heavily cleaned to try to remove as much scabby grain as possible.

Data from the 2014-2015 State Variety Trial:

Line	Mead	N. Platte	Sidney
	Yield	Yield	Yield
	Bu/a	Bu/a	Bu/a
NE10589	35	73	32
Nursery mean	32	58	26
LSD (P=.05%)	13	11	3

Lines submitted for testing:

NE10589:

NE10589 is a hard red winter wheat (*Triticum aestivum* L.) cultivar developed cooperatively by the Nebraska Agricultural Experiment Station and the USDA-ARS and released in 2016 by the developing institutions. It was released primarily for its superior adaptation to rainfed wheat production systems throughout Nebraska and in adjacent wheat producing states. NE10589 will be marketed as Husker Genetics Brand 'Ruth' Hard Red Winter Wheat. It was named in honor of our greenhouse manager who was a huge aid to the breeding program and who died far too young. NE10589 genetically is a semi-dwarf wheat, containing the RhtB1b allele (formerly known as Rht1).

NE10589 was selected from the cross 'OK98697'/'Jagalene'//'Camelot' where the pedigree of OK98697 is 'TAM 200'/'HBB313E'//'2158'. NE10589 was evaluated in Nebraska replicated yield nurseries starting in 2010, in the USDA-ARS coordinated Northern Regional Performance Nursery in 2013 and 2014, in the Southern Regional Performance Nursery in 2014, and in the University of Nebraska Fall Sown Wheat Performance Trials in 2014 to 2015. In the Nebraska Intrastate Nursery (2012 to 2015, Table 1), NE10589 performed extremely well across Nebraska in head-to-head comparisons for grain yield with the currently popularly available wheat cultivars.

NE10589 is resistant to *Soilborne wheat mosaic virus* in field nurseries in Nebraska It is moderately resistant to stem rust (caused by *Puccinia graminis Pers.: Pers. f. sp. tritici* Eriks & E. Henn.) in field nursery tests at St. Paul, MN and to stripe rust (caused by *P. striiformis* Westendorp f. sp. t*ritici*) ,in field nurseries in Nebraska. In greenhouse seedling tests, it is resistant or segregating for resistance to stem rust races QFCSC, QTHJC, MCCFC, RCRSC, RKQQC, and TMPKC, but susceptible to race TTTTF. It is moderately susceptible to susceptible for leaf rust (caused by *P. triticina* Eriks,) data obtained from field observations in the Great Plains). By molecular markers, it is believed to carry the Lr37/Sr38/Yr17 translocation. NE10589 is moderately susceptible to Fusarium head blight (caused by *Fusarium graminearum,* data from greenhouse and field observations in Nebraska and Kansas) and moderately susceptible to DON accumulation. NE10589 is moderately resistant to moderately susceptible to Hessian fly (*Mayetiola destructor* Say,), but its reaction can be quite variable among greenhouse seedling tests. It is susceptible to *Barley yellow dwarf virus*, and *Wheat streak mosaic virus* (data obtained from the USDA-ARS Noirthern Regional Performance Nursery and field observations in NE).

NE10589 has high grain volume weight (Tables 1), which is similar to most high grain volume weight wheats and higher than Panhandle and Wesley winter wheat, both of which are considered to be lower grain volume weight cultivars. The milling and baking properties of NE10589 were determined for four years by the Nebraska Wheat Quality Laboratory. In these tests, Wesley, an excellent milling and baking wheat and Overland, a poorer baking wheat, were used for comparison. The average flour protein content of NE10589 (11.6%) was lower than Wesley (113.1%) and similar to Overland for the corresponding years. The result was confirmed with data from the Nebraska State Variety Trial (Table 2). The average flour extraction on the Buhler Laboratory Mill for NE10589 (72.3%) was lower than Wesley, but higher than Overland (Table3). The flour ash content (0.43%) was higher than Wesley and similar to Overland. Dough mixing properties of NE10589 were acceptable (mixtime peak was 4.72 minutes and mixtime tolerance was scored as 4.3 on a one to 7 scale where 7 is very tolerant) and weaker than Wesley, but stronger than Overland. Average baking absorption (63.5%) was lower than Wesley and similar to Overland for the corresponding years. The average loaf volume of NE10589 (865 cm^3) was lower than Wesley and higher than Overland. The scores for the external appearance, internal crumb grain and texture were 4.3, 3.8 and 3.8, respectively, which were lower than Wesley, but higher than Overland. The overall end-use quality characteristics for NE10589 (scored as 4.0, where 3 is fair, 4 is good and 7 is excellent) was lower than Wesley, but higher than Overland and similar to many commonly grown wheat cultivars. NE10589 should be acceptable to the milling and baking industries.

Jagalene: The approved standard check. No internal check was added as we feel that Jagalene is an acceptable quality check for Nebraska.

Table 1. Head to head comparisons of NE10589 to popularly grown or new cultivars from trials in Nebraska beginning in 2012 until 2015. Data on grain yield, grain volume weight, and plant height were from trials at up to eight rainfed locations (Mead, Lincoln, Clay Center, North Platte, McCook, Grant, Sidney, and Alliance) in Nebraska in each year (total environments in the comparison is N) and not every cultivar was grown in the same trial across the state.

Line		Grain Yield (kg/ha)				Grain Volume Weight (kg/hl)				Height (cm)		
	N	Line	NE10589		N	Line	NE10589		N	Line	NE10589	
Camelot	22	3951	4399	**	12	72.9	73.6	ns	17	94.1	88.9	**
Goodstreak	31	3374	3950	**	14	73.0	73.2	ns	24	104.0	90.7	**
McGill	17	4074	4431	**	8	76.0	77.4	ns	13	92.8	88.7	**
Panhandle	26	3263	3885	**	10	74.2	76.1	**	20	101.4	90.9	**
Freeman	26	3674	3885	**	10	74.1	76.1	ns	20	87.5	90.9	**
Robidoux	26	3639	3885	**	10	76.6	76.1	ns	20	90.9	90.9	**
Overland	31	3706	3950	**	14	73.8	73.2	ns	24	93.0	90.7	**
Settler CL	26	3339	3885	**	10	76.9	76.1	ns	20	85.7	90.9	**
Wesley	31	3325	3950	**	14	71.6	73.2	**	24	85.2	90.7	**

** Significantly different at the P=0.01 probability level.

Nebraska: 2015 (Small-Scale) Samples

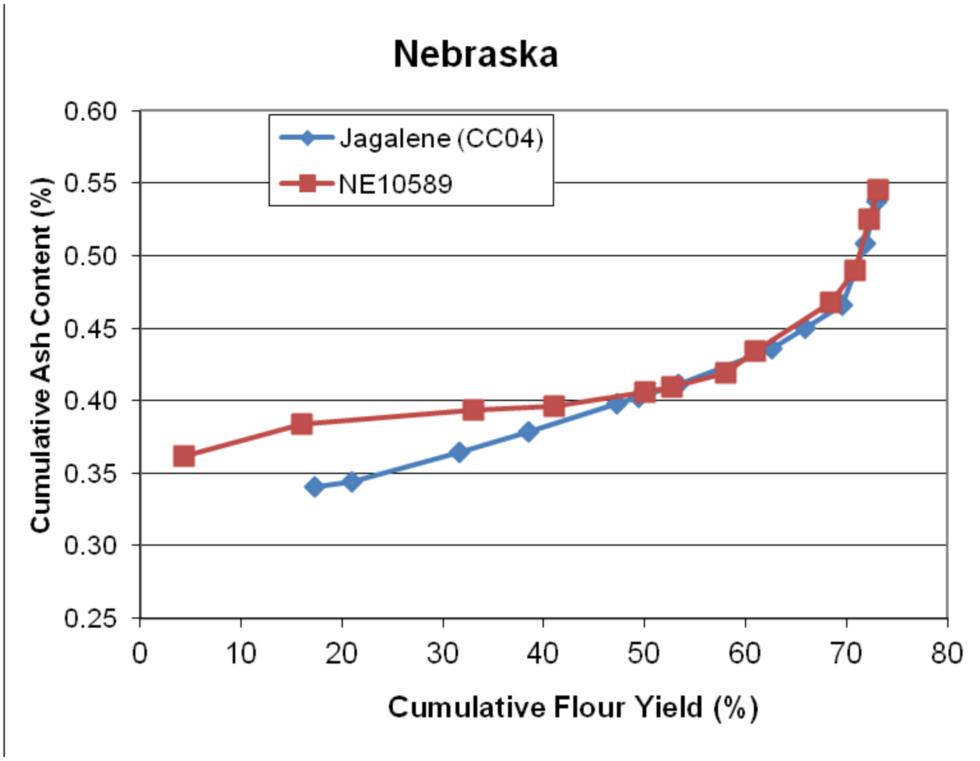
Test entry number	15-2404	15-2405
Sample identification	**Jagalene (CC04)**	**NE10589**
Wheat Data		
GIPSA classification	1 HRW	2 HRW
Test weight (lb/bu) **Hectoliter weight (kg/hl)**	60.1 79.1	58.3 76.7
1000 kernel weight (gm)	31.6	29.0
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 71.7 27.3 1.1	 70.0 30.0 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	 57.1/17.1 31.6/9.4 2.70/0.37 10.7/0.4 08-18-29-45-02 Hard	 54.4/20.3 29.0/8.9 2.61/0.38 10.8/0.4 15-19-26-40-03 Mixed
Wheat protein (12% mb) **Wheat ash (12% mb)**	12.3 1.58	11.5 1.64
Milling and Flour Quality Data		
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 72.6 68.6	 74.7 68.0
Flour moisture (%) **Flour protein (14% mb)** **Flour ash (14% mb)**	13.1 11.1 0.54	13.0 10.2 0.53
Rapid Visco-Analyser Peak Time (min) Peak Viscosity (RVU) Breakdown (RVU) Final Viscosity at 13 min (RVU)	 6.1 208.2 83.3 244.8	 6.2 218.7 82.8 244.9
Minolta color meter L* a* b* **PPO**	 91.29 -1.4 9.78 0.530	 91.23 -1.23 8.43 0.626
Falling number (sec)	452	464
Damaged Starch (AI%) (AACC76-31)	 96.65 6.79	 95.20 5.67

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

Nebraska: Physical Dough Tests and Gluten Analysis For 2015 (Small-Scale) Samples

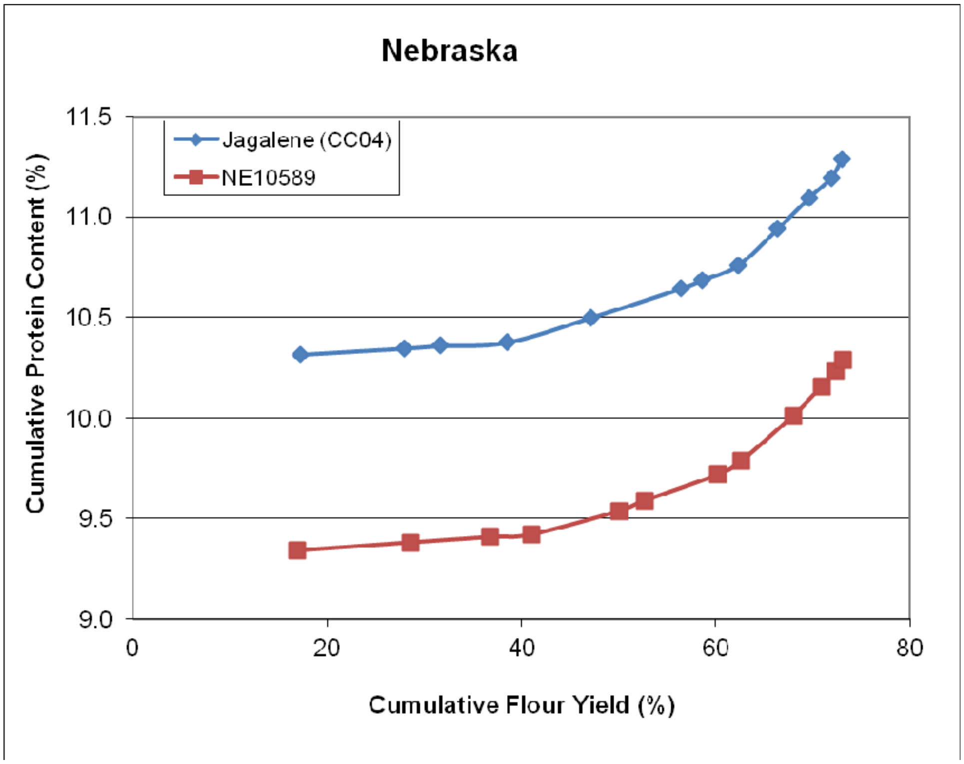
Test Entry Number	15-2404	15-2405
Sample Identification	**Jagalene (CC04)**	**NE10589**
MIXOGRAPH		
Flour Abs (% as-is)	64.0	60.6
Flour Abs (14% mb)	62.9	59.4
Mix Time (min)	4.0	3.9
Mix tolerance (0-6)	4	4
FARINOGRAPH		
Flour Abs (% as-is)	59.2	56.9
Flour Abs (14% mb)	58.2	55.7
Development time (min)	7.2	6.9
Mix stability (min)	10.8	9.3
Mix Tolerance Index (FU)	30	33
Breakdown time (min)	12.1	11.0
ALVEOGRAPH		
P(mm): Tenacity	76	73
L(mm): Extensibility	90	91
G(mm): Swelling index	21.1	21.2
W(10^{-4} J): strength (curve area)	251	228
P/L: curve configuration ratio	0.84	0.80
Ie(P_{200}/P): elasticity index	61.5	57.3
EXTENSIGRAPH		
Resist (BU at 45/90/135 min)	377/415/428	313/387/389
Extensibility (mm at 45/90/135 min)	152/169/152	147/154/144
Energy (cm^2 at 45/90/135 min)	105/134/117	83/112/98
Resist $_{max}$ (BU at 45/90/135 min)	524/598/602	425/556/515
Ratio (at 45/90/135 min)	2.48/2.45/2.81	2.14/2.51/2.71
PROTEIN ANALYSIS		
HMW-GS Composition	2*,1, 17+18, 5+10	2*,1, 7+9, 5+10
%IPP	50.91	48.62
SEDIMENTATION TEST		
Volume (ml)	47.5	39.5

Nebraska: Cumulative Ash Curves



Jagalene (CC04)					NE10589				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	17.26	0.34	17.26	0.34	1M Red	4.35	0.36	4.35	0.36
1M Red	3.73	0.36	21.00	0.34	1M	11.72	0.39	16.07	0.38
1M	10.61	0.41	31.61	0.36	2M	16.90	0.40	32.98	0.39
1BK	6.89	0.44	38.50	0.38	1BK	8.10	0.41	41.08	0.40
FILTER FLR	8.69	0.49	47.19	0.40	FILTER FLR	9.00	0.45	50.08	0.41
Grader	2.16	0.50	49.34	0.40	Grader	2.64	0.48	52.72	0.41
2BK	4.05	0.52	53.39	0.41	2BK	5.29	0.51	58.00	0.42
3M	9.22	0.58	62.61	0.44	3BK	2.92	0.74	60.92	0.43
3BK	3.23	0.72	65.84	0.45	3M	7.52	0.74	68.44	0.47
4M	3.79	0.74	69.63	0.47	4M	2.45	1.11	70.89	0.49
5M	2.25	1.83	71.88	0.51	5M	1.41	2.29	72.30	0.52
BRAN FLR	1.14	2.35	73.02	0.54	BRAN FLR	0.86	2.31	73.16	0.55
Break Shorts	2.88	4.02	75.90	0.67	Break Shorts	2.72	4.08	75.88	0.67
Red Dog	1.66	2.98	77.56	0.72	Red Dog	1.45	3.13	77.34	0.72
Red Shorts	0.40	3.73	77.96	0.73	Red Shorts	0.31	3.81	77.65	0.73
Filter Bran	5.47	1.11	83.43	0.76	Filter Bran	3.33	1.08	80.98	0.75
Bran	16.57	5.93	100.0	1.62	Bran	19.02	5.85	100.0	1.72
Wheat		1.54					1.61		
St. Grd. Fl.		0.54					0.53		

Nebraska: Cumulative Protein Curves

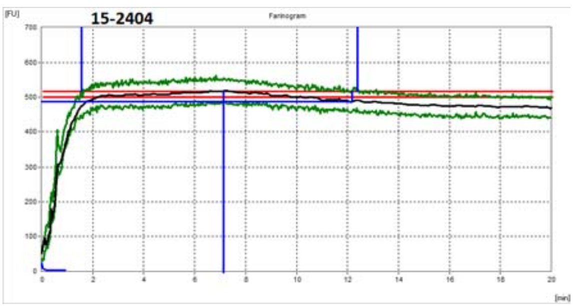


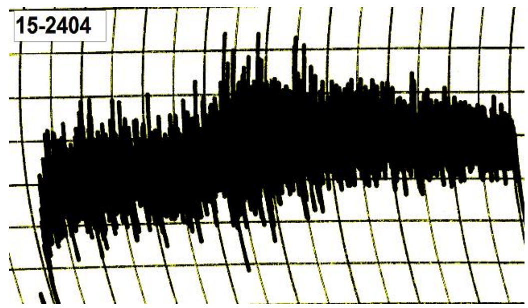
Jagalene (CC04)					NE10589				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
2M	17.26	10.32	17.26	10.32	2M	16.90	9.34	16.90	9.34
1M	10.61	10.40	27.87	10.35	1M	11.72	9.44	28.63	9.38
1M Red	3.73	10.45	31.61	10.36	1BK	8.10	9.50	36.73	9.41
1BK	6.89	10.45	38.50	10.38	1M Red	4.35	9.53	41.08	9.42
FILTER FLR	8.69	11.05	47.19	10.50	FILTER FLR	9.00	10.07	50.08	9.54
3M	9.22	11.38	56.40	10.64	Grader	2.64	10.57	52.72	9.59
Grader	2.16	11.77	58.56	10.69	3M	7.52	10.63	60.24	9.72
4M	3.79	11.94	62.35	10.76	4M	2.45	11.50	62.69	9.79
2BK	4.05	13.73	66.40	10.94	2BK	5.29	12.66	67.98	10.01
3BK	3.23	14.26	69.63	11.10	3BK	2.92	13.48	70.89	10.15
5M	2.25	14.27	71.88	11.20	5M	1.41	14.19	72.30	10.23
BRAN FLR	1.14	17.21	73.02	11.29	BRAN FLR	0.86	15.04	73.16	10.29
Break Shorts	2.88	16.42	75.90	11.49	Break Shorts	2.72	14.97	75.88	10.46
Red Dog	1.66	15.04	77.56	11.56	Red Dog	1.45	13.27	77.34	10.51
Red Shorts	0.40	13.80	77.96	11.57	Red Shorts	0.31	12.30	77.65	10.52
Filter Bran	5.47	11.01	83.43	11.54	Filter Bran	3.33	10.17	80.98	10.50
Bran	16.57	15.28	100.00	12.16	Bran	19.02	14.79	100.00	11.32
Wheat		12.05					11.21		
St. Grd. Fl		11.25					10.31		

Physical Dough Tests
2015 (Small Scale) Samples – Nebraska

Farinograms

Mixograms

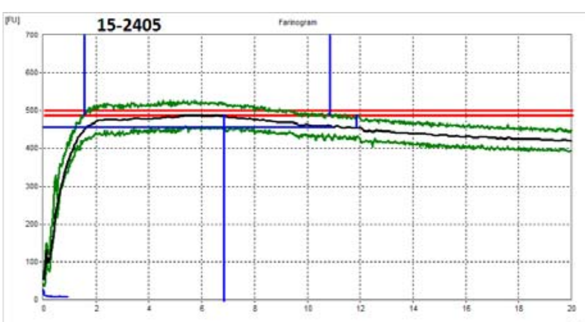


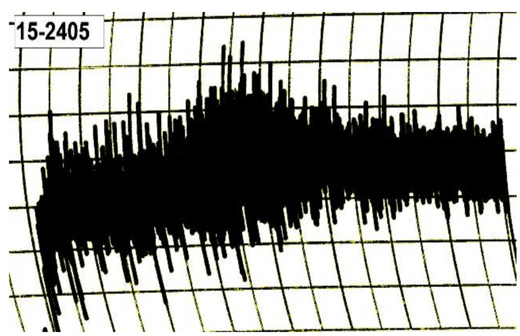


Water abs = 58.2%, Peak time = 7.2 min,
Mix stab = 10.8 min, MTI = 30 FU

Water abs = 62.9%
Mix time = 4.0 min

15-2404, Jagalene (CC04)



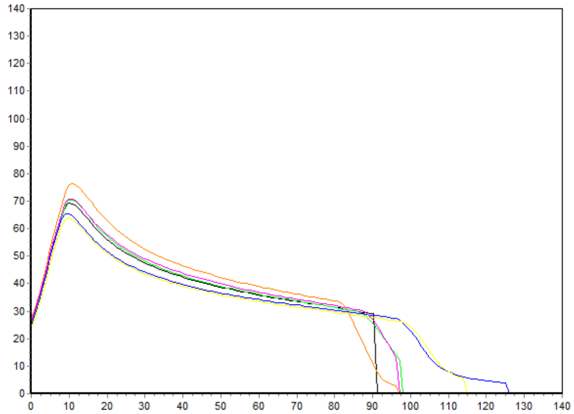


Water abs = 55.7%, Peak time = 6.9 min,
Mix stab = 9.3 min, MTI = 33 FU

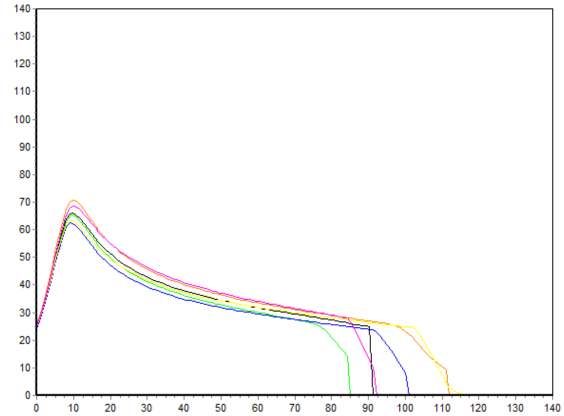
Water abs = 59.4%
Mix time = 3.9 min

15-2405, NE10589

Physical Dough Tests - Alveograph
2015 (Small Scale) Samples – Nebraska

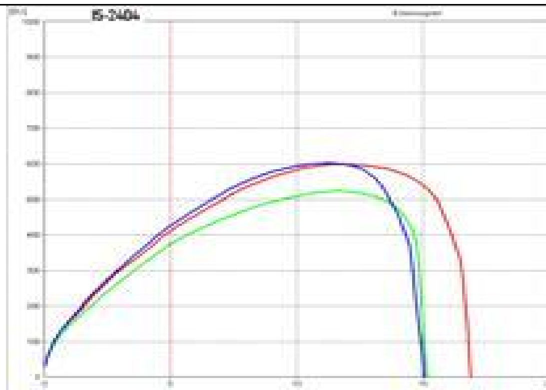


15-2404, Jagalene (CC04)
P (mm H_20) = 76, L (mm) = 90, W ($10E^{-4}$J) = 251

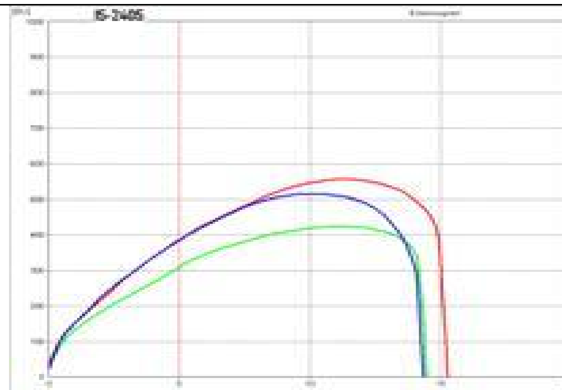


15-2405, NE10589
P (mm H_20) = 73, L (mm) = 91, W ($10E^{-4}$J) = 228

Physical Dough Tests - Extensigraph
2015 (Small Scale) Samples – Nebraska



15-2404, Jagalene (CC04)
R (BU) = 415, E (mm) = 169, W (cm^2) = 134
Rmax (BU) = 598, Ratio = 2.5 at 90 min



15-2405, NE10589
R (BU) = 387, E (mm) = 154, W (cm^2) = 112
Rmax (BU) = 556, Ratio = 2.5 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
2015 (Small-Scale) Samples

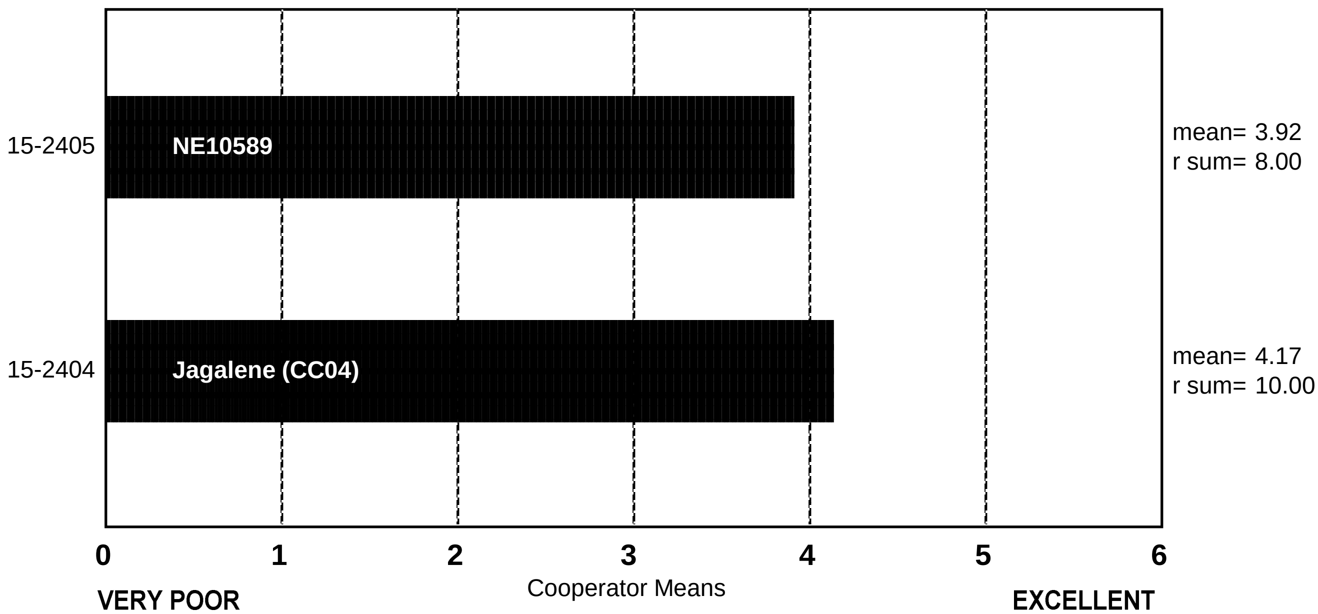
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2404	6218	144.4	4115	0.431	1.864	3.105	1.673	-17.25
2405	6107	146.4	4083	0.434	1.836	2.462	1.665	-19.85

SPONGE CHARACTERISTICS

(Small Scale) Nebraska

ncoop= 6
chisq= 0.67
chisqc= 2.00
cvchisq= 3.84
crdiff=

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

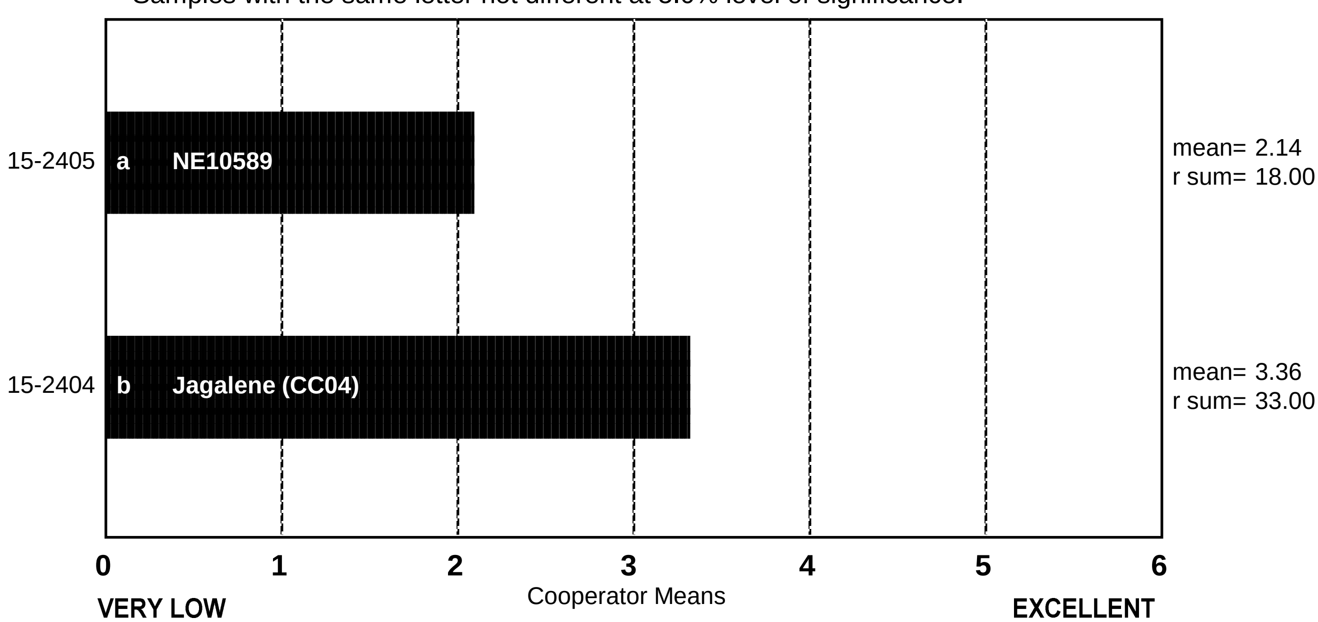


BAKE ABSORPTION

(Small Scale) Nebraska

ncoop= 17
chisq= 13.24
chisqc= 15.00
cvchisq= 3.84
crdiff= 1.53

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. O
15-2404 Jagalene (CC04)	**64.2**	**66.0**	**57.0**	**60.0**	**60.3**	**63.0**	**68.2**	**61.4**	**61.7**	**58.2**	**64.9**	**60.8**	**58.0**	**61.1**	**58.2**	**54.0**	**59.2**
15-2405 NE10589	**60.7**	**63.0**	**56.0**	**60.0**	**58.4**	**61.0**	**67.0**	**59.6**	**59.0**	**55.7**	**62.6**	**59.5**	**56.0**	**59.5**	**55.7**	**53.0**	**56.2**

BAKE MIX TIME, ACTUAL

(Small Scale) Nebraska

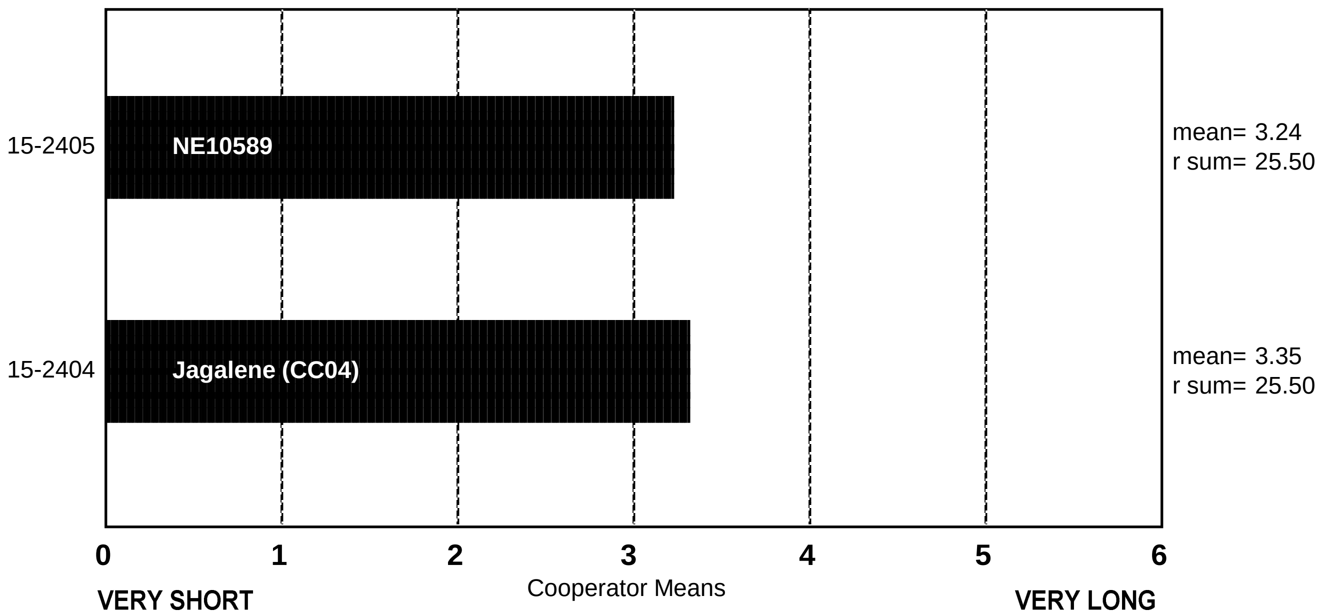
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2404 Jagalene (CC04)	**3.8**	**4.0**	**6.0**	**6.0**	**4.3**	**5.0**	**5.0**	**4.3**	**3.1**	**5.3**	**4.3**	**4.2**	**14.0**	**5.3**	**3.5**	**4.0**	**6.0**
15-2405 NE10589	**3.9**	**3.5**	**6.0**	**6.0**	**4.9**	**5.3**	**5.5**	**4.5**	**3.0**	**5.3**	**5.0**	**4.2**	**8.0**	**5.6**	**3.0**	**4.0**	**7.0**

BAKE MIX TIME

(Small Scale) Nebraska

ncoop= 17
chisq= 0.00
chisqc= 0.00
cvchisq= 3.84
crdiff=

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

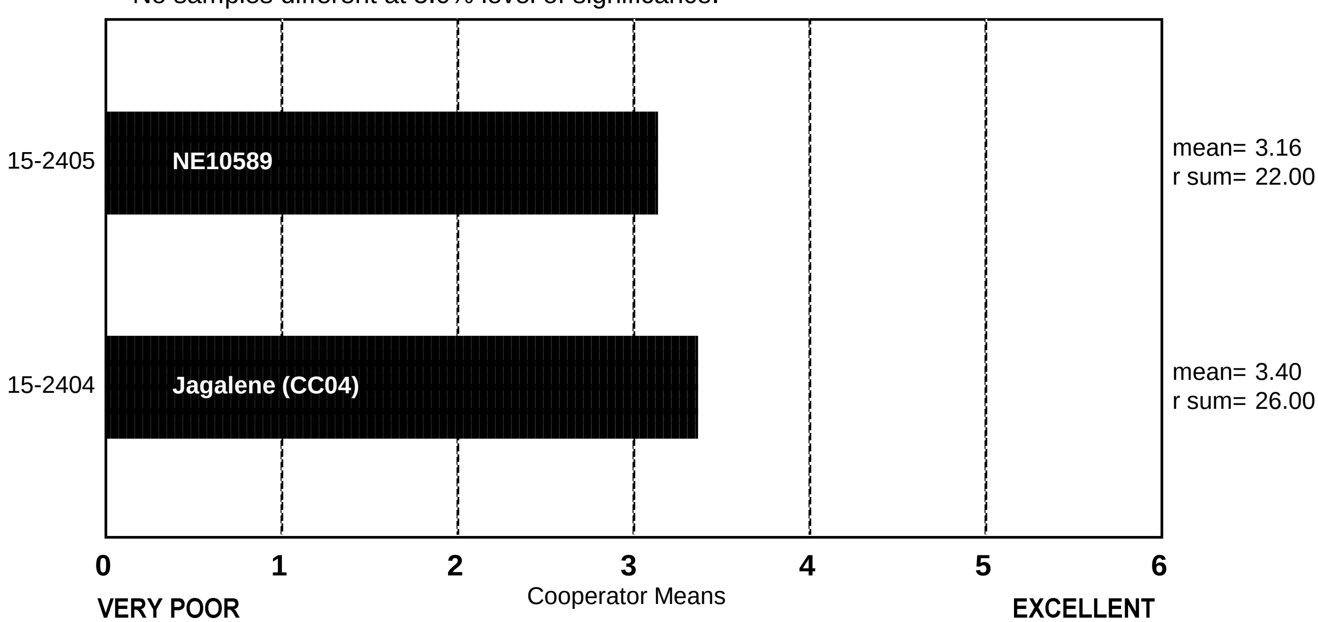


MIXING TOLERANCE

(Small Scale) Nebraska

ncoop= 16
chisq= 1.00
chisqc= 1.60
cvchisq= 3.84
crdiff=

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

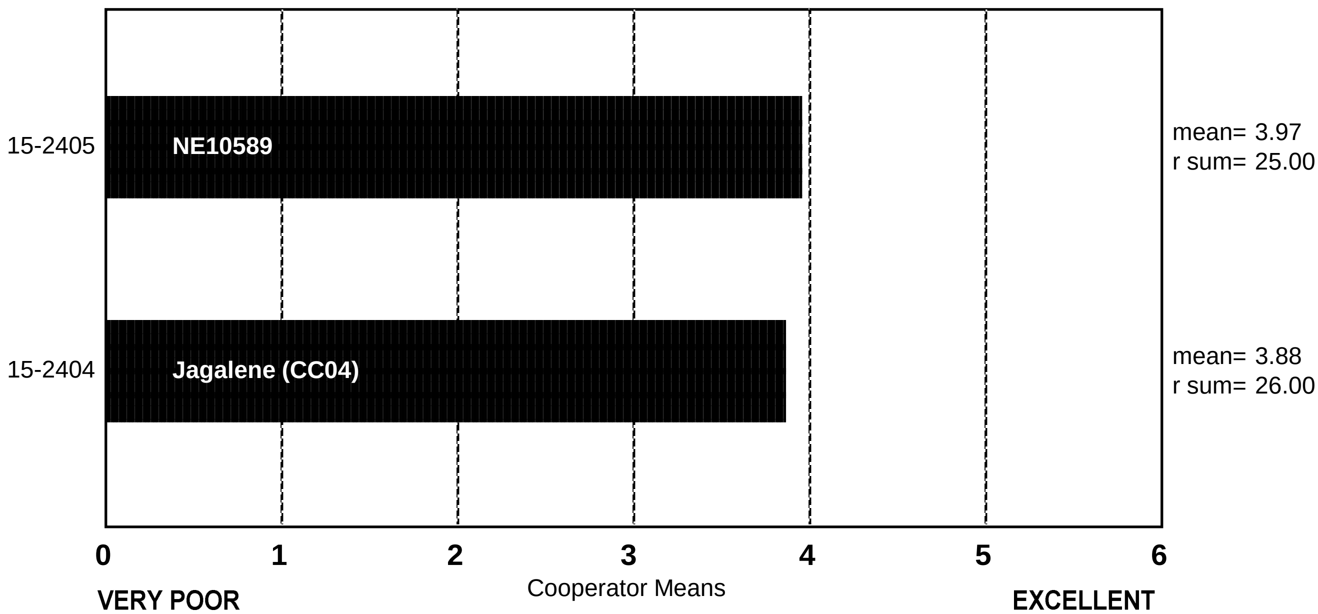


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Nebraska

ncoop= 17
chisq= 0.06
chisqc= 0.10
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) Nebraska

	Sticky	Wet	Tough	Good	Excellent
15-2404 Jagalene (CC04)	2	2	1	10	2
15-2405 NE10589	3	0	4	9	1

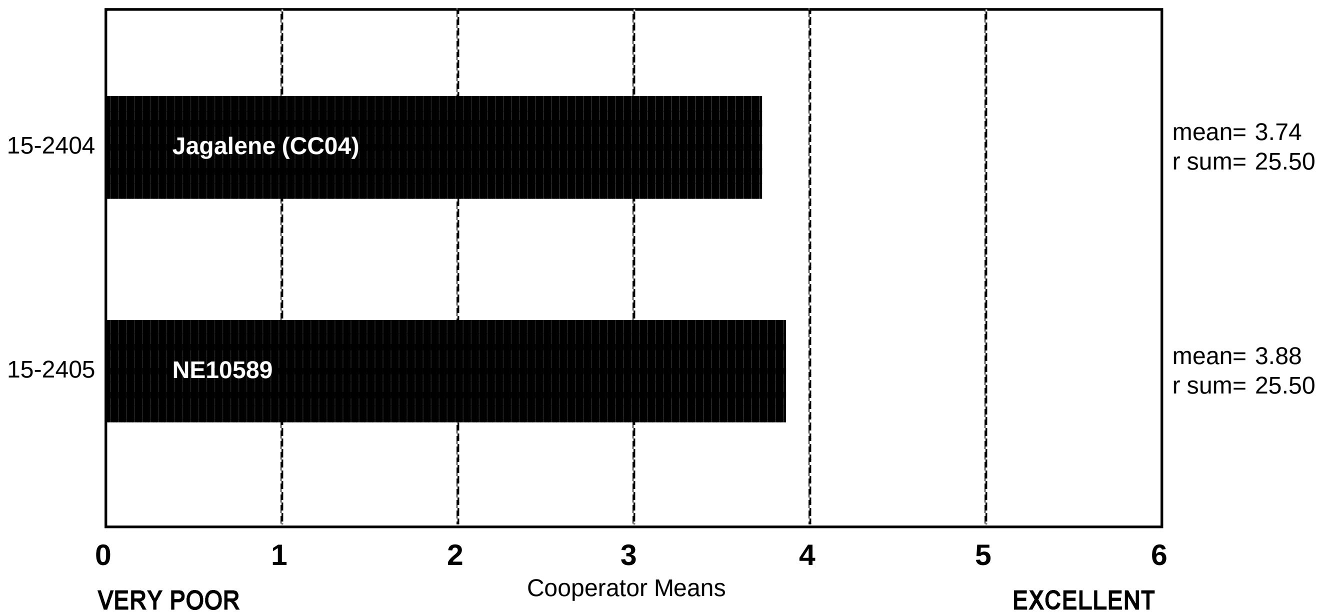
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Nebraska

ncoop= 17
chisq= 0.00
chisqc= 0.00
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) Nebraska

	Sticky	Wet	Tough	Good	Excellent
15-2404 Jagalene (CC04)	1	4	0	10	1
15-2405 NE10589	1	4	1	9	2

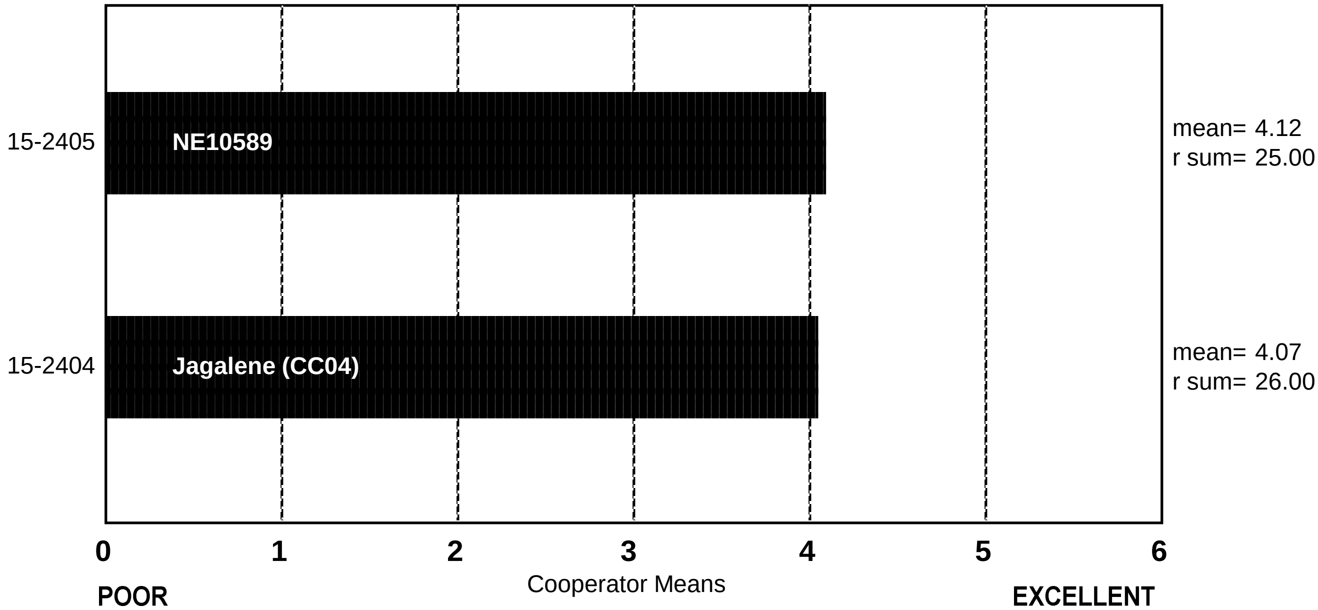
Frequency Table

CRUMB GRAIN

(Small Scale) Nebraska

ncoop= 17
chisq= 0.06
chisqc= 0.08
cvchisq= 3.84
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Nebraska

	Open	Fine	Dense
15-2404 Jagalene (CC04)	**7**	**10**	**0**
15-2405 NE10589	**4**	**11**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Nebraska

	Round	Irregular	Elongated
15-2404 Jagalene (CC04)	**2**	**7**	**8**
15-2405 NE10589	**3**	**4**	**10**

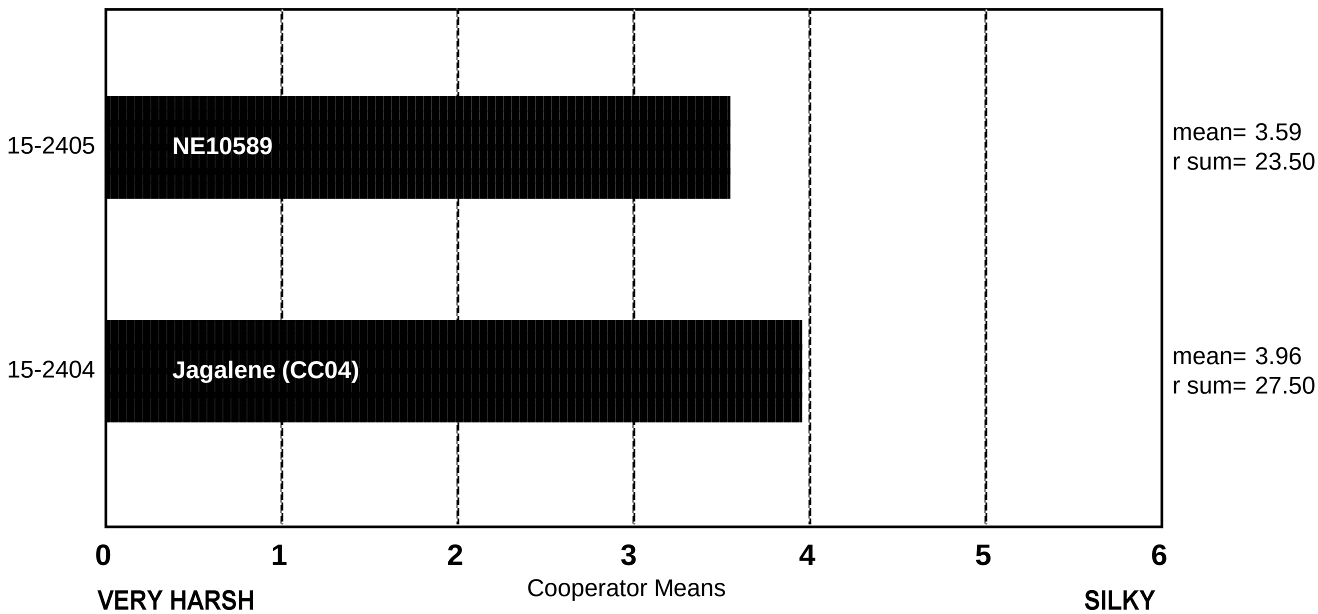
Frequency Table

CRUMB TEXTURE

(Small Scale) Nebraska

ncoop= 17
chisq= 0.94
chisqc= 1.45
cvchisq= 3.84
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Nebraska

	Harsh	Smooth	Silky
15-2404 Jagalene (CC04)	**5**	**7**	**5**
15-2405 NE10589	**8**	**7**	**2**

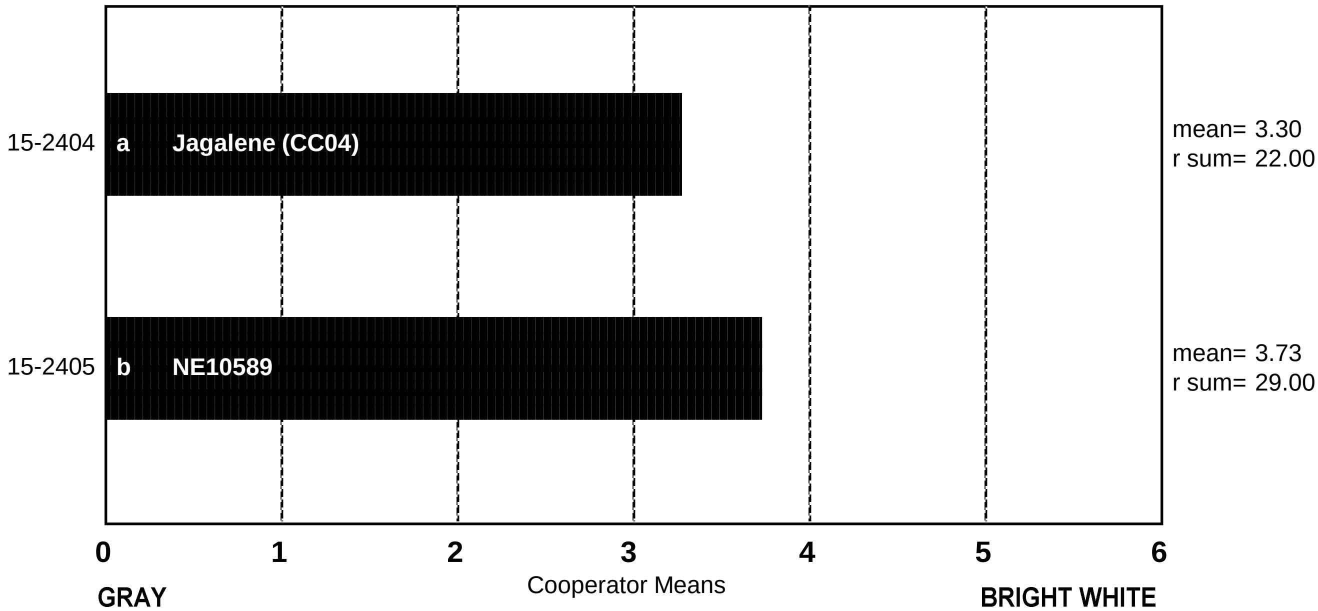
Frequency Table

CRUMB COLOR

(Small Scale) Nebraska

ncoop= 17
chisq= 2.88
chisqc= 4.45
cvchisq= 3.84
crdiff= 2.34

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
15-2404 Jagalene (CC04)	**0**	**0**	**3**	**6**	**8**	**0**	**0**
15-2405 NE10589	**0**	**0**	**0**	**3**	**13**	**1**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Nebraska

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
15-2404 Jagalene (CC04)	**136.7**	**140.7**	**395.0**		**128.9**	**133.1**	**154.1**	**138.6**	**142.4**	**452.9**	**129.5**			**147.9**	**119.1**	**483.0**	**453.0**
15-2405 NE10589	**136.2**	**143.0**	**398.0**		**128.0**	**133.4**	**151.5**	**140.3**	**141.8**	**449.8**	**127.4**			**146.0**	**116.8**	**485.5**	**460.0**

LOAF VOLUME, ACTUAL

(Small Scale) Nebraska

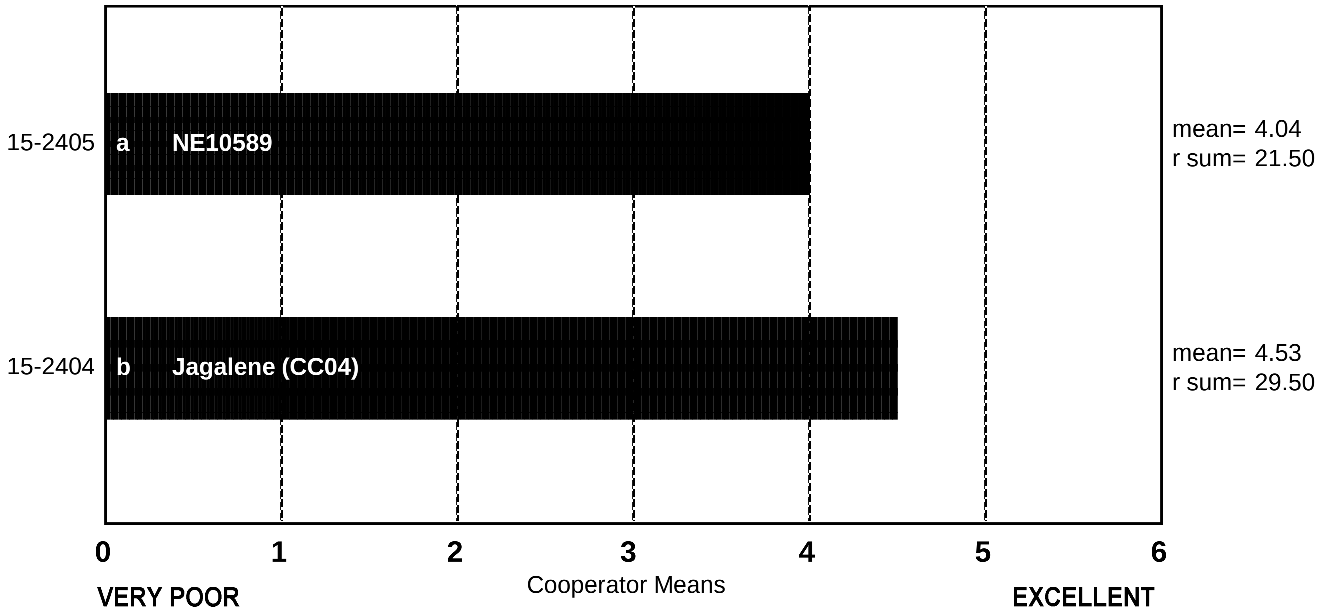
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2404 Jagalene (CC04)	**894**	**685**	**3000**	**1050**	**980**	**1048**	**995**	**1050**	**930**	**2958**	**1090**	**940**	**2897**	**935**	**2425**	**2713**	**2250**
15-2405 NE10589	**884**	**578**	**2850**	**975**	**850**	**968**	**955**	**965**	**795**	**3138**	**990**	**850**	**2839**	**880**	**2500**	**2563**	**2275**

LOAF VOLUME

(Small Scale) Nebraska

ncoop= 17
chisq= 3.76
chisqc= 5.33
cvchisq= 3.84
crdiff= 3.31

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

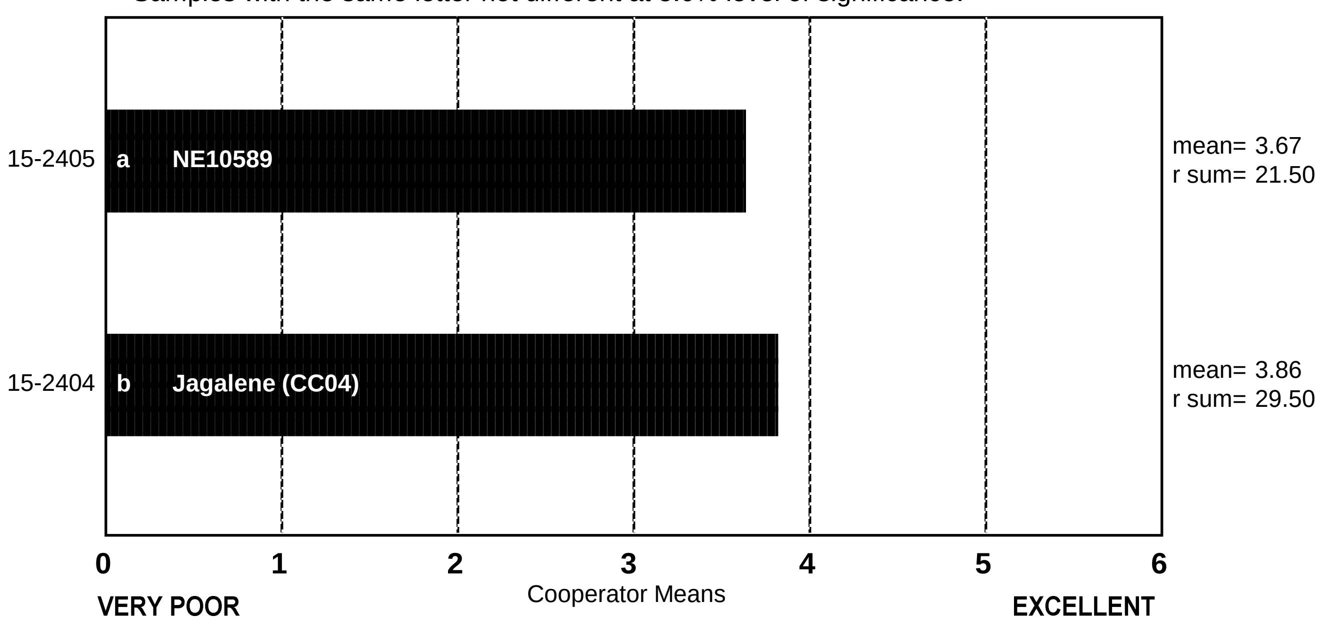


OVERALL BAKING QUALITY

(Small Scale) Nebraska

ncoop= 17
chisq= 3.76
chisqc= 5.33
cvchisq= 3.84
crdiff= 3.31

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. **15-2404 Jagalene (CC04)**

A. No comment.
B. Satisfactory quality overall.
C. No comment.
D. No comment.
E. Good dough performance, nice oven spring and break and shred but lower bread quality.
F. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, open elongated cells, resilient & slightly harsh texture.
G. Generally good dough mix time and strength but showing some signs of weakness in height of curve, good absorption, excellent volume for protein but weak crumb grain.
H. Excellent externals.
I. Lower absorption.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Long mix time, weak at pan, good crumb grain and loaf volume.
O. Average absorption, low mix time, excellent dough, bread collapsed before reading volume, good grain rating.
P. Very low absorption, short mix time, nice dough, excellent grain, excellent volume.
Q. Very sticky and slack, hard to get through sheeter.

COOP. **15-2405 NE10589**

A. No comment.
B. Questionable quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Low water absorption, normal mix time, slight sticky & weak dough, high volume, creamy crumb, fine elongated cells, resilient & very smooth texture.
G. Generally good dough mix time and strength but showing some signs of weakness in height of curve, good absorption, excellent volume for protein with average crumb grain.
H. No comment.
I. Very low protein, lower absorption.
J. No comment.
K. No comment.
L. No comment.
M. No comment.

N. Low flour protein, low bake absorption, weak at pan, satisfactory crumb grain, low loaf volume-rated lower than check.
O. Low absorption, low mix time, dough was good, good volume and grain rating.
P. Very low absorption, short mix time, excellent grain.
Q. No comment.

Notes: **C, D, M, O, P and Q** conducted sponge and dough bake tests

WESTBRED

15-2406	Jagalene (CC06)
15-2407	BZ9W09-2075
15-2408	HV9W10-1002

Description of Test Plots and Breeder Entries

Westbred (Monsanto) - Sid Perry

The test samples were grown in Filer, Idaho. The plots were planted on October 30, 2014. Pre-plant N was applied at a rate targeting 125 bushel per acre yields. Post flowering N was applied at a rate of 30 lb/acre. The growth regulator Palisade was applied at jointing. Full irrigation was provided and produced a yield level of 135 bushels per acre. Fungicide was applied at heading to prevent stripe rust infection.

Jagalene (Common Check)

HV9W10-1002

HV9W10-1002 is a hard red winter line derived from the cross PFAU/WEAVER/3/MASON/JGR//PECOS/4/FARMEC. This is a population that was developed by Oklahoma State University introgressing CIMMYT based germplasm. It is medium early for the southern plains with excellent straw strength. HV9W10-1002 is moderately resistant to leaf rust and stripe rust, resistant to soil borne mosaic virus, and moderately resistant to powdery mildew and tan spot. It is MS-S to Fusarium Head Blight. Internal quality evaluations have described HV9W10-1002 as good baking quality. Test weight has been below average. Performance has been best south of I-70. HV9W10-1002 will be marketed as WB4303.

BZ9W09-2075

BZ9W09-2075 is a hard red winter line derived from the cross NUHORIZON/CDCFALCON. This line is medium maturity for Montana and North Dakota. BZ9W09-2075 has excellent test weight and strong straw. It is susceptible to wheat stem sawfly, and is moderately resistant to stripe rust. Information on Fusarium Head Blight is not available. Winterhardiness has been acceptable. Internal quality testing has found this line to be very good baking quality. Best performance has been in the Triangle of Montana, and western North Dakota.

Westbred: 2015 (Small-Scale) Samples

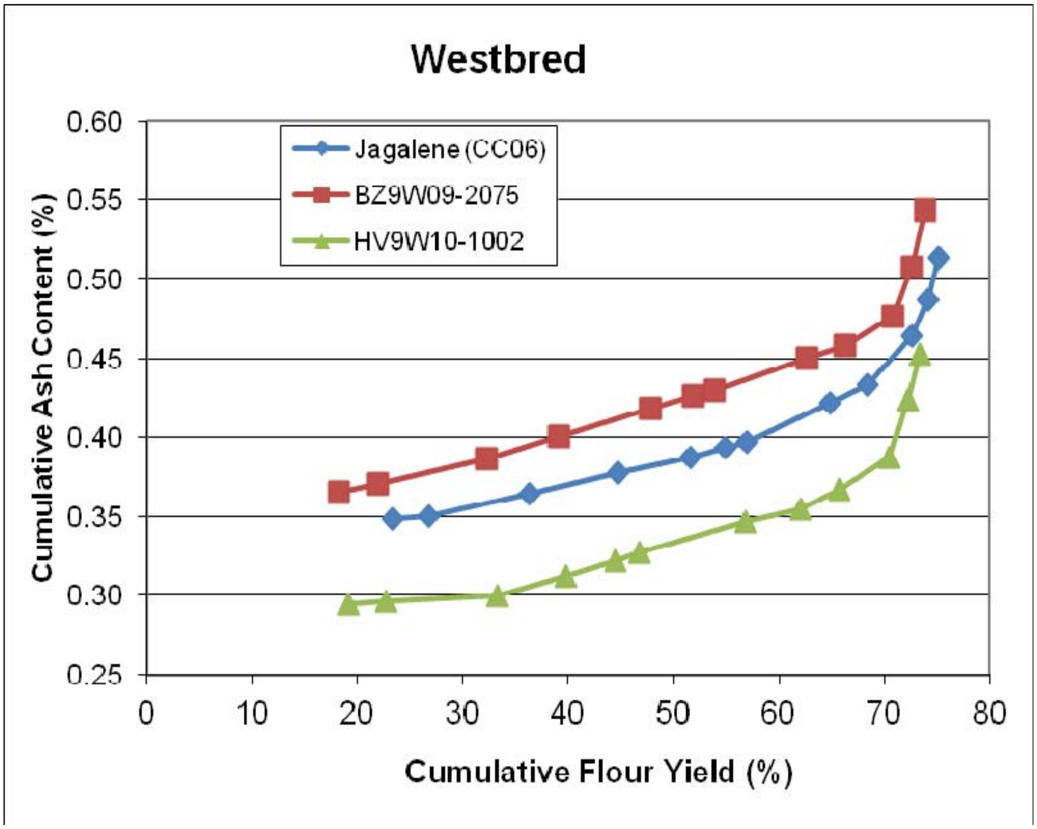
Test entry number	15-2406	15-2407	15-2408
Sample identification	Jagalene (CC06)	BZ9W09-2075	HV9W10-1002
Wheat Data			
GIPSA classification	1 HRW	1 HRW	1 HRW
Test weight (lb/bu) Hectoliter weight (kg/hl)	63.8 83.8	62.8 82.6	60.6 79.7
1000 kernel weight (gm)	38.6	30.0	34.8
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 90.0 10.0 0.0	 59.2 40.8 0.0	 87.3 12.7 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	 71.2/14.1 38.6/7.1 2.98/0.32 10.6/0.3 01-03-12084-01 Hard	 71.8/15.1 30.0/6.7 2.57/0.28 10.5/0.3 01-03-14-82-01 Hard	 65.3/14.7 34.8/7.2 2.62/0.31 10.9/0.3 01-06-23-70-01 Hard
Wheat protein (12% mb) Wheat ash (12% mb)	13.0 1.44	13.2 1.55	12.9 1.37
Milling and Flour Quality Data			
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 72.8 69.9	 73.1 67.9	 73.0 68.4
Flour moisture (%) Flour protein (14% mb) Flour ash (14% mb)	12.6 11.5 0.48	13.0 12.0 0.58	13.4 11.8 0.45
Rapid Visco-Analyser Peak time (min) Peak viscosity (RVU) Breakdown (RVU) Final viscosity at 13 min (RVU)	 6.1 176.8 56.8 231.8	 6.1 196.6 65.8 244.8	 6.2 206.3 69.5 247.7
Minolta color meter L* a* b* **PPO**	 91.57 -1.28 9.23 0.385	 91.37 -1.15 8.55 0.437	 91.20 -1.29 9.67 0.434
Falling number (sec)	435	466	401
Damaged Starch (AI%) (AACC76-31)	 97.76 7.71	 96.86 6.96	 97.28 7.30

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

Westbred: Physical Dough Tests and Gluten Analysis 2015 (Small-Scale) Samples

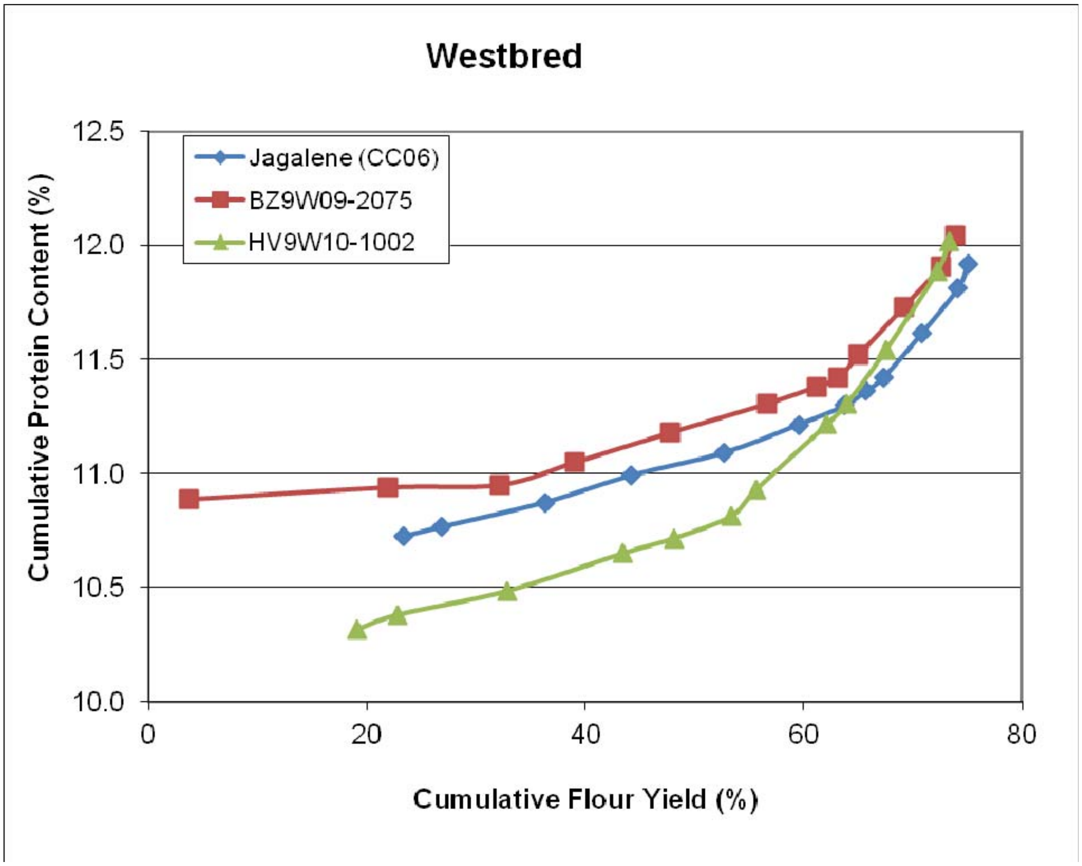
Test Entry Number	15-2406	15-2407	15-2408
Sample Identification	Jagalene (CC06)	BZ9W09-2075	HV9W10-1002
MIXOGRAPH			
Flour Abs (% as-is)	66.7	64.1	66.3
Flour Abs (14% mb)	65.1	63.0	65.7
Mix Time (min)	3.5	4.4	3.4
Mix tolerance (0-6)	3	4	2
FARINOGRAPH			
Flour Abs (% as-is)	64.0	60.0	65.7
Flour Abs (14% mb)	62.4	58.8	65.0
Development time (min)	6.8	7.7	10.8
Mix stability (min)	12.8	21.1	12.2
Mix Tolerance Index (FU)	20	21	22
Breakdown time (min)	15.8	18.8	17.5
ALVEOGRAPH			
P(mm): Tenacity	116	89	126
L(mm): Extensibility	92	90	82
G(mm): Swelling index	21.4	21.1	20.2
W(10^{-4} J): strength (curve area)	383	296	353
P/L: curve configuration ratio	1.26	0.99	1.54
Ie(P_{200}/P): elasticity index	62.0	61.9	55.9
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	372/444/525	396/519/514	296/442/560
Extensibility (mm at 45/90/135 min)	153/142/151	150/148/147	142/145/132
Energy (cm^2 at 45/90/135 min)	106/117/155	110/140/139	74/118/113
Resist $_{max}$ (BU at 45/90/135min)	537/673/831	570/776/762	386/660/729
Ratio (at 45/90/135 min)	2.43/3.12/3.47	2.64/3.51/3.51	2.08/3.05/4.26
PROTEIN ANALYSIS			
HMW-GS Composition	2*,1, 17+18, 5+10	2*, 7+9, 5+10	2*, 7+8, 5+10
%IPP	50.38	50.98	48.75
SEDIMENTATION TEST			
Volume (ml)	48.7	50.9	46.7

Westbred: Cumulative Ash Curves



Jagalene (CC06)					BZ9W09-2075					HV9W10-1002				
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	23.36	0.35	23.36	0.35	2M	18.20	0.37	18.20	0.37	2M	19.10	0.29	19.10	0.29
1M Red	3.47	0.36	26.83	0.35	1M Red	3.74	0.40	21.94	0.37	1M Red	3.66	0.31	22.76	0.30
1M	9.45	0.40	36.29	0.36	1M	10.28	0.42	32.22	0.39	1M	10.51	0.31	33.27	0.30
FILTER FLR	8.45	0.44	44.74	0.38	1BK	6.87	0.47	39.09	0.40	1BK	6.49	0.38	39.76	0.31
1BK	6.87	0.44	51.60	0.39	FILTER FLR	8.74	0.50	47.83	0.42	2BK	4.74	0.40	44.49	0.32
2BK	3.33	0.49	54.93	0.39	2BK	4.08	0.52	51.90	0.43	Grader	2.21	0.43	46.71	0.33
Grader	1.98	0.50	56.92	0.40	Grader	2.03	0.52	53.93	0.43	3M	10.11	0.44	56.82	0.35
3M	7.93	0.60	64.85	0.42	3M	8.76	0.57	62.69	0.45	FILTER FLR	5.26	0.44	62.08	0.35
3BK	3.49	0.63	68.33	0.43	3BK	3.47	0.59	66.16	0.46	3BK	3.58	0.58	65.66	0.37
4M	4.23	0.97	72.57	0.46	4M	4.62	0.75	70.78	0.48	4M	4.77	0.67	70.43	0.39
5M	1.55	1.57	74.12	0.49	5M	1.84	1.69	72.62	0.51	5M	1.83	1.82	72.27	0.42
BRAN FLR	0.96	2.53	75.08	0.51	BRAN FLR	1.29	2.62	73.91	0.54	BRAN FLR	1.10	2.34	73.37	0.45
Break Shorts	2.76	3.79	77.84	0.63	Break Shorts	3.14	4.09	77.05	0.69	Break Shorts	3.20	3.82	76.57	0.59
Red Dog	1.15	2.78	78.99	0.66	Red Dog	1.86	3.13	78.92	0.75	Red Dog	1.72	2.72	78.28	0.64
Red Shorts	0.24	3.85	79.23	0.67	Red Shorts	0.40	3.59	79.32	0.76	Red Shorts	0.30	3.43	78.58	0.65
Filter Bran	4.49	0.81	83.72	0.68	Filter Bran	4.03	0.89	83.35	0.77	Filter Bran	4.39	0.92	82.97	0.66
Bran	16.28	5.59	100.0	1.48	Bran	16.65	5.50	100.0	1.56	Bran	17.03	4.81	100.0	1.37
Wheat		1.40					1.51					1.34		
St. Grd. Fl.		0.48					0.58					0.45		

Westbred: Cumulative Protein Curves



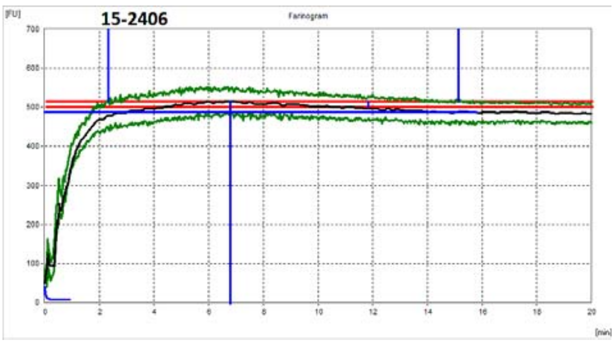
Jagalene (CC06)					BZ9W09-2075					HV9W10-1002				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
2M	23.36	10.72	23.36	10.72	1M Red	3.74	10.89	3.74	10.89	2M	19.10	10.32	19.10	10.32
1M Red	3.47	11.04	26.83	10.76	2M	18.20	10.95	21.94	10.94	1M Red	3.66	10.71	22.76	10.38
1M	9.45	11.18	36.29	10.87	1M	10.28	10.98	32.22	10.95	3M	10.11	10.72	32.87	10.49
3M	7.93	11.53	44.21	10.99	1BK	6.87	11.51	39.09	11.05	1M	10.51	11.16	43.38	10.65
FILTER FLR	8.45	11.61	52.67	11.09	FILTER FLR	8.74	11.76	47.83	11.18	4M	4.77	11.33	48.15	10.72
1BK	6.87	12.16	59.53	11.21	3M	8.76	11.99	56.59	11.31	FILTER FLR	5.26	11.70	53.41	10.81
4M	4.23	12.48	63.77	11.30	4M	4.62	12.31	61.21	11.38	Grader	2.21	13.66	55.63	10.93
Grader	1.98	13.44	65.75	11.36	Grader	2.03	12.62	63.24	11.42	1BK	6.49	13.68	62.12	11.21
5M	1.55	13.86	67.30	11.42	5M	1.84	14.89	65.08	11.52	5M	1.83	14.37	63.95	11.31
3BK	3.49	15.33	70.79	11.61	2BK	4.08	15.05	69.15	11.73	3BK	3.58	15.70	67.53	11.54
2BK	3.33	16.04	74.12	11.81	3BK	3.47	15.54	72.62	11.91	2BK	4.74	16.83	72.27	11.89
BRAN FLR	0.96	20.23	75.08	11.92	BRAN FLR	1.29	19.53	73.91	12.04	BRAN FLR	1.10	20.67	73.37	12.02
Break Shorts	2.76	16.49	77.84	12.08	Break Shorts	3.14	16.94	77.05	12.24	Break Shorts	3.20	16.32	76.57	12.20
Red Dog	1.15	14.17	78.99	12.11	Red Dog	1.86	15.70	78.92	12.32	Red Dog	1.72	14.30	78.28	12.24
Red Shorts	0.24	13.69	79.23	12.12	Red Shorts	0.40	13.16	79.32	12.33	Red Shorts	0.30	12.82	78.58	12.25
Filter Bran	4.49	10.64	83.72	12.04	Filter Bran	4.03	11.59	83.35	12.29	Filter Bran	4.39	11.36	82.97	12.20
Bran	16.28	17.02	100.00	12.85	Bran	16.65	15.46	100.00	12.82	Bran	17.03	15.36	100.00	12.74
Wheat		12.66					12.92					12.58		
St. Grd. Fl		11.63					12.06					11.96		

