Milling and Baking Test Results for Hard Winter Wheat

Harvested in 2006

57th 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, 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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Credit: the cover and back photographs courtesy of **Dr. Scott Bean**, Research Chemist, USDA, ARS, GMPRC in Manhattan, Kansas.

2006

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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OKLAHOMA

SOUTH DAKOTA

TEXAS

2006 WQC MILLING AND BAKING SCORE

Description of the 2006 Testing Program

Wheat harvested in 2006 represented the 57th 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, as well as noodle data and tortilla data submitted under separate cover. 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 2006 Wheat Samples

	Test Entry Number	Sample Identification
KANSAS-MANHATTAN		
	06-2401	Overley (check)
	06-2402	Fuller
	06-2403	KS990498-3-&~2
	06-2404	KS970274-14*9
WESTBRED		
	06-2405	Overley (check)
	06-2406	Smoky Hill
	06-2407	Aspen
NEBRASKA		
	06-2408	Millennium (check)
	06-2409	NW98SO97-ARS
	06-2410	NO2Y5117-ARS
	06-2411	NEO1643-UNL
	05-2412	NEO2584-UNL
OKLAHOMA		
	06-2413	OK Bullet (check)
	06-2414	Duster
	06-2415	OK01420
	06-2416	OK02405
	06-2417	OK02522W
SOUTH DAKOTA		
	06-2418	Tandem (check)
	06-2419	SD96240-3-1
	06-2420	SD01122
	06-2421	SD01W064
TEXAS		
	06-2422	Tam 111 (check)
	06-2423	Tam 112 (check)
	06-2424	TX01A5936
	06-2425	TX01D3232
	06-2426	TX01V5314

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

Description of Test Plots and Breeder Entries

Kansas-Manhattan – Reported by Allan Fritz

Location

All lines were grown in a single strip plot increase nursery at the North Agronomy Farm in Manhattan, KS. The plots were fertilized with 90 pounds of nitrogen that was split between fall and spring application. Growing conditions were very good and yields in this nursery were high. There was little disease pressure on these particular plots.

Overley (2401)

This line was submitted as the check. Overley was grown on 15% of the Kansas wheat acreage in 2006 and was concentrated largely in south central Kansas. In our experience, Overley has excellent overall quality. It is large seeded and has had a milling yield advantage in our tests. Its mix time and tolerance, as well as baking scores have compared favorably with Jagger, with Overley having an advantage over Jagger in low to mid protein samples.

Fuller (2402)

Fuller is a hard red winter wheat that was released by the Kansas Agricultural Experiment Station in 2006. The pedigree of Fuller is not known, but almost certainly contains a high percentage of Jagger. Compared to Jagger, Fuller is about a day later, has a slightly higher test weight, is resistant to leaf rust and less prone to shattering in drier environments. Fuller has good foliar disease resistance and is best adapted to central Kansas, but has also performed well in western Kansas. The quality of Fuller has been comparable to Jagger in K-State tests.

KS990498-3-&~2 (2403)

This is a hard red winter wheat with the pedigree KS91W049-1-5-1/CM95091//X920709-B-5-2/3/Jagger ‘S’/Heyne ‘S’//HBB036J. It is a medium maturity wheat with good rust and foliar leaf disease resistance that has performed well in central Kansas. The primary weakness of this line is a tendency toward low test weight which adversely affects milling performance. This line has historically had good baking performance. A decision on whether or not to proceed with this line will be made after the 2007 harvest.

KS970274-14-*9 (2404)

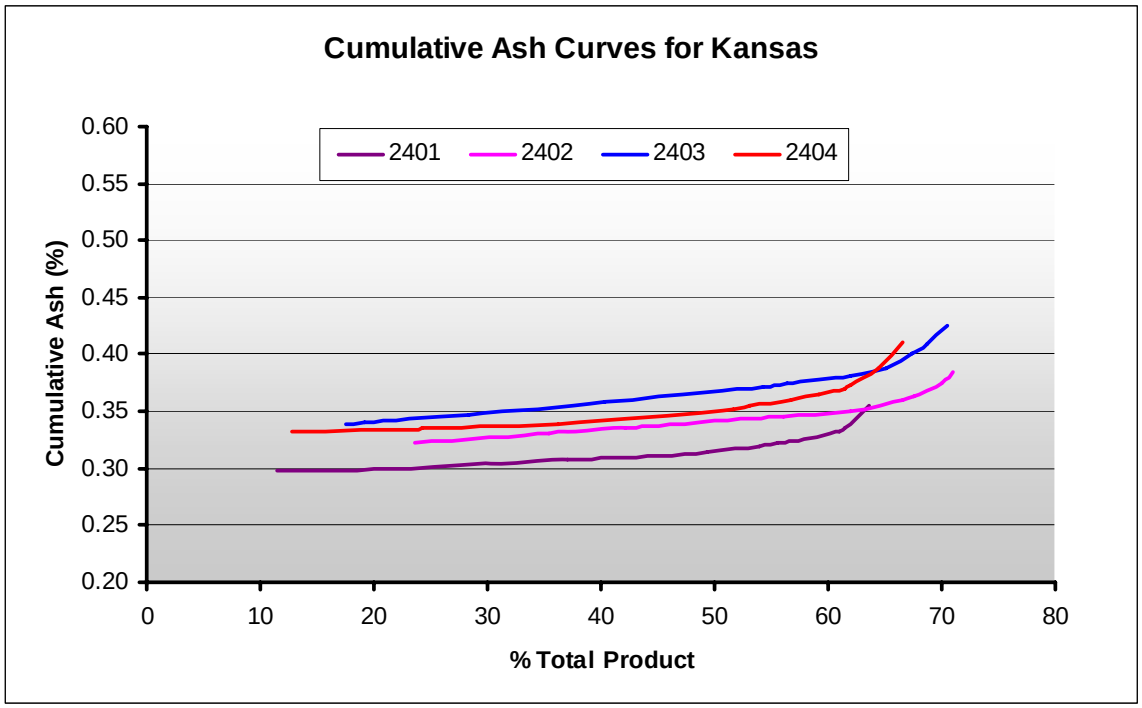
This line is a hard red winter wheat with the pedigree N10362/KS93U134//Jagger. It is a late maturing wheat with good foliar disease resistance, including resistance to leaf and stripe rust. The maturity of this line makes it best suited for northern Kansas, but it has questionable winter hardiness. KS970274-14-*9 has good test weight patterns and has had good milling characteristics in K-State tests. It is a strong gluten wheat with a long mix time and would probably perform best blended with weaker gluten wheats. A decision on whether or not to proceed with this line will be made after the 2007 harvest.

