Milling and Baking Test Results for Hard Winter Wheat

Harvested in 2007

58th 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 report was prepared in cooperation with the Wheat Quality Council, Pierre, SD; The United States Department of Agriculture; The Agricultural Experiment Stations of Colorado, Kansas, Montana, Nebraska, Oklahoma, South Dakota, and Texas; Private wheat breeding companies of AgriPro Wheat and Westbred, LLC; and laboratories of milling, baking, grain trade and other firms and research organizations. Trade names, if used, are used to identify products. No endorsement is intended, nor is criticism implied of similar products not mentioned.

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2007

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 2007 Testing Program

Wheat harvested in 2007 represented the 58th year the Hard Winter Wheat Milling and Baking Evaluation Program has been sponsored by the Wheat Quality Council. Wheat experimental lines and check varieties were submitted by public and private breeding programs. This report includes FGIS market classification, physical grain testing, milling, analytical, rheological, and bread baking results. Alkaline noodle data generated by USDA, Hard Winter Wheat Quality Lab in Manhattan, KS and tortilla data generated by Texas A&M University are also included in the report. Methods used to evaluate wheat lines are given in Appendix A.

All entries this year were grown in special locations by participating wheat breeders and submitted for small-scale testing. Wheat samples were milled on the Miag Multomat Mill at Kansas State University (Methods, Appendix A). The flours were distributed to thirteen baking cooperators, with thirteen returning baking results.

Identity of 2007 Wheat Samples

	Test Entry Number	Sample Identification
COLORADO		
	07-2401	Hatcher (check)
	07-2402	CO03W239
	07-2403	CO03W054
	07-2404	CO02W237
NEBRASKA UNL		
	07-2405	Millennium (check)
	07-2406	NH03614
OKLAHOMA		
	07-2407	OK Bullet (check)
	07-2408	OK00514-05806
	07-2409	OK05737W
	07-2410	OK03522
	07-2411	OK02405
SOUTH DAKOTA		
	07-2412	Tandem (check)
	07-2413	SD98W175-1
	07-2414	SD01058
	07-2415	SD0111-9
	07-2416	SD01273
MONTANA		
	07-2417	Genou (check)
	07-2418	MT0495
	07-2419	MTS04114

Wheat Classification Results from FGIS

FACTOR	FACTOR	FACTOR	FACTOR	FACTOR	FACTOR	FACTOR	FACTOR	FACTOR	FACTOR	FACTOR	FACTOR	FACTOR	REMARKS
ID	Dockage	Test Weight	Moisture	Odor	Heat Damage	Damaged Kernels Total	Foreign Material	Shrunken & Broken	Defects	Contrasting Classes	Wheat of Other Classes	CLASS	
07-2401	0.00	62.6	8.5	OK	0.0	0.0	0.0	1.0	1.0	0.0	0.0	HRW	US N0. 1 HRW DKG 0.0%
07-2402	0.00	61.5	8.6	OK	0.0	0.0	0.0	0.9	0.9			XWHT	US N0. 1 XWHT DKG 0.0% (HDWH 84.0%/HRW 16.0%)
07-2403	0.00	61.5	8.6	OK	0.0	0.1	0.0	0.1	0.2	0.0	0.0	HDWH	US N0. 1 HDWH DKG 0.0% (2 SMUT BALLS IN 250 GRAMS)
07-2404	0.00	62.0	8.8	OK	0.0	0.0	0.0	0.2	0.2	4.4	4.4	HDWH	US N0. 4 HDWH DKG 0.0%
07-2405	0.01	58.9	8.3	OK	0.0	0.2	0.0	1.5	1.7	0.0	0.0	HRW	US N0. 2 HRW DKG 0.0%
07-2406	0.01	58.9	8.4	OK	0.0	1.2	0.0	1.3	2.5	0.0	0.0	HRW	US N0. 2 HRW DKG 0.0%
07-2407	0.00	63.5	9.4	OK	0.0	0.0	0.0	0.7	0.7	0.0	1.2	HRW	US N0.1 HRW DKG 0.0%
07-2408	0.00	63.1	9.3	OK	0.0	0.2	0.0	0.2	0.4	0.0	0.2	HRW	US N0. 1 HRW DKG 0.0%
07-2409	0.00	61.0	8.7	OK	0.0	0.0	0.0	0.7	0.7	0.0	0.0	HDWH	US N0. 1 HDWH DKG 0.0%
07-2410	0.00	64.0	11.1	OK	0.0	0.2	0.0	0.1	0.3	0.2	0.2	HRW	US N0. 1 HRW DKG 0.0%
07-2411	0.10	59.0	11.5	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	HRW	US N0. 2 HRW DKG 0.1%
07-2412	0.01	61.9	11.4	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	HRW	US N0. 1 HRW DKG 0.0%
07-2413	0.01	61.9	11.6	OK	0.0	0.1	0.0	0.4	0.5	8.7	8.7	HDWH	US N0. 4 HDWH DKG 0.0%
07-2414	0.01	60.9	12.0	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	HRW	US N0. 1 HRW DKG 0.0%
07-2415	0.00	61.5	12.3	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	HRW	US N0. 1 HRW DKG 0.0%
07-2416	0.00	61.5	12.6	OK	0.0	0.0	0.0	0.5	0.5	0.0	0.0	HRW	US N0. 1 HRW DKG 0.0%
07-2417	0.04	58.3	10.7	OK	0.0	0.0	0.0	2.3	2.3	0.0	0.0	HRW	US N0. 2 HRW DKG 0.0%
07-2418	0.00	61.4	10.6	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	HRW	US N0.1 HRW DKG 0.0%
07-2419	0.00	62.2	10.9	OK	0.0	0.0	0.0	0.1	0.1	0.7	0.7	HDWH	US N0. 1 HDWH DKG 0.0%

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

Description of Test Plots and Breeder Entries

Colorado – Reported by 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.

Growing conditions included good fall emergence and growth, adequate fall subsoil moisture, excellent winter precipitation from heavy snowfall in late December and early January, decent early spring precipitation, mild spring temperatures, and drought stress symptoms appearing by early May but relieved by moderate rainfall in late May and mid-June. No significant disease or insect problems were noted.

Grain yields of the adjacent state variety trial averaged 60.9 bu/a (42.8 – 70.1 bu/a range) with an average test weight of 61.9 lb/bu (59.8 – 63.1 lb/bu range).

Hatcher (check) (07-2401)

Hatcher is a hard red winter wheat that was released in 2004. Hatcher was tested in previous WQC sample sets under its experimental number CO980607. Hatcher was chosen because it has shown good milling and baking quality characteristics and because it has become the most planted wheat in Colorado based on the 2008 Colorado Wheat Cultivar Acreage survey (22.2% of total acreage).

CO03W239 (07-2402)

CO03W239 is a hard white wheat developed from the cross KS01-5539/CO99W165 made by Colorado State University in 2000. CO03W239 was first tested in the Southern Regional Performance Nursery (SRPN) in 2007 and is currently on Foundation seed increase for possible release in fall 2008. CO03W239 is a medium-early maturing semidwarf that carries tolerance to *Beyond* and *Clearmax* herbicides (*Clearfield** wheat), moderate resistance to stripe rust, and moderate susceptibility to pre-harvest sprouting (similar to NuHills/NuDakota). In two years of testing in the dryland Colorado Uniform Variety Performance Trial (UVPT), CO03W239 has been the third highest entry in the trials with higher yield than all other *Clearfield** cultivars tested.

CO03W054 (07-2403)

CO03W054 is a hard white wheat developed from the cross KS96HW94//Trego/CO960293 made by Colorado State University in 1999. CO03W054 was first tested in the Southern Regional Performance Nursery (SRPN) in 2007 and is currently on breeder seed increase for earliest possible release in fall 2009. CO03W054 is a medium-maturing semidwarf that carries "near-immunity" to wheat streak mosaic virus (from the CO060293 parent), moderate resistance to stripe rust, and moderate tolerance to pre-harvest sprouting (similar to Trego). In two years of testing in the CSU Elite Trial, CO03W054 has yielded slightly less than popular hard red winter wheat cultivars but more than the hard white checks (i.e., Danby, Avalanche, Trego, NuFrontier).

CO02W237 (07-2404)

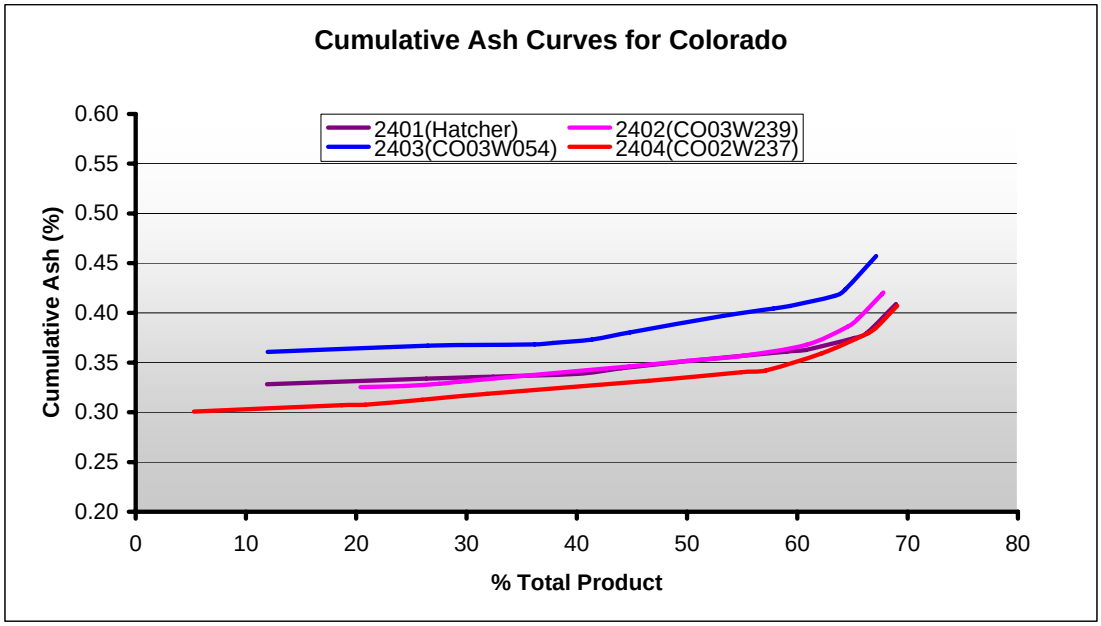
CO02W237 is a hard white wheat developed from the cross KS98HW519/KS96HW94 made by the KSU Wheat Breeding Program at Hays, KS, in 1998. CO02W237 was first tested in the Southern Regional Performance Nursery (SRPN) in 2008 and is currently on breeder seed increase for earliest possible release in fall 2009. CO02W237 is a medium-maturing semidwarf with moderate susceptibility to stripe rust and moderate susceptibility to pre-harvest sprouting (intermediate between Trego and NuHills/NuDakota). In two years of testing in the dryland Colorado Uniform Variety Performance Trial (UVPT), CO02W237 has yielded similar to Danby but less than popular hard red winter wheat cultivars

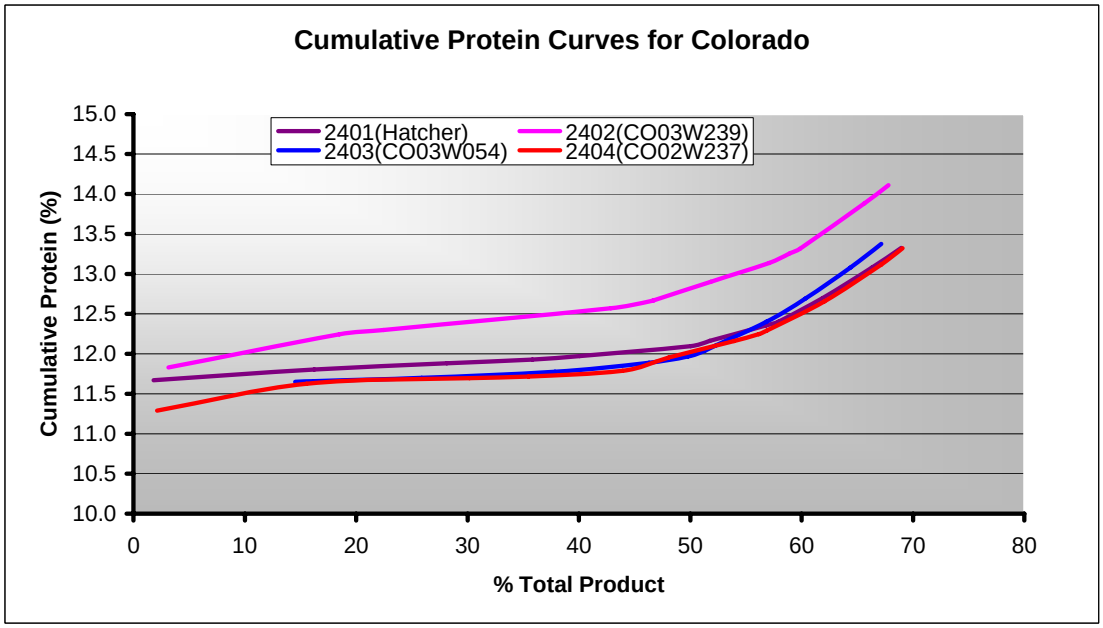
Colorado: 2007 (Small-Scale) Samples [a]

Test entry number	07-2401	07-2402	07-2403	07-2404
Sample identification	Hatcher (check)	CO03W239	CO03W054	CO02W237
Wheat Data				
FGIS classification	1 HRW	1 XWHT	1 HDWH	4 HDWH
Test weight (lb/bu)	62.6	61.5	61.5	62.0
Hectoliter weight (kg/hl)	82.3	80.9	80.9	81.5
1000 kernel weight (gm)	31.4	30.1	30.8	28.4
NIR hardness	72	73	78	69
Wheat kernel size (Rotap)				
Over 7 wire (%)	55.9	62.1	61.4	44.1
Over 9 wire (%)	43.5	37.6	38.5	55.6
Through 9 wire (%)	0.5	0.3	0.1	0.3
Single kernel (skcs)				
Hardness (avg /s.d)	60/15.4	64/14.5	70/14.7	53/15.0
Weight (mg) (avg/s.d)	33.1/10.0	30.5/7.4	32.4/8.2	29.5/7.3
Diameter (mm)(avg/s.d)	2.29/0.48	2.22/0.46	2.34/0.45	2.11/0.38
SKCS distribution	04-14-26-56	03-08-24-65	00-06-16-78	08-24-34-34
Classification	Hard	Hard	Hard	Hard
SKCS Wheat moisture (%)	11.6	11.6	11.6	11.1
Wheat protein (12% mb)	14.7	14.5	14.6	14.7
Wheat ash (12% mb)	1.63	1.43	1.53	1.39
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	69.0	67.8	67.2	69.1
Quadrumat Sr. Mill	71.3	71.4	70.3	69.4
Flour moisture (%)	11.5	10.6	10.7	10.9
Flour protein (14% mb)	13.5	13.2	13.4	13.3
Flour ash (14% mb)	0.42	0.39	0.45	0.40
Glutomatic				
Wet gluten (%)	40.8	39.2	34.4	36.8
Dry gluten (%)	14.0	14.3	12.7	12.9
Gluten index	84.8	95.4	99.1	96.7
Flour color				
Agtron flour color	69	65	67	70
Simon/Kent-Jones flour color	-0.59	0.33	0.40	-0.16
Minolta color meter				
L*	92.98	92.45	92.45	92.93
a*	-1.31	-1.57	-1.97	-1.77
b*	8.44	9.57	10.45	9.58
Falling number (sec)	644	678	812	661
Flour particle size (avg)				
Fisher sub sieve sizer	19.5	24.0	22.5	19.8

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

Colorado: Cumulative Ash and Protein Curves

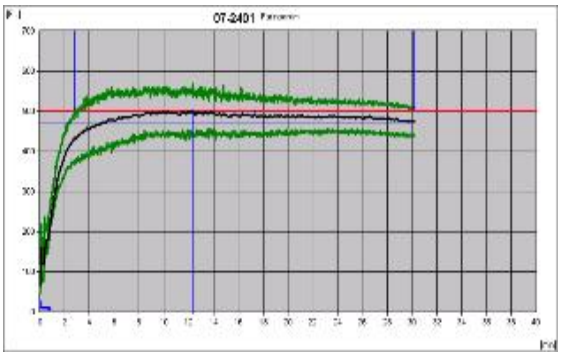




Physical Dough Tests

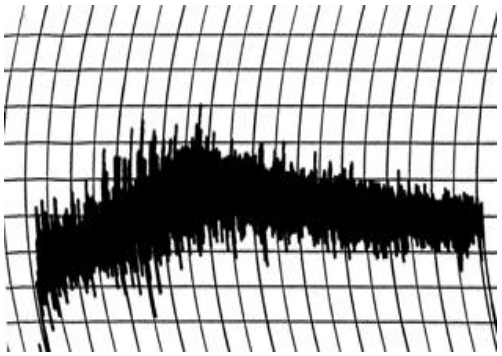
2007 (Small Scale) Samples – Colorado

Farinograms



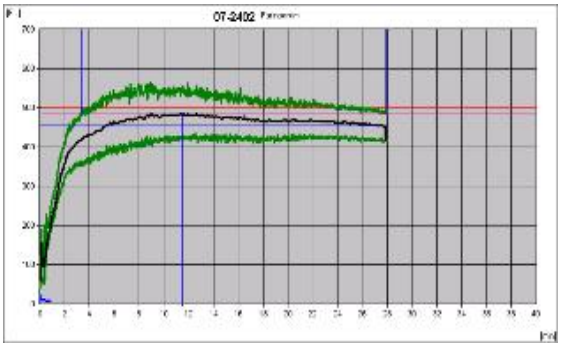
Abs. 62.3%, Peak 12.3 min, Stab. 27.3 min

Mixograms

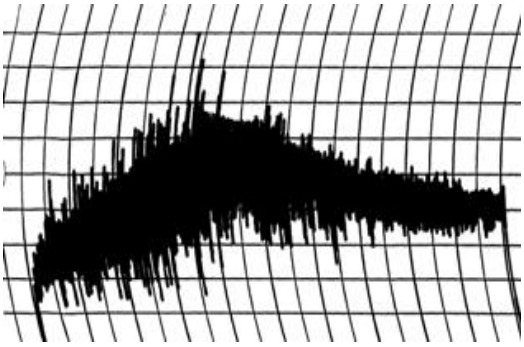


Abs. 65.5%, Mix time 3.8 min, Mix tol 3

07-2401, Hatcher (check)



Abs. 60.4%, Peak 11.5 min, Stab. 24.6 min



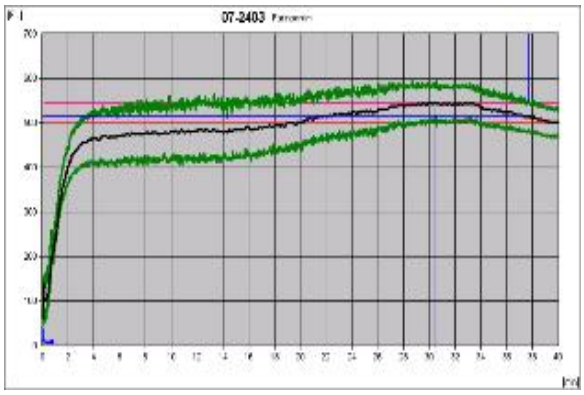
Abs. 64.0%, Mix time 3.6 min, Mix tol 2

07-2402, CO03W239

Physical Dough Tests

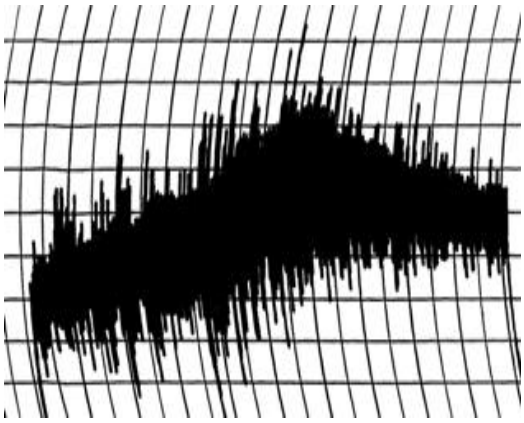
2007 (Small Scale) Samples – Colorado (continued)

Farinograms



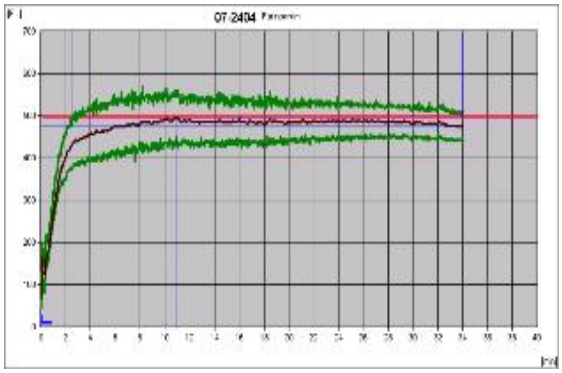
Abs. 66.4%, Peak 26.3 min, Stab. 28.7 min

Mixograms

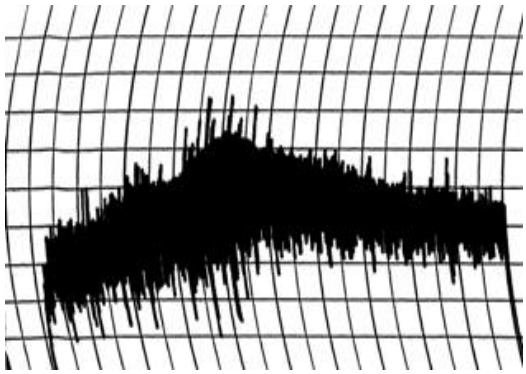


Abs. 66.7%, Mix time 6.0 min, Mix tol 6

07-2403, CO03W054



Abs. 61.6%, Peak 11.0 min, Stab. 31.4 min

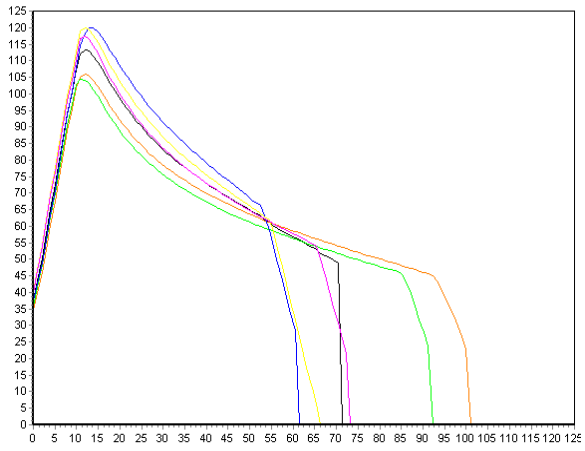


Abs. 64.0%, Mix time 4.3 min, Mix tol 4

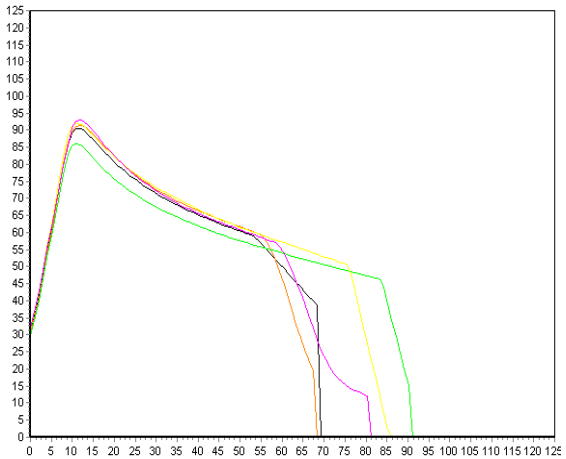
07-2404, CO02W237

Physical Dough Tests - Alveograph

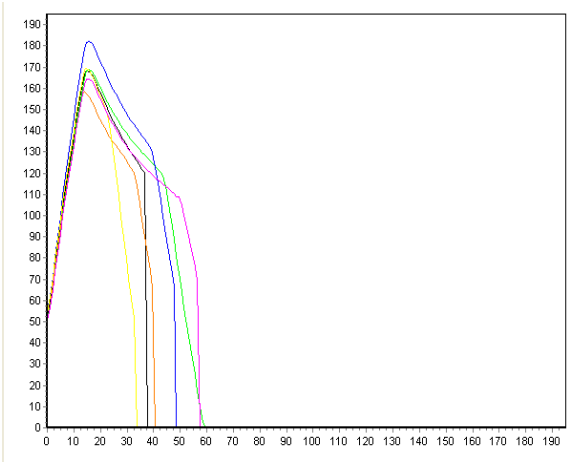
2007 (Small Scale) Samples – Colorado



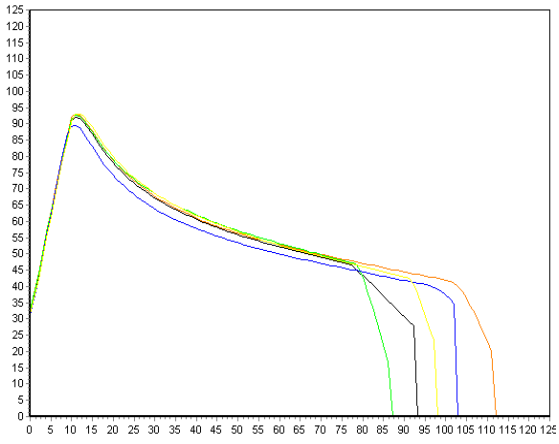
07-2401 (Hatcher)
P =124 (mm H20), L =71 mm, P/L=1.75



07-2402 (CO03W239)
P = 100 (mm H20), L=69 mm, P/L=1.45

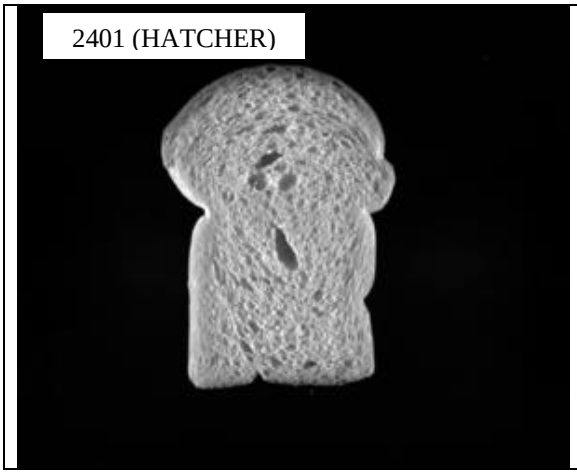


07-2403 (CO03W054)
P = 185 (mm H20), L = 37 mm, P/L = 5.00

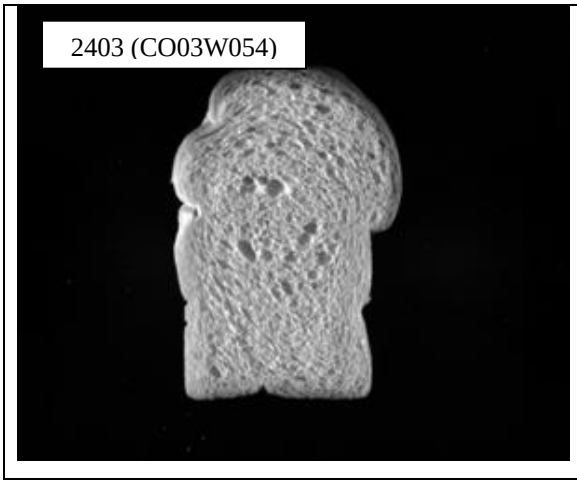


07-2404 (CO02W237)
P = 101 (mm H20), L = 92 mm, P/L = 1.10

Colorado: C-Cell Bread Images and Analysis for 2007(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	6074	155.4	3812	0.442	1.986	2.88	1.67	-3.2
2402	6433	152.2	3815	0.446	2.090	2.04	1.69	-13.1



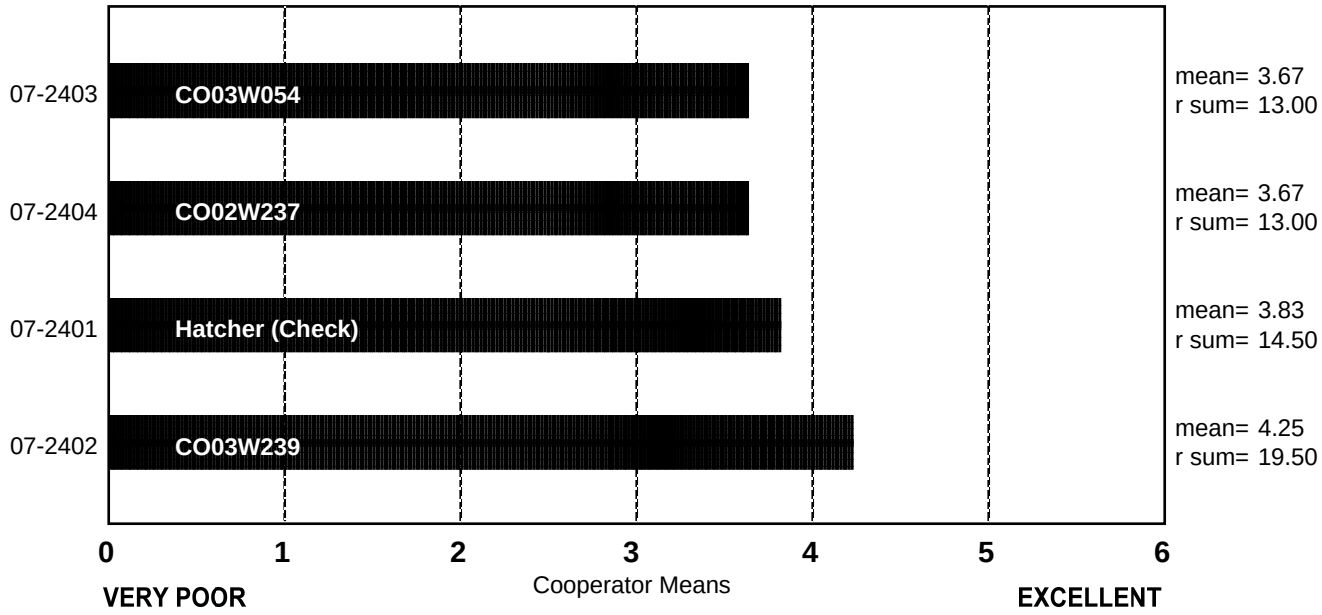
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2403	6523	153.0	3600	0.458	2.096	1.521	1.71	-19.2
2404	6554	144.8	3727	0.451	2.195	1.640	1.68	-19.1

SPONGE CHARACTERISTICS

(Small Scale) Colorado

ncoop= 6
chisq= 2.85
chisqc= 4.17
cvchisq= 7.82
crdiff=

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

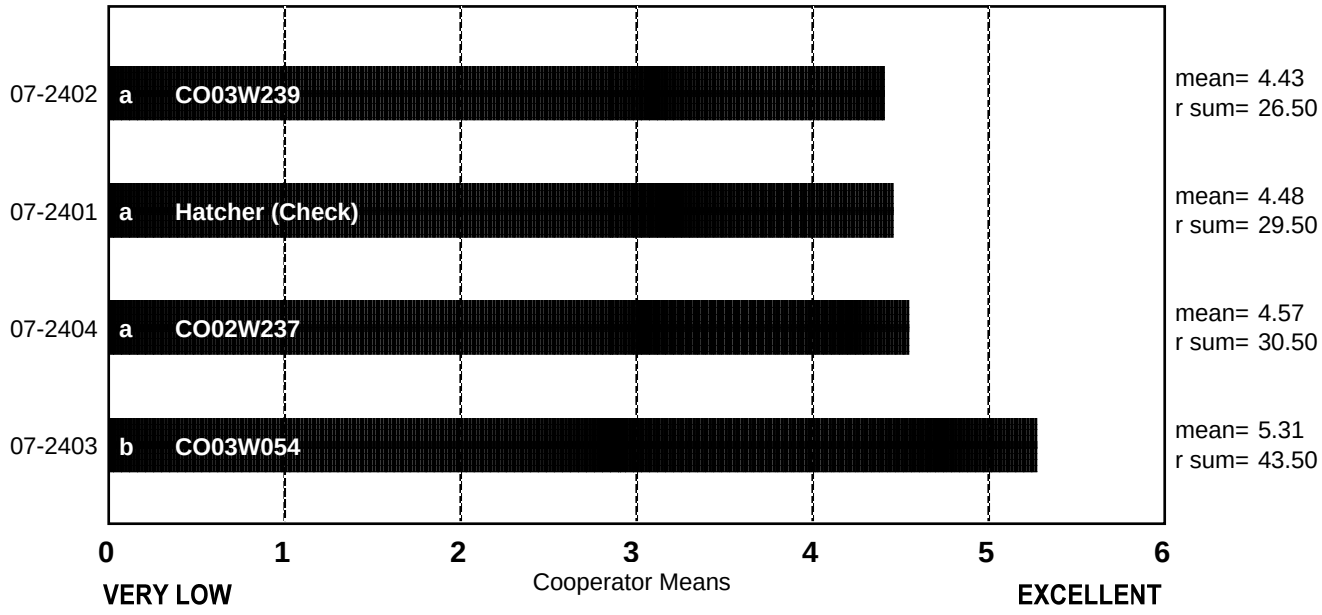


BAKE ABSORPTION

(Small Scale) Colorado

ncoop= 13
chisq= 7.85
chisqc= 12.91
cvchisq= 7.82
crdiff= 8.86

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Colorado

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2401 Hatcher (Check)	**60.0**	**71.6**	**62.0**	**63.0**	**69.2**	**63.6**	**63.6**	**64.3**	**60.8**	**65.3**	**64.0**	**63.0**	**62.9**
07-2402 CO03W239	**60.0**	**70.1**	**62.0**	**61.0**	**70.2**	**62.7**	**62.1**	**62.4**	**58.9**	**63.4**	**64.0**	**60.0**	**62.4**
07-2403 CO03W054	**60.0**	**72.8**	**64.0**	**66.0**	**75.2**	**68.6**	**64.3**	**68.4**	**64.9**	**69.4**	**64.0**	**66.0**	**66.6**
07-2404 CO02W237	**60.0**	**70.1**	**62.0**	**61.0**	**70.7**	**63.1**	**62.1**	**63.6**	**60.1**	**64.6**	**64.0**	**62.0**	**63.3**

BAKE MIX TIME, ACTUAL

(Small Scale) Colorado

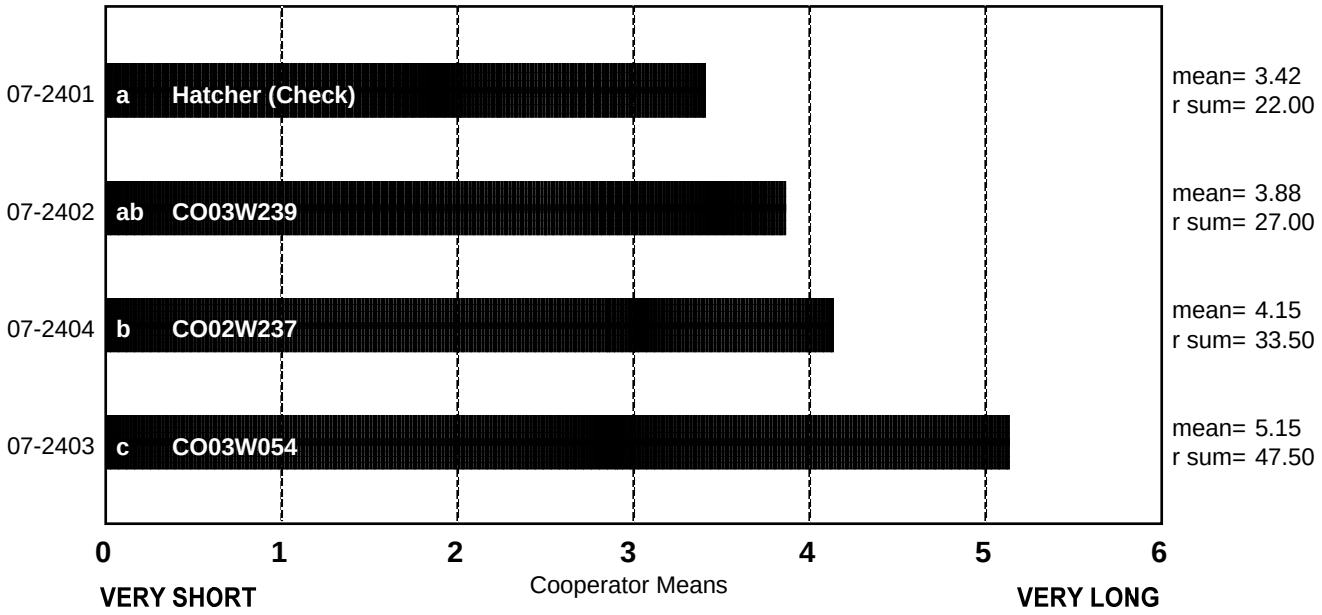
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2401 Hatcher (Check)	**20.0**	**3.0**	**5.0**	**25.0**	**3.5**	**2.0**	**4.0**	**7.0**	**2.5**	**12.0**	**6.0**	**7.0**	**4.0**
07-2402 CO03W239	**20.0**	**4.0**	**5.3**	**20.0**	**4.6**	**2.3**	**4.5**	**7.5**	**3.3**	**11.0**	**6.0**	**12.0**	**5.3**
07-2403 CO03W054	**20.0**	**5.5**	**7.2**	**25.0**	**7.6**	**4.0**	**6.0**	**7.5**	**5.0**	**17.0**	**9.0**	**20.0**	**7.6**
07-2404 CO02W237	**20.0**	**3.8**	**5.8**	**25.0**	**5.2**	**2.0**	**4.5**	**8.0**	**3.5**	**12.0**	**6.0**	**11.0**	**5.1**

BAKE MIX TIME

(Small Scale) Colorado

ncoop= 13
chisq= 16.92
chisqc= 22.91
cvchisq= 7.82
crdiff= 7.67

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

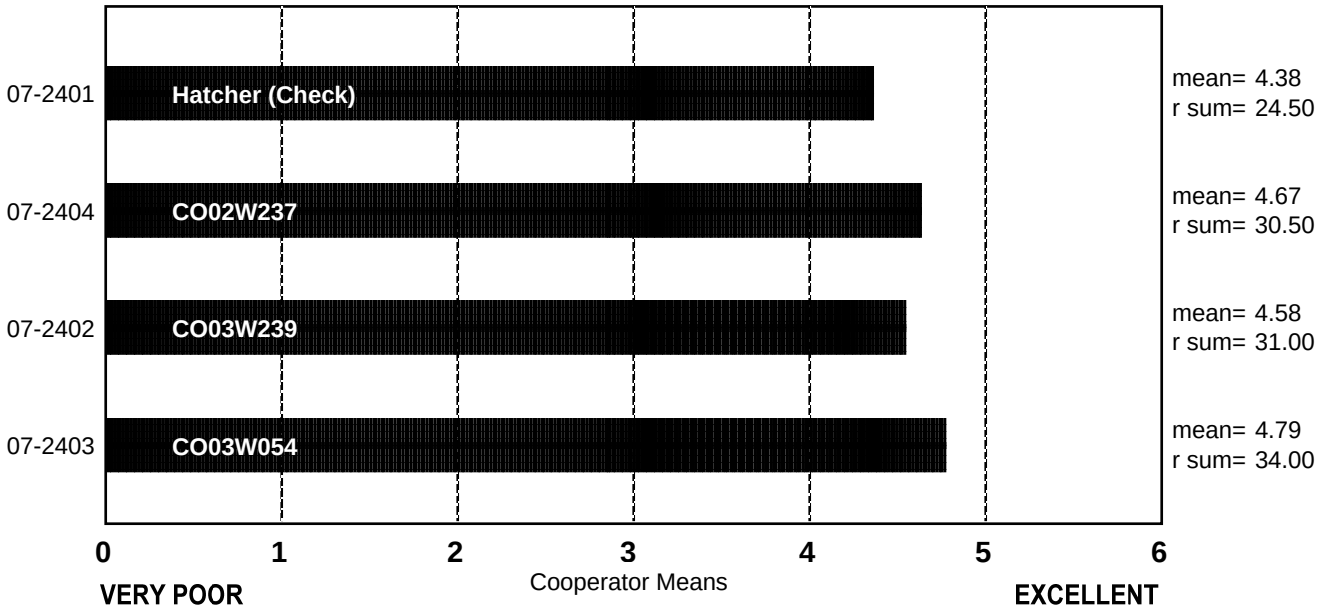


MIXING TOLERANCE

(Small Scale) Colorado

ncoop= 12
chisq= 2.38
chisqc= 3.90
cvchisq= 7.82
crdiff=

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

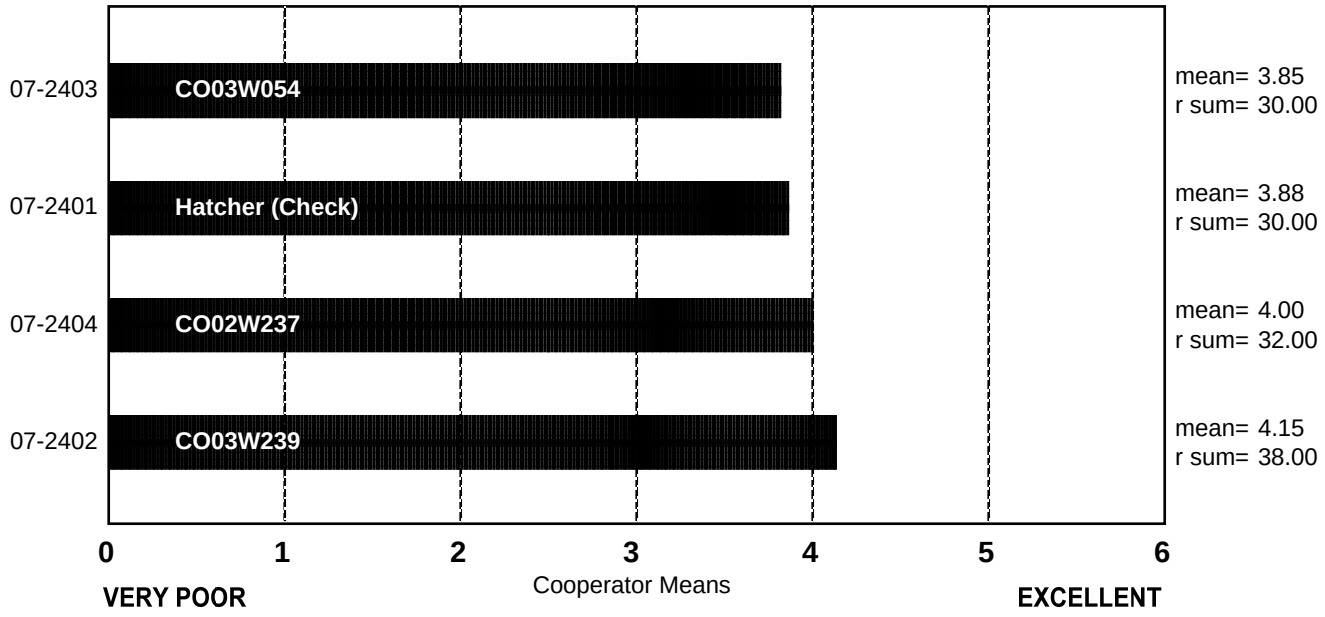


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Colorado

ncoop= 13
chisq= 1.98
chisqc= 3.35
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Colorado