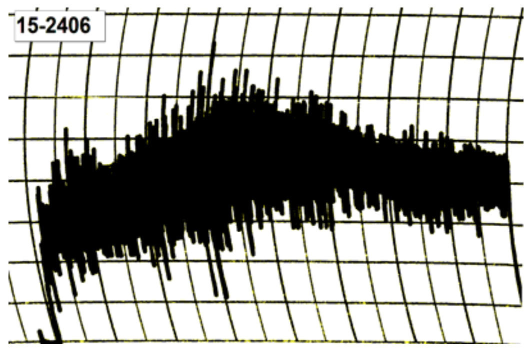
Physical Dough Tests

2015 (Small Scale) Samples - Westbred

Farinograms

Mixograms

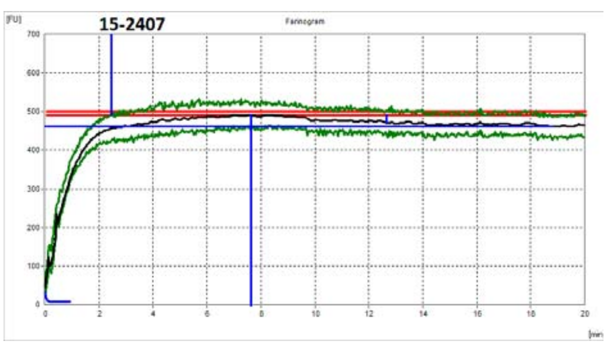


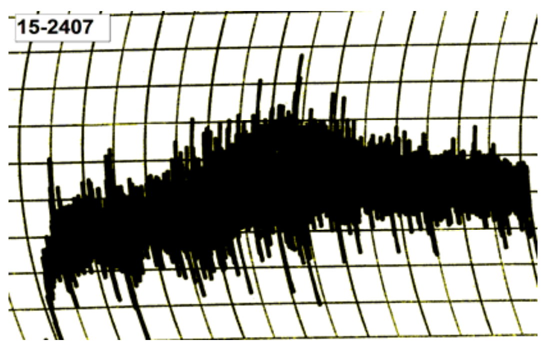


Water abs = 62.4%, Peak time = 6.8 min,
Mix stab = 12.8 min, MTI = 20 FU

Water abs = 65.1%
Mix time = 3.5 min

15-2406, Jagalene (CC06)





Water abs = 58.8%, Peak time = 7.7 min,
Mix stab = 21.1 min, MTI = 21 FU

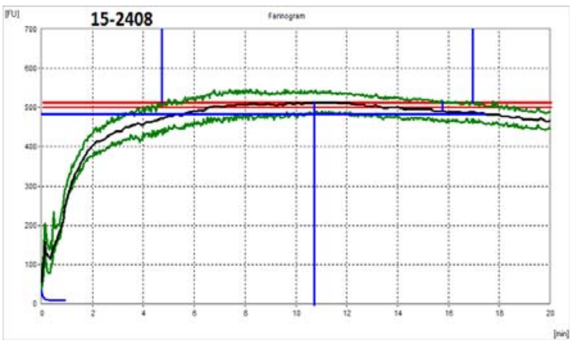
Water abs = 63.0%
Mix time = 4.4 min

15-2407, BZ9W10-1002

Physical Dough Tests

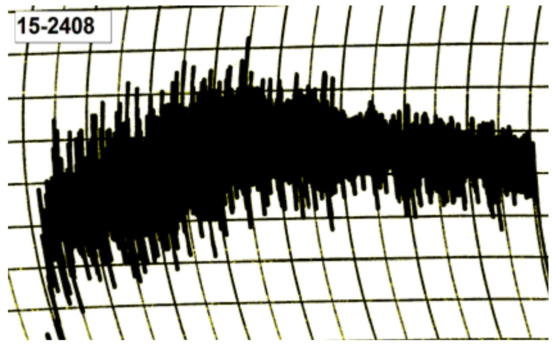
2015 (Small Scale) Samples - Westbred (continued)

Farinograms



Water abs= 65.0%, Peak time = 10.8 min,
Mix stab = 12.2 min, MTI = 22 FU

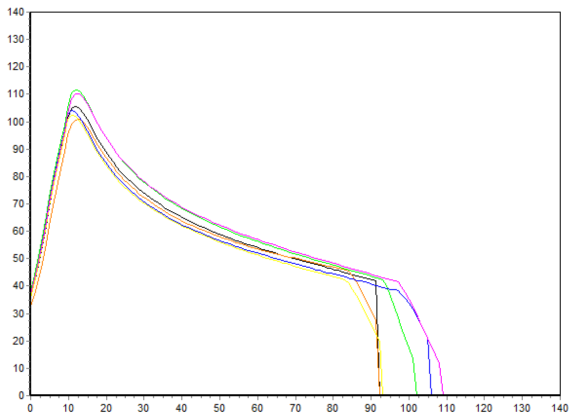
Mixograms



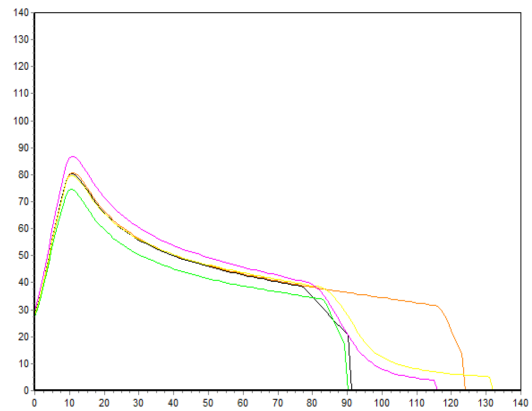
Water abs = 65.7%
Mix time = 3.4 min

15-2408, HV9W10-1002

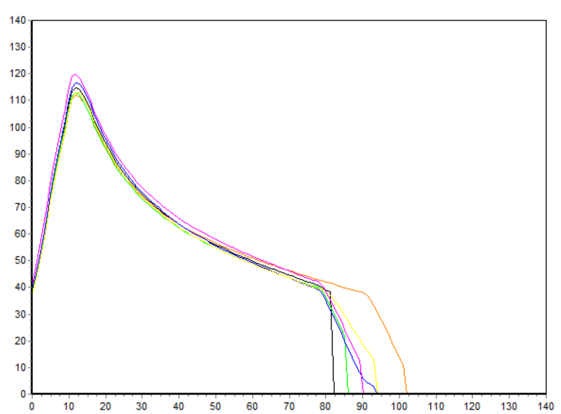
Physical Dough Tests - Alveograph
2015 (Small Scale) Samples – Westbred



15-2406, Jagalene (CC06)
P(mm H_20)=116, L(mm)=92, W($10E^{-4}$ J)=383



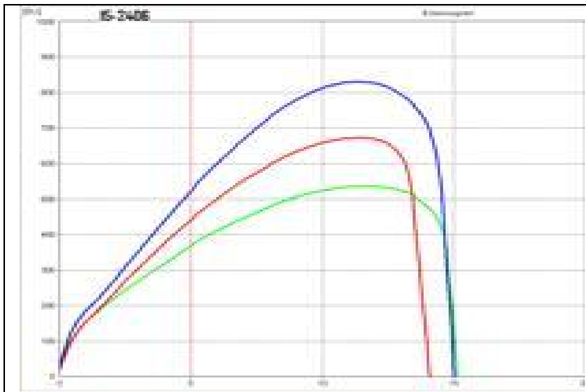
15-2407, BZ9W09-2075
P(mm H_20)=89, L(mm)=90, W($10E^{-4}$ J)=296



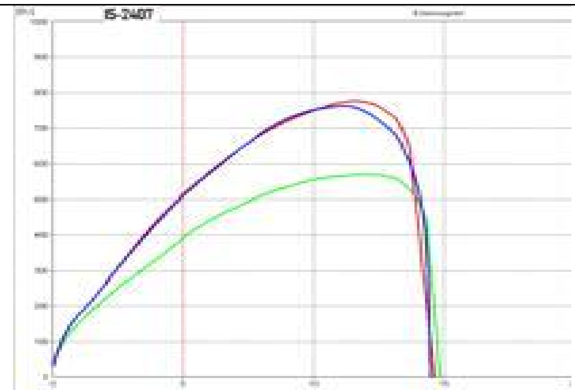
15-2408, HV9W10-1002
P(mm H_20)=126, L(mm)=82, W($10E^{-4}$ J)=353

Physical Dough Tests - Extensigraph

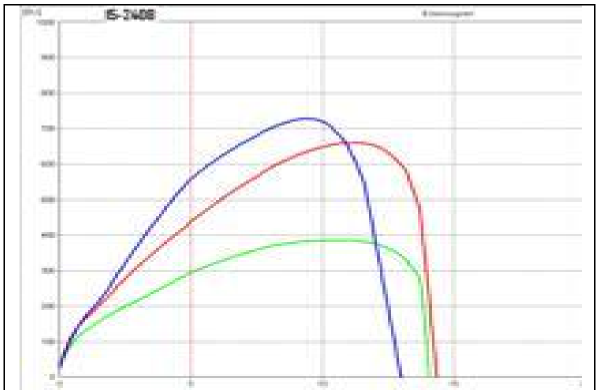
2015 (Small Scale) Samples – Westbred



15-2406, Jagalene (CC06)
R (BU) = 444, E (mm) =142, W (cm^2) = 117
Rmax (BU) = 673, Ratio = 3.1 at 90 min



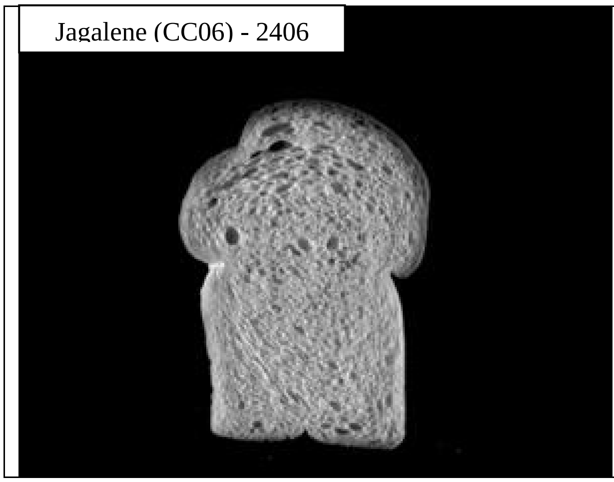
15-2407, BZ9W09-2075
R (BU) = 519, E (mm) =148, W (cm^2) = 140
Rmax (BU) = 776, Ratio = 3.5 at 90 min



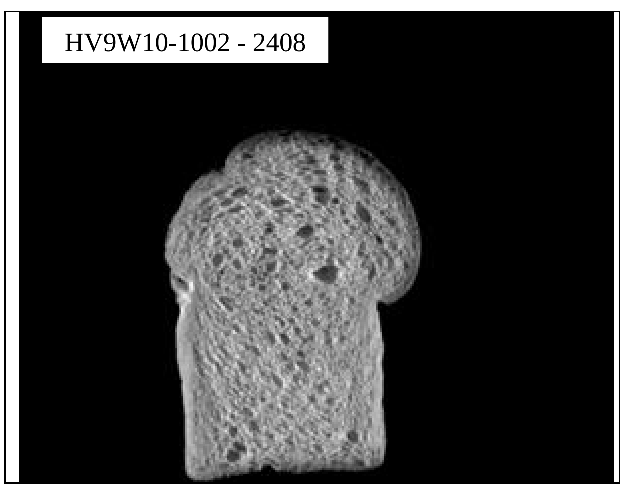
15-2408, HV9W10-1002
R (BU) = 442, E (mm) = 145, W (cm^2) = 118
Rmax (BU) = 660, Ratio = 3.1 at 90 min

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

Westbred: C-Cell Bread Images and Analysis for 2015 (Small-Scale) Samples



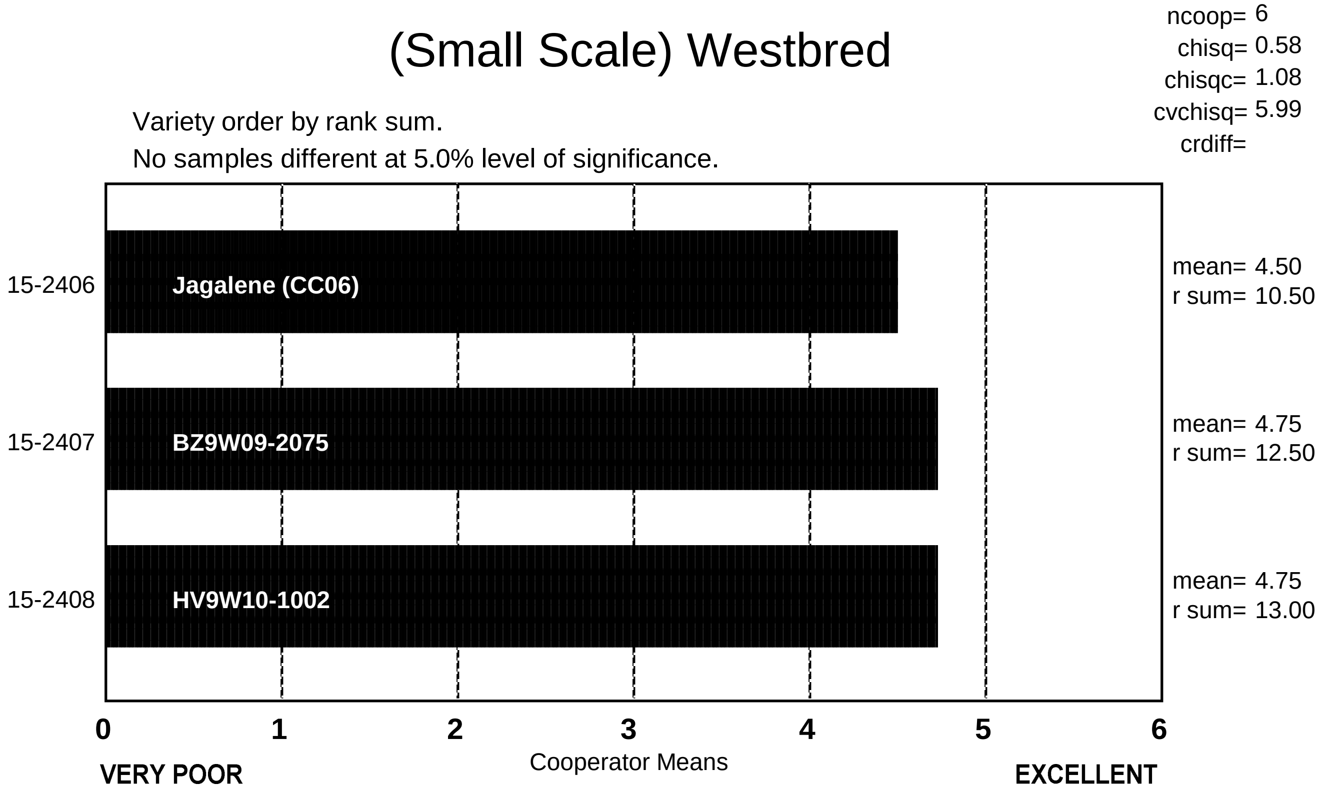
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2406	6319	142.8	4020	0.437	1.988	1.279	1.693	-23.20
2407	7180	141.1	4421	0.440	2.061	3.689	1.738	-24.25



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2408	6498	137.5	3835	0.451	2.166	3.058	1.685	-17.30

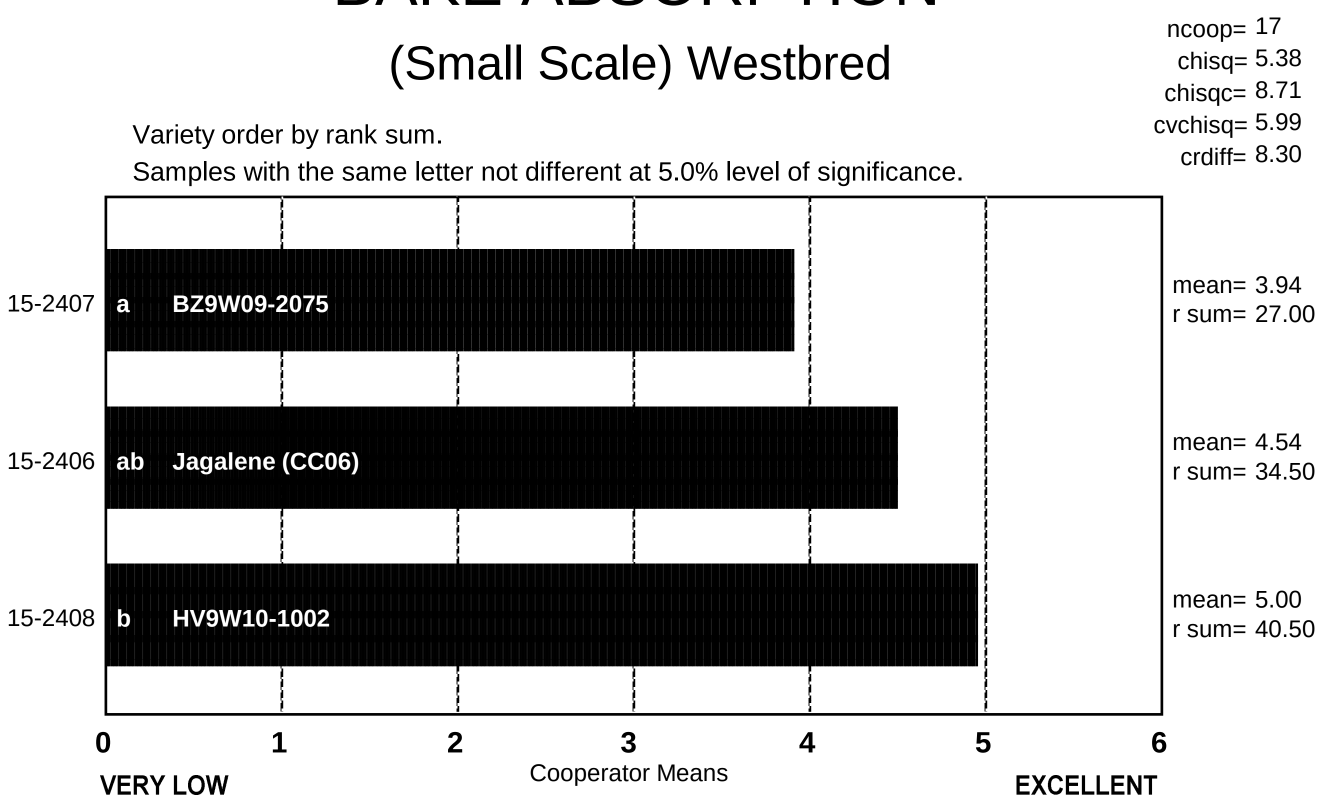
SPONGE CHARACTERISTICS

(Small Scale) Westbred



BAKE ABSORPTION

(Small Scale) Westbred



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Westbred

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2406 Jagalene (CC06)	**66.6**	**69.0**	**58.0**	**61.0**	**64.4**	**65.0**	**69.1**	**61.9**	**63.9**	**62.4**	**70.1**	**61.6**	**61.0**	**63.6**	**62.4**	**58.0**	**63.5**
15-2407 BZ9W09-2075	**64.2**	**66.0**	**58.0**	**62.0**	**60.2**	**62.0**	**69.5**	**63.4**	**63.0**	**58.8**	**65.8**	**62.2**	**58.0**	**63.6**	**58.8**	**55.0**	**59.7**
15-2408 HV9W10-1002	**66.5**	**68.0**	**58.0**	**62.0**	**65.2**	**65.0**	**70.5**	**63.3**	**63.0**	**65.0**	**71.2**	**62.1**	**64.0**	**66.1**	**65.0**	**61.0**	**66.0**

BAKE MIX TIME, ACTUAL

(Small Scale) Westbred

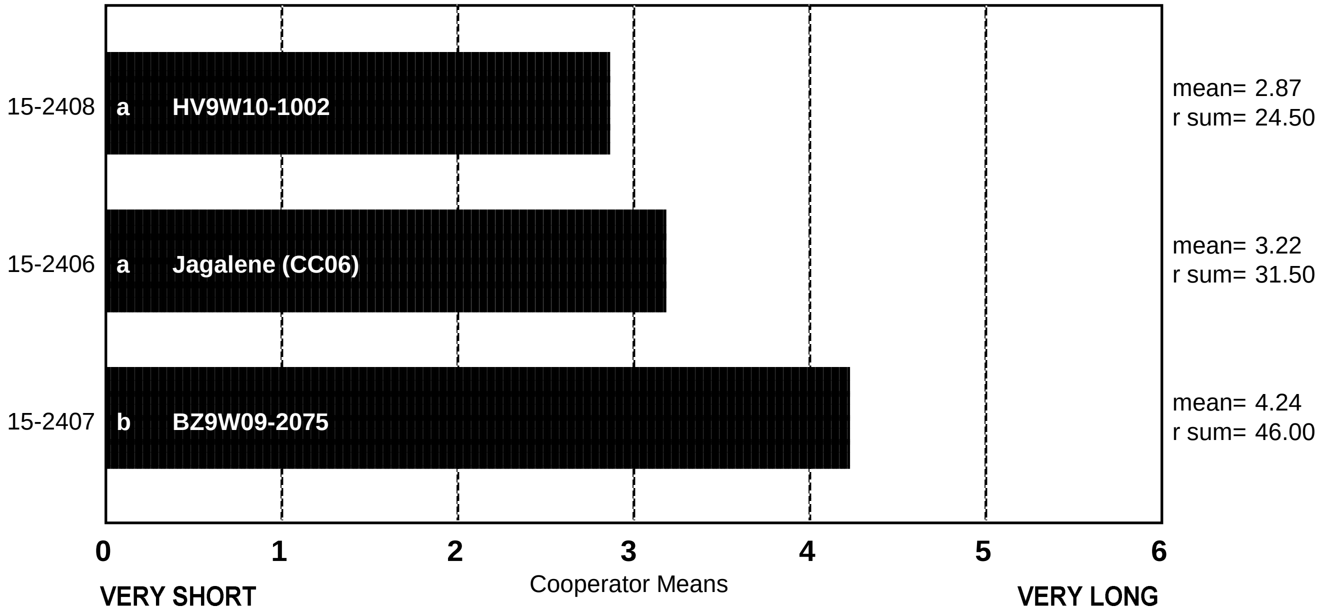
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2406 Jagalene (CC06)	**3.8**	**3.8**	**7.0**	**6.0**	**3.8**	**5.0**	**4.0**	**3.8**	**2.5**	**6.0**	**3.8**	**4.0**	**16.0**	**4.5**	**5.5**	**5.0**	**7.0**
15-2407 BZ9W09-2075	**4.4**	**5.8**	**10.0**	**6.0**	**4.5**	**6.6**	**6.1**	**4.8**	**3.5**	**6.3**	**5.0**	**4.2**	**20.0**	**6.6**	**8.0**	**7.0**	**8.0**
15-2408 HV9W10-1002	**3.3**	**2.8**	**5.0**	**6.0**	**3.1**	**3.8**	**4.5**	**3.3**	**2.7**	**7.0**	**3.8**	**3.0**	**15.0**	**4.0**	**4.0**	**4.0**	**8.0**

BAKE MIX TIME

(Small Scale) Westbred

ncoop= 17
chisq= 14.15
chisqc= 17.81
cvchisq= 5.99
crdiff= 7.53

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

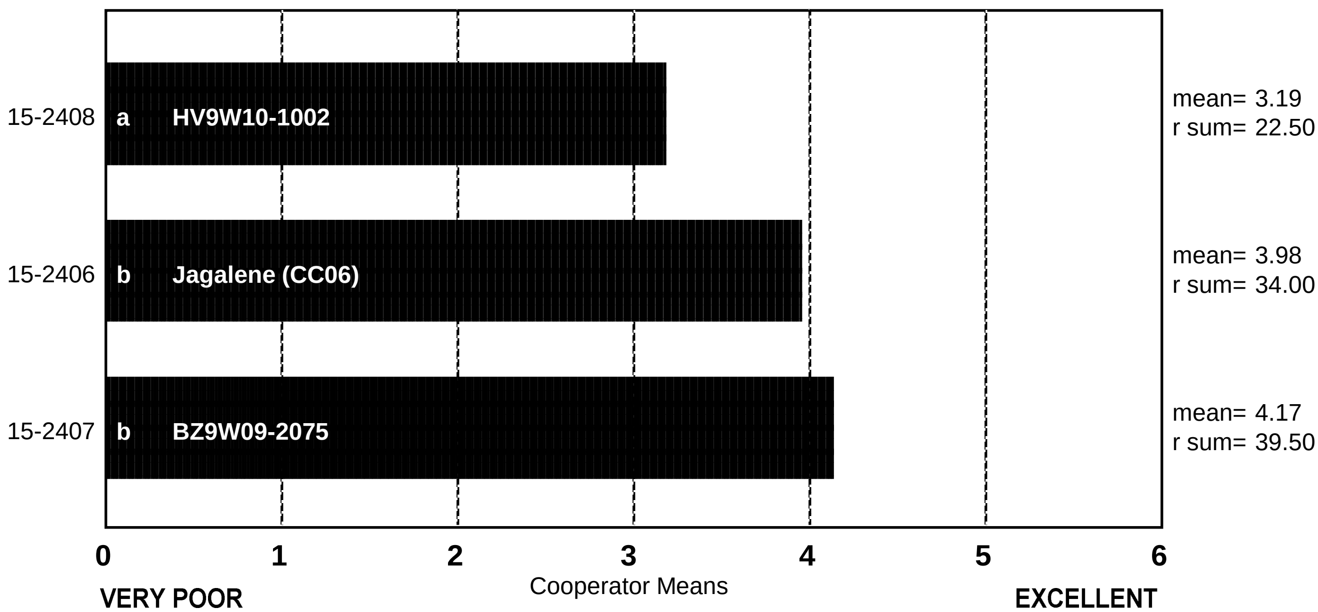


MIXING TOLERANCE

(Small Scale) Westbred

ncoop= 16
chisq= 9.41
chisqc= 12.54
cvchisq= 5.99
crdiff= 8.06

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

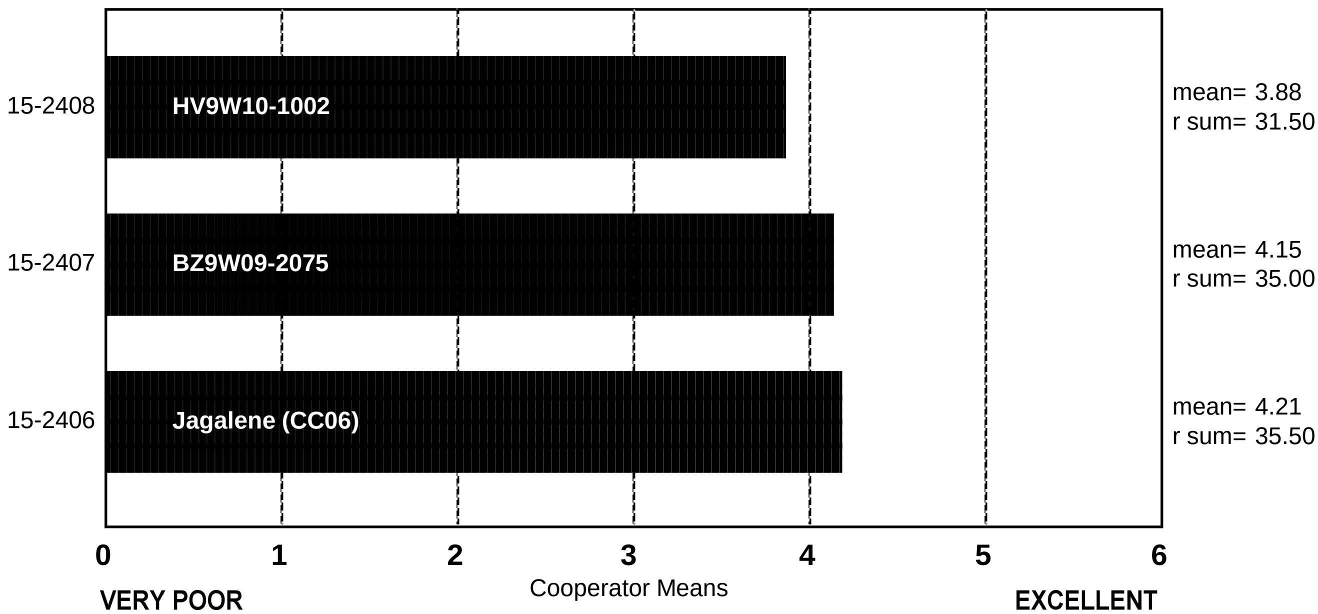


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Westbred

ncoop= 17
chisq= 0.56
chisqc= 0.78
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Westbred

	Sticky	Wet	Tough	Good	Excellent
15-2406 Jagalene (CC06)	1	0	1	12	3
15-2407 BZ9W09-2075	0	1	4	7	5
15-2408 HV9W10-1002	3	2	2	7	3

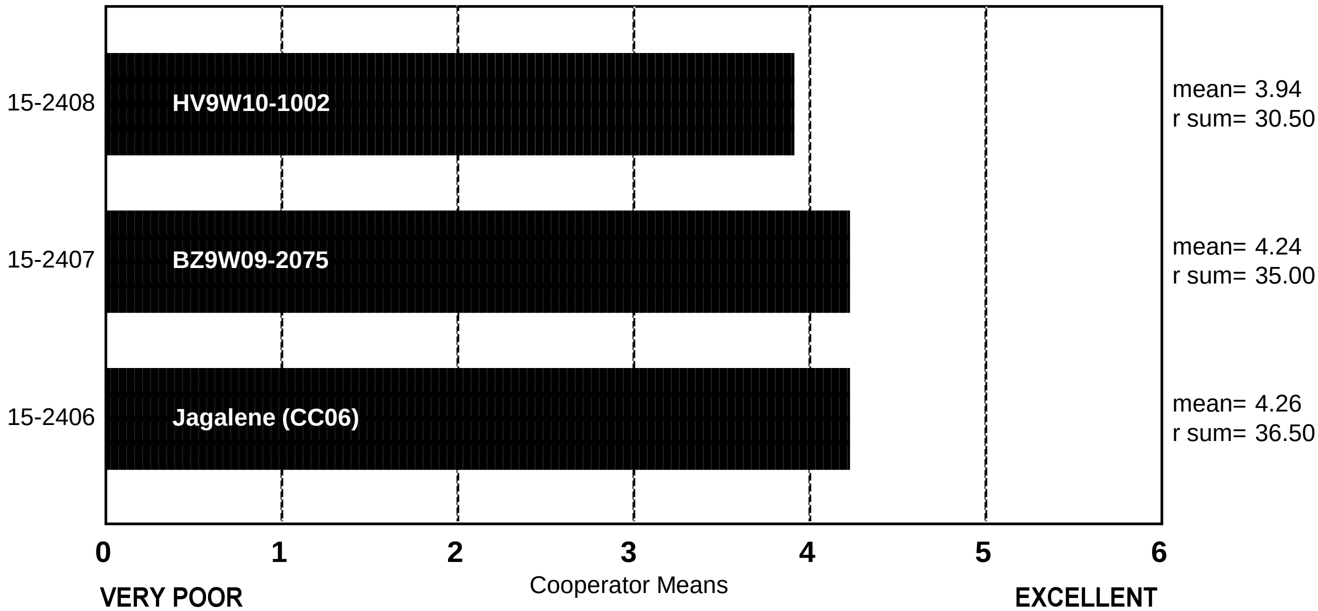
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Westbred

ncoop= 17
chisq= 1.15
chisqc= 2.11
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Westbred

	Sticky	Wet	Tough	Good	Excellent
15-2406 Jagalene (CC06)	0	2	1	9	5
15-2407 BZ9W09-2075	1	0	3	9	4
15-2408 HV9W10-1002	2	3	1	8	3

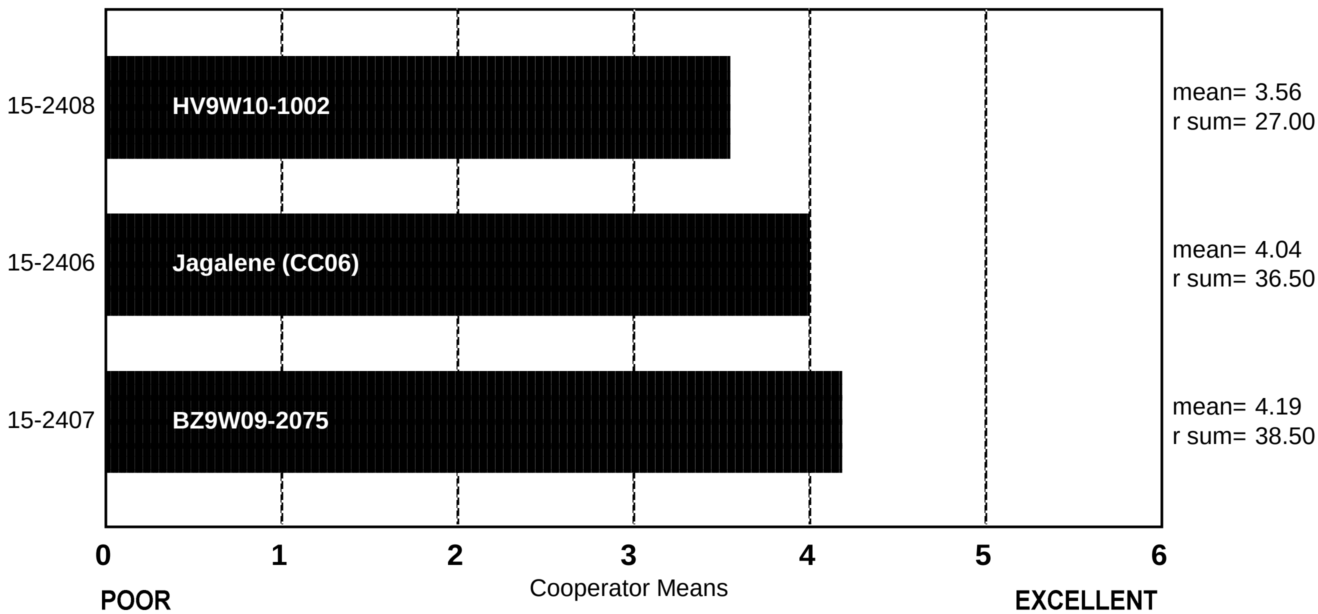
Frequency Table

CRUMB GRAIN

(Small Scale) Westbred

ncoop= 17
chisq= 4.44
chisqc= 5.81
cvchisq= 5.99
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Westbred

	Open	Fine	Dense
15-2406 Jagalene (CC06)	10	5	2
15-2407 BZ9W09-2075	7	9	1
15-2408 HV9W10-1002	10	6	1

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Westbred

	Round	Irregular	Elongated
15-2406 Jagalene (CC06)	**3**	**4**	**10**
15-2407 BZ9W09-2075	**4**	**5**	**8**
15-2408 HV9W10-1002	**6**	**3**	**8**

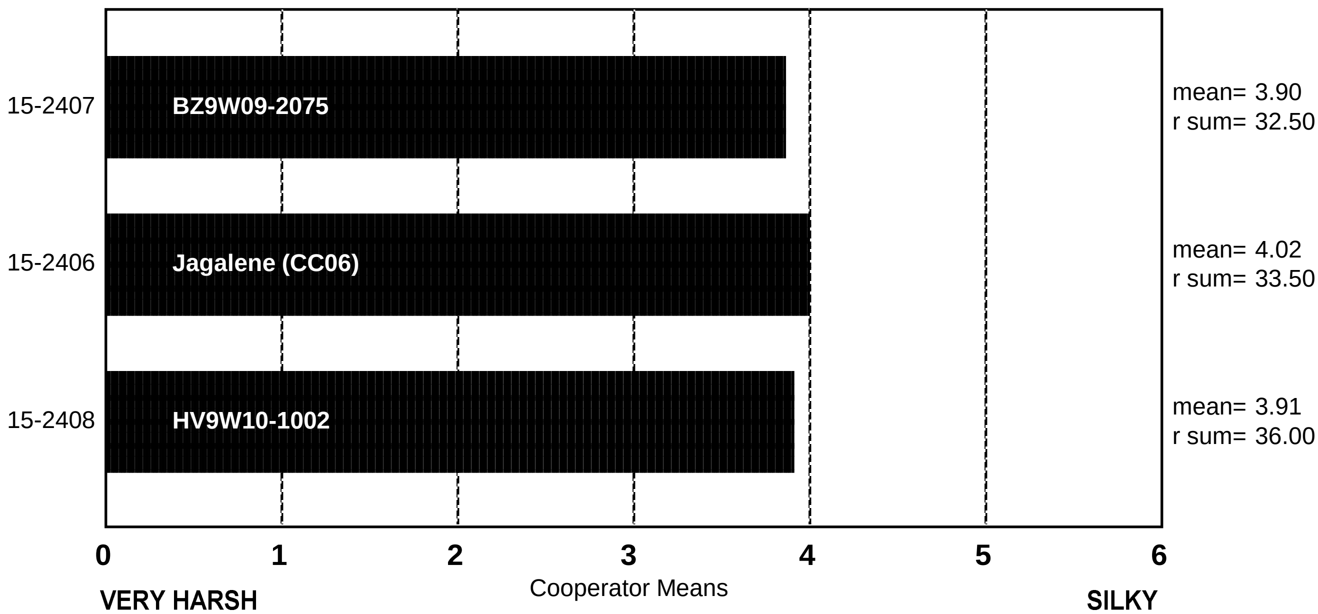
Frequency Table

CRUMB TEXTURE

(Small Scale) Westbred

ncoop= 17
chisq= 0.38
chisqc= 0.63
cvchisq= 5.99
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Westbred

	Harsh	Smooth	Silky
15-2406 Jagalene (CC06)	3	10	4
15-2407 BZ9W09-2075	4	10	3
15-2408 HV9W10-1002	4	11	2

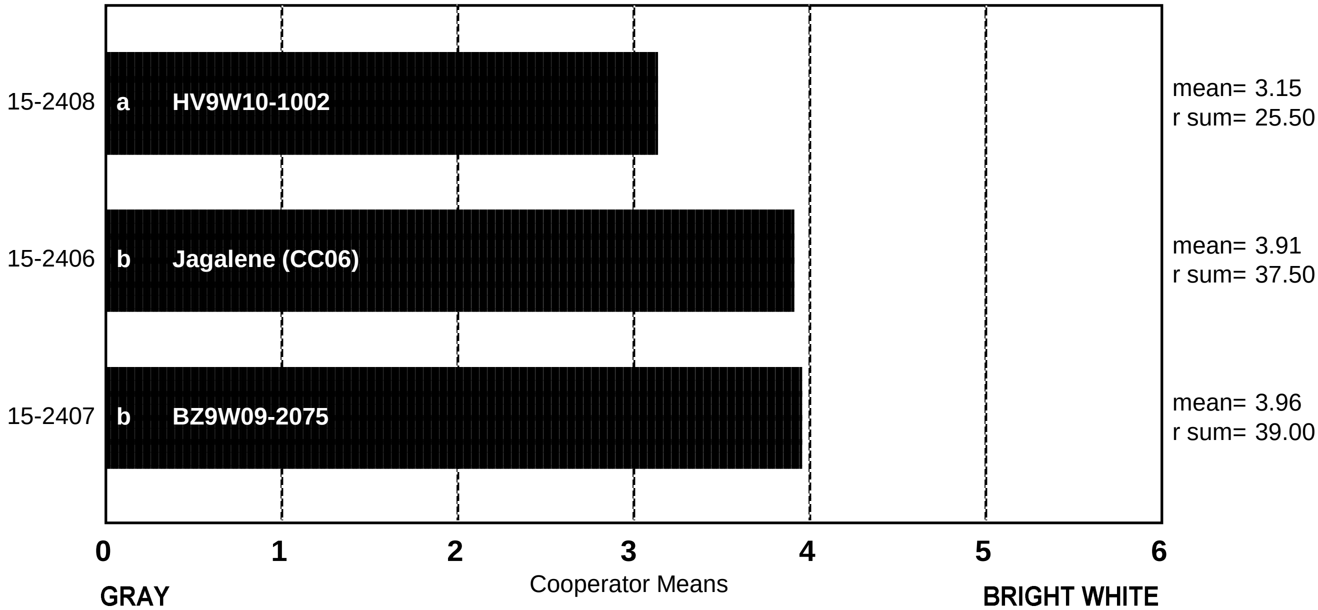
Frequency Table

CRUMB COLOR

(Small Scale) Westbred

ncoop= 17
chisq= 6.44
chisqc= 10.95
cvchisq= 5.99
crdiff= 7.14

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



CRUMB COLOR, DESCRIBED

(Small Scale) Westbred

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
15-2406 Jagalene (CC06)	0	0	2	1	8	5	1
15-2407 BZ9W09-2075	0	0	0	2	11	3	1
15-2408 HV9W10-1002	0	0	3	8	6	0	0

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Westbred

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
15-2406 Jagalene (CC06)	**136.2**	**142.8**	**396.0**		**134.9**	**142.6**	**150.7**	**141.3**	**144.5**	**448.9**	**133.2**			**149.7**	**116.5**	**484.4**	**457.0**
15-2407 BZ9W09-2075	**135.6**	**137.9**	**396.0**		**130.4**	**136.8**	**152.6**	**142.6**	**141.7**	**448.4**	**131.3**			**148.5**	**125.6**	**484.2**	**461.0**
15-2408 HV9W10-1002	**134.1**	**136.7**	**395.0**		**130.4**	**140.7**	**155.9**	**143.8**	**141.9**	**444.5**	**131.9**			**151.5**	**119.3**	**481.8**	**456.0**

LOAF VOLUME, ACTUAL

(Small Scale) Westbred

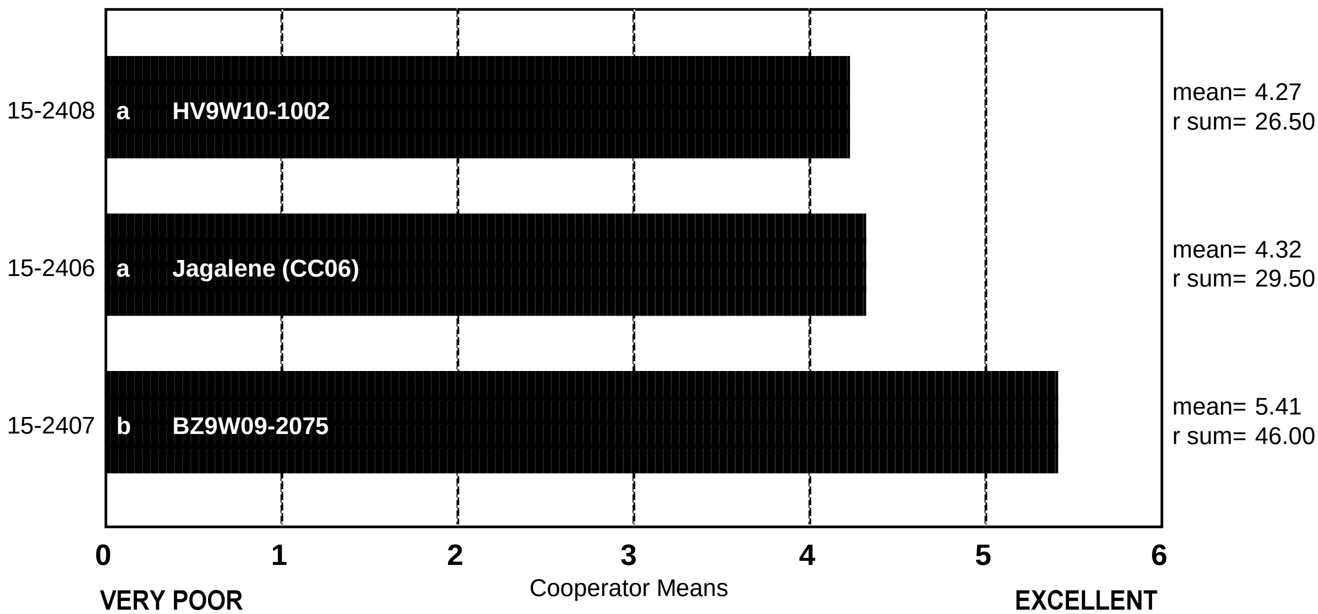
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2406 Jagalene (CC06)	**886**	**985**	**3000**	**995**	**943**	**965**	**905**	**1020**	**815**	**2877**	**1040**	**830**	**2897**	**975**	**2400**	**2575**	**2200**
15-2407 BZ9W09-2075	**990**	**968**	**3000**	**1050**	**970**	**1050**	**1025**	**1150**	**995**	**3068**	**1020**	**1000**	**3045**	**1040**	**2600**	**2763**	**2175**
15-2408 HV9W10-1002	**882**	**940**	**2875**	**930**	**938**	**1050**	**975**	**1020**	**830**	**2804**	**1000**	**785**	**2839**	**980**	**2425**	**2688**	**2150**

LOAF VOLUME

(Small Scale) Westbred

ncoop= 17
chisq= 12.97
chisqc= 16.96
cvchisq= 5.99
crdiff= 7.58

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

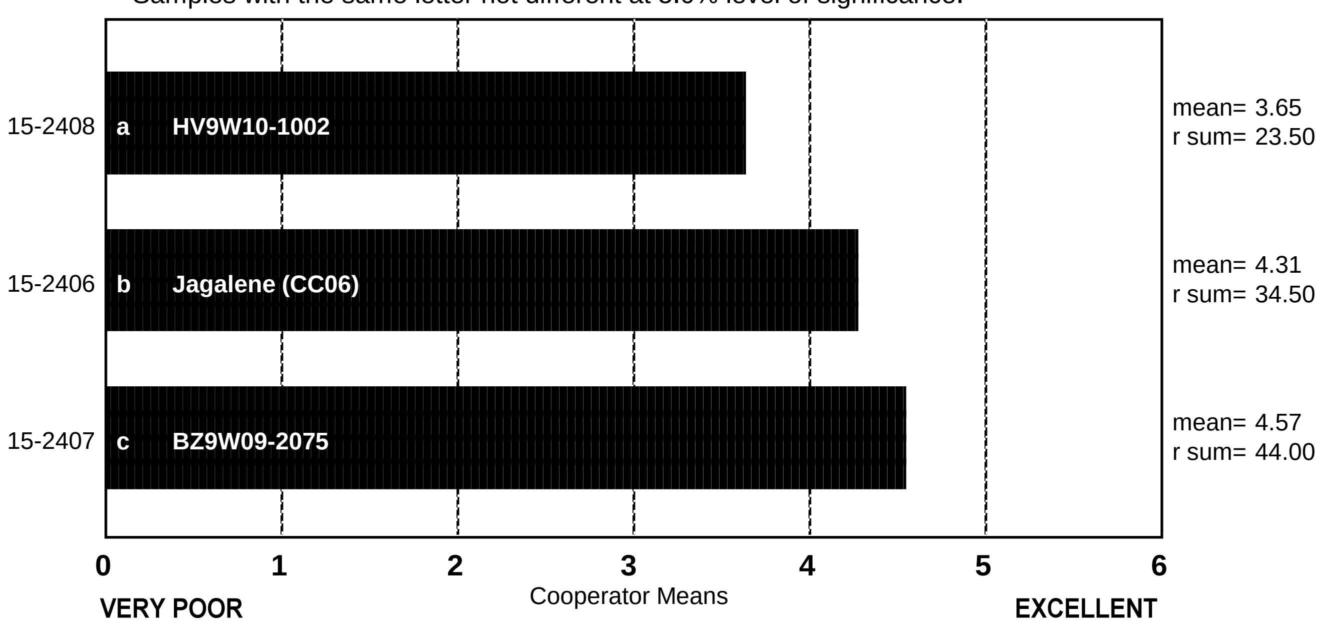


OVERALL BAKING QUALITY

(Small Scale) Westbred

ncoop= 17
chisq= 12.38
chisqc= 14.77
cvchisq= 5.99
crdiff= 8.43

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



COOPERATOR'S COMMENTS
(Small Scale) Westbred

COOP. **15-2406 Jagalene (CC06)**

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption and mix time, slight sticky & strong dough, very high volume, creamy crumb, open elongated cells, resilient & smooth texture.
G. Good dough properties with very good overall strength, excellent absorption, average volume and grain.
H. Rough break and shred.
I. Very good color, poor volume.
J. No comment.
K. Good crumb color and crumb characteristics.
L. No comment.
M. No comment.
N. Good bake absorption and mix time, excellent at makeup, crumb open, good loaf volume.
O. High absorption, good mix time, dough was excellent, bread collapsed before volume reading, excellent dense grain rating.
P. Good grain, average in most categories.
Q. No comment.

COOP. **15-2407 BZ9W09-2075**

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. Good dough performance, nice oven spring and break and shred.
F. Normal water absorption and mix time, slight sticky & strong dough, very high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
G. Good dough properties with very good overall strength, excellent absorption, very good volume and grain.
H. Excellent externals.
I. Excellent color, good volume and grain.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Rated higher than check, longer mix time, excellent at makeup, crumb grain and loaf volume.
O. Good absorption, good mix time, dough was excellent, excellent volume and dense grain rating.
P. Very low absorption, good mix time, excellent volume.
Q. Weak structure, collapsed in volume reader.

COOP. 15-2408 HV9W10-1002

A. No comment.
B. Satisfactory quality overall.
C. No comment.
D. No comment.
E. Long farinograph development time was not reflected in bake mixing time.
F. Normal water absorption and mix time, slight sticky & strong dough, very high volume, creamy crumb, fine elongated cells, resilient & very smooth texture.
G. Good dough properties, excellent absorption, very good volume with weaker crumb grain.
H. Nice externals.
I. Good protein, poor volume and grain.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Rated equal to check, excellent bake absorption and mix time, good crumb and loaf volume.
O. High absorption, low mix time, dough was excellent, bread collapsed before volume reading, open grain rating.
P. Good absorption, short mix time, yellow crumb, good volume.
Q. Weak structure, hard to get volume, collapsed in volume reader, nice crumb, poor strength on structure.

Notes: **C, D, M, O, P and Q** conducted sponge and dough bake tests

COLORADO

15-2409	Jagalene (CC09)
15-2410	Byrd (IC)
15-2411	CO11D1397
15-2412	CO11D1539
15-2413	CO11D1767

Description of Test Plots and Breeder Entries

Colorado – Scott Haley

Growing Location & Conditions

The Wheat Quality Council samples from Colorado originated from strip increases grown under dryland conditions at the USDA-ARS Central Great Plains Research Station at Akron, CO. The field with the strip increases, including 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 9/15/14 and the harvest date was 7/14/15.

Growing conditions included: timely planting into excellent moisture, very lush fall growth due to warm temperatures and abundant fall precipitation, warm fall terminated by severe freezing temperatures November 10-12, significant winter injury observed by early February, relatively dry during early spring hindered regrowth, freezing temperatures May 9-10 causing significant head sterility, very wet May with long spells of cool and foggy weather, stripe rust observed at high levels by late May, fungicide applied too late for effective control, late rains prior to harvest reduced test weights. Barley yellow dwarf virus was observed throughout the nursery at atypical levels and Russian wheat aphids were present due to early drought, but were effectively kept in check by abundant May moisture.

Grain yields of the adjacent state extension variety trial (UVPT) were less than might be expected with the abundant moisture, averaging 44 bu/a with an average test weight of 55.4 lb/bu. Due to the combination of severe winter injury, spring freeze, and stripe rust infection the range of grain yield in the UVPT was extremely wide (90.2-8.6 bu/a). Average grain protein concentration from the group of five strips harvested for the WQC was 12.9% (12% mb).

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, including particularly strong dough mixing properties, high loaf volume, and good crumb grain scores. Byrd is marketed by the Colorado Wheat Research Foundation (CWRF) under the PlainsGold Brand. In 2015, Byrd displaced Hatcher as the most widely grown wheat cultivar in Colorado (28.5% of total acreage).

CO11D1397

CO11D1397 is a doubled-haploid hard red winter wheat experimental line from the cross CO050337-2/Byrd made in 2010. The parental line CO050337-2 is a sister-selection to the varieties Denali and Cowboy. CO11D1397 is medium-short and medium-early maturing, and has a medium-short coleoptile, below average straw strength, and slightly above average test weight. CO11D1397 is susceptible to stripe rust, moderately susceptible to leaf rust and stem rust, susceptible to Hessian fly and all biotypes of Russian wheat aphid, and moderately resistant to wheat soilborne mosaic virus. In field trials in Colorado in 2014 and 2015 under heavy wheat stem sawfly pressure, CO11D1397 showed field resistance not associated with the solid-stem trait. The reaction of CO11D1397 to Fusarium head blight is not known.

Across 27 site-years in the CSU Elite Trial (2014 and 2015) and UVPT (2015), grain yield of CO11D1397 was about 8% lower than Antero and 3% higher than Byrd. In the 2015 Southern Regional Performance Nursery (SRPN), CO11D1397 was very near the bottom of the trial, only slightly higher than Scout 66 across available locations.

CO11D1397 has shown good overall milling and baking properties in tests conducted in the CSU Wheat Quality Lab. Compared to Byrd, CO11D1397 has shown larger kernels, lower Brabender quadrumat senior flour yield, similar mixograph peak time and tolerance, lower loaf volume, and similar crumb grain scores. CO11D1397 is on a limited foundation seed increase in 2016 with the intent to release as a new cultivar in fall 2016.

CO11D1539

CO11D1539 is a doubled-haploid hard red winter wheat experimental line from the cross Byrd/Antero made in 2010. CO11D1539 is medium-height and medium-early maturing, and has a medium-long coleoptile, below average straw strength, and above average test weight. CO11D1539 is moderately resistant to stripe rust and stem rust, moderately susceptible to leaf rust, susceptible to Hessian fly and all biotypes of Russian wheat aphid, and moderately resistant to wheat soilborne mosaic virus. The reaction of CO11D1539 to Fusarium head blight is not known.

Across 27 site-years in the CSU Elite Trial (2014 and 2015) and UVPT (2015), grain yield of CO11D1539 was similar to Antero and about 10% higher than Byrd. In the 2015 Southern Regional Performance Nursery (SRPN), grain yield of CO11D1539 was above average, ranking 15th across available locations.

CO11D1539 has shown good overall milling and baking properties in tests conducted in the CSU Wheat Quality Lab. Compared to Byrd, CO11D1539 has shown larger kernels, similar Brabender quadrumat senior flour yield, shorter mixograph peak time, lower mixograph tolerance, lower loaf volume, and similar crumb grain scores. CO11D1539 is on breeder seed increase in 2016 with no immediate plans for further increase (pending evaluations in 2016).

CO11D1767

CO11D1767 is a doubled-haploid hard red winter wheat experimental line from the cross CO07MAS114/Cowboy made in 2010. The parental line CO07MAS114 is a backcross derivative of the variety Ripper that carries the *Yr5* gene for resistance to stripe rust. CO11D1397 is medium-short and medium-late maturing, and has a medium-short coleoptile, average straw strength, and below average test weight. CO11D1767 is resistant to stripe rust, moderately susceptible to leaf rust and stem rust, susceptible to Hessian fly and all biotypes of Russian wheat aphid, and moderately resistant to wheat soilborne mosaic virus. The reaction of CO11D1767 to Fusarium head blight is not known.

Across 27 site-years in the CSU Elite Trial (2014 and 2015) and UVPT (2015), grain yield of CO11D1767 was slightly higher than Antero and approximately 13% higher than Byrd. In the 2015 Southern Regional Performance Nursery (SRPN), grain yield of CO11D1767 was well above average, ranking 4th across locations.

CO11D1767 has shown acceptable overall milling and baking properties in tests conducted in the CSU Wheat Quality Lab. Compared to Byrd, CO11D1767 has shown larger kernels, lower Brabender quadrumat senior flour yield, shorter mixograph peak time, lower mixograph tolerance, lower loaf volume, and similar crumb grain scores. CO11D1767 is on a limited foundation seed increase in 2016 with the intent to release as a new cultivar in fall 2016.

Colorado: 2015 (Small-Scale) Samples

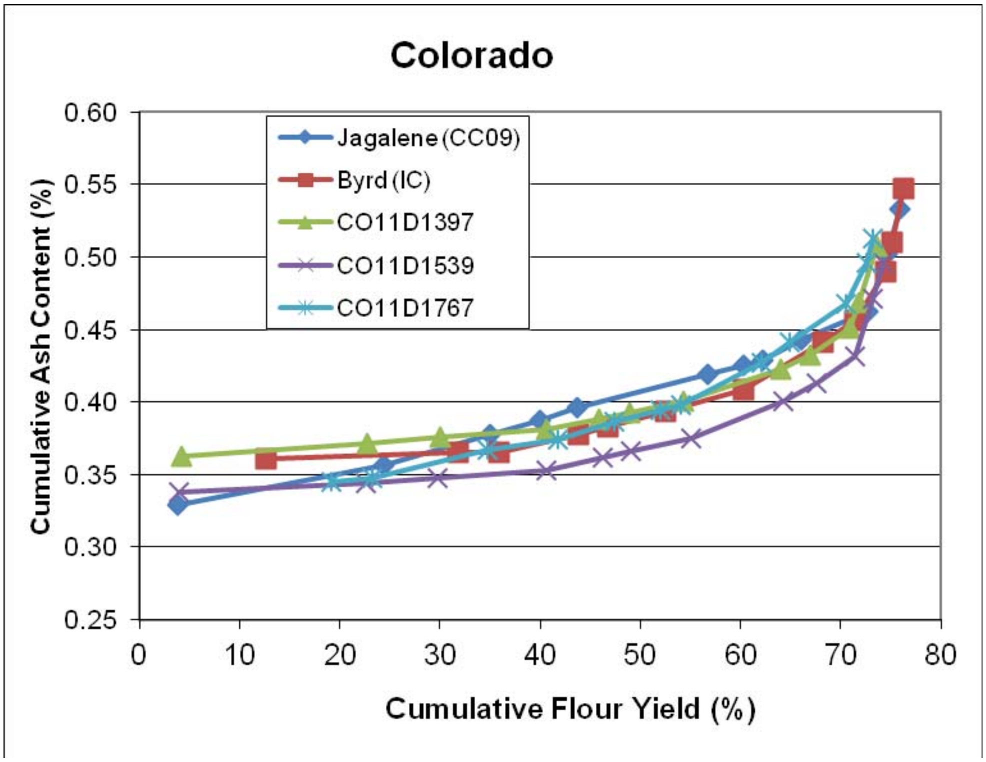
Test entry number	15-2409	15-2410	15-2411	15-2412	15-2413
Sample identification	**Jagalene (CC09)**	**Byrd (IC)**	**CO11D1397**	**CO11D1539**	**CO11D1767**
Wheat Data					
GIPSA classification	1 HRW	2 HRW	2 HRW	1 HRW	2 HRW
Test weight (lb/bu) **Hectoliter weight (kg/hl)**	62.3 81.9	58.1 76.5	58.4 76.9	61.2 80.5	59.0 77.6
1000 kernel weight (gm)	30.9	28.1	26.7	32.4	30.9
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 66.8 33.2 0.0	 57.8 42.1 0.1	 45.4 53.6 1.0	 72.6 27.3 0.1	 71.5 28.5 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	 64.8/15.7 30.9/7.5 2.68/0.30 10.9/0.3 03-07-24-66-01 Hard	 40.2/17.1 28.1/8.6 2.49/0.32 11.4/0.3 36-29-20-15-03 Mixed	 45.7/17.1 26.7/8.1 2.39/0.30 10.9/0.4 23-29-28-20-03 Mixed	 52.7/13.7 32.4/9.2 2.63/0.34 11.0/0.4 08-21-40-31-02 Hard	 53.7/15.6 30.9/8.0 2.59/0.32 11.1/0.3 09-22-32-37-02 Hard
Wheat protein (12% mb) **Wheat ash (12% mb)**	12.8 1.53	12.9 1.62	12.2 1.57	12.3 1.62	12.2 1.53
Milling and Flour Quality Data					
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 69.8 69.4	 73.6 70.9	 75.4 67.2	 73.5 68.0	 71.2 68.6
Flour moisture (%) **Flour protein (14% mb)** **Flour ash (14% mb)**	13.1 11.5 0.55	12.6 11.7 0.52	12.5 10.9 0.50	12.9 11.0 0.50	13.2 11.0 0.51
Rapid Visco-Analyser Peak time (min) Peak viscosity (RVU) Breakdown (RVU) Final viscosity at 13 min (RVU)	 6.2 188.3 62.7 236.1	 6.2 234.2 84.8 276.7	 6.2 219.6 74.9 270.8	 6.3 231.5 65.8 294.3	 6.1 210.5 70.3 267.0
Minolta color meter L* a* b* **PPO**	 91.12 -1.44 10.30 0.409	 90.98 -1.38 9.96 0.402	 91.59 -1.37 9.30 0.408	 91.65 -1.56 9.89 0.538	 91.54 -1.71 10.77 0.527
Falling number (sec)	462	524	458	507	465
Damaged Starch (AI%) (AACC76-31)	 97.36 7.37	 95.94 6.23	 95.95 6.23	 96.02 6.29	 95.41 5.82

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

Colorado: Physical Dough Tests and Gluten Analysis
2015 (Small-Scale) Samples

Test Entry Number	15-2409	15-2410	15-2411	15-2412	15-2413
Sample Identification	**Jagalene (CC09)**	**Byrd (IC)**	**CO11D1397**	**CO11D1539**	**CO11D1767**
MIXOGRAPH					
Flour Abs (% as-is)	65.2	64.0	62.8	63.6	63.7
Flour Abs (14% mb)	64.1	62.4	61.0	62.4	62.8
Mix Time (min)	3.4	5.1	4.9	3.3	3.3
Mix tolerance (0-6)	3	4	5	4	3
FARINOGRAPH					
Flour Abs (% as-is)	64.3	58.3	58.0	61.3	58.1
Flour Abs (14% mb)	63.3	56.7	56.3	60.0	57.2
Development time (min)	7.7	8.3	7.2	5.0	5.2
Mix stability (min)	8.9	13.3	12.7	12.8	8.3
Mix Tolerance Index (FU)	20	19	19	18	26
Breakdown time (min)	14.6	14.3	13.5	16.5	10.9
ALVEOGRAPH					
P(mm): Tenacity	123	74	81	86	62
L(mm): Extensibility	85	98	89	116	133
G(mm): Swelling index	20.5	22.0	21.0	24.0	25.7
W(10^{-4} J): strength (curve area)	344	263	254	287	221
P/L: curve configuration ratio	1.45	0.76	0.91	0.74	0.47
Ie(P_{200}/P): elasticity index	54.2	61.4	57.8	51.9	50.9
EXTENSIGRAPH					
Resist (BU at 45/90/135 min)	269/390/422	373/585/670	415/632/688	265/358/409	237/330/352
Extensibility (mm at 45/90/135 min)	151/154/144	151/139/138	146/142/137	157/163/152	161/167/155
Energy (cm^2 at 45/90/135 min)	73/111/107	101/148/158	106/157/163	79/107/119	72/104/101
Resist $_{max}$ (BU at 45/90/135min)	370/554/577	529/847/915	558/913/974	373/498/606	328/462/492
Ratio (at 45/90/135 min)	1.78/2.53/2.92	2.46/4.20/4.86	2.85/4.47/5.04	1.69/2.20/2.69	1.47/1.98/2.27
PROTEIN ANALYSIS					
HMW-GS Composition	2*,1, 17+18, 5+10	2*, 7+8, 5+10	2*, 7+8, 5+10	2*, 7+9, 5+10	2*, 7+8, 2+12
%IPP	49.31	50.89	50.49	44.63	47.01
SEDIMENTATION TEST					
Volume (ml)	49.0	56.1	49.1	46.9	42.6

Colorado: Cumulative Ash Curves

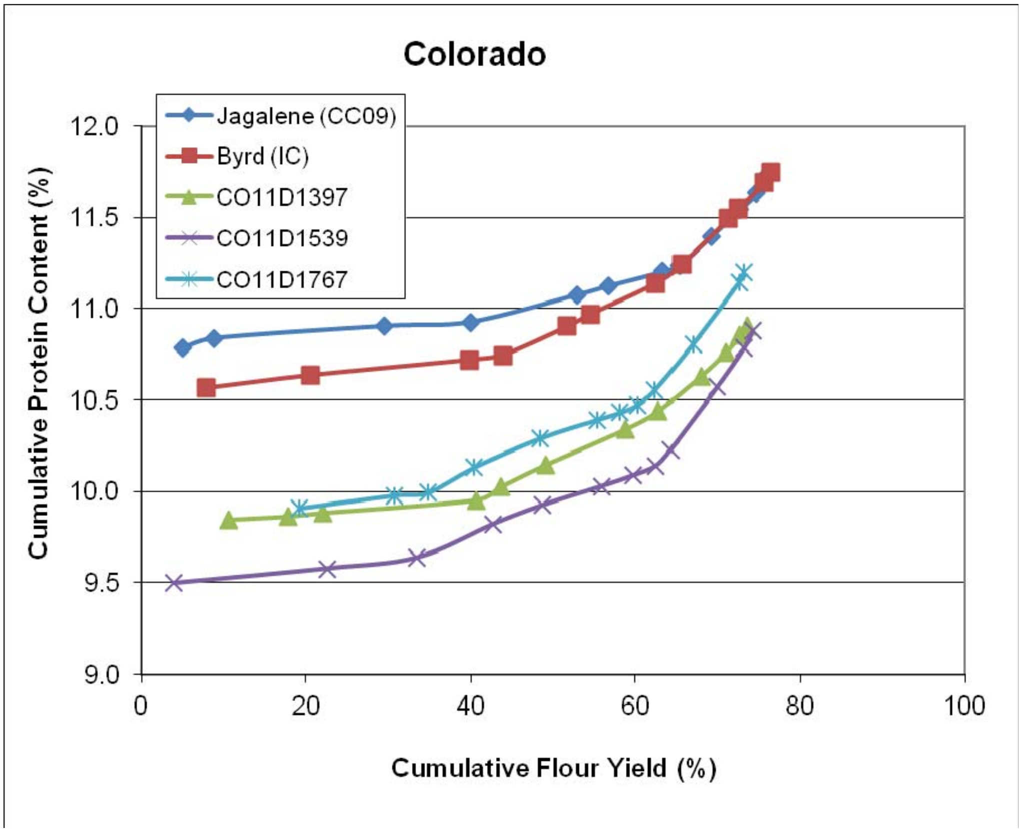


Jagalene (CC09)					Byrd (IC)					CO11D1397				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
1M Red	3.86	0.33	3.86	0.33	1M	12.62	0.36	12.62	0.36	1M Red	4.26	0.36	4.26	0.36
2M	20.58	0.36	24.44	0.36	2M	19.21	0.37	31.84	0.37	2M	18.49	0.37	22.75	0.37
1M	10.50	0.43	34.94	0.38	1M Red	4.10	0.37	35.93	0.37	1BK	7.21	0.39	29.96	0.38
1BK	4.99	0.45	39.94	0.39	1BK	7.94	0.43	43.87	0.38	1M	10.62	0.40	40.59	0.38
FILTER FLR	3.77	0.49	43.71	0.40	Grader	2.86	0.47	46.72	0.38	2BK	5.22	0.44	45.81	0.39
3M	13.04	0.50	56.75	0.42	2BK	5.71	0.48	52.44	0.39	Grader	3.08	0.45	48.89	0.39
2BK	3.48	0.53	60.23	0.43	FILTER FLR	7.88	0.50	60.32	0.41	FILTER FLR	5.40	0.48	54.29	0.40
Grader	1.99	0.55	62.22	0.43	3M	7.89	0.69	68.21	0.44	3M	9.73	0.55	64.02	0.42
3BK	3.84	0.66	66.06	0.44	3BK	3.16	0.78	71.37	0.46	3BK	2.97	0.64	66.99	0.43
4M	6.58	0.66	72.64	0.46	4M	3.05	1.29	74.42	0.49	4M	3.88	0.77	70.87	0.45
5M	2.00	1.96	74.64	0.50	BRAN FLR	0.71	2.64	75.14	0.51	BRAN FLR	0.90	1.86	71.77	0.47
BRAN FLR	1.20	2.45	75.84	0.53	5M	1.19	2.88	76.32	0.55	5M	1.76	2.09	73.53	0.51
Break Shorts	2.85	3.60	78.68	0.64	Break Shorts	3.30	4.70	79.62	0.72	Break Shorts	3.61	3.83	77.14	0.66
Red Dog	1.57	3.00	80.26	0.69	Red Dog	1.53	3.13	81.15	0.76	Red Dog	1.96	2.83	79.09	0.72
Red Shorts	0.20	3.72	80.46	0.70	Red Shorts	0.28	4.55	81.44	0.78	Red Shorts	0.45	4.09	79.54	0.74
Filter Bran	2.70	1.39	83.16	0.72	Filter Bran	2.64	1.86	84.08	0.81	Filter Bran	2.35	1.38	81.89	0.75
Bran	16.84	5.77	100.0	1.57	Bran	15.92	6.08	100.0	1.65	Bran	18.11	5.40	100.0	1.60
Wheat		1.49					1.58					1.53		
St. Grd. Fl.		0.55					0.52					0.50		

Colorado: Cumulative Ash Curves (continued)

CO11D1539					CO11D1767				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
1M Red	3.93	0.34	3.93	0.34	2M	19.20	0.35	19.20	0.35
2M	18.68	0.35	22.61	0.34	1M Red	4.01	0.36	23.22	0.35
1BK	7.19	0.36	29.80	0.35	1M	11.54	0.41	34.75	0.37
1M	10.80	0.37	40.60	0.35	1BK	6.95	0.41	41.71	0.37
2BK	5.63	0.42	46.23	0.36	FILTER FLR	5.64	0.48	47.34	0.39
Grader	2.81	0.44	49.04	0.37	2BK	4.64	0.48	51.98	0.39
FILTER FLR	5.95	0.45	54.99	0.38	Grader	2.10	0.49	54.08	0.40
3M	9.32	0.55	64.31	0.40	3M	8.00	0.62	62.08	0.43
3BK	3.29	0.64	67.60	0.41	4M	2.80	0.76	64.88	0.44
4M	3.85	0.77	71.45	0.43	3BK	5.58	0.78	70.46	0.47
5M	1.71	2.14	73.15	0.47	5M	2.07	1.45	72.53	0.50
BRAN FLR	1.05	2.23	74.20	0.50	BRAN FLR	0.62	2.46	73.14	0.51
Break Shorts	2.81	4.12	77.02	0.63	Break Shorts	3.08	4.13	76.22	0.66
Red Dog	1.69	2.87	78.71	0.68	Red Dog	1.79	2.98	78.01	0.71
Red Shorts	0.27	4.39	78.98	0.69	Red Shorts	0.23	4.19	78.24	0.72
Filter Bran	2.93	1.18	81.92	0.71	Filter Bran	5.87	0.90	84.12	0.73
Bran	18.08	5.92	100.0	1.65	Bran	15.88	5.76	100.0	1.53
Wheat		1.58					1.49		
St. Grd. Fl.		0.50					0.51		

Colorado: Cumulative Protein Curves



Jagalene (CC09)					Byrd (IC)					CO11D1397				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1BK	4.99	10.78	4.99	10.78	1BK	7.94	10.56	7.94	10.56	1M	10.62	9.84	10.62	9.84
1M Red	3.86	10.91	8.85	10.84	1M	12.62	10.68	20.56	10.63	1BK	7.21	9.89	17.84	9.86
2M	20.58	10.93	29.43	10.91	2M	19.21	10.81	39.77	10.72	1M Red	4.26	9.96	22.10	9.88
1M	10.50	10.99	39.94	10.93	1M Red	4.10	11.00	43.87	10.75	2M	18.49	10.04	40.59	9.95
3M	13.04	11.54	52.98	11.08	FILTER FLR	7.88	11.79	51.75	10.90	Grader	3.08	10.99	43.67	10.03
FILTER FLR	3.77	11.80	56.75	11.13	Grader	2.86	12.19	54.61	10.97	FILTER FLR	5.40	11.11	49.07	10.15
4M	6.58	11.88	63.33	11.20	3M	7.89	12.31	62.50	11.14	3M	9.73	11.33	58.80	10.34
Grader	1.99	12.36	65.32	11.24	4M	3.05	13.34	65.55	11.24	4M	3.88	11.92	62.68	10.44
3BK	3.84	14.07	69.16	11.40	2BK	5.71	14.39	71.26	11.50	2BK	5.22	12.94	67.90	10.63
2BK	3.48	14.49	72.64	11.54	5M	1.19	14.71	72.45	11.55	3BK	2.97	13.71	70.87	10.76
5M	2.00	14.76	74.64	11.63	3BK	3.16	14.94	75.61	11.69	5M	1.76	14.61	72.63	10.85
BRAN FLR	1.20	17.91	75.84	11.73	BRAN FLR	0.71	17.81	76.32	11.75	BRAN FLR	0.90	15.34	73.53	10.91
Break Shorts	2.85	15.62	78.68	11.87	Break Shorts	3.30	15.85	79.62	11.92	Break Shorts	3.61	15.06	77.14	11.10
Red Dog	1.57	14.71	80.26	11.93	Red Dog	1.53	13.80	81.15	11.95	Red Dog	1.96	13.30	79.09	11.16
Red Shorts	0.20	13.12	80.46	11.93	Red Shorts	0.28	13.30	81.44	11.96	Red Shorts	0.45	13.00	79.54	11.17
Filter Bran	2.70	12.17	83.16	11.94	Filter Bran	2.64	11.90	84.08	11.96	Filter Bran	2.35	11.53	81.89	11.18
Bran	16.84	16.72	100.00	12.74	Bran	15.92	14.84	100.00	12.41	Bran	18.11	15.77	100.00	12.01
Wheat		12.48					12.60					11.94		
St. Grd. Fl		11.79					11.85					11.05		

Colorado: Cumulative Protein Curves (continued)