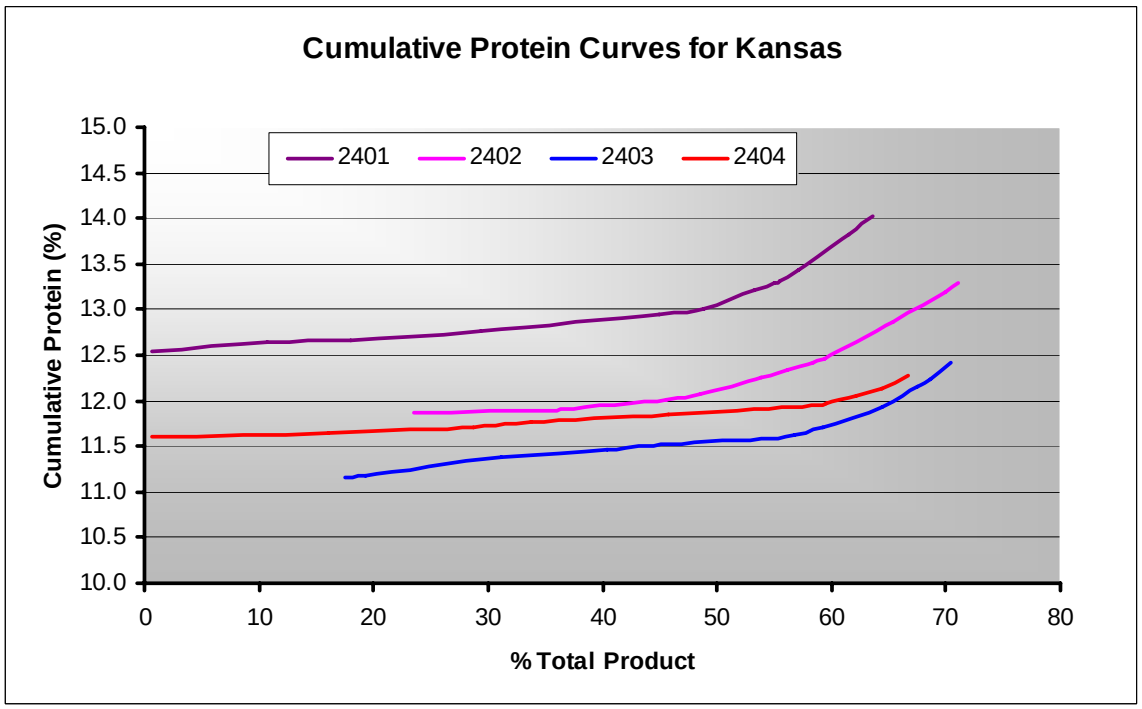
Kansas-Manhattan: 2006 (Small-Scale) Samples[a]

Test entry number	06-2401	06-2402	06-2403	06-2404
Sample identification	Overley (check)	Fuller	KS990498-3-&-2	KS970274-14*9
Wheat Data				
FGIS classification	1 HRW	1 HRW	3 HRW	1 HRW
Test weight (lb/bu)	60.0	60.1	57.8	61.0
Hectoliter weight (kg/hl)	78.9	79.1	76.1	80.2
1000 kernel weight (gm)	39.1	37.5	32.1	35.0
NIR hardness	64.4	64.0	62.3	71.5
Wheat kernel size (Rotap)				
Over 7 wire (%)	88.4	89.0	73.9	84.2
Over 9 wire (%)	11.6	11.0	25.8	15.6
Through 9 wire (%)	0.1	0.0	0.3	0.1
Single kernel (skcs)				
Hardness (avg /s.d)	54.5/14.9	50.9/14.5	64.8/13.5	66.9/13.8
Weight (mg) (avg/s.d)	39.6/9.1	38.6/9.0	33.9/7.8	35.8/6.7
Diameter (mm)(avg/s.d)	2.73/0.49	2.65/0.46	2.34/0.44	2.64/0.41
SKCS distribution	08-19-36-37	09-24-42-25	01-07-23-69	01-06-22-71
Classification	Hard	Hard	Hard	Hard
Wheat moisture (%)	11.6	11.8	11.6	12.2
Wheat protein (12% mb)	14.3	14.8	13.1	13.6
Wheat ash (12% mb)	1.39	1.38	1.44	1.33
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	63.6	71.0	70.5	66.6
Quadrumat Sr. Mill	73.0	72.6	72.5	74.2
Flour moisture (%)	12.9	11.7	12.5	13.4
Flour protein (14% mb)	13.2	13.3	12.1	12.3
Flour ash (14% mb)	0.38	0.38	0.41	0.39
Glutomatic				
Wet gluten (%)	36.0	36.1	30.8	33.5
Dry gluten (%)	13.1	13.1	11.5	11.8
Gluten index	97.8	98.1	99.4	98.5
Flour color				
Agtron flour color	73	74	76	75
Simon/Kent-Jones flour color	-0.16	0.07	-0.20	-0.33
Minolta color meter				
L*	92.90	92.77	92.97	92.89
a*	-1.38	-1.07	-1.20	-1.64
b*	9.02	7.89	8.36	9.55
Falling number (sec)	448	489	439	463
Flour particle size (avg)				
Fisher sub sieve sizer	23	19	21	22