	Sticky	Wet	Tough	Good	Excellent
07-2401 Hatcher (Check)	**0**	**0**	**5**	**7**	**1**
07-2402 CO03W239	**0**	**0**	**6**	**6**	**1**
07-2403 CO03W054	**0**	**0**	**5**	**6**	**2**
07-2404 CO02W237	**0**	**0**	**6**	**6**	**1**

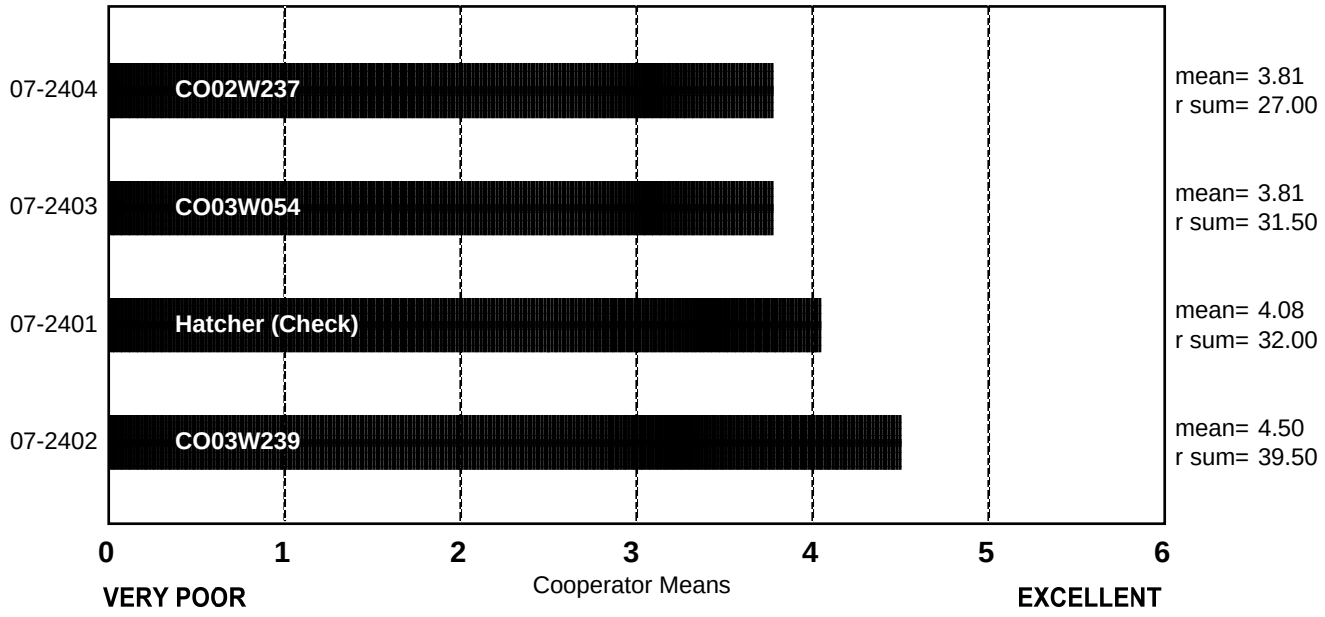
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Colorado

ncoop= 13
chisq= 3.72
chisqc= 5.14
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Colorado

	Sticky	Wet	Tough	Good	Excellent
07-2401 Hatcher (Check)	**0**	**0**	**4**	**7**	**2**
07-2402 CO03W239	**0**	**0**	**4**	**6**	**3**
07-2403 CO03W054	**0**	**0**	**8**	**2**	**3**
07-2404 CO02W237	**0**	**0**	**7**	**5**	**1**

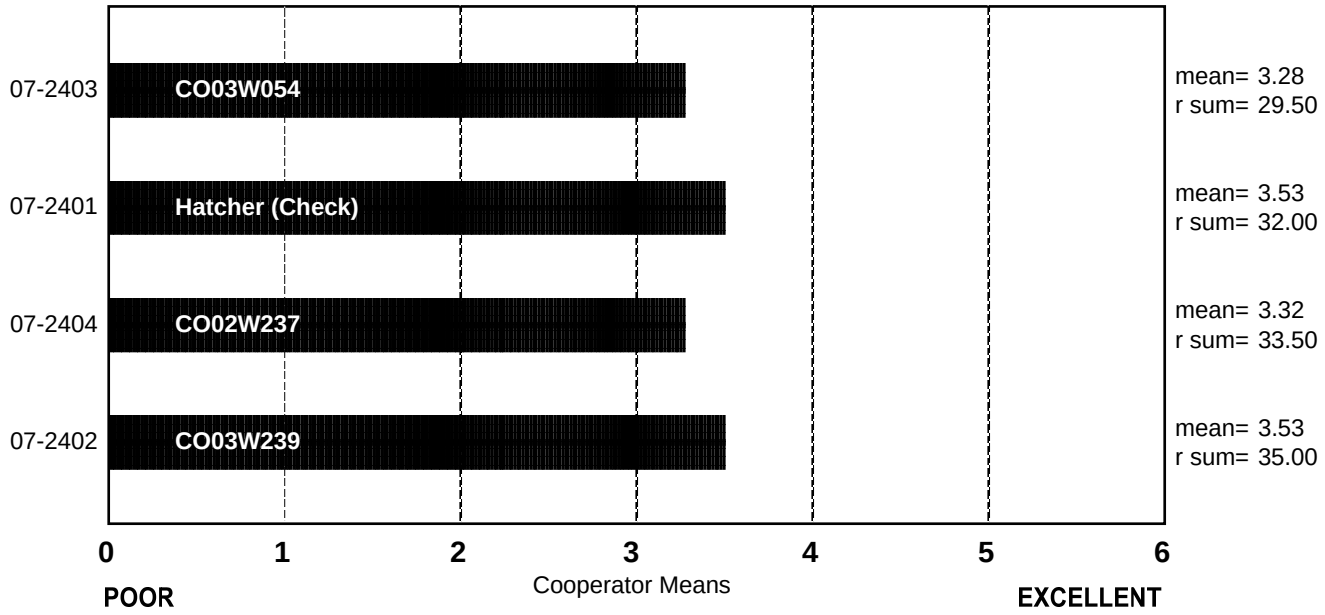
Frequency Table

CRUMB GRAIN

(Small Scale) Colorado

ncoop= 13
chisq= 0.76
chisqc= 0.93
cvchisq= 7.82
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Colorado

	Open	Fine	Dense
07-2401 Hatcher (Check)	**8**	**5**	**0**
07-2402 CO03W239	**7**	**6**	**0**
07-2403 CO03W054	**8**	**4**	**1**
07-2404 CO02W237	**7**	**5**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Colorado

	Round	Irregular	Elongated
07-2401 Hatcher (Check)	**3**	**4**	**6**
07-2402 CO03W239	**4**	**6**	**3**
07-2403 CO03W054	**3**	**6**	**4**
07-2404 CO02W237	**3**	**5**	**5**

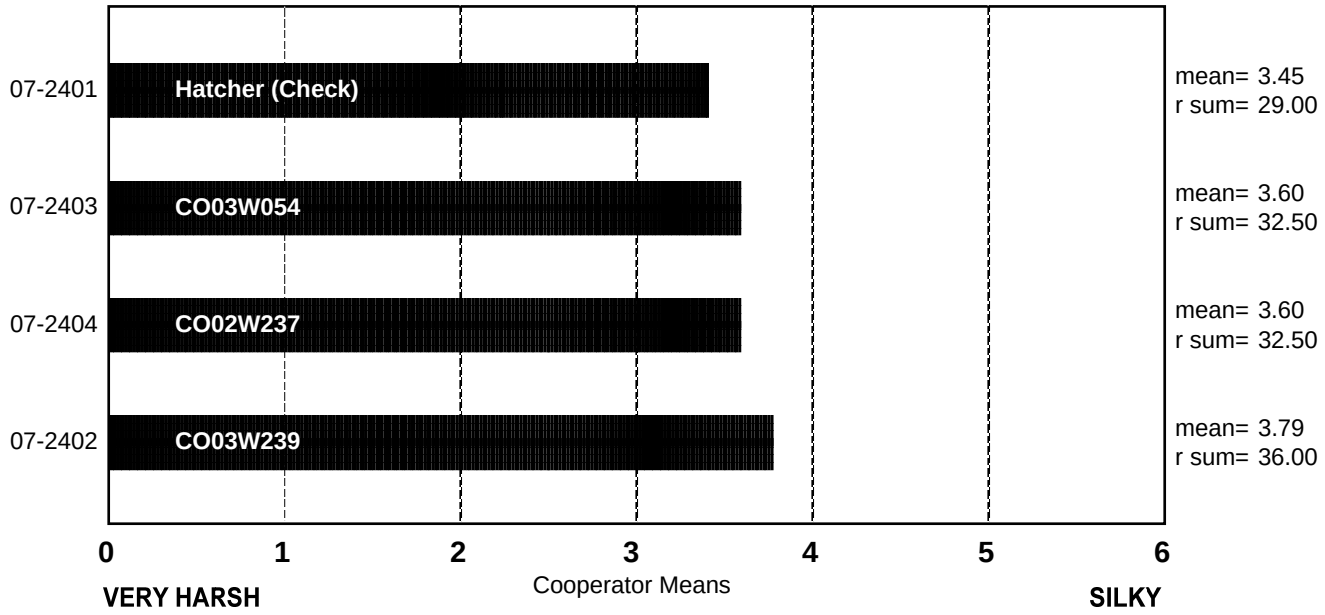
Frequency Table

CRUMB TEXTURE

(Small Scale) Colorado

ncoop= 13
chisq= 1.13
chisqc= 1.67
cvchisq= 7.82
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Colorado

	Harsh	Smooth	Silky
07-2401 Hatcher (Check)	**4**	**9**	**0**
07-2402 CO03W239	**3**	**8**	**2**
07-2403 CO03W054	**4**	**8**	**1**
07-2404 CO02W237	**3**	**8**	**2**

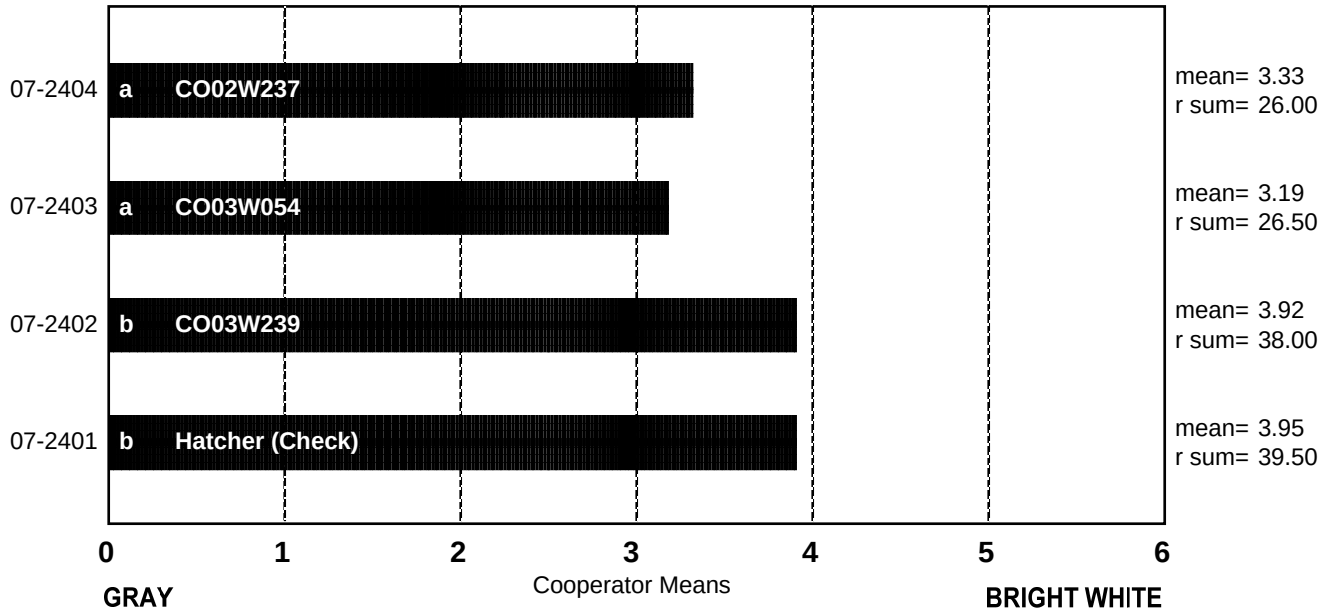
Frequency Table

CRUMB COLOR

(Small Scale) Colorado

ncoop= 13
chisq= 7.27
chisqc= 10.16
cvchisq= 7.82
crdiff= 10.11

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
07-2401 Hatcher (Check)	**0**	**0**	**2**	**1**	**6**	**3**	**0**
07-2402 CO03W239	**0**	**0**	**1**	**2**	**7**	**3**	**0**
07-2403 CO03W054	**0**	**1**	**5**	**1**	**4**	**2**	**0**
07-2404 CO02W237	**0**	**1**	**1**	**2**	**9**	**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
07-2401 Hatcher (Check)	**425.0**	**146.5**	**144.6**	**476.0**	**156.4**	**138.5**	**489.5**	**463.0**	**131.0**	**418.0**	**134.0**	**466.6**	**151.5**
07-2402 CO03W239	**428.0**	**151.3**	**141.9**	**485.1**	**157.0**	**136.0**	**491.0**	**461.0**	**130.1**	**418.4**	**134.0**	**467.2**	**149.1**
07-2403 CO03W054	**425.0**	**148.0**	**144.0**	**468.3**	**157.6**	**140.4**	**490.0**	**460.0**	**131.3**	**413.4**	**134.0**	**467.3**	**151.1**
07-2404 CO02W237	**426.0**	**148.6**	**143.3**	**464.1**	**157.8**	**139.3**	**488.0**	**461.0**	**128.9**	**417.9**	**134.0**	**465.1**	**150.0**

LOAF VOLUME, ACTUAL

(Small Scale) Colorado

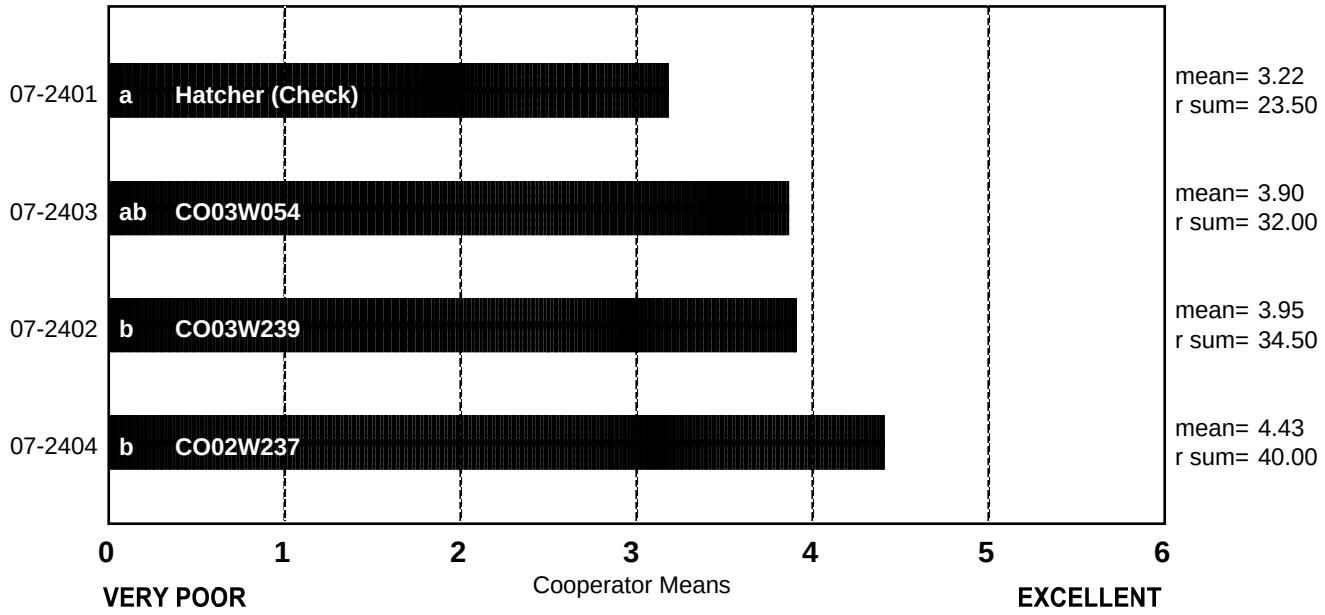
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2401 Hatcher (Check)	**2700**	**843**	**938**	**3074**	**955**	**730**	**2700**	**2925**	**910**	**2130**	**937**	**2550**	**873**
07-2402 CO03W239	**2800**	**955**	**935**	**3104**	**1030**	**725**	**2600**	**2800**	**910**	**2230**	**988**	**2575**	**955**
07-2403 CO03W054	**2700**	**923**	**915**	**3104**	**1025**	**730**	**2600**	**2800**	**965**	**2420**	**868**	**2550**	**1005**
07-2404 CO02W237	**2800**	**920**	**913**	**3104**	**1050**	**725**	**2900**	**3025**	**875**	**2310**	**990**	**2713**	**978**

LOAF VOLUME

(Small Scale) Colorado

ncoop= 13
chisq= 6.53
chisqc= 8.58
cvchisq= 7.82
crdiff= 10.71

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

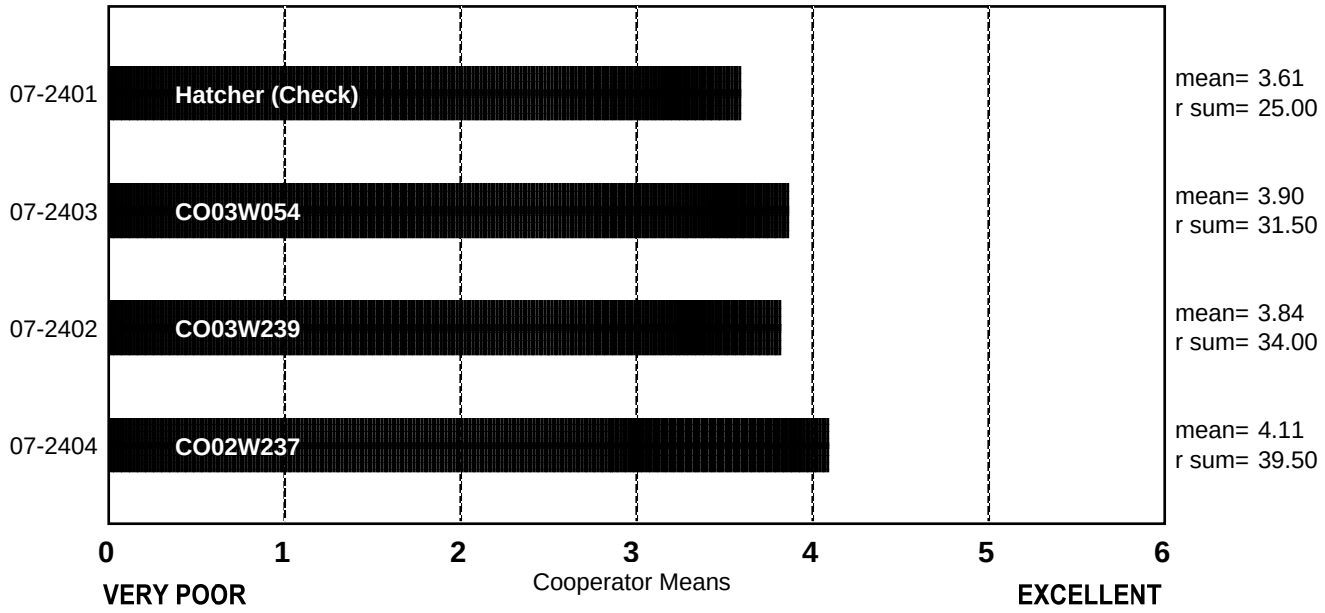


OVERALL BAKING QUALITY

(Small Scale) Colorado

ncoop= 13
chisq= 5.01
chisqc= 5.52
cvchisq= 7.82
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Colorado

COOP. 07-2401 (Hatcher (check))

A. Tough and bucky. 20 minute mix time. Slightly open grain. Nice interior.
B. No comments.
C. High and smooth oven-spring, resilient texture.
D. Slightly open grain, coarse texture, excellent volume and mix strength.
E. Average dough strength, underperformed for protein level.
F. No comment.
G. Good absorption, low bake volume.
H. No comment.
I. Average sample with harsh texture; Creamy crumb color and good loaf volume.
J. No comment.
K. Good strong doughs. White crumb color. Okay tolerance, but does not meet expectations based on protein level.
L. High absorption, average grain.
M. Excellent flour protein & mixing time; absorption good; loaf volume low; crumb grain questionable; slightly yellow crumb.

COOP. 07-2402 (CO03W239)

A. Tough and bucky. 20 minute mix time. Open grain. Good volume.
B. Best flour overall.
C. High and smooth oven-spring, resilient texture. Hole on the side.
D. Fairly tight grain, slightly coarse texture, excellent volume.
E. Good dough, performed well.
F. Good dough elasticity at panning.
G. Round cells and low volume.
H. No comment.
I. Average sample with lower bake absorption. White crumb color.
J. No comment.
K. Good doughs, but open grain and slight drop in tolerance on long mix.
L. Slightly long mix time; tough dough; open grain.
M. Excellent flour protein & loaf volume; mixing time long; absorption good; Crumb grain questionable, but satisfactory with creamy crumb color.

COOPERATOR'S COMMENTS
(Small Scale) Colorado (Continued)

COOP. 07-2403 (CO03W054)

A. Very tough and bucky. Shotty grain (3 & 4 worst shotty grain). Large cell structure.
B. Slightly long mix, tough at makeup.
C. High and smooth oven-spring, resilient texture.
D. Extremely strong mixing requirement. Open, streaky grain. Excellent volume.
E. No comment.
F. Dough had tendency to tear at panning.
G. Good absorption, tough at makeup, low volume.
H. No comment.
I. Excellent bake absorption. Yellow crumb color with good loaf volume. Long mix time, open crumb with irregular cells.
J. No comment.
K. Longest mix requirement of group, but great tolerance. Bucky, dry doughs with great absorption. Short mix extremely underdeveloped (rating volumes taken into consideration). Fourth favorite overall.
L. Very high absorption and long mix time. Tough dough, open grain, and yellow crumb.
M. Excellent flour protein; good absorption & loaf volume; long mixing time; Crumb grain questionable, but satisfactory.

COOP. 07-2404 (CO02W237)

A. Tough and bucky. Very open shotty grain. (1 through 4 equal overall; #1 best grain).
B. Tough at makeup.
C. High and smooth oven-spring, resilient texture.
D. Very strong mixing dough; slightly open grain; excellent volume.
E. Good performance for protein level.
F. No comment.
G. Good volume.
H. No comment.
I. Average sample, with harsh texture and a dull crumb color.
J. No comment.
K. Excellent doughs; open grain; short mix, slightly under developed; second favorite overall.
L. Good absorption; slightly long mix time; tough dough, but good volume.
M. Excellent flour protein, tolerance and loaf volume. Satisfactory crumb grain with a slightly yellow crumb color.

Notes: **A, D, G, J, K and L** comments based on sponge and dough bake test.

Description of Test Plots and Breeder Entries

Nebraska – reported by Stephen P. Baenziger

Millennium (check) (07-2405)

Long-term check and generally has excellent end-use quality. Very dependable line with less variation in its end-use properties.

NH03614 (07-2406)

NH03614 CL was selected from the cross Wesley sib//Millennium sib/Above sib. NH03614 CL was released primarily for its herbicide resistance and superior adaptation to rainfed wheat production systems in Nebraska, South Dakota, and Wyoming and in wheat producing counties in adjacent states. It is a Clearfield™ wheat that will be used with Beyond® herbicide(active ingredient imazamox (2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-(methoxymethyl)-3-pyridinecarboxylic acid) BASF Corp., Triangle Park, NC). As a Clearfield wheat, the line that is most important to compare it with is Infinity CL as both are herbicide tolerant. Based upon the Nebraska data NH03614 seems to be superior in western NE to Infinity CL which is superior in eastern NE.

NH03614 is a semi-dwarf wheat cultivar and most likely contains *RhtB1b* (formerly *Rht1*, data provided by Dr. Guihua Bai). The winter hardiness of NH03614 is good to very good and comparable to other winter wheat cultivars adapted and commonly grown in Nebraska. NH03614 is moderately resistant to stem rust (caused by *Puccinia graminis Pers.: Pers*. *f. sp. tritici* Eriks & E. Henn.) and to wheat soilborne mosaic virus. NH03614 is moderately resistant to moderately susceptible to Hessian fly (*Mayetiola destructor* Say). It is moderately susceptible to leaf rust (caused by *P. triticina* Eriks), stripe rust (caused by *P. striiformis* Westendorp f. sp. t*ritici*). NH03614 is slightly less susceptible to *Fusarium* head blight (caused by *Fusarium graminearum* Schwabe) than many widely grown lines, based on disease severity ratings obtained from misted screening nurseries in Nebraska and South Dakota,. It is susceptible to wheat streak mosaic virus.

NH03614 is genetically high in grain volume weight (75.4 kg hl^{-1}), similar to Harding (75.2 kg hl^{-1}) and higher than Wesley (74.2 kg hl^{-1}) based upon 25 environments in the Northern Regional Performance Nursery. The milling and baking properties of NH03614 were determined for three years by the Nebraska Wheat Quality Laboratory. In these tests, Scout 66, a good milling and baking wheat, was used as for comparison. The average wheat and flour protein

content of NH03614 (141 and 115 g kg^{-1}) were similar to Scout 66 (150 and 130 g kg^{-1}) for the corresponding years. The slightly lower grain protein content was confirmed by the Nebraska cultivar performance trials where NH03614 had 122 g protein kg^{-1} compared to Millennium with a value of 124 g kg^{-1}. The average flour extraction on the Buhler Laboratory Mill for NH03614 (725 g kg^{-1}) was lower than Scout 66 (739 g kg^{-1}). The flour ash content (4.5 g kg^{-1}) was higher than Scout 66 (4.1 g kg^{-1}). Dough mixing properties of NH03614 were strong (mixtime peak was 4.9 minutes and mixtime tolerance was scored as 4.2) which was stronger than Scout 66 (mixtime peak of 3.5 minutes and mixtime tolerance scored as 3.9). Average baking absorption (600 H_2O g kg^{-1}) was slightly lower than Scout 66 (610 H_2Og kg^{-1}) for the corresponding years. The average loaf volume of NH03614 (881 cm^3) was higher than Scout 66 (830 cm^3). The scores for the internal crumb grain and texture ranged from fair to good plus, which was slightly better than Scout 66 which ranged from fair to good). The overall end-use quality characteristics for NH03614 are acceptable and similar to many commonly grown wheat cultivars which are well received by to the milling and baking industries.

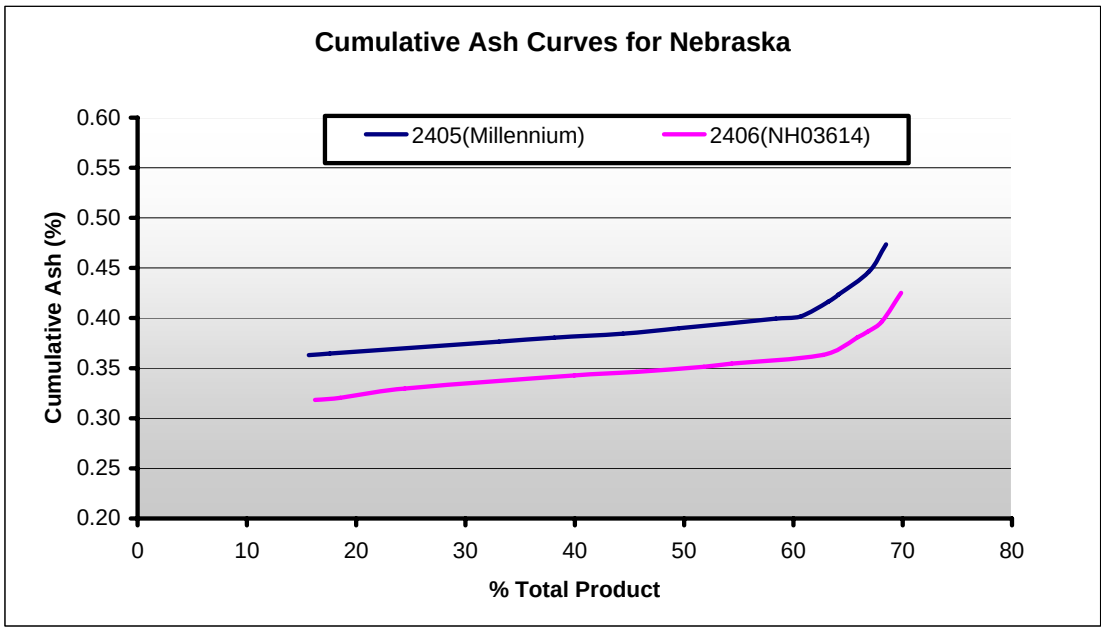
The sample is a bulk sample that was collected from fields at Mead, North Platte, Sidney, and Kimball, NE using standard agronomic practices. Mead and North Platte were generally favorable environments, whereas Sidney and Scottsbluffl tended to be droughty. The main diseases present in eastern NE were leaf rust and Fusarium head blight. Drought prevented most diseases from occurring in western NE.

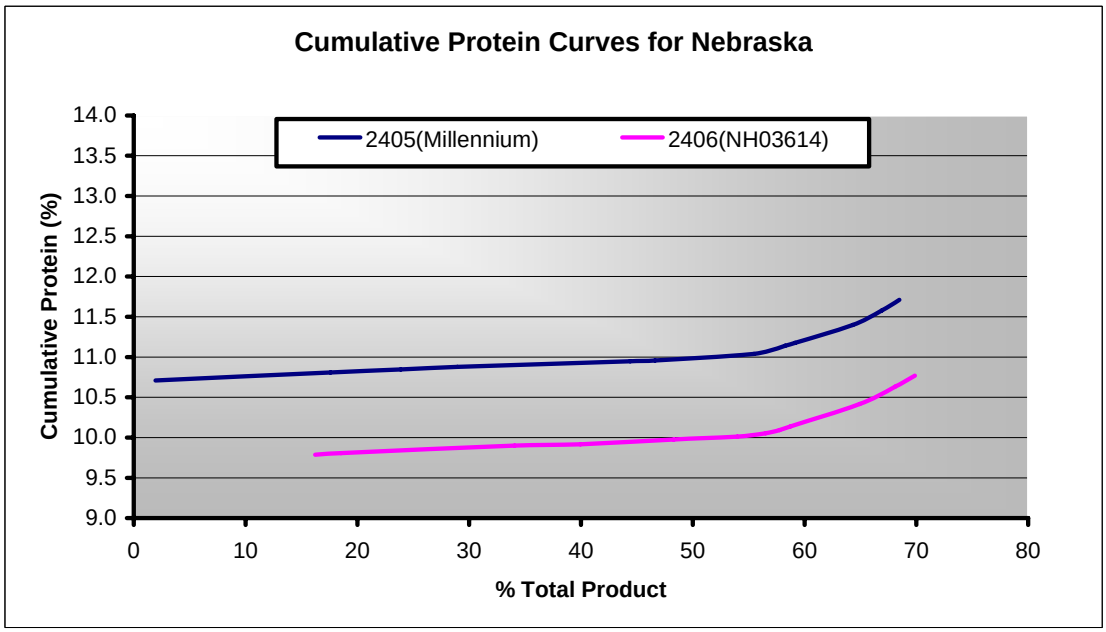
Nebraska: 2007 (Small-Scale) Samples [a]

Test entry number	07-2405	07-2406
Sample identification	Millennium (check)	NH03614
Wheat Data		
FGIS classification	2 HRW	2HRW
Test weight (lb/bu)	58.9	58.9
Hectoliter weight (kg/hl)	77.5	77.5
1000 kernel weight (gm)	26.4	28.8
NIR hardness	66	63
Wheat kernel size (Rotap)		
Over 7 wire (%)	44.0	58.2
Over 9 wire (%)	53.7	40.5
Through 9 wire (%)	2.3	1.3
Single kernel (skcs)		
Hardness (avg /s.d)	66/18.8	55/18.3
Weight (mg) (avg/s.d)	29.2/8.4	32.4/10.0
Diameter (mm)(avg/s.d)	2.13/0.48	2.32/0.53
SKCS distribution	04-14-16-66	12-17-31-40
Classification	Hard	Mixed
SKCS Wheat moisture (%)	11.3	11.3
Wheat protein (12% mb)	13.3	12.2
Wheat ash (12% mb)	1.71	1.63
Milling and Flour Quality Data		
Flour yield (%, str. grade)		
Miag Multomat Mill	68.5	69.9
Quadrumat Sr. Mill	69.9	72.6
Flour moisture (%)	10.9	11.4
Flour protein (14% mb)	11.91	11.03
Flour ash (14% mb)	0.48	0.44
Glutomatic		
Wet gluten (%)	34.5	25.9
Dry gluten (%)	11.8	9.5
Gluten index	86.7	98.8
Flour color		
Agtron flour color	67	65
Simon/Kent-Jones flour color	1.78	1.80
Minolta color meter		
L*	92.27	92.33
a*	-1.53	-1.47
b*	9.11	8.53
Falling number (sec)	665	592
Flour particle size (avg)		
Fisher sub sieve sizer	19.8	19.0

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

Nebraska: Cumulative Ash and Protein Curves

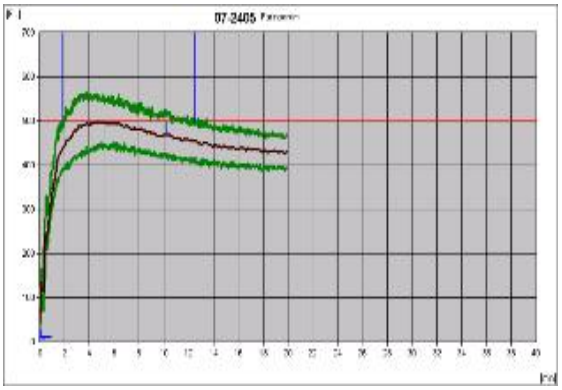




Physical Dough Tests

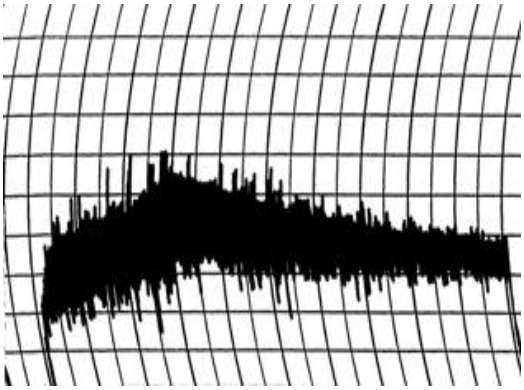
2007 (Small Scale) Samples - Nebraska

Farinograms



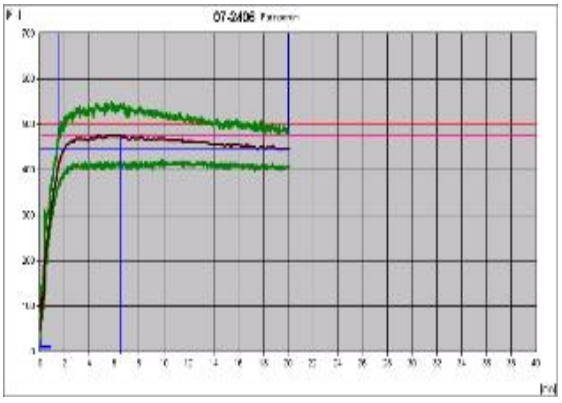
Abs. 58.5%, Peak 5.2 min, Stab. 10.7 min

Mixograms

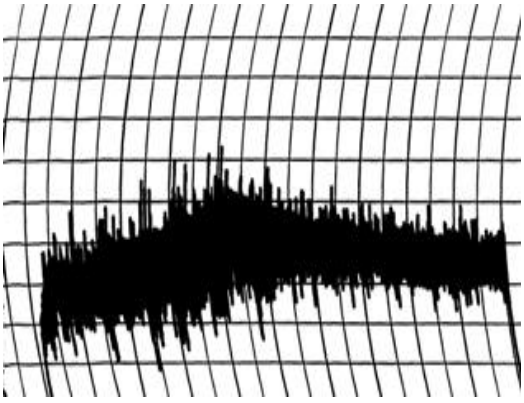


Abs. 62.8%, Mix time 3.0 min, Mix tol 2

07-2405, Millennium (check)



Abs. 55.9%, Peak 6.5 min, Stab. 18.5 min

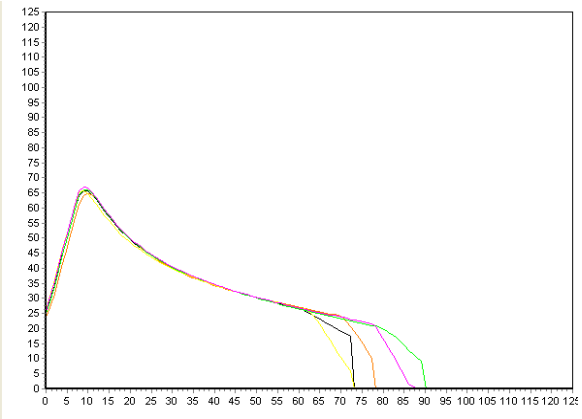


Abs. 60.3%, Mix time 4.1 min, Mix tol 3

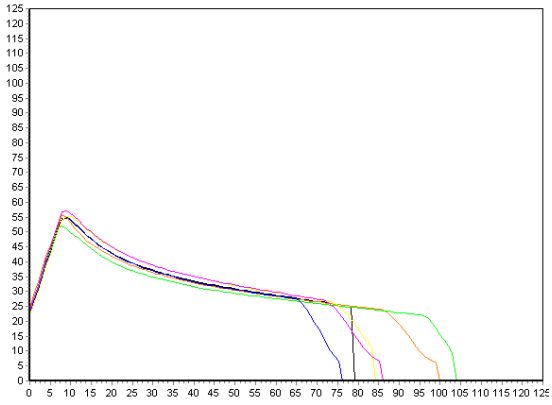
07-2406, NH03614

Physical Dough Tests - Alveograph

2007 (Small Scale) Samples - Nebraska

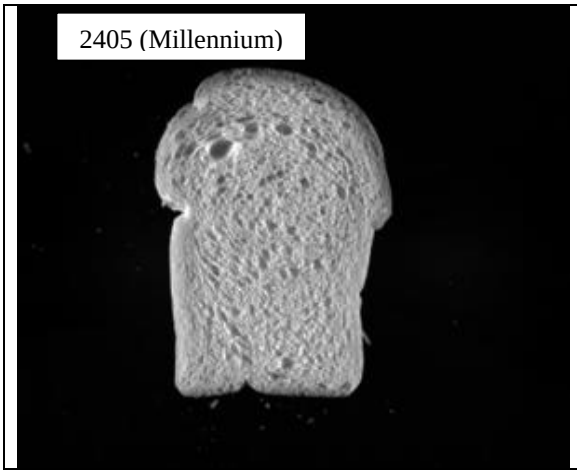


07-2405 (Millennium)
P =72 (mm H20), L = 73 mm, P/L=0.99



07-2406 (NH03614)
P = 60 (mm H20), L=79 mm, P/L=0.76

Nebraska: C-Cell Bread Images and Analysis for 2007(Small-Scale) Samples



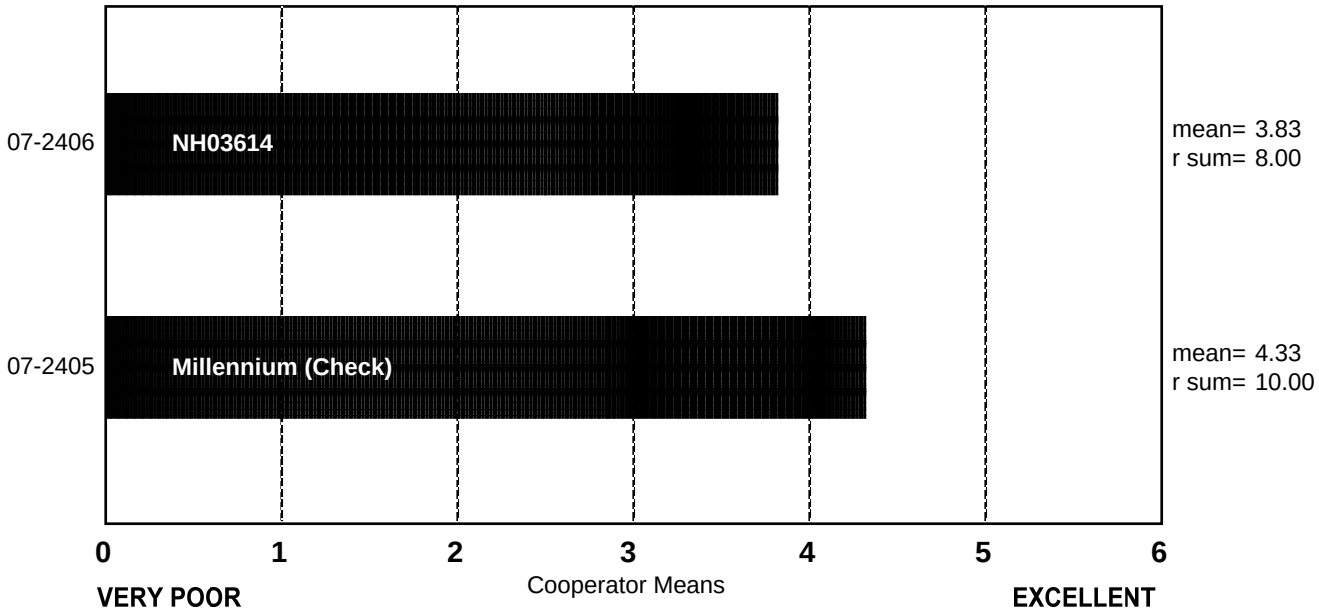
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2405	6438	154.4	4033	0.446	1.948	0.98	1.68	-17.1
2406	6141	150.4	3843	0.440	1.896	1.67	1.64	-22.5