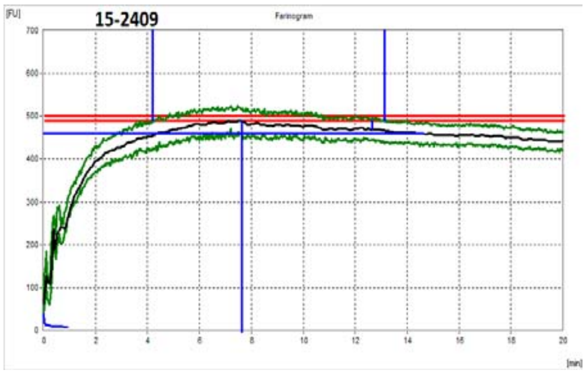
CO11D1539					CO11D1767				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1M Red	3.93	9.50	3.93	9.50	2M	19.20	9.91	19.20	9.91
2M	18.68	9.59	22.61	9.58	1M	11.54	10.10	30.74	9.98
1M	10.80	9.76	33.41	9.64	1M Red	4.01	10.10	34.75	9.99
3M	9.32	10.48	42.73	9.82	FILTER FLR	5.64	10.99	40.39	10.13
FILTER FLR	5.95	10.67	48.68	9.92	3M	8.00	11.09	48.39	10.29
1BK	7.19	10.74	55.87	10.03	1BK	6.95	11.10	55.34	10.39
4M	3.85	10.95	59.72	10.09	4M	2.80	11.21	58.14	10.43
Grader	2.81	11.28	62.53	10.14	Grader	2.10	11.63	60.24	10.47
5M	1.71	13.37	64.24	10.23	5M	2.07	12.85	62.31	10.55
2BK	5.63	14.49	69.87	10.57	2BK	4.64	14.23	66.95	10.81
3BK	3.29	15.38	73.15	10.79	3BK	5.58	15.21	72.53	11.15
BRAN FLR	1.05	17.41	74.20	10.88	BRAN FLR	0.62	17.92	73.14	11.20
Break Shorts	2.81	15.36	77.02	11.04	Break Shorts	3.08	15.82	76.22	11.39
Red Dog	1.69	13.37	78.71	11.09	Red Dog	1.79	14.28	78.01	11.46
Red Shorts	0.27	12.98	78.98	11.10	Red Shorts	0.23	13.34	78.24	11.46
Filter Bran	2.93	10.46	81.92	11.08	Filter Bran	5.87	10.75	84.12	11.41
Bran	18.08	12.60	100.00	11.35	Bran	15.88	15.29	100.00	12.03
Wheat		12.06					11.88		
St. Grd. Fl		11.18					11.05		

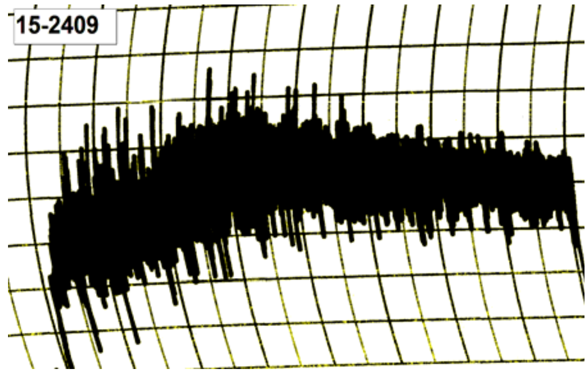
Physical Dough Tests

2015 (Small Scale) Samples - Colorado

Farinograms

Mixograms

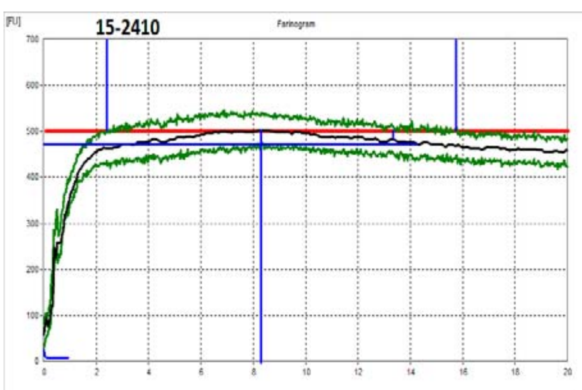


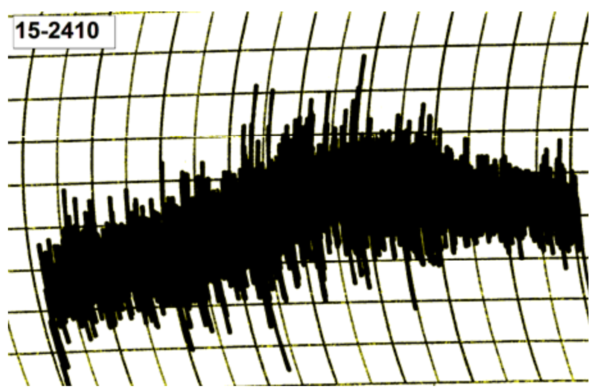


Water abs = 63.3%, Peak time = 7.7 min,
Mix stab = 8.9 min, MTI = 20 FU

Water abs = 64.1%
Mix time = 3.4 min

15-2409, Jagalene (CC09)





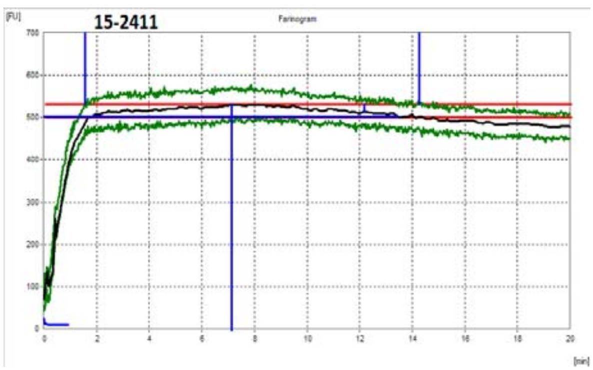
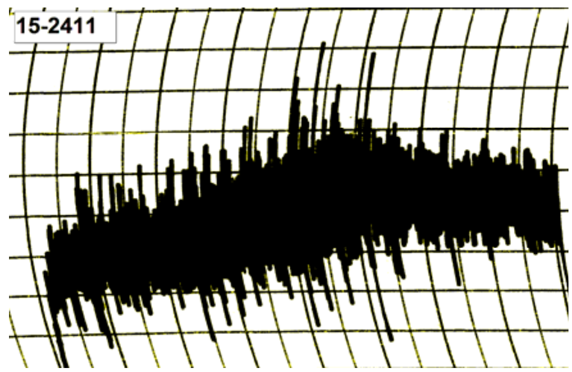
Water abs = 56.7%, Peak time = 8.8 min,
Mix stab = 13.3 min, MTI = 19 FU

Water abs = 62.4%
Mix time = 5.1 min

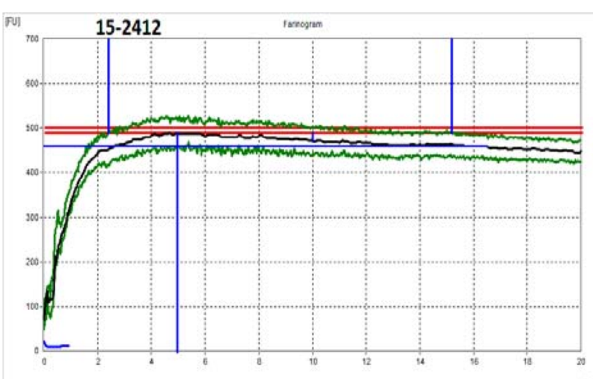
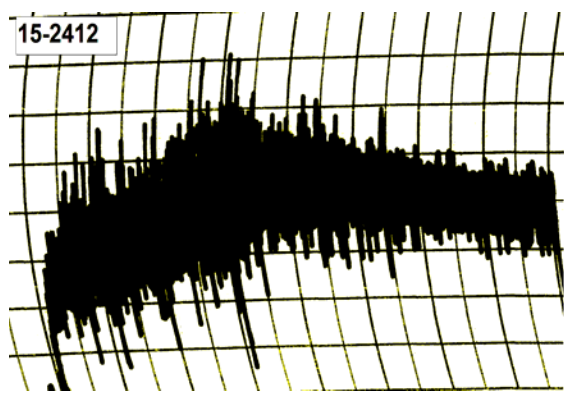
15-2410, Byrd (IC)

Physical Dough Tests

2015 (Small Scale) Samples - Colorado (continued)

Farinograms	Mixograms
	
Water abs= 56.3%, Peak time = 7.2 min, Mix stab = 12.7 min, MTI = 19 FU	Water abs = 61.0% Mix time = 4.9 min

15-2411, CO11D1397

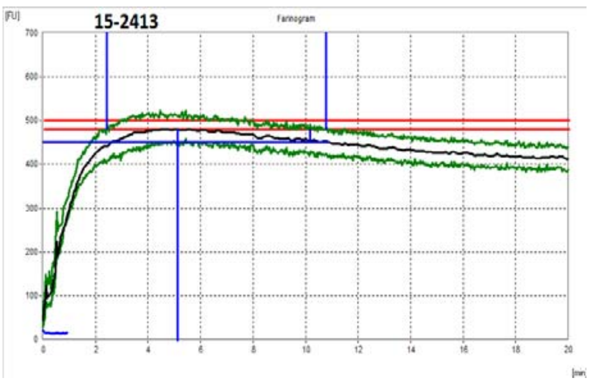
Farinograms	Mixograms
	
Water abs= 60.0%, Peak time = 5.0 min, Mix stab = 12.8 min, MTI = 18 FU	Water abs = 62.4% Mix time = 3.3 min

15-2412, CO11D1539

Physical Dough Tests

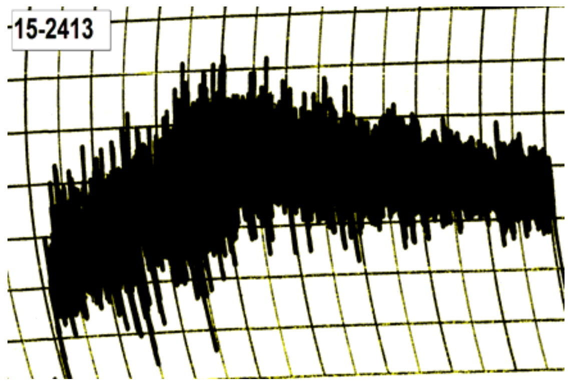
2015 (Small Scale) Samples - Colorado (continued)

Farinograms



Water abs= 57.2%, Peak time = 5.2 min,
Mix stab = 8.3 min, MTI = 26 FU

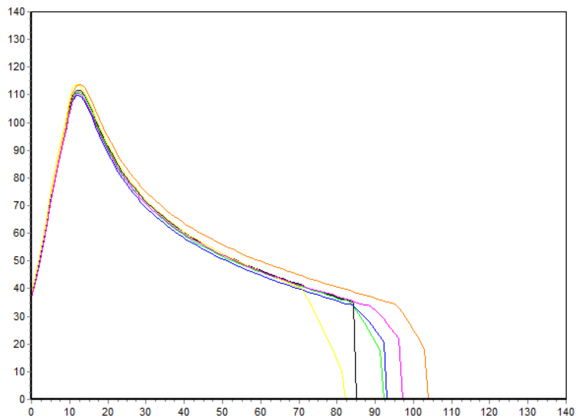
Mixograms



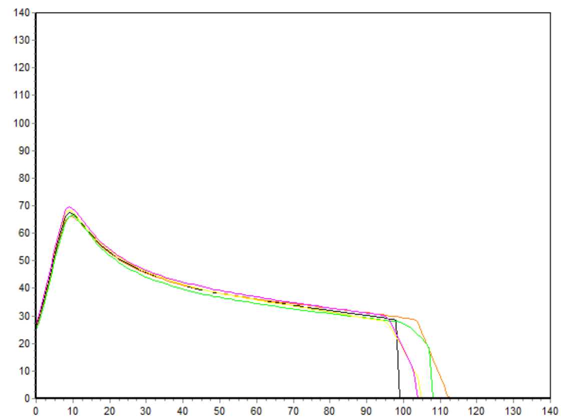
Water abs = 62.8%
Mix time = 3.3 min

15-2413, CO11D1767

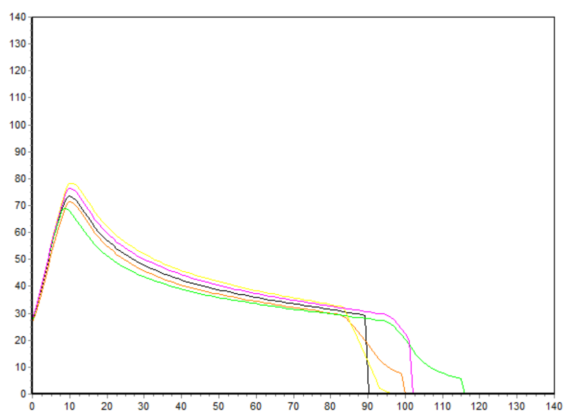
Physical Dough Tests - Alveograph
2015 (Small Scale) Samples – Colorado



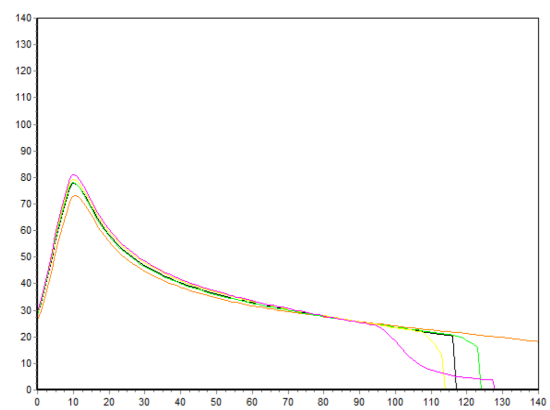
15-2409, Jagalene (CC09)
P(mm H_20)=123, L(mm)=85, W(10E^{-4} J)=344



15-2410, Byrd (IC)
P(mm H_20)=74, L(mm)=98, W(10E^{-4} J)=263

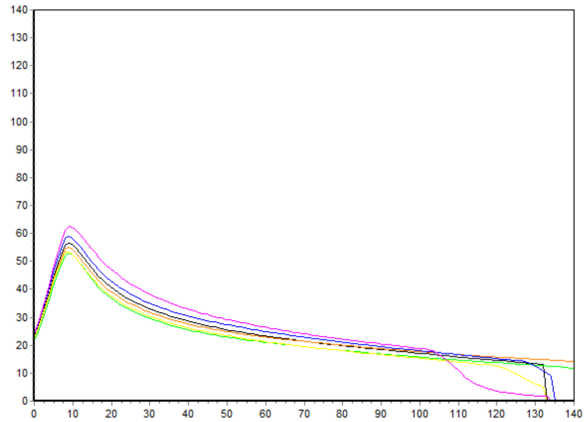


15-2411, CO11D1397
P(mm H_20)=81, L(mm)=89, W(10E^{-4} J)=254



15-2412, CO11D1539
P(mm H_20)=86, L(mm)=116, W(10E^{-4} J)=287

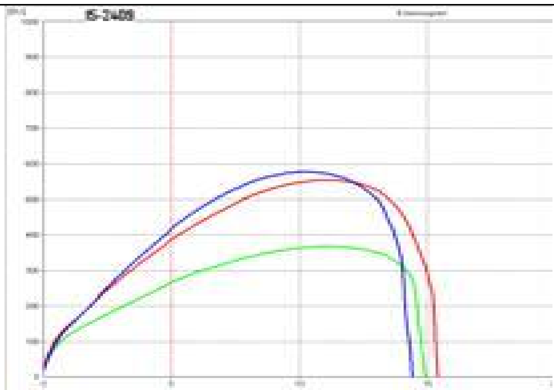
Physical Dough Tests - Alveograph
2015 (Small Scale) Samples – Colorado (continued)



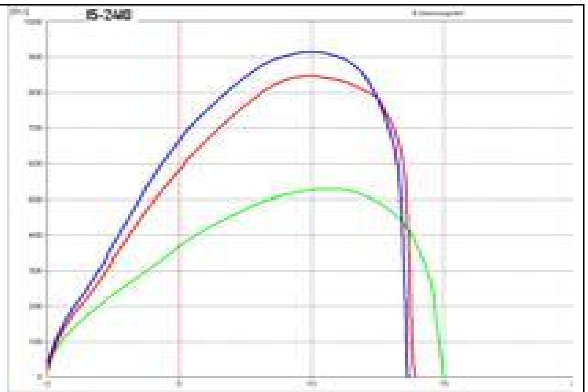
15-2413, CO11D1767
P(mm $H_2$0)=62, L(mm)=133, W(10E^{-4} J)=221

Physical Dough Tests - Extensigraph

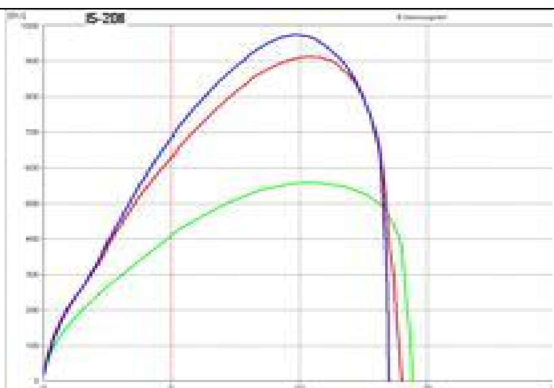
2015 (Small Scale) Samples – Colorado



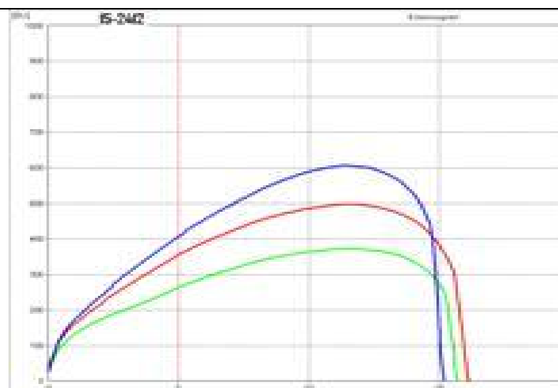
15-2409, Jagalene (CC09)
R (BU) = 390, E (mm) = 154, W (cm^2) = 111
Rmax (BU) = 554, Ratio = 2.5 at 90 min



15-2410, Byrd (IC)
R (BU) = 585, E (mm) = 139, W (cm^2) = 148
Rmax (BU) = 847, Ratio = 4.2 at 90 min

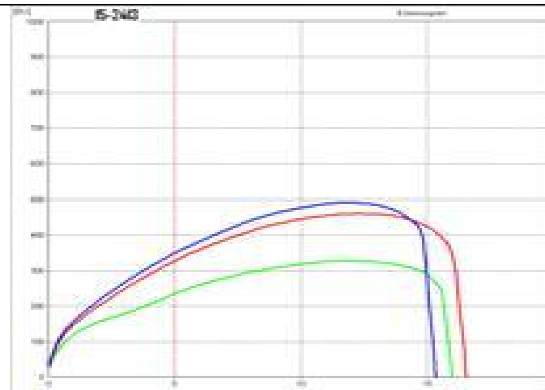


15-2411, CO11D1397
R (BU) = 632, E (mm) =142, W (cm^2) = 157
Rmax (BU) = 913, Ratio = 4.5 at 90 min



15-2412, CO11D1539
R (BU) = 358, E (mm) = 163, W (cm^2) = 107
Rmax (BU) = 498, Ratio = 2.2 at 90 min

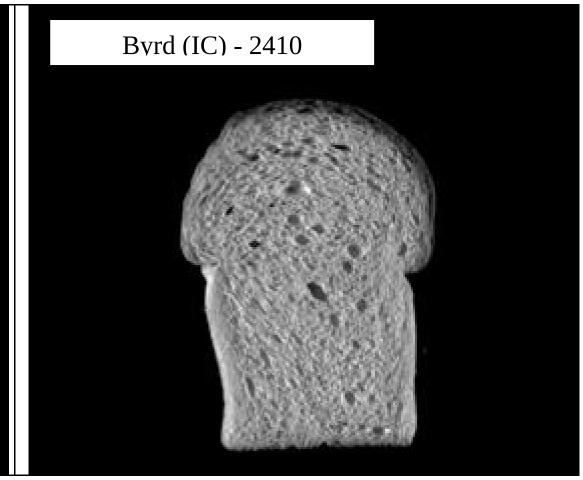
Physical Dough Tests - Extensigraph
2015 (Small Scale) Samples – Colorado (continued)



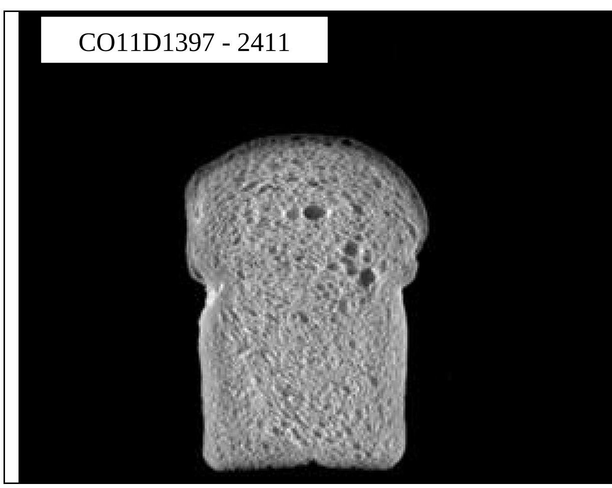
15-2413, CO11D1767
R (BU) = 330, E (mm) = 167, W (cm^2) = 104
Rmax (BU) = 462, Ratio = 2.0 at 90 min

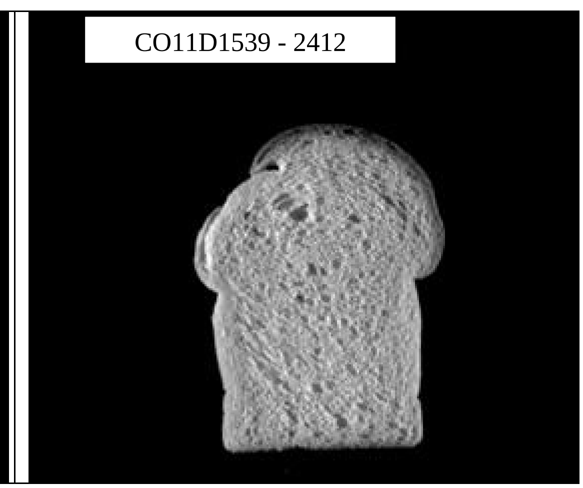
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Colorado: C-Cell Bread Images and Analysis for 2015 (Small-Scale) Samples



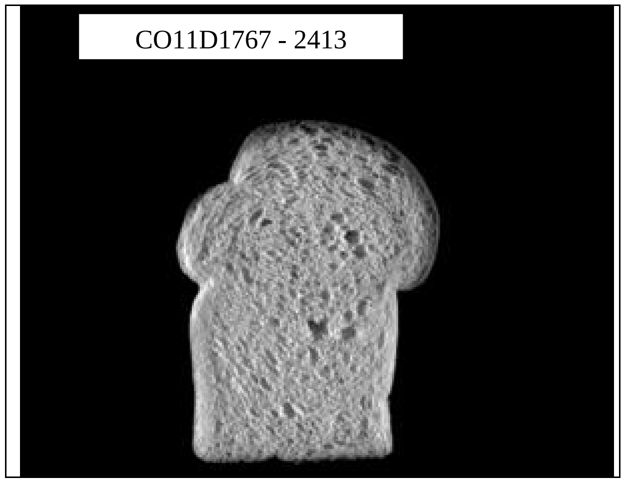
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2409	6140	143.3	3968	0.436	1.993	2.633	1.715	-20.30
2410	6556	136.2	4261	0.430	1.854	1.238	1.693	-19.35





Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2411	6075	138.1	4081	0.430	1.817	3.726	1.663	-11.95
2412	6064	145.0	3941	0.438	1.937	1.158	1.638	-17.73

Colorado: C-Cell Bread Images and Analysis for 2015 (Small-Scale) Samples (continued)



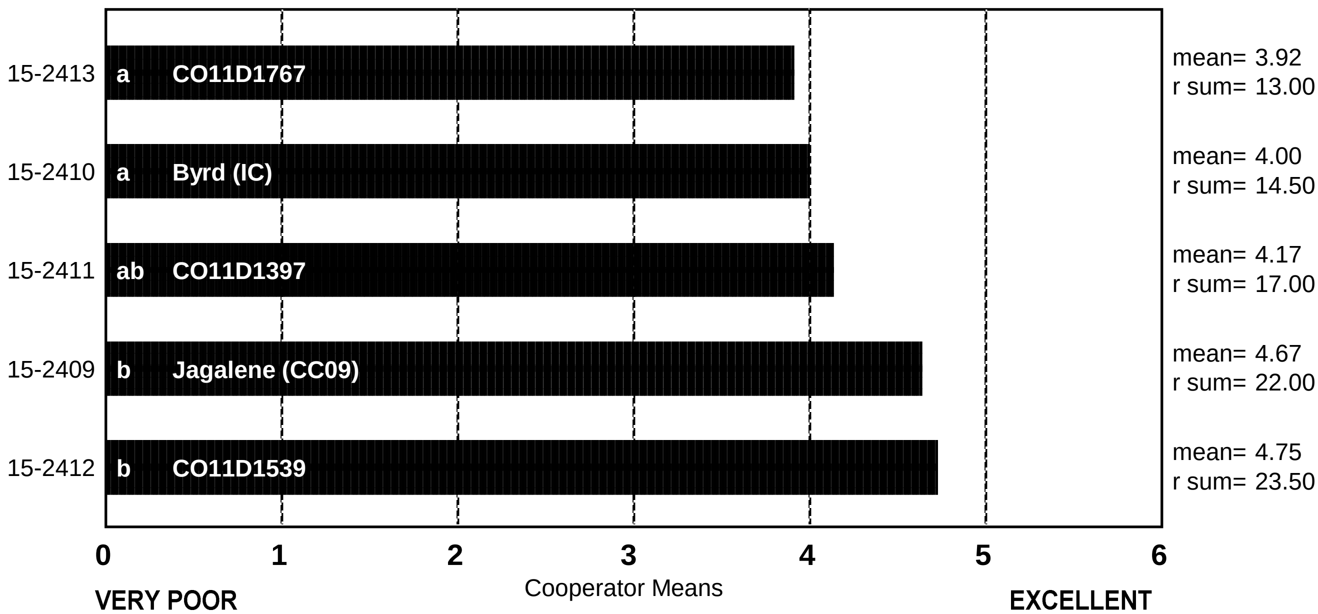
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2413	6346	144.9	4175	0.434	1.884	0.906	1.643	-15.65

SPONGE CHARACTERISTICS

(Small Scale) Colorado

ncoop= 6
chisq= 5.63
chisqc= 9.94
cvchisq= 9.49
crdiff= 7.21

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

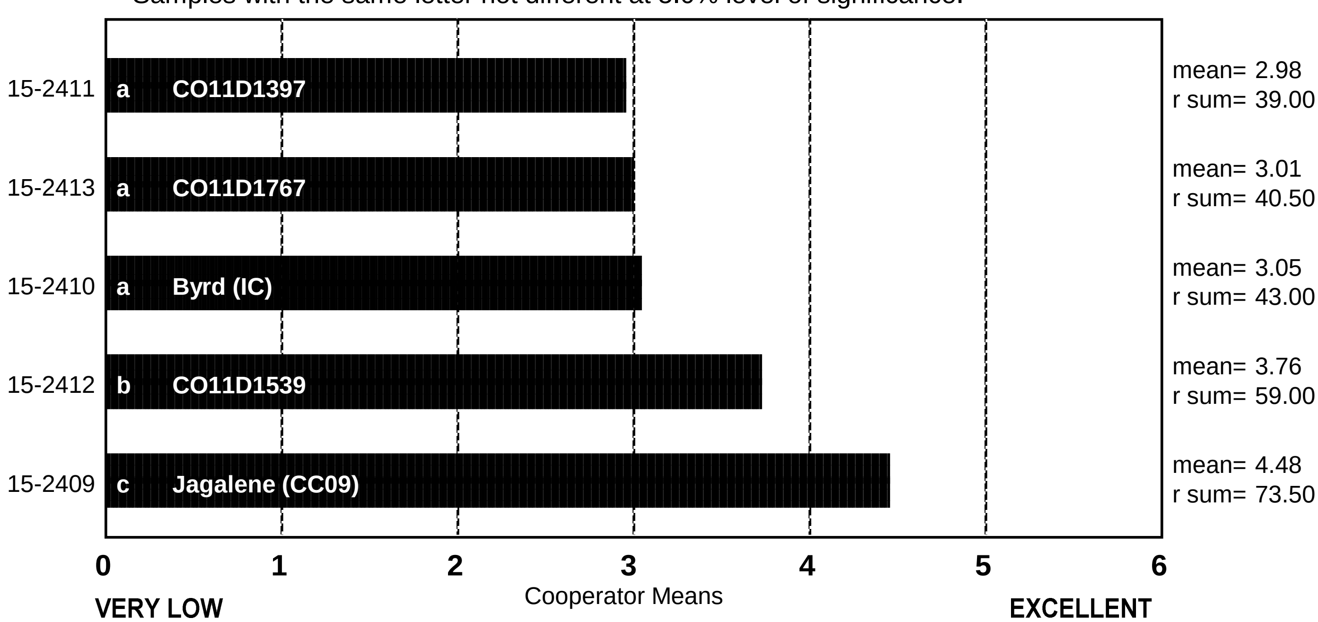


BAKE ABSORPTION

(Small Scale) Colorado

ncoop= 17
chisq= 20.91
chisqc= 29.87
cvchisq= 9.49
crdiff= 11.95

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. O
15-2409 Jagalene (CC09)	**65.2**	**67.0**	**57.0**	**61.0**	**63.0**	**64.0**	**69.7**	**62.4**	**63.3**	**63.3**	**70.0**	**61.7**	**62.0**	**63.1**	**63.3**	**59.0**	**62.8**
15-2410 Byrd (IC)	**64.0**	**66.0**	**58.0**	**61.0**	**57.8**	**62.0**	**71.1**	**62.4**	**62.5**	**56.7**	**64.3**	**61.5**	**56.0**	**62.6**	**56.7**	**53.0**	**57.2**
15-2411 CO11D1397	**62.6**	**65.0**	**57.0**	**60.0**	**58.5**	**63.0**	**68.5**	**62.7**	**62.8**	**56.3**	**64.1**	**60.5**	**56.0**	**59.9**	**56.3**	**53.0**	**56.2**
15-2412 CO11D1539	**63.8**	**66.0**	**57.0**	**60.0**	**60.7**	**63.0**	**68.9**	**62.1**	**62.7**	**60.0**	**67.1**	**60.9**	**59.0**	**61.5**	**60.0**	**56.0**	**60.3**
15-2413 CO11D1767	**63.6**	**66.0**	**57.0**	**60.0**	**58.1**	**62.0**	**67.8**	**62.0**	**61.7**	**57.2**	**63.7**	**60.6**	**57.0**	**60.8**	**57.2**	**57.0**	**57.5**

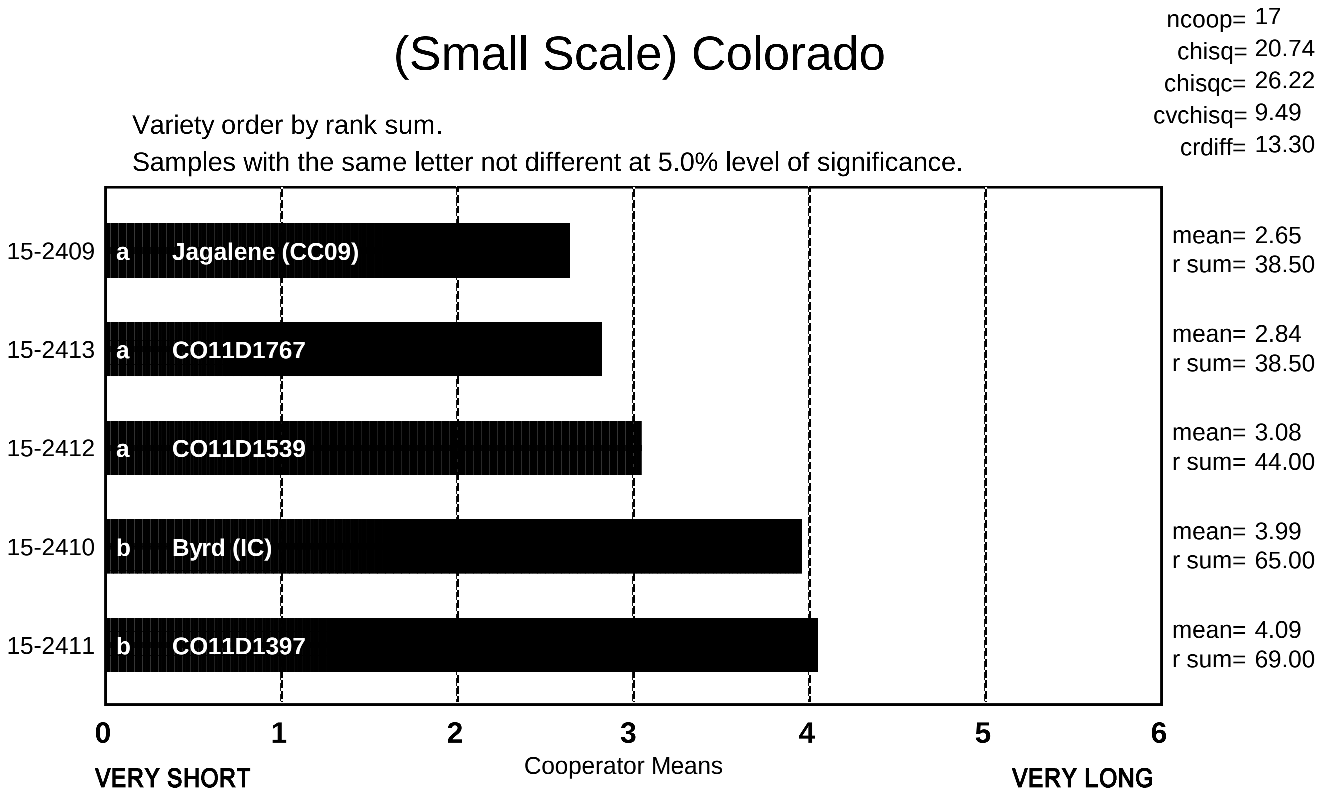
BAKE MIX TIME, ACTUAL

(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
15-2409 Jagalene (CC09)	**2.9**	**2.8**	**5.0**	**6.0**	**3.3**	**4.1**	**3.3**	**3.3**	**2.6**	**6.3**	**3.5**	**3.2**	**12.0**	**3.8**	**5.0**	**4.0**	**7.0**
15-2410 Byrd (IC)	**5.0**	**5.3**	**8.0**	**6.0**	**4.8**	**6.6**	**5.8**	**4.8**	**3.4**	**7.0**	**4.5**	**4.3**	**20.0**	**6.8**	**4.5**	**6.0**	**10.0**
15-2411 CO11D1397	**4.9**	**5.5**	**13.0**	**6.0**	**4.9**	**7.4**	**5.4**	**5.3**	**3.6**	**6.0**	**4.5**	**4.2**	**20.0**	**6.8**	**5.0**	**7.0**	**10.0**
15-2412 CO11D1539	**3.1**	**3.3**	**10.0**	**6.0**	**3.4**	**4.0**	**3.6**	**3.3**	**2.6**	**5.0**	**4.0**	**3.0**	**18.0**	**4.1**	**4.0**	**4.0**	**8.0**
15-2413 CO11D1767	**3.3**	**3.0**	**6.0**	**6.0**	**3.4**	**4.0**	**3.9**	**3.5**	**2.6**	**5.3**	**3.5**	**2.5**	**20.0**	**3.5**	**4.0**	**4.0**	**5.0**

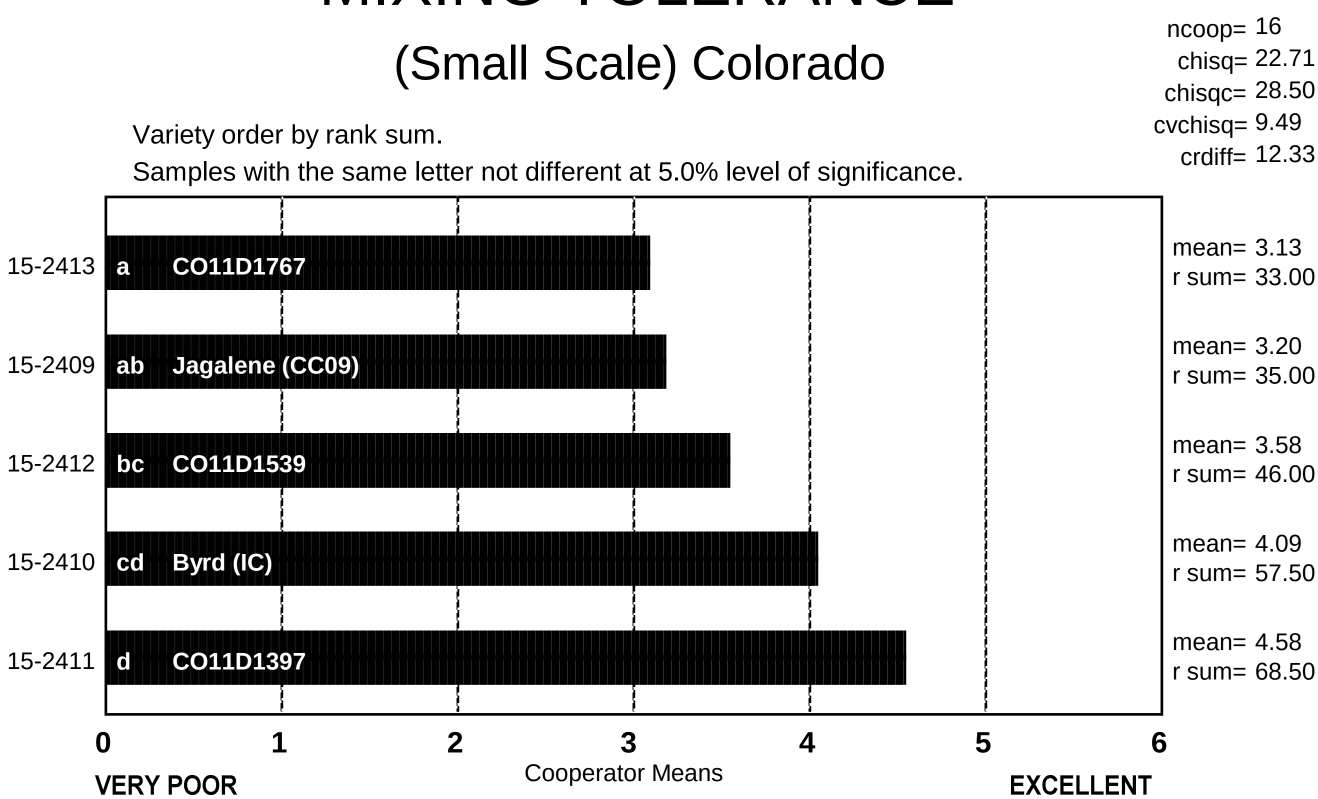
BAKE MIX TIME

(Small Scale) Colorado



MIXING TOLERANCE

(Small Scale) Colorado

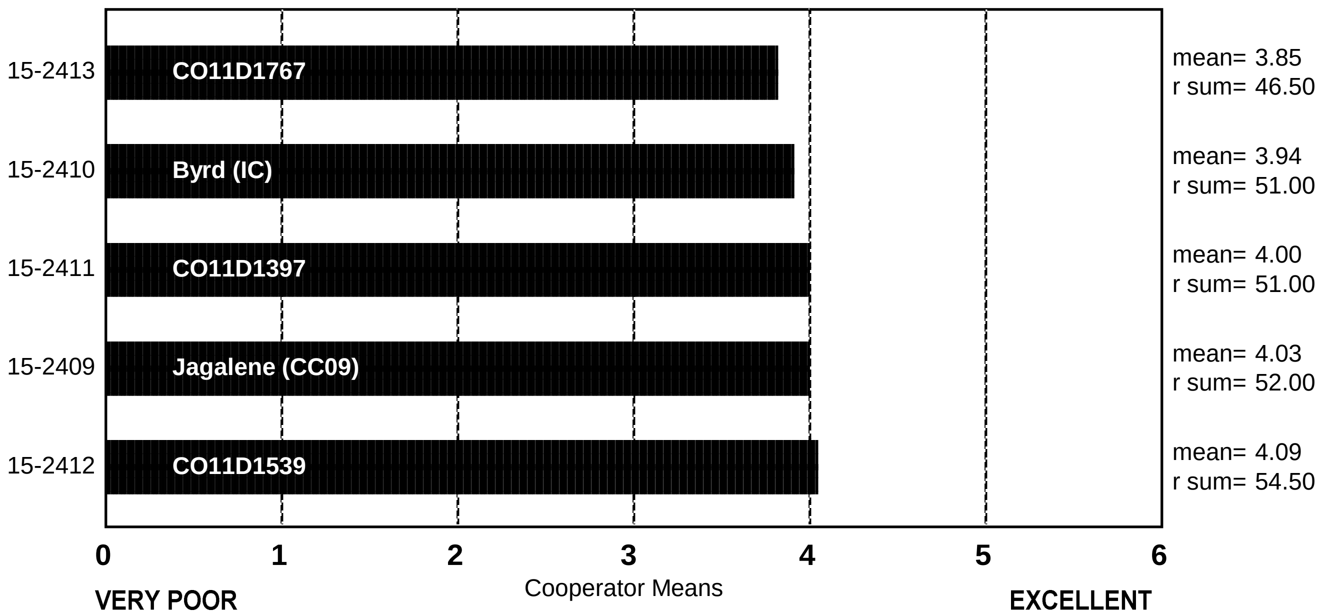


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Colorado

ncoop= 17
chisq= 0.79
chisqc= 1.05
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) Colorado

	Sticky	Wet	Tough	Good	Excellent
15-2409 Jagalene (CC09)	4	1	1	9	2
15-2410 Byrd (IC)	1	1	3	8	4
15-2411 CO11D1397	1	1	3	8	4
15-2412 CO11D1539	1	0	4	9	3
15-2413 CO11D1767	2	0	4	8	3

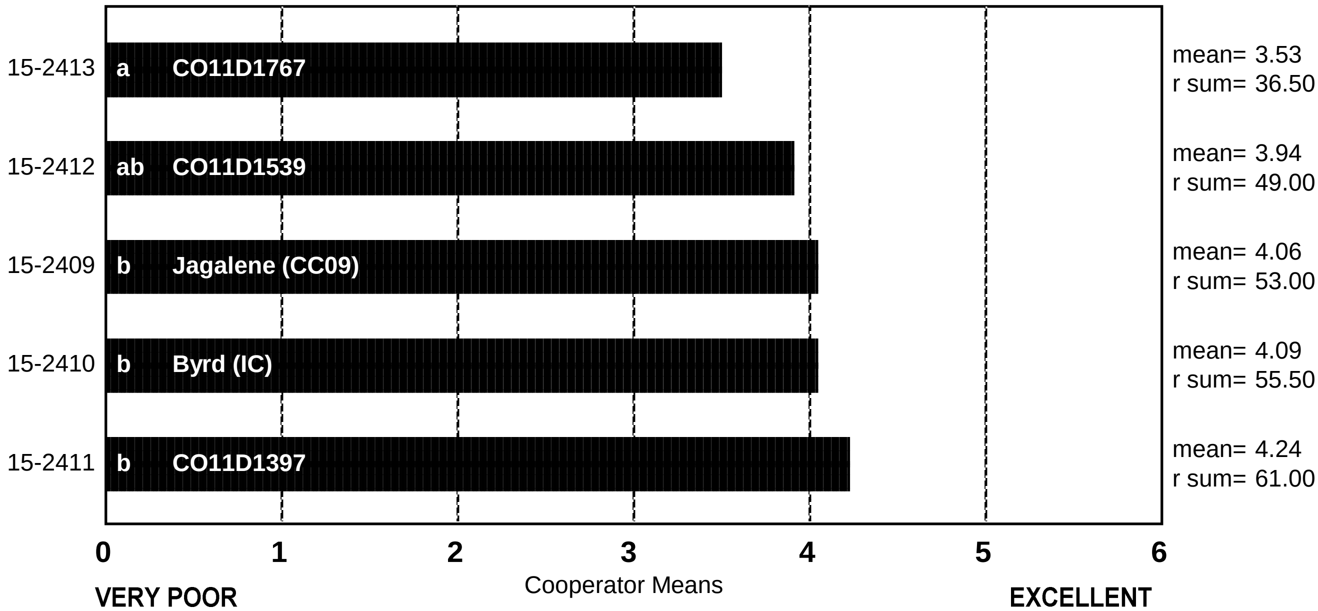
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Colorado

ncoop= 17
chisq= 7.96
chisqc= 12.65
cvchisq= 9.49
crdiff= 13.65

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Colorado

	Sticky	Wet	Tough	Good	Excellent
15-2409 Jagalene (CC09)	1	1	1	14	0
15-2410 Byrd (IC)	0	0	3	12	2
15-2411 CO11D1397	0	0	3	10	4
15-2412 CO11D1539	0	0	4	11	2
15-2413 CO11D1767	3	3	2	8	1

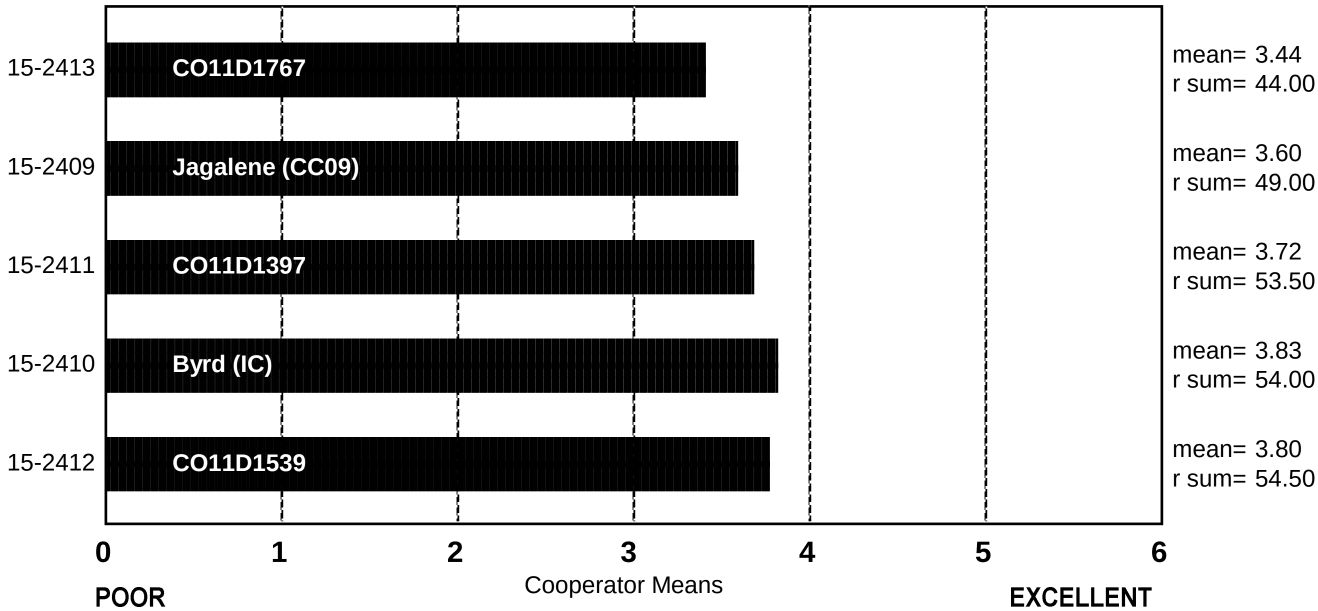
Frequency Table

CRUMB GRAIN

(Small Scale) Colorado

ncoop= 17
chisq= 1.89
chisqc= 2.35
cvchisq= 9.49
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Colorado

	Open	Fine	Dense
15-2409 Jagalene (CC09)	9	6	2
15-2410 Byrd (IC)	6	10	1
15-2411 CO11D1397	8	8	1
15-2412 CO11D1539	3	12	2
15-2413 CO11D1767	10	4	3

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Colorado

	Round	Irregular	Elongated
15-2409 Jagalene (CC09)	**5**	**5**	**7**
15-2410 Byrd (IC)	**3**	**7**	**7**
15-2411 CO11D1397	**4**	**6**	**7**
15-2412 CO11D1539	**6**	**3**	**8**
15-2413 CO11D1767	**6**	**7**	**4**

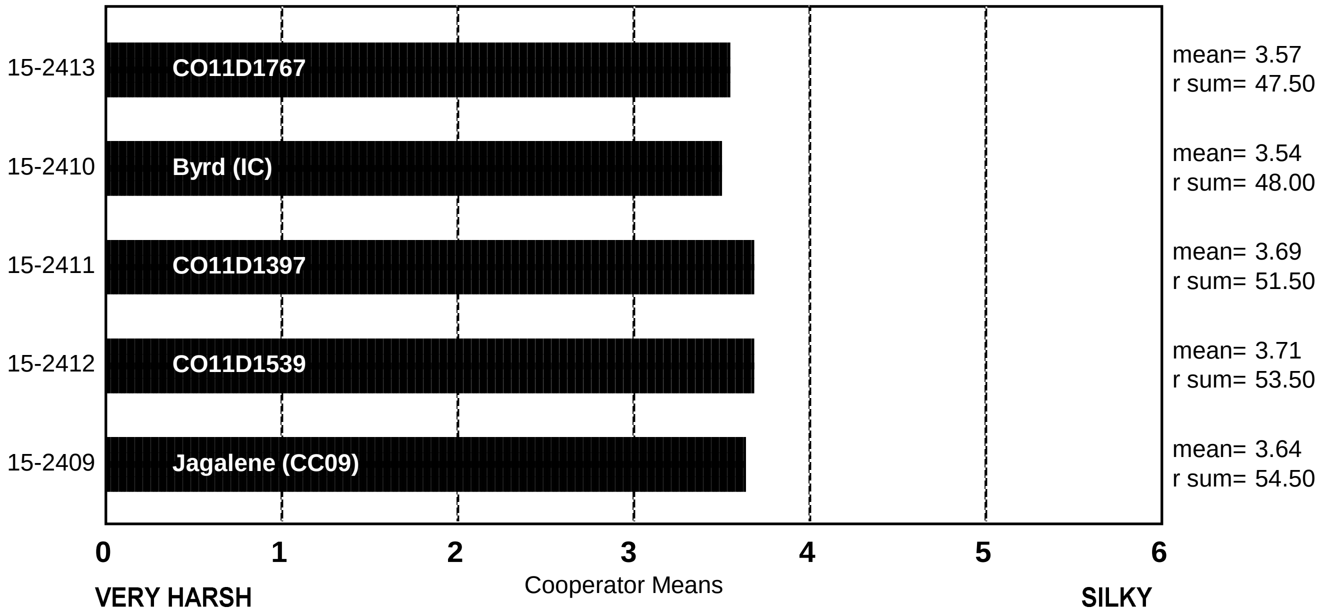
Frequency Table

CRUMB TEXTURE

(Small Scale) Colorado

ncoop= 17
chisq= 0.94
chisqc= 1.61
cvchisq= 9.49
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Colorado

	Harsh	Smooth	Silky
15-2409 Jagalene (CC09)	**4**	**10**	**3**
15-2410 Byrd (IC)	**5**	**10**	**2**
15-2411 CO11D1397	**4**	**10**	**3**
15-2412 CO11D1539	**5**	**9**	**3**
15-2413 CO11D1767	**5**	**10**	**2**

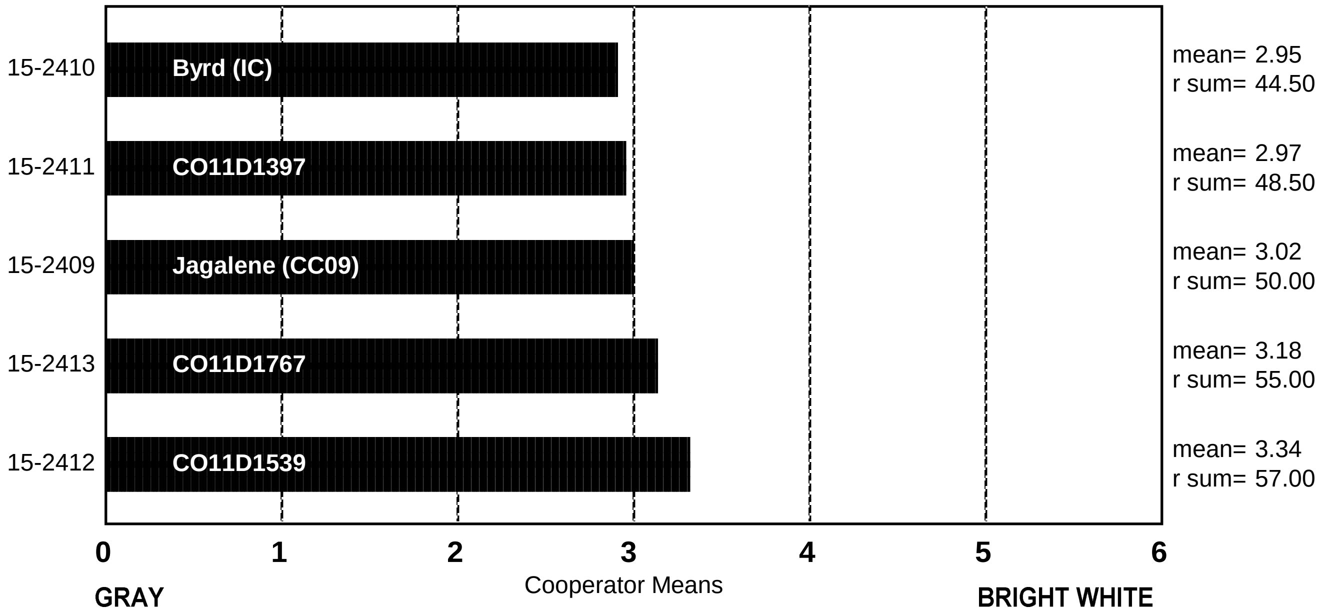
Frequency Table

CRUMB COLOR

(Small Scale) Colorado

ncoop= 17
chisq= 2.39
chisqc= 5.34
cvchisq= 9.49
crdiff=

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



CRUMB COLOR, DESCRIBED

(Small Scale) Colorado

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
15-2409 Jagalene (CC09)	0	1	6	4	5	1	0
15-2410 Byrd (IC)	0	2	3	5	7	0	0
15-2411 CO11D1397	0	1	4	4	7	0	1
15-2412 CO11D1539	0	1	5	3	6	1	1
15-2413 CO11D1767	0	1	6	3	4	2	1

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. O
15-2409 Jagalene (CC09)	**136.6**	**139.1**	**395.0**		**132.4**	**139.0**	**154.4**	**142.8**	**141.8**	**446.4**	**132.1**			**149.4**	**118.9**	**482.7**	**455.0**
15-2410 Byrd (IC)	**137.4**	**137.8**	**397.0**		**128.9**	**137.1**	**150.8**	**140.5**	**141.9**	**447.7**	**130.3**			**148.1**	**124.6**	**482.8**	**456.0**
15-2411 CO11D1397	**137.7**	**140.2**	**396.0**		**127.6**	**138.2**	**150.6**	**140.0**	**141.9**	**452.2**	**129.6**			**146.7**	**119.7**	**486.3**	**460.0**
15-2412 CO11D1539	**137.9**	**142.1**	**400.0**		**130.7**	**141.8**	**153.8**	**141.6**	**142.5**	**450.5**	**127.6**			**148.9**	**111.9**	**486.5**	**455.0**
15-2413 CO11D1767	**139.4**	**139.4**	**396.0**		**131.2**	**140.6**	**153.3**	**142.7**	**143.6**	**454.2**	**130.1**			**148.6**	**114.5**	**485.0**	**458.0**

LOAF VOLUME, ACTUAL

(Small Scale) Colorado

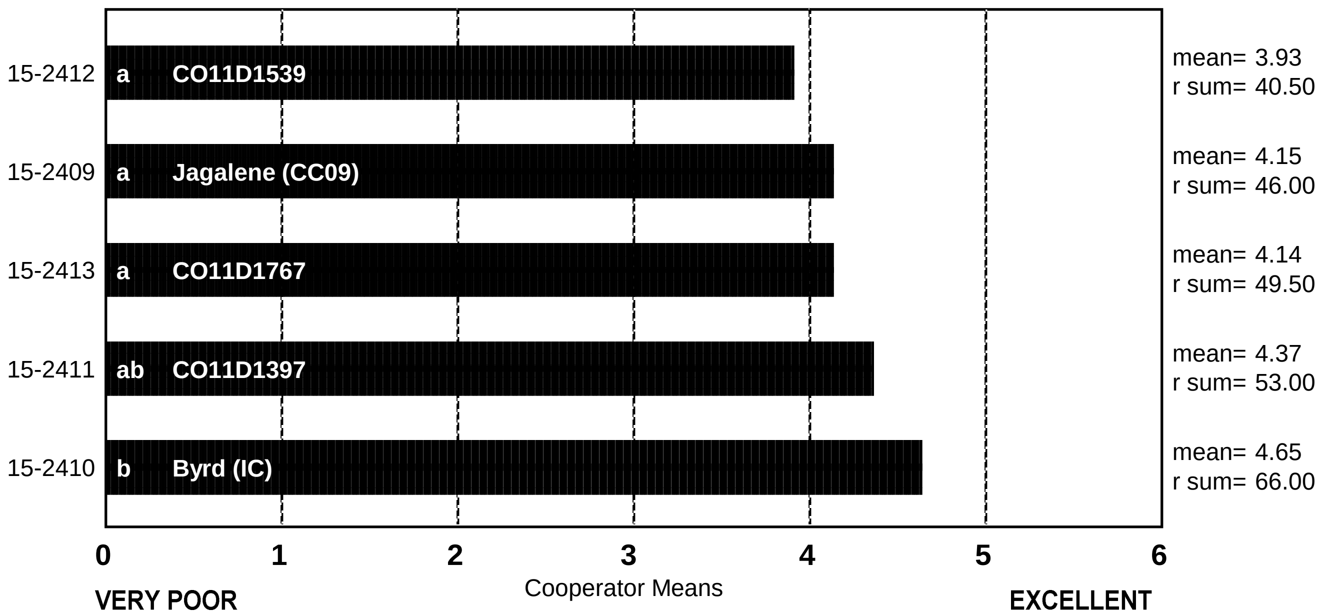
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2409 Jagalene (CC09)	**838**	**993**	**3100**	**995**	**890**	**1045**	**945**	**955**	**805**	**2830**	**965**	**790**	**2780**	**960**	**2400**	**2750**	**2275**
15-2410 Byrd (IC)	**852**	**943**	**3100**	**1050**	**868**	**1050**	**1055**	**1015**	**905**	**2958**	**1005**	**985**	**2927**	**975**	**2550**	**2488**	**2250**
15-2411 CO11D1397	**898**	**1018**	**2900**	**995**	**860**	**1030**	**975**	**985**	**905**	**2921**	**970**	**900**	**2839**	**925**	**2550**	**2413**	**2150**
15-2412 CO11D1539	**872**	**945**	**2850**	**960**	**883**	**973**	**955**	**905**	**780**	**2970**	**970**	**845**	**2603**	**925**	**2400**	**2475**	**2250**
15-2413 CO11D1767	**792**	**955**	**2875**	**1010**	**833**	**948**	**974**	**905**	**915**	**3114**	**1000**	**850**	**2927**	**945**	**2450**	**2525**	**2300**

LOAF VOLUME

(Small Scale) Colorado

ncoop= 17
chisq= 8.62
chisqc= 10.58
cvchisq= 9.49
crdiff= 15.82

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

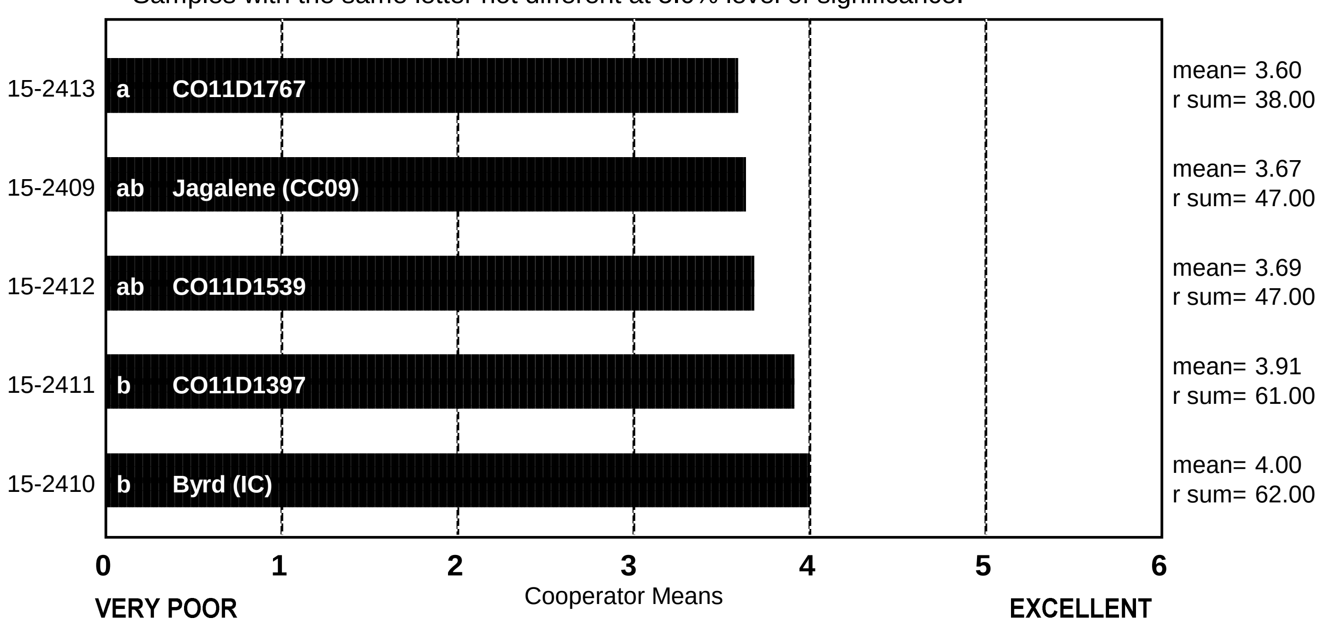


OVERALL BAKING QUALITY

(Small Scale) Colorado

ncoop= 17
chisq= 9.93
chisqc= 11.25
cvchisq= 9.49
crdiff= 16.37

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. **15-2409 Jagalene (CC09)**

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption, normal mix time, slight sticky & strong dough, very high volume, yellow crumb, open elongated cells, resilient & slightly harsh texture.
G. Shorter mix time but good overall mix strength, excellent absorption, average volume and crumb grain.
H. Rough break and shred.
I. Poor volume and grain.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Good bake absorption, mix time and dough strength; excellent crumb grain and loaf volume-nice check.
O. High absorption, low mix time, dough was good, bread collapsed before volume reading, good grain rating.
P. Short mix time, open grain, excellent volume.
Q. No comment.

COOP. **15-2410 Byrd (IC)**

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. Nice dough performance but poor bread quality; corn bread-like.
F. Normal water absorption, long mix time, slight sticky & strong dough, very high volume, yellow crumb, open elongated cells, resilient & slightly harsh texture.
G. Good dough properties, excellent absorption, very good volume and crumb grain.
H. No comment.
I. Low absorption for protein, good strength, poor grain.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Long mix time, good at makeup, satisfactory crumb grain, excellent loaf volume-nice check.
O. Average absorption, low mix time, dough was excellent, bread had excellent volume with a good grain rating.
P. Very low absorption, dark yellow crumb.
Q. Never reached full proof height, pulled at 75 minutes, wild break and shred, dark crust color and tough.

COOP. 15-2411 CO11D1397

A. No comment.
B. Very good quality overall.
C. No comment.
D. No comment.
E. Very yellow.
F. Normal water absorption, long mix time, slight sticky & strong dough, very high volume, yellow crumb, fine elongated cells, resilient & smooth texture.
G. Excellent dough properties, very good absorption, good volume performance but crumb grain weaker looking.
H. No comment.
I. Good volume for protein.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Low bake absorption, long mix time, good at makeup with satisfactory crumb grain and nice loaf volume-good experimental.
O. Low absorption, low mix time, dough was excellent, bread had excellent volume with a dense grain rating.
P. Very low absorption, good mix time, good grain, yellow crumb, low volume.
Q. Never reached full proof height, pulled at 75 minutes.

COOP. 15-2412 CO11D1539

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption and mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & very smooth texture.
G. Generally good dough properties but showing some signs of weakness in height of curve, very good absorption, good loaf volume and crumb grain.
H. No comment.
I. Poor volume, grain and color.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Good mix time, satisfactory crumb grain and loaf volume-good experimental.
O. Good absorption, low mix time, dough was excellent, bread had small volume with a dense grain rating.
P. Low absorption, short mix time, yellow crumb.
Q. No comment.

COOP. **15-2413 CO11D1767**

A. No comment.
B. Satisfactory quality overall.
C. No comment.
D. No comment.
E. Poor dough and bread performance.
F. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, open round cells, resilient & slightly harsh texture.
G. Average dough properties but showing some signs of weakness in height of curve, very good absorption, good loaf volume with weaker crumb grain.
H. No comment.
I. Good volume but open, poor color.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Rated lower than checks due to more open crumb grain, however good dough at makeup with nice loaf volume.
O. Low absorption, low mix time, dough was good, bread had good volume with an excellent dense grain rating.
P. Low absorption, short mix time, sticky dough, yellow crumb.
Q. No comment.

Notes: **C, D, M, O, P and Q** conducted sponge and dough bake tests

OKLAHOMA

15-2414	Jagalene (CC14)
15-2415	Gallagher (IC)
15-2416	OK11D25056
15-2417	OK13625
15-2418	OK10728W

Description of Test Plots and Breeder Entries

Oklahoma - Brett Carver

Grain samples for the 2015 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. Grain yields at this site averaged around 35 bu/ac in 2015 but fluctuated widely according to specific variety responses to an early and extended infection of stripe rust. Other foliar diseases finished what stripe rust started during the last two weeks of May when record-setting precipitation occurred. Fusarium head blight was much less a factor at Lahoma versus areas to the east. Compared with long-term trends, protein levels in 2015 at Lahoma were down about one-half to one percentage unit, and flour yields were depressed by five percentage points or more. Thousand-kernel weight was also greatly reduced by 5 to 10 g, though kernel diameter was less affected. Mixing tolerance and sedimentation volumes were on par with long-term trends.

Entries included in the Oklahoma set included the standard check, Jagalene, produced alongside the three experimentals and local check, Gallagher. We were forced to forego Ruby Lee as the intended local check due to sprout damage. All experimental entries have been tested or are currently being tested in the USDA-ARS Southern Regional Performance Nursery.

15-2415 **Gallagher (local check)**

Standing in this year for Ruby Lee as the local check is Gallagher, a participant in the WQC evaluation program in 2012, the same year it was released alongside Iba. Gallagher is a hard red winter (HRW) progeny of Duster but with improved grain yield potential and kernel size, earlier maturity, and excellent protection against current races of stripe rust. Gallagher has occupied a significant portion of the Oklahoma wheat acreage, behind Duster and Endurance.

15-2416 **OK11D25056**

A doubled haploid from the cross, OK05511(=TAM 110/2174)/Gallagher, this HRW experimental line combines resistance to Hessian fly (Duster source of resistance) and to biotype E greenbug, and was produced in cooperation with AgriPro-Syngenta (original collaboration with David Worrall). OK11D25056 is widely adapted and shows excellent leaf hygiene, except in the presence of wheat streak mosaic or under conditions of physiological leaf spotting. It is highly effective against current races of stripe rust and contains *Lr34*/*Yr1*8. Milling and baking properties have been acceptable. Foundation seed production is currently in the second year.

***15-2417* OK13625**

This HRW candidate comes from the cross, AP01T1114/Billings, and produces grain close in appearance and functionality to Billings. Hence OK13625 normally produces high test weight combined with large kernel size, above-average protein levels, and excellent dough strength. Among this panel of candidates, OK13625 may represent the best overall end-use quality. Agronomically, OK13625 shows very rapid emergence and canopy closure, along with good field tolerance to drought and/or low nitrogen fertility. OK13625 appears best fit to downstate Oklahoma given its exceptional disease package but below-average winterhardiness in higher elevations. Foundation seed production is currently in the second year.

***15-2418* OK10728W**

This hard white candidate comes from a cross of two hard white parents (OK Rising/OK98G508W-2-49) and is best described as a yield-improved version of OK Rising with bronze chaff. OK Rising shared the same pedigree with OK Bullet (Jagger/KS96WGRC39). OK98G508W-2-49 was developed from the single cross, Rio Blanco/KS90WGRC10. Milling and baking properties of OK10728W have been acceptable and similar to OK Bullet. Features that stand out, for better or worse, are good pre-harvest sprouting tolerance, elevated flour yield, and susceptibility to leaf rust. Kernel size has typically been above-average, though the sample submitted here showed unduly low thousand-kernel weight due to a poor finish at Lahoma, OK in 2015. OK107288W is well adapted to the northern half of Oklahoma, but if released it will likely be positioned for production in north central Oklahoma.