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

Kansas-Manhattan: Cumulative Ash and Protein Curves

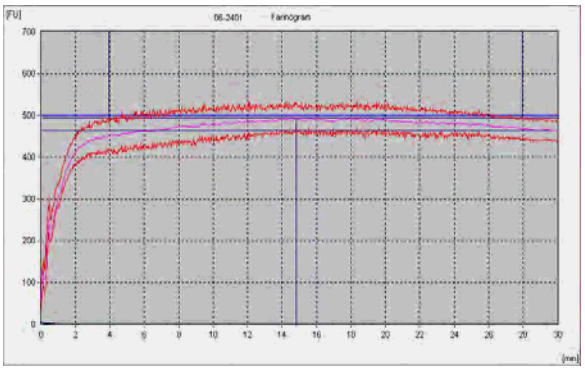




Physical Dough Tests

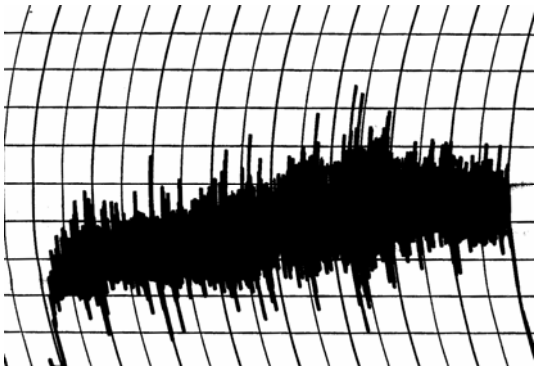
2006 (Small Scale) Samples – Kansas-Manhattan

Farinograms



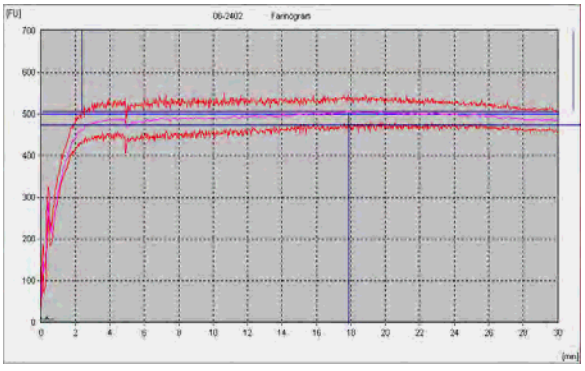
Abs. 59.5%, Peak 14.9 min, Stab. 24.0 min

Mixograms

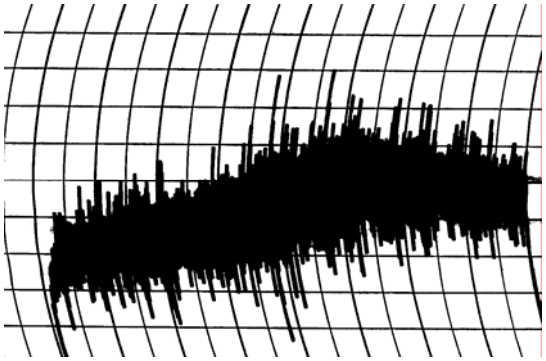


Abs. 63.9%, Mix time 5.9 min

06-2401, Overley (check)



Abs. 59.8%, Peak 17.9 min, Stab. 28.5 min



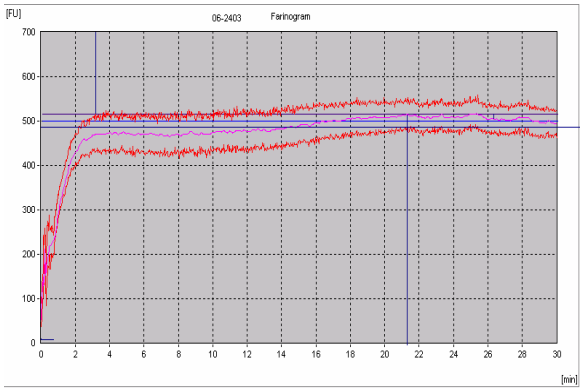
Abs. 64.0%, Mix time 5.4 min

06-2402, Fuller

Physical Dough Tests

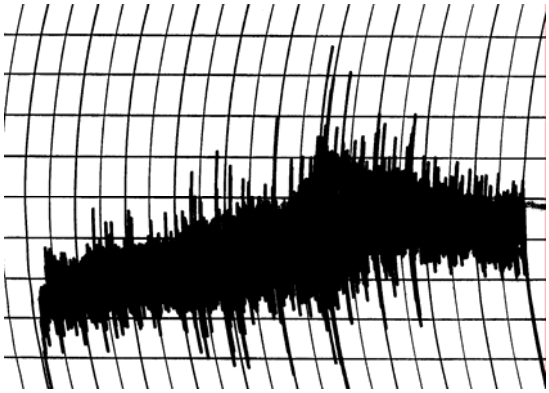
2006 (Small Scale) Samples – Kansas-Manhattan (continued)

Farinograms



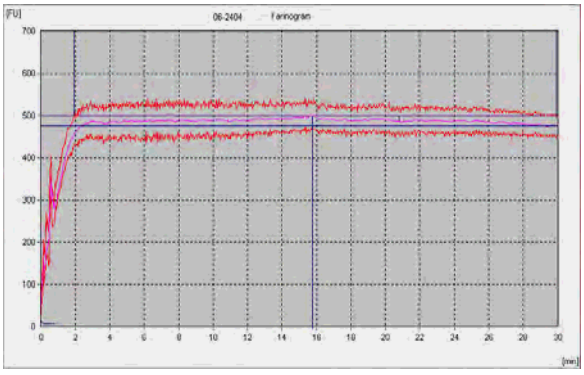
Abs. 56.9%, Peak 21.3 min, Stab. 30.6 min

