Milling and Baking Test Results
for Hard Winter Wheat
Harvested in 2009

60th Report on Wheat Quality
Hard Winter Wheat Technical Board of the Wheat Quality Council

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

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

The Wheat Quality Council (WQC) provides funds for the project.

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2009

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 2009 Testing Program

Founded in 1949, this is the **60th** 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 the Kansas State University Department of Grain Science and Industry. Wheat experimental lines and check varieties were submitted by public and private breeding programs in the Great Plains growing region. This technical report includes FGIS wheat market classification, physical grain testing, milling, analytical, rheological, and bread baking results.

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

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

2009 Entries

	Test Entry Number	Sample Identification
WESTBRED	09-2401	Smoky Hill (check)
	09-2402	Stout (HV9W03-539R)
KANSAS-HAYS	09-2403	RonL (check)
	09-2404	Tiger
COLORADO	09-2405	Hatcher (check)
	09-2406	CO04393
	09-2407	CO04499
OKLAHOMA	09-2408	OK Bullet (check)
	09-2409	Billings
	09-2410	OK05526
AGRIPRO	09-2411	PostRock (check)
	09-2412	CJ
	09-2413	SY Gold (AP00x0100-51)
MONTANA	09-2414	Yellowstone (check)
	09-2415	MT06103
	09-2416	MTS0713
TEXAS-AMARILLO	09-2417	TAM 111 (check)
	09-2418	TX02A0252
NEBRASKA	09-2419	Millennium (check)
	09-2420	NE01481
	09-2421	NI04421

Wheat Classification Results from FGIS

FGIS Market Classification

Sample ID	Program	Entry Name	Wht Cl	DKG	TW	M	ODOR	HT	DKT	FM	SHBN	DEF	CCL	WOCL	GRADE
09-2401	Westbred	Smoky Hill (check)	HRW	0.00	61.4	10.8	ok	0.0	0.2	0.0	0.2	0.4	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2402	Westbred	Stout (HV9W03-539R)	HRW	0.04	59.2	11.2	ok	0.0	0.2	0.1	0.1	0.4	0.0	0.0	U.S. NO. 2 HRW DKG 0.0%
09-2403	Kansas_Hays	RonL (check)	HDWH	0.00	62.2	11.1	ok	0.0	0.6	0.0	0.2	0.8	0.0	0.0	U.S. NO. 1 HDWH DKG 0.0%
09-2404	Kansas_Hays	Tiger	HDWH	0.00	60.7	11.7	ok	0.0	0.2	0.0	0.8	1.0	0.0	0.0	U.S. NO. 1 HDWH DKG 0.0%
09-2405	Colorado	Hatcher (check)	HRW	0.00	61.8	11.1	ok	0.0	0.2	0.0	0.5	0.7	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2406	Colorado	CO04393	HRW	0.00	61.8	10.2	ok	0.0	0.2	0.0	0.6	0.8	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2407	Colorado	CO04499	HRW	0.00	62.3	10.4	ok	0.0	0.4	0.0	0.9	1.3	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2408	Oklahoma	OK Bullet (check)	HRW	0.00	60.2	11.4	ok	0.0	0.0	0.0	0.4	0.4	0.0	2.0	U.S. NO. 1 HRW DKG 0.0%
09-2409	Oklahoma	Billings	HRW	0.00	60.8	11.5	ok	0.0	0.1	0.0	0.1	0.2	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2410	Oklahoma	OK05526	HRW	0.02	61.2	11.3	ok	0.0	0.3	0.0	0.1	0.4	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2411	Agripro	PostRock (check)	HRW	0.00	61.7	11.3	ok	0.0	0.0	0.0	0.1	0.1	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2412	Agripro	CJ	HRW	0.00	60.3	11.1	ok	0.0	0.0	0.0	0.2	0.2	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2413	Agripro	SY Gold (AP00x0100-51)	HRW	0.00	61.4	11.6	ok	0.0	0.2	0.0	0.1	0.3	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2414	Montana	Yellowstone (check)	HRW	0.00	64.5	10.3	ok	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2415	Montana	MT06103	HRW	0.00	64.2	10.0	ok	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U,S, NO. 1 HRW DKG 0.0%
09-2416	Montana	MTS0713	HRW	0.00	65.6	10.3	ok	0.0	0.0	0.0	0.2	0.2	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2417	Texas-Amarillo	TAM 111 (check)	HRW	0.00	60.6	10.4	ok	0.0	0.7	0.0	0.8	1.5	0.0	0.0	U.S. NO. 1 HRW DKG 0.0%
09-2418	Texas-Amarillo	TX02A0252	HRW	0.00	61.0	10.7	ok	0.0	0.0	0.0	0.9	0.9	0.0	0.1	U.S. NO. 1 HRW DKG 0.0%
09-2419	Nebraska	Millennium (check)	HRW	0.00	59.6	12.5	ok	0.0	0.4	0.0	0.6	1.0	0.0	0.0	U.S. NO. 2 HRW DKG 0.0%
09-2420	Nebraska	NE01481	HRW	0.00	59.1	12.3	ok	0.0	0.1	0.0	0.6	0.7	0.0	0.0	U.S. NO. 2 HRW DKG 0.0%
09-2421	Nebraska	NI04421	HRW	0.00	58.0	11.9	ok	0.0	0.5	0.0	1.0	1.5	0.0	0.0	U.S. NO, 2 HRW DKG 0.0%

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

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

Description of Test Plots and Breeder Entries

Westbred – Sid Perry

The samples were produced at our Haven, Kansas location. The plots were seeded on October 14, 2008, at a rate of 70 lb/acre. A pre-plant fertilizer application of 30 lb N was followed up with a top-dress application of 40 lb N and a late boot application of 10 lb N.

The plots did suffer some late freeze damage, as well as lodging from excessive rain events, and wet conditions at harvest time. Harvest was delayed until the first week of July. Yields were in the 50 bu/acre range, and test weights struggled to reach normal due to the above mentioned factors.

Smoky Hill (check)

Smoky Hill has been a very consistent variety in its target environment, and remains the best quality check in our commercial lineup since it's release in 2006. Best adaptation has been in areas north of I-70. Performance in northwest KS, northeast Colorado, and southwest Nebraska has been very good. Although adequate winterhardiness for the northern plains is average and requires proper management, Smoky Hill has been the top yielding hard winter wheat variety in the South Dakota state tests for 2008 and 2009. Smoky Hill has good leaf, stripe, and stem rust resistance. Test weights have been good and straw strength average, with intermediate resistances to speckled leaf blotch and tan spot. Resistant to soil-borne mosaic but susceptible to wheat streak mosaic.

Stout (HV9W03-539R)

HV9W03-539R is a hard red winter wheat with the pedigree KS94U275/G1878//Jagger. This line has been released as the variety "Stout". It has shown broad adaptation, with good leaf, stripe, and stem rust resistance. Maturity is early-medium. Stout is resistant to soil-borne mosaic, and moderately resistant to tan spot and speckled leaf blotch. It has good shatter resistance but only average straw strength. In the course of purifying this variety, we identified one selection with best stripe rust reaction. Unfortunately, it also had the lowest test weight patterns of the group, and we see this today in Stout, which only has average to below average test weights. On the other hand, the baking performance of this variety has been exceptional, and has compared favorably in previous years with checks such as Smoky Hill and Overley.

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

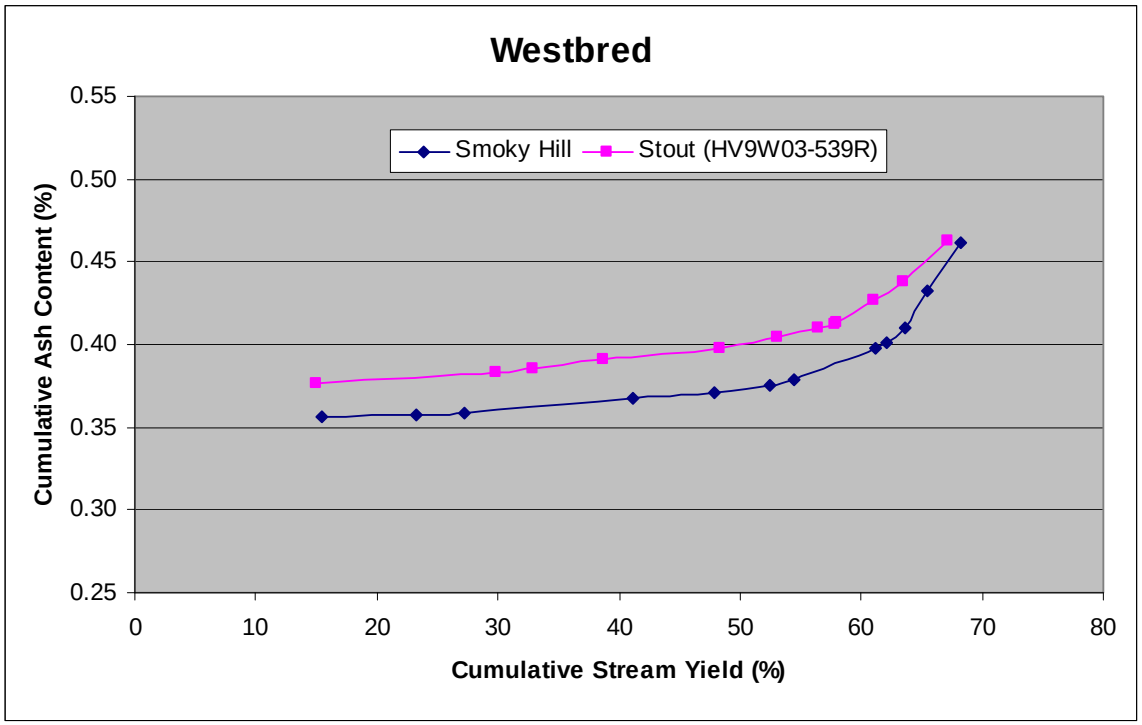
Test entry number	09-2401	09-2402
Sample identification	**Smoky Hill (check)**	**Stout**
Wheat Data		
FGIS classification	1 HRW	2 HRW
Test weight (lb/bu)	61.4	59.2
Hectoliter weight (kg/hl)	80.7	77.9
1000 kernel weight (gm)	25.9	31.4
NIR hardness	67	85
Wheat kernel size (Rotap)		
Over 7 wire (%)	32.0	68.6
Over 9 wire (%)	67.8	31.2
Through 9 wire (%)	0.3	0.2
Single kernel (skcs)		
Hardness (avg /s.d)	81.2/13.3	85.6/14.2
Weight (mg) (avg/s.d)	26.5/5.8	31.8/8.3
Diameter (mm)(avg/s.d)	2.55/0.23	2.71/0.32
SKCS distribution	00-00-05-95	00-00-03-97
Classification	Hard	Hard
Wheat moisture (%)	9.9	10.3
Wheat protein (12% mb)	14.6	14.5
Wheat ash (12% mb)	1.60	1.50
Milling and Flour Quality Data		
Flour yield (%, str. grade)		
Miag Multomat Mill	68.2	67.2
Quadrumat Sr. Mill	65.5	64.4
NIR Flour moisture (%)	11.9	12.4
NIR Flour protein (14% mb)	12.2	12.6
Flour ash (14% mb)	0.46	0.50
Glutomatic		
Wet gluten (%)	30.6	33.3
Dry gluten (%)	11.7	12.2
Gluten index	99.3	98.5
Rapid Visco-Analyser		
Peak Time (min)	6.1	6.4
Peak Viscosity (RVU)	209.7	208.3
Breakdown (RVU)	79.8	71.5
Final Viscosity at 13 min (RVU)	241.3	239.3
Minolta color meter		
L*	92.50	92.41
a*	-1.30	-1.53
b*	8.36	9.57
Falling number (sec)	414	389
Damaged Starch		
(AI%)	96.2	97.3
(AACC76-31)	6.42	7.28

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

Westbred: Physical Dough Tests and Gluten Analysis For 2009 (Small-Scale) Samples

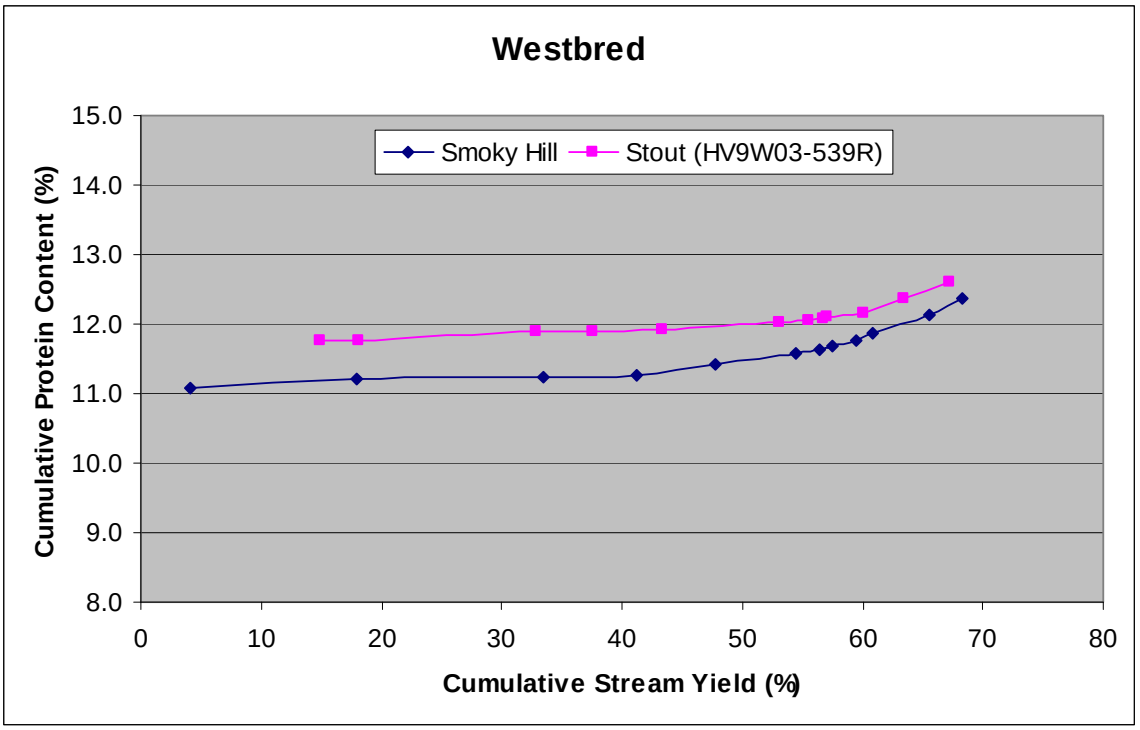
Test Entry Number	09-2401	09-2402
Sample Identification	Smoky Hill (check)	Stout
MIXOGRAPH		
Flour Abs (% as-is)	66.7	67.8
Flour Abs (14% mb)	64.3	66.0
Mix Time (min)	6.38	4.63
Mix tolerance (0-6)	5	4
FARINOGRAPH		
Flour Abs (% as-is)	61.7	66.2
Flour Abs (14% mb)	59.3	64.4
Development time (min)	9.7	6.9
Mix stability (min)	26.2	32.0
Mix Tolerance Index (FU)	17	19
Breakdown time (min)	21.3	16.6
ALVEOGRAPH		
P(mm. $_{H2O}$): Tenacity	79	119
L(mm): Extensibility	132	109
G($mm_{0.5}$): Swelling index	25.6	23.2
W(10^{-4} J): strength (curve area)	389	451
P/L: curve configuration ratio	0.60	1.09
Ie(P_{200}/P): elasticity index	67.8	62.7
EXTENSIGRAPH		
Resist (BU at 30/60/90 min)	639/989/988	452/606/664
Extensibility (mm at 30/60/90 min)	133/121/112	153/145/159
Energy (cm^2 at 30/60/90 min)	141/169/158	128/155/190
Resist $_{max}$ (BU at 30/60/90 min)	838/989/988	650/864/960
Ratio (at 30/60/90 min)	4.8/8.2/8.8	3.0/4.2/4.2
PROTEIN ANALYSIS		
HMW-GS Composition	1, 7+9, 5+10	2*, 7+8, 5+10
Glu/Gli	1.71	1.86
HMW/LMW	0.44	0.40
%IPP	54.86	51.66
SEDIMENTATION TEST		
Volume (ml)	62.0	66.8

Westbred: Cumulative Ash Curves



Smoky Hill - 2401					Stout (HV9W03-539R) - 2402				
Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)	Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)
2M	15.43	0.36	15.43	0.36	2M	14.95	0.38	14.95	0.38
1M	7.74	0.36	23.17	0.36	3M	14.84	0.39	29.79	0.38
1M Red	4.11	0.36	27.29	0.36	1M Red	3.09	0.41	32.88	0.39
3M	13.89	0.39	41.18	0.37	1M	5.77	0.42	38.65	0.39
1BK	6.63	0.39	47.81	0.37	4M	9.66	0.43	48.31	0.40
2BK	4.63	0.42	52.44	0.38	1BK	4.70	0.47	53.01	0.40
Grader	2.07	0.45	54.51	0.38	2BK	3.37	0.50	56.39	0.41
4M	6.62	0.55	61.13	0.40	Grader	1.36	0.53	57.74	0.41
FILTER FLR	0.99	0.66	62.12	0.40	FILTER FLR	0.19	0.63	57.93	0.41
3BK	1.46	0.78	63.58	0.41	5M	3.11	0.68	61.04	0.43
5M	1.94	1.16	65.51	0.43	BRAN FLR	2.43	0.71	63.47	0.44
BRAN FLR	2.71	1.18	68.23	0.46	3BK	3.69	0.89	67.16	0.46
Break Shorts	0.57	3.65	68.80	0.49	Break Shorts	2.59	3.15	69.75	0.56
Red Dog	2.35	1.79	71.15	0.53	Red Dog	2.84	1.73	72.59	0.61
Red Shorts	0.08	2.57	71.23	0.53	Red Shorts	0.20	3.32	72.78	0.62
Filter Bran	0.39	1.82	71.62	0.54	Filter Bran	0.29	1.89	73.07	0.62
Bran	28.38	4.42	100.00	1.64	Bran	26.93	3.99	100.00	1.53
Wheat Ash		1.56			Wheat Ash		1.46		
Straight Grade Flour Ash		0.46			Straight Grade Flour Ash		0.50		

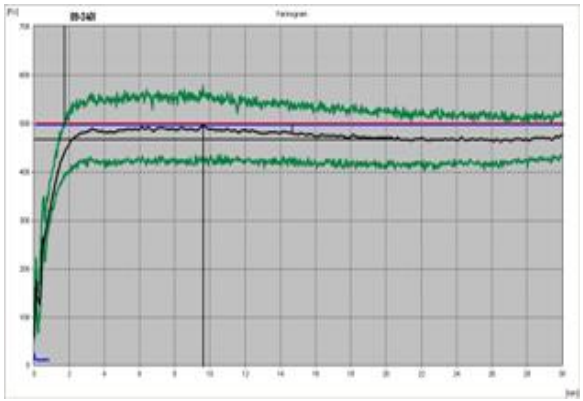
Westbred: Cumulative Protein Curves



Smoky Hill - 2401					Stout (HV9W03-539R) - 2402				
Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)	Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)
1M Red	4.1	11.1	4.1	11.1	2M	15.0	11.8	15.0	11.8
3M	13.9	11.3	18.0	11.2	1M Red	3.1	11.8	18.0	11.8
2M	15.4	11.3	33.4	11.2	3M	14.8	12.0	32.9	11.9
1M	7.7	11.4	41.2	11.3	1BK	4.7	12.0	37.6	11.9
4M	6.6	12.4	47.8	11.4	1M	5.8	12.1	43.4	11.9
1BK	6.6	12.7	54.4	11.6	4M	9.7	12.4	53.0	12.0
Grader	2.1	13.1	56.5	11.6	BRAN FLR	2.4	13.0	55.4	12.1
FILTER FLR	1.0	14.1	57.5	11.7	Grader	1.4	13.3	56.8	12.1
5M	1.9	14.5	59.4	11.8	FILTER FLR	0.2	13.3	57.0	12.1
3BK	1.5	15.4	60.9	11.9	5M	3.1	13.5	60.1	12.2
2BK	4.6	15.6	65.5	12.1	2BK	3.4	16.1	63.5	12.4
BRAN FLR	2.7	18.1	68.2	12.4	3BK	3.7	16.4	67.2	12.6
Break Shorts	0.6	16.7	68.8	12.4	Break Shorts	2.6	17.0	69.7	12.8
Red Dog	2.4	14.8	71.2	12.5	Red Dog	2.8	15.7	72.6	12.9
Red Shorts	0.1	14.2	71.2	12.5	Red Shorts	0.2	14.8	72.8	12.9
Filter Bran	0.4	13.6	71.6	12.5	Filter Bran	0.3	10.0	73.1	12.9
Bran	28.4	17.6	100.0	13.9	Bran	26.9	18.3	100.0	14.3
Whole Wheat		14.3			Whole Wheat		14.1		
St Grade Flour		12.4			St Grade Flour		12.8		

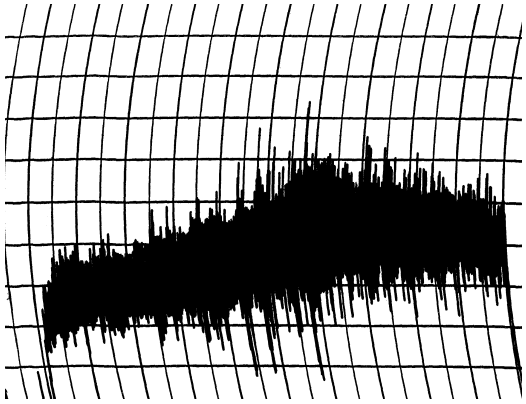
Physical Dough Tests
2009 (Small Scale) Samples – Westbred

Farinograms



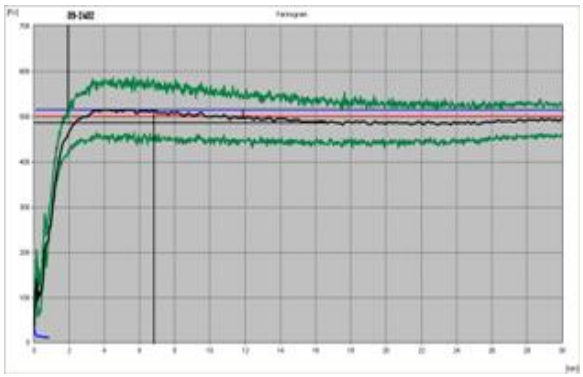
Water abs = 59.3%, Peak time = 9.7 min,
Mix stab = 26.2 min, MTI = 17 FU

Mixograms

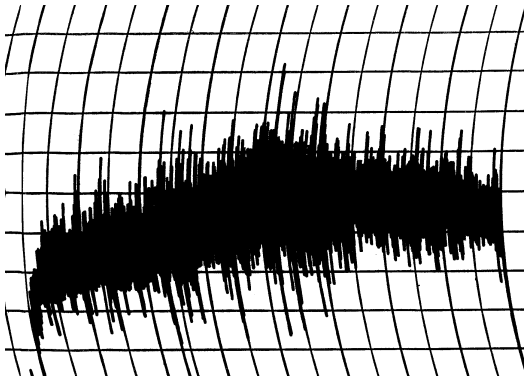


Water abs = 64.3%
Mix time = 6.4 min

09-2401, Smoky Hill (check)



Water abs. = 64.4%, Peak time = 6.9 min,
Mix stab. = 32.0 min, MTI = 19 FU

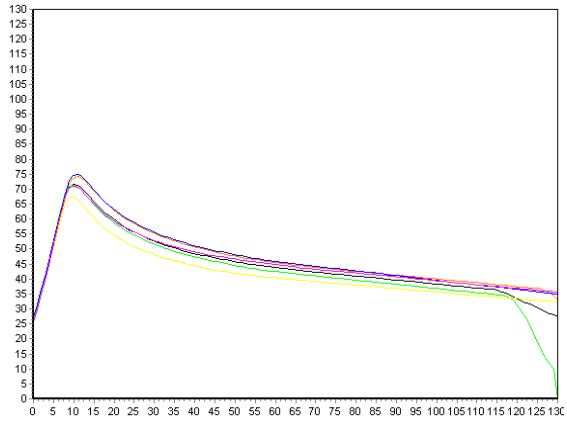


Water abs = 66.0%
Mix time = 4.6 min

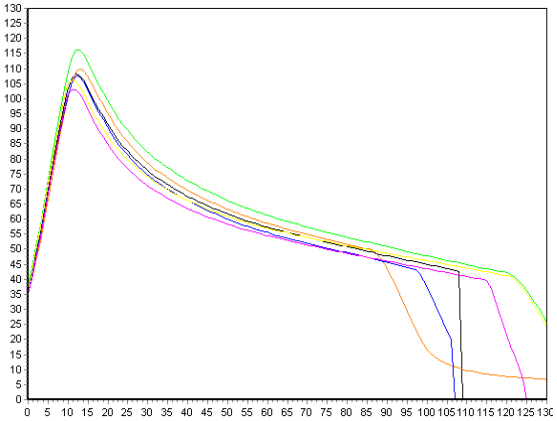
09-2402, Stout

Physical Dough Tests - Alveograph

2009 (Small Scale) Samples – Westbred



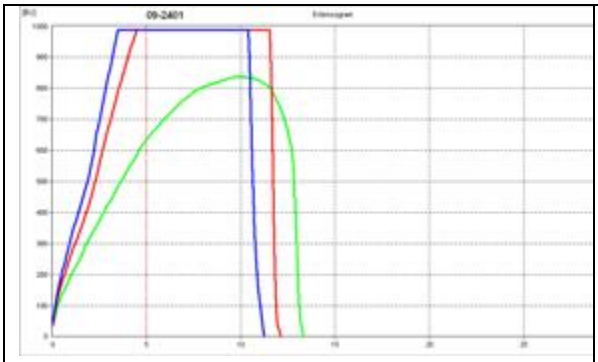
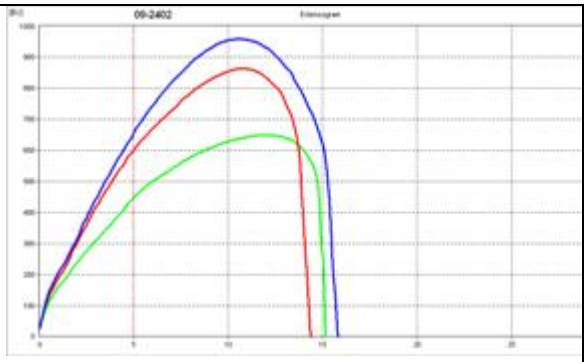
09-2401 (Smoky Hill - check)
P(mm $_{H20}$)=79, L(mm)=132, W($10E^{-4}$ J)=389



09-2402 (Stout)
P(mm $_{H20}$)=119, L(mm)=109, W($10E^{-4}$ J)=451

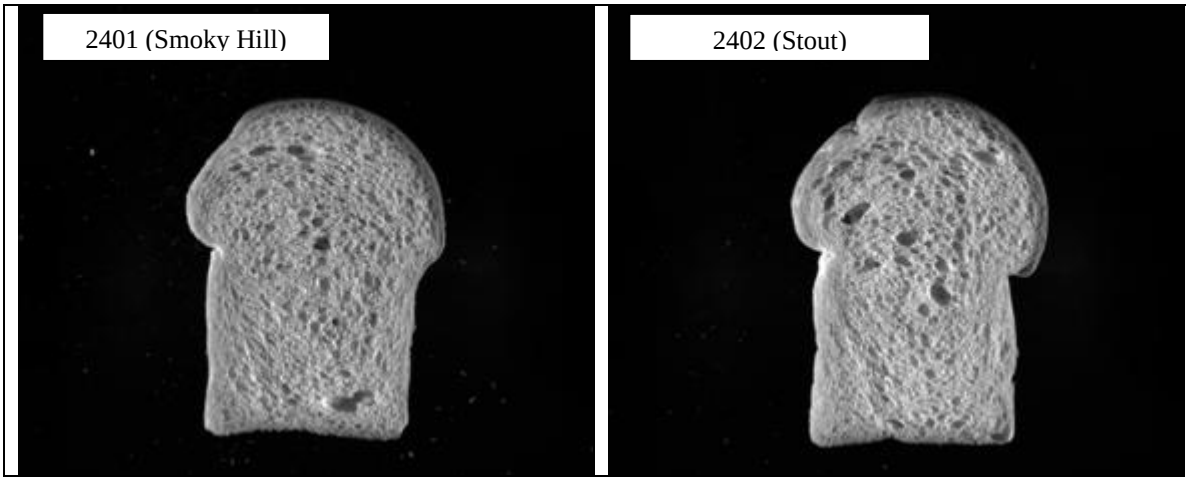
Physical Dough Tests - Extensigraph

2009 (Small Scale) Samples – Westbred

	
09-2401 (Smoky Hill - check) R (BU) = 639, E (mm) = 133, W (cm^2) = 141 Rmax (BU) = 838, Ratio = 4.8 at 30 min	**09-2402 (Stout)** R (BU) = 452, E (mm) = 153, W (cm^2) = 128 Rmax (BU) = 650, Ratio = 3.0 at 30 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

Westbred: C-Cell Bread Images and Analysis for 2009 (Small-Scale) Samples



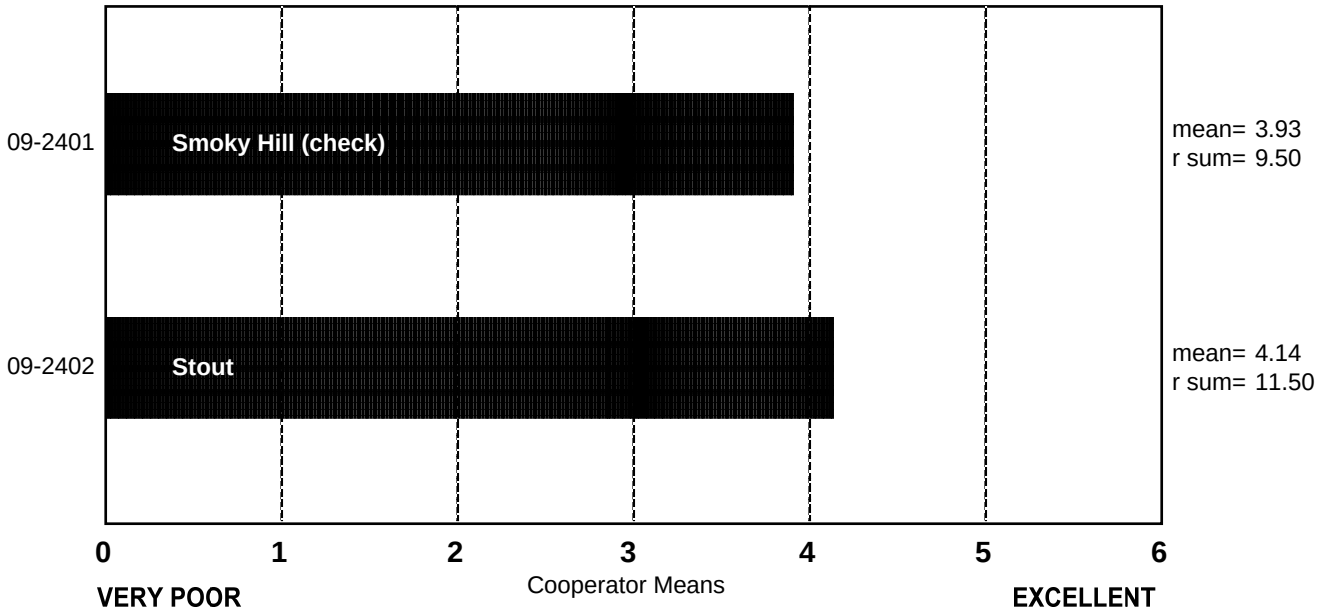
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2401	6623	136.95	3910	0.450	2.023	3.820	1.715	-17.05
2402	6809	150.75	4100	0.446	2.033	0.984	1.695	-15.05

SPONGE CHARACTERISTICS

(Small Scale) Westbred

ncoop= 7
chisq= 0.57
chisqc= 2.00
cvchisq= 3.84
crdiff=

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

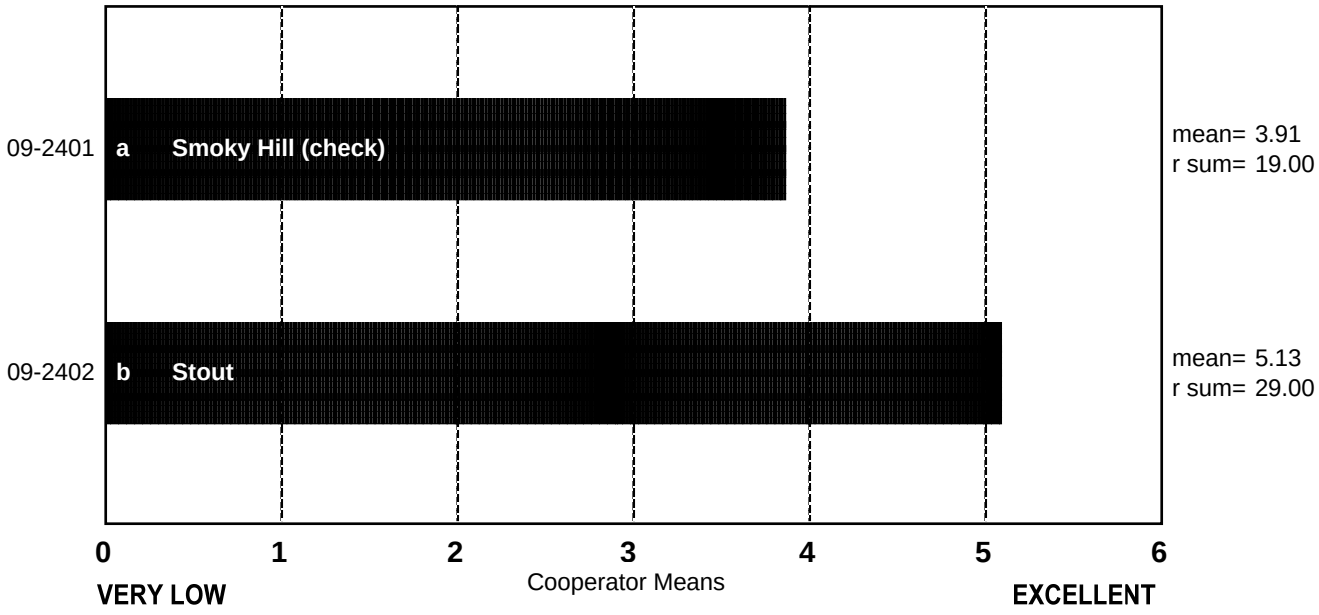


BAKE ABSORPTION

(Small Scale) Westbred

ncoop= 16
chisq= 6.25
chisqc= 10.00
cvchisq= 3.84
crdiff= 4.26

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) 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
09-2401 Smoky Hill (check)	**61.3**	**57.0**	**59.0**	**66.4**	**64.3**	**61.3**	**63.0**	**63.0**	**60.0**	**60.0**	**68.1**	**64.1**	**60.0**	**64.5**	**62.3**	**57.8**	**64.3**
09-2402 Stout	**65.9**	**62.0**	**59.0**	**68.7**	**66.0**	**66.4**	**64.0**	**63.0**	**66.0**	**65.0**	**70.1**	**66.1**	**62.5**	**65.7**	**67.4**	**62.9**	**65.9**

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
09-2401 Smoky Hill (check)	**3.0**	**9.0**	**15.0**	**6.0**	**7.0**	**8.0**	**8.3**	**9.0**	**12.0**	**25.0**	**6.0**	**6.4**	**27.0**	**4.6**	**11.0**	**5.3**	**8.9**
09-2402 Stout	**2.3**	**7.0**	**17.0**	**5.2**	**5.0**	**8.5**	**6.3**	**9.0**	**12.0**	**25.0**	**4.5**	**5.3**	**30.0**	**3.8**	**12.0**	**4.3**	**6.1**

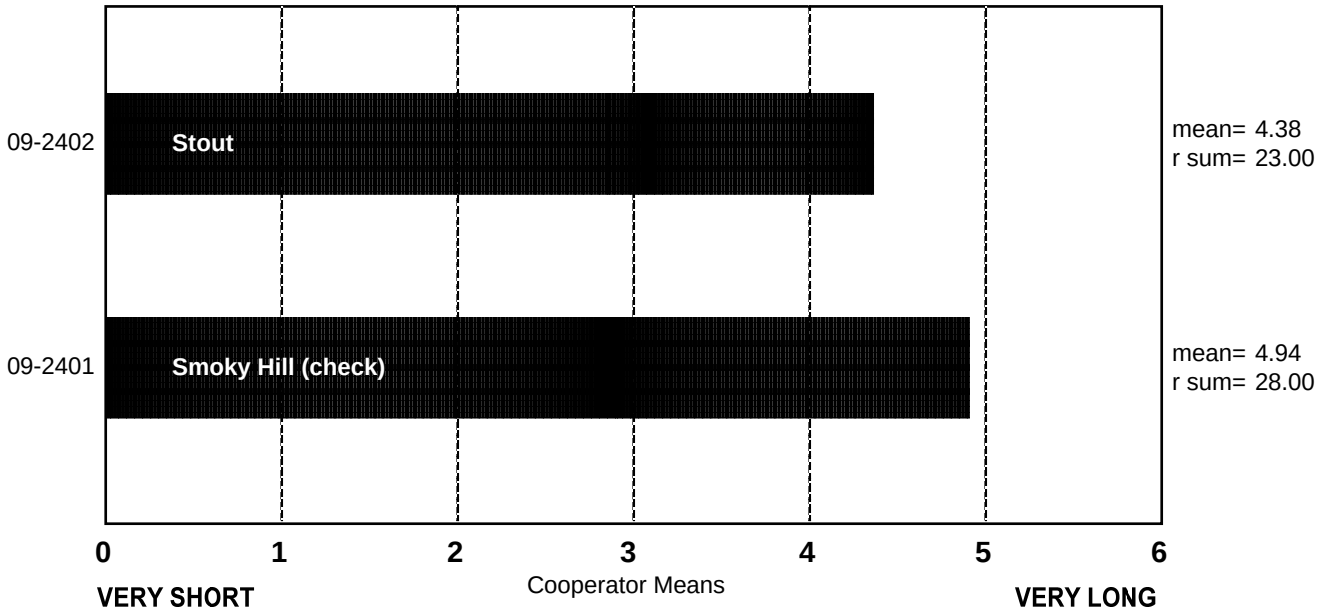
Raw Data

BAKE MIX TIME

(Small Scale) Westbred

ncoop= 17
chisq= 1.47
chisqc= 2.78
cvchisq= 3.84
crdiff=

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

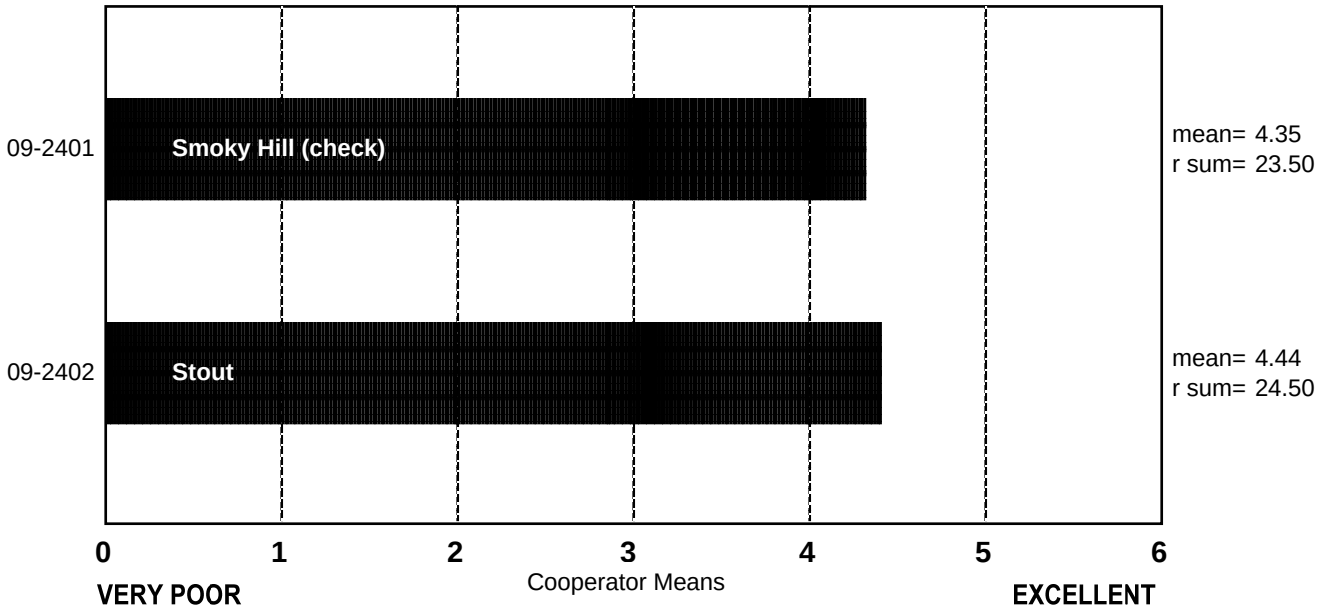


MIXING TOLERANCE

(Small Scale) Westbred

ncoop= 16
chisq= 0.06
chisqc= 0.08
cvchisq= 3.84
crdiff=

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

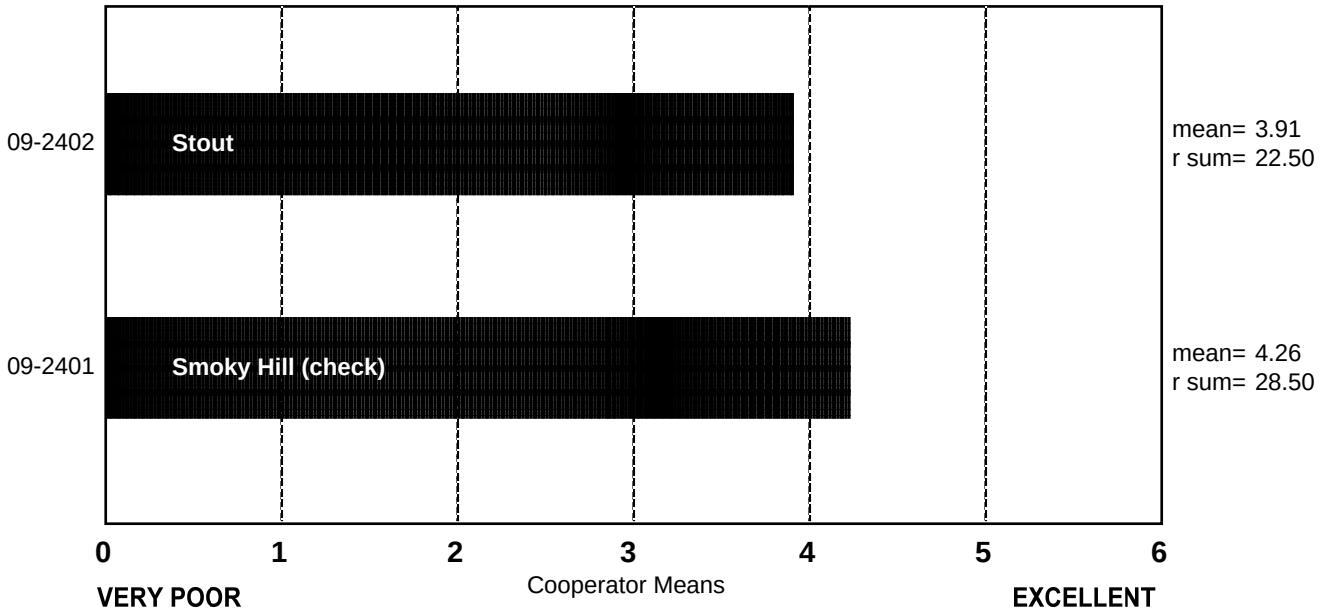


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Westbred

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

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Westbred

	Sticky	Wet	Tough	Good	Excellent
09-2401 Smoky Hill (check)	**1**	**1**	**3**	**10**	**2**
09-2402 Stout	**3**	**1**	**2**	**10**	**1**

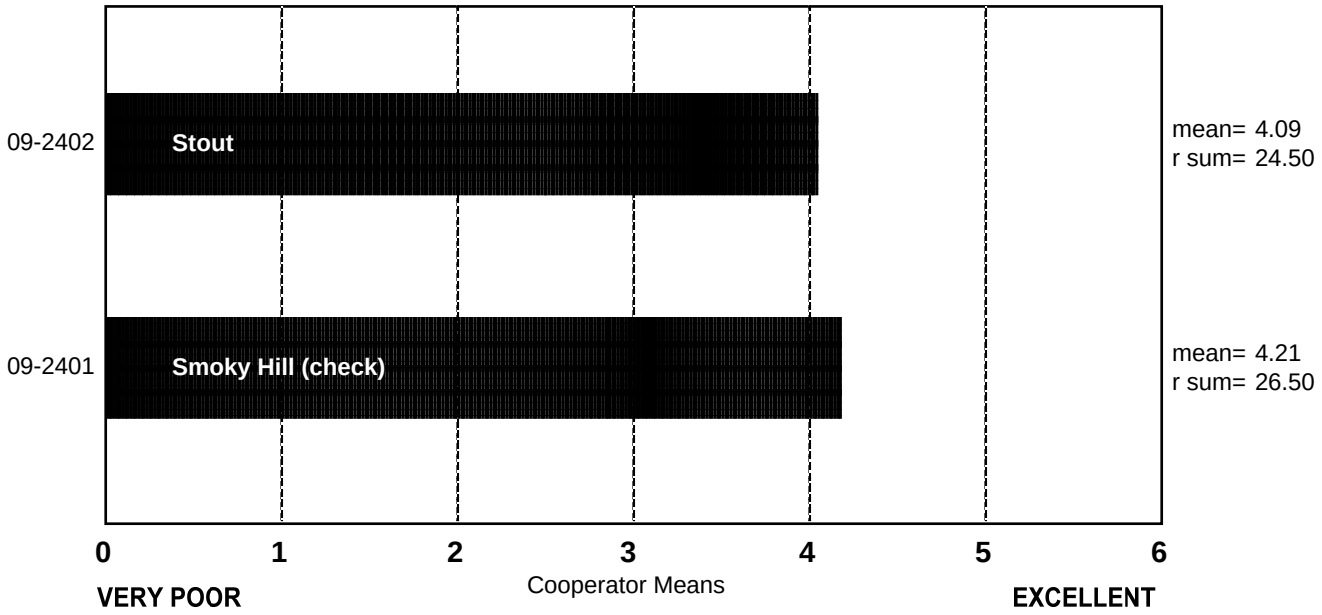
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Westbred

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

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Westbred

	Sticky	Wet	Tough	Good	Excellent
09-2401 Smoky Hill (check)	**0**	**0**	**4**	**11**	**2**
09-2402 Stout	**3**	**1**	**2**	**10**	**1**

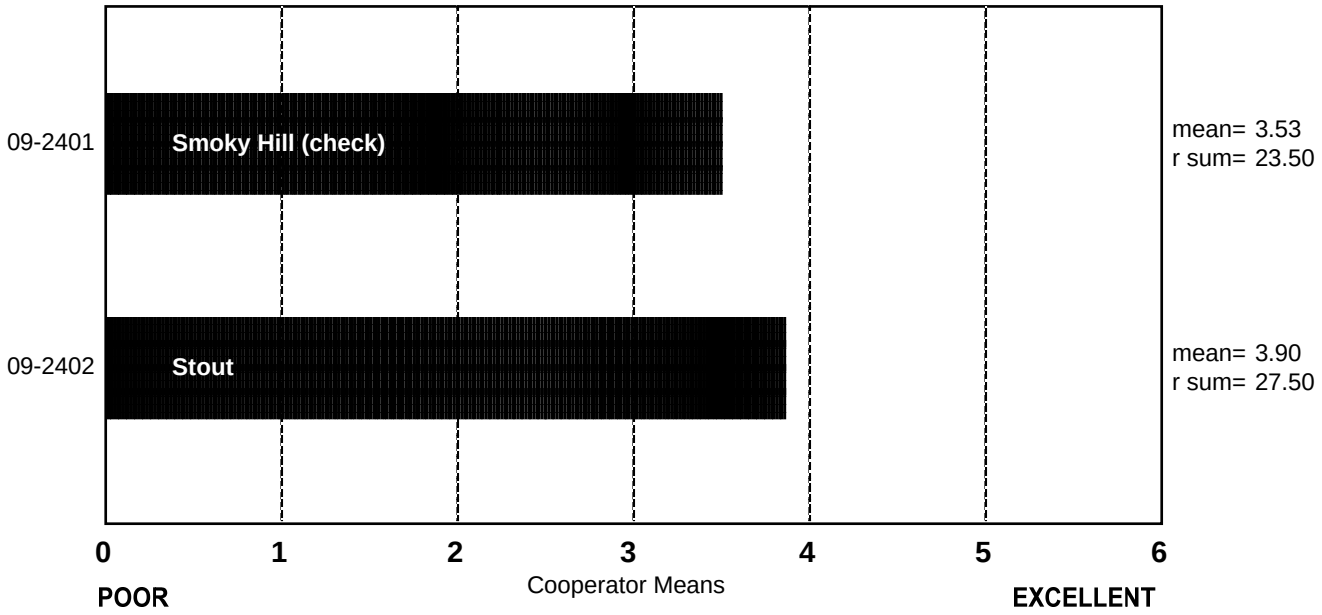
Frequency Table

CRUMB GRAIN

(Small Scale) Westbred

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.



CRUMB GRAIN, DESCRIBED

(Small Scale) Westbred

	Open	Fine	Dense
09-2401 Smoky Hill (check)	**10**	**6**	**1**
09-2402 Stout	**9**	**8**	**0**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Westbred

	Round	Irregular	Elongated
09-2401 Smoky Hill (check)	**3**	**6**	**8**
09-2402 Stout	**1**	**8**	**8**

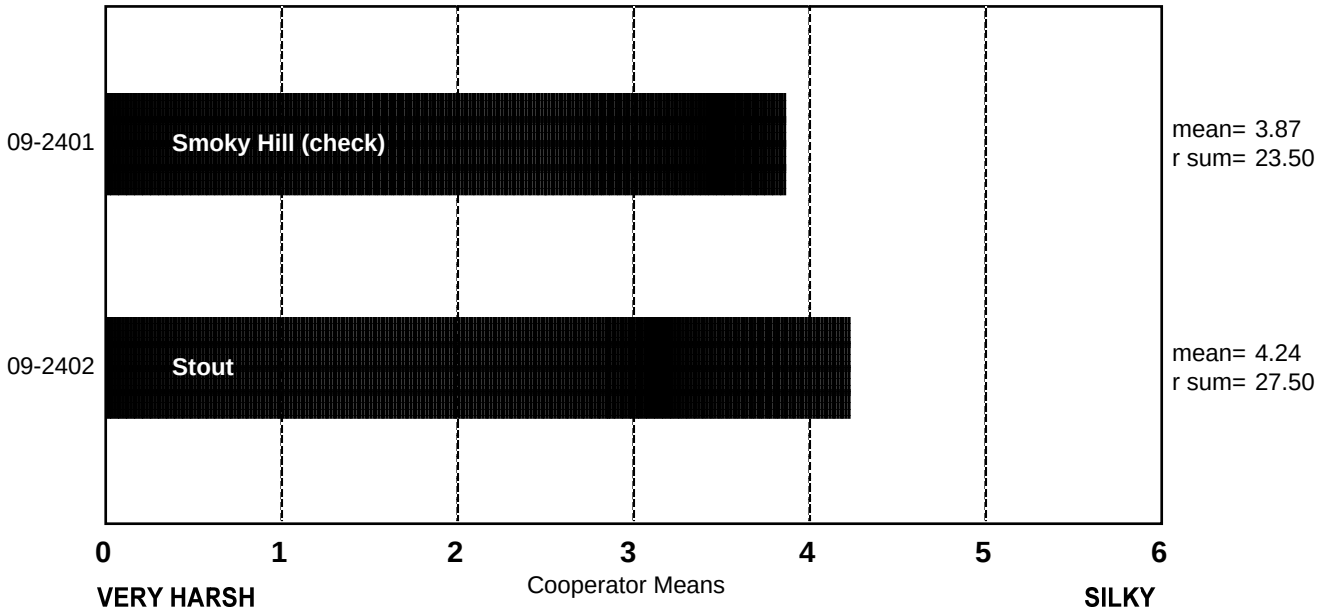
Frequency Table

CRUMB TEXTURE

(Small Scale) Westbred

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.



mean= 3.87
r sum= 23.50

mean= 4.24
r sum= 27.50

CRUMB TEXTURE, DESCRIBED

(Small Scale) Westbred

	Harsh	Smooth	Silky
09-2401 Smoky Hill (check)	**3**	**12**	**2**
09-2402 Stout	**1**	**14**	**2**

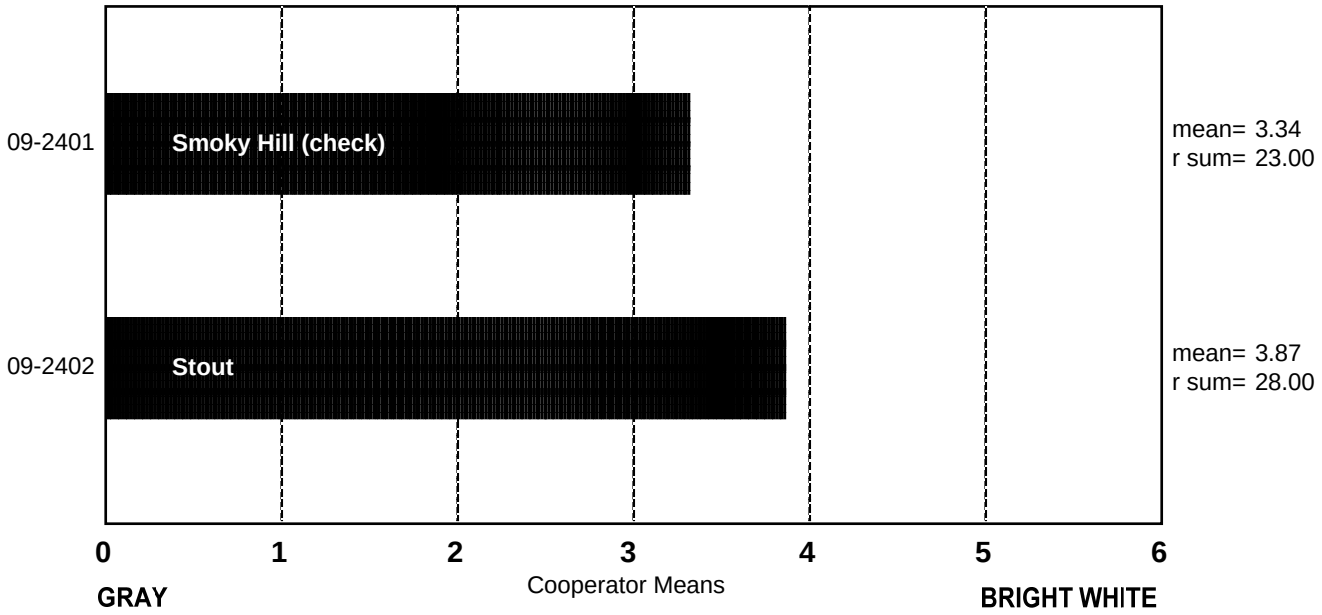
Frequency Table

CRUMB COLOR

(Small Scale) Westbred

ncoop= 17
chisq= 1.47
chisqc= 3.13
cvchisq= 3.84
crdiff=

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



CRUMB COLOR, DESCRIBED

(Small Scale) Westbred

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
09-2401 Smoky Hill (check)	**2**	**0**	**0**	**6**	**8**	**1**	**0**
09-2402 Stout	**0**	**0**	**1**	**3**	**10**	**3**	**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. O
09-2401 Smoky Hill (check)	**132.9**	**495.0**	**417.0**	**153.9**	**156.3**	**474.0**	**144.6**		**466.8**	**469.0**	**137.2**	**138.2**			**456.8**	**124.8**	**149.4**
09-2402 Stout	**136.5**	**490.0**	**415.0**	**154.6**	**153.4**	**472.0**	**143.2**		**462.8**	**470.0**	**141.1**	**139.4**			**449.2**	**127.5**	**151.6**

LOAF VOLUME, ACTUAL

(Small Scale) Westbred

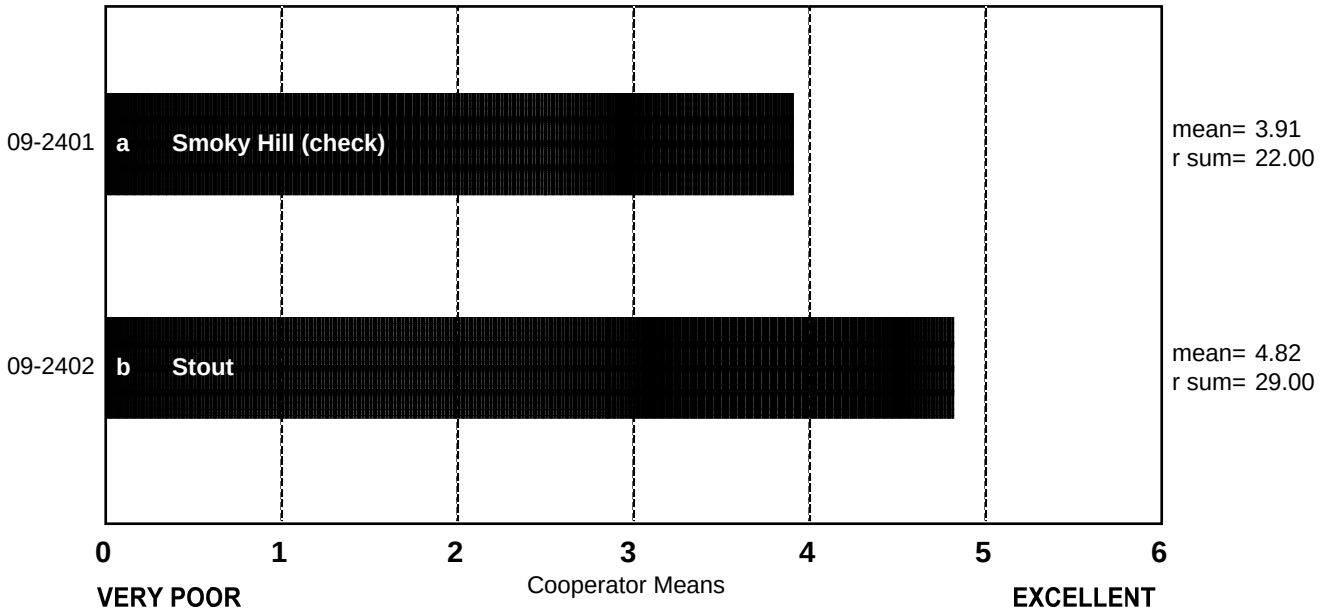
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2401 Smoky Hill (check)	**725**	**2400**	**3000**	**945**	**624**	**2950**	**980**	**1023**	**2500**	**3104**	**1018**	**922**	**2675**	**995**	**2200**	**885**	**910**
09-2402 Stout	**800**	**2950**	**3050**	**1025**	**715**	**2850**	**1028**	**1013**	**2538**	**3104**	**1085**	**957**	**2775**	**1050**	**2500**	**915**	**975**

LOAF VOLUME

(Small Scale) Westbred

ncoop= 17
chisq= 2.88
chisqc= 4.45
cvchisq= 3.84
crdiff= 2.86

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



mean= 3.91
r sum= 22.00

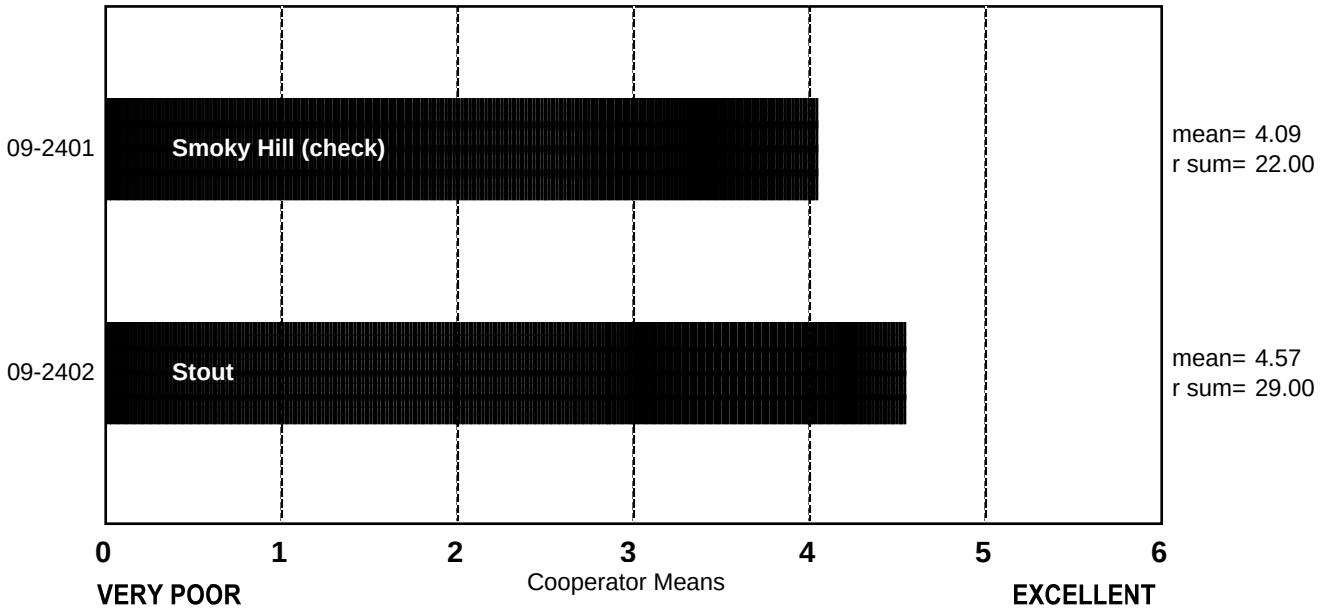
mean= 4.82
r sum= 29.00

OVERALL BAKING QUALITY

(Small Scale) Westbred

ncoop= 17
chisq= 2.88
chisqc= 3.27
cvchisq= 3.84
crdiff=

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



mean= 4.09
r sum= 22.00

mean= 4.57
r sum= 29.00

COOPERATOR'S COMMENTS
(Small Scale) WestBred

COOP. **09-2401 Smoky Hill (check)**

A. Low loaf volume.
B. Very low volume and gray.
C. Very open shotty grain. Good mix time and excellent volume. Good out of mixer and make-up.
D. Better break & shred, Excellent dough properties, average interior and loaf volume performance.
E. No comment.
F. No comment.
G. Normal Water Abs, Longer Mix & Proof Time, Soft & Strong Dough, Very High OS & Vol, Fine Elongated Small Cells, Creamy Crumb, Silky & Medium Resilient Texture.
H. High protein, excellent bake quality. Great dough handling, volumes, and mix tolerance.
I. Slightly long mix time, open grain.
J. Tight, consistent, smooth grain, excellent volume.
K. No comment.
L. Slow dough pickup during mixing - downgraded the mixing score.
M. No comment.
N. No comment.
O. Low Abs.- Open Grain-Low Volume- Tough at Make-Up.
P. No comment.
Q. Satisfactory absorption; long MT; excellent mixing tolerance & at pan; good LV; open & irreg. crumb.

COOP. **09-2402 Stout**

A. No comment.
B. Good absorption, color and volume.
C. Open grain. Good out of mixer Creamy crumb color.
D. very good dough properties and loaf volume performance, average interior.
E. No comment.
F. No comment.
G. Normal Water Abs, Medium Mix Time & Shorter Proof Time, Soft & Strong Dough, Very High OS & Vol, Fine Elongated Cells, Creamy Crumb, Smooth & Medium Resilient Texture.
H. High protein, excellent bake quality. Great dough handling, volumes, and mix tolerance (slightly better grain than #1).
I. High absorption, slightly long mix time, good grain.
J. Very good absorption, tight, consistent, smooth grain, excellent volume.
K. No comment.
L. Slow dough pickup during mixing - downgraded the mixing score.
M. No comment.
N. No comment.
O. High Absorption- Good Grain and Volume.
P. No comment.

Q. Satisfactory absorption; long MT; satisfactory mixing tolerance & at pan; crumb fine; excellent LV.

Notes: **B, C, H, I, J, M, and O** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

Kansas-Hays – Joe Martin

The samples submitted were grown at a bottomland site at Hays in 2009. The nursery was not fertilized. The yield of the entries at this location ranged from 60 to 70 bushels per acre. There was early drought stress on the nursery until relief came on Easter day. From Easter on we had very good growing conditions. Light amounts of leaf rust did develop on the RonL check variety which showed up too late to do much damage.

RonL (check)

RonL is a hard white wheat variety released to Kansas seed producers in 2006. It is resistant to stripe rust, soil-borne mosaic virus and has a high level of resistance to wheat streak mosaic virus. RonL has been tested previously by the WQC and its overall baking properties were judged to be very similar to that of Jagger.

Tiger (KS05HW136-3)

Tiger is a hard white winter wheat primarily adapted to western Kansas dryland production. It was released to seed producers this year. It was selected from the cross KS98HW518//KS98H245/Trego. It has been a top performing wheat across our western Kansas locations of the KIN the last three years. It has an excellent disease resistance package, it is resistant to leaf and stripe rust, it is resistant to soil-borne mosaic virus and it has a good level of resistance to Septoria leaf blotch. Tiger is our first Hessian fly resistant white wheat. Tiger was tested by the WQC last year under its experimental number KS05HW136-3. Tiger rated very high in overall baking performance. Tiger is also low in PPO similar to Lakin. Tiger's release was a restricted release, it only went to those individuals or organizations that could produce this wheat for an identity preserved market and take advantage of its noodle making characteristics.