Oklahoma: 2015 (Small-Scale) Samples

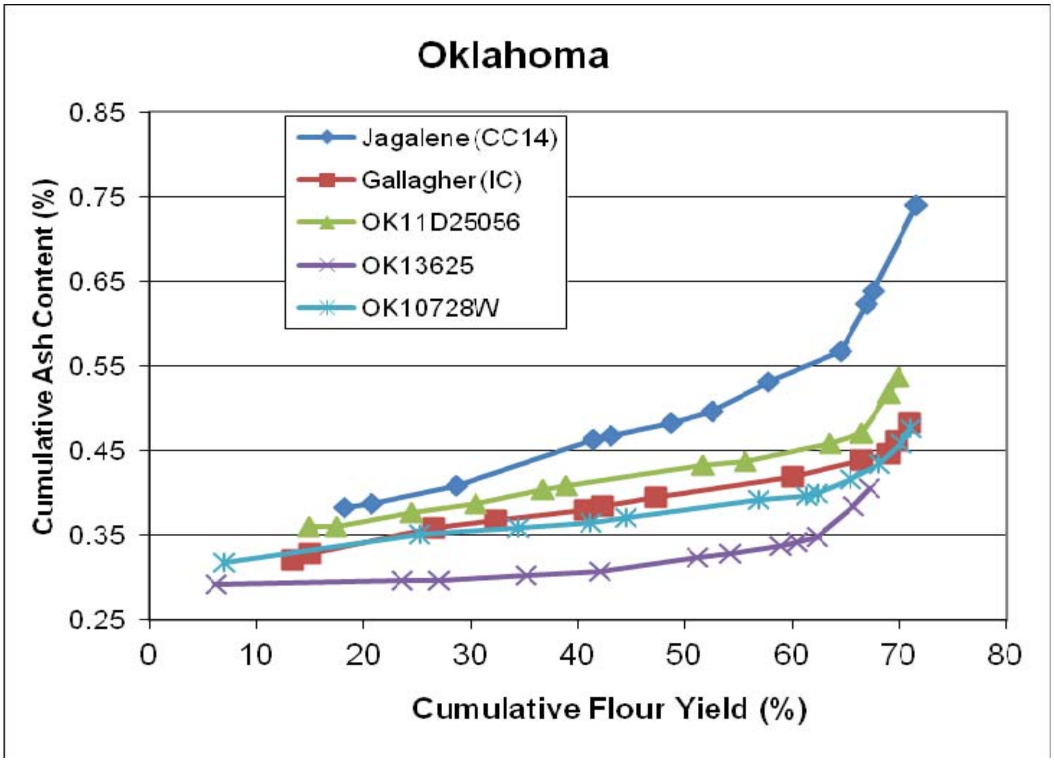
Test entry number	15-2414	15-2415	15-2416	15-2417	15-2418
Sample identification	**Jagalene (CC14)**	**Gallagher (IC)**	**OK11D25056**	**OK13625**	**OK10728W**
Wheat Data					
GIPSA classification	2 HRW	1 HRW	1 HRW	1 HRW	3HDWH
Test weight (lb/bu) **Hectoliter weight (kg/hl)**	59.0 77.6	62.3 81.9	60.3 79.3	62.2 81.8	56.7 74.7
1000 kernel weight (gm)	27.8	31.8	29.4	31.5	24.0
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 42.9 53.3 3.8	 68.9 29.8 1.3	 50.0 47.5 2.5	 61.8 37.3 0.9	 33.3 62.5 4.2
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	 71.7/18.9 27.8/9.1 2.55/0.37 11.4/0.4 03-08-13-76-01 Hard	 70.3/15.5 31.8/9.4 2.67/0.36 11.7/0.4 02-03-18-77-01 Hard	 69.9/15.1 29.4/8.1 2.55/0.32 11.5/0.4 01-06-13-80-01 Hard	 56.6/15.0 31.5/9.4 2.67/0.32 11.6/0.4 06-18-32-44-02 Hard	 55.4/17.0 24.0/7.0 2.36/0.28 11.7/0.4 09-19-32-40-02 Hard
Wheat protein (12% mb) **Wheat ash (12% mb)**	12.4 1.62	11.4 1.48	11.8 1.52	12.6 1.58	12.4 1.66
Milling and Flour Quality Data					
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 74.1 63.8	 72.0 64.2	 74.6 63.5	 71.9 62.3	 70.6 64.9
Flour moisture (%) **Flour protein (14% mb)** **Flour ash (14% mb)**	12.5 11.2 0.62	13.0 10.6 0.50	13.4 11.0 0.56	12.2 11.0 0.42	12.3 11.1 0.49
Rapid Visco-Analyser Peak time (min) Peak viscosity (RVU) Breakdown (RVU) Final viscosity at 13 min (RVU)	 5.9 178.1 74.3 208.2	 6.1 171.0 62.3 213.8	 6.0 188.1 76.5 215.6	 5.9 193.1 90.0 201.2	 6.1 211.9 88.5 238.7
Minolta color meter L* a* b* **PPO**	 91.01 -1.19 9.89 0.507	 91.21 -1.66 10.49 0.224	 90.87 -1.22 9.49 0.599	 92.28 -1.29 8.06 0.157	 92.02 -1.67 9.61 0.485
Falling number (sec)	397	551	529	371	514
Damaged Starch (AI%) (AACC76-31)	 97.36 7.37	 97.42 7.42	 97.02 7.09	 96.82 6.93	 96.34 6.54

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

Oklahoma: Physical Dough Tests and Gluten Analysis
2015 (Small-Scale) Samples

Test Entry Number	15-2414	15-2415	15-2416	15-2417	15-2418
Sample Identification	Jagalene (CC14)	Gallagher (IC)	OK11D25056	OK13625	OK10728W
MIXOGRAPH					
Flour Abs (% as-is)	65.9	63.8	65.4	67.9	66.3
Flour Abs (14% mb)	64.2	62.7	64.7	65.8	64.4
Mix Time (min)	3.5	3.8	4.5	4.4	3.4
Mix tolerance (0-6)	3	4	4	4	4
FARINOGRAPH					
Flour Abs (% as-is)	62.8	62.3	62.6	62.9	58.1
Flour Abs (14% mb)	61.1	61.1	61.9	60.8	56.2
Development time (min)	5.3	5.3	2.7	2.9	4.8
Mix stability (min)	7.2	9.4	8.9	7.0	8.6
Mix Tolerance Index (FU)	35	24	24	25	28
Breakdown time (min)	9.3	11.4	9.2	8.9	9.8
ALVEOGRAPH					
P(mm): Tenacity	104	114	120	116	79
L(mm): Extensibility	93	72	70	84	133
G(mm): Swelling index	21.5	18.9	18.6	20.4	25.7
W(10^{-4} J): strength (curve area)	309	281	296	333	295
P/L: curve configuration ratio	1.12	1.58	1.71	1.38	0.59
Ie(P_{200}/P): elasticity index	53.4	51.6	52.8	54.9	52.8
EXTENSIGRAPH					
Resist (BU at 45/90/135 min)	341/400/386	329/383/409	424/577/616	423/491/576	377/419/449
Extensibility (mm at 45/90/135 min)	146/152/146	142/144/139	132/134/125	136/137/138	160/162/157
Energy (cm^2 at 45/90/135 min)	86/111/99	82/96/95	92/130/124	98/116/135	112/126/132
Resist $_{max}$ (BU at 45/90/135min)	442/560/532	417/503/515	525/762/776	542/655/774	508/577/636
Ratio (at 45/90/135 min)	2.34/2.63/2.65	2.31/2.67/2.95	3.22/4.32/4.92	3.12/3.59/4.18	2.36/2.58/2.86
PROTEIN ANALYSIS					
HMW-GS Composition	2*,1, 17+18, 5+10	2*, 7+9, 5+10	2*, 7+8, 5+10	1, 7+9, 5+10	2*, 7+8, 5+10
%IPP	52.39	47.06	50.13	46.96	46.46
SEDIMENTATION TEST					
Volume (ml)	46.7	38.1	40.2	64.6	51.0

Oklahoma: Cumulative Ash Curves



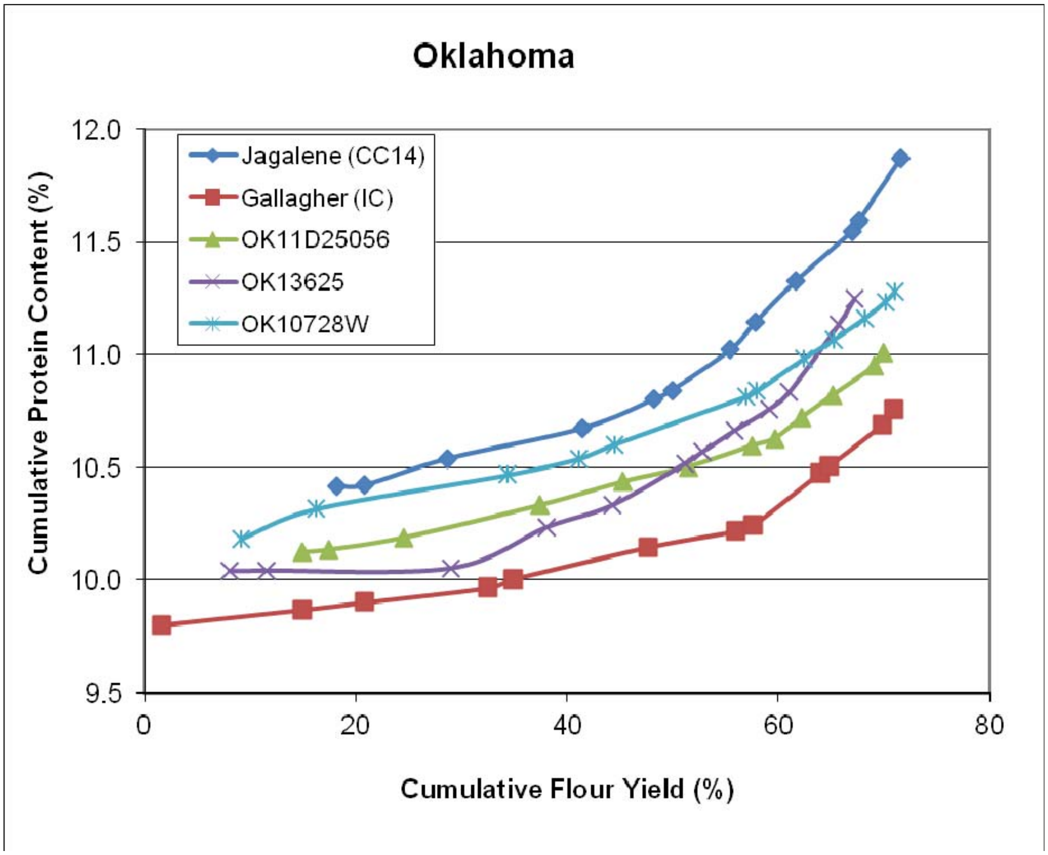
Jagalene (CC14)					Gallagher (IC)					OK11D25056				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
2M	18.23	0.38	18.23	0.38	2M	13.39	0.32	13.39	0.32	2M	14.91	0.36	14.91	0.36
1M Red	2.57	0.42	20.81	0.39	1M Red	1.60	0.39	14.99	0.33	1M Red	2.52	0.36	17.43	0.36
1M	7.91	0.46	28.72	0.41	3M	11.59	0.40	26.57	0.36	1M	7.11	0.42	24.54	0.38
3M	12.76	0.59	41.48	0.46	1M	5.89	0.41	32.46	0.37	1BK	6.00	0.43	30.54	0.39
Grader	1.71	0.59	43.20	0.47	1BK	8.25	0.43	40.71	0.38	FILTER FLR	6.23	0.48	36.77	0.40
1BK	5.56	0.60	48.75	0.48	Grader	1.69	0.47	42.40	0.38	Grader	2.13	0.50	38.89	0.41
2BK	3.79	0.67	52.54	0.50	2BK	5.01	0.49	47.41	0.39	3M	12.85	0.50	51.75	0.43
3BK	5.33	0.86	57.87	0.53	FILTER FLR	12.77	0.51	60.19	0.42	2BK	3.88	0.51	55.62	0.44
4M	6.73	0.89	64.60	0.57	3BK	6.38	0.62	66.57	0.44	4M	7.91	0.61	63.54	0.46
5M	2.36	2.16	66.96	0.62	4M	2.44	0.66	69.01	0.45	3BK	3.03	0.70	66.57	0.47
BRAN FLR	0.66	2.22	67.62	0.64	5M	0.82	1.74	69.83	0.46	5M	2.51	1.76	69.08	0.52
FILTER FLR	3.96	2.46	71.58	0.74	BRAN FLR	1.16	1.76	70.99	0.48	BRAN FLR	0.90	2.16	69.98	0.54
Break Shorts	3.22	4.44	74.80	0.90	Break Shorts	3.27	3.68	74.26	0.62	Break Shorts	3.64	3.95	73.62	0.71
Red Dog	2.22	3.04	77.02	0.96	Red Dog	0.55	2.32	74.82	0.64	Red Dog	1.97	2.64	75.59	0.76
Red Shorts	0.24	4.05	77.26	0.97	Red Shorts	0.10	3.51	74.92	0.64	Red Shorts	0.22	3.63	75.81	0.77
Filter Bran	4.95	3.07	82.22	1.10	Filter Bran	7.63	1.29	82.55	0.70	Filter Bran	6.12	0.86	81.93	0.77
Bran	17.78	5.67	100.0	1.91	Bran	17.45	5.09	100.0	1.47	Bran	18.07	5.26	100.0	1.58
Wheat		1.58					1.45					1.49		
St. Grd. Fl.		0.62					0.50					0.56		

Oklahoma: Cumulative Ash Curves (continued)

OK13625					OK10728W				
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
3M	6.19	0.29	6.19	0.29	1M Red	7.02	0.32	7.02	0.32
2M	17.38	0.30	23.57	0.30	2M	18.21	0.36	25.23	0.35
1M Red	3.49	0.30	27.06	0.30	1M	9.19	0.38	34.42	0.36
1M	8.10	0.32	35.16	0.30	1BK	6.77	0.40	41.19	0.36
1BK	6.91	0.33	42.07	0.31	Grader	3.32	0.44	44.51	0.37
4M	9.09	0.40	51.15	0.32	3M	12.43	0.47	56.94	0.39
Grader	3.11	0.41	54.27	0.33	2BK	4.47	0.47	61.41	0.40
2BK	4.66	0.43	58.93	0.34	FILTER FLR	1.05	0.54	62.46	0.40
FILTER FLR	1.61	0.53	60.54	0.34	3BK	3.01	0.75	65.47	0.42
3BK	1.93	0.54	62.47	0.35	4M	2.75	0.87	68.21	0.43
5M	3.23	1.10	65.70	0.38	5M	1.95	1.31	70.16	0.46
BRAN FLR	1.52	1.29	67.22	0.41	BRAN FLR	0.89	1.90	71.06	0.48
Break Shorts	3.52	2.82	70.74	0.53	Break Shorts	4.94	4.39	76.00	0.73
Red Dog	2.15	2.01	72.89	0.57	Red Dog	4.03	2.35	80.03	0.81
Red Shorts	0.47	3.34	73.36	0.59	Red Shorts	0.20	4.58	80.23	0.82
Filter Bran	3.03	1.31	76.39	0.62	Filter Bran	2.21	1.77	82.44	0.85
Bran	23.61	4.99	100.0	1.65	Bran	17.56	5.40	100.0	1.65

Wheat		1.55					1.62		
St. Grd. Fl.		0.42					0.49		

Oklahoma: Cumulative Protein Curves



Jagalene (CC14)					Gallagher (IC)					OK11D25056				
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	18.23	10.42	18.23	10.42	1M Red	1.60	9.80	1.60	9.80	2M	14.91	10.12	14.91	10.12
1M Red	2.57	10.45	20.81	10.42	2M	13.39	9.88	14.99	9.87	1M Red	2.52	10.20	17.43	10.13
1M	7.91	10.85	28.72	10.54	1M	5.89	9.99	20.88	9.90	1M	7.11	10.32	24.54	10.19
3M	12.76	10.98	41.48	10.68	3M	11.59	10.09	32.46	9.97	3M	12.85	10.61	37.39	10.33
4M	6.73	11.59	48.21	10.80	4M	2.44	10.49	34.91	10.00	4M	7.91	10.93	45.31	10.44
Grader	1.71	11.99	49.93	10.84	FILTER FLR	12.77	10.54	47.68	10.15	FILTER FLR	6.23	10.99	51.54	10.50
1BK	5.56	12.65	55.48	11.03	1BK	8.25	10.63	55.93	10.22	1BK	6.00	11.39	57.54	10.60
5M	2.36	14.03	57.84	11.15	Grader	1.69	11.08	57.62	10.24	Grader	2.13	11.50	59.66	10.63
2BK	3.79	14.08	61.63	11.33	3BK	6.38	12.60	64.00	10.48	5M	2.51	12.89	62.17	10.72
3BK	5.33	14.12	66.96	11.55	5M	0.82	12.67	64.82	10.51	3BK	3.03	12.93	65.20	10.82
BRAN FLR	0.66	16.36	67.62	11.60	2BK	5.01	13.08	69.83	10.69	2BK	3.88	13.09	69.08	10.95
FILTER FLR	3.96	16.60	71.58	11.87	BRAN FLR	1.16	14.94	70.99	10.76	BRAN FLR	0.90	15.46	69.98	11.01
Break Shorts	3.22	16.12	74.80	12.06	Break Shorts	3.27	14.21	74.26	10.91	Break Shorts	3.64	14.56	73.62	11.18
Red Dog	2.22	14.16	77.02	12.12	Red Dog	0.55	12.66	74.82	10.92	Red Dog	1.97	13.03	75.59	11.23
Red Shorts	0.24	13.41	77.26	12.12	Red Shorts	0.10	12.53	74.92	10.93	Red Shorts	0.22	12.34	75.81	11.24
Filter Bran	4.95	13.24	82.22	12.19	Filter Bran	7.63	11.07	82.55	10.94	Filter Bran	6.12	10.74	81.93	11.20
Bran	17.78	14.47	100.00	12.59	Bran	17.45	14.40	100.00	11.54	Bran	18.07	15.50	100.00	11.98
Wheat		12.15					11.13					11.55		
St. Grd. Fl		11.40					10.76					11.05		

Oklahoma: Cumulative Protein Curves (continued)

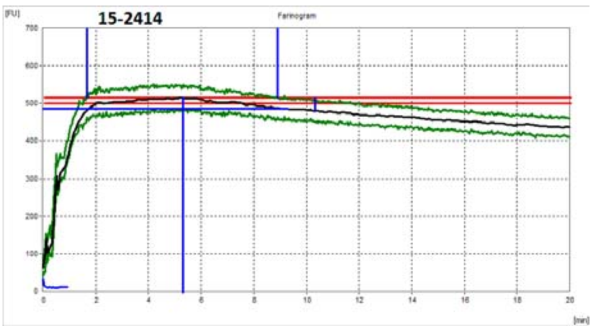
OK13625					OK10728W				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1M	8.10	10.04	8.10	10.04	1M	9.19	10.18	9.19	10.18
1M Red	3.49	10.05	11.59	10.04	1M Red	7.02	10.49	16.21	10.32
2M	17.38	10.06	28.98	10.05	2M	18.21	10.60	34.42	10.47
4M	9.09	10.82	38.06	10.24	1BK	6.77	10.91	41.19	10.54
3M	6.19	10.93	44.25	10.33	Grader	3.32	11.38	44.51	10.60
1BK	6.91	11.71	51.15	10.52	3M	12.43	11.57	56.94	10.81
FILTER FLR	1.61	12.14	52.77	10.57	FILTER FLR	1.05	12.18	57.99	10.84
Grader	3.11	12.31	55.88	10.67	2BK	4.47	12.86	62.46	10.98
5M	3.23	12.37	59.11	10.76	4M	2.75	12.91	65.21	11.07
3BK	1.93	13.21	61.04	10.84	3BK	3.01	13.27	68.21	11.16
2BK	4.66	15.03	65.70	11.13	5M	1.95	13.84	70.16	11.24
BRAN FLR	1.52	16.26	67.22	11.25	BRAN FLR	0.89	14.74	71.06	11.28
Break Shorts	3.52	13.84	70.74	11.38	Break Shorts	4.94	15.66	76.00	11.57
Red Dog	2.15	13.84	72.89	11.45	Red Dog	4.03	14.19	80.03	11.70
Red Shorts	0.47	12.95	73.36	11.46	Red Shorts	0.20	14.97	80.23	11.71
Filter Bran	3.03	12.30	76.39	11.49	Filter Bran	2.21	12.60	82.44	11.73
Bran	23.61	16.42	100.00	12.66	Bran	17.56	15.42	100.00	12.38
Wheat		12.31					12.07		
St. Grd. Fl		11.22					11.27		

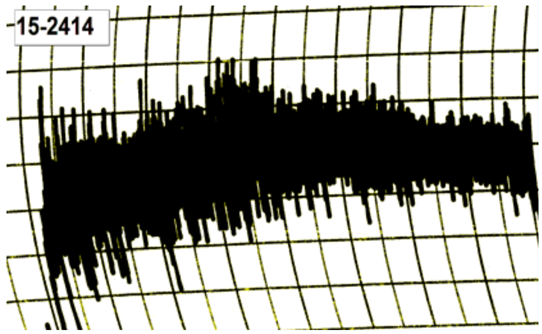
Physical Dough Tests

2015 (Small Scale) Samples - Oklahoma

Farinograms

Mixograms

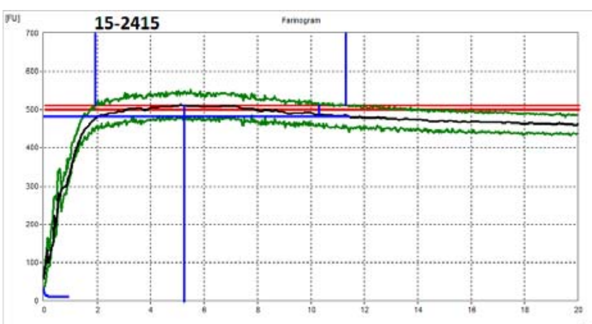


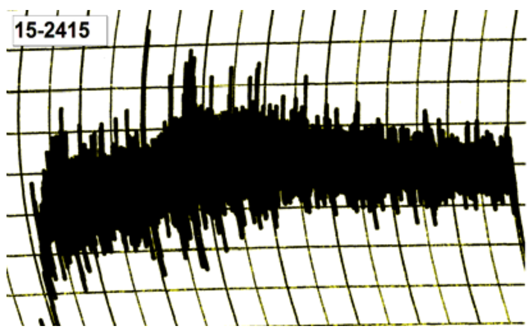


Water abs = 61.1%, Peak time = 5.3 min,
Mix stab = 7.2 min, MTI = 35 FU

Water abs = 64.2%
Mix time = 3.5 min

15-2414, Jagalene (CC14)





Water abs = 61.1%, Peak time = 5.3 min,
Mix stab = 9.4 min, MTI = 24 FU

Water abs = 62.7%
Mix time = 3.8 min

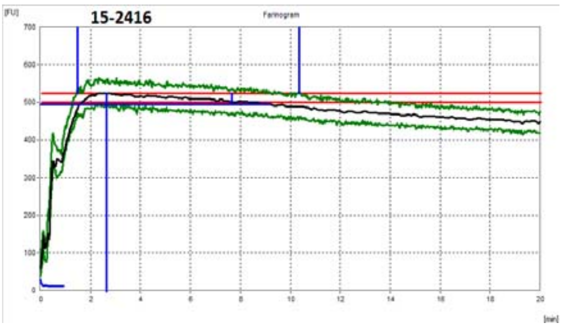
15-2415, Gallagher (IC)

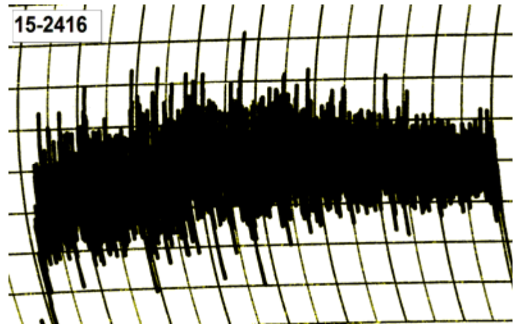
Physical Dough Tests

2015 (Small Scale) Samples - Oklahoma (continued)

Farinograms

Mixograms

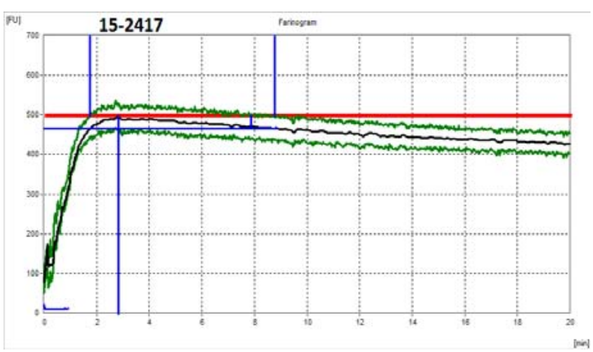


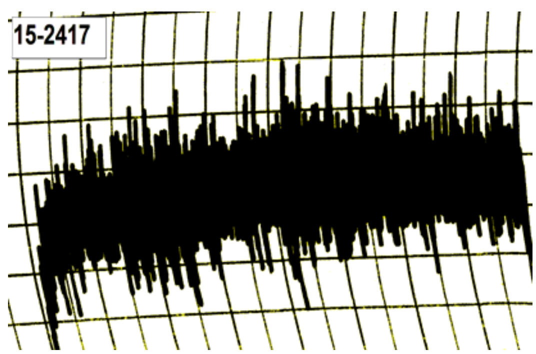


Water abs= 61.9%, Peak time = 2.7 min,
Mix stab = 8.9 min, MTI = 24 FU

Water abs = 64.7%
Mix time = 4.5 min

15-2416, OK11D25056





Water abs= 60.8%, Peak time = 2.9 min,
Mix stab = 7.0 min, MTI = 25 FU

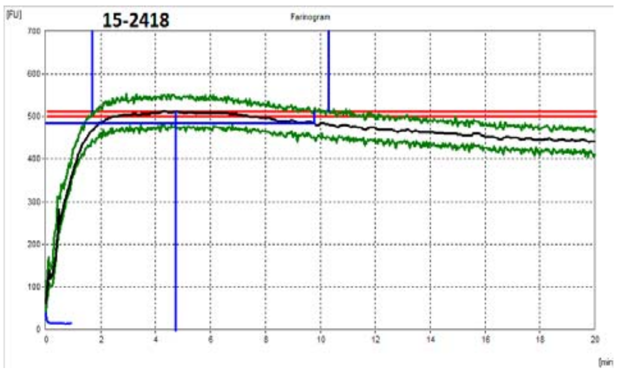
Water abs = 65.8%
Mix time = 4.4 min

15-2417, OK13625

Physical Dough Tests

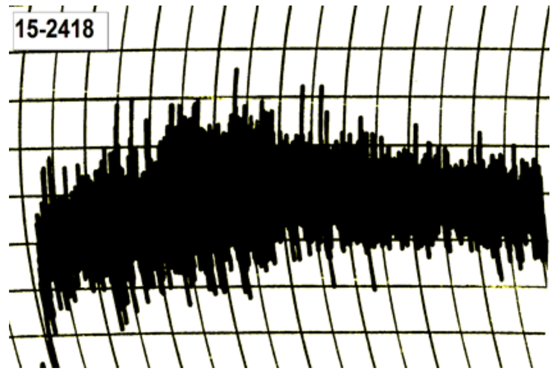
2015 (Small Scale) Samples - Oklahoma (continued)

Farinograms



Water abs= 56.2%, Peak time = 4.8 min,
Mix stab = 8.6 min, MTI = 28 FU

Mixograms

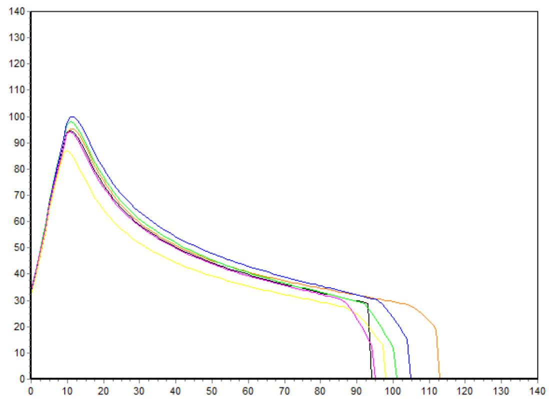


Water abs = 64.4%
Mix time = 3.4 min

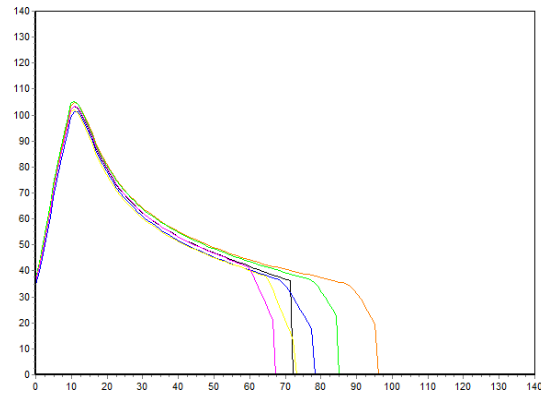
15-2418, OK10728W

Physical Dough Tests - Alveograph

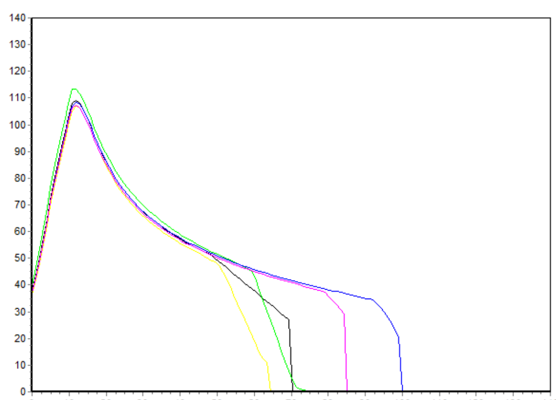
2015 (Small Scale) Samples – Oklahoma



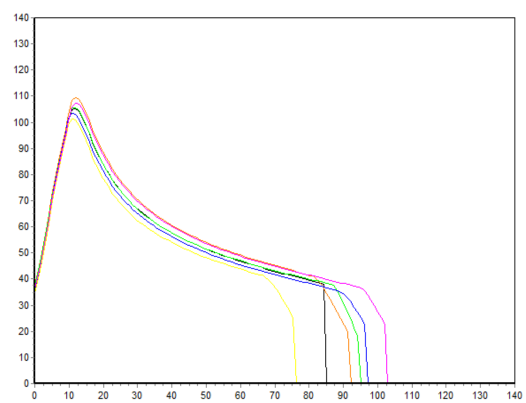
15-2414, Jagalene (CC14)
P(mm H_20)=104, L(mm)=93, W($10E^{-4}$ J)=309



15-2415, Gallagher (IC)
P(mm H_20)=114, L(mm)=72, W($10E^{-4}$ J)=281

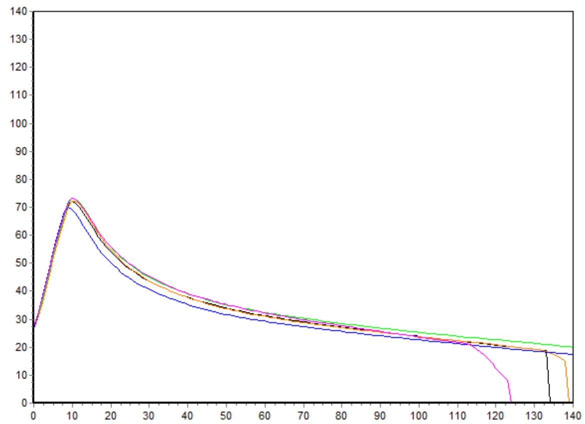


15-2416, OK11D25056
P(mm H_20)=120, L(mm)=70 W($10E^{-4}$ J)=296



15-2417, OK13625
P(mm H_20)=116, L(mm)=84, W($10E^{-4}$ J)=333

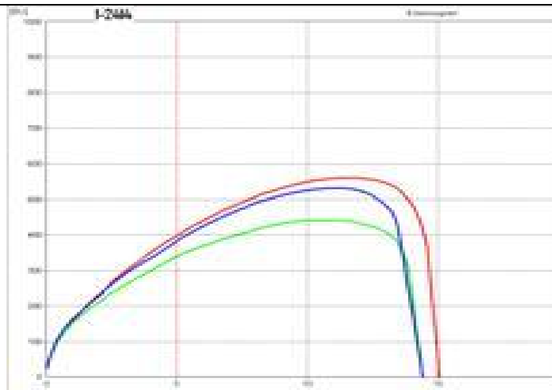
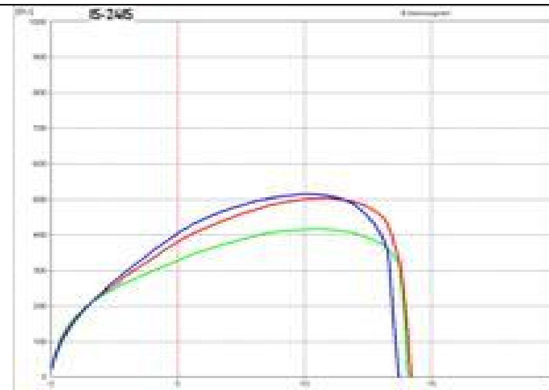
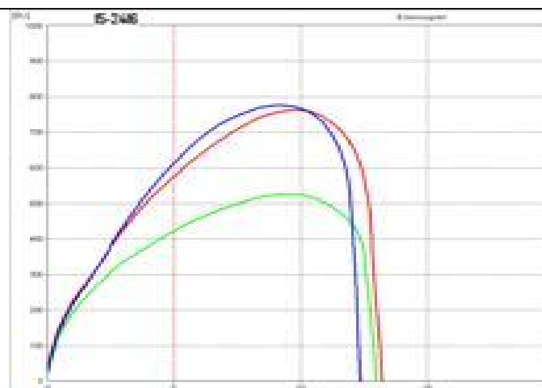
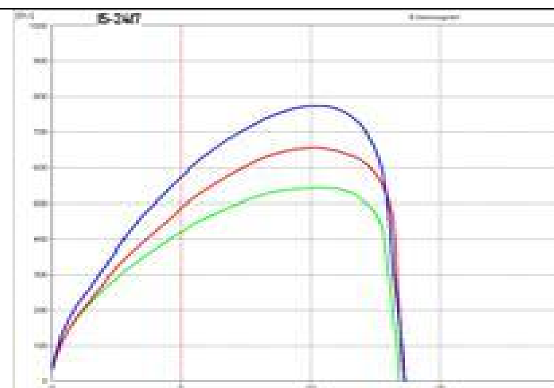
Physical Dough Tests - Alveograph
2015 (Small Scale) Samples – Oklahoma (continued)



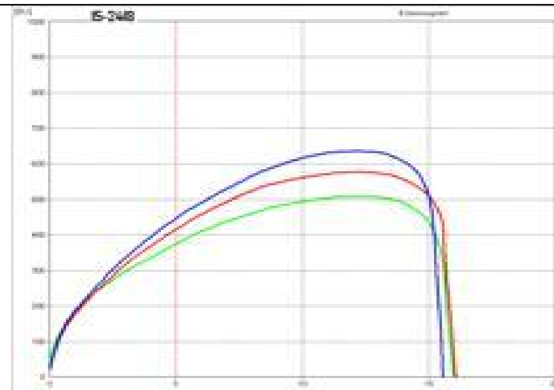
15-2418, OK10728W
P(mm H_20)=79, L(mm)=133, W(10E^{-4} J)=295

Physical Dough Tests - Extensigraph

2015 (Small Scale) Samples – Oklahoma

 **15-2414 Jagalene (CC14)** R (BU) = 400, E (mm) = 152, W (cm^2) = 111 Rmax (BU) = 560, Ratio = 2.6 at 90 min	 **15-2415 Gallagher (IC)** R (BU) = 383, E (mm) = 144, W (cm^2) = 96 Rmax (BU) = 503, Ratio = 2.7 at 90 min
 **15-2416 OK11D25056** R (BU) = 577, E (mm) = 134, W (cm^2) = 130 Rmax (BU) = 762, Ratio = 4.3 at 90 min	 **15-2417 OK13625** R (BU) = 491, E (mm) = 137, W (cm^2) = 116 Rmax (BU) = 655, Ratio = 3.6 at 90 min

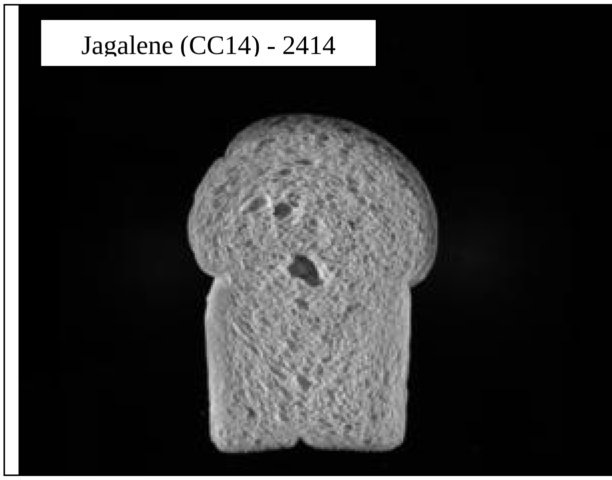
Physical Dough Tests - Extensigraph
2015 (Small Scale) Samples – Oklahoma (continued)



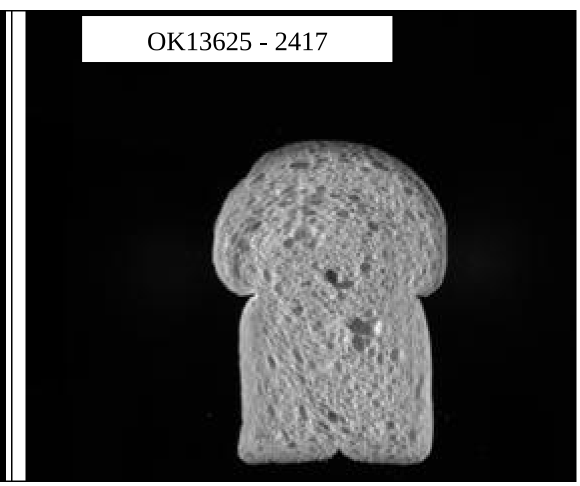
15-2418 OK10728W
R (BU) = 419, E (mm) = 162, W (cm^2) = 126
Rmax (BU) = 577, Ratio = 2.6 at 90 min

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 2015 (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	6566	134.3	4395	0.433	1.825	2.687	1.680	-22.28
2415	5719	141.2	3915	0.433	1.795	2.392	1.665	-21.98



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	6028	135.7	3869	0.440	1.907	2.654	1.678	-19.63
2417	6058	144.1	3968	0.441	1.914	4.446	1.718	-20.73

Oklahoma: C-Cell Bread Images and Analysis for 2015 (Small-Scale) Samples (continued)

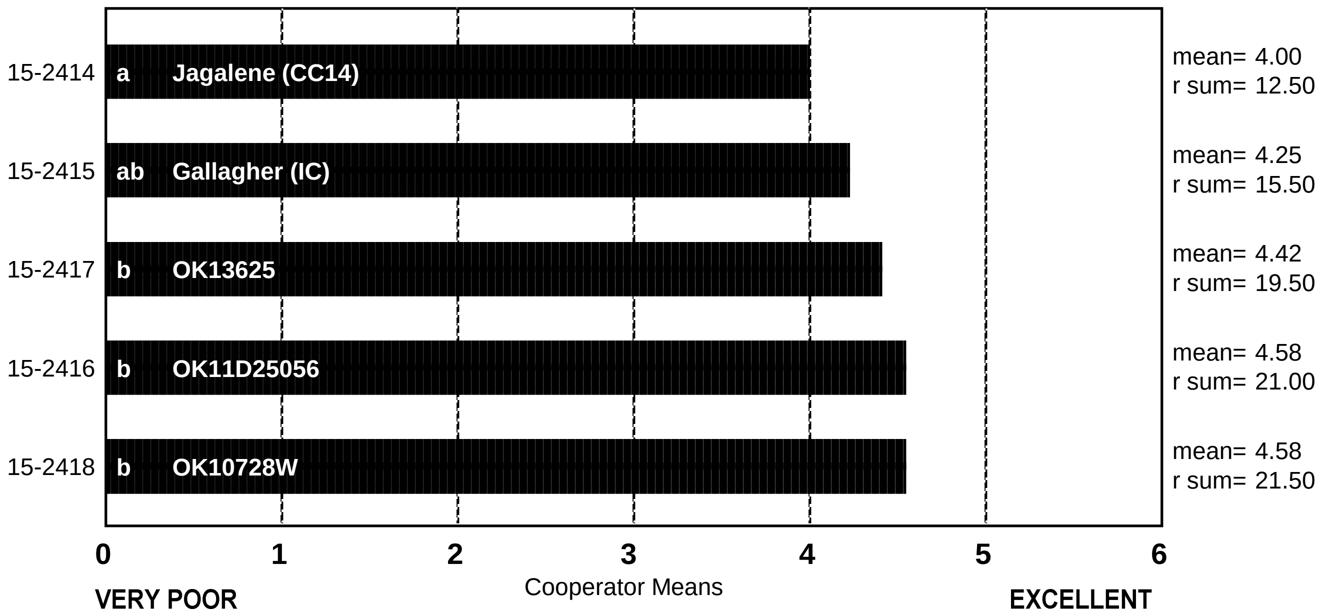
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2418	5879	146.1	4152	0.429	1.746	3.312	1.675	-24.53

SPONGE CHARACTERISTICS

(Small Scale) Oklahoma

ncoop= 6
chisq= 4.00
chisqc= 9.60
cvchisq= 9.49
crdiff= 6.26

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

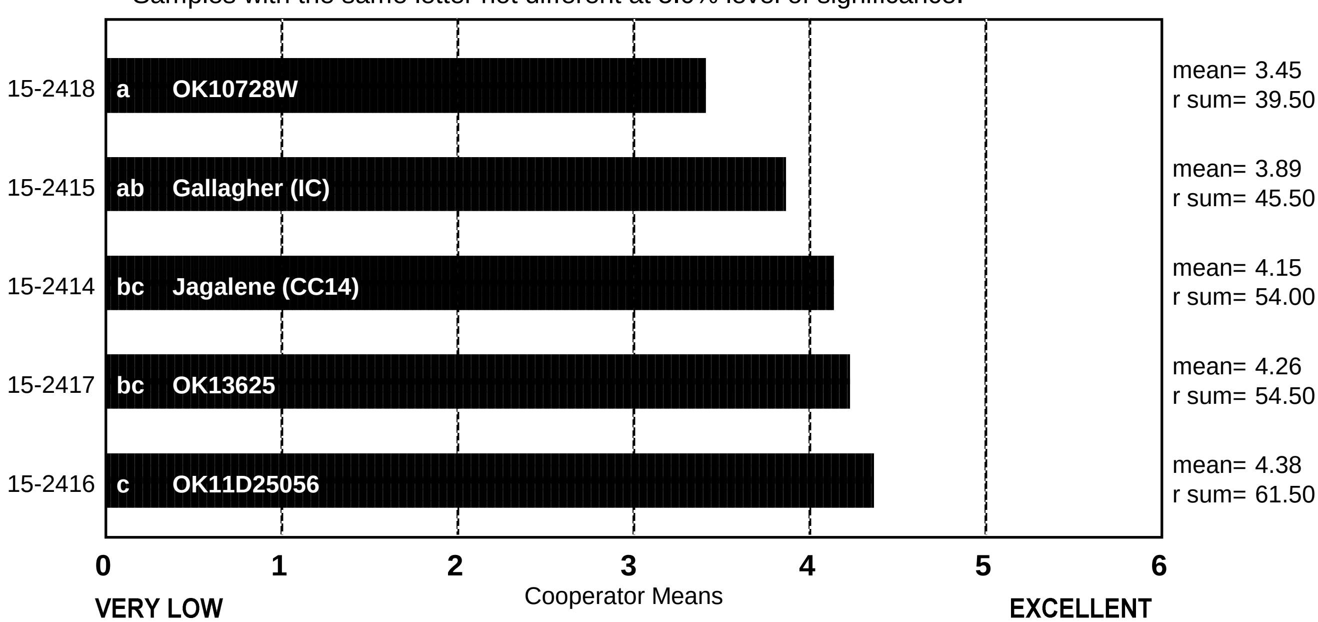


BAKE ABSORPTION

(Small Scale) Oklahoma

ncoop= 17
chisq= 6.92
chisqc= 10.09
cvchisq= 9.49
crdiff= 13.82

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. O
15-2414 Jagalene (CC14)	**66.1**	**68.0**	**57.0**	**60.0**	**63.5**	**65.0**	**69.0**	**62.4**	**63.5**	**61.1**	**69.0**	**61.1**	**60.0**	**62.0**	**61.1**	**57.0**	**62.1**
15-2415 Gallagher (IC)	**63.7**	**66.0**	**57.0**	**60.0**	**63.5**	**63.0**	**69.5**	**61.3**	**62.3**	**61.1**	**68.1**	**60.2**	**60.0**	**62.6**	**61.1**	**59.0**	**56.1**
15-2416 OK11D25056	**65.5**	**67.0**	**57.0**	**60.0**	**64.9**	**64.0**	**68.0**	**62.7**	**63.5**	**61.9**	**68.1**	**60.6**	**61.0**	**65.0**	**61.9**	**58.0**	**62.1**
15-2417 OK13625	**67.9**	**70.0**	**57.0**	**60.0**	**61.1**	**64.0**	**70.1**	**62.2**	**63.0**	**60.8**	**70.3**	**60.9**	**60.0**	**63.6**	**60.8**	**57.0**	**59.4**
15-2418 OK10728W	**66.3**	**68.0**	**57.0**	**60.0**	**59.2**	**64.0**	**68.2**	**61.3**	**63.2**	**56.2**	**64.3**	**61.2**	**56.0**	**62.8**	**56.2**	**59.0**	**57.2**

BAKE MIX TIME, ACTUAL

(Small Scale) Oklahoma

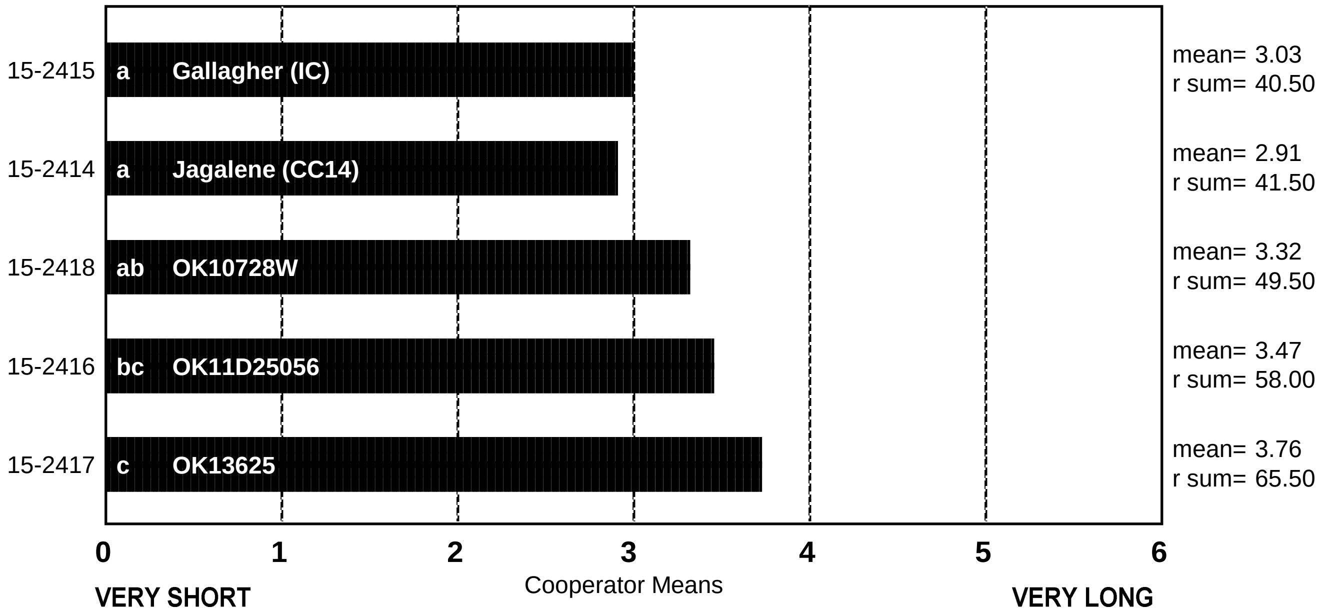
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2414 Jagalene (CC14)	**3.5**	**3.8**	**5.0**	**6.0**	**4.0**	**4.8**	**3.9**	**3.8**	**3.1**	**5.3**	**4.3**	**4.0**	**9.0**	**4.9**	**3.0**	**4.0**	**6.0**
15-2415 Gallagher (IC)	**3.8**	**3.3**	**6.0**	**6.0**	**4.0**	**4.2**	**3.2**	**4.0**	**3.0**	**5.3**	**5.0**	**4.0**	**20.0**	**5.0**	**3.0**	**4.0**	**7.0**
15-2416 OK11D25056	**4.0**	**3.8**	**8.0**	**6.0**	**4.4**	**4.1**	**4.3**	**4.5**	**3.2**	**6.3**	**4.5**	**4.0**	**20.0**	**5.5**	**5.0**	**5.0**	**7.0**
15-2417 OK13625	**4.4**	**3.5**	**18.0**	**6.0**	**4.5**	**5.2**	**4.4**	**4.3**	**3.1**	**7.0**	**4.8**	**4.3**	**20.0**	**5.6**	**7.0**	**5.0**	**7.0**
15-2418 OK10728W	**3.4**	**3.5**	**8.0**	**6.0**	**4.0**	**4.9**	**4.0**	**3.8**	**2.8**	**7.3**	**4.0**	**3.2**	**20.0**	**5.0**	**5.0**	**4.0**	**7.0**

BAKE MIX TIME

(Small Scale) Oklahoma

ncoop= 17
chisq= 10.87
chisqc= 16.95
cvchisq= 9.49
crdiff= 13.23

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

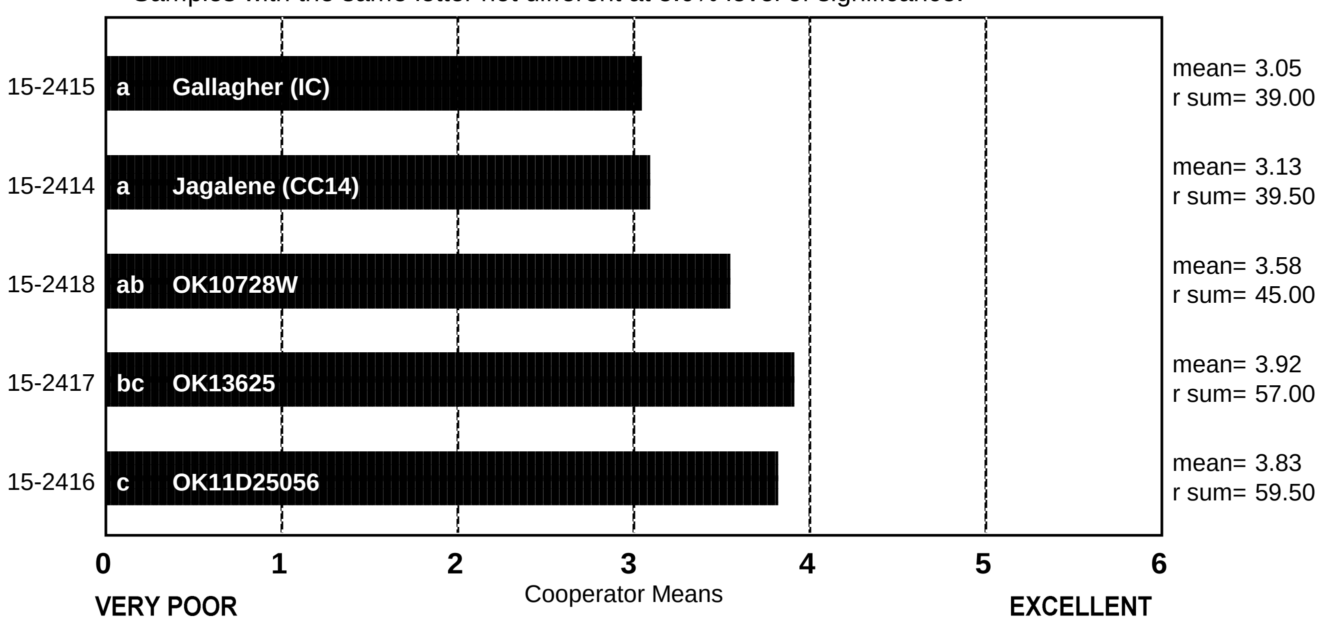


MIXING TOLERANCE

(Small Scale) Oklahoma

ncoop= 16
chisq= 9.39
chisqc= 14.80
cvchisq= 9.49
crdiff= 12.95

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

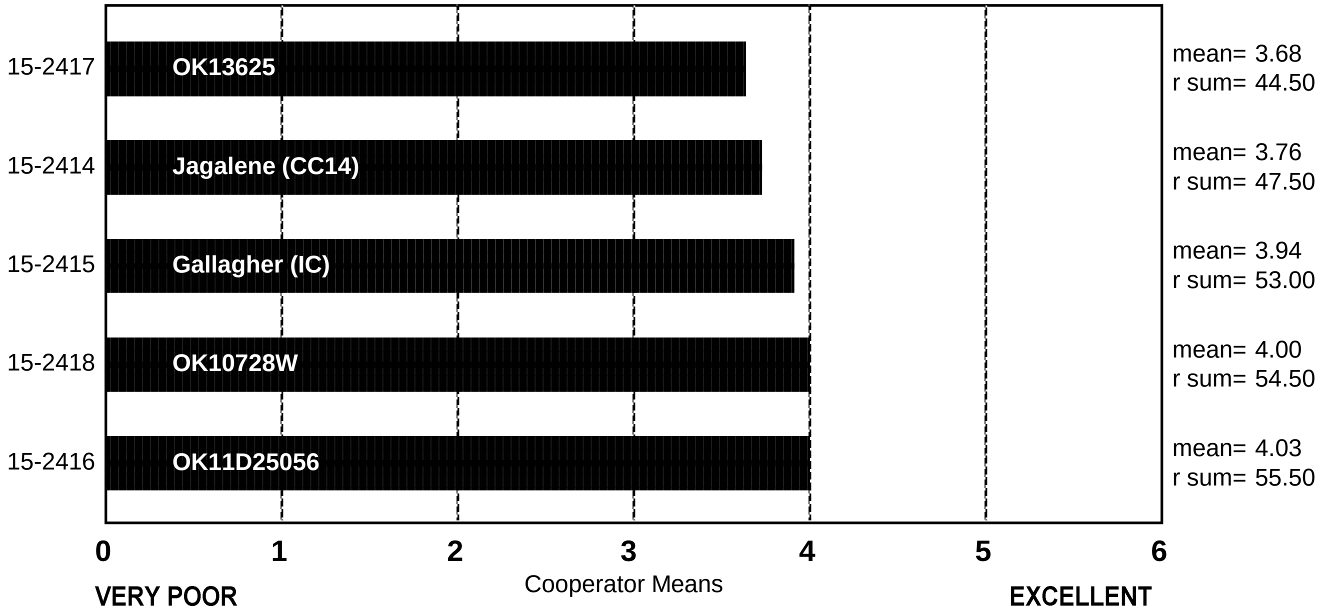


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Oklahoma

ncoop= 17
chisq= 2.14
chisqc= 3.66
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) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
15-2414 Jagalene (CC14)	2	1	3	9	2
15-2415 Gallagher (IC)	2	0	5	10	0
15-2416 OK11D25056	2	0	4	9	2
15-2417 OK13625	1	0	5	8	3
15-2418 OK10728W	0	1	3	10	3

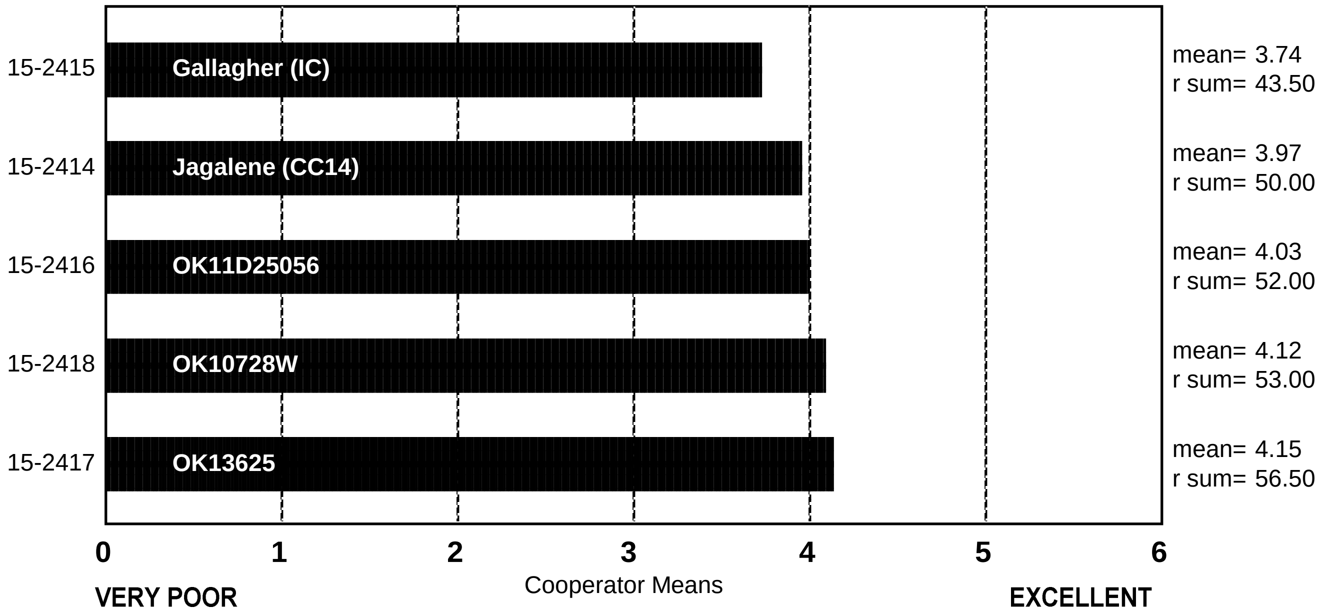
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Oklahoma

ncoop= 17
chisq= 2.18
chisqc= 3.54
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) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
15-2414 Jagalene (CC14)	2	0	2	13	0
15-2415 Gallagher (IC)	1	1	4	10	1
15-2416 OK11D25056	1	0	7	7	2
15-2417 OK13625	0	0	5	8	4
15-2418 OK10728W	1	1	3	9	3

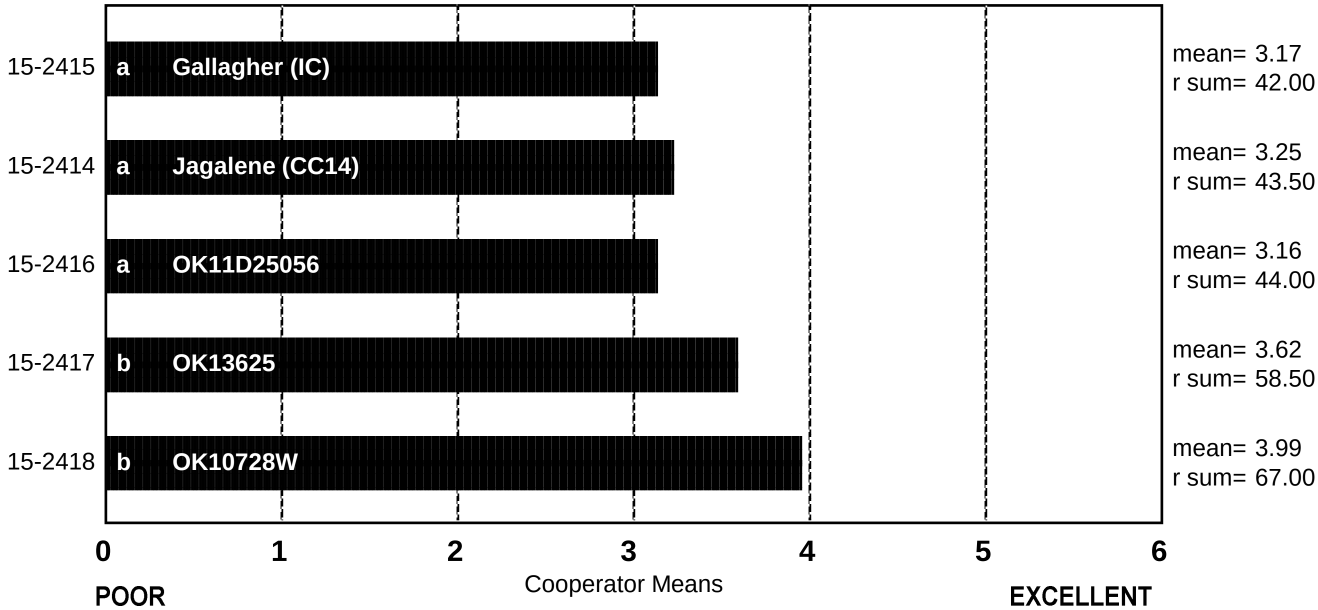
Frequency Table

CRUMB GRAIN

(Small Scale) Oklahoma

ncoop= 17
chisq= 11.73
chisqc= 16.02
cvchisq= 9.49
crdiff= 14.27

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Oklahoma

	Open	Fine	Dense
15-2414 Jagalene (CC14)	11	4	2
15-2415 Gallagher (IC)	9	3	5
15-2416 OK11D25056	10	6	1
15-2417 OK13625	9	6	2
15-2418 OK10728W	7	7	3

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Oklahoma

	Round	Irregular	Elongated
15-2414 Jagalene (CC14)	**10**	**3**	**4**
15-2415 Gallagher (IC)	**9**	**4**	**4**
15-2416 OK11D25056	**6**	**8**	**3**
15-2417 OK13625	**3**	**7**	**7**
15-2418 OK10728W	**3**	**6**	**8**

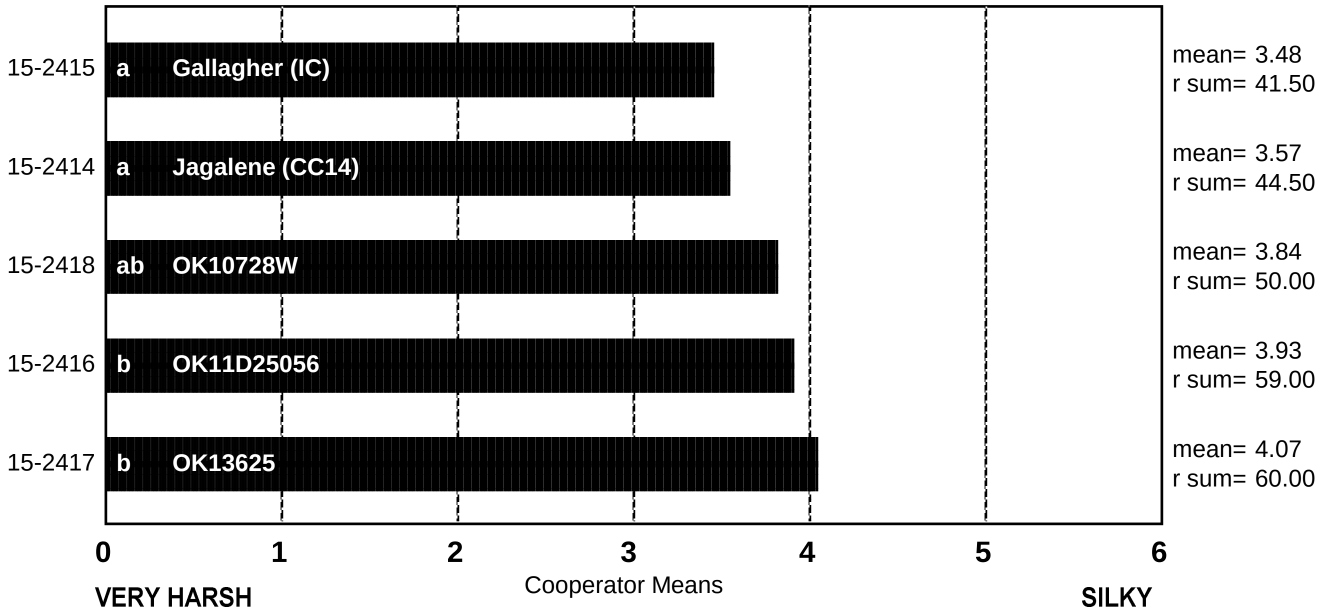
Frequency Table

CRUMB TEXTURE

(Small Scale) Oklahoma

ncoop= 17
chisq= 6.55
chisqc= 11.08
cvchisq= 9.49
crdiff= 13.42

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Oklahoma

	Harsh	Smooth	Silky
15-2414 Jagalene (CC14)	6	9	2
15-2415 Gallagher (IC)	8	7	2
15-2416 OK11D25056	4	9	4
15-2417 OK13625	4	8	5
15-2418 OK10728W	2	12	3

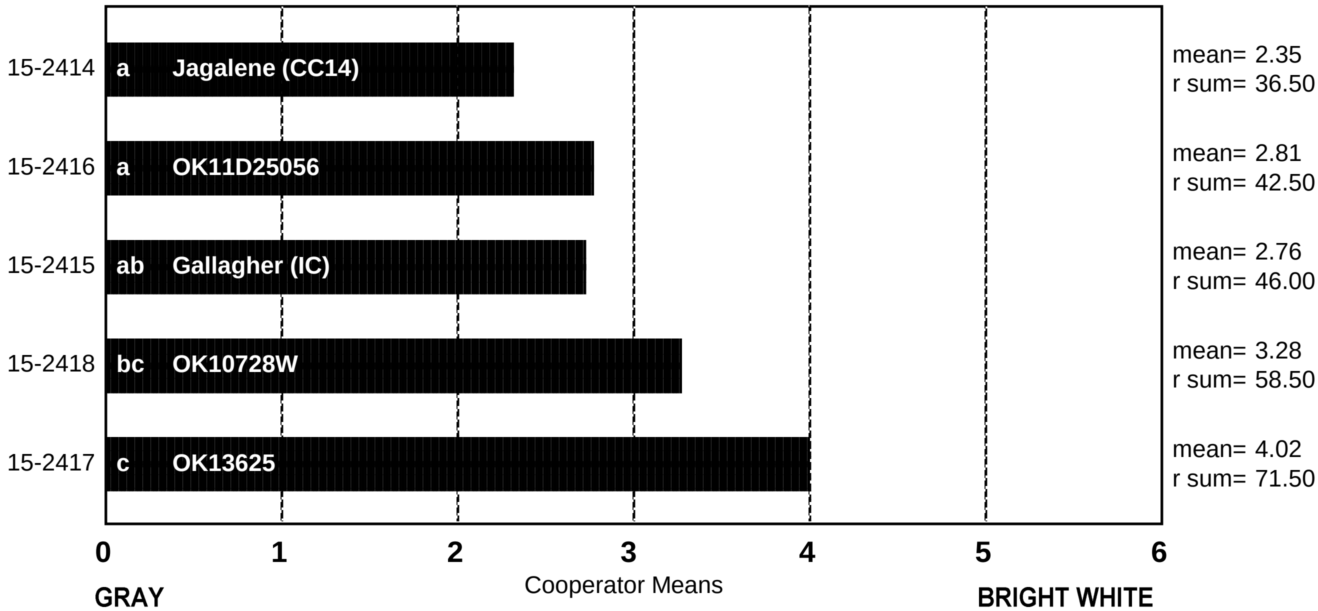
Frequency Table

CRUMB COLOR

(Small Scale) Oklahoma

ncoop= 17
chisq= 18.45
chisqc= 24.31
cvchisq= 9.49
crdiff= 13.32

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
15-2414 Jagalene (CC14)	4	2	2	6	3	0	0
15-2415 Gallagher (IC)	0	2	6	3	5	1	0
15-2416 OK11D25056	1	1	5	7	3	0	0
15-2417 OK13625	0	0	3	2	7	2	3
15-2418 OK10728W	0	2	4	2	8	0	1

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. O
15-2414 Jagalene (CC14)	**138.4**	**138.9**	**398.0**		**132.6**	**140.3**	**152.4**	**144.3**	**145.1**	**450.9**	**130.8**			**149.2**	**114.8**	**481.9**	**459.0**
15-2415 Gallagher (IC)	**139.4**	**144.0**	**400.0**		**131.3**	**141.5**	**155.7**	**145.8**	**145.5**	**453.5**	**133.7**			**150.9**	**108.3**	**485.9**	**457.0**
15-2416 OK11D25056	**137.5**	**140.1**	**400.0**		**133.6**	**142.2**	**154.4**	**144.7**	**146.8**	**450.8**	**131.4**			**152.0**	**124.6**	**484.0**	**456.0**
15-2417 OK13625	**137.6**	**148.6**	**395.0**		**130.7**	**145.1**	**151.5**	**142.7**	**142.4**	**450.5**	**136.7**			**150.1**	**113.9**	**485.7**	**456.0**
15-2418 OK10728W	**138.2**	**136.3**	**400.0**		**129.2**	**142.8**	**154.5**	**143.6**	**144.7**	**456.3**	**131.2**			**149.7**	**122.0**	**482.8**	**459.0**

LOAF VOLUME, ACTUAL

(Small Scale) Oklahoma

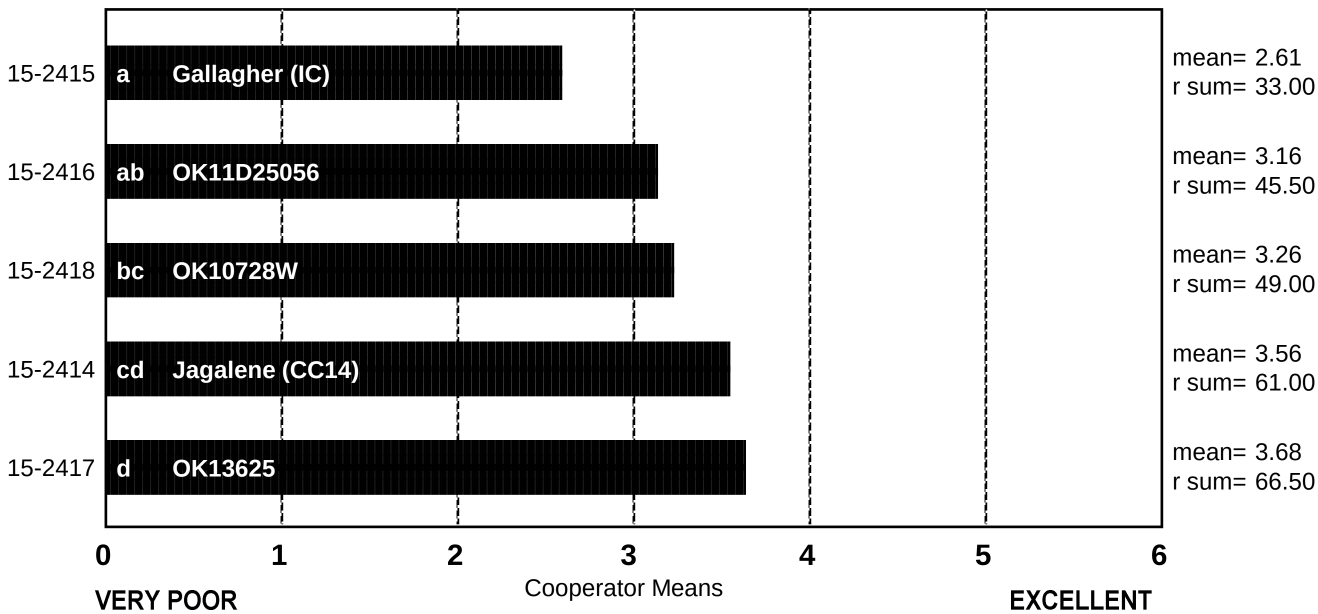
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2414 Jagalene (CC14)	**847**	**903**	**2725**	**930**	**843**	**1020**	**895**	**910**	**780**	**2916**	**915**	**720**	**2839**	**900**	**2375**	**2475**	**2175**
15-2415 Gallagher (IC)	**752**	**825**	**2700**	**890**	**818**	**881**	**810**	**765**	**675**	**2714**	**860**	**710**	**2750**	**810**	**2200**	**2450**	**2300**
15-2416 OK11D25056	**824**	**840**	**2700**	**860**	**863**	**883**	**875**	**875**	**755**	**2665**	**920**	**715**	**2809**	**865**	**2600**	**2475**	**2150**
15-2417 OK13625	**860**	**755**	**2700**	**910**	**835**	**953**	**910**	**990**	**845**	**2814**	**970**	**800**	**2927**	**880**	**2425**	**2538**	**2300**
15-2418 OK10728W	**818**	**983**	**2625**	**910**	**770**	**908**	**935**	**865**	**735**	**2743**	**860**	**745**	**2809**	**855**	**2620**	**2363**	**2150**

LOAF VOLUME

(Small Scale) Oklahoma

ncoop= 17
chisq= 16.44
chisqc= 19.96
cvchisq= 9.49
crdiff= 14.55

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

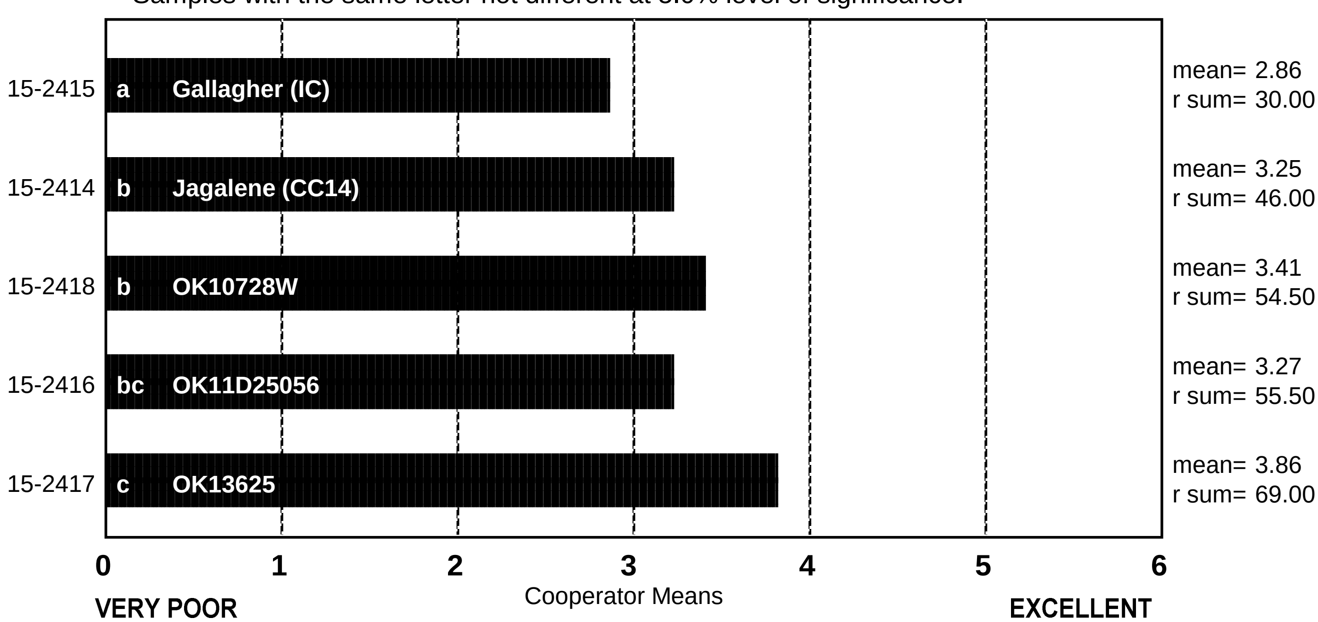


OVERALL BAKING QUALITY

(Small Scale) Oklahoma

ncoop= 17
chisq= 19.35
chisqc= 22.93
cvchisq= 9.49
crdiff= 14.27

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



COOPERATOR'S COMMENTS
(Small Scale) Oklahoma

COOP. 15-2414 Jagalene (CC14)

A. No comment.
B. Satisfactory quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption, long mix time, slight sticky & strong dough, very high volume, dark yellow crumb, open elongated cells, resilient & slightly harsh texture.
G. Generally good dough properties but showing some signs of weakness in height of curve, excellent absorption, average volume with weaker crumb grain.
H. No comment.
I. Very bad color, poor grain and volume.
J. No comment.
K. Poor color.
L. No comment.
M. No comment.
N. Good mix time, questionable to satisfactory ratings throughout with nice loaf volume.
O. Good absorption, low mix time, dough was good, bread collapsed before volume reading, good grain rating.
P. Low absorption, short mix time.
Q. No comment.

COOP. 15-2415 Gallagher (IC)

A. No comment.
B. Satisfactory quality overall.
C. No comment.
D. No comment.
E. Nice dough performance for bread loaf volume.
F. Normal water absorption and mix time, slight sticky & strong dough, OK volume, yellow crumb, open round cells, resilient & slightly harsh texture.
G. Somewhat short mix time with average overall strength but showing some signs of weakness in height of curve, excellent absorption, volume somewhat average for protein level, weaker crumb grain.
H. Cap.
I. Low protein, overall poor baker.
J. No comment.
K. Poor color, poor crumb.
L. No comment.
M. No comment.
N. Long mix time, satisfactory dough at mix and makeup, Q-S crumb, lower loaf volume.
O. Good absorption, low mix time, dough was good, bread had low volume with a dense grain.
P. Short mix time, sticky dough, open grain, yellow crumb.
Q. No comment.

COOP. 15-2416 OK11D25056

A. No comment.
B. Satisfactory quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption and mix time, slight sticky & strong dough, OK volume, dull yellow crumb, open round cells, resilient & slightly harsh texture.
G. Generally good dough properties but showing some signs of weakness in height of curve, very good absorption, average volume and crumb grain.
H. No comment.
I. Very poor baker.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Excellent absorption, long mix time, good dough strength at all stages, Q-S crumb-rated higher than the checks.
O. Good absorption, good mix time, dough was excellent, good volume and grain rating.
P. Good dough, average in most categories.
Q. Loaf collapsed in volume reader, estimated 2150 cc.

COOP. 15-2417 OK13625

A. No comment.
B. Questionable quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption and mix time, slight sticky & strong dough, high volume, white crumb, fine elongated cells, resilient & very smooth texture.
G. Generally good dough properties but showing some signs of weakness in height of curve, very good absorption, average volume and crumb grain.
H. Rough break and shred.
I. Excellent color, average baker.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Same as 2416-rated higher than the checks.
O. Good absorption, excellent mix time, dough was excellent, average volume with a good grain rating.
P. Low absorption, tough dough, good grain.
Q. No comment.

COOP. **15-2418 OK10728W**

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. Good dough performance but poor loaf volume.
F. Normal water absorption and mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
G. Generally good dough properties but showing some signs of weakness in height of curve, very good absorption, average volume and crumb grain.
H. No comment.
I. Poor color and grain, low volume.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Bake absorption lower, dough strength good, above satisfactory crumb grain-rated higher than the checks.
O. Low absorption, low mix time, dough was excellent, bread had excellent volume with a dense grain rating.
P. Short mix time, good dough, yellow crumb, low volume.
Q. No comment.

Notes: **C, D, M, O, P and Q** conducted sponge and dough bake tests

MONTANA

15-2419	Jagalene (CC19)
15-2420	Yellowstone (IC)
15-2421	MTS1224
15-2422	MT1265

Description of Test Plots and Breeder Entries

Montana - Phil Bruckner/Jim Berg

The Post Agronomy Farm, west of Bozeman, had a 21% decrease in average rainfall for the 2015 crop year (12.5in versus 15.8in for the 58yr average). There was normal snow cover during winter months and no winterkill was observed. Heading (June 11) was earlier than average by 9 days. Temperatures from March to August (except May) were above average with below average moisture recorded in March, April, June and August and above average moisture in May and July, Harvest, at the beginning of August, was earlier than our average mid-August harvest.

June was a critical month at Bozeman for the 2015 crop year. June is normally the wettest month at 2.7in. In 2015, we received only 0.7in, 25% of normal. The hottest recorded temperature of the year, 96°F, was recorded on June 29th. Stripe rust was evident in early June and was a major factor in yield and test weight reduction for replicated field tests (which were not sprayed with fungicide). The WQC strips were sprayed with fungicide (Quilt) on June 3rd.

The Montana Intrastate Winter Wheat Test (varieties and elite lines) which includes lines grown in the WQC drill strips had yields (average = 71 bu/a, range 41 – 97 bu/a) and test weights (average = 56.2 lb/bu, range 51.4 - 61.1 lb/bu) which were considerably below recent averages. Proteins were way above average at 17.0% (range 13.5 to 19.6%). Stripe rust infection averaged 15% on June 16th (range 0 – 57% flag leaf involvement).

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 21% of the acreage (494,000 acres) in 2015.

MTS1224 – a semi-solid stemmed hard red winter wheat line with the pedigree, Yellowstone//MTS0112/MTS0125. MTS1224 has above average yield and average test weight and protein. Over 42 location-years, yield of MTS1224 was 2 bu/a lower than Yellowstone, but 6 and 7 bu/a higher than the solid-stemmed varieties, Warhorse and Judee (#2 variety grown in Montana in 2014 and 2015). MTS1224 has decent winter hardiness and may be suited for eastern Montana and western North Dakota. MTS1224 has medium-late heading date and is shorter (3.6 in. less) in height than Yellowstone. MTS1224 has a solidness rating of 19 (similar to Genou, on a 5 to 25 scale), while Judee, Bearpaw, and Warhorse would rate 20, 21,and 22, respectively. MTS1224 is resistant to both stem rust (Yellowstone is susceptible) and stripe rust.