SPONGE CHARACTERISTICS

(Small Scale) Nebraska

ncoop= 6
chisq= 0.67
chisqc= 1.33
cvchisq= 3.84
crdiff=

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

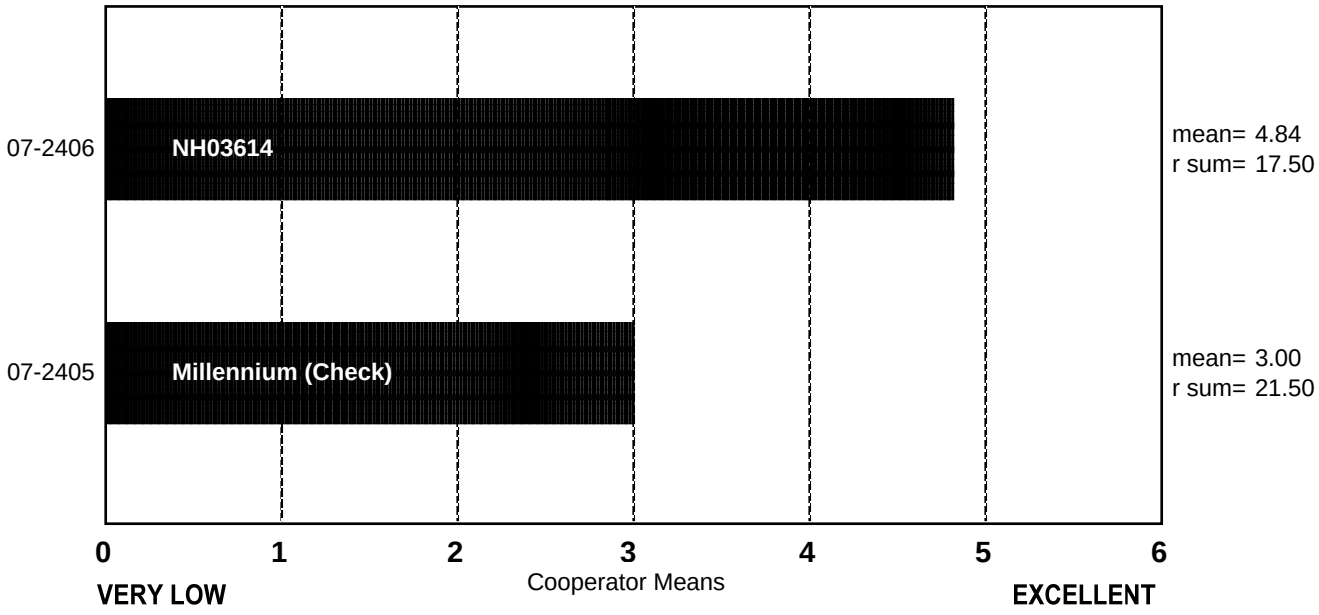


BAKE ABSORPTION

(Small Scale) Nebraska

ncoop= 13
chisq= 1.23
chisqc= 1.33
cvchisq= 3.84
crdiff=

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) 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
07-2405 Millennium (Check)	**59.0**	**61.1**	**60.0**	**59.0**	**68.7**	**60.5**	**60.7**	**60.5**	**57.0**	**61.5**	**62.0**	**58.0**	**58.2**
07-2406 NH03614	**58.0**	**66.1**	**57.0**	**58.0**	**65.2**	**57.9**	**58.6**	**57.9**	**54.4**	**58.9**	**60.0**	**56.0**	**59.6**

BAKE MIX TIME, ACTUAL

(Small Scale) Nebraska

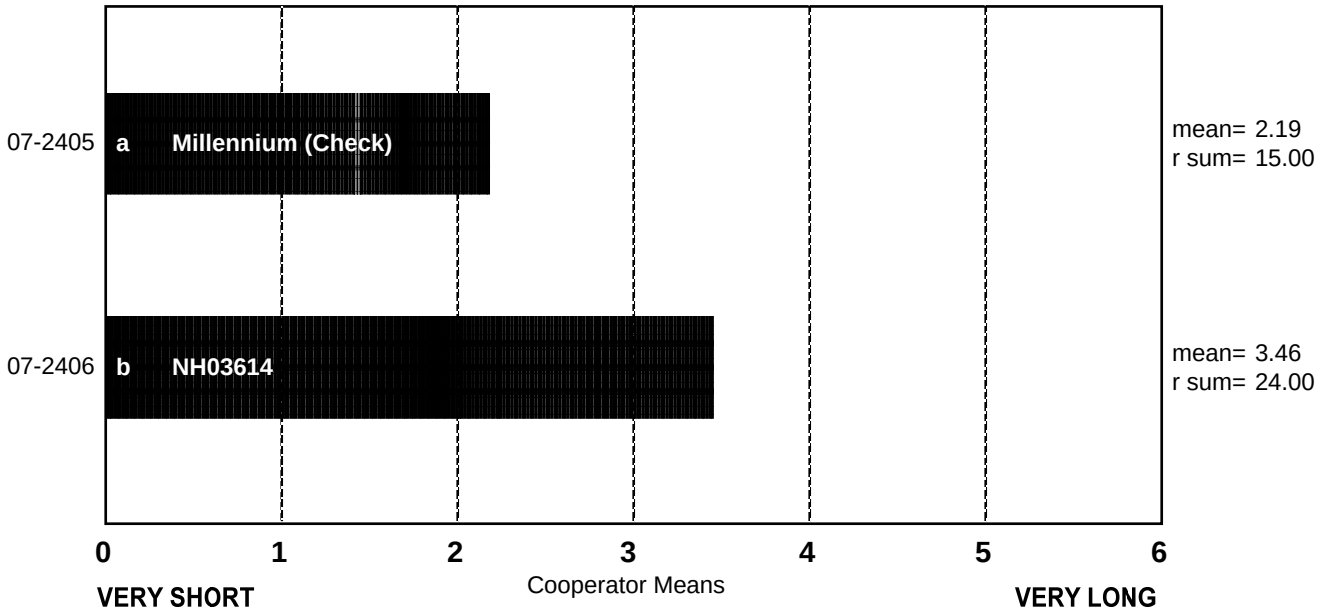
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2405 Millennium (Check)	**12.0**	**2.5**	**4.7**	**14.0**	**3.6**	**1.5**	**3.5**	**5.5**	**2.3**	**5.0**	**3.0**	**5.0**	**3.8**
07-2406 NH03614	**11.0**	**3.8**	**6.2**	**19.0**	**5.1**	**1.8**	**4.0**	**6.0**	**3.5**	**9.0**	**6.0**	**6.0**	**6.1**

BAKE MIX TIME

(Small Scale) Nebraska

ncoop= 13
chisq= 6.23
chisqc= 9.00
cvchisq= 3.84
crdiff= 3.77

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

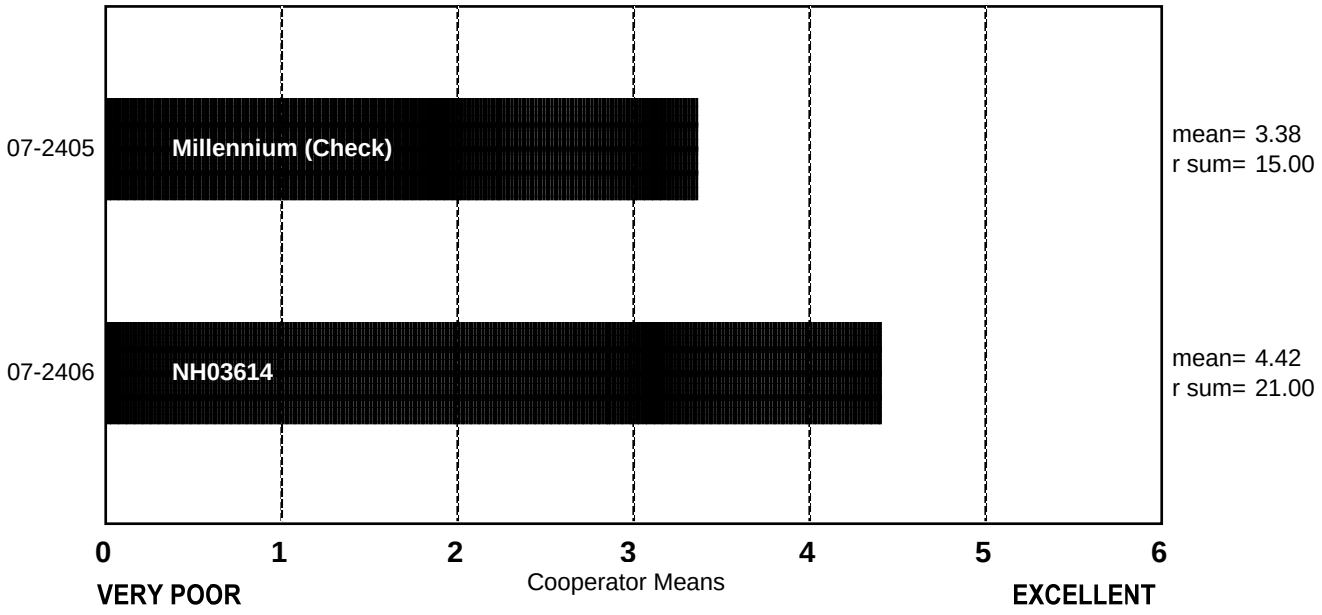


MIXING TOLERANCE

(Small Scale) Nebraska

ncoop= 12
chisq= 3.00
chisqc= 3.00
cvchisq= 3.84
crdiff=

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

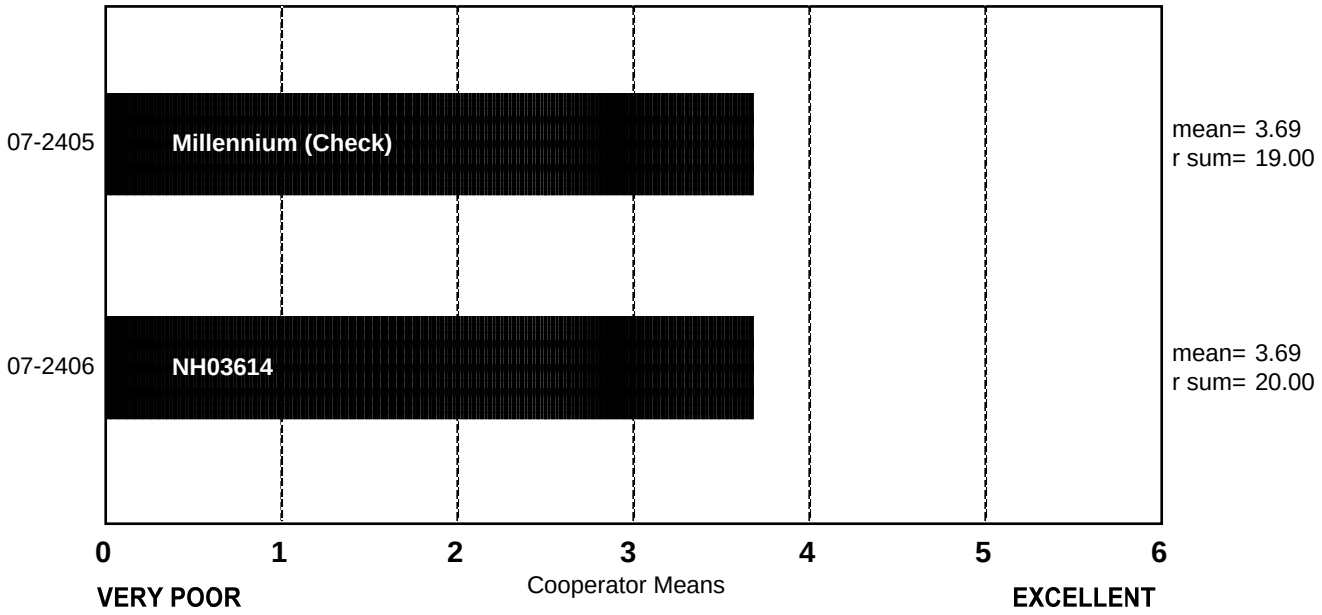


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Nebraska

ncoop= 13
chisq= 0.08
chisqc= 0.11
cvchisq= 3.84
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
07-2405 Millennium (Check)	**3**	**1**	**3**	**5**	**1**
07-2406 NH03614	**2**	**1**	**3**	**6**	**1**

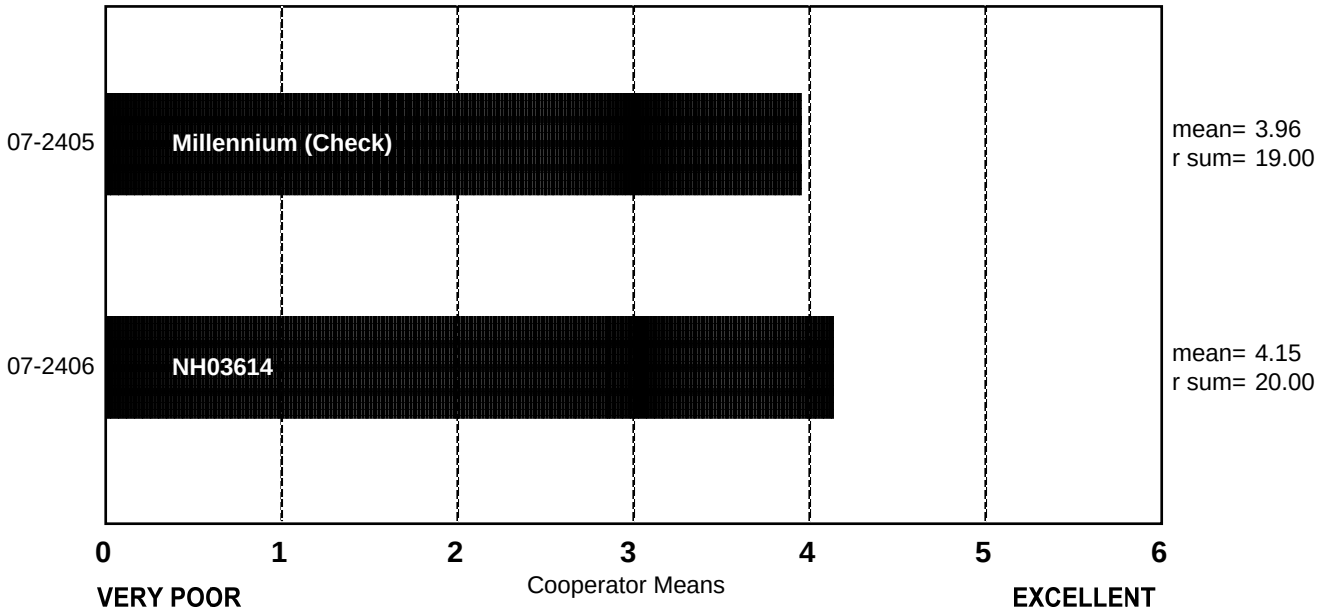
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Nebraska

ncoop= 13
chisq= 0.08
chisqc= 0.13
cvchisq= 3.84
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Nebraska

	Sticky	Wet	Tough	Good	Excellent
07-2405 Millennium (Check)	**2**	**0**	**0**	**10**	**1**
07-2406 NH03614	**0**	**1**	**2**	**8**	**1**

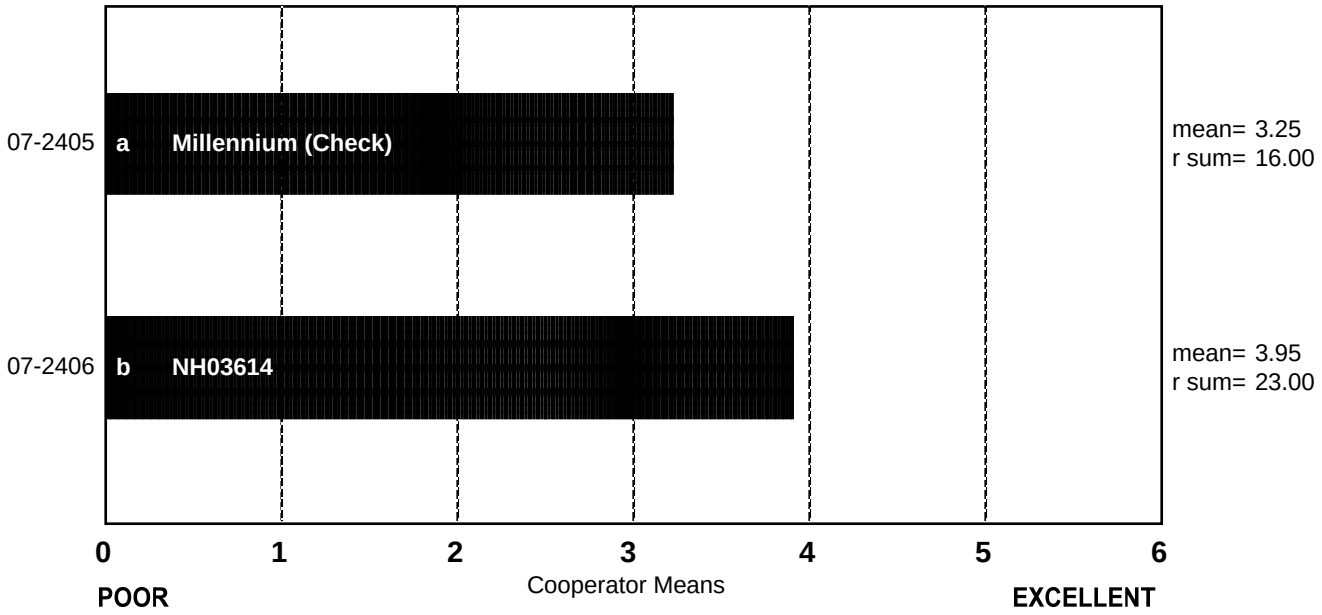
Frequency Table

CRUMB GRAIN

(Small Scale) Nebraska

ncoop= 13
chisq= 3.77
chisqc= 5.44
cvchisq= 3.84
crdiff= 5.19

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Nebraska

	Open	Fine	Dense
07-2405 Millennium (Check)	**4**	**6**	**3**
07-2406 NH03614	**3**	**8**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Nebraska

	Round	Irregular	Elongated
07-2405 Millennium (Check)	**3**	**4**	**6**
07-2406 NH03614	**2**	**6**	**5**

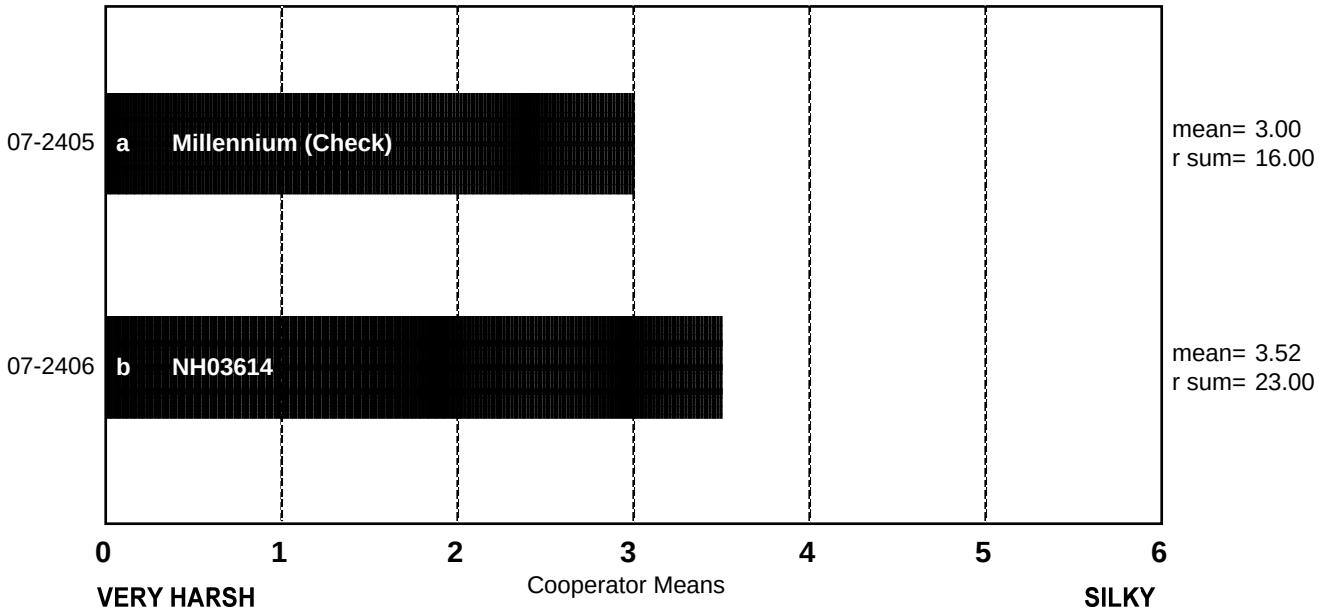
Frequency Table

CRUMB TEXTURE

(Small Scale) Nebraska

ncoop= 13
chisq= 3.77
chisqc= 7.00
cvchisq= 3.84
crdiff= 4.08

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Nebraska

	Harsh	Smooth	Silky
07-2405 Millennium (Check)	**8**	**4**	**1**
07-2406 NH03614	**6**	**6**	**1**

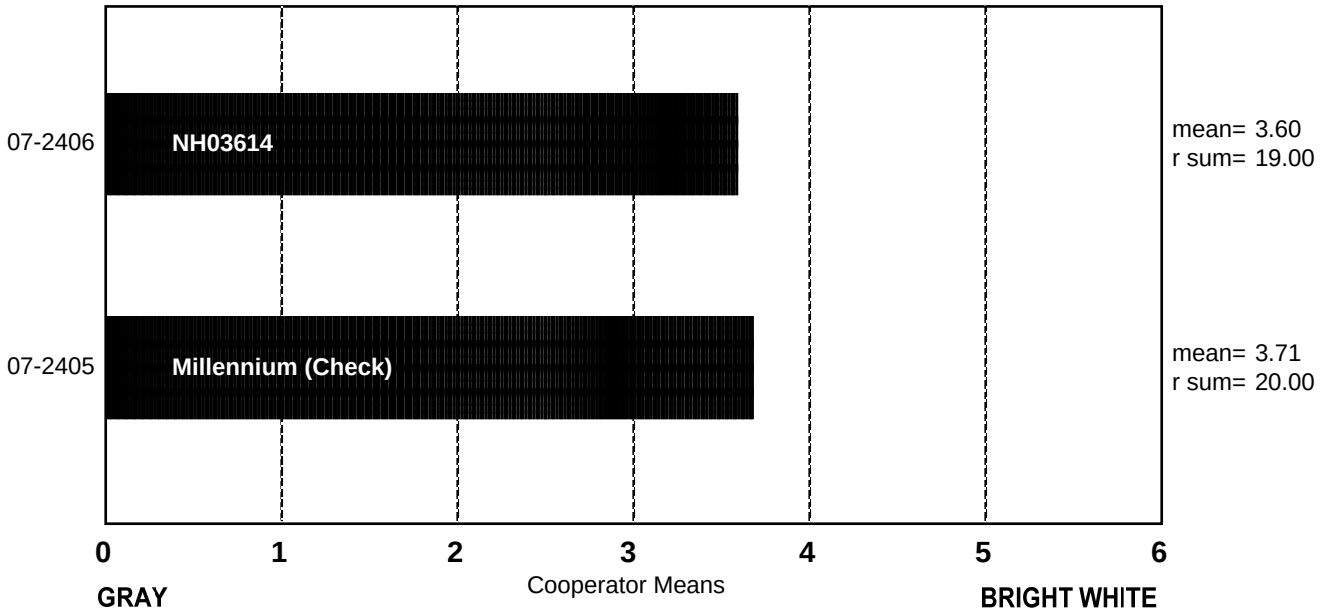
Frequency Table

CRUMB COLOR

(Small Scale) Nebraska

ncoop= 13
chisq= 0.08
chisqc= 0.14
cvchisq= 3.84
crdiff=

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



CRUMB COLOR, DESCRIBED

(Small Scale) Nebraska

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
07-2405 Millennium (Check)	**1**	**1**	**0**	**1**	**7**	**3**	**0**
07-2406 NH03614	**1**	**1**	**0**	**2**	**6**	**3**	**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
07-2405 Millennium (Check)	**425.0**	**145.5**	**143.2**	**478.2**	**157.3**	**140.9**	**489.0**	**459.0**	**127.6**	**418.2**	**134.0**	**469.5**	**146.1**
07-2406 NH03614	**426.0**	**147.0**	**141.1**	**478.2**	**153.9**	**136.2**	**490.5**	**458.0**	**128.3**	**417.6**	**134.0**	**468.0**	**148.9**

LOAF VOLUME, ACTUAL

(Small Scale) Nebraska

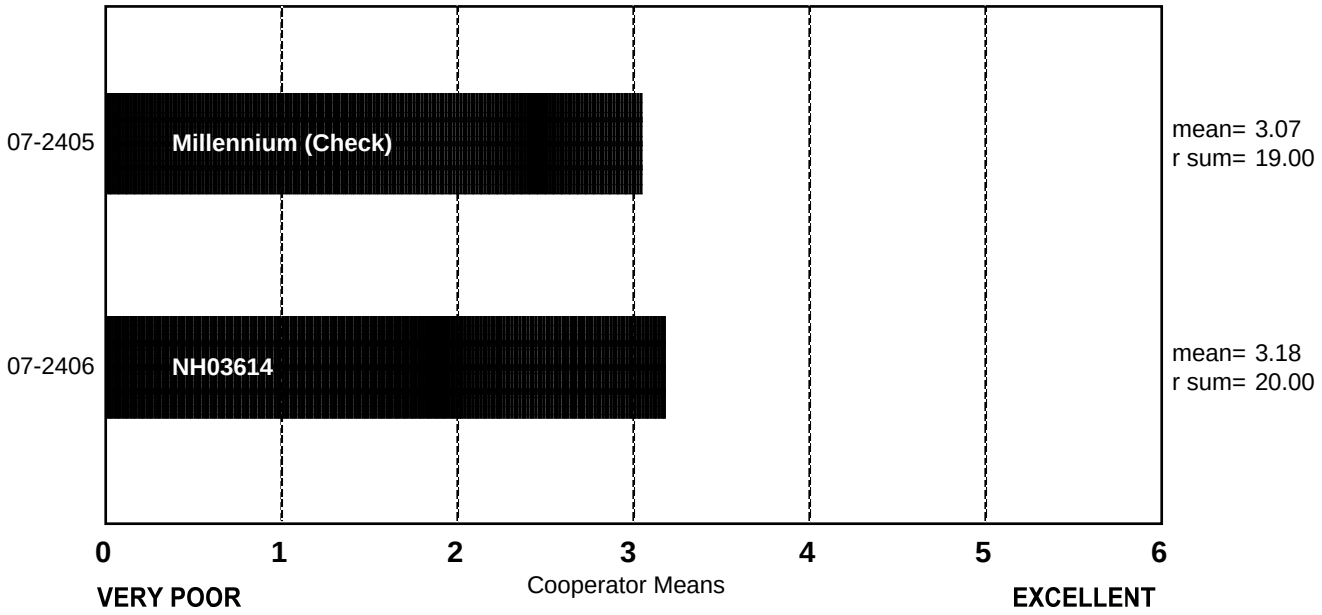
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2405 Millennium (Check)	**2800**	**730**	**835**	**3015**	**965**	**550**	**2750**	**2875**	**845**	**2240**	**927**	**2638**	**890**
07-2406 NH03614	**2800**	**820**	**875**	**3000**	**950**	**655**	**2550**	**2925**	**830**	**2340**	**912**	**2613**	**850**

LOAF VOLUME

(Small Scale) Nebraska

ncoop= 13
chisq= 0.08
chisqc= 0.17
cvchisq= 3.84
crdiff=

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

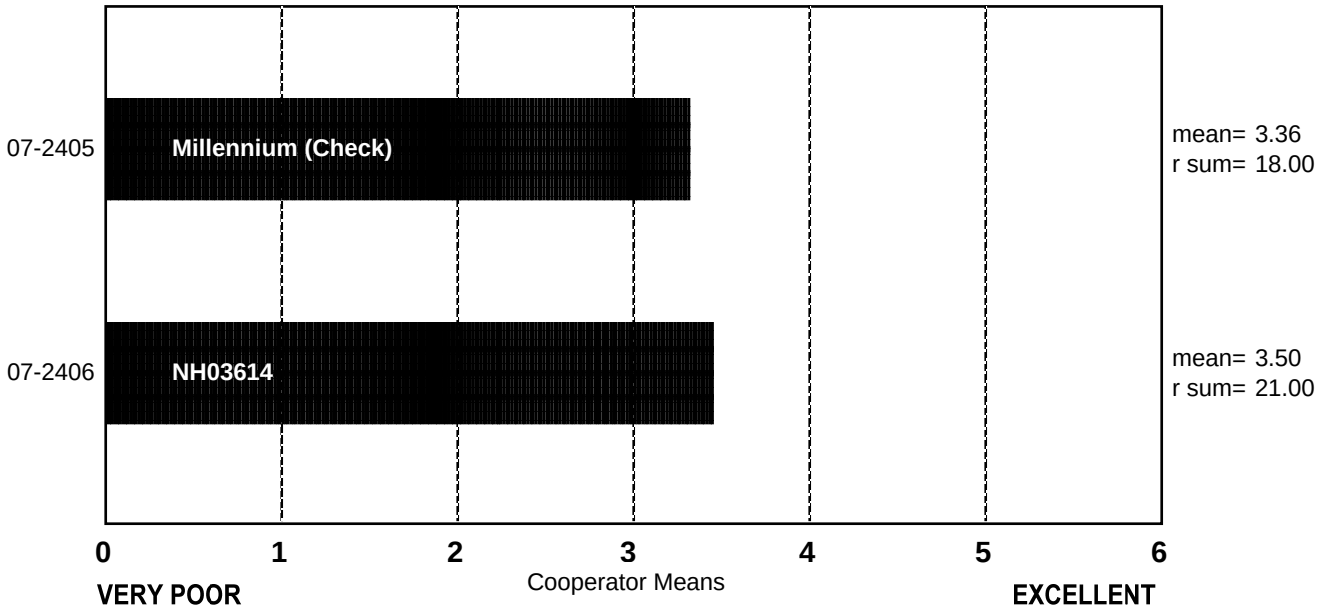


OVERALL BAKING QUALITY

(Small Scale) Nebraska

ncoop= 13
chisq= 0.69
chisqc= 0.82
cvchisq= 3.84
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Nebraska

COOP. 07-2405 (Millennium (check))

A. Good dough elasticity and volume. Very good at mixer and makeup. Excellent feeling dough. One of the best overall.
B. Low absorption, short mix, poor volume and grain; worst overall.
C. Medium and smooth oven-spring, resilient texture.
D. Open, irregular grain, harsh texture. Good volume.
E. Good performance (for protein level).
F. Dough very soft (weak) at panning; very low bread volume.
G. Short mix time, low volume.
H. No comment.
I. Low absorption, short mix time, dense grain, harsh texture. Creamy crumb color.
J. No comment.
K. Weak, tacky doughs. Poor mix tolerance.
L. Low absorption, slightly short mix time, average grain.
M. Low bake absorption; questionable tolerance, but satisfactory crumb grain with creamy crumb color.

COOP. 07-2406 (NH03614)

A. Good dough and volume. Average mix time (11 minutes). Dull crumb color.
B. No comment.
C. Medium and smooth oven-spring, resilient texture.
D. Low absorption, fairly tight grain, good volume.
E. Exceptional performance (for protein level).
F. Low flour protein and absorption; dough had very low gas retention at panning.
G. Low absorption, sticky dough, very low volume. Grey crumb color.
H. No comment.
I. Very low bake absorption, harsh texture, dull crumb color.
J. No comment.
K. Soft doughs, slightly poor mix tolerance. Grain opens up on long mix.
L. Very low absorption, tough dough, very fine grain, white crumb.
M. Low bake absorption. Long mixing time; good dough handling characteristics; satisfactory crumb grain with a creamy crumb color.

Notes: **A, D, G, J, K, and L** comments based on sponge and dough bake test.

Description of Test Plots and Breeder Entries

Oklahoma State University - Reported by Brett Carver

In opposite fashion to the 2006 crop, WQC grain samples were produced only at the Oklahoma Panhandle Research and Extension Center at Goodwell, OK in 2007. Another WQC grow-out was placed at the North Central Agronomy Research Station at Lahoma, OK, but drought-ending, never-ending rainfall throughout June precluded harvest.

The irrigated site at Goodwell was planted on 27 September 2006 and harvested on 22 June 2007. Grain yield at Goodwell hit record levels in 2007, thanks to timely rainfall and suitable temperatures. Yield in the WQC plots easily exceeded 100 bu/ac, even with moderate infection of leaf rust and stripe rust. This site was fertilized pre-plant to provide (residual plus applied) 200 lb/ac N and 60 lb/ac P_2O_5 (subsurface plus applied), according to a yield goal of 100 bu/ac. Wheat protein content (12.5%) was about one-half percentage point lower than the long-term station average.

OK Bullet (Check) (07-2407)

Three years after its release, seed supply of OK Bullet (*KS96WGRC39/Jagger*) has reached levels that will allow it to consume some of Oklahoma's wheat acreage currently occupied by 2174 and Jagger. OK Bullet emerges rapidly to produce ample pasture for an early grazing initiation date but will reach first-hollow-stem stage relatively early, or similar to Jagger. Leaf rust resistance held in Oklahoma until the spring of 2007, when late infections could easily be observed on flag leaves. Though yield loss was not as great on OK Bullet as other varieties that showed symptoms much earlier in development, this pattern does deserve monitoring as leaf rust races with virulence to *Lr41* will likely increase in frequency. OK Bullet is widely adapted and shows excellent green-leaf retention and tolerance to wheat spindle streak mosaic virus, soilborne mosaic virus, septoria leaf blotch, stripe rust, and acidic soils. Mean wheat protein content exceeds 13.5%, with a HMW-GS signuature of 1/17+18/5+10 (identical to Jagger). OK Bullet combines high test weight with large kernel size. OK Bullet has above-average milling and baking quality, excelling in loaf-internal characteristics but sometimes lacking in mixing tolerance, in the form of high mixograph-stability value.

OK00514-05806 (07-2408)

An OK Bullet reselection, this HRW experimental is regarded as a more uniform version of OK Bullet, with slightly higher yield potential but otherwise indistinguishable characteristics in the field or in the lab. Its yield superiority can be as high as 5 bu/ac in

higher yielding environments. Further disposition of OK00514-05806 is pending evaluation in 2007-2008, but I would be curious if WQC cooperators perceive any difference between these two lines.

OK05737W (07-2409)

Another product off the OK Bullet assembly line – this time with a white bran coat – is OK05737W. Again, not much variance exists here from OK Bullet, but one distinction that OK05737W carries is a decent level of pre-harvest sprout tolerance, though in Dr. Joe Martin's tests, tolerance may not be as high as Danby. Yield performance in 2007 was somewhat disappointing in that it performed about the same as OK Bullet. This was not the case in previous years. If OK05737W does not deliver in 2008, we may stay the course with other OK Bullet white wheat siblings (OK00611W and OK02522W) previously evaluated in the WQC evaluation program and currently in the pipeline for some form of release.

OK03522 (07-2410)

This HRW experimental resulted from a single cross of a Ukrainian wheat (N566) and an OSU experimental line (OK94P597) derived from the Pioneer hard winter wheat program with the pedigree, HBY3598/Fundulea 133//TAM 200. Grain yields were well up in 2005 under severe stripe rust, but down in 2006 with severe drought stress, and back up again in 2007 under severe leaf rust. What remained consistent was moderately high grain protein (one-half point lower than OK Bullet), excellent farinograph absorption (>61.5%) and stability (>12 min) with average peak time (5 min), and excellent mixograph stability (<7.0) and high curve width at 2 min past the peak (> 15 mm). The high kernel weight of this particular WQC grain sample is not the result of deceitful or ruthless seed cleaning. Station means for kernel weight and kernel diameter at Goodwell in 2007 were about 32 mg and 2.40 mm, which lie in the higher end of typical values. Our analysis of this sample showed 42 mg and 2.78 mm, which are not typical values - far from it; no other experimental in this lineup came close. Flour extraction for OK03522 does not appear to be as impressive as kernel size, however. Unique agronomic features of this line, besides the leaf rust resistance already mentioned, are high tolerance to soil acidity, resistance to WSBMV/WSSMV and stripe rust, tolerance to powdery mildew, good green-leaf duration, good shattering tolerance, and moderate field tolerance to Hessian fly. OK03522 has been placed under foundation seed increase during the 2007-2008 crop year.

OK02405 (07-2411)

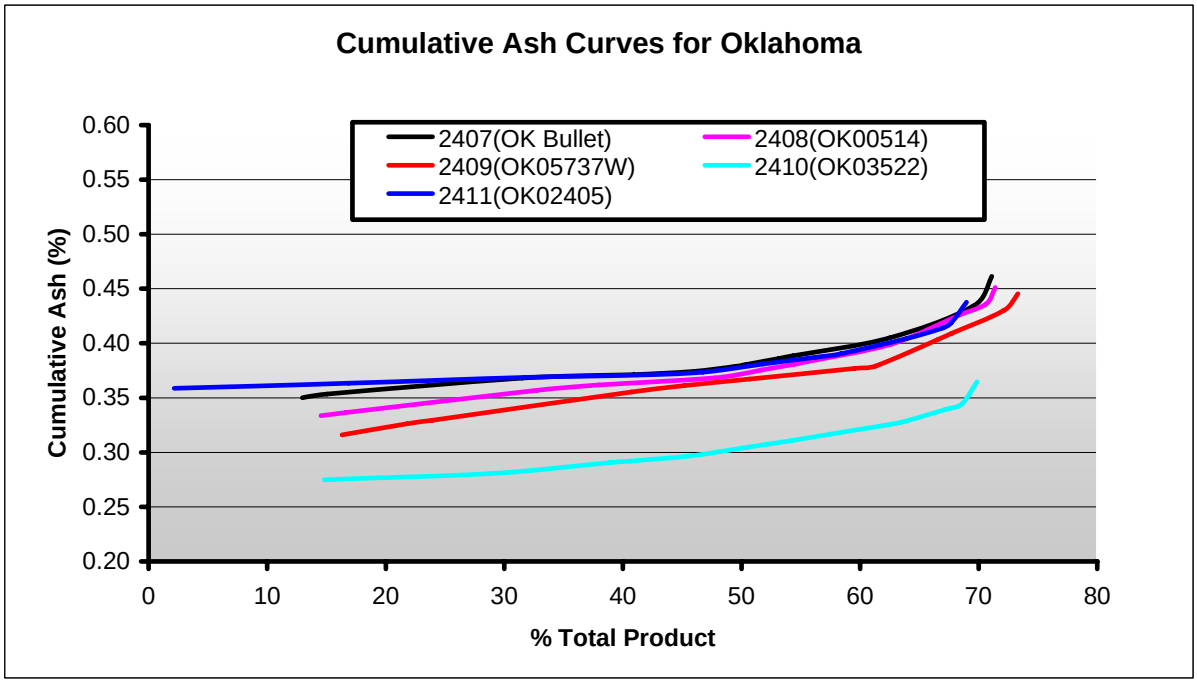
This awnless HRW experimental line is taking a mulligan in the WQC evaluation program. We continue to search for an awnless wheat that can double for forage and grain production fit for the hard red winter wheat class. 'Deliver' certainly fit that bill, with high test weight combined with large kernel size, and attractive quality. As always, grain yield could stand to be improved. OK02405 (*Tonkawa/GK50*) can outyield Deliver in more northerly locations, including our panhandle under irrigation, whereas Deliver has gained more acceptance in southwestern Oklahoma. OK02405 does not have the test weight ability of Deliver (2 lb/bu less), due to a wider crease and poorer threshability. Otherwise, it has excellent leaf rust and stripe rust resistance that held up well in 2007. Kernel size, dough strength, and absorption rank highly, though mixing time can be too long. GK50 was provided by the former Cereal Research Institute at Szeged, Hungary and was re-selected from Yubilejnaya 50 for tolerance to drought stress and acid soils, large kernel size, and strong gluten. OK02405 has been placed under small-scale foundation seed increase for 2007-2008.