Kansas-Hays: 2009 (Small-Scale) Samples [a]

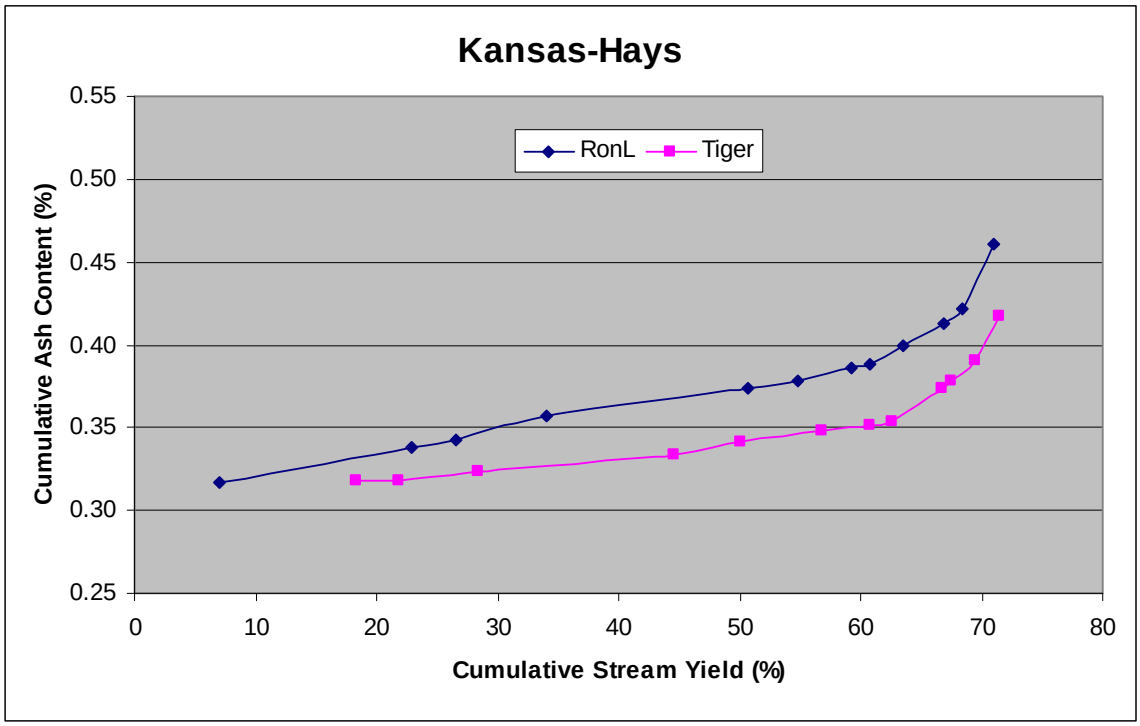
Test entry number	09-2403	09-2404
Sample identification	**RonL (check)**	**Tiger**
Wheat Data		
FGIS classification	1 HDWH	1 HDWH
Test weight (lb/bu)	62.2	60.7
Hectoliter weight (kg/hl)	81.8	79.8
1000 kernel weight (gm)	34.2	29.2
NIR hardness	85	70
Wheat kernel size (Rotap)		
Over 7 wire (%)	75.3	64.9
Over 9 wire (%)	24.6	34.5
Through 9 wire (%)	0.1	0.6
Single kernel (skcs)		
Hardness (avg /s.d)	83.0/13.0	61.7/16.5
Weight (mg) (avg/s.d)	35.3/8.8	32.5/8.3
Diameter (mm)(avg/s.d)	2.78/0.37	2.67/0.29
SKCS distribution	00-01-03-96	04-12-30-54
Classification	Hard	Hard
Wheat moisture (%)	10.2	10.7
Wheat protein (12% mb)	12.5	12.6
Wheat ash (12% mb)	1.67	1.50
Milling and Flour Quality Data		
Flour yield (%, str. grade)		
Miag Multomat Mill	70.9	71.6
Quadrumat Sr. Mill	67.7	69.8
NIR Flour moisture (%)	12.0	12.4
NIR Flour protein (14% mb)	10.9	11.0
Flour ash (14% mb)	0.46	0.43
Glutomatic		
Wet gluten (%)	30.2	30.6
Dry gluten (%)	11.0	11.0
Gluten index	98.3	98.7
Rapid Visco-Analyser		
Peak time (min)	6.3	6.0
Peak viscosity (RVU)	231.8	203.8
Breakdown (RVU)	87.1	113.8
Final viscosity at 13 min (RVU)	258.0	169.5
Minolta color meter		
L*	92.55	93.26
a*	-1.88	-1.47
b*	9.92	7.94
Falling number (sec)	463	360
Damaged Starch		
(AI%)	97.12	95.71
(AACC76-31)	7.17	6.05

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

Kansas-Hays: Physical Dough Tests and Gluten Analysis For 2009 (Small-Scale) Samples

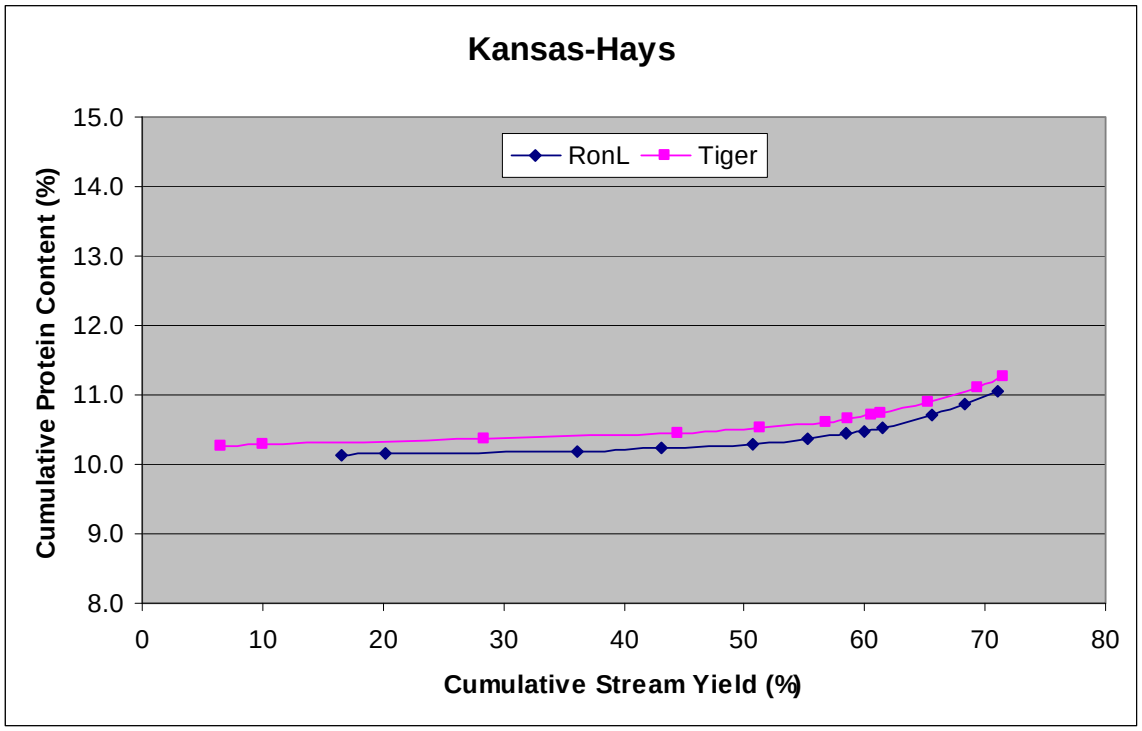
Test Entry Number	09-2403	09-2404
Sample Identification	RonL (check)	Tiger
MIXOGRAPH		
Flour Abs (% as-is)	65.3	63.2
Flour Abs (14% mb)	63.1	61.3
Mix Time (min)	4.38	4.13
Mix tolerance (0-6)	5	3
FARINOGRAPH		
Flour Abs (% as-is)	62.4	59.1
Flour Abs (14% mb)	60.1	57.3
Development time (min)	8.3	6.2
Mix stability (min)	24.8	23.8
Mix Tolerance Index (FU)	11	7
Breakdown time (min)	25.3	21.8
ALVEOGRAPH		
P(mm. $_{H2O}$): Tenacity	99	89
L(mm): Extensibility	103	106
G($mm_{0.}5$): Swelling index	22.6	22.9
W(10^{-4} J): strength (curve area)	347	337
P/L: curve configuration ratio	0.96	0.84
Ie(P_{200}/P): elasticity index	58.8	62.9
EXTENSIGRAPH		
Resist (BU at 30/60/90 min)	447/666/731	499/783/749
Extensibility (mm at 30/60/90 min)	139/147/137	153/145/128
Energy (cm^2 at 30/60/90 min)	109/165/160	140/196/159
Resist $_{max}$ (BU at 30/60/90 min)	611/920/938	728/995/999
Ratio (at 30/60/90 min)	3.2/4.6/5.4	3.3/5.4/5.9
PROTEIN ANALYSIS		
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+9, 5+10
Glu/Gli	1.57	2.19
HMW/LMW	0.34	0.36
%IPP	49.09	49.89
SEDIMENTATION TEST		
Volume (ml)	46.9	59.4

Kansas-Hays: Cumulative Ash Curves



	RonL - 2403					Tiger - 2404				
Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)		Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)
1M	7.02	0.32	7.02	0.32		2M	18.37	0.32	18.37	0.32
3M	15.87	0.35	22.89	0.34		1M Red	3.43	0.32	21.80	0.32
1M Red	3.65	0.37	26.54	0.34		1M	6.57	0.34	28.36	0.32
4M	7.56	0.41	34.11	0.36		3M	16.17	0.35	44.54	0.33
2M	16.55	0.41	50.66	0.37		1BK	5.60	0.40	50.14	0.34
2BK	4.12	0.43	54.78	0.38		4M	6.71	0.40	56.85	0.35
1BK	4.52	0.47	59.30	0.39		2BK	3.97	0.41	60.82	0.35
Grader	1.54	0.49	60.84	0.39		Grader	1.71	0.43	62.52	0.35
3BK	2.72	0.65	63.56	0.40		3BK	4.20	0.67	66.72	0.37
5M	3.31	0.68	66.87	0.41		FILTER FLR	0.75	0.73	67.47	0.38
FILTER FLR	1.50	0.80	68.37	0.42		5M	1.95	0.83	69.43	0.39
BRAN FLR	2.66	1.46	71.03	0.46		BRAN FLR	2.07	1.31	71.50	0.42
Break Shorts	0.37	0.83	71.40	0.46		Break Shorts	2.68	3.82	74.18	0.54
Red Dog	2.42	2.22	73.82	0.52		Red Dog	1.63	2.35	75.81	0.58
Red Shorts	0.12	3.85	73.94	0.53		Red Shorts	0.04	3.89	75.85	0.58
Filter Bran	0.54	2.10	74.48	0.54		Filter Bran	0.33	1.66	76.18	0.59
Bran	25.52	4.90	100.00	1.65		Bran	23.82	4.57	100.00	1.53
Wheat Ash		1.63				Wheat Ash		1.46		
Straight Grade Flour Ash		0.46				Straight Grade Flour Ash		0.43		

Kansas-Hays: Cumulative Protein Curves

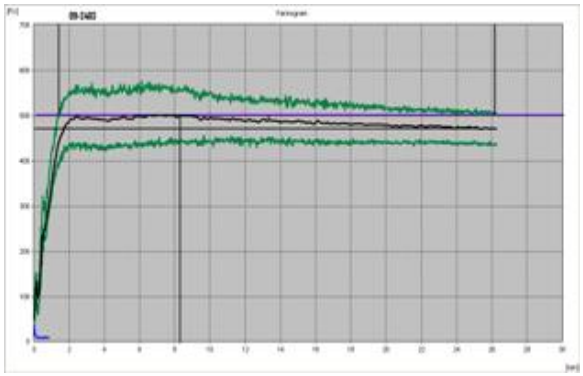


	RonL - 2403					Tiger - 2404			
Mill Streams	**Strm Yld (14%mb)**	**Protein (14%mb)**	**Cumulative Yield (14%)**	**Prtn (14%)**	**Mill Streams**	**Strm Yld (14%mb)**	**Protein (14%mb)**	**Cumulative Yield (14%)**	**Prtn (14%)**
2M	16.6	10.1	16.6	10.1	1M	6.6	10.3	6.6	10.3
1M Red	3.7	10.2	20.2	10.2	1M Red	3.4	10.3	10.0	10.3
3M	15.9	10.2	36.1	10.2	2M	18.4	10.4	28.4	10.4
1M	7.0	10.4	43.1	10.2	3M	16.2	10.6	44.5	10.5
4M	7.6	10.7	50.7	10.3	4M	6.7	10.9	51.2	10.5
1BK	4.5	11.4	55.2	10.4	1BK	5.6	11.5	56.8	10.6
5M	3.3	11.4	58.5	10.4	Grader	1.7	11.9	58.6	10.6
Grader	1.5	11.5	60.0	10.5	5M	2.0	12.3	60.5	10.7
FILTER FLR	1.5	13.1	61.5	10.5	FILTER FLR	0.7	12.6	61.3	10.7
2BK	4.1	13.5	65.6	10.7	2BK	4.0	13.4	65.2	10.9
3BK	2.7	14.3	68.4	10.9	3BK	4.2	14.7	69.4	11.1
BRAN FLR	2.7	15.8	71.0	11.0	BRAN FLR	2.1	16.0	71.5	11.3
Break Shorts	0.4	10.8	71.4	11.0	Break Shorts	2.7	15.2	74.2	11.4
Red Dog	2.4	13.6	73.8	11.1	Red Dog	1.6	14.0	75.8	11.5
Red Shorts	0.1	13.7	73.9	11.1	Red Shorts	0.0	14.2	75.8	11.5
Filter Bran	0.5	10.3	74.5	11.1	Filter Bran	0.3	11.6	76.2	11.5
Bran	25.5	17.1	100.0	12.7	Bran	23.8	17.1	100.0	12.8
Whole Wheat		12.2			**Whole Wheat**		12.3		
St Grade Flour		11.1			**St Grade Flour**		11.3		

Physical Dough Tests

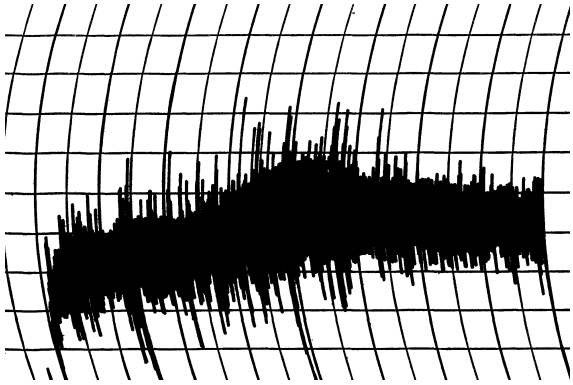
2009 (Small Scale) Samples – Kansas-Hays

Farinograms



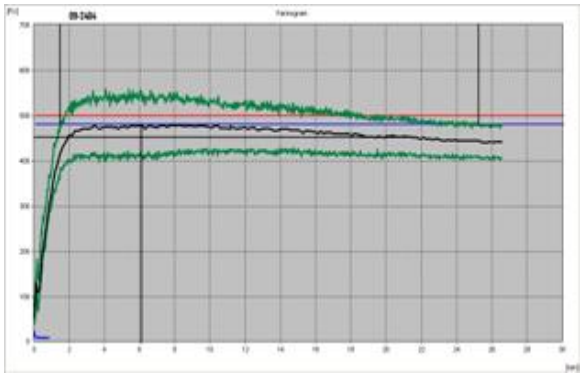
Water abs = 60.1%, Peak time = 8.3 min,
Mix stab = 24.8 min, MTI = 11 FU

Mixograms

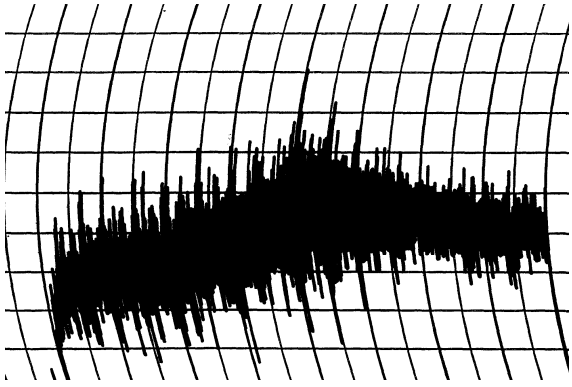


Water abs = 63.1%
Mix time = 4.4 min

09-2403, RonL (check)



Water abs = 57.3%, Peak time = 6.2 min,
Mix stab = 23.8 min, MTI = 7 FU

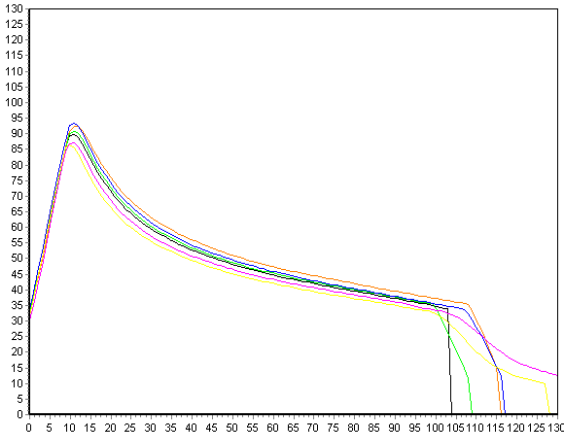


Water abs = 61.3%
Mix time = 4.1 min

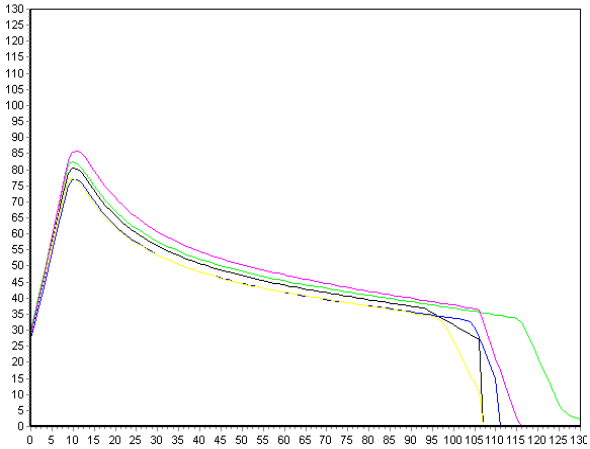
09-2404, Tiger

Physical Dough Tests - Alveograph

2009 (Small Scale) Samples – Kansas-Hays



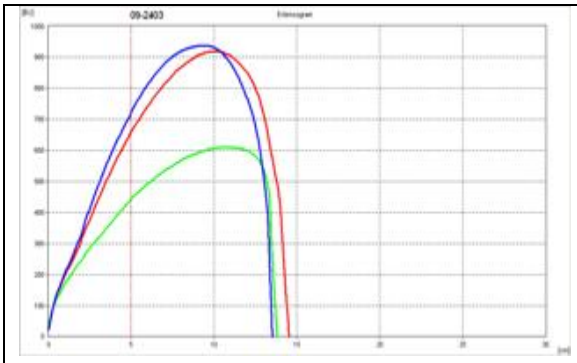
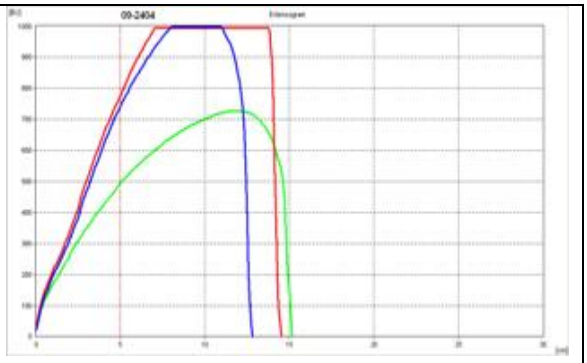
09-2403 (RonL - check)
P(mm $_{H20}$)=99, L(mm)=103, W(10E^{-4} J)=347



09-2404 (Tiger)
P(mm $_{H20}$)=89, L(mm)=106, W(10E^{-4} J)=337

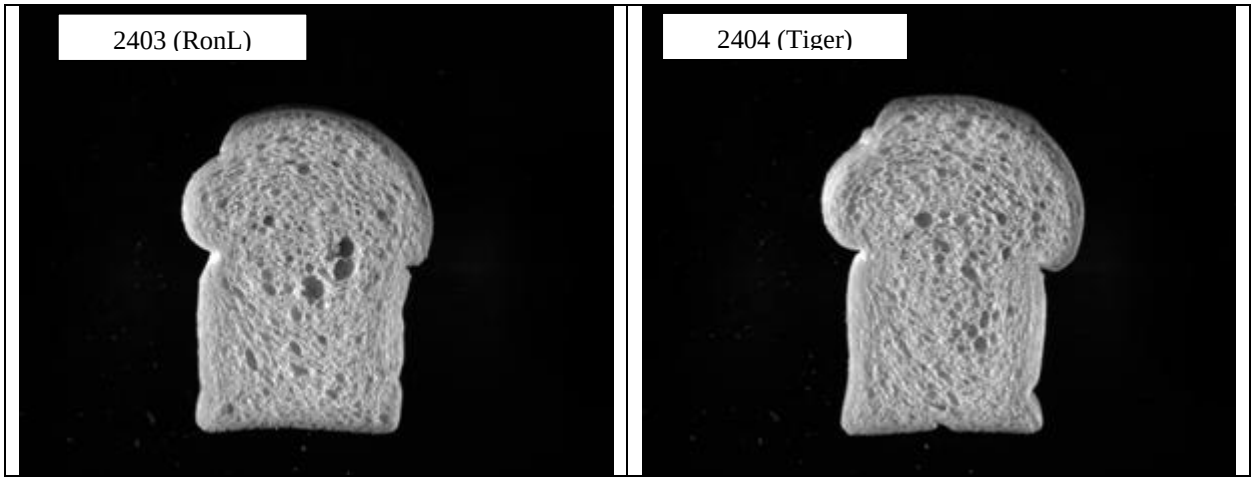
Physical Dough Tests - Extensigraph

2009 (Small Scale) Samples – Kansas-Hays

	
09-2403 (RonL - check) R (BU) = 447, E (mm) =139, W (cm^2) = 109 Rmax (BU) = 611, Ratio = 3.2 at 30 min	**09-2404 (Tiger)** R (BU) = 499, E (mm) =153, W (cm^2) = 140 Rmax (BU) = 728, Ratio = 3.3 at 30 min

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

Kansas-Hays: C-Cell Bread Images and Analysis for 2009 (Small-Scale) Samples



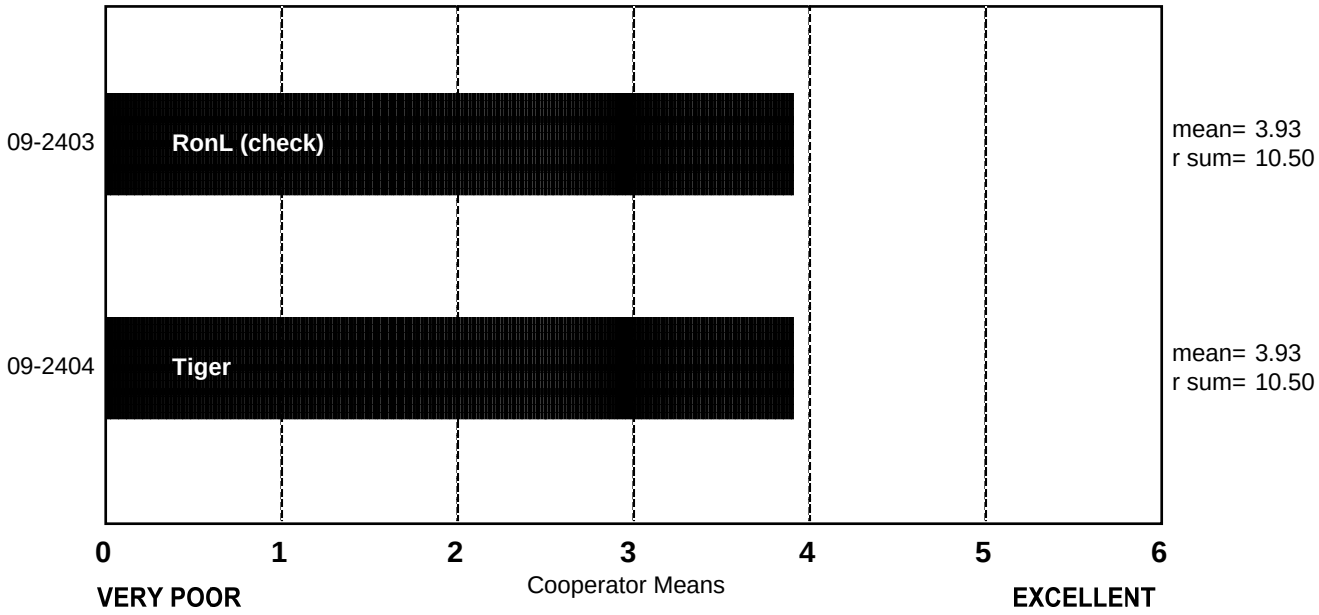
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2403	6240	153.40	3934	0.443	1.928	3.964	1.69	-21.7
2404	6617	153.85	3912	0.451	2.111	3.244	1.69	-20.3

SPONGE CHARACTERISTICS

(Small Scale) Kansas-Hays

ncoop= 7
chisq= -0.00
chisqc= 0.00
cvchisq= 3.84
crdiff=

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

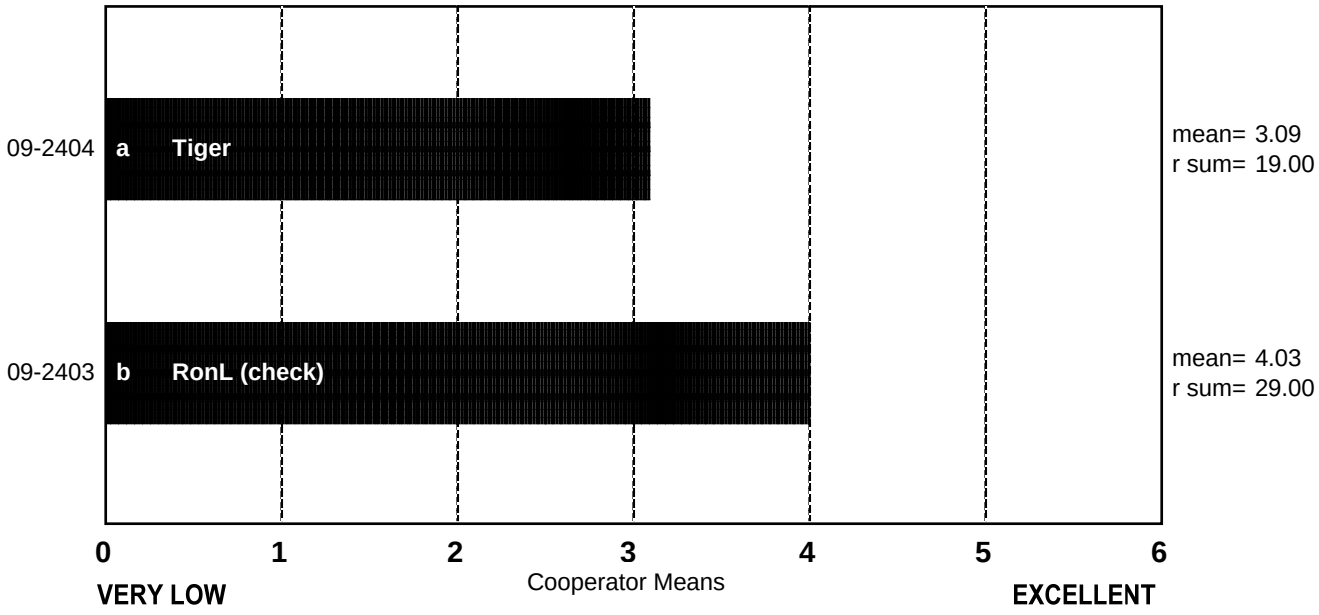


BAKE ABSORPTION

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 6.25
chisqc= 8.33
cvchisq= 3.84
crdiff= 5.28

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Kansas-Hays

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2403 RonL (check)	**62.6**	**57.0**	**57.0**	**67.2**	**63.1**	**62.1**	**64.5**	**60.0**	**60.0**	**60.0**	**67.1**	**63.3**	**59.0**	**62.1**	**63.1**	**58.6**	**64.5**
09-2404 Tiger	**59.3**	**54.0**	**57.0**	**67.8**	**61.3**	**59.3**	**63.5**	**61.0**	**58.0**	**59.0**	**65.1**	**61.5**	**58.0**	**62.6**	**60.3**	**55.8**	**63.8**

Raw Data

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
09-2403 RonL (check)	**2.5**	**8.0**	**20.0**	**4.8**	**5.0**	**4.5**	**7.0**	**6.0**	**10.0**	**25.0**	**4.3**	**4.4**	**30.0**	**3.7**	**8.0**	**4.3**	**5.8**
09-2404 Tiger	**2.0**	**6.0**	**17.0**	**6.1**	**5.5**	**4.5**	**6.8**	**9.0**	**14.0**	**20.0**	**4.5**	**4.1**	**28.0**	**3.9**	**11.0**	**4.0**	**5.9**

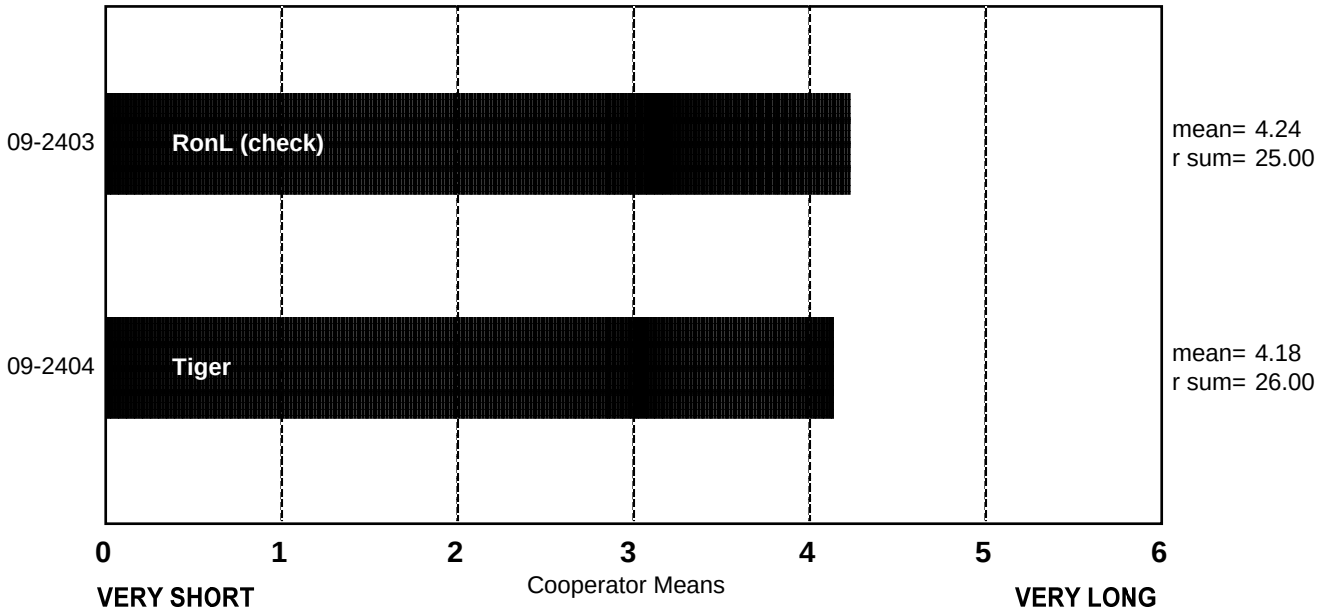
Raw Data

BAKE MIX TIME

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 0.06
chisqc= 0.09
cvchisq= 3.84
crdiff=

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

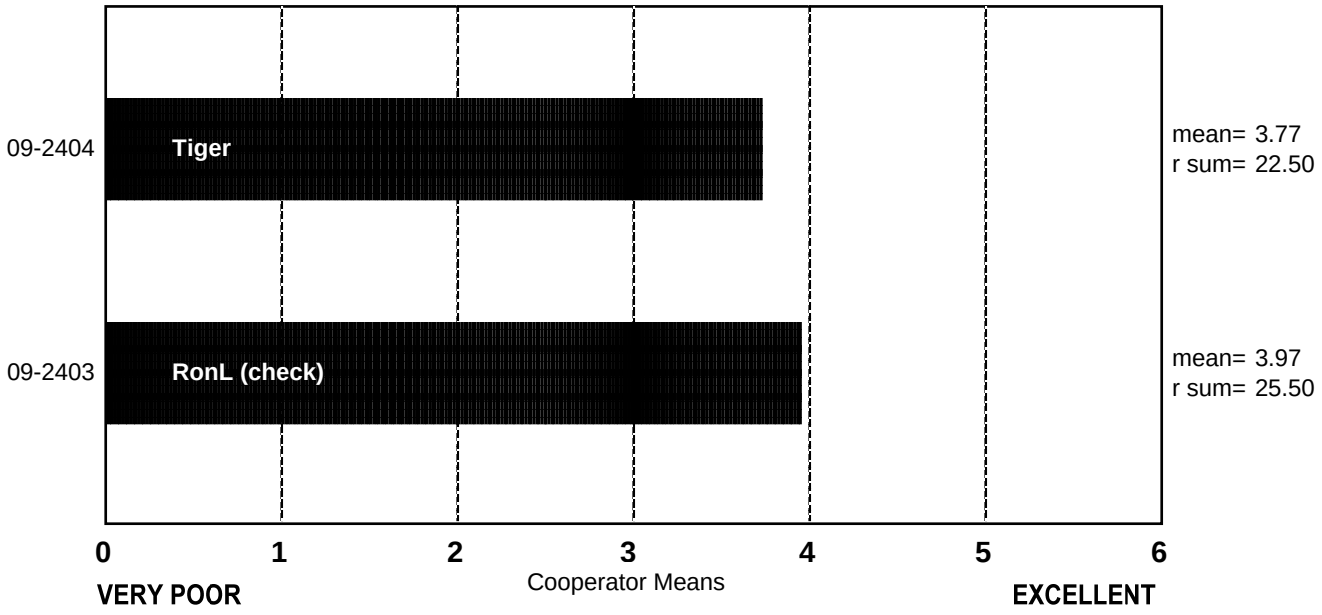


MIXING TOLERANCE

(Small Scale) Kansas-Hays

ncoop= 16
chisq= 0.56
chisqc= 1.00
cvchisq= 3.84
crdiff=

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

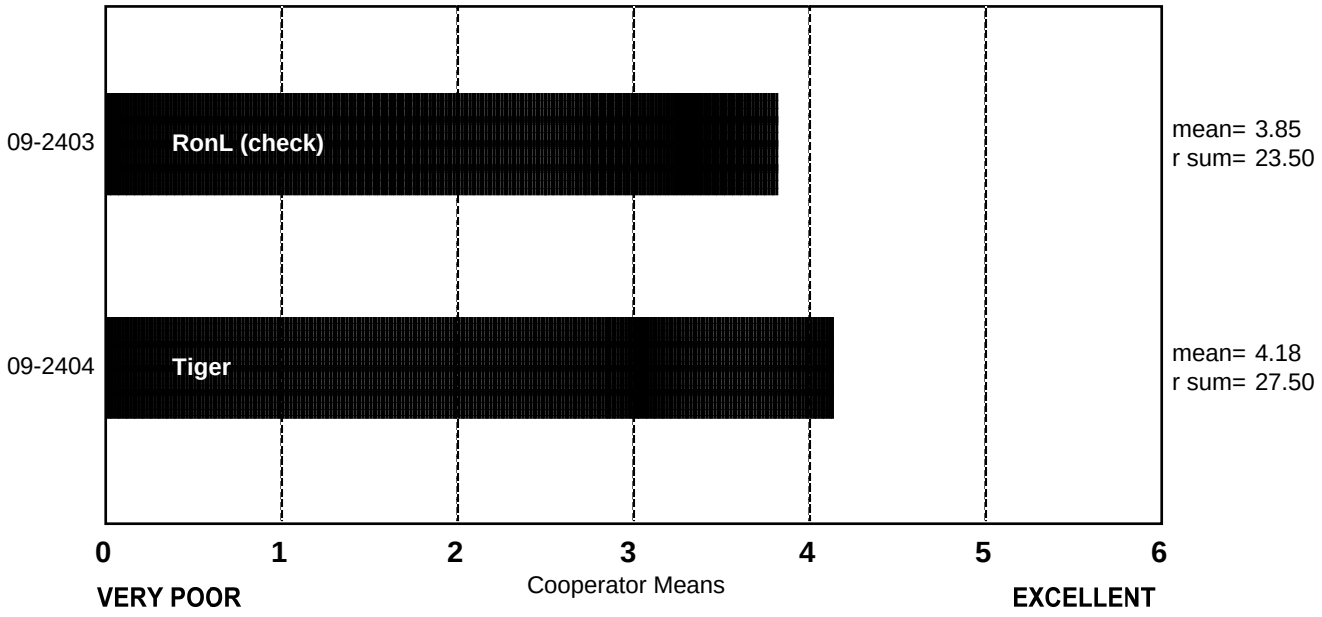


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Kansas-Hays

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.



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Kansas-Hays

	Sticky	Wet	Tough	Good	Excellent
09-2403 RonL (check)	**3**	**1**	**4**	**8**	**1**
09-2404 Tiger	**5**	**0**	**2**	**7**	**3**

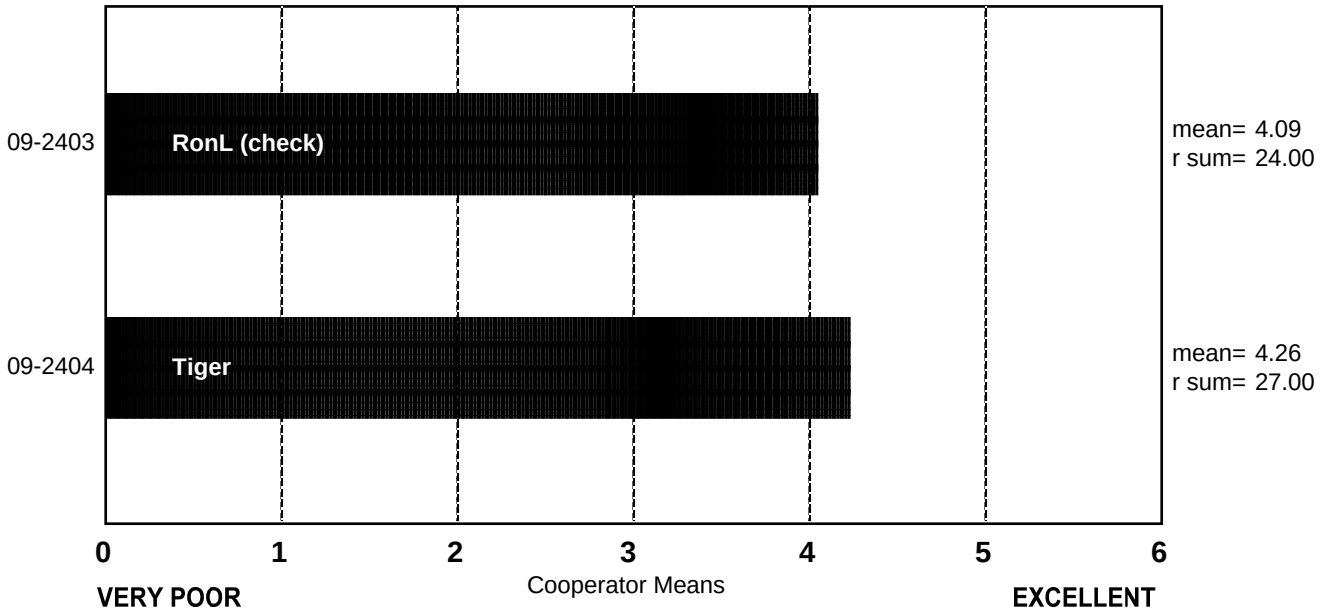
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 0.53
chisqc= 1.29
cvchisq= 3.84
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Kansas-Hays

	Sticky	Wet	Tough	Good	Excellent
09-2403 RonL (check)	**2**	**1**	**4**	**9**	**1**
09-2404 Tiger	**2**	**1**	**2**	**10**	**2**

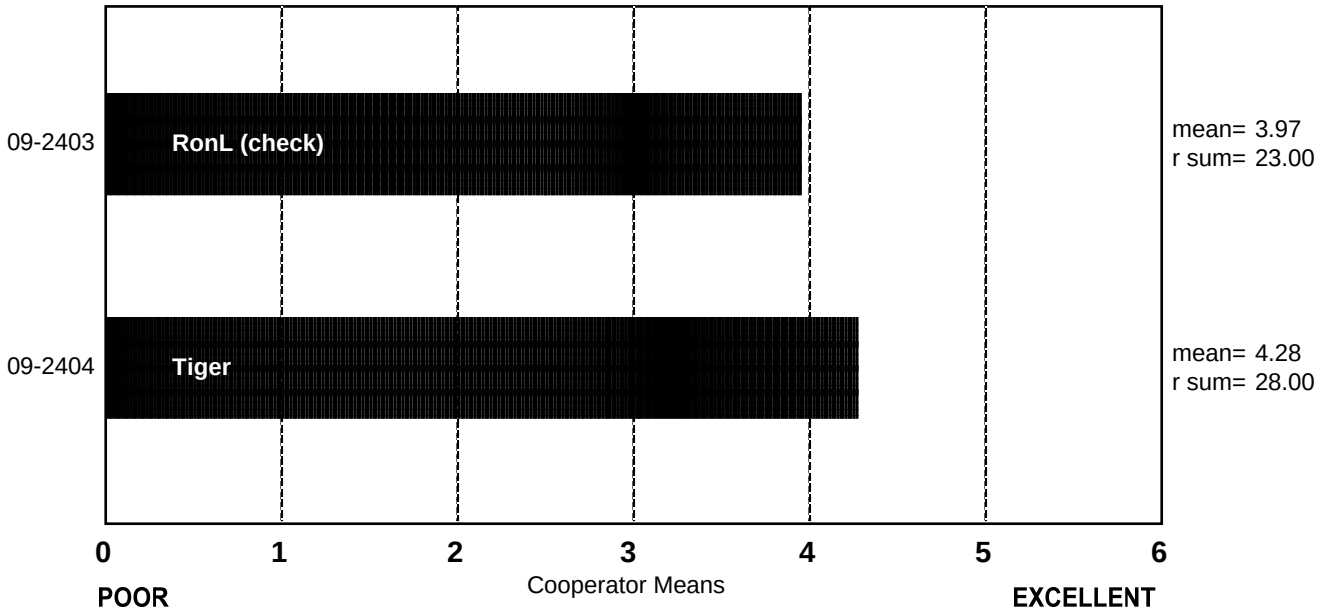
Frequency Table

CRUMB GRAIN

(Small Scale) Kansas-Hays

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

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Kansas-Hays

	Open	Fine	Dense
09-2403 RonL (check)	**9**	**7**	**1**
09-2404 Tiger	**7**	**9**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Kansas-Hays

	Round	Irregular	Elongated
09-2403 RonL (check)	**2**	**9**	**6**
09-2404 Tiger	**2**	**6**	**9**

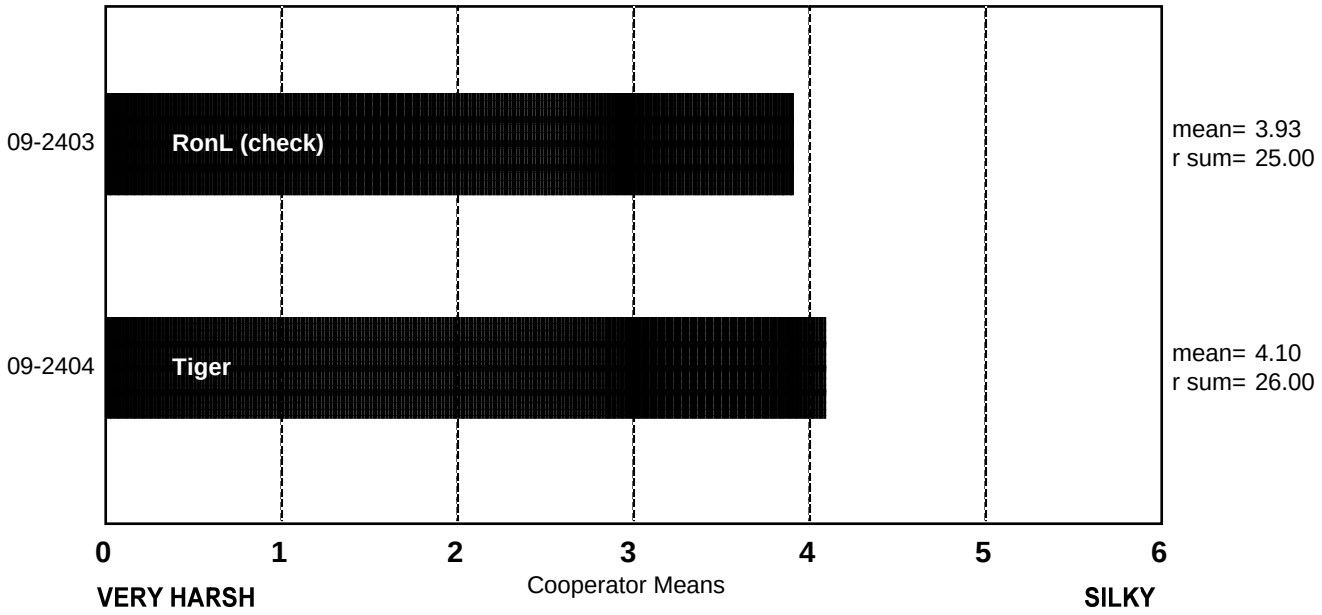
Frequency Table

CRUMB TEXTURE

(Small Scale) Kansas-Hays

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.



CRUMB TEXTURE, DESCRIBED

(Small Scale) Kansas-Hays

	Harsh	Smooth	Silky
09-2403 RonL (check)	**1**	**14**	**2**
09-2404 Tiger	**2**	**10**	**5**

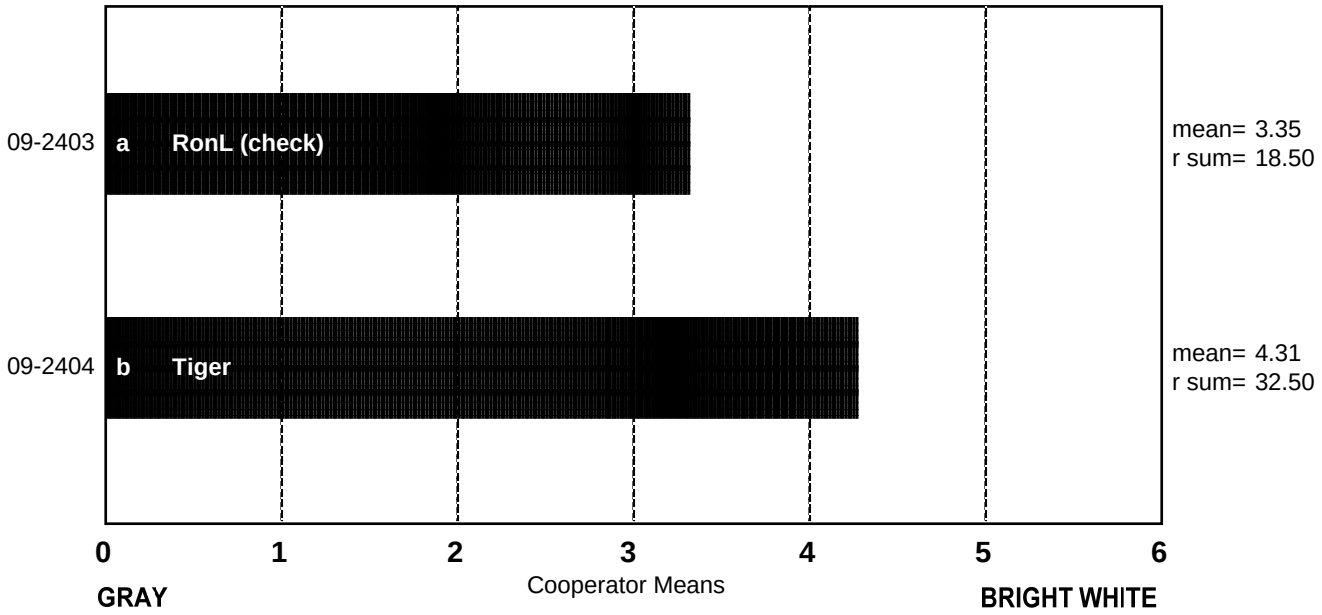
Frequency Table

CRUMB COLOR

(Small Scale) Kansas-Hays

ncoop= 17
chisq= 11.53
chisqc= 14.00
cvchisq= 3.84
crdiff= 1.81

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
09-2403 RonL (check)	**0**	**0**	**2**	**6**	**8**	**1**	**0**
09-2404 Tiger	**0**	**0**	**0**	**1**	**9**	**6**	**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. O
09-2403 RonL (check)	**134.2**	**495.0**	**421.0**	**155.9**	**155.2**	**473.0**	**143.6**		**466.5**	**469.6**	**140.1**	**138.0**			**450.5**	**124.3**	**150.6**
09-2404 Tiger	**132.9**	**495.0**	**416.0**	**152.1**	**154.9**	**473.0**	**141.6**		**467.9**	**468.8**	**142.1**	**134.5**			**451.2**	**122.7**	**152.1**

Raw Data

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
09-2403 RonL (check)	**705**	**2900**	**3000**	**905**	**631**	**2775**	**935**	**948**	**2613**	**3104**	**945**	**917**	**2625**	**970**	**2525**	**800**	**870**
09-2404 Tiger	**760**	**2800**	**3100**	**1005**	**654**	**2675**	**905**	**1028**	**2700**	**3104**	**1138**	**983**	**2700**	**1085**	**2550**	**875**	**955**

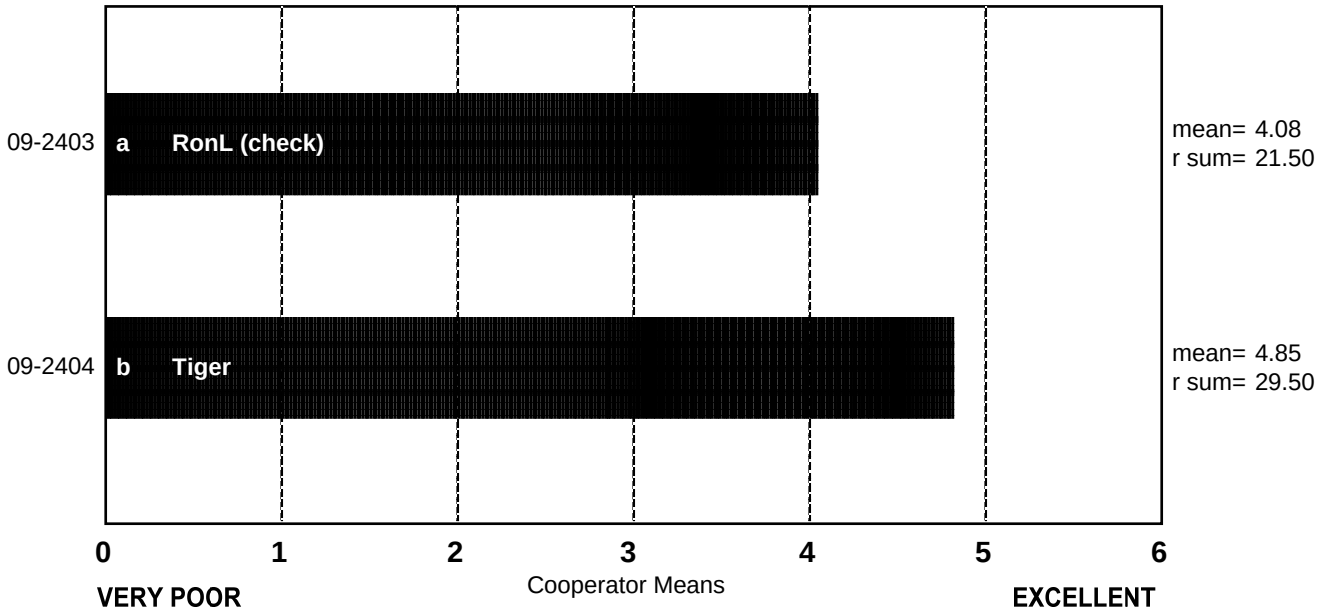
Raw Data

LOAF VOLUME

(Small Scale) Kansas-Hays

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.

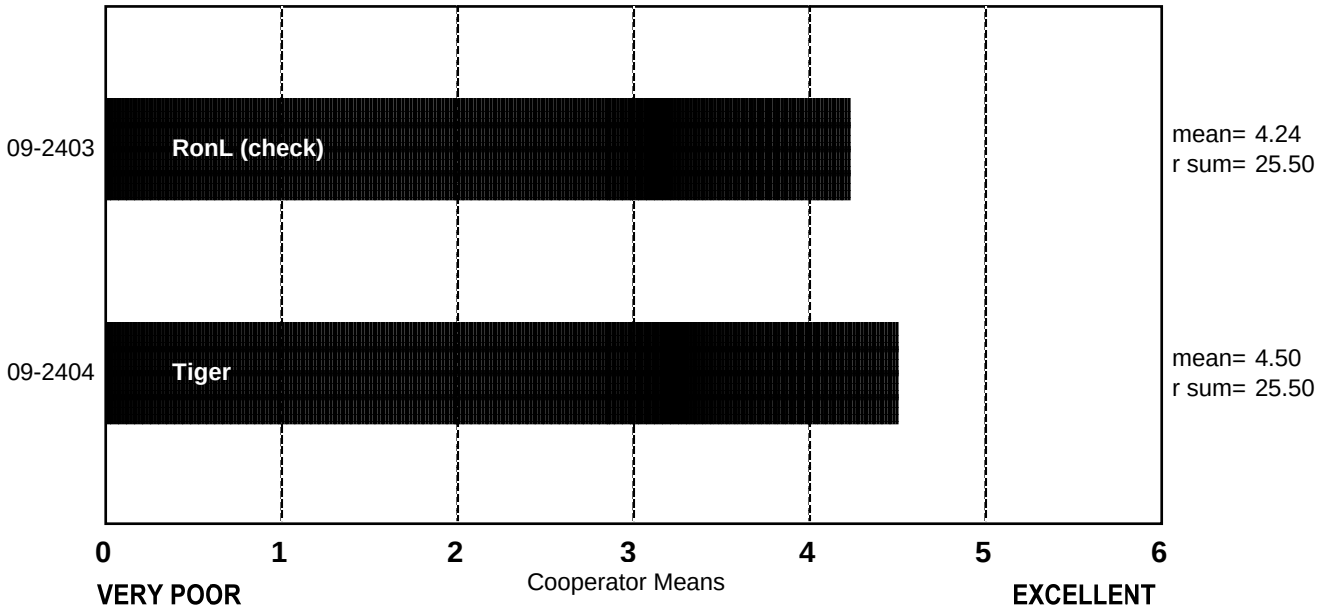


OVERALL BAKING QUALITY

(Small Scale) Kansas-Hays

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.



COOPERATOR'S COMMENTS
(Small Scale) Kansas-Hays

COOP. **09-2403 RonL (check)**

A. Low loaf volume.
B. No comment.
C. Very nice interior. Slightly tough at make up but performed well. Very strong mix. Creamy crumb. Lower protein.
D. a solid all around performance.
E. No comment.
F. No comment.
G. Normal Water Abs, Longer Mix Time & Shorter Proof Time, Sticky & Slight Strong Dough, Very High OS & Vol, Open Elongated Cells, Slight Yellow Crumb, Smooth & Medium Resilient Texture.
H. More water may have improved performance, sample had tough dough handling. Otherwise average performance.
I. Sticky dough, good grain, average volume.
J. Very tight, consistent, smooth grain, excellent volume.
K. No comment.
L. No comment.
M. No comment.
N. No comment.
O. Low Mix Time- Good Grain Volume and Color.
P. No comment.
Q. Satisfactory absorption; good MT; excellent mixing tolerance & at pan; satisfactory crumb grain; low LV.

COOP. **09-2404 Tiger**

A. No comment.
B. Low absorption.
C. Close grain, bright interior. Good extensible dough. Lower protein. Long mix.
D. Better break & shred, excellent dough properties and loaf volume performance with good interior BEST OF SHOW.
E. No comment.
F. No comment.
G. Normal Water Abs, Longer Mix Time & Shorter Proof Time, Sticky & Slight Strong Dough, Very High OS & Vol, Open Elongated Cells, Slight Yellow Crumb, Smooth & Medium Resilient Texture.
H. Great bake performance for protein level. Good dough handling, volumes, and mix tolerance.
I. Low absorption, long mix time, open grain, white crumb, good volume.
J. Slightly below average absorption, slightly open, variable grain, excellent volume.
K. No comment.
L. No comment.

M. No comment.
N. No comment.
O. Low Abs. - Good Volume and Color.
P. No comment.
Q. Satisfactory absorption; long MT; good at pan; fine crumb grain & rated higher than the check.

Notes: **B, C, H, I, J, M, and O** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

Colorado – Scott Haley

Growing Location & Conditions

The Wheat Quality Council samples from Colorado originated from strip increases grown under dryland conditions at the USDA-ARS Central Great Plains Research Station at Akron, CO. The strip increases were fertilized prior to planting based on a soil test and a 60 bu/a yield goal. The planting date was 9/18/08 and the harvest date was 7/14/09.

Growing conditions included good fall stand establishment and growth, dry winter and early spring soil moisture conditions, noticeable drought stress symptoms by early May followed by excellent rains and mild temperatures throughout grain filling. Stripe rust, leaf rust, and Russian wheat aphid were all present at relatively low levels.

Data from the adjacent state dryland variety trials were not reported to growers due to excessive field variability. The adjacent Southern Regional Performance Nursery (SRPN) showed very high grain yields, averaging 89 bu/a (42-111 bu/a range) with an average test weight of 60.7 lb/bu (56.9-62.8 lb/bu range). Grain protein concentration (12% m.b.) from a set of samples used for location characterization averaged 14.3% with a range of 11.8-17.0%.

Hatcher (check)

Hatcher is a hard red winter wheat that was released in 2004. Hatcher was tested in previous WQC sample sets as a check and initially under its experimental number CO980607. Hatcher was chosen because it has shown good milling and baking quality characteristics and because it has become a dominant cultivar in Colorado acreage estimates (32.9% of the 2009 crop).

CO04393

CO04393 is a hard red winter wheat from the cross Stanton/CO950043 made in 2000. Stanton is a hard red winter wheat cultivar from Kansas State University and CO950043 is an unreleased experimental line from CSU with the pedigree Hill/PI294994-GBR//Lamar. CO04393 is a medium-maturing, tall semidwarf with average straw strength. CO04393 is moderately resistant to stripe rust and moderately susceptible to leaf rust. CO04393 was the top yielding entry in its first year in the dryland 2009 CSU Uniform Variety Performance Trial (UVPT) and is the top yielding entry on a two-year average in the CSU Irrigated Variety Performance Trial (IVPT). CO04393 has shown very good milling and baking

quality characteristics in tests conducted in the CSU Wheat Quality Lab, with significantly longer Mixograph mix time and larger loaf volume compared to Hatcher (19 tests, 2006-08). CO04393 is on breeder seed increase in 2010 with the earliest possible release being fall 2011.

CO04499

CO04499 is a hard red winter wheat from the cross Above/Stanton made in 2000. Above is a hard red *Clearfield** winter wheat cultivar from CSU and Stanton is a hard red winter wheat cultivar from Kansas State University. CO04499 is an early maturing, tall semi-dwarf with below average straw strength. CO04499 carries a gene from Above for tolerance to BEYOND™ herbicide (*Clearfield** wheat). CO04499 is moderately susceptible to stripe rust and susceptible to leaf rust. CO04499 was the second highest yielding entry in its first year in the dryland 2009 CSU Uniform Variety Performance Trial (UVPT). If released, CO04499 will not be targeted toward irrigation. CO04393 has shown good milling and baking quality characteristics in tests conducted in the CSU Wheat Quality Lab, with similar Mixograph mix time and slightly larger loaf volume compared to Hatcher (19 tests, 2006-08). CO04499 is on breeder seed increase in 2010 with the earliest possible release being fall 2011.

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

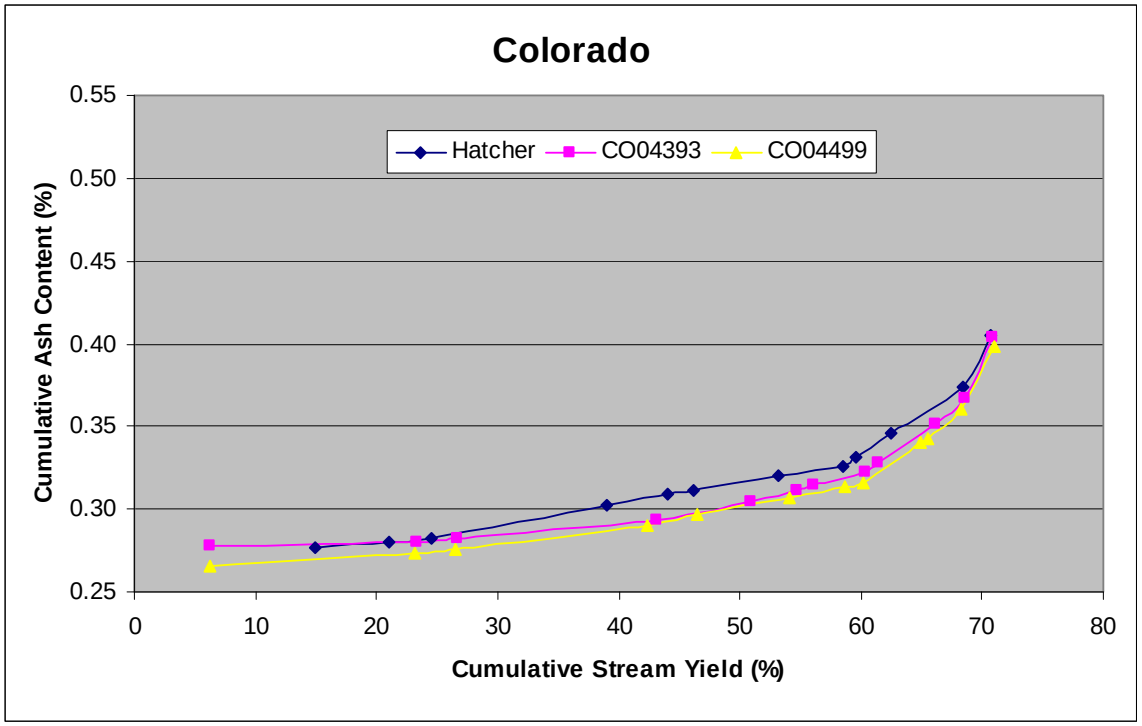
Test entry number	09-2405	09-2406	09-2407
Sample identification	**Hatcher (check)**	**CO04393**	**CO04499**
Wheat Data			
FGIS classification	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	61.8	61.8	62.3
Hectoliter weight (kg/hl)	81.3	81.3	81.9
1000 kernel weight (gm)	31.6	33.9	33.0
NIR hardness	68	68	72
Wheat kernel size (Rotap)			
Over 7 wire (%)	68.0	83.4	84.2
Over 9 wire (%)	31.5	16.2	15.3
Through 9 wire (%)	0.5	0.4	0.4
Single kernel (skcs)			
Hardness (avg /s.d)	64.5/15.3	64.8/14.1	63.3/13.5
Weight (mg) (avg/s.d)	34.8/8.3	35.8/7.9	36.3/6.9
Diameter (mm)(avg/s.d)	2.70/0.32	2.88/0.32	2.84/0.35
SKCS distribution	00-13-23-64	01-07-23-69	02-07-29-62
Classification	Hard	Hard	Hard
Wheat moisture (%)	10.2	10.0	10.0
Wheat protein (12% mb)	14.3	15.1	14.6
Wheat ash (12% mb)	1.68	1.64	1.56
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	70.8	71.0	70.9
Quadrumat Sr. Mill	67.8	66.6	67.4
NIR Flour moisture (%)	11.8	12.9	12.8
NIR Flour protein (14% mb)	12.8	13.2	12.8
Flour ash (14% mb)	0.44	0.44	0.44
Glutomatic			
Wet gluten (%)	37.4	35.5	35.4
Dry gluten (%)	13.2	12.6	12.4
Gluten index	96.1	95.4	93.1
Rapid Visco-Analyser			
Peak Time (min)	6.3	6.5	6.5
Peak Viscosity (RVU)	188.6	240.3	228.8
Breakdown (RVU)	49.8	80.3	68.9
Final Viscosity at 13 min (RVU)	259.9	269.7	267.5
Minolta color meter			
L*	92.81	92.71	92.61
a*	-1.18	-1.57	-1.80
b*	7.61	8.92	9.74
Falling number (sec)	449	427	394
Damaged Starch			
(AI%)	95.35	95.34	95.82
(AACC76-31)	5.78	5.77	6.13

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

Colorado: Physical Dough Tests and Gluten Analysis For 2009 (Small-Scale) Samples

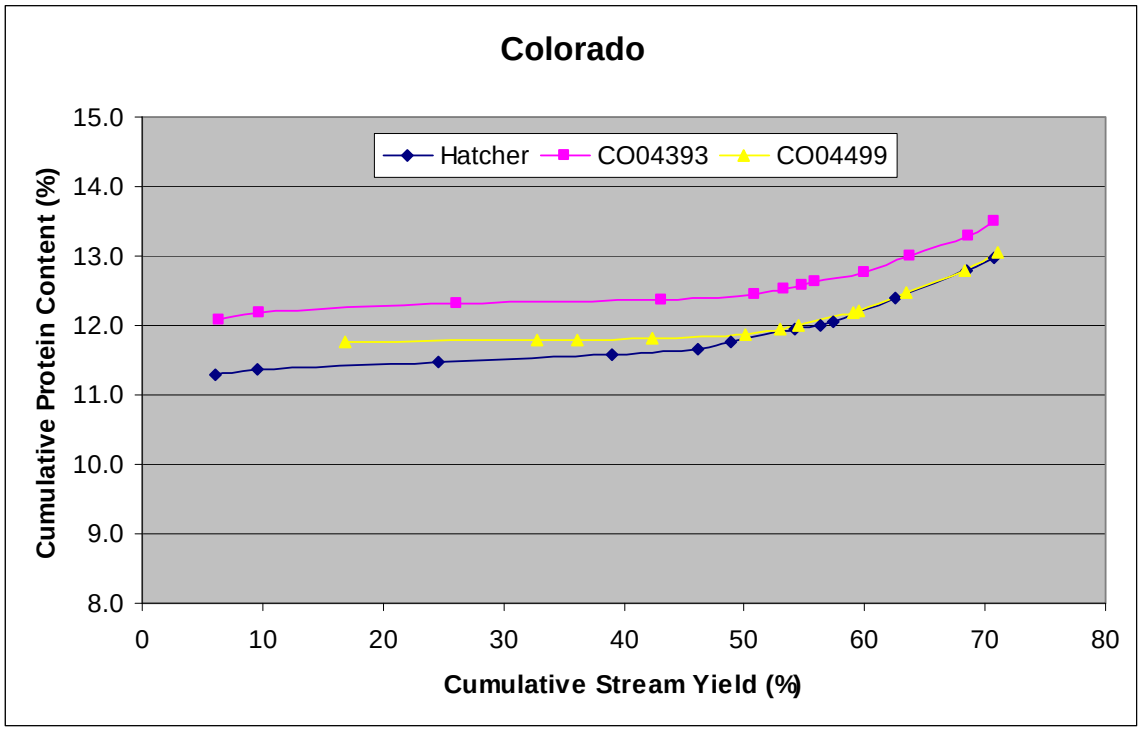
Test Entry Number	09-2405	09-2406	09-2407
Sample Identification	Hatcher (check)	CO04393	CO04499
MIXOGRAPH			
Flour Abs (% as-is)	66.9	66.2	65.6
Flour Abs (14% mb)	64.4	65.0	64.3
Mix Time (min)	4.00	5.38	3.75
Mix tolerance (0-6)	4	5	3
FARINOGRAPH			
Flour Abs (% as-is)	62.3	60.8	63.0
Flour Abs (14% mb)	59.8	59.6	61.6
Development time (min)	6.4	6.9	9.0
Mix stability (min)	36.3	29.5	24.3
Mix Tolerance Index (FU)	16	16	10
Breakdown time (min)	37.1	17.2	24.6
ALVEOGRAPH			
P(mm. $_{H2O}$): Tenacity	75	86	95
L(mm): Extensibility	123	97	94
G($mm_{0.5}$): Swelling index	24.7	21.9	21.6
W(10^{-4} J): strength (curve area)	335	323	330
P/L: curve configuration ratio	0.61	0.89	1.01
Ie(P_{200}/P): elasticity index	66.0	68.2	64.4
EXTENSIGRAPH			
Resist (BU at 30/60/90 min)	440/610/664	531/886/965	430/558/642
Extensibility (mm at 30/60/90 min)	153/142/142	124/114/103	133/130/126
Energy (cm^2 at 30/60/90 min)	121/153/166	104/140/125	94/114/125
Resist $_{max}$ (BU at 30/60/90 min)	621/872/973	676/1000/997	553/714/817
Ratio (at 30/60/90 min)	2.9/4.3/4.7	4.3/7.8/9.4	3.2/4.3/5.1
PROTEIN ANALYSIS			
HMW-GS Composition	?, 1, 7+8, 5+10	2*, 7+8, 5+10	2*, 7+8, 5+10
Glu/Gli	1.80	1.76	2.22
HMW/LMW	0.50	0.50	0.30
%IPP	50.47	53.15	49.25
SEDIMENTATION TEST			
Volume (ml)	68.7	68.7	61.7

Colorado: Cumulative Ash Curves



Hatcher - 2405					CO04393 - 2406					CO04499 - 2407				
Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)	Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)	Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)
2M	14.94	0.28	14.94	0.28	1M	6.32	0.28	6.32	0.28	1M	6.28	0.27	6.28	0.27
1M	6.07	0.29	21.00	0.28	2M	16.96	0.28	23.28	0.28	2M	16.88	0.28	23.16	0.27
1M Red	3.55	0.30	24.55	0.28	1M Red	3.43	0.30	26.71	0.28	1M Red	3.33	0.29	26.50	0.28
3M	14.49	0.34	39.04	0.30	3M	16.42	0.31	43.13	0.29	3M	15.93	0.32	42.42	0.29
2BK	5.03	0.36	44.07	0.31	4M	7.79	0.36	50.92	0.30	2BK	4.00	0.36	46.42	0.30
Grader	2.06	0.37	46.13	0.31	2BK	3.73	0.40	54.65	0.31	4M	7.75	0.37	54.17	0.31
4M	7.06	0.38	53.20	0.32	Grader	1.49	0.43	56.14	0.31	1BK	4.51	0.39	58.68	0.31
1BK	5.31	0.38	58.51	0.33	1BK	4.21	0.43	60.35	0.32	Grader	1.45	0.40	60.12	0.32
FILTER FLR	1.14	0.63	59.65	0.33	BRAN FLR	0.99	0.64	61.34	0.33	3BK	4.86	0.64	64.98	0.34
5M	2.84	0.64	62.48	0.35	3BK	4.81	0.66	66.15	0.35	FILTER FLR	0.50	0.66	65.49	0.34
3BK	5.97	0.67	68.46	0.37	5M	2.40	0.80	68.56	0.37	5M	2.86	0.76	68.34	0.36
BRAN FLR	2.24	1.34	70.70	0.40	FILTER FLR	2.26	1.50	70.82	0.40	BRAN FLR	2.67	1.37	71.01	0.40
Break Shorts	2.22	2.98	72.92	0.48	Break Shorts	2.02	3.52	72.83	0.49	Break Shorts	2.17	4.58	73.19	0.52
Red Dog	2.42	1.67	75.34	0.52	Red Dog	1.97	2.06	74.80	0.53	Red Dog	2.41	1.22	75.60	0.54
Red Shorts	0.07	4.12	75.41	0.52	Red Shorts	0.04	3.26	74.84	0.53	Red Shorts	0.00	3.42	75.60	0.54
Filter Bran	0.55	1.80	75.97	0.53	Filter Bran	0.75	2.57	75.59	0.55	Filter Bran	0.61	2.10	76.21	0.56
Bran	24.03	4.98	100.00	1.60	Bran	24.41	4.98	100.00	1.63	Bran	23.79	4.80	100.00	1.57
Wheat Ash		1.64			Wheat Ash		1.61			Wheat Ash		1.52		
Straight Grade Flour Ash		0.44			Straight Grade Flour Ash		0.45			Straight Grade Flour Ash		0.44		

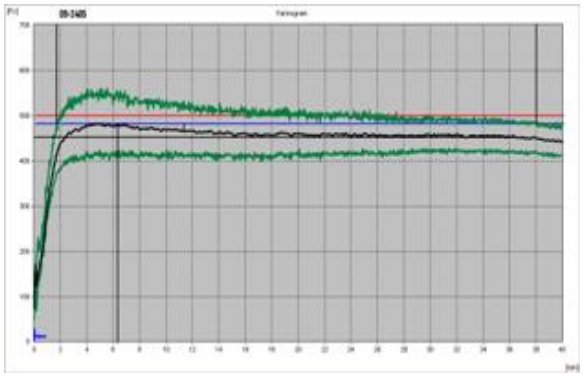
Colorado: Cumulative Protein Curves



	Hatcher - 2405					CO04393 - 2406					CO04499 - 2407			
Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)	Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)	Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)
1M	6.1	11.3	6.1	11.3	1M	6.3	12.1	6.3	12.1	2M	16.9	11.8	16.9	11.8
1M Red	3.5	11.5	9.6	11.4	1M Red	3.4	12.4	9.8	12.2	3M	15.9	11.8	32.8	11.8
2M	14.9	11.5	24.6	11.5	3M	16.4	12.4	26.2	12.3	1M Red	3.3	11.8	36.1	11.8
3M	14.5	11.7	39.0	11.6	2M	17.0	12.4	43.1	12.4	1M	6.3	12.0	42.4	11.8
4M	7.1	12.2	46.1	11.7	4M	7.8	12.9	50.9	12.4	4M	7.7	12.1	50.2	11.9
5M	2.8	13.2	48.9	11.8	5M	2.4	14.5	53.3	12.5	5M	2.9	13.4	53.0	11.9
1BK	5.3	13.6	54.3	11.9	Grader	1.5	14.6	54.8	12.6	Grader	1.4	14.1	54.5	12.0
Grader	2.1	13.8	56.3	12.0	BRAN FLR	1.0	14.6	55.8	12.6	1BK	4.5	14.4	59.0	12.2
FILTER FLR	1.1	13.9	57.5	12.0	1BK	4.2	14.7	60.0	12.8	FILTER FLR	0.5	14.7	59.5	12.2
2BK	5.0	16.3	62.5	12.4	2BK	3.7	16.4	63.7	13.0	2BK	4.0	16.4	63.5	12.5
3BK	6.0	17.0	68.5	12.8	3BK	4.8	17.2	68.6	13.3	3BK	4.9	17.2	68.3	12.8
BRAN FLR	2.2	18.7	70.7	13.0	FILTER FLR	2.3	19.7	70.8	13.5	BRAN FLR	2.7	19.6	71.0	13.1
Break Shorts	2.2	17.3	72.9	13.1	Break Shorts	2.0	16.6	72.8	13.6	Break Shorts	2.2	16.4	73.2	13.2
Red Dog	2.4	14.5	75.3	13.2	Red Dog	2.0	16.5	74.8	13.7	Red Dog	2.4	15.6	75.6	13.2
Red Shorts	0.1	15.0	75.4	13.2	Red Shorts	0.0	15.3	74.8	13.7	Red Shorts	0.0	14.8	75.6	13.2
Filter Bran	0.6	12.7	76.0	13.2	Filter Bran	0.7	18.1	75.6	13.7	Filter Bran	0.6	13.2	76.2	13.2
Bran	24.0	19.0	100.0	14.6	Bran	24.4	19.7	100.0	15.2	Bran	23.8	19.0	100.0	14.6
Whole Wheat		14.0			Whole Wheat		14.7			Whole Wheat		14.3		
St Grade Flour		13.0			St Grade Flour		13.5			St Grade Flour		13.1		

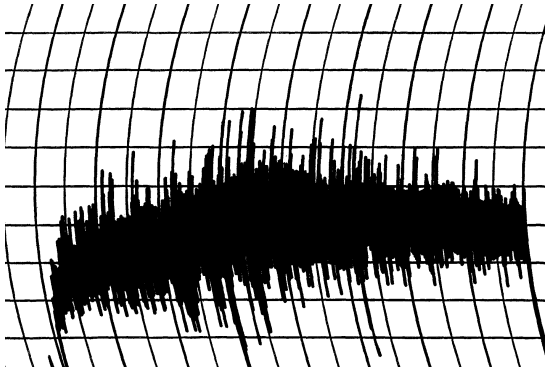
Physical Dough Tests
2009 (Small Scale) Samples – Colorado

Farinograms



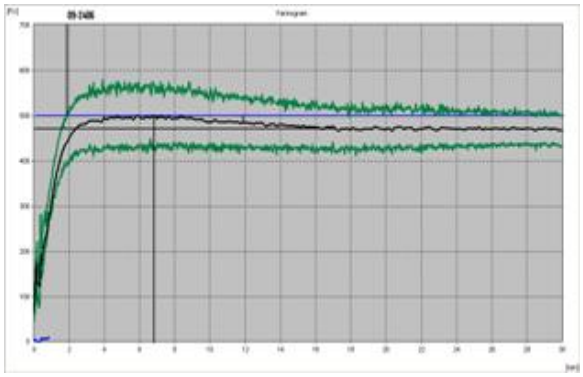
Water abs = 59.8%, Peak time = 6.4 min,
Mix stab = 36.3 min, MTI = 16 FU