Mixograms

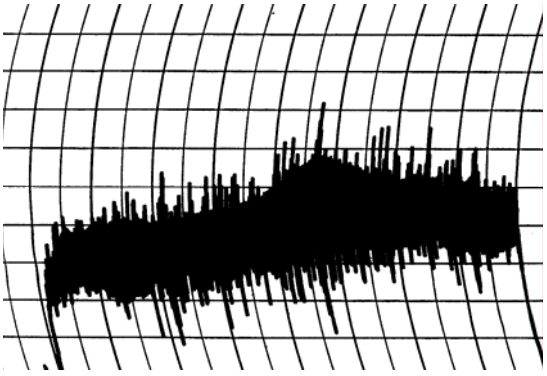


Abs. 63.1%, Mix time 6.4 min

06-2403, KS990498-3-&~2



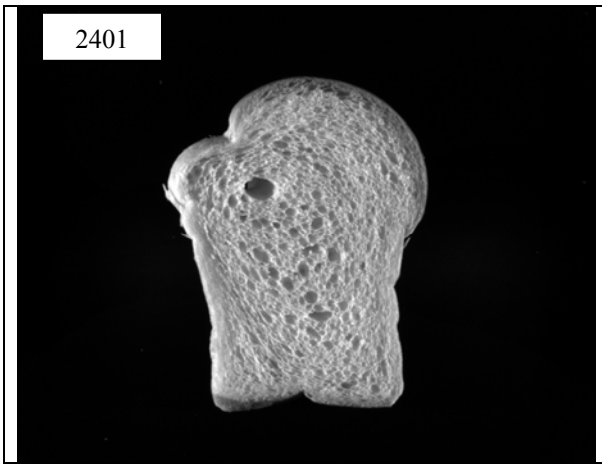
Abs. 58.3%, Peak 15.8 min, Stab. 28.0 min



Abs. 63.5%, Mix time 4.8 min

06-2404, KS970274

Kansas-Manhattan: C-Cell Bread Images and Analysis for 2006(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	6783	150.5	3966	0.447	2.111	7.04	1.703	-27.6
2402	6953	145.3	4069	0.446	2.065	3.98	1.698	-25.3

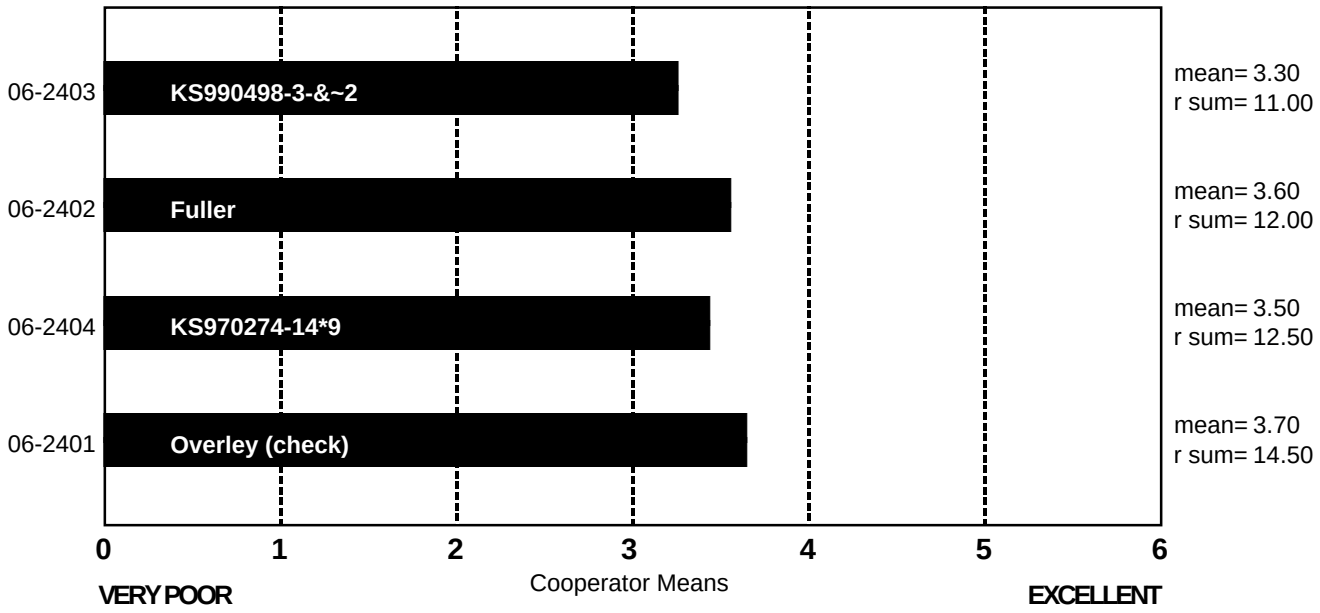
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2403	6996	153.0	4214	0.445	2.037	1.00	1.710	-25.0
2404	6333	150.2	3985	0.438	1.936	1.36	1.685	-20.0