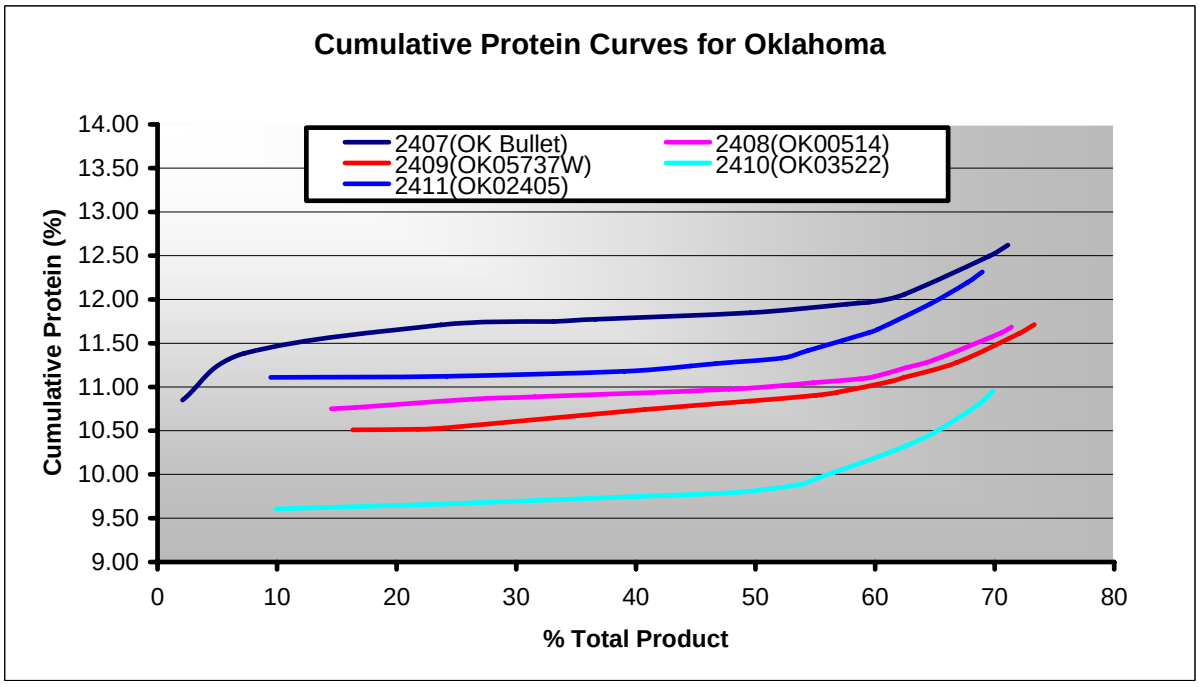
Oklahoma: 2007 (Small-Scale) Samples [a]

Test entry number	07-2407	07-2408	07-2409	07-2410	07-2411
Sample identification	OK Bullet	OK00514-05806	OK05737W	OK03522	OK02405
Wheat Data					
FGIS classification	1 HRW	1 HRW	1 HDWH	1 HRW	2 HRW
Test weight (lb/bu)	63.5	63.1	61.0	64.0	59.0
Hectoliter weight (kg/hl)	83.5	82.9	80.2	84.1	77.6
1000 kernel weight (gm)	31.7	31.3	27.5	37.9	30.8
NIR hardness	87	82	70	76	70
Wheat kernel size (Rotap)					
Over 7 wire (%)	80.1	77.8	69.7	81.9	66.1
Over 9 wire (%)	19.6	21.9	29.8	18.0	33.3
Through 9 wire (%)	0.3	0.3	0.5	0.1	0.6
Single kernel (skcs)					
Hardness (avg /s.d)	77/15.8	80/14.3	65/15.8	75/14.1	80/14.2
Weight (mg) (avg/s.d)	33.5/9.1	33.6/10.7	32.0/8.5	38.5/10.2	31.8/9.3
Diameter (mm)(avg/s.d)	2.55/0.48	2.55/0.60	2.40/0.53	2.63/0.51	2.34/0.51
SKCS distribution	01-01-10-88	01-02-04-93	04-0523-68	00-04-09-87	00-01-08-91
Classification	Hard	Hard	Hard	Hard	Hard
SKCS Wheat moisture (%)	11.2	11.4	11.2	11.0	12.6
Wheat protein (12% mb)	14.0	13.1	13.1	12.8	13.4
Wheat ash (12% mb)	1.37	1.40	1.45	1.55	1.66
Milling and Flour Quality Data					
Flour yield (%, str. grade)					
Miag Multomat Mill	71.1	71.4	73.3	69.9	69.0
Quadrumat Sr. Mill	75.5	75.0	74.5	73.7	72.5
SKCS Flour moisture (%)	11.3	11.4	12.4	12.5	12.1
Flour protein (14% mb)	12.4	11.6	11.7	11.9	12.1
Flour ash (14% mb)	0.46	0.48	0.46	0.39	0.44
Glutomatic					
Wet gluten (%)	35.8	33.7	33.0	30.4	31.6
Dry gluten (%)	12.2	11.9	11.6	10.7	11.7
Gluten index	89.5	95.7	97.6	97.4	99.2
Flour color					
Agtron flour color	59	62	63	67	67
Simon/Kent-Jones flour color	2.75	2.13	1.99	-0.12	0.37
Minolta color meter					
L*	91.48	91.51	92.02	92.28	92.07
a*	-1.41	-1.42	-1.59	-1.39	-1.58
b*	9.07	9.36	9.94	9.01	9.71
Falling number (sec)	642	600	631	500	508
Flour particle size (avg)					
Fisher sub sieve sizer	23.3	23.8	20.5	23.0	20.3

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

Oklahoma: Cumulative Ash and Protein Curves

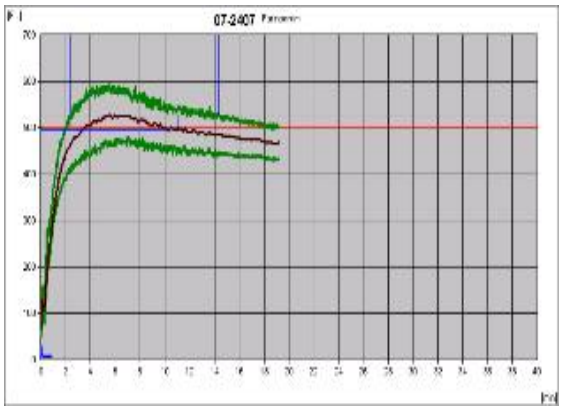




Physical Dough Tests

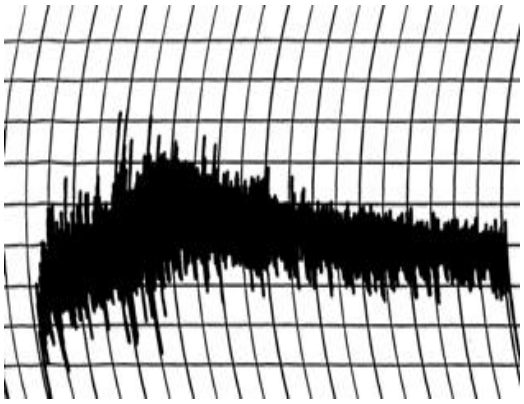
2007 (Small Scale) Samples - Oklahoma

Farinograms



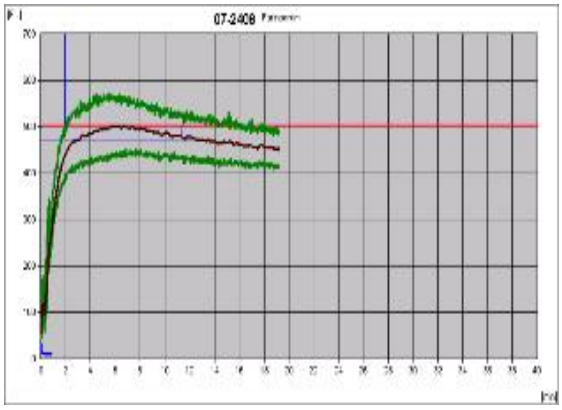
Abs. 62.4%, Peak 6.0 min, Stab. 11.9 min

Mixograms

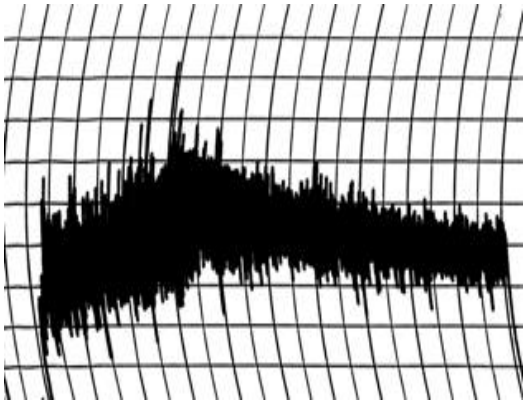


Abs. 63.6%, Mix time 3.0 min, Mix tol 2

07-2407, OK Bullet (check)



Abs. 62.2%, Peak 6.3 min, Stab. 14.9 min



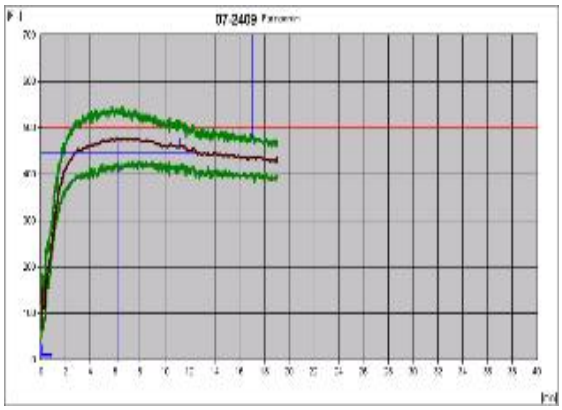
Abs. 62.3%, Mix time 3.4 min, Mix tol 3

07-2408, OK00514-05806

Physical Dough Tests

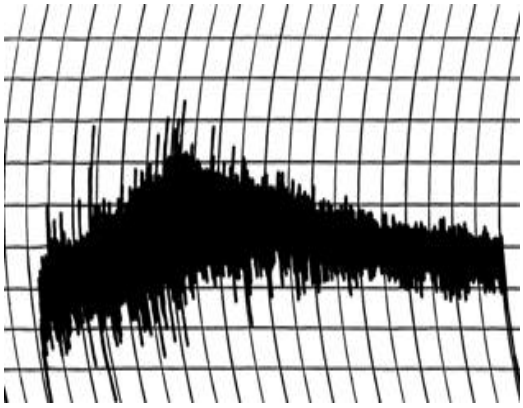
2007 (Small Scale) Samples - Oklahoma (continued)

Farinograms



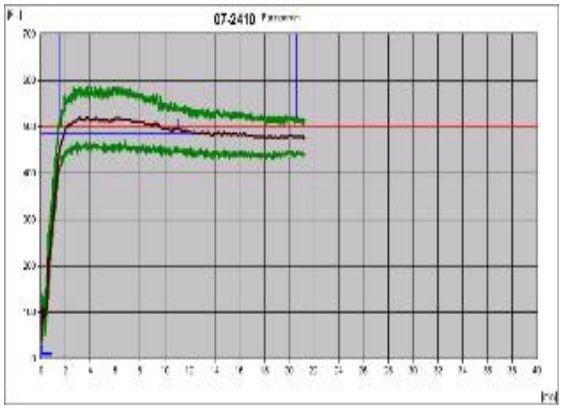
Abs.60.5%, Peak 6.2 min, Stab. 14.9 min

Mixograms

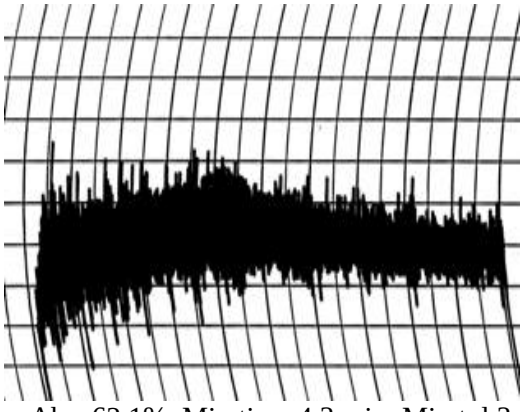


Abs. 63.5%, Mix time 3.4 min, Mix tol 2

07-2409, OK05737W



Abs. 63.8%, Peak 6.1 min, Stab.19.1 min



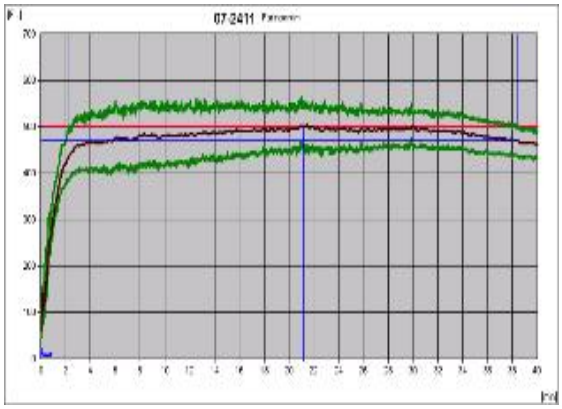
Abs. 62.1%, Mix time 4.3 min, Mix tol 3

06-2410, OK03522

Physical Dough Tests

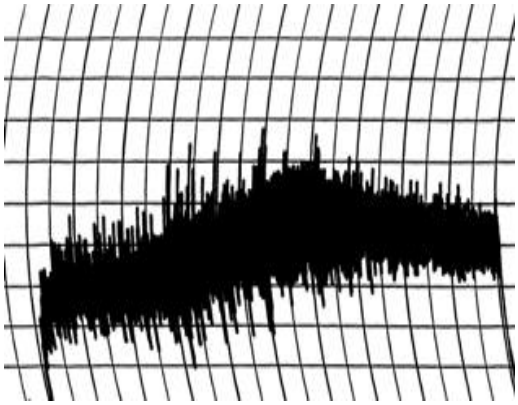
2007 (Small Scale) Samples - Oklahoma (continued)

Farinograms



Abs. 60.8%, Peak 20.2 min, Stab.31.6 min

Mixograms

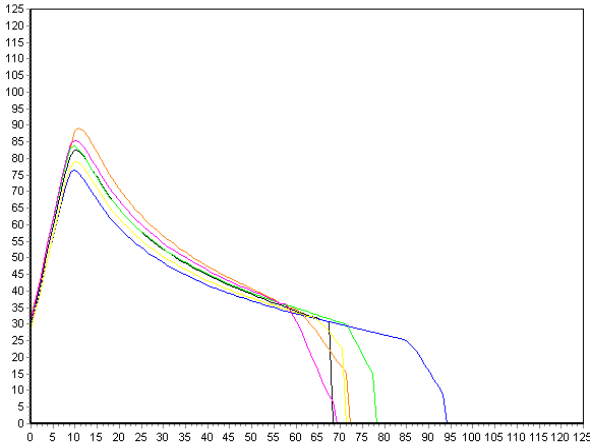


Abs. 63.1%, Mix time 5.9 min, Mix tol 6

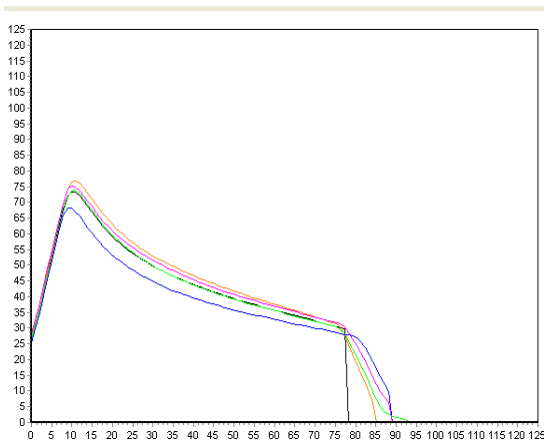
06-2411, OK02405

Physical Dough Tests - Alveograph

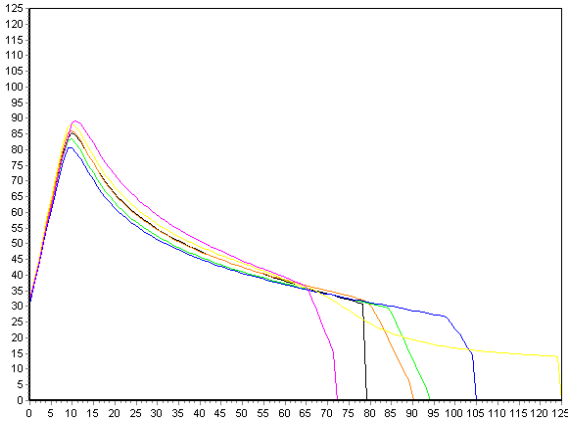
2007 (Small Scale) Samples – Oklahoma



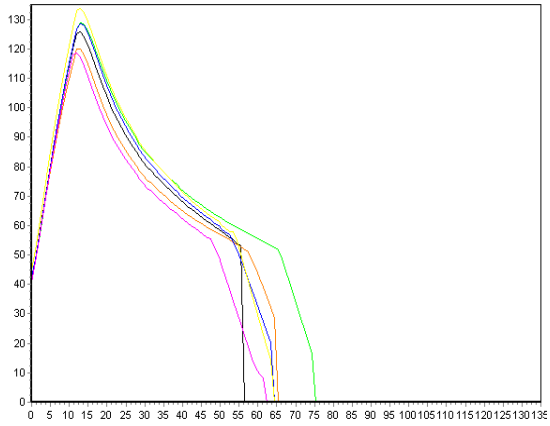
07-2407 (OK Bullet)
P =91 (mm H20), L =68 mm, P/L=1.34



07-2408 (OK00514-05806)
P = 81 (mm H20), L=78 mm, P/L=1.04



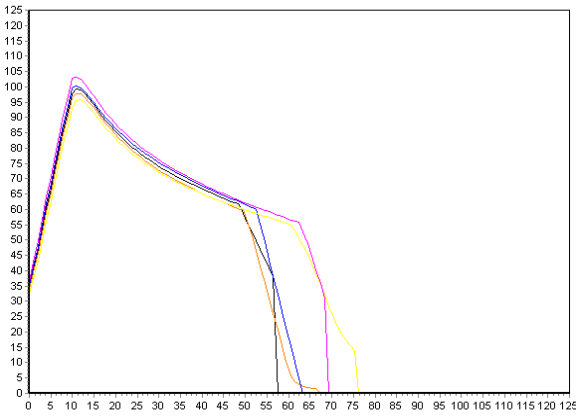
07-2409 (OK05737W)
P = 94 (mm H20), L = 79 mm, P/L = 1.19



07-2410 (OK03522)
P = 138 (mm H20), L = 56 mm, P/L = 2.46

Physical Dough Tests - Alveograph

2007 (Small Scale) Samples – Oklahoma (continued)

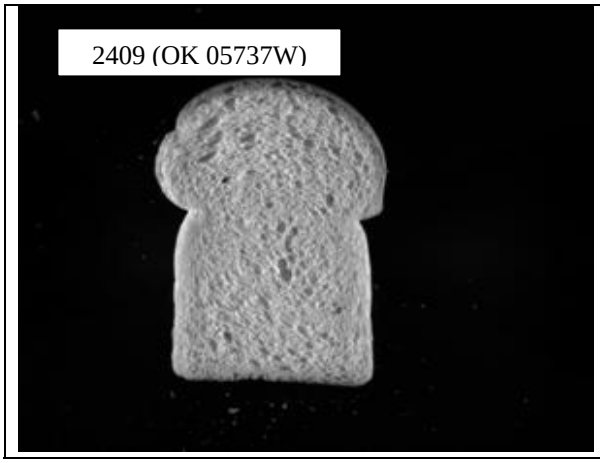


07-2411 (OK02405)

P =109 (mm H20), L =57 mm, P/L=1.91

Oklahoma: C-Cell Bread Images and Analysis for 2007(Small-Scale) Samples

Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2407	6235	145.2	3662	0.446	2.004	4.05	1.65	-14.8
2408	6164	147.8	3854	0.444	1.986	0.58	1.63	-17.7



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2409	5936	151.2	3763	0.44	1.829	0.83	1.65	-11.7
2410	5710	150.7	3594	0.44	1.967	0.99	1.62	-18.4

Oklahoma: C-Cell Bread Images and Analysis for 2007(Small-Scale) Samples (continued)

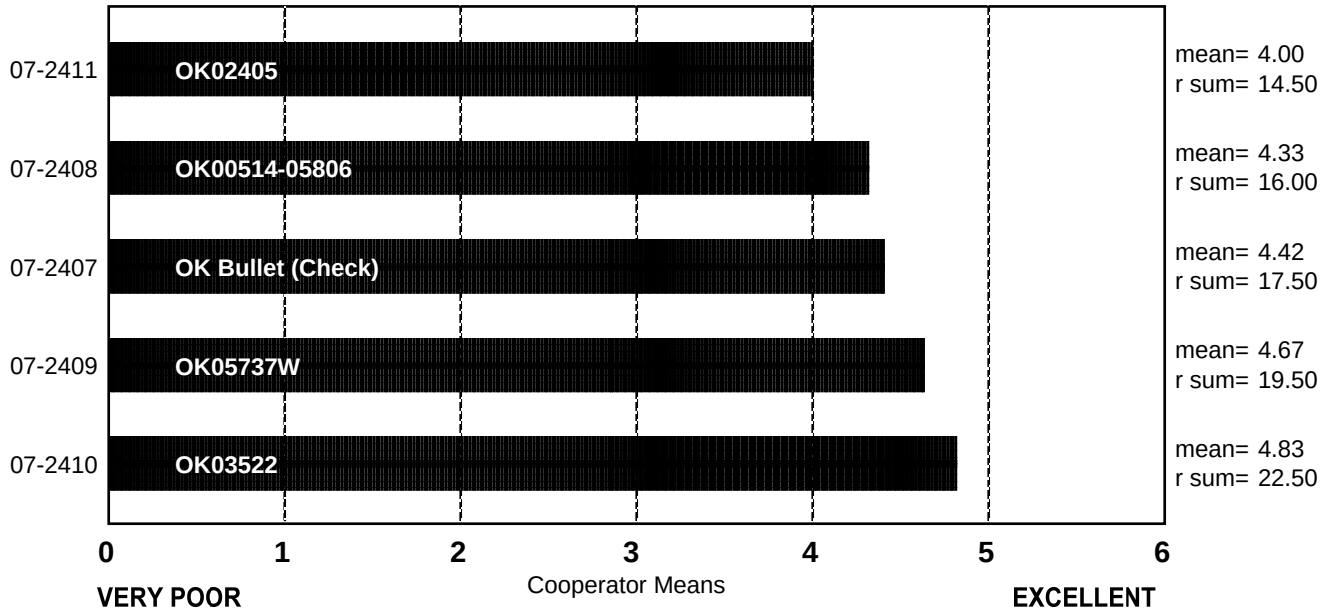
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2411	5941	150.4	3716	0.442	1.998	0.97	1.66	-16.3

SPONGE CHARACTERISTICS

(Small Scale) Oklahoma

ncoop= 6
chisq= 2.60
chisqc= 3.76
cvchisq= 9.49
crdiff=

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

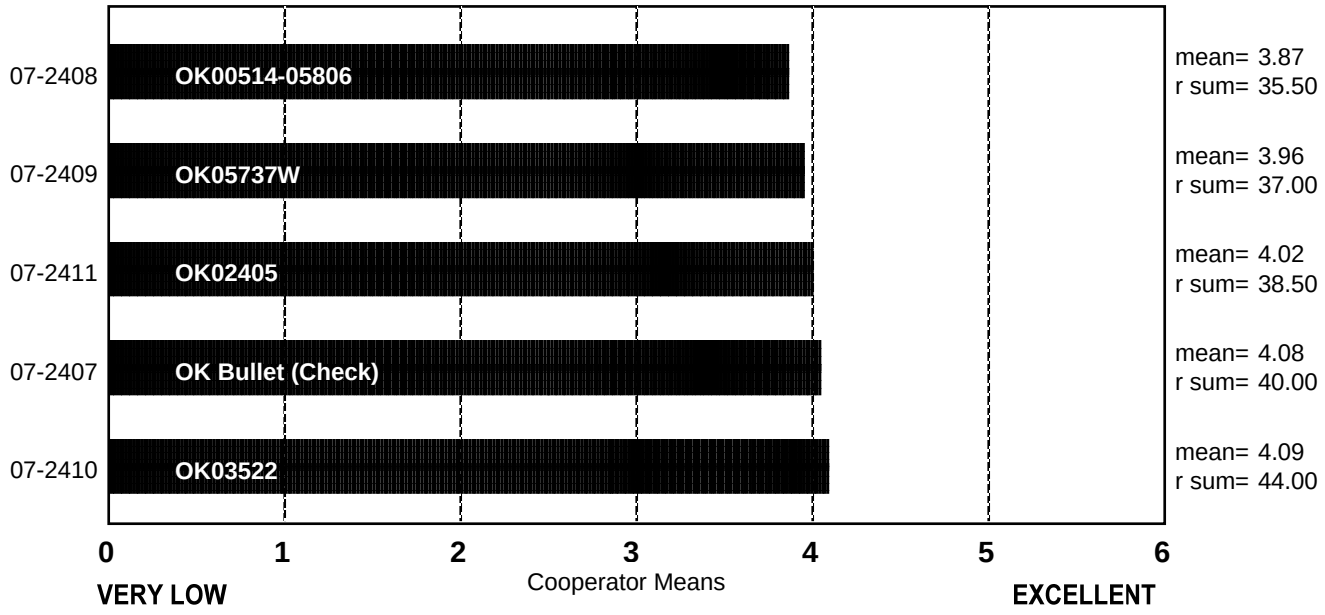


BAKE ABSORPTION

(Small Scale) Oklahoma

ncoop= 13
chisq= 1.31
chisqc= 2.05
cvchisq= 9.49
crdiff=

Variety order by rank sum.
No samples 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
07-2407 OK Bullet (Check)	**59.0**	**69.7**	**62.0**	**63.0**	**68.2**	**63.5**	**61.4**	**64.4**	**60.9**	**65.4**	**63.0**	**61.0**	**62.1**
07-2408 OK00514-05806	**58.0**	**68.4**	**62.0**	**63.0**	**66.7**	**63.7**	**60.0**	**64.2**	**60.7**	**65.2**	**61.0**	**60.0**	**62.6**
07-2409 OK05737W	**58.0**	**69.6**	**61.0**	**61.0**	**68.7**	**60.6**	**61.4**	**62.5**	**59.0**	**63.5**	**61.0**	**59.0**	**62.4**
07-2410 OK03522	**58.0**	**68.2**	**63.0**	**63.0**	**67.2**	**64.4**	**60.0**	**65.8**	**62.3**	**66.8**	**60.0**	**61.0**	**64.0**
07-2411 OK02405	**59.0**	**69.2**	**61.0**	**61.0**	**68.7**	**61.6**	**61.4**	**62.8**	**59.3**	**63.8**	**62.0**	**59.0**	**64.5**

BAKE MIX TIME, ACTUAL

(Small Scale) Oklahoma

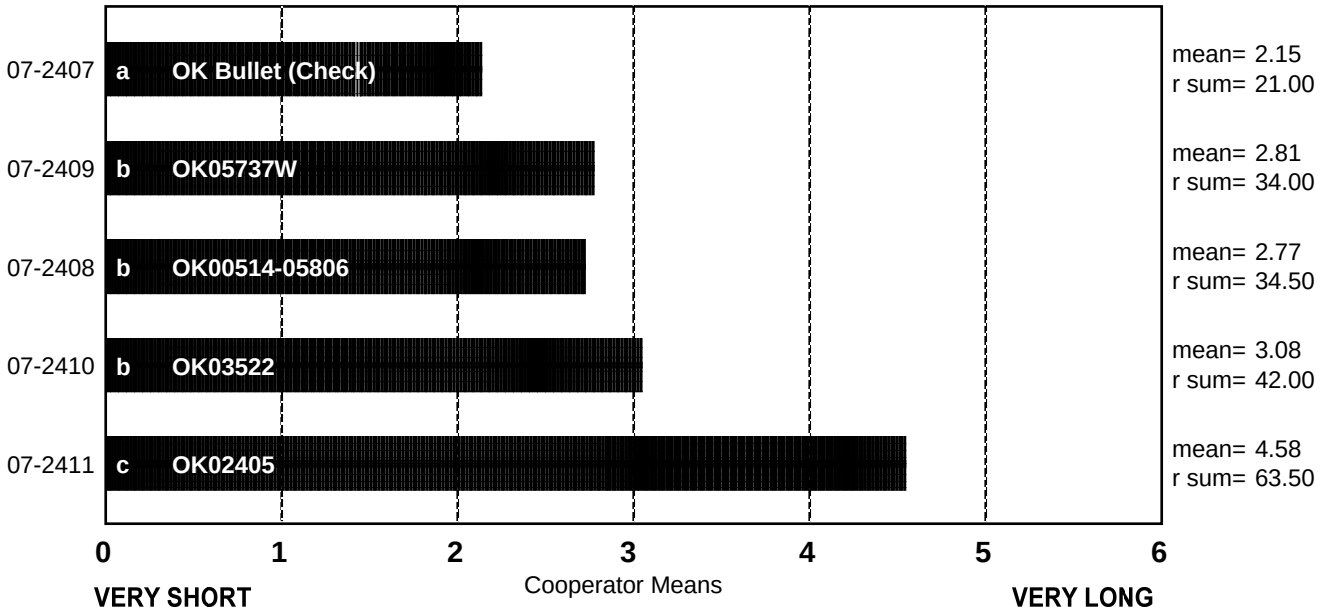
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2407 OK Bullet (Check)	**7.0**	**2.5**	**4.8**	**14.0**	**3.6**	**1.5**	**4.5**	**5.0**	**2.5**	**7.0**	**3.0**	**5.0**	**3.5**
07-2408 OK00514-05806	**6.0**	**2.8**	**5.4**	**19.0**	**4.2**	**2.0**	**3.5**	**5.5**	**3.3**	**6.0**	**6.0**	**5.0**	**4.9**
07-2409 OK05737W	**6.0**	**3.5**	**5.1**	**17.0**	**4.3**	**1.8**	**3.5**	**6.0**	**3.0**	**8.0**	**3.0**	**5.0**	**4.4**
07-2410 OK03522	**9.0**	**3.3**	**5.4**	**17.0**	**4.2**	**2.0**	**4.5**	**6.0**	**3.5**	**8.0**	**6.0**	**6.0**	**4.5**
07-2411 OK02405	**15.0**	**5.5**	**6.9**	**25.0**	**5.8**	**3.0**	**6.5**	**7.5**	**4.3**	**14.0**	**6.0**	**10.0**	**7.4**

BAKE MIX TIME

(Small Scale) Oklahoma

ncoop= 13
chisq= 30.11
chisqc= 36.75
cvchisq= 9.49
crdiff= 8.27

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

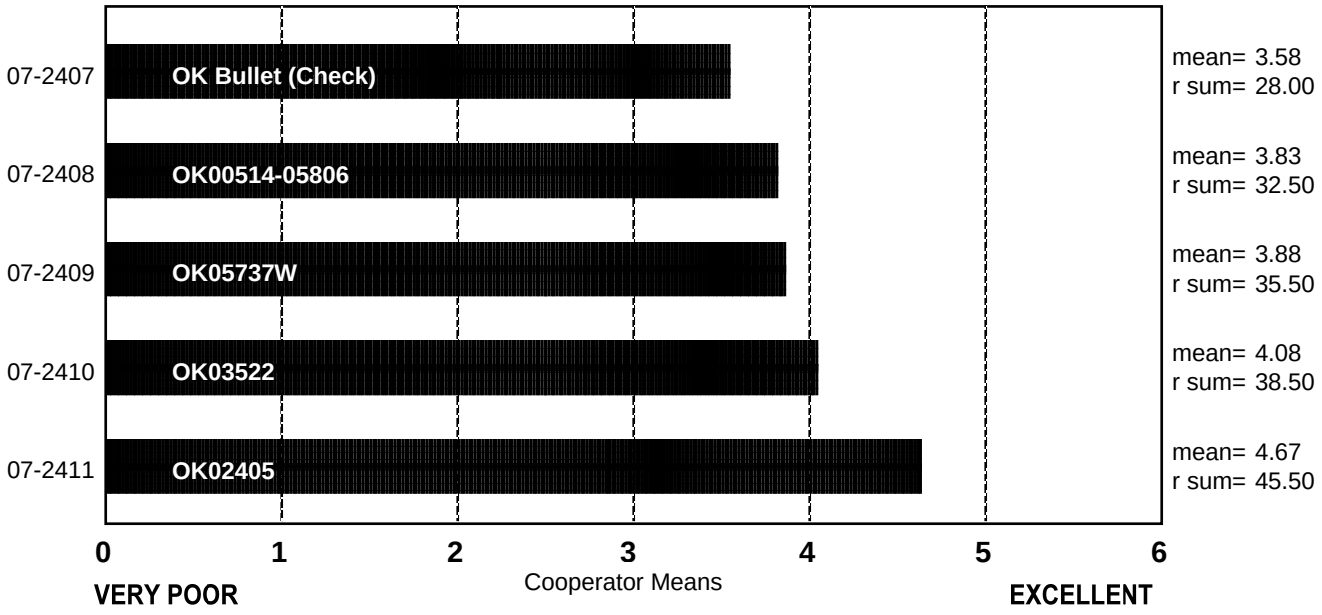


MIXING TOLERANCE

(Small Scale) Oklahoma

ncoop= 12
chisq= 5.77
chisqc= 8.82
cvchisq= 9.49
crdiff=

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

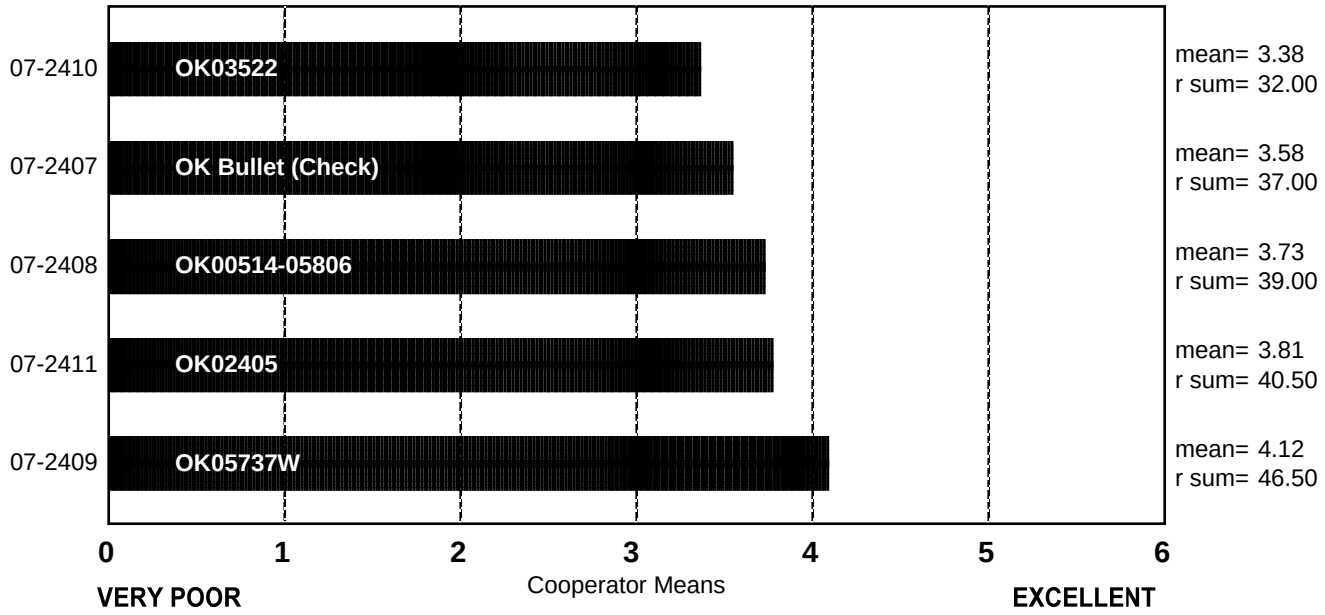


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Oklahoma

ncoop= 13
chisq= 3.43
chisqc= 4.33
cvchisq= 9.49
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
07-2407 OK Bullet (Check)	**5**	**1**	**1**	**5**	**1**
07-2408 OK00514-05806	**4**	**2**	**2**	**5**	**0**
07-2409 OK05737W	**3**	**1**	**2**	**5**	**2**
07-2410 OK03522	**2**	**1**	**5**	**5**	**0**
07-2411 OK02405	**2**	**1**	**3**	**7**	**0**

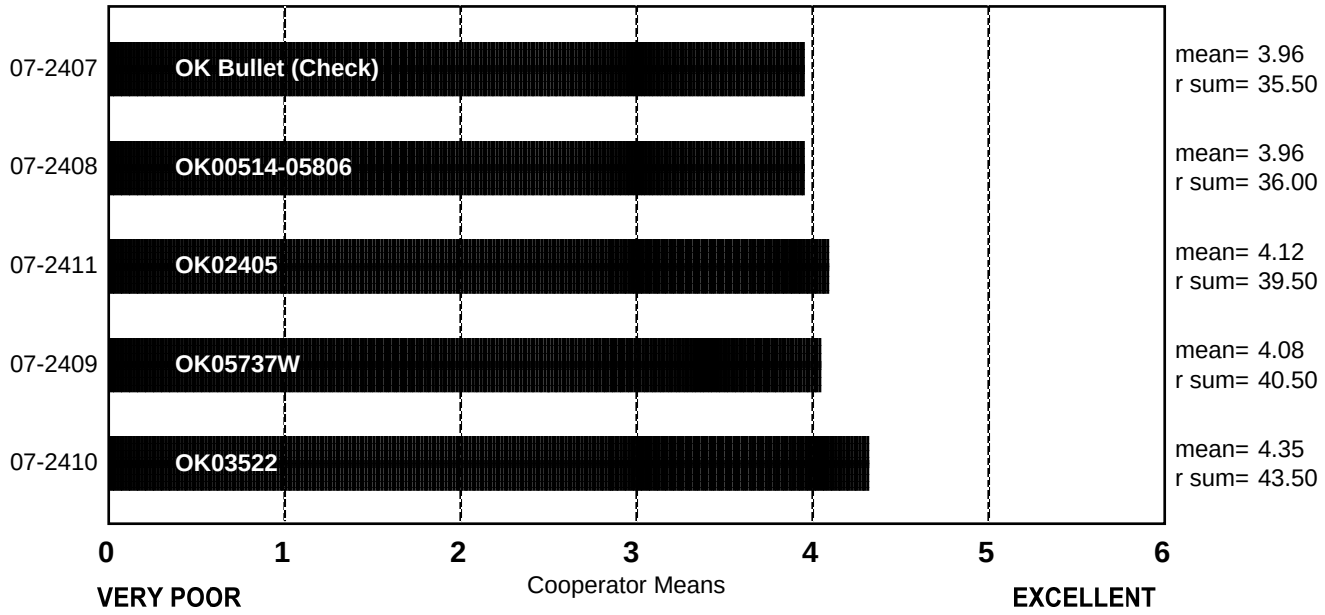
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Oklahoma

ncoop= 13
chisq= 1.35
chisqc= 2.29
cvchisq= 9.49
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Oklahoma

	Sticky	Wet	Tough	Good	Excellent
07-2407 OK Bullet (Check)	**2**	**3**	**0**	**7**	**1**
07-2408 OK00514-05806	**3**	**1**	**0**	**9**	**0**
07-2409 OK05737W	**3**	**0**	**1**	**8**	**1**
07-2410 OK03522	**1**	**0**	**1**	**10**	**1**
07-2411 OK02405	**0**	**1**	**4**	**7**	**1**

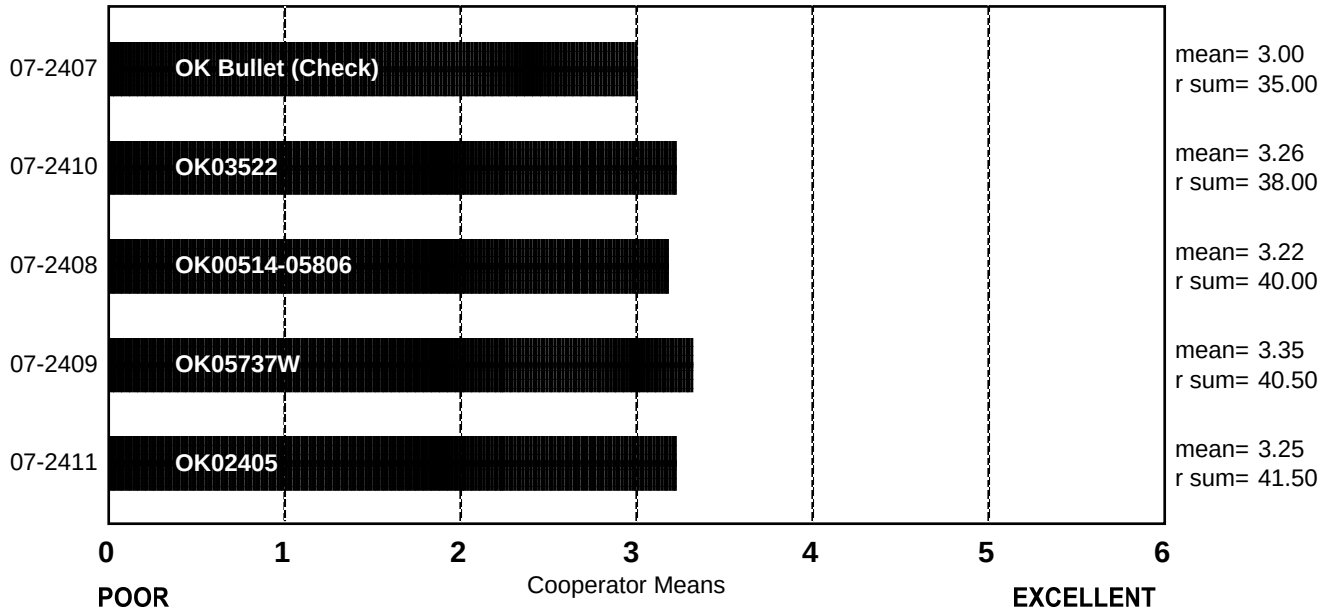
Frequency Table

CRUMB GRAIN

(Small Scale) Oklahoma

ncoop= 13
chisq= 0.82
chisqc= 1.01
cvchisq= 9.49
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Oklahoma

	Open	Fine	Dense
07-2407 OK Bullet (Check)	**7**	**6**	**0**
07-2408 OK00514-05806	**9**	**4**	**0**
07-2409 OK05737W	**9**	**3**	**1**
07-2410 OK03522	**9**	**3**	**1**
07-2411 OK02405	**7**	**5**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Oklahoma

	Round	Irregular	Elongated
07-2407 OK Bullet (Check)	**5**	**6**	**2**
07-2408 OK00514-05806	**4**	**7**	**2**
07-2409 OK05737W	**7**	**5**	**1**
07-2410 OK03522	**5**	**5**	**3**
07-2411 OK02405	**2**	**7**	**4**

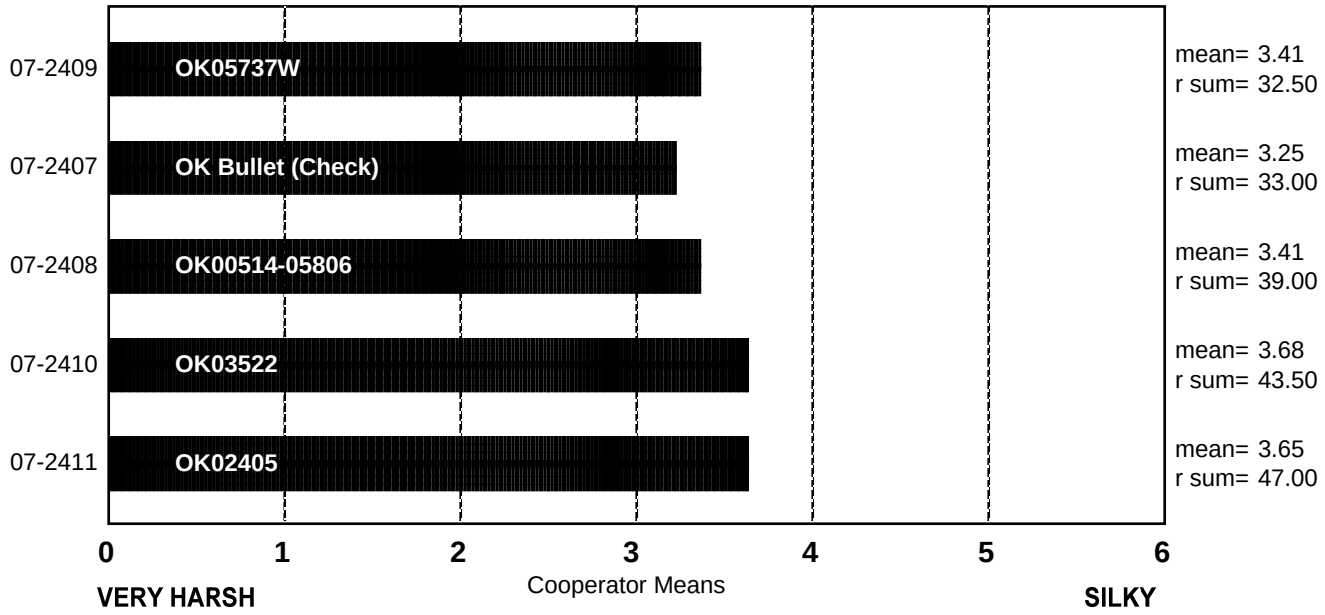
Frequency Table

CRUMB TEXTURE

(Small Scale) Oklahoma

ncoop= 13
chisq= 5.00
chisqc= 7.56
cvchisq= 9.49
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Oklahoma

	Harsh	Smooth	Silky
07-2407 OK Bullet (Check)	**6**	**7**	**0**
07-2408 OK00514-05806	**6**	**4**	**3**
07-2409 OK05737W	**8**	**4**	**1**
07-2410 OK03522	**4**	**6**	**3**
07-2411 OK02405	**3**	**7**	**3**