Mixograms

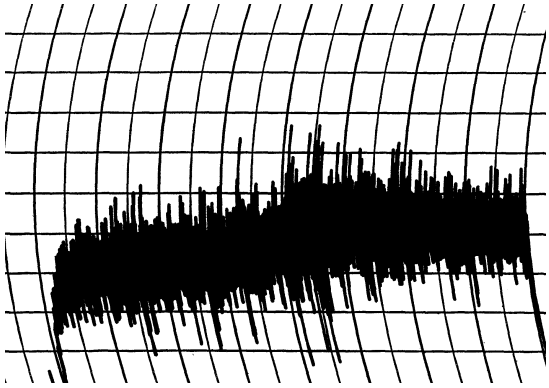


Water abs = 64.4%
Mix time = 4.0 min

09-2405, Hatcher (check)



Water abs = 59.6%, Peak time = 6.9 min,
Mix stab = 29.5 min, MTI = 16 FU



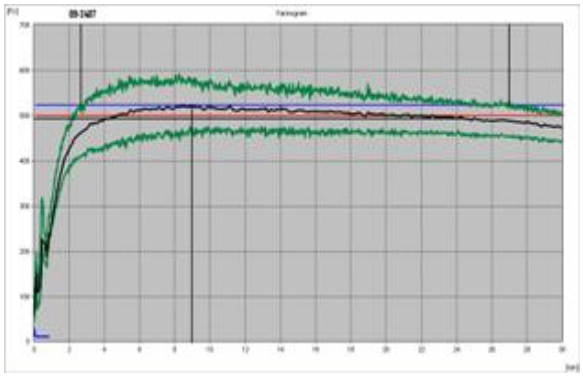
Water abs = 65.0%
Mix time = 5.4 min

09-2406, CO04393

Physical Dough Tests

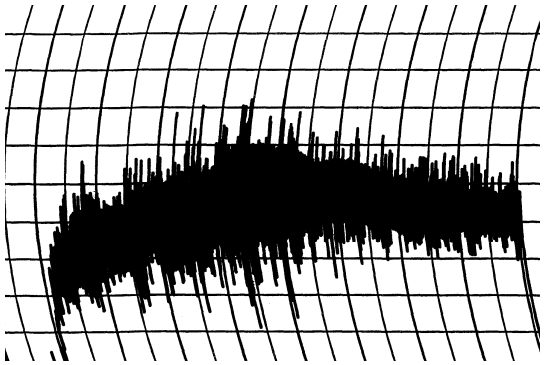
2009 (Small Scale) Samples – Colorado (continued)

Farinograms



Water abs. = 61.6%, Peak time = 9.0 min,
Mix stab = 24.3 min, MTI = 10 FU

Mixograms

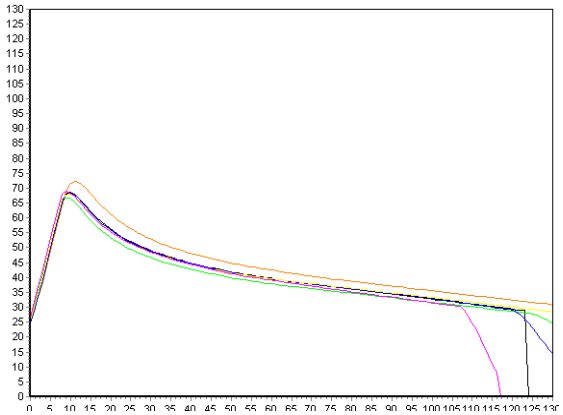


Water abs = 64.3%
Mix time = 3.8 min

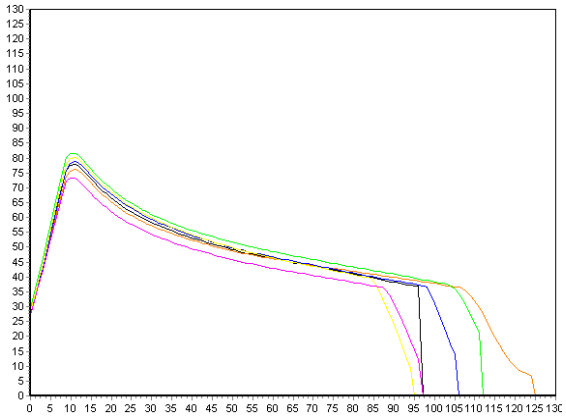
09-2407, CO04499

Physical Dough Tests - Alveograph

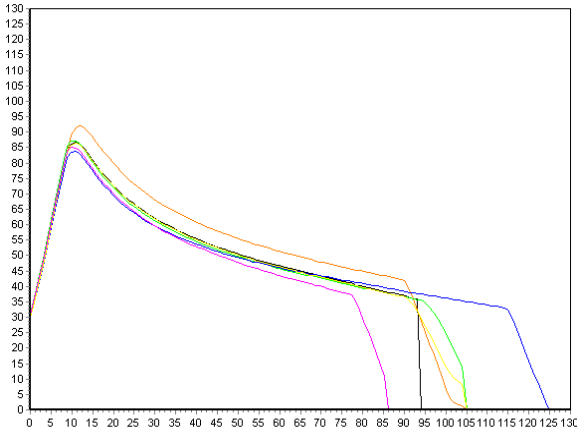
2009 (Small Scale) Samples – Colorado



09-2405 (Hatcher – check)
P(mm $_{H20}$)=75, L(mm)=123, W(10^{-4} J)=335



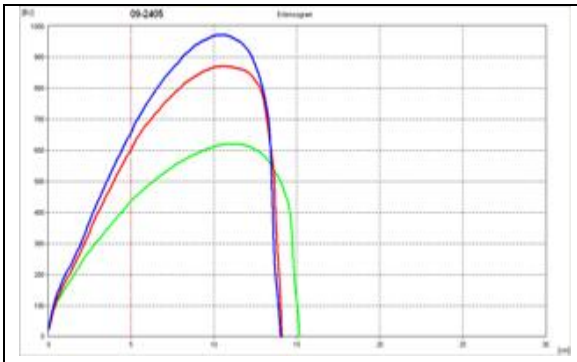
09-2406 (CO04393)
P(mm $_{H20}$)=86, L(mm)=97, W(10^{-4} J)=323



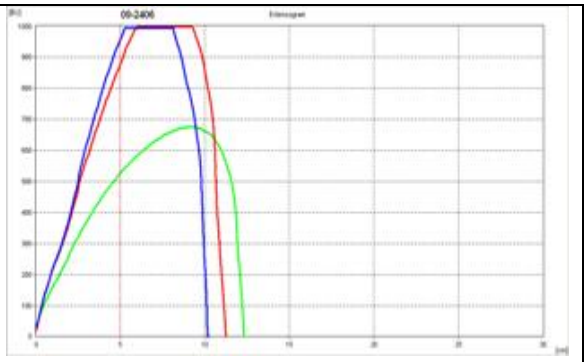
09-2407 (CO04499)
P(mm $_{H20}$)=95, L(mm)=94, W(10^{-4} J)=330

Physical Dough Tests - Extensigraph

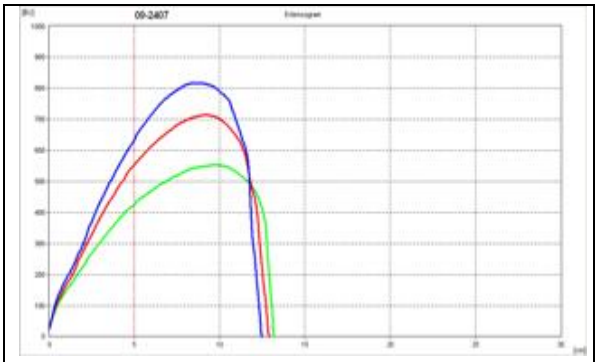
2009 (Small Scale) Samples – Colorado



09-2405 (Hatcher - check)
R (BU) = 440, E (mm) = 153, W (cm^2) = 121
Rmax (BU) = 621, Ratio = 2.9 at 30 min



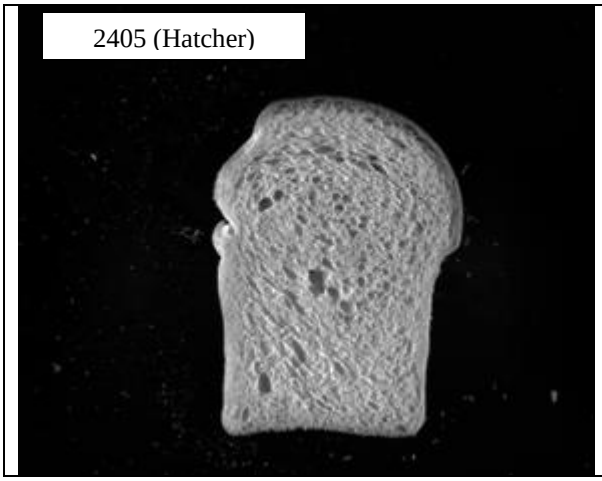
09-2406 (CO04393)
R (BU) = 531, E (mm) = 124, W (cm^2) = 104
Rmax (BU) = 676, Ratio = 4.3 at 30 min

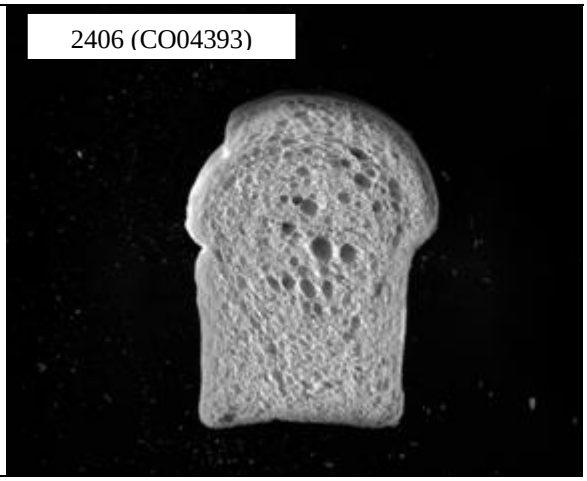


09-2407 (CO04499)
R (BU) = 430, E (mm) = 133, W (cm^2) = 94
Rmax (BU) = 553, Ratio = 3.2 at 30 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

Colorado: C-Cell Bread Images and Analysis for 2009 (Small-Scale) Samples





Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2405	6577	147.4	4016	0.448	2.032	4.933	1.69	-26.5
2406	6459	146.8	3626	0.453	2.198	3.127	1.66	-20.0

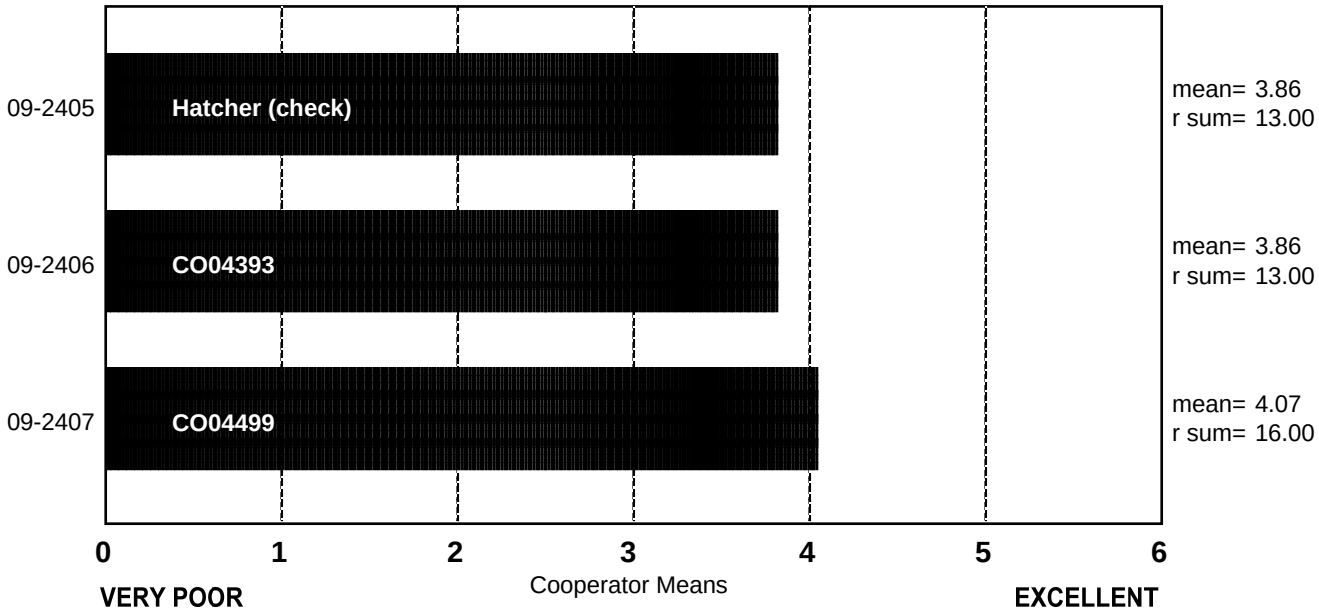
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2407	6376	143.3	3897	0.446	2.041	5.085	1.70	-19.7

SPONGE CHARACTERISTICS

(Small Scale) Colorado

ncoop= 7
chisq= 0.86
chisqc= 1.50
cvchisq= 5.99
crdiff=

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

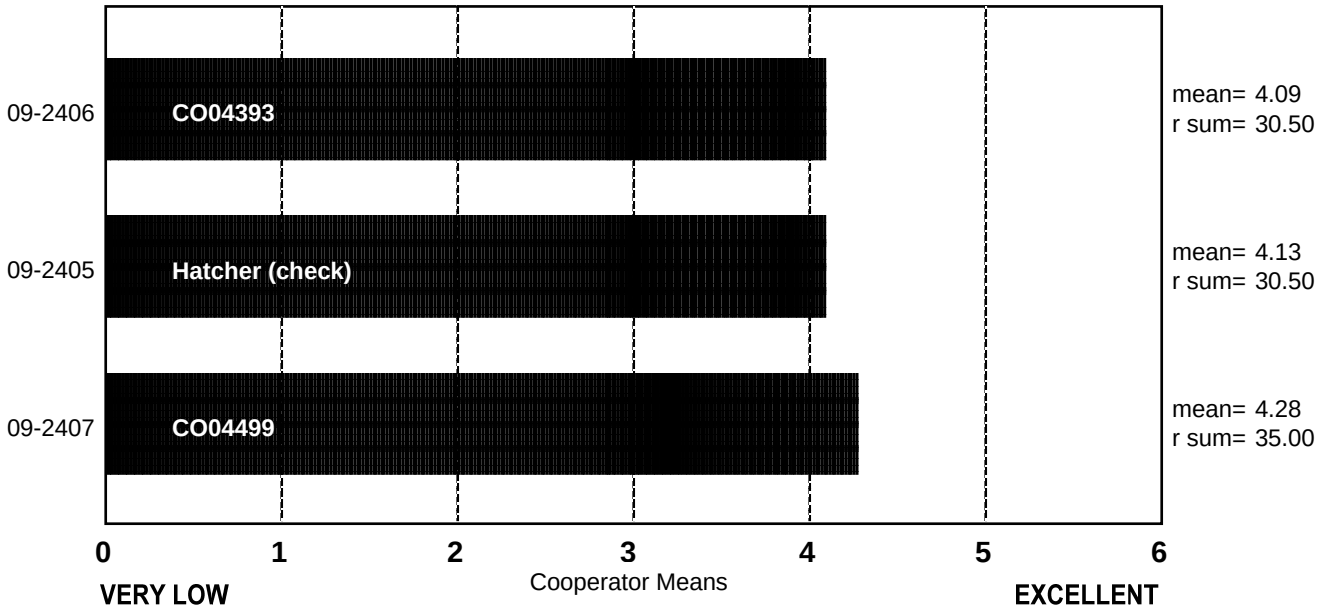


BAKE ABSORPTION

(Small Scale) Colorado

ncoop= 16
chisq= 0.84
chisqc= 1.23
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) 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
09-2405 Hatcher (check)	**61.3**	**57.0**	**59.0**	**67.7**	**64.4**	**61.8**	**63.5**	**64.0**	**60.0**	**60.0**	**68.1**	**69.3**	**60.5**	**64.9**	**62.8**	**58.3**	**64.7**
09-2406 CO04393	**61.1**	**58.0**	**60.0**	**69.8**	**65.0**	**61.6**	**65.0**	**64.0**	**61.0**	**60.0**	**69.1**	**69.9**	**60.5**	**64.4**	**62.6**	**58.1**	**65.5**
09-2407 CO04499	**62.6**	**56.0**	**59.0**	**69.0**	**64.3**	**63.3**	**63.5**	**64.0**	**62.0**	**61.0**	**68.1**	**69.2**	**61.0**	**64.2**	**64.6**	**60.1**	**65.9**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Colorado

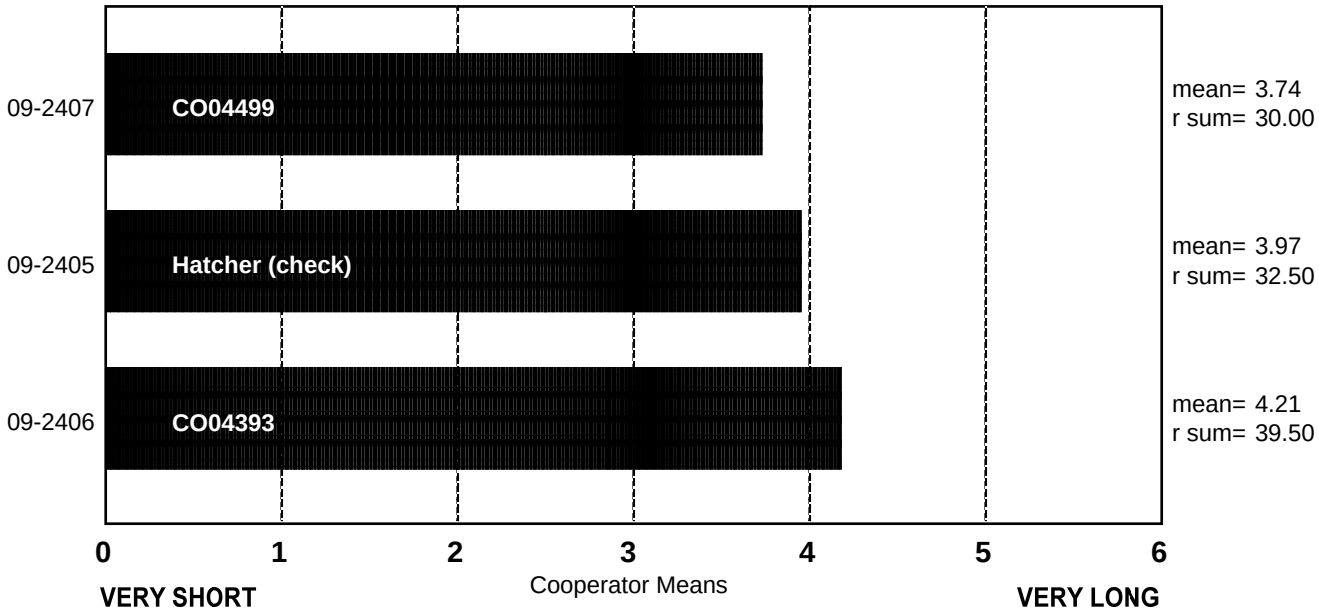
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2405 Hatcher (check)	**2.0**	**6.0**	**20.0**	**4.6**	**4.0**	**6.5**	**5.3**	**9.0**	**6.0**	**25.0**	**3.8**	**4.7**	**29.0**	**3.2**	**10.0**	**4.5**	**5.4**
09-2406 CO04393	**1.8**	**7.0**	**11.0**	**5.0**	**5.0**	**7.0**	**6.0**	**9.0**	**10.0**	**25.0**	**5.3**	**5.4**	**30.0**	**3.9**	**8.0**	**5.3**	**5.6**
09-2407 CO04499	**2.0**	**9.0**	**12.0**	**4.4**	**4.0**	**8.0**	**5.8**	**9.0**	**7.0**	**25.0**	**3.8**	**4.5**	**19.0**	**2.9**	**7.0**	**4.3**	**4.5**

BAKE MIX TIME

(Small Scale) Colorado

ncoop= 17
chisq= 2.85
chisqc= 4.13
cvchisq= 5.99
crdiff=

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

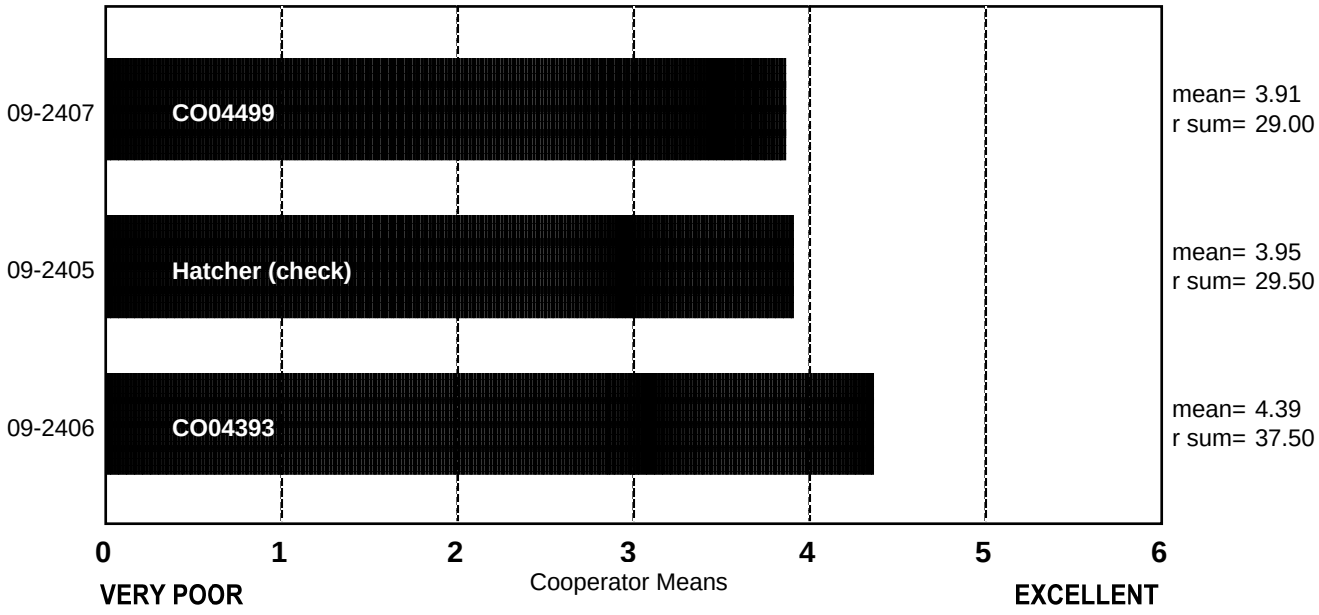


MIXING TOLERANCE

(Small Scale) Colorado

ncoop= 16
chisq= 2.84
chisqc= 3.71
cvchisq= 5.99
crdiff=

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

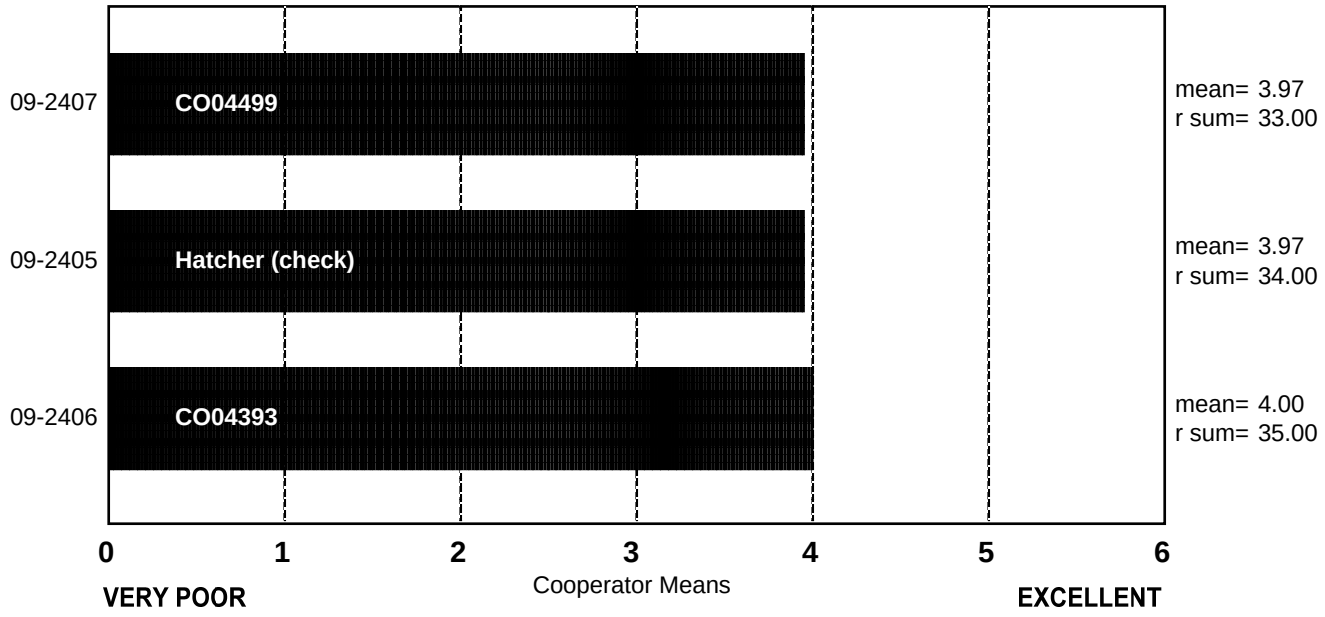


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Colorado

ncoop= 17
chisq= 0.12
chisqc= 0.20
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) Colorado

	Sticky	Wet	Tough	Good	Excellent
09-2405 Hatcher (check)	**2**	**2**	**5**	**6**	**2**
09-2406 CO04393	**1**	**3**	**4**	**8**	**1**
09-2407 CO04499	**2**	**2**	**1**	**11**	**1**

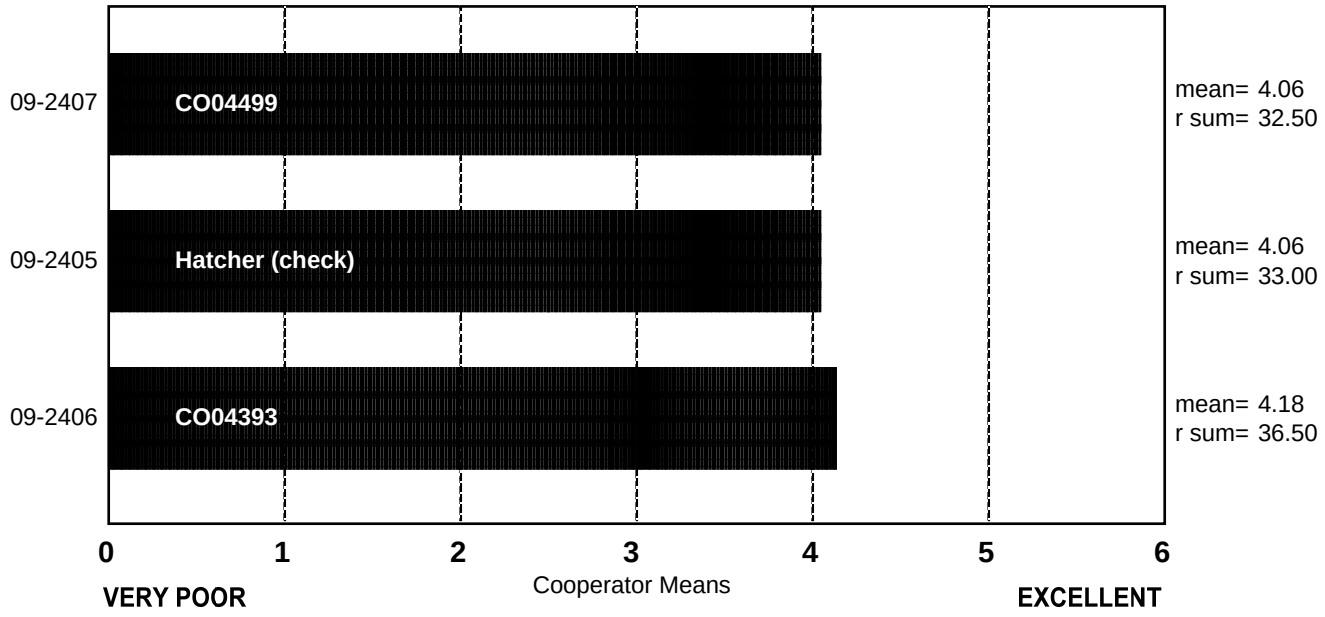
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Colorado

ncoop= 17
chisq= 0.56
chisqc= 0.97
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) Colorado

	Sticky	Wet	Tough	Good	Excellent
09-2405 Hatcher (check)	**0**	**2**	**5**	**8**	**2**
09-2406 CO04393	**0**	**1**	**4**	**11**	**1**
09-2407 CO04499	**2**	**1**	**1**	**12**	**1**

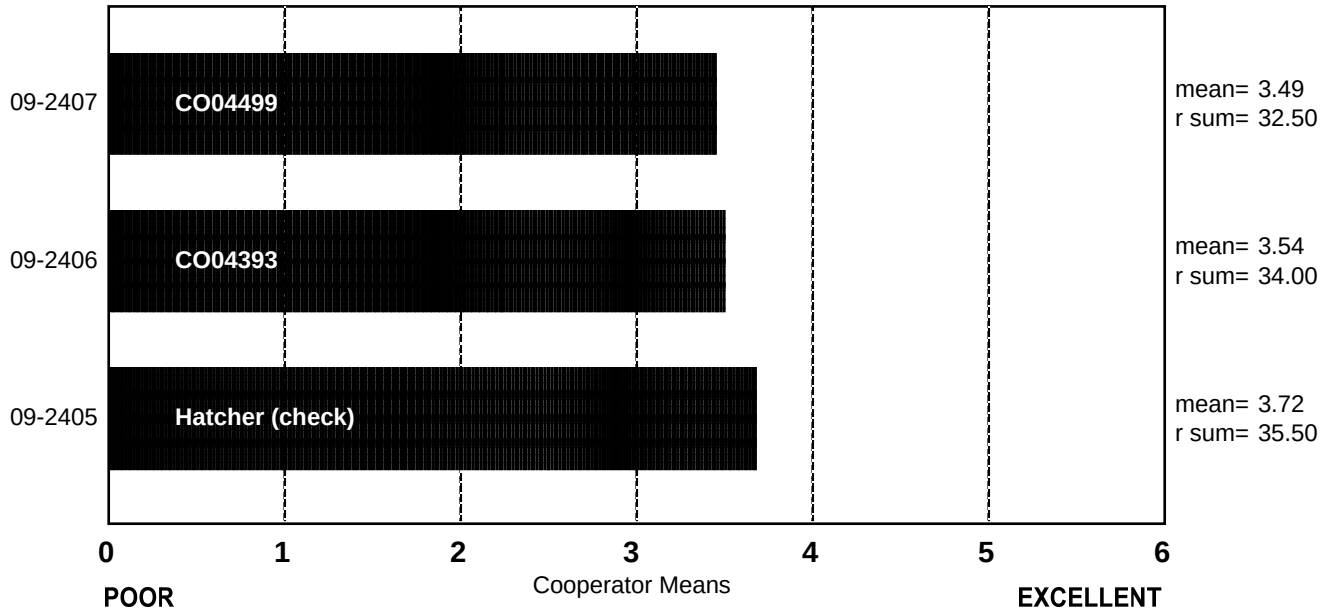
Frequency Table

CRUMB GRAIN

(Small Scale) Colorado

ncoop= 17
chisq= 0.26
chisqc= 0.38
cvchisq= 5.99
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Colorado

	Open	Fine	Dense
09-2405 Hatcher (check)	**11**	**5**	**1**
09-2406 CO04393	**11**	**6**	**0**
09-2407 CO04499	**13**	**4**	**0**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Colorado

	Round	Irregular	Elongated
09-2405 Hatcher (check)	**5**	**6**	**6**
09-2406 CO04393	**6**	**4**	**7**
09-2407 CO04499	**4**	**8**	**5**

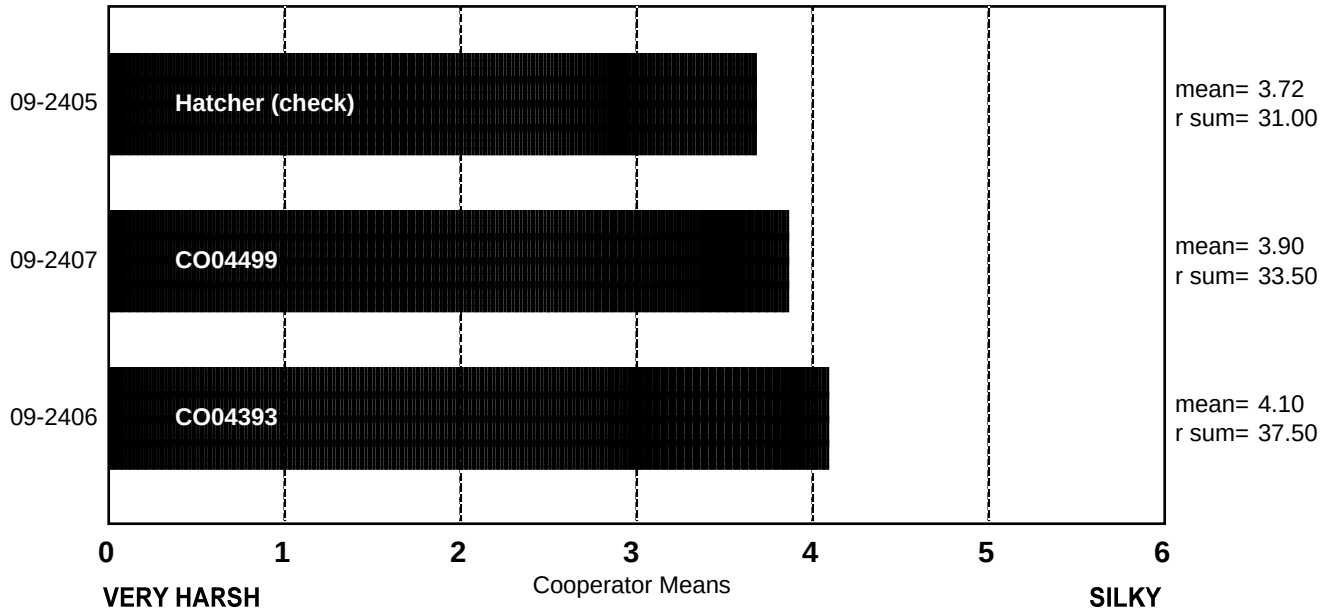
Frequency Table

CRUMB TEXTURE

(Small Scale) Colorado

ncoop= 17
chisq= 1.26
chisqc= 1.91
cvchisq= 5.99
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Colorado

	Harsh	Smooth	Silky
09-2405 Hatcher (check)	**4**	**11**	**2**
09-2406 CO04393	**3**	**11**	**3**
09-2407 CO04499	**2**	**14**	**1**

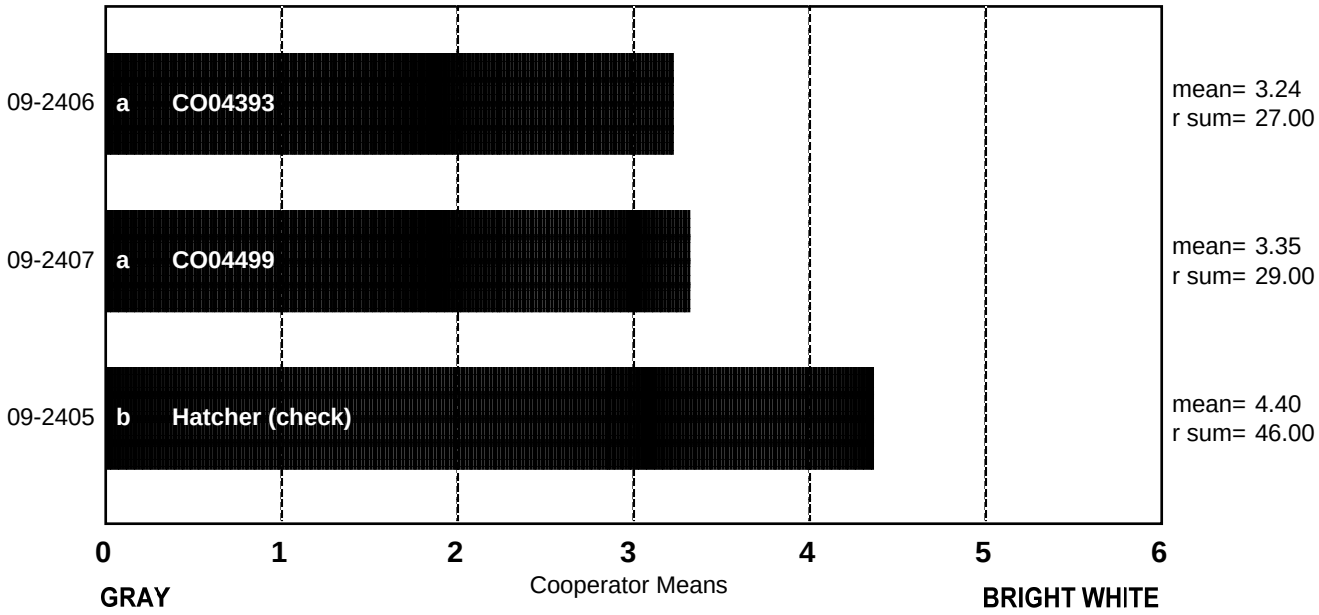
Frequency Table

CRUMB COLOR

(Small Scale) Colorado

ncoop= 17
chisq= 12.82
chisqc= 18.17
cvchisq= 5.99
crdiff= 6.36

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



CRUMB COLOR, DESCRIBED

(Small Scale) Colorado

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
09-2405 Hatcher (check)	**0**	**0**	**0**	**2**	**6**	**8**	**1**
09-2406 CO04393	**0**	**1**	**2**	**9**	**5**	**0**	**0**
09-2407 CO04499	**0**	**2**	**2**	**5**	**8**	**0**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Colorado

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2405 Hatcher (check)	**133.9**	**490.0**	**419.0**	**153.5**	**154.8**	**471.0**	**144.6**		**465.4**	**468.8**	**139.3**	**144.3**			**452.7**	**126.7**	**153.2**
09-2406 CO04393	**134.6**	**495.0**	**415.0**	**156.2**	**154.0**	**471.0**	**148.4**		**462.7**	**471.3**	**140.0**	**143.8**			**455.6**	**126.8**	**149.7**
09-2407 CO04499	**134.7**	**490.0**	**418.0**	**156.4**	**154.1**	**472.0**	**145.9**		**462.9**	**470.8**	**141.5**	**146.4**			**458.2**	**126.9**	**153.6**

LOAF VOLUME, ACTUAL

(Small Scale) Colorado

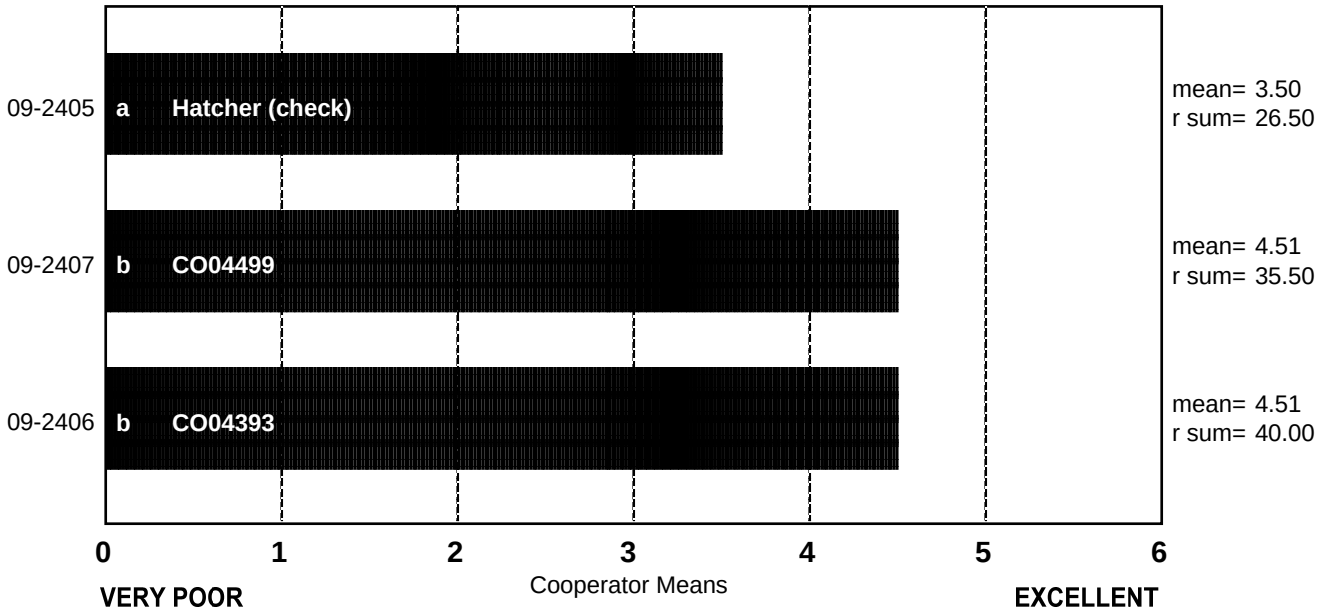
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2405 Hatcher (check)	**700**	**2800**	**2900**	**935**	**646**	**2775**	**898**	**990**	**2563**	**3074**	**1085**	**782**	**2725**	**930**	**2375**	**820**	**875**
09-2406 CO04393	**745**	**2900**	**2950**	**995**	**662**	**2850**	**938**	**1020**	**2663**	**3104**	**1195**	**931**	**2800**	**1040**	**2400**	**870**	**920**
09-2407 CO04499	**740**	**3100**	**2925**	**905**	**631**	**2850**	**940**	**978**	**2563**	**3104**	**1048**	**958**	**2800**	**1025**	**2350**	**830**	**930**

LOAF VOLUME

(Small Scale) Colorado

ncoop= 17
chisq= 5.56
chisqc= 7.88
cvchisq= 5.99
crdiff= 8.51

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

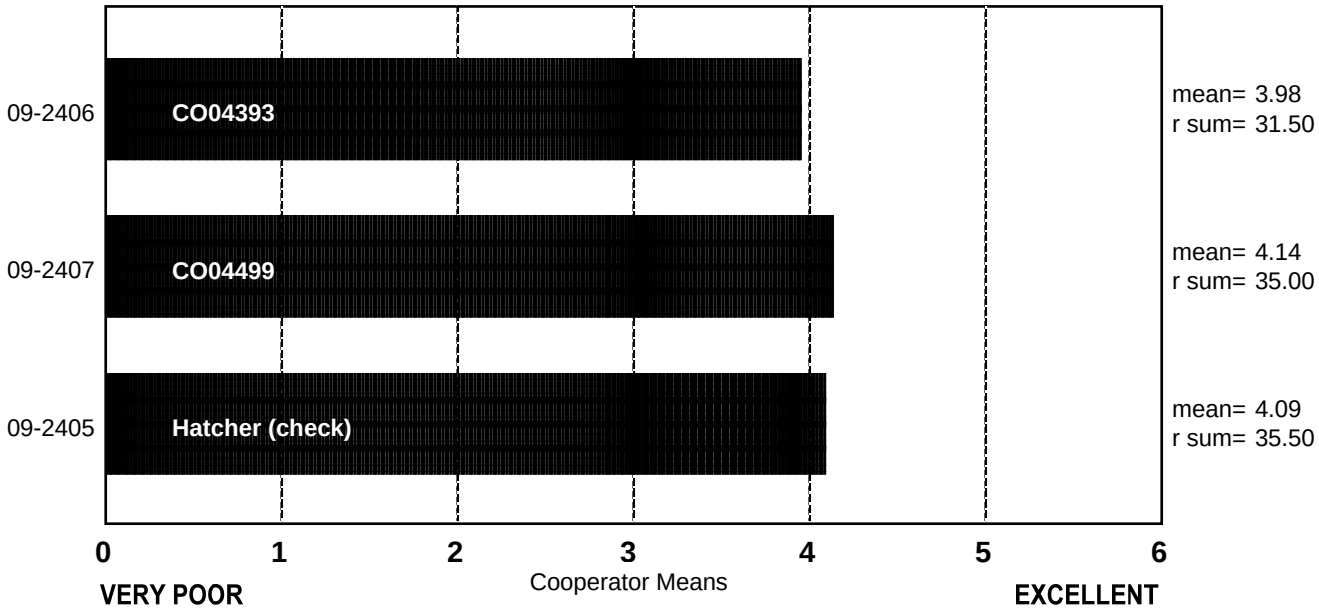


OVERALL BAKING QUALITY

(Small Scale) Colorado

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

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



COOPERATOR'S COMMENTS
(Small Scale) Colorado

COOP. **09-2405 Hatcher (check)**

A. Low loaf volume.
B. No comment.
C. Open grain. Average volume. Tough out of mixer. Strong dough Harsh texture.
D. Good dough properties, loaf volume performance less than expected, average interior.
E. No comment.
F. No comment.
G. Normal Water Abs & Mix Time, Shorter Proof Time, Soft & Slight Strong Dough, Very High OS & Vol, fine elongated cells, white crumb, silky & medium resilient texture.
H. High protein, average bake performance for that protein level, but good dough handling.
I. Good grain.
J. sl. Open, variable, sl. Coarse grain, excellent volume
K. No comment.
L. Slow dough pickup during mixing - downgraded the mixing score.
M. No comment.
N. No comment.
O. Low Abs.- Good Grain- Average Volume and Color.
P. No comment.
Q. Satisfactory absorption; good MT; satisfactory tolerance; good at pan; open & irregualr crumb; dull color.

COOP. **09-2406 CO04393**

A. Low loaf volume.
B. Open grain and dull.
C. Very open shotty grain. Slightly soft out of mixer Good at make-up. Dull crumb color. Good volume.
D. Very good dough properties, average interior and loaf volume performance.
E. No comment.
F. No comment.
G. Higher Water Abs, Medium Mix Time, Shorter Proof Time, Slight Sticky & Strong Dough, Very High OS & Vol, open elongated Cells, Slight Yellow Crumb, Smooth & Medium Resilient Texture.
H. High protein, good bake performance. Sl weak out of mixer but good handling on the bench - gassy doughs.
I. Tough dough, open grain, average volume.
J. Slightly open, sl. Irregular grain, coarse texture, excellent volume.
K. No comment.
L. Slow dough pickup during mixing - downgraded the mixing score.
M. No comment.
N. No comment.
O. Low Abs- Low Mix Time- Tough in mixer and make-up phase.

P. No comment.
Q. Satisfactory absorption; good MT; excellent tolerance; good at pan; fine crumb grain.

COOP. 09-2407 CO04499

A. Low loaf volume.
B. Good volume.
C. Very open shotty grain. Good dough out of mixer. Good volume. Slightly dull crumb color.
D. Very good dough properties, average interior and low loaf volume performance.
E. No comment.
F. No comment.
G. Normal water abs, medium mix time & proof time, slight sticky & strong dough, very high OS & Vol, Open Elongated Cells, Slight Yellow Crumb, Smooth & Low Resilient Texture.
H. High protein, good bake performance but weak out of mixer and weak dough handling on the bench. Bread recovered somewhat but sample had less than ideal dough handling characteristics.
I. Open grain.
J. Slightly open, sl. Irregular grain, coarse texture, excellent volume.
K. No comment.
L. Slow dough pickup during mixing - downgraded the mixing score.
M. No comment.
N. No comment.
O. Low Mix Time- Good Grain- Average Volume.
P. No comment.
Q. Excellent absorption & bake MT; slight weakness at pan; above satisfactory crumb grain; creamy crumb.

Notes: **B, C, H, I, J, M, and O** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

Oklahoma State University - Brett Carver

Our 2009 WQC grain samples were produced under limited supplemental irrigation at the Oklahoma Panhandle Research and Extension Center at Goodwell, OK, and with no supplemental irrigation at the North Central Agronomy Research Station at Lahoma, OK. The grow-out at Goodwell was moderately hindered by wheat streak mosaic virus and barley yellow dwarf virus. Grain yield hovered in the 70-to-80 bu/ac range, though yields surpassing 90 bu/ac were not uncommon. Wheat protein content averaged 14.5% at Goodwell, a level that is common to the Oklahoma panhandle. Standard pre-plant fertilization practices were conducted, anticipating 100 bu/ac yields.

The grow-out at Lahoma endured a potential knockout from an early spring freeze event in April, only to come back to a moderately heavy infection of leaf rust and other foliar pathogens in May. Average yields at Lahoma struggled to break the soil-fertility target of 50 bu/ac. Wheat protein levels at Lahoma came out right on target – about 13%. The Goodwell location, though harvested later relative to final maturity, produced overall better milling quality (57 lb/bu test wt. or better) than the Lahoma site (56 lb/bu or better), thanks to a damp harvest. Entries included in the 2009 WQC Oklahoma sample feature inherently higher milling quality.

OK Bullet (check)

We continue to use OK Bullet (*KS96WGRC39/Jagger*) as a WQC check, as it rapidly climbed to fourth place in planted Oklahoma acreage in 2009. Since its release to registered seed producers in fall 2005, OK Bullet has shown utility throughout the state but has commanded greatest attention in the southwest and northwest. Interest in northcentral Oklahoma has already moderated with the advent of leaf rust races with virulence to *Lr41*. OK Bullet shows excellent green-leaf retention and tolerance to wheat spindle streak mosaic virus (WSSMV), wheat soil-borne mosaic virus (WSBMV), stripe rust, and moderate tolerance to acidic soils. Winter hardiness is average. Wheat protein content typically falls between 12.5 and 13.5%, exceeding Endurance by at least one percentage point. OK Bullet combines high test weight with large kernel size, has above-average milling and baking quality, and excels in internal loaf characteristics. It sometimes scores below-average in mixing tolerance due to a steeper angle of decline in the mixing curve, though bandwidth is acceptable, typically 20 mm at 2 min past peak dough development. We will likely replace OK Bullet with either Duster or Billings in future WQC evaluations, as the latter appear to have broader grower appeal and they prevail in the pedigrees of OSU underclassmen.

Billings

No longer an experimental as previously tested under the number OK03522, Billings resulted from a single cross of a line developed by the Institute of Plant

Breeding in Odessa, Ukraine (N566) and an OSU experimental line (OK94P597) derived from the Pioneer hard winter wheat program with the pedigree, HBY3598/Fundulea 133//TAM 200. With exception of the drought-stress year of 2006, and with exception of the southwest corner of the state, grain yields have easily matched or exceeded those of Endurance, OK Bullet, and Duster, with superior performance exhibited in the Enid area, and in the panhandle under irrigation. Performance in 2009, however, was foiled by Billings' early winter dormancy release. Based on alleles present at three loci known to influence reproductive development (*VRN-A1*, *PPD-D1*, and *VRN-D3*), the developmental pattern of Billings most closely resembles the variety Jagalene.

Over the past five years, Billings has averaged 12.5% wheat protein across Oklahoma (or about 0.3 percentage point lower than OK Bullet), excellent farinograph absorption (>61.5%) and stability (>12 min) with average peak time (5 min), and excellent mixograph stability (<6.5) with high bandwidth at 2 min past the peak (> 15 mm). Billings produces a distinctive kernel: elongated and large. It takes OSU germplasm where it has previously not been, even compared to OK Bullet. Though 2009 was not the ideal year for measuring kernel weight, we expect Billings to settle in at a TKW exceeding 33g and kernel diameter >2.5mm.

Billings provides adult-plant resistance to stripe rust, seedling and adult-plant resistance to leaf rust, some tolerance to powdery mildew (between Duster and OK Bullet), good tolerance to soil acidity, good resistance to WSBMV (perhaps less to WSSMV), and excellent shattering tolerance. Jeers for Billings include susceptibilities to barley yellow dwarf virus, spring drought stress, and delayed-harvest sprouting. Though not necessarily a negative characteristic, Billings might be considered a reverse-vegetarian, as it prefers not to be consumed by beef cattle, due in part to below-average grazing tolerance. This HRW variety was licensed to Oklahoma Genetics, Inc. in 2009, and is currently in the hands of certified seed producers.

OK05526

The OSU Wheat Improvement Team has made it a personal goal to find an Endurance prodigy that has more endurance. OK05526 is our first shot, having the pedigree KS94U275/OK94P549. The second parent in the pedigree was the heterogeneous line from which Endurance (OK94P549-98-6611, or OK94P549-11 for short) was selected. We wanted a line that has the blood and guts of Endurance, but with improved test weight and yielding ability, earlier maturity, more consistent plant height expression, and even better quality. We found all of that in OK05526, but we had to sacrifice tolerance to acid soils (moderately susceptible, similar to Fuller) to get it. Reaction to stripe rust under field conditions is no better than Endurance, either. Wheat protein content, mixograph performance, and milling properties are almost identical to Billings, as described previously, with possibly even higher loaf volume than Billings. This HRW experimental has excelled in all quality parameters, contrary to its HMW-GS signature of 2*, 7+8, 2+12. Four candidate lines were placed under preliminary foundation seed increase in fall 2009, one of which is OK05526. Its sister line, OK05128, appeared in the 2009 SRPN but will not be advanced.

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

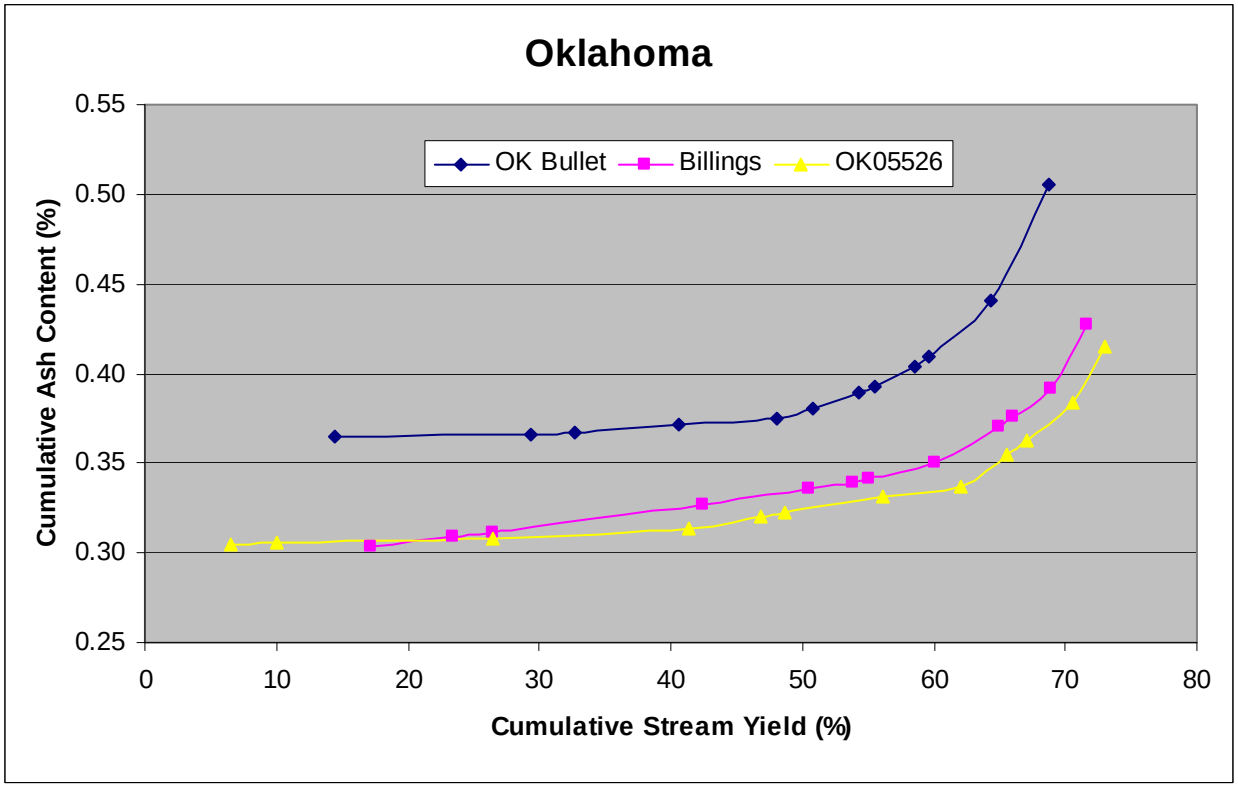
Test entry number	09-2408	09-2409	09-2410
Sample identification	**OK Bullet (check)**	**Billings**	**OK05526**
Wheat Data			
FGIS classification	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	60.2	60.8	61.2
Hectoliter weight (kg/hl)	79.2	80.0	80.5
1000 kernel weight (gm)	26.7	32.2	31.1
NIR hardness	91	84	66
Wheat kernel size (Rotap)			
Over 7 wire (%)	57.2	65.3	70.3
Over 9 wire (%)	42.4	34.6	29.7
Through 9 wire (%)	0.4	0.1	0.0
Single kernel (skcs)			
Hardness (avg /s.d)	91.8/14.8	81.0/14.0	70.8/14.2
Weight (mg) (avg/s.d)	28.5/8.5	34.0/9.2	30.7/8.1
Diameter (mm)(avg/s.d)	2.61/0.33	2.75/0.31	2.68/0.32
SKCS distribution	00-00-01-99	01-01-03-95	00-04-15-81
Classification	Hard	Hard	Hard
Wheat moisture (%)	10.6	10.6	10.5
Wheat protein (12% mb)	14.3	14.0	13.8
Wheat ash (12% mb)	1.56	1.57	1.63
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	68.7	71.5	73.0
Quadrumat Sr. Mill	68.8	69.8	70.1
NIR Flour moisture (%)	12.1	12.6	12.7
NIR Flour protein (14% mb)	12.4	12.5	12.4
Flour ash (14% mb)	0.49	0.45	0.45
Glutomatic			
Wet gluten (%)	33.5	34.7	32.8
Dry gluten (%)	12.1	12.3	12.3
Gluten index	98.2	96.8	98.6
Rapid Visco-Analyser			
Peak time (min)	6.2	6.3	6.2
Peak viscosity (RVU)	212.1	191.4	217.3
Breakdown (RVU)	138.2	55.8	71.8
Final viscosity at 13 min (RVU)	257.8	255.0	272.1
Minolta color meter			
L*	92.01	92.28	92.76
a*	-1.44	-1.32	-1.37
b*	9.76	9.19	8.80
Falling number (sec)	371	419	492
Damaged Starch			
(AI%)	96.99	97.81	95.55
(AACC76-31)	7.07	7.75	5.93

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

Oklahoma: Physical Dough Tests and Gluten Analysis For 2009 (Small-Scale) Samples

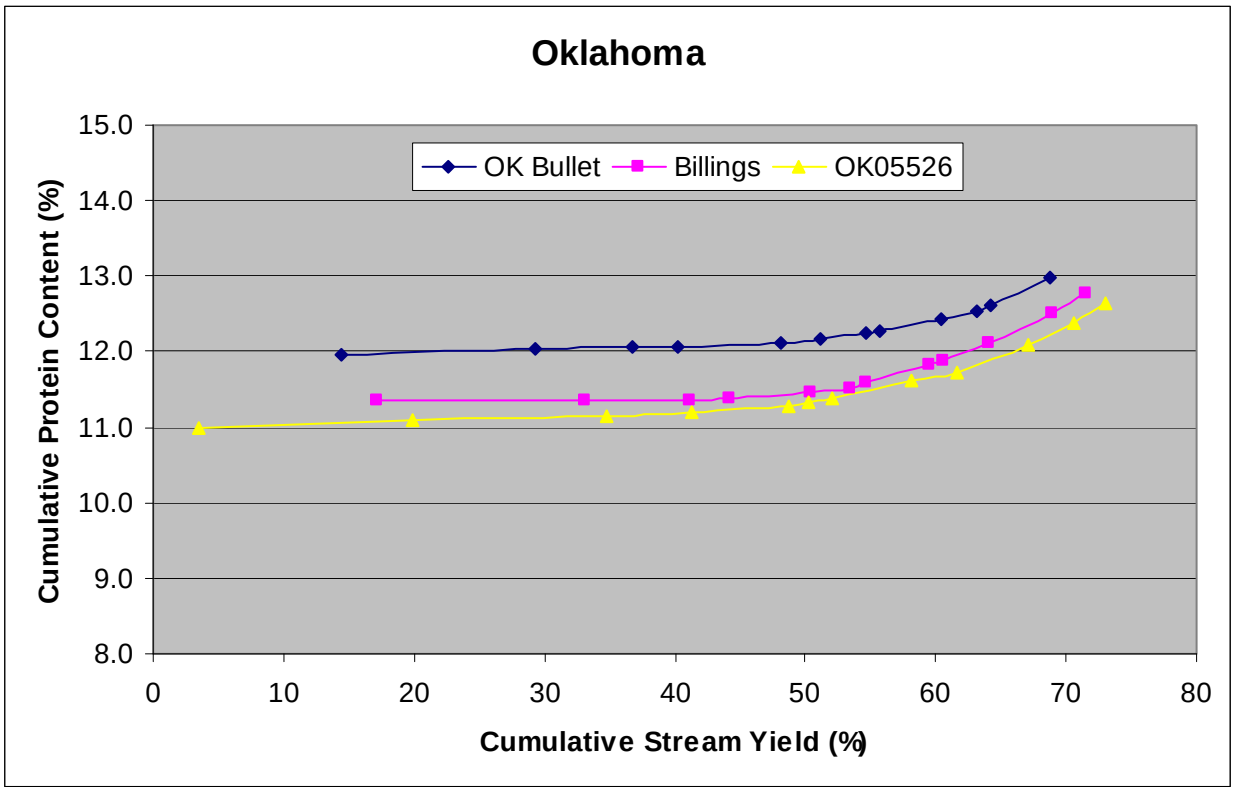
Test Entry Number	09-2408	09-2409	09-2410
Sample Identification	OK Bullet (check)	Billings	OK05526
MIXOGRAPH			
Flour Abs (% as-is)	67.8	67.8	67.0
Flour Abs (14% mb)	65.7	66.2	65.5
Mix Time (min)	4.75	3.63	4.50
Mix tolerance (0-6)	4	4	3
FARINOGRAPH			
Flour Abs (% as-is)	63.5	64.5	61.1
Flour Abs (14% mb)	61.3	62.9	59.6
Development time (min)	7.3	5.3	8.9
Mix stability (min)	29.9	27.7	33.9
Mix Tolerance Index (FU)	7	14	15
Breakdown time (min)	30.0	28.6	36.1
ALVEOGRAPH			
P(mm. $_{H2O}$): Tenacity	100	103	82
L(mm): Extensibility	108	133	131
G($mm_{0.5}$): Swelling index	23.1	25.7	25.5
W(10^{-4} J): strength (curve area)	394	438	373
P/L: curve configuration ratio	0.93	0.77	0.63
Ie(P_{200}/P): elasticity index	65.7	61.1	63.6
EXTENSIGRAPH			
Resist (BU at 30/60/90 min)	430/659/731	433/579/579	541/840/857
Extensibility (mm at 30/60/90 min)	139/132/126	154/144/151	161/147/147
Energy (cm^2 at 30/60/90 min)	105/150/151	123/150/162	156/201/199
Resist $_{max}$ (BU at 30/60/90 min)	613/981/1000	613/831/863	746/995/997
Ratio (at 30/60/90 min)	3.1/5.0/5.8	2.8/4.0/3.8	3.4/5.7/5.9
PROTEIN ANALYSIS			
HMW-GS Composition	1, 17+18, 5+10	1, 7+9, 5+10	1, 2*, 7+9, 2+12
Glu/Gli	1.50	1.95	1.86
HMW/LMW	0.27	0.36	0.51
%IPP	49.78	48.48	51.68
SEDIMENTATION TEST			
Volume (ml)	48.0	65.0	69.0

Oklahoma: Cumulative Ash Curves



OK Bullet - 2408					Billings - 2409					OK05526 - 2410				
Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)	Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)	Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)
2M	14.42	0.36	14.42	0.36	2M	17.13	0.30	17.13	0.30	1M	6.59	0.30	6.59	0.30
3M	14.86	0.37	29.28	0.37	1M	6.22	0.32	23.35	0.31	1M Red	3.51	0.31	10.11	0.31
1M Red	3.44	0.38	32.72	0.37	1M Red	3.10	0.33	26.45	0.31	2M	16.41	0.31	26.52	0.31
1M	7.92	0.39	40.64	0.37	3M	15.97	0.35	42.42	0.33	3M	14.84	0.33	41.36	0.31
4M	7.44	0.40	48.08	0.37	4M	8.01	0.38	50.42	0.34	2BK	5.41	0.36	46.77	0.32
2BK	2.76	0.48	50.84	0.38	2BK	3.42	0.38	53.84	0.34	Grader	1.96	0.38	48.73	0.32
1BK	3.52	0.52	54.36	0.39	Grader	1.25	0.44	55.09	0.34	4M	7.38	0.39	56.11	0.33
Grader	1.11	0.55	55.47	0.39	1BK	4.94	0.45	60.03	0.35	1BK	6.00	0.39	62.10	0.34
5M	3.05	0.61	58.52	0.40	3BK	4.96	0.62	64.99	0.37	3BK	3.48	0.67	65.58	0.35
3BK	1.13	0.68	59.65	0.41	FILTER FLR	1.03	0.71	66.02	0.38	5M	1.43	0.75	67.02	0.36
FILTER FLR	4.64	0.85	64.28	0.44	5M	2.96	0.73	68.97	0.39	FILTER FLR	3.51	0.77	70.53	0.38
BRAN FLR	4.43	1.43	68.71	0.51	BRAN FLR	2.60	1.38	71.57	0.43	BRAN FLR	2.43	1.34	72.96	0.42
Break Shorts	1.74	3.82	70.45	0.59	Break Shorts	2.63	4.04	74.20	0.56	Break Shorts	1.77	4.04	74.74	0.50
Red Dog	0.24	1.55	70.69	0.59	Red Dog	2.36	2.14	76.55	0.60	Red Dog	1.18	1.87	75.91	0.52
Red Shorts	0.00	3.90	70.69	0.59	Red Shorts	0.05	4.39	76.60	0.61	Red Shorts	0.05	3.83	75.96	0.52
Filter Bran	0.00	1.48	70.69	0.59	Filter Bran	0.44	2.26	77.04	0.62	Filter Bran	1.06	1.56	77.02	0.54
Bran	29.31	4.40	100.00	1.71	Bran	22.96	5.13	100.00	1.65	Bran	22.98	5.56	100.00	1.69
Wheat Ash		1.53			Wheat Ash		1.53			Wheat Ash		1.59		
Straight Grade Flour Ash		0.49			Straight Grade Flour Ash		0.45			Straight Grade Flour Ash		0.45		

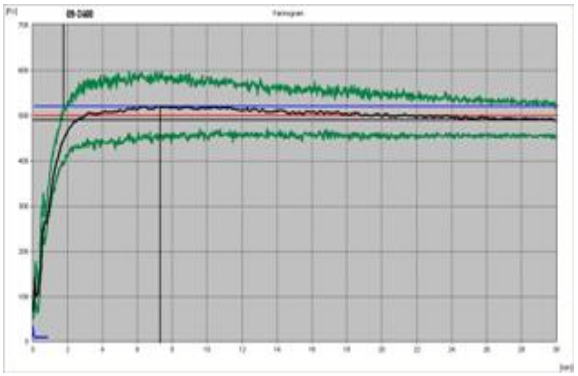
Oklahoma: Cumulative Protein Curves



	OK Bullet- 2408					Billings- 2409					OK05526 - 2410			
Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)	Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)	Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)
2M	14.4	12.0	14.4	12.0	2M	17.1	11.3	17.1	11.3	1M Red	3.5	11.0	3.5	11.0
3M	14.9	12.1	29.3	12.0	3M	16.0	11.3	33.1	11.3	2M	16.4	11.1	19.9	11.1
4M	7.4	12.1	36.7	12.1	4M	8.0	11.4	41.1	11.4	3M	14.8	11.2	34.8	11.1
1M Red	3.4	12.3	40.2	12.1	1M Red	3.1	11.5	44.2	11.4	1M	6.6	11.4	41.4	11.2
1M	7.9	12.3	48.1	12.1	1M	6.2	12.1	50.4	11.5	4M	7.4	11.7	48.7	11.3
5M	3.1	13.0	51.1	12.2	5M	3.0	12.6	53.4	11.5	5M	1.4	13.1	50.2	11.3
1BK	3.5	13.5	54.7	12.2	Grader	1.2	14.0	54.6	11.6	Grader	2.0	13.3	52.1	11.4
Grader	1.1	13.9	55.8	12.3	1BK	4.9	14.6	59.6	11.8	1BK	6.0	13.5	58.1	11.6
FILTER FLR	4.6	14.1	60.4	12.4	FILTER FLR	1.0	14.7	60.6	11.9	FILTER FLR	3.5	13.9	61.6	11.7
2BK	2.8	15.3	63.2	12.5	2BK	3.4	16.3	64.0	12.1	2BK	5.4	16.2	67.0	12.1
3BK	1.1	15.9	64.3	12.6	3BK	5.0	17.4	69.0	12.5	3BK	3.5	18.0	70.5	12.4
BRAN FLR	4.4	18.4	68.7	13.0	BRAN FLR	2.6	20.1	71.6	12.8	BRAN FLR	2.4	19.7	73.0	12.6
Break Shorts	1.7	15.2	70.5	13.0	Break Shorts	2.6	16.2	74.2	12.9	Break Shorts	1.8	16.4	74.7	12.7
Red Dog	0.2	12.8	70.7	13.0	Red Dog	2.4	14.7	76.6	13.0	Red Dog	1.2	14.5	75.9	12.8
Red Shorts	0.0	13.3	70.7	13.0	Red Shorts	0.0	14.8	76.6	13.0	Red Shorts	0.0	14.8	76.0	12.8
Filter Bran	0.0	12.5	70.7	13.0	Filter Bran	0.4	12.9	77.0	13.0	Filter Bran	1.1	10.6	77.0	12.7
Bran	29.3	17.7	100.0	14.4	Bran	23.0	19.2	100.0	14.4	Bran	23.0	17.7	100.0	13.9
Whole Wheat		13.9			**Whole Wheat**		13.7			**Whole Wheat**		13.5		
St Grade Flour		12.8			**St Grade Flour**		12.7			**St Grade Flour**		12.6		

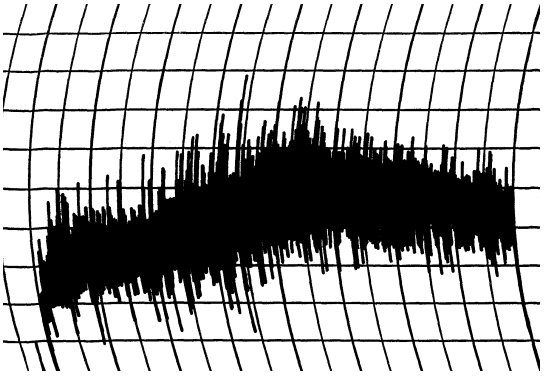
Physical Dough Tests
2009 (Small Scale) Samples - Oklahoma

Farinograms



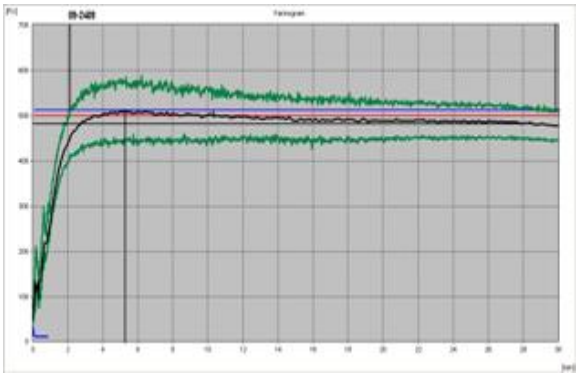
Water abs = 61.3%, Peak time = 7.3 min,
Mix stab = 29.9 min, MTI = 7 FU