SPONGE CHARACTERISTICS

(Small Scale) Kansas-Manhattan

ncoop= 5
chisq= 0.78
chisqc= 1.34
cvchisq= 7.82
crdiff=

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

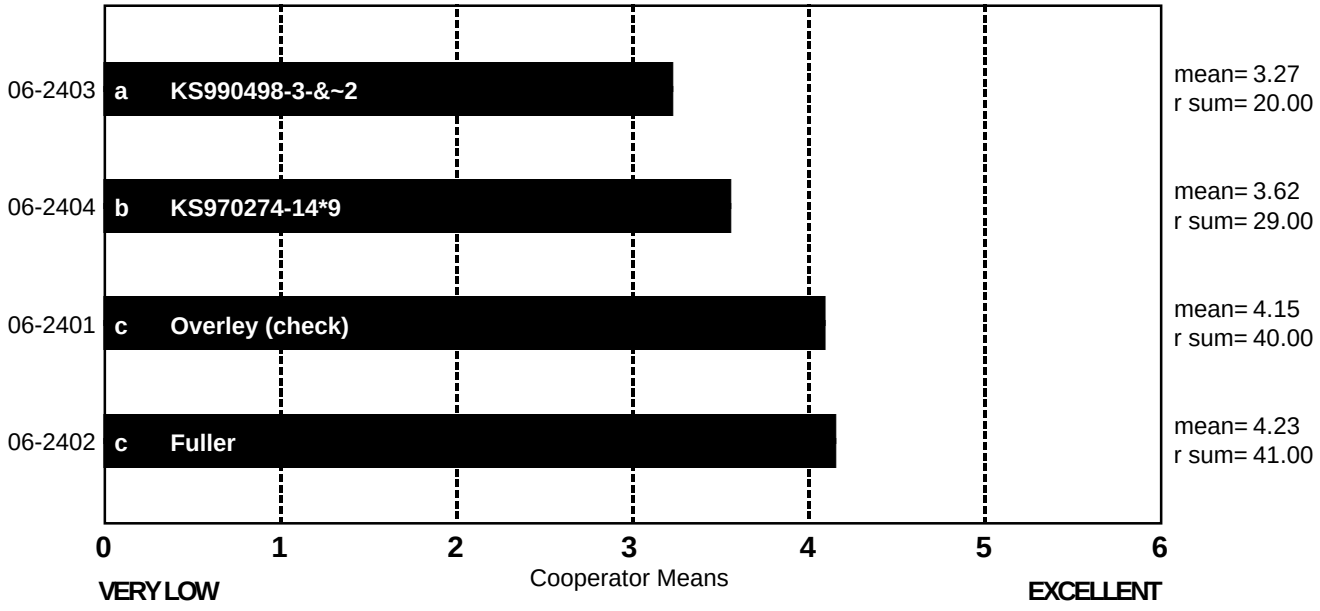


BAKE ABSORPTION

(Small Scale) Kansas-Manhattan

ncoop= 13
chisq= 13.71
chisqc= 21.21
cvchisq= 7.82
crdiff= 7.54

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Kansas-Manhattan

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2401 Overley (check)	**60.0**	**60.4**	**63.9**	**62.5**	**61.0**	**65.0**	**57.9**	**64.0**	**63.9**	**61.5**	**66.8**	**62.0**	**58.0**
06-2402 Fuller	**60.0**	**60.4**	**63.6**	**62.8**	**61.0**	**64.3**	**57.9**	**64.0**	**64.4**	**61.8**	**68.5**	**64.0**	**58.3**
06-2403 KS990498-3-&~2	**59.0**	**59.1**	**63.1**	**59.9**	**59.0**	**64.0**	**53.6**	**63.0**	**63.0**	**58.9**	**66.5**	**60.0**	**55.4**
06-2404 KS970274-14*9	**59.0**	**59.0**	**63.6**	**61.3**	**59.0**	**65.1**	**56.4**	**63.0**	**64.0**	**60.3**	**67.5**	**60.0**	**56.8**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Kansas-Manhattan

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2401 Overley (check)	**9.0**	**3.5**	**6.5**	**20.0**	**25.0**	**4.9**	**6.5**	**9.0**	**7.5**	**9.0**	**5.9**	**12.0**	**4.0**
06-2402 Fuller	**20.0**	**3.5**	**6.4**	**24.0**	**25.0**	**4.0**	**7.5**	**9.0**	**7.5**	**9.5**	**5.5**	**18.0**	**3.8**
06-2403 KS990498-3-&~2	**20.0**	**4.3**	**11.0**	**24.0**	**25.0**	**7.0**	**9.0**	**9.0**	**11.0**	**9.5**	**8.4**	**25.0**	**5.0**
06-2404 KS970274-14*9	**20.0**	**3.0**	**8.0**	**16.0**	**25.0**	**4.5**	**7.0**	**9.0**	**8.5**	**8.5**	**6.9**	**16.0**	**3.8**