MTS1224 is a medium-low PPO line with above average flour yield and average flour protein in MSU tests. Ash is good and lower than Yellowstone. Mix times are long, similar to most Montana varieties. Mixing tolerance is above average. Mix and bake absorption is above average (and greater than Yellowstone values). Loaf volume is excellent (similar to Judee) and exceeding Yellowstone.

MT1265 – a hollow stemmed hard red winter wheat line with the pedigree Yellowstone*4/KS96WGRC40. MT1265 is similar to Yellowstone. MT1265 has above average yield and average test weight and protein. Over 27 location-years, yield of MT1265 was 1 bu/a lower than Yellowstone. MT265 has winter hardiness similar to Yellowstone. MT1265 has medium-late heading date (0.6da later than Yellowstone). MT1265 is taller (0.6in) in height than Yellowstone. MT1265 is susceptible to stem rust, like Yellowstone, and resistant to stripe rust. MT1265 carries the Lr41 (leaf rust) gene and wheat curl mite resistance from the KS96WGRC40 parent.

MT1265 is a medium PPO line with above average flour yield and average flour protein in MSU tests. Ash is average and similar to Yellowstone. Mix times are long, similar to Yellowstone. Mixing tolerance is above average and similar to Yellowstone. Mix and bake absorption is above average (and greater than Yellowstone). Loaf volume is good, exceeding Yellowstone.

Montana: 2015 (Small-Scale) Samples

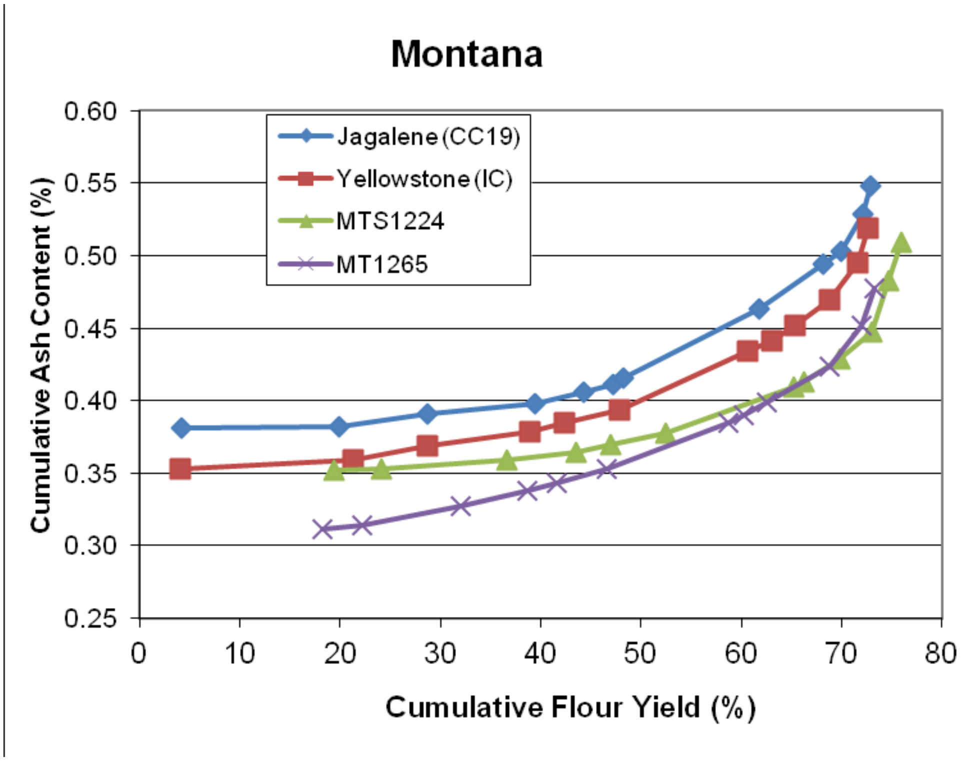
Test entry number	15-2419	15-2420	15-2421	15-2422
Sample identification	**Jagalene (CC19)**	**Yellowstone (IC)**	**MTS1224**	**MT1265**
Wheat Data				
GIPSA classification	3 HRW	3 HRW	3 HRW	3 HRW
Test weight (lb/bu) **Hectoliter weight (kg/hl)**	57.5 75.7	57.5 75.7	57.5 75.6	56.5 74.4
1000 kernel weight (gm)	24.9	26.3	23.1	26.4
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 19.8 74.5 5.7	 43.2 55.6 1.2	 19.0 76.3 4.7	 45.2 53.9 0.9
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	 50.7/19.8 24.9/8.4 2.38/0.32 9.5/0.6 20-17-28-35-03 Mixed	 60.4/16.6 26.3/8.2 2.42/0.32 9.7/0.5 06-12-25-57-02 Hard	 63.8/18.1 23.1/7.9 2.28/0.32 9.6/0.6 05-11-21-63-01 Hard	 61.7/15.8 26.4/8.0 2.41/0.33 9.6/0.5 04-11-26-59-01 Hard
Wheat protein (12% mb) **Wheat ash (12% mb)**	14.9 1.65	14.5 1.71	14.2 1.64	14.4 1.69
Milling and Flour Quality Data				
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 69.4 65.2	 67.5 65.6	 70.3 67.4	 71.4 66.8
Flour moisture (%) **Flour protein (14% mb)** **Flour ash (14% mb)**	12.6 13.6 0.54	12.2 13.4 0.52	12.6 12.8 0.51	14.0 13.3 0.51
Rapid Visco-Analyser Peak Time (min) Peak Viscosity (RVU) Breakdown (RVU) Final Viscosity at 13 min (RVU)	 6.3 188.3 51.2 244.1	 6.5 226.8 61.6 271.9	 5.8 181.8 93.3 174.2	 6.4 224.1 64.5 267.4
Minolta color meter L* a* b* **PPO**	 91.73 -1.57 9.93 0.637	 91.52 -1.32 9.27 0.539	 92.18 -1.63 9.13 0.414	 91.56 -1.32 9.22 0.453
Falling number (sec)	465	467	374	477
Damaged Starch (AI%) (AACC76-31)	 95.48 5.88	 95.60 5.97	 94.87 5.43	 95.67 6.02

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

Montana: Physical Dough Tests and Gluten Analysis
2015 (Small-Scale) Samples

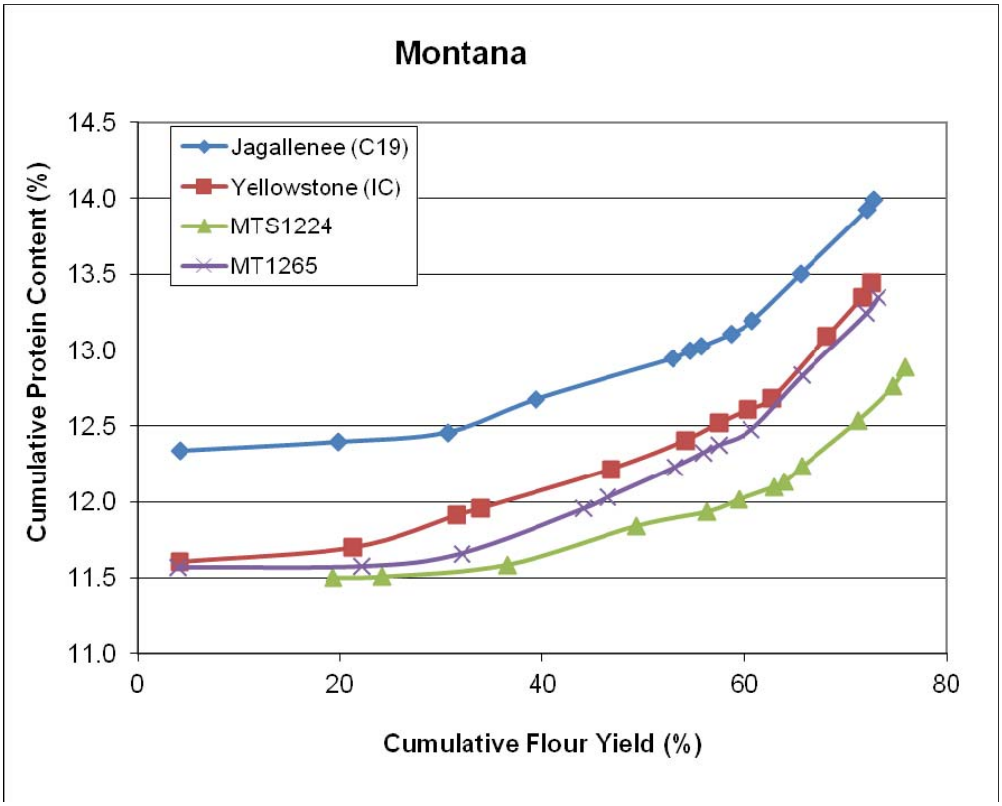
Test Entry Number	15-2419	15-2420	15-2421	15-2422
Sample Identification	Jagalene (CC19)	Yellowstone (IC)	MTS1224	MT1265
MIXOGRAPH				
Flour Abs (% as-is)	67.2	67.3	65.9	65.0
Flour Abs (14% mb)	65.6	65.2	64.2	65.0
Mix Time (min)	4.5	8.6	7.4	11.5
Mix tolerance (0-6)	6	6	6	6
FARINOGRAPH				
Flour Abs (% as-is)	58.2	58.0	57.8	58.1
Flour Abs (14% mb)	56.6	55.9	56.2	58.1
Development time (min)	8.8	8.4	9.0	6.7
Mix stability (min)	16.8	17.8	55.3	20.7
Mix Tolerance Index (FU)	15	14	10	14
Breakdown time (min)	18.3	16.3	59.5	18.6
ALVEOGRAPH				
P(mm): Tenacity	77	70	77	92
L(mm): Extensibility	119	133	127	90
G(mm): Swelling index	24.3	25.7	25.1	21.1
W(10^{-4} J): strength (curve area)	355	360	381	353
P/L: curve configuration ratio	0.65	0.53	0.61	1.02
Ie(P_{200}/P): elasticity index	70.0	67.9	68.7	71.0
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	502/657/759	741/995/991	733/986/995	999/1000/978
Extensibility (mm at 45/90/135 min)	178/185/164	137/131/130	144/139/121	113/95/84
Energy (cm^2 at 45/90/135 min)	187/242/225	177/184/186	187/201/173	154/135/116
Resist $_{max}$ (BU at 45/90/135 min)	836/997/997	997/995/991	999/986/1000	1000/1000/978
Ratio (at 45/90/135 min)	2.81/3.55/4.64	5.42/7.60/7.61	5.10/7.07/8.23	8.83/10.49/11.64
PROTEIN ANALYSIS				
HMW-GS Composition	2*,1, 17+18, 5+10	1, 7+8, 5+10	1, 7+8, 5+10	1, 7+8, 5+10
%IPP	52.34	54.24	53.90	55.38
SEDIMENTATION TEST				
Volume (ml)	70.4	70.5	69.3	72.0

Montana: Cumulative Ash Curves



Jagalene (CC19)					Yellowstone (IC)					MTS1224					MT1265				
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
1M Red	4.18	0.38	4.18	0.38	1M Red	4.11	0.35	4.11	0.35	2M	19.34	0.35	19.34	0.35	2M	18.30	0.31	18.30	0.31
2M	15.69	0.38	19.87	0.38	2M	17.18	0.36	21.29	0.36	1M Red	4.80	0.36	24.14	0.35	1M Red	3.87	0.33	22.17	0.31
1BK	8.82	0.41	28.69	0.39	1BK	7.37	0.39	28.66	0.37	1M	12.44	0.37	36.58	0.36	1M	9.86	0.36	32.03	0.33
1M	10.75	0.42	39.44	0.40	1M	10.28	0.41	38.94	0.38	1BK	6.97	0.39	43.56	0.36	1BK	6.70	0.39	38.72	0.34
2BK	4.84	0.47	44.28	0.41	Grader	3.38	0.46	42.32	0.38	Grader	3.43	0.44	46.99	0.37	Grader	2.82	0.41	41.54	0.34
Grader	2.93	0.48	47.21	0.41	2BK	5.50	0.46	47.82	0.39	2BK	5.50	0.45	52.49	0.38	2BK	5.05	0.43	46.59	0.35
FILTER FLR	1.05	0.61	48.27	0.42	3M	12.87	0.59	60.69	0.43	3M	12.77	0.54	65.26	0.41	3M	12.08	0.51	58.67	0.39
3M	13.46	0.64	61.73	0.46	FILTER FLR	2.36	0.64	63.04	0.44	FILTER FLR	1.05	0.65	66.31	0.41	FILTER FLR	1.53	0.56	60.20	0.39
3BK	6.48	0.79	68.21	0.49	4M	2.38	0.74	65.42	0.45	3BK	3.48	0.73	69.80	0.43	4M	2.33	0.63	62.53	0.40
4M	1.80	0.85	70.01	0.50	3BK	3.43	0.81	68.85	0.47	4M	3.18	0.86	72.98	0.45	3BK	6.32	0.67	68.86	0.42
5M	2.09	1.37	72.10	0.53	5M	2.82	1.11	71.68	0.50	5M	1.75	1.95	74.74	0.48	5M	3.20	1.07	72.05	0.45
BRAN FLR	0.74	2.43	72.84	0.55	BRAN FLR	0.92	2.41	72.59	0.52	BRAN FLR	1.18	2.20	75.92	0.51	BRAN FLR	1.16	2.06	73.22	0.48
Break Shorts	4.07	4.68	76.92	0.77	Break Shorts	4.19	4.87	76.79	0.76	Break Shorts	3.46	4.70	79.38	0.69	Break Shorts	4.15	4.77	77.37	0.71
Red Dog	3.13	3.56	80.05	0.88	Red Dog	3.26	3.13	80.04	0.85	Red Dog	2.21	3.80	81.60	0.78	Red Dog	3.14	3.10	80.51	0.80
Red Shorts	0.64	5.10	80.69	0.91	Red Shorts	0.88	5.35	80.93	0.90	Red Shorts	0.46	5.39	82.05	0.80	Red Shorts	0.98	4.90	81.49	0.85
Filter Bran	2.42	1.96	83.11	0.94	Filter Bran	2.90	2.73	83.83	0.97	Filter Bran	1.06	2.43	83.11	0.82	Filter Bran	2.14	2.14	83.63	0.88
Bran	16.89	5.24	100.0	1.67	Bran	16.17	5.49	100.0	1.70	Bran	16.89	5.61	100.0	1.63	Bran	16.37	4.88	100.0	1.54
Wheat		1.61					1.67					1.60					1.65		
St. Grd. Fl.		0.54					0.52					0.51					0.51		

Montana: Cumulative Protein Curves



Jagalene (CC19)				
Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein
1M Red	4.18	12.34	4.18	12.34
2M	15.69	12.41	19.87	12.40
1M	10.75	12.57	30.62	12.46
1BK	8.82	13.43	39.44	12.68
3M	13.46	13.74	52.90	12.95
4M	1.80	14.42	54.70	12.99
FILTER FLR	1.05	14.51	55.75	13.02
Grader	2.93	14.70	58.68	13.11
5M	2.09	15.57	60.77	13.19
2BK	4.84	17.43	65.62	13.50
3BK	6.48	18.20	72.10	13.93
BRAN FLR	0.74	20.78	72.84	14.00
Break Shorts	4.07	17.99	76.92	14.21
Red Dog	3.13	17.23	80.05	14.33
Red Shorts	0.64	16.57	80.69	14.34
Filter Bran	2.42	14.54	83.11	14.35
Bran	16.89	17.65	100.00	14.91
Wheat		14.55		
St. Grd. Fl		13.70		

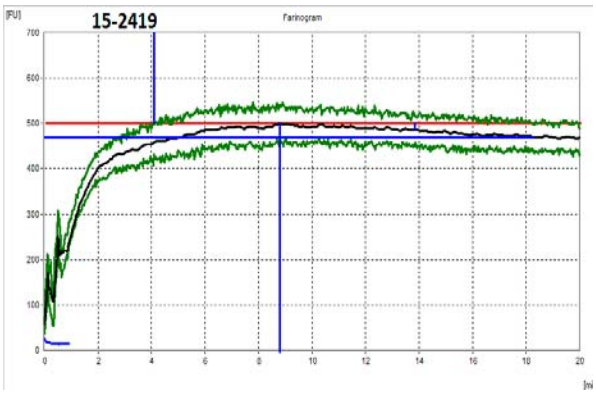
Yellowstone (IC)				
Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein
1M Red	4.11	11.60	4.11	11.60
2M	17.18	11.72	21.29	11.70
1M	10.28	12.35	31.57	11.91
4M	2.38	12.55	33.94	11.95
3M	12.87	12.90	46.81	12.21
1BK	7.37	13.61	54.18	12.40
Grader	3.38	14.36	57.56	12.52
5M	2.82	14.37	60.39	12.61
FILTER FLR	2.36	14.53	62.74	12.68
2BK	5.50	17.78	68.24	13.09
3BK	3.43	18.47	71.68	13.35
BRAN FLR	0.92	20.79	72.59	13.44
Break Shorts	4.19	17.53	76.79	13.66
Red Dog	3.26	16.04	80.04	13.76
Red Shorts	0.88	16.11	80.93	13.79
Filter Bran	2.90	14.89	83.83	13.82
Bran	16.17	17.25	100.00	14.38
Wheat		14.18		
St. Grd. Fl		13.37		

MTS1224				
Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein
2M	19.34	11.50	19.34	11.50
1M Red	4.80	11.53	24.14	11.51
1M	12.44	11.74	36.58	11.58
3M	12.77	12.57	49.35	11.84
1BK	6.97	12.59	56.33	11.93
4M	3.18	13.47	59.51	12.02
Grader	3.43	13.51	62.95	12.10
FILTER FLR	1.05	14.10	64.00	12.13
5M	1.75	15.96	65.75	12.23
2BK	5.50	16.16	71.25	12.54
3BK	3.48	17.37	74.74	12.76
BRAN FLR	1.18	20.63	75.92	12.88
Break Shorts	3.46	18.03	79.38	13.11
Red Dog	2.21	15.89	81.60	13.18
Red Shorts	0.46	16.38	82.05	13.20
Filter Bran	1.06	14.00	83.11	13.21
Bran	16.89	16.56	100.00	13.78
Wheat		13.87		
St. Grd. Fl		12.81		

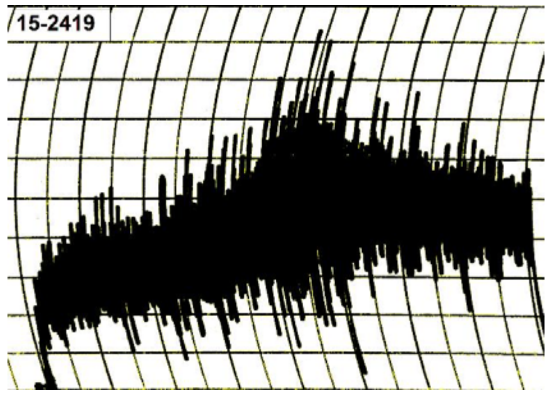
MT1265				
Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein
1M Red	3.87	11.57	3.87	11.57
2M	18.30	11.57	22.17	11.57
1M	9.86	11.85	32.03	11.66
3M	12.08	12.74	44.11	11.96
4M	2.33	13.40	46.44	12.03
1BK	6.70	13.64	53.13	12.23
Grader	2.82	14.10	55.95	12.32
FILTER FLR	1.53	14.19	57.48	12.37
5M	3.20	14.32	60.68	12.48
2BK	5.05	17.12	65.73	12.83
3BK	6.32	17.50	72.05	13.24
BRAN FLR	1.16	20.02	73.22	13.35
Break Shorts	4.15	17.74	77.37	13.59
Red Dog	3.14	16.15	80.51	13.69
Red Shorts	0.98	15.79	81.49	13.71
Filter Bran	2.14	12.74	83.63	13.69
Bran	16.37	18.28	100.00	14.44
Wheat		14.11		
St. Grd. Fl		13.23		

Physical Dough Tests
2015 (Small Scale) Samples – Montana

Farinograms | **Mixograms**

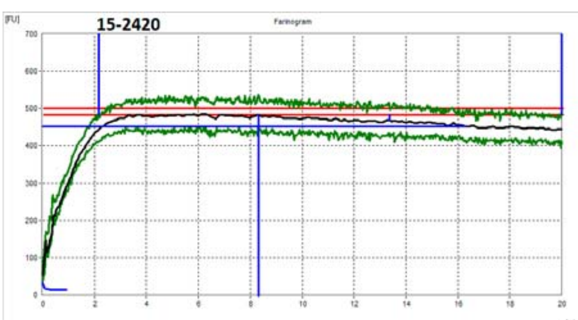


Water abs = 56.6%, Peak time = 8.8 min,
Mix stab = 16.8 min, MTI = 15 FU

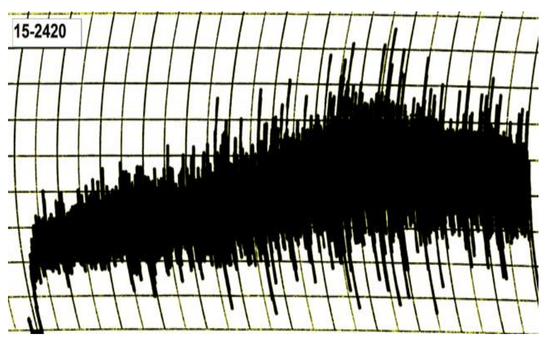


Water abs = 65.6%
Mix time = 4.5 min

15-2419, Jagalene (CC19)



Water abs = 55.9%, Peak time = 8.4 min,
Mix stab = 17.8 min, MTI = 14 FU



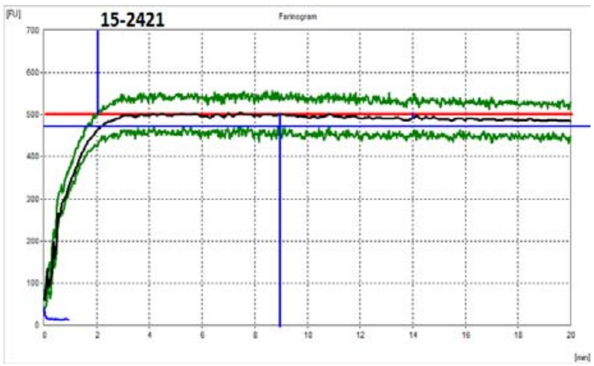
Water abs = 65.2%
Mix time = 8.6 min

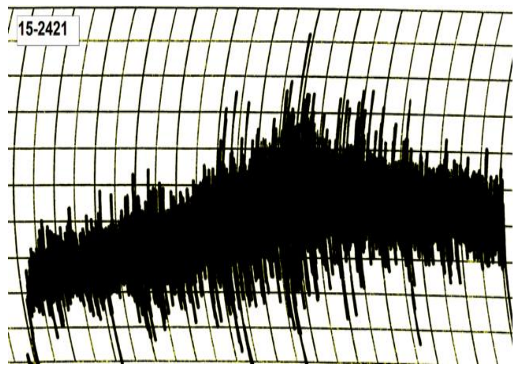
15-2420, Yellowstone (IC)

Physical Dough Tests

2015 (Small Scale) Samples – Montana (continued)

Farinograms | **Mixograms**

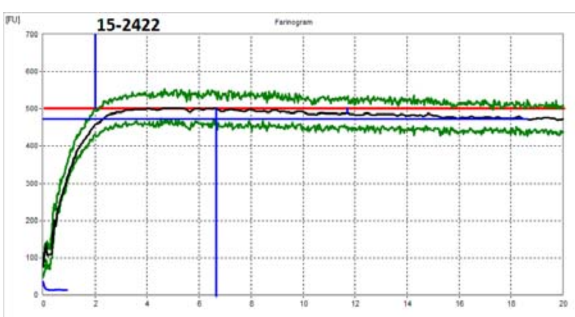


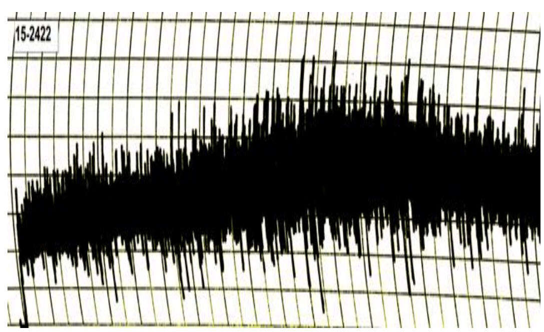


Water abs. = 56.2%, Peak time = 9.0 min,
Mix stab = 55.3 min, MTI = 10 FU

Water abs = 64.2%
Mix time = 7.4 min

15-2421, MTS1224





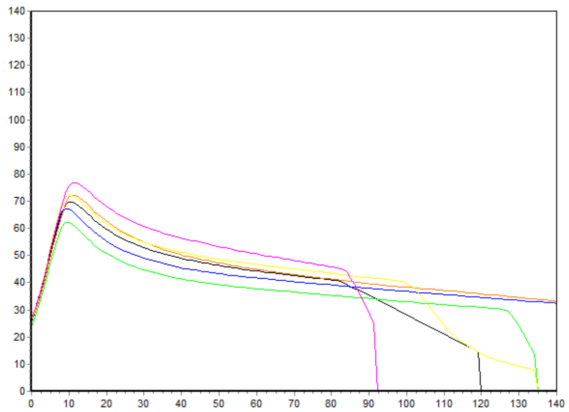
Water abs. = 58.1%, Peak time = 6.7 min,
Mix stab = 20.7 min, MTI = 14 FU

Water abs = 65.0%
Mix time = 11.5 min

15-2422, MT1265

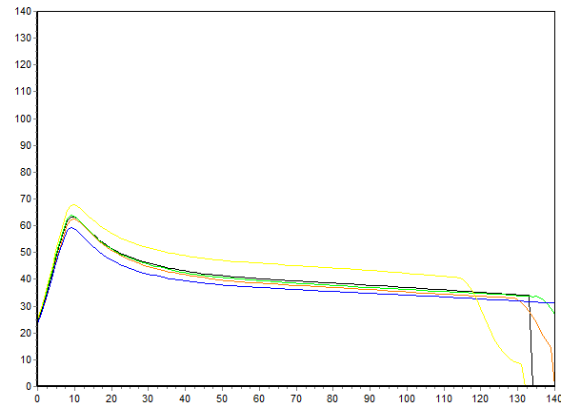
Physical Dough Tests - Alveograph

2015 (Small Scale) Samples – Montana



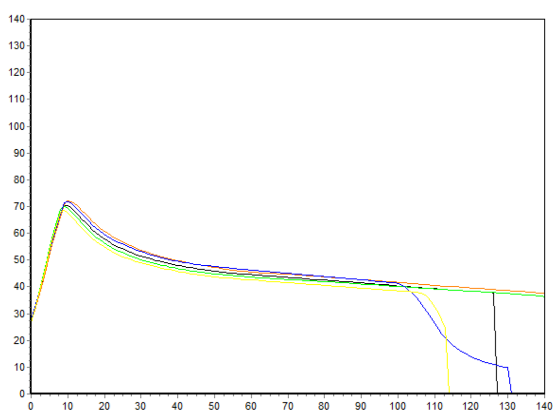
15-2419, Jagalene (CC19)

P (mm H_20) = 77, L (mm) = 119, W ($10E^{-4}$J) = 355



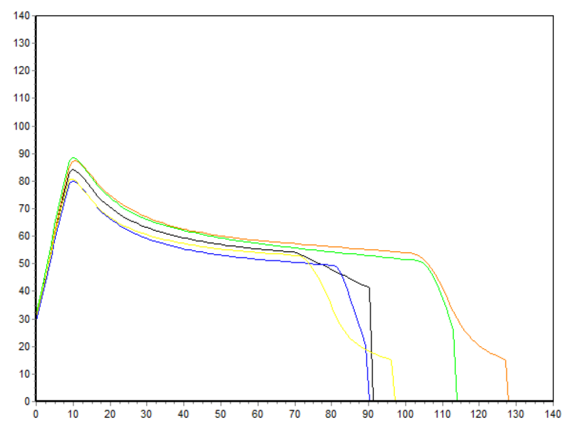
15-2420, Yellowstone (IC)

P (mm H_20) = 70, L (mm) = 133, ($10E^{-4}$J) = 360



15-2421, MTS1224

P (mm H_20) = 77, L (mm) = 127, W ($10E^{-4}$J) = 381

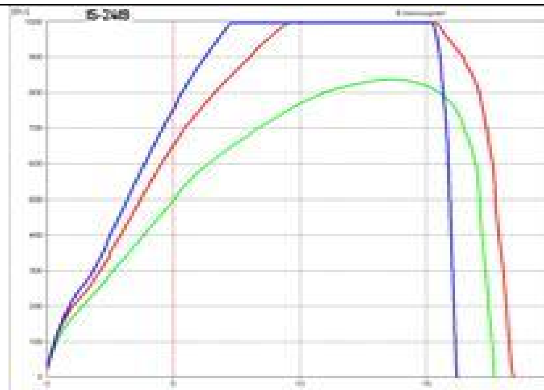


15-2422, MT1265

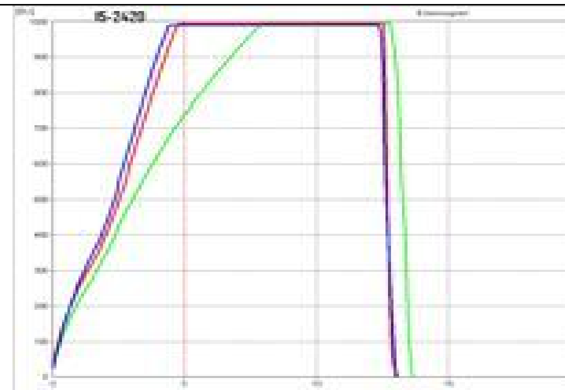
P (mm H_20) = 92, L (mm) = 90, ($10E^{-4}$J) = 353

Physical Dough Tests - Extensigraph

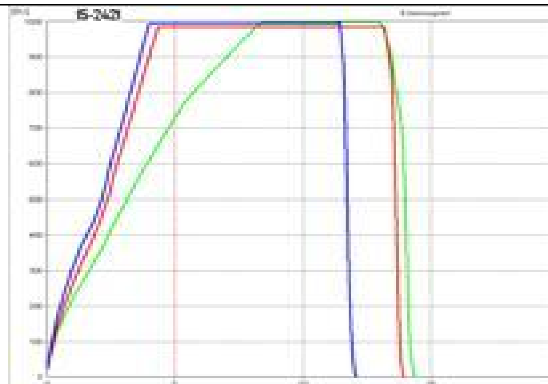
2015 (Small Scale) Samples – Montana



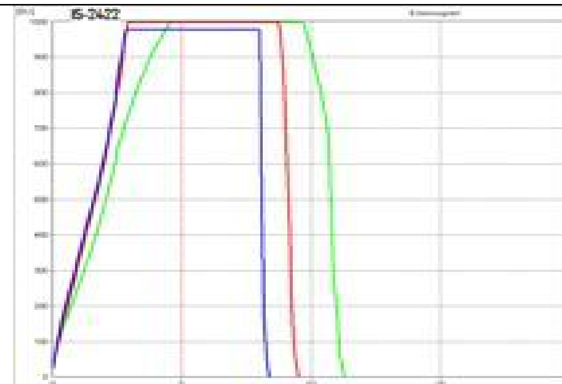
15-2419, Jagalene (CC19)
R (BU) = 657, E (mm) = 185, W (cm^2) = 242
Rmax (BU) = 997, Ratio = 3.6 at 90 min



15-2420, Yellowstone (IC)
R (BU) = 995, E (mm) = 131, W (cm^2) = 184135
Rmax (BU) = 995, Ratio = 7.6 at 90 min



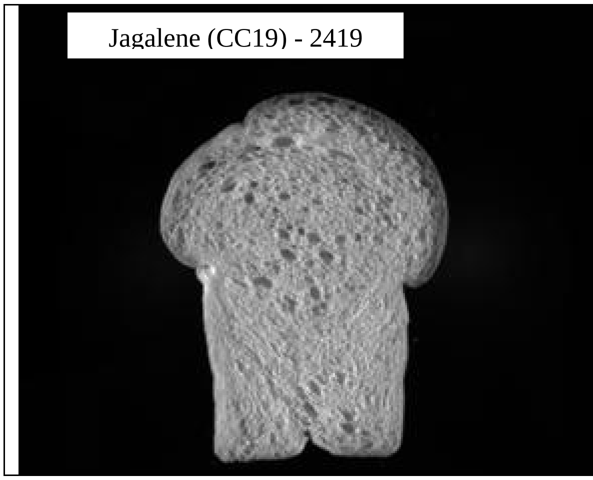
15-2421, MTS1224
R (BU) = 986, E (mm) = 139, W (cm^2) = 201
Rmax (BU) = 986, Ratio = 7.1 at 90 min

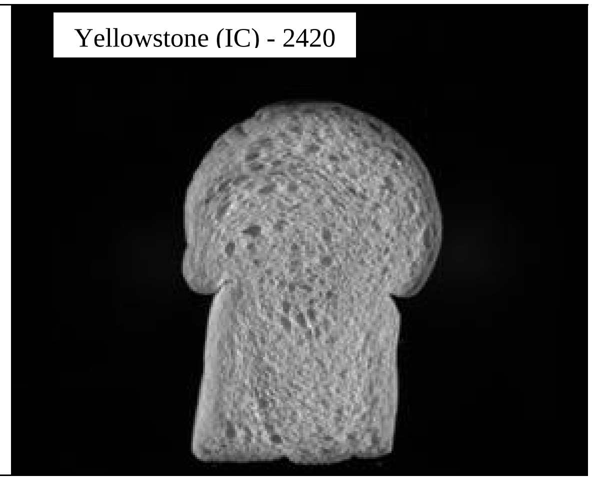


15-2422, MT1265
R (BU) = 1000, E (mm) = 95, W (cm^2) = 135
Rmax (BU) = 1000, Ratio = 10.5 at 90 min

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
2015 (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})
2419	7156	139.4	4489	0.439	1.970	4.506	1.685	-22.43
2420	7076	141.5	4412	0.443	1.995	5.208	1.683	-18.73

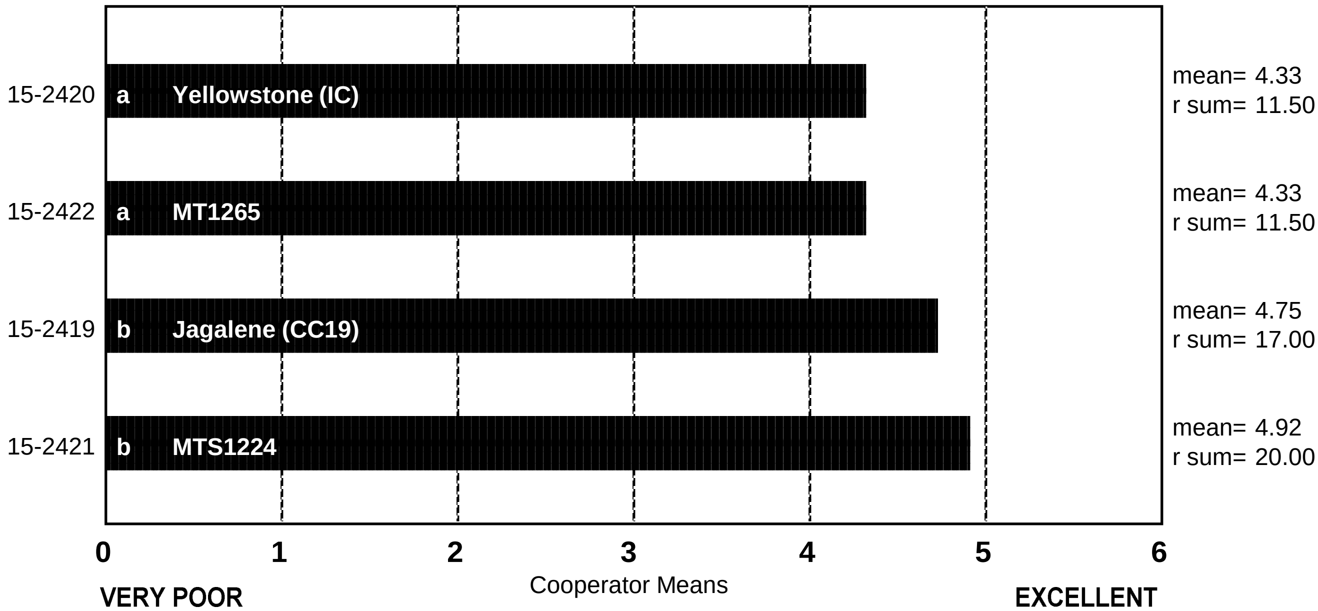
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2421	6759	140.0	4088	0.446	2.054	4.823	1.703	-19.68
2422	6724	143.4	4185	0.446	2.039	7.218	1.723	-26.65

SPONGE CHARACTERISTICS

(Small Scale) Montana

ncoop= 6
chisq= 5.35
chisqc= 10.35
cvchisq= 7.82
crdiff= 4.89

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

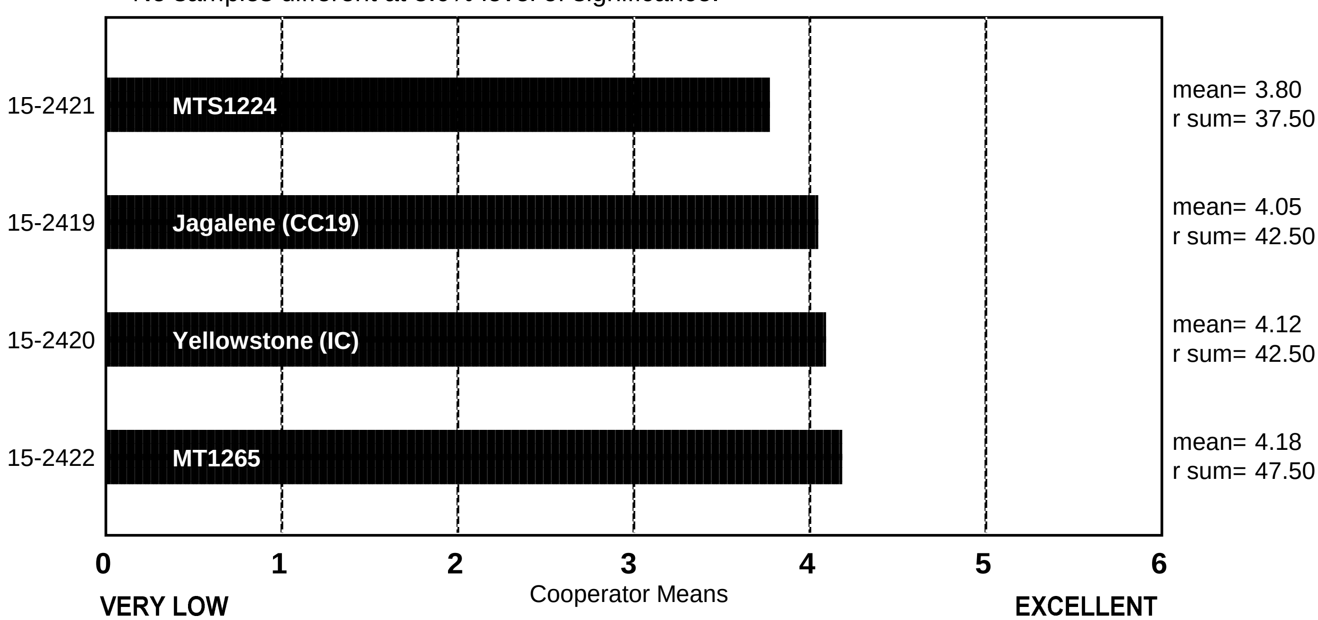


BAKE ABSORPTION

(Small Scale) Montana

ncoop= 17
chisq= 1.76
chisqc= 3.85
cvchisq= 7.82
crdiff=

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Montana

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2419 Jagalene (CC19)	**67.1**	**69.0**	**60.0**	**64.0**	**57.2**	**65.0**	**71.6**	**65.3**	**66.0**	**56.6**	**64.2**	**64.5**	**56.0**	**65.1**	**56.6**	**57.0**	**57.4**
15-2420 Yellowstone (IC)	**67.4**	**69.0**	**60.0**	**64.0**	**57.0**	**64.0**	**71.6**	**65.8**	**67.2**	**55.9**	**64.3**	**64.1**	**56.0**	**65.1**	**55.9**	**56.0**	**56.5**
15-2421 MTS1224	**66.1**	**68.0**	**59.0**	**63.0**	**58.3**	**65.0**	**72.1**	**65.0**	**66.0**	**56.2**	**62.8**	**63.3**	**56.0**	**65.0**	**56.2**	**56.0**	**57.1**
15-2422 MT1265	**65.0**	**67.0**	**59.0**	**64.0**	**60.6**	**65.0**	**73.2**	**66.1**	**64.7**	**58.1**	**63.1**	**63.8**	**57.0**	**65.2**	**58.1**	**58.0**	**58.6**

BAKE MIX TIME, ACTUAL

(Small Scale) Montana

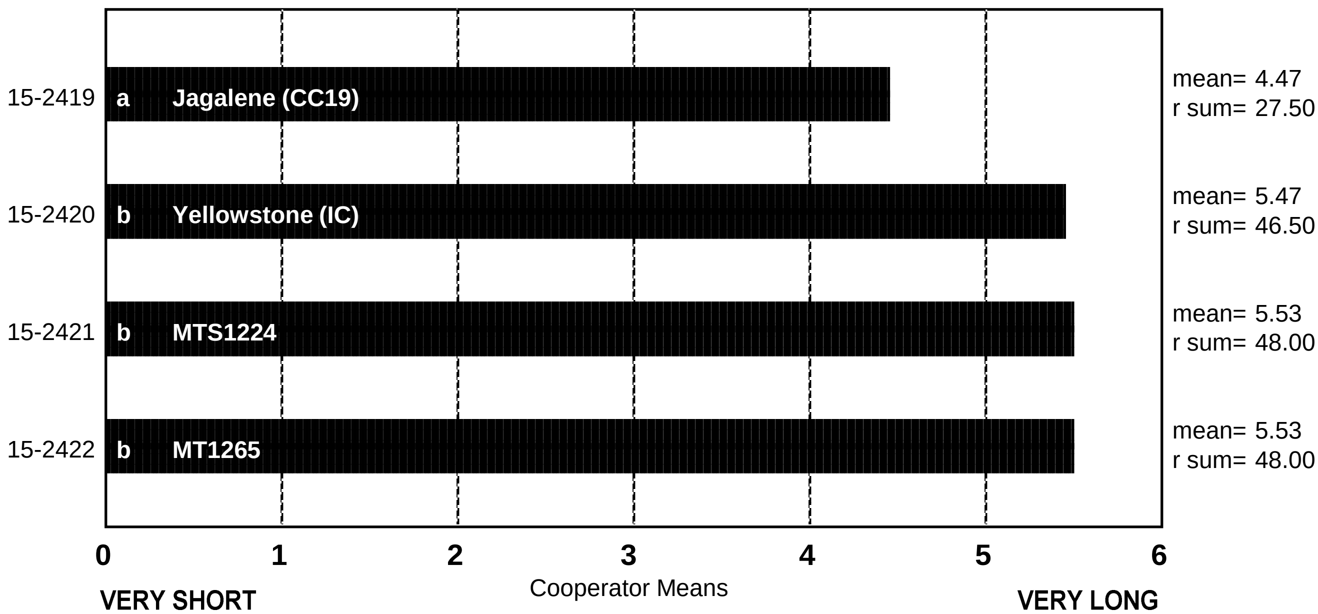
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
15-2419 Jagalene (CC19)	**5.0**	**7.0**	**9.0**	**6.0**	**4.3**	**7.7**	**5.7**	**4.8**	**3.7**	**10.3**	**4.5**	**4.2**	**20.0**	**8.0**	**12.0**	**8.0**	**12.0**
15-2420 Yellowstone (IC)	**7.9**	**10.5**	**20.0**	**6.0**	**6.8**	**13.0**	**13.0**	**8.0**	**5.5**	**24.0**	**6.5**	**6.5**	**20.0**	**14.0**	**25.0**	**25.0**	**14.0**
15-2421 MTS1224	**7.9**	**10.0**	**20.0**	**6.0**	**6.4**	**12.1**	**11.8**	**7.0**	**5.1**	**30.0**	**6.0**	**6.0**	**20.0**	**12.3**	**19.0**	**22.0**	**14.0**
15-2422 MT1265	**8.6**	**11.3**	**20.0**	**6.0**	**7.4**	**16.6**	**13.6**	**9.0**	**6.9**	**19.0**	**6.5**	**7.5**	**20.0**	**15.1**	**31.0**	**32.0**	**14.0**

BAKE MIX TIME

(Small Scale) Montana

ncoop= 17
chisq= 10.64
chisqc= 20.56
cvchisq= 7.82
crdiff= 7.80

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

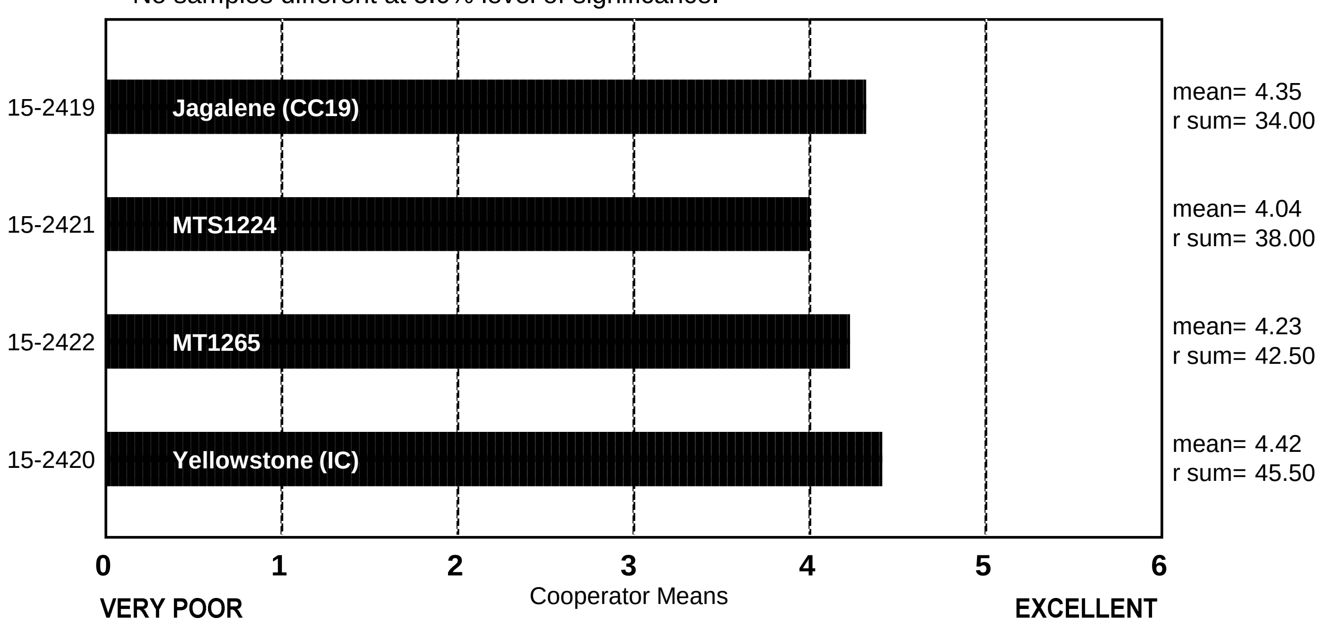


MIXING TOLERANCE

(Small Scale) Montana

ncoop= 16
chisq= 2.87
chisqc= 5.53
cvchisq= 7.82
crdiff=

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

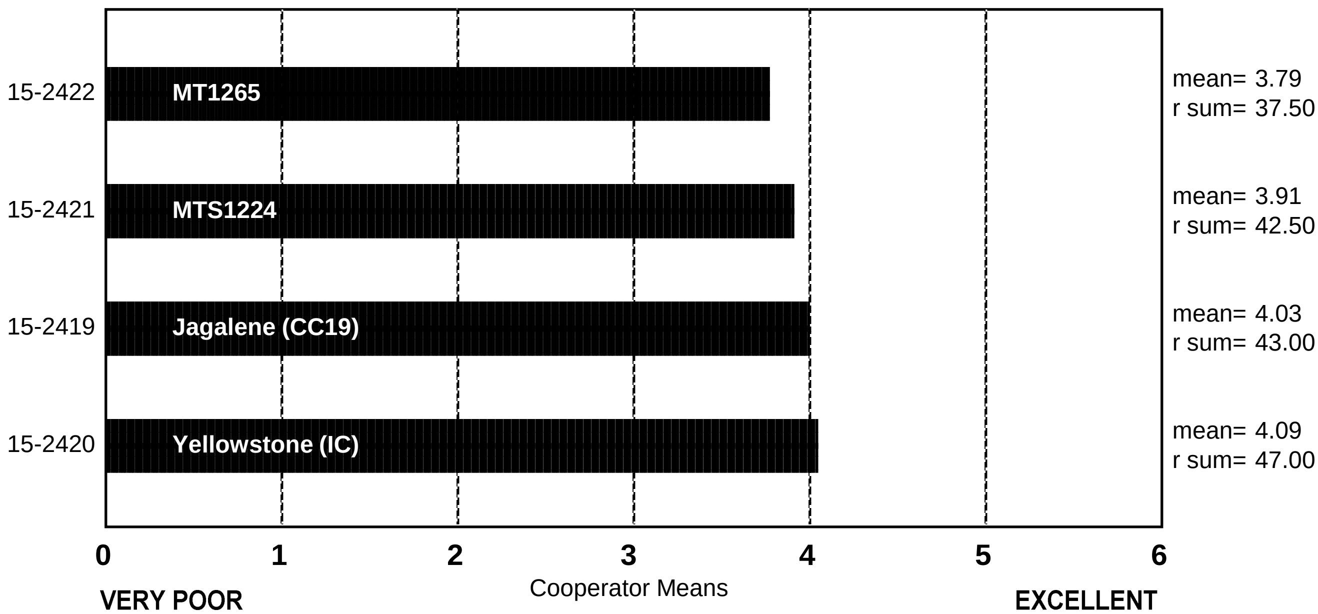


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Montana

ncoop= 17
chisq= 1.61
chisqc= 2.76
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) Montana

	Sticky	Wet	Tough	Good	Excellent
15-2419 Jagalene (CC19)	0	1	5	6	5
15-2420 Yellowstone (IC)	0	0	8	5	4
15-2421 MTS1224	0	1	7	5	4
15-2422 MT1265	0	0	10	4	3

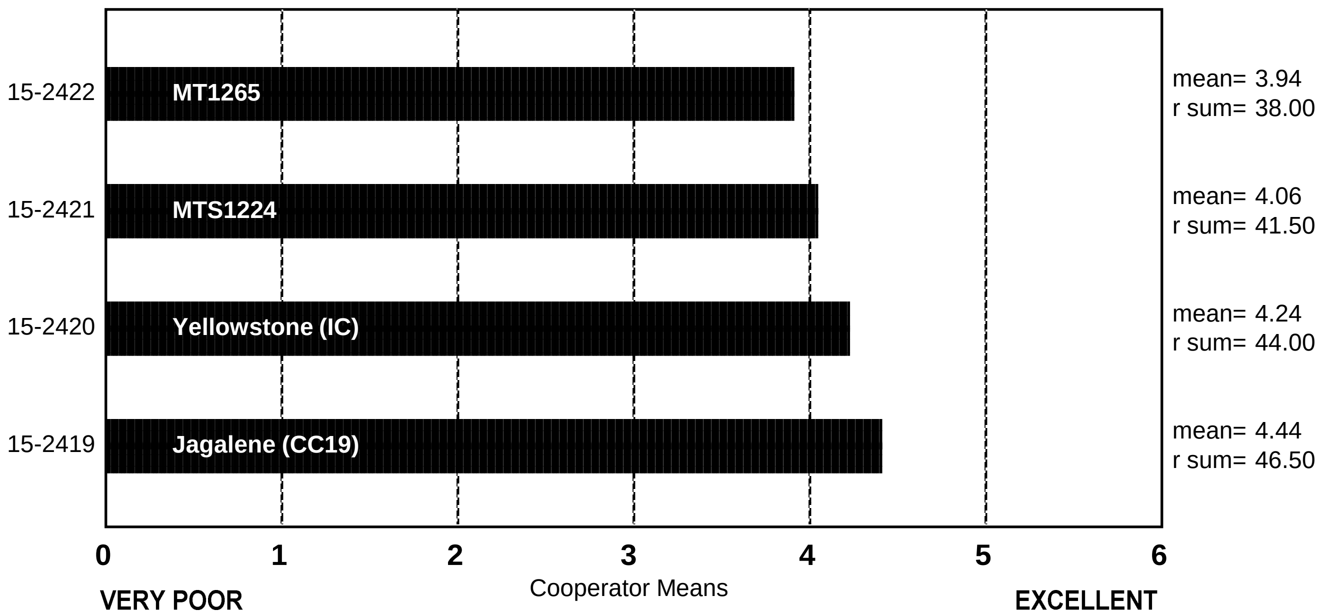
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Montana

ncoop= 17
chisq= 1.39
chisqc= 3.12
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
15-2419 Jagalene (CC19)	0	0	5	6	6
15-2420 Yellowstone (IC)	0	0	6	6	5
15-2421 MTS1224	0	0	7	6	4
15-2422 MT1265	0	0	8	6	3

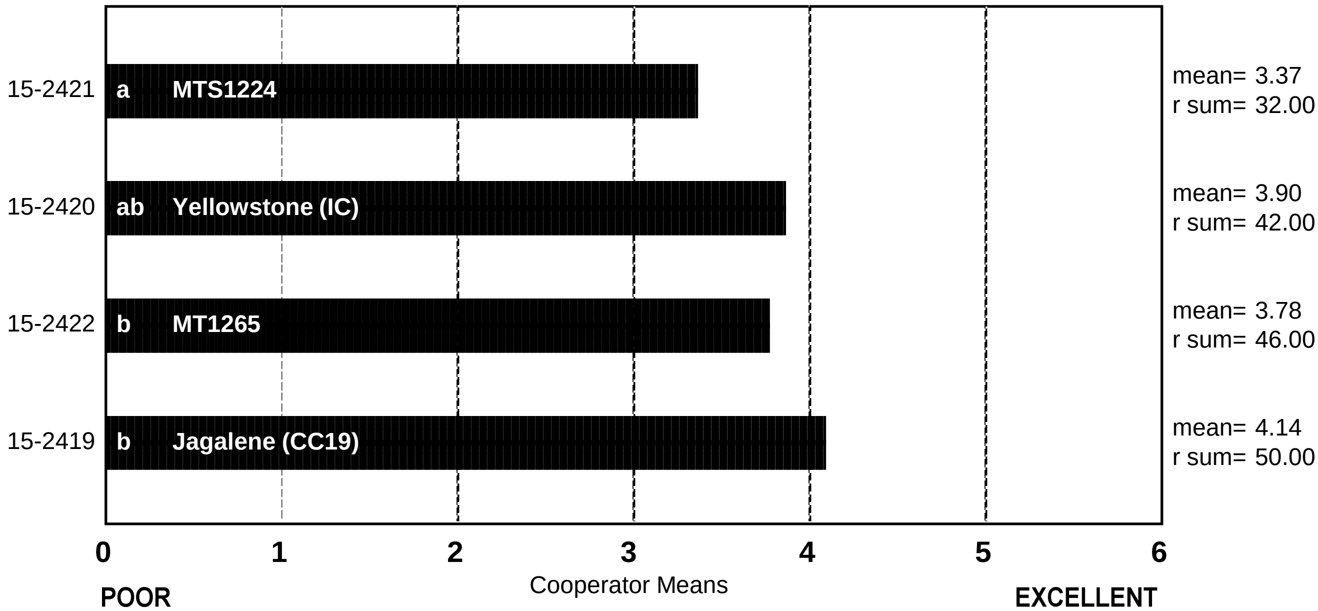
Frequency Table

CRUMB GRAIN

(Small Scale) Montana

ncoop= 17
chisq= 6.32
chisqc= 8.08
cvchisq= 7.82
crdiff= 12.08

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
15-2419 Jagalene (CC19)	7	9	1
15-2420 Yellowstone (IC)	8	8	1
15-2421 MTS1224	8	6	3
15-2422 MT1265	7	8	2

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Montana

	Round	Irregular	Elongated
15-2419 Jagalene (CC19)	**2**	**5**	**10**
15-2420 Yellowstone (IC)	**4**	**4**	**9**
15-2421 MTS1224	**3**	**6**	**8**
15-2422 MT1265	**4**	**6**	**7**

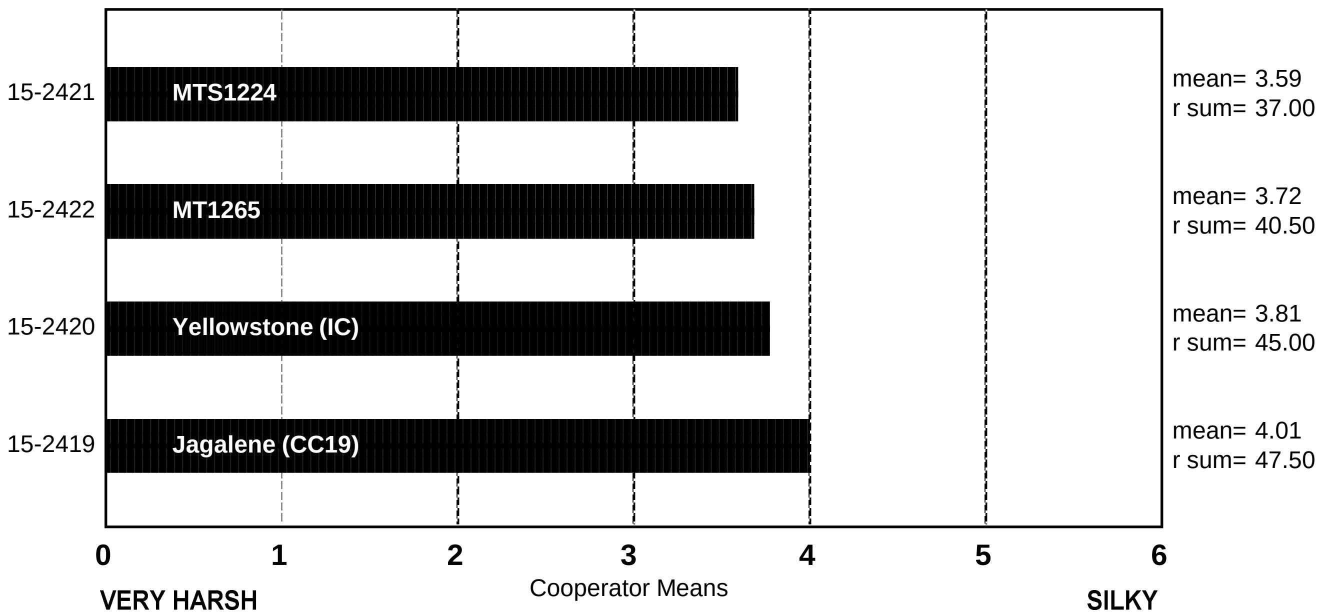
Frequency Table

CRUMB TEXTURE

(Small Scale) Montana

ncoop= 17
chisq= 2.31
chisqc= 3.57
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
15-2419 Jagalene (CC19)	2	13	2
15-2420 Yellowstone (IC)	4	10	3
15-2421 MTS1224	5	9	3
15-2422 MT1265	5	7	5

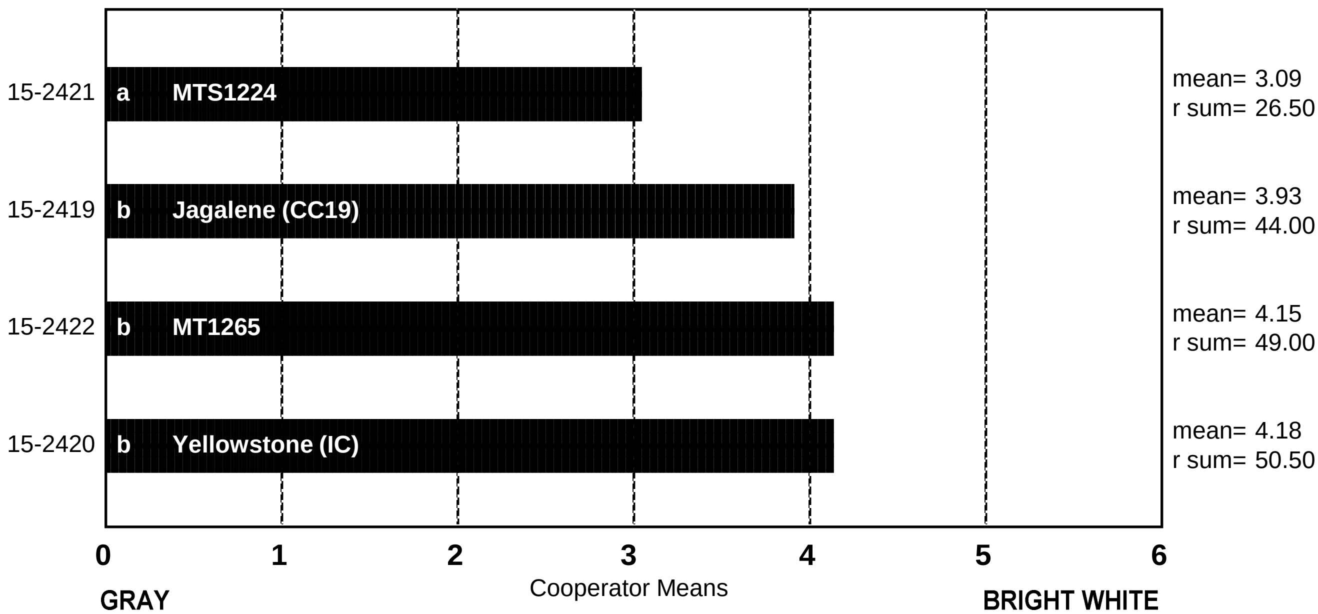
Frequency Table

CRUMB COLOR

(Small Scale) Montana

ncoop= 17
chisq= 12.86
chisqc= 17.78
cvchisq= 7.82
crdiff= 10.02

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



CRUMB COLOR, DESCRIBED

(Small Scale) Montana

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
15-2419 Jagalene (CC19)	**0**	**0**	**1**	**3**	**11**	**0**	**2**
15-2420 Yellowstone (IC)	**0**	**0**	**1**	**2**	**9**	**3**	**2**
15-2421 MTS1224	**0**	**0**	**8**	**2**	**6**	**1**	**0**
15-2422 MT1265	**0**	**0**	**0**	**4**	**9**	**3**	**1**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Montana

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2419 Jagalene (CC19)	**136.2**	**143.6**	**396.0**		**127.2**	**141.0**	**153.7**	**143.5**	**144.8**	**454.9**	**129.1**			**149.9**	**118.1**	**485.6**	**457.0**
15-2420 Yellowstone (IC)	**137.2**	**142.2**	**402.0**		**126.3**	**137.3**	**150.0**	**143.4**	**144.6**	**458.4**	**131.2**			**148.9**	**116.9**	**485.6**	**464.0**
15-2421 MTS1224	**135.8**	**136.7**	**402.0**		**126.1**	**142.0**	**152.5**	**140.4**	**142.2**	**459.2**	**128.8**			**147.4**	**123.8**	**489.1**	**460.0**
15-2422 MT1265	**135.6**	**139.1**	**400.0**		**127.7**	**140.4**	**153.5**	**138.9**	**139.6**	**456.2**	**131.2**			**146.4**	**122.4**	**489.2**	**461.0**

LOAF VOLUME, ACTUAL

(Small Scale) Montana

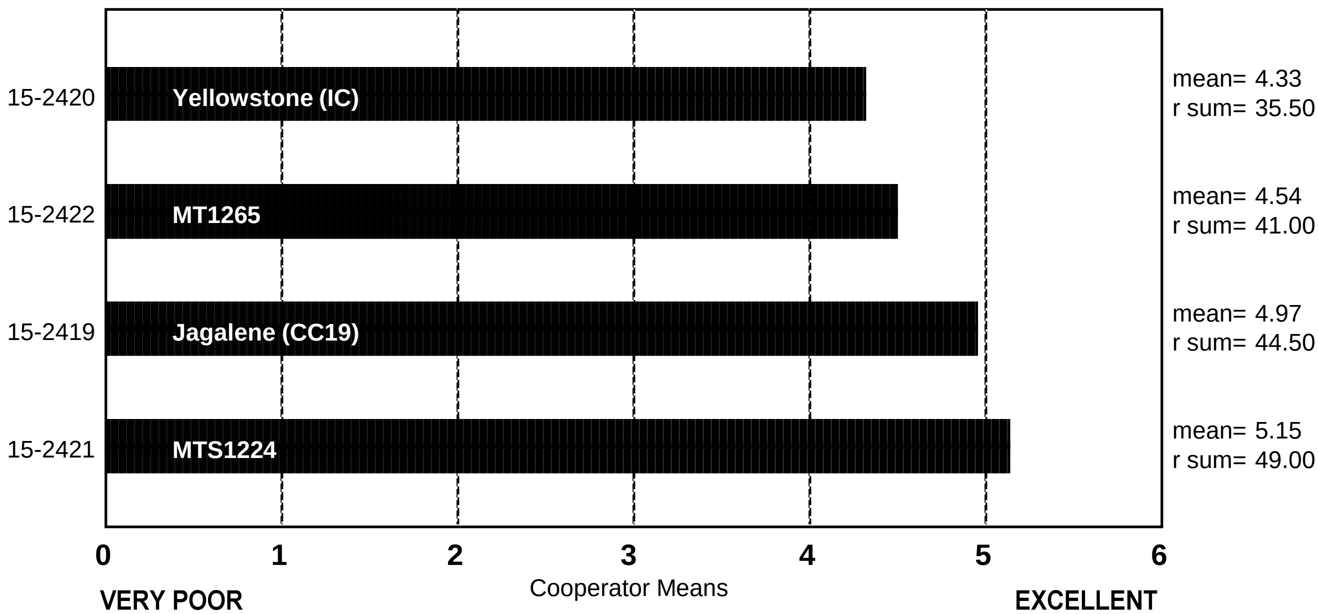
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2419 Jagalene (CC19)	**1001**	**953**	**3000**	**1050**	**868**	**1050**	**1045**	**980**	**905**	**3075**	**1140**	**965**	**3104**	**1085**	**2450**	**2650**	**2375**
15-2420 Yellowstone (IC)	**924**	**953**	**3000**	**1010**	**888**	**968**	**1045**	**1005**	**905**	**3017**	**1045**	**965**	**2897**	**1125**	**2425**	**2513**	**2075**
15-2421 MTS1224	**984**	**1143**	**3000**	**940**	**1005**	**895**	**1075**	**1040**	**1010**	**2943**	**1120**	**1065**	**3104**	**1130**	**2550**	**2550**	**2275**
15-2422 MT1265	**892**	**1055**	**3000**	**975**	**985**	**1033**	**1015**	**1065**	**1070**	**3179**	**995**	**995**	**2868**	**1100**	**2550**	**2513**	**2050**

LOAF VOLUME

(Small Scale) Montana

ncoop= 17
chisq= 3.44
chisqc= 4.83
cvchisq= 7.82
crdiff=

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

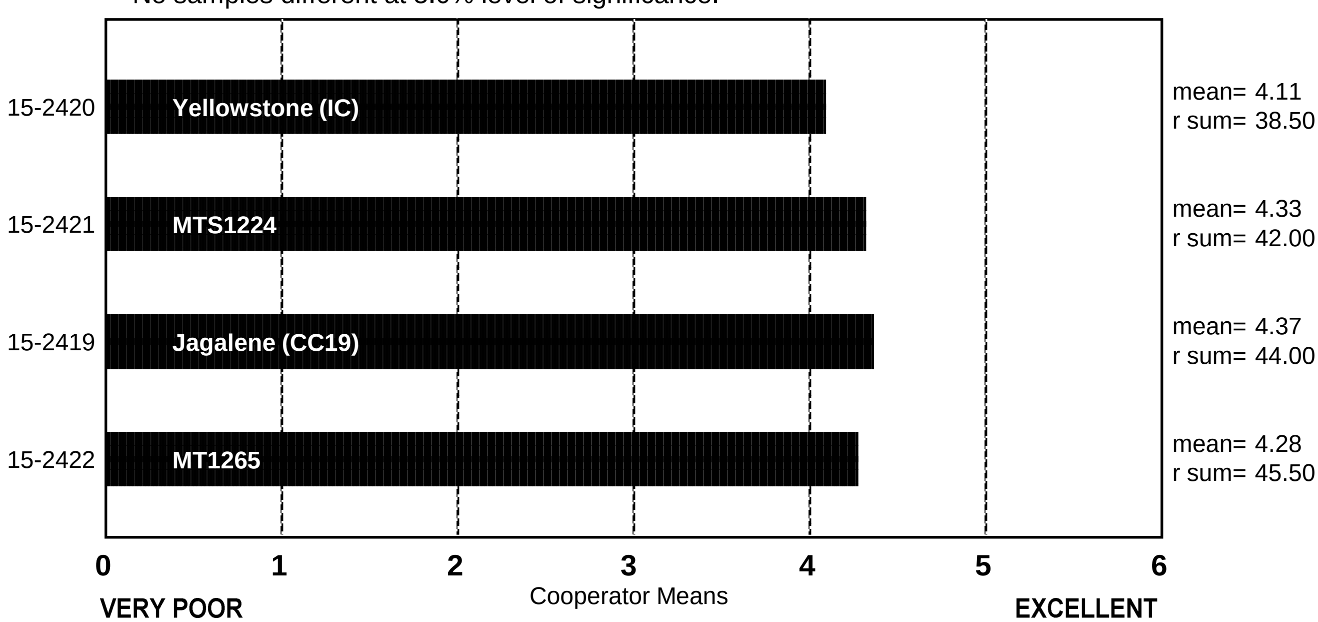


OVERALL BAKING QUALITY

(Small Scale) Montana

ncoop= 17
chisq= 0.97
chisqc= 1.15
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. 15-2419 Jagalene (CC19)

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption and mix time, slight sticky & strong dough, very high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
G. Good dough properties, excellent absorption, average volume and crumb grain.
H. No comment.
I. Very good protein but poor volume and grain.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Excellent absorption, long mix time, good dough strength at all stages, excellent crumb, excellent loaf volume.
O. Low absorption, long mix time, dough was excellent, bread had good volume with a dense grain rating.
P. Low absorption, good mix time, yellow crumb, good volume.
Q. Wild break and shred.

COOP. 15-2420 Yellowstone (IC)

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption, very long mix time, slight sticky & strong dough, high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
G. Very strong dough properties, too strong without blending, excellent absorption, average volume for protein level, grain below average due to strong dough type.
H. Nice externals.
I. Good protein and absorption, long mixing, good grain.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Excellent absorption, crazy long mix time, good dough strength at all stages, excellent crumb, excellent loaf volume.
O. Low absorption, long mix time, dough was bucky, bread had good volume with a dense grain rating.
P. Low absorption, long mix time, tough dough, nice grain.
Q. Never reached peak proof height, pulled at 80 minutes, wild break and shred.

COOP. 15-2421 MTS1224

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. Great dough and bread performance, very nice loaf.
F. Normal water absorption, very long mix time, slight sticky & strong dough, high volume, yellow crumb, fine elongated cells, resilient & smooth texture.
G. Very strong dough properties, too strong without blending, excellent absorption, excellent volume and crumb grain performance.
H. Nice externals.
I. Better protein, longer mixing, good volume, very poor grain and color.
J. No comment.
K. Blending wheat.
L. No comment.
M. No comment.
N. Excellent absorption, long mix time, satisfactory crumb grain, excellent loaf volume.
O. Low absorption, long mix time, dough was bucky, bread had excellent volume with a dense grain rating.
P. Low absorption, long mix time, tough dough, good grain, yellow crumb.
Q. Never reached peak proof height, pulled at 80 minutes, wild break and shred made volume look better.

COOP. 15-2422 MT1265

A. No comment.
B. Very good quality overall.
C. No comment.
D. No comment.
E. Very nice; one of the best.
F. Normal water absorption, very long mix time, slight sticky & strong dough, very high volume, creamy crumb, fine elongated cells, resilient & very smooth texture.
G. Very strong dough properties, too strong without blending, excellent absorption, average volume and crumb grain performance.
H. Excellent externals.
I. Good protein, too long mix, excellent color, good volume, poor grain.
J. No comment.
K. Blending wheat.
L. No comment.
M. No comment.
N. Excellent absorption, crazy long mix time, good dough strength at all stages, excellent crumb and loaf volume.
O. Had a lower absorption, highest mix time, dough was bucky, bread had excellent volume and grain rating.
P. Very long mix time, very tough dough, excellent grain.
Q. Never reached peak proof height, pulled at 80 minutes, flat loaf, no oven spring.

Notes: **C, D, M, O, P and Q** conducted sponge and dough bake tests

SOUTH DAKOTA

15-2423	Ideal (IC)
15-2424	SD10257-2

Description of Test Plots and Breeder Entries

South Dakota - Sunish Sehgal

Growing Location & Conditions

The Wheat Quality Council samples from South Dakota originated from 5 feet wide and 1000 feet long strip increases grown under dryland conditions at SDSU Aurora research station, Brookings, SD. The field with the strip increases and the adjacent breeding trials were fertilized with a pre-plant application of 10 gallons/a of liquid 10-34-0. The planting date was 9/22/14 and the harvest date was 8/12/15.

Growing conditions included: late planting into excessive moisture, moderate fall growth, followed immediately by below zero daytime temperatures November 5-12. January rains cover the field with a sheet of ice and winter injury occurred by February. Relatively dry and freezing temperatures during early spring hindered regrowth. A long cool spring with adequate moisture during May encouraged good growth and but with cool weather the stripe rust was observed at high levels by late May and early June. Fusarium head blight was also observed in late June and fungicide was applied for some control.

Grain yields of the adjacent state crop performance trial (CPT) were less than expected due to winter kill averaging 38 bu/a with an average test weight of 56.3 lb/bu and average protein content of 11.7%. Due to a combination of severe winter injury, and stripe rust infection the range of grain yield in the crop performance trial was particularly wide (22.7-49.7 bu/a). Average grain protein concentration from the group of four strips harvested for the WQC was 11.9% (12% mb).

Ideal (check) – local check

Ideal is a hard red winter wheat (HRW) with the pedigree Wesley/NE93613 and released by South Dakota State University in 2011. Ideal was tested in the 2010 WQC sample set under experimental number SD5118-1 and has been included as our check since 2012. Ideal is considered to have average to good milling quality and average to very good baking quality. It occupies more than 12% area in South Dakota.

SD10257-2

SD10257-2 was developed from the cross Ransom/SD96240-3-1. It has an excellent yield potential and above average test weights. SD10257-2 is an inch taller than Overland but heading is similar to Overland which is 2 days later than Expedition. Line SD10257-2 was evaluated in the South Dakota Crop Performance Trial (CPT) and in the Northern Regional Performance Nursery (NRPN) in 2013, 2014 and 2015. When evaluated in the NRPN, SD10257-2 ranked 1st

for average grain yield in both 2013 and 2014. In the 2013, 2014 and 2015 CPT, SD10257-2 average ranked 12th, 10th, and 9th respectively based on average grain yield among all entries evaluated. SD10257-2 ranked 2nd based on three-year average for grain yield among all entries evaluated (2012-2015). SD10257-2 is moderately resistant to leaf, stripe rust, and wheat streak mosaic virus (WSMV) and moderately resistant to moderately susceptible to Fusarium head blight and moderately susceptible to stem rust. SD10257-2 has average protein content and has very good milling quality but lower than average overall baking quality. SD10257-2 is in foundation seed increase in 2016 with the intent to release as a new cultivar in fall 2016.