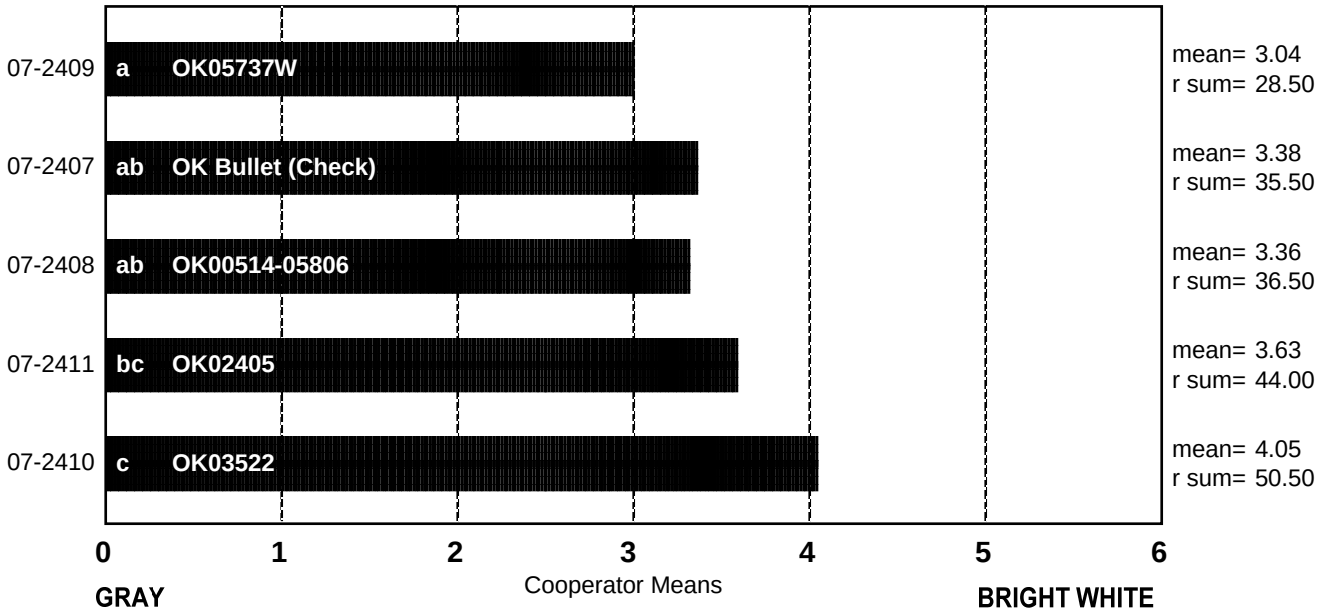
Frequency Table

CRUMB COLOR

(Small Scale) Oklahoma

ncoop= 13
chisq= 8.80
chisqc= 11.92
cvchisq= 9.49
crdiff= 12.73

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
07-2407 OK Bullet (Check)	**1**	**0**	**1**	**6**	**3**	**2**	**0**
07-2408 OK00514-05806	**1**	**0**	**1**	**6**	**2**	**3**	**0**
07-2409 OK05737W	**0**	**1**	**4**	**2**	**6**	**0**	**0**
07-2410 OK03522	**0**	**0**	**2**	**2**	**3**	**5**	**1**
07-2411 OK02405	**0**	**0**	**1**	**2**	**10**	**0**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2407 OK Bullet (Check)	**420.0**	**152.6**	**139.7**	**452.9**	**156.7**	**139.4**	**486.5**	**459.0**	**131.0**	**415.3**	**134.0**	**468.1**	**149.6**
07-2408 OK00514-05806	**420.0**	**145.2**	**142.2**	**465.1**	**156.8**	**137.2**	**487.5**	**461.0**	**131.4**	**414.8**	**134.0**	**465.6**	**150.2**
07-2409 OK05737W	**423.0**	**146.0**	**143.2**	**457.8**	**156.5**	**138.8**	**490.0**	**466.0**	**129.7**	**419.2**	**134.0**	**468.0**	**150.3**
07-2410 OK03522	**423.0**	**147.9**	**145.7**	**466.3**	**155.0**	**140.0**	**488.0**	**460.0**	**136.7**	**415.9**	**134.0**	**466.4**	**151.5**
07-2411 OK02405	**416.0**	**148.1**	**142.2**	**474.3**	**155.2**	**137.6**	**480.0**	**463.0**	**128.8**	**422.1**	**134.0**	**467.1**	**150.1**

LOAF VOLUME, ACTUAL

(Small Scale) Oklahoma

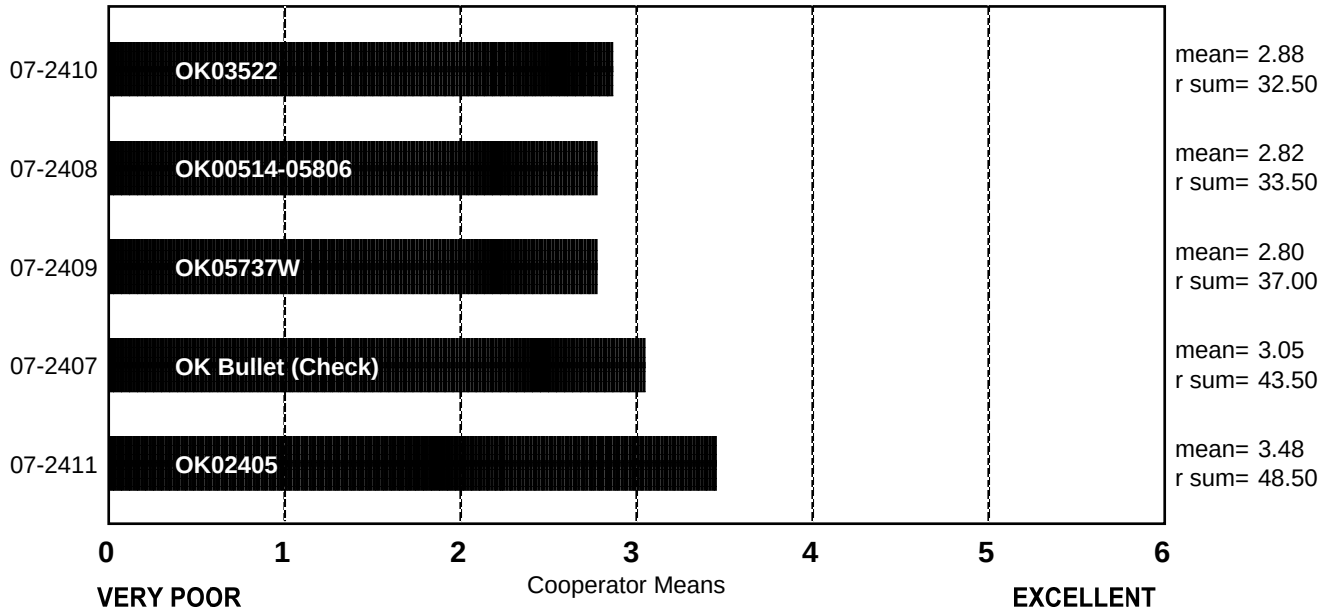
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2407 OK Bullet (Check)	**2800**	**798**	**833**	**2897**	**975**	**670**	**2850**	**2750**	**845**	**2370**	**935**	**2550**	**898**
07-2408 OK00514-05806	**2700**	**835**	**870**	**2883**	**925**	**720**	**2700**	**2875**	**825**	**2360**	**898**	**2525**	**870**
07-2409 OK05737W	**2650**	**885**	**830**	**2853**	**935**	**675**	**2600**	**2800**	**855**	**2190**	**917**	**2588**	**883**
07-2410 OK03522	**2625**	**880**	**820**	**3045**	**920**	**680**	**2800**	**2750**	**800**	**2250**	**872**	**2575**	**840**
07-2411 OK02405	**2800**	**928**	**840**	**3104**	**970**	**720**	**2750**	**3000**	**855**	**2280**	**905**	**2550**	**873**

LOAF VOLUME

(Small Scale) Oklahoma

ncoop= 13
chisq= 5.75
chisqc= 7.56
cvchisq= 9.49
crdiff=

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

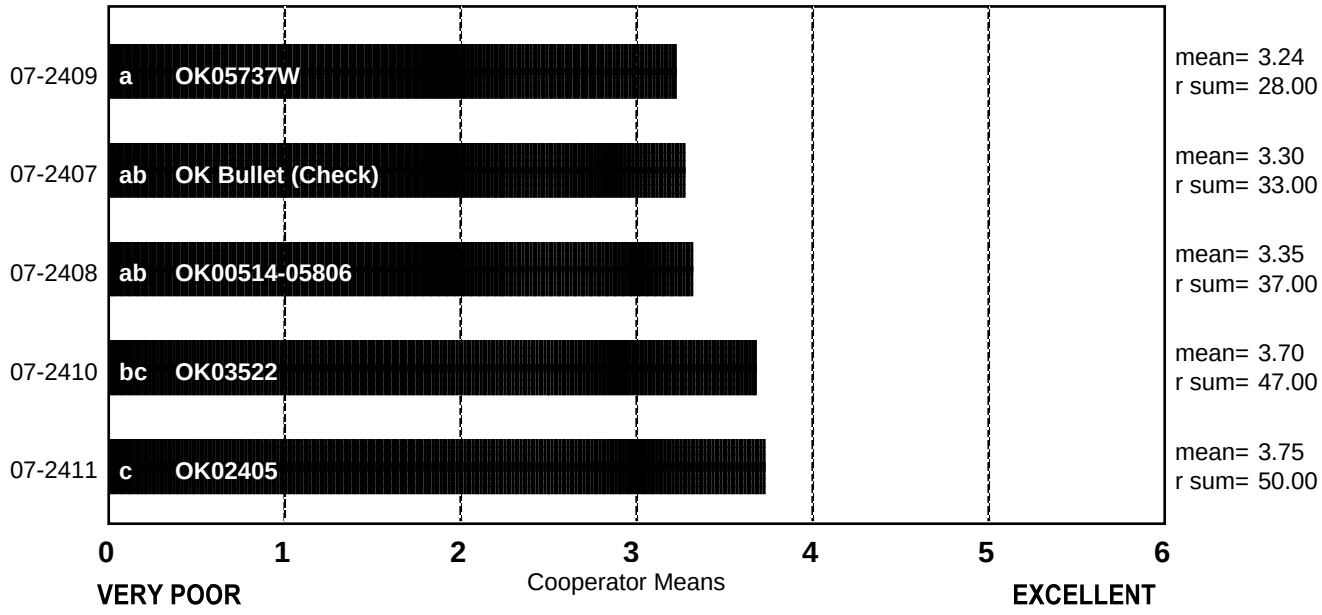


OVERALL BAKING QUALITY

(Small Scale) Oklahoma

ncoop= 13
chisq= 10.65
chisqc= 11.73
cvchisq= 9.49
crdiff= 14.15

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



COOPERATOR'S COMMENTS
(Small Scale) Oklahoma

COOP. 07-2407 (OK Bullet (check))

A. Soft out of mixer, but recovered at makeup. Short mix time (7 minutes). Good volume, but dull crumb color. (7, 8, 9, and 10 equal overall).
B. Short mix.
C. Low and smooth oven-spring, resilient texture.
D. Slack, sticky doughs; very open, irregular grain, average volume.
E. Crumb grain a little weak looking.
F. No comment.
G. Round cells and harsh texture.
H. No comments.
I. Average sample.
J. No comment.
K. Weak, soft doughs. Very poor mix tolerance and open grain. Least favorite overall.
L. Slightly short mix time; sticky dough; open grain.
M. Poor quality exterior appearance with dark crust; good mixing time and loaf volume; questionable open crumb grain.

COOP. 07-2408 (OK00514-05806)

A. Soft dough. Short mixing time (6 minutes). Dull crumb color.
B. Short mix.
C. Medium and smooth oven-spring, resilient texture.
D. Slacky doughs. Very open, extremely irregular grain. Very harsh texture; average volume.
E. Crumb grain a little weak looking.
F. No comment.
G. Short mix time, harsh texture, low volume.
H. No comment.
I. Average sample. Silky texture.
J. No comment.
K. Okay doughs. Weaken significantly during long mix. Poor mix tolerance.
L. Slightly short mix time and low volume. Good grain with white crumb.
M. Good bake absorption; questionable crumb grain with dull crumb color.

COOPERATOR'S COMMENTS
(Small Scale) Oklahoma (Continued)

COOP. 07-2409 (OK005737W)

A. Soft out of mixer and makeup. Short mix time (6 minutes). Very creamy crumb. Scored low mainly due to short mixing time and low volume.
B. No comment.
C. Low and smooth oven-spring, resilient texture.
D. Extremely open grain, very harsh texture. Yellow crumb color.
E. No comment.
F. No comment.
G. Low volume.
H. No comment.
I. Low bake absorption; average sample; yellow crumb color.
J. No comment.
K. Average doughs; poor mix tolerance.
L. Low absorption, slightly short mixing time, good grain.
M. Poor quality exterior; good mixing time; questionable crumb grain with yellow crumb color.

COOP. 07-2410 (OK03522)

A. Dough not very pliable out of mixer. Slightly soft at makeup. 10 minute mixing time. Open grain, low volume, and creamy crumb color.
B. No comment.
C. Medium and smooth oven-spring, resilient texture.
D. Good absorption and volume; very open and irregular grain.
E. Good dough strength and loaf volume (for protein level).
F. Low flour protein.
G. Tough out of mixer.
H. No comment.
I. Good bake absorption; tough out of mixer; poor loaf volume; white crumb color.
J. No comment.
K. Small tolerance window; Doughs slightly strong and dry (but getting putty)- long mix. Underdeveloped on short mix, but two long mixes showed poor tolerance (in bread). White crumb color.
L. Tough dough, open grain, white crumb.
M. Good bake absorption and mixing time; good dough at makeup; questionable crumb grain.

COOPERATOR'S COMMENTS
(Small Scale) Oklahoma (Continued)

COOP. 07-2411 (OK02405)

A. Good strong dough, volume, and mixing time (15 minutes). Slightly open grain. One of the best overall quality.
B. Long mix, tough at makeup.
C. Medium and smooth oven-spring, resilient texture. Hole on side.
D. Slightly open grain, good mixing strength, and excellent volume.
E. Nice crumb grain.
F. No comment.
G. Stronger flour with low volume.
H. No comment.
I. Tough out of mixer and makeup; average sample.
J. No comment.
K. Good doughs, mix tolerance, and grain. Underdeveloped on short mixing time. Fifth favorite overall.
L. Low absorption, slightly long mixing time, average grain.
M. Good absorption and dough handling characteristics; long mixing time; questionable crumb grain with dull crumb color.

Notes: **A, D, G, J, K, and L** comments based on sponge and dough bake test.

Description of Test Plots and Breeder Entries

South Dakota State University – Reported by Amir Ibrahim

Each of the five samples was made of a composite with equal proportions from three locations in western South Dakota (Wall, Winner, and Dakota Lakes). Fall stand establishment and growth were excellent. A mild winter was followed by good moisture in April and May. June and July were very dry but with average temperatures. Average grain yield at 13 locations across the state were as follows: SD00111-9 (56 bu/ac), SD01273 (51 bu/ac), SD01058 (47 bu/ac), SD98W175-1 (46 bu/ac) and Tandem (46 bu/ac).

Tandem (Check) (07-2412)

Tandem (released in 1997) hard red winter wheat (HRWW) was developed from the cross 'Brule'/'Agate'. It is medium maturing and medium height (very similar to 'Arapahoe'). It has moderate resistance to stem rust and is moderately susceptible to both leaf rust and wheat streak mosaic virus (WSMV). Tandem was chosen as a check due to its excellent milling and baking quality attributes and prior favorable performance in the WQC testing.

SD98W175-1 (07-2413)

SD98W175-1 HWWW was developed from the cross KS84273BB-10/KSSB110-9//KS831374-141B/YE1110/3/KS82W418/SPN and is in its second year of testing in the CPT. SD98W175-1 was the highest yielding experimental line in the 2003 Preliminary Yield Trials White (PYTW) nursery and was the second highest yielding in 2004 AYT. SD98W175-1 has good resistance to stem rust and is moderately susceptible to leaf rust. SD98W175-1 had good milling but only fair baking quality attributes in preliminary testing

SD01058 (07-2414)

SD01058 HRWW was developed from the cross XH1877/NE967430 and is in its third year of testing in the CPT. SD01058 was the sixth highest yielding line in 2005 AYT, ranked 3rd in 2006 CPT, and 15th in 2007 CPT. It has excellent disease resistance, including leaf rust, and is postulated to have *Lr24* and *Lr16*.

SD0111-9 (07-2415)

SD0111-9 HRWW was developed from the cross KS93U134/'Arapahoe' and is in its second year of testing in the Crop Performance Testing (CPT) Variety Trial. It ranked best in the 2007 CPT and second best in the 2006 Advanced Yield Trials (AYT). SD0111-9 has excellent disease resistance, including leaf rust, and is postulated to have *Lr24* and Lr*16*, a combination that provided good resistance to leaf rust races prevalent in the northern Great Plains. SD0111-9 had excellent milling and very good baking attributes in predictive quality testing.

SD01273 (07-2416)

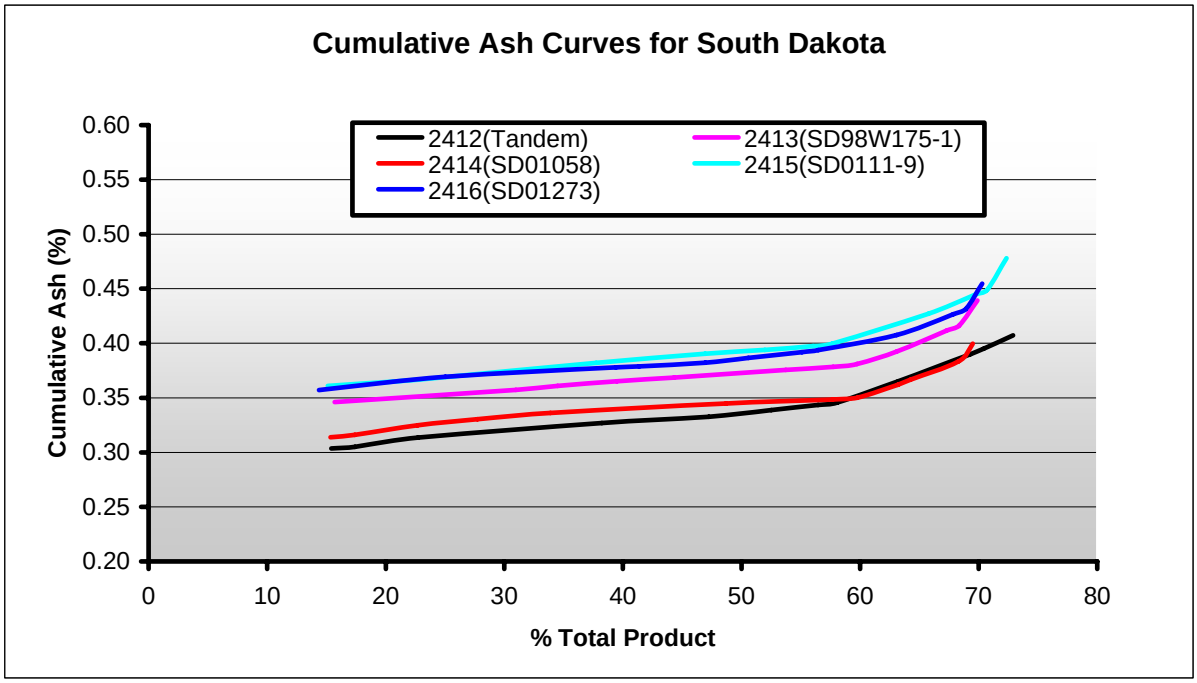
SD01273 HRWW was developed from the cross KS95U589/NE94517 and is in its second year of testing in the CPT. It has good resistance to stem, leaf, and stripe rusts in addition to very good predictive baking and milling quality attributes.

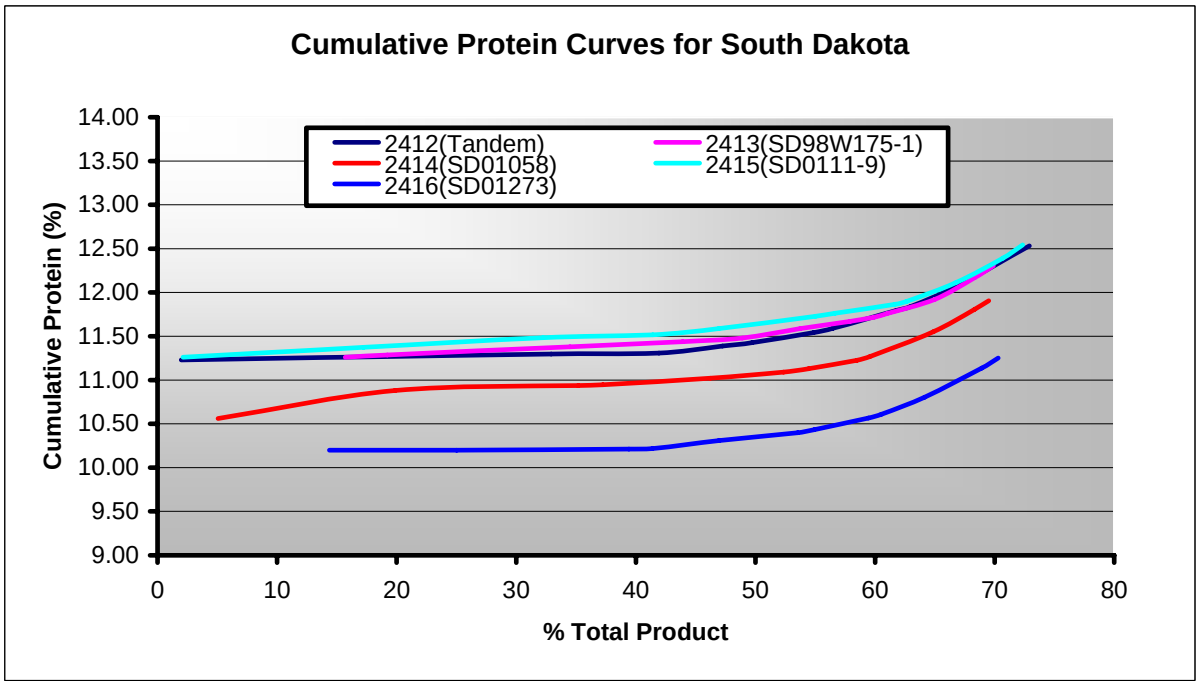
South Dakota: 2007 (Small-Scale) Samples [a]

Test entry number	07-2412	07-2413	07-2414	07-2415	07-2416
Sample identification	Tandem (check)	SD98W175-1	SD01058	SD0111-9	SD01273
Wheat Data					
FGIS classification	1 HRW	4 HDWH	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	61.9	61.9	60.9	61.5	61.5
Hectoliter weight (kg/hl)	81.4	81.4	80.1	80.9	80.9
1000 kernel weight (gm)	32.9	27.8	30.6	32.6	32.8
NIR hardness	80	79	75	83	86
Wheat kernel size (Rotap)					
Over 7 wire (%)	68.4	57.4	60.6	66.3	72.9
Over 9 wire (%)	31.3	41.8	38.9	33.5	26.7
Through 9 wire (%)	0.3	0.8	0.5	0.2	0.4
Single kernel (skcs)					
Hardness (avg /s.d)	66/13.2	70/15.3	57/15.1	68/14.1	72/14.6
Weight (mg) (avg/s.d)	34.4/8.7	29.2/7.7	31.4/9.3	33.9/8.5	33.1/8.6
Diameter (mm)(avg/s.d)	2.46/0.45	2.22/0.48	2.16/0.48	2.41/0.47	2.27/0.50
SKCS distribution	01-04-23-72	00-05-17-78	06-17-35-42	01-05-21-73	01-02-17-80
Classification	Hard	Hard	Hard	Hard	Hard
SKCS Wheat moisture (%)	12.0	11.9	12.4	12.9	12.9
Wheat protein (12% mb)	13.9	14.0	13.4	13.6	12.7
Wheat ash (12% mb)	1.62	1.59	1.54	1.62	1.54
Milling and Flour Quality Data					
Flour yield (%, str. grade)					
Miag Multomat Mill	72.6	69.9	69.5	72.4	70.3
Quadrumat Sr. Mill	73.0	71.8	71.5	73.3	71.7
Flour moisture (%)	12.1	11.4	12.3	11.7	12.1
Flour protein (14% mb)	12.5	12.3	11.9	12.4	11.1
Flour ash (14% mb)	0.42	0.44	0.41	0.48	0.46
Glutomatic					
Wet gluten (%)	36.4	27.3	34.2	37.3	32.1
Dry gluten (%)	12.9	12.4	12.1	12.6	11.0
Gluten index	95.1	80.6	94.2	80.8	93.0
Flour color					
Agtron flour color	70	71	72	70	69
Simon/Kent-Jones flour color	-0.47	-0.43	-0.23	-0.52	-0.11
Minolta color meter					
L*	92.23	92.49	92.51	92.21	92.13
a*	-1.66	-1.40	-1.83	-1.78	-2.07
b*	10.01	8.93	10.35	10.81	11.70
Falling number (sec)	550	594	591	522	500
Flour particle size (avg)					
Fisher sub sieve sizer	21.8	22.5	21.8	21.5	22.0

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

South Dakota: Cumulative Ash and Protein Curves

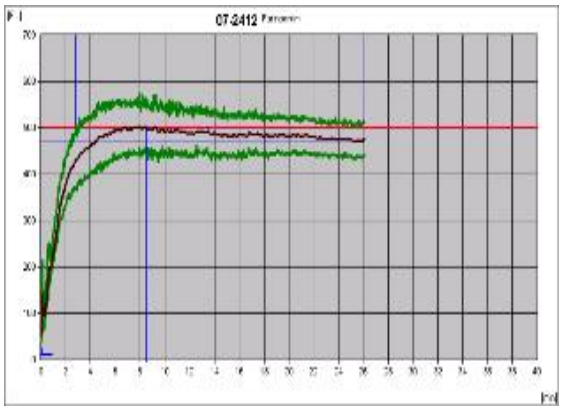




Physical Dough Tests

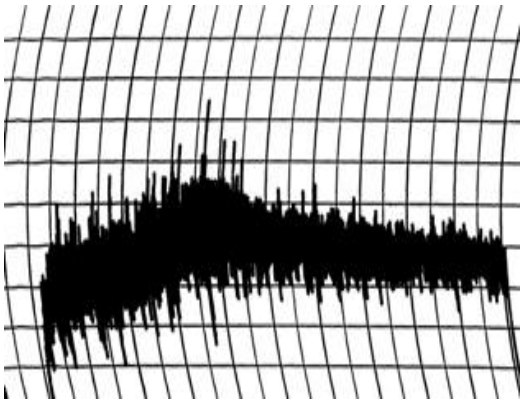
2007 (Small Scale) Samples – South Dakota

Farinograms



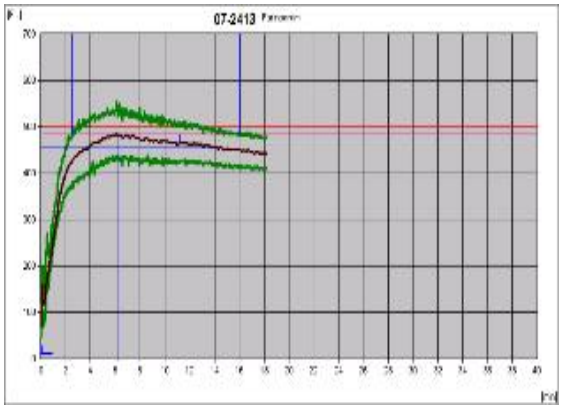
Abs. 61.5%, Peak 8.5 min, Stab. 23.2 min

Mixograms

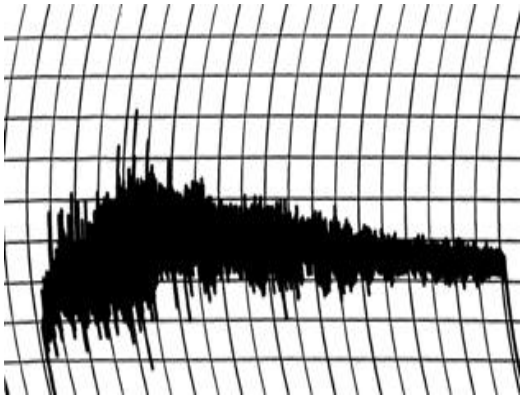


Abs.63.7%, Mix time 3.6 min, Mix tol 2

07-2412, Tandem (check)



Abs. 60.8%, Peak6.2 min, Stab. 13.5 min



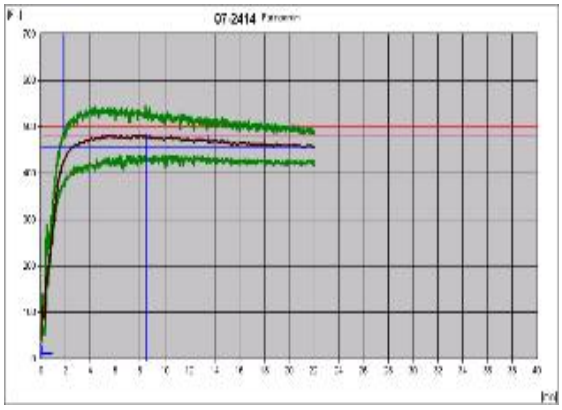
Abs. 63.4%, Mix time 2.5 min, Mix tol 1

07-2413, SD98W175-1

Physical Dough Tests

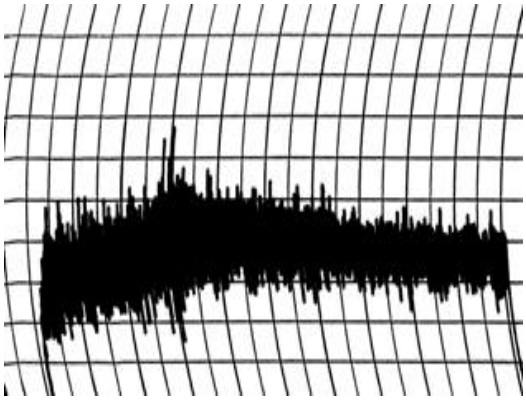
2007 (Small Scale) Samples – South Dakota (continued)

Farinograms



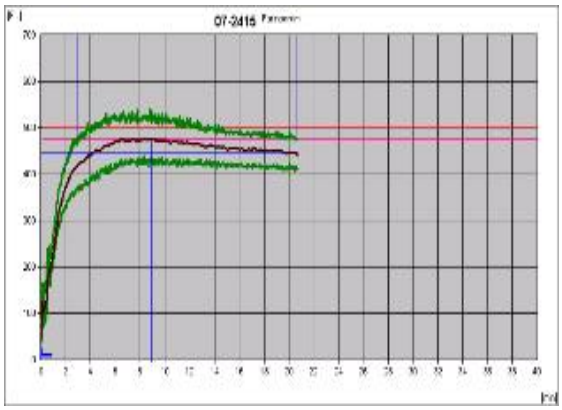
Abs. 60.3%, Peak 8.5 min, Stab. 20.2 min

Mixograms

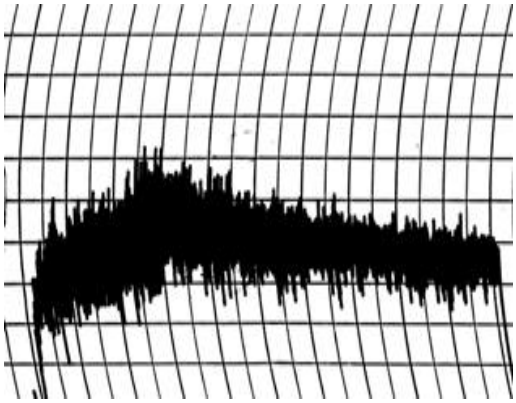


Abs. 61.8%, Mix time 3.3 min, Mix tol 2

07-2414, SD01058



Abs. 60.6%, Peak 9.0 min, Stab. 17.7 min



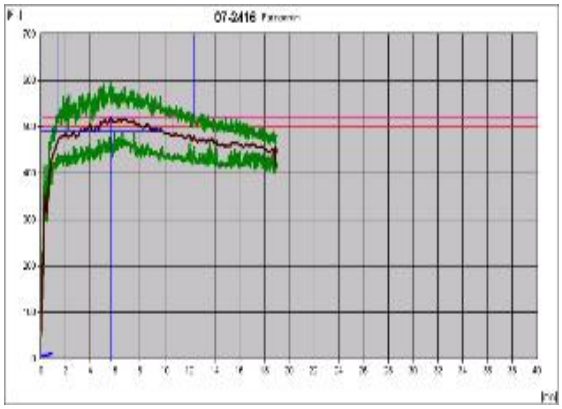
Abs. 62.6%, Mix time 3.0 min, Mix tol 2

07-2415, SD0111-9

Physical Dough Tests

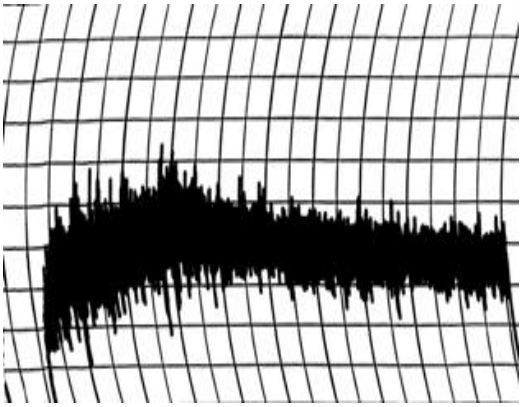
2007 (Small Scale) Samples – South Dakota (continued)

Farinograms



Abs. 61.9%, Peak 6.2 min, Stab.14.0 min

Mixograms

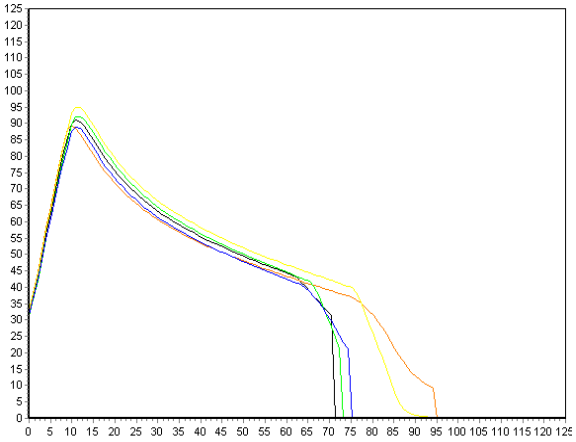


Abs. 61.5%, Mix time 3.0 min, Mix tol 2

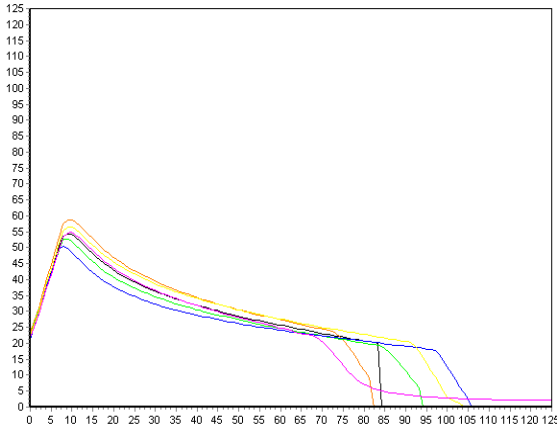
07-2416, SD01273

Physical Dough Tests - Alveograph

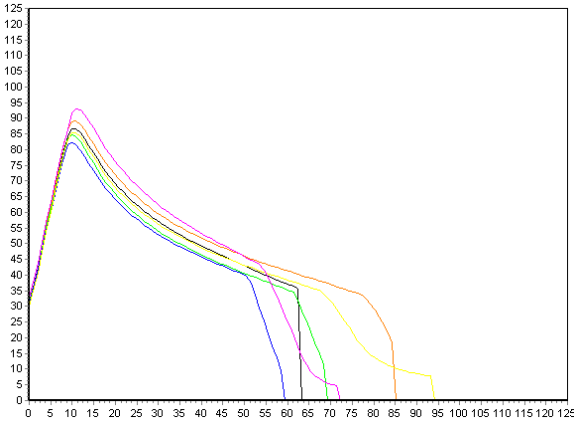
2007 (Small Scale) Samples – South Dakota



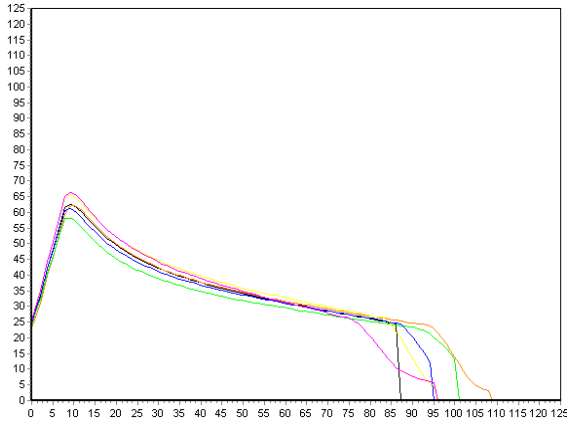
07-2412 (Tandem)
P =100 (mm H20), L =71 mm, P/L=1.41



07-2413 (SD98W175-1)
P = 60 (mm H20), L=83 mm, P/L=0.72



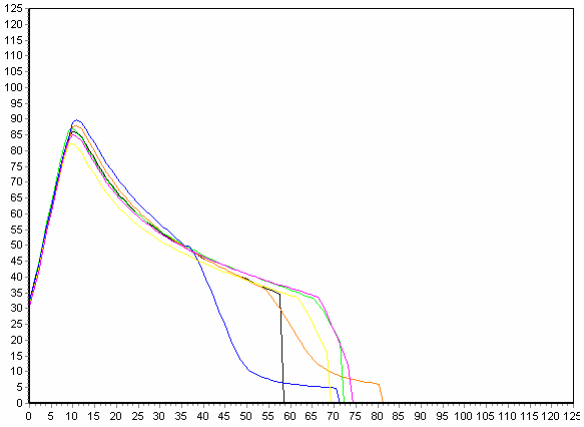
07-2414 (SD01058)
P = 95 (mm H20), L = 63 mm, P/L = 1.51



07-2415 (SD0111-9)
P = 69 (mm H20), L = 87 mm, P/L = 0.79

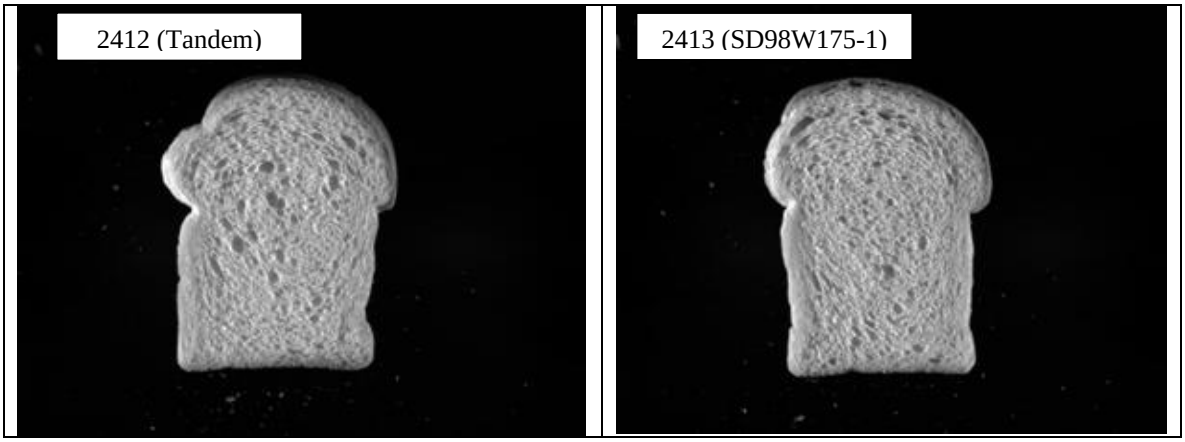
Physical Dough Tests - Alveograph

2007 (Small Scale) Samples – South Dakota (continued)

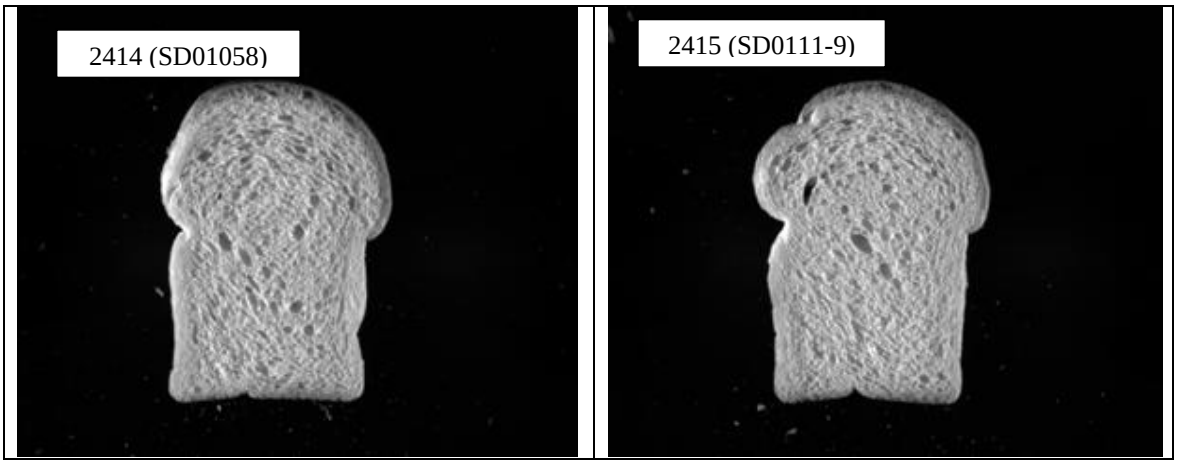


07-2416 (SD01273)
P =95 (mm H20), L =58 mm, P/L=1.64

South Dakota: C-Cell Bread Images and Analysis for 2007(Small-Scale) Samples



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2412	5950	153.3	3326	0.459	2.072	1.63	1.73	-8.9
2413	6131	151.0	3839	0.441	1.967	0.99	1.66	-17.6



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	6302	156.5	3808	0.446	2.078	1.08	1.72	-17.3
2415	6373	156.9	4084	0.441	1.998	1.14	1.66	-22.8

South Dakota: C-Cell Bread Images and Analysis for 2007(Small-Scale) Samples (continued)

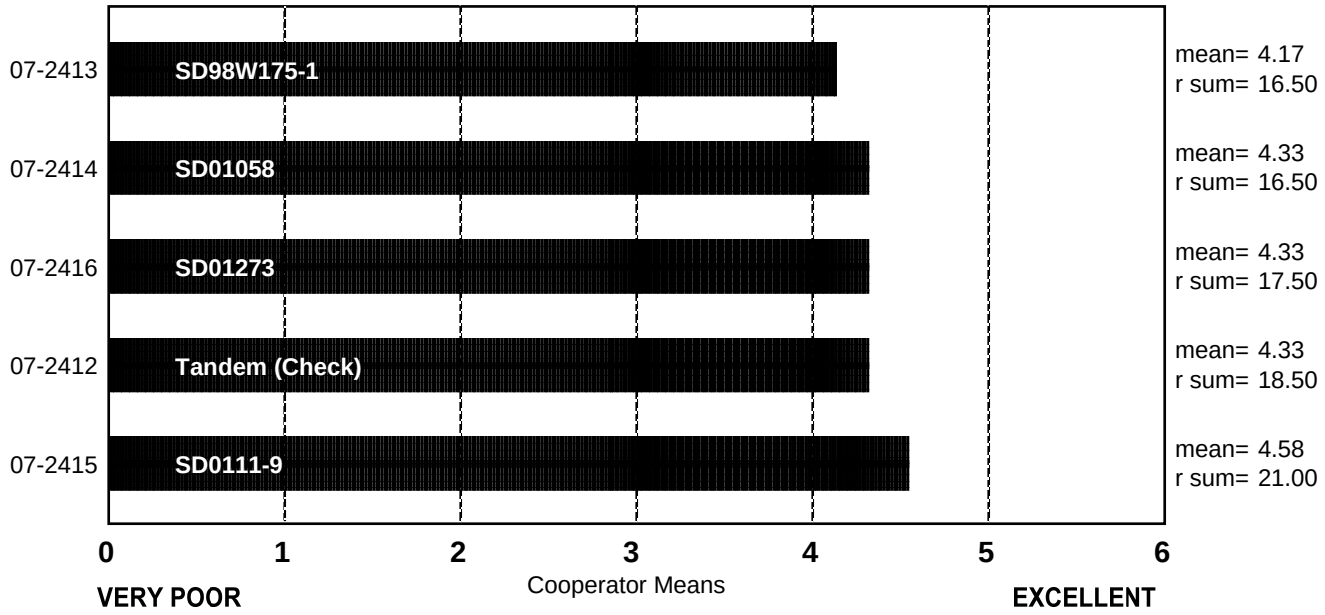
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2416	6005	156.4	3880	0.437	1.954	1.60	1.67	-17.9