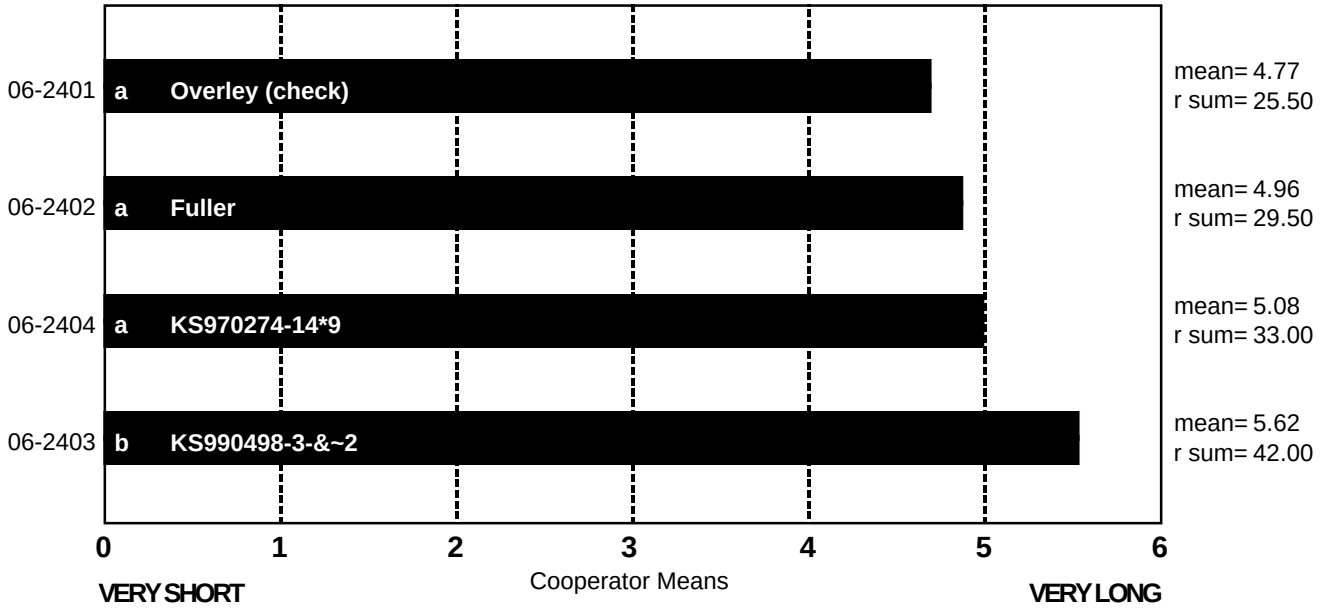
Raw Data

BAKE MIX TIME

(Small Scale) Kansas-Manhattan

ncoop= 13
chisq= 6.85
chisqc= 12.21
cvchisq= 7.82
crdiff= 8.63

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

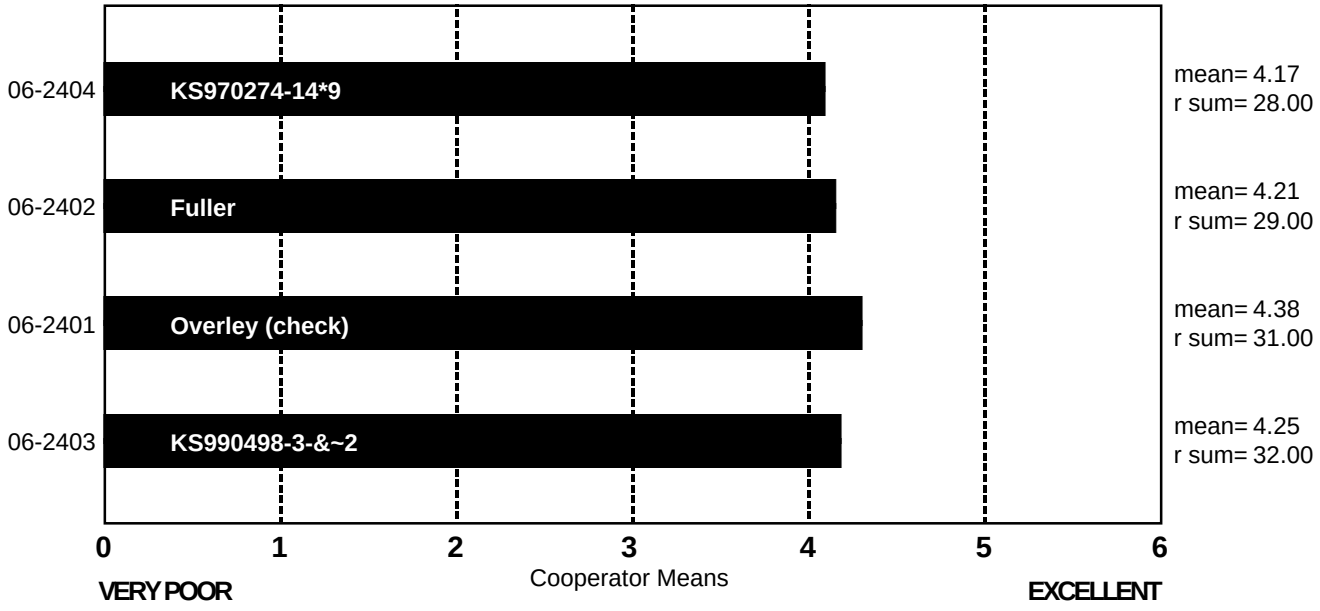


MIXING TOLERANCE

(Small Scale) Kansas-Manhattan

ncoop= 12
chisq= 0.50
chisqc= 1.09
cvchisq= 7.82
crdiff=

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

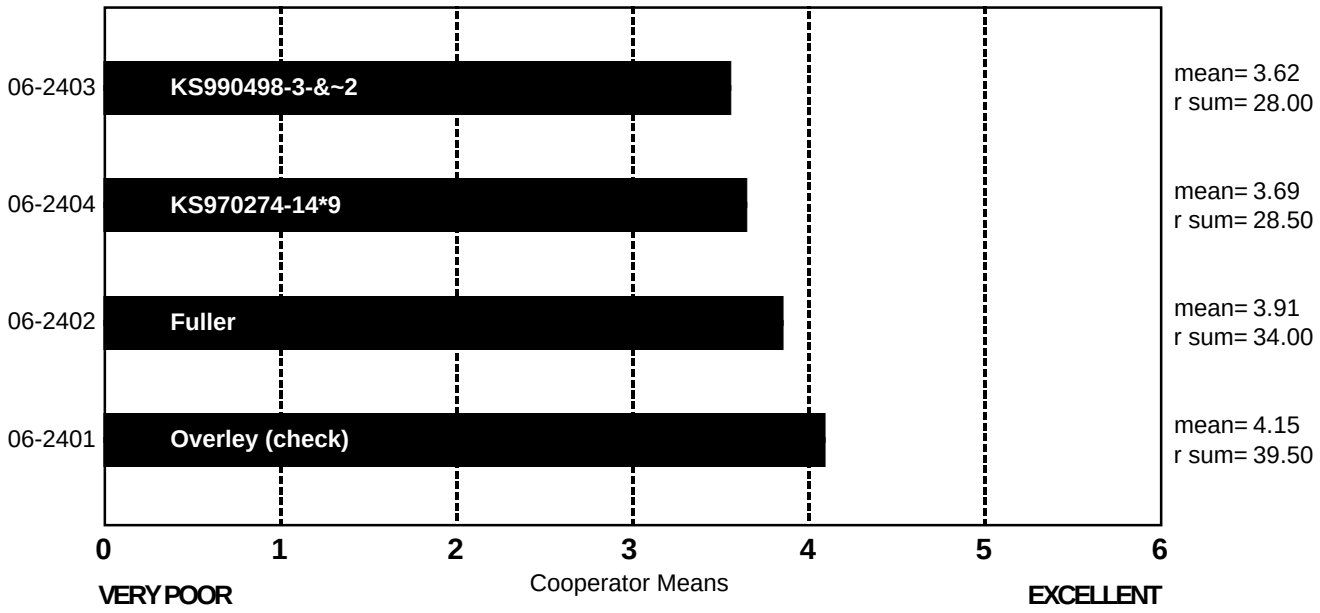


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Kansas-Manhattan

ncoop= 13
chisq= 4.04
chisqc= 7.61
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Kansas-Manhattan

	Sticky	Wet	Tough	Good	Excellent
06-2401 Overley (check)	**0**	**0**	**2**	**9**	**2**
06-2402 Fuller	**0**	**0**	**3**	**7**	**3**
06-2403 KS990498-3-&~2	**2**	**1**	**3**	**6**	**1**
06-2404 KS970274-14*9	**1**	**0**	**5**	**6**	**1**