South Dakota: 2015 (Small-Scale) Samples

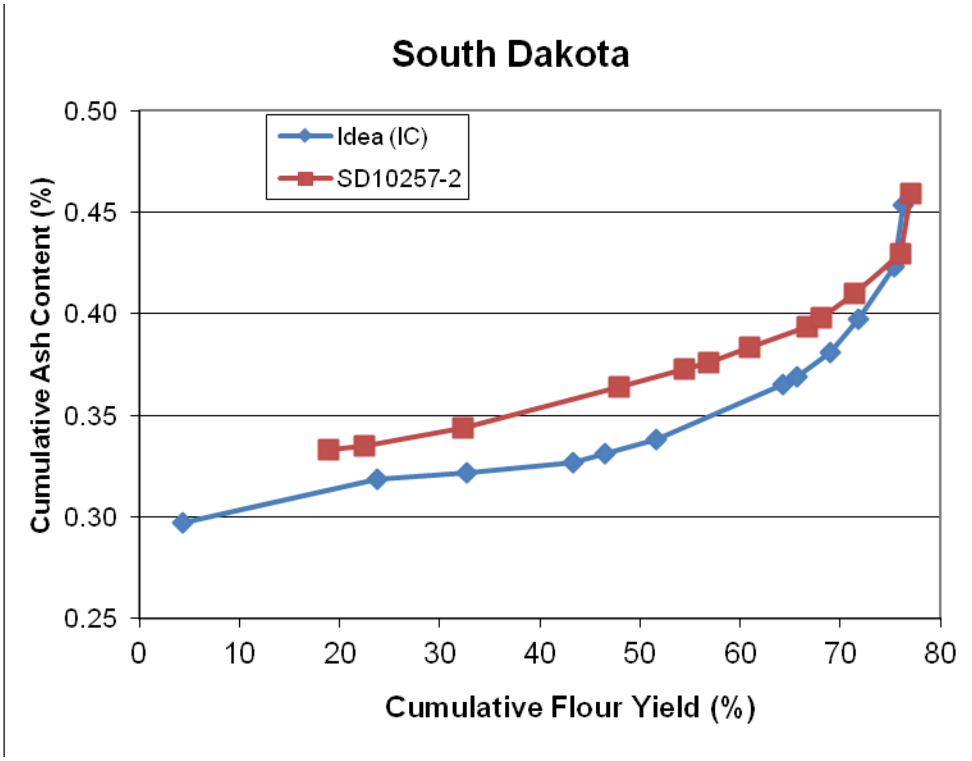
Test entry number	15-2423	15-2424
Sample identification	**Ideal (IC)**	**SD10257-2**
Wheat Data		
GIPSA classification	1 HRW	1 HRW
Test weight (lb/bu) **Hectoliter weight (kg/hl)**	63.9 84.0	63.0 82.8
1000 kernel weight (gm)	34.5	38.4
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 85.2 14.8 0.0	 84.7 15.2 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	 58.9/17.5 34.5/8.1 2.78/0.36 11.7/0.3 06-21-25-48-02 Hard	 70.8/14.2 38.4/10.8 2.87/0.38 11.7/0.3 00-03-17-80-01 Hard
Wheat protein (12% mb) **Wheat ash (12% mb)**	10.0 1.61	12.5 1.50
Milling and Flour Quality Data		
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 69.6 68.7	 69.9 69.6
Flour moisture (%) **Flour protein (14% mb)** **Flour ash (14% mb)**	13.6 8.7 0.45	13.3 11.1 0.48
Rapid Visco-Analyser Peak time (min) Peak viscosity (RVU) Breakdown (RVU) Final viscosity at 13 min (RVU)	 6.1 203.7 73.0 252.6	 6.1 199.7 65.7 256.5
Minolta color meter L* a* b* **PPO**	 90.88 -1.92 12.14 0.505	 91.55 -1.33 8.87 0.525
Falling number (sec)	422	460
Damaged Starch (AI%) (AACC76-31)	 96.92 7.00	 96.75 6.87

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

South Dakota: Physical Dough Tests and Gluten Analysis 2015 (Small-Scale) Samples

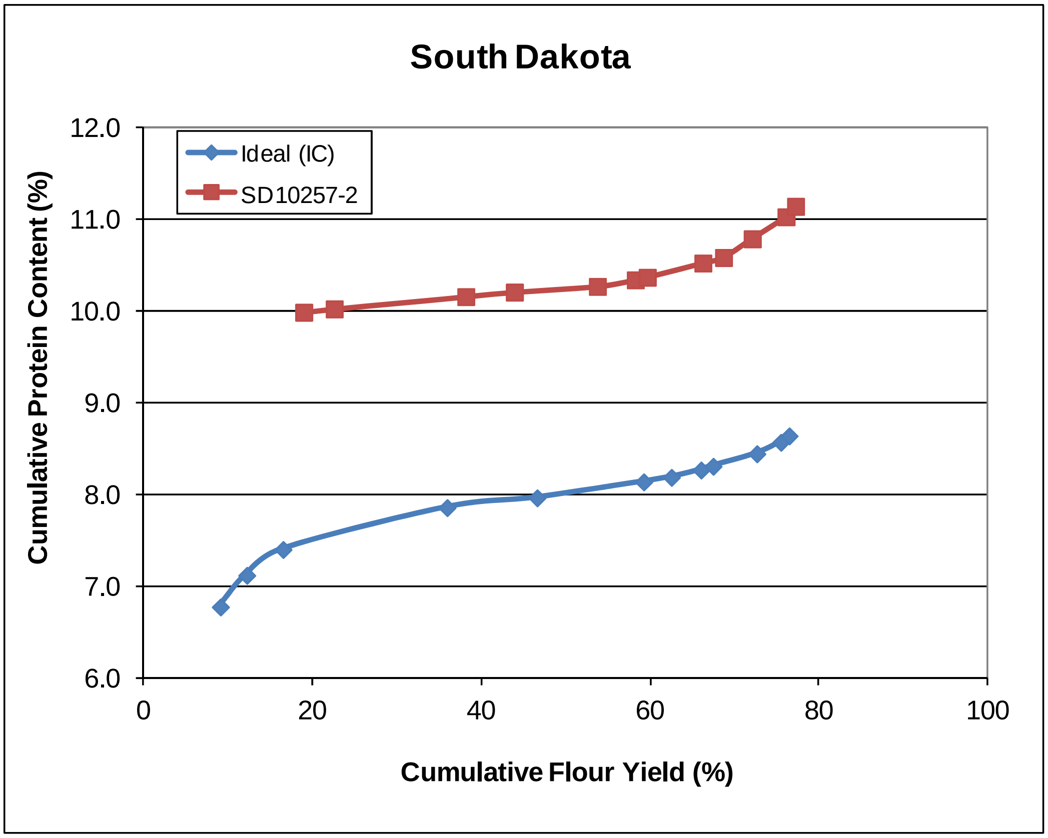
Test Entry Number	**15-2423**	**15-2424**
Sample Identification	**Ideal (IC)**	**SD10257-2**
MIXOGRAPH		
Flour Abs (% as-is)	60.5	63.2
Flour Abs (14% mb)	60.0	62.4
Mix Time (min)	6.4	1.8
Mix tolerance (0-6)	4	1
FARINOGRAPH		
Flour Abs (% as-is)	57.4	63.8
Flour Abs (14% mb)	56.9	63.0
Development time (min)	1.7	3.5
Mix stability (min)	1.6	3.5
Mix Tolerance Index (FU)	81	47
Breakdown time (min)	2.6	6.6
ALVEOGRAPH		
P(mm): Tenacity	97	83
L(mm): Extensibility	52	96
G(mm): Swelling index	16.1	21.8
W(10^{-4} J): strength (curve area)	211	199
P/L: curve configuration ratio	1.87	0.86
Ie(P_{200}/P): elasticity index	61.2	39.6
EXTENSIGRAPH		
Resist (BU at 45/90/135 min)	500/790/838	171/179/177
Extensibility (mm at 45/90/135 min)	132/119/116	164/180/178
Energy (cm^2 at 45/90/135 min)	119/148/149	48/57/56
Resist $_{max}$ (BU at 45/90/135min)	725/1000/995	198/212/213
Ratio (at 45/90/135 min)	3.78/6.61/7.23	1.05/1.00/0.99
PROTEIN ANALYSIS		
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+9, 2+12
%IPP	51.68	39.31
SEDIMENTATION TEST		
Volume (ml)	41.8	35.7

South Dakota: Cumulative Ash Curves



	Idea (IC)					SD10257-2			
Mill	Strm-yld	Ash	Cumul (14%)		Mill	Strm-yld	Ash	Cumul (14%)	
Streams	(14%mb)		Yield	Ash	Streams	(14%mb)		Yield	Ash
1M Red	4.29	0.30	4.29	0.30	2M	18.83	0.33	18.83	0.33
2M	19.42	0.32	23.71	0.32	1M Red	3.61	0.34	22.45	0.33
1BK	8.97	0.33	32.68	0.32	1M	9.83	0.36	32.28	0.34
1M	10.66	0.34	43.34	0.33	3M	15.58	0.40	47.85	0.36
Grader	3.13	0.39	46.47	0.33	1BK	6.59	0.44	54.44	0.37
2BK	5.18	0.40	51.65	0.34	Grader	2.44	0.45	56.89	0.38
3M	12.62	0.47	64.27	0.37	2BK	3.99	0.49	60.88	0.38
FILTER FLR	1.43	0.56	65.70	0.37	4M	5.75	0.50	66.64	0.39
4M	3.29	0.62	68.99	0.38	FILTER FLR	1.41	0.59	68.04	0.40
3BK	2.84	0.79	71.82	0.40	3BK	3.41	0.65	71.45	0.41
5M	3.51	0.95	75.33	0.42	5M	4.50	0.74	75.95	0.43
BRAN FLR	0.99	2.77	76.32	0.45	BRAN FLR	1.13	2.45	77.07	0.46
Break Shorts	3.04	4.20	79.36	0.60	Break Shorts	2.82	3.95	79.90	0.58
Red Dog	2.79	2.47	82.15	0.66	Red Dog	2.67	2.03	82.57	0.63
Red Shorts	0.48	4.40	82.63	0.68	Red Shorts	0.45	4.17	83.03	0.65
Filter Bran	0.64	2.12	83.27	0.69	Filter Bran	0.61	1.56	83.64	0.66
Bran	16.73	6.12	100.0	1.60	Bran	16.36	6.23	100.0	1.57
Wheat		1.58					1.47		
St. Grd. Fl.		0.45					0.49		

South Dakota: Cumulative Protein Curves



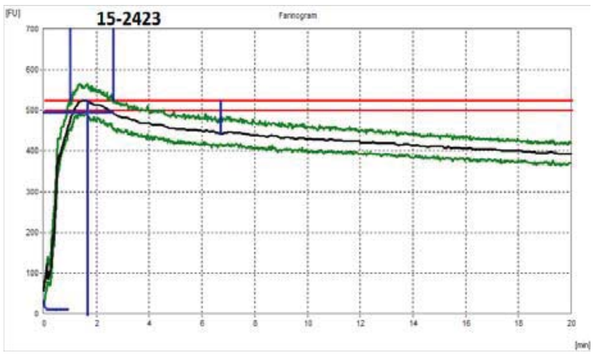
Ideal (IC)					SD10257-2				
Mill	Strm-yld	Protein	Cumulative (14%)		Mill	Strm-yld	Protein	Cumulative (14%)	
Streams	(14%mb)		Yield	Protein	Streams	(14%mb)		Yield	Protein
1BK	8.97	6.77	8.97	6.77	2M	18.83	9.98	18.83	9.98
Grader	3.13	8.11	12.09	7.12	1M Red	3.61	10.21	22.45	10.02
1M Red	4.29	8.19	16.39	7.40	3M	15.58	10.35	38.02	10.15
2M	19.42	8.24	35.81	7.85	4M	5.75	10.54	43.78	10.20
1M	10.66	8.32	46.47	7.96	1M	9.83	10.54	53.61	10.27
3M	12.62	8.77	59.09	8.13	5M	4.50	11.19	58.10	10.34
4M	3.29	9.08	62.37	8.18	FILTER FLR	1.41	11.53	59.51	10.37
5M	3.51	9.67	65.88	8.26	1BK	6.59	11.92	66.10	10.52
FILTER FLR	1.43	10.20	67.31	8.31	Grader	2.44	12.21	68.55	10.58
2BK	5.18	10.22	72.49	8.44	3BK	3.41	14.90	71.95	10.78
3BK	2.84	11.75	75.33	8.57	2BK	3.99	15.34	75.95	11.02
BRAN FLR	0.99	13.97	76.32	8.64	BRAN FLR	1.13	18.85	77.07	11.14
Break Shorts	3.04	13.28	79.36	8.81	Break Shorts	2.82	15.80	79.90	11.30
Red Dog	2.79	11.34	82.15	8.90	Red Dog	2.67	13.50	82.57	11.37
Red Shorts	0.48	12.34	82.63	8.92	Red Shorts	0.45	14.08	83.03	11.39
Filter Bran	0.64	10.32	83.27	8.93	Filter Bran	0.61	11.34	83.64	11.39
Bran	16.73	13.28	100.00	9.66	Bran	16.36	16.61	100.00	12.24
Wheat		9.82					12.23		
St. Grd. Fl		8.72					11.12		

Physical Dough Tests

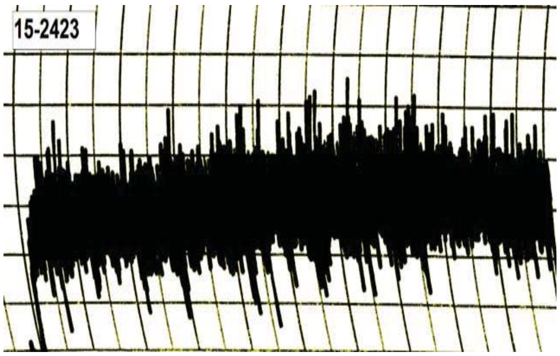
2015 (Small Scale) Samples - South Dakota

Farinograms

Mixograms

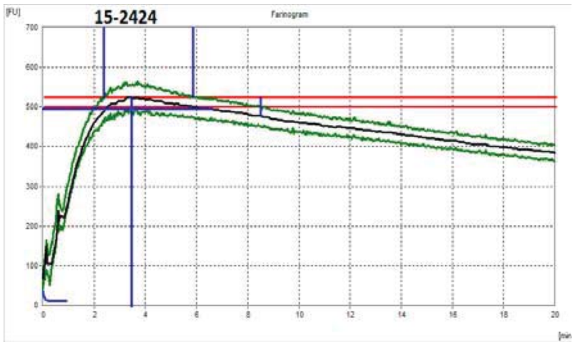


Water abs = 56.9%, Peak time = 1.7 min,
Mix stab = 1.6 min, MTI = 81 FU

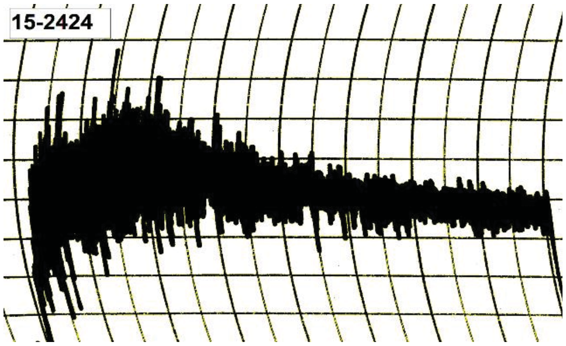


Water abs = 60.0%
Mix time = 6.4 min

15-2423, Ideal (IC)



Water abs = 63.0%, Peak time = 3.5 min,
Mix stab = 3.5 min, MTI = 47 FU

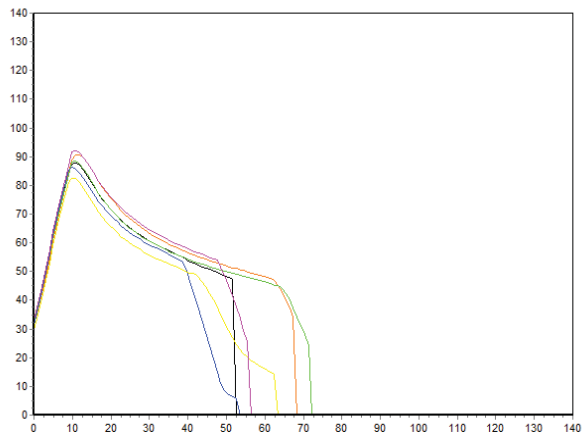


Water abs = 62.4%
Mix time = 1.8 min

15-2424, SD10257-2

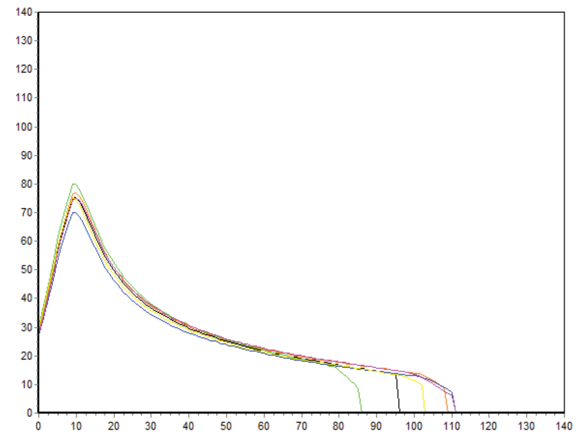
Physical Dough Tests - Alveograph

2015 (Small Scale) Samples – South Dakota



15-2423, Ideal (IC)

P(mm H_20)=97, L(mm)= 52, W($10E^{-4}$ J)= 211

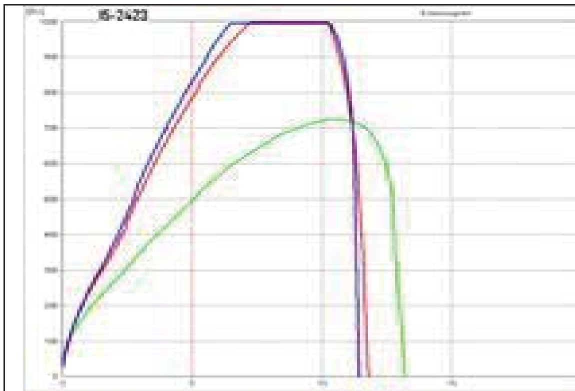


15-2424, SD10257-2

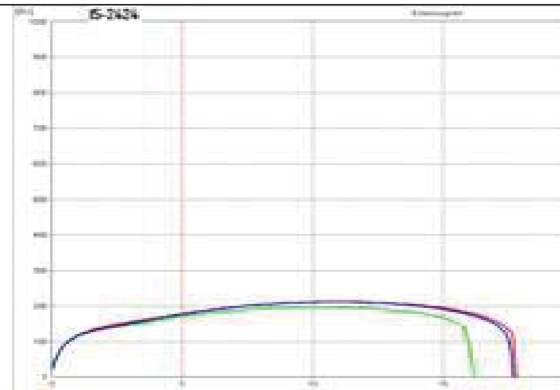
P(mm H_20)=83, L(mm)= 96, W($10E^{-4}$ J)= 199

Physical Dough Tests - Extensigraph

2015 (Small Scale) Samples – South Dakota



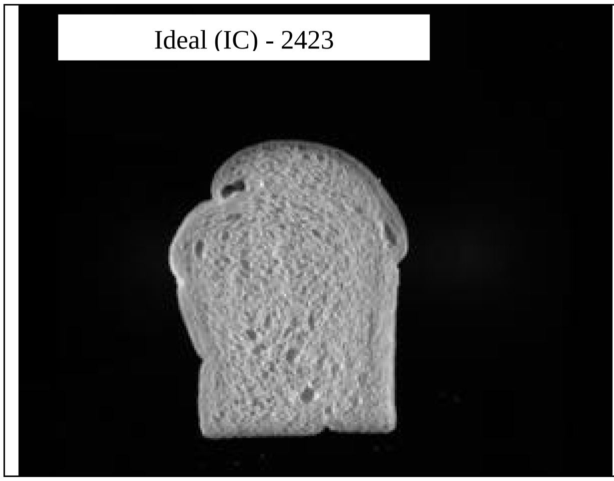
15-2423, Ideal (IC)
R (BU) = 790, E (mm) = 119, W (cm^2) = 148
Rmax (BU) = 1000, Ratio = 6.6 at 90 min



15-2424, SD10257-2
R (BU) = 179, E (mm) = 180, W (cm^2) = 57
Rmax (BU) = 212, Ratio = 1.0 at 90 min

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

South Dakota: C-Cell Bread Images and Analysis
2015 (Small-Scale) Samples



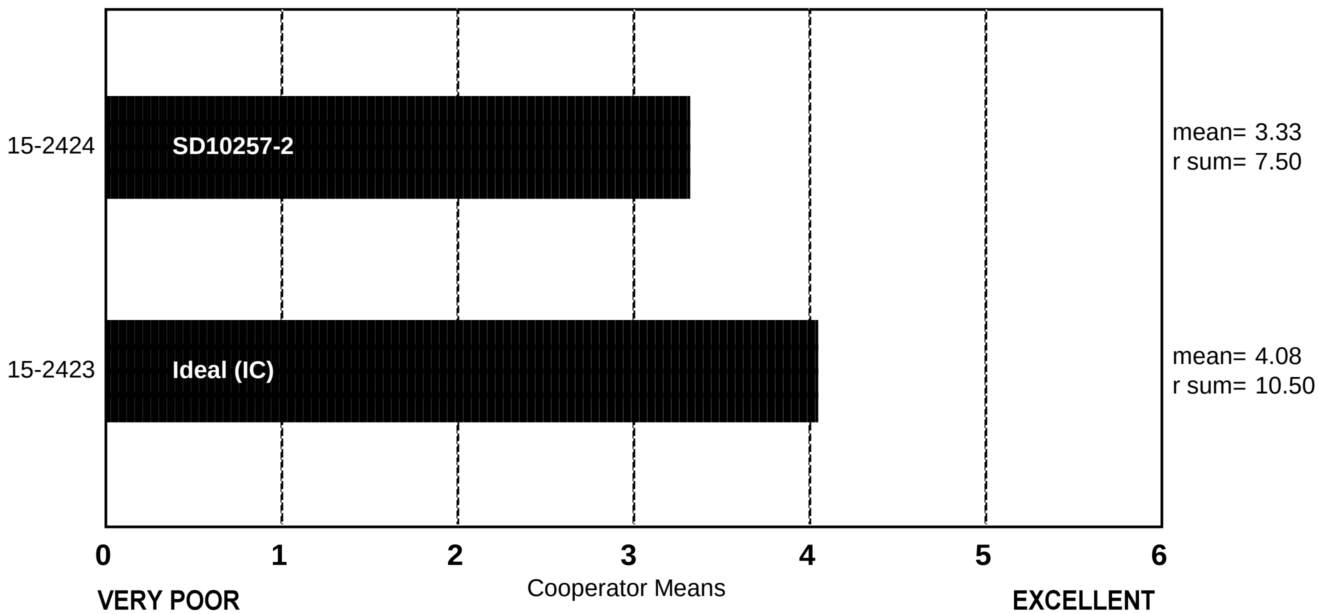
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2423	5453	148.2	3910	0.427	1.690	2.386	1.720	-19.73
2424	5544	148.1	3658	0.442	1.914	1.687	1.578	-27.45

SPONGE CHARACTERISTICS

(Small Scale) South Dakota

ncoop= 6
chisq= 1.50
chisqc= 3.00
cvchisq= 3.84
crdiff=

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

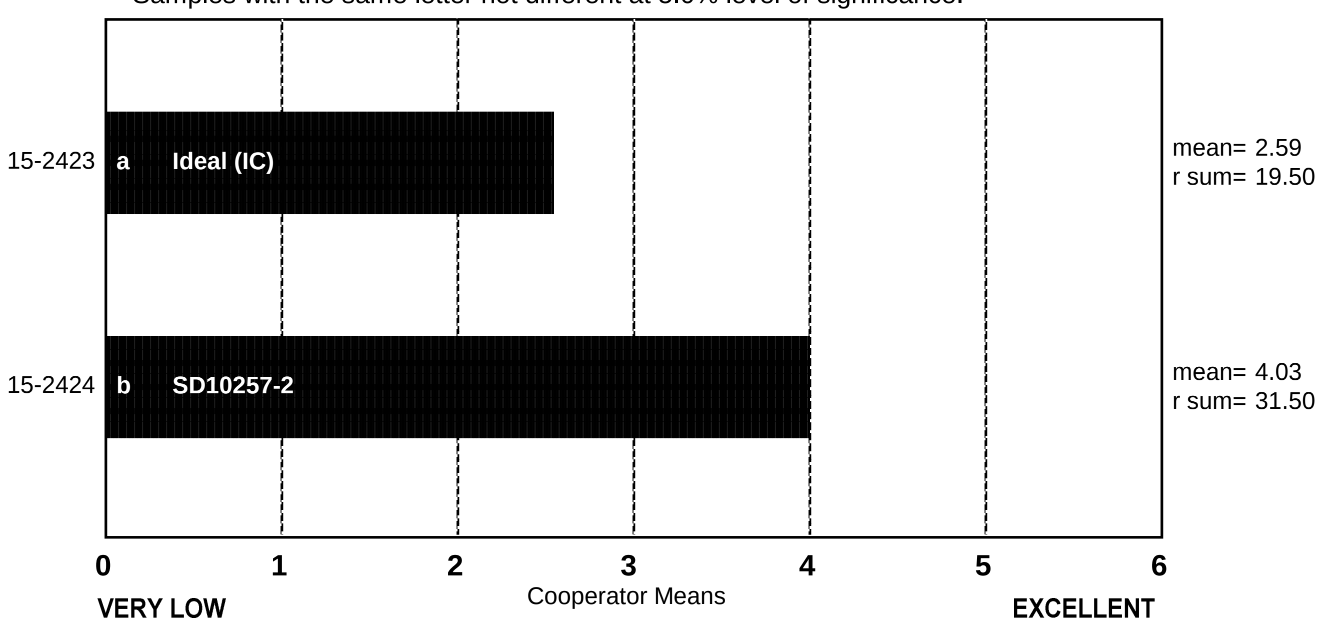


BAKE ABSORPTION

(Small Scale) South Dakota

ncoop= 17
chisq= 8.47
chisqc= 10.29
cvchisq= 3.84
crdiff= 2.71

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) South Dakota

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2423 Ideal (IC)	**60.3**	**63.0**	**55.0**	**60.0**	**59.9**	**61.0**	**66.7**	**59.0**	**60.0**	**56.9**	**62.7**	**57.5**	**57.0**	**59.2**	**56.9**	**55.0**	**57.2**
15-2424 SD10257-2	**63.0**	**65.0**	**57.0**	**60.0**	**64.0**	**62.5**	**67.4**	**60.9**	**62.4**	**63.0**	**69.4**	**60.9**	**62.0**	**59.9**	**63.0**	**59.0**	**64.6**

BAKE MIX TIME, ACTUAL

(Small Scale) South Dakota

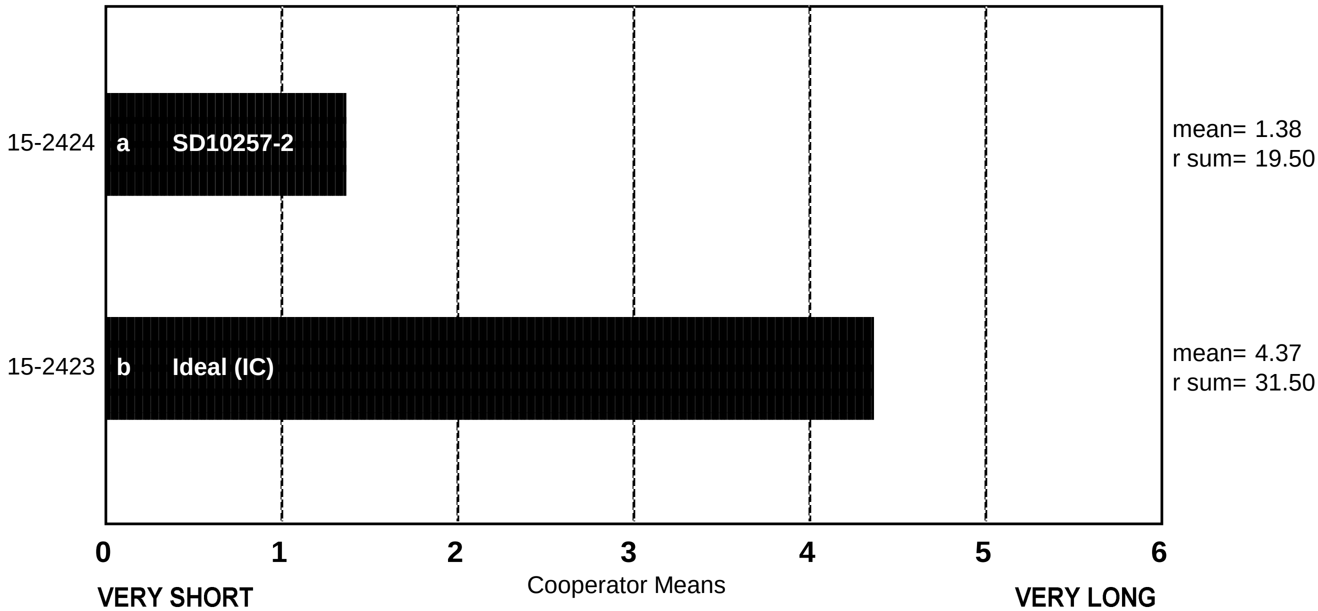
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2423 Ideal (IC)	**6.4**	**7.5**	**10.0**	**6.0**	**7.0**	**9.5**	**8.0**	**6.8**	**5.1**	**1.0**	**6.5**	**7.0**	**20.0**	**11.5**	**5.5**	**8.0**	**6.0**
15-2424 SD10257-2	**1.8**	**1.3**	**4.0**	**6.0**	**2.0**	**3.0**	**2.4**	**2.3**	**1.8**	**2.3**	**2.5**	**2.0**	**8.0**	**2.5**	**1.5**	**3.0**	**4.0**

BAKE MIX TIME

(Small Scale) South Dakota

ncoop= 17
chisq= 8.47
chisqc= 10.29
cvchisq= 3.84
crdiff= 2.71

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

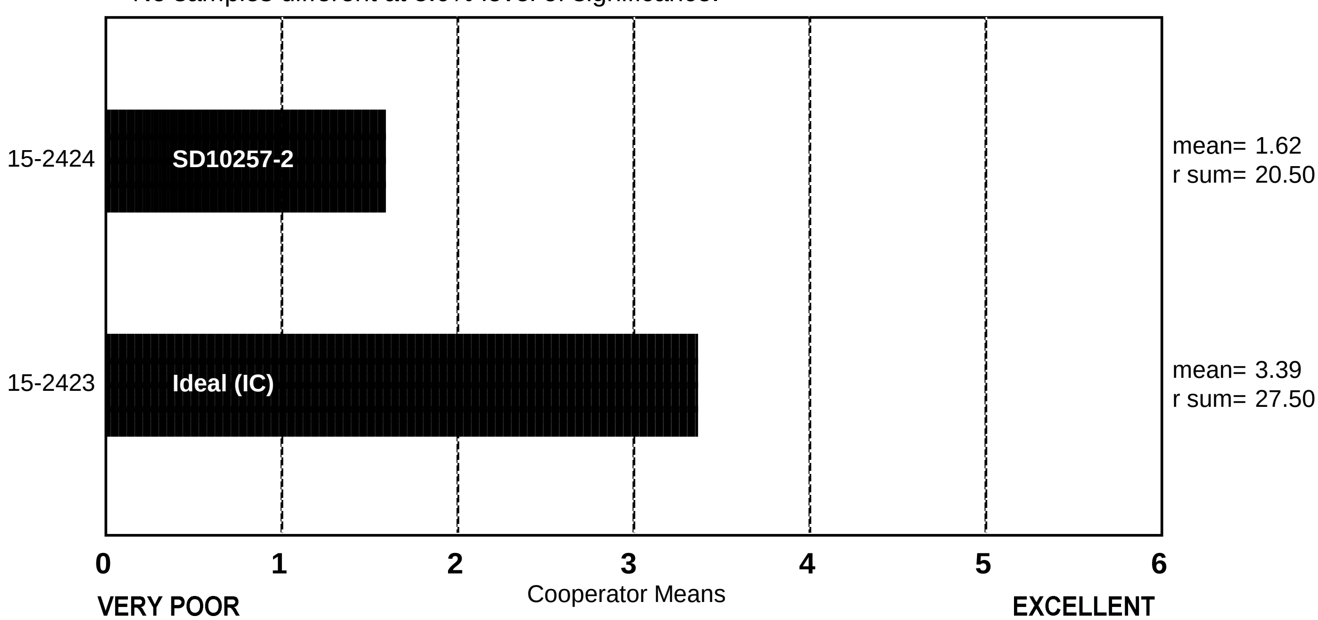


MIXING TOLERANCE

(Small Scale) South Dakota

ncoop= 16
chisq= 3.06
chisqc= 3.77
cvchisq= 3.84
crdiff=

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

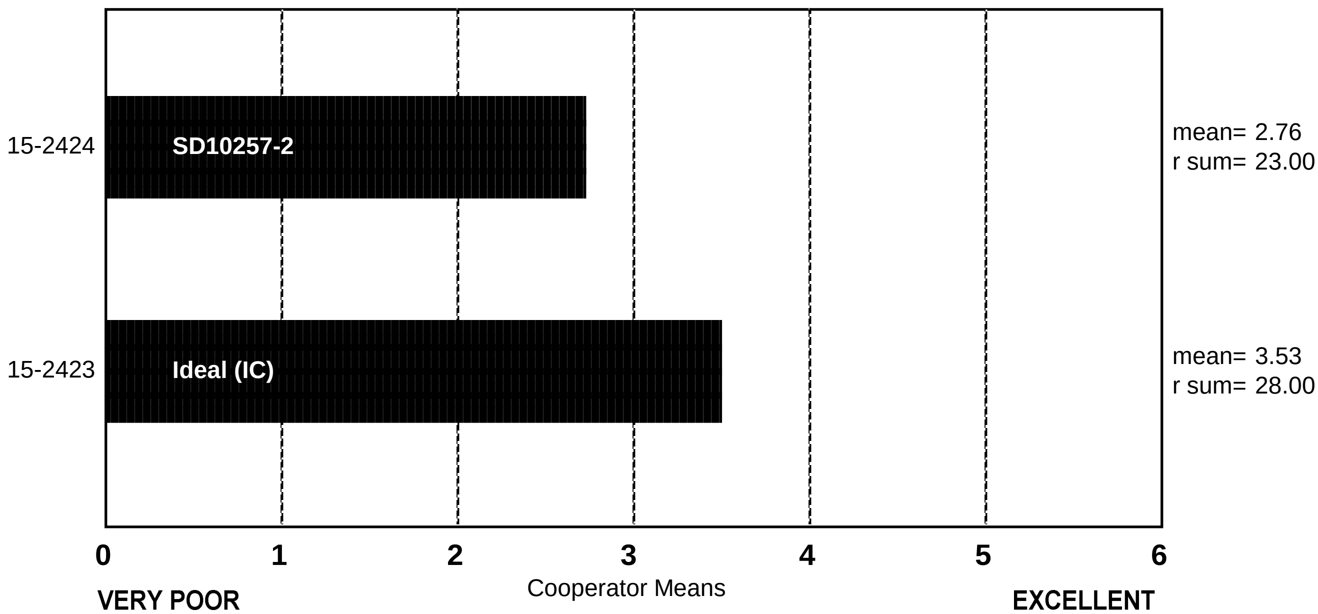


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) South Dakota

ncoop= 17
chisq= 1.47
chisqc= 1.67
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) South Dakota

	Sticky	Wet	Tough	Good	Excellent
15-2423 Ideal (IC)	**1**	**0**	**6**	**10**	**0**
15-2424 SD10257-2	**7**	**0**	**3**	**7**	**0**

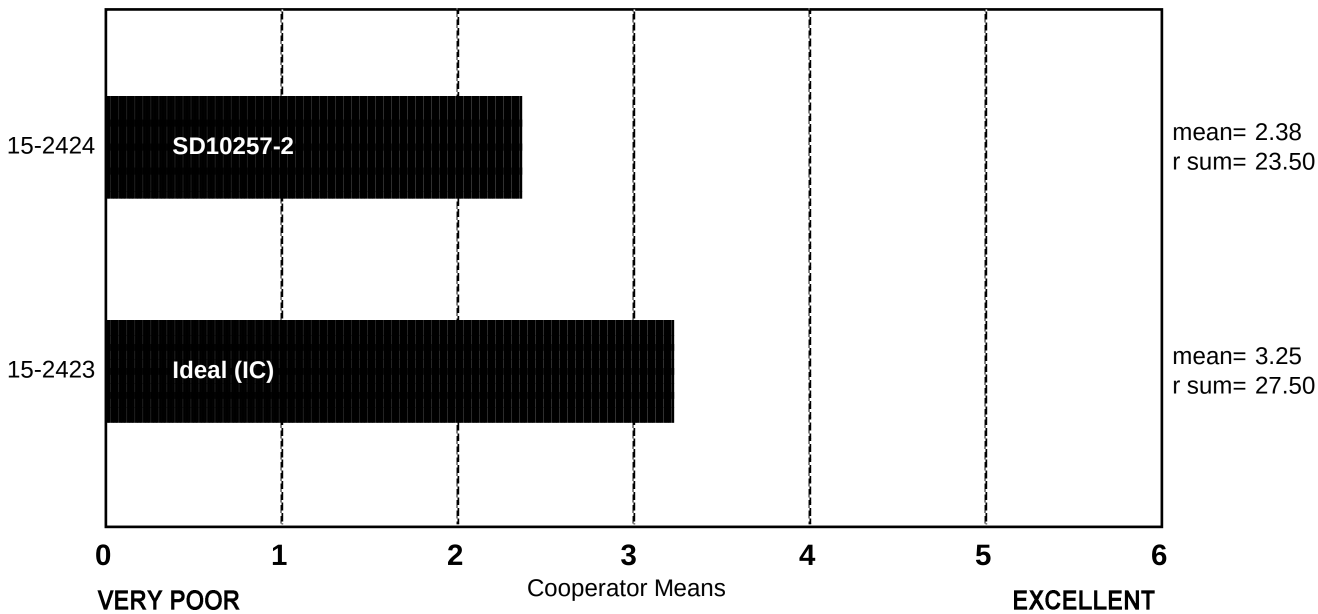
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) South Dakota

ncoop= 17
chisq= 0.94
chisqc= 1.14
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) South Dakota

	Sticky	Wet	Tough	Good	Excellent
15-2423 Ideal (IC)	**3**	**1**	**7**	**5**	**1**
15-2424 SD10257-2	**4**	**6**	**1**	**6**	**0**

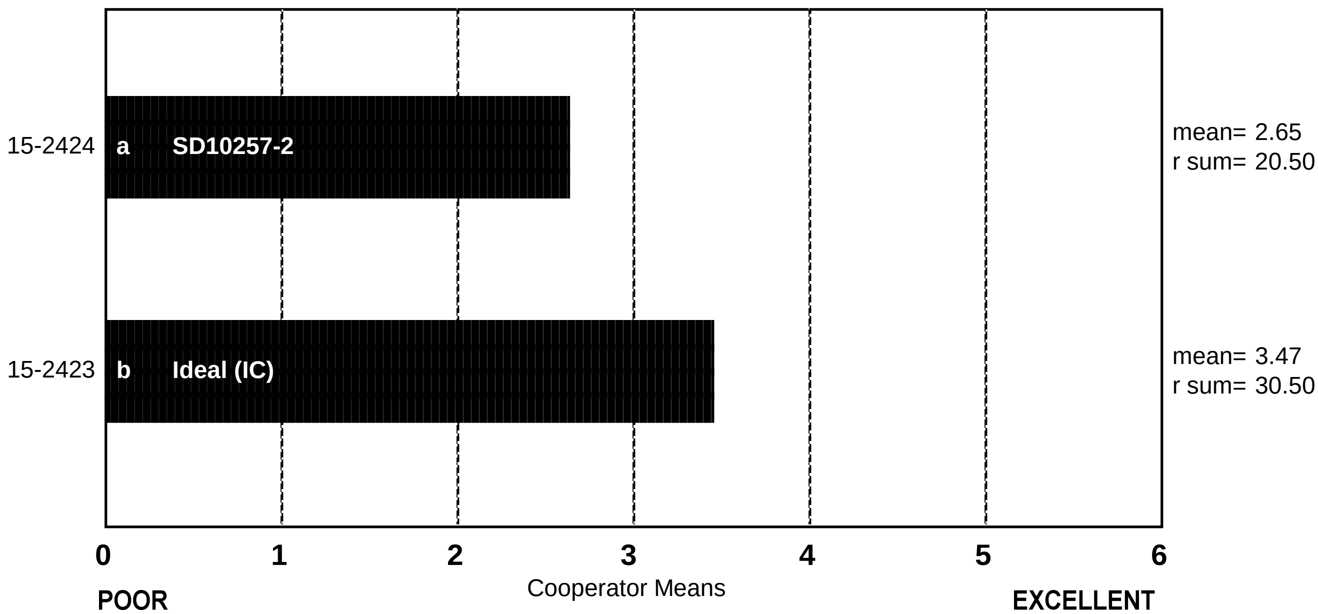
Frequency Table

CRUMB GRAIN

(Small Scale) South Dakota

ncoop= 17
chisq= 5.88
chisqc= 6.67
cvchisq= 3.84
crdiff= 3.29

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



CRUMB GRAIN, DESCRIBED

(Small Scale) South Dakota

	Open	Fine	Dense
15-2423 Ideal (IC)	**7**	**6**	**4**
15-2424 SD10257-2	**10**	**2**	**5**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) South Dakota

	Round	Irregular	Elongated
15-2423 Ideal (IC)	**3**	**8**	**6**
15-2424 SD10257-2	**6**	**10**	**1**

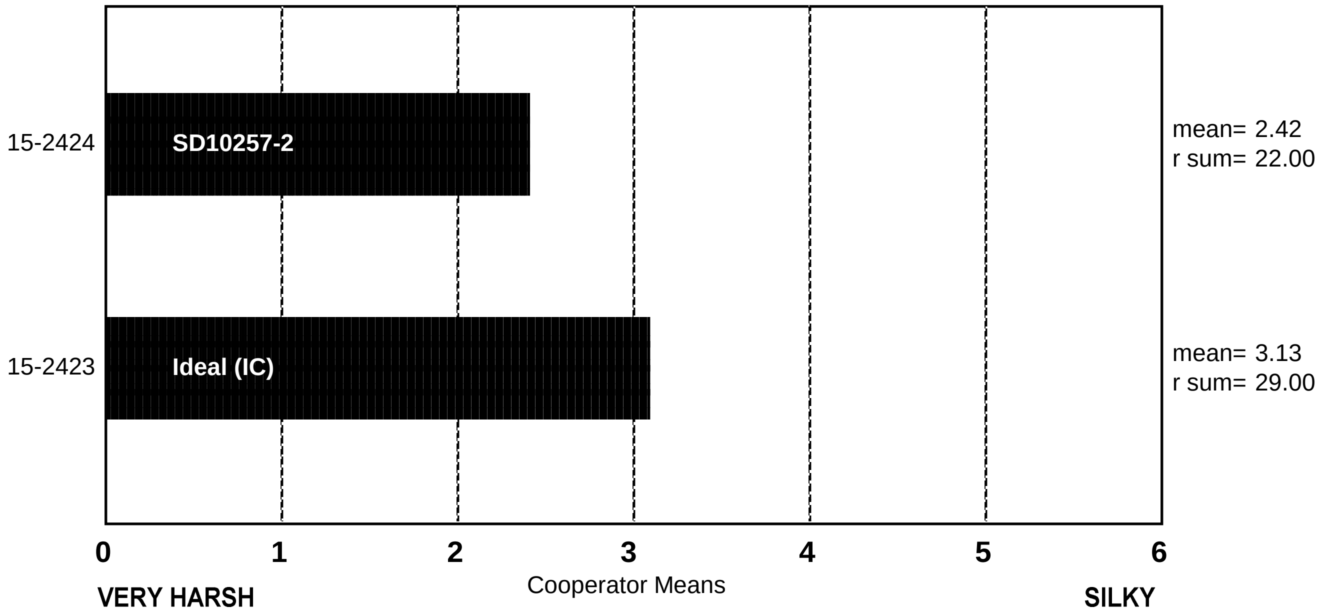
Frequency Table

CRUMB TEXTURE

(Small Scale) South Dakota

ncoop= 17
chisq= 2.88
chisqc= 3.77
cvchisq= 3.84
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) South Dakota

	Harsh	Smooth	Silky
15-2423 Ideal (IC)	**8**	**7**	**2**
15-2424 SD10257-2	**11**	**6**	**0**

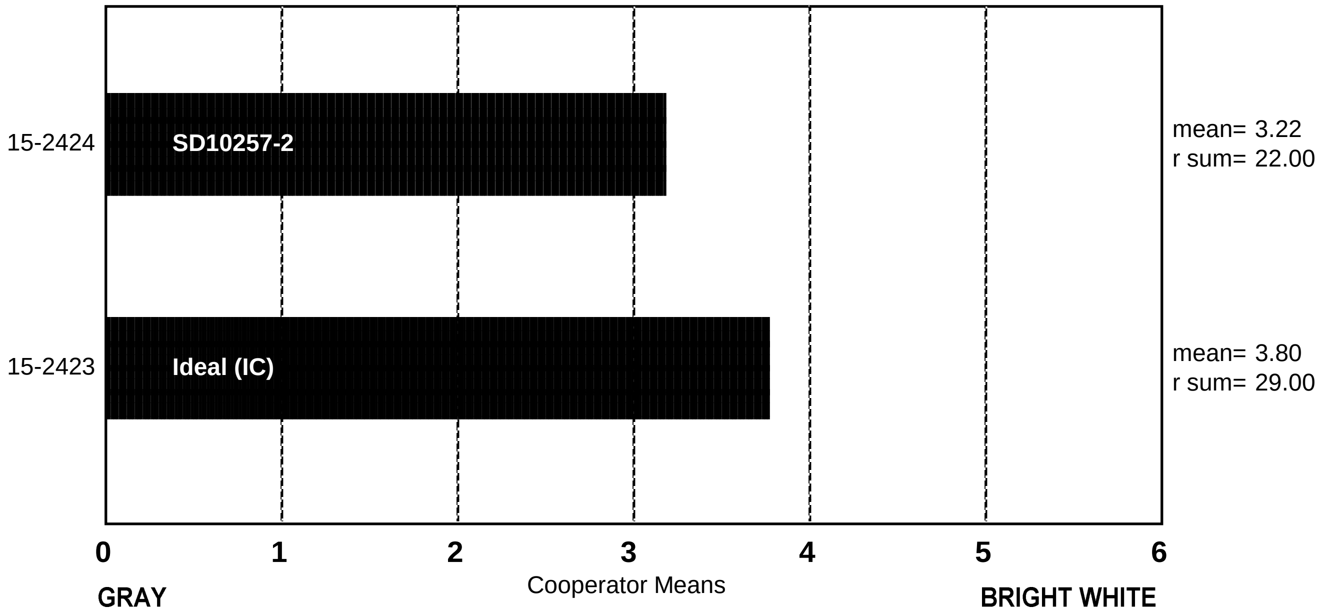
Frequency Table

CRUMB COLOR

(Small Scale) South Dakota

ncoop= 17
chisq= 2.88
chisqc= 3.77
cvchisq= 3.84
crdiff=

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



CRUMB COLOR, DESCRIBED

(Small Scale) South Dakota

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
15-2423 Ideal (IC)	0	1	1	3	9	3	0
15-2424 SD10257-2	0	1	1	10	3	2	0

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) South Dakota

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2423 Ideal (IC)	**138.2**	**137.8**	**399.0**		**128.2**	**142.1**	**153.4**	**139.7**	**136.0**	**468.4**	**131.1**			**146.1**	**110.7**	**485.4**	**459.0**
15-2424 SD10257-2	**138.9**	**140.2**	**395.0**		**134.2**	**140.5**	**153.1**	**143.7**	**145.3**	**459.0**	**136.4**			**150.4**	**108.1**	**486.8**	**450.0**

LOAF VOLUME, ACTUAL

(Small Scale) South Dakota

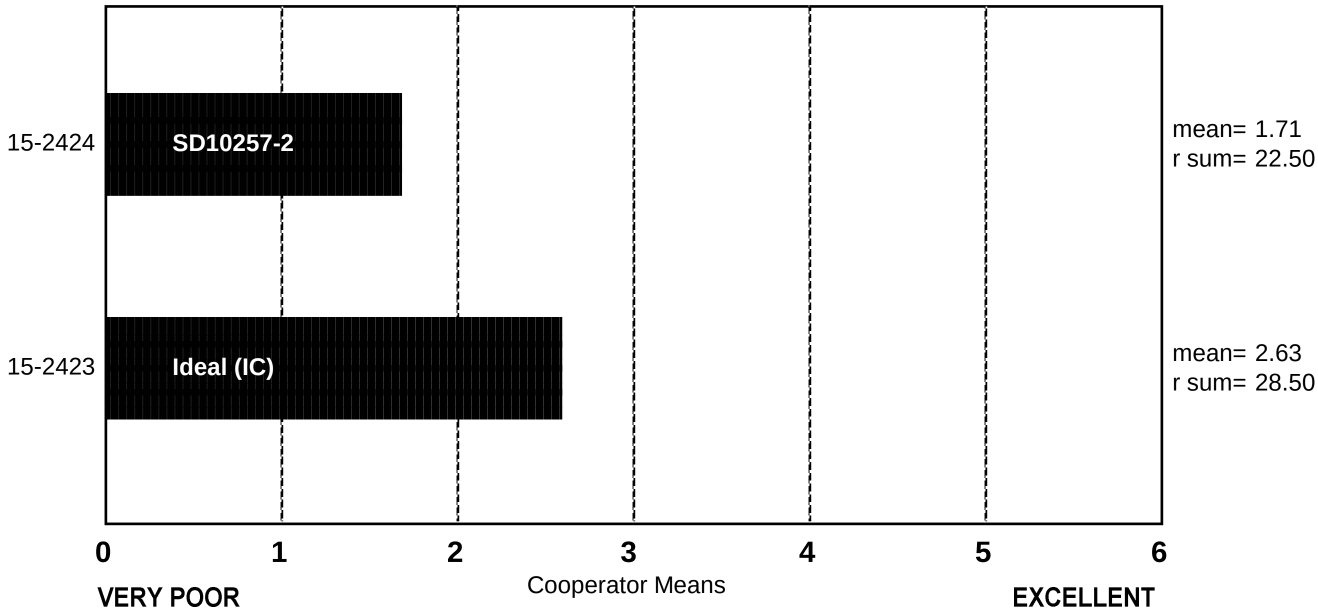
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2423 Ideal (IC)	**784**	**428**	**2900**	**765**	**850**	**725**	**780**	**910**	**845**	**2185**	**925**	**660**	**2839**	**760**	**2300**	**2388**	**1950**
15-2424 SD10257-2	**696**	**650**	**2650**	**850**	**740**	**976**	**810**	**700**	**685**	**2479**	**915**	**690**	**2544**	**790**	**2200**	**2288**	**2175**

LOAF VOLUME

(Small Scale) South Dakota

ncoop= 17
chisq= 2.12
chisqc= 2.57
cvchisq= 3.84
crdiff=

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

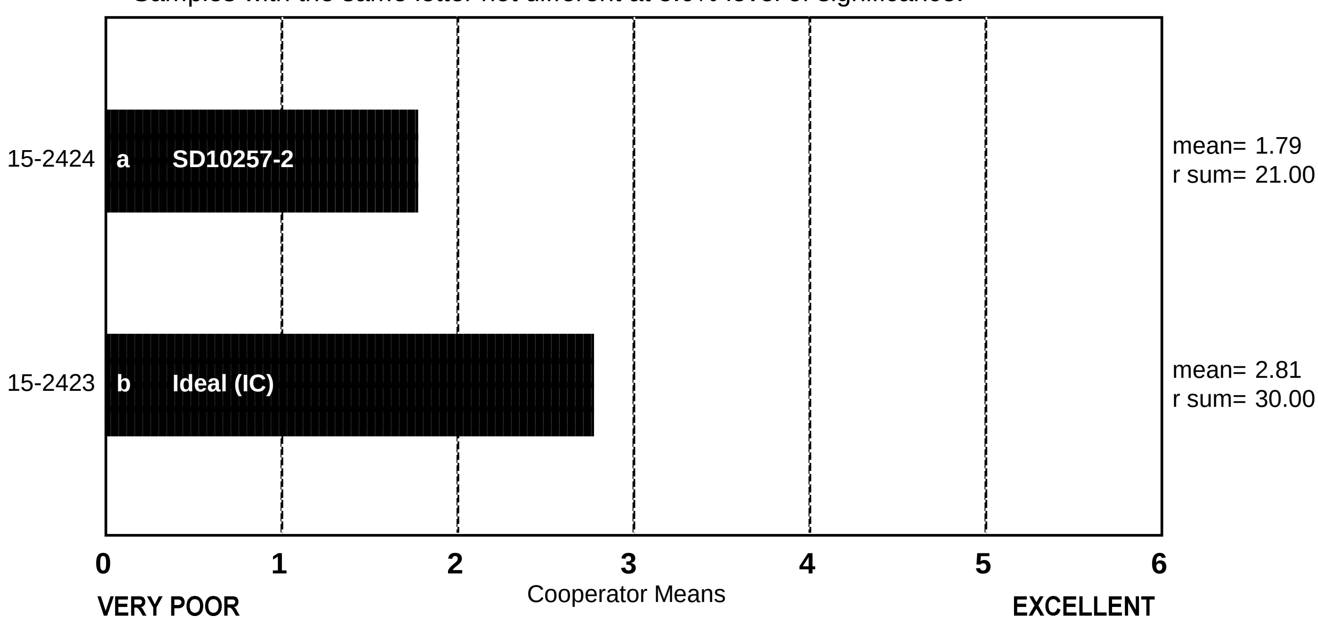


OVERALL BAKING QUALITY

(Small Scale) South Dakota

ncoop= 17
chisq= 4.76
chisqc= 4.76
cvchisq= 3.84
crdiff= 4.04

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



COOPERATOR'S COMMENTS
(Small Scale) South Dakota

COOP. **15-2423 Ideal (IC)**

A. No comment.
B. Satisfactory quality overall.
C. No comment.
D. No comment.
E. Short farinograph development time was not reflected in bake mixing time, decent dough performance for lower flour protein.
F. Low water absorption and long mix time, slight sticky & weak dough, fair volume, yellow crumb, dense round cells, tight resilient & harsh texture.
G. Very strong dough properties, too strong without blending, good absorption, average volume with poor crumb grain performance; probably due to dough being very strong.
H. Rough break and shred.
I. Extremely low protein but good volume, good color, poor grain.
J. Lots of dusting flour was used and dough mixed for only 1 minute.
K. Good crumb color, short stability.
L. No comment.
M. No comment.
N. Low flour protein, low bake absorption, very long mix time, weak at pan, Q-S crumb grain, low loaf volume.
O. Low absorption, a lower mix time, dough was slack, bread had low volume with a dense grain rating.
P. Very low absorption, good mix time, tough dough, nice grain, low volume.
Q. Never reached peak proof height, pulled at 80 minutes, flat loaf, no oven spring, poor product all through bake.

COOP. **15-2424 SD10257-2**

A. No comment.
B. Questionable quality overall.
C. No comment.
D. No comment.
E. Poor dough and bread performance.
F. Normal water absorption, short mix time, slight sticky & strong dough, high volume, white crumb, open round cells, resilient & slightly harsh texture.
G. Very weak dough properties, good absorption, below average volume with very weak looking crumb grain.
H. No comment.
I. Weak, small, short mixer, poor grain; just bad.
J. Little more dusting flour was used and dough mixed for only 2.3 minutes.
K. Unacceptable for bread flour.
L. No comment.
M. No comment.

N. Low bake absorption, short mix time, weak at makeup, questionable crumb grain.
O. High absorption, a really low mix time, dough was slightly bucky, bread had low volume with a good grain rating.
P. Short mix time, wet and sticky dough, open and dense grain, very low volume.
Q. Flat loaf.

Notes: **C, D, M, O, P and Q** conducted sponge and dough bake tests

LIMAGRAIN

15-2425	LCH13DH-20-87
15-2426	Jagalene (CC09)

Description of Test Plots and Breeder Entries

Limagrain - Marla Dale Barnett

Growing Location & Conditions

The hard red winter Wheat Quality Council samples from Limagrain Cereal Seeds originated from strip increases grown in Fort Collins, CO under flood irrigation. Growing conditions included timely planting into excellent soil moisture, excellent fall stands and growth. The field was planted September 25, 2014, fertilized with 50 lbs N in April, and harvested on July 19, 2015. Foliar fungicide was applied by aerial application on June 25, 2015. Average grain yield of LCH13DH-20-87 from the Fort Collins increase was 100 bu/ac. Stripe rust and Fusarium head blight were prevalent in the surrounding field.

LCH13DH-20-87 (LCS Chrome)

LCS Chrome (experimental name LCH13DH-20-87) is a hard red winter wheat variety released by Limagrain Cereal Seeds in 2015. LCS Chrome is a widely adapted, mid-season, medium height, hard red winter wheat with high yield potential. LCS Chrome has an obvious blue-green juvenile plant color. LCS Chrome is widely adapted across Kansas, Oklahoma, Nebraska and Colorado. It performs well under irrigation and in dryland crop management systems. Excellent leaf rust and stripe rust resistance combined with very good winter-hardiness, straw strength, and yield potential provide LCS Chrome a broad area of adaptation within the Great Plains. Yield data can be attained from the 2015 Kansas State University winter wheat performance trial, 2015 Oklahoma State University wheat variety trial, and the 2015 USDA-ARS Southern Regional Performance Nursery.

Milling and baking quality data from LCS show acceptable overall milling and baking qualities. In 2015 LCS trials, LCH13DH-20-87 had an average test weight 59.0 lbs/bu, 62% water absorption, and a mixing tolerance of 3. Loaf volume is good to excellent at 860 cc. Crumb grain and color is good to excellent at 5 and 4 respectively.

Check - Jagalene

The increase strip of Jagalene was heavily infected with stripe rust and Fusarium head blight resulting in very poor test weight. Therefore, the check sample of Jagalene was not submitted. Comparisons to the Jagalene sample grown in Akron, CO by Colorado State University are as follows.

	Production Location	Wheat Protein (%)	Flour Protein (%)	Midline Peak Time (min)
Jagalene	Fort Collins	11.65	9.85	4.27
Jagalene	Akron	12.16	11.26	4.22

Limagrain: 2015 (Small-Scale) Samples

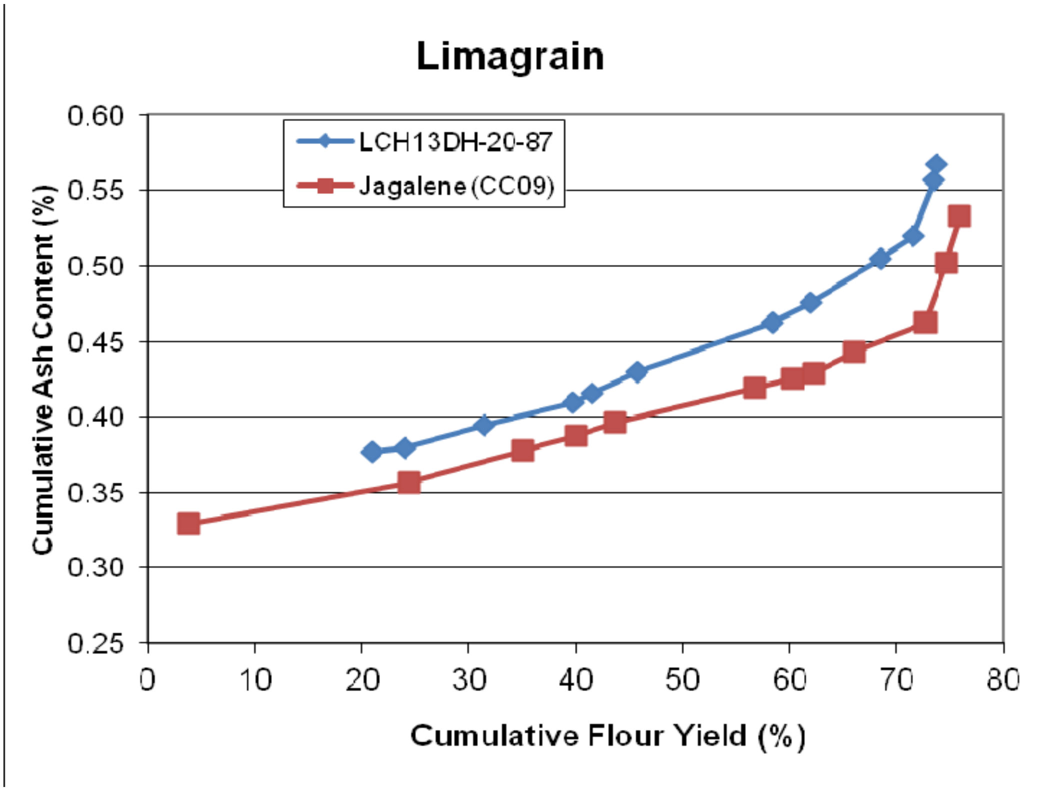
Test entry number	15-2425	15-2426*
Sample identification	LCH13DH-20-87	Jagalene (CC09)
Wheat Data		
GIPSA classification	1 HRW	1 HRW
Test weight (lb/bu) Hectoliter weight (kg/hl)	62.6 82.3	62.3 81.9
1000 kernel weight (gm)	30.7	30.9
Wheat kernel size (Rotap) Over 7 wire (%) Over 9 wire (%) Through 9 wire (%)	 74.0 25.9 0.1	 66.8 33.2 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	 68.4/16.6 30.7/7.6 2.65/0.32 11.5/0.3 01-09-19-71-01 Hard	 64.8/15.7 30.9/7.5 2.68/0.30 10.9/0.3 03-07-24-66-01 Hard
Wheat protein (12% mb) Wheat ash (12% mb)	11.9 1.69	12.8 1.53
Milling and Flour Quality Data		
Flour yield (%, str. grade) Miag Multomat Mill Quadrumat Sr. Mill	 70.2 68.1	 69.8 69.4
Flour moisture (%) Flour protein (14% mb) Flour ash (14% mb)	12.9 10.7 0.55	13.1 11.5 0.55
Rapid Visco-Analyser Peak time (min) Peak viscosity (RVU) Breakdown (RVU) Final viscosity at 13 min (RVU)	 6.3 198.4 67.7 234.3	 6.2 188.3 62.7 236.1
Minolta color meter L* a* b* **PPO**	 91.52 -1.31 8.73 0.614	 91.12 -1.44 10.30 0.409
Falling number (sec)	445	462
Damaged Starch (AI%) (AACC76-31)	 96.93 7.01	 97.36 7.37

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

Limagrain: Physical Dough Tests and Gluten Analysis
2015 (Small-Scale) Samples

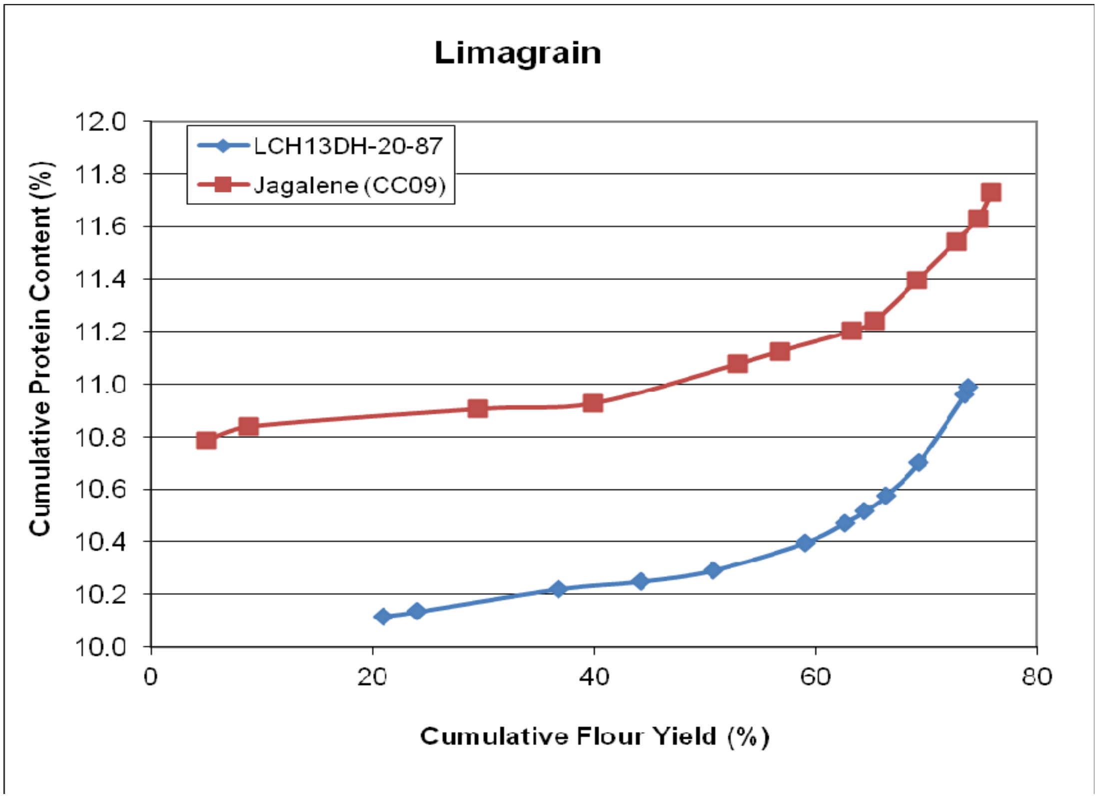
Test Entry Number	15-2425	15-2426*
Sample Identification	LCH13DH-20-87	Jagalene (CC09)
MIXOGRAPH		
Flour Abs (% as-is)	63.1	65.2
Flour Abs (14% mb)	61.8	64.1
Mix Time (min)	2.1	3.4
Mix tolerance (0-6)	1	3
FARINOGRAPH		
Flour Abs (% as-is)	62.1	64.3
Flour Abs (14% mb)	60.8	63.3
Development time (min)	4.2	7.7
Mix stability (min)	4.7	8.9
Mix Tolerance Index (FU)	33	20
Breakdown time (min)	7.1	14.6
ALVEOGRAPH		
P(mm): Tenacity	78	123
L(mm): Extensibility	84	85
G(mm): Swelling index	20.4	20.5
W(10^{-4} J): strength (curve area)	190	344
P/L: curve configuration ratio	0.93	1.45
Ie(P_{200}/P): elasticity index	44.0	54.2
EXTENSIGRAPH		
Resist (BU at 45/90/135 min)	188/217/233	269/390/422
Extensibility (mm at 45/90/135 min)	164/179/176	151/154/144
Energy (cm^2 at 45/90/135 min)	56/74/76	73/111/107
Resist $_{max}$ (BU at 45/90/135min)	241/289/306	370/554/577
Ratio (at 45/90/135 min)	1.14/1.21/1.32	1.78/2.53/2.92
PROTEIN ANALYSIS		
HMW-GS Composition	2*, 17+18,, 5+10	2*,1, 17+18, 5+10
%IPP	41.87	49.31
SEDIMENTATION TEST		
Volume (ml)	39.5	49.0

Limagrain: Cumulative Ash Curves



LCH13DH-20-87					Jagalene (CC09)				
Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash	Mill Streams	Strm-yld (14%mb)	Ash (14%mb)	Cumul (14%) Yield	Cumul (14%) Ash
2M	20.96	0.38	20.96	0.38	1M Red	3.86	0.33	3.86	0.33
1M Red	3.02	0.40	23.98	0.38	2M	20.58	0.36	24.44	0.36
1BK	7.45	0.44	31.43	0.39	1M	10.50	0.43	34.94	0.38
1M	8.30	0.47	39.73	0.41	1BK	4.99	0.45	39.94	0.39
Grader	1.82	0.55	41.55	0.42	FILTER FLR	3.77	0.49	43.71	0.40
2BK	4.12	0.57	45.67	0.43	3M	13.04	0.50	56.75	0.42
3M	12.74	0.58	58.41	0.46	2BK	3.48	0.53	60.23	0.43
FILTER FLR	3.59	0.69	62.00	0.48	Grader	1.99	0.55	62.22	0.43
4M	6.54	0.79	68.53	0.51	3BK	3.84	0.66	66.06	0.44
3BK	2.97	0.86	71.50	0.52	4M	6.58	0.66	72.64	0.46
5M	1.94	1.95	73.44	0.56	5M	2.00	1.96	74.64	0.50
BRAN FLR	0.31	3.04	73.75	0.57	BRAN FLR	1.20	2.45	75.84	0.53
Break Shorts	1.40	4.57	75.14	0.64	Break Shorts	2.85	3.60	78.68	0.64
Red Dog	1.43	3.14	76.58	0.69	Red Dog	1.57	3.00	80.26	0.69
Red Shorts	0.13	4.57	76.70	0.70	Red Shorts	0.20	3.72	80.46	0.70
Filter Bran	11.11	1.96	87.81	0.86	Filter Bran	2.70	1.39	83.16	0.72
Bran	12.19	6.29	100.0	1.52	Bran	16.84	5.77	100.0	1.57
Wheat		1.65					1.49		
St. Grd. Fl.		0.55					0.55		

Limagrain: Cumulative Protein Curves



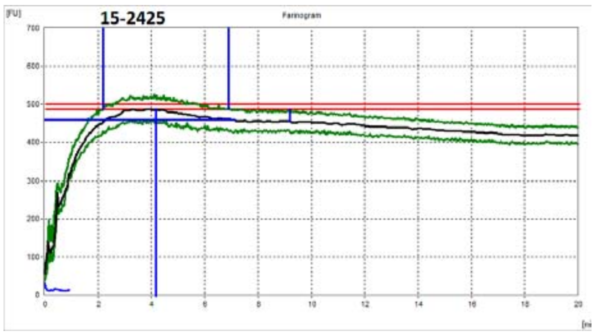
LCH13DH-20-87					Jagalene (CC09)				
Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein	Mill Streams	Strm-yld (14%mb)	Protein (14%mb)	Cumulative (14%) Yield	Cumulative (14%) Protein
2M	20.96	10.12	20.96	10.12	1BK	4.99	10.78	4.99	10.78
1M Red	3.02	10.25	23.98	10.13	1M Red	3.86	10.91	8.85	10.84
3M	12.74	10.38	36.72	10.22	2M	20.58	10.93	29.43	10.91
1BK	7.45	10.39	44.17	10.25	1M	10.50	10.99	39.94	10.93
4M	6.54	10.57	50.71	10.29	3M	13.04	11.54	52.98	11.08
1M	8.30	11.04	59.01	10.40	FILTER FLR	3.77	11.80	56.75	11.13
FILTER FLR	3.59	11.72	62.60	10.47	4M	6.58	11.88	63.33	11.20
Grader	1.82	12.00	64.42	10.52	Grader	1.99	12.36	65.32	11.24
5M	1.94	12.56	66.35	10.57	3BK	3.84	14.07	69.16	11.40
3BK	2.97	13.53	69.32	10.70	2BK	3.48	14.49	72.64	11.54
2BK	4.12	15.30	73.44	10.96	5M	2.00	14.76	74.64	11.63
BRAN FLR	0.31	17.95	73.75	10.99	BRAN FLR	1.20	17.91	75.84	11.73
Break Shorts	1.40	15.82	75.14	11.08	Break Shorts	2.85	15.62	78.68	11.87
Red Dog	1.43	13.30	76.58	11.12	Red Dog	1.57	14.71	80.26	11.93
Red Shorts	0.13	12.58	76.70	11.12	Red Shorts	0.20	13.12	80.46	11.93
Filter Bran	11.11	11.42	87.81	11.16	Filter Bran	2.70	12.17	83.16	11.94
Bran	12.19	14.56	100.00	11.57	Bran	16.84	16.72	100.00	12.74
Wheat		15.07					14.20		
St. Grd. Fl		14.29					13.35		

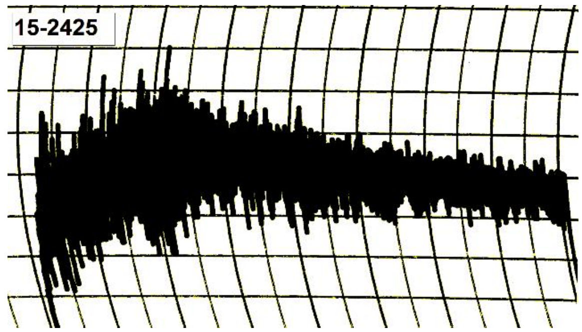
Physical Dough Tests

2015 (Small Scale) Samples - Limagrain

Farinograms

Mixograms

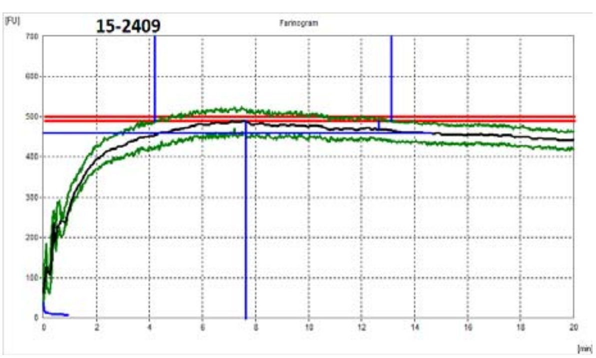


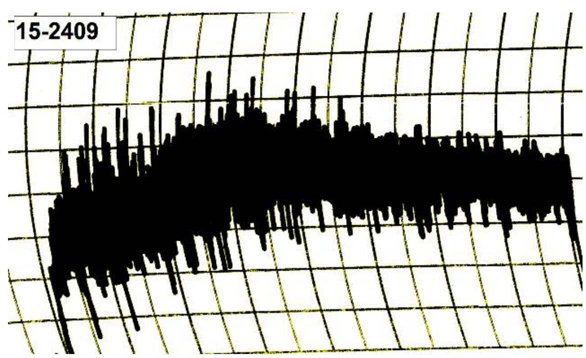


Water abs = 60.8%, Peak time = 4.2 min,
Mix stab = 4.7 min, MTI = 33 FU

Water abs = 61.8%
Mix time = 2.1 min

15-2425, LCH13DH-20-87



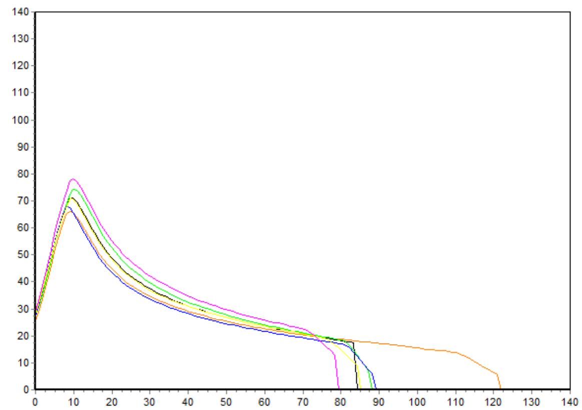


Water abs = 63.3%, Peak time = 7.7 min,
Mix stab = 8.9 min, MTI = 20 FU

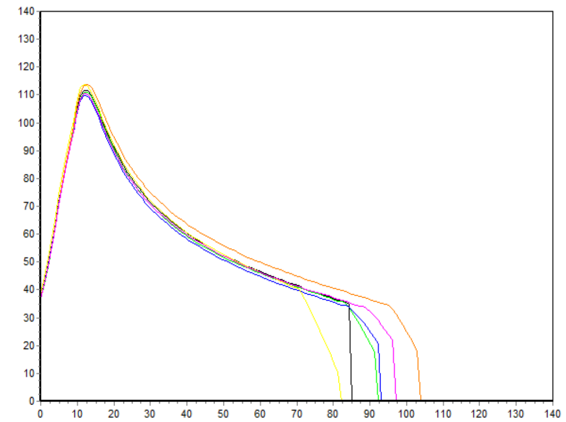
Water abs = 64.1%
Mix time = 3.4 min

15-2426*, Jagalene (CC09)