SPONGE CHARACTERISTICS

(Small Scale) South Dakota

ncoop= 6
chisq= 0.93
chisqc= 1.37
cvchisq= 9.49
crdiff=

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

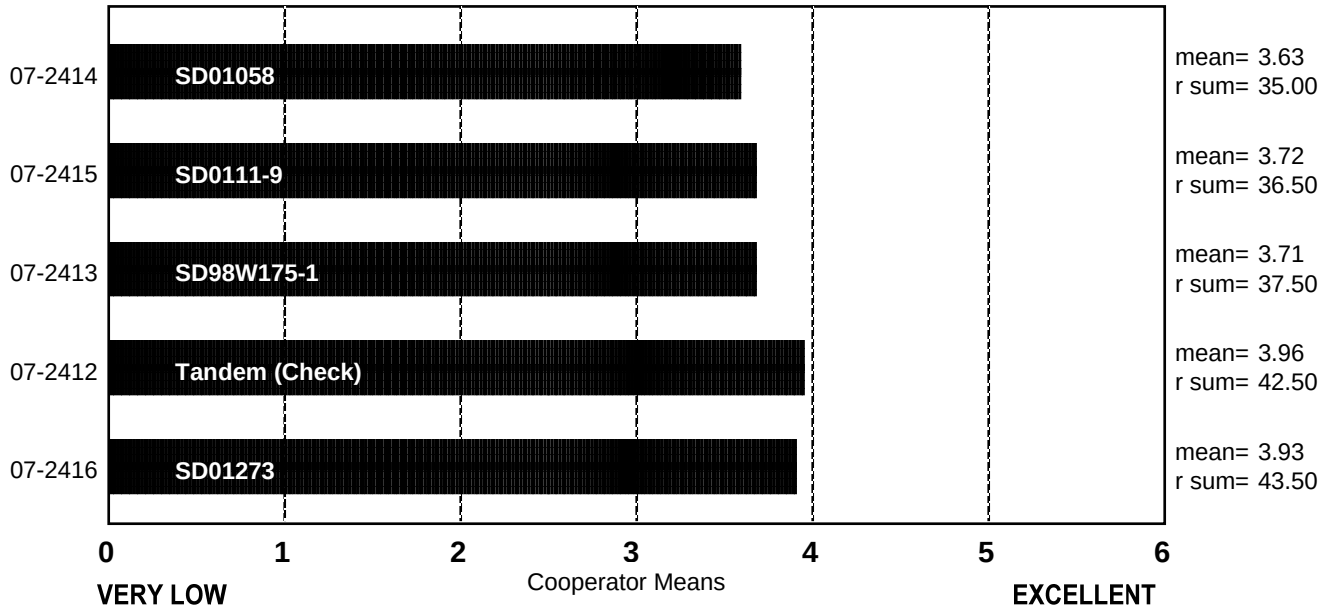


BAKE ABSORPTION

(Small Scale) South Dakota

ncoop= 13
chisq= 1.75
chisqc= 3.59
cvchisq= 9.49
crdiff=

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) South Dakota

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2412 Tandem (Check)	**59.0**	**69.8**	**61.0**	**61.0**	**67.7**	**61.7**	**61.4**	**63.5**	**60.0**	**64.5**	**63.0**	**60.0**	**61.8**
07-2413 SD98W175-1	**59.0**	**69.5**	**61.0**	**61.0**	**66.7**	**61.7**	**61.4**	**62.8**	**59.3**	**63.8**	**63.0**	**60.0**	**60.3**
07-2414 SD01058	**59.0**	**67.9**	**60.0**	**61.0**	**68.2**	**60.7**	**59.3**	**62.3**	**58.8**	**63.3**	**62.0**	**60.0**	**60.2**
07-2415 SD0111-9	**59.0**	**68.7**	**61.0**	**61.0**	**66.2**	**61.2**	**60.7**	**62.6**	**59.1**	**63.6**	**63.0**	**61.0**	**59.4**
07-2416 SD01273	**58.0**	**67.6**	**62.0**	**61.0**	**66.2**	**62.1**	**59.3**	**63.9**	**60.4**	**64.9**	**60.0**	**62.0**	**63.5**

BAKE MIX TIME, ACTUAL

(Small Scale) South Dakota

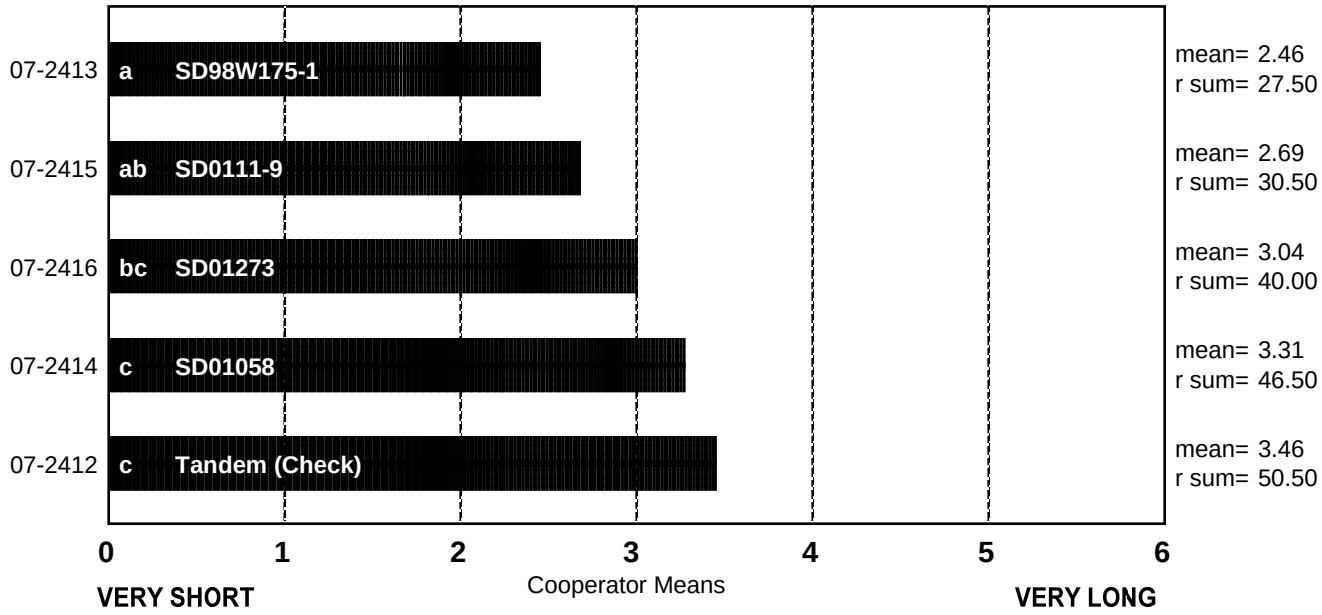
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2412 Tandem (Check)	**10.0**	**3.0**	**4.6**	**25.0**	**4.1**	**2.0**	**4.0**	**8.0**	**3.0**	**8.0**	**6.0**	**8.0**	**4.1**
07-2413 SD98W175-1	**6.0**	**2.5**	**4.1**	**24.0**	**3.1**	**1.5**	**2.5**	**5.5**	**2.8**	**6.0**	**6.0**	**7.0**	**3.1**
07-2414 SD01058	**11.0**	**3.3**	**4.8**	**25.0**	**3.6**	**1.8**	**4.0**	**6.5**	**2.5**	**12.0**	**6.0**	**7.0**	**4.0**
07-2415 SD0111-9	**8.0**	**3.0**	**4.4**	**22.0**	**3.1**	**1.8**	**2.5**	**6.0**	**2.5**	**8.0**	**3.0**	**7.0**	**3.5**
07-2416 SD01273	**10.0**	**3.0**	**4.7**	**24.0**	**4.2**	**1.5**	**3.0**	**5.5**	**2.5**	**10.0**	**3.0**	**5.0**	**3.9**

BAKE MIX TIME

(Small Scale) South Dakota

ncoop= 13
chisq= 12.12
chisqc= 18.43
cvchisq= 9.49
crdiff= 11.00

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

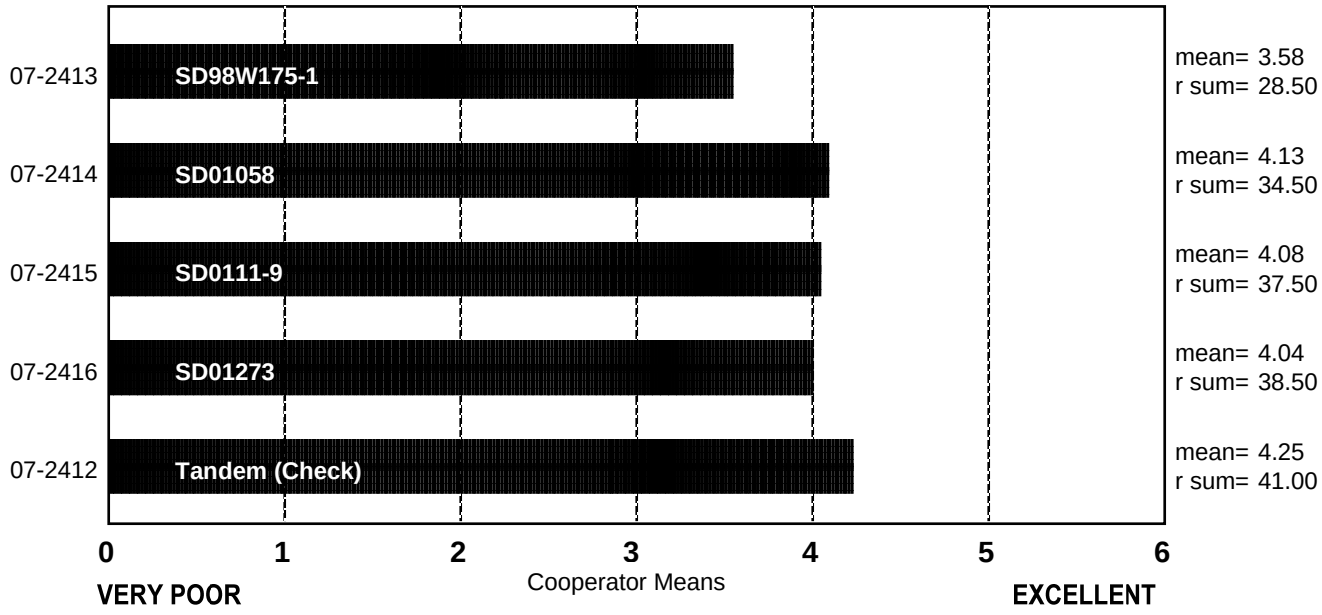


MIXING TOLERANCE

(Small Scale) South Dakota

ncoop= 12
chisq= 3.07
chisqc= 5.15
cvchisq= 9.49
crdiff=

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

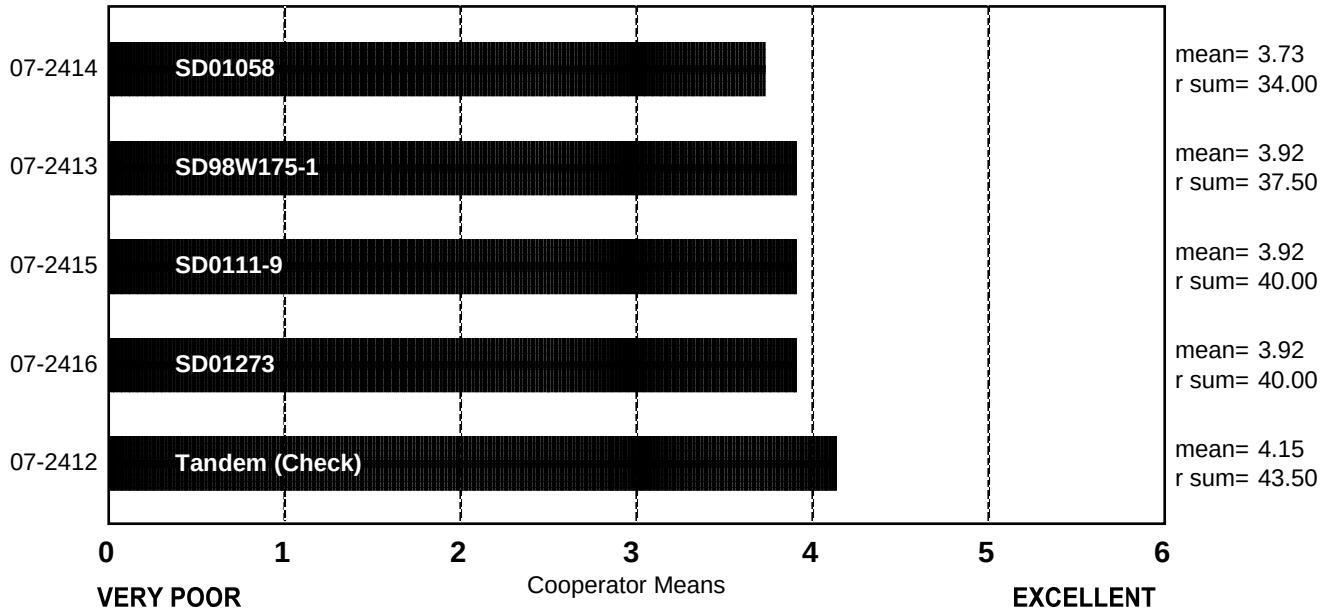


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) South Dakota

ncoop= 13
chisq= 1.52
chisqc= 2.40
cvchisq= 9.49
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) South Dakota

	Sticky	Wet	Tough	Good	Excellent
07-2412 Tandem (Check)	**0**	**0**	**3**	**8**	**2**
07-2413 SD98W175-1	**5**	**0**	**1**	**6**	**1**
07-2414 SD01058	**5**	**0**	**3**	**5**	**0**
07-2415 SD0111-9	**3**	**1**	**1**	**7**	**1**
07-2416 SD01273	**2**	**1**	**4**	**6**	**0**

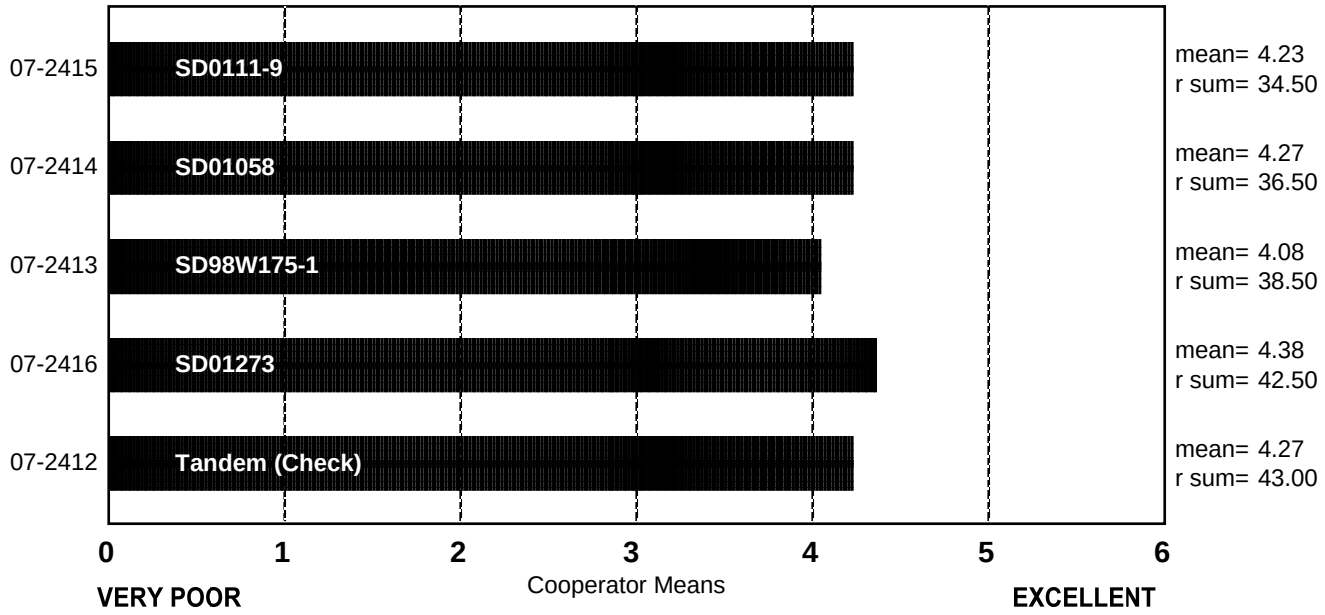
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) South Dakota

ncoop= 13
chisq= 1.69
chisqc= 2.42
cvchisq= 9.49
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) South Dakota

	Sticky	Wet	Tough	Good	Excellent
07-2412 Tandem (Check)	**0**	**1**	**5**	**6**	**1**
07-2413 SD98W175-1	**3**	**1**	**0**	**8**	**1**
07-2414 SD01058	**1**	**0**	**2**	**10**	**0**
07-2415 SD0111-9	**1**	**1**	**2**	**7**	**2**
07-2416 SD01273	**0**	**0**	**3**	**9**	**1**

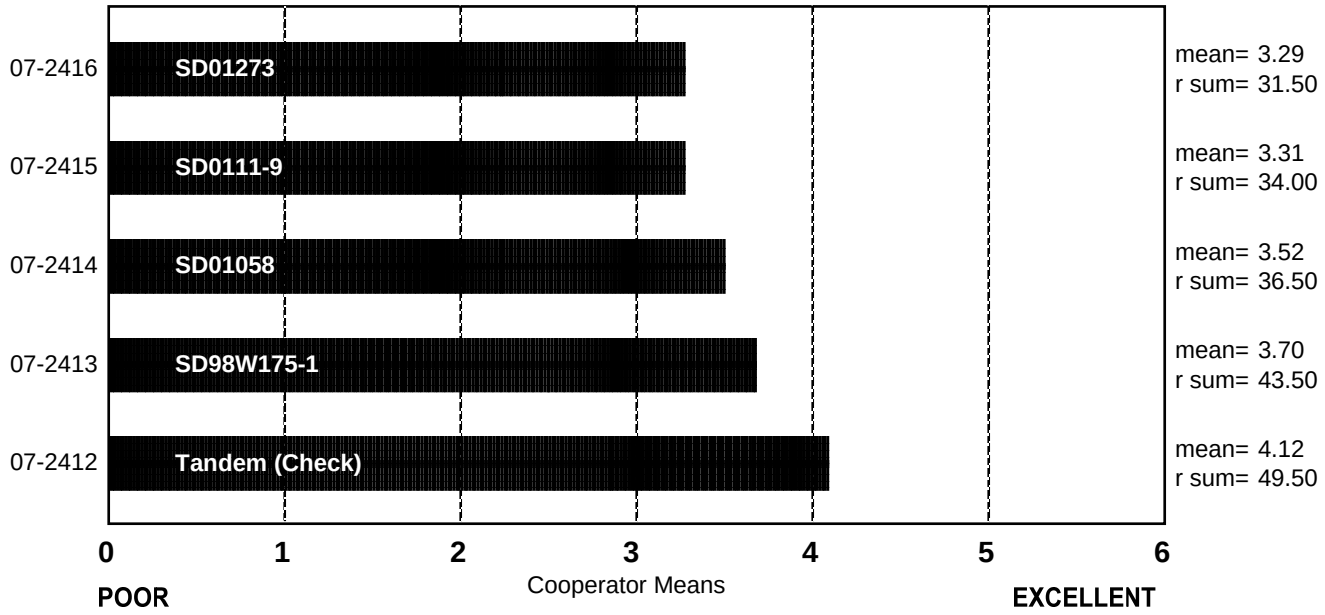
Frequency Table

CRUMB GRAIN

(Small Scale) South Dakota

ncoop= 13
chisq= 6.71
chisqc= 7.65
cvchisq= 9.49
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) South Dakota

	Open	Fine	Dense
07-2412 Tandem (Check)	**7**	**5**	**1**
07-2413 SD98W175-1	**4**	**8**	**1**
07-2414 SD01058	**7**	**5**	**1**
07-2415 SD0111-9	**7**	**6**	**0**
07-2416 SD01273	**7**	**4**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) South Dakota

	Round	Irregular	Elongated
07-2412 Tandem (Check)	**4**	**2**	**7**
07-2413 SD98W175-1	**3**	**6**	**4**
07-2414 SD01058	**1**	**5**	**7**
07-2415 SD0111-9	**2**	**5**	**6**
07-2416 SD01273	**5**	**5**	**3**

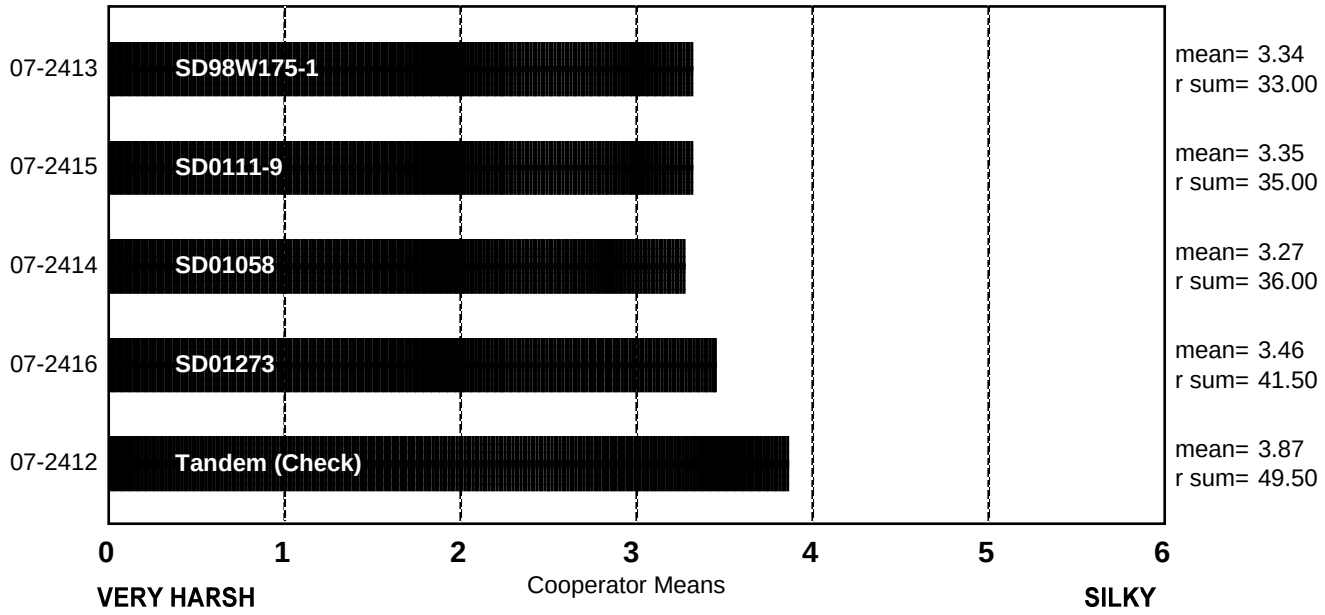
Frequency Table

CRUMB TEXTURE

(Small Scale) South Dakota

ncoop= 13
chisq= 5.46
chisqc= 7.24
cvchisq= 9.49
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) South Dakota

	Harsh	Smooth	Silky
07-2412 Tandem (Check)	**2**	**8**	**3**
07-2413 SD98W175-1	**3**	**10**	**0**
07-2414 SD01058	**5**	**7**	**1**
07-2415 SD0111-9	**5**	**7**	**1**
07-2416 SD01273	**2**	**11**	**0**

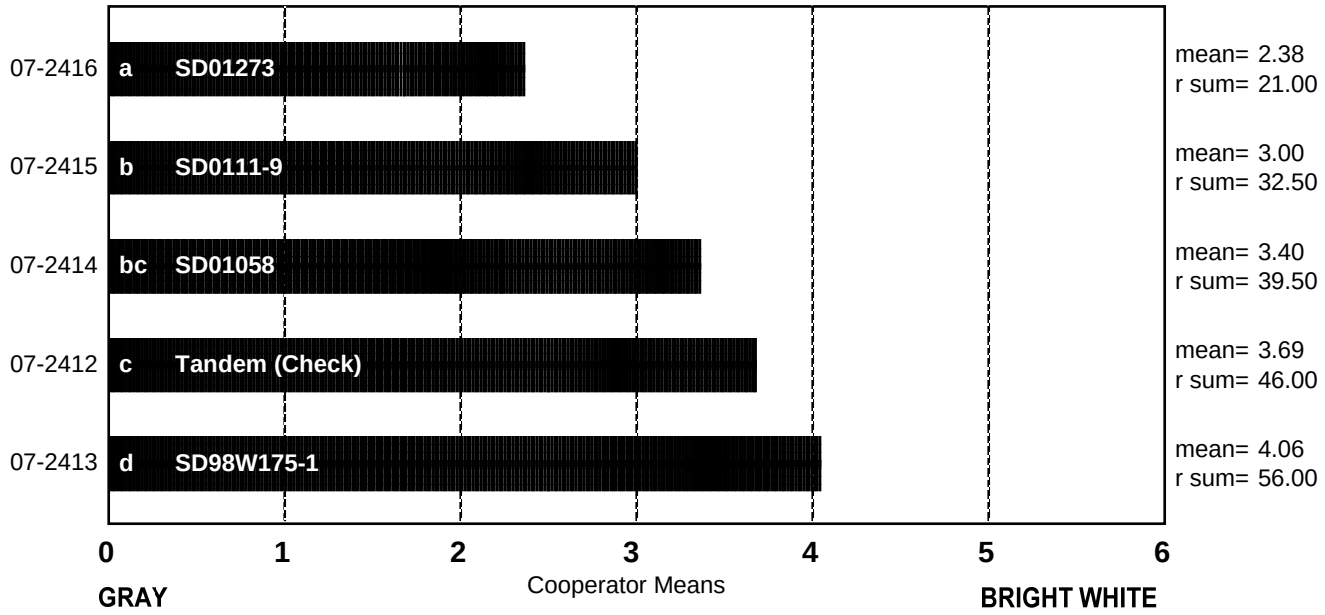
Frequency Table

CRUMB COLOR

(Small Scale) South Dakota

ncoop= 13
chisq= 21.68
chisqc= 28.32
cvchisq= 9.49
crdiff= 9.96

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



CRUMB COLOR, DESCRIBED

(Small Scale) South Dakota

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
07-2412 Tandem (Check)	**0**	**0**	**2**	**2**	**7**	**2**	**0**
07-2413 SD98W175-1	**0**	**0**	**1**	**1**	**6**	**4**	**0**
07-2414 SD01058	**0**	**1**	**2**	**2**	**7**	**1**	**0**
07-2415 SD0111-9	**0**	**0**	**5**	**2**	**6**	**0**	**0**
07-2416 SD01273	**0**	**1**	**7**	**4**	**1**	**0**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) South Dakota

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2412 Tandem (Check)	**411.0**	**149.7**	**145.1**	**469.8**	**157.6**	**137.8**	**487.0**	**457.0**	**132.1**	**418.3**	**134.0**	**467.7**	**149.1**
07-2413 SD98W175-1	**411.0**	**147.4**	**143.3**	**469.4**	**154.2**	**138.7**	**485.0**	**455.0**	**128.3**	**418.2**	**134.0**	**467.5**	**149.5**
07-2414 SD01058	**418.0**	**147.5**	**148.5**	**481.2**	**155.2**	**137.3**	**489.0**	**452.0**	**133.0**	**424.2**	**134.0**	**466.0**	**147.9**
07-2415 SD0111-9	**418.0**	**146.4**	**144.8**	**488.6**	**156.5**	**137.4**	**489.5**	**458.0**	**129.9**	**419.1**	**134.0**	**466.9**	**147.3**
07-2416 SD01273	**413.0**	**150.1**	**143.7**	**487.5**	**155.1**	**139.5**	**487.0**	**451.0**	**134.4**	**416.5**	**134.0**	**463.1**	**151.3**

LOAF VOLUME, ACTUAL

(Small Scale) South Dakota

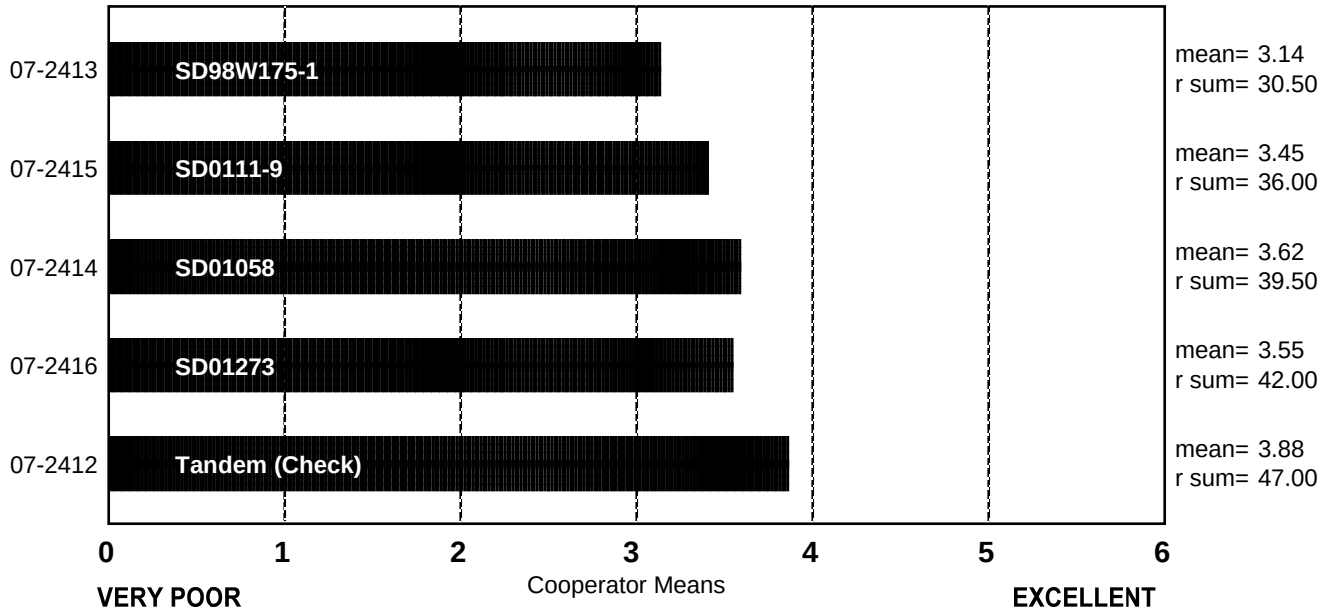
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2412 Tandem (Check)	**2900**	**923**	**835**	**3104**	**985**	**775**	**2850**	**2850**	**905**	**2300**	**955**	**2638**	**890**
07-2413 SD98W175-1	**2775**	**885**	**855**	**2839**	**980**	**640**	**2850**	**2875**	**840**	**2275**	**932**	**2638**	**865**
07-2414 SD01058	**2900**	**943**	**845**	**3045**	**975**	**720**	**2800**	**2850**	**880**	**2075**	**977**	**2588**	**908**
07-2415 SD0111-9	**2800**	**848**	**838**	**3045**	**965**	**725**	**2650**	**2825**	**875**	**2280**	**982**	**2650**	**880**
07-2416 SD01273	**2900**	**938**	**850**	**3045**	**910**	**700**	**2850**	**2525**	**880**	**2410**	**945**	**2713**	**880**

LOAF VOLUME

(Small Scale) South Dakota

ncoop= 13
chisq= 4.75
chisqc= 6.47
cvchisq= 9.49
crdiff=

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

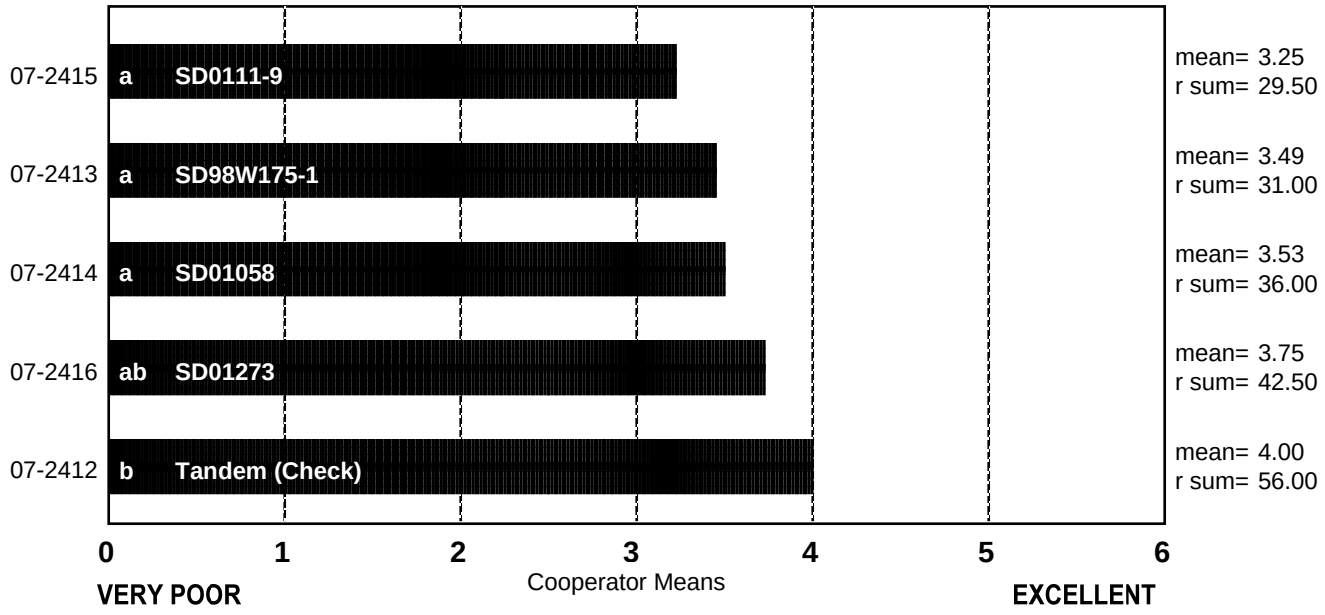


OVERALL BAKING QUALITY

(Small Scale) South Dakota

ncoop= 13
chisq= 14.29
chisqc= 15.55
cvchisq= 9.49
crdiff= 13.55

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



COOPERATOR'S COMMENTS
(Small Scale) South Dakota

COOP. 07-2412 (Tandem (check))

A. Good feeling dough. 10 minute mix time. Nice interior with creamy crumb. Excellent volume; better quality.
B. Mellow dough.
C. Medium and smooth oven-spring, resilient texture.
D. Very good strength, slightly open grain, excellent volume.
E. Good performance for protein level.
F. Good elasticity of dough at panning; good bread volume.
G. Overall good bake.
H. No comment.
I. Average sample with silky texture, but tough at makeup.
J. No comment.
K. Good doughs. Tolerance drops off a bit on long mix though.
L. Tough dough, good grain, yellow crumb.
M. Good mixing time especially at makeup. Satisfactory crumb grain with creamy crumb color.

COOP. 07-2413 (SD98W175-1)

A. Soft dough. Short mix time (6 minutes). Nice interior, but scored down due to mix time and soft dough with average volume.
B. Short mix, mellow dough.
C. Medium and smooth oven-spring, resilient texture.
D. Extremely open and irregular grain. Thick cell walls, harsh texture, slightly low volume.
E. Good loaf volume for protein level. Dough marginal.
F. No comment.
G. Short mix time, round cells.
H. No comment.
I. Average sample with good grain.
J. No comment.
K. Weak and tacky doughs. Poor mix tolerance on long mix, but nice grain with white crumb color.
L. Average grain, white crumb.
M. Short mixing time, poor tolerance. Questionable crumb grain, but satisfactory with a dull crumb color.

COOPERATOR'S COMMENTS
(Small Scale) South Dakota (Continued)

COOP. 07-2414 (SD01058)

A. Slightly tough out of mixer, but recovered well at makeup. Eleven minute mix time; good volume.
B. No comment.
C. Medium and smooth oven-spring, resilient texture.
D. Very open, irregular grain; good mixing strength and volume.
E. Good overall quality (for protein level).
F. No comment.
G. Low absorption.
H. No comment.
I. Average sample, low bake absorption, but good, silky texture.
J. No comment.
K. Okay doughs, but recovered significantly in bread by baking up well. Third favorite overall.
L. Good grain.
M. Medium mixing time; questionable crumb grain with yellow crumb color.

COOP. 07-2415 (SD0111-9)

A. Good dough and volume; 8 minute mix time; Machined well, open grain, slightly dull crumb. (15, 16, and 19 overall equal).
B. Mellow dough with a yellow color.
C. Medium and smooth oven-spring, resilient texture. Hole located on side.
D. Open, irregular grain with a harsh texture, but good volume.
E. Dough a little weak with average loaf.
F. Good dough elasticity at panning.
G. Short mix time. Low volume, with yellow crumb.
H. No comment.
I. Average sample with low bake absorption, but good, silky texture.
J. No comment.
K. Good, strong doughs. Slightly, poor mix tolerance; open grain.
L. Open grain with yellow crumb.
M. Questionable crumb grain, but satisfactory with yellow crumb color.

COOPERATOR'S COMMENTS
(Small Scale) South Dakota (Continued)

COOP. 07-2416 (SD01273)

A. Good strong dough with nice volume, but dull color and open grain. 10 minute mix time.
B. Yellow color.
C. Medium and smooth oven-spring, resilient texture.
D. Fairly tight grain. Very good dough feel and volume.
E. Good performance (for protein level).
F. Low protein level for flour. Dough very soft and weak at panning.
G. Low absorption, short mix time, yellow crumb color.
H. No comment.
I. Average sample, tough out of mixer and makeup with yellow crumb color.
J. No comment.
K. Strong, dry doughs. Slightly poor mix tolerance; open grain.
L. Good absorption, slightly short mix time, yellow crumb, good volume.
M. Good bake absorption and mixing time. Questionable crumb grain with yellow crumb color.

Notes: **A, D, G, J, K, and L** comments based on sponge and dough bake test.

Description of Test Plots and Breeder Entries

Montana State University – reported by Phil L. Bruckner

Montana CQC drill strips were grown at Bozeman, MT (planting date 9/29/2006 for MT0495 and MTS04114, 11/8/2006 for Genou). Growing conditions were favorable at this site with timely and abundant rainfall leading to grain yield potential near 100 bu/acre. Genotypes were differentially infected by stripe rust with Genou showing a moderately susceptible reaction and MT0495 and MTS04114 showing resistant reactions.

Genou (07-2417)

Genou is a solid-stem hard red winter wheat with tolerance to wheat stem sawfly which was released by the Montana Agricultural Experiment Station in 2004. In 2007, Genou replaced Rampart as the most planted winter wheat cultivar in Montana occupying about 16% of Montana's 2.2 million acres. In Montana, solid-stem cultivars are completive with hollow-stem cultivars for yield only in wheat stem sawfly-infested environments.

MT0495 (07-2418)

MT0495 (MT9640/Hybritech NB1133) is a high-yielding hard red winter wheat line with excellent cold tolerance which is being purified and increased for potential release. One potential area of concern with MT0495 is moderate to low test weight (similar to Wahoo and Yellowstone).

MTS04114 (07-2419)

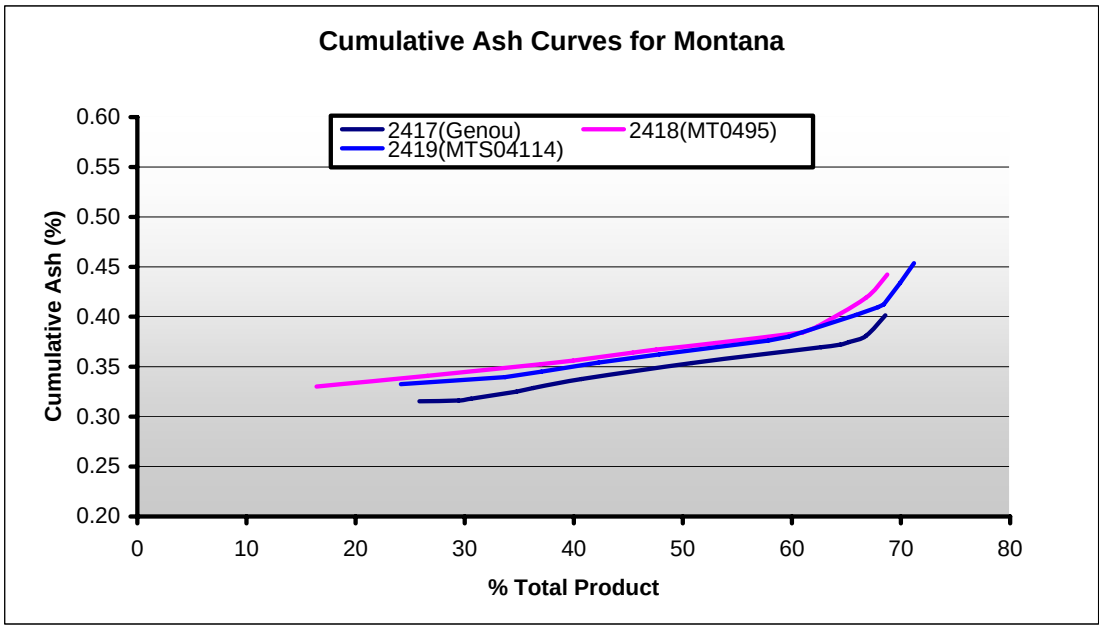
MTS04114 (L'Govskaya 167/Rampart//MT9409) is a high-yielding, solid-stem hard white winter wheat line with tolerance to wheat stem sawfly. MTS04114 has improved grain yield potential (+9%, n=45) and cold tolerance relative to commercial check, Genou. MTS04114 is a high PPO hard white line with poor Asian noodle color stability. For this reason we plan to release a low PPO backcross derivative of MTS04114 rather than this original line.