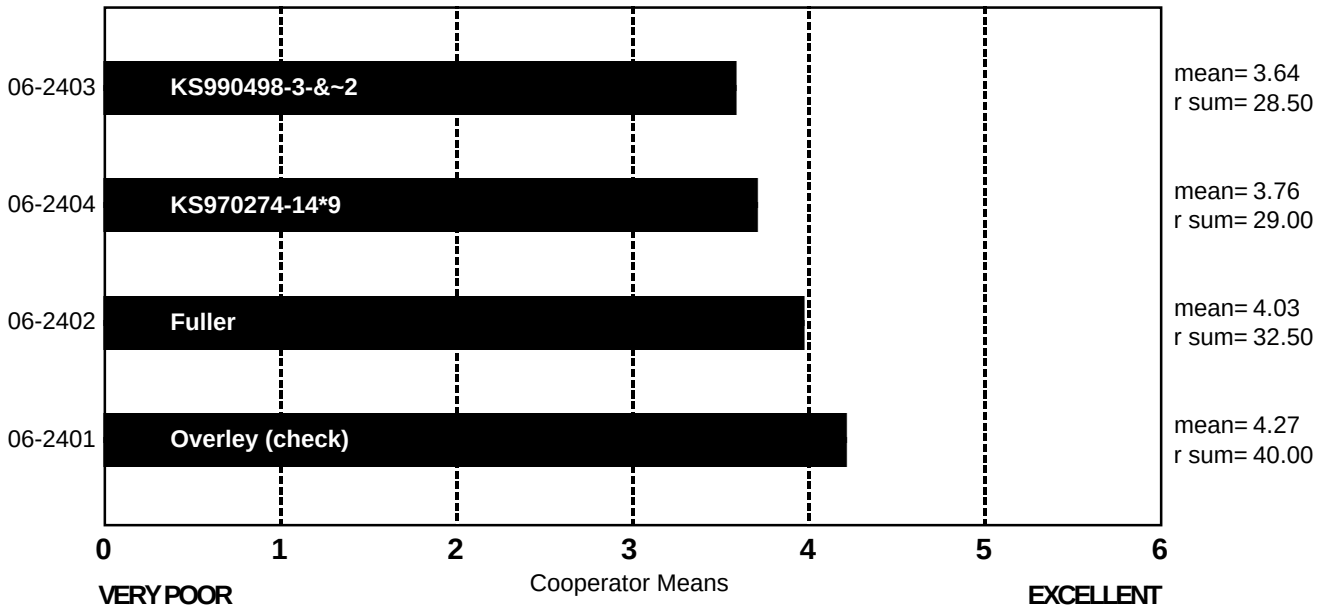
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Kansas-Manhattan

ncoop= 13
chisq= 3.90
chisqc= 7.80
cvchisq= 7.82
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Kansas-Manhattan

	Sticky	Wet	Tough	Good	Excellent
06-2401 Overley (check)	**2**	**0**	**3**	**5**	**3**
06-2402 Fuller	**1**	**0**	**4**	**5**	**3**
06-2403 KS990498-3-&~2	**2**	**1**	**5**	**3**	**2**
06-2404 KS970274-14*9	**3**	**0**	**4**	**4**	**2**

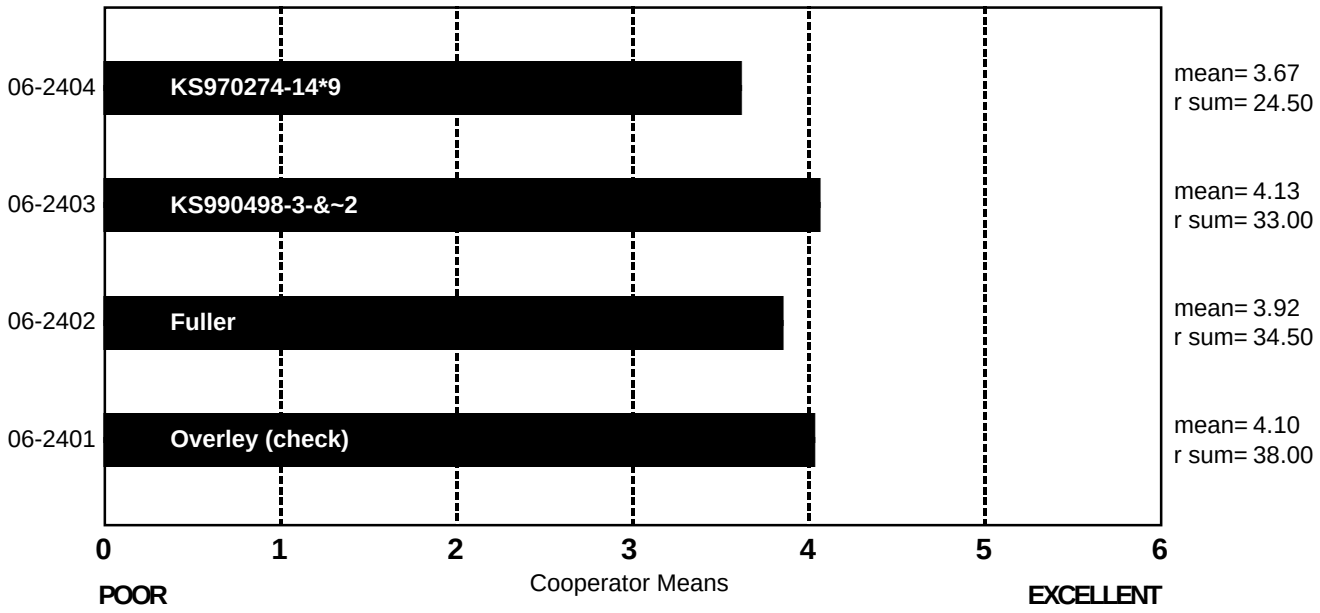
Frequency Table

CRUMB GRAIN

(Small Scale) Kansas-Manhattan

ncoop= 13
chisq= 4.55
chisqc= 5.52
cvchisq= 7.82
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Kansas-Manhattan

	Open	Fine	Dense
06-2401 Overley (check)	**5**	**8**	**0**
06-2402 Fuller	**4**	**9**	**0**
06-2403 KS990498-3-&~2	**3**	**8**	**2**
06-2404 KS970274-14*9	**7**	**5**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Kansas-Manhattan

	Round	Irregular	Elongated
06-2401 Overley (check)	**3**	**6**	**4**
06-2402 Fuller	**3**	**5**	**5**
06-2403 KS990498-3-&~2	**2**	**6**	**5**
06-2404 KS970274-14*9	**5**	**6**	**2**