Mixograms

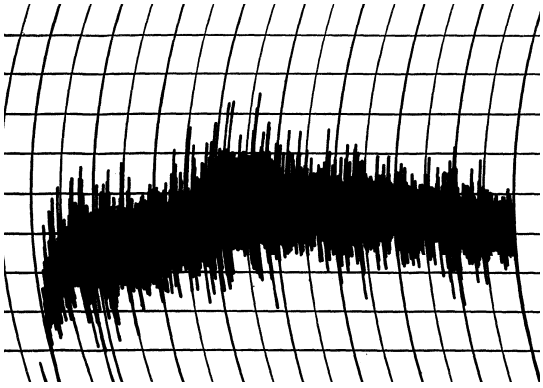


Water abs = 65.7%
Mix time = 4.8 min

09-2408, OK Bullet (check)



Water abs = 62.9%, Peak time = 5.3 min,
Mix stab = 27.7 min, MTI = 14 FU



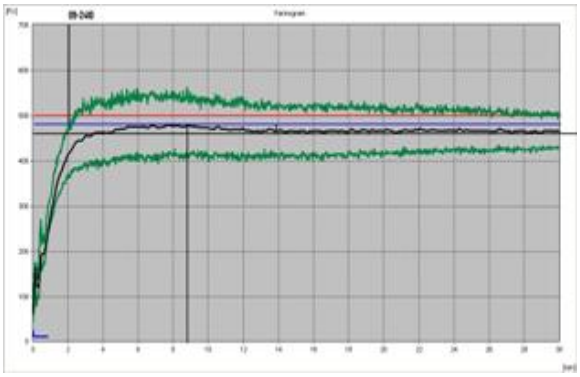
Water abs = 66.2%
Mix time = 3.6 min

09-2409, Billings

Physical Dough Tests

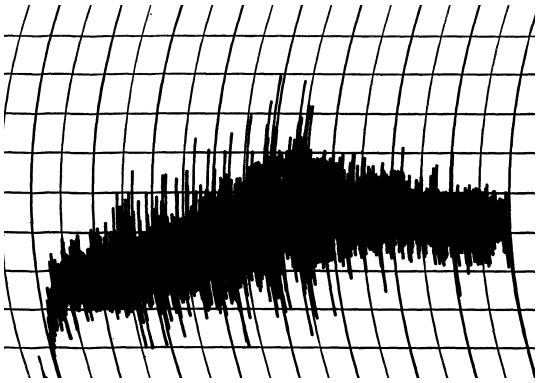
2009 (Small Scale) Samples - Oklahoma (continued)

Farinograms



Water abs= 59.6%, Peak time = 8.9 min,
Mix stab = 33.9 min, MTI = 15 FU

Mixograms

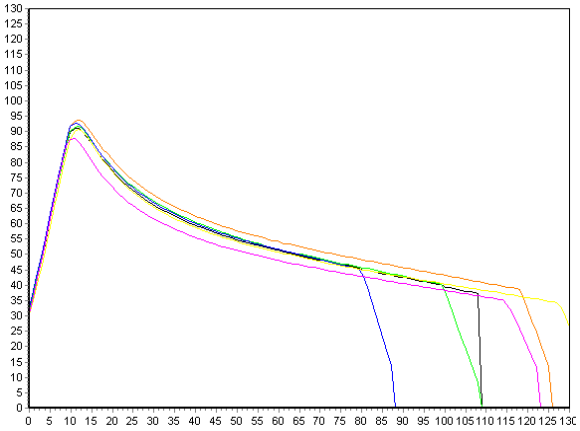


Water abs = 65.5%
Mix time = 4.5 min

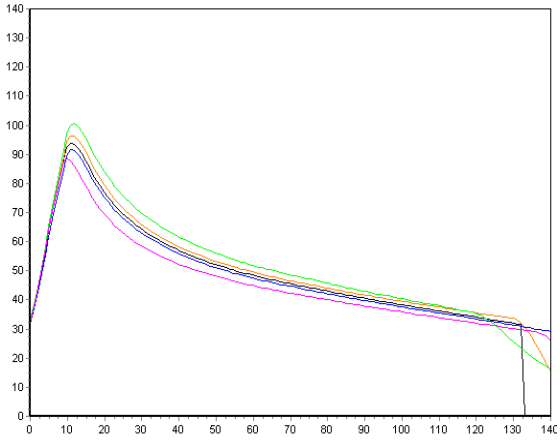
09-2410, OK05526

Physical Dough Tests - Alveograph

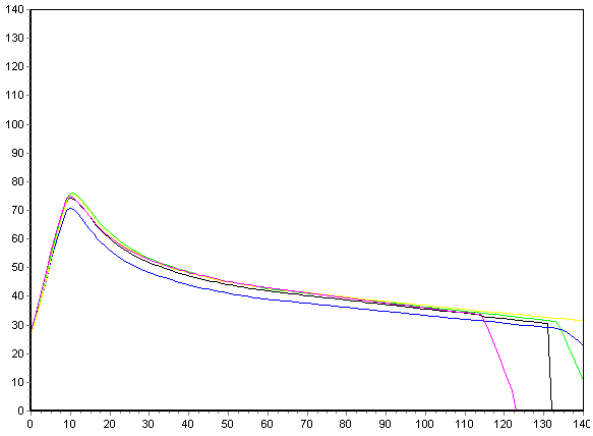
2009 (Small Scale) Samples – Oklahoma



09-2408 (OK Bullet - check)
P(mm $_{H20}$)=100, L(mm)=108, W(10E^{-4} J)=394



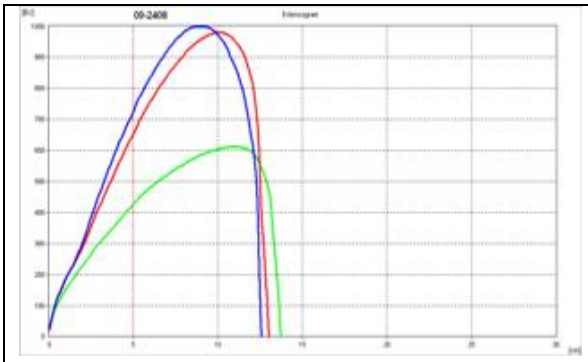
09-2409 (Billings)
P(mm $_{H2}$0)=103, L(mm)=133, W(10E^{-4} J)=438



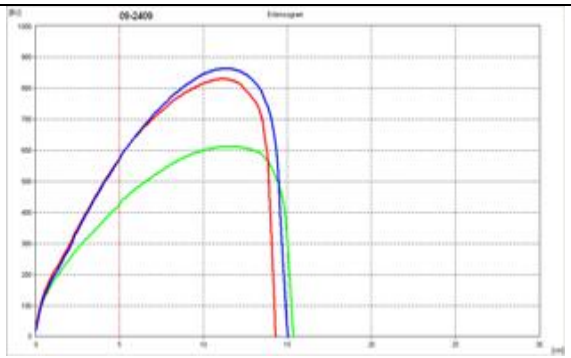
09-2410 (OK05526)
P(mm $_{H20}$)=82, L(mm)=131, W(10^{-4} J)=373

Physical Dough Tests - Extensigraph

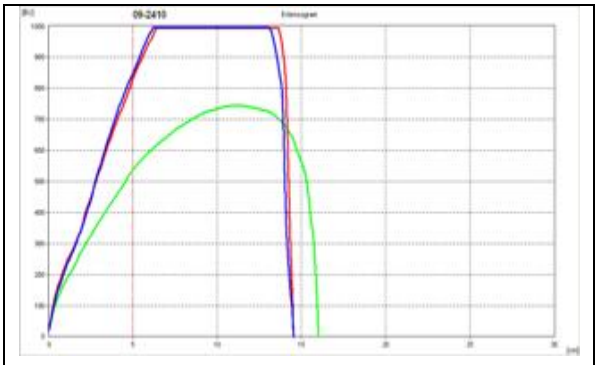
2009 (Small Scale) Samples – Oklahoma



09-2408 (OK Bullet - check)
R (BU) = 430, E (mm) =139, W (cm^2) = 105
Rmax (BU) = 613, Ratio = 3.1 at 30 min



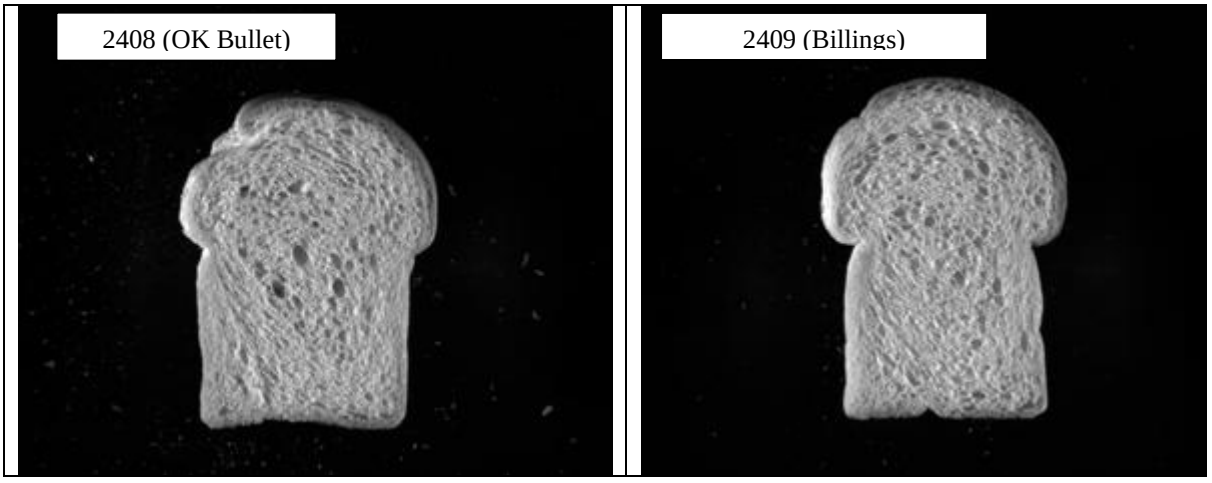
09-2409 (Billings)
R (BU) = 433, E (mm) =154, W (cm^2) = 123
Rmax (BU) = 613, Ratio = 2.8 at 30 min



09-2410 (OK05566)
R (BU) = 541, E (mm) =161, W (cm^2) = 156
Rmax (BU) = 746, Ratio = 3.4 at 30 min

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

Oklahoma: C-Cell Bread Images and Analysis for 2009 (Small-Scale) Samples



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2408	6573	149.6	4070	0.442	1.986	4.628	1.72	-19.9
2409	6467	150.3	3987	0.440	1.979	0.773	1.72	-22.1

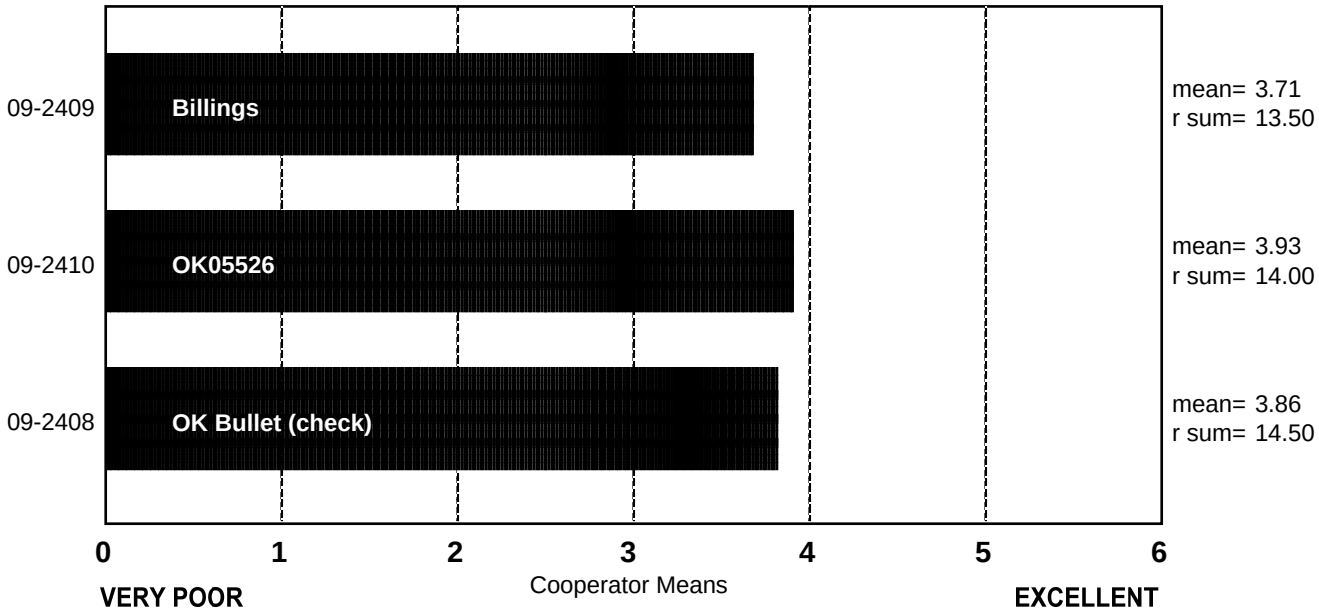
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2410	6588	149.2	3959	0.447	2.060	3.341	1.70	-29.9

SPONGE CHARACTERISTICS

(Small Scale) Oklahoma

ncoop= 7
chisq= 0.07
chisqc= 0.29
cvchisq= 5.99
crdiff=

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

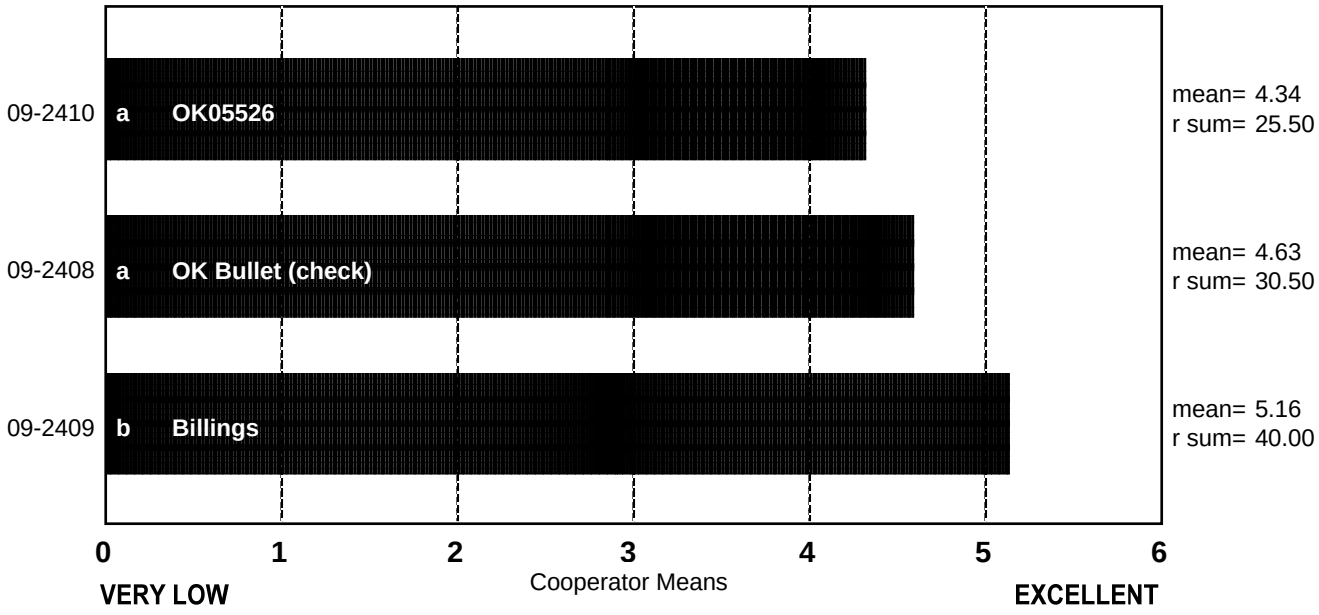


BAKE ABSORPTION

(Small Scale) Oklahoma

ncoop= 16
chisq= 6.78
chisqc= 14.00
cvchisq= 5.99
crdiff= 6.23

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) 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
09-2408 OK Bullet (check)	**63.0**	**59.0**	**59.0**	**68.8**	**65.7**	**63.3**	**63.0**	**63.0**	**61.0**	**61.0**	**70.1**	**70.5**	**63.5**	**65.3**	**64.3**	**59.8**	**65.6**
09-2409 Billings	**63.9**	**60.0**	**59.0**	**69.0**	**66.2**	**64.9**	**66.0**	**63.0**	**64.0**	**63.0**	**70.1**	**71.0**	**64.0**	**65.5**	**65.9**	**61.4**	**66.1**
09-2410 OK05526	**61.1**	**57.0**	**59.0**	**71.0**	**65.5**	**61.6**	**63.0**	**63.0**	**62.0**	**60.0**	**70.1**	**65.5**	**65.0**	**65.3**	**62.6**	**58.1**	**66.2**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2408 OK Bullet (check)	**2.3**	**7.0**	**16.0**	**4.5**	**5.0**	**8.5**	**6.8**	**9.0**	**9.0**	**25.0**	**4.5**	**5.0**	**25.0**	**3.3**	**9.0**	**4.8**	**5.6**
09-2409 Billings	**1.5**	**5.0**	**20.0**	**4.5**	**4.0**	**8.0**	**5.0**	**6.0**	**10.0**	**25.0**	**3.5**	**4.6**	**24.0**	**2.8**	**9.0**	**4.3**	**5.4**
09-2410 OK05526	**2.3**	**9.0**	**20.0**	**4.7**	**6.0**	**8.0**	**5.5**	**9.0**	**17.0**	**25.0**	**4.3**	**4.5**	**30.0**	**3.3**	**11.0**	**4.8**	**6.4**

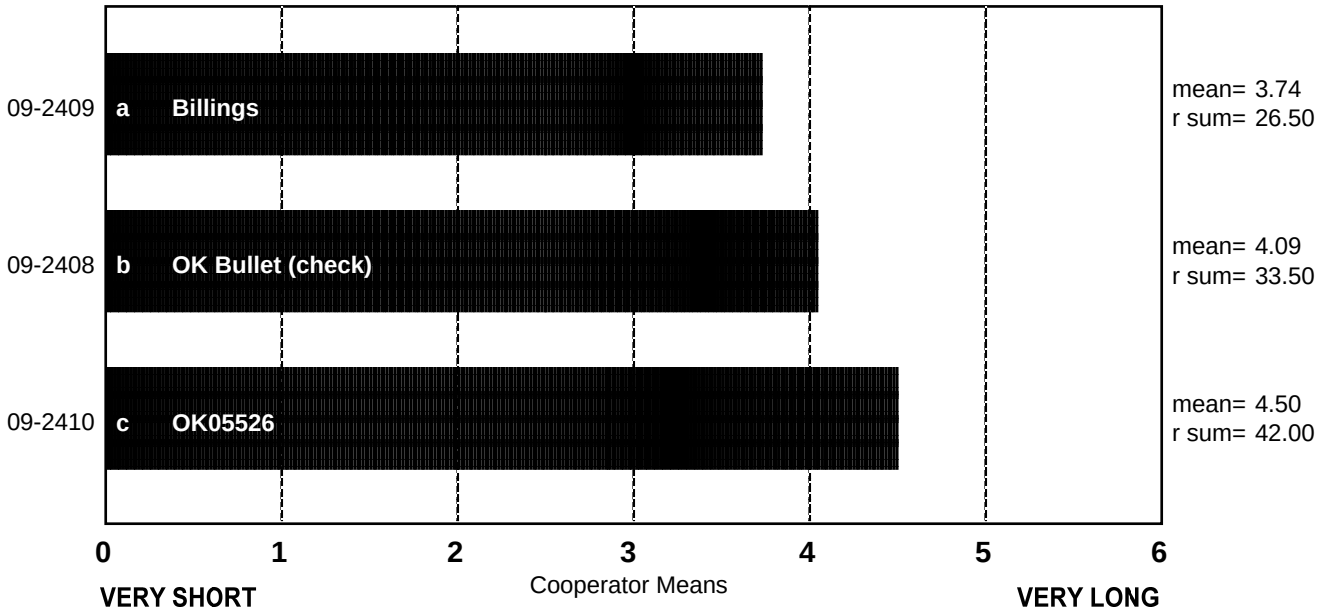
Raw Data

BAKE MIX TIME

(Small Scale) Oklahoma

ncoop= 17
chisq= 7.09
chisqc= 12.05
cvchisq= 5.99
crdiff= 6.94

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

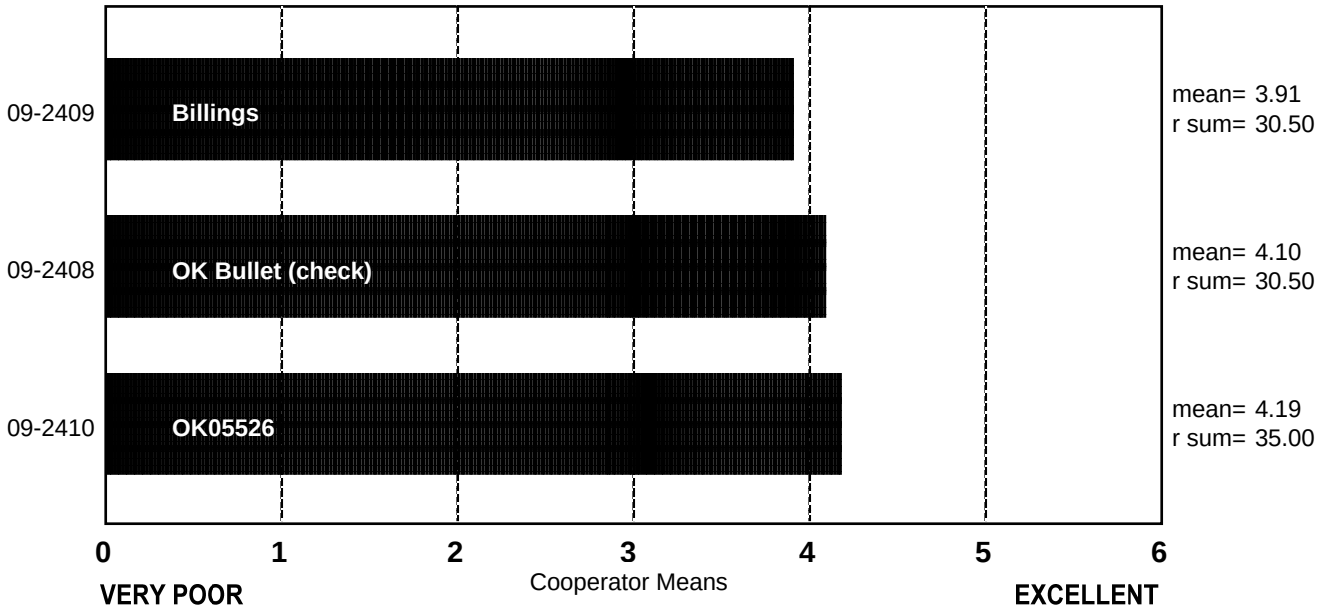


MIXING TOLERANCE

(Small Scale) Oklahoma

ncoop= 16
chisq= 0.84
chisqc= 1.50
cvchisq= 5.99
crdiff=

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

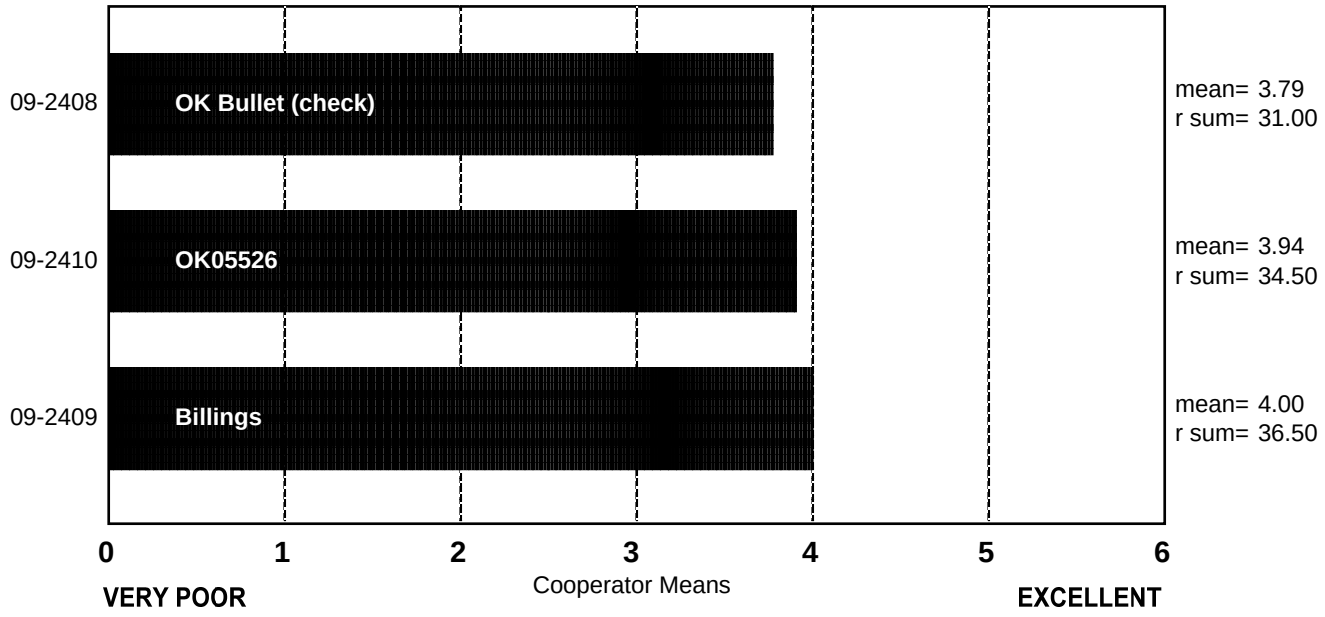


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Oklahoma

ncoop= 17
chisq= 0.91
chisqc= 1.59
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
09-2408 OK Bullet (check)	**1**	**3**	**4**	**9**	**0**
09-2409 Billings	**2**	**1**	**3**	**9**	**2**
09-2410 OK05526	**3**	**1**	**4**	**8**	**1**

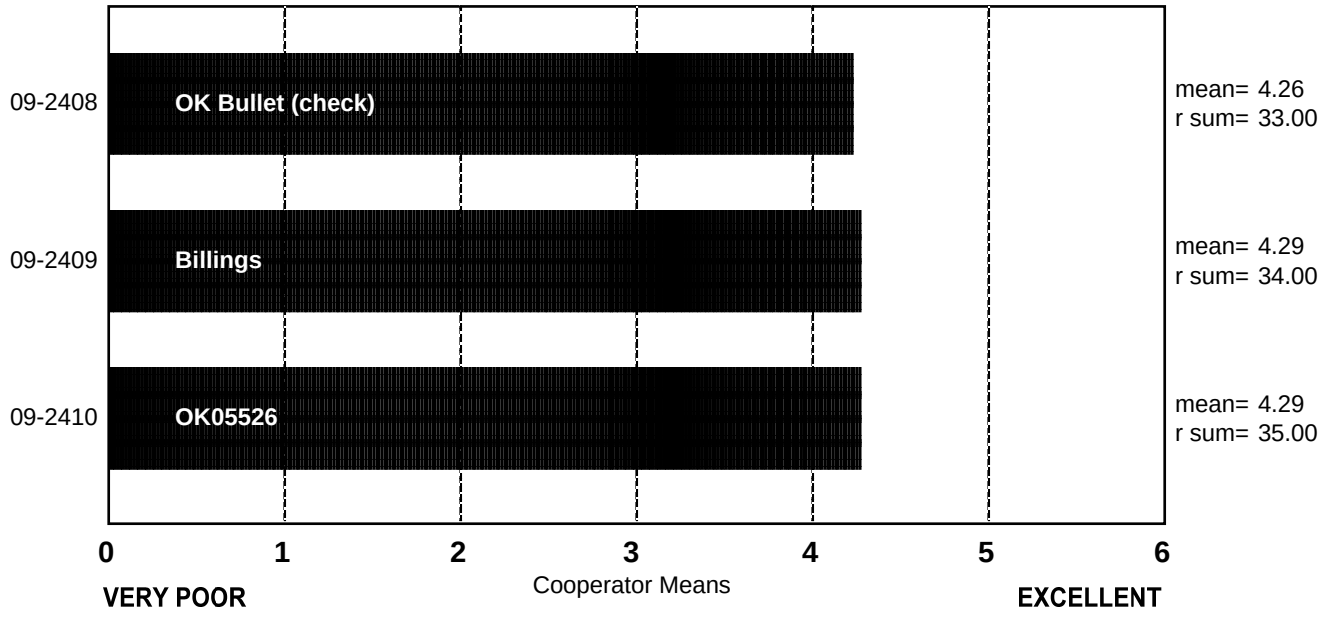
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Oklahoma

ncoop= 17
chisq= 0.12
chisqc= 0.23
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
09-2408 OK Bullet (check)	**1**	**1**	**2**	**11**	**2**
09-2409 Billings	**2**	**1**	**3**	**9**	**2**
09-2410 OK05526	**2**	**1**	**3**	**7**	**4**

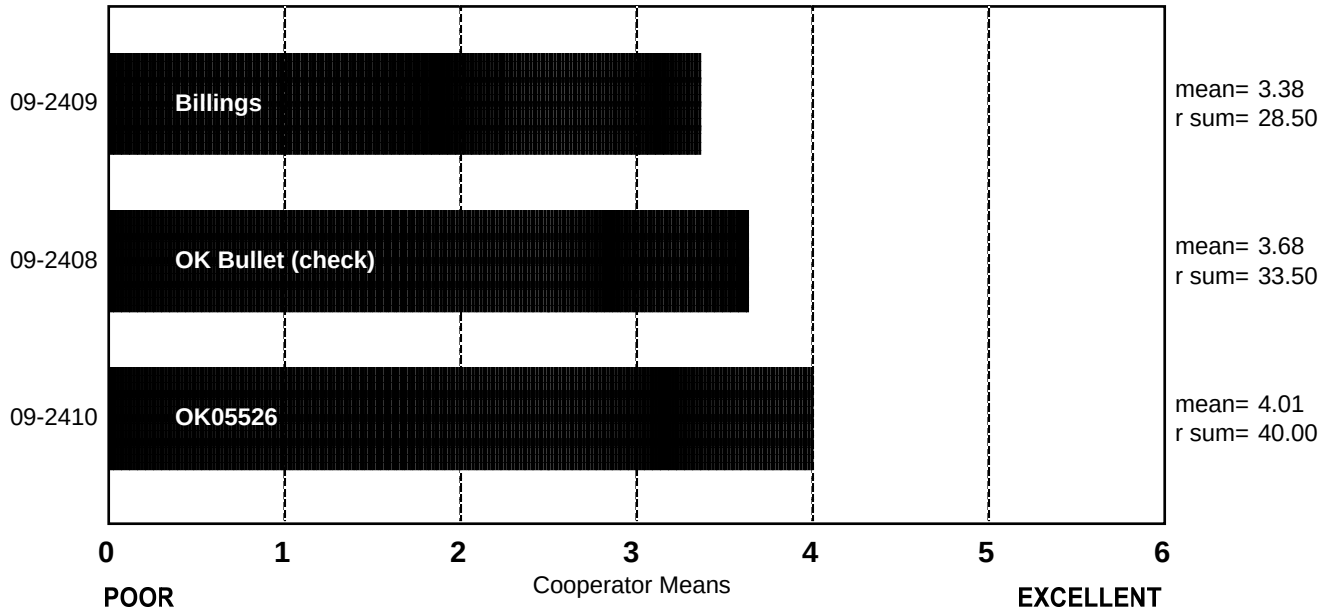
Frequency Table

CRUMB GRAIN

(Small Scale) Oklahoma

ncoop= 17
chisq= 3.91
chisqc= 5.22
cvchisq= 5.99
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Oklahoma

	Open	Fine	Dense
09-2408 OK Bullet (check)	**12**	**4**	**1**
09-2409 Billings	**13**	**3**	**1**
09-2410 OK05526	**6**	**9**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Oklahoma

	Round	Irregular	Elongated
09-2408 OK Bullet (check)	**4**	**8**	**5**
09-2409 Billings	**5**	**7**	**5**
09-2410 OK05526	**2**	**7**	**8**

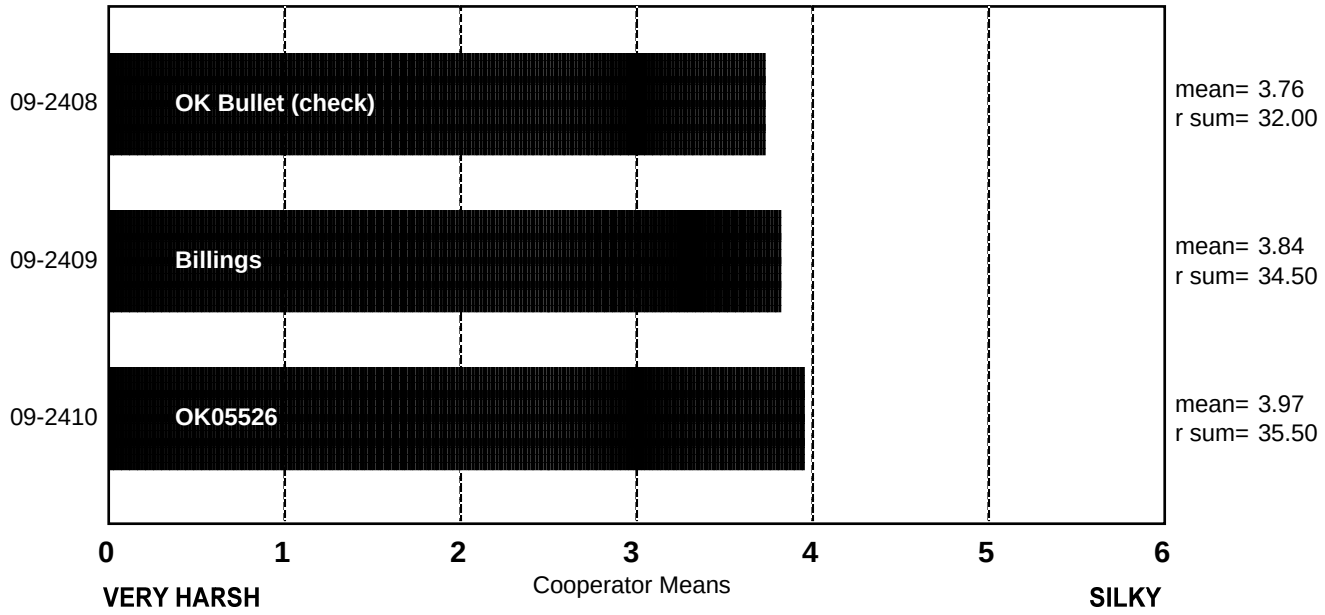
Frequency Table

CRUMB TEXTURE

(Small Scale) Oklahoma

ncoop= 17
chisq= 0.38
chisqc= 0.55
cvchisq= 5.99
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Oklahoma

	Harsh	Smooth	Silky
09-2408 OK Bullet (check)	**3**	**11**	**3**
09-2409 Billings	**2**	**11**	**4**
09-2410 OK05526	**3**	**9**	**5**

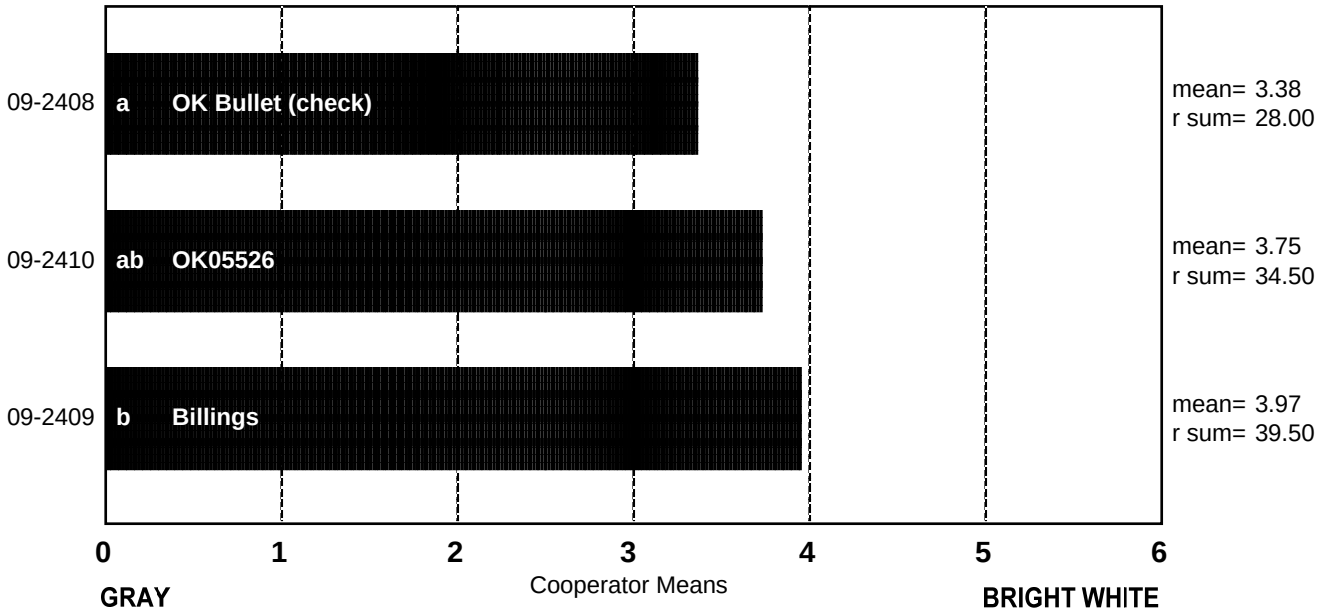
Frequency Table

CRUMB COLOR

(Small Scale) Oklahoma

ncoop= 17
chisq= 3.91
chisqc= 6.19
cvchisq= 5.99
crdiff= 8.81

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
09-2408 OK Bullet (check)	**1**	**0**	**1**	**7**	**7**	**1**	**0**
09-2409 Billings	**1**	**0**	**0**	**4**	**7**	**4**	**1**
09-2410 OK05526	**0**	**0**	**0**	**4**	**11**	**2**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2408 OK Bullet (check)	**134.7**	**490.0**	**421.0**	**154.8**	**155.3**	**474.0**	**142.7**		**463.9**	**471.2**	**140.5**	**148.0**			**448.5**	**125.7**	**150.0**
09-2409 Billings	**137.8**	**485.0**	**423.0**	**156.8**	**153.6**	**472.0**	**145.9**		**463.1**	**471.3**	**142.8**	**146.8**			**455.8**	**129.0**	**151.3**
09-2410 OK05526	**133.0**	**495.0**	**420.0**	**157.8**	**153.4**	**471.0**	**144.0**		**467.2**	**470.2**	**142.6**	**143.8**			**450.2**	**127.6**	**152.7**

LOAF VOLUME, ACTUAL

(Small Scale) Oklahoma

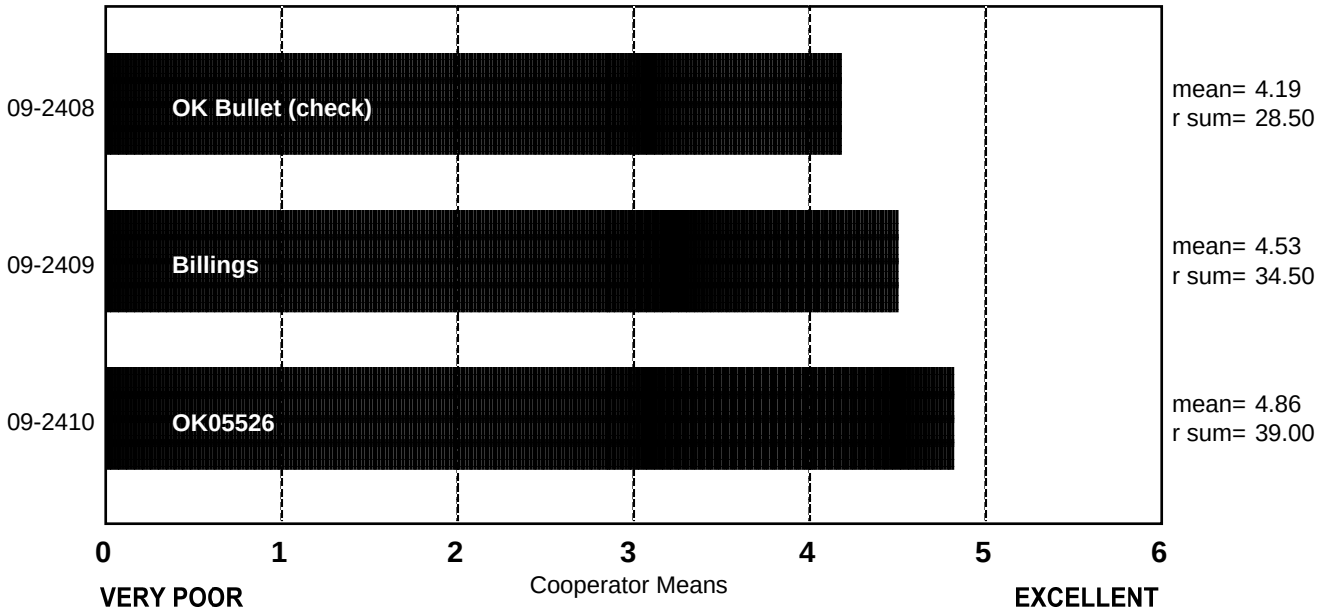
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2408 OK Bullet (check)	**775**	**2800**	**3000**	**940**	**613**	**2825**	**928**	**1025**	**2538**	**3104**	**1035**	**916**	**2700**	**1055**	**2525**	**840**	**920**
09-2409 Billings	**825**	**3000**	**3050**	**905**	**652**	**3025**	**930**	**1003**	**2588**	**3104**	**1213**	**980**	**2700**	**1080**	**2300**	**900**	**920**
09-2410 OK05526	**800**	**3050**	**3000**	**960**	**698**	**3200**	**930**	**1025**	**2700**	**3162**	**1023**	**990**	**2700**	**1150**	**2425**	**905**	**925**

LOAF VOLUME

(Small Scale) Oklahoma

ncoop= 17
chisq= 3.26
chisqc= 4.83
cvchisq= 5.99
crdiff=

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

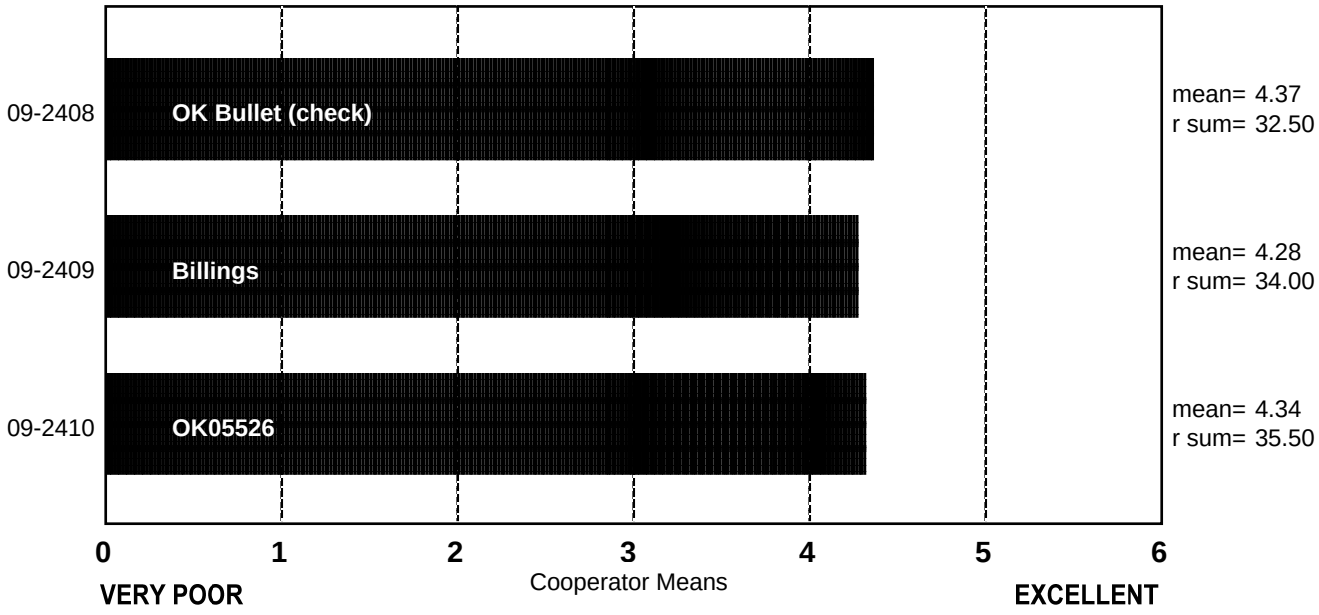


OVERALL BAKING QUALITY

(Small Scale) Oklahoma

ncoop= 17
chisq= 0.26
chisqc= 0.31
cvchisq= 5.99
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Oklahoma

COOP. **09-2408 OK Bullet (check)**

A. No comment.
B. No comment.
C. Open grain. Very slightly soft out of mixer but recovered well at make-up. Creamy crumb. Good mix time and excellent volume.
D. Good dough properties and average interior, loaf volume performance less than expected.
E. No comment.
F. No comment.
G. Normal Water Abs, Medium Mix & Proof Time, Slight Sticky & Strong Dough, Very High OS & Vol, Fine Elongated Cells, Slight Yellow Crumb, Silky & Medium Resilient Texture.
H. High protein, excellent baking quality. Great dough handling, mix tolerance, and volumes. Nice grain as well. Sample could take more water.
I. Good grain.
J. Slightly open, slightly streaky grain, very strong dough mixing, excellent volume.
K. No comment.
L. Slow dough pickup during mixing - downgraded the mixing score.
M. No comment.
N. No comment.
O. Good Grain- Good Volume.
P. No comment.
Q. Excellent absorption & bake MT; above satisfactory crumb grain; dull crumb color; good LV.

COOP. **09-2409 Billings**

A. No comment.
B. Good absorption and volume.
C. Very strong dough. Long mix, excellent volume. Harsh texture. Slightly tough dough.
D. Better break & Shred, very good dough performance, average interior, low loaf volume performance.
E. No comment.
F. No comment.
G. Higher Water Abs, Normal Mix & Proof Time, Slight Sticky & Strong Dough, Very High OS & volume, Open Elongated Cells, Creamy Crumb, Smooth & Medium Resilient Texture.
H. High protein, great bake quality. Great dough handling - would have liked to see better tolerance given handling characteristics, there was a slight drop in volume in the long mix.
I. High absorption, open grain, white crumb.
J. Tight, consistent, smooth grain, good absorption, excellent volume.
K. No comment.
L. Slow dough pickup during mixing - downgraded the mixing score.
M. No comment.
N. No comment.
O. Open Grain- Good Make-Up- Low Volume.

P. No comment.
Q. Excellent absorption & bake MT; excellent out of mixer; satisfactory crumb grain; dull crumb color

COOP. 09-2410 OK05526

A. No comment.
B. Good volume.
C. Very open grain. Dull crumb. Tough out of mixer. Long mix time. Good volume.
D. Very good dough properties, average interior and loaf volume performance.
E. No comment.
F. No comment.
G. Normal Water Abs, Mix & Proof Time, Slight Soft & Strong Dough, Very High OS & Vol, Fine Elongated Cells, Creamy Crumb, Silky & Medium Resilient Texture.
H. High protein, excellent baking quality. Strong dough handling and great grain and volumes. Sample could take more water.
I. Long mix time, good volume.
J. Fairly tight, smooth grain, excellent volume.
K. No comment.
L. Slow dough pickup during mixing - downgraded the mixing score.
M. No comment.
N. No comment.
O. Tough out of mixer- Slightly above average volume and grain.
P. No comment.
Q. Excellent absorption; long MT; excellent at pan; open & irregular crumb; creamy crumb color; good LV.

Notes: **B, C, H, I, J, M, and O** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

AgriPro – Rollin Sears

PostRock

PostRock is a hard red winter wheat adapted to Kansas and southern Nebraska. In 2009 it occupied approximately 6% of the Kansas planted acreage and is expected to increase in 2010. PostRock has above average protein concentration and good milling and baking properties.

CJ (BC01138-5)

CJ is a hard red winter wheat best adapted to the eastern and central regions of the central plains. It has been named for Chuck Johnson, long-time central plains business manager and friend of many in the wheat industry. CJ is early in maturity and has excellent disease resistance. Approximately 500 acres of CJ have been planted to produce Foundation and Registered seed with anticipated sale to AgriPro seed associates in the fall of 2010. Certified seed will be available to wheat farmers in the fall of 2011. CJ is currently being tested in state variety yield trials, USDA regional nurseries and Syngenta Cereals yield trials across the central plains.

SY Gold (AP00x0100-51)

It is a hard red winter wheat best adapted to the western plains of Kansas, Colorado and southwestern Nebraska. This experimental line at this writing has not been named but we anticipate that it will be named prior to the WQC meetings in late February. AP00x0100-51 has excellent disease resistance, stiff straw and has yielded well in both dryland and irrigated environments. Approximately 500 acres of AP00x0100-51 have been planted to produce Foundation and Registered seed with anticipated sale to AgriPro seed associates in the fall of 2010. Certified seed will be available to wheat farmers in the fall of 2011. AP00x0100-51 is currently being tested in state variety yield trials, USDA regional nurseries and Syngenta Cereals yield trials across the central plains.

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

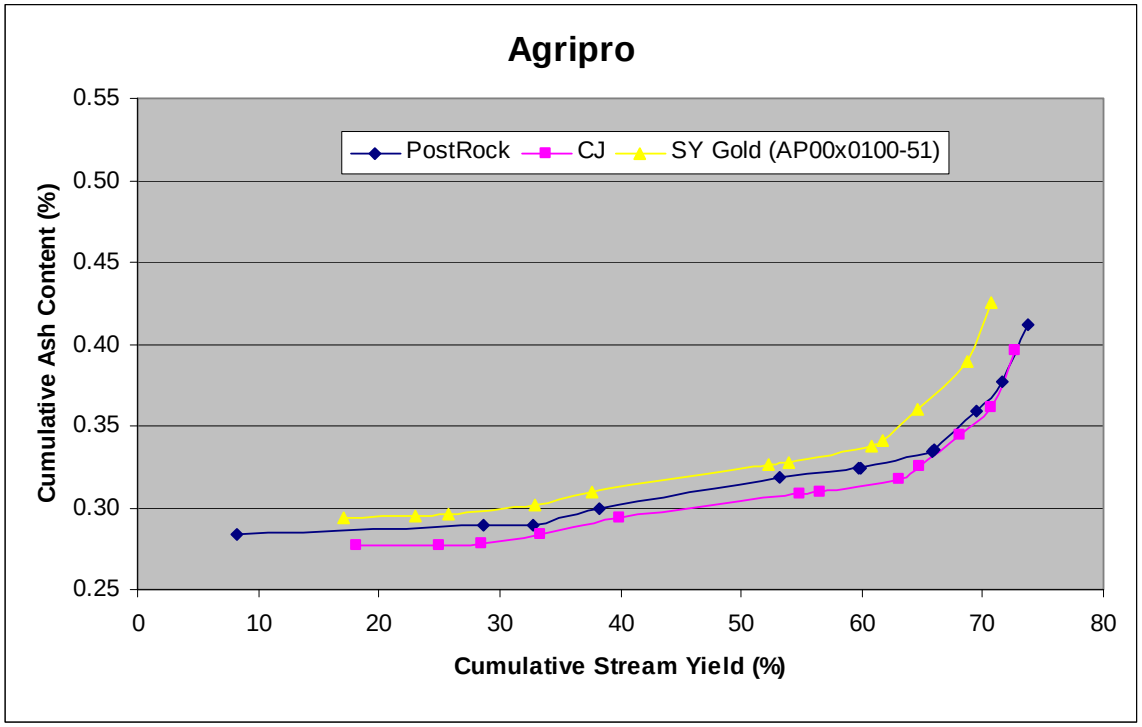
Test entry number	09-2411	09-2412	09-2413
Sample identification	**PostRock (check)**	**CJ**	**SY Gold**
Wheat Data			
FGIS classification	1 HRW	1 HRW	1HRW
Test weight (lb/bu)	61.7	60.3	61.4
Hectoliter weight (kg/hl)	81.1	79.3	80.7
1000 kernel weight (gm)	35.5	32.6	34.0
NIR hardness	59	70	75
Wheat kernel size (Rotap)			
Over 7 wire (%)	85.9	85.2	84.2
Over 9 wire (%)	14.0	14.7	15.8
Through 9 wire (%)	0.1	0.1	0.0
Single kernel (skcs)			
Hardness (avg /s.d)	58.1/15.1	59.5/16.3	72.0/17.2
Weight (mg) (avg/s.d)	37.0/8.6	33.4/8.8	35.1/9.0
Diameter (mm)(avg/s.d)	2.93/0.35	2.79/0.37	2.80/0.34
SKCS distribution	03-17-37-43	04-20-27-49	01-06-17-76
Classification	Hard	Hard	Hard
Wheat moisture (%)	10.5	10.6	10.6
Wheat protein (12% mb)	12.5	11.9	12.7
Wheat ash (12% mb)	1.55	1.54	1.56
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	73.8	72.8	70.8
Quadrumat Sr. Mill	71.4	69.9	67.8
NIR flour moisture (%)	13.1	13.0	12.9
NIR flour protein (14% mb)	10.9	10.0	10.5
Flour ash (14% mb)	0.45	0.43	0.47
Glutomatic			
Wet gluten (%)	31.0	26.9	28.4
Dry gluten (%)	10.8	9.6	10.2
Gluten index	91.3	99.4	97.4
Rapid Visco-Analyser			
Peak time (min)	6.3	6.2	6.1
Peak viscosity (RVU)	229.3	242.8	209.9
Breakdown (RVU)	80.8	101.0	77.9
Final viscosity at 13 min (RVU)	270.1	249.6	249.3
Minolta color meter			
L*	92.94	92.94	92.54
a*	-1.43	-1.67	-1.45
b*	8.48	9.07	8.69
Falling number (sec)	384	388	383
Damaged Starch			
(AI%)	95.69	95.88	96.56
(AACC76-31)	6.04	6.18	6.71

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

AgriPro: Physical Dough Tests and Gluten Analysis For 2009(Small-Scale) Samples

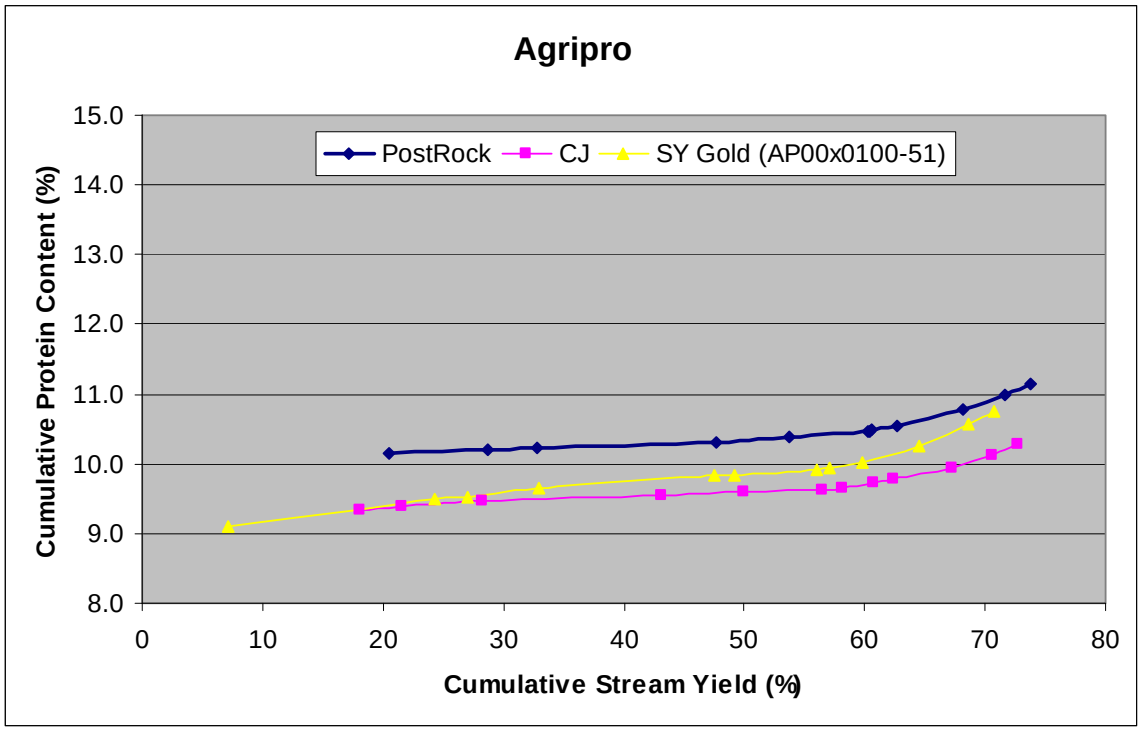
Test Entry Number	09-2411	09-2412	09-2413
Sample Identification	PostRock (check)	CJ	SY Gold
MIXOGRAPH			
Flour Abs (% as-is)	61.1	60.8	61.7
Flour Abs (14% mb)	60.1	59.6	60.4
Mix Time (min)	3.50	3.88	4.00
Mix tolerance (0-6)	2	3	3
FARINOGRAPH			
Flour Abs (% as-is)	57.2	56.8	60.6
Flour Abs (14% mb)	56.2	55.6	59.3
Development time (min)	4.0	2.3	2.3
Mix stability (min)	14.8	10.6	13.5
Mix Tolerance Index (FU)	19	23	22
Breakdown time (min)	11.9	9.4	10.4
ALVEOGRAPH			
P(mm. H2O): Tenacity	63	63	93
L(mm): Extensibility	91	93	73
G($mm_{0.5}$): Swelling index	21.2	21.5	19.0
W(10^{-4} J): strength (curve area)	211	212	248
P/L: curve configuration ratio	0.69	0.68	1.27
Ie(P_{200}/P): elasticity index	62.3	61.6	57.0
EXTENSIGRAPH			
Resist (BU at 30/60/90 min)	335/445/500	359/503/542	368/485/528
Extensibility (mm at 30/60/90 min)	148/136/147	147/133/132	142/130/123
Energy (cm2 at 30/60/90 min)	89/107/129	94/113/120	91/104/102
Resist $_{max}$ (BU at 30/60/90 min)	455/624/699	488/673/757	491/619/660
Ratio (at 30/60/90 min)	2.3/3.3/3.4	2.5/3.8/4.1	2.6/3.8/4.3
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+8, 5+10	2*, 7+9, 5+10	null, 7+9, 5+10
Glu/Gli	1.89	2.03	1.86
HMW/LMW	0.28	0.36	0.44
%IPP	46.99	48.26	47.07
SEDIMENTATION TEST			
Volume (ml at 14% mc)	46.5	41.0	42.0

AgriPro: Cumulative Ash Curves



PostRock - 2411					CJ - 2412					SY Gold (AP00x0100-51) - 2413				
Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)	Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)	Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)
1M	8.16	0.28	8.16	0.28	2M	18.09	0.28	18.09	0.28	2M	17.08	0.29	17.08	0.29
2M	20.50	0.29	28.65	0.29	1M	6.89	0.28	24.99	0.28	1M	5.90	0.30	22.97	0.29
1M Red	4.13	0.29	32.78	0.29	1M Red	3.53	0.28	28.52	0.28	1M Red	2.83	0.31	25.80	0.30
2BK	5.52	0.36	38.30	0.30	2BK	4.85	0.32	33.36	0.28	1BK	7.14	0.32	32.94	0.30
3M	14.93	0.37	53.24	0.32	1BK	6.61	0.34	39.97	0.29	2BK	4.74	0.37	37.68	0.31
1BK	6.50	0.37	59.74	0.32	3M	14.83	0.35	54.80	0.31	3M	14.52	0.37	52.20	0.33
Grader	0.07	0.38	59.81	0.32	Grader	1.79	0.36	56.59	0.31	Grader	1.69	0.38	53.89	0.33
4M	6.08	0.44	65.89	0.33	4M	6.47	0.38	63.06	0.32	4M	6.86	0.41	60.74	0.34
FILTER FLR	0.16	0.56	66.05	0.34	FILTER FLR	1.77	0.59	64.82	0.32	FILTER FLR	1.03	0.60	61.77	0.34
3BK	3.47	0.81	69.52	0.36	3BK	3.35	0.73	68.18	0.34	5M	2.81	0.78	64.58	0.36
5M	2.11	0.96	71.63	0.38	5M	2.47	0.83	70.65	0.36	3BK	4.09	0.85	68.67	0.39
BRAN FLR	2.11	1.59	73.74	0.41	BRAN FLR	2.06	1.58	72.71	0.40	BRAN FLR	2.00	1.64	70.67	0.43
Break Shorts	2.30	4.19	76.05	0.53	Break Shorts	2.63	3.73	75.34	0.51	Break Shorts	5.62	2.74	76.29	0.60
Red Dog	2.08	2.14	78.13	0.57	Red Dog	2.24	2.16	77.57	0.56	Red Dog	2.75	1.99	79.04	0.64
Red Shorts	0.06	3.76	78.19	0.57	Red Shorts	0.06	3.92	77.64	0.56	Red Shorts	0.06	3.96	79.10	0.65
Filter Bran	0.31	1.91	78.50	0.58	Filter Bran	0.76	1.91	78.40	0.58	Filter Bran	0.60	1.46	79.70	0.65
Bran	21.50	5.22	100.00	1.57	Bran	21.60	5.13	100.00	1.56	Bran	20.30	5.36	100.00	1.61
Wheat Ash		1.52			Wheat Ash		1.50			Wheat Ash		1.52		
Straight Grade Flour Ash		0.45			Straight Grade Flour Ash		0.43			Straight Grade Flour Ash		0.47		

AgriPro: Cumulative Protein Curves

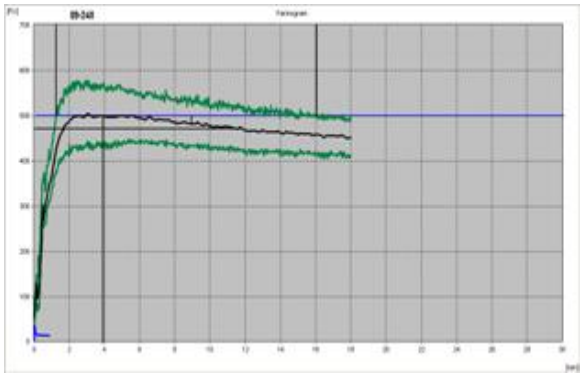


PostRock - 2411					CJ - 2412					SY Gold (AP00x0100-51)- 2413				
Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)	Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)	Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)
2M	20.5	10.1	20.5	10.1	1BK	18.1	9.3	18.1	9.3	1BK	7.1	9.1	7.1	9.1
1M	8.2	10.3	28.7	10.2	2M	3.5	9.7	21.6	9.4	2M	17.1	9.7	24.2	9.5
1M Red	4.1	10.3	32.8	10.2	1M Red	6.6	9.7	28.2	9.5	1M Red	2.8	9.9	27.0	9.5
3M	14.9	10.5	47.7	10.3	1M	14.8	9.7	43.1	9.6	1M	5.9	10.2	32.9	9.6
4M	6.1	11.0	53.8	10.4	3M	6.9	9.8	50.0	9.6	3M	14.5	10.2	47.5	9.8
1BK	6.5	11.2	60.3	10.5	Grader	6.5	10.0	56.4	9.6	Grader	1.7	10.2	49.1	9.8
Grader	0.1	11.7	60.4	10.5	4M	1.8	10.4	58.2	9.7	4M	6.9	10.5	56.0	9.9
FILTER FLR	0.2	12.0	60.5	10.5	FILTER FLR	2.5	11.2	60.7	9.7	FILTER FLR	1.0	11.2	57.0	9.9
5M	2.1	12.5	62.6	10.5	5M	1.8	11.7	62.4	9.8	5M	2.8	11.7	59.8	10.0
2BK	5.5	13.6	68.2	10.8	2BK	4.8	12.1	67.3	9.9	2BK	4.7	13.1	64.6	10.3
3BK	3.5	15.0	71.6	11.0	3BK	3.4	13.6	70.6	10.1	3BK	4.1	15.5	68.7	10.6
BRAN FLR	2.1	16.7	73.7	11.2	BRAN FLR	2.1	15.2	72.7	10.3	BRAN FLR	2.0	17.2	70.7	10.8
Break Shorts	2.3	16.0	76.0	11.3	Break Shorts	2.6	15.0	75.3	10.4	Break Shorts	5.6	13.0	76.3	10.9
Red Dog	2.1	14.2	78.1	11.4	Red Dog	2.2	13.3	77.6	10.5	Red Dog	2.7	13.5	79.0	11.0
Red Shorts	0.1	14.5	78.2	11.4	Red Shorts	0.1	14.1	77.6	10.5	Red Shorts	0.1	14.6	79.1	11.0
Filter Bran	0.3	12.3	78.5	11.4	Filter Bran	0.8	11.4	78.4	10.5	Filter Bran	0.6	10.6	79.7	11.0
Bran	21.5	17.1	100.0	12.6	Bran	21.6	16.5	100.0	11.8	Bran	20.3	17.0	100.0	12.2
Whole Wheat		11.6			**Whole Wheat**		11.6			**Whole Wheat**		12.4		
St Grade Flour		10.2			**St Grade Flour**		10.2			**St Grade Flour**		10.7		

Physical Dough Tests

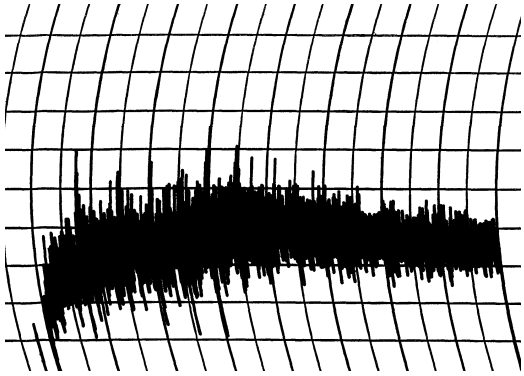
2009 (Small Scale) Samples – AgriPro

Farinograms



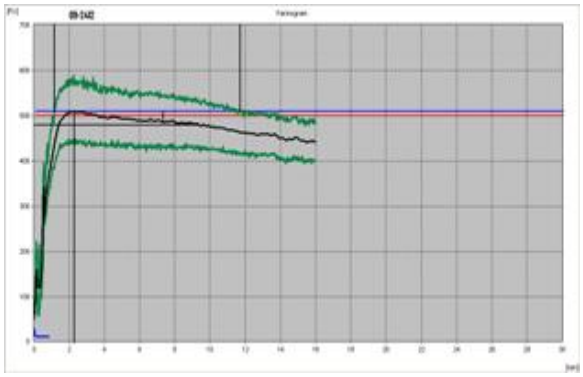
Water abs= 56.2%, Peak time = 4.0 min,
Mix stab = 14.8 min, MTI = 19 FU

Mixograms

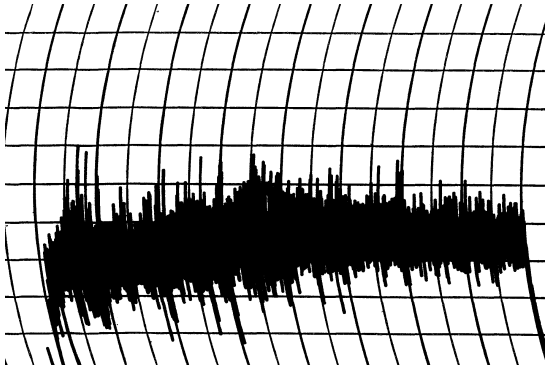


Water abs = 60.1%
Mix time = 3.5 min

09-2411, PostRock (check)



Water abs = 55.6%, Peak time = 2.3 min,
Mix stab = 10.6 min, MTI = 23 FU



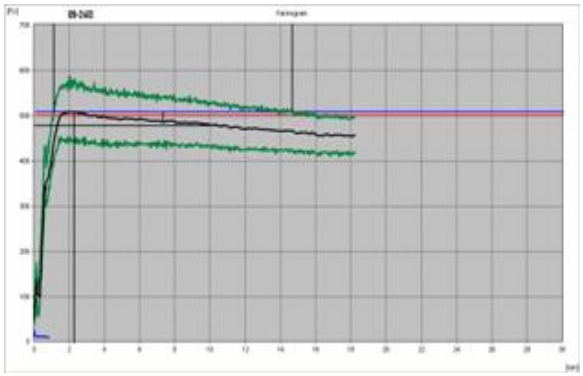
Water abs = 59.6%
Mix time = 3.9 min

09-2412, CJ

Physical Dough Tests

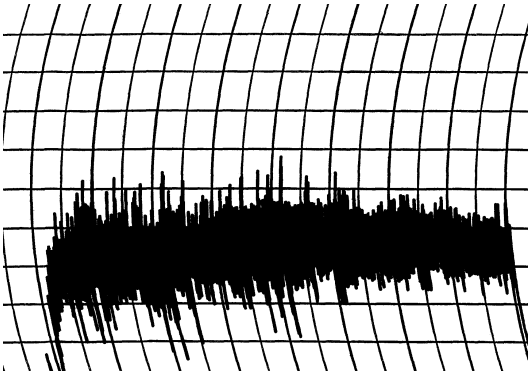
2009 (Small Scale) Samples – AgriPro (continued)

Farinograms



Water abs = 59.3%, Peak time = 2.3 min,
Mix stab = 13.5 min, MTI = 22 FU

Mixograms

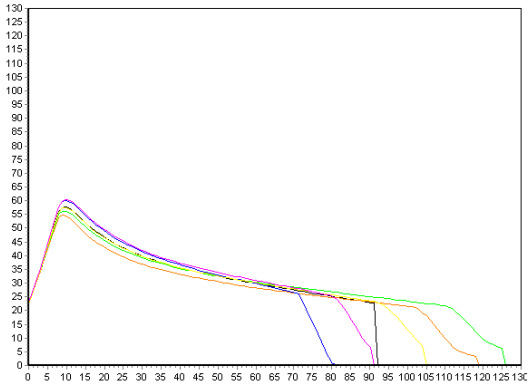


Water abs = 60.4%
Mix time = 4.0 min

09-2413, SY Gold

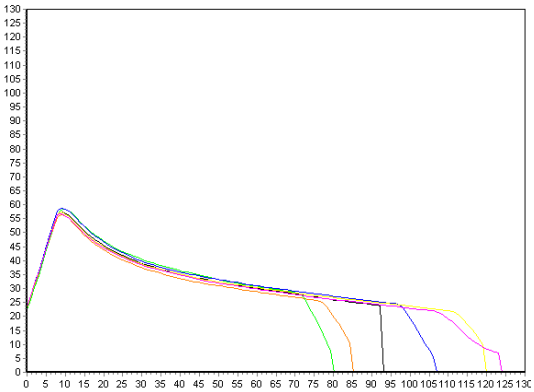
Physical Dough Tests - Alveograph

2009 (Small Scale) Samples – AgriPro



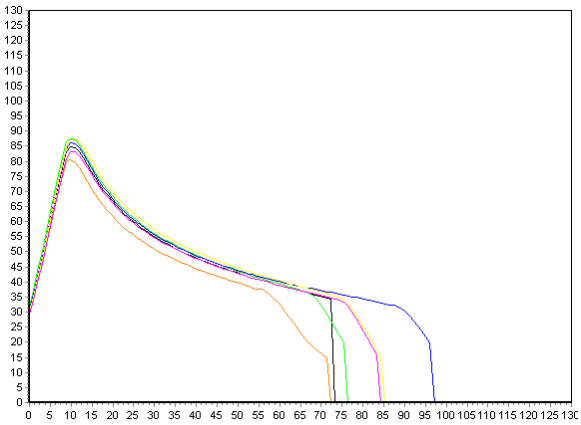
09-2411 (PostRock - check)

P (mm $_{H2O}$)=63, L(mm) =91, W(10E^{-4} J) =211



09-2412 (CJ)