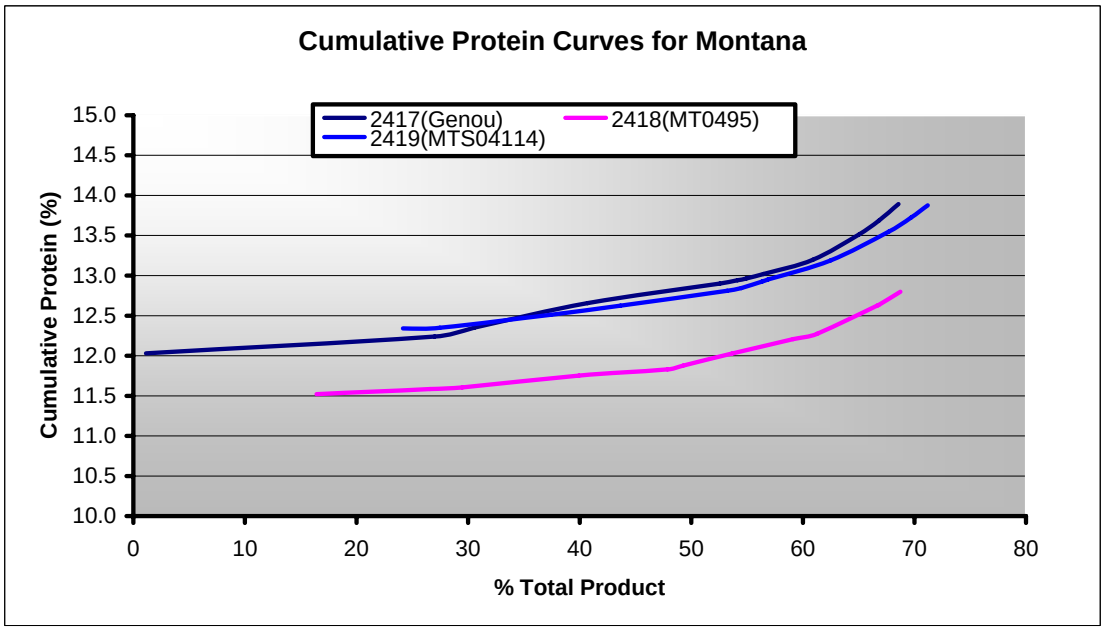
Montana: 2007 (Small-Scale) Samples [a]

Test entry number	07-2417	07-2418	07-2419
Sample identification	Genou (Check)	MT0495	MTS04114
Wheat Data			
FGIS classification	2 HRW	1 HRW	1 HDWH
Test weight (lb/bu)	58.3	61.4	62.2
Hectoliter weight (kg/hl)	77	81	82
1000 kernel weight (gm)	22.3	32.8	33.2
NIR hardness	71.0	70.3	68.2
Wheat kernel size (Rotap)			
Over 7 wire (%)	23.4	71.1	67.1
Over 9 wire (%)	72.7	28.8	32.9
Through 9 wire (%)	3.9	0.1	0.0
Single kernel (skcs)			
Hardness (avg /s.d)	64/16.5	69/13.4	56/14.2
Weight (mg) (avg/s.d)	24.4/8.5	32.9/7.3	35.5/9.2
Diameter (mm)(avg/s.d)	1.87/0.42	2.43/0.45	2.41/0.50
SKCS distribution	07-07-21-65	02-05-14-79	05-23-32-40
Classification	Hard	Hard	Hard
SKCS Wheat moisture (%)	10.6	10.5	10.5
Wheat protein (12% mb)	15.1	12.5	13.1
Wheat ash (12% mb)	1.60	1.51	1.49
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	70.6	72.5	73.1
Quadrumat Sr. Mill	73.0	73.2	73.5
Flour moisture (%)	12.4	12.9	13.0
Flour protein (14% mb)	13.7	11.0	11.7
Flour ash (14% mb)	0.43	0.38	0.39
Glutomatic			
Wet gluten (%)	36.4	31.7	32.9
Dry gluten (%)	13.8	11.0	11.5
Gluten index	98.8	94.3	97.1
Flour color			
Agtron flour color	72	74	74
Simon/Kent-Jones flour color	-0.84	-1.25	-1.15
Minolta color meter			
L*	92.58	92.53	92.74
a*	-1.69	-1.82	-1.82
b*	9.57	10.18	10.0
Falling number (sec)	471	384	440
Flour particle size (avg)			
Fisher sub sieve sizer	19.0	19.3	19.0

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

Montana: Cumulative Ash and Protein Curves

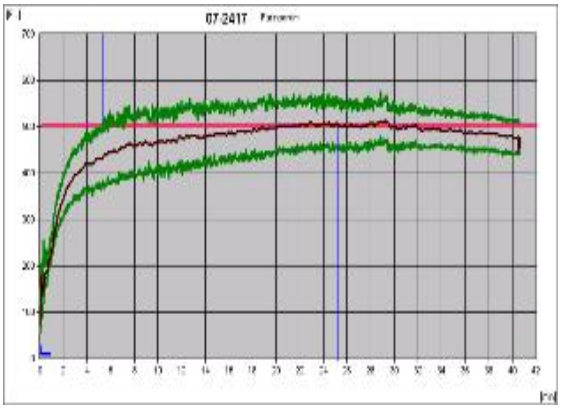




Physical Dough Tests

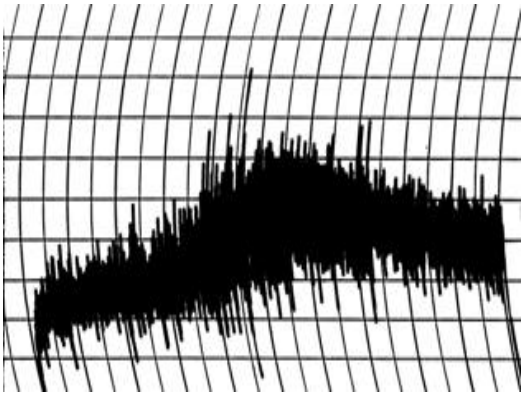
2007 (Small Scale) Samples - Montana

Farinograms



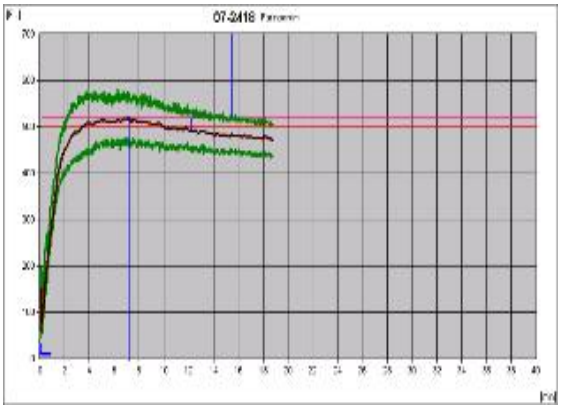
Abs. 61.0%, Peak 25.3 min, Stab. 35.2 min

Mixograms

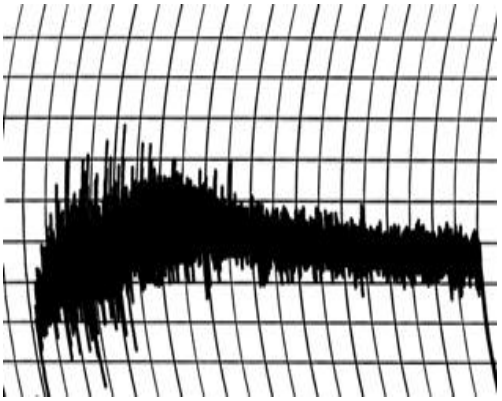


Abs. 65.8%, Mix time 5.5 min, Mix tol 6

07-2417, Genou (check)



Abs. 60.6%, Peak 7.2 min, Stab. 13.3 min



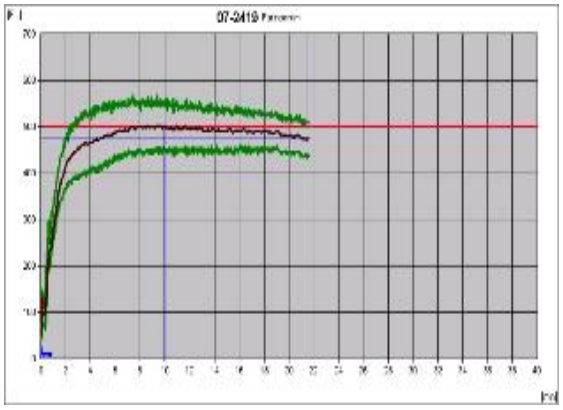
Abs. 61.3%, Mix time 3.0 min, Mix tol 2

07-2418, MT0495

Physical Dough Tests

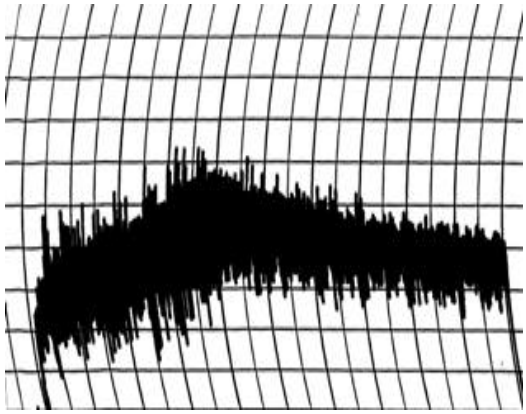
2007 (Small Scale) Samples - Montana (continued)

Farinograms



Abs. 59.3%, Peak 10.0 min, Stab. 19.1 min

Mixograms

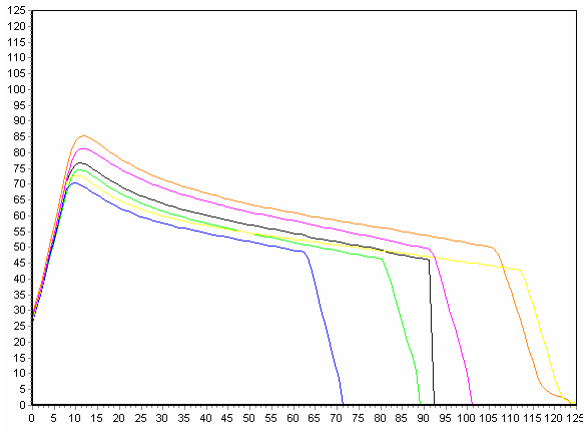


Abs. 62.5%, Mix time 4.0 min, Mix tol 4

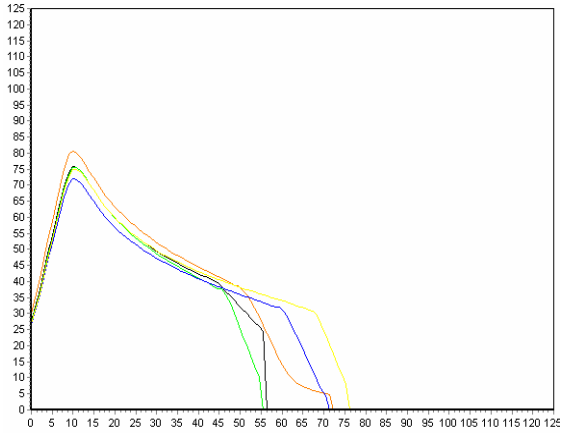
07-2419, MTS04114

Physical Dough Tests - Alveograph

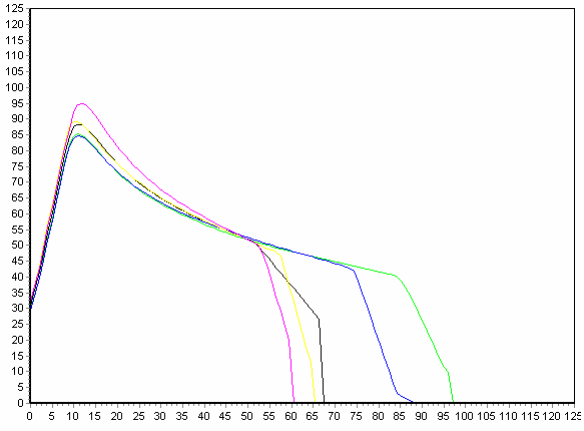
2007 (Small Scale) Samples – Montana



07-2417 (Genou)
P = 84 (mm H20), L = 91 mm, P/L = 0.92

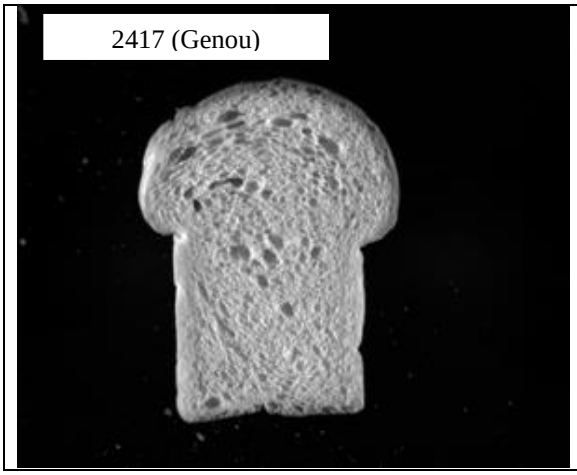


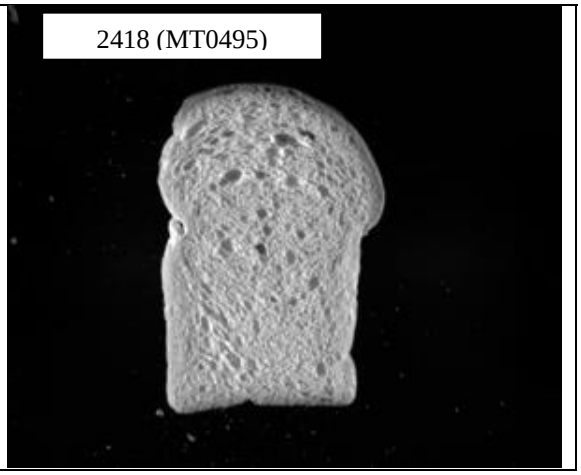
07-2418 (MT0495)
P = 83 (mm H20), L = 56 mm, P/L = 1.48



07-2419 (MTS04114)
P = 97 (mm H20), L = 67 mm, P/L = 1.45

Montana: C-Cell Bread Images and Analysis for 2007(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	6914	156.0	4198	0.444	1.960	0.98	1.67	-27.7
2418	6235	159.4	3977	0.437	1.909	0.99	1.64	-22.7

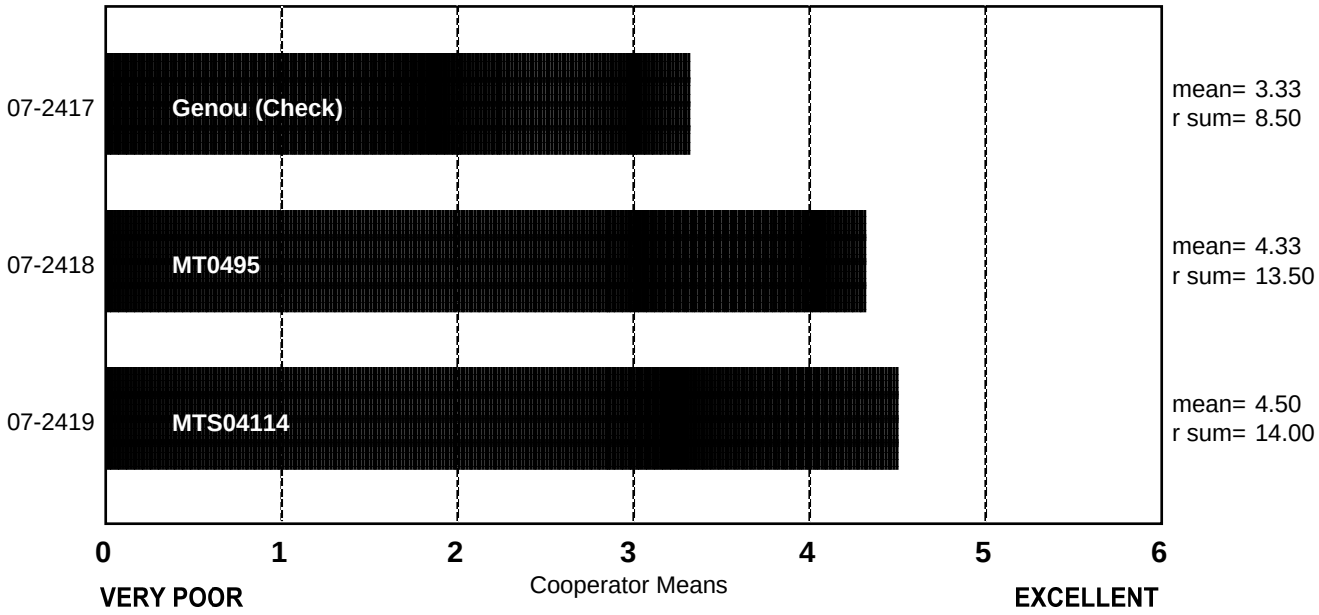
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2419	6111	153.5	3904	0.438	1.915	1.88	1.71	-24.1

SPONGE CHARACTERISTICS

(Small Scale) Montana

ncoop= 6
chisq= 3.08
chisqc= 5.69
cvchisq= 5.99
crdiff=

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

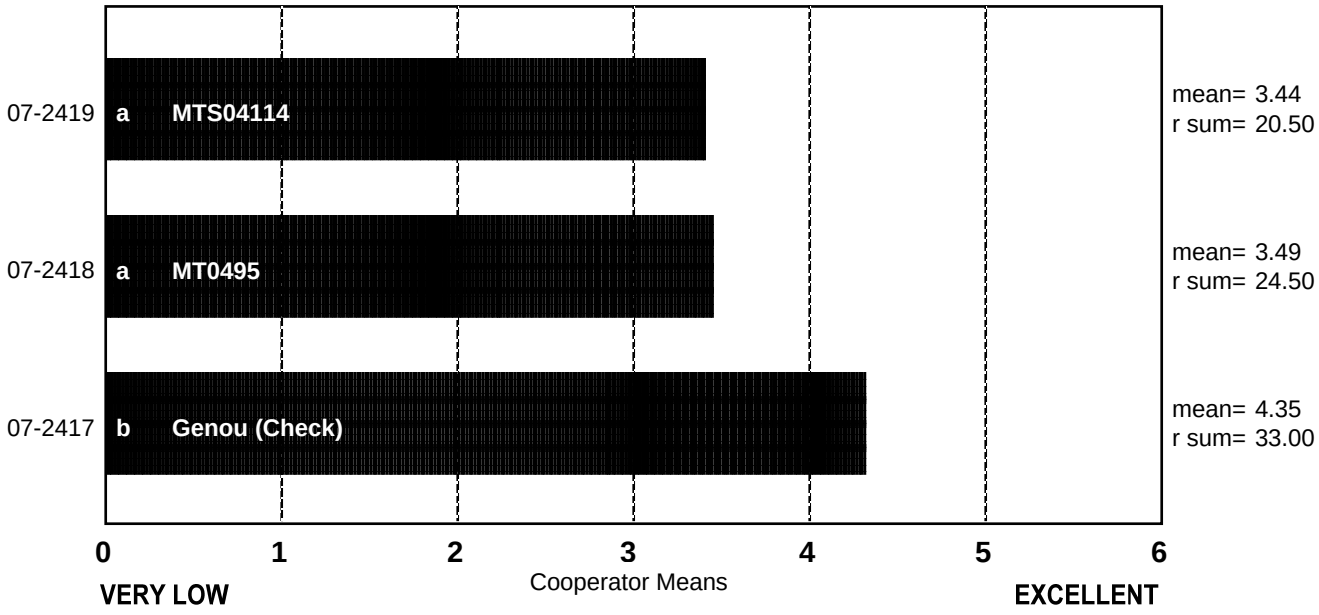


BAKE ABSORPTION

(Small Scale) Montana

ncoop= 13
chisq= 6.27
chisqc= 8.81
cvchisq= 5.99
crdiff= 7.51

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
07-2417 Genou (Check)	**61.0**	**71.9**	**61.0**	**61.0**	**68.2**	**60.8**	**63.6**	**63.0**	**59.5**	**64.0**	**64.0**	**62.0**	**64.8**
07-2418 MT0495	**58.0**	**67.4**	**61.0**	**61.0**	**66.7**	**59.9**	**59.3**	**62.6**	**59.1**	**63.6**	**60.0**	**58.0**	**60.4**
07-2419 MTS04114	**59.0**	**68.6**	**60.0**	**60.0**	**65.7**	**58.5**	**60.7**	**61.3**	**57.8**	**62.3**	**61.0**	**58.0**	**61.5**

BAKE MIX TIME, ACTUAL

(Small Scale) Montana

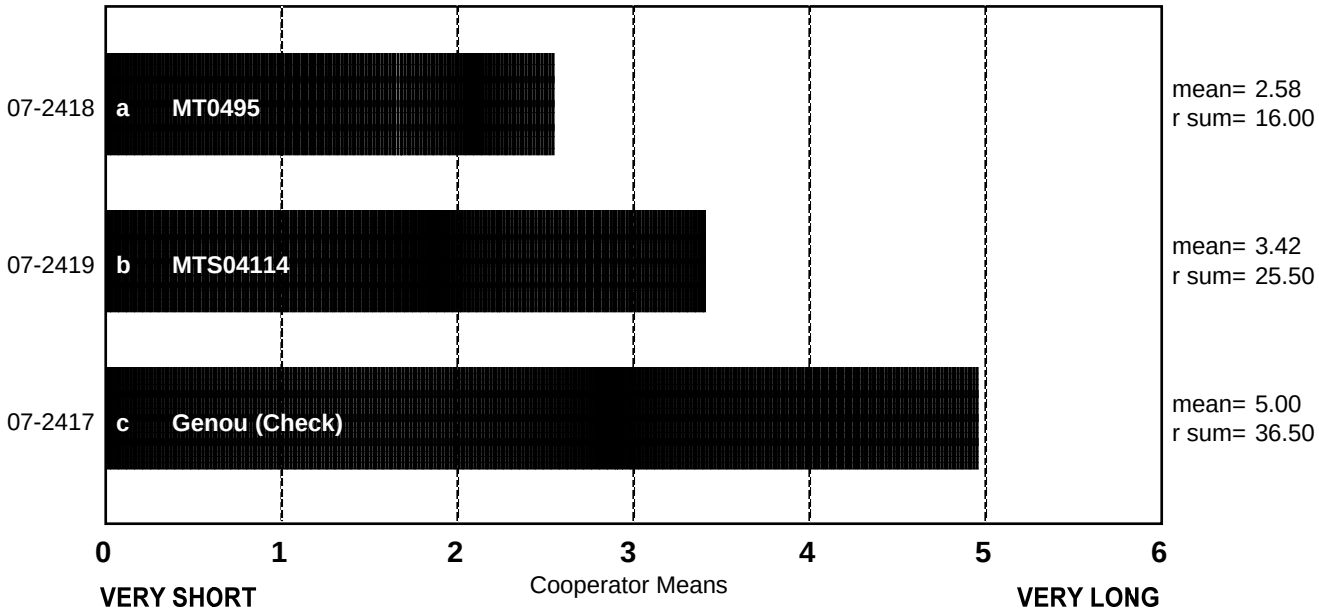
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2417 Genou (Check)	**9.0**	**7.5**	**7.1**	**25.0**	**6.0**	**3.0**	**5.5**	**8.0**	**3.8**	**18.0**	**9.0**	**16.0**	**7.8**
07-2418 MT0495	**13.0**	**3.0**	**4.4**	**18.0**	**3.6**	**1.5**	**4.0**	**5.5**	**2.5**	**6.0**	**3.0**	**4.0**	**3.6**
07-2419 MTS04114	**9.0**	**4.5**	**5.7**	**25.0**	**3.9**	**2.0**	**4.0**	**6.5**	**3.0**	**8.0**	**6.0**	**10.0**	**4.6**

BAKE MIX TIME

(Small Scale) Montana

ncoop= 13
chisq= 16.19
chisqc= 17.91
cvchisq= 5.99
crdiff= 5.81

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

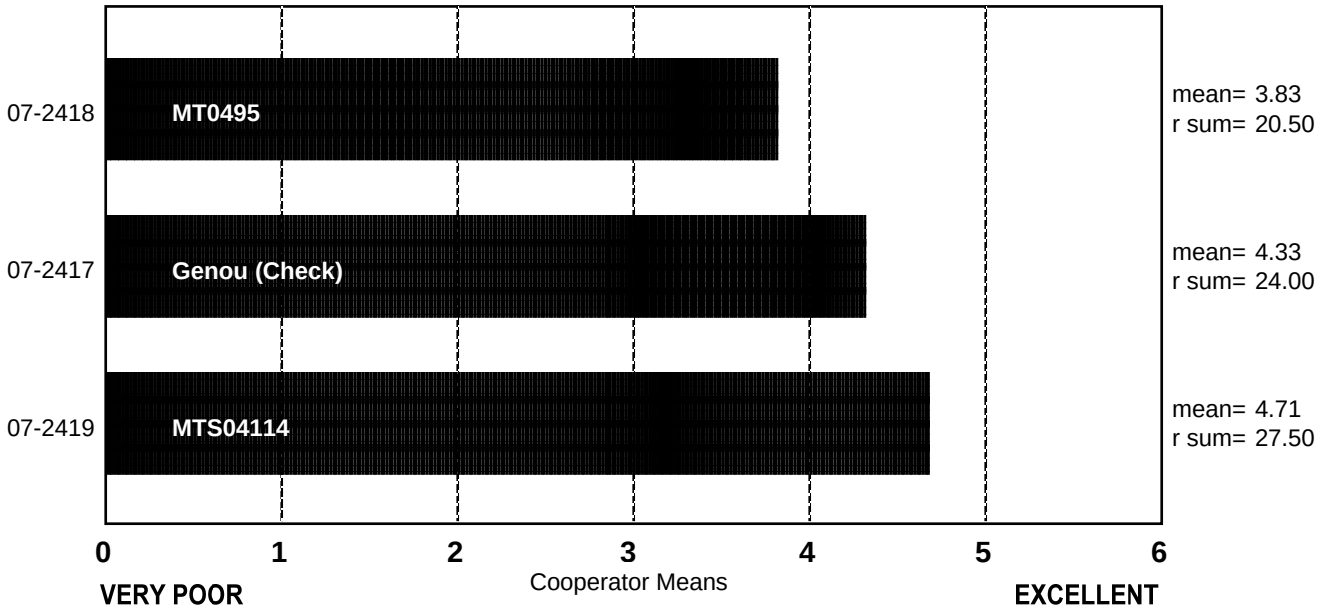


MIXING TOLERANCE

(Small Scale) Montana

ncoop= 12
chisq= 2.04
chisqc= 2.72
cvchisq= 5.99
crdiff=

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

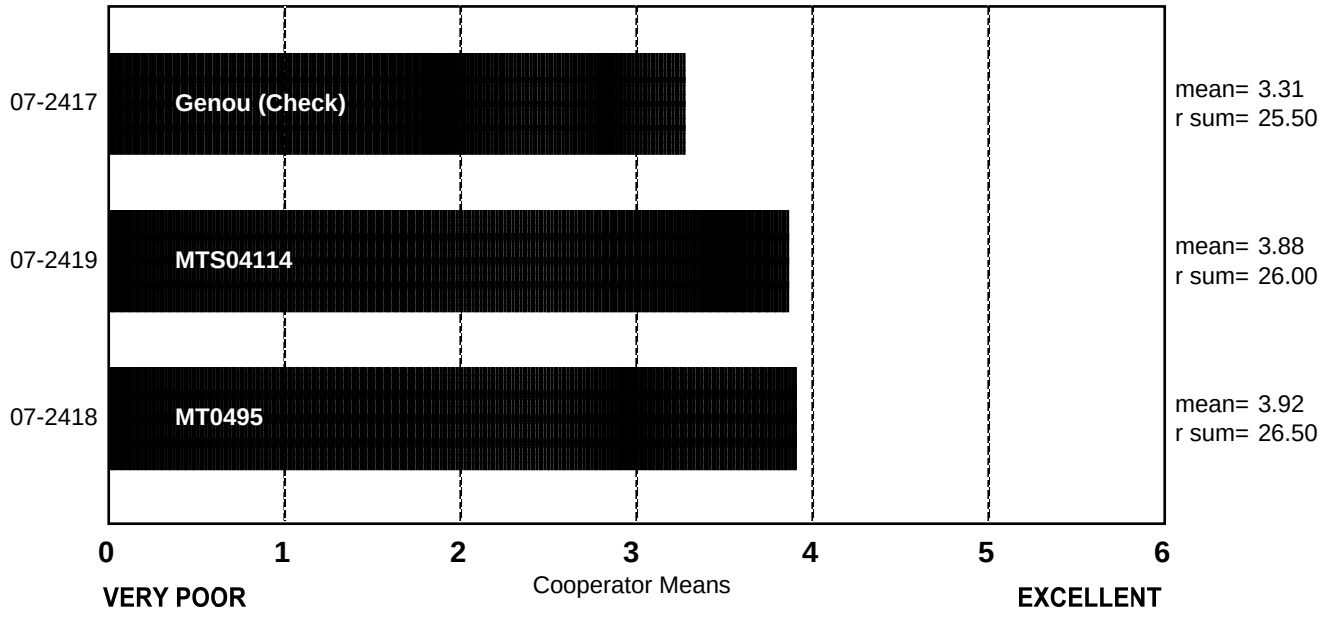


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Montana

ncoop= 13
chisq= 0.04
chisqc= 0.06
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Montana

	Sticky	Wet	Tough	Good	Excellent
07-2417 Genou (Check)	**3**	**1**	**2**	**7**	**0**
07-2418 MT0495	**3**	**1**	**0**	**9**	**0**
07-2419 MTS04114	**4**	**0**	**2**	**7**	**0**

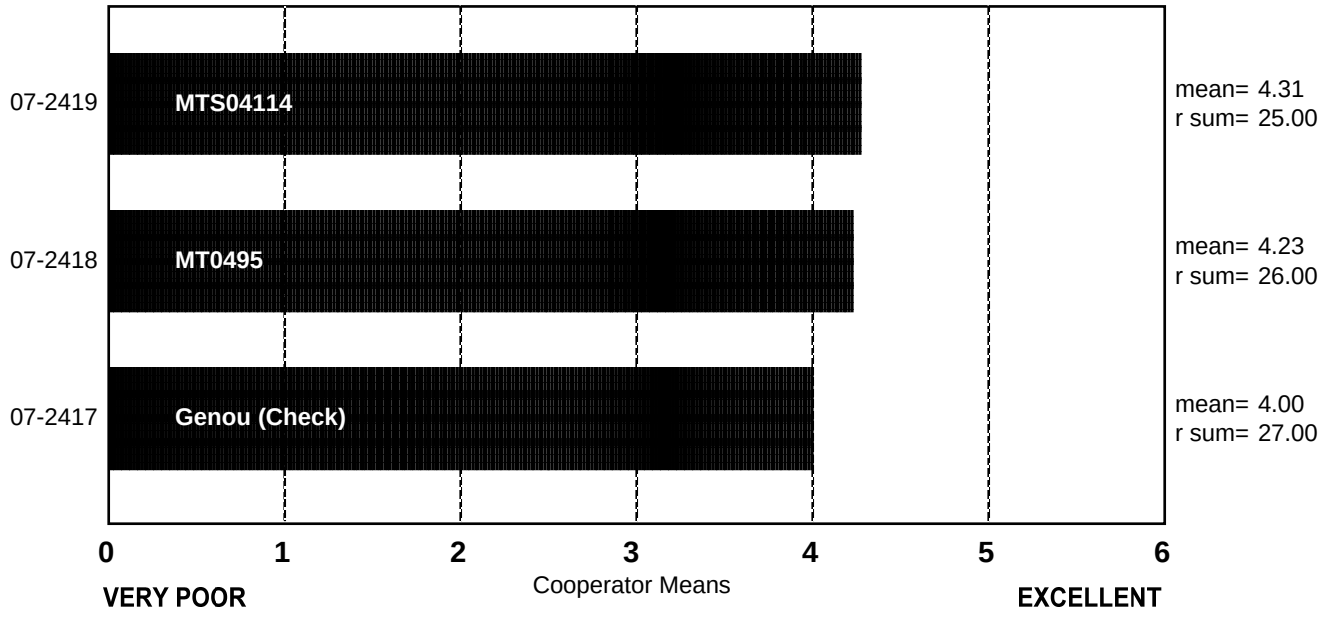
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Montana

ncoop= 13
chisq= 0.15
chisqc= 0.19
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
07-2417 Genou (Check)	**2**	**0**	**3**	**5**	**3**
07-2418 MT0495	**1**	**1**	**0**	**10**	**0**
07-2419 MTS04114	**3**	**0**	**2**	**6**	**2**

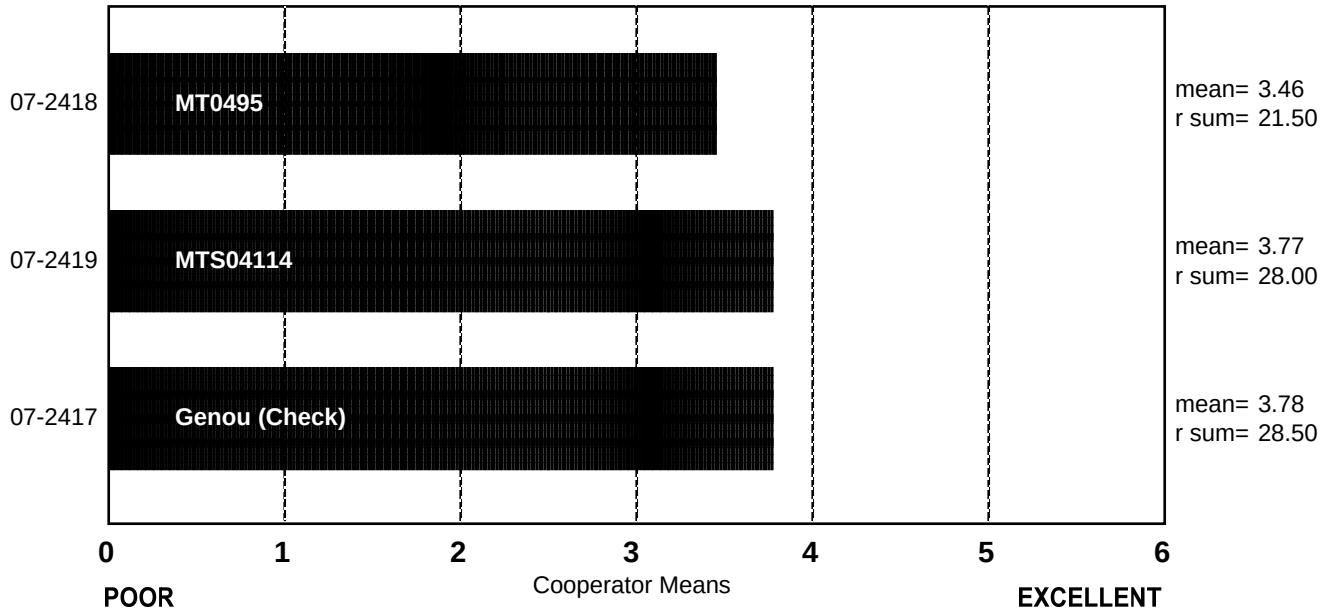
Frequency Table

CRUMB GRAIN

(Small Scale) Montana

ncoop= 13
chisq= 2.35
chisqc= 2.65
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
07-2417 Genou (Check)	**9**	**4**	**0**
07-2418 MT0495	**8**	**4**	**1**
07-2419 MTS04114	**7**	**5**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Montana

	Round	Irregular	Elongated
07-2417 Genou (Check)	**2**	**4**	**7**
07-2418 MT0495	**5**	**6**	**2**
07-2419 MTS04114	**2**	**6**	**5**

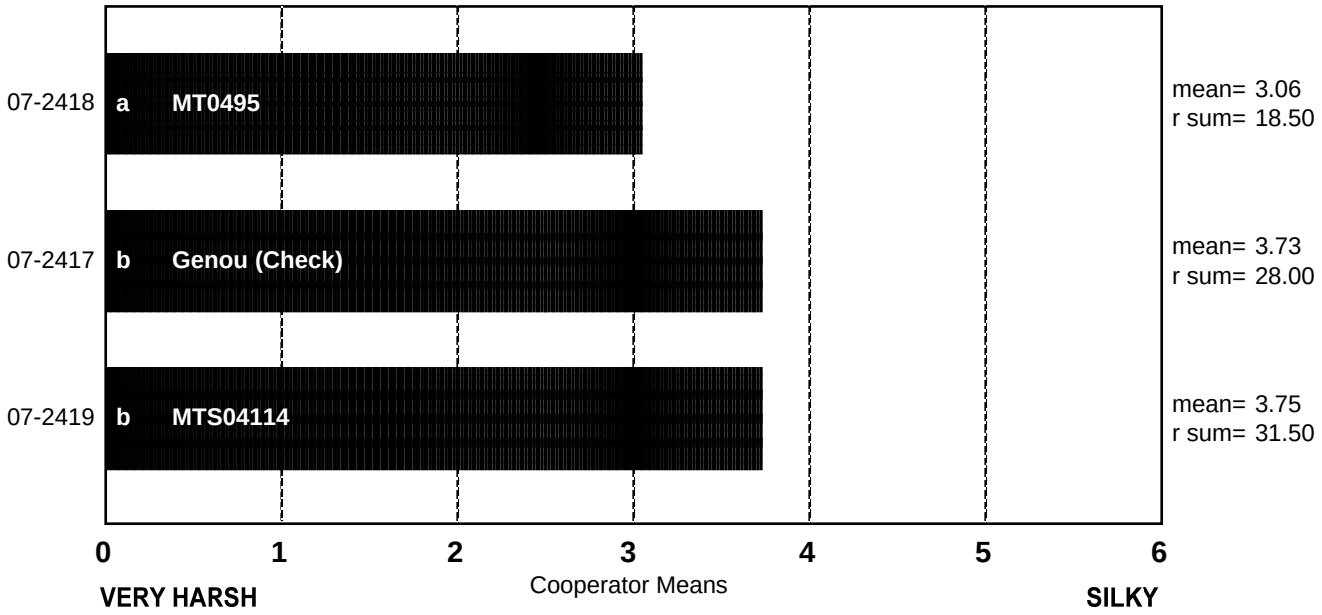
Frequency Table

CRUMB TEXTURE

(Small Scale) Montana

ncoop= 13
chisq= 6.96
chisqc= 9.05
cvchisq= 5.99
crdiff= 7.76

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
07-2417 Genou (Check)	**3**	**7**	**3**
07-2418 MT0495	**8**	**5**	**0**
07-2419 MTS04114	**3**	**8**	**2**

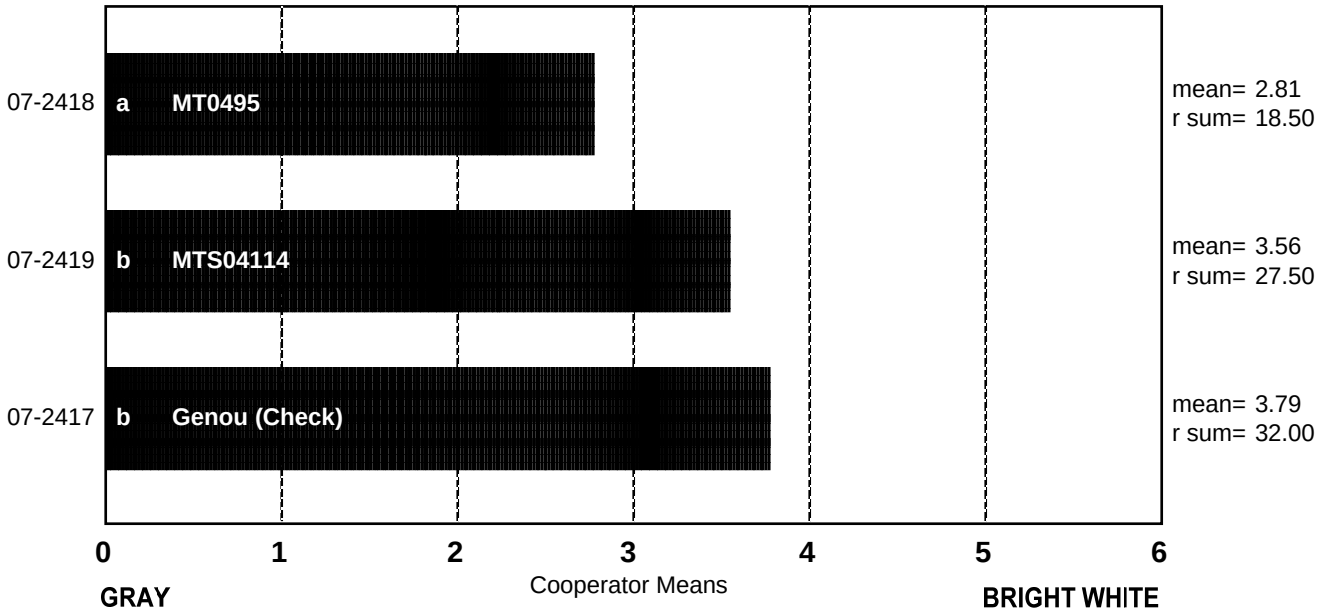
Frequency Table

CRUMB COLOR

(Small Scale) Montana

ncoop= 13
chisq= 7.27
chisqc= 9.00
cvchisq= 5.99
crdiff= 7.96

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



CRUMB COLOR, DESCRIBED

(Small Scale) Montana

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
07-2417 Genou (Check)	**0**	**0**	**1**	**2**	**7**	**3**	**0**
07-2418 MT0495	**0**	**1**	**3**	**4**	**5**	**0**	**0**
07-2419 MTS04114	**0**	**0**	**2**	**2**	**9**	**0**	**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
07-2417 Genou (Check)	**413.0**	**148.6**	**142.4**	**485.8**	**155.8**	**137.6**	**490.5**	**456.0**	**129.2**	**424.7**	**134.0**	**464.2**	**151.4**
07-2418 MT0495	**409.0**	**147.7**	**143.1**	**491.4**	**153.9**	**138.9**	**481.0**	**459.0**	**130.4**	**419.5**	**134.0**	**464.4**	**149.3**
07-2419 MTS04114	**418.0**	**146.3**	**143.0**	**486.3**	**155.8**	**136.5**	**490.0**	**455.0**	**129.1**	**421.1**	**134.0**	**468.4**	**149.7**

LOAF VOLUME, ACTUAL

(Small Scale) Montana

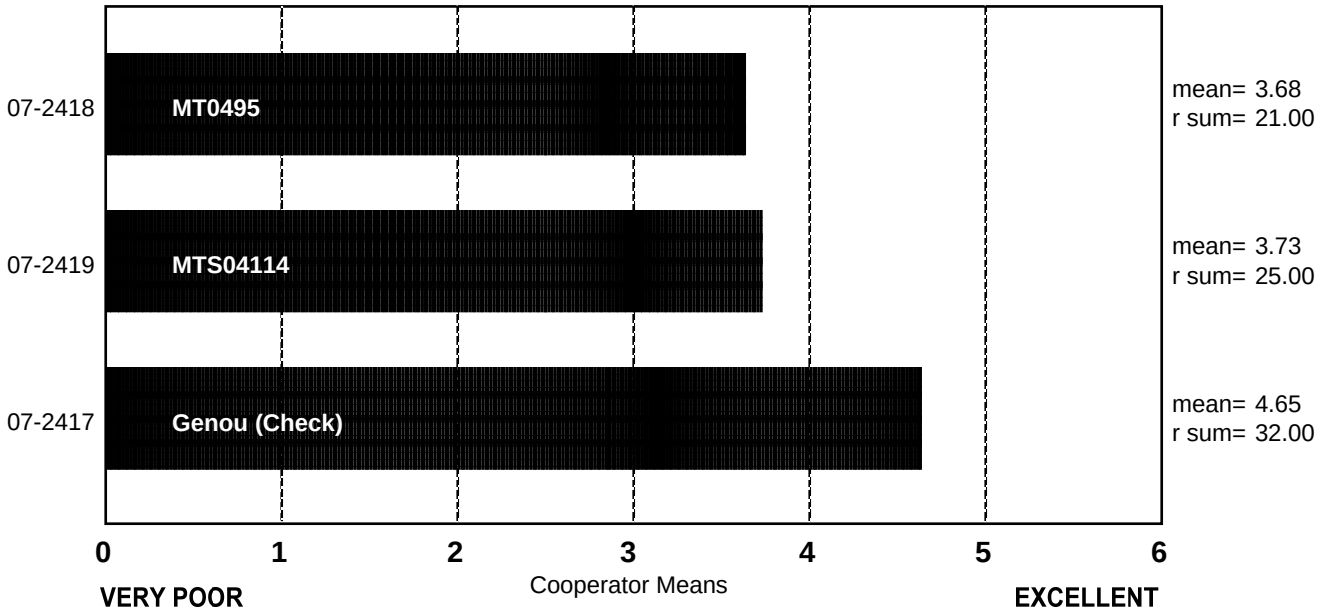
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
07-2417 Genou (Check)	**2850**	**1100**	**905**	**3162**	**1025**	**885**	**2750**	**3075**	**1050**	**2070**	**1045**	**2625**	**1013**
07-2418 MT0495	**2925**	**880**	**850**	**2927**	**935**	**700**	**3050**	**3000**	**875**	**2275**	**957**	**2638**	**878**
07-2419 MTS04114	**2750**	**990**	**950**	**2986**	**975**	**755**	**2600**	**2850**	**870**	**2300**	**958**	**2688**	**900**

LOAF VOLUME

(Small Scale) Montana

ncoop= 13
chisq= 4.77
chisqc= 5.17
cvchisq= 5.99
crdiff=

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

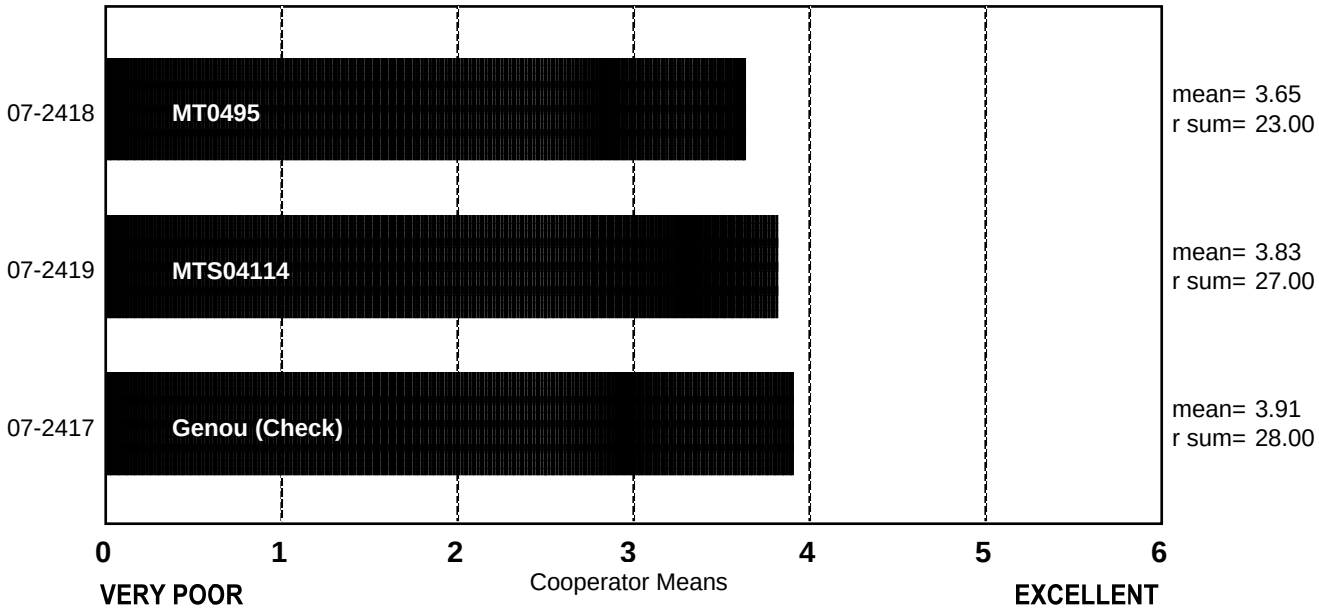


OVERALL BAKING QUALITY

(Small Scale) Montana

ncoop= 13
chisq= 1.08
chisqc= 1.12
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. 07-2417 (Genou (check))

A. High protein (13.8). Soft and sticky (through 9 minute mix). Short mix, nice interior, creamy crumb. Good volume.
B. Strong flour with very long mix. Tough dough. Great volume.
C. High and smooth oven-spring, resilient texture.
D. Extremely strong flour, slightly streaky grain, excellent volume.
E. Good dough strength (as expected for protein level).
F. Good dough elasticity at panning; good bread volume.
G. Wet out of mixer, open and round grain, harsh texture.
H. No comment.
I. Lower bake absorption; good dough handling and crumb. Silky texture and very good loaf volume.
J. No comment.
K. Excellent doughs and bread; good grain. Best overall.
L. Good absorption, long mix time, yellow crumb.
M. Good flour protein, bake absorption, and loaf volume; long mixing time; Excellent dough at makeup. Satisfactory crumb grain; creamy crumb color; Best of entire set of 19.