Physical Dough Tests - Alveograph
2015 (Small Scale) Samples – Limagrain



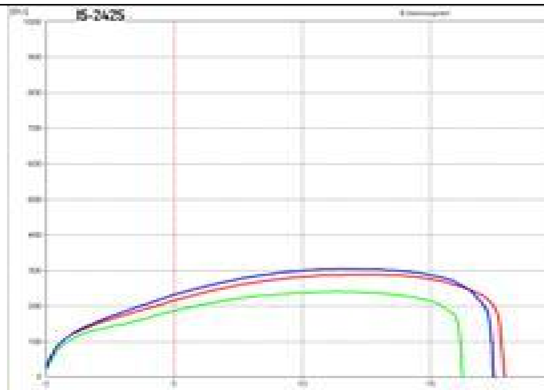
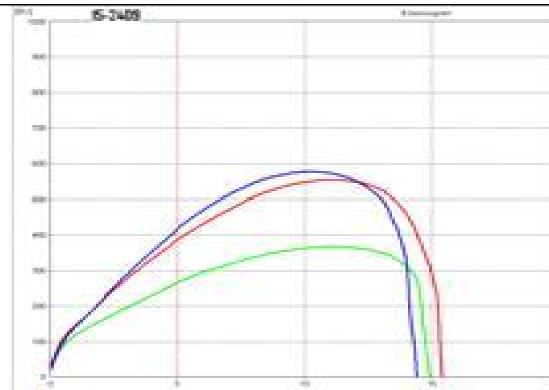
15-2425, LCH13DH-20-87
P(mm H_20) =78, L(mm) = 84, W(10E^{-4} J) = 190



15-2426*, (Jagalene (CC09)
P(mm H_20) = 123, L(mm) = 85, W(10E^{-4} J) = 344

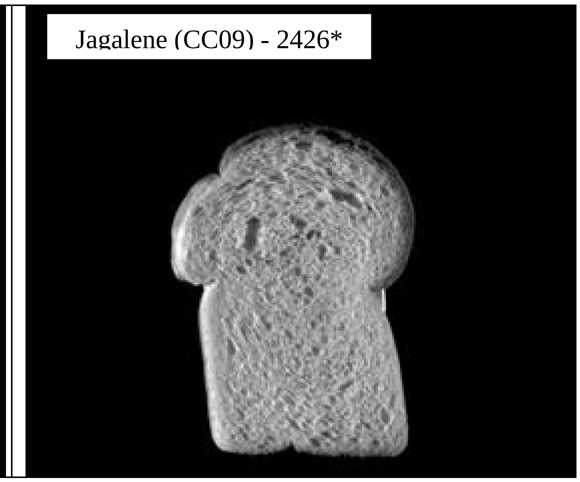
Physical Dough Tests - Extensigraph

2015 (Small Scale) Samples – Limagrain

	
15-2425, LCH13DH-20-87 R (BU) = 217, E (mm) = 179, W (cm^2) = 74 Rmax (BU) = 289, Ratio = 1.21 at 90 min	**15-2426*, Jagalene (CC09)** R (BU) = 390, E (mm) = 154, W (cm^2) = 111 Rmax (BU) = 554, Ratio = 2.5 at 90 min

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

Limagrain: C-Cell Bread Images and Analysis
2015 (Small-Scale) Samples



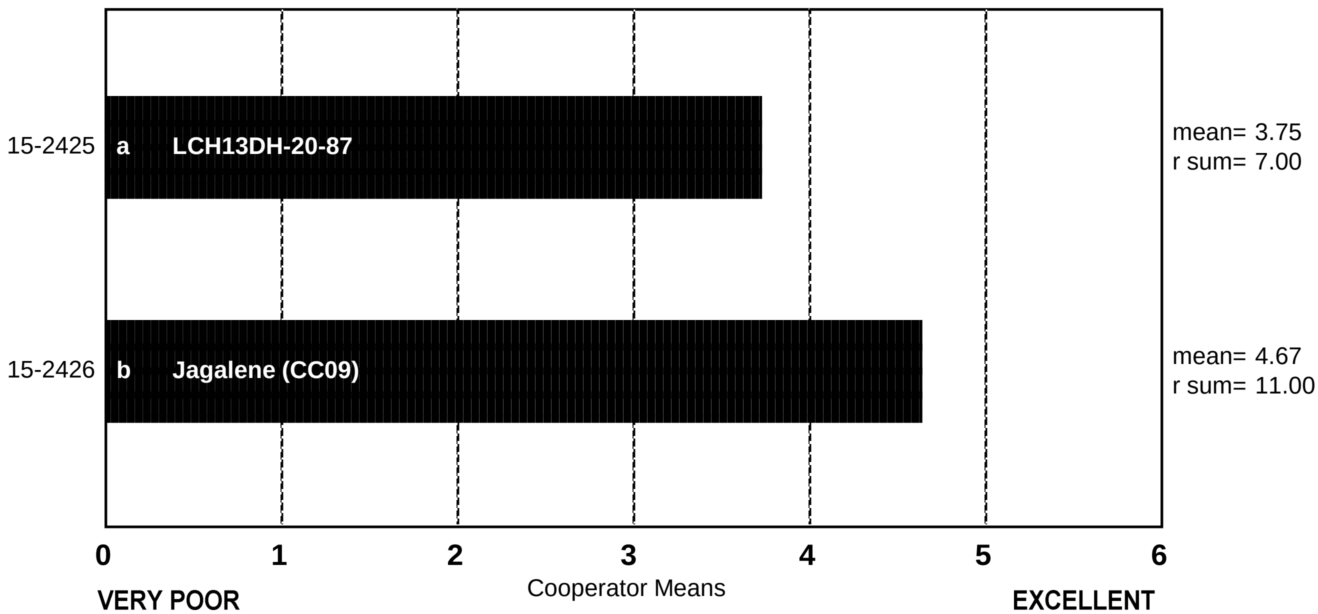
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2425	6182	146.2	4132	0.438	1.858	1.955	1.635	-29.53
2426*	6140	143.3	3968	0.436	1.993	2.633	1.715	-20.30

SPONGE CHARACTERISTICS

(Small Scale) Limagrain

ncoop= 6
chisq= 2.67
chisqc= 4.00
cvchisq= 3.84
crdiff= 3.25

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

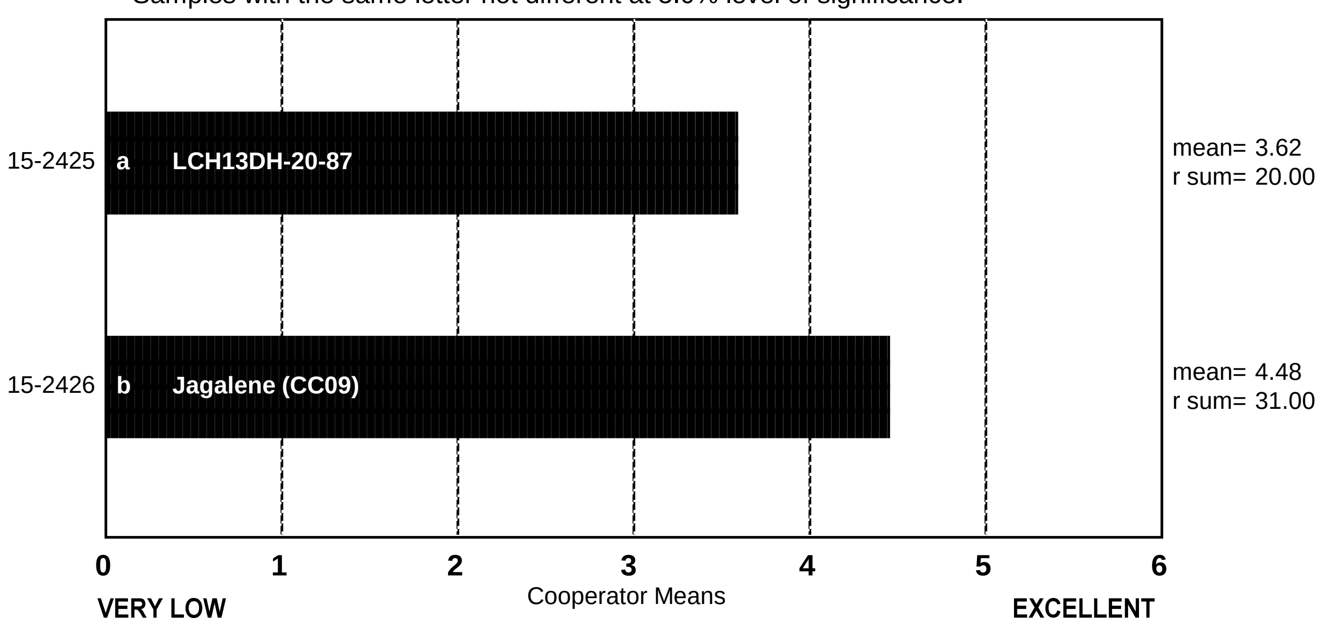


BAKE ABSORPTION

(Small Scale) Limagrain

ncoop= 17
chisq= 7.12
chisqc= 10.08
cvchisq= 3.84
crdiff= 2.27

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) Limagrain

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2425 LCH13DH-20-87	**63.3**	**65.0**	**57.0**	**60.0**	**61.8**	**62.5**	**68.9**	**60.4**	**61.0**	**60.8**	**68.0**	**60.4**	**60.0**	**59.4**	**60.8**	**57.0**	**61.8**
15-2426 Jagalene (CC09)	**65.2**	**67.0**	**57.0**	**61.0**	**63.0**	**64.0**	**69.7**	**62.4**	**63.3**	**63.3**	**70.0**	**61.7**	**62.0**	**63.1**	**63.3**	**59.0**	**62.8**

BAKE MIX TIME, ACTUAL

(Small Scale) Limagrain

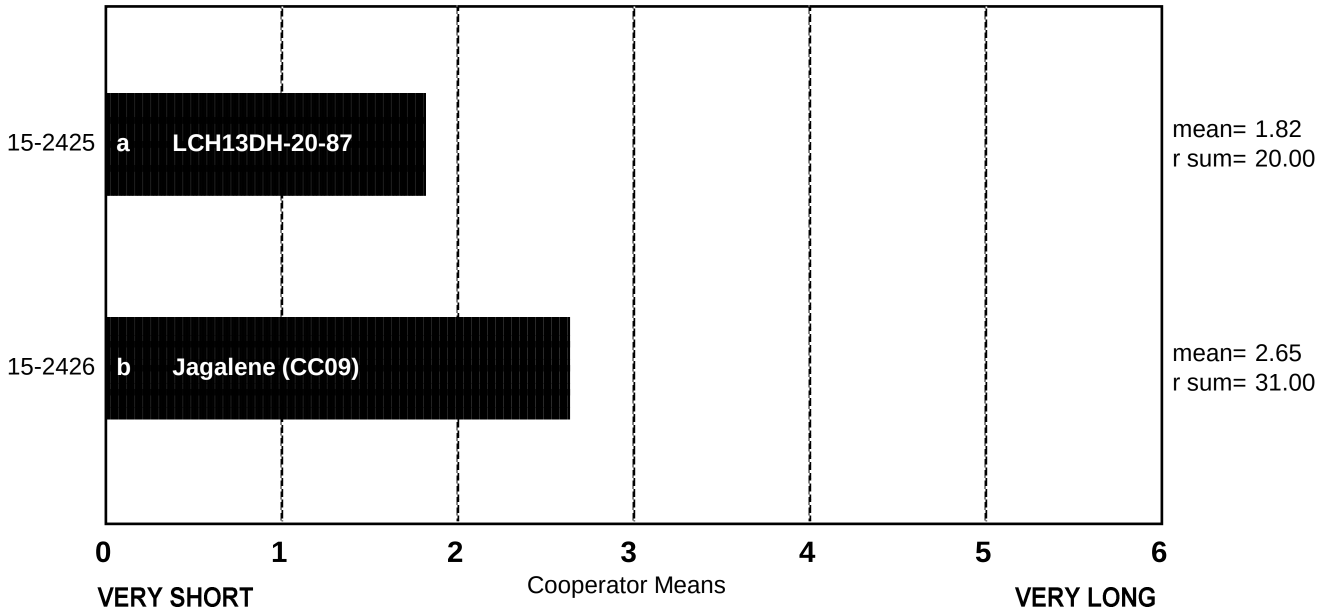
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2425 LCH13DH-20-87	**2.1**	**2.0**	**4.0**	**6.0**	**2.5**	**3.3**	**3.3**	**3.0**	**2.1**	**4.3**	**2.8**	**2.2**	**9.0**	**2.9**	**3.0**	**4.0**	**4.0**
15-2426 Jagalene (CC09)	**2.9**	**2.8**	**5.0**	**6.0**	**3.3**	**4.1**	**3.3**	**3.3**	**2.6**	**6.3**	**3.5**	**3.2**	**12.0**	**3.8**	**5.0**	**4.0**	**7.0**

BAKE MIX TIME

(Small Scale) Limagrain

ncoop= 17
chisq= 7.12
chisqc= 10.08
cvchisq= 3.84
crdiff= 2.27

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

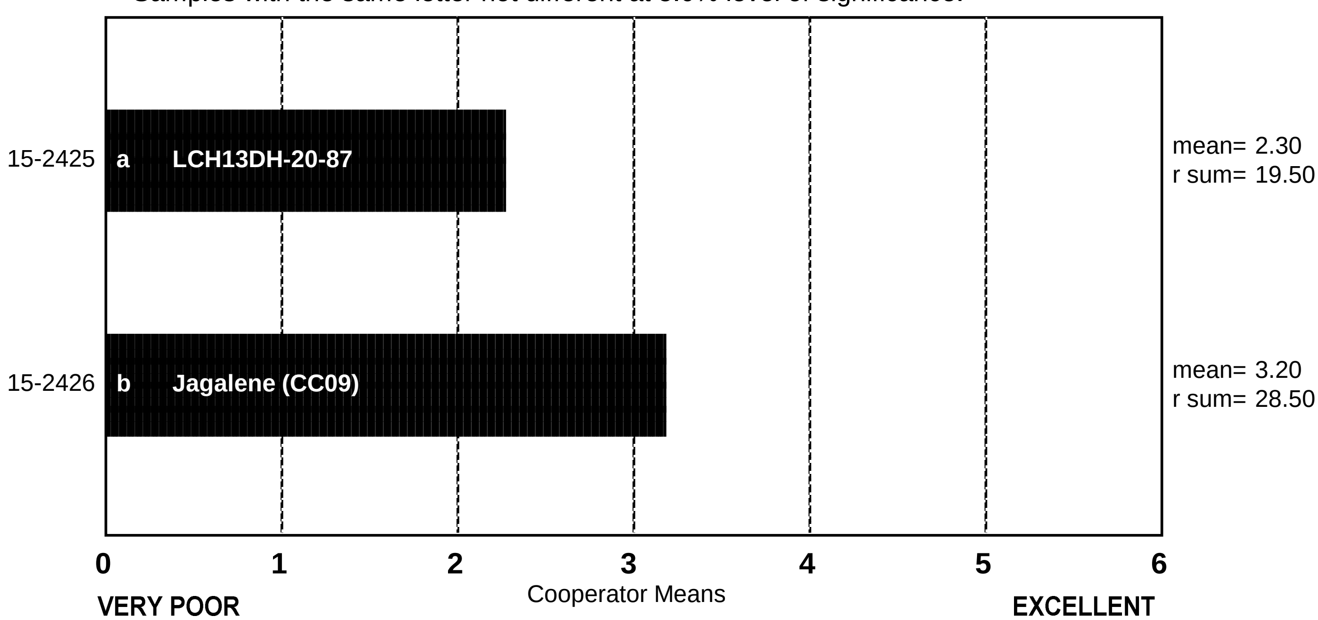


MIXING TOLERANCE

(Small Scale) Limagrain

ncoop= 16
chisq= 5.06
chisqc= 6.23
cvchisq= 3.84
crdiff= 6.20

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

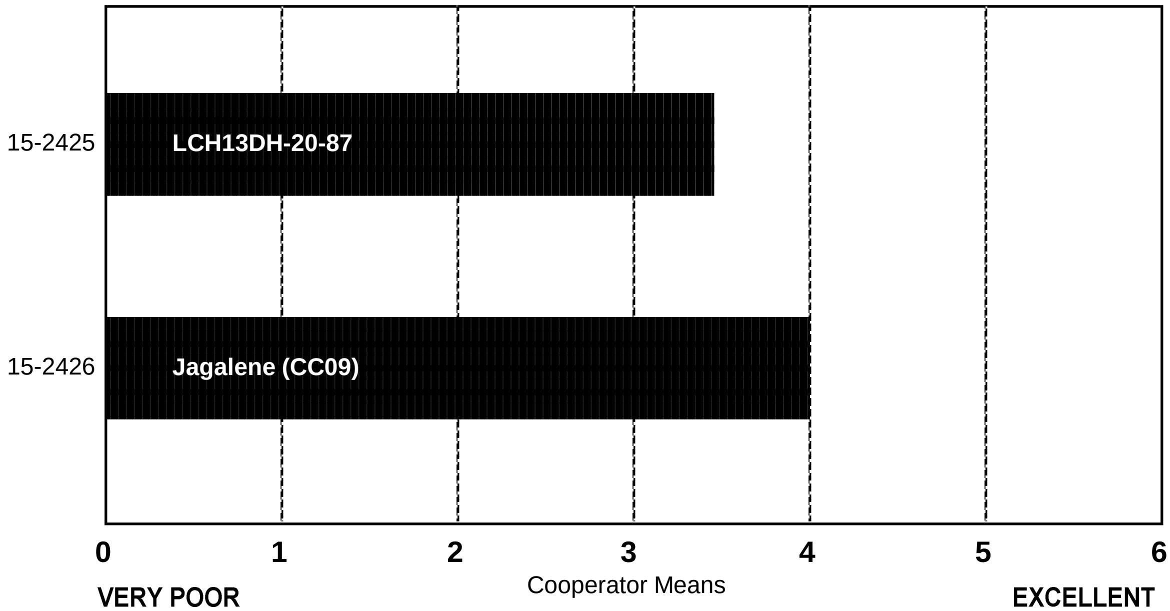


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Limagrain

ncoop= 17
chisq= 1.47
chisqc= 2.50
cvchisq= 3.84
crdiff=

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



mean= 3.47
r sum= 23.00

mean= 4.03
r sum= 28.00

DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Limagrain

	Sticky	Wet	Tough	Good	Excellent
15-2425 LCH13DH-20-87	**4**	**2**	**2**	**8**	**1**
15-2426 Jagalene (CC09)	**4**	**1**	**1**	**9**	**2**

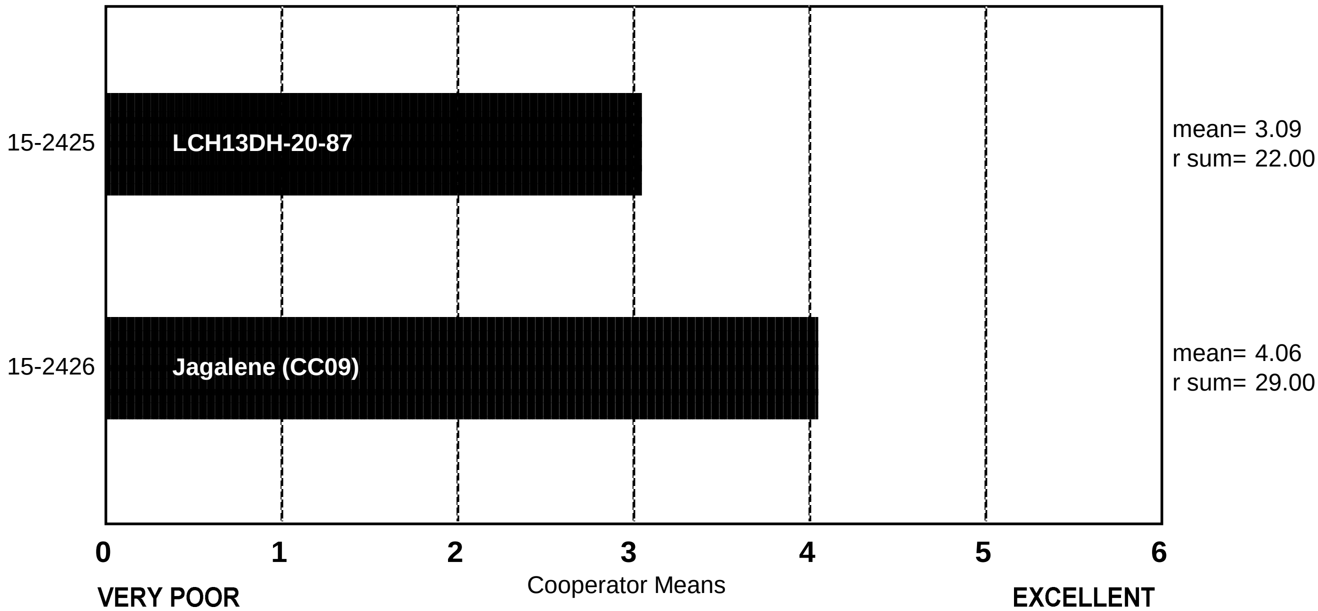
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Limagrain

ncoop= 17
chisq= 2.88
chisqc= 3.77
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) Limagrain

	Sticky	Wet	Tough	Good	Excellent
15-2425 LCH13DH-20-87	**4**	**3**	**2**	**6**	**2**
15-2426 Jagalene (CC09)	**1**	**1**	**1**	**14**	**0**

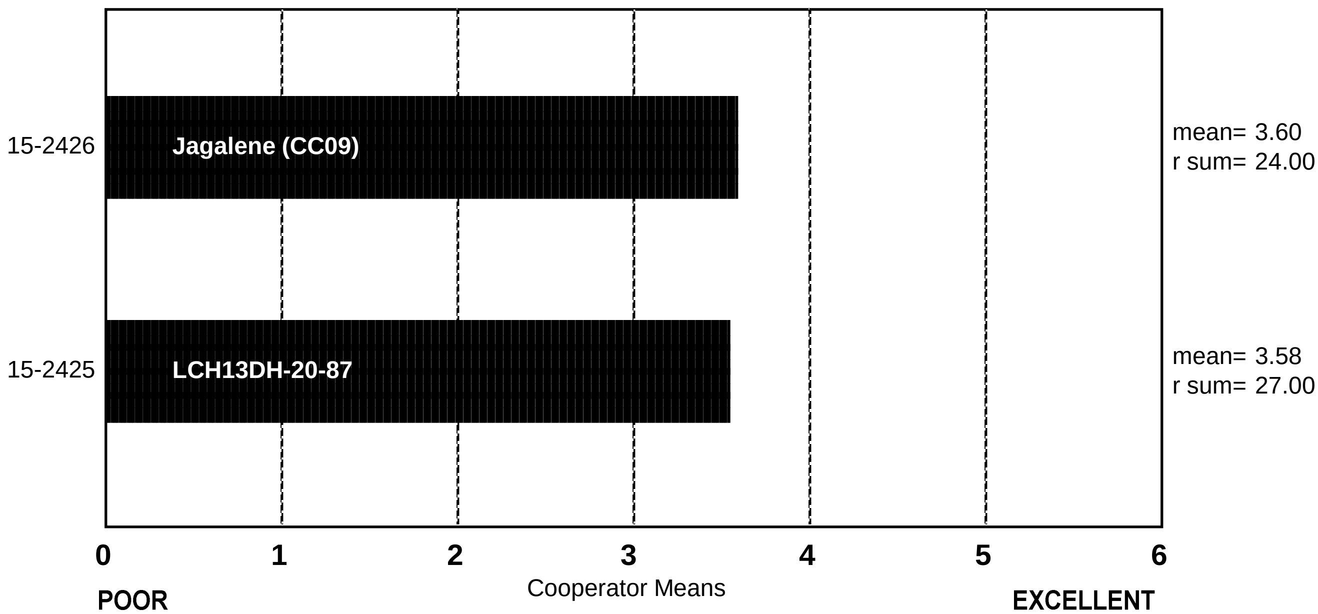
Frequency Table

CRUMB GRAIN

(Small Scale) Limagrain

ncoop= 17
chisq= 0.53
chisqc= 0.69
cvchisq= 3.84
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Limagrain

	Open	Fine	Dense
15-2425 LCH13DH-20-87	**8**	**8**	**1**
15-2426 Jagalene (CC09)	**9**	**6**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Limagrain

	Round	Irregular	Elongated
15-2425 LCH13DH-20-87	**6**	**6**	**5**
15-2426 Jagalene (CC09)	**5**	**5**	**7**

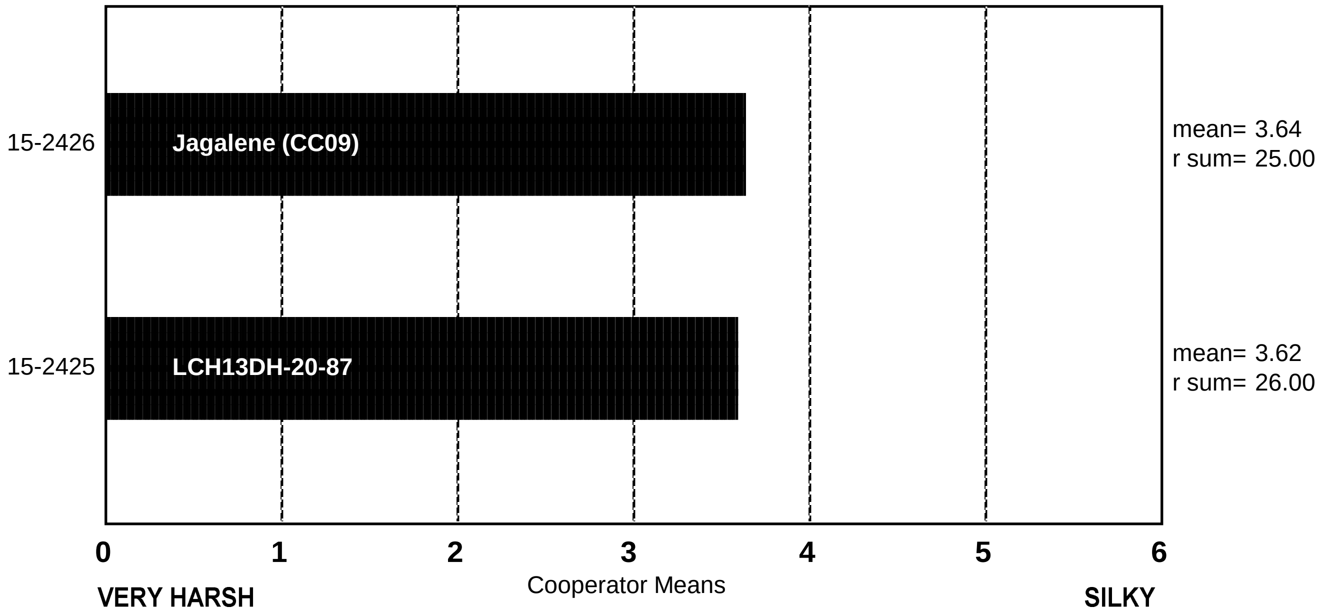
Frequency Table

CRUMB TEXTURE

(Small Scale) Limagrain

ncoop= 17
chisq= 0.06
chisqc= 0.08
cvchisq= 3.84
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Limagrain

	Harsh	Smooth	Silky
15-2425 LCH13DH-20-87	**6**	**8**	**3**
15-2426 Jagalene (CC09)	**4**	**10**	**3**

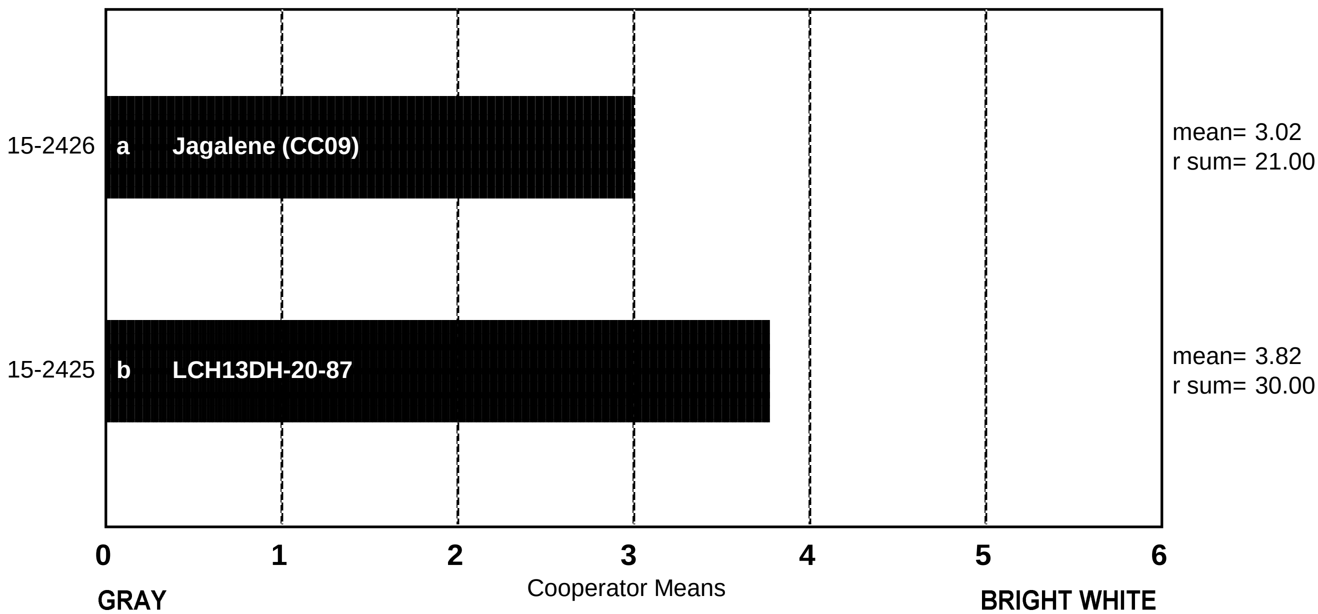
Frequency Table

CRUMB COLOR

(Small Scale) Limagrain

ncoop= 17
chisq= 4.76
chisqc= 6.23
cvchisq= 3.84
crdiff= 3.31

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



CRUMB COLOR, DESCRIBED

(Small Scale) Limagrain

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
15-2425 LCH13DH-20-87	0	0	0	4	9	3	1
15-2426 Jagalene (CC09)	0	1	6	4	5	1	0

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Limagrain

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2425 LCH13DH-20-87	**136.3**	**136.6**	**395.0**		**130.6**	**140.9**	**149.8**	**139.6**	**142.9**	**454.7**	**132.0**			**146.7**	**108.3**	**488.3**	**454.0**
15-2426 Jagalene (CC09)	**136.6**	**139.1**	**395.0**		**132.4**	**139.0**	**154.4**	**142.8**	**141.8**	**446.4**	**132.1**			**149.4**	**118.9**	**482.7**	**455.0**

LOAF VOLUME, ACTUAL

(Small Scale) Limagrain

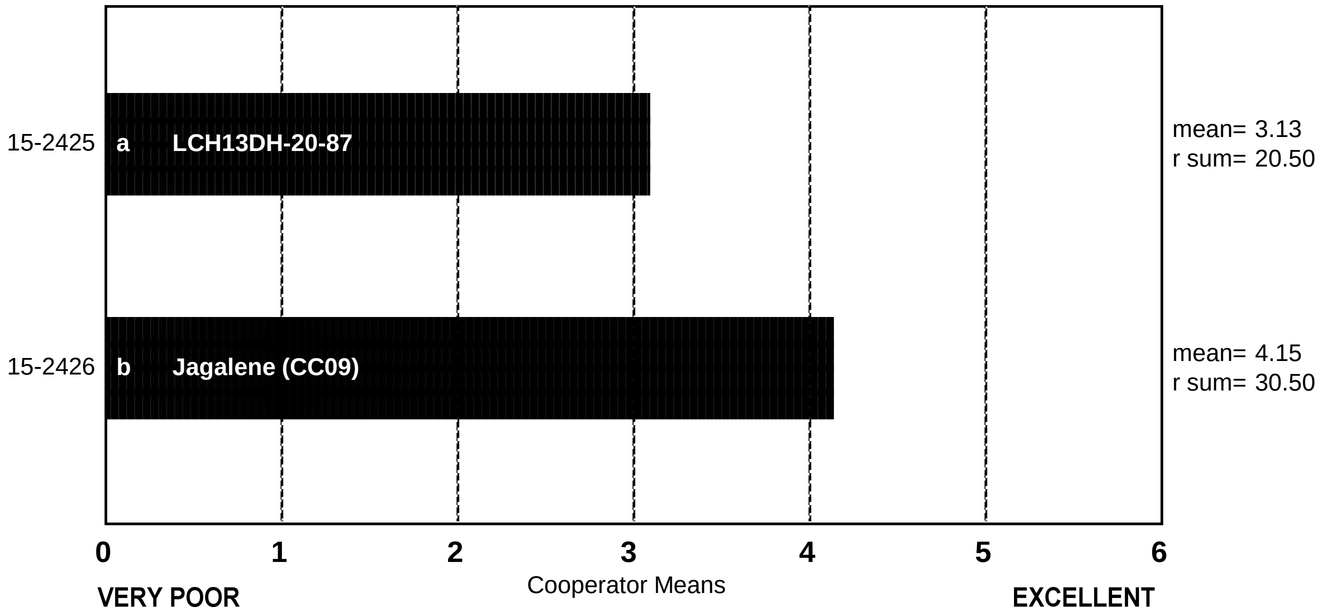
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
15-2425 LCH13DH-20-87	**829**	**883**	**2675**	**860**	**835**	**1023**	**865**	**900**	**820**	**2900**	**900**	**770**	**2633**	**905**	**2250**	**2438**	**2250**
15-2426 Jagalene (CC09)	**838**	**993**	**3100**	**995**	**890**	**1045**	**945**	**955**	**805**	**2830**	**965**	**790**	**2780**	**960**	**2400**	**2750**	**2275**

LOAF VOLUME

(Small Scale) Limagrain

ncoop= 17
chisq= 5.88
chisqc= 8.33
cvchisq= 3.84
crdiff= 2.86

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

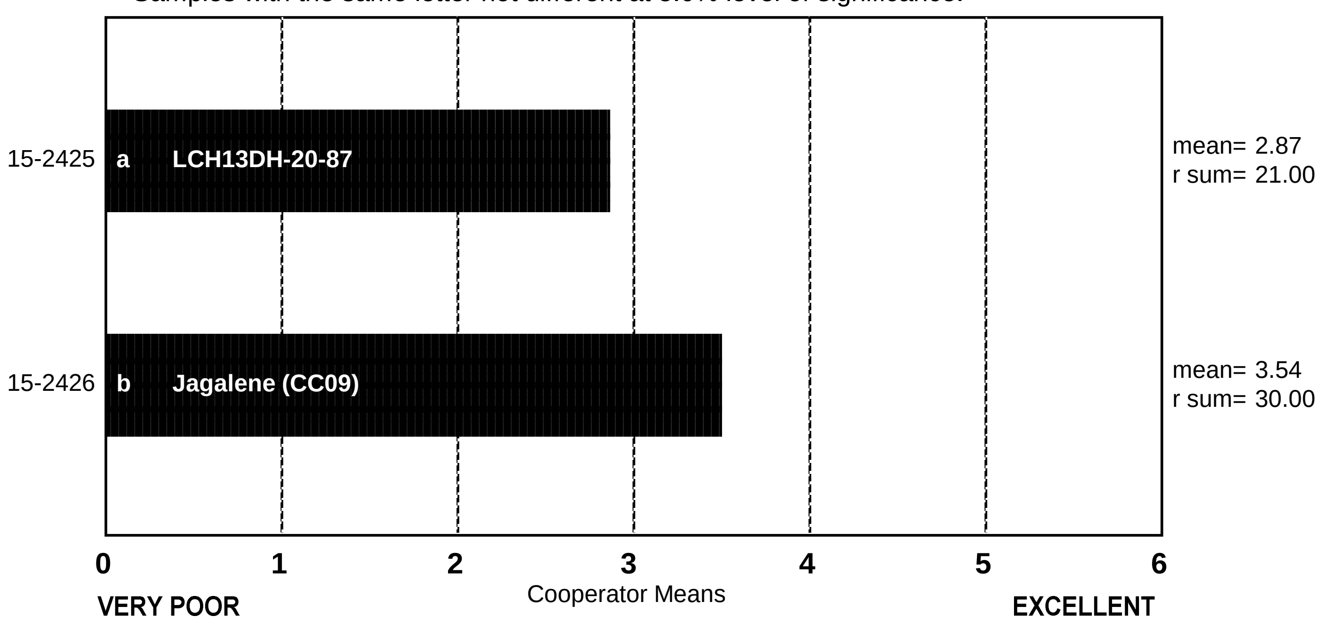


OVERALL BAKING QUALITY

(Small Scale) Limagrain

ncoop= 17
chisq= 4.76
chisqc= 5.40
cvchisq= 3.84
crdiff= 3.69

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



COOPERATOR'S COMMENTS
(Small Scale) Limagrain

COOP. **15-2425 LCH13DH-20-87**

A. No comment.
B. Questionable quality overall.
C. No comment.
D. No comment.
E. Weaker dough performance.
F. Normal water absorption, short mix time, slight sticky & strong dough, very high volume, white crumb, fine elongated cells, resilient & smooth texture.
G. Somewhat weaker dough properties, good absorption, average volume and crumb grain.
H. OK.
I. Lower protein, poor grain.
J. No comment.
K. Unacceptable for bread flour.
L. No comment.
M. No comment.
N. Low bake absorption, short mix time, weak at makeup.
O. Good absorption, low mix time, dough was excellent, bread had a low volume with an excellent dense grain rating.
P. Low absorption, short mix time, wet dough, low volume.
Q. Loaf collapsed in volume reader, estimated 2250 cc, good finished product other than weak structure and slack at mixer.

COOP. **15-2426 Jagalene (CC09)**

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption, normal mix time, slight sticky & strong dough, very high volume, yellow crumb, open elongated cells, resilient & slightly harsh texture.
G. Shorter mix time but good overall mix strength, excellent absorption, average volume and crumb grain.
H. Rough break and shred.
I. Poor volume and grain.
J. No comment.
K. No comment.
L. No comment.
M. No comment.

N. Good bake absorption, mix time and dough strength; excellent crumb grain and loaf volume-nice check.
O. High absorption, low mix time, dough was good, bread collapsed before volume reading, good grain rating.
P. Short mix time, open grain, excellent volume.
Q. No comment.

Notes: **C, D, M, O, P and Q** conducted sponge and dough bake tests

COMMOM CHECK

15-2427	Jagalene (CC01)
15-2428	Jagalene (CC04)
15-2429	Jagalene (CC06)
15-2430	Jagalene (CC09)
15-2431	Jagalene (CC14)
15-2432	Jagalene (CC19)

End-use Quality of the **Common Check**

Common Check – Jagalene

A Hard Red Winter Wheat variety, Jagalene, was used as a common check for each of breeding programs in 2015. Six breeding programs submitted their common checks with their breeding lines for WQC baking evaluation. They were:

15-2401	Jagalene (CC01)	Kansas (Hays)
15-2404	Jagalene (CC04)	Nebraska
15-2406	Jagalene (CC06)	Westbred
15-2409	Jagalene (CC09)	Colorado
15-2414	Jagalene (CC14)	Oklahoma
15-2419	Jagalene (CC19)	Montana

In order to facilitate relational database output of statistical data in the same manner as breeding lines contained with the WQC annual report, the common checks were treated as a breeding program for baking data analysis and their comparisons in order to see how different they are in terms of baking performance quality characteristics.

Wheat and Flour Quality Characteristics of the Common Checks

Entry No.	**15-2401**	**15-2404**	**15-2406**	**15-2409**	**15-2414**	**15-2419**
ID for CC[1] comparison	**15-2427**	**15-2428**	**15-2429**	**15-2430**	**15-2431**	**15-2432**
Breeding Programs	Kansas	Nebraska	Westbred	Colorado	Oklahoma	Montana
Wheat Protein (14%mb)	11.9	12.2	12.7	12.4	12,5	14.8
Flour Protein (14%mb)	11.0	11.1	11.5	11.5	11.2	13.6
Flour Ash (14%mb)	0.520	0.536	0.481	0.547	0.615	0.543
IPP (%)*	49.5	50.9	50.4	49.3	52.4	52.3
TPP/TMP*	0.896	0.867	0.864	0.897	0.919	0.849
Sedimentation (ml 14%mc)	47.1	47.5	48.7	49.0	46.7	70.4
Mixograph Abs (14%mb)	64.8	62.9	65.1	64.1	64.2	65.6
Mix Time (min)	3.4	4.0	3.5	3.4	3.5	4.5
Tolerance	4	4	3	3	3	6
Farinograph Abs (14%mb)	63.0	58.2	62.4	63.3	61.1	56.6
Development time (min)	5.3	7.2	6.8	7.7	5.3	8.8
Stability (min)	9.0	10.8	12.8	8.9	7.2	16.8
MTI (FU)	27	30	20	20	35	15
Bake Abs (14%mb)[+]	66.2	63.4	66.0	65.3	65.4	65.6
Bake Mix Time (min)[+]	3.9	4.3	3.9	3.3	4.0	5.6
Loaf Volume (cc)[+]	907	956	948	933	890	1003
Crumb Color Rating (0-5)[+]	2.7	2.8	3.7	2.6	1.4	3.7
Crumb Grain Rating (0-5)[+]	3.6	3.8	3.8	3.3	3.0	3.9
Crumb Texture Rating (0-5)[+]	3.6	3.9	4.1	3.4	3.3	3.9

[1] CC = Common Check.

* IPP- Insoluble polymeric protein, TPP/TMP= total polymeric protein/total monomeric protein.

[+] The bake data is an average on eight cooperators who conducted pup-loaf straight dough bake tests.

Brief Conclusions:

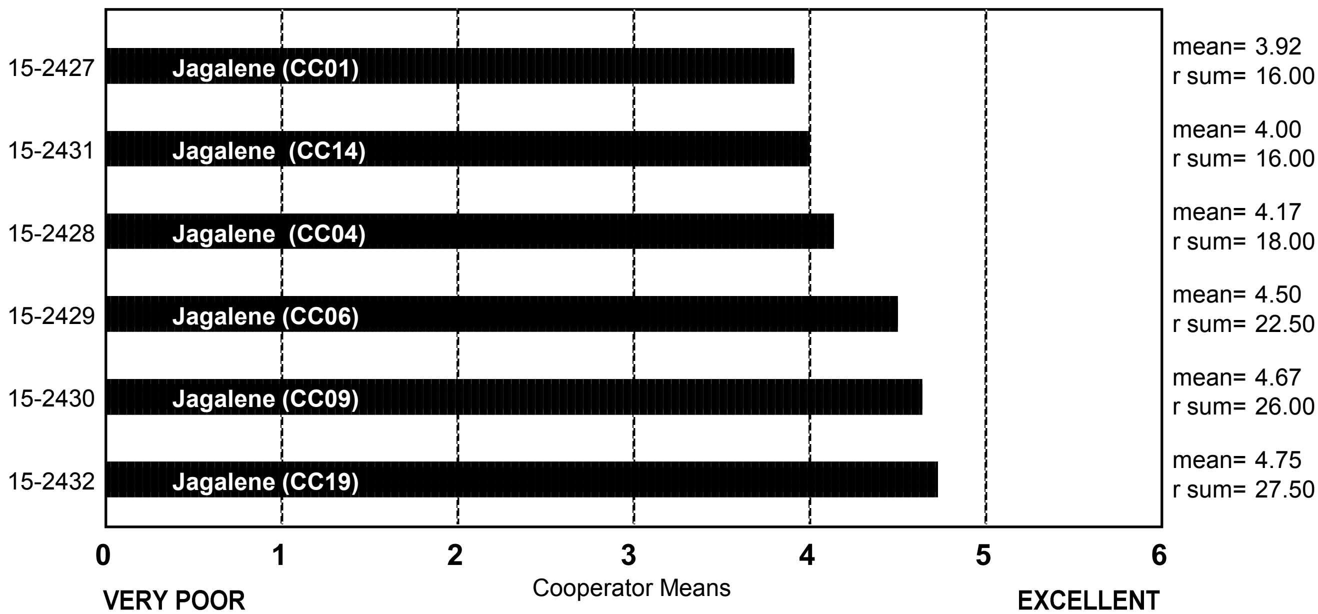
Six of 17 cooperators conducted the sponge-and-dough baking test and didn't find any statistically significant differences in the sponge dough characteristics of the common checks at the 5% level of signficance. However, other baking performance quality characteristics evaluated by the 17 cooperators were found to be significantly different (at the 0.5% level) among the common checks. These characteristics included bake absorption, bake mix time, mixing tolerance, crumb grain, crumb color, loaf volume, and overall baking quality. No significant differences were found among crumb texture, dough character 'at makeup', and dough character 'out of mixer' quality characteristics. Details can be found on the following pages.

SPONGE CHARACTERISTICS

(Small Scale) Common Check

ncoop= 6
chisq= 6.12
chisqc= 9.88
cvchisq= 11.07
crdiff=

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

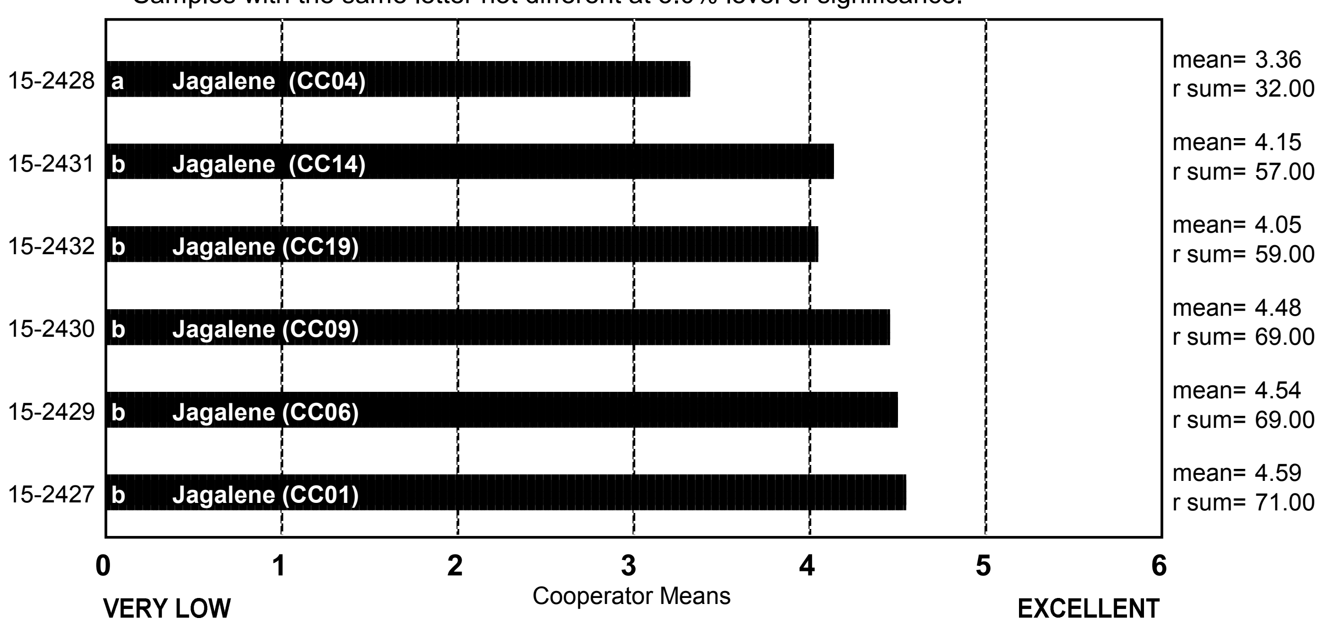


BAKE ABSORPTION

(Small Scale) Common Check

ncoop= 17
chisq= 18.08
chisqc= 25.73
cvchisq= 11.07
crdiff= 15.80

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) Common Check

	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
15-2427 Jagalene (CC01)	66.7	69.0	57.0	60.0	65.3	65.5	68.8	62.3	63.2	63.0	71.1	60.8	62.0	63.9	63.0	59.0	63.1
15-2428 Jagalene (CC04)	64.2	66.0	57.0	60.0	60.3	63.0	68.2	61.4	61.7	58.2	64.9	60.8	58.0	61.1	58.2	54.0	59.2
15-2429 Jagalene (CC06)	66.6	69.0	58.0	61.0	64.4	65.0	69.1	61.9	63.9	62.4	70.1	61.6	61.0	63.6	62.4	58.0	63.5
15-2430 Jagalene (CC09)	65.2	67.0	57.0	61.0	63.0	64.0	69.7	62.4	63.3	63.3	70.0	61.7	62.0	63.1	63.3	59.0	62.8
15-2431 Jagalene (CC14)	66.1	68.0	57.0	60.0	63.5	65.0	69.0	62.4	63.5	61.1	69.0	61.1	60.0	62.0	61.1	57.0	62.1
15-2432 Jagalene (CC19)	67.1	69.0	60.0	64.0	57.2	65.0	71.6	65.3	66.0	56.6	64.2	64.5	56.0	65.1	56.6	57.0	57.4

BAKE MIX TIME, ACTUAL

(Small Scale) Common Check

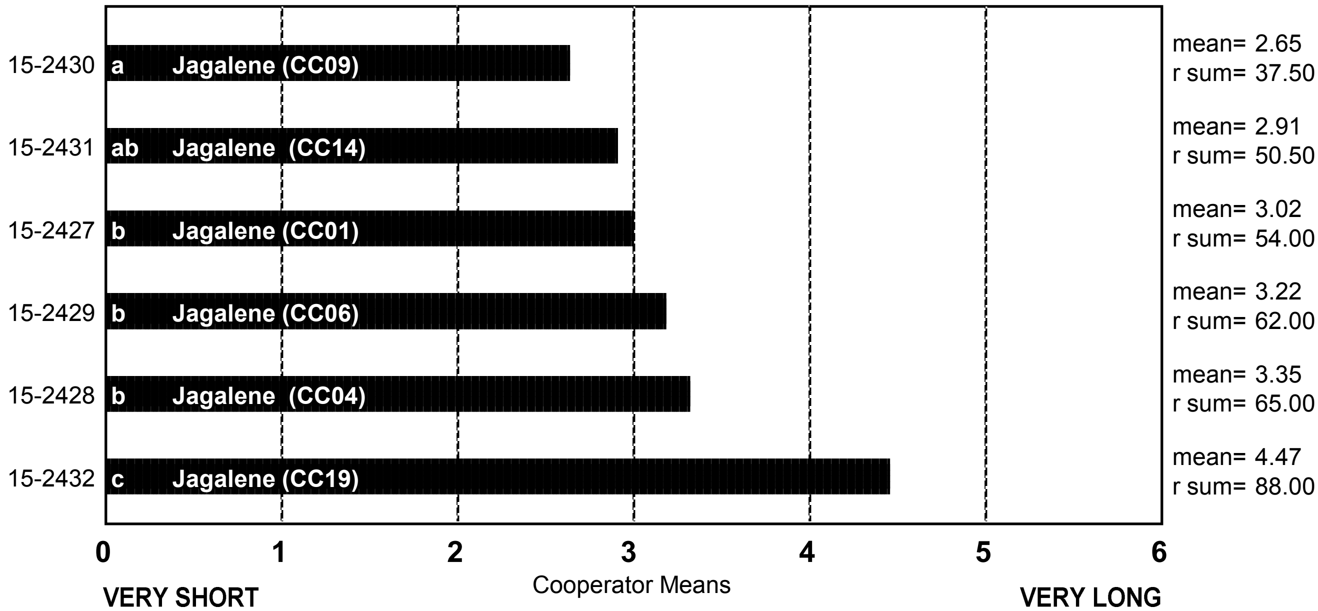
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
15-2427 Jagalene (CC01)	**3.4**	**3.8**	**7.0**	**6.0**	**4.0**	**3.9**	**4.1**	**4.3**	**3.0**	**7.0**	**4.0**	**4.0**	**8.0**	**4.5**	**4.0**	**4.0**	**5.0**
15-2428 Jagalene (CC04)	**3.8**	**4.0**	**6.0**	**6.0**	**4.3**	**5.0**	**5.0**	**4.3**	**3.1**	**5.3**	**4.3**	**4.2**	**14.0**	**5.3**	**3.5**	**4.0**	**6.0**
15-2429 Jagalene (CC06)	**3.8**	**3.8**	**7.0**	**6.0**	**3.8**	**5.0**	**4.0**	**3.8**	**2.5**	**6.0**	**3.8**	**4.0**	**16.0**	**4.5**	**5.5**	**5.0**	**7.0**
15-2430 Jagalene (CC09)	**2.9**	**2.8**	**5.0**	**6.0**	**3.3**	**4.1**	**3.3**	**3.3**	**2.6**	**6.3**	**3.5**	**3.2**	**12.0**	**3.8**	**5.0**	**4.0**	**7.0**
15-2431 Jagalene (CC14)	**3.5**	**3.8**	**5.0**	**6.0**	**4.0**	**4.8**	**3.9**	**3.8**	**3.1**	**5.3**	**4.3**	**4.0**	**9.0**	**4.9**	**3.0**	**4.0**	**6.0**
15-2432 Jagalene (CC19)	**5.0**	**7.0**	**9.0**	**6.0**	**4.3**	**7.7**	**5.7**	**4.8**	**3.7**	**10.3**	**4.5**	**4.2**	**20.0**	**8.0**	**12.0**	**8.0**	**12.0**

BAKE MIX TIME

(Small Scale) Common Check

ncoop= 17
chisq= 24.27
chisqc= 34.22
cvchisq= 11.07
crdiff= 14.69

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

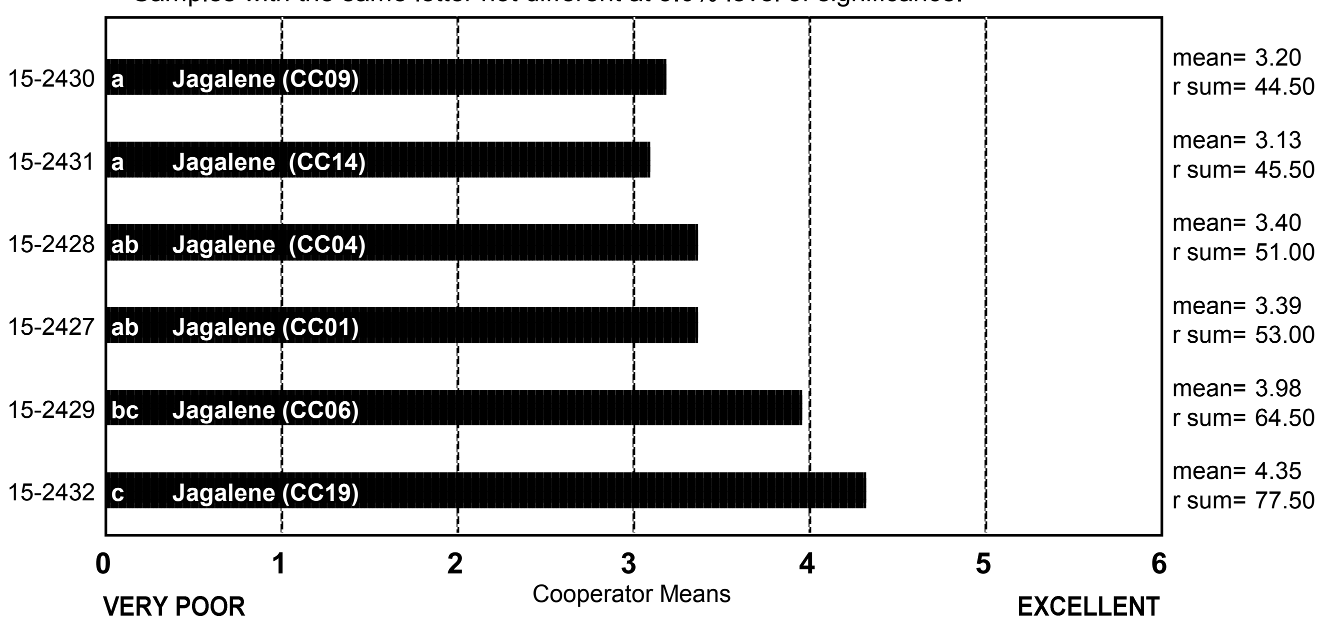


MIXING TOLERANCE

(Small Scale) Common Check

ncoop= 16
chisq= 14.48
chisqc= 17.79
cvchisq= 11.07
crdiff= 17.46

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

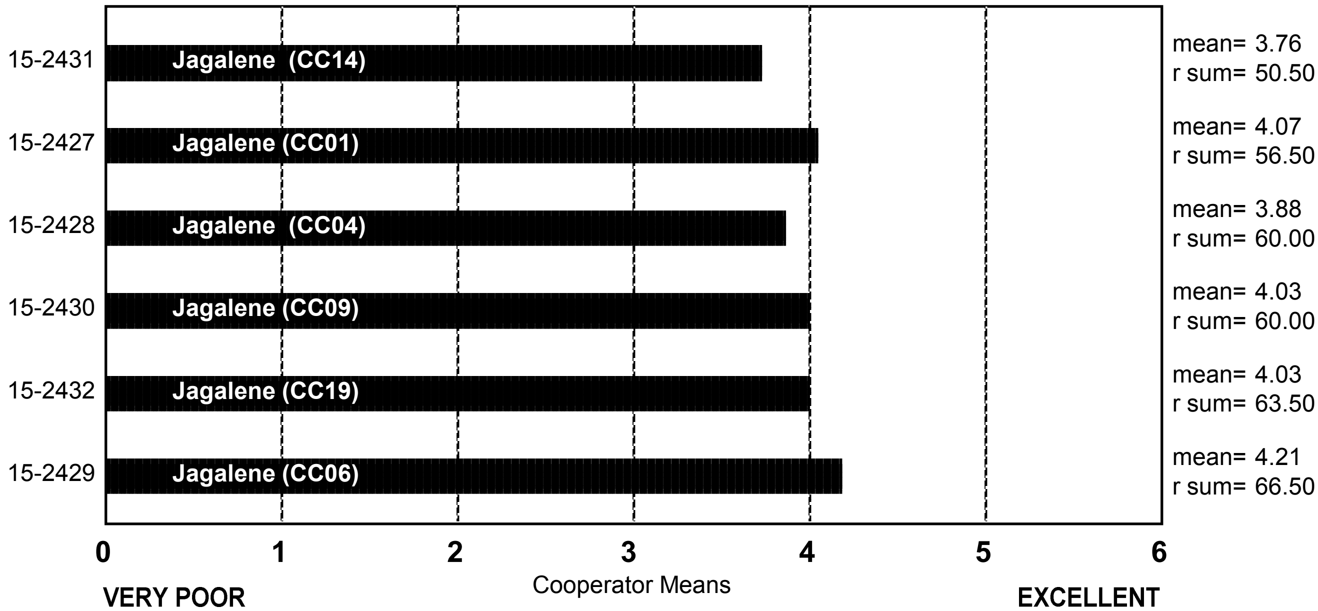


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Common Check

ncoop= 17
chisq= 2.61
chisqc= 3.51
cvchisq= 11.07
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Common Check

	Sticky	Wet	Tough	Good	Excellent
15-2427 Jagalene (CC01)	**2**	**1**	**2**	**11**	**1**
15-2428 Jagalene (CC04)	**2**	**2**	**1**	**10**	**2**
15-2429 Jagalene (CC06)	**1**	**0**	**1**	**12**	**3**
15-2430 Jagalene (CC09)	**4**	**1**	**1**	**9**	**2**
15-2431 Jagalene (CC14)	**2**	**1**	**3**	**9**	**2**
15-2432 Jagalene (CC19)	**0**	**1**	**5**	**6**	**5**

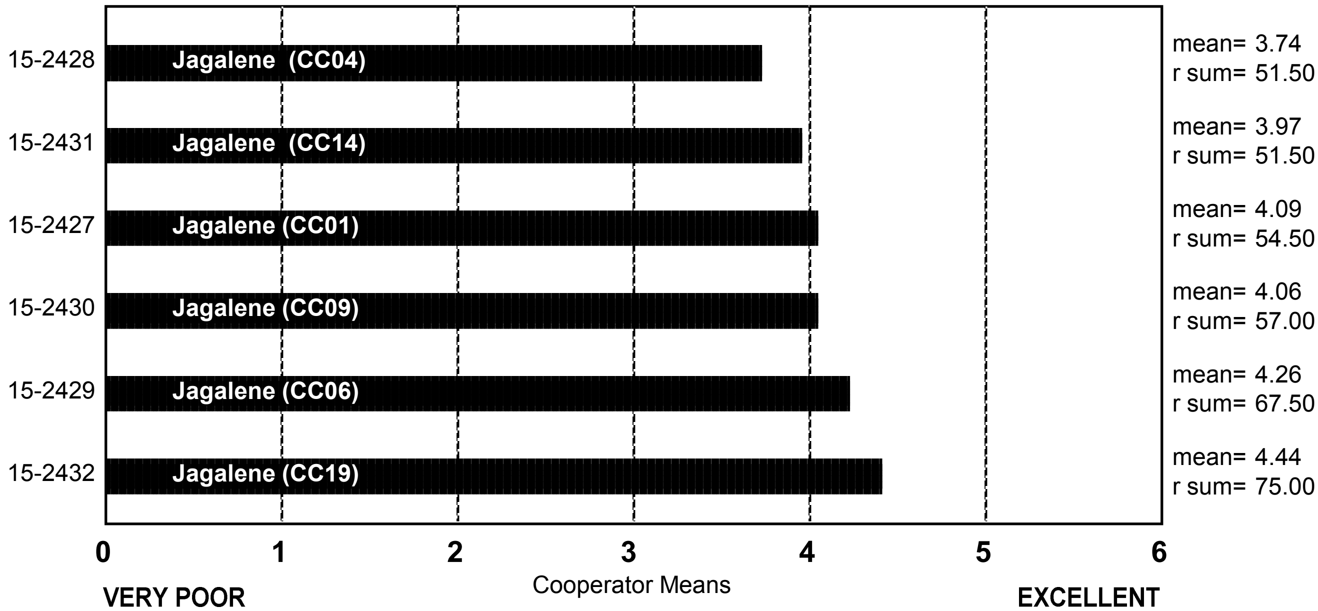
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Common Check

ncoop= 17
chisq= 7.79
chisqc= 10.58
cvchisq= 11.07
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Common Check

	Sticky	Wet	Tough	Good	Excellent
15-2427 Jagalene (CC01)	1	2	1	13	0
15-2428 Jagalene (CC04)	1	4	0	10	1
15-2429 Jagalene (CC06)	0	2	1	9	5
15-2430 Jagalene (CC09)	1	1	1	14	0
15-2431 Jagalene (CC14)	2	0	2	13	0
15-2432 Jagalene (CC19)	0	0	5	6	6

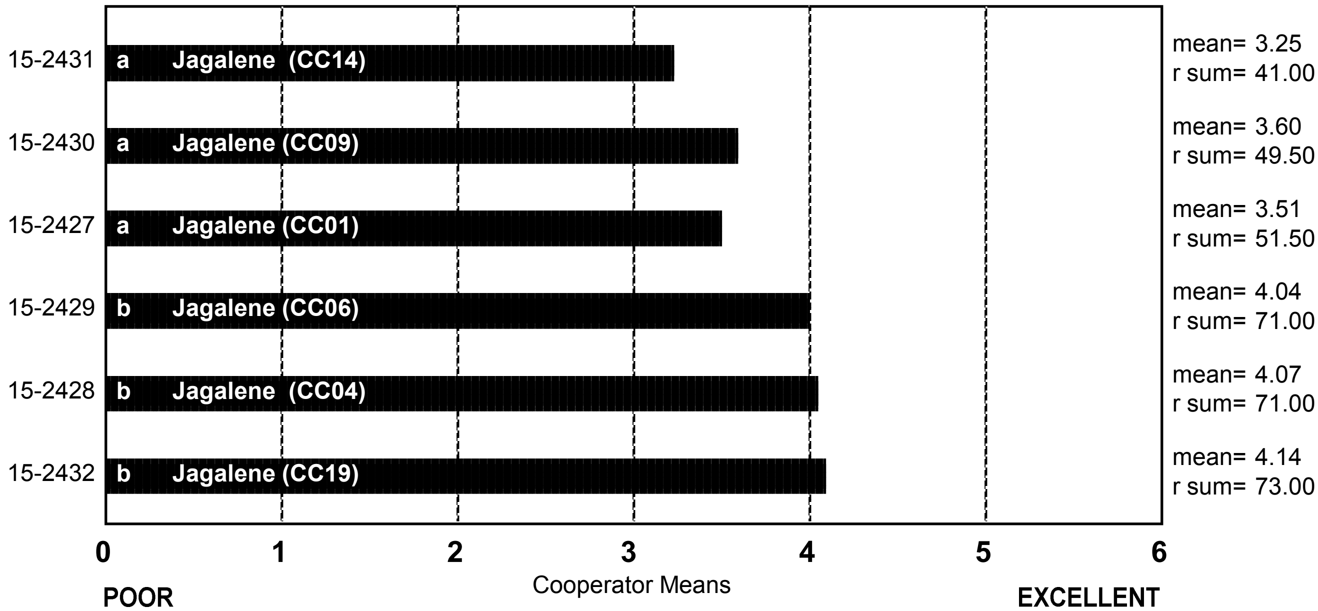
Frequency Table

CRUMB GRAIN

(Small Scale) Common Check

ncoop= 17
chisq= 16.02
chisqc= 18.98
cvchisq= 11.07
crdiff= 18.27

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Common Check

	Open	Fine	Dense
15-2427 Jagalene (CC01)	**8**	**6**	**3**
15-2428 Jagalene (CC04)	**7**	**10**	**0**
15-2429 Jagalene (CC06)	**10**	**5**	**2**
15-2430 Jagalene (CC09)	**9**	**6**	**2**
15-2431 Jagalene (CC14)	**11**	**4**	**2**
15-2432 Jagalene (CC19)	**7**	**9**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Common Check

	Round	Irregular	Elongated
15-2427 Jagalene (CC01)	**4**	**5**	**8**
15-2428 Jagalene (CC04)	**2**	**7**	**8**
15-2429 Jagalene (CC06)	**3**	**4**	**10**
15-2430 Jagalene (CC09)	**5**	**5**	**7**
15-2431 Jagalene (CC14)	**10**	**3**	**4**
15-2432 Jagalene (CC19)	**2**	**5**	**10**

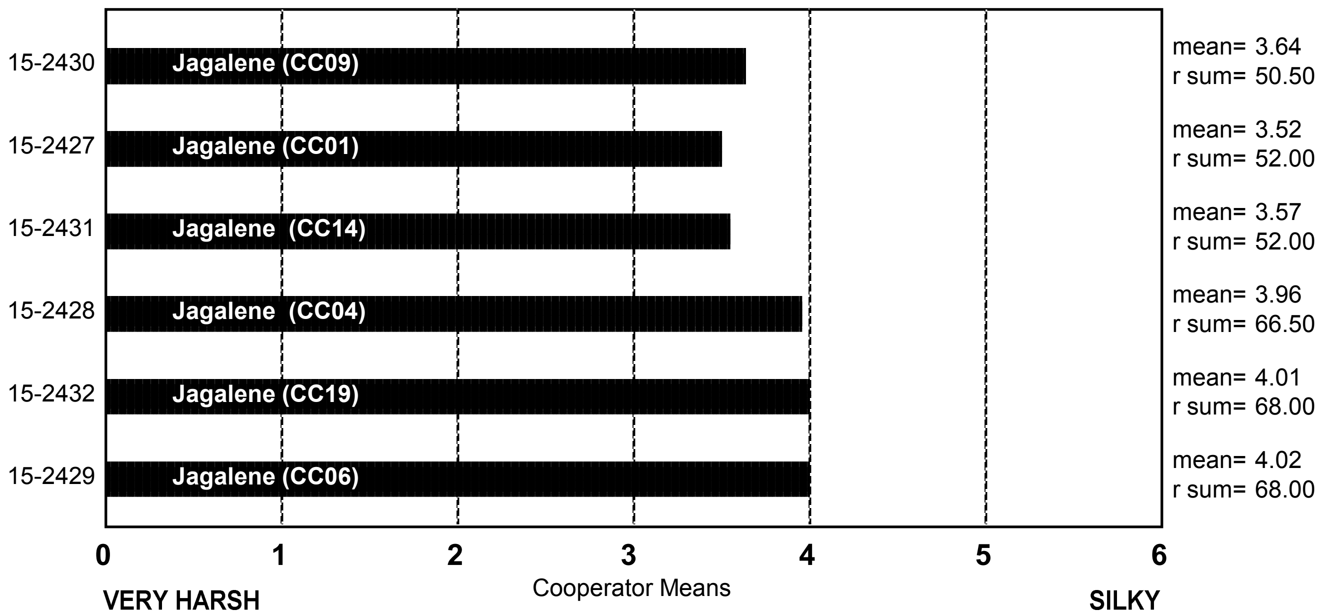
Frequency Table

CRUMB TEXTURE

(Small Scale) Common Check

ncoop= 17
chisq= 6.50
chisqc= 9.08
cvchisq= 11.07
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Common Check

	Harsh	Smooth	Silky
15-2427 Jagalene (CC01)	5	10	2
15-2428 Jagalene (CC04)	5	7	5
15-2429 Jagalene (CC06)	3	10	4
15-2430 Jagalene (CC09)	4	10	3
15-2431 Jagalene (CC14)	6	9	2
15-2432 Jagalene (CC19)	2	13	2

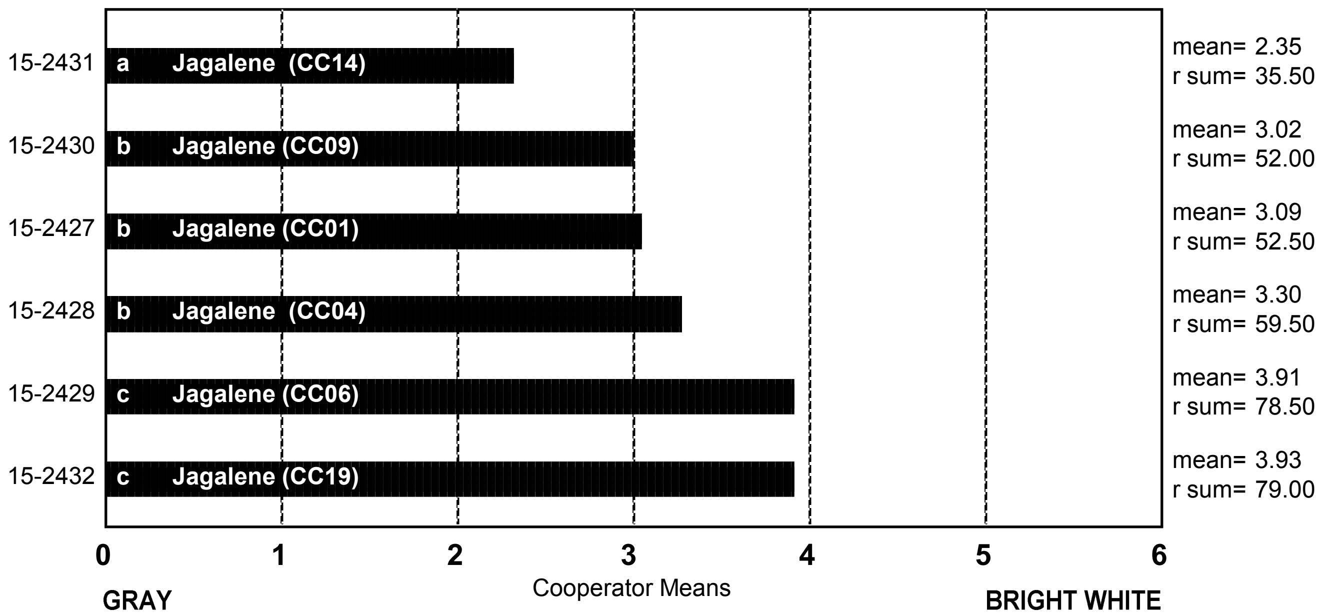
Frequency Table

CRUMB COLOR

(Small Scale) Common Checck

ncoop= 17
chisq= 23.91
chisqc= 32.48
cvchisq= 11.07
crdiff= 15.22

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



CRUMB COLOR, DESCRIBED

(Small Scale) Common Check

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
15-2427 Jagalene (CC01)	**1**	**0**	**8**	**2**	**5**	**1**	**0**
15-2428 Jagalene (CC04)	**0**	**0**	**3**	**6**	**8**	**0**	**0**
15-2429 Jagalene (CC06)	**0**	**0**	**2**	**1**	**8**	**5**	**1**
15-2430 Jagalene (CC09)	**0**	**1**	**6**	**4**	**5**	**1**	**0**
15-2431 Jagalene (CC14)	**4**	**2**	**2**	**6**	**3**	**0**	**0**
15-2432 Jagalene (CC19)	**0**	**0**	**1**	**3**	**11**	**0**	**2**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Common Check

	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
15-2427 Jagalene (CC01)	**136.1**	**137.3**	**395.0**		**133.1**	**139.2**	**156.0**	**139.4**	**141.8**	**449.5**	**131.7**			**149.9**	**119.7**	**481.8**	**454.0**
15-2428 Jagalene (CC04)	**136.7**	**140.7**	**395.0**		**128.9**	**133.1**	**154.1**	**138.6**	**142.4**	**452.9**	**129.5**			**147.9**	**119.1**	**483.0**	**453.0**
15-2429 Jagalene (CC06)	**136.2**	**142.8**	**396.0**		**134.9**	**142.6**	**150.7**	**141.3**	**144.5**	**448.9**	**133.2**			**149.7**	**116.5**	**484.4**	**457.0**
15-2430 Jagalene (CC09)	**136.6**	**139.1**	**395.0**		**132.4**	**139.0**	**154.4**	**142.8**	**141.8**	**446.4**	**132.1**			**149.4**	**118.9**	**482.7**	**455.0**
15-2431 Jagalene (CC14)	**138.4**	**138.9**	**398.0**		**132.6**	**140.3**	**152.4**	**144.3**	**145.1**	**450.9**	**130.8**			**149.2**	**114.8**	**481.9**	**459.0**
15-2432 Jagalene (CC19)	**136.2**	**143.6**	**396.0**		**127.2**	**141.0**	**153.7**	**143.5**	**144.8**	**454.9**	**129.1**			**149.9**	**118.1**	**485.6**	**457.0**

LOAF VOLUME, ACTUAL

(Small Scale) Common Check

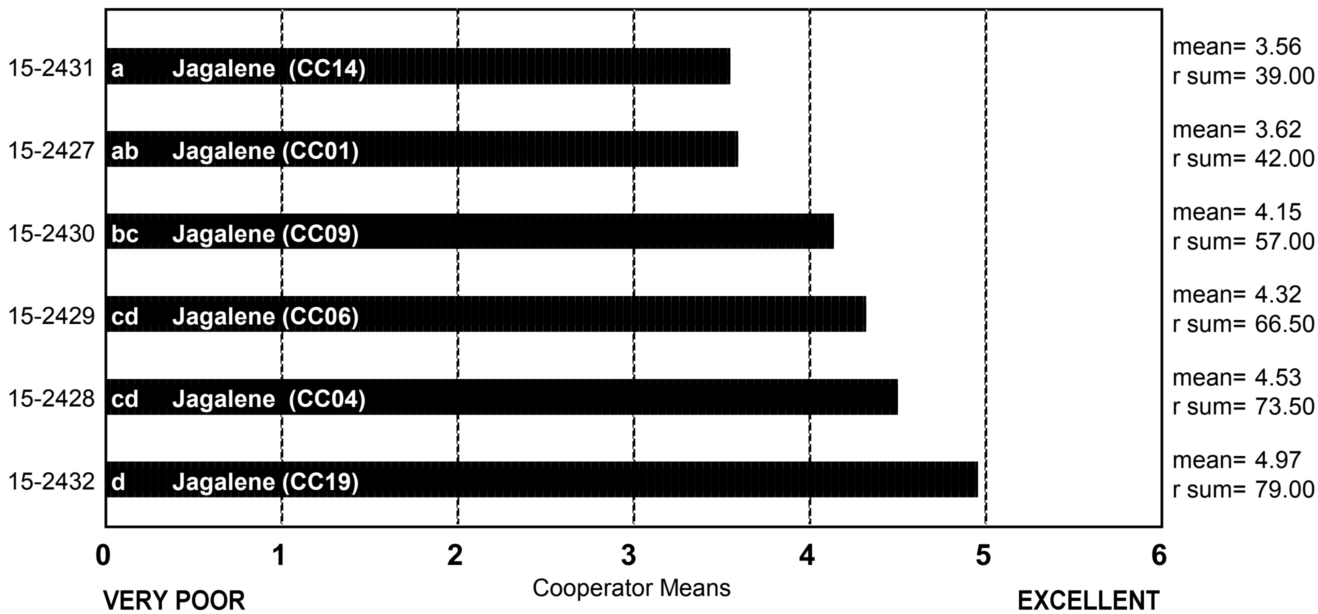
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. Q
15-2427 Jagalene (CC01)	**866**	**868**	**2800**	**940**	**923**	**1004**	**880**	**975**	**760**	**2846**	**960**	**635**	**2691**	**925**	**2550**	**2638**	**2250**
15-2428 Jagalene (CC04)	**894**	**685**	**3000**	**1050**	**980**	**1048**	**995**	**1050**	**930**	**2958**	**1090**	**940**	**2897**	**935**	**2425**	**2713**	**2250**
15-2429 Jagalene (CC06)	**886**	**985**	**3000**	**995**	**943**	**965**	**905**	**1020**	**815**	**2877**	**1040**	**830**	**2897**	**975**	**2400**	**2575**	**2200**
15-2430 Jagalene (CC09)	**838**	**993**	**3100**	**995**	**890**	**1045**	**945**	**955**	**805**	**2830**	**965**	**790**	**2780**	**960**	**2400**	**2750**	**2275**
15-2431 Jagalene (CC14)	**847**	**903**	**2725**	**930**	**843**	**1020**	**895**	**910**	**780**	**2916**	**915**	**720**	**2839**	**900**	**2375**	**2475**	**2175**
15-2432 Jagalene (CC19)	**1001**	**953**	**3000**	**1050**	**868**	**1050**	**1045**	**980**	**905**	**3075**	**1140**	**965**	**3104**	**1085**	**2450**	**2650**	**2375**

LOAF VOLUME

(Small Scale) Common Check

ncoop= 17
chisq= 22.82
chisqc= 26.07
cvchisq= 11.07
crdiff= 17.58

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

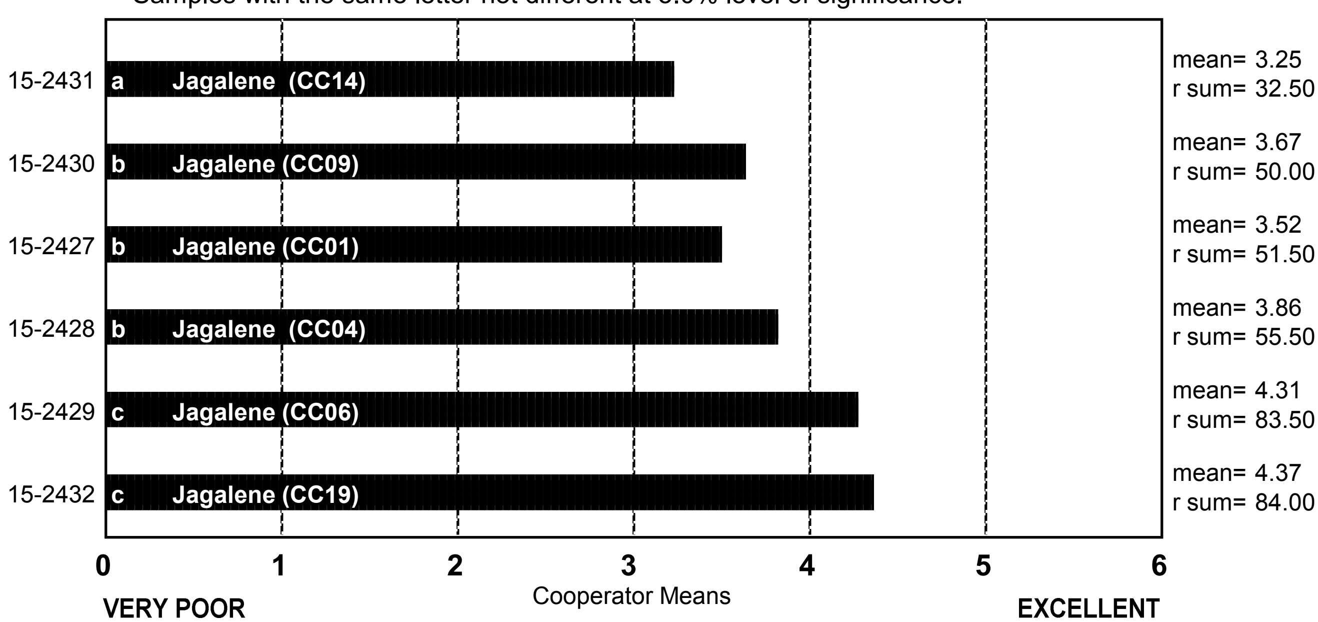


OVERALL BAKING QUALITY

(Small Scale) Common Check

ncoop= 17
chisq= 34.88
chisqc= 38.58
cvchisq= 11.07
crdiff= 15.86

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



COOPERATOR'S COMMENTS
(Small Scale) Common Checks

COOP. 15-2427 Jagalene (CC01)

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. Highest water absorption in the set.
F. Normal water absorption and mix time, slight sticky & strong dough, very high volume, yellow crumb, open elongated cells, resilient & smooth texture.
G. Somewhat weaker dough properties but feel was good, absorption was very good, volume and grain average.
H. Slight cap.
I. Poor bread bake, low volume, poor color.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Good rating for bake absorption, out of mixer, mix time, loaf volume and Q-S crumb-nice check.
O. High absorption, low mix time, excellent volume and grain rating.
P. Short mix time, wet and sticky dough, open grain, yellow crumb, good volume.
Q. Slightly sticky at makeup, weak crust.