P (mm $_{H2O}$)=63, L(mm) =93, W(10E^{-4} J) =212

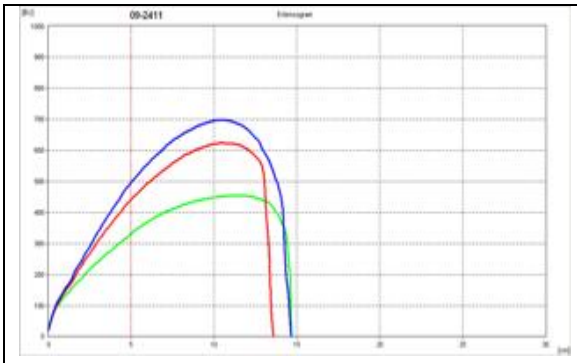


09-2413 (SY Gold)

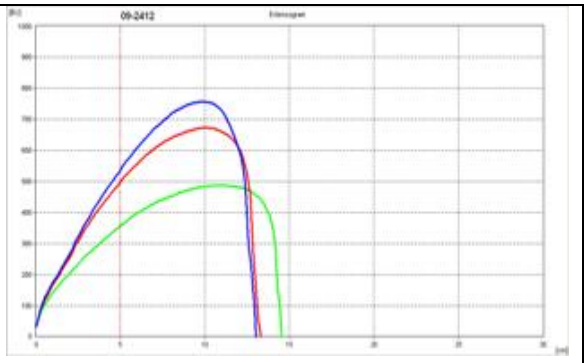
P (mm $_{H2O}$)=93, L(mm) =73, W(10E^{-4} J) =248

Physical Dough Tests - Extensigraph

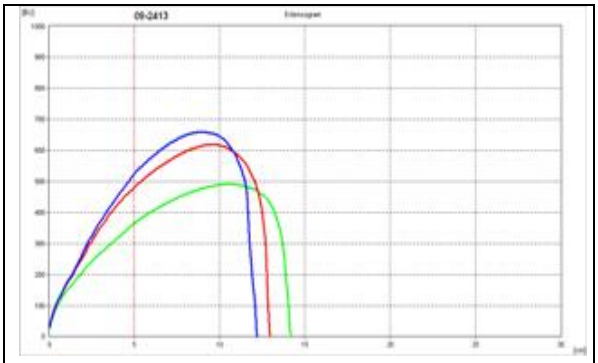
2009 (Small Scale) Samples – AgriPro



09-2411 (PostRock - check)
R (BU) = 335, E (mm) =148, W (cm^2) = 89
Rmax (BU) = 455, Ratio = 2.3 at 30 min



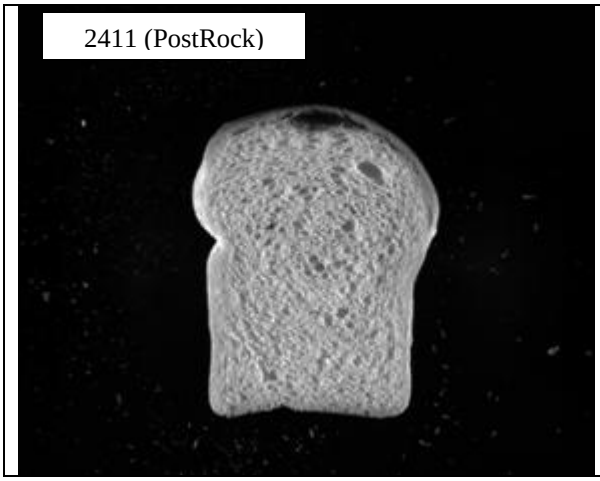
09-2412 (CJ)
R (BU) = 359, E (mm) =147, W (cm^2) = 94
Rmax (BU) = 488, Ratio = 2.5 at 30 min

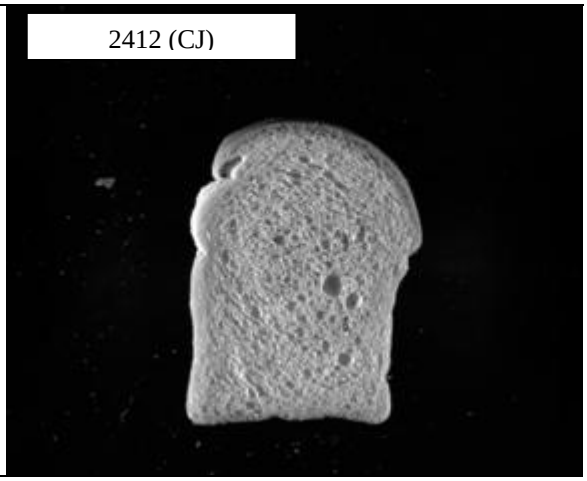


09-2413 (SY Gold)
R (BU) = 368, E (mm) =142, W (cm^2) = 91
Rmax (BU) = 491, Ratio = 2.6 at 30 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

AgriPro: C-Cell Bread Images and Analysis for 2009 (Small-Scale) Samples





Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2411	5848	154.5	3644	0.442	1.968	0.657	1.63	-26.5
2412	5594	147.2	3653	0.433	1.815	1.317	1.63	-13.4

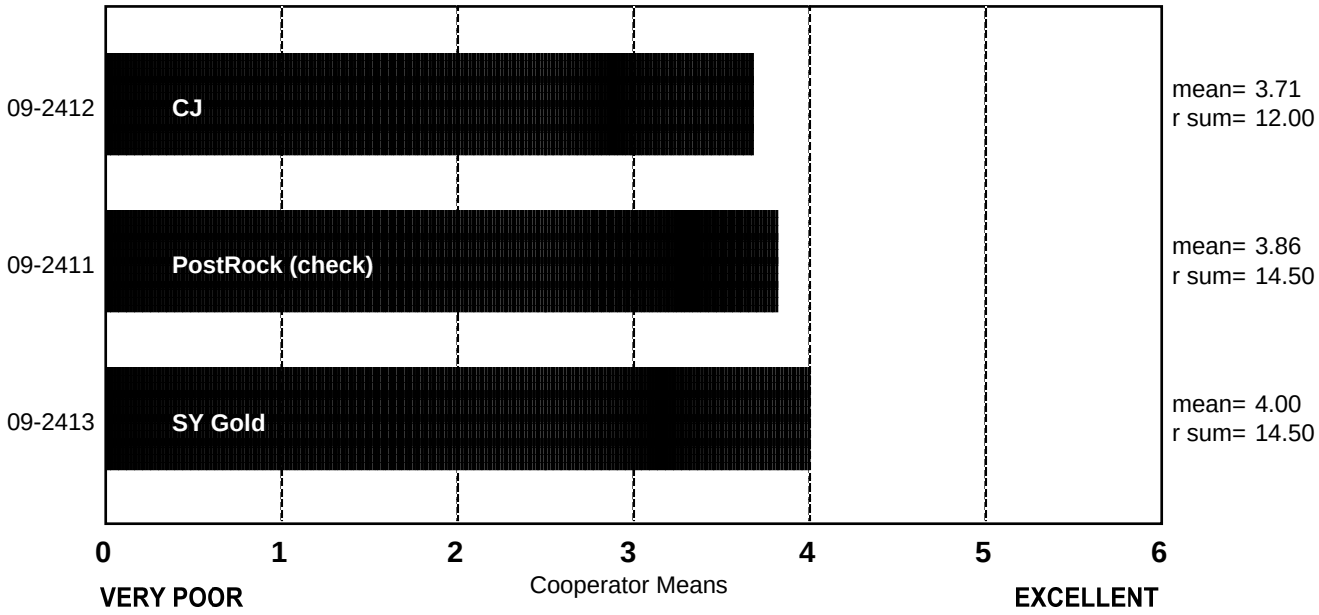
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2413	5668	156.2	3649	0.440	1.879	1.261	1.67	-28.0

SPONGE CHARACTERISTICS

(Small Scale) Agripro

ncoop= 7
chisq= -3.36
chisqc= 1.52
cvchisq= 5.99
crdiff=

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

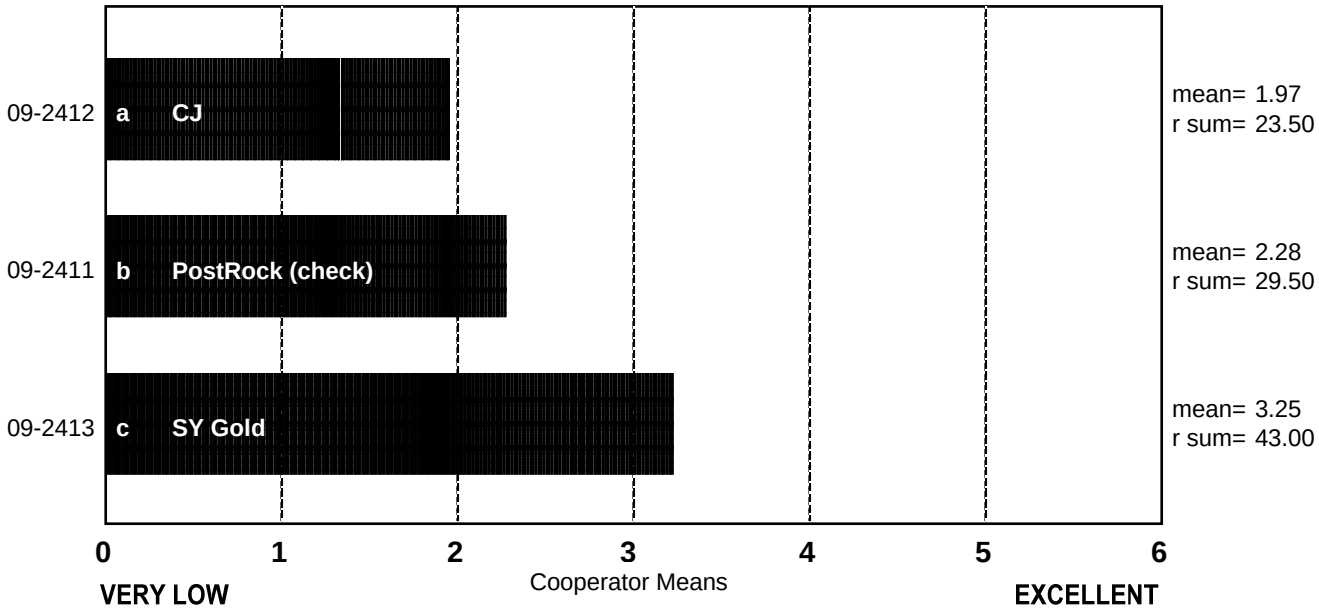


BAKE ABSORPTION

(Small Scale) Agripro

ncoop= 16
chisq= 12.47
chisqc= 20.46
cvchisq= 5.99
crdiff= 5.59

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Agripro

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2411 PostRock (check)	**57.2**	**521.0**	**57.0**	**63.4**	**60.1**	**58.2**	**63.0**	**60.0**	**56.0**	**58.0**	**64.1**	**60.0**	**57.0**	**60.3**	**59.2**	**54.7**	**60.7**
09-2412 CJ	**57.6**	**52.0**	**56.0**	**63.2**	**59.6**	**57.6**	**62.0**	**60.0**	**56.0**	**57.0**	**64.1**	**59.6**	**56.5**	**58.9**	**57.6**	**54.1**	**61.5**
09-2413 SY Gold	**61.6**	**56.0**	**57.0**	**64.6**	**60.4**	**61.3**	**64.0**	**60.0**	**59.0**	**60.0**	**64.1**	**60.6**	**58.0**	**60.9**	**62.3**	**57.8**	**60.4**

BAKE MIX TIME, ACTUAL

(Small Scale) Agripro

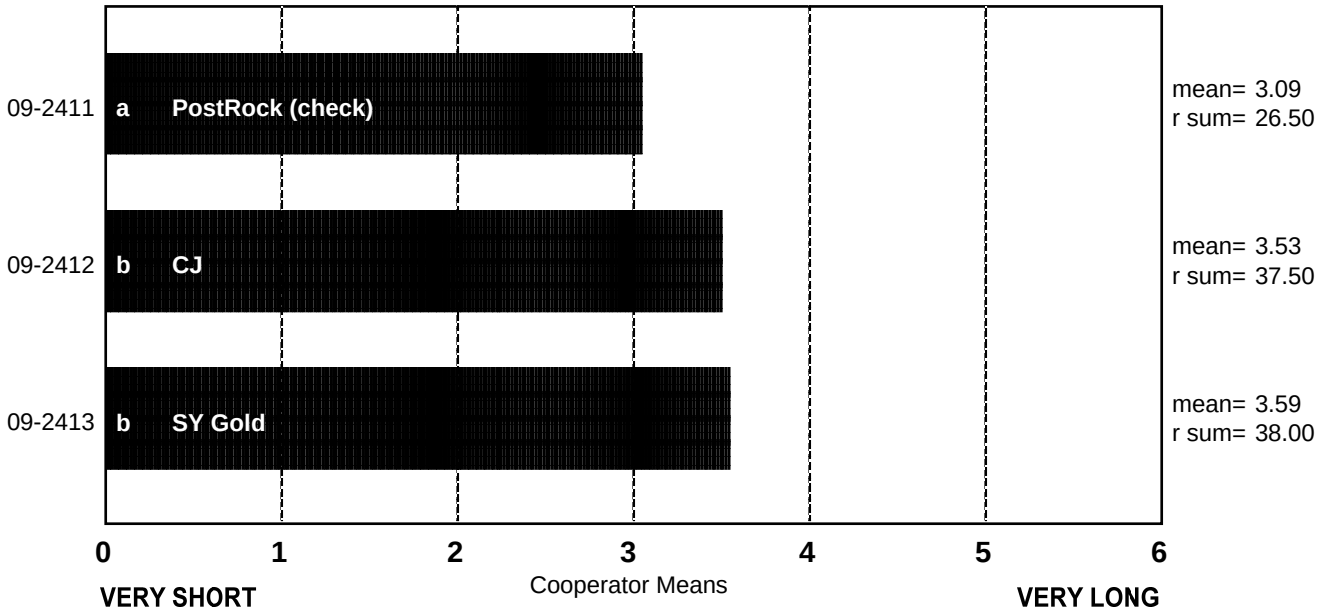
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2411 PostRock (check)	**1.5**	**4.0**	**8.0**	**4.3**	**4.0**	**6.0**	**5.0**	**6.0**	**7.0**	**21.0**	**3.3**	**3.5**	**11.0**	**3.0**	**6.0**	**4.0**	**4.4**
09-2412 CJ	**1.3**	**5.0**	**7.0**	**5.0**	**4.5**	**5.0**	**5.8**	**6.0**	**7.0**	**23.0**	**3.8**	**3.9**	**15.0**	**3.2**	**5.0**	**5.0**	**6.1**
09-2413 SY Gold	**1.5**	**5.0**	**8.0**	**4.7**	**4.5**	**6.0**	**5.8**	**6.0**	**5.0**	**21.0**	**3.8**	**4.0**	**21.0**	**3.1**	**5.0**	**6.5**	**6.0**

BAKE MIX TIME

(Small Scale) Agripro

ncoop= 17
chisq= 4.97
chisqc= 8.24
cvchisq= 5.99
crdiff= 8.27

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

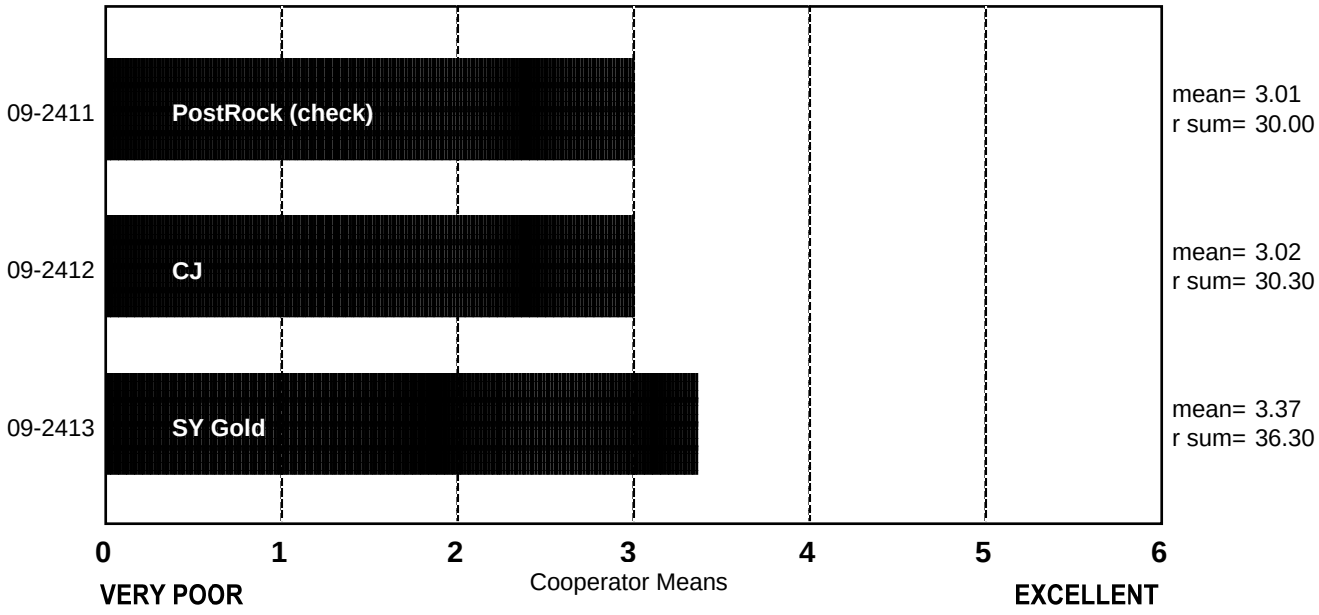


MIXING TOLERANCE

(Small Scale) Agripro

ncoop= 16
chisq= 3.99
chisqc= 5.94
cvchisq= 5.99
crdiff=

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

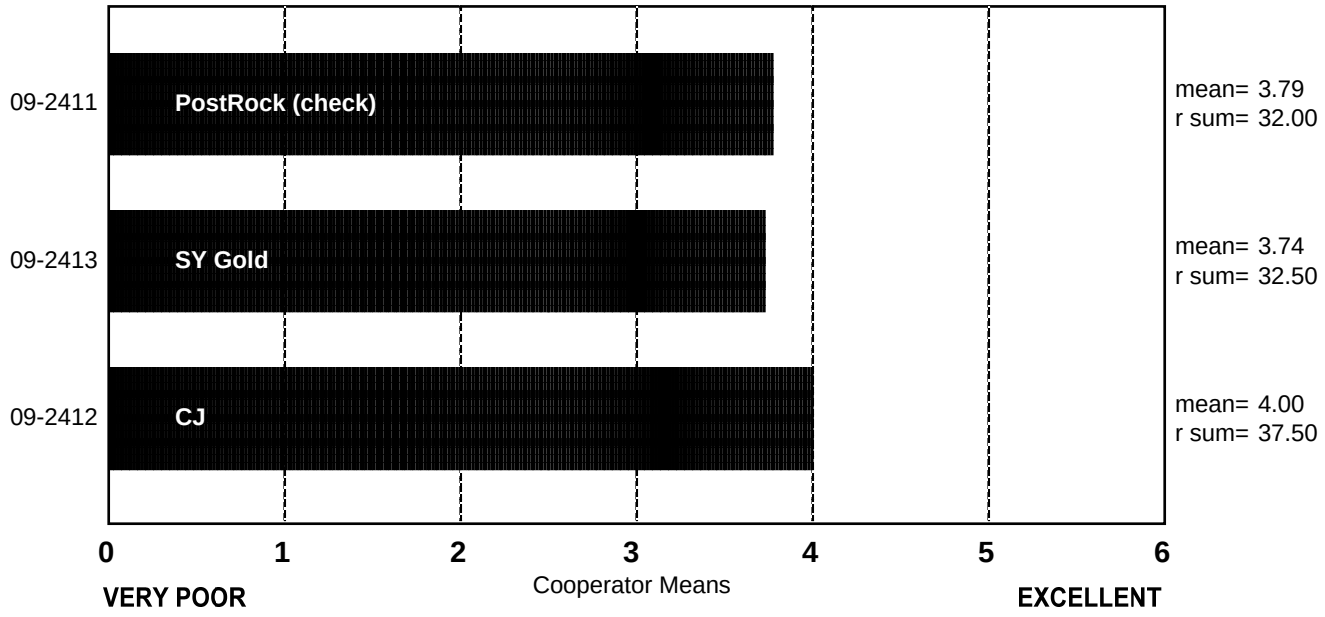


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Agripro

ncoop= 17
chisq= 1.09
chisqc= 1.95
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Agripro

	Sticky	Wet	Tough	Good	Excellent
09-2411 PostRock (check)	**5**	**0**	**1**	**10**	**1**
09-2412 CJ	**1**	**1**	**2**	**11**	**1**
09-2413 SY Gold	**3**	**1**	**3**	**10**	**0**

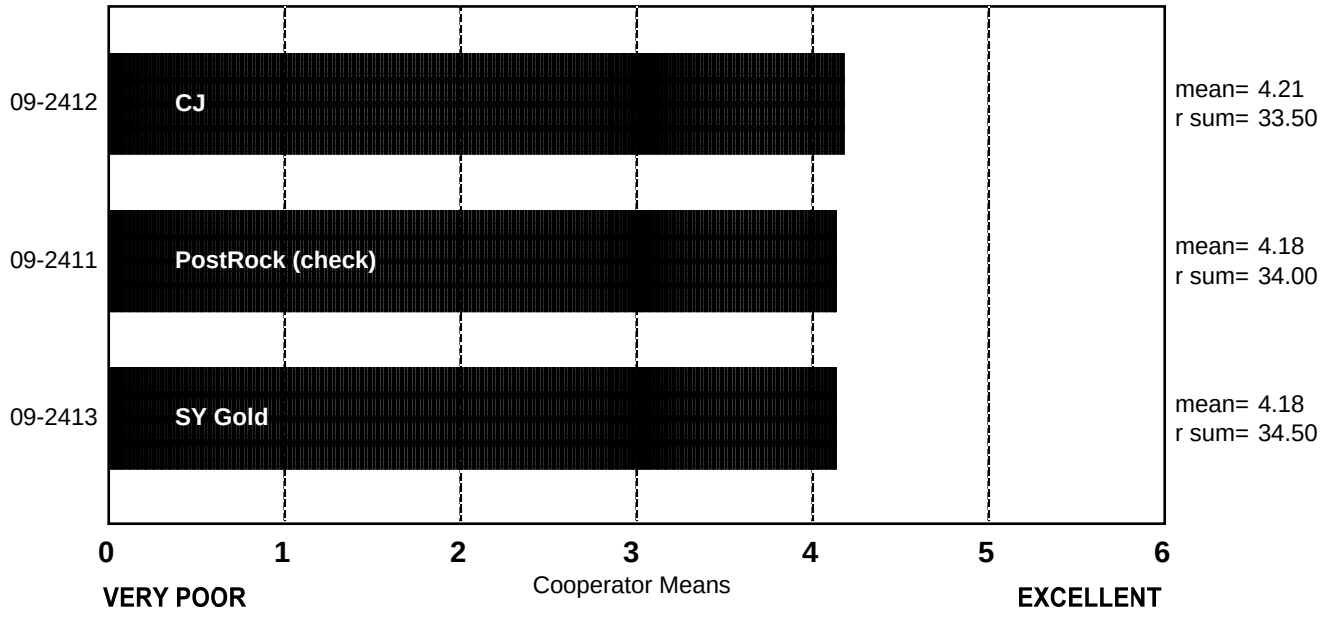
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Agripro

ncoop= 17
chisq= 0.03
chisqc= 0.05
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Agripro

	Sticky	Wet	Tough	Good	Excellent
09-2411 PostRock (check)	**3**	**1**	**1**	**11**	**1**
09-2412 CJ	**1**	**1**	**2**	**11**	**2**
09-2413 SY Gold	**1**	**1**	**2**	**13**	**0**

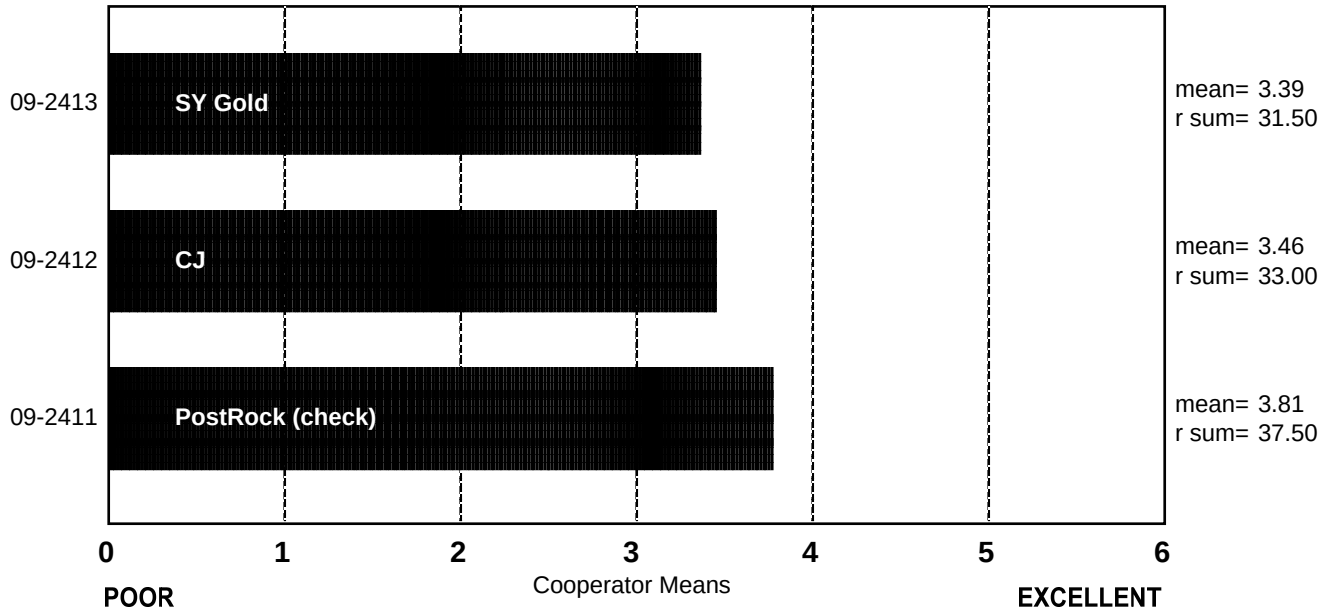
Frequency Table

CRUMB GRAIN

(Small Scale) Agripro

ncoop= 17
chisq= 1.15
chisqc= 2.05
cvchisq= 5.99
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Agripro

	Open	Fine	Dense
09-2411 PostRock (check)	**7**	**8**	**2**
09-2412 CJ	**9**	**6**	**2**
09-2413 SY Gold	**9**	**6**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Agripro

	Round	Irregular	Elongated
09-2411 PostRock (check)	**1**	**12**	**4**
09-2412 CJ	**3**	**10**	**4**
09-2413 SY Gold	**3**	**11**	**3**

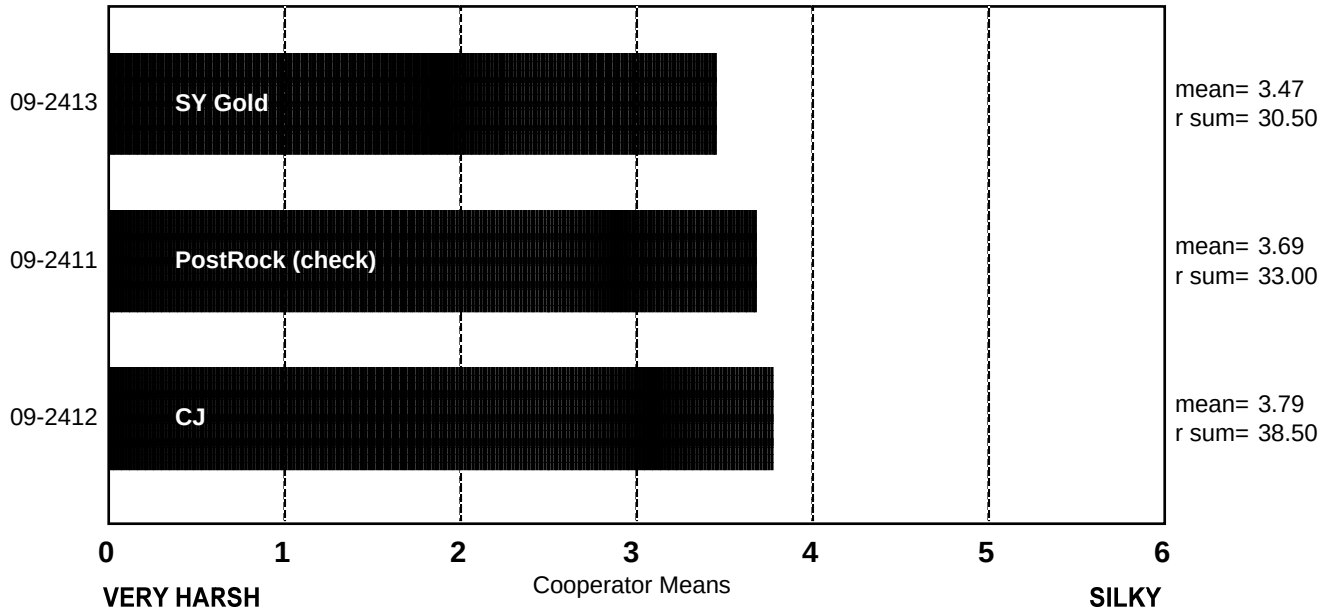
Frequency Table

CRUMB TEXTURE

(Small Scale) Agripro

ncoop= 17
chisq= 1.97
chisqc= 2.98
cvchisq= 5.99
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Agripro

	Harsh	Smooth	Silky
09-2411 PostRock (check)	**3**	**12**	**2**
09-2412 CJ	**2**	**13**	**2**
09-2413 SY Gold	**5**	**11**	**1**

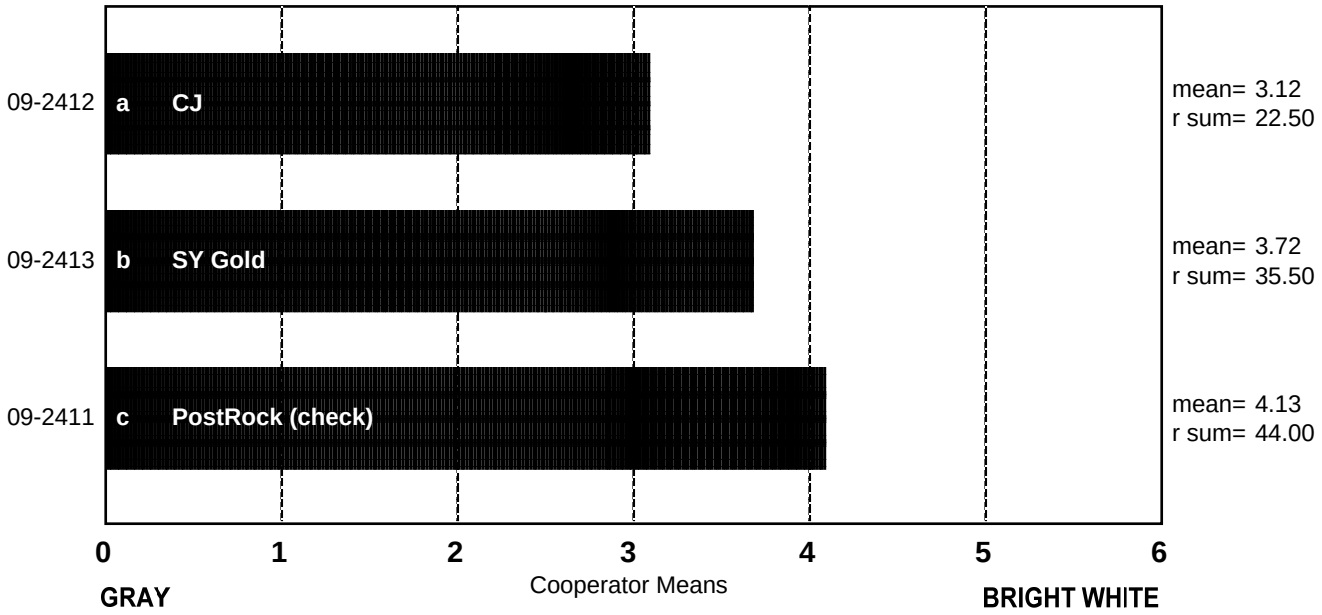
Frequency Table

CRUMB COLOR

(Small Scale) Agripro

ncoop= 17
chisq= 13.79
chisqc= 19.54
cvchisq= 5.99
crdiff= 6.71

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



CRUMB COLOR, DESCRIBED

(Small Scale) Agripro

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
09-2411 PostRock (check)	**0**	**0**	**0**	**2**	**10**	**5**	**0**
09-2412 CJ	**0**	**0**	**2**	**9**	**6**	**0**	**0**
09-2413 SY Gold	**0**	**0**	**0**	**8**	**6**	**3**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Agripro

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2411 PostRock (check)	**132.0**	**500.0**	**421.0**	**153.5**	**155.9**	**474.0**	**143.8**		**466.0**	**469.0**	**138.6**	**140.9**			**458.2**	**127.0**	**149.1**
09-2412 CJ	**132.5**	**480.0**	**417.0**	**150.0**	**155.6**	**471.0**	**144.0**		**465.3**	**468.7**	**139.3**	**138.9**			**451.8**	**127.2**	**150.2**
09-2413 SY Gold	**136.2**	**480.0**	**421.0**	**153.3**	**156.8**	**474.0**	**149.0**		**467.4**	**469.5**	**136.5**	**140.7**			**454.3**	**129.6**	**148.8**

LOAF VOLUME, ACTUAL

(Small Scale) Agripro

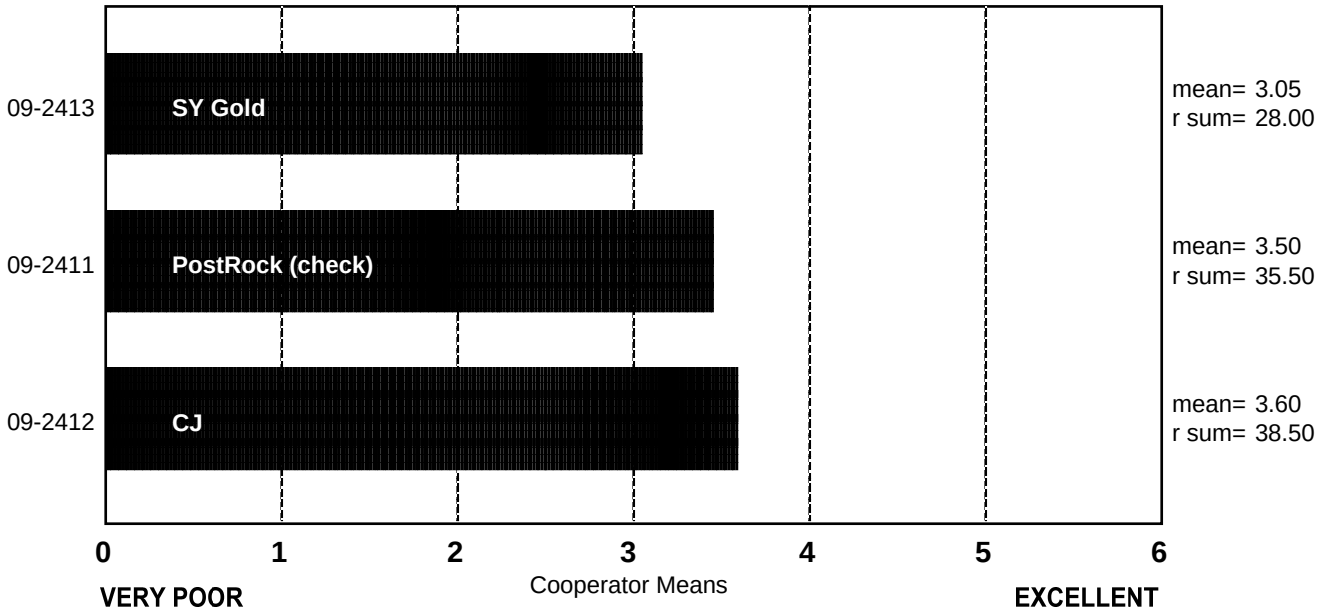
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2411 PostRock (check)	**715**	**2750**	**2900**	**830**	**589**	**2600**	**858**	**923**	**2675**	**2986**	**1018**	**795**	**2825**	**1035**	**2300**	**800**	**820**
09-2412 CJ	**670**	**2950**	**2900**	**805**	**595**	**2750**	**815**	**953**	**2713**	**2956**	**1008**	**834**	**2700**	**955**	**2450**	**740**	**822**
09-2413 SY Gold	**640**	**2750**	**2925**	**860**	**566**	**2575**	**885**	**905**	**2538**	**2927**	**918**	**833**	**2725**	**930**	**2475**	**640**	**765**

LOAF VOLUME

(Small Scale) Agripro

ncoop= 17
chisq= 3.44
chisqc= 4.50
cvchisq= 5.99
crdiff=

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

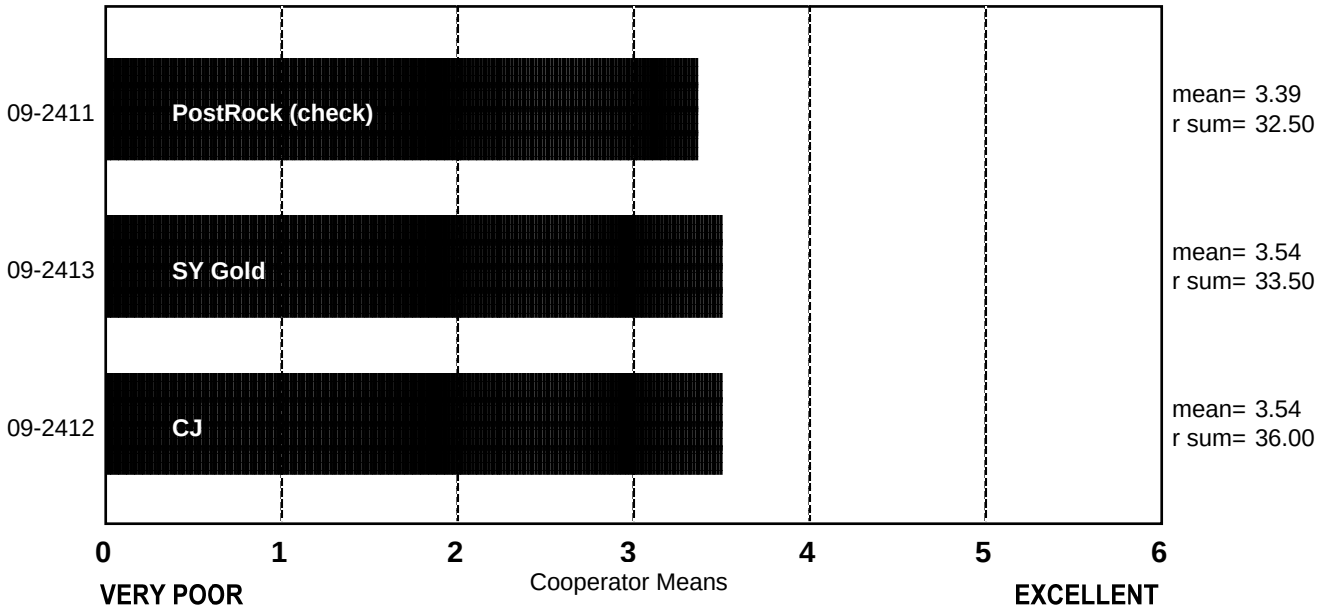


OVERALL BAKING QUALITY

(Small Scale) Agripro

ncoop= 17
chisq= 0.38
chisqc= 0.48
cvchisq= 5.99
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) AgriPro

COOP. **09-2411 PostRock (check)**

A. Low loaf volume.
B. Very low absorption and low volume.
C. Slightly open grain, good extensible dough. Lower protein and shorter mix.
D. Average dough and interior, low loaf volume performance.
E. No comment.
F. No comment.
G. Normal Water Abs & Mix Time, Longer Proof Time, Slight Sticky & Weak Dough, High OS & Vol, open elongated Cells, White Crumb, Smooth & Slight Low Resilient Texture.
H. OK bake performance but dough handling was weak out of mixer and on the bench. Grain was open and irregular.
I. Very low absorption, fine grain, white crumb, average volume.
J. Low absorption, sl. Open grain, good volume.
K. No comment.
L. No comment.
M. No comment.
N. No comment.
O. Very low absorption - Low mix time- Average volume-Good color.
P. No comment.
Q. Low bake absorption; good bake MT; low tolerance; weak at pan; satisfactory crumb; creamy crumb color; low LV.

COOP. **09-2412 CJ**

A. Low loaf volume, flour protein and bake absorption also short mix time.
B. Very low absorption and open grain.
C. Open grain. Good pliable dough. Lower protein and shorter mix. Creamy crumb.
D. Average dough and loaf volume performance, poor interior.
E. No comment.
F. No comment.
G. Normal Water Abs & Mix Time, Proof Time, Sloght Sticky & Weak Dough, High OS & Vol, open elongated Cells, Slight Yellow Crumb, Smooth & Slight Low Resilient Texture.
H. Lower protein level. Marginal bake performance. Very weak dough handling -mellow and soft. Poor mix tolerance but had nice grain.
I. Very low absorption, good grain, good volume.
J. low absorption, tight, consistent, smooth grain, good volume
K. No comment.
L. No comment.
M. No comment.
N. No comment.
O. Very low absorption, low mix time- Good Grain and Volume.

P. No comment.
Q. Low bake absorption; long MT; some weakness at pan; above satisfactory crumb; dull crumb color; low LV.

COOP. 09-2413 SY Gold

A. Low loaf volume, flour protein and bake absorption
B. Low absorption and low volume.
C. Lower protein. Open grain. Average volume for protein level. Good dough.
D. Average dough and loaf volume performance, poor interior.
E. No comment.
F. No comment.
G. Medium Water Abs & Mix Time, Longer Proof Time, Slight Soft & Strong Dough, Very High OS & Vol, Fine Enlognated Cells, White Crumb, Silky & Medium Resilient Texture.
H. Poor dough characteristics, tough/dry doughs - more water may help performance but unsure given the sample weakness by the end of processing. Poor mix tolerance and volumes. (DNP)
I. Low absorption, short mix time, fine grain, white crumb.
J. Slightly open, slightly irregular grain, slightly above average volume
K. No comment.
L. No comment.
M. No comment.
N. No comment.
O. Low mix Time- Open Grain
P. No comment.
Q. Low bake absorption; long MT; some weakness at pan; above satisfactory crumb; creamy crumb color; very low LV.

Notes: **B, C, H, I, J, M, and O** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

Montana – Phil Bruckner

2009 Crop Year – Bozeman, MT

The Post Agronomy Farm (6mi west of Bozeman) had above average rainfall for the 2009 crop year (17.1in versus 16.0in for the 52yr average). There was adequate snow cover during winter months and no winterkill was observed. Spring heading was only slightly later than average. Below average June and July temperatures led to later maturity of the crop (harvested in late August instead of early August). A hail storm on June 30th caused around 10% head breakage (2-33% depending on variety). Yields were average at ~100 bu/a (Montana winter wheat producers average = 37bu/a), but above average test weights (62.6 lb/bu) were observed, possibly due to a longer grain fill period. Proteins were average at 13.3%. Stripe rust was observed in mid to late June (only the Genou was sprayed).

Yellowstone (check)

Yellowstone is 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 was the second leading winter wheat variety planted in Montana in 2009 with 12.7% of the acreage (312,000 acres).

MT06103

This is hard red winter wheat line with the pedigree, MT9409/(W94-137, Ontario mother line). MT06103 has above average yield, test weight, and protein. It is earlier heading and taller than most Montana lines. In limited testing the line does not appear to be very winterhardy in eastern Montana and western North Dakota. MT06103 is resistant to both stem and stripe rust prevalent in Montana. Mill and bake characteristics are average in our tests for MT06103.

MTS0713

This is a solid stemmed hard red winter wheat line with the pedigree, (Vanguard/ Norstar//Judith dwarf, 93X312E14)/3/NuHorizon. MTS0713 has average yield and protein, but above average test weight. It is average heading and shorter than most Montana lines. Like most solid stem lines, it does not appear to be very winterhardy in eastern Montana and western North Dakota, in limited testing. MTS0713 is resistant to stripe rust, but susceptible to stem rust. Milling characteristics were average and baking (highest loaf volume in 2008) was above average in Montana tests.

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

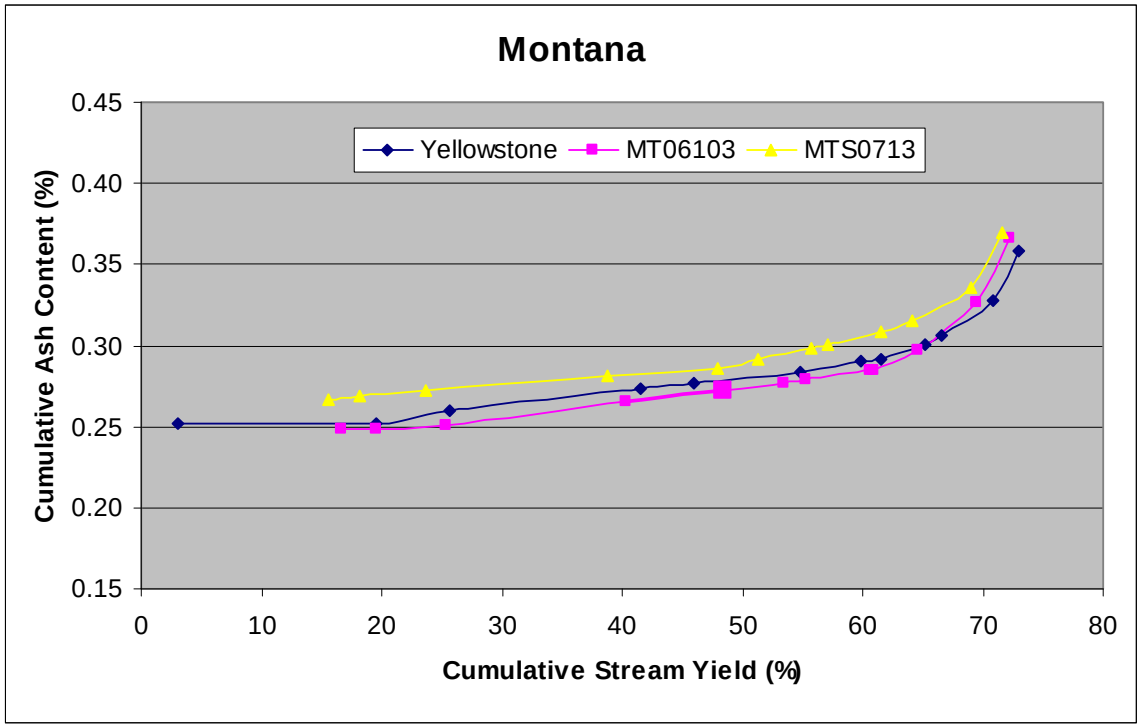
Test entry number	09-2414	09-2415	09-2416
Sample identification	**Yellowstone (check)**	**MT06103**	**MTS0713**
Wheat Data			
FGIS classification	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	64.5	64.2	65.6
Hectoliter weight (kg/hl)	84.8	84.4	86.2
1000 kernel weight (gm)	44.3	44.9	44.4
NIR hardness	77	77	77
Wheat kernel size (Rotap)			
Over 7 wire (%)	96.3	96.4	95.5
Over 9 wire (%)	3.7	3.6	4.5
Through 9 wire (%)	0.0	0.0	0.0
Single kernel (skcs)			
Hardness (avg /s.d)	65.1/12.3	56.7/13.9	63.8/12.4
Weight (mg) (avg/s.d)	43.5/8.5	44.6/9.6	44.6/9.0
Diameter (mm)(avg/s.d)	3.02/0.34	3.17/0.34	3.14/0.35
SKCS distribution	00-05-28-67	05-17-34-44	02-06-26-66
Classification	Hard	Hard	Hard
Wheat moisture (%)	9.7	9.7	9.7
Wheat protein (12% mb)	12.6	15.0	13.7
Wheat ash (12% mb)	1.50	1.74	1.50
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	73.1	72.1	71.4
Quadrumat Sr. Mill	71.0	70.4	71.6
NIR Flour moisture (%)	13.0	12.8	13.1
NIR Flour protein (14% mb)	10.8	13.1	12.4
Flour ash (14% mb)	0.40	0.40	0.38
Glutomatic			
Wet gluten (%)	29.6	38.7	34.1
Dry gluten (%)	11.0	13.9	11.9
Gluten index	99.0	97.7	95.7
Rapid Visco-Analyser			
Peak Time (min)	6.1	6.3	6.1
Peak Viscosity (RVU)	201.7	168.7	148.9
Breakdown (RVU)	71.8	39.3	56.1
Final Viscosity at 13 min (RVU)	231.9	233.0	176.8
Minolta color meter			
L*	93.01	93.08	92.97
a*	-1.42	-1.63	-1.55
b*	8.26	8.89	8.77
Falling number (sec)	340	445	317
Damaged Starch			
(AI%)	96.62	96.94	96.88
(AACC76-31)	6.76	7.02	6.98

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

Montana: Physical Dough Tests and Gluten Analysis For 2009 (Small-Scale) Samples

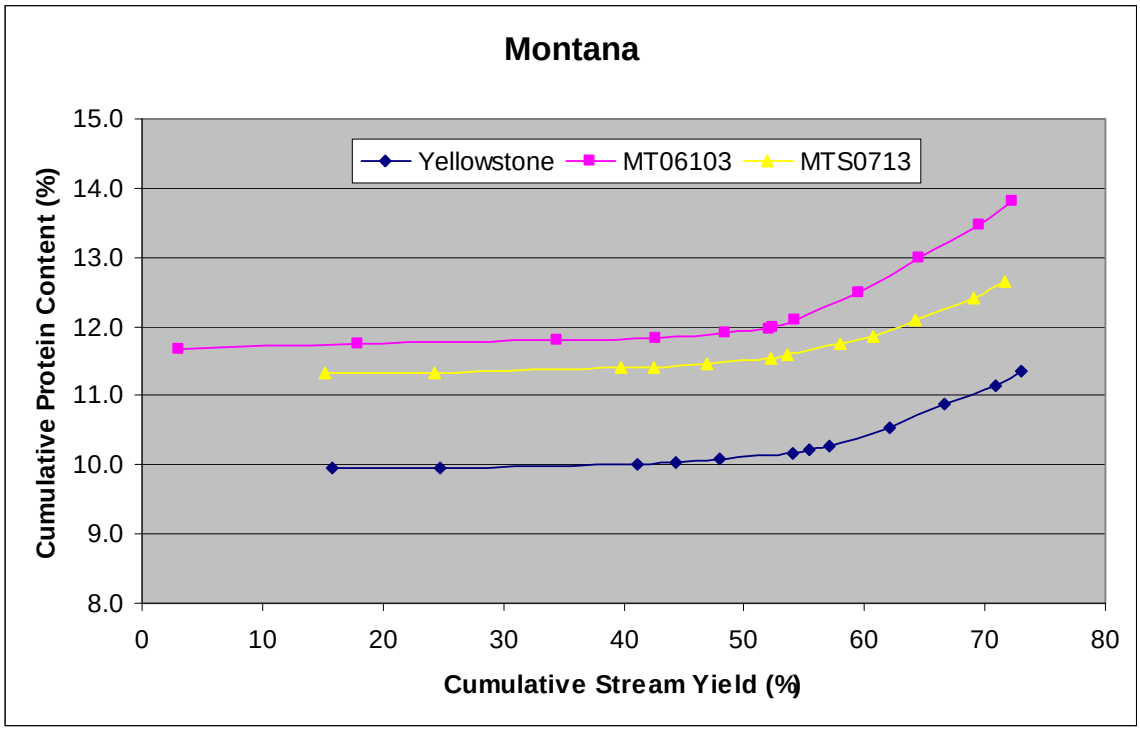
Test Entry Number	09-2414	09-2415	09-2416
Sample Identification	Yellowstone (check)	MT06103	MTS0713
MIXOGRAPH			
Flour Abs (% as-is)	66.2	69.7	66.6
Flour Abs (14% mb)	65.0	68.3	65.5
Mix Time (min)	5.38	4.50	3.50
Mix tolerance (0-6)	4	4	2
FARINOGRAPH			
Flour Abs (% as-is)	63.1	65.0	64.0
Flour Abs (14% mb)	61.9	63.6	63.0
Development time (min)	4.4	13.7	9.7
Mix stability (min)	12.0	24.7	26.2
Mix Tolerance Index (FU)	25	12	11
Breakdown time (min)	10.2	28.4	28.5
ALVEOGRAPH			
P(mm. $_{H2O}$): Tenacity	114	143	121
L(mm): Extensibility	83	82	90
G($mm_{0.5}$): Swelling index	20.3	20.2	21.1
W(10^{-4} J): strength (curve area)	383	467	422
P/L: curve configuration ratio	1.37	1.74	1.34
Ie(P_{200}/P): elasticity index	68.4	68.3	67.1
EXTENSIGRAPH			
Resist (BU at 30/60/90 min)	593/827/818	703/959/996	465/581/596
Extensibility (mm at 30/60/90 min)	128/124/115	135/122/121	158/142/145
Energy (cm^2 at 30/60/90 min)	118/154/135	147/160/158	142/151/163
Resist $_{max}$ (BU at 30/60/90 min)	751/998/998	851/991/996	718/879/916
Ratio (at 30/60/90 min)	4.6/6.7/7.2	5.2/7.9/8.2	3.0/4.1/4.1
PROTEIN ANALYSIS			
HMW-GS Composition	1, 7+8, 5+10	2*, 7+9, 5+10	1, 7+9, 5+10
Glu/Gli	1.92	2.09	2.14
HMW/LMW	0.45	0.44	0.43
%IPP	52.02	49.90	49.34
SEDIMENTATION TEST			
Volume (ml)	70.2	71.0	69.3

Montana: Cumulative Ash Curves



Yellowstone - 2414					MT06103- 2415					MTS0713 - 2416				
Mill	Strm Yld	Ash	Cumulative		Mill	Strm Yld	Ash	Cumulative		Mill	Strm Yld	Ash	Cumulative	
Streams	(14%mb)	(14%mb)	Yield (14%)	Ash (14%)	Streams	(14%mb)	(14%mb)	Yield (14%)	Ash (14%)	Streams	(14%mb)	(14%mb)	Yield (14%)	Ash (14%)
1M Red	3.09	0.25	3.09	0.25	2M	16.57	0.25	16.57	0.25	2M	15.51	0.27	15.51	0.27
2M	16.51	0.25	19.60	0.25	1M Red	2.99	0.25	19.56	0.25	1M Red	2.72	0.28	18.22	0.27
1M	6.08	0.28	25.68	0.26	1M	5.78	0.26	25.34	0.25	1M	5.39	0.28	23.62	0.27
3M	15.79	0.29	41.48	0.27	3M	14.90	0.29	40.24	0.27	3M	15.14	0.29	38.76	0.28
2BK	4.48	0.31	45.96	0.28	4M	8.19	0.31	48.43	0.27	4M	9.11	0.31	47.87	0.29
4M	8.91	0.32	54.87	0.28	2BK	5.01	0.32	53.44	0.28	2BK	3.41	0.36	51.28	0.29
1BK	5.02	0.36	59.89	0.29	Grader	1.79	0.33	55.23	0.28	1BK	4.50	0.38	55.79	0.30
Grader	1.67	0.36	61.56	0.29	1BK	5.36	0.34	60.59	0.28	Grader	1.33	0.39	57.12	0.30
5M	3.66	0.46	65.22	0.30	FILTER FLR	0.34	0.42	60.93	0.29	5M	4.35	0.41	61.47	0.31
FILTER FLR	1.35	0.53	66.57	0.31	5M	3.61	0.50	64.55	0.30	FILTER FLR	2.68	0.47	64.15	0.32
3BK	4.29	0.67	70.86	0.33	3BK	4.91	0.71	69.46	0.33	3BK	4.85	0.61	69.01	0.34
BRAN FLR	2.14	1.37	73.00	0.36	BRAN FLR	2.73	1.36	72.19	0.37	BRAN FLR	2.58	1.26	71.59	0.37
Break Shorts	2.59	3.46	75.59	0.46	Break Shorts	2.42	3.79	74.61	0.48	Break Shorts	2.87	2.56	74.46	0.45
Red Dog	2.75	1.43	78.33	0.50	Red Dog	3.26	1.33	77.88	0.51	Red Dog	4.06	1.13	78.51	0.49
Red Shorts	0.04	3.90	78.37	0.50	Red Shorts	0.07	3.96	77.94	0.52	Red Shorts	0.10	3.42	78.61	0.49
Filter Bran	0.67	2.08	79.05	0.51	Filter Bran	0.40	2.27	78.34	0.52	Filter Bran	0.35	1.30	78.96	0.50
Bran	20.95	5.80	100.00	1.62	Bran	21.66	6.01	100.00	1.71	Bran	21.04	5.27	100.00	1.50
Wheat Ash		1.46			Wheat Ash		1.70			Wheat Ash		1.47		
Straight Grade Flour Ash		0.40			Straight Grade Flour Ash		0.40			Straight Grade Flour Ash		0.38		

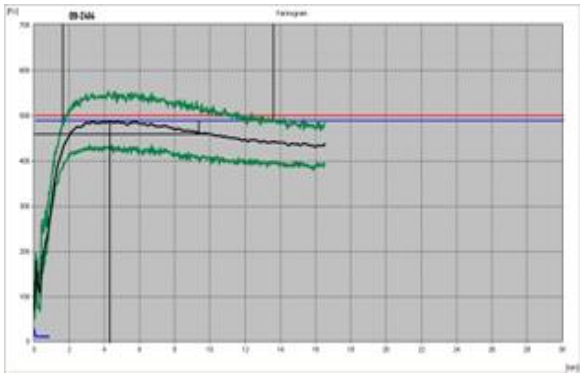
Montana: Cumulative Protein Curves



Yellowstone - 2414					MT06103 - 2415					MTS0713 - 2416				
Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)	Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)	Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)
3M	15.8	9.9	15.8	9.9	1M Red	3.0	11.7	3.0	11.7	3M	15.1	11.3	15.1	11.3
4M	8.9	10.0	24.7	10.0	3M	14.9	11.8	17.9	11.8	4M	9.1	11.4	24.3	11.3
2M	16.5	10.1	41.2	10.0	2M	16.6	11.8	34.5	11.8	2M	15.5	11.5	39.8	11.4
1M Red	3.1	10.2	44.3	10.0	4M	8.2	12.0	42.6	11.8	1M Red	2.7	11.5	42.5	11.4
5M	3.7	10.7	48.0	10.1	1M	5.8	12.4	48.4	11.9	5M	4.4	11.9	46.8	11.5
1M	6.1	10.9	54.0	10.2	5M	3.6	12.9	52.0	12.0	1M	5.4	12.3	52.2	11.5
FILTER FLR	1.3	12.2	55.4	10.2	FILTER FLR	0.3	13.9	52.4	12.0	Grader	1.3	13.6	53.6	11.6
Grader	1.7	12.6	57.1	10.3	Grader	1.8	15.4	54.2	12.1	1BK	4.5	13.8	58.1	11.8
1BK	5.0	13.5	62.1	10.5	1BK	5.4	16.3	59.5	12.5	FILTER FLR	2.7	13.9	60.7	11.9
2BK	4.5	15.4	66.6	10.9	2BK	5.0	19.0	64.5	13.0	2BK	3.4	16.3	64.2	12.1
3BK	4.3	15.6	70.9	11.2	3BK	4.9	19.7	69.5	13.5	3BK	4.9	16.6	69.0	12.4
BRAN FLR	2.1	17.6	73.0	11.3	BRAN FLR	2.7	22.5	72.2	13.8	BRAN FLR	2.6	18.9	71.6	12.6
Break Shorts	2.6	13.5	75.6	11.4	Break Shorts	2.4	15.4	74.6	13.9	Break Shorts	2.9	14.1	74.5	12.7
Red Dog	2.7	12.3	78.3	11.4	Red Dog	3.3	14.9	77.9	13.9	Red Dog	4.1	13.7	78.5	12.8
Red Shorts	0.0	13.3	78.4	11.4	Red Shorts	0.1	14.6	77.9	13.9	Red Shorts	0.1	15.0	78.6	12.8
Filter Bran	0.7	10.8	79.0	11.4	Filter Bran	0.4	11.8	78.3	13.9	Filter Bran	0.4	12.1	79.0	12.8
Bran	21.0	16.0	100.0	12.4	Bran	21.7	19.7	100.0	15.1	Bran	21.0	18.3	100.0	13.9
Whole Wheat		12.3			**Whole Wheat**		14.6			**Whole Wheat**		13.4		
St Grade Flour		11.2			**St Grade Flour**		13.7			**St Grade Flour**		12.5		

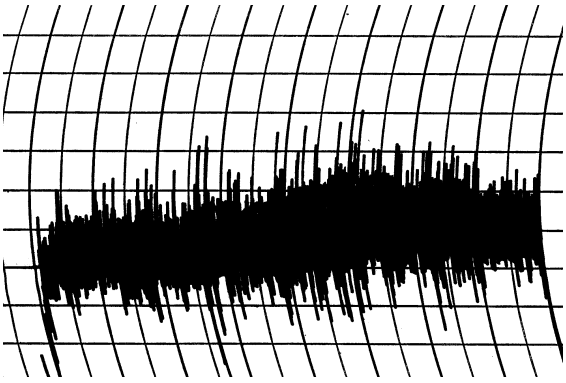
Physical Dough Tests
2009 (Small Scale) Samples – Montana

Farinograms



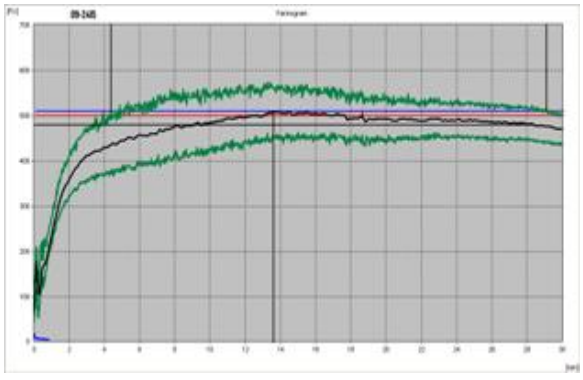
Water abs = 61.9%, Peak time = 4.4 min,
Mix stab = 12.0 min, MTI = 25 FU

Mixograms

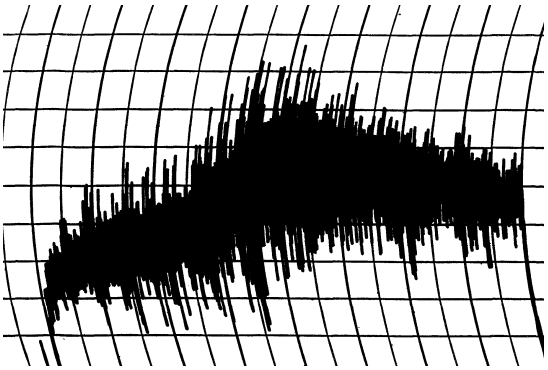


Water abs = 65.0%
Mix time = 5.4 min

09-2414, Yellowstone (check)



Water abs = 63.6%, Peak time = 13.7 min,
Mix stab = 24.7 min, MTI = 12 FU



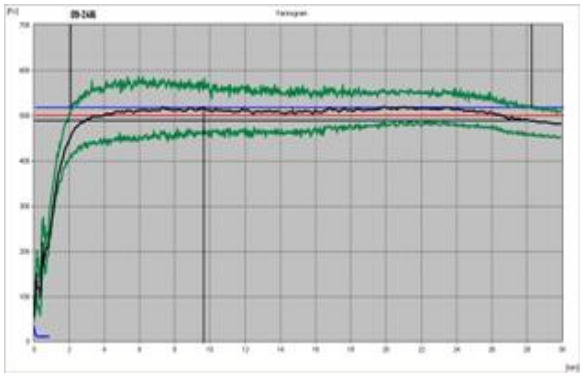
Water abs = 68.3%
Mix time = 4.5 min

09-2415, MT06103

Physical Dough Tests

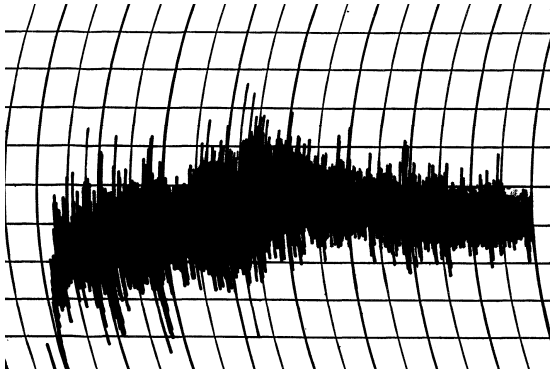
2009 (Small Scale) Samples – Montana (continued)

Farinograms



Water abs = 63.0%, Peak time = 9.7 min,
Mix stab = 26.2 min, MTI = 11FU

Mixograms

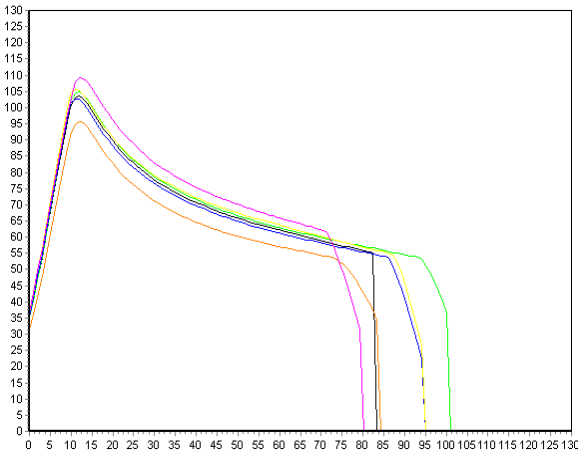


Water abs = 65.5%
Mix time = 3.5 min

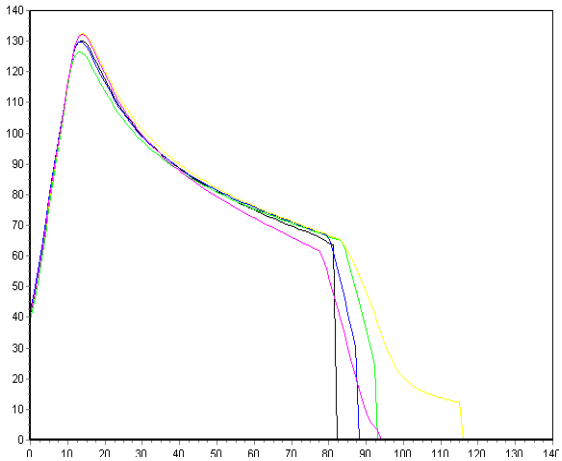
09-2416, MTS0713

Physical Dough Tests - Alveograph

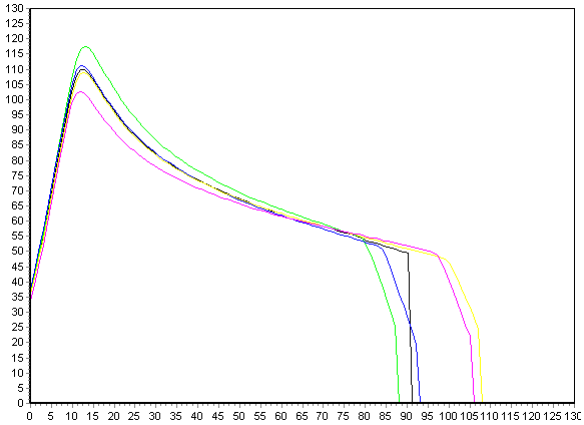
2009 (Small Scale) Samples – Montana



09-2414 (Yellowstone - check)
P(mm $_{H20}$)=114, L(mm)=83, W(10E^{-4} J)=383



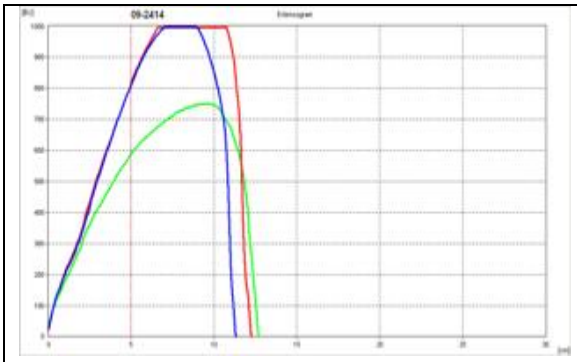
09-2415 (MT06103)
P(mm $_{H20}$)=143, L(mm)=82, W(10E^{-4} J)=467



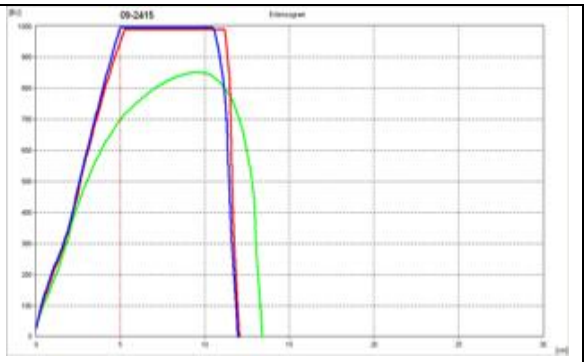
09-2416 (MTS0713)
P(mm $_{H20}$)=121, L(mm)=90, W(10E^{-4} J)=422

Physical Dough Tests - Extensigraph

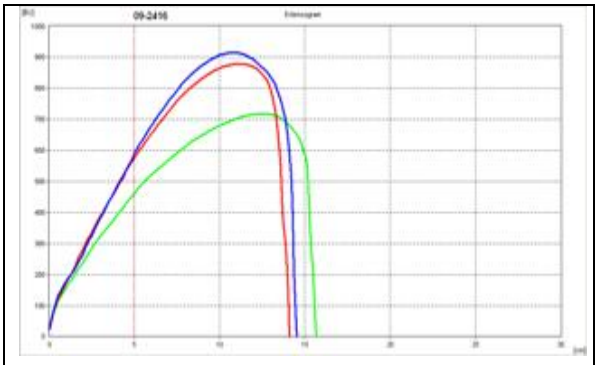
2009 (Small Scale) Samples – Montana



09-2414 (Yellowstone - check)
R (BU) = 593, E (mm) = 128, W (cm^2) = 118
Rmax (BU) = 751, Ratio = 4.6 at 30 min



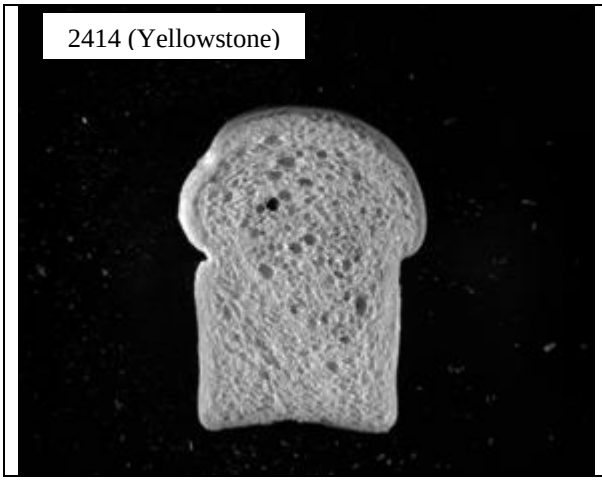
09-2415 (MT06103)
R (BU) = 703, E (mm) = 135, W (cm^2) = 147
Rmax (BU) = 851, Ratio = 5.2 at 30 min



09-2416 (MTS0713)
R (BU) = 465, E (mm) = 158, W (cm^2) = 142
Rmax (BU) = 718, Ratio = 3.0 at 30 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