COOP. 07-2418 (MT0495)

A. Very good strong dough. 13 minute mix time. Creamy color and good volume. Had large cell structure, but overall on of the best.
B. No comment.
C. Medium and smooth oven-spring, resilient texture.
D. Open, irregular grain. Slightly above average volume.
E. Good dough feel; excellent performance for protein level.
F. Low flour protein.
G. Low absorption, harsh grain, good volume.
H. No comment.
I. Lower bake absorption and dull crumb color.
J. No comment.
K. Okay doughs, weak on long mix. Poor mix tolerance.
L. Low absorption; short mix time; good grain; yellow crumb.
M. Questionable crumb grain with yellow crumb color.

COOPERATOR'S COMMENTS
(Small Scale) Montana (Continued)

COOP. 07-2419 (MTS04114)

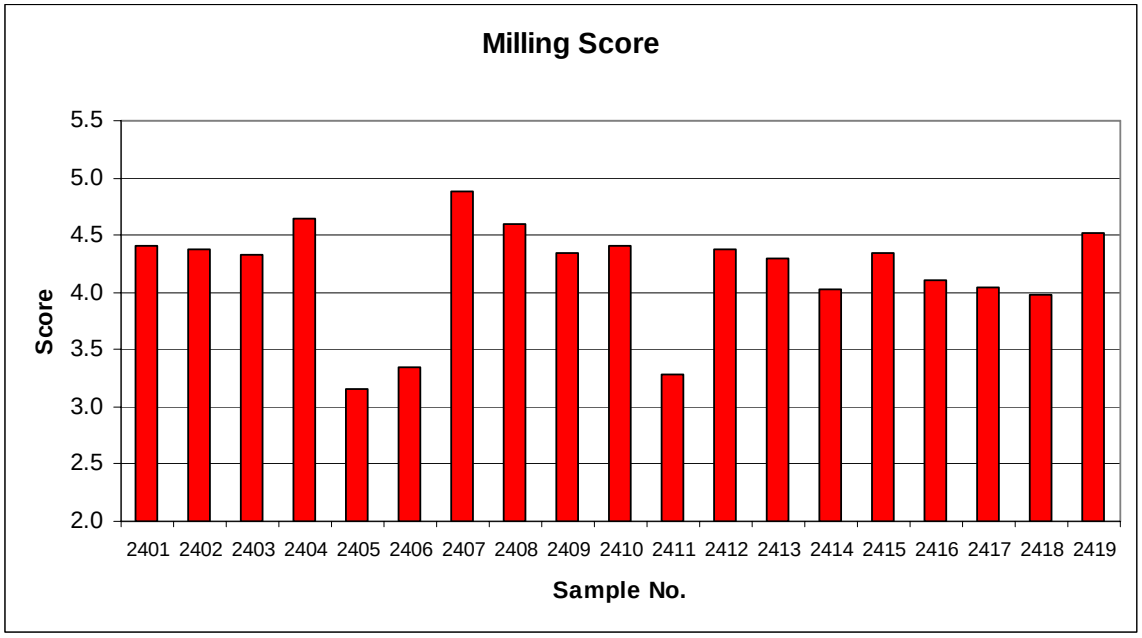
A. Good dough (machined well). Short mix time (9 minutes). Open grain with lower volume, but overall good quality.
B. Tough at makeup.
C. High and smooth oven-spring, resilient texture.
D. Good dough feel, slightly open grain, good volume.
E. Good dough feel, excellent performance for protein level.
F. No comment.
G. Sticky out of mixer, low volume.
H. No comment.
I. Low absorption, slightly tough to tough dough (out of mixer and at makeup), harsh texture, and dull crumb color.
J. No comment.
K. Good doughs and grain. Tolerance drops off a bit on long mix though.
L. Low absorption, slightly long mix time, sticky dough; good grain.
M. Quality exterior appearance with good mixing time and loaf volume. Questionable crumb grain with yellow crumb color.

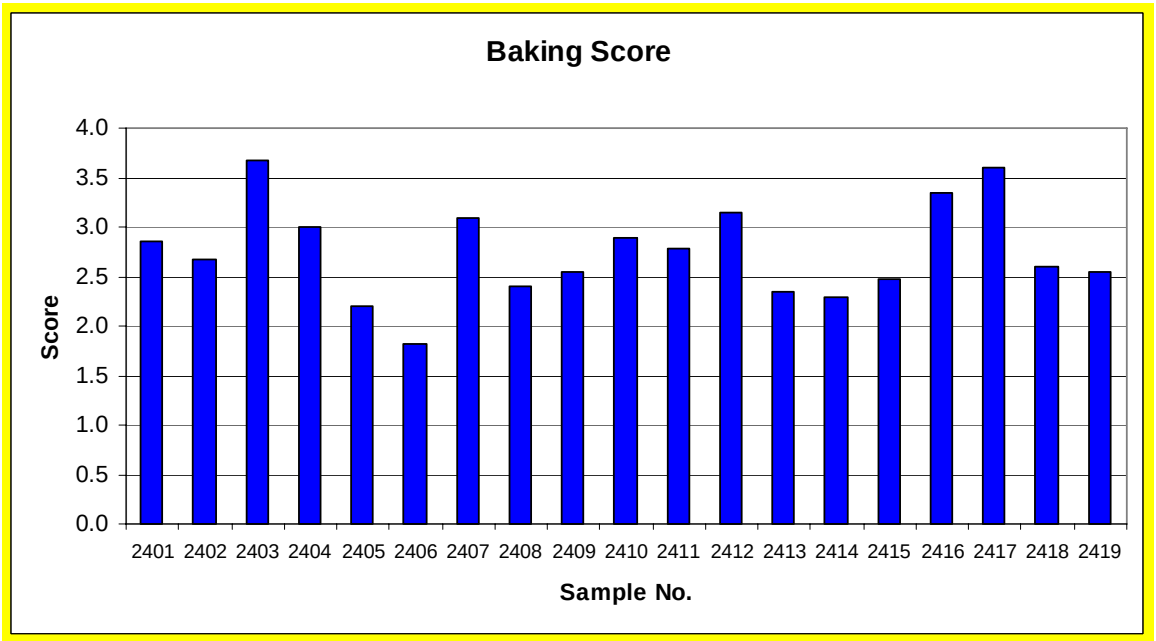
Notes: **A, D, G, J, K, and L** comments based on sponge and dough bake test.

2007 WQC Milling and Baking Score

2007 WQC Milling & Baking Scores

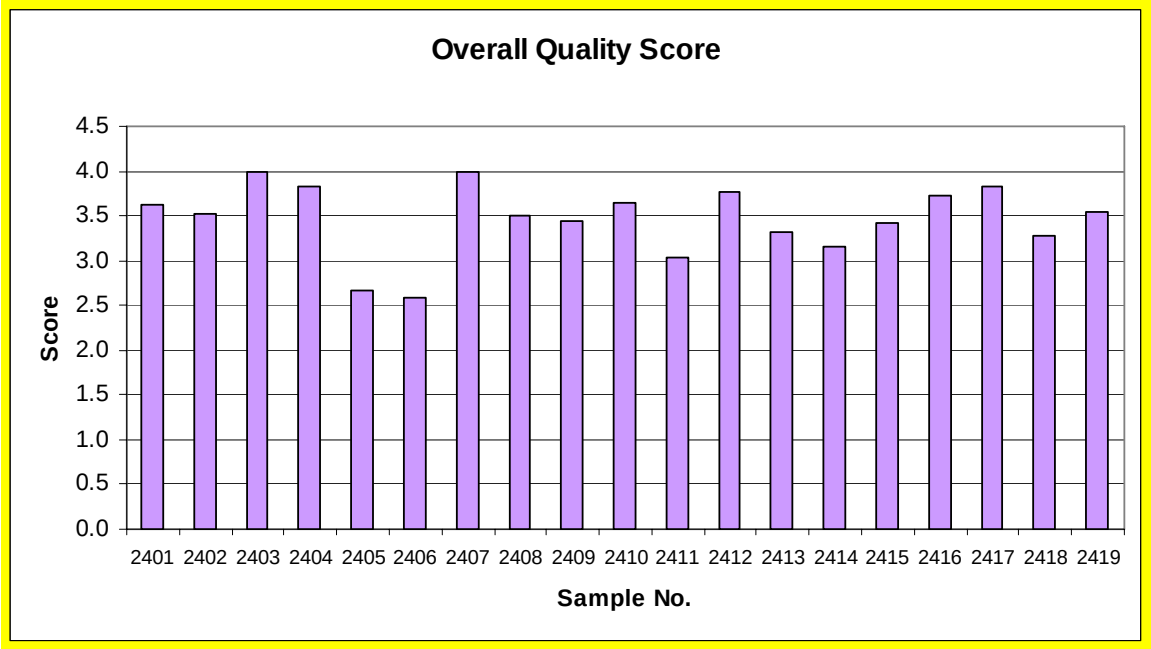
(Based upon HWWQL Quality Data)





2007 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).

2007 WQC Sample

Alkaline Noodle

USDA-ARS Hard Winter Wheat Quality Laboratory
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2007 Wheat Quality Council (WQC) Sample Report: Alkaline Noodle

Objectives: Evaluate noodle color and cooking characteristics of 2007 WQC flours.

Materials: The WQC samples, harvested in 2007 (19 wheat and 19 flour samples).

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:

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

↓

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

↓

Rest for 30 min in a plastic bag

↓

Plug roll gap with plastic tubing and pour mixed dough

↓

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

↓

Cutting

Measurement of Noodle Dough Color:

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

Cooking Noodles:

1. After cutting noodles, rest noodles in plastic bags for 1 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 of tap water (100 mL) and gently rinse 30 sec.
6. Drain water by shaking the colander 20 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, multiple 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 followings.

Noodle Color (*L* value, Higher is better.) ***at 0 hr***: 2403 (83.5), 2410 (83.4), 2404 (83.2)

Noodle Color (*L* value, Higher is better.) ***at 24 hr***: 2410 (73.2), 2414 (69.9), 2418 (69.1)

Delta L (Change of *L* value, Lower absolute value is better.)
2410 (-10.2), 2418 (-11.9), 2414 (-12.4)

PPO (Lower is better.): 2410 (0.174), 2418 (0.191), 2407 (0.421)

Table II shows the followings.

Hardness : 2415 (2.92), 2416 (2.90), 2413 (2.90)

Springiness : 2401 (0.992), 2408 (0.982), 2417 (0.981)

Chewiness : 2401 (1.82), 2416 (1.81), 2415 (1.79)

Resilience : 2410 (0.423), 2411 (0.412), 2403 (0.404)

Cohesiveness : 2403 (0.683), 2410 (0.682), 2404 (0.679)

Water Uptake : 2416 (87.7), 2417 (87.7), 2410 (86.5)

Cooking Loss : 2417 (5.8), 2404 (6.4), 2412 (6.6)

Discussion

Sample 2410 showed the lowest PPO level, the brightest noodle color at 24 hr, the highest resilience, the second highest cohesiveness, and the third highest water uptake with moderate cooking loss. Noodles made with the sample 2410, however, were the softest, which is not considered a desirable characteristic for alkaline noodles. Alkaline noodles should be firm and elastic, with a high degree of chewiness. Overall, 2410 would be a good noodle flour, especially for white salted noodles (Japanese Udon type) which are supposed to have bright noodle color and soft texture. Sample 2414 showed the second brightest noodle color at 24 hr. The sample 2418 showed the third brightest noodle color at 24 hr even though it had less than average brightness at 0 hr (probably due to low PPO level).

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	81.6	67.7	-1.28	-0.24	19.5	24.4	-13.9	1.05	4.97	0.511
2402	82.3	65.6	-1.63	-0.25	18.4	23.4	-16.7	1.38	4.99	0.692
2403	83.5	68.9	-2.37	-0.84	19.3	23.0	-14.6	1.53	3.61	0.680
2404	83.2	67.5	-2.01	-0.87	19.3	23.0	-15.7	1.14	3.74	0.555
2405	81.5	66.3	-1.40	0.26	19.1	23.6	-15.2	1.66	4.54	0.545
2406	81.5	66.3	-1.18	0.13	16.8	23.4	-15.2	1.31	6.60	0.597
2407	80.9	67.2	-1.31	0.08	17.8	22.7	-13.7	1.38	4.91	0.421
2408	81.6	68.3	-1.29	-0.10	18.3	23.5	-13.3	1.20	5.26	0.436
2409	80.8	67.0	-1.40	0.11	20.7	24.4	-13.8	1.51	3.73	0.516
2410	83.4	73.2	-1.79	-1.20	20.0	25.1	-10.2	0.59	5.10	0.174
2411	82.9	68.8	-1.69	-0.95	19.9	26.9	-14.1	0.75	7.02	0.563
2412	81.9	66.8	-1.88	-0.29	21.7	26.1	-15.1	1.59	4.48	0.534
2413	82.4	69.2	-1.86	-0.52	20.7	24.6	-13.2	1.34	3.85	0.551
2414	82.2	69.9	-2.09	-1.26	22.6	27.1	-12.3	0.82	4.55	0.513
2415	81.7	67.2	-1.96	-0.29	23.5	27.9	-14.5	1.67	4.39	0.542
2416	82.9	68.6	-2.15	-0.74	22.2	28.0	-14.3	1.40	5.73	0.563
2417	81.0	63.4	-1.64	-0.13	20.6	24.3	-17.6	1.51	3.71	0.739
2418	81.1	69.1	-2.02	-0.96	23.5	27.7	-11.9	1.06	4.22	0.191
2419	81.7	67.3	-2.26	-0.57	23.4	25.6	-14.3	1.69	2.19	0.760
Average	82.0	67.8	-1.75	-0.46	20.4	25.0	-14.2	1.30	4.61	0.530
LSD*	1.3	1.2	0.31	0.31	2.3	0.91	1.24	0.31	1.89	0.027

*LSD=Least significant difference at P = 0.05.

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	2.76	0.992	1.82	0.379	0.664	78.2	7.6
2402	2.62	0.979	1.74	0.394	0.678	78.7	7.7
2403	2.65	0.943	1.71	0.404	0.683	80.2	7.0
2404	2.70	0.967	1.77	0.392	0.679	82.1	6.4
2405	2.86	0.953	1.70	0.340	0.624	83.4	7.7
2406	2.75	0.941	1.61	0.344	0.622	82.1	8.0
2407	2.79	0.964	1.77	0.382	0.660	86.1	6.7
2408	2.69	0.982	1.74	0.394	0.659	84.9	7.3
2409	2.71	0.950	1.69	0.396	0.658	81.9	7.0
2410	2.38	0.975	1.58	0.423	0.682	86.5	7.0
2411	2.54	0.973	1.67	0.412	0.677	80.8	7.0
2412	2.67	0.975	1.72	0.395	0.663	83.8	6.6
2413	2.90	0.945	1.76	0.373	0.641	84.1	7.0
2414	2.87	0.946	1.73	0.367	0.640	83.7	6.8
2415	2.92	0.952	1.79	0.373	0.646	81.9	7.3
2416	2.90	0.960	1.81	0.371	0.650	87.7	7.2
2417	2.72	0.981	1.77	0.387	0.668	87.7	5.8
2418	2.59	0.962	1.57	0.352	0.631	82.0	7.2
2419	2.60	0.963	1.63	0.388	0.651	81.7	6.9
Average	2.72	0.963	1.71	0.382	0.656	83.0	7.1
LSD*	0.14	0.025	0.08	0.014	0.012	2.9	0.7

*LSD=Least significant difference at P = 0.05.

TORTILLA BAKING TEST

J. Novie Alviola and Lloyd Rooney

Department of Soil and Crop Sciences

Texas A&M University

Procedures to Produce and Evaluate Wheat Flour Tortillas Using a Small 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

1. Mixing dry ingredients and shortening

The mixing bowl has copper tubes in spiral shape around and outside the lower one-fourth. Heated water is pumped through the copper tube to maintain the temperature of the dough in the bowl between 30-35^{0}C, preferably between 32-33^{0}C. Dry ingredients are mixed for 2 minutes at low speed with a paddle in the mixing bowl. Then shortening is added and mixed at low speed for 6 min.

2. Mixing with water

Water is weighed and preheated to 35^{0}C in a microwave oven. Water is added to the bowl and mixed with the dry ingredients with a hook at low speed for 1 min. Then, the dough is mixed for 5 min at medium speed, unless the dough requires less or more mixing. This is indicated by excessive stickiness or firmness of the dough; water absorption also can be varied to impact stickiness or firmness of the dough. The first approximation for tortilla dough water absorption is the percent absorption from Mixograph analysis minus 10 units, e.g., if Mixograph absorption is 61% then the tortilla dough absorption is 51%. (61 – 10)

3. First resting of the dough in proof chamber

Dough is placed on a tray and a thermometer with a probe is used to measure the temperature. The dough is evaluated for smoothness, softness and toughness. The tray is placed in the proof chamber for 5 min. The proof chamber (model 57638, National Manufacturing Co., Lincoln, NE) is set at 35^{0}C and 70% relative humidity.

4. Dividing and rounding of dough
The dough is removed from the tray and pressed by hand on a stainless steel round plate, which is part of the divider/rounder. The dough is evaluated for press rating. The dividing and rounding equipment (model RR 399, Dutchess Tool Company, Beacon, NY) is used to cut the dough into pieces and round for 30 sec the dough into 36 dough balls of 43 g each. Then, the dough balls are transferred to the tray so the dough balls are not misshapen during the transfer or touching each other.

5. Second resting of the dough
The plastic tray is placed in the proof chamber (same settings as before) for 10 min.

6. Hot pressing
Each dough ball is placed on the Teflon belt of the hot press in such a way that the dough ball is in the middle of the heated plattens during the compression cycle. The laboratory-scale, commercial hot-press (Micro-Combo model 0P01004-02, Lawrence Equipment Company Inc., El Monte, CA) is used to transform the dough balls into thin circular disks. The equipment parameters are 395^0F temperature for the top and bottom platens, 1.35 sec cycle time and 1100 psi hydraulic pressure.

7. Baking
The disks are automatically transferred from the press into a three-tier oven (Micro-Combo model 0P01004-02, Lawrence Equipment Company Inc., El Monte, CA). The oven parameters are a temperature of $350\text{-}360^0$F about an inch above the middle tier and 30 sec dwell time. Temperatures of the tiers determined using a remote (infrared) thermometer are top – $305\text{-}320^0$F, middle – $285\text{-}295^0$F, and bottom – $275\text{-}285^0$F.

8. Cooling
Tortillas are cooled after baking on two tiers of stainless steel mesh belting under the oven and three tiers of stainless steel mesh belting on a cooling conveyor (model 3106 INF, Food Machinery Inc., Pivo Machinery Inc., Pico Rivera, CA). The duration of cooling is 3.3 min.

9. Selection and packaging
Tortillas are removed from the stainless steel mesh belting and placed by hand on a clean, disinfected table. Tortillas are allowed to cool for 1 min and then flipped by hand to cool the other side for 1.5 min. The tortillas with big bubbles and non-typical diameters (large or small) are removed. The tortillas with similar appearance and diameter are stacked and packaged in low-density polyethylene bags.

Evaluation of Dough Properties

The dough properties are evaluated subjectively for smoothness, softness and toughness on the third step and for press rating on the fourth step of processing.

Smoothness refers to the appearance and texture of the dough surface. It is rated from 1 to 5, 1= very smooth, 5=Rough. The "ideal" smooth dough is rated as 2.0.
Softness refers to the viscosity or firmness of the dough when compressed. It is obtained by pressing the dough with the fingers. It is rated from 1 to 5, 1= soft, less viscous, 5 = firm, more viscous.
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. It is rated from 1 to 5, 1=less tough, less elastic, 5= excessively elastic.
Extensibility refers to the length the dough extends when pulled apart. It is obtained by pulling the dough and is rated from 1 to 5, 1=breaks immediately, 5= extends readily into long thin dough pieces.
Press rating refers to the force required to press the dough on the stainless steel round plate before dividing and rounding. It is rated from 1 to 5, 1= very easy to press, 5= very hard to press.

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 subjectively for weight, diameter, height 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.

2. Diameter
Five tortillas are measured by using a ruler at two points across the tortilla: the larger diameter and the smaller diameter. Values from measurements of five tortillas are averaged.

3. Height
Ten tortillas are stacked and a digital caliper is used to measure their height. The height of one tortilla is calculated by dividing the height by 10.

4. pH
pH is determined by blending 10 g of ground tortillas with 40 ml of distilled water. The pH of the mixture is measured after 10-15 sec.

5. Moisture
Moisture is determined using a two-stage procedure (AACC, Method 44-15A, 2000).

6. Opacity
Ten tortillas are evaluated subjectively for opacity using a continuous scale of 0-100: 0 = 100% translucent, 100 = 100% opaque.

7. Color Values
The color values of lightness (L*), $\pm$a* (redness and greenness) and $\pm$b* (yellowness and blueness) of tortillas are determined using a handheld colorimeter (model CR-300, Minolta Camera Co., Ltd., Chuo-Ku, Osaka, Japan).

8. Specific Volume
Specific volume is calculated: $= \pi * (\text{Diameter}/2)^2 * \text{height} * 1000 / \text{weight}$. [$cm^3/g$]

9.Quality Index
Quality Index is calculated: = Opacity * Specific Volume * Rollability Score (12^{th} day of storage)

10. Tortilla Rollability Score
Two tortillas are removed from the plastic bag on 4, 8, 12, and 16 days of storage. Rollability score is evaluated by wrapping a tortilla around a dowel (1.0 cm diameter). Both sides of the tortilla are rolled around the dowel. 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

11. Objective rheological test
Two tortillas are removed from the plastic bag on 4, 8, 12, 16 days of storage. Extensibility of whole tortillas is conducted by 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 - 2007 DATA WORKSHEET

COOPERATOR NAME:	J. N. Alviola and L. 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
Cysteine	30 ppm for most samples
Resting TIME:	10 min
Hot-Press Temp (top/bottom):	395 / 395 F
Hot-Press Time:	1.40 sec
Hot-Press Pressure:	1150 psi
OVEN TEMPERATURE:	365 F
BAKE TIME:	30 sec

2007 Tortilla TEST No.	Dough Absorp %	Dough Temp C	Smooth-ness Dough Rating	Soft-ness Dough Rating	Force to Extend Dough Rating	Extensi-bility Dough Rating	Press Rating Dough Rating
IDCODE	Water	Temp	Smoothness	Softness	Toughness	Toughness	Press Rating
Tortilla Ref.	52.0	29.8	1.8	2.2	3.5	3.0	2.0
2401	52.0	33.5	1.9	1.9	3.3	3.3	2.0
2402	51.0	32.1	2.0	2.2	3.8	3.5	2.2
2403 (+)	53.0	31.2	2.0	2.2	3.8	3.0	2.2
2404	52.5	32.6	2.0	2.2	3.5	3.0	2.3
2405 (-)	48.5	30.1	2.4	2.5	3.8	2.5	2.5
2406	47.5	31.9	2.3	2.3	3.5	3.0	2.0
2407	51.0	31.1	2.0	2.3	3.8	3.0	2.4
2408	52.0	33.5	1.9	2.0	3.3	3.5	2.0
2409	49.0	31.7	2.0	2.0	3.5	3.3	2.2
2410	52.0	32.4	1.9	2.4	3.8	3.0	2.0
2411 (+)	52.0	31.4	1.8	2.0	3.8	3.5	2.0
2412	50.5	33.0	1.9	1.9	3.3	3.3	2.0
2413	49.0	31.0	1.8	2.0	3.5	3.5	2.0
2414	51.0	32.2	1.9	1.9	3.3	3.3	2.0
2415	49.5	31.2	1.9	2.2	3.5	3.0	2.0
2416	51.0	32.4	2.0	2.0	3.5	3.5	2.0
2417 (+)	51.0	32.8	1.7	1.7	3.3	4.0	1.7
2418	48.5	30.8	1.9	2.0	3.5	3.3	2.0
2419	49.0	30.9	2.0	2.0	3.5	3.3	2.2
Descriptors Or Scale	record actual absorption added water (%)	record actual Temperature (C)	from 1 = satin smooth to 5 =very rough	resistance 1 = low to 5 = high	cohesiveness 1 = low to 5 = high		Force2Press 1 = low to 5 = high

"+" indicates 50 ppm cysteine; "-" indicates 0 ppm cysteine; others are 30 ppm cysteine

2007 Tortilla TEST No.	Tortilla Moisture %	Tortilla Weight g	Tortilla Height mm	Measured pH	Tortilla Diameter mm	Tortilla Opacity %	Calc Sp.Vol. cm^3/g
ID CODE	Moisture	Weight	Height	pH	Diameter	Opacity	Sp. Volume
Tortilla Ref.	33.6	39.5	2.99	5.6	155	81	1.42
2401	32.2	40.4	2.93	5.6	166	74	1.56
2402	31.9	40.3	2.98	5.6	162	72	1.53
2403	33.3	42.1	3.13	5.6	152	47	1.35
2404	32.2	41.0	3.01	5.7	161	68	1.50
2405	31.0	40.8	3.35	5.7	158	83	1.60
2406	29.9	39.5	2.95	5.7	163	79	1.56
2407	31.1	39.5	2.90	5.7	170	82	1.66
2408	31.7	40.8	2.76	5.7	170	73	1.53
2409	31.9	40.7	2.89	5.8	165	74	1.52
2410	32.1	40.6	2.78	5.6	168	78	1.52
2411	31.4	40.9	2.92	5.7	171	79	1.64
2412	31.3	40.3	2.77	5.7	171	69	1.58
2413	30.8	40.7	2.93	5.6	175	78	1.73
2414	31.7	39.2	2.90	5.7	174	78	1.76
2415	30.7	40.0	2.91	5.7	177	81	1.79
2416	31.4	39.7	3.00	5.7	174	81	1.79
2417	31.9	39.7	2.82	5.6	169	62	1.59
2418	30.2	38.2	2.90	5.7	178	87	1.90
2419	30.6	39.8	2.91	5.6	171	79	1.68
Descript. Or Scale	air dry then oven dry calculate moisture	measure weight of 10 tortillas / 10 = average	measure height of 10 tortillas / 10 = average	record the actual pH	measure 5 tortillas min & max values = average	*from* Translucent *= 0%* to Opaque = 100%	radius*radius * pi * height * 1000 / weight = cm^3 / g

2007 Tortilla TEST No.	Rollability Score 4 days	Rollability Score 8 days	Rollability Score 12 days	Rollability Score 16 days	Calc Quality Index (12 d)	Calc Quality Index (16 d)	Calc Quality Index (16 d)	*** Rating	Comments
ID CODE	RS 4	RS 8	RS 12	RS 16	opacity	opacity	Light.	Rating	
Tortilla Ref.	4.6	3.6	3.4	2.5	387	287	296	Fair	
2401	5.0	4.9	4.8	4.0	550	463	520	**Good**	
2402	5.0	4.9	4.4	3.8	483	414	480	**Good**	
2403	5.0	4.5	4.4	4.1	275	259	467	Poor	
2404	5.0	5.0	4.8	4.6	482	470	582	**Good**	
2405	5.0	4.3	3.0	2.5	398	332	335	Poor	
2406	4.5	4.1	3.0	2.0	372	248	260	Poor	
2407	4.9	4.0	3.0	2.5	406	338	342	Poor	
2408	4.6	4.3	3.4	2.6	377	293	327	Fair	
2409	5.0	4.8	4.0	3.0	450	338	379	Fair	
2410	5.0	4.1	3.3	2.4	382	279	300	Poor	
2411	5.0	4.6	4.5	3.1	582	404	428	**Good**	
2412	5.0	4.4	3.5	3.0	382	327	397	Fair	
2413	5.0	4.8	3.8	2.8	501	368	402	Fair	
2414	4.6	4.1	3.9	3.1	528	426	466	**Good**	
2415	4.4	4.1	3.0	2.4	433	342	361	Poor	
2416	4.8	3.9	3.0	2.3	436	327	340	Poor	
2417	5.0	5.0	5.0	4.8	490	466	631	**Good**	
2418	4.0	3.0	2.4	1.6	391	267	263	Poor	
2419	5.0	4.4	3.4	2.4	447	315	340	Poor	
Descript. or Scale	1 = none to 5 = breaks 4 days	1 = none to 5 = breaks 8 days	1 = none to 5 = breaks 12 days	1 = none to 5 = breaks 16 days	opacity * Sp.Volume * 12 day RS	Opacity * Sp.Volume * 16 d RS	Light-1 * Sp.Volume * 16 d RS		

***Rating based on Rollability Score, Opacity, Specific Volume

2007	Modulus	Force	Distance	Work	Lightness	Lightness	"b"	"b"
Tortilla	2-D	2-D	2-D	2-D	2-baked	1-baked	2-baked	1-baked
TEST No.	12 day	12 day	12 day	12 day	side	side	side	Side
ID CODE	Mod12	Force12	Dist12	Work12	Light-2	Light-1	b-2	b-1
Tortilla Ref.	1.34	9.05	10.97	37.82	83.44	83.22	17.58	18.38
2401	1.17	8.94	12.24	40.51	84.11	83.40	18.49	19.51
2402	1.26	10.84	12.78	56.55	84.78	83.74	18.27	20.10
2403	1.35	12.44	13.85	73.52	83.32	83.84	21.62	20.76
2404	1.29	10.79	13.14	59.29	84.27	83.88	20.36	21.63
2405	1.25	9.27	11.53	42.80	84.43	83.63	16.96	18.36
2406	1.13	7.62	11.24	32.31	82.94	82.91	17.14	17.97
2407	1.26	8.48	11.06	35.01	82.84	82.46	16.71	17.25
2408	1.37	9.20	10.98	37.88	81.82	81.55	17.57	18.16
2409	1.39	10.03	11.63	43.57	83.23	83.09	19.40	20.17
2410	1.27	9.11	11.41	38.19	84.28	83.49	17.91	18.95
2411	1.08	8.11	11.86	36.57	84.20	83.51	19.34	20.86
2412	1.13	7.89	11.27	32.84	84.07	83.63	19.87	20.63
2413	1.09	7.98	11.86	34.42	85.06	84.65	18.42	18.97
2414	0.95	7.17	12.00	29.52	85.10	84.77	20.47	20.92
2415	0.97	6.55	10.95	27.54	85.50	85.19	20.13	20.96
2416	1.08	7.08	10.79	28.53	84.57	84.57	21.16	21.72
2417	0.90	9.26	15.22	56.92	83.35	83.28	20.63	20.58
2418	0.93	5.92	10.53	22.95	85.82	85.46	19.74	20.57
2419	1.01	6.99	11.06	29.30	85.64	85.13	19.32	20.75
Descriptors or Scale	Modulus N/mm 12 days	Force to Rupture N 12 days	Distance to Rupture mm 12 days	Work to Rupture N.mm 12 days				

APPENDIX A
Credits and Methods

CREDITS

Milling, Sample Analysis, Ingredients and Report Preparation

Mixograms and Farinograms	USDA/ARS//HWWQL Manhattan, KS
Falling Number and Agtron	Kansas Wheat Quality Lab KSU Dept. Grain Science & Ind. Manhattan, KS
C-cell Test and Marketing Scores	USDA/ARS/HWWQL Manhattan, KS
Quadrumatic Sr. Mill and Glutomatic Test	USDA/ARS/HWWQL Manhattan, KS
Simon/Kent-Jones Flour Color and Minolta Flour Color	Kansas Wheat Quality Lab KSU Dept. Grain Science & Ind. Manhattan, KS
Wheat Classification	Federal Grain Inspection Service Kansas City, MO
Wheat Single Kernel Characterization, 1000 Kernel Weight, Wheat Kernel Size, Test Weight	USDA/ARS/HWWQL Manhattan, KS
Moisture, Ash, and Protein	USDA/ARS/HWWQL Manhattan, KS
Fisher Flour Granulation	Kansas Wheat Quality Lab KSU Dept. Grain Science & Ind. Manhattan, KS
Flour Milling (Miag Multomat)	KSU Dept. Grain Science & Ind. Manhattan, KS
Doh-Tone 2 as Fungi α-amylase	Caravan Ingredients Company 3947 Broadway Kansas City, MO 64111
Data Compilation and Report Preparation	Hard Winter Wheat Quality lab USDA, ARS, GMPRC Manhattan, KS

CREDITS

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CREDITS

Baking Collaborators

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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
Cargill Inc. 3794 Williston, Rd., Minnetonka, MN 55345	Miller	**Jill BryanEhr** (952)238-4886 Jill_Bryanehr@cargill.com
Cereal Food Processors 701 E. 17th Street Wichita, KS 67214	Miller	**Tim Aschbrenner** (316)267-7311 t.aschbrenner@cerealfood.com
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CREDITS

Baking Collaborators

Address	Collaborator Type	Contact
General Mill RTC 9931 419 2nd Street Minneapolis, MN 55414	Miller	**Dave Katzke** (776)764-2737 Dave.katzke@genmills.com
Mennel Milling Co. Findlay & Vine Street Fostoria, OH 44830	Miller	**Jan Levenhagen** (419) 436-5130 Jlevenhagen@mennel.com
North Dakota State Univ. Plant Science Department Harris Hall 122A Fargo, ND 58105	Wheat Quality Lab	**Brent Hinsz** (701)231-7734 Brent.Hinsz@ndsu.edu
Univ. of Nebraska Dept of Agronomy 180 Plant Science Bldg. Lincoln, NE 68583	Wheat Quality Lab	**Lan Xu** (402)472-2909 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
USDA/ARS Harris Hall North Dakota State Univ. Fargo, ND 58105	Wheat Quality Lab	**Gary Hareland** (701) 231-7711 harelang@fargo.ars.usda.gov
USDA/ARS/WWQL E-202 FSHN Washington State Univ. Pullman, WA 99614	Wheat Quality Lab	**Doug Engle** (509) 335-4062 doug_engle@wsu.edu

METHODS

Test Weight – AACC Approved Method 55-10. Test weight is the weight per Winchester bushel expressed to the nearest tenth of a pound.

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 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 130EC for one hour.

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.

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.

Fisher Flour Granulation - Determinations are made using the Fisher Sub-Sieve Sizer. 1.44 g. of flour is placed in the sample tube, packed to the standard height. The average particle size in microns is read using a porosity of 0.465.

Simon/Kent-Jones Flour Color Grader - Determination is made per instruction manual, using a flour-water slurry that is compared by a microprocessor against an internal standard. Lower readings indicate a brighter (better) color.

Agtron Flour Color - AACC Approved Method 14-30 (modified to dry flour method). M 400 A model Agtron with modifications to relate values to those from the F2 model. Higher readings indicate brighter (better) color.

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.

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

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.

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.

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.

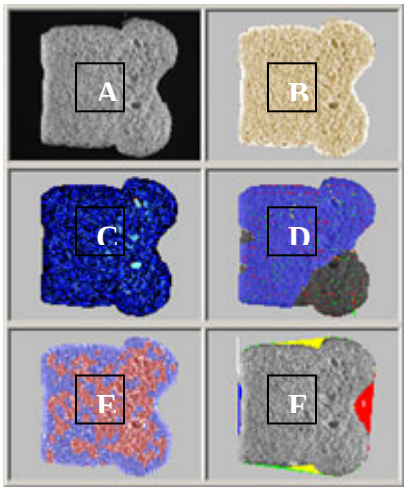
Similarly, cumulative protein curves are determined by arranging millstreams in ascending order of protein content, and tabulating the protein content of the total flour produced with the addition of successive millstreams. Wheat that gives high protein content at low extraction, and a fast rate of protein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

APPENDIX B

Hard Winter Wheat Quality Council Goals for Hard Winter Wheat Breeders

Hard Winter Wheat Quality Council

2007 Technical Board Officers

CHAIR: Tim Aschbrenner, Cereal Food Processors

VICE CHAIR: Rollie Sears, AgriPro Wheat

SECRETARY: Kendall McFall, Kansas State University

MEMBER: Margo Caley, USDA/ARS/HWWQL

MEMBER: Becky Miller, Kansas State University

2007 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***

CONTACT:
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Hard Winter Wheat Quality Laboratory
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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 Rollie Sears

Annual Meeting Feb. 20-22, 2007

Hard Winter Wheat Quality Council Meeting Minutes
Annual Meeting February 20 – 22, 2007

Minutes of the Hard Winter Wheat Technical Committee
Feb. 21, 2007

Tim Aschbrenner notified all members that the minutes for the 2006 meeting have been published in the Wheat Quality Council Annual report and asked that the minutes be approved. Stephen Baenziger approved and seconded by Laura McLaughlin; motion passed.

Nominations were accepted the 2006 technical board. Margo Caley was nominated as a new member of the technical board and Kendall McFall as secretary. The committee voted unanimously to accept their nominations. The 2006 technical board is composed of the following individuals:

Chair: Tim Aschbrenner
Vice chair: Rollin Sears
Secretary: Kendall McFall
Member: Becky Miller
Member: Margo Caley

Continuing members of the Hard Winter Wheat Quality Evaluation and Advisory committee are:

Brad Seabourn: USDA / ARS / HWWQL
Allan Fritz: KSU
Brian Stouts: AIB
Ken Ulbrich: Bay State Milling
Richard Chen: USDA/ ARS / HWWQL

Brad Seabourn presented additional improvements in the Hard Winter Wheat quality targets. After discussion, the committee voted to approve the targets as a working philosophy and that all targets should be considered as targets that are subject to change over time. The HWW quality targets are published in the annual report every year.

Kendall McFall reported on the 2006 milling results at Kansas State. Generally all milling went well. It was decided that a standard wheat blend would be used to warm up the mill for a specified time for all future small scale milling.

Richard Chen reported on the baking procedures utilized in the 2006 report. Ash values reported in 2005 have been corrected in the finalized 2005 report. Richard asked that any comments on the baking procedures or results be forwarded to him.

Brad Seabourn discussed the Milling and Baking scores for the 2006 samples which can be found on pages 131 & 132 of the report. An overall quality score (new) was assigned

using weighted values for the first time on page 133. Brad Seabourn asked that people review the overall scores and provide feedback to him.

Dave Katzke reported on the distribution of the WQC annual report for 2006. This year the report was circulated via electronic format to save printing costs. Generally this change in circulation was well received and the committee plans to continue this format for the 2007 annual report.

John Oades reported on the Overseas Variety Analysis program. It will be continued and remains as an interface for overseas users and wheat breeders.

Submitted by Rollin Sears

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