COOP. 15-2428 Jagalene (CC04)

A. No comment.
B. Satisfactory quality overall.
C. No comment.
D. No comment.
E. Good dough performance, nice oven spring and break and shred but lower bread quality.
F. Normal water absorption and mix time, slight sticky & strong dough, high volume, yellow crumb, open elongated cells, resilient & slightly harsh texture.
G. Generally good dough mix time and strength but showing some signs of weakness in height of curve, good absorption, excellent volume for protein but weak crumb grain.
H. Excellent externals.
I. Lower absorption.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Long mix time, weak at pan, good crumb grain and loaf volume.
O. Average absorption, low mix time, excellent dough, bread collapsed before reading volume, good grain rating.
P. Very low absorption, short mix time, nice dough, excellent grain, excellent volume.
Q. Very sticky and slack, hard to get through sheeter.

COOP. 15-2429 Jagalene (CC06)

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption and mix time, slight sticky & strong dough, very high volume, creamy crumb, open elongated cells, resilient & smooth texture.
G. Good dough properties with very good overall strength, excellent absorption, average volume and grain.
H. Rough break and shred.
I. Very good color, poor volume.
J. No comment.
K. Good crumb color and crumb characteristics.
L. No comment.
M. No comment.
N. Good bake absorption and mix time, excellent at makeup, crumb open, good loaf volume.
O. High absorption, good mix time, dough was excellent, bread collapsed before volume reading, excellent dense grain rating.
P. Good grain, average in most categories.
Q. No comment.

COOP. 15-2430 Jagalene (CC09)

A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption, normal mix time, slight sticky & strong dough, very high volume, yellow crumb, open elongated cells, resilient & slightly harsh texture.
G. Shorter mix time but good overall mix strength, excellent absorption, average volume and crumb grain.
H. Rough break and shred.
I. Poor volume and grain.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Good bake absorption, mix time and dough strength; excellent crumb grain and loaf volume-nice check.
O. High absorption, low mix time, dough was good, bread collapsed before volume reading, good grain rating.
P. Short mix time, open grain, excellent volume.
Q. No comment.

COOP. 15-2431 Jagalene (CC14)

A. No comment.
B. Satisfactory quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption, long mix time, slight sticky & strong dough, very high volume, dark yellow crumb, open elongated cells, resilient & slightly harsh texture.
G. Generally good dough properties but showing some signs of weakness in height of curve, excellent absorption, average volume with weaker crumb grain.
H. No comment.
I. Very bad color, poor grain and volume.
J. No comment.
K. Poor color.
L. No comment.
M. No comment.
N. Good mix time, questionable to satisfactory ratings throughout with nice loaf volume.
O. Good absorption, low mix time, dough was good, bread collapsed before volume reading, good grain rating.
P. Low absorption, short mix time.
Q. No comment.

COOP. 15-2432 Jagalene (CC19)

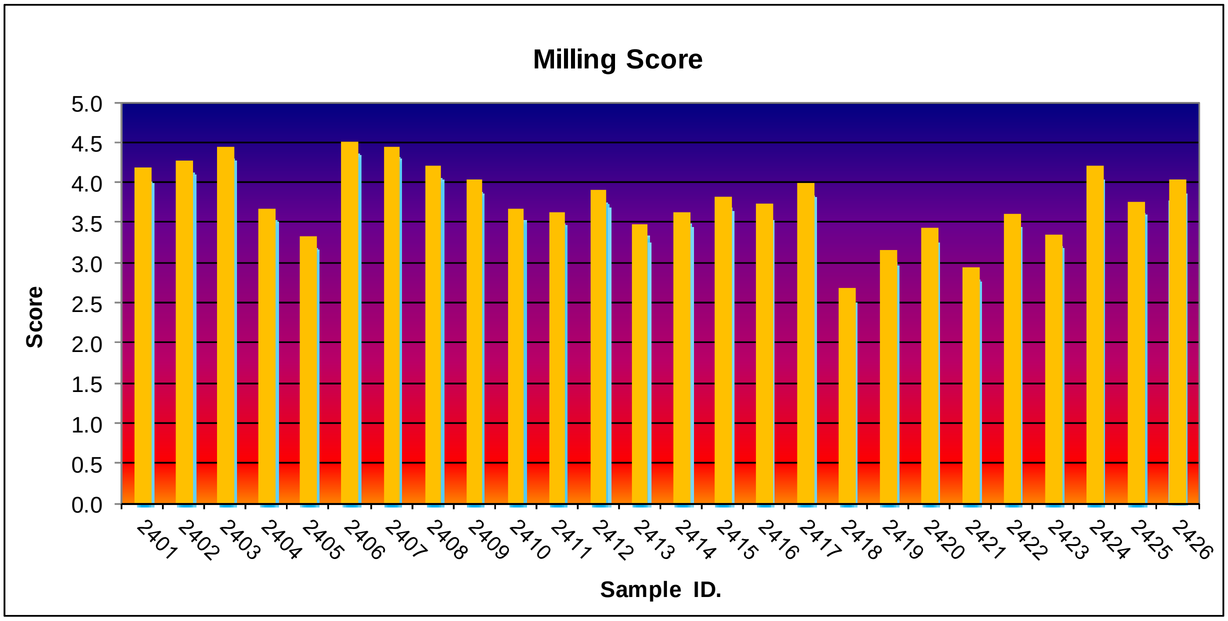
A. No comment.
B. Good quality overall.
C. No comment.
D. No comment.
E. No comment.
F. Normal water absorption and mix time, slight sticky & strong dough, very high volume, creamy crumb, fine elongated cells, resilient & smooth texture.
G. Good dough properties, excellent absorption, average volume and crumb grain.
H. No comment.
I. Very good protein but poor volume and grain.
J. No comment.
K. No comment.
L. No comment.
M. No comment.
N. Excellent absorption, long mix time, good dough strength at all stages, excellent crumb, excellent loaf volume.
O. Low absorption, long mix time, dough was excellent, bread had good volume with a dense grain rating.
P. Low absorption, good mix time, yellow crumb, good volume.
Q. Wild break and shred.

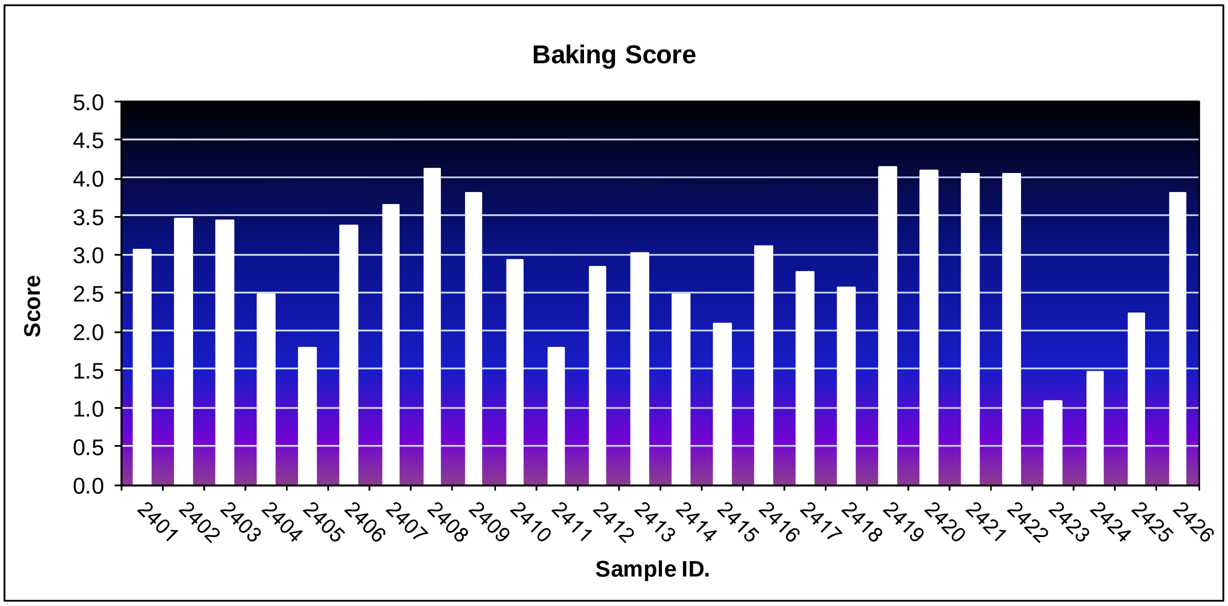
Notes: **C, D, M, O, P and Q** conducted sponge and dough bake tests

2015 WQC Milling and Baking Marketing Scores

2015 WQC Milling & Baking Marketing Scores

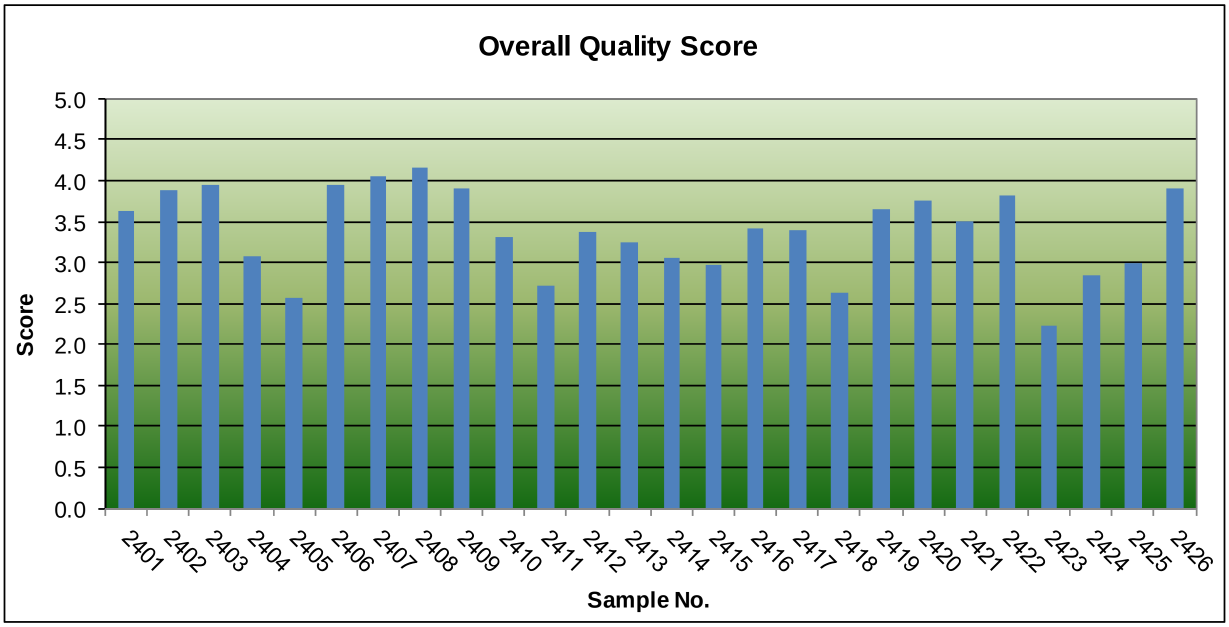
(Based upon HWWQL Quality Data and KSU Milling Data)





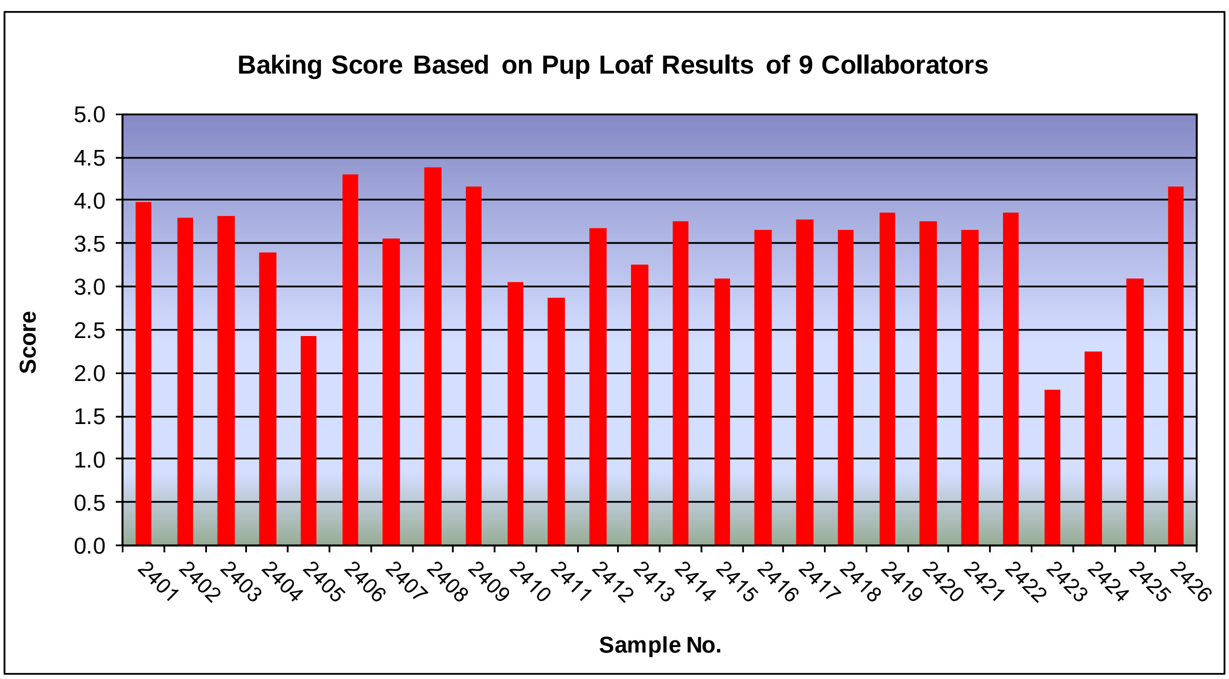
2015 WQC Milling & Baking Marketing Scores

(Based upon HWWQL Quality Data and KSU Milling Data)



2015 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
2015 WQC Hard Winter Wheat Entries

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Alkaline Noodle Quality Report

Objectives: Evaluate alkaline noodle color and cooking characteristics.

Materials: 25 WQC hard winter wheat samples harvested in 2015.

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-410) at 0 and 24 hr.

Cooking Noodles:

1. After cutting noodles, rest noodles in plastic bags for 2 hr at 21^oC.
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:

<u>Cooking Loss:</u>

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^oC.
   Drying time is about 20 hr.
4. Cool beakers and weigh to 0.01 g.
   For 25 g sample, multiply by 4 → % cooking loss.

<u>Water Uptake:</u>

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***: 2423 (83.25), 2417(79.79), 2401 (79.75)

Noodle Color (*L* value, Higher is better.) ***at 24 hr***: 2423 (73.05), 2417 (68.24), 2401 (66.92)

Delta L (Change of *L* value, Lower absolute value is better.)
2423 (-10.21), 2422 (-11.30), 2417 (-11.55)

PPO (Lower is better.): 2417 (0.157), 2415 (0.224), 2406 (0.385)

Table II shows the following:

Hardness: 2425 (2.806), 2415 (2.744), 2410 (2.738)

Springiness: 2416 (0.942), 2418 (0.940), 2401 (0.933)

Chewiness: 2416 (1.730), 2407 (1.712), 2410 (1.702)

Resilience: 2417 (0.430), 2422 (0.430), 2402 (0.430)

Cohesiveness: 2422 (0.693), 2421 (0.691), 2417 (0.687)

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

Cooking Loss: 2419 (6.08), 2407 (6.08), 2410 (6.16)

Discussion

Sample 2423 had the highest L-value (brightness) at both 0 and 24 hrs , and had the lowest delta *L**. This sample also had relatively high springiness and hardness in texture after cooking. Bright noodle color 24 hr after production and a firmer texture following cooking are considered desirable characteristics for alkaline noodles. Thus, sample 2423 would be considered the most favorable variety overall for alkaline noodle quality.

Sample 2417 had the second highest L-value (brightness) at both 0 and 24 hrs , This sample also had the third lowest delta *L**, the lowest PPO value, the highest resilience, the second highest chewiness and third highest cohesiveness after cooking. Therefore, sample 2417 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 2422 had the second lowest delta *L**, and the highest resilience and cohesiveness after cooking.

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	79.75	66.92	-1.51	0.39	21.57	23.36	-12.83	1.90	1.80	0.481
2402	79.74	65.38	-1.78	0.69	22.47	25.21	-14.43	2.47	2.74	0.574
2403	78.51	63.38	-1.47	1.04	22.16	24.15	-15.13	2.51	1.99	0.553
2404	77.38	62.51	-0.98	1.56	22.73	24.51	-14.87	2.54	1.78	0.530
2405	78.39	63.64	-1.19	1.26	21.24	23.84	-14.75	2.45	2.60	0.626
2406	78.76	64.73	-1.16	0.76	21.79	24.22	-14.04	1.91	2.44	0.385
2407	76.63	60.79	-1.29	1.06	22.06	23.20	-15.84	2.35	1.15	0.437
2408	74.90	59.41	-1.12	1.73	23.23	25.38	-15.49	2.84	2.15	0.434
2409	78.22	63.06	-1.19	1.66	23.14	25.95	-15.16	2.85	2.81	0.409
2410	76.23	59.46	-0.61	2.52	21.51	24.69	-16.77	3.13	3.18	0.402
2411	77.28	60.81	-0.87	2.23	23.67	25.33	-16.48	3.10	1.66	0.408
2412	78.51	65.33	-1.22	1.32	24.00	26.03	-13.18	2.54	2.03	0.538
2413	77.05	65.00	-1.43	1.14	26.18	28.21	-12.05	2.57	2.04	0.527
2414	74.55	58.29	-0.62	2.40	22.48	24.84	-16.26	3.01	2.37	0.507
2415	78.19	66.49	-0.95	0.99	23.11	29.90	-11.71	1.94	6.79	0.224
2416	75.64	62.27	-0.29	2.17	22.87	27.02	-13.37	2.46	4.16	0.599
2417	79.79	68.24	-1.03	0.68	21.52	27.66	-11.55	1.71	6.14	0.157
2418	78.14	66.51	-1.18	0.97	24.65	29.64	-11.63	2.15	4.99	0.485
2419	76.78	64.93	-1.25	0.60	26.66	26.71	-11.86	1.85	0.05	0.637
2420	77.76	65.83	-0.81	1.28	23.94	27.15	-11.93	2.09	3.21	0.539
2421	77.34	62.98	-1.14	1.09	23.81	28.07	-14.36	2.23	4.26	0.414
2422	77.86	66.57	-1.03	0.85	24.11	26.83	-11.30	1.88	2.73	0.453
2423	83.25	73.05	-2.10	-1.05	20.25	25.65	-10.21	1.05	5.40	0.485
2424	78.75	65.88	-1.30	0.54	21.67	24.52	-12.87	1.84	2.85	0.525
2425	77.53	64.15	-1.42	0.79	22.62	24.17	-13.38	2.21	1.55	0.614
Avg	77.88	64.22	-1.16	1.14	22.94	25.85	-13.66	2.30	2.91	0.477

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	0.933	2.504	1.595	0.413	0.682	91.16	6.72
2402	0.906	2.512	1.541	0.430	0.677	88.52	6.84
2403	0.929	2.509	1.531	0.389	0.657	93.84	6.80
2404	0.921	2.567	1.553	0.385	0.657	91.48	6.72
2405	0.915	2.693	1.595	0.368	0.647	91.16	6.84
2406	0.929	2.598	1.633	0.417	0.676	87.76	6.92
2407	0.929	2.538	1.592	0.403	0.675	82.16	6.08
2408	0.919	2.539	1.572	0.427	0.674	84.20	6.72
2409	0.925	2.602	1.598	0.392	0.664	88.88	6.64
2410	0.917	2.738	1.702	0.415	0.678	88.76	6.16
2411	0.927	2.490	1.579	0.426	0.684	83.52	7.28
2412	0.910	2.524	1.489	0.385	0.648	87.96	7.52
2413	0.883	2.708	1.490	0.384	0.623	88.24	7.76
2414	0.910	2.520	1.523	0.409	0.664	86.28	7.20
2415	0.917	2.744	1.625	0.384	0.646	81.80	9.20
2416	0.942	2.734	1.730	0.419	0.672	84.48	6.80
2417	0.927	2.689	1.712	0.430	0.687	83.36	7.16
2418	0.940	2.444	1.567	0.429	0.683	88.24	6.48
2419	0.910	2.432	1.502	0.401	0.678	84.80	6.08
2420	0.907	2.494	1.545	0.407	0.684	81.84	6.60
2421	0.908	2.648	1.662	0.413	0.691	81.20	6.96
2422	0.923	2.475	1.583	0.430	0.693	77.00	7.00
2423	0.913	2.619	1.489	0.368	0.623	82.56	9.20
2424	0.908	2.544	1.511	0.399	0.654	88.88	7.48
2425	0.901	2.806	1.600	0.375	0.633	93.04	7.40

TORTILLA BAKING TEST of 2015 WQC SAMPLES

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Texas A&M University, College Station, TX
(January 2015)

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 2015 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 Propionate	0.4%
Potassium Sorbate	0.6%
All-purpose Shortening	6.0%
Sodium Bicarbonate	0.6%
Fumaric Acid - encapsulated	0.33%
Sodium Aluminum Phosphate	0.58%

Tortilla Processing

MIX

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

↓

PROOF
5 min, 32°C, 70% RH

Subjective Dough Evaluation ←

↓

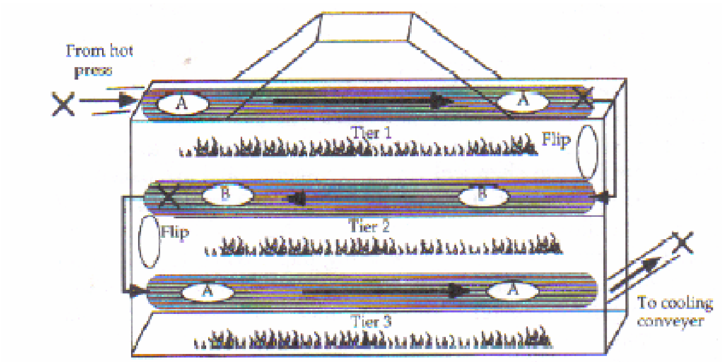
DIVIDE and ROUND
Obtain 43-g dough balls

↓

PROOF
10 min, 32°C, 70% RH

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

HOT-PRESS



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

BAKE

COOL and PACKAGE

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

Subjective Dough Evaluation

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

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

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

BOLD values = desired dough properties.

Evaluation of Tortilla Properties

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

1. Weight
Ten tortillas are weighed on an analytical balance. The weight of one tortilla is calculated by dividing total weight by 10. 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

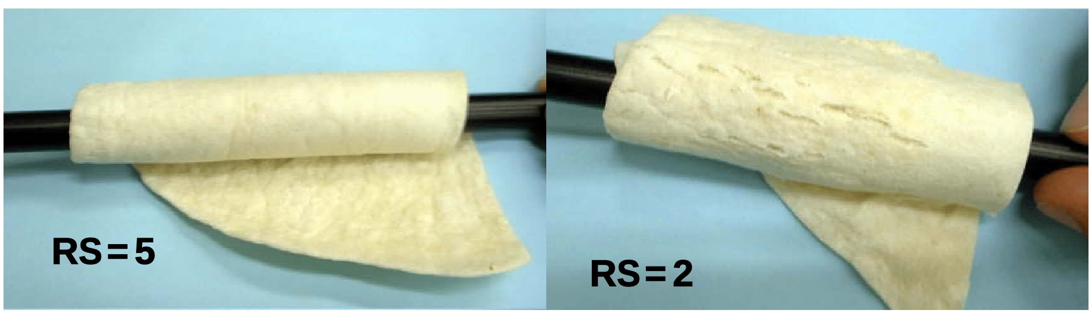
The color values of lightness (L*), +a* (redness and greenness) and +b* (yellowness and blueness) of tortillas are determined using a handheld colorimeter (model CR-300, Minolta Camera Co., Ltd., Chuo-Ku, Osaka, Japan). L*-values correlate with opacity and are usually greater than 80.

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.

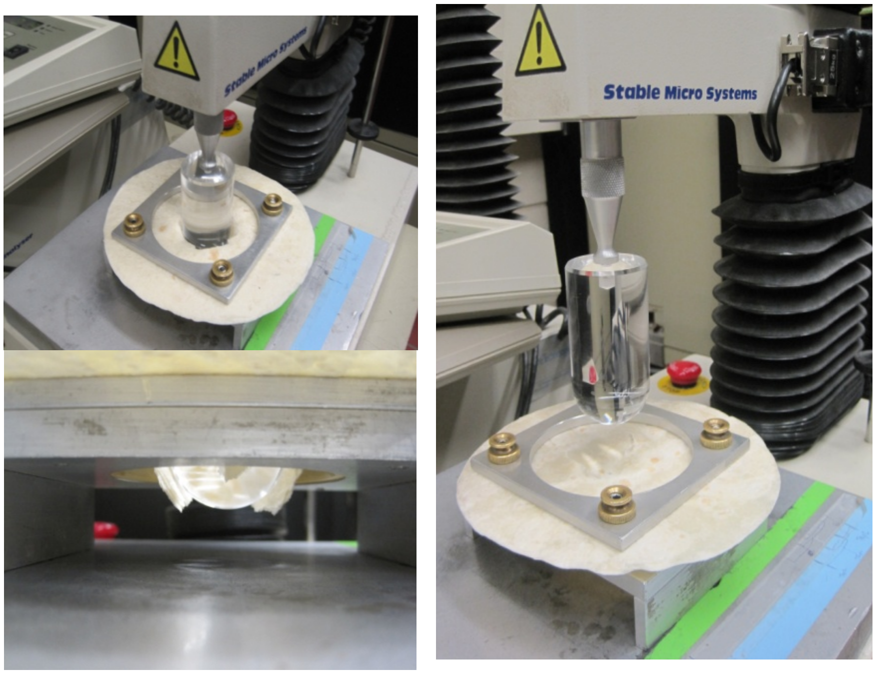
7. Tortilla Rollability Score

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 - 2015 DATA WORKSHEET

COOPERATOR NAME:	Audrey L. Girard, Sharris Vader, 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	11	3.38	4	5.3	9	27	11
2402	11.3	2.58	2	4.4	7.9	24	11
2403	11.5	3.13	1	5.7	7.1	27	11.2
2404	11.1	4	4	7.2	10.8	30	12.1
2405	10.2	3.88	4	6.9	9.3	33	11
2406	11.5	3.5	3	6.8	12.8	20	15.8
2407	12	4.38	4	7.7	21.1	21	18.8
2408	11.8	3.38	2	10.8	12.2	22	17.5
2409	11.5	3.38	3	7.7	8.9	20	14.6
2410	11.7	5.13	4	8.3	13.3	19	14.3
2411	10.9	4.88	5	7.2	12.7	19	13.5
2412	11	3.25	4	5	12.8	18	16.5
2413	11	3.25	3	5.2	8.3	26	10.9
2414	11.2	3.5	3	5.3	7.2	35	9.3
2415	10.6	3.75	4	5.3	9.4	24	11.4
2416	11	4.5	4	2.7	8.9	24	9.2
2417	11	4.38	4	2.9	7	25	8.9
2418	11.1	3.38	4	4.8	8.6	28	9.8
2419	13.6	4.5	6	8.8	16.8	15	18.3
2420	13.4	8.63	6	8.4	17.8	14	16.3
2421	12.8	7.38	6	9	55.3	10	59.5
2422	13.3	11.5	6	6.7	20.7	14	18.6
2423	8.7	6.38	4	1.7	1.6	81	2.6
2424	11.1	1.75	1	3.5	3.5	47	6.6
2425	10.7	2.13	1	4.2	4.7	33	7.1

*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* (°C)	*Smooth-ness* (Rating)	*Soft-ness* (Rating)	*Extensi-bility* (Rating)	*Force to Extend* (Rating)	*Press Rating* (Rating)
Tortilla Ref.	52.0	9.0	27.3	3.0	2.0	3.0	3.0	4.0
2401	56.8	10.0	26.1	2.0	2.0	3.0	2.0	3.0
2402	53.8	8.0	26.6	3.0	1.0	3.0	2.0	2.0
2403	54.2	8.0	25.6	2.0	1.0	3.0	2.0	2.0
2404	52.9	8.0	28.2	2.0	2.0	3.0	2.0	2.0
2405	49.4	9.0	26.4	2.0	2.0	4.0	2.0	3.0
2406	55.1	8.5	27.2	2.0	2.0	4.0	1.0	2.0
2407	53.0	8.5	26.8	1.0	1.0	3.0	2.0	2.0
2408	55.7	8.0	26.8	2.0	1.0	4.0	2.0	2.0
2409	54.1	8.5	26.7	1.0	2.0	3.0	2.0	2.0
2410	52.4	8.0	26.9	2.0	1.0	4.0	1.0	3.0
2411	51.0	8.5	27.2	2.0	2.0	3.0	2.0	2.0
2412	52.4	8.0	26.8	3.0	2.0	4.0	2.0	2.0
2413	52.8	8.0	26.9	2.0	1.0	4.0	1.0	2.0
2414	54.2	9.0	26.7	3.0	2.0	4.0	1.0	2.0
2415	52.7	9.5	26.1	3.0	2.0	3.0	2.0	2.0
2416	54.7	9.0	26.4	3.0	3.0	3.0	2.0	2.0
2417	55.8	9.0	26.6	2.0	2.0	3.0	2.0	2.0
2418	54.4	8.0	26.9	1.0	1.0	5.0	1.0	1.0
2419	55.6	8.0	27.7	1.0	1.0	5.0	1.0	1.0
2420	55.2	8.0	27.3	1.0	1.0	5.0	1.0	1.0
2421	54.2	9.0	27.3	1.0	2.0	4.0	2.0	2.0
2422	55.0	8.0	27.3	1.0	2.0	4.0	1.0	1.0
2423	50.0	8.0	27.3	2.0	3.0	3.0	3.0	3.0
2424	52.4	7.5	27.1	2.0	2.0	3.0	2.0	2.0
2425	51.8	8.0	26.6	2.0	2.0	2.0	2.0	2.0
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.

Overall the doughs were quite soft. Most of the doughs were generally easy to process except for doughs 2418, 2419, and 2420 which were excessively soft and sticky. This was reflected in their high extensibility scores along with low scores for softness (very soft), force to extend (less force), and press rating (very easy to press). All of the samples were readily extended. Samples 2401, 2405, 2410, and 2423 required the most force to flatten and to press on the stainless steel plate, but they were not too hard.

Table 3. **Physical properties of tortillas.**

TEST No.	*Moisture*	*Weight*	*Thicknes s*	*Diameter*	*Sp. Volume*	*Lightnes s**
	%	g	mm	mm	cm^3/g	L-value
Tortilla Ref.	32.18	40.76	2.00	165.6	1.1	97.3
2401	24.90	40.05	2.19	172.1	1.3	99.6
2402	33.66	38.59	2.20	186.1	1.6	100.5
2403	31.02	39.11	2.22	189.4	1.6	102.6
2404	34.05	38.54	2.05	180.5	1.4	101.4
2405	31.38	39.60	2.26	178.2	1.4	102.8
2406	33.92	38.80	2.12	178.2	1.4	101.3
2407	30.31	39.90	2.26	177.0	1.4	100.4
2408	31.76	39.27	2.23	182.4	1.5	99.4
2409	34.37	38.69	2.35	184.8	1.6	100.6
2410	33.54	39.82	2.15	180.0	1.4	97.6
2411	31.78	38.55	2.23	178.4	1.4	99.2
2412	33.00	39.49	2.11	183.9	1.4	100.7
2413	30.75	38.96	2.14	192.9	1.6	100.4
2414	31.87	39.45	2.23	180.8	1.5	96.2
2415	34.40	39.38	2.24	181.5	1.5	98.6
2416	31.73	39.61	2.20	184.4	1.5	96.7
2417	31.54	39.33	2.17	180.7	1.4	99.9
2418	33.59	38.61	2.21	185.3	1.5	101.6
2419	34.66	38.37	2.11	179.5	1.4	102.6
2420	34.10	38.83	2.30	169.4	1.3	102.6
2421	33.42	39.84	2.28	166.5	1.2	101.3
2422	34.265	39.72	2.97	169.0	1.7	101.5
2423	30.819	39.78	2.30	173.6	1.4	105.4
2424	33.015	38.39	2.20	188.0	1.6	103.5
2425	31.54	38.45	2.09	190.9	1.6	102.2
Descriptors or Scale	Calculate using two-step method	Record actual weight	Record actual thickness	Record actual diameter	Calculate as = p(radius)^2 *thickness *1000/wt	Record actual L-value; 0 = black to 100 = white

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

All tortillas had good diameter (at least 165 mm). Samples with >165 mm tortilla diameter had lightness scores >80 and >1.1 cm^3/g specific volume indicating that the dough discs did not shrink back during hot-pressing. Generally, small diameter tortillas (<156 mm) would have had corresponding low specific volume and been less fluffy, darker, and dense.

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

TEST No.	Force day 0 (N)	Distance day 0 (mm)	Work day 0 (N.mm)	Force day 16 (N)	Distance day 16 (mm)	Work day 16 (N.mm)
Tortilla Ref.	16.8	22.8	165.3	18.1	21.1	151.8
2401	10.1	20.7	71.6	6.5	12.9	28.5
2402	8.0	19.3	53.5	6.0	14.2	31.3
2403	7.5	19.4	53.6	6.0	14.2	31.2
2404	8.7	20.5	67.2	6.5	13.0	30.8
2405	8.5	19.6	60.6	6.1	14.5	33.6
2406	10.5	22.0	83.9	7.2	14.0	35.8
2407	9.2	21.9	74.8	7.2	15.3	40.2
2408	8.2	20.9	64.2	7.3	13.8	34.7
2409	10.0	20.1	70.7	7.4	13.5	35.9
2410	9.6	21.3	77.8	9.0	14.8	50.4
2411	7.7	18.4	49.5	7.3	15.8	43.2
2412	8.0	19.2	53.6	7.0	13.6	34.6
2413	8.1	19.3	57.1	5.7	14.1	30.2
2414	7.8	20.2	54.7	6.0	13.5	32.4
2415	9.4	18.8	56.2	5.4	12.4	25.7
2416	8.9	19.5	60.5	7.4	13.2	35.9
2417	12.0	17.3	61.5	8.8	16.7	51.7
2418	10.5	18.6	60.1	7.1	14.1	38.4
2419	10.5	25.3	113.1	7.6	17.6	55.6
2420	9.7	24.3	101.4	9.8	18.7	76.3
2421	7.8	22.3	77.0	9.5	18.1	69.2
2422	11.7	19.6	75.9	8.6	18.1	62.1
2423	7.8	17.8	49.0	7.0	12.1	31.0
2424	6.8	18.2	40.9	4.9	11.3	19.9
2425	6.5	17.9	40.3	5.2	12.0	22.4
Descriptors or Scale	Determine parameters using texture analyzer 1 day after processing			Determine parameters using texture analyzer 16 days after processing		

Tortillas from all the samples had a reduction in extensibility distance from day 1 to day 16; however, the severity of these reductions varied widely. Sample 2411 had the least changing force, distance, and work needed to rupture the tortillas especially after 16 days of storage at room temperature, meaning that it appears to have staled the least. Samples 2401, 2406, and 2419 had the most drastic reductions in distance before rupture and work to rupture.

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	4.8	166	Good
2401	5.0	2.5	172	Poor
2402	5.0	3.0	186	Good
2403	5.0	4.0	189	Good
2404	5.0	4.8	181	Good
2405	5.0	3.5	178	Good
2406	5.0	4.3	178	Good
2407	5.0	5.0	177	Good
2408	5.0	4.8	182	Good
2409	5.0	4.0	185	Good
2410	5.0	3.5	180	Good
2411	5.0	2.5	178	Poor
2412	5.0	3.3	184	Good
2413	5.0	2.3	193	Poor
2414	5.0	3.0	181	Good
2415	5.0	3.8	182	Good
2416	5.0	5.0	184	Good
2417	5.0	4.8	181	Good
2418	5.0	3.5	185	Good
2419	5.0	4.5	180	Good
2420	5.0	4.5	169	Good
2421	5.0	5.0	167	Good
2422	5.0	4.8	169	Good
2423	5.0	1.5	174	Poor
2424	5.0	2.3	188	Poor
2425	5.0	2.0	191	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 2401, 2411, 2413, 2423, 2424, and 2425 had very good diameters but low rollability scores (typical of weak flours). All other samples had acceptable diameter and day-16 rollability scores (Figure 1).

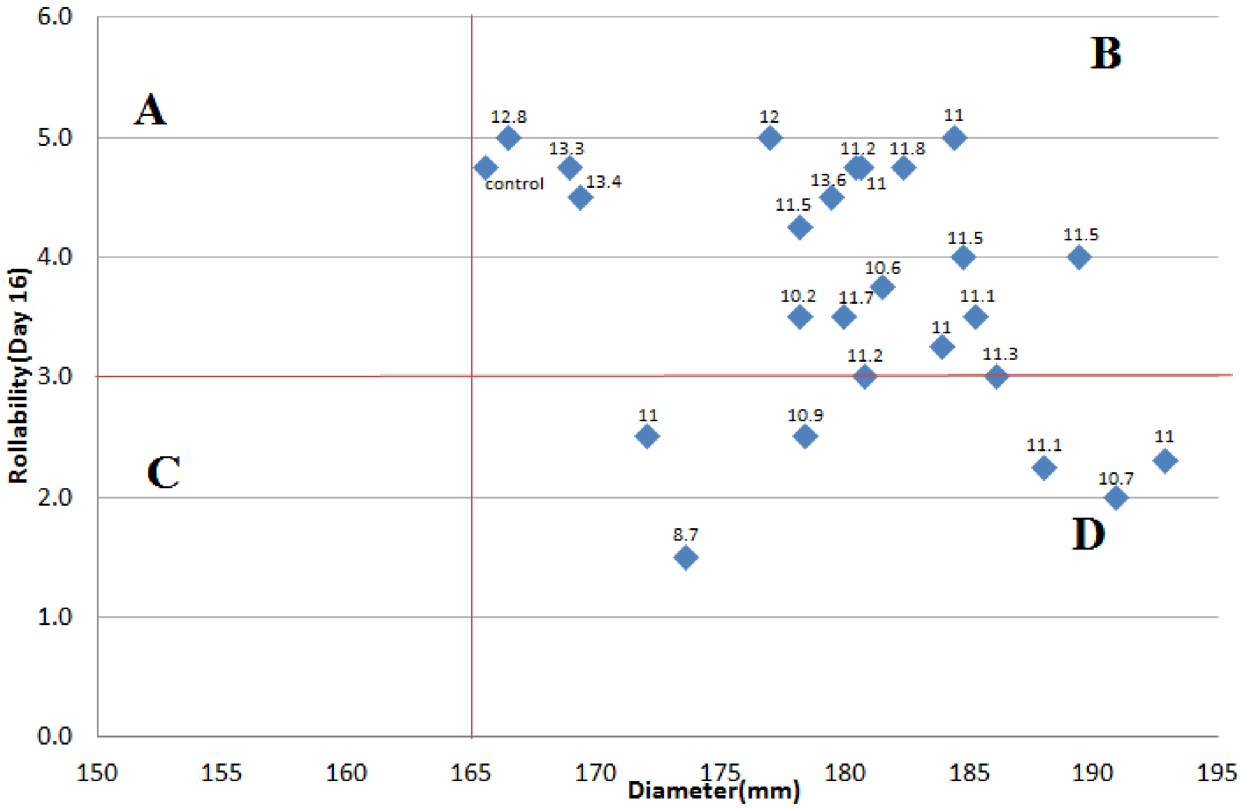


Fig. 1 - Relationship of tortilla diameter, rollability score (day 16), and flour protein content (14% mb; shown as numbers inside the box). Quadrant A: good shelf-stability, poor diameter; B: acceptable diameter and shelf-stability; C: poor diameter, poor shelf-stability; D: good diameter, poor shelf-stability.

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 2419, which (along with many others) gave the best tortilla quality, does not fall into this category (i.e., has 13.6% 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 10-14%.

Protein quality, on the other hand, seems to be a better (but still not perfect) predictor of tortilla quality. Figure 2 shows that samples with longer than 3 min mixograph mixing time generally gave smaller diameters (though still well beyond the 165mm benchmark) and good shelf-stability, while one sample in the B quadrant with less than 3 min mixing time had tortilla with good diameter and acceptable shelf-stability as did the sample with 11.5 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.

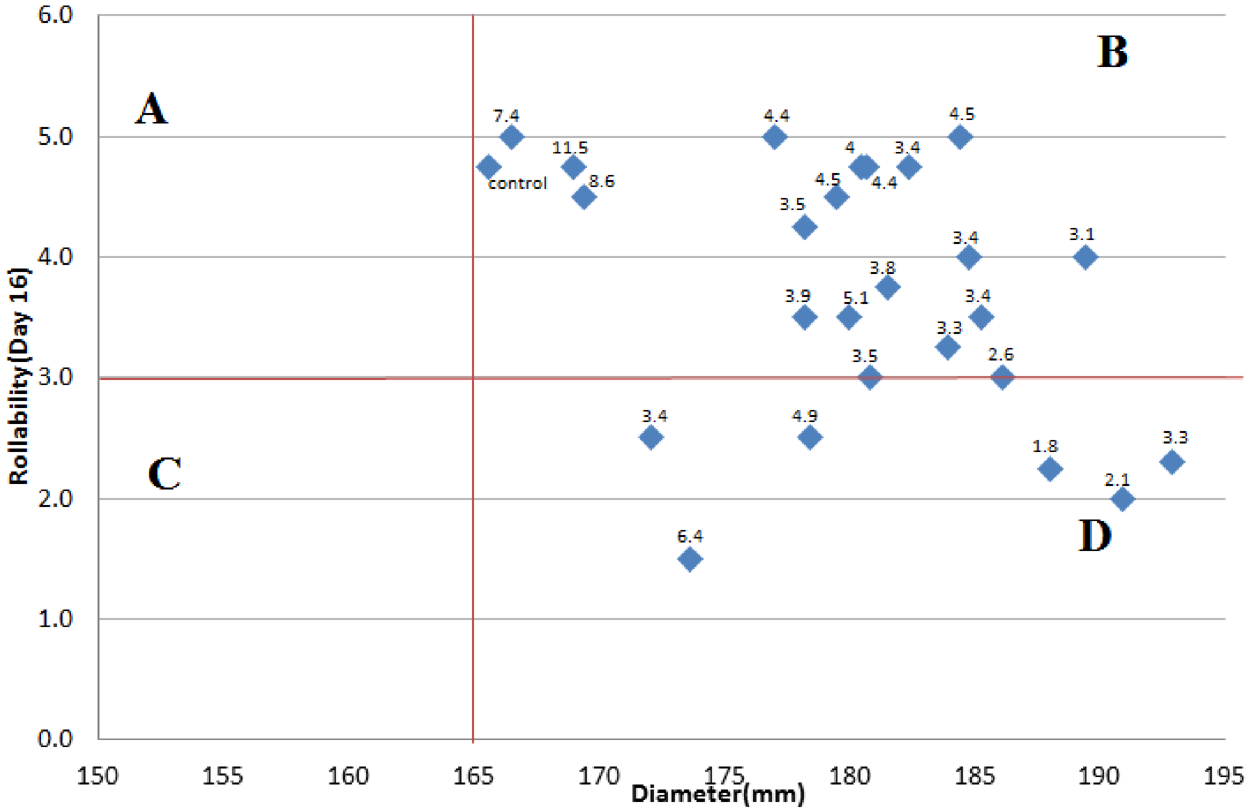


Fig. 2 - Relationship of tortilla diameter, rollability score (day 16), and mixograph mixing time (shown as numbers inside the box). Quadrant A: good shelf-stability, poor diameter; B: acceptable diameter and shelf-stability; C: poor diameter, poor shelf-stability; D: good diameter, poor shelf-stability.

References:

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

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

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

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

2015 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

		HMW GLUTENIN SUBUNITS				
SAMPLE	Sample ID	GLU-A1	GLU- B1	GLU- D1	IPP (%)	TPP/TMP
15-2401	Jagalene	2*,1	17+18	5+10	49.54	0.896
15-2402	Danby	2*,1	7+9	5+10	42.31	0.867
15-2403	KS11HW39-5	2*,1	7+9	5+10	42.92	0.759
15-2404	Jagalene	2*,1	17+18	5+10	50.91	0.867
15-2405	NE10589	2*,1	7+9	5+10	48.62	0.814
15-2406	Jagalene	2*,1	17+18	5+10	50.38	0.864
15-2407	BZ9W09-2075	2*	7+9	5+10	50.98	0.850
15-2408	HV9W10-1002	2*	7+8	5+10	48.75	0.789
15-2409	Jagalene	2*,1	17+18	5+10	49.31	0.897
15-2410	Byrd	2*	7+8	5+10	50.89	0.866
15-2411	CO11D1397	2*	7+8	5+10	50.49	0.850
15-2412	CO11D1539	2*	7+9	5+10	44.63	0.804
15-2413	CO11D1767	2*	7+8	2+12	47.01	0.848
15-2414	Jagalene	2*,1	17+18	5+10	52.39	0.919
15-2415	Gallagher	2*	7+9	5+10	47.06	0.781
15-2416	OK11D25056	2*	7+8	5+10	50.13	0.876
15-2417	**OK13625**	1	7+9	5+10	46.96	0.878
15-2418	OK10728W	2*	7+8	5+10	46.46	0.841
15-2419	MT-Jagalene	2*,1	17+18	5+10	52.34	0.849
15-2420	MT-Yellowstone	1	7+8	5+10	54.24	0.775
15-2421	MT S-1224	1	7+8	5+10	53.90	0.832
15-2422	MT -1265	1	7+8	5+10	55.38	0.836
15-2423	Ideal -local check	2*	7+9	5+10	51.68	0.845
15-2424	SD 10257-2	2*	7+9	2+12	39.31	0.740
15-2425	LCH13DH-20-87	2*	17+18	5+10	41.87	0.877

IPP - Insoluble polymeric protein

TPP/TMP= total polymeric protein / total monomeric protein

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	Corbion 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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Bay State Milling Co. P.O. Box 188 55 Franklin Street Winona, MN 55987	Miller	**Terry A. Selleck/Darrell Nelson** (507)452-1770 terry.wn@bsm.com dnelson@bsm.com
Ardent Mills 3794 Williston, Rd., Minnetonka, MN 55345	Miller	**Grace Nelson** (952)238-4894 Grace.Nelson@ArdentMills.com
Grain Craft 701 E. 17th Street Wichita, KS 67214	Miller	**Tim Aschbrenner** (316)267-7311 t.aschbrenner@cerealfood.com
Colorado State University Dept. Soil and Crop Sciences Ft. Collins, CO 80523	Wheat Quality Lab	**John Stromberger** (970)491-2664 John.Stromberger@colostate.edu
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CREDITS

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Mennel Milling Co. Findlay & Vine Street Fostoria, OH 44830	Miller	**C.J. Lin** (419) 436-5130 Cjlin@mennel.com
North Dakota State Univ. Plant Science Department 1250 Bolley Drive Fargo, ND 58108	Wheat Quality Lab	**Senay Simsek** (701)231-7737 Senay.simsek@ndsu.edu
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Texas A&M University Soil & Crop Science Dept 2474 TAMU College Station, TX 77843-2472	Wheat Quality Lab	**Joseph Awika** (979) 845-2985 jawika@ag.tamu.edu

CREDITS
Baking Collaborators

Address	Collaborator Type	Contact
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USDA/ARS/WQL Harris Hall North Dakota State Univ. Fargo, ND 58105	Wheat Quality Lab	**Linda Dykes** (701) 239-1377 Linda.Dykes@.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 by SKCS.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The time required for a Mixograph or Farinograph curve to reach the "peak" is an estimate of the amount of mixing required to properly develop the dough for handling and baking. The rate at which a curve falls and narrows after the peak and stability of peak height on either side of the peak are indicators of mixing tolerance. Terms used to describe the Farinograph curve or "farinogram" include:

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

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

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

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

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

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

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

Cumulative Ash and Protein Curves

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

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

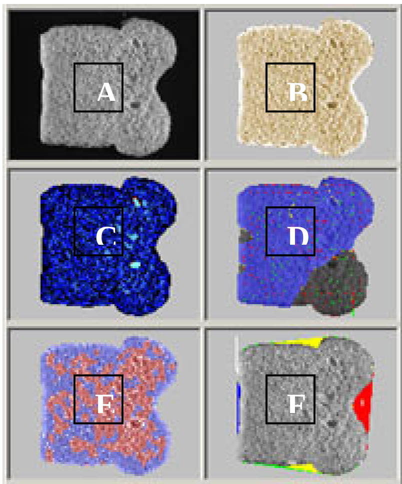
Similarly, cumulative protein curves are determined by arranging millstreams in ascending order of protein content, and tabulating the protein content of the total flour produced with the addition of successive millstreams. Wheat that gives high protein content at low extraction, and a fast rate of protein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

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

C-Cell Image Analysis

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

Images:



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

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

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

Data:

Forty-eight (48) individual measurements are presented in the data display screens and are saved to the database.
Cell Size: Numbers and dimensions of cells and holes are measured. Wall thickness & coarse/fine clustering.
Cell Elongation and Orientation: Cell alignment and elongation, circulation and curvature
Dimensions: Sample area, height, breadth, ratios and wrapper length.
Brightness: Sample brightness and cell contrast.
Shape: Various physical features including, break, concavity and roundness.
Slice Area: The total area of a product slice (mm^2).

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

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

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

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

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

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

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

Collaborators’ Baking Test Profiles and Other Information

2015 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	200g, 170 g dough	Mixograph	180 min	419	24
B	2	Pup-loaf straight dough	100 g		90 min	401	22
C	3	Sponge and dough	600 g flour, 480 g dough	Other	240 min (sponge time) and 45 min (fermentation)	420	20
D	4	Sponge and dough	600 g flour, 160 g dough	Mixing series	240 min	425	16
E	5	Pup-loaf straight dough	100 g flour	Farinograph	120 min	390	25
F	6	Straight dough	100 g flour, approx. 175 g dough	Farinograph and Mixograph	180 fermentation and 60 min proof time	400	25
G	7	Pup-loaf straight dough	100 g flour, approx 175 g dough	Mixograph	90 min	425	21
H	8	Pup-loaf straight dough	100 g, approx 170 g	Mixograph	90 min	400	25
I	9	Pop loaf straight	100 g	Mixograph	90 min	400	25
J	10	Straight dough	700 g flour, 525 g dough	Mixing series	120 min	400	25
K	11	Pup-loaf straight dough	100 g flour, approx 160 g dough	Farinograph	120 min	425	20
L	12	Pup-loaf straight dough	100 g	Mixograph	90 min	400	25
M	13	Sponge and dough	540 g dough	Mixing series	210 min	430	23
N	14	Pup-loaf straight dough	100 g flour, approx 170 g dough	Mixograph	120 min	420	18
O	15	Sponge and dough	1000 g flour, 500 g dough	Farinograph	240 min	425	20
P	16	Sponge and dough	700 g flour, 524 g dough	Farinograph with mixing evalu	240 min (sponge time) and 60 min (fermentation)	420	20
Q	17	Sponge and dough	700 g flour, 19 oz	Farinograph	180 min (sponge) and 70 min (fermentation)	420	20

APPENDIX B

Hard Winter Wheat Quality Council
Goals for Hard Winter Wheat Breeders

Hard Winter Wheat Quality Council

2015 Technical Board Officers

CHAIR:	**Janet Lewis,** Bayer CropScience
VICE CHAIR:	**Vance Lamb,** ADM
SECRETARY:	**Ben Moreno,** Monsanto/WestBred
MEMBER:	**Scott Baker,** Ardent Mills
MEMBER:	**Charlie Moon,** Flowers Food

2015 Quality Evaluation & Advisory Committee

Brad Seabourn, USDA/ARS/HWWQL

Terry Selleck, Bay State Milling

Jon Rich, Syngenta/AgriPro

Craig Warner, BIMBO Bakeries USA

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***

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

APPENDIX D

Hard White Wheat Quality Targets
Adopted from PNW for Great Plains

Hard White Wheat Quality Targets
Dual Purpose -- Chinese Noodles and Western Pan Bread
Updated on March 1, 2002 at Hard White Wheat Quality Targets Meeting
Wheat Marketing Center, Portland, Oregon

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

Notes:

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

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

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

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

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

Wheat Marketing Center, Portland, Oregon

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

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

APPENDIX E

WQC Business Meeting Minutes

by Justin Turner

Feb. 19, 2015

Hard Winter Wheat Quality Council Meeting Minutes
Annual Meeting February 18, 2015

Meeting Minutes
Minutes of the Hard Winter Wheat Quality Council
February 18, 2015

8:05 AM: Ben Handcock opens this year's meeting

- Review of 2014's minutes: Janet Lewis, Chair, HWWQC Board.
- Review/corrections to the minutes: passed as is.

Nominations for 2 new members/officers:

- Scott Baker, Ardent Mills, nominated and elected.
- Charlie Moon, Flowers Foods, nominated and elected.

- **Board for 2015:**

  Chair – Janet Lewis, Bayer CropScience
  Vice Chair – Vance Lamb, ADM
  Secretary – Ben Moreno, Monsanto/WestBred
  Member – Scott Baker, Ardent Mills
  Member – Charlie Moon, Flowers Foods

Nominations for a new Breeder Rep and a new Baker Rep on the Wheat Quality Evaluation and Advisory Committee:

- Jon Rich, Syngenta-Agripro, nominated and elected.
- Craig Warner, Bimbo Bakeries USA, nominated and elected.

  Members of this Board for 2015 will be:

  Brad Seabourn-USDA/ARS/CGAHR
  Richard Chen-USDA/ARS/CGAHR
  Terry Selleck-Bay State Milling
  Jon Rich-Syngenta/AgriPro
  Craig Warner-Bimbo Bakeries USA

Ben Handcock opened up a discussion to the floor on when lines should be dropped:

- Cathy Butti explained the background of the request for dropping a Syngenta line (mixograph and Farinograph did not show a representative sample, possible soil deficiency)
- Steve Baenziger thinks that if the initial tests aren't good the line should be dropped (environmental factors)
- Blake Cooper mentioned that if breeders believe a line isn't moving forward they should be able to pull it from the testing to save time and resources.
- Brad Seabourn suggested testing all lines to the end on the chance that serendipity shows us something new.
- Ben asked Jon Rich to draft a proposal that will be presented to the board of trustees at next year's meeting.

Brad Seabourn, WQC Report for 2014: USDA HRW WQC Lab, Manhattan, KS, 29 entries by, 8 breeders, 19 collaborators.

- Collaborators provide bake tests, tortilla tests, noodle quality tests, protein analysis, and wheat analysis. Mark Friend also had samples submitted to SFBI for testing in artisan bread.
- Reports will stay digital due to the large size (has not been printed since 2007)
- The report was pulled for a short period of time due to mislabeled tables. The database has been a godsend but occasionally has issues. The board of trustees will look into future options
- Feedback is useful and welcome.

Overview of F14 Milling and Sampling, Shawn Thiele, KSU Mill Operations Manager.

- Miag repairs - Continuing to work on all of the rolls. Reduction rolls (1-5 Midds) were resurfaced. Interlock drive shaft was repaired to prevent slipping. New bearings, seals, belts, sifter reeds, and an hour meter were installed as well. Work will continue into this year
- Miag repairs for 2015 include Stainless steel sifter frames, a new sifter drive motor, sifter box repairs, installation of new cyclones, and the development of a PM plan with future costs. 2015 estimated cost is $12,700.
- 29 samples were brought to KSU and cleaned by a Carter Dockage Tester and tempered to 16.5% moisture. After a warmup sample, flour was milled (1^{st} BK 43%, 2^{nd} BK 48%, 3^{rd} BK cleanup). All flour was rebolted and bran duster stock was sifted. Samples were finished on November 19^{th}

Ben Handcock, remarks:

- Overall a good year for the council, 29 samples
- New members with Rich Products and Flowers Foods. Still bringing in consultants. Also, increasing allied attendance after doubling dues (Charm and Central Life Sciences)
- There are some accounting issues with letting the soft wheat group have their own meeting in Indianapolis. Ben, is actively working through this issue with them.

Len Heflich, remarks:

- This is a very important process for our industry.
- There has been a lot of transition and consolidation throughout the entire chain of our industry. The soft wheat group is holding their own meeting in Indianapolis. Issues like biotech wheat and wheat quality will require a unified group.
- Ben Handcock will also be retiring in 2017 and the board is concerned about being able to replace Ben's dedication and experience.
- The Board will be forming a sub-committee to define a five year vision and would appreciate feedback on what this future state should look like.

2014 HRW Wheat Update and New Crop Overview, Dave Green:

- Continuing to lose acres to corn and soybeans
- A crops characteristics seem to be 2/3 environment and 1/3 genetics.
- Crop quality programs consist of pre-harvest, harvest, and post-harvest analysis.
- Gathering samples/data by region and then comparing data region to region and year to year
- The southern plains struggled due to drought conditions. All of KS was poor, averaging 28 bu/acre
- Baking qualities have shown good functional strength and most places have had smooth transitions with minor adjustments.

Update on Regional Crop Conditions:

MT: Jim Berg – Good moisture in the fall. 2.2 million acres of HRW with good snow cover until January. As of February 1st Montana has been 70% open (monitoring cautiously). Normal green-up will start in April and watching out for 15 degree temps in May that will change winter acres into spring acres. Barley acres are increasing, hurting the spring wheat acreage

CO: Scott Haley – 2.5 million acres planted in the fall. Great fall planting conditions (warm fall with plenty of moisture). Quite a bit of growth with good snow cover this winter. Really need precipitation over the next 6 weeks. Crop Report says 86% is average or better. Some believe that is al little optimistic and that there might be more winter-kill.

SD: Reed Christopherson – Saw increased planting, winter wheat is up 22%. Winter has consisted of bizarre temperature swings (-20 to 60F). But, optimistic that soil temps have stayed acceptable.

NE: Steve Wiese – Corn vs. Wheat. Acres will depend on corn. Heavy interest with cover crops. Nebraska is up 10% on planted acres of HRW mostly from the eastern part of the state. Great start in the fall with plenty of growth. Cold temps with snow this winter especially in western Nebraska. Government report says 97% average or above.

KS: Hearing concerns over moisture in the western KS region. Only reports of top soil moisture. Bottom soil may be worse than last year

OK: Mark Hodges – Slightly up on acres due to drop in canola. Enough moisture and a little disease. The drought seems to be moving east. No subsoil moisture, just moisture for germination and rooting. Need timely rainfall starting now.

TX: Jackie Rudd – Has a chance at a good/average crop. Stands are good with enough snowfall and rain. After four years of drought there is no subsoil moisture. Small amounts of rust scattered throughout the state.

Adjourned at 9:40.

Vance Lamb, Sec.

APPENDIX F

Historical WQC Hard Winter Wheat Entries from 2001 to 2015

A History of WQC Hard Winter Wheat Entries

2015						
Entry ID	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Jagalene (CC01)	15-2401	HRW				Kansas-Hays
Danby (IC)	15-2402	HRW				Kansas-Hays
KS11HW39-5	15-2403	HRW	yes	Joe	2015	Kansas-Hays
Jagalene (CC04)	15-2404	HRW				Nebraska
NE1059	15-2405	HRW	yes	Ruth	2016	Nebraska
Jagalene (CC06)	15-2406	HRW				Monsanto
BZ9W09-2075	15-2407	HWW				Monsanto
HV9W10-1002	15-2408	HWW	yes	WB4303	2015	Monsanto
Jagalene (CC09)	15-2409	HRW				Colorado
Byrd (IC)	15-2410	HRW				Colorado
CO11D1397	15-2411	HRW				Colorado
CO11D1539	15-2412	HRW				Colorado
CO11D1767	15-2413	HRW				Colorado
Jagalene (CC14)	15-2414	HRW				Oklahoma
Gallagher (IC)	15-2415	HRW				Oklahoma
OK11D25056	15-2416	HRW				Oklahoma
OK13625	15-2417	HRW				Oklahoma
OK10728W	15-2418	HWW				Oklahoma
Jagalene (CC19)	15-2419	HRW				Montana
Yellowstone (IC)	15-2420	HRW				Montana
MTS1224	15-2421	HRW				Montana
MT1265	15-2422	HRW				Montana
Ideal (IC)	15-2423	HRW				South Dakota
SD10257-2	15-2424	HRW				South Dakota
LCH13DH-20-87	15-2425	HRW	Yes	LCS Chrome	2015	Limagrain

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
2014						
Jagalene (CC01)	14-2401	HRW				Kansas_Hays
Danby (IC)	14-2402	HWW				Kansas_Hays
KS11HW15-4	14-2403	HWW				Kansas_Hays
KS11W39-5	14-2404	HWW				Kansas_Hays
Jagalene (CC05)	14-2405	HRW				Texas_Amarillo
TAM 111 (IC)	14-2406	HRW				Texas_Amarillo
TX08A001249	14-2407	HRW				Texas_Amarillo
TX09A001194	14-2408	HRW				Texas_Amarillo
TX09D1172	14-2409	HRW				Texas_Amarillo
Jagalene (CC10)	14-2410	HRW				Colorado
Byrd (IC)	14-2411	HRW				Colorado
CO11D174	14-2412	HRW	yes	Avery	2014	Colorado
CO11D446	14-2413	HRW				Colorado
Jagalene (CC)	14-2414	HRW				Nebraska
Camelot (IC)	14-2415	HRW				Nebraska
NE07531	14-2416	HRW				Nebraska
NE09521	14-2417	HRW				Nebraska
Jagalene (CC18)	14-2418	HRW				Montana
Yellowstone (IC)	14-2419	HRW				Montana
MT1078	14-2420	HRW				Montana
MT1138	14-2421	HRW				Montana
Jagalene (CC22)	14-2422	HRW				Oklahoma
Ruby Lee (IC)	14-2423	HRW				Oklahoma
OK09125	14-2424	HRW	yes	Bentley	2015	Oklahoma
OK10126	14-2425	HRW				Oklahoma
Jagalene (CC26)	14-2426	HRW				Kansas_Manhattan
KanMark	14-2427	HRW				Kansas_Manhattan
06BC722#25	14-2428	HRW	yes	SY Flint	2015	Agripro
06BC796#68	14-2429	HRW	yes	SY Sunrise	2015	Agripro
2013						
Check Blend (check)	13-2401	HRW				Limagrain
LCH08-80	13-2402	HRW				Limagrain
lCS Mint	13-2403	HRW				Limagrain
Danby (check)	13-2404	HWW				Kansas-Hays
Oakley CL	13-2405	HRW	yes	Oakley CL	2013	Kansas-Hays
KS10HW78-1	13-2406	HWW				Kansas-Hays
Lyman (check)	13-2407	HRW				South Dakota
SD08200	13-2408	HRW				South Dakota
SD09192	13-2409	HRW				South Dakota
Postorock (check)	13-2410	HRW				Agripro
04BC574-2	13-2411	HRW	yes	SY Monument	2014	Agripro
Millennium (check)	13-2412	HRW				Nebraska
NE09521	13-2413	HRW				Nebraska
NE08499	13-2414	HRW				Nebraska
Yellowstone (check)	13-2415	HRW				Montana
MT1090	13-2416	HRW				Montana
MTW08168	13-2417	HWW	yes	WB3768	2013	Montana
Ruby Lee (check)	13-2418	HRW				Oklahoma
Doublestop CL+	13-2419	HRW	yes	Doublestop CL+	2013	Oklahoma
OK09125	13-2420	HRW				Oklahoma

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
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	yes	Northern	2015	Montana
TAM 111 (check)	12-2422	HRW				Texas
TX07A001505	12-2423	HRW				Texas
TX03A0563-07	12-2424	HRW				Texas
2011						
Danby (check)	11-2401	HWW				Kansas-Hays
Tiger	11-2402	HWW	yes			Kansas-Hays
KS08HW35-1	11-2403	HWW	yes	Clara CL	2011	Kansas-Hays
PostRock (check)	11-2404	HRW				AgriPro
SY Wolf	11-2405	HRW	yes			AgriPro
Syngenta Exp 138-45	11-2406	HRW	yes	SY Southwind	2012	AgriPro
Fuller (check)	11-2407	HRW				Kansas-Manhattan
KS020319-7-3	11-2408	HRW	yes	1863	2012	Kansas-Manhattan
KS020633M-13	11-2409	HRW	no			Kansas-Manhattan
McGill (check)	11-2410	HRW				Nebraska
NE05496	11-2411	HRW	no			Nebraska
NE05548	11-2412	HRW	no			Nebraska
NI08708	11-2413	HRW	no			Nebraska
Jagalene (check)	11-2414	HRW				Westbred
HV9W06-509	11-2415	HWW	yes	WB-Grainfield	2012	Westbred
Yellowstone (check)	11-2416	HRW				Montana
MTS0808	11-2417	HRW	yes	Warhorse	2013	Montana
MT0871	11-2418	HRW	no			Montana
Lyman (check)	11-2419	HRW				South Dakota
SD06158	11-2420	HRW	no			South Dakota
SD07184	11-2421	HRW	no			South Dakota

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

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

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

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
2004						
Jagger (check)	04-2401	HRW				KSU-Hays
2137	04-2402	HRW	yes			KSU-Hays
KS02HW34	04-2403	HWW	yes	Danby	2005	KSU-Hays
KS02HW35-5	04-2404	HWW	no			KSU-Hays
KS03HW158	04-2405	HWW	yes	RonL	2006	KSU-Hays
Antelope (check)	04-2406	HRW				NE-USDA-ARS
Arrowsmith	04-2407	HRW	yes			NE-USDA-ARS
NW99L7068	04-2408	HRW	no			NE-USDA-ARS
Millennium (check)	04-2409	HRW				NU
NE99495	04-2410	HRW	yes	NE99495	2005	NU
OK102 (check)	04-2411	HRW				OSU
OK00618W	04-2412	HWW	yes	Guymon	2005	OSU
OK99212	04-2413	HRW	no			OSU
OK00514	04-2414	HRW	yes	OK Bullet	2005	OSU
OK02909C	04-2415	HRW	yes	Okfield	2005	OSU
Tandem (check)	04-2416	HRW				SDSU
SD97W609	04-2417	HWW	yes	Alice	2006	SDSU
SD97538	04-2418	HRW	no			SDSU
SD98102	04-2419	HRW	yes	Darrell	2006	SDSU

2003						
Akron (check)	03-2401	HRW				CSU
CO980607	03-2402	HRW	yes	Hatcher	2004	CSU
CO00D007	03-2403	HRW	yes	Bond CL	2004	CSU
Jagger (check)	03-2404	HRW				KSU-Hays
2137	03-2405	HRW	yes			KSU-Hays
KS01HW152-6	03-2406	HWW	no			KSU-Hays
KS01HW163-4	03-2407	HWW	no			KSU-Hays
KS02HW34	03-2408	HWW	yes	Danby	2005	KSU-Hays
Jagger (check)	03-2409	HRW				KSU-Manhattan
2137	03-2410	HRW	yes			KSU-Manhattan
Overley	03-2411	HRW	yes			KSU-Manhattan
KS940786-6-9	03-2412	HRW	no			KSU-Manhattan
OK 102 (check)	03-2413	HRW				OSU
OK94P549-11	03-2414	HRW	yes	Endurance	2004	OSU
OK98690	03-2415	HRW	yes	Deliver	2004	OSU
Crimson (check)	03-2416	HRW				SDSU
SD97W604	03-2417	HWW	yes	Wendy	2004	SDSU
SD92107-5	03-2418	HRW	no			SDSU

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

Thank you for reviewing this report of 2015 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