Montana: C-Cell Bread Images and Analysis for 2009 (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	6104	149.0	3547	0.458	2.112	8.234	1.68	-27.4
2415	6453	146.3	3542	0.460	2.219	5.490	1.69	-21.1

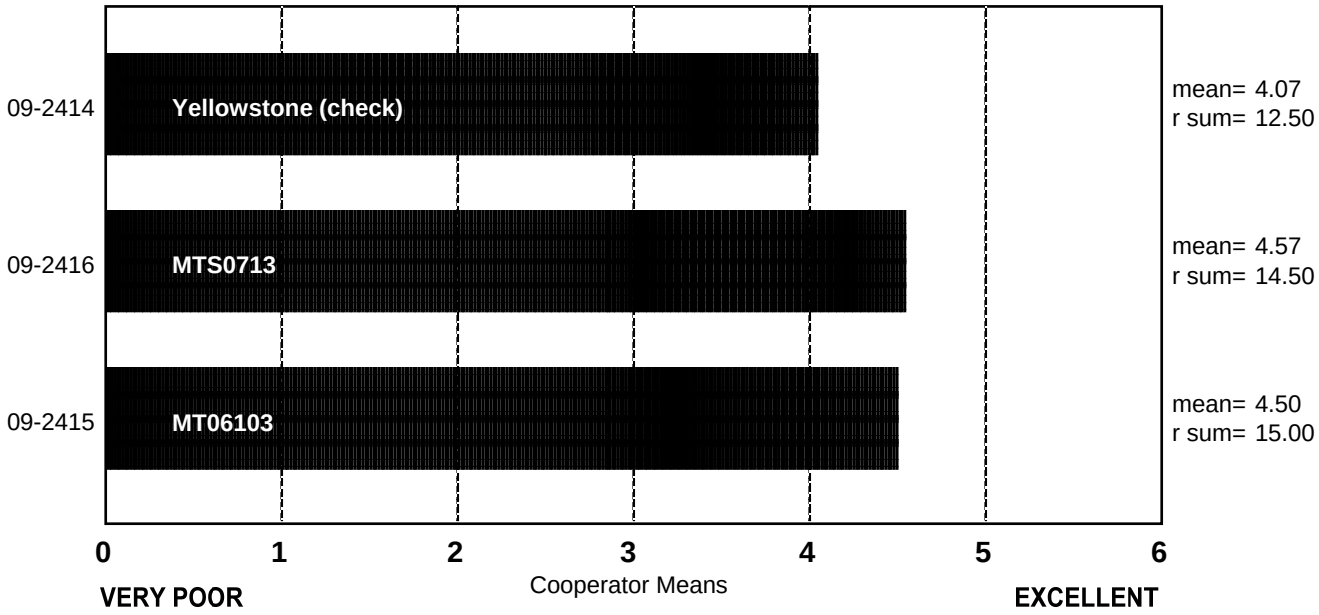
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2416	5981	150.5	3465	0.458	2.169	1.824	1.63	-23.8

SPONGE CHARACTERISTICS

(Small Scale) Montana

ncoop= 7
chisq= 0.50
chisqc= 0.74
cvchisq= 5.99
crdiff=

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

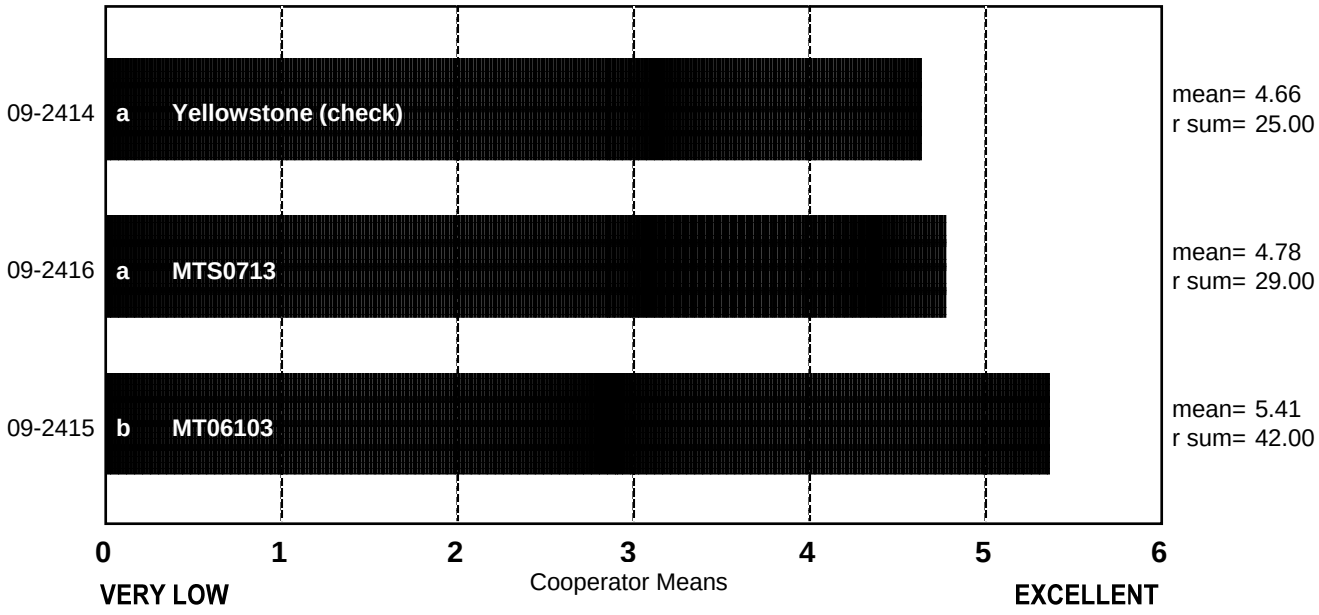


BAKE ABSORPTION

(Small Scale) Montana

ncoop= 16
chisq= 9.88
chisqc= 15.80
cvchisq= 5.99
crdiff= 6.71

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) 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
09-2414 Yellowstone (check)	**63.9**	**59.0**	**57.0**	**65.5**	**65.0**	**63.9**	**63.5**	**60.0**	**62.0**	**61.0**	**69.1**	**65.2**	**63.5**	**63.7**	**64.9**	**60.4**	**65.0**
09-2415 MT06103	**65.1**	**60.0**	**60.0**	**72.5**	**68.3**	**65.6**	**65.5**	**64.0**	**64.0**	**63.0**	**72.1**	**68.1**	**64.0**	**69.0**	**65.6**	**62.1**	**67.8**
09-2416 MTS0713	**64.0**	**60.0**	**58.0**	**68.5**	**65.5**	**65.0**	**64.5**	**63.0**	**62.0**	**63.0**	**70.1**	**65.7**	**61.5**	**65.3**	**66.0**	**61.5**	**65.6**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Montana

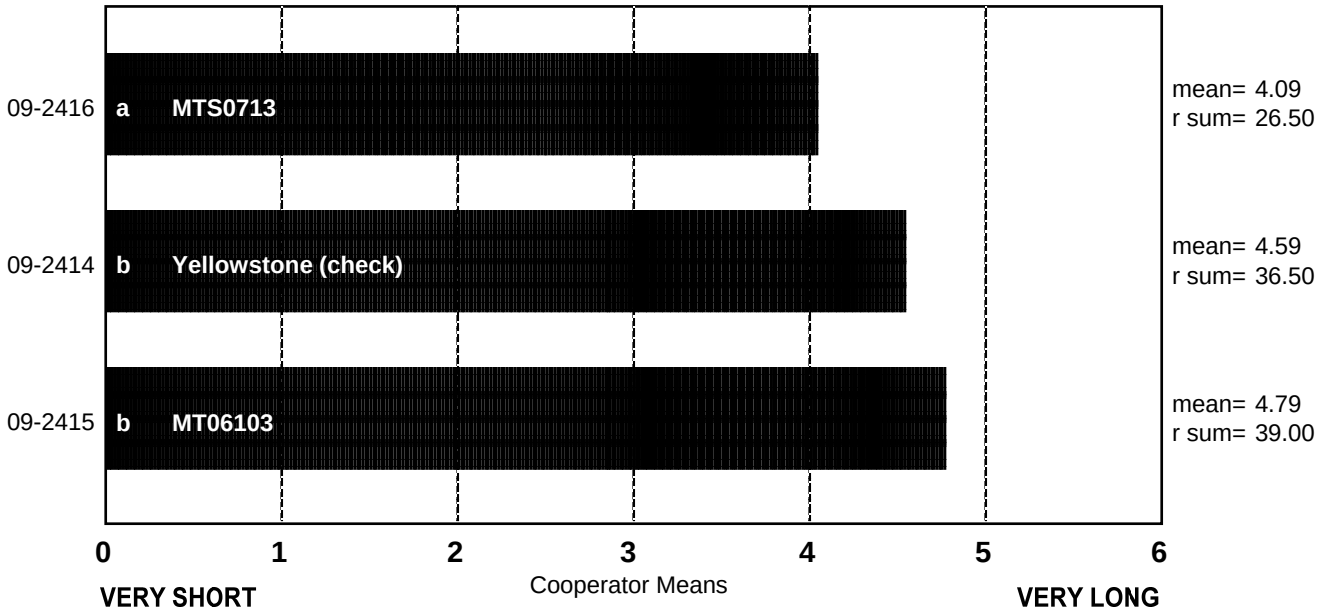
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2414 Yellowstone (check)	**1.8**	**5.0**	**20.0**	**5.5**	**5.5**	**5.5**	**6.3**	**9.0**	**17.0**	**25.0**	**5.5**	**5.4**	**30.0**	**4.1**	**8.0**	**6.5**	**7.3**
09-2415 MT06103	**2.5**	**9.0**	**20.0**	**5.2**	**5.0**	**7.0**	**5.7**	**9.0**	**25.0**	**25.0**	**4.8**	**4.5**	**30.0**	**3.4**	**13.0**	**4.3**	**6.0**
09-2416 MTS0713	**2.3**	**9.0**	**12.0**	**4.5**	**4.0**	**7.0**	**5.7**	**6.0**	**8.0**	**25.0**	**4.0**	**3.5**	**30.0**	**3.2**	**10.0**	**4.5**	**5.4**

BAKE MIX TIME

(Small Scale) Montana

ncoop= 17
chisq= 5.15
chisqc= 7.61
cvchisq= 5.99
crdiff= 8.87

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

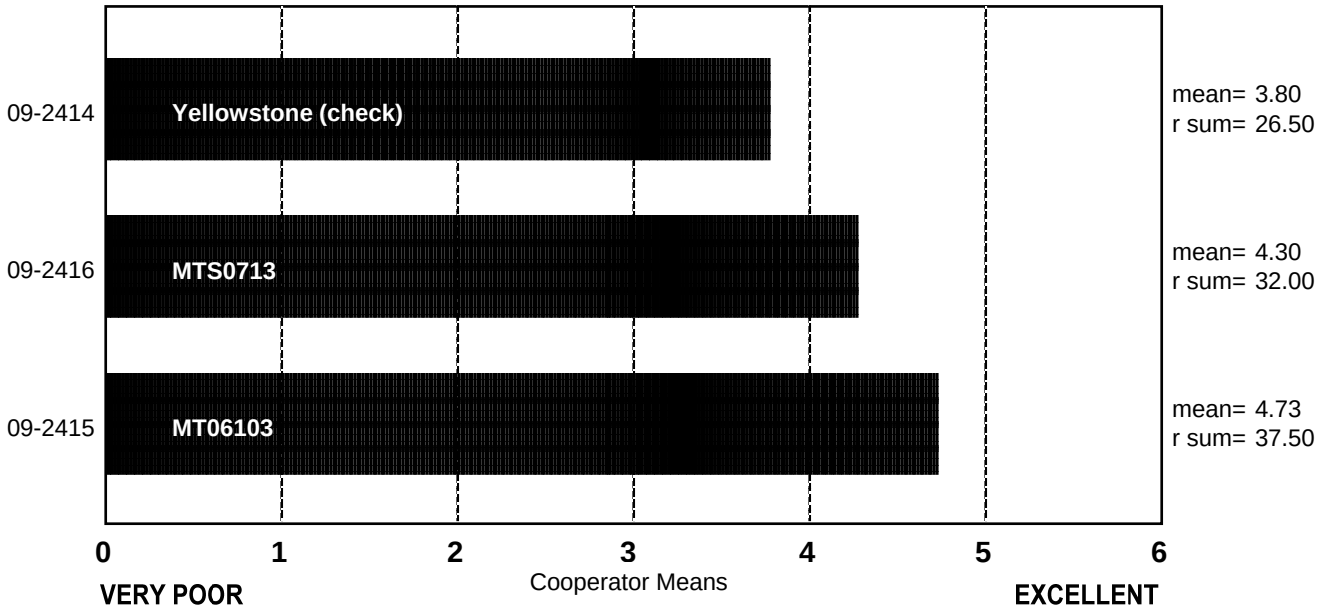


MIXING TOLERANCE

(Small Scale) Montana

ncoop= 16
chisq= 3.78
chisqc= 5.26
cvchisq= 5.99
crdiff=

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

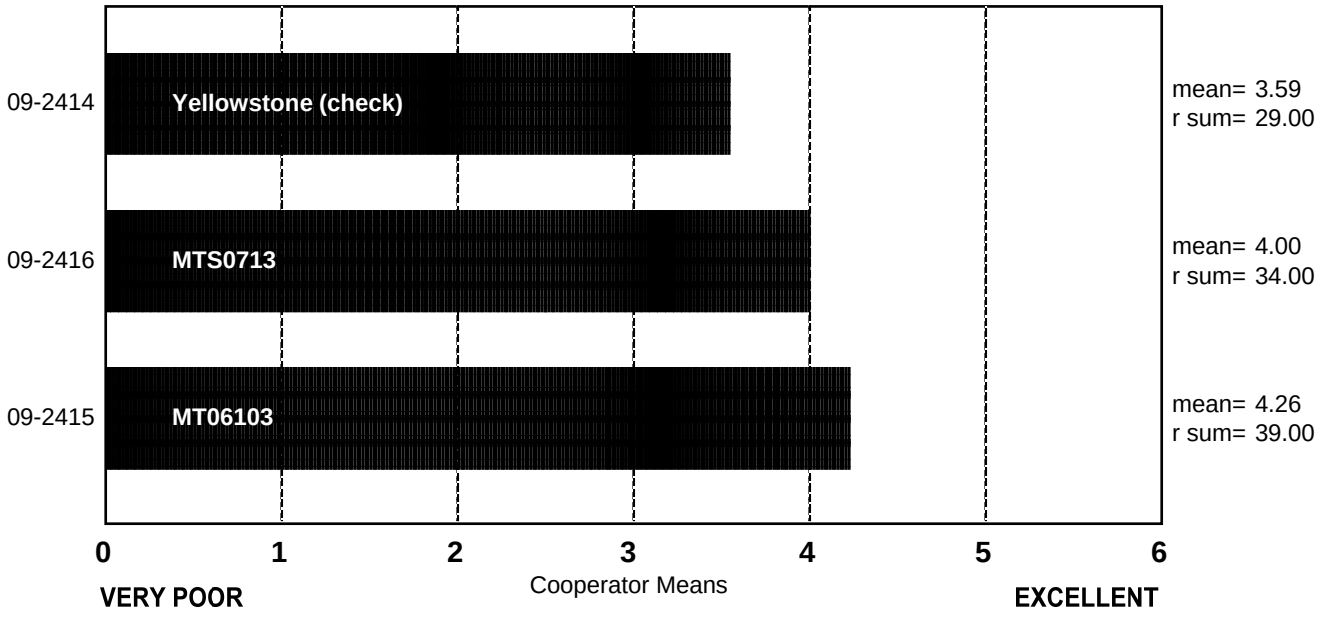


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Montana

ncoop= 17
chisq= 2.94
chisqc= 3.77
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Montana

	Sticky	Wet	Tough	Good	Excellent
09-2414 Yellowstone (check)	**4**	**1**	**5**	**7**	**0**
09-2415 MT06103	**2**	**2**	**5**	**5**	**3**
09-2416 MTS0713	**1**	**1**	**3**	**11**	**1**

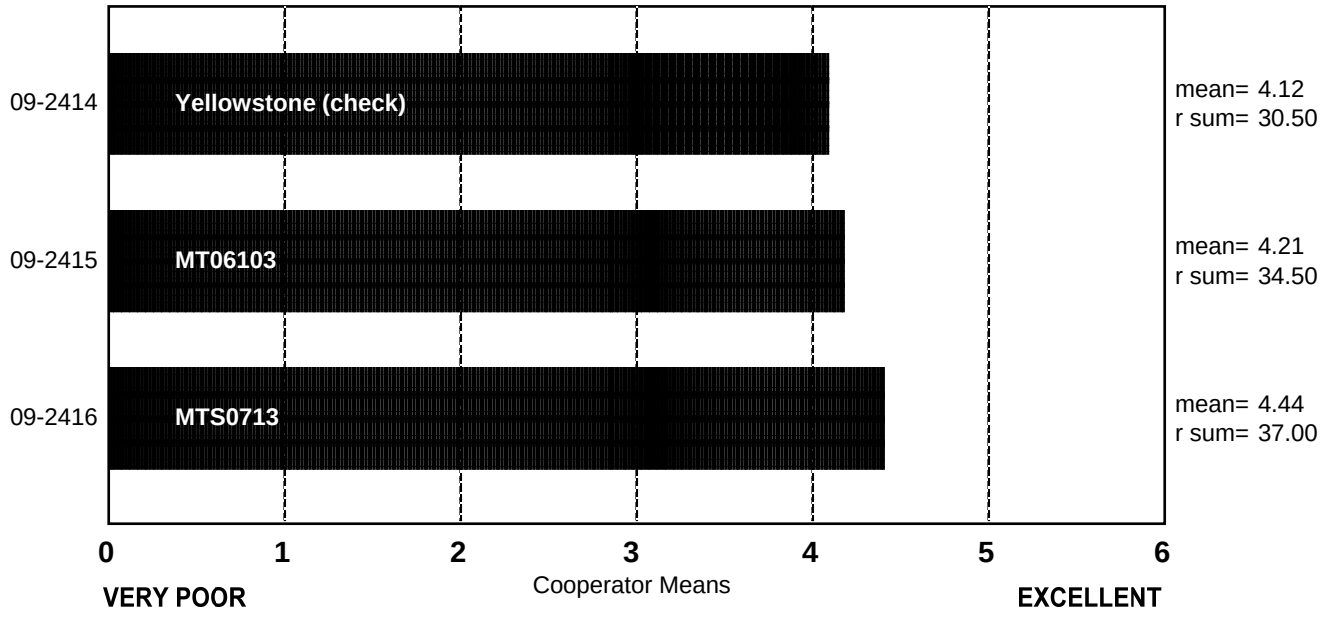
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Montana

ncoop= 17
chisq= 1.26
chisqc= 2.05
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Montana

	Sticky	Wet	Tough	Good	Excellent
09-2414 Yellowstone (check)	**1**	**1**	**7**	**8**	**0**
09-2415 MT06103	**0**	**2**	**7**	**5**	**3**
09-2416 MTS0713	**0**	**1**	**3**	**12**	**1**

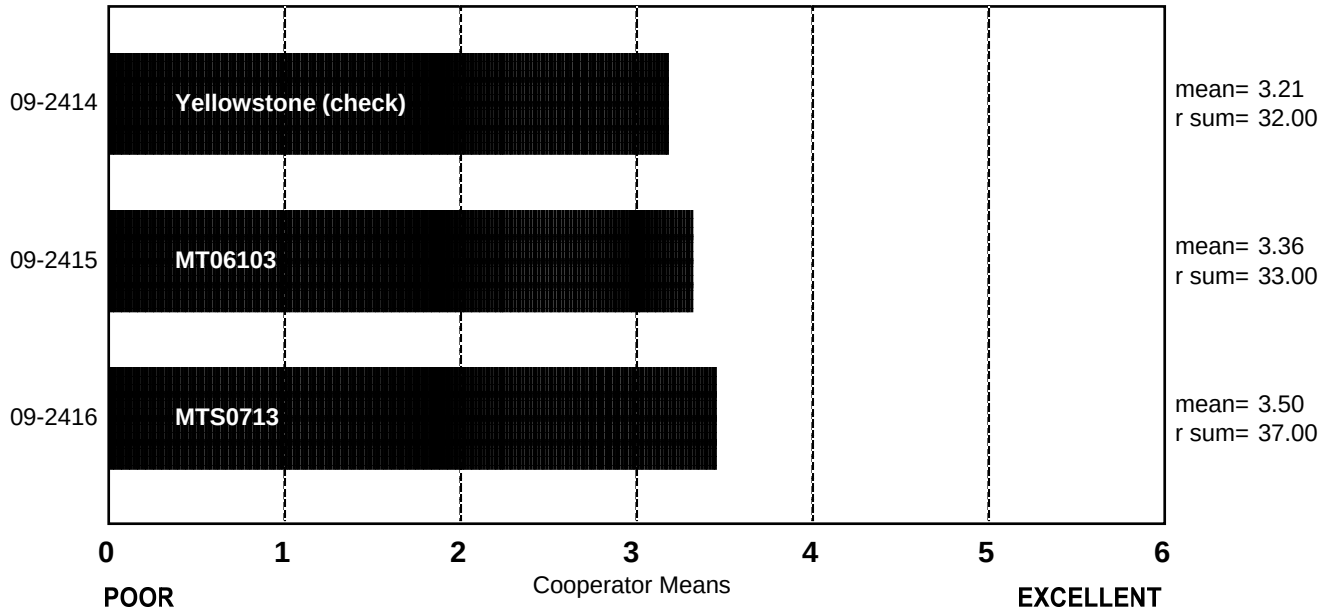
Frequency Table

CRUMB GRAIN

(Small Scale) Montana

ncoop= 17
chisq= 0.82
chisqc= 1.22
cvchisq= 5.99
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Montana

	Open	Fine	Dense
09-2414 Yellowstone (check)	**13**	**3**	**1**
09-2415 MT06103	**13**	**4**	**0**
09-2416 MTS0713	**11**	**5**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Montana

	Round	Irregular	Elongated
09-2414 Yellowstone (check)	**6**	**6**	**5**
09-2415 MT06103	**6**	**3**	**8**
09-2416 MTS0713	**6**	**5**	**6**

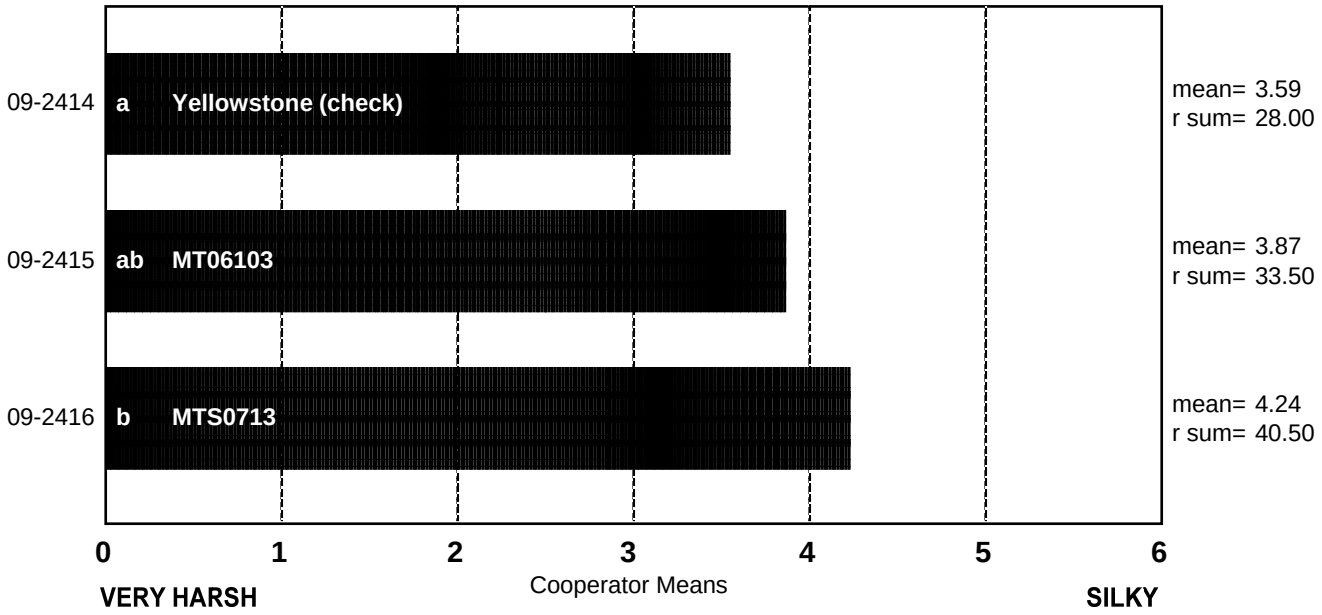
Frequency Table

CRUMB TEXTURE

(Small Scale) Montana

ncoop= 17
chisq= 4.62
chisqc= 6.83
cvchisq= 5.99
crdiff= 8.50

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Montana

	Harsh	Smooth	Silky
09-2414 Yellowstone (check)	**4**	**11**	**2**
09-2415 MT06103	**3**	**12**	**2**
09-2416 MTS0713	**3**	**6**	**8**

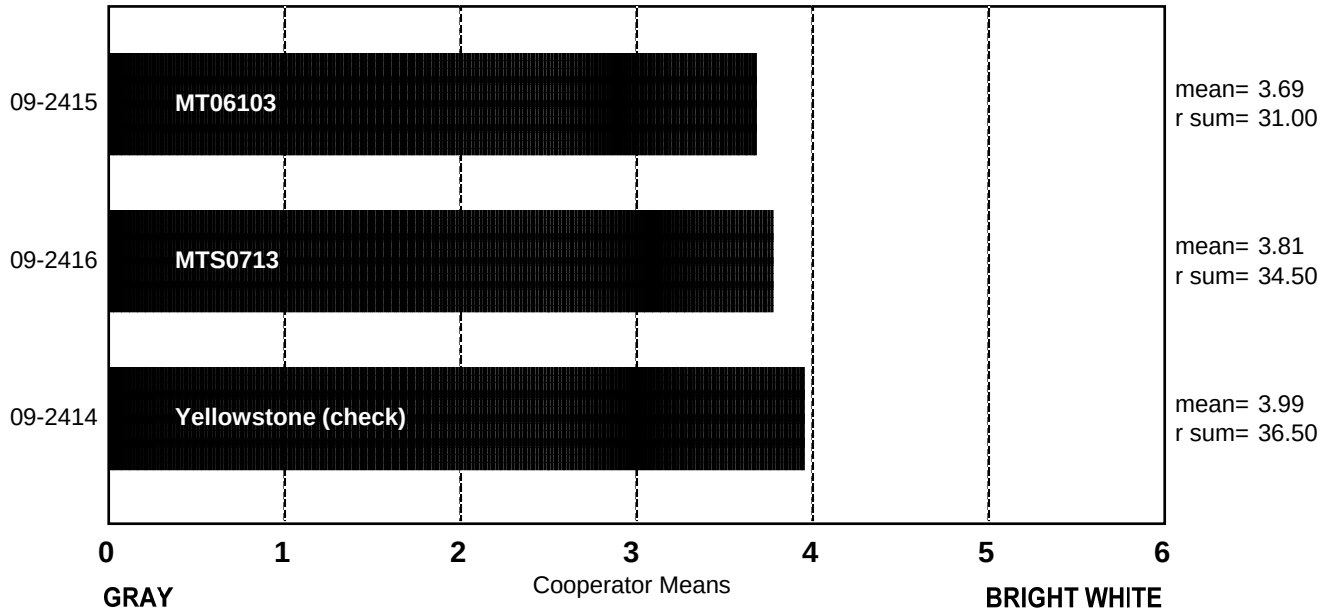
Frequency Table

CRUMB COLOR

(Small Scale) Montana

ncoop= 17
chisq= 0.91
chisqc= 1.72
cvchisq= 5.99
crdiff=

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



CRUMB COLOR, DESCRIBED

(Small Scale) Montana

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
09-2414 Yellowstone (check)	**0**	**0**	**0**	**5**	**7**	**4**	**1**
09-2415 MT06103	**0**	**0**	**1**	**4**	**9**	**3**	**0**
09-2416 MTS0713	**0**	**0**	**0**	**5**	**9**	**3**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Montana

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2414 Yellowstone (check)	**137.3**	**485.0**	**420.0**	**155.9**	**155.9**	**470.0**	**141.5**		**464.8**	**470.9**	**140.5**	**143.8**			**453.7**	**128.6**	**152.2**
09-2415 MT06103	**136.8**	**485.0**	**420.0**	**159.2**	**154.3**	**469.0**	**149.5**		**467.8**	**471.2**	**144.5**	**145.1**			**454.7**	**131.4**	**154.2**
09-2416 MTS0713	**134.6**	**495.0**	**418.0**	**157.4**	**154.9**	**472.0**	**146.3**		**461.8**	**468.9**	**143.3**	**144.0**			**452.8**	**129.8**	**152.8**

LOAF VOLUME, ACTUAL

(Small Scale) Montana

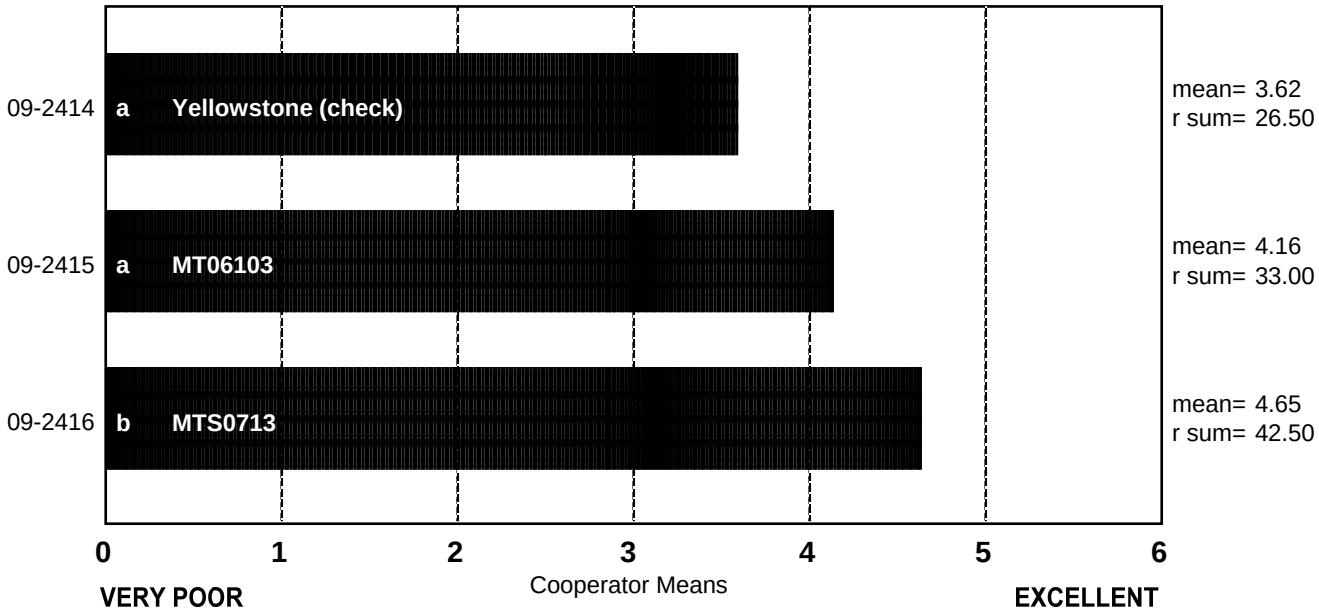
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2414 Yellowstone (check)	**695**	**2700**	**2850**	**810**	**579**	**2900**	**870**	**905**	**2538**	**3074**	**973**	**846**	**2750**	**995**	**2300**	**775**	**835**
09-2415 MT06103	**890**	**2900**	**2875**	**890**	**540**	**3075**	**868**	**968**	**2450**	**3074**	**1013**	**927**	**2575**	**1150**	**2300**	**900**	**905**
09-2416 MTS0713	**900**	**2900**	**3000**	**930**	**598**	**3000**	**900**	**1028**	**2563**	**3104**	**1020**	**999**	**2700**	**1105**	**2450**	**895**	**893**

LOAF VOLUME

(Small Scale) Montana

ncoop= 17
chisq= 7.62
chisqc= 9.77
cvchisq= 5.99
crdiff= 9.12

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

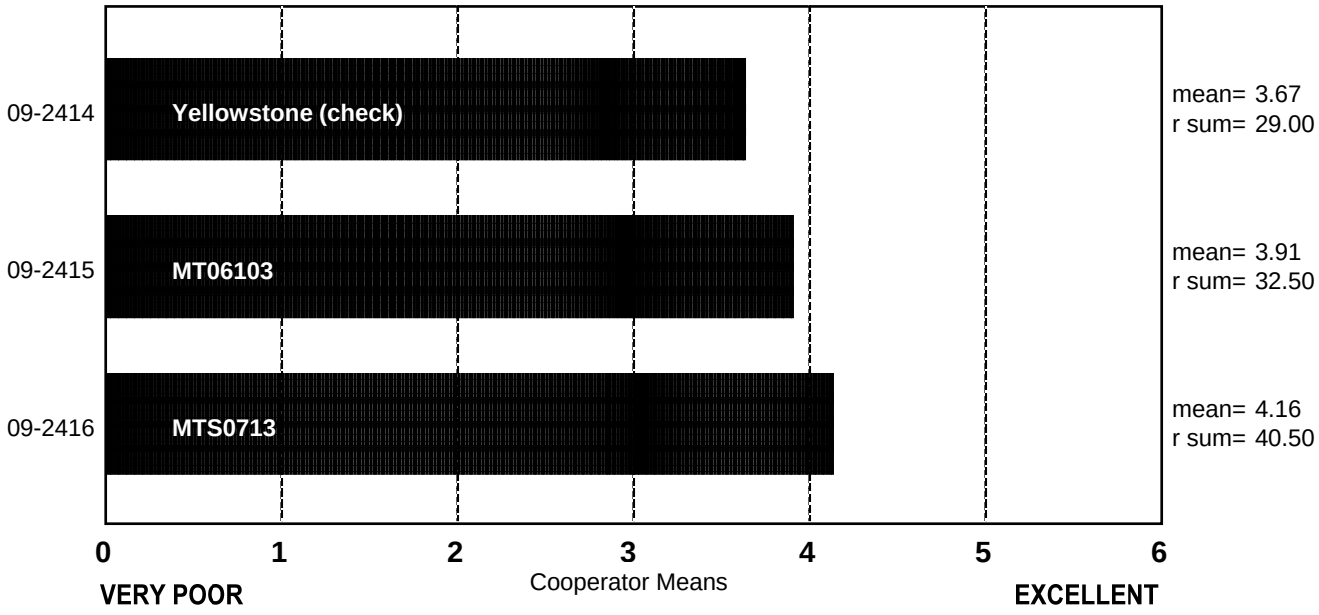


OVERALL BAKING QUALITY

(Small Scale) Montana

ncoop= 17
chisq= 4.09
chisqc= 4.71
cvchisq= 5.99
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Montana

COOP. **09-2414 Yellowstone (check)**

A. Low loaf volume.
B. Low volume.
C. Very open shotty grain. Tough out of mixer and slightly tough at make-up. Long mix. Lower protein.
D. Unusually good dough properties for the bread produced and average loaf volume performance, poor interior.
E. No comment.
F. No comment.
G. Medium Water Abs & Mix Time, Proof Time, Strong Dough, Very High OS & Vol, fine elongated Cells, Cream Crumb, Smooth & Medium Resilient Texture.
H. Tough/dry doughs on bench but good out of mixer. Sample could take more water to be more optimally developed. Average bake performance overall, but may be improved with the extra water.
I. Long mix time, good grain, and bright white crumb.
J. Fairly tight, smooth grain, excellent volume.
K. No comment.
L. No comment.
M. No comment.
N. No comment.
O. Tough out of mixer and make-up- Open Grain.
P. No comment.
Q. Excellent bake absorption; long MT; questionable/satisfactory crumb; creamy crumb color; low LV.

COOP. **09-2415 MT06103**

A. No comment.
B. No comment.
C. Very open grain. Long mix and tough dough. Below average volume. Slightly creamy.
D. Very good dough properties with average interior and loaf volume performance.
E. No comment.
F. No comment.
G. Higher Water Abs, medium Mixing Time & Proof Time, Slight Sticky & Strong Dough, Very High OS & Vol, Fine Elongated Cells, Cream Crumb, Smooth & Medium Resilient Texture.
H. High protein, great strong dough handling, sample looked slightly underdeveloped on the short mix. Volumes not as big as expected given the handling characteristics and protein level. Sample could probably take more water.
I. High absorption, very long mix time, open grain, white crumb, low volume.
J. Fairly tight, smooth grain, excellent volume, good absorption.
K. No comment.
L. No comment.

M. No comment.
N. No comment.
O. Good absorption- Long Mix Time- tough out of mixer and make-up- Open grain.
P. No comment.
Q. Excellent bake absorption; long MT; excellent out of mixer; satisfactory crumb grain; dull crumb color; good LV.

COOP. 09-2416 MTS0713

A. No comment.
B. Good absorption, low volume.
C. Very shotty grain. Dull crumb color. Average mix. Good out if mixer.
D. Good dough properties with average interior and loaf volume performance.
E. No comment.
F. No comment.
G. Higher Water Abs, Medium Mixing Time & Proof Time, Soft & Slight Strong Dough, Very High OS & Vol, Fine Elongated Cells, Cream Crumb, Silky & Medium Resilient Texture.
H. High protein, great bake quality. Great dough handling but slightly weak out of mixer.
I. Tough dough, good grain.
J. Open, very irregular grain, harsh texture, excellent volume.
K. No comment.
L. No comment.
M. No comment.
N. No comment.
O. Good absorption- tough out mixer and make-up.
P. No comment.
Q. Excellent bake absorption; good MT; showed weakness in dough; questionable crumb; dull crumb color; low LV.

Notes: **B, C, H, I, J, M, and O** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

Texas-Amarillo – Jackie Rudd

Texas A&M, Bushland, TX

The Wheat Quality Council samples submitted by Texas A&M were harvested from strips planted adjacent to our irrigated yield trials at Bushland (near Amarillo in the Texas Panhandle). We fertilized for a yield goal of 100 bu/a. The grain yields of TAM 111 and TX02A0252 were 62, and 65 bu/a respectively. As through most of the Great Plains in 2009, the temperatures were above average and the rainfall was below average. The crop was flood irrigated four times from early March to early May. Although, there was no significant disease pressure, there was a noticeable damage from Russian Wheat Aphid.

TAM 111 (CHECK)

TAM 111 (TX95A3091), a hard red winter wheat from the cross
TAM 107//TX78V3620/CTK78/3/TX87V1233, was released in 2002 and licensed to Agripro Wheat. It has good yield under dryland and irrigated conditions, good bread-making quality, and is resistant to stripe rust. A Texas Wheat Variety Survey this past summer indicated that TAM 111 is the most widely grown variety in the state occupying 8.3% of the total acreage. It was the number one variety across the Panhandle and South Plains of the Texas High Plains.

TX02A0252

This hard red winter wheat experimental was selected from the TAM Wheat program in Amarillo from the cross TX90V6313//TX94V3724(TAM-200 BC41254-1-8-1-1/TX86V1405. It is resistant to leaf rust (Lr 24, ??) and stripe rust (APR), and has Sr24 gene for stem rust. It has good yield under dryland and irrigated conditions, and is particularly suited for the Texas High Plains. TX02A0252 has good test weight and single kernel characteristics along with an optimum mixing time and stability.

Texas-Amarillo: 2009 (Small-Scale) Samples [a]

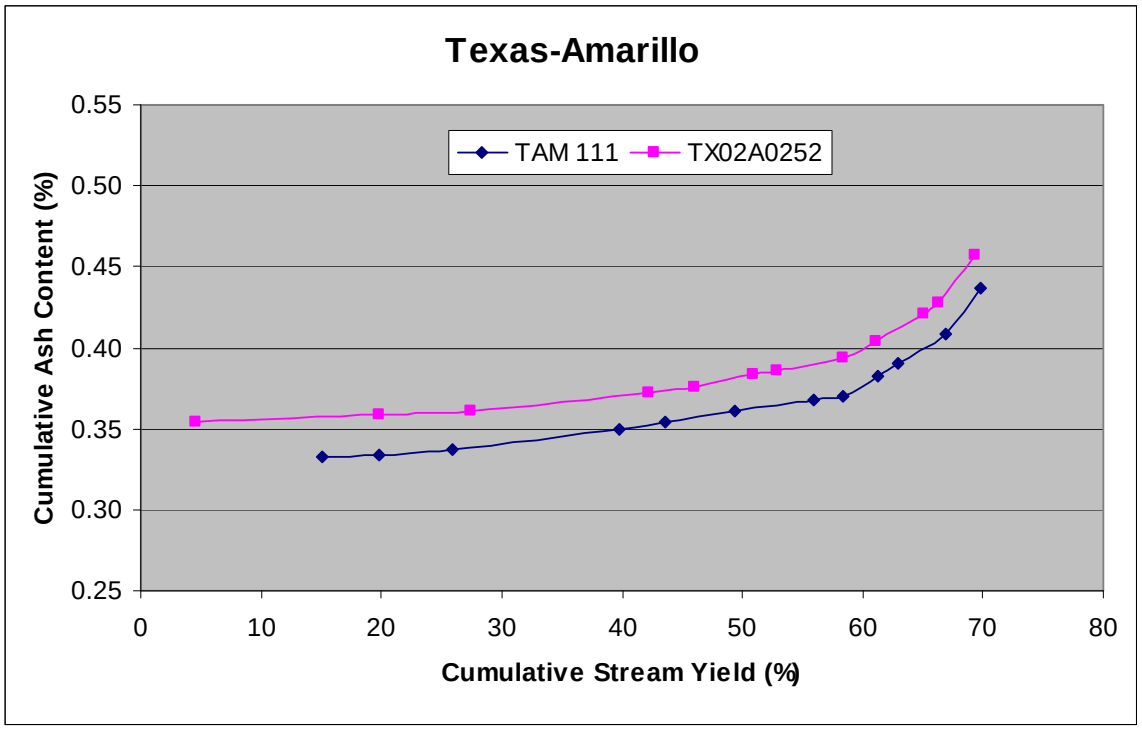
Test entry number	09-2417	09-2418
Sample identification	**TAM 111 (check)**	**TX02A0252**
Wheat Data		
FGIS classification	1 HRW	1 HRW
Test weight (lb/bu)	60.6	61.0
Hectoliter weight (kg/hl)	79.7	80.2
1000 kernel weight (gm)	26.7	25.5
NIR hardness	64	77
Wheat kernel size (Rotap)		
Over 7 wire (%)	56.7	33.3
Over 9 wire (%)	42.8	64.7
Through 9 wire (%)	0.5	2.0
Single kernel (skcs)		
Hardness (avg /s.d)	73.3/15.8	80.2/17.0
Weight (mg) (avg/s.d)	26.8/7.7	28.6/8.8
Diameter (mm)(avg/s.d)	2.51/0.30	2.61/0.30
SKCS distribution	01-02-15-82	01-02-10-87
Classification	Hard	Hard
Wheat moisture (%)	9.6	9.6
Wheat protein (12% mb)	14.4	13.8
Wheat ash (12% mb)	1.44	1.53
Milling and Flour Quality Data		
Flour yield (%, str. grade)		
Miag Multomat Mill	69.7	69.5
Quadrumat Sr. Mill	67.4	68.1
NIR Flour moisture (%)	13.3	12.6
NIR Flour protein (14% mb)	12.8	12.1
Flour ash (14% mb)	0.47	0.47
Glutomatic		
Wet gluten (%)	37.8	33.5
Dry gluten (%)	13.6	11.8
Gluten index	88.5	96.4
Rapid Visco-Analyser		
Peak time (min)	6.3	6.3
Peak viscosity (RVU)	222.3	203.4
Breakdown (RVU)	78.8	66.2
Final viscosity at 13 min (RVU)	262.8	256.3
Minolta color meter		
L*	92.66	92.71
a*	-1.50	-1.72
b*	8.55	9.49
Falling number (sec)	416	453
Damaged Starch		
(AI%)	95.62	96.61
(AACC76-31)	5.98	6.76

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

Texas-Amarillo: Physical Dough Tests and Gluten Analysis For 2009 (Small-Scale) Samples

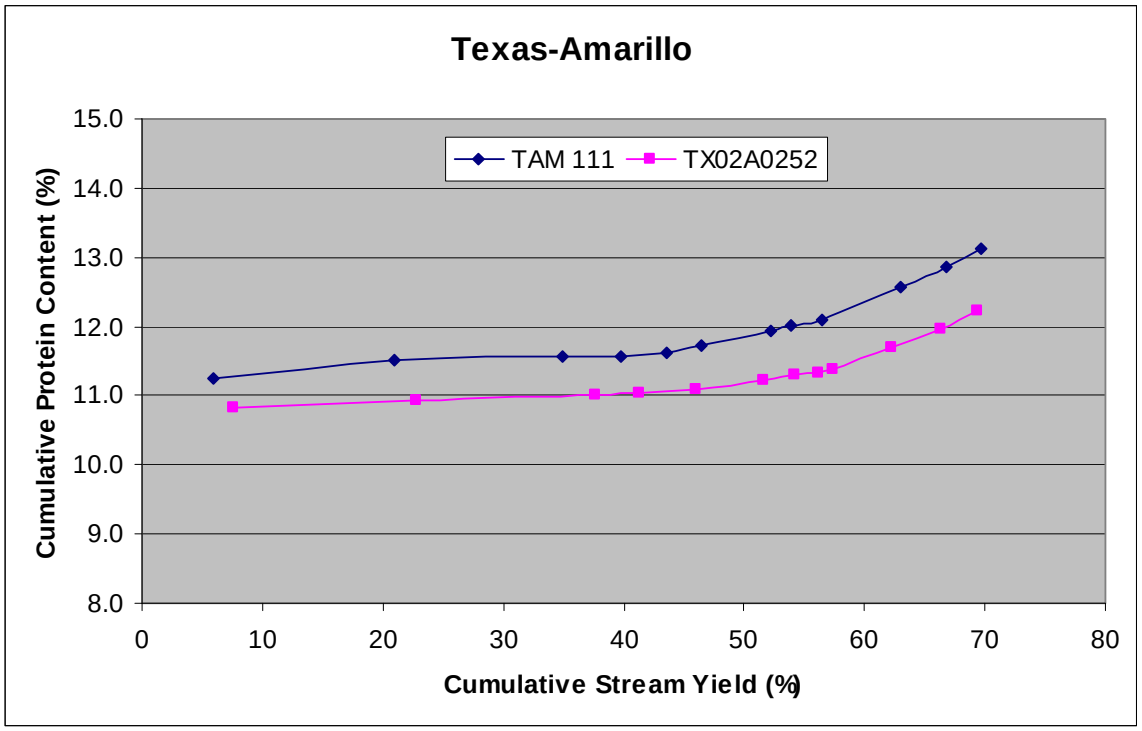
Test Entry Number	09-2417	09-2418
Sample Identification	TAM 111 (check)	TX02A0252
MIXOGRAPH		
Flour Abs (% as-is)	68.1	66.2
Flour Abs (14% mb)	67.3	64.6
Mix Time (min)	3.38	3.88
Mix tolerance (0-6)	2	3
FARINOGRAPH		
Flour Abs (% as-is)	61.6	60.4
Flour Abs (14% mb)	60.8	58.8
Development time (min)	8.7	9.5
Mix stability (min)	31.0	41.0
Mix Tolerance Index (FU)	12	11
Breakdown time (min)	32.3	39.9
ALVEOGRAPH		
P(mm. $_{H2O}$): Tenacity	76	93
L(mm): Extensibility	95	126
G($mm_{0.5}$): Swelling index	21.7	25.0
W(10^{-4} J): strength (curve area)	253	390
P/L: curve configuration ratio	0.80	0.74
Ie(P_{200}/P): elasticity index	60.6	61.5
EXTENSIGRAPH		
Resist (BU at 30/60/90 min)	327/481/515	424/582/670
Extensibility (mm at 30/60/90 min)	169/168/176	164/154/156
Energy (cm^2 at 30/60/90 min)	105/159/186	129/174/194
Resist $_{max}$ (BU at 30/60/90 min)	466/734/851	600/951/999
Ratio (at 30/60/90 min)	1.9/2.9/2.9	2.6/3.8/4.3
PROTEIN ANALYSIS		
HMW-GS Composition	2*, 7+9, 2+12	2*, 7+8, 5+10
Glu/Gli	2.52	2.33
HMW/LMW	0.34	0.34
%IPP	45.05	46.97
SEDIMENTATION TEST		
Volume (ml)	66.4	66.9

Texas-Amarillo: Cumulative Ash Curves



TAM 111 - 2417					TX02A0252 - 2418				
Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)	Mill Streams	Strm Yld (14%mb)	Ash (14%mb)	Cumulative Yield (14%)	Cumulative Ash (14%)
2M	15.02	0.33	15.02	0.33	1M	4.63	0.35	4.63	0.35
1M	4.85	0.34	19.87	0.33	2M	15.14	0.36	19.77	0.36
1M Red	5.98	0.35	25.84	0.34	1M Red	7.64	0.37	27.41	0.36
3M	13.91	0.37	39.75	0.35	3M	14.81	0.39	42.22	0.37
4M	3.83	0.40	43.59	0.35	4M	3.78	0.42	46.00	0.38
1BK	5.85	0.41	49.43	0.36	2BK	4.91	0.45	50.91	0.38
2BK	6.51	0.42	55.94	0.37	Grader	1.91	0.46	52.81	0.39
Grader	2.50	0.43	58.44	0.37	1BK	5.57	0.46	58.38	0.39
5M	2.84	0.64	61.28	0.38	5M	2.66	0.63	61.04	0.40
FILTER FLR	1.65	0.67	62.93	0.39	3BK	4.01	0.69	65.05	0.42
3BK	3.93	0.69	66.86	0.41	FILTER FLR	1.27	0.76	66.32	0.43
BRAN FLR	2.89	1.09	69.75	0.44	BRAN FLR	3.05	1.10	69.37	0.46
Break Shorts	3.45	3.53	73.19	0.58	Break Shorts	3.08	3.57	72.45	0.59
Red Dog	3.96	1.76	77.15	0.64	Red Dog	3.05	1.84	75.49	0.64
Red Shorts	0.29	3.31	77.44	0.65	Red Shorts	0.26	3.40	75.76	0.65
Filter Bran	0.46	1.79	77.90	0.66	Filter Bran	0.31	1.55	76.07	0.65
Bran	22.10	3.97	100.00	1.39	Bran	23.93	4.25	100.00	1.52
Wheat Ash		1.40			Wheat Ash		1.50		
Straight Grade Flour Ash		0.47			Straight Grade Flour Ash		0.47		

Texas-Amarillo: Cumulative Protein Curves

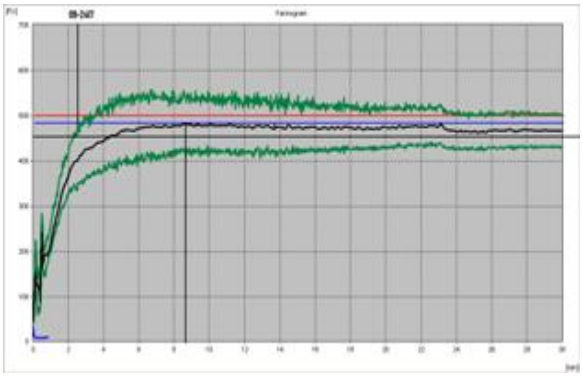


	TAM 111 - 2417					TX02A0252 - 2418			
Mill Streams	**Strm Yld (14%mb)**	**Protein (14%mb)**	**Cumulative Yield (14%)**	**Prtn (14%)**	**Mill Streams**	**Strm Yld (14%mb)**	**Protein (14%mb)**	**Cumulative Yield (14%)**	**Prtn (14%)**
1M Red	6.0	11.2	6.0	11.2	1M Red	7.6	10.8	7.6	10.8
2M	15.0	11.6	21.0	11.5	2M	15.1	11.0	22.8	10.9
3M	13.9	11.6	34.9	11.6	3M	14.8	11.2	37.6	11.0
1M	4.8	11.7	39.8	11.6	4M	3.8	11.4	41.4	11.0
4M	3.8	12.2	43.6	11.6	1M	4.6	11.4	46.0	11.1
5M	2.8	13.1	46.4	11.7	1BK	5.6	12.4	51.6	11.2
1BK	5.8	13.7	52.3	11.9	5M	2.7	12.5	54.2	11.3
FILTER FLR	1.7	14.1	53.9	12.0	Grader	1.9	12.8	56.1	11.3
Grader	2.5	14.2	56.4	12.1	FILTER FLR	1.3	13.2	57.4	11.4
2BK	6.5	16.7	62.9	12.6	2BK	4.9	15.3	62.3	11.7
3BK	3.9	17.6	66.9	12.9	3BK	4.0	16.3	66.3	12.0
BRAN FLR	2.9	19.0	69.7	13.1	BRAN FLR	3.0	17.6	69.4	12.2
Break Shorts	3.4	16.3	73.2	13.3	Break Shorts	3.1	15.8	72.4	12.4
Red Dog	4.0	15.3	77.2	13.4	Red Dog	3.0	14.8	75.5	12.5
Red Shorts	0.3	14.7	77.4	13.4	Red Shorts	0.3	14.8	75.8	12.5
Filter Bran	0.5	12.4	77.9	13.4	Filter Bran	0.3	12.2	76.1	12.5
Bran	22.1	18.4	100.0	14.5	Bran	23.9	17.4	100.0	13.6
Whole Wheat		14.0			**Whole Wheat**		13.5		
St Grade Flour		13.3			**St Grade Flour**		12.3		

Physical Dough Tests

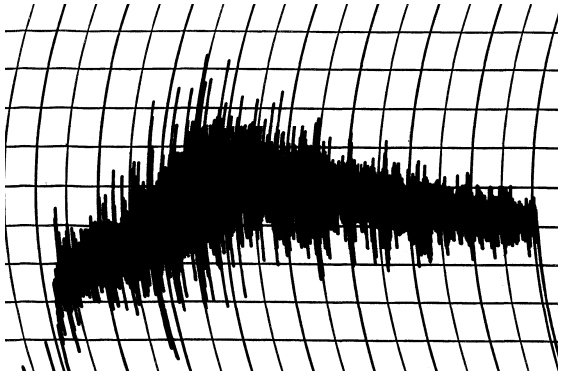
2009 (Small Scale) Samples – Texas-Amarillo

Farinograms



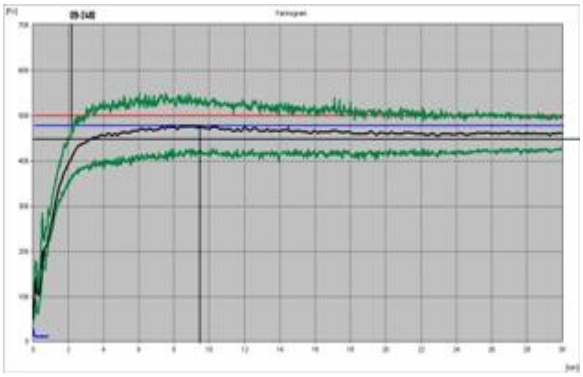
Water abs = 60.8%, Peak time = 8.7 min,
Mix stab = 31.0 min, MTI = 12 FU

Mixograms

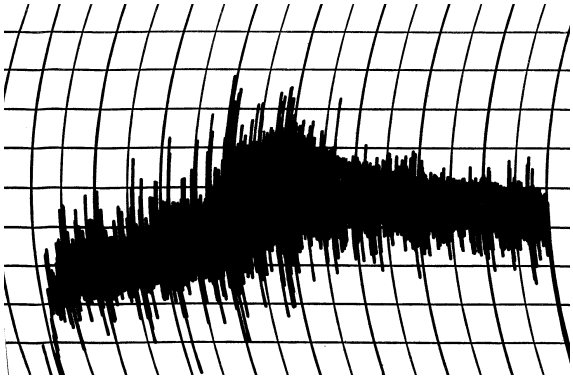


Water abs = 67.3%
Mix time = 3.4 min

09-2417, TAM 111 (check)



Water abs = 58.8%, Peak time = 9.5 min,
Mix stab = 41.0 min, MTI = 11 FU

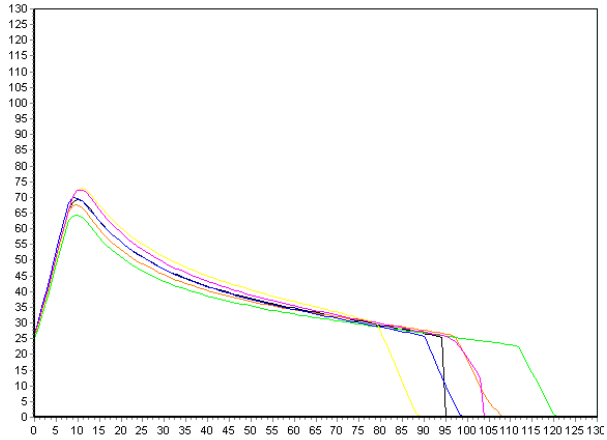


Water abs = 64.6%
Mix time = 3.9 min

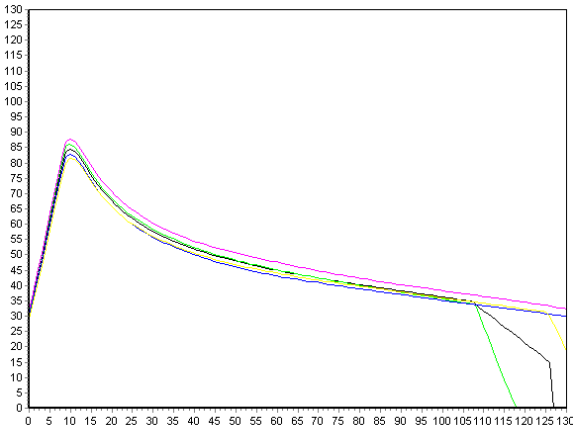
09-2418, TX02A0252

Physical Dough Tests - Alveograph

2009 (Small Scale) Samples – Texas-Amarillo



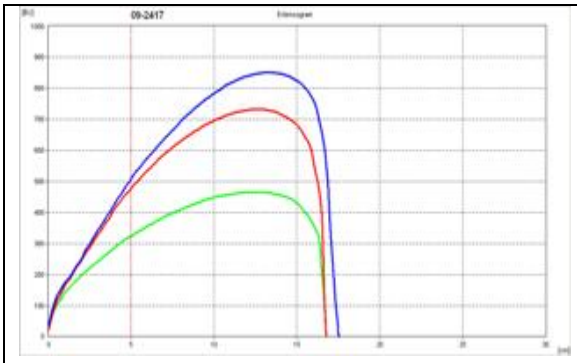
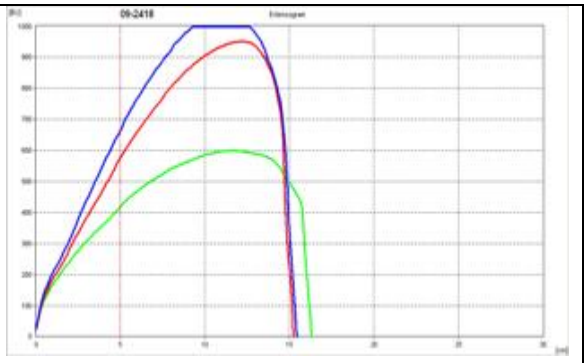
00-2417 (TAM 111 - check)
P(mm $_{H20}$)=76, L(mm)=95, W(10E^{-4} J)=253



09-2418 (TX02A0252)
P(mm $_{H20}$)=93, L(mm)=126, W(10E^{-4} J)=390

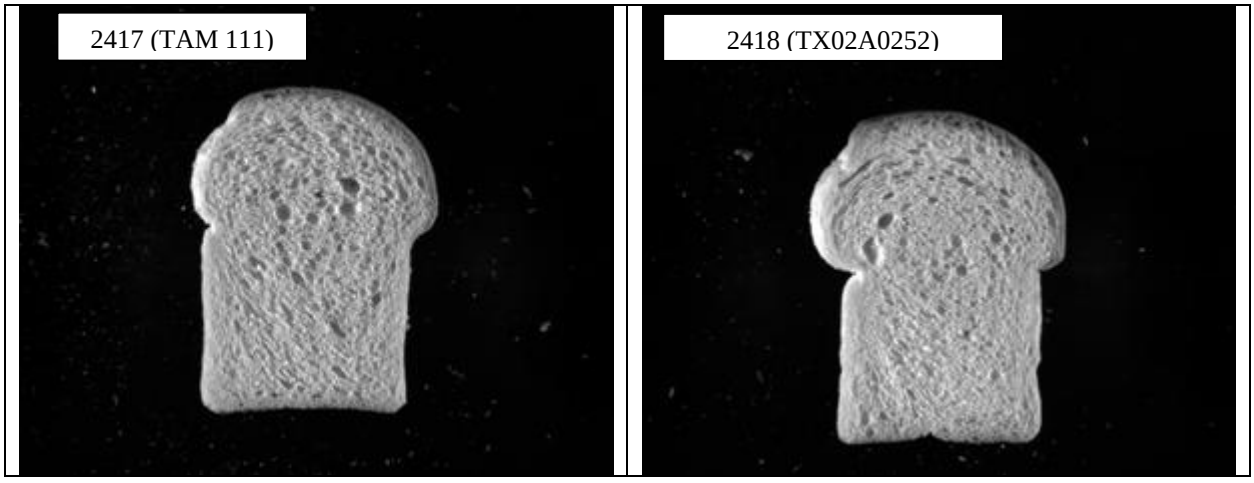
Physical Dough Tests - Extensigraph

2009 (Small Scale) Samples – Texas-Amarillo

	
09-2417 (TAM 111 - check) R (BU) = 327, E (mm) =169, W (cm^2) = 105 Rmax (BU) = 466, Ratio = 1.9 at 30 min	**09-2418 (TX02A0252)** R (BU) = 424, E (mm) =164, W (cm^2) = 129 Rmax (BU) = 600, Ratio = 2.6 at 30 min

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

Texas-Amarillo: C-Cell Bread Images and Analysis for 2009 (Small-Scale) Samples



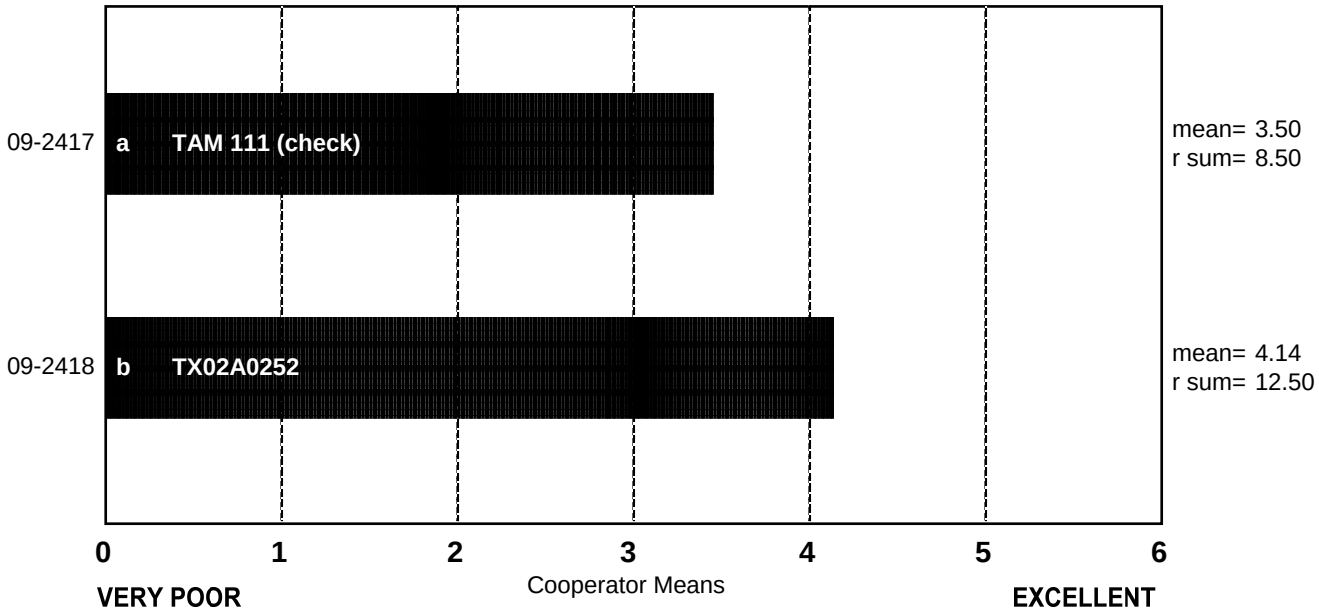
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2417	6224	152.6	3615	0.458	2.200	1.946	1.65	-22.4
2418	6442	157.2	4398	0.423	1.797	0.927	1.66	-19.5

SPONGE CHARACTERISTICS

(Small Scale) Texas-Amarillo

ncoop= 7
chisq= 2.29
chisqc= 4.00
cvchisq= 3.84
crdiff= 3.46

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

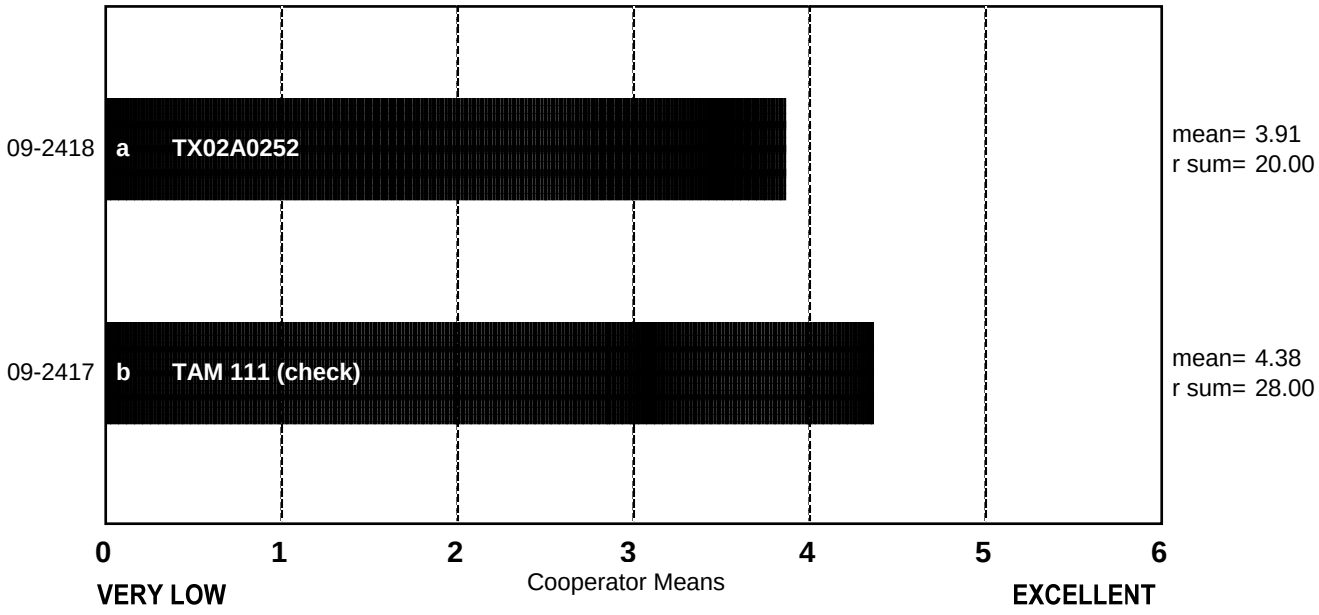


BAKE ABSORPTION

(Small Scale) Texas-Amarillo

ncoop= 16
chisq= 4.00
chisqc= 6.40
cvchisq= 3.84
crdiff= 5.39

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Texas-Amarillo

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2417 TAM 111 (check)	**61.5**	**58.0**	**59.0**	**71.5**	**67.3**	**62.8**	**63.0**	**64.0**	**61.0**	**61.0**	**71.1**	**67.2**	**60.5**	**68.0**	**63.8**	**59.3**	**63.9**
09-2418 TX02A0252	**60.3**	**56.0**	**58.0**	**68.6**	**64.6**	**60.8**	**62.0**	**63.0**	**61.0**	**59.0**	**69.1**	**64.7**	**63.0**	**65.7**	**61.8**	**57.3**	**66.1**

BAKE MIX TIME, ACTUAL

(Small Scale) Texas-Amarillo

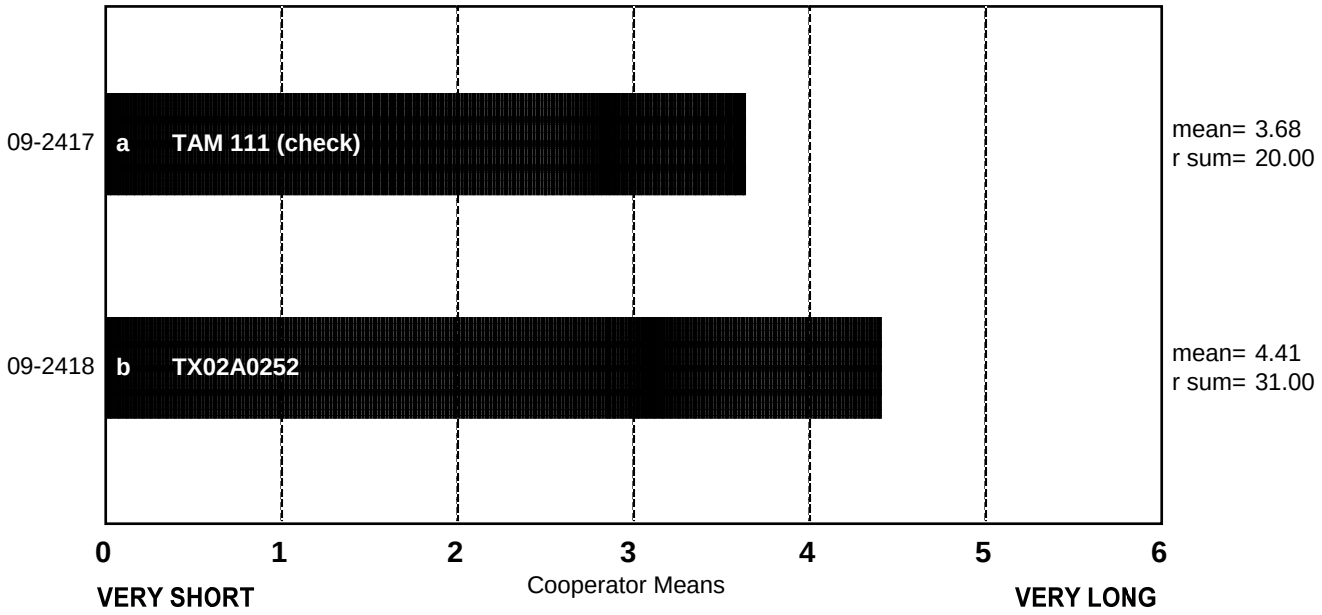
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2417 TAM 111 (check)	**1.3**	**9.0**	**15.0**	**4.2**	**4.5**	**7.5**	**4.6**	**6.0**	**8.0**	**25.0**	**3.5**	**3.7**	**30.0**	**2.7**	**11.0**	**3.0**	**3.5**
09-2418 TX02A0252	**2.0**	**9.0**	**20.0**	**4.8**	**4.5**	**7.5**	**5.5**	**9.0**	**18.0**	**25.0**	**4.0**	**3.9**	**30.0**	**3.3**	**18.0**	**4.3**	**5.3**

BAKE MIX TIME

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 7.12
chisqc= 11.00
cvchisq= 3.84
crdiff= 2.27

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

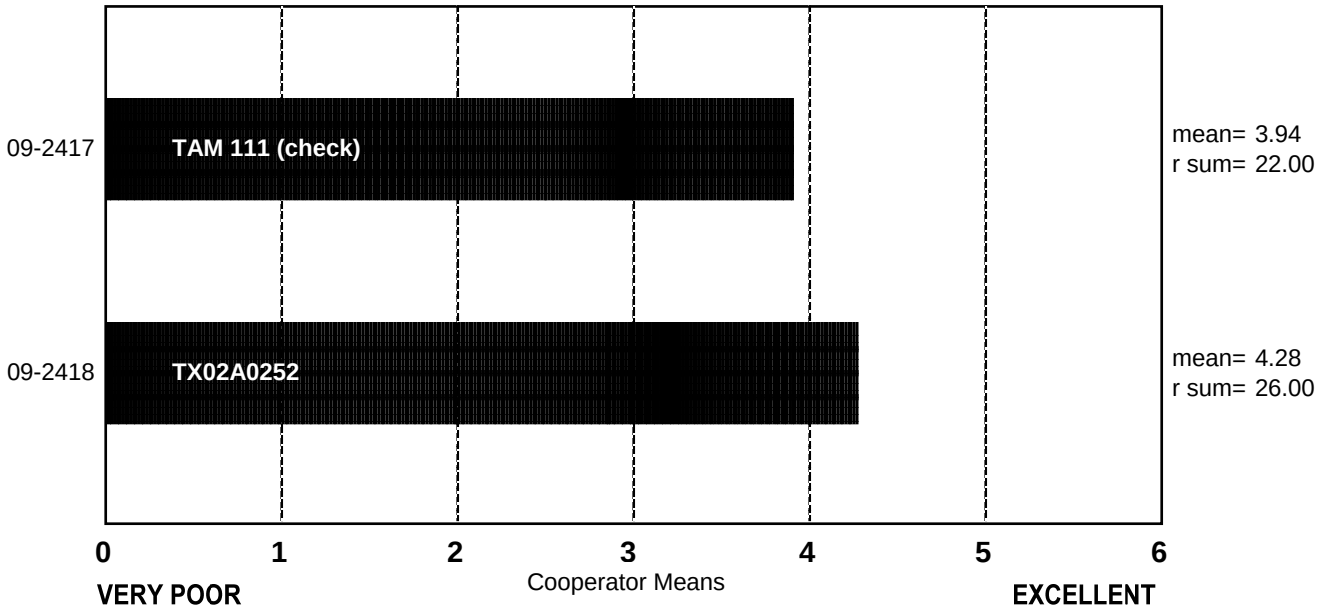


MIXING TOLERANCE

(Small Scale) Texas-Amarillo

ncoop= 16
chisq= 1.00
chisqc= 2.00
cvchisq= 3.84
crdiff=

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

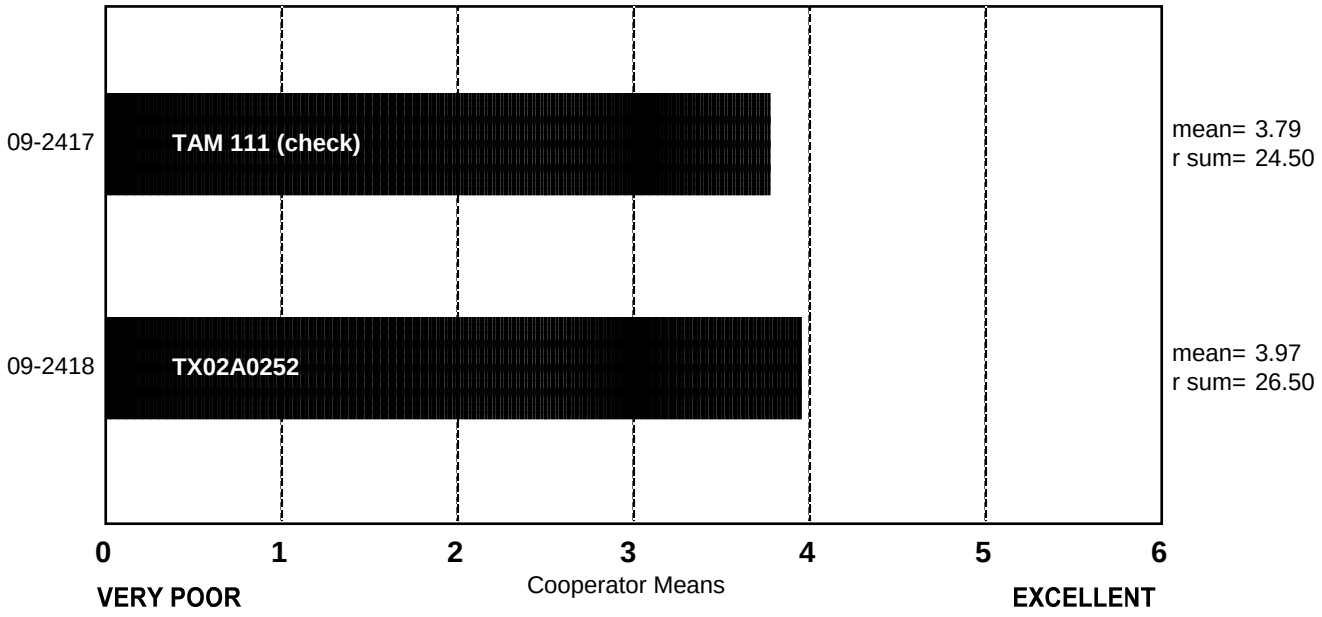


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 0.24
chisqc= 0.40
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) Texas-Amarillo

	Sticky	Wet	Tough	Good	Excellent
09-2417 TAM 111 (check)	**3**	**2**	**1**	**9**	**2**
09-2418 TX02A0252	**1**	**2**	**5**	**8**	**1**

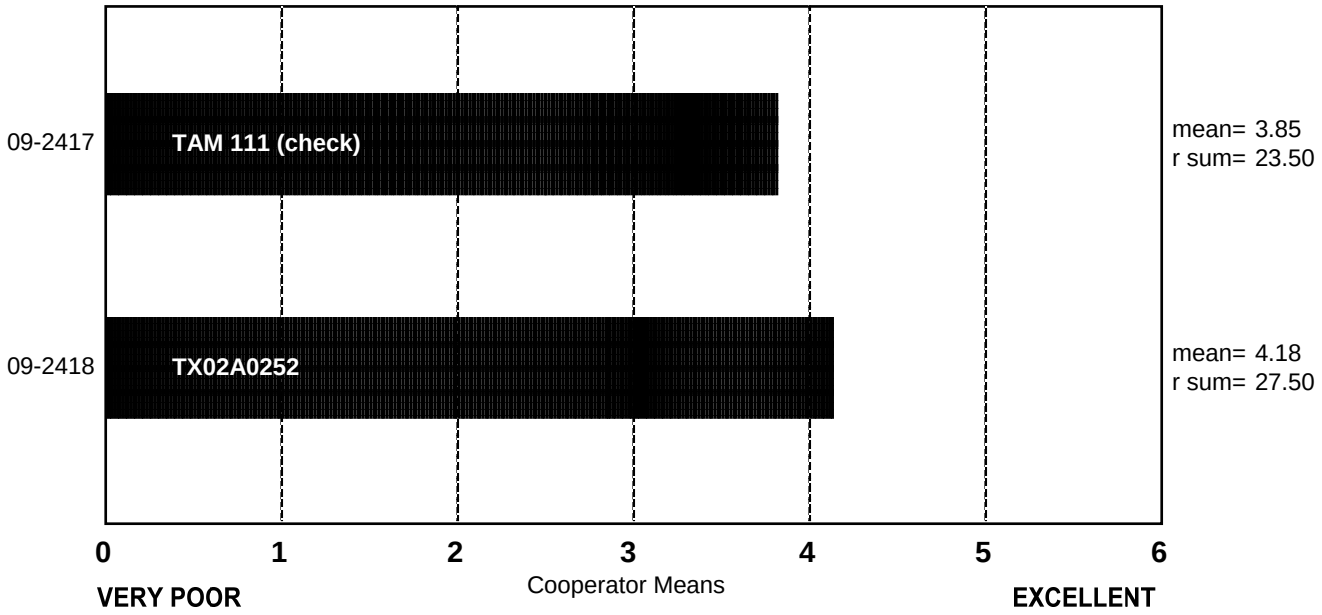
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 0.94
chisqc= 1.60
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) Texas-Amarillo

	Sticky	Wet	Tough	Good	Excellent
09-2417 TAM 111 (check)	**2**	**4**	**2**	**8**	**1**
09-2418 TX02A0252	**1**	**2**	**4**	**9**	**1**

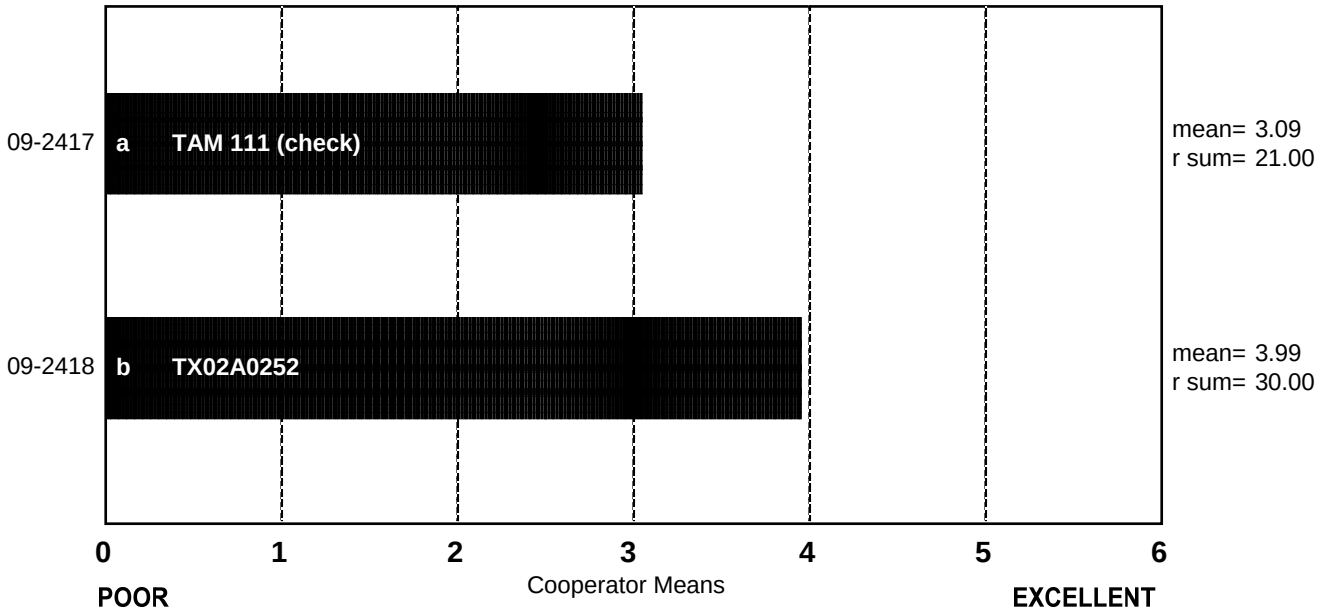
Frequency Table

CRUMB GRAIN

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 4.76
chisqc= 7.36
cvchisq= 3.84
crdiff= 2.88

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Texas-Amarillo

	Open	Fine	Dense
09-2417 TAM 111 (check)	**13**	**4**	**0**
09-2418 TX02A0252	**8**	**9**	**0**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Texas-Amarillo

	Round	Irregular	Elongated
09-2417 TAM 111 (check)	**8**	**5**	**4**
09-2418 TX02A0252	**2**	**7**	**8**

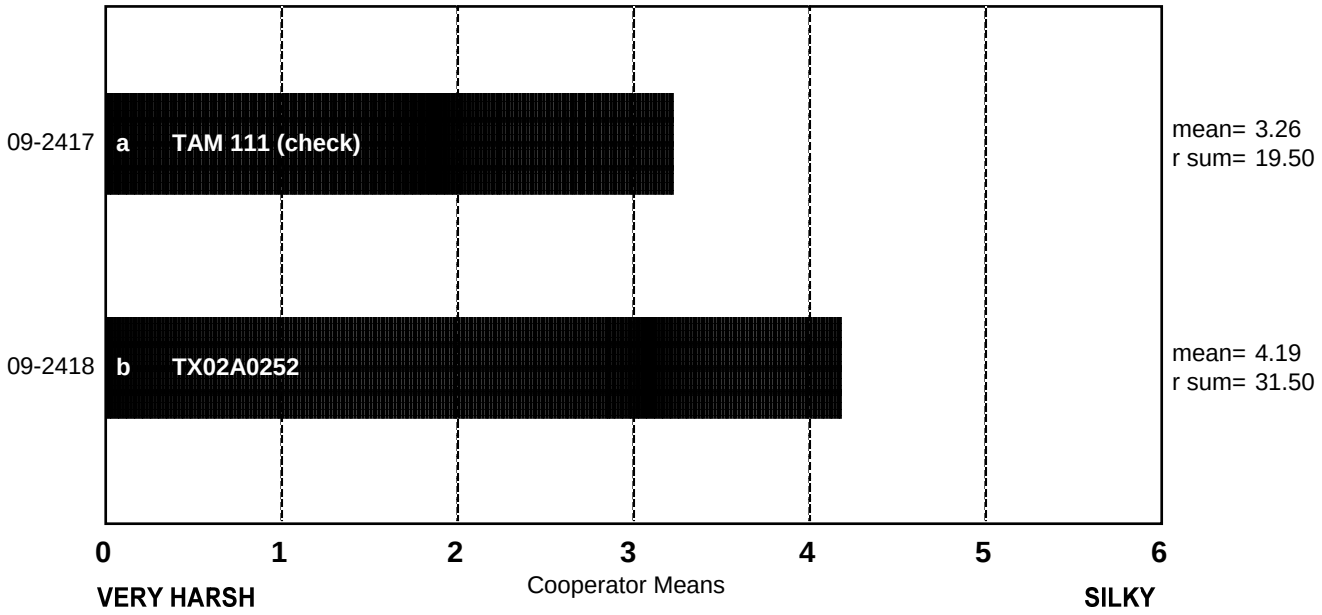
Frequency Table

CRUMB TEXTURE

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 8.47
chisqc= 9.60
cvchisq= 3.84
crdiff= 2.71

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Texas-Amarillo

	Harsh	Smooth	Silky
09-2417 TAM 111 (check)	**6**	**10**	**1**
09-2418 TX02A0252	**3**	**7**	**7**

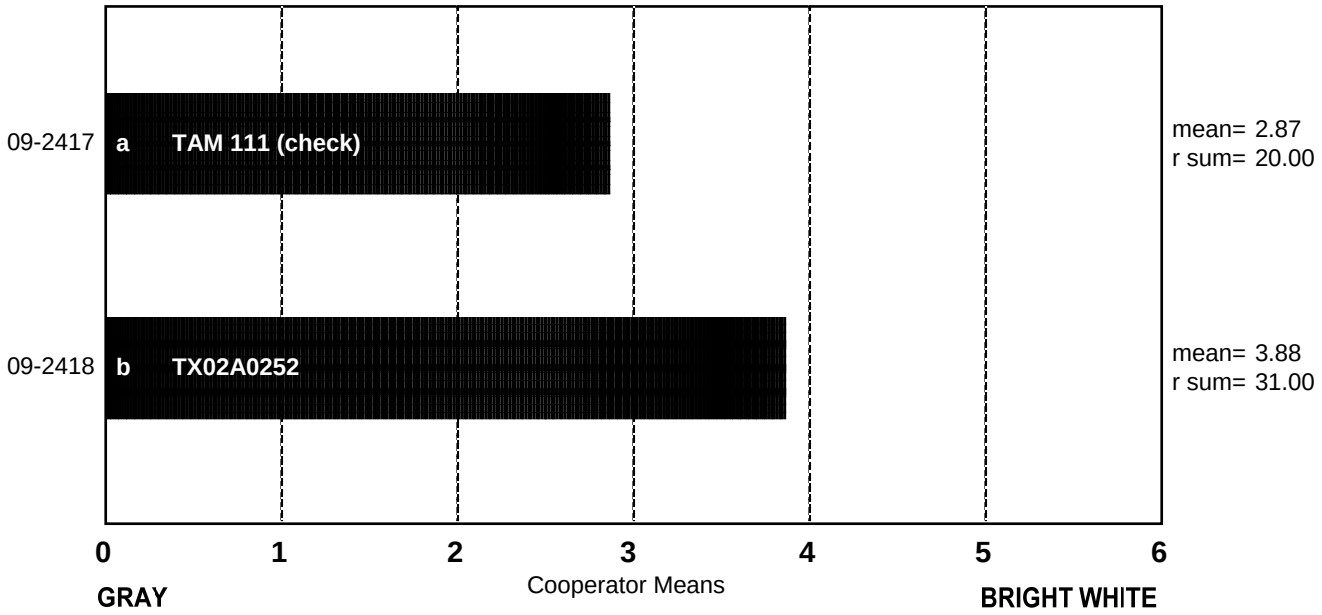
Frequency Table

CRUMB COLOR

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 7.12
chisqc= 8.64
cvchisq= 3.84
crdiff= 2.80

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



CRUMB COLOR, DESCRIBED

(Small Scale) Texas-Amarillo

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
09-2417 TAM 111 (check)	**1**	**1**	**4**	**6**	**5**	**0**	**0**
09-2418 TX02A0252	**0**	**0**	**0**	**4**	**10**	**3**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Texas-Amarillo

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2417 TAM 111 (check)	**135.8**	**500.0**	**418.0**	**156.4**	**156.9**	**473.0**	**144.8**		**463.8**	**469.0**	**135.4**	**145.0**			**454.6**	**128.4**	**152.0**
09-2418 TX02A0252	**135.4**	**495.0**	**419.0**	**153.7**	**154.5**	**474.0**	**143.5**		**467.1**	**471.0**	**143.5**	**144.9**			**454.1**	**130.4**	**154.4**

LOAF VOLUME, ACTUAL

(Small Scale) Texas-Amarillo

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2417 TAM 111 (check)	**745**	**2700**	**2800**	**970**	**511**	**2500**	**845**	**963**	**2500**	**2868**	**978**	**860**	**2525**	**1075**	**2275**	**850**	**845**
09-2418 TX02A0252	**790**	**2750**	**3100**	**1000**	**583**	**3050**	**935**	**983**	**2575**	**3104**	**1078**	**914**	**2825**	**1130**	**2425**	**890**	**905**

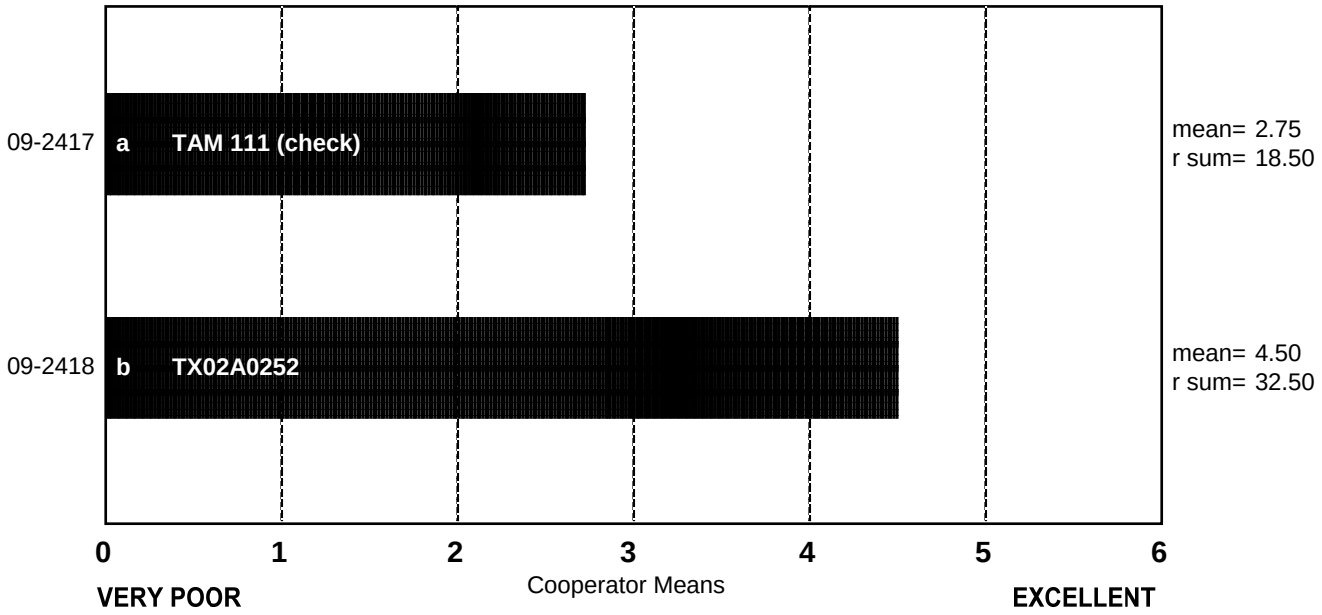
Raw Data

LOAF VOLUME

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 11.53
chisqc= 14.00
cvchisq= 3.84
crdiff= 1.81

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

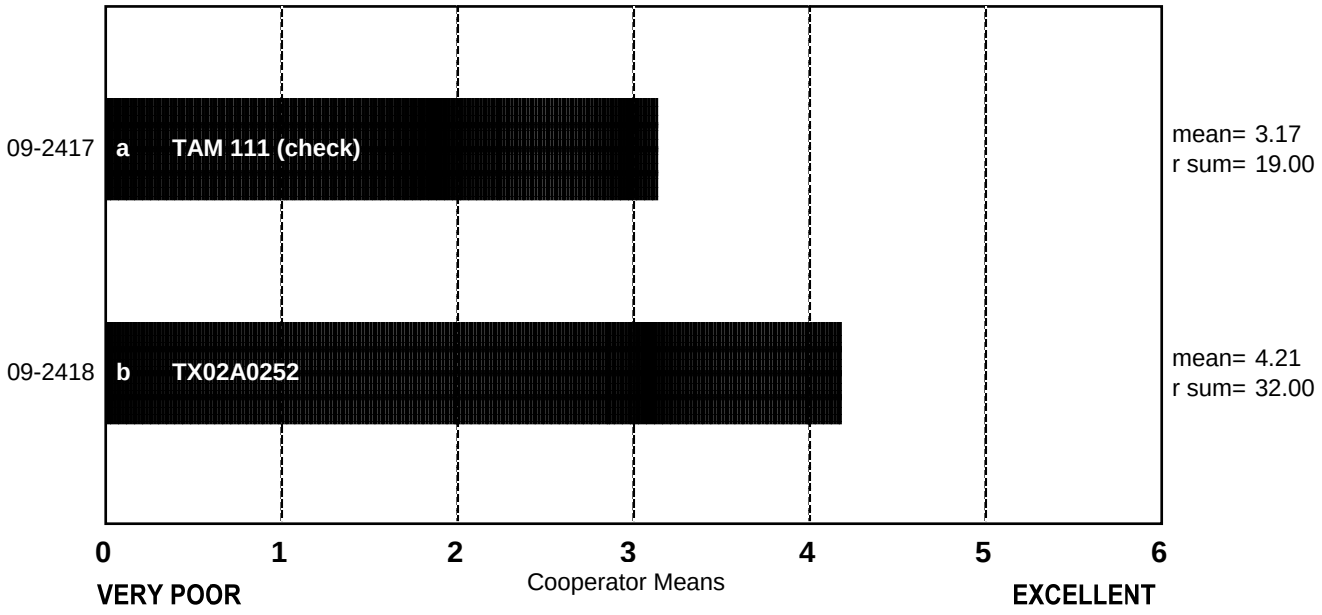


OVERALL BAKING QUALITY

(Small Scale) Texas-Amarillo

ncoop= 17
chisq= 9.94
chisqc= 9.94
cvchisq= 3.84
crdiff= 3.07

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



COOPERATOR'S COMMENTS
(Small Scale) Texas-Amarillo

COOP. **09-2417 TAM 111 (check)**

A. Low loaf volume and short mix time.
B. Low volume.
C. Slightly open grain. Good out of mixer but had no oven spring. Squatty loaf and yellow crumb color.
D. Average performance in loaf, dough and interior.
E. No comment.
F. No comment.
G. Medium Water Abs. Shorter Mixing Time & Longer Proof Time, Soft & Slight Strong Dough, Very High OS & Vol, fine elongated Cells, Slight Yellow Crumb, Smooth & Medium Resilient Texture.
H. High protein, dough handling was gassy and soft and grain was open and irregular. Poor mix tolerance and volumes, especially for this protein level.
I. Open grain, dark yellow crumb.
J. Slightly open, slightly irregular, slightly round grain, average volume.
K. No comment.
L. Slow dough pickup during mixing - downgraded the mixing score.
M. No comment.
N. No comment.
O. Open Grain and Low Volume.
P. No comment.
Q. Medium bake absorption; short MT; good at pan; below satisfactory crumb grain; creamy color with low LV.

COOP. **09-2418 TX02A0252**

A. No comment.
B. Low absorption, low volume.
C. Very nice grain. Slightly tough out of mixer but recovered well. Long mix. Excellent volume. Bright crumb color.
D. Better break & Shred, good solid performance all around.
E. No comment.
F. No comment.
G. Medium Water Abs., Mixing Time & Proof Time, Soft & Slight Strong Dough, Very High OS & Vol, Fine elongated Cells, Creamy Crumb, Silky & Medium Resilient Texture.
H. High protein, great bake quality, dough handling, and volumes.
I. Long mix time, good grain.
J. Slightly low absorption, slightly open, streaky grain, excellent volume.
K. No comment.
L. Slightly slow dough pickup during mixing - downgraded the mixing score.
M. No comment.
N. No comment.

O. High Mix Time- Tough out of mixer- Good Grain and volume.
P. No comment.
Q. Excellent bake absorption; good MT; good at pan; excellent crumb grain; creamy crumb color; good LV.

Notes: **B, C, H, I, J, M, and O** conducted sponge and dough bake tests

Description of Test Plots and Breeder Entries

Nebraska – Stephen Baenziger

Growing Conditions of Wheat Quality Samples

The samples are a composite of approximately 1 bu each produced at Sidney, North Platte, and Mead NE. All the samples were grown under normal production practices for those regions. The 2008-2009 growing season was unusually wet in most of Nebraska, so the protein levels of the samples may be lower than normal due to high yields and N leaching from the soils. Due to a cool season everywhere, Fusarium head blight was generally low throughout the state, but very widespread. Other disease and insect damage was minor.

Milling and baking check is **Millennium**.

Lines submitted for testing:

NE01481

The pedigree of NE01481 is NE92458/Ike where the pedigree of NE92458 is OK83201/REDLAND and the pedigree of OK83201 is Vona//Chisholm/Plainsman V. It is a moderately early, medium height semi-dwarf wheat with good winterhardiness and straw strength. In our tests, it has soil-borne wheat mosaic virus resistance (a rarity among our lines), moderate resistance to stem rust, but is moderately resistant to moderately susceptible to leaf rust and is susceptible to Hessian fly, Fusarium head blight, and wheat streak mosaic virus. It has performed well for grain yield in southeast and southcentral NE. In wet years, it has also done well in southerwestern NE. We view it as an excellent new wheat with a trait that is valuable to a part of our state that we have had difficulty finding good new varieties with the right disease resistances. In addition, in our end-use quality assays it has above average end-use quality. It was tested in the SRPN in 2004 and 2005 (data available at http://www.ars.usda.gov/Research/docs.htm?docid=11932) and in the Nebraska State Variety Trials (data available at: http://cropwatch.unl.edu/web/varietytest/wheat).

NI04421

The pedigree of NI04421 is NE96644/Wahoo (sib) where the pedigree of NE96644 is ODESSKAYA P./CODY//PAVON 76/*3 SCOUT66. It is a medium maturity, medium height semi-dwarf wheat with good winterhardiness and

medium straw strength. In our tests, it is moderately resistant to moderately susceptible to leaf rust and stem rust. It is moderately susceptible to soil-borne wheat mosaic virus and moderately susceptible to susceptible to Hessian fly and wheat streak mosaic virus. It is susceptible to common bunt (syn. stinking smut) and seed treatments are recommended. It has performed well under irrigation though it does not have the highest yield under optimum conditions. In addition, it has performed well in rainfed conditions in western NE where drought is common. It appears to be a wheat line ideally suited to being grown in western Nebraska under irrigation, especially when the last irrigation was insufficient (e.g. has some stress at finish) and in rainfed conditions in western Nebraska where drought stress is common. In addition, in our end-use quality assays it has above average end-use quality. It was tested in the SRPN in 2006 and 2007 (data available at http://www.ars.usda.gov/Research/docs.htm?docid=11932) and in the Nebraska State Variety Trials (data available at: http://cropwatch.unl.edu/web/varietytest/wheat).

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

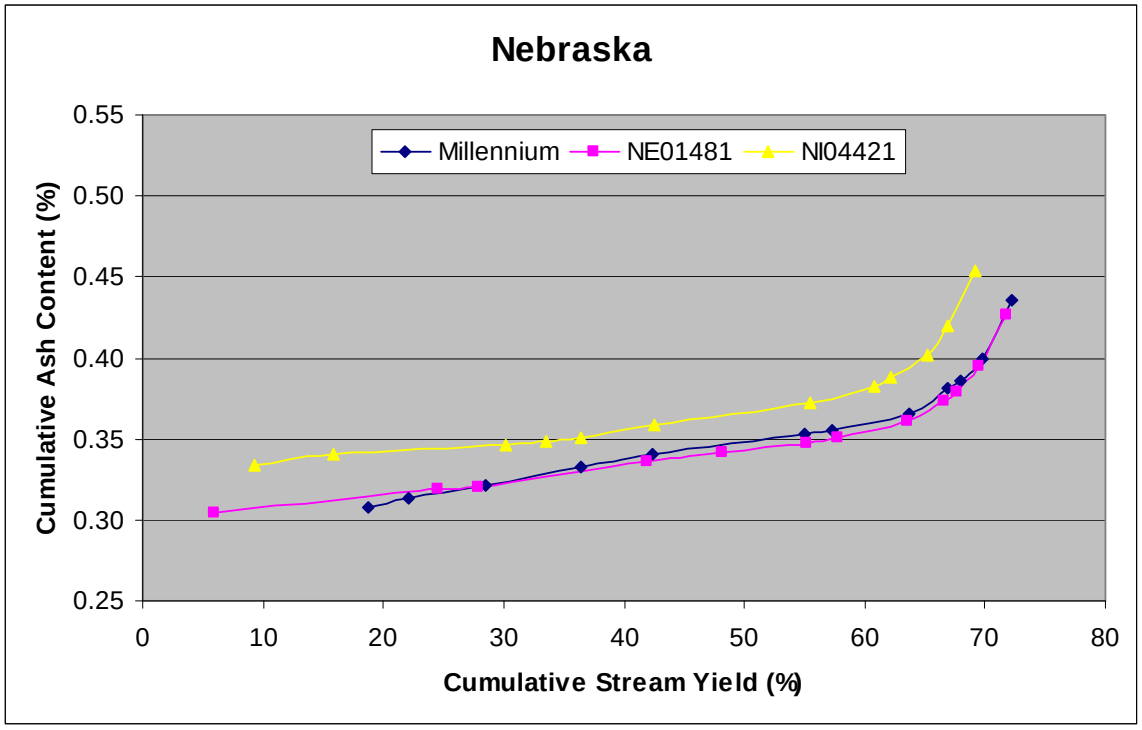
Test entry number	09-2419	09-2420	09-2421
Sample identification	**Millennium (check)**	**NE01481**	**NI04421**
Wheat Data			
FGIS classification	2 HRW	2 HRW	2 HRW
Test weight (lb/bu)	59.6	59.1	58.0
Hectoliter weight (kg/hl)	78.4	77.8	76.4
1000 kernel weight (gm)	29.6	29.2	28.2
NIR hardness	77	75	61
Wheat kernel size (Rotap)			
Over 7 wire (%)	62.1	65.4	64.7
Over 9 wire (%)	36.7	33.9	34.2
Through 9 wire (%)	1.2	0.7	1.1
Single kernel (skcs)			
Hardness (avg /s.d)	62.1/14.9	60.8/15.9	59.9/17.4
Weight (mg) (avg/s.d)	33.1/9.7	31.6/8.5	30.8/9.3
Diameter (mm)(avg/s.d)	2.67/0.35	2.67/0.33	2.70/0.35
SKCS distribution	02-09-29-60	02-16-26-56	05-16-28-51
Classification	Hard	Hard	Hard
Wheat moisture (%)	11.2	10.9	10.9
Wheat protein (12% mb)	13.4	12.2	11.9
Wheat ash (12% mb)	1.64	1.58	1.63
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	72.2	71.9	69.4
Quadrumat Sr. Mill	69.8	68.6	67.6
NIR Flour moisture (%)	12.1	12.5	12.8
NIR Flour protein (14% mb)	11.0	10.5	10.5
Flour ash (14% mb)	0.46	0.48	0.46
Glutomatic			
Wet gluten (%)	31.5	28.0	27.8
Dry gluten (%)	10.9	10.0	11.7
Gluten index	91.1	97.9	97.7
Rapid Visco-Analyser			
Peak Time (min)	6.1	6.2	6.3
Peak Viscosity (RVU)	173.5	214.3	195.2
Breakdown (RVU)	63.2	104.42	59.0
Final Viscosity at 13 min (RVU)	210.1	190.6	257.2
Minolta color meter			
L*	92.50	92.73	92.71
a*	-1.53	-1.49	-1.79
b*	8.77	8.40	9.47
Falling number (sec)	352	335	362
Damaged Starch			
(AI%)	95.48	94.42	95.96
(AACC76-31)	5.87	5.11	6.25

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

Nebraska: Physical Dough Tests and Gluten Analysis For 2009 (Small-Scale) Samples

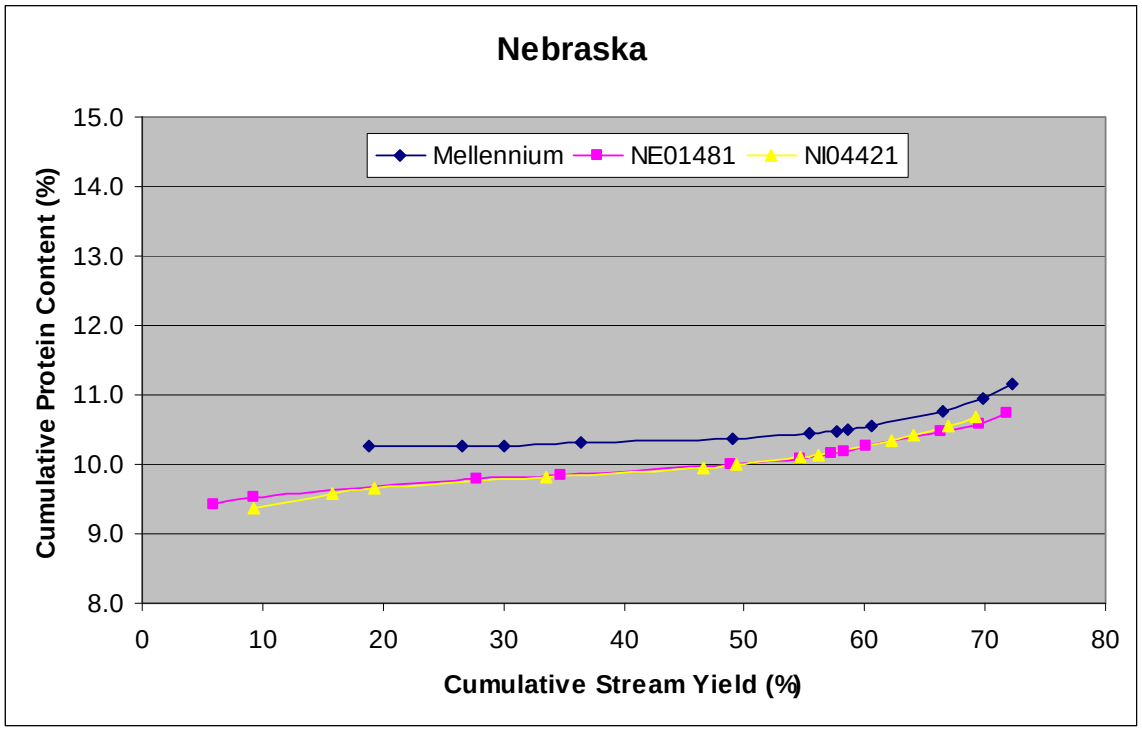
Test Entry Number	**09-2419**	**09-2420**	**09-2421**
Sample Identification	Millennium (check)	NE01481	NI04421
MIXOGRAPH			
Flour Abs (% as-is)	63.4	63.2	61.9
Flour Abs (14% mb)	61.3	61.4	60.5
Mix Time (min)	3.50	4.00	4.25
Mix tolerance (0-6)	3	3	4
FARINOGRAPH			
Flour Abs (% as-is)	57.4	57.7	56.9
Flour Abs (14% mb)	55.2	56.0	55.5
Development time (min)	4.5	5.5	2.4
Mix stability (min)	11.4	12.2	9.9
Mix Tolerance Index (FU)	25	35	34
Breakdown time (min)	10.0	9.5	6.0
ALVEOGRAPH			
P(mm. $_{H2O}$): Tenacity	58	58	75
L(mm): Extensibility	107	112	110
G($mm_{0.5}$): Swelling index	23.0	23.6	23.3
W(10^{-4} J): strength (curve area)	198	220	290
P/L: curve configuration ratio	0.54	0.52	0.68
Ie(P_{200}/P): elasticity index	55.8	60.1	62.4
EXTENSIGRAPH			
Resist (BU at 30/60/90 min)	323/426/445	325/498/494	390/523/577
Extensibility (mm at 30/60/90 min)	163/165/154	159/156/154	152/135/134
Energy (cm^2 at 30/60/90 min)	100/132/130	97/149/146	110/125/134
Resist $_{max}$ (BU at 30/60/90 min)	465/614/653	465/762/760	566/734/803
Ratio (at 30/60/90 min)	2.0/2.6/2.9	2.1/3.2/3.2	2.6/3.9/4.3
PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+9. 5+10	2*, 7+8/7+9, 5+10
Glu/Gli	2.18	2.01	1.96
HMW/LMW	0.45	0.36	0.37
%IPP	45.04	48.12	48.42
SEDIMENTATION TEST			
Volume (ml)	50.1	59.9	52.3

Nebraska: Cumulative Ash Curves



	Millennium - 2419					NE01481- 2420					NI04421 - 2421				
Mill	Strm Yld	Ash	Cumulative		Mill	Strm Yld	Ash	Cumulative		Mill	Strm Yld	Ash	Cumulative	
Streams	(14%mb)	(14%mb)	Yield (14%)	Ash (14%)	Streams	(14%mb)	(14%mb)	Yield (14%)	Ash (14%)	Streams	(14%mb)	(14%mb)	Yield (14%)	Ash (14%)
2M	18.78	0.31	18.78	0.31	1M	5.98	0.30	5.98	0.30	1BK	9.32	0.33	9.32	0.33
1M Red	3.36	0.35	22.14	0.31	2M	18.55	0.32	24.53	0.32	1M	6.53	0.35	15.86	0.34
1M	6.43	0.35	28.57	0.32	1M Red	3.28	0.33	27.81	0.32	2M	14.26	0.35	30.12	0.35
1BK	7.86	0.37	36.43	0.33	3M	14.10	0.37	41.91	0.34	1M Red	3.46	0.37	33.58	0.35
2BK	6.00	0.39	42.42	0.34	2BK	6.28	0.38	48.19	0.34	Grader	2.78	0.39	36.35	0.35
3M	12.65	0.39	55.08	0.35	1BK	7.02	0.39	55.21	0.35	2BK	6.11	0.41	42.46	0.36
Grader	2.27	0.41	57.34	0.36	Grader	2.61	0.41	57.82	0.35	3M	13.04	0.42	55.50	0.37
4M	6.29	0.46	63.64	0.37	4M	5.75	0.46	63.57	0.36	4M	5.32	0.48	60.82	0.38
3BK	3.31	0.68	66.94	0.38	3BK	3.09	0.64	66.66	0.37	FILTER FLR	1.40	0.65	62.22	0.39
FILTER FLR	1.01	0.70	67.96	0.39	FILTER FLR	1.07	0.68	67.73	0.38	3BK	2.92	0.69	65.14	0.40
5M	1.89	0.88	69.84	0.40	5M	1.77	1.00	69.50	0.39	5M	1.80	1.08	66.94	0.42
BRAN FLR	2.41	1.50	72.26	0.44	BRAN FLR	2.29	1.39	71.79	0.43	BRAN FLR	2.29	1.44	69.23	0.45
Break Shorts	2.03	4.28	74.29	0.54	Break Shorts	2.20	4.03	73.99	0.53	Break Shorts	2.28	4.22	71.51	0.57
Red Dog	1.61	2.29	75.90	0.58	Red Dog	1.78	2.44	75.77	0.58	Red Dog	1.94	2.43	73.45	0.62
Red Shorts	0.04	3.93	75.94	0.58	Red Shorts	0.07	3.80	75.84	0.58	Red Shorts	0.05	4.04	73.50	0.63
Filter Bran	0.33	1.58	76.27	0.58	Filter Bran	0.50	1.63	76.33	0.59	Filter Bran	0.65	3.49	74.14	0.65
Bran	23.73	5.32	100.00	1.71	Bran	23.67	5.12	100.00	1.66	Bran	25.86	5.05	100.00	1.79
Wheat Ash		1.60			Wheat Ash		1.54			Wheat Ash		1.59		
Straight Grade Flour Ash		0.46			Straight Grade Flour Ash		0.48			Straight Grade Flour Ash		0.46		

Nebraska: Cumulative Protein Curves



Millennium - 2419

Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)
2M	18.8	10.3	18.8	10.3
1BK	7.9	10.3	26.6	10.3
1M Red	3.4	10.3	30.0	10.3
1M	6.4	10.5	36.4	10.3
3M	12.7	10.6	49.1	10.4
4M	6.3	10.9	55.4	10.4
Grader	2.3	11.0	57.6	10.5
FILTER FLR	1.0	12.2	58.7	10.5
5M	1.9	12.3	60.5	10.6
2BK	6.0	12.8	66.5	10.8
3BK	3.3	14.9	69.8	11.0
BRAN FLR	2.4	16.8	72.3	11.2
Break Shorts	2.0	16.6	74.3	11.3
Red Dog	1.6	14.4	75.9	11.4
Red Shorts	0.0	14.5	75.9	11.4
Filter Bran	0.3	11.6	76.3	11.4
Bran	23.7	17.4	100.0	12.8
Whole Wheat		13.1		
St Grade Flour		11.4		

NE01481 - 2420

Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)
1M	6.0	9.4	6.0	9.4
1M Red	3.3	9.7	9.3	9.5
2M	18.5	9.9	27.8	9.8
1BK	7.0	10.1	34.8	9.8
3M	14.1	10.3	48.9	10.0
4M	5.7	10.9	54.7	10.1
Grader	2.6	11.4	57.3	10.1
FILTER FLR	1.1	12.3	58.4	10.2
5M	1.8	12.4	60.1	10.3
2BK	6.3	12.7	66.4	10.5
3BK	3.1	12.9	69.5	10.6
BRAN FLR	2.3	14.8	71.8	10.7
Break Shorts	2.2	15.9	74.0	10.9
Red Dog	1.8	14.2	75.8	11.0
Red Shorts	0.1	13.9	75.8	11.0
Filter Bran	0.5	11.8	76.3	11.0
Bran	23.7	14.6	100.0	11.8
Whole Wheat		11.9		
St Grade Flour		10.9		

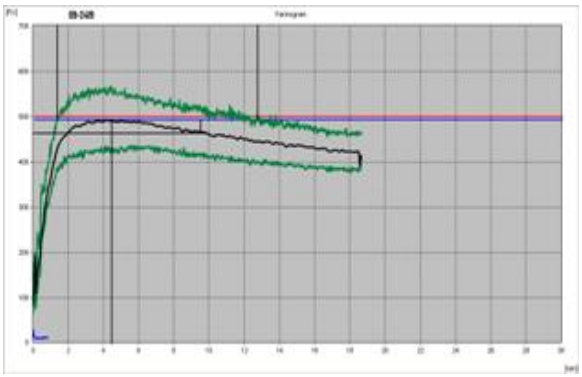
NI04421 - 2421

Mill Streams	Strm Yld (14%mb)	Protein (14%mb)	Cumulative Yield (14%)	Cumulative Prtn (14%)
1BK	9.3	9.4	9.3	9.4
1M	6.5	9.9	15.9	9.6
1M Red	3.5	10.0	19.3	9.6
2M	14.3	10.0	33.6	9.8
3M	13.0	10.4	46.6	10.0
Grader	2.8	10.8	49.4	10.0
4M	5.3	11.0	54.7	10.1
FILTER FLR	1.4	11.7	56.1	10.1
2BK	6.1	12.3	62.2	10.4
5M	1.8	12.4	64.0	10.4
3BK	2.9	13.7	66.9	10.6
BRAN FLR	2.3	14.6	69.2	10.7
Break Shorts	2.3	15.1	71.5	10.8
Red Dog	1.9	13.5	73.4	10.9
Red Shorts	0.0	13.4	73.5	10.9
Filter Bran	0.6	11.5	74.1	10.9
Bran	25.9	15.4	100.0	12.1
Whole Wheat		11.7		
St Grade Flour		11.0		

Physical Dough Tests

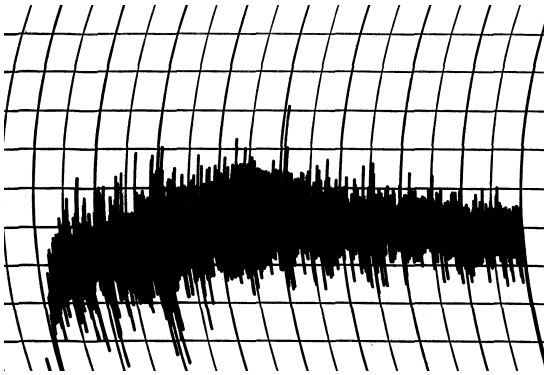
2009 (Small Scale) Samples – Nebraska

Farinograms



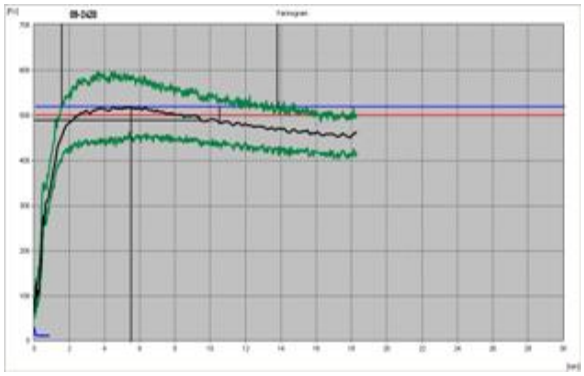
Water abs = 55.2%, Peak time = 4.5 min,
Mix stab = 11.4 min, MTI = 25 FU

Mixograms

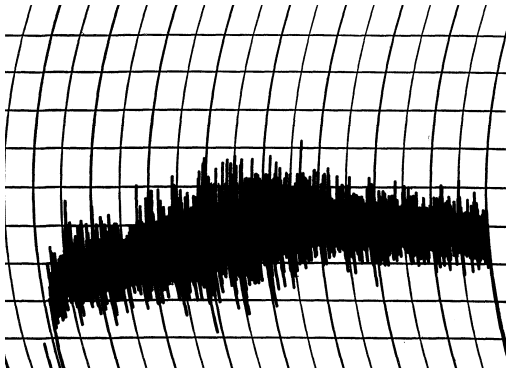


Water abs = 61.3%
Mix time = 3.5 min

09-2419, Millennium (check)



Water abs = 56.0%, Peak time = 5.5 min,
Mix stab = 12.2 min, MTI = 35 FU



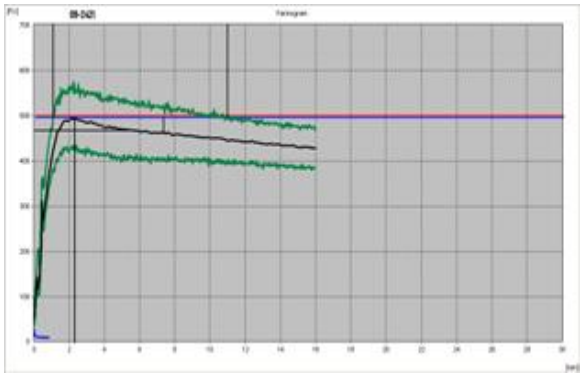
Water abs = 61.4%
Mix time = 4.0 min

09-2420, NE01481

Physical Dough Tests

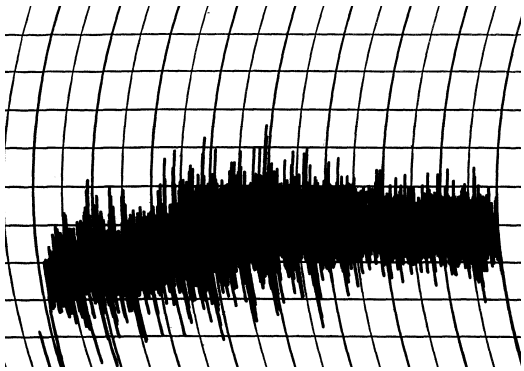
2009 (Small Scale) Samples – Nebraska (continued)

Farinograms



Water abs = 55.5%, Peak time = 2.4 min,
Mix stab = 9.9 min, MTI = 34 FU

Mixograms

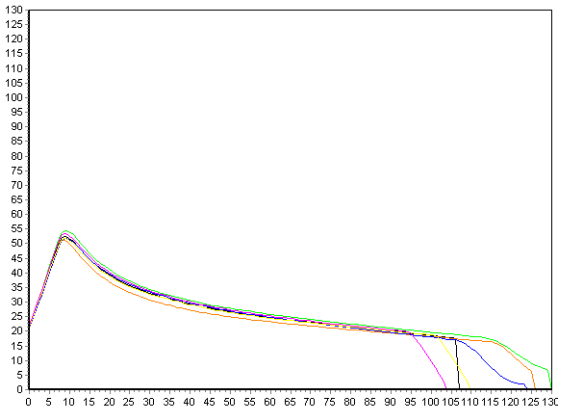


Water abs = 60.5%
Mix time = 4.3 min

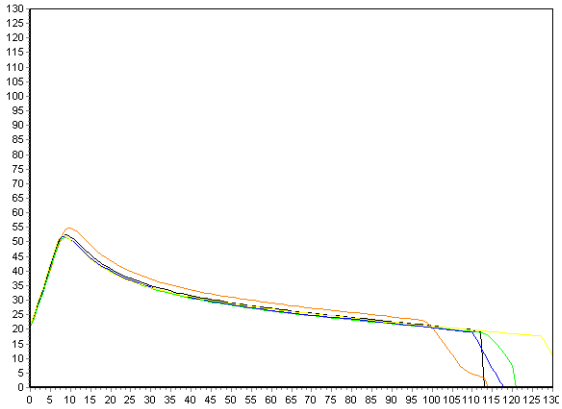
09-2421, NI04421

Physical Dough Tests - Alveograph

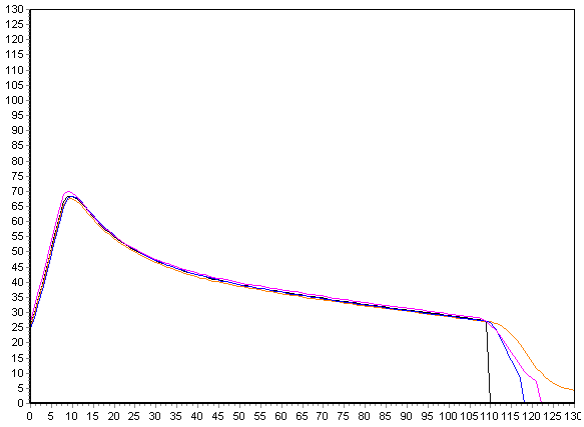
2009 (Small Scale) Samples – Nebraska



09-2419 (Millennium - check)
P(mm $_{H20}$)=58, L(mm)=107, W($10E^{-4}$ J)=198



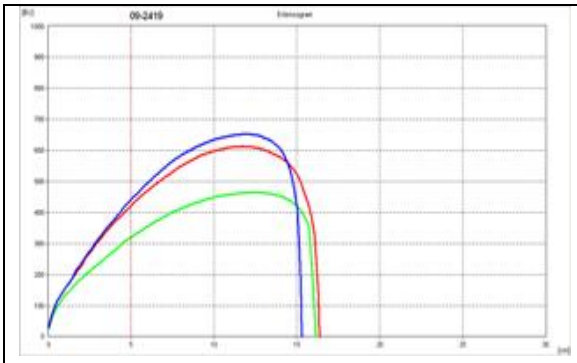
09-2420 (NE01481)
P(mm $_{H20}$)=58, L(mm)=112, W($10E^{-4}$ J)=220



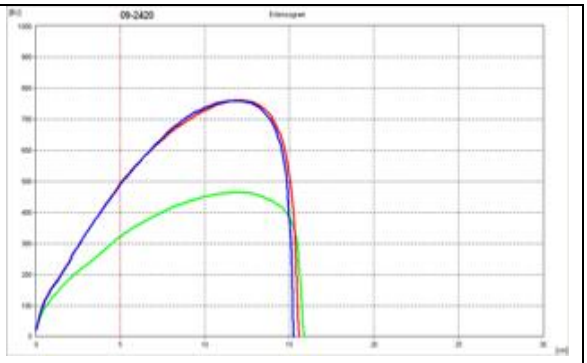
09-2421 (NI04421)
P(mm $_{H20}$)=75, L(mm)=110, W($10E^{-4}$ J)=290

Physical Dough Tests - Extensigraph

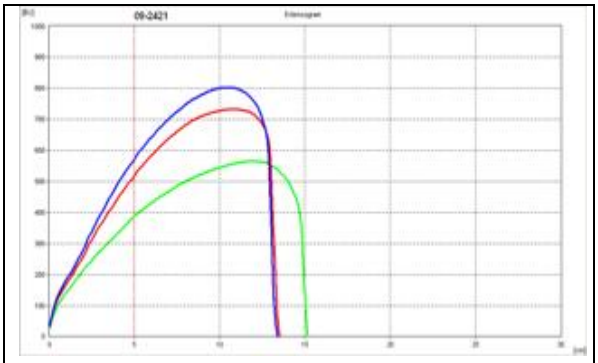
2009 (Small Scale) Samples – Nebraska



09-2419 (Millennium - check)
R (BU) = 323, E (mm) = 163, W (cm^2) = 100
Rmax (BU) = 465, Ratio = 2.0 at 30 min



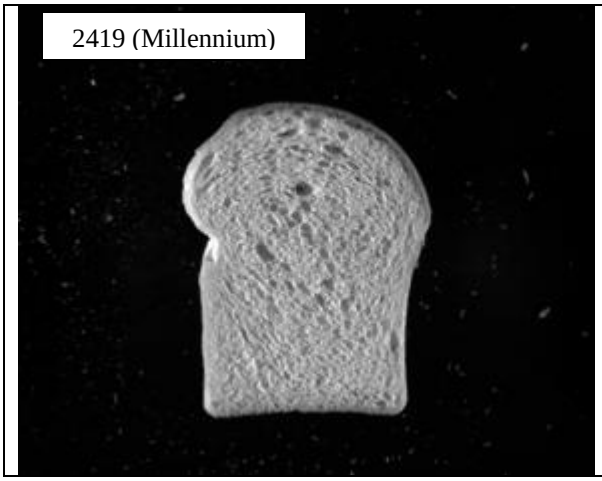
09-2420 (NE01481)
R (BU) = 325, E (mm) = 159, W (cm^2) = 97
Rmax (BU) = 465, Ratio = 2.1 at 30 min

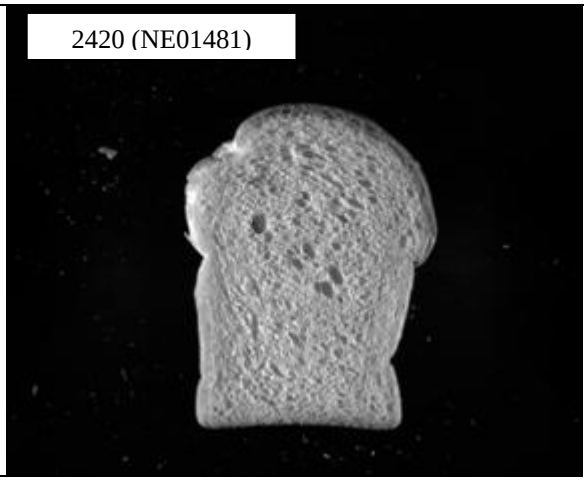


09-2421 (NI04421)
R (BU) = 390, E (mm) = 152, W (cm^2) = 110
Rmax (BU) = 566, Ratio = 2.6 at 30 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm2) = Energy; Rmax (BU) = Maximum resistance. Green = 30 min, Red = 60 min, and Blue = 90 min.

Nebraska: C-Cell Bread Images and Analysis for 2009 (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	5979	151.9	3756	0.443	1.963	0.938	1.64	-20.9
2420	6246	147.1	3884	0.443	2.017	3.342	1.67	-22.2

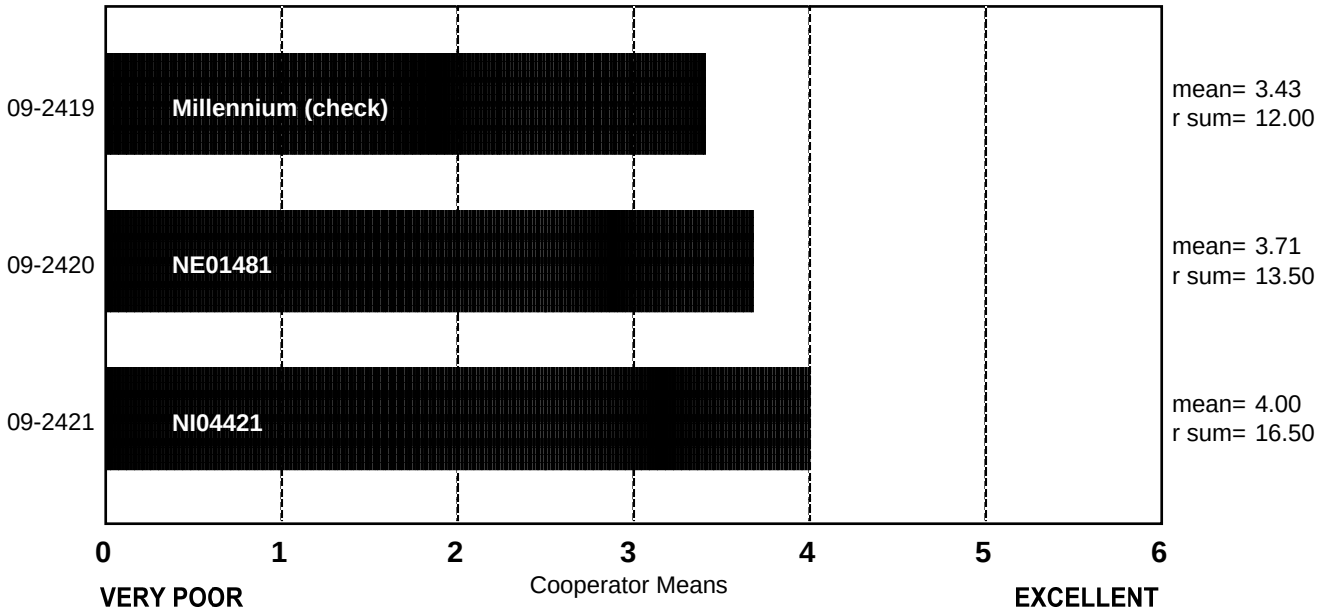
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2421	6060	155.1	3848	0.443	1.856	1.063	1.69	-15.8

SPONGE CHARACTERISTICS

(Small Scale) Nebraska

ncoop= 7
chisq= 1.50
chisqc= 3.00
cvchisq= 5.99
crdiff=

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

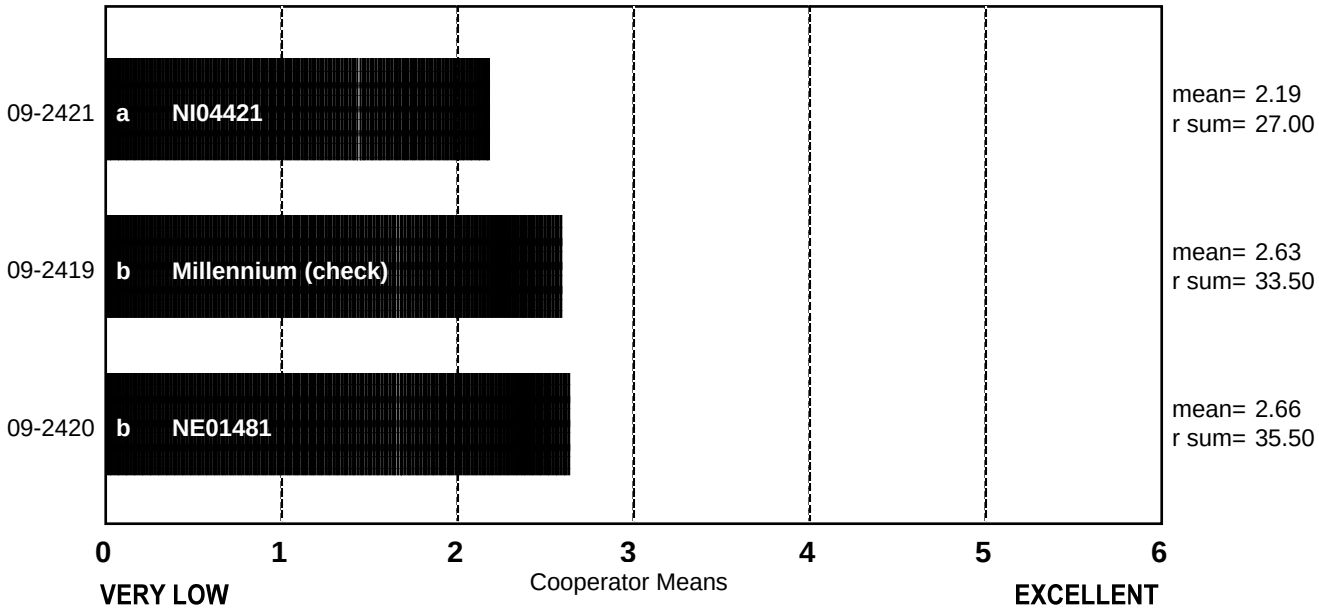


BAKE ABSORPTION

(Small Scale) Nebraska

ncoop= 16
chisq= 2.47
chisqc= 6.08
cvchisq= 5.99
crdiff= 6.16

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
09-2419 Millennium (check)	**57.7**	**52.0**	**57.0**	**65.9**	**61.3**	**57.2**	**62.5**	**61.0**	**57.0**	**57.0**	**65.1**	**61.5**	**59.5**	**62.7**	**58.2**	**53.7**	**60.6**
09-2420 NE01481	**58.0**	**53.0**	**57.0**	**66.3**	**61.4**	**58.0**	**60.8**	**60.0**	**57.0**	**58.0**	**65.1**	**61.5**	**58.0**	**61.6**	**59.0**	**56.5**	**62.9**
09-2421 NI04421	**57.5**	**53.0**	**57.0**	**65.8**	**60.5**	**57.5**	**61.0**	**60.0**	**57.0**	**57.0**	**64.1**	**60.3**	**57.5**	**60.8**	**58.5**	**54.0**	**61.3**

BAKE MIX TIME, ACTUAL

(Small Scale) Nebraska

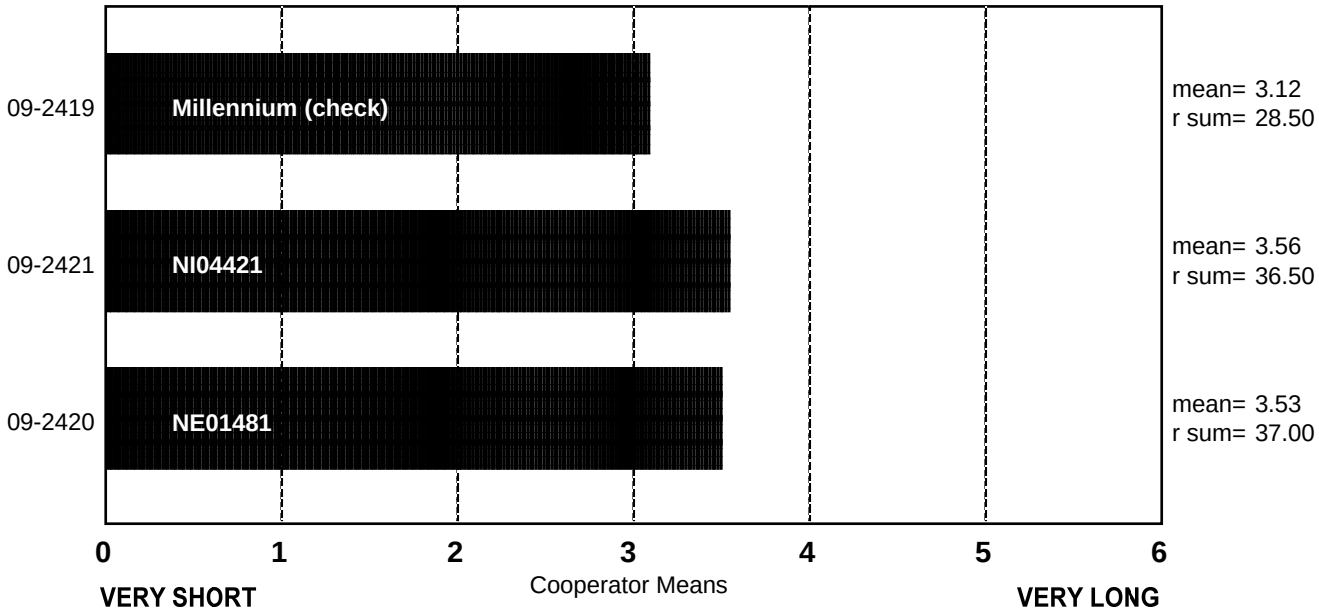
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2419 Millennium (check)	**1.5**	**5.0**	**7.0**	**3.6**	**4.0**	**5.0**	**5.0**	**6.0**	**6.0**	**25.0**	**3.5**	**3.5**	**12.0**	**3.0**	**6.0**	**4.0**	**4.6**
09-2420 NE01481	**1.5**	**6.0**	**10.0**	**4.9**	**4.0**	**5.0**	**5.8**	**6.0**	**5.0**	**25.0**	**4.5**	**4.2**	**18.0**	**3.2**	**6.0**	**4.3**	**6.1**
09-2421 NI04421	**1.5**	**4.0**	**7.0**	**5.1**	**5.0**	**5.0**	**6.0**	**6.0**	**5.0**	**25.0**	**4.3**	**4.2**	**13.0**	**3.6**	**5.0**	**5.5**	**6.6**

BAKE MIX TIME

(Small Scale) Nebraska

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

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

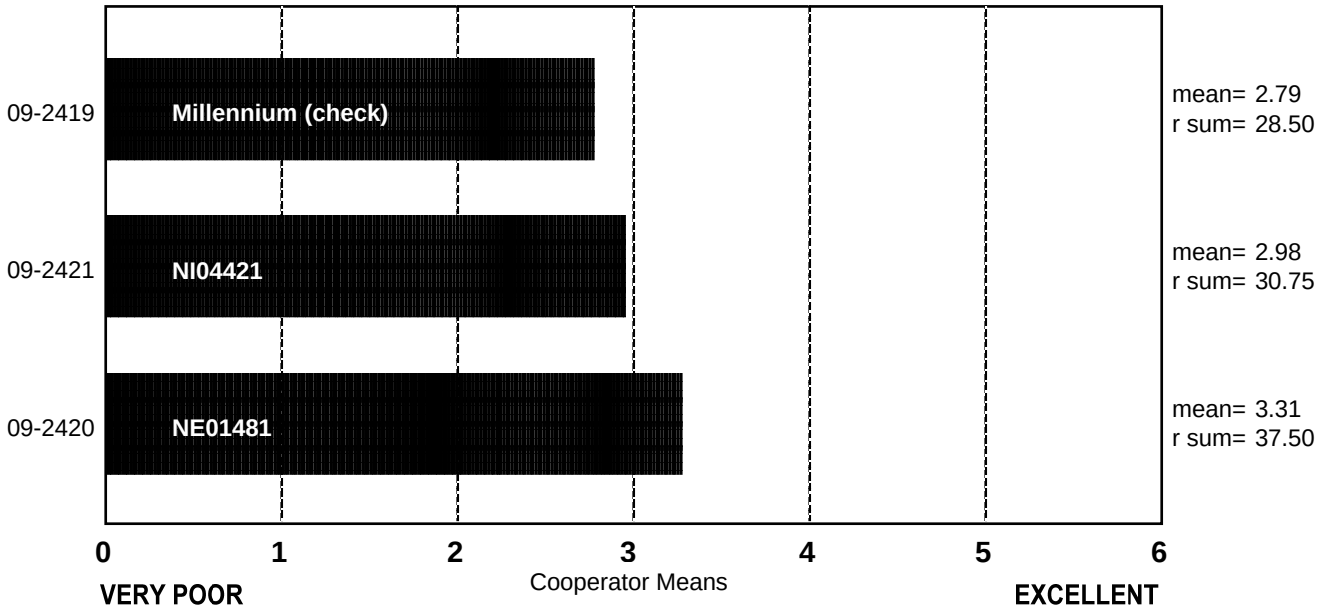


MIXING TOLERANCE

(Small Scale) Nebraska

ncoop= 16
chisq= 5.75
chisqc= 5.85
cvchisq= 5.99
crdiff=

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

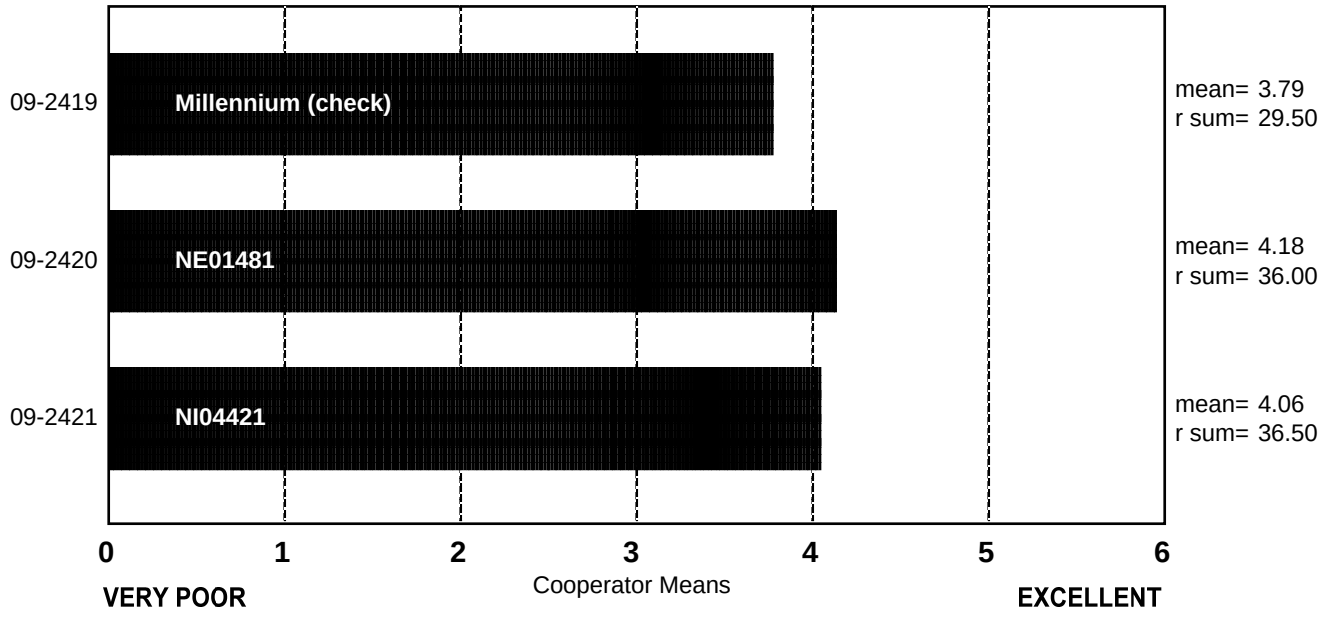


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Nebraska

ncoop= 17
chisq= 1.79
chisqc= 3.30
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
09-2419 Millennium (check)	**4**	**2**	**1**	**10**	**0**
09-2420 NE01481	**2**	**2**	**1**	**11**	**1**
09-2421 NI04421	**2**	**2**	**1**	**11**	**1**

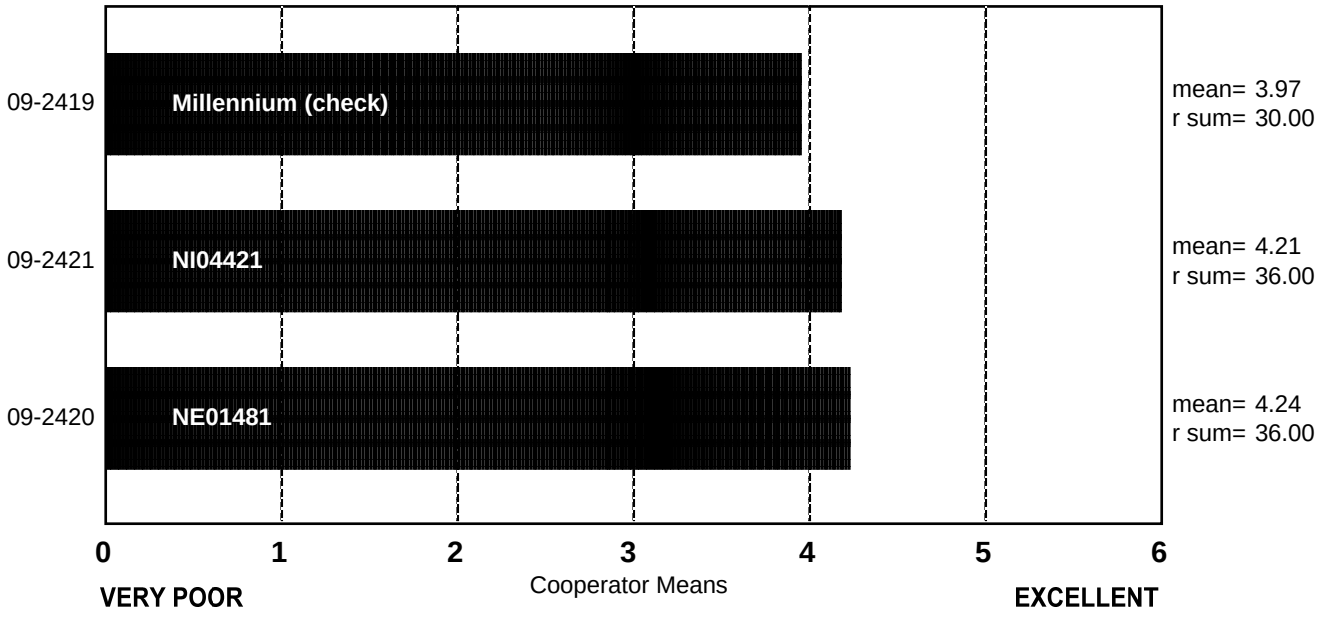
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Nebraska

ncoop= 17
chisq= 1.41
chisqc= 4.17
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
09-2419 Millennium (check)	**2**	**3**	**3**	**8**	**1**
09-2420 NE01481	**3**	**1**	**0**	**12**	**1**
09-2421 NI04421	**2**	**2**	**1**	**10**	**2**

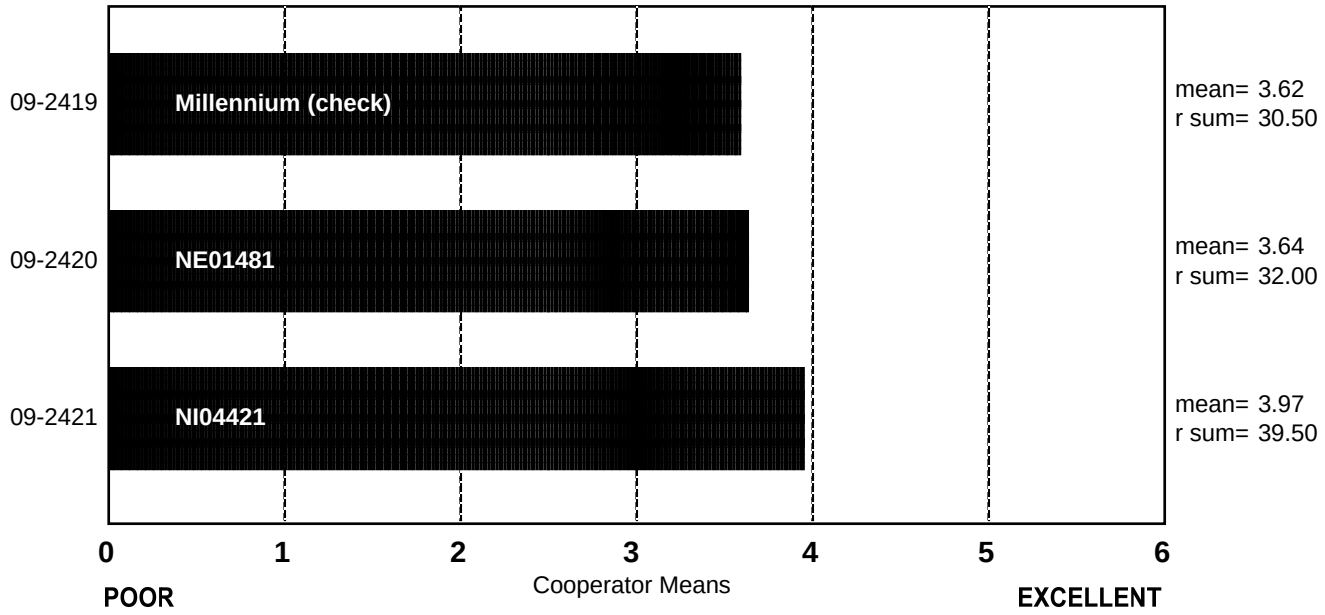
Frequency Table

CRUMB GRAIN

(Small Scale) Nebraska

ncoop= 17
chisq= 2.74
chisqc= 3.65
cvchisq= 5.99
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Nebraska

	Open	Fine	Dense
09-2419 Millennium (check)	**7**	**9**	**1**
09-2420 NE01481	**10**	**7**	**0**
09-2421 NI04421	**6**	**9**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Nebraska

	Round	Irregular	Elongated
09-2419 Millennium (check)	**1**	**9**	**7**
09-2420 NE01481	**4**	**8**	**5**
09-2421 NI04421	**2**	**10**	**5**

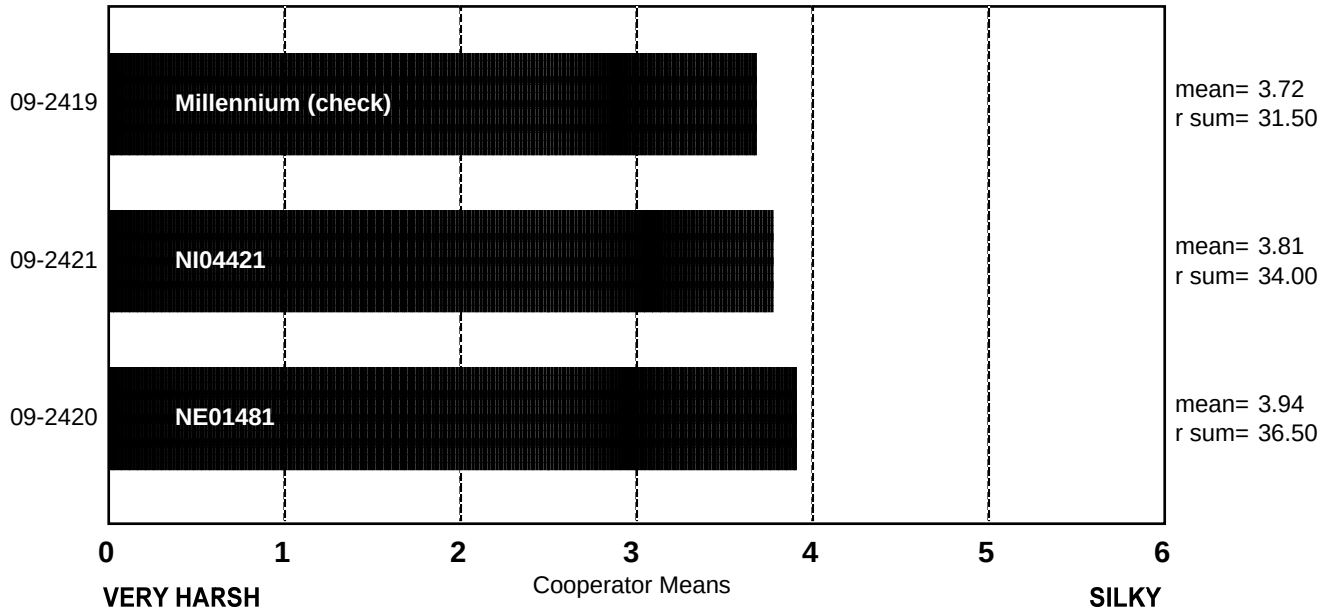
Frequency Table

CRUMB TEXTURE

(Small Scale) Nebraska

ncoop= 17
chisq= 0.74
chisqc= 1.09
cvchisq= 5.99
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Nebraska

	Harsh	Smooth	Silky
09-2419 Millennium (check)	**3**	**12**	**2**
09-2420 NE01481	**3**	**11**	**3**
09-2421 NI04421	**3**	**11**	**3**

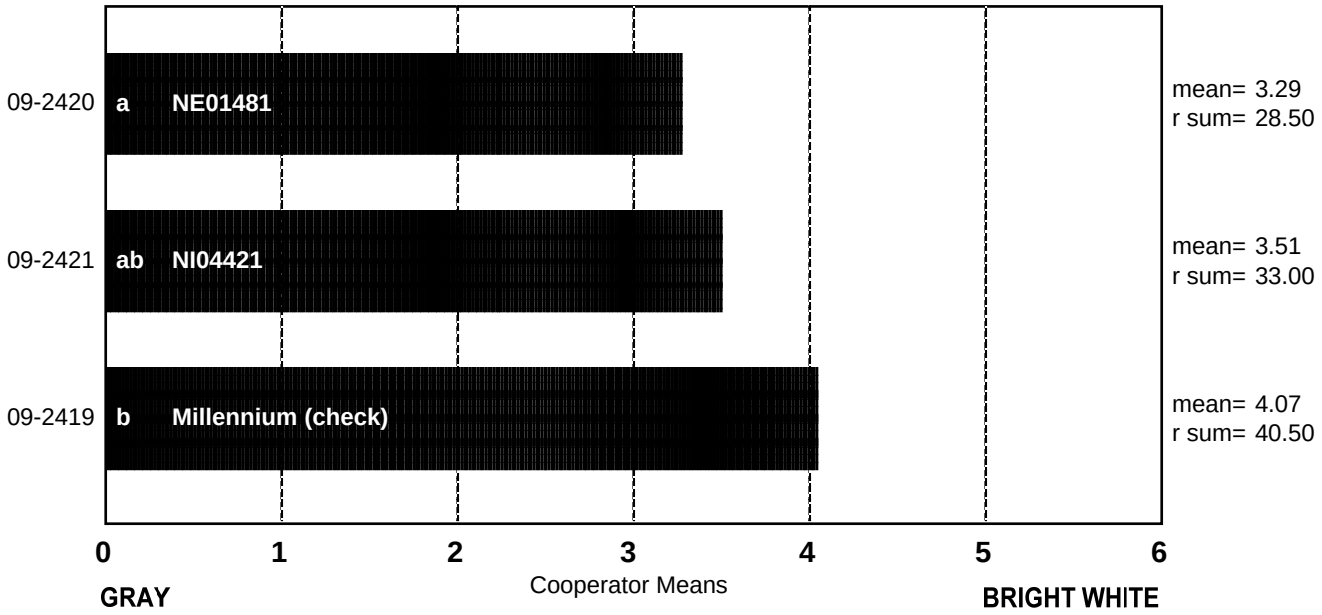
Frequency Table

CRUMB COLOR

(Small Scale) Nebraska

ncoop= 17
chisq= 4.32
chisqc= 6.00
cvchisq= 5.99
crdiff= 8.95

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
09-2419 Millennium (check)	**0**	**0**	**1**	**3**	**8**	**4**	**1**
09-2420 NE01481	**0**	**0**	**2**	**7**	**7**	**1**	**0**
09-2421 NI04421	**0**	**0**	**1**	**6**	**8**	**2**	**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. O
09-2419 Millennium (check)	**132.2**	**500.0**	**421.0**	**151.8**	**156.1**	**475.0**	**144.7**		**467.6**	**468.8**	**140.7**	**141.9**			**455.2**	**127.1**	**150.7**
09-2420 NE01481	**130.1**	**495.0**	**412.0**	**153.0**	**154.7**	**479.0**	**142.3**		**465.0**	**468.5**	**137.1**	**140.0**			**452.1**	**126.8**	**146.9**
09-2421 NI04421	**132.1**	**495.0**	**415.0**	**154.3**	**156.7**	**478.0**	**142.8**		**468.5**	**469.7**	**137.8**	**140.9**			**453.4**	**125.5**	**149.4**

LOAF VOLUME, ACTUAL

(Small Scale) Nebraska

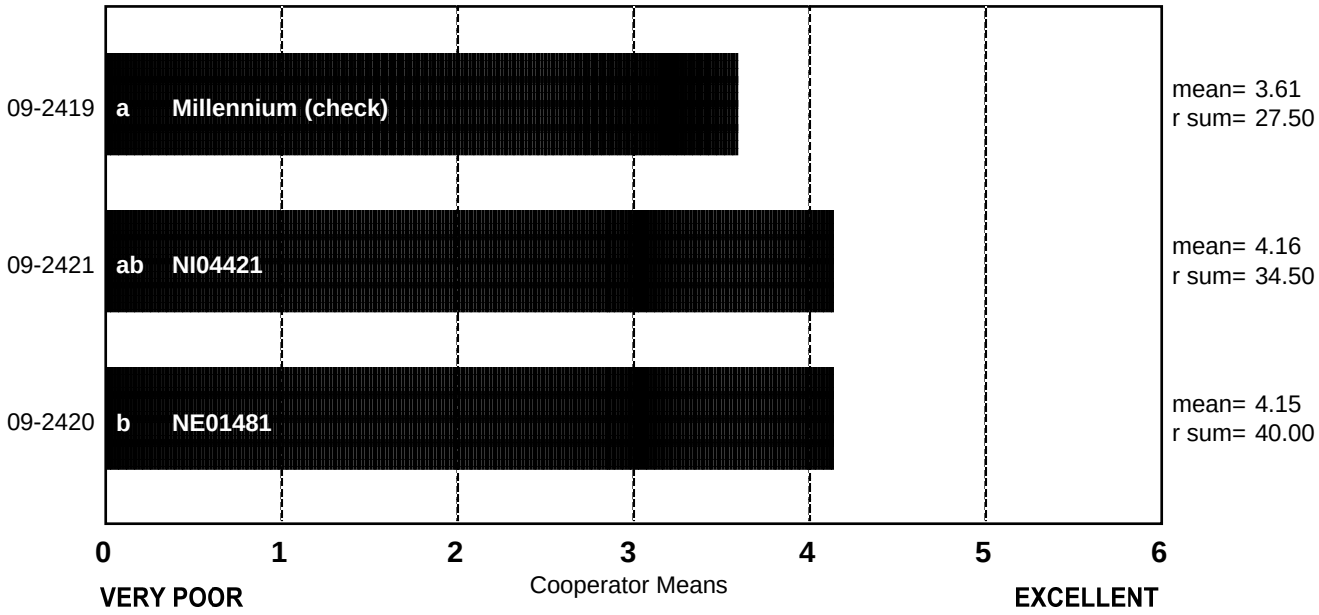
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M	Coop. N	Coop. O	Coop. P	Coop. O
09-2419 Millennium (check)	**675**	**2700**	**3000**	**935**	**605**	**2675**	**888**	**935**	**2675**	**3045**	**1015**	**838**	**2600**	**1030**	**2325**	**785**	**805**
09-2420 NE01481	**740**	**2800**	**3000**	**1025**	**613**	**2625**	**875**	**1025**	**2738**	**3015**	**1055**	**928**	**2725**	**1050**	**2350**	**835**	**875**
09-2421 NI04421	**710**	**2900**	**3000**	**895**	**618**	**3075**	**945**	**973**	**2675**	**3045**	**970**	**892**	**2800**	**1040**	**2525**	**780**	**808**

LOAF VOLUME

(Small Scale) Nebraska

ncoop= 17
chisq= 4.62
chisqc= 7.85
cvchisq= 5.99
crdiff= 8.24

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

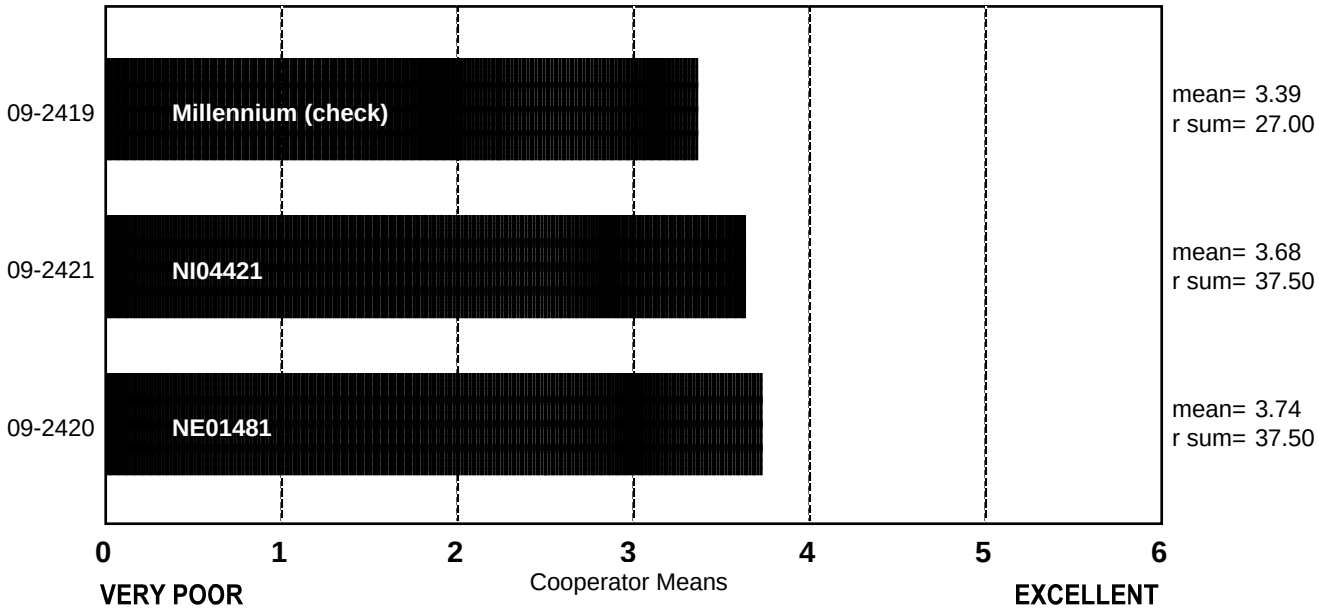


OVERALL BAKING QUALITY

(Small Scale) Nebraska

ncoop= 17
chisq= 4.32
chisqc= 5.07
cvchisq= 5.99
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Nebraska

COOP. **09-2419 Millennium (check)**

A. Low loaf volume and bake absorption.
B. Very low absorption, low volume.
C. Short mix time. Slightly soft out of mixer and make-up. Good volume and very close grain. Lower protein. Nice interior.
D. Good performance in loaf, dough and interior.
E. No comment.
F. No comment.
G. Medium Water Abs. & Mixing Time, Longer Proof Time, Sticky & Slight Weak Dough, Very High OS & Vol, Open Elongated Cells, Creamy Crumb, Smooth & Medium Resilient Texture.
H. Poor mix tolerance and irregular grain. Weak dough handling and small volumes.
I. Very low absorption, good grain, average volume.
J. Low absorption, good crumb color, sl. Open grain, coarse texture, very good volume.
K. No comment.
L. No comment.
M. No comment.
N. No comment.
O. Low Abs- Low Mix Time- Good Grain and Average Volume.
P. No comment.
Q. Low bake absorption; good bake MT; satisfactory crumb grain; creamy crumb color; low LV.

COOP. **09-2420 NE01481**

A. Low loaf volume and flour protein.
B. Very low absorption.
C. Average mix for protein. Close grain. Good pliable dough. Good volume and Creamy bright interior.
D. Better break & Shred, excellent dough and loaf volume properties, great performance for the low protein level, SECOND BEST OF SHOW.
E. No comment.
F. No comment.
G. Lower Water Abs., Medium Mixing Time, Longer Proof Time, Soft & Slight Weak Dough, Very High OS & Vol, open, elongated Cells, Slight Yellow Crumb, Smooth & Medium Resilient Texture.
H. Weak dough handling but bread recovered somewhat with good volumes, but did have open grain.
I. Very low absorption, short mix time, good grain, yellow crumb, good volume.
J. Open, irregular, coarse texture, very good volume.
K. No comment.
L. Slow dough pickup during mixing - downgraded the mixing score.
M. No comment.
N. No comment.

O. Low Abs- Low Mix Time- Good Grain and Average Volume.
P. No comment.
Q. Low bake absorption; long bake MT; excellent at pan; satisfactory crumb grain; creamy color; low LV.

COOP. 09-2421 NI04421

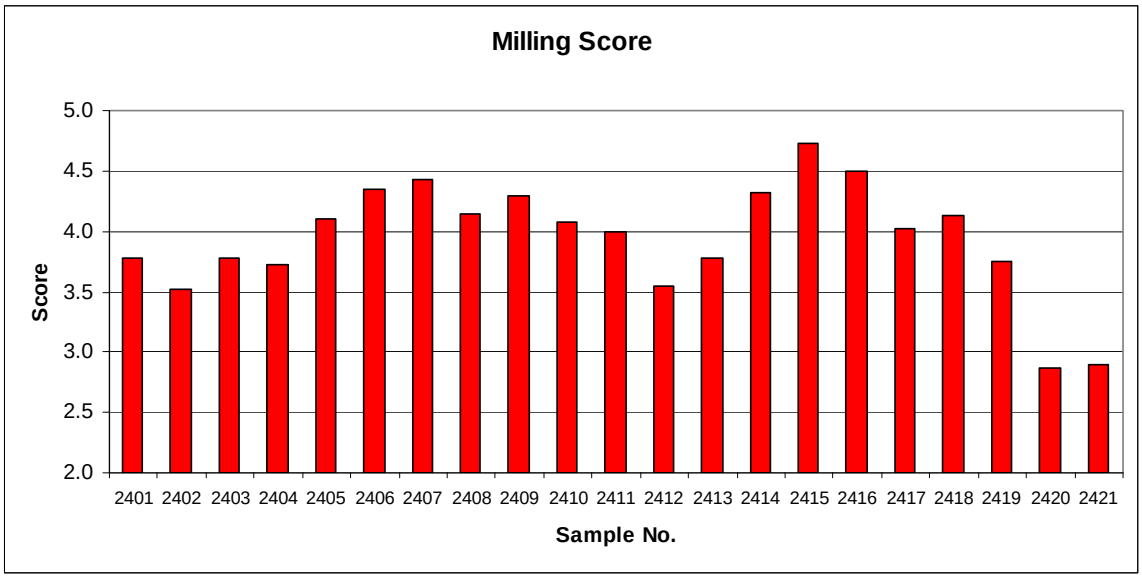
A. Low loaf volume, flour protein and bake absorption.
B. Very low absorption.
C. Short mix time. Good volume. Slightly soft out of mixer. Bright crumb color and close grain.
D. Good performance in loaf, dough and interior.
E. No comment.
F. No comment.
G. Lower Water Abs., Medium Mixing Time & Proof Time, Soft & Slight Weak Dough, Very High OS & Vol, open elongated Cells, Creamy Crumb, smooth & Medium Resilient Texture.
H. Poor mix tolerance and weak dough handling but did have good volumes.
I. Very low absorption, short mix time, fine grain, average volume.
J. Low absorption, sl. Open grain, good volume.
K. No comment.
L. No comment.
M. No comment.
N. No comment.
O. Low Abs- Low Mix Time- Good Grain and Good Volume.
P. No comment.
Q. Low bake absorption; long bake MT; excellent crumb grain; creamy crumb color; low LV

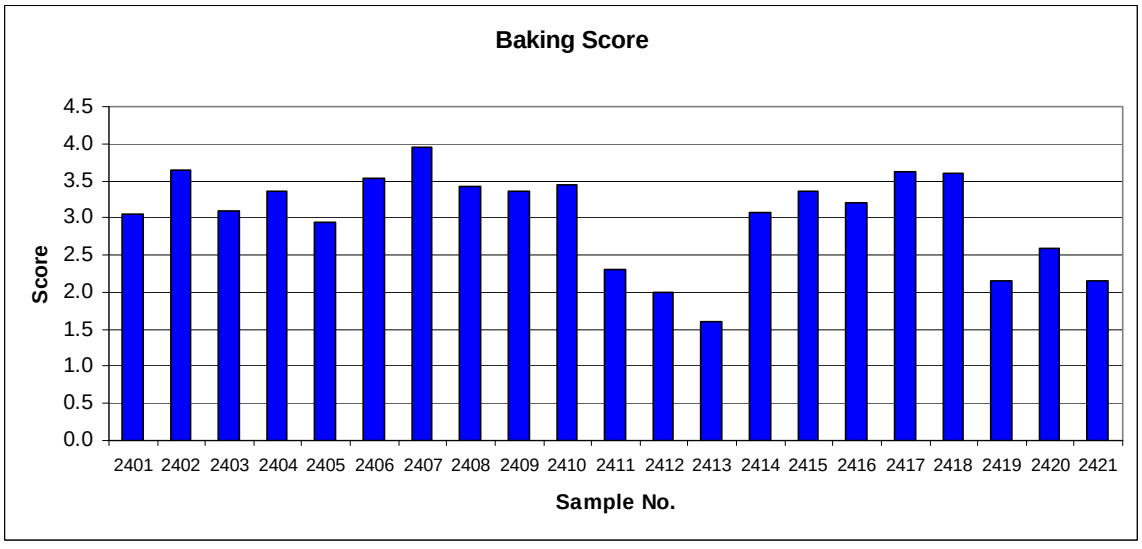
Notes: **B, C, H, I, J, M, and O** conducted sponge and dough bake tests

2009 WQC Milling and Baking Score

2009 WQC Milling & Baking Scores

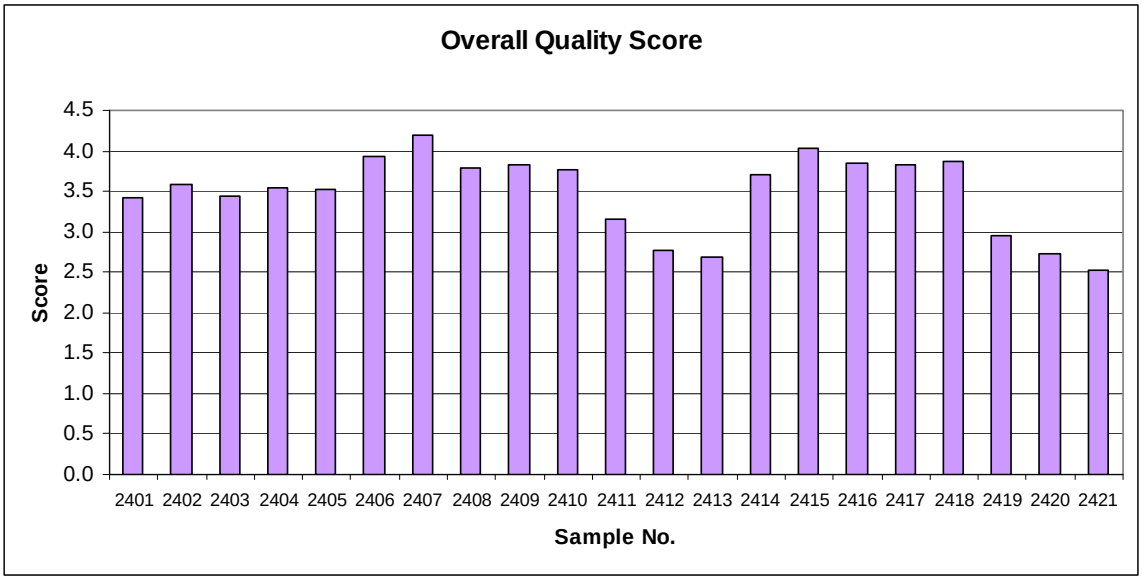
(Based upon HWWQL Quality Data)





2009 WQC Milling & Baking Scores

(Based upon HWWQL Quality Data)



Marketing Scores

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

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

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

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

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

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

Alkaline Noodle Quality Tests of 2009 WQC Hard Winter Wheat Samples

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Alkaline Noodle Quality Report of 2009WQC Samples

Objectives: Evaluate noodle color and cooking characteristics of 2009 WQC hard winter wheat samples.

Materials: 21 WQC samples harvested in 2009.

Methods:

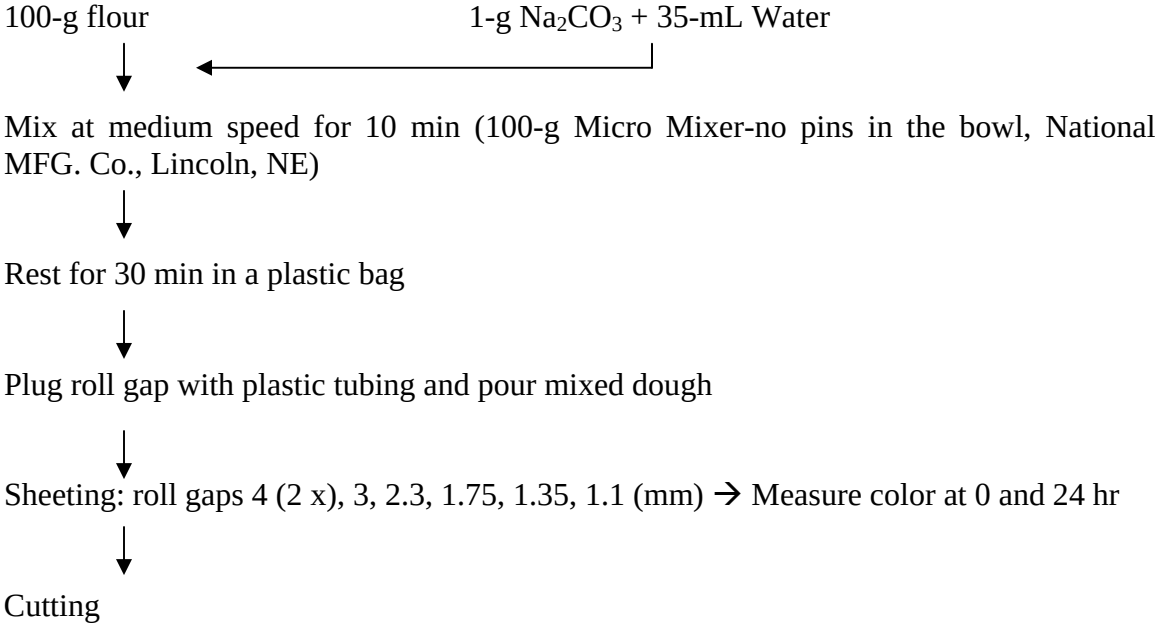
PPO (Polypenol Oxidase) Test:
The PPO level in wheat meal was determined using a method modified from AACCI Approved Method 22-85:

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

Noodle Making:

Formulation:
Alkaline Noodle was made with 100 g flour, 1-g Na_2CO_3, and 35- mL of water (fixed).

Procedure:



Measurement of Noodle Dough Color:

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

Cooking Noodles:

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

Measurement of Cooking Loss and Water Uptake:

Cooking Loss:

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

Water Uptake:

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

Texture Profile Analysis (TPA) of Noodle:

Immediately after cooking, the TPA of noodle was conducted using 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***: 2403 (83.6), 2404 (82.4), 2420 (81.8)

Noodle Color (*L* value, Higher is better.) ***at 24 hr***: 2414 (72.4), 2403 (71.6), 2404 (71.2)

Delta L (Change of *L* value, Lower absolute value is better.)
2414 (-8.6), 2411 (-10.6), 2412 (-11.1)

PPO (Lower is better.): 2404 (0.156), 2409 (0.196), 2414 (0.352)

Table II shows the following:

Hardness: 2421 (2.69), 2401 (2.65), 2420 (2.60)

Springiness: 2417 (0.986), 2414 (0.982), 2419 (0.977)

Chewiness: 2409 (1.70), 2401 (1.64), 2402 (1.63)

Resilience: 2415 (0.430), 2414 (0.422), 2409 (0.416)

Cohesiveness: 2415 (0.687), 2409 (0.686), 2414 (0.685)

Water Uptake: 2420 (93.6), 2413 (91.6), 2419 (91.3)

Cooking Loss: 2410 (5.3), 2409 (5.6), 2417 (5.9)

Discussion

Sample 2414 showed the highest brightness in noodle color at 24 hr and lowest *Delta L* value, the second highest *Springiness* and *Resilience* in texture, and the third highest *Cohesiveness* in texture and the third lowest PPO level. The bright noodle color after 24 hr production and the firmer texture after cooking are considered as desirable characteristics for alkaline noodles. Thus, the sample 2414 would be most favourable for alkaline noodle. Sample 2404 showed the third brightest and yellowness noodle color at 24 hr, and the lowest PPO level. Therefore, the sample 2404 would be a good flour for alkaline noodle too. Sample 2403 showed the second brightest noodle color at 24 hr.

Table I. Noodle Color and PPO Level

Sample	*L* @ 0	*L* @ 24	*a* @ 0	*a* @ 24	*b* @ 0	*b* @ 24	delta *L*	delta *a*	delta *b*	PPO
2401	81.02	67.65	-1.05	0.13	17.94	23.75	-13.37	1.18	5.81	0.657
2402	80.38	67.73	-1.58	-0.16	22.30	26.16	-12.66	1.42	3.86	0.653
2403	83.61	71.59	-2.44	-0.91	20.42	24.87	-12.03	1.54	4.45	0.539
2404	82.44	71.19	-1.71	-0.81	19.82	25.23	-11.26	0.91	5.41	0.156
2405	80.91	68.02	-1.14	0.11	20.11	23.78	-12.89	1.25	3.67	0.678
2406	78.41	64.03	-1.65	0.40	24.00	24.24	-14.39	2.05	0.24	0.669
2407	77.74	65.30	-1.75	0.05	25.36	26.37	-12.44	1.79	1.01	0.704
2408	81.55	67.99	-1.43	0.09	20.62	25.82	-13.57	1.52	5.21	0.462
2409	79.29	67.56	-1.24	-0.02	22.37	26.89	-11.73	1.22	4.53	0.196
2410	80.69	66.84	-1.35	0.07	21.13	25.52	-13.85	1.41	4.39	0.552
2411	81.13	70.49	-2.04	-0.50	24.22	24.83	-10.64	1.54	0.61	0.567
2412	80.56	69.43	-2.04	-0.72	22.57	25.27	-11.13	1.33	2.70	0.676
2413	80.09	68.28	-1.39	-0.01	20.88	25.35	-11.81	1.38	4.48	0.580
2414	81.04	72.40	-1.55	-0.48	21.37	24.16	-8.64	1.07	2.79	0.352
2415	81.49	69.22	-1.67	-0.63	21.65	24.91	-12.27	1.04	3.26	0.495
2416	81.19	68.21	-1.72	-0.58	20.54	23.20	-12.98	1.14	2.66	0.702
2417	78.52	67.13	-1.66	-0.19	23.72	25.95	-11.39	1.47	2.23	0.890
2418	80.83	67.21	-1.80	-0.46	21.61	26.55	-13.62	1.35	4.95	0.778
2419	80.72	68.44	-1.89	-0.91	20.47	24.96	-12.28	0.98	4.49	0.654
2420	81.76	66.90	-1.74	-0.39	18.40	26.02	-14.86	1.35	7.62	0.654
2421	80.80	69.25	-2.42	-1.26	22.56	26.90	-11.56	1.16	4.34	0.598
Average	80.67	68.32	-1.68	-0.34	21.52	25.27	-12.35	1.34	3.75	0.581

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

Sample	Hardness	Springiness	Chewiness	Resilience	Cohesiveness	Water uptake	Cooking loss
	N	ratio	no unit	ratio	ratio	%	%
2401	2.65	0.936	1.64	0.385	0.662	81.5	7.8
2402	2.51	0.971	1.63	0.397	0.671	85.2	6.6
2403	2.33	0.969	1.51	0.396	0.669	88.1	6.9
2404	2.34	0.967	1.50	0.402	0.665	87.8	7.0
2405	2.50	0.953	1.61	0.384	0.675	81.2	7.3
2406	2.54	0.949	1.60	0.379	0.663	77.7	6.9
2407	2.37	0.959	1.52	0.395	0.667	83.3	6.8
2408	2.51	0.957	1.60	0.401	0.669	85.6	6.4
2409	2.58	0.959	1.70	0.416	0.686	84.0	5.6
2410	2.48	0.971	1.61	0.392	0.668	85.0	5.3
2411	2.38	0.959	1.46	0.366	0.640	87.3	7.3
2412	2.38	0.959	1.42	0.338	0.621	88.4	7.0
2413	2.42	0.949	1.42	0.336	0.619	91.6	7.4
2414	2.28	0.982	1.53	0.422	0.685	83.2	8.0
2415	2.15	0.975	1.44	0.430	0.687	81.1	6.4
2416	2.28	0.973	1.50	0.409	0.676	79.4	7.3
2417	2.30	0.986	1.53	0.396	0.674	88.8	5.9
2418	2.33	0.975	1.50	0.389	0.658	87.9	6.1
2419	2.54	0.977	1.55	0.348	0.625	91.3	7.3
2420	2.60	0.943	1.54	0.347	0.626	93.6	6.2
2421	2.69	0.969	1.61	0.335	0.616	87.3	6.5
Average	2.44	0.964	1.54	0.384	0.658	85.7	6.8

TORTILLA BAKING TEST of 2009 WQC SAMPLES

J. Novie Alviola, Joseph M. Awika and Lloyd W. Rooney

Cereal Quality Lab, Department of Soil and Crop Sciences

Texas A&M University, College Station, TX

(January 2010)

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

Tortilla Formulation

Ingredients	Amount
Wheat flour	100%
Salt	1.5%
Sodium Stearoyl Lactylate	0.5%
Sodium Propionate	0.4%
Potassium Sorbate	0.4%
All purpose Shortening	6.0%
Sodium Bicarbonate	0.6%
Fumaric Acid - encapsulated	0.33%
Sodium Aluminum Sulfate	0.58%
Cysteine	0.003%

Tortilla Processing

MIX

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

Subjective Dough Evaluation

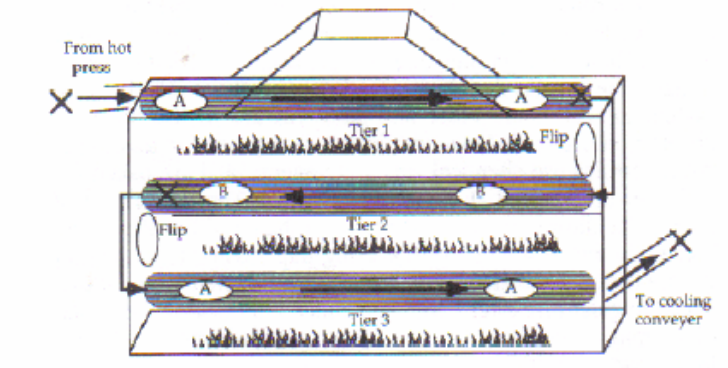
PROOF
5 min, 32°C, 70% RH

DIVIDE and ROUND
Obtain 43-g dough balls

PROOF
10 min, 32°C, 70% RH

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

HOT-PRESS



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

BAKE

COOL and PACKAGE

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

Subjective Dough Evaluation

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

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

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

BOLD values = desired dough properties.

Evaluation of Tortilla Properties

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

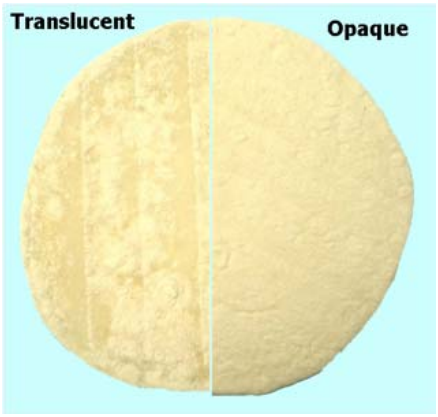
1. Weight
Ten tortillas are weighed on an analytical balance. The weight of one tortilla is calculated by dividing total weight by 10. This ranges from 39 to 41 g.

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

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

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

5. Opacity
Ten tortillas are evaluated subjectively for opacity using a continuous scale of 0-100: 0 = 100% translucent, 100 = 100% opaque. Values vary widely; desired value is > 70%.



6. 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.

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

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

10. Objective rheological test

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

WHEAT QUALITY COUNCIL - 2009 DATA WORKSHEET

COOPERATOR NAME:	J.N. Alviola, J.M. Awika and L.W. Rooney
COOOPERATOR TYPE: MILLER, BAKER, QUALITY LAB	University, Quality Lab
MIXING TOLERANCE METHOD: FARINOGRAPH, MIXOGRAPH, MIXING SERIES, OTHER	
BAKE TEST METHOD: STRAIGHT DOUGH, SPONGE & DOUGH, OTHER	Tortilla Bake Test
DOUGH WEIGHT:	43 gram
Resting TIME:	10 min
Hot-Press Temp (top/bottom):	395 / 395 F
Hot-Press Time:	1.4 sec
Hot-Press Pressure:	1100 psi
OVEN TEMPERATURE:	390 F
BAKE TIME:	30 sec

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

TEST No.	Protein (%, 14% mb)	Mix Time (min)	Devt. Time (min)	Stability (min)	Tolerance Index (FU)	Breakdown (min)
2401	12.43	6.38	9.7	26.2	17	21.3
2402	12.84	4.63	6.9	32.0	19	16.6
2403	11.13	4.38	8.3	24.8	11	25.3
2404	11.32	4.13	6.2	23.8	7	21.8
2405	13.01	4.00	6.4	36.3	16	37.1
2406	13.45	5.38	6.9	29.5	16	17.2
2407	13.07	3.75	9.0	24.3	10	24.6
2408	12.76	4.75	7.3	29.9	7	30.0
2409	12.74	3.63	5.3	27.7	14	28.6
2410	12.62	4.50	8.9	33.9	15	36.1
2411	11.13	3.50	4.0	14.8	19	11.9
2412	10.17	3.88	2.3	10.6	23	9.4
2413	10.73	4.00	2.3	13.5	22	10.4
2414	11.21	5.38	4.4	12.0	25	10.2
2415	13.69	4.50	13.7	24.7	12	28.4
2416	12.51	3.50	9.7	26.2	11	28.5
2417	13.28	3.38	8.7	31.0	12	32.3
2418	12.34	3.88	9.5	41.0	11	39.9
2419	11.38	3.50	4.5	11.4	25	10.0
2420	10.93	4.00	5.5	12.2	35	9.5
2421	10.87	4.25	2.4	9.9	34	6.0

*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***	*Smooth-ness*	*Soft-ness*	*Force to Extend*	*Extensi-bility*	*Press Rating*
	%	(min)	(Rating)	(Rating)	(Rating)	(Rating)	(Rating)
Tortilla Ref.	52	7	2.0	2.0	3.3	3.0	2.0
2401	52	6	2.3	2.5	3.0	3.5	2.5
2402	56	5	2.0	2.3	3.3	3.5	2.0
2403	52	4	2.0	2.8	2.5	3.5	2.3
2404	49	4	2.0	2.8	2.5	3.3	2.8
2405	52	4	1.8	2.5	2.3	3.5	2.3
2406	51	5	2.0	2.5	3.0	3.5	3.0
2407	53	4	1.8	2.5	3.3	3.3	2.3
2408	54	5	1.8	2.3	3.3	3.3	2.5
2409	55	4	1.8	2.5	2.5	3.5	2.3
2410	51	5	1.8	2.0	3.3	3.5	2.3
2411	47	4	2.0	2.8	2.3	3.3	2.0
2412	47	4	2.3	2.8	2.0	3.5	2.8
2413	51	4	2.0	2.8	2.0	3.3	2.3
2414	53	5	1.8	2.5	2.8	3.8	2.3
2415	55	5	1.8	2.3	3.3	3.5	2.0
2416	54	4	2.0	2.5	2.8	3.5	2.3
2417	52	4	2.0	2.0	3.5	3.0	2.0
2418	50	4	2.0	2.8	2.5	3.5	2.3
2419	47	4	2.3	2.8	3.3	3.3	2.3
2420	48	4	2.3	2.5	3.3	3.5	2.3
2421	47	4	2.3	3.0	2.3	3.5	2.0
HSD (α = 0.05)			*0.5*	*0.7*	*0.7*	*1.0*	*0.6*
Descriptors or Scale	record actual absorption		*from* 1 = satin smooth *to* 5 = very rough	*from* 1 = very soft *to* 5 = very hard	*from* 1 = less force *to* 5 = extreme force	*from* 1 = breaks immediately *to* 5 = extends readily	*from* 1 = less force *to* 5 = extreme force

* Tortilla dough water absorption was the percent absorption from Farinograph analysis minus 10 units, e.g., if Farinograph absorption was 61% then the tortilla dough absorption was 51%.

** Dough was mixed at medium speed at variable mixing times based on mixograph peak times.

All doughs were generally easy to process (i.e., no excessive stickiness or firmness). Sample 2406, however, was slightly firm and hard to press (to the stainless steel plate) and round.

Table 3. Physical properties of tortillas

TEST No.	Moisture	Weight	Thickness	Diameter	Opacity	Sp. Volume	Lightness*
	%	g	mm	mm	%	cm^3/g	L-value
Tortilla Ref.	32.9	41.6	3.08	156	79	1.4	81.11
2401	33.0	42.4	3.13	146	44	1.2	79.07
2402	34.2	40.4	3.11	154	69	1.4	82.10
2403	33.3	41.8	3.23	152	69	1.4	82.74
2404	32.5	41.7	3.35	146	62	1.4	82.78
2405	33.5	41.4	3.27	152	67	1.4	82.15
2406	32.9	41.4	3.16	149	53	1.3	80.54
2407	33.3	40.7	3.18	154	73	1.4	82.39
2408	33.1	41.2	3.09	158	75	1.5	81.64
2409	34.3	41.0	3.17	161	81	1.6	83.10
2410	32.6	40.0	3.09	157	69	1.5	82.55
2411	31.5	39.4	3.14	159	82	1.6	84.71
2412	31.4	40.9	3.17	158	82	1.5	83.73
2413	32.7	39.9	3.00	156	83	1.4	83.29
2414	34.2	41.4	3.11	153	72	1.4	83.91
2415	35.0	42.0	3.02	151	61	1.3	83.06
2416	34.3	40.6	2.99	157	84	1.4	84.29
2417	33.3	40.8	3.23	164	87	1.7	83.83
2418	32.8	42.1	3.16	156	75	1.4	83.81
2419	30.1	39.8	3.17	162	83	1.6	83.62
2420	31.2	40.1	3.22	158	80	1.6	82.22
2421	31.6	40.8	3.10	156	79	1.5	83.54
HSD (α = 0.05)	*1.0*	*3.6*	*0.16*	*7*	*14*	*0.2*	*2.64*
Descriptors or Scale	Calculate using two-step method	Record actual weight	Record actual thickness	Record actual diameter	*from 0%* = Trans-lucent to 100% = Opaque	Calculate as = π(radius)^2 *thickness *1000/wt	Record actual L-value; 0 = black to 100 = white

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

All samples yielded tortillas that were relatively thick and small in diameter (i.e., lower than the desired 165 mm). Samples 2409, 2411, 2417, 2419 and 2420 had high opacity and specific volume values.

Table 4. Texture profile of tortillas measured on day of processing and after 14 days of storage.

TEST No.	*Modulus day 0*	*Force day 0*	*Distance day 0*	*Work day 0*	*Modulus day 14*	*Force day 14*	*Distance day 14*	*Work day 14*
	(N/mm)	(N)	(mm)	(N.mm)	(N/mm)	(N)	(mm)	(N.mm)
Tortilla Ref.	0.70	9.34	21.49	78.99	1.39	8.12	9.60	29.70
2401	0.80	11.83	24.89	123.37	1.34	9.72	11.53	43.21
2402	0.59	9.33	25.47	91.52	1.08	8.54	11.84	38.64
2403	0.68	9.62	23.21	89.54	1.19	8.30	10.84	35.24
2404	0.72	10.46	23.18	99.19	1.24	9.24	11.33	40.31
2405	0.70	9.61	22.86	90.45	1.31	9.54	11.09	40.74
2406	0.70	10.70	25.20	109.70	1.29	10.30	11.89	48.17
2407	0.64	9.49	24.75	93.49	1.10	9.45	12.37	44.45
2408	0.67	10.07	24.04	92.64	1.13	8.92	11.86	38.06
2409	0.57	9.44	26.30	99.02	1.08	9.06	12.22	40.12
2410	0.67	10.25	24.75	101.12	1.04	8.03	11.75	35.48
2411	0.78	9.43	20.82	71.82	1.27	7.88	10.08	28.57
2412	0.73	8.74	20.58	65.84	1.35	7.28	9.01	25.77
2413	0.66	8.33	22.10	67.43	1.20	7.52	10.00	28.70
2414	0.59	8.83	24.23	83.02	1.26	8.84	10.87	35.94
2415	0.56	10.45	30.09	138.05	0.97	10.73	14.96	64.96
2416	0.54	8.19	24.43	78.31	1.16	8.63	11.17	35.99
2417	0.49	7.47	24.41	71.99	0.89	7.34	12.08	33.68
2418	0.69	9.79	23.39	90.18	1.10	8.19	11.36	37.29
2419	0.73	8.29	18.95	65.52	1.16	7.79	10.42	30.81
2420	0.67	7.99	20.21	59.26	0.99	7.22	10.69	31.38
2421	0.79	9.32	20.00	69.60	0.95	7.04	11.06	29.82
HSD (α = 0.05)	*0.09*	*1.52*	*3.27*	*27.48*	*0.28*	*1.75*	*1.47*	*10.81*
Descriptors or Scale	Determine parameters using texture analyzer on day of processing				Determine parameters using texture analyzer after 14 days of storage			

All samples had tortillas that became less extensible with storage. Sample 2415 consistently had the highest force, distance and work needed to rupture the tortillas after 14 days of storage at room temperature. This was the most extensible (less prone to break) compared to the other samples.

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

TEST No.	*Rollability Scores (RS)*				*Diameter*	Rating*
	4 days	7 days	11 days	14 days	mm	
Tortilla Ref.	4.1	3.3	2.8	2.3	156	Poor
2401	5.0	4.6	3.9	3.9	146	Poor
2402	4.9	4.8	4.6	4.1	154	Poor
2403	4.9	4.0	3.0	2.8	152	Poor
2404	4.8	3.8	3.1	2.6	146	Poor
2405	5.0	4.5	4.1	4.1	152	Poor
2406	5.0	4.8	4.8	4.5	149	Poor
2407	5.0	4.6	4.3	4.3	154	Poor
2408	5.0	5.0	4.5	4.3	158	Fair
2409	5.0	4.8	4.6	4.5	161	Fair
2410	5.0	4.9	4.6	4.1	157	Fair
2411	4.6	3.1	2.6	1.8	159	Poor
2412	3.3	2.4	1.8	1.4	158	Poor
2413	4.0	2.9	2.5	2.0	156	Poor
2414	4.8	3.9	3.5	3.3	153	Poor
2415	5.0	5.0	4.8	4.5	151	Poor
2416	5.0	4.8	4.3	3.9	157	Fair
2417	5.0	5.0	5.0	4.4	164	Fair
2418	5.0	5.0	3.9	3.5	156	Poor
2419	3.8	3.6	2.9	2.5	162	Poor
2420	4.0	3.0	2.4	2.1	158	Poor
2421	4.9	2.9	2.1	1.8	156	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 14):
Good = rollability score >3 on day 14, ≥165 mm
Fair = rollability score >3 on day 14, 157-164 mm
Poor = rollability score <3 on day 14, any diameter

Samples 2408, 2409, 2410, 2416 and 2417 had “fair” ratings (acceptable rollability score but relatively small diameter). Other samples either had very good rollability scores but small diameters (typical of strong flours that give doughs that shrink when hot-pressed) or acceptable diameter but break after 14 days of storage (typical of

weak flours) (Figure 1). Between the two, the former is easier to 'tweak' to create acceptable tortillas. Reducing agents like L-cysteine can be added to the formulation to reduce elasticity, lessen shrinking back, and result in tortillas with bigger diameters (Figure 2). It is important, however, that a balance between decreasing dough elasticity and maintaining the desired tortilla flexibility be met (i.e., too much reducing agent results in a tortilla that breaks easily).

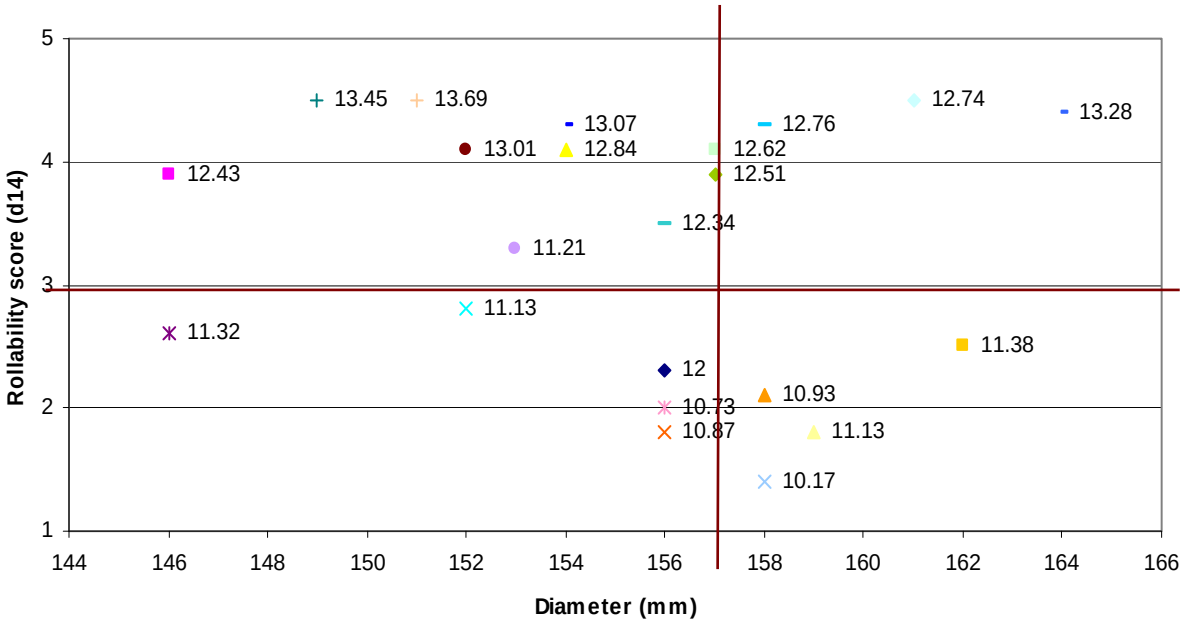


Fig. 1. Relationship of tortilla diameter, rollability score (day 14) and flour protein content (14% mb; shown as numbers inside the box). Quadrant A: good shelf-stability, poor diameter; B: acceptable diameter and shelf-stability; C: poor diameter and shelf-stability; D: good diameter, poor shelf-stability.

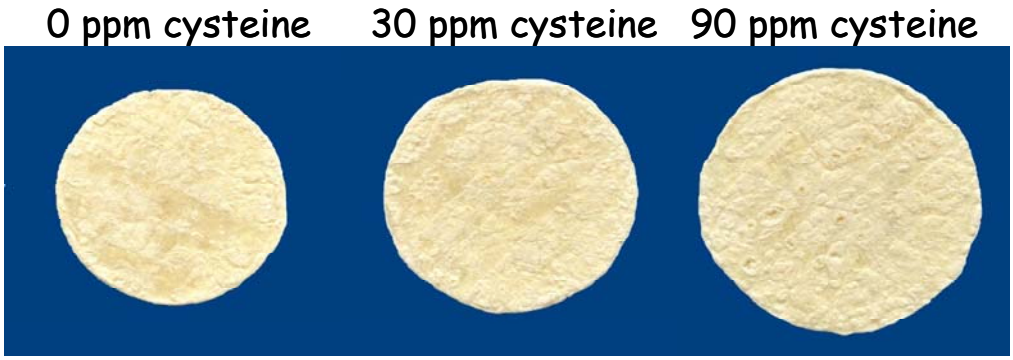


Fig. 2. Tortillas from commercial bread flour (13.3% protein) with and without L-cysteine.

Currently, the characteristics of flour that will give excellent tortilla quality are not completely understood. Waniska et al. (2004) stated that the list of flour properties should include intermediate protein content (10-12%), intermediate protein quality and low levels of starch damage.

Using 2007 and 2008 crop year samples, we determined grain, flour and dough properties that may predict tortilla quality (primarily tortilla diameter, opacity/L-value and texture parameters). The dough resistance-to-extension can predict the most number of tortilla parameters, namely: diameter, L-value and rupture force. Fitting mixograph mixing time values into the model will give approximate diameter measurements. Farinograph stability time and protein content are excellent predictors for texture properties specifically rupture distance and work. When considering only flour properties to develop the models, insoluble polymeric proteins, gluten index and protein content are the parameters that come out as good predictors.

The work to establish the attributes required for optimum tortilla production still requires significant efforts. We think that excellent progress is being made to understand the tortilla baking system, which differs significantly from bread baking.

References:

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Flour Protein Analysis

Michael Tilley and Val Pierucci

USDA, CGAHR, Manhattan, KS

Mention of firm names or trade products does not constitute endorsement by the U.S. Department of Agriculture over others that may also be suitable.

Procedures

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

Sequential protein extraction:

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

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

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

- Determine areas of the curve corresponding the HMW-GS and LMW-GS by manual integration and calculate the ratio HMW-GS/LMW-GS.

3. Determination of Gliadin to Glutenin ratio

- Protein extraction (Gupta et al 1993**)**:
- 100 mg flour + 1 ml 0.05M Sodium phosphate buffer, ph 6.9, containing 0.5% SDS (w/v)- sonicate for 15 s at power setting 10 W. Collect the supernatant (contains total protein).
- Filter the supernatant in a 0.45 µm filter and analyze by size-exclusion HPLC (SE-HPLC).
- SE-HPLC was conducted using a 300.0 x 7.8 mm BioSep S4000 column (Phenomenex, Torrance, CA), kept at 50°C, with a constant gradient composed of 50 mM Sodium phosphate buffer, pH 7.0, containing 1% SDS, flow rate of 1.0 ml/min during 20 min.
- The chromatograms were manually integrated. The area of the first peak corresponds to Glutenin and the area of the second peak to Gliadin. The ratio Glutenin/Gliadin was determined using the areas of the chromatograms.

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

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

References

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

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

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

Results of Flour Proteins Analysis

2009	*HMW-GS composition*	*Glutenin/Gliadin ratio*	*HMW-GS/LMW-GS ratio*	*%IPP*
ID CODE	HMW-GS	Gli/Glut	HMW/LMW	%IPP
09-002401	1, 7+9, 5+10	1.71	0.44	54.86
09-002402	2*, 7+8, 5+10	1.86	0.40	51.66
09-002403	2*, 7+9, 5+10	1.57	0.34	49.09
09-002404	2*, 7+9, 5+10	2.19	0.36	49.89
09-002405	?, 1, 7+8, 5+10	1.80	0.50	50.47
09-002406	2*, 7+8, 5+10	1.76	0.50	53.15
09-002407	2*, 7+8, 5+10	2.22	0.30	49.25
09-002408	1, 17+18, 5+10	1.50	0.27	49.78
09-002409	1, 7+9, 5+10	1.95	0.36	48.48
09-002410	1, 2*, 7+9, 2+12	1.86	0.51	51.68
09-002411	2*, 7+8, 5+10	1.89	0.28	46.99
09-002412	2*, 7+9, 5+10	2.03	0.36	48.26
09-002413	null, 7+9, 5+10	1.86	0.44	47.07
09-002414	1, 7+8, 5+10	1.92	0.45	52.02
09-002415	2*, 7+9, 5+10	2.09	0.44	49.90
09-002416	1, 7+9, 5+10	2.14	0.43	49.34
09-002417	2*, 7+9, 2+12	2.52	0.34	45.05
09-002418	2*, 7+8, 5+10	2.33	0.34	46.97
09-002419	2*, 7+9, 5+10	2.18	0.45	45.04
09-002420	2*, 7+9. 5+10	2.01	0.36	48.12
09-002421	2*, 7+8/7+9, 5+10	1.96	0.37	48.42
Descriptors or Scale	Determined by bioanalyzer	Determined by SE-HPLC- area of chromatograms	Determined by RP-HPLC- area of chromatograms	Determined by LECO

APPENDIX A
Credits and Methods

CREDITS

Milling, Sample Analysis, Ingredients and Report Preparation

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

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American Institute of Baking 1213 Baker's Way Manhattan, KS 66502	Baker	**Theresa Sutton** (785)537-4750 tsutton@aibonline.org
Bay State Milling Co. P.O. Box 188 55 Franklin Street Winona, MN 55987	Miller	**Ken A. Ulbrich** (507)452-1770 kenu.wn@bsm.com
Caravan Ingredients 7905 Quivira Road Lenexa, KS 66215	Ingredient Company	**Guohua Feng** (913)890-5691 gfeng@caravaningredients.com
Cargill Inc. 3794 Williston, Rd., Minnetonka, MN 55345	Miller	**Brian Walker** (952)238-4886 Brian_walker@cargill.com
Cereal Food Processors 701 E. 17th Street Wichita, KS 67214	Miller	**Tim Aschbrenner** (316)267-7311 t.aschbrenner@cerealfood.com
ConAgra Foods ConAgra Drive, 6-108 Omaha, NE 68102	Miller	**Scott Baker** (402)595-5107 scott.baker@conagrafoods.com

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
Univ. of Nebraska Dept of Agronomy 180 Plant Science Bldg. Lincoln, NE 68583	Wheat Quality Lab	**Lan Xu** (402)472-6243 lxu4@unlnotes.unl.edu
USDA/ARS/HWWQL 1515 College Ave. Manhattan, KS 66502	Wheat Quality Lab	**Margo Caley** (785) 776-2755 margo.caley@gmprc.ksu.edu
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CREDITS

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Wheat Marketing Center 1200 NW Naito PRKWY STE 230 Portland, OR 97209	Wheat Quality Lab	**Bon Lee** (503)295-0823 blee@wmcinc.org

METHODS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Cumulative Ash and Protein Curves

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

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

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

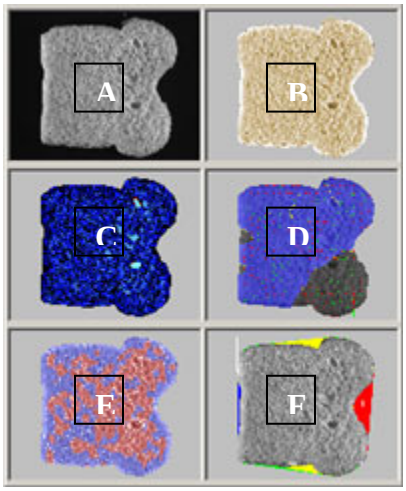
Similarly, cumulative protein curves are determined by arranging millstreams in ascending order of protein content, and tabulating the protein content of the total flour produced with the addition of successive millstreams. Wheat that gives high protein content at low extraction, and a fast rate of protein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

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

C-Cell Image Analysis

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

Images:



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

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

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

Data:

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

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

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

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

Brightness: Sample brightness and cell contrast.

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

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

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

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

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

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

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

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

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

Collaborators' Baking Test Profiles

Coop		Test Methods	Est. Flour Wt (g)*	Mixing Tolerance	Fermentation time	Oven Temp	Baking Time
A	1	Straight Dough	100	Farinograph	180 min	400 F	20 min
B	**2**	Spong Dough	350	Farinograph	240 min	420 F	20 min
C	**3**	Spong Dough	350	Other	**240 Min for spong, 50 min for ferm**	420 F	20 min
D	4	Straight Dough	100	Mixograph	90 min	425 F	21 min
E	**5**	Straight Dough	100	Mixograh	**70 min**	420 F	**12 min**
F	**6**	Straight Dough	350	Mixing Series	120 min	400 F	25 min
G	7	Straight Dough	100	Farinograph and mixograph	180 min	400 F	24 min
H	**8**	Spong Dough	100	Mixing Series	240 min for spong and 60 min for ferm	425 F	**16 min**
I	9	Spong Dough	350	Mixing Series	240 min for spong and 60 min (var) for ferm	420 F	20 min
J	**10**	Spong Dough	350	Mixing Series	**2 min for spong and 3.5 hrs for ferm**	430 F	23 min
K	11	Straight Dough	100		90 min	401 F	22 min
L	12	Straight Dough	100	Farinograph	**180 min**	419 F	24 min
M	**13**	Spong Dough	350	Other	270 min Fermentation time	400 F	18 min
N	14	Straight Dough	100	Mixograph	90 min	400 F	25 min
O	**15**	Spong Dough	350	Farinograph	Spong 1 min @ low+ 3 min @ med+4 hrs ferment	425 F	**25 min**
P	16	Straight Dough	100	Farinograph	120 min	425 F	**25 min**
Q	17	Straight Dough	100	Mixograph	120 min	420 F	18 min

*100 = pup loaf, 350 = one pound loaf

APPENDIX B

Hard Winter Wheat Quality Council
Goals for Hard Winter Wheat Breeders

Hard Winter Wheat Quality Council

2009 Technical Board Officers

CHAIR: Margo Caley, USDA/ARS/HWWQL

VICE CHAIR: Becky Miller, Kansas State University

SECRETARY: Sid Perry, Westbred

MEMBER: Craig Warner, Sara Lee

MEMBER:

2009 Quality Evaluation & Advisory Committee

Brad Seabourn, USDA/ARS/HWWQL

Allan Fritz, Kansas State University

Brian Strouts, American Institute of Baking

Ken Ulbrich, Bay State Milling

Richard Chen, USDA/ARS/HWWQL

Hard Winter Wheat Quality Council (HWWQC)

Charter
Revised and Approved (February 20, 2003)

Mission, Policy, and Operating Procedure

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

Objectives

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

Membership

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

HWWQC Technical Board

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

Duties of the Technical Board

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

Compensation

- Technical Board members shall serve without compensation.

Expenses

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

Hard Winter Wheat Quality Evaluation and Advisory Committee

Committee Purpose

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

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

Evaluation and Responsibilities

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

Sample/Locations

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

Annual Meeting

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

Finances and Budget

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

Amendments

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

Outlined Goals for Hard Winter Wheat Breeders

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

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

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

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

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

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

Performance on KSU Pilot Mill

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

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

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

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

APPENDIX C

Hard Red Winter Wheat Quality Targets

RECOMMENDED* QUALITY TARGETS FOR HARD RED WINTER WHEAT

HWW Quality Targets Committee
Approved February, 2006

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

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

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APPENDIX D

Hard White Wheat Quality Targets Adopted Tentatively 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 Margo Caley

Annual Meeting Feb. 17-19, 2009

Hard Winter Wheat Quality Council Meeting Minutes
Annual Meeting February 17-19, 2009

Minutes of the Hard Winter Wheat Technical Committee February 18, 2009

Rollie Sears called the meeting at order at 8:05am; reported that the minutes had been posted to the WQC website.

Slate of Officers for 2009-2010
Chair: Margo Caley
Vice Chair: Becky Miller
Secretary: Jill BryanEhr
Member: Sid Perry-nominated by Jay Romsa
Member: Craig Warner-nominated by Jackie Rudd

Vote to accept new members was passed by voice vote.

Report by Richard Chen on WQC Report for 2008

- Six breeders submitted 18 samples
- Eighteen collaborators involved in testing (16 bakers; 2 tortillas)
- More data will be included this year: RVA; Extensigraph; SDS; Protein analysis
- Flour color result determined by Minolta Chroma Meter instrument
- Cumulative ash and protein will be used only as a reference in this report
- Dr. Chen recognized appreciation to the breeders; bakers & the Hard Winter Wheat Quality Lab for their work.

Ben Handcock gave thanks to Richard Chen for his work as Editor of the WQC Milling and Baking Test Results for Hard Winter Wheats book.

Overview of 2008 Milling & Sampling by Brad Seabourn
Milling was conducted on the KSU MIAG mill. Brad made comment on the short window to bakers when flour was delivered to them; thanked bakers for their effort working with the short turn around time. Brad commented on the age of the mill and the future of the mill. No changes are expected in the sample handling or milling for the 2009 samples.

Overseas Varietals Analysis (OVA) Program Review/Changes

- John Oades reported The Wheat Quality Improvement Team went to Mexico; Guatemala and Costa Rico; good trip.
- Hard Red Winter had 20 slots for varietal submission; continue to be very concerned to fill those slots in the program.
- A list will be developed of varieties that need to be submitted into the program. Customers will look at the varieties they would use.
- Sample size of 6 bushel each/20 kilograms of flour was suggested. Brad Seabourn stated that this amount could not be milled or stored.

- There was discussion about milling; storage; moisture and bug infestation problems. Brett Carver suggested breeders meet and talk about these problems that afternoon.

Report on National Wheat Improvement Committee
Jackie Rudd stated two important wheat research initiatives:

- Cereal Rust Disease Initiative
- Genotyping Lab Initiative

Wheat Quality Labs-need support & facility up-grades. NWIC supports maintaining existing USDA funding; oppose cuts to USDA-ARS grains programs.

Jane Demarchi, Director of North American Millers Association stated NAMA is aware of the need at the USDA lab locations. Fifty million dollars was taken out of the stimulus package; USDA got zero dollars. Currently lobbying for the FY2010 budget but there is very little money. Jane stated the rust initiatives looks good but other initiatives look very tough.

Update on Crop Conditions

Colorado-Scott Haley
Scott Haley reported that Colorado had dry & blowing conditions; very, very windy and some wheat was lost to the blowing. August provided rain and lots of it! Hessian fly reported in Eastern Colorado. Overall they were hanging in there with all the different weather conditions.

Texas-Jackie Rudd
Jackie Rudd reported the high plains of Texas had a great start but was going downhill. They too were hanging on; a lot depended on the spring rains. West Texas was not good due to lack of rain.

Agripro-Coker-Jon Rich
Jon Rich reported Kansas conditions showed good fall moisture. Late plantings had good sub-soil moisture. Wheat out west looked pretty good now but will need some rain soon.

Oklahoma-Keith Kisling
Keith Kisling reported some wheat used for grazing.
At certain locations the wheat stands didn't look good due to later planting and dry top soil. Central Oklahoma wheat still in good shape; the next two weeks will tell better what kind of wheat crop Oklahoma will have.

South Dakota-Laird Larson
Laird Larson reported at this time wheat crop was 46% fair; an average crop. There was no snow cover in February and temperatures were warmer than usual. Despite the lack of snow, moisture was still good.

Nebraska-Royce Schaneman
Royce Schaneman of the Nebraska Wheat Board reported overall conditions were good; little snow in western Nebraska. Overall they were hanging on too.

Laura Mclaughlin moved to adjourn, Theresa Sutton seconded the motion. Vote to adjourn passed by voice vote. Meeting adjourned at 9:00am.

Thank you very much for reviewing the report. Please let me know if you have any suggestions or recommendations for improving the report of the WQC hard winter wheat. I can be reached at (785)776-2750 or by email, Richard.chen@ars.usda.gov