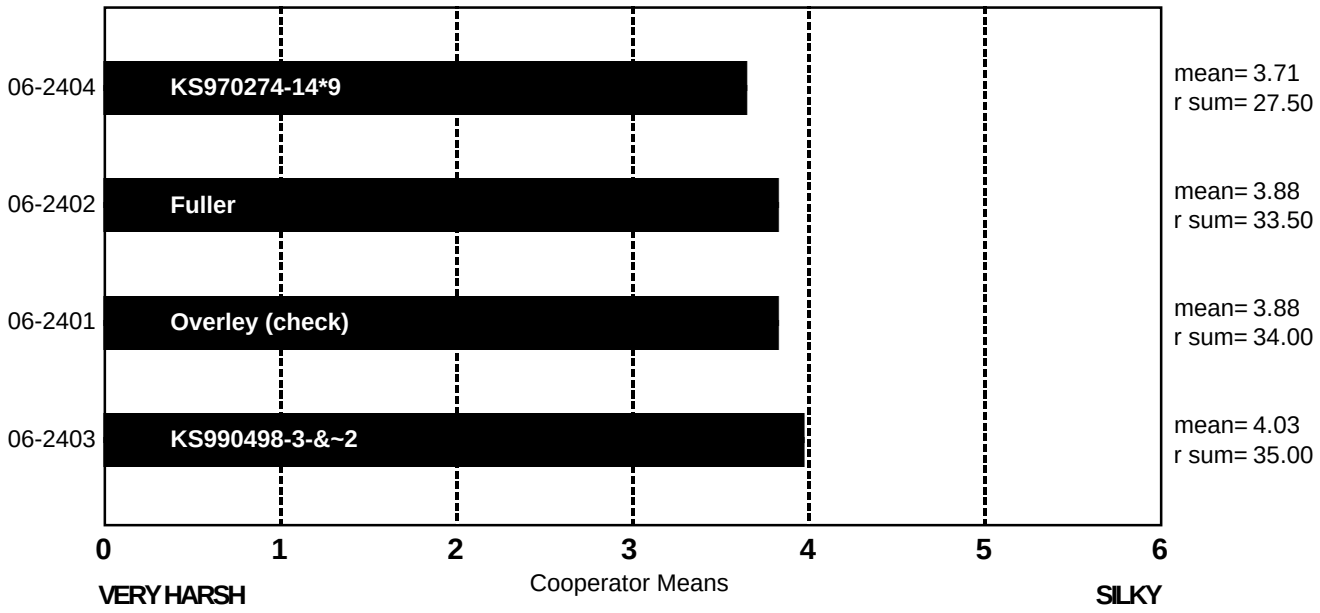
Frequency Table

CRUMB TEXTURE

(Small Scale) Kansas-Manhattan

ncoop= 13
chisq= 1.59
chisqc= 2.38
cvchisq= 7.82
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Kansas-Manhattan

	Harsh	Smooth	Silky
06-2401 Overley (check)	**2**	**8**	**3**
06-2402 Fuller	**3**	**9**	**1**
06-2403 KS990498-3-&~2	**2**	**7**	**4**
06-2404 KS970274-14*9	**4**	**7**	**2**

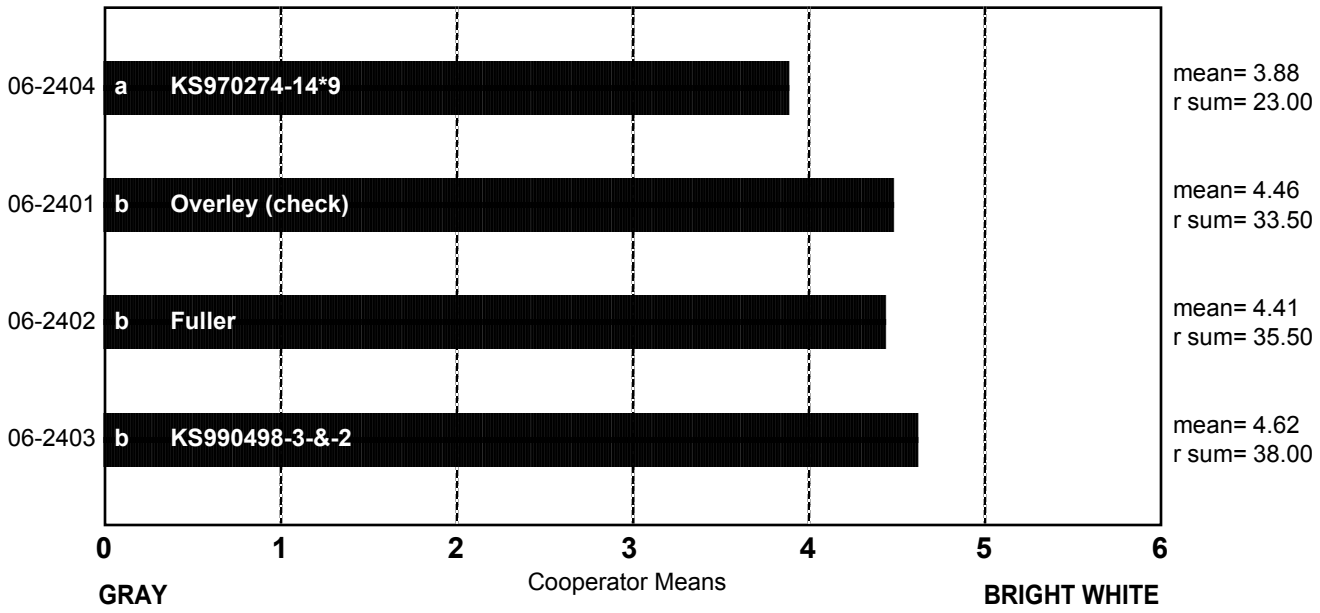
Frequency Table

CRUMB COLOR

(Small Scale) Kansas-Manhattan

ncoop= 13
chisq= 6.02
chisqc= 9.79
cvchisq= 7.82
crdiff= 9.43

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



CRUMB COLOR, DESCRIBED

(Small Scale) Kansas-Manhattan

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
06-2401 Overley (check)	**0**	**0**	**0**	**1**	**5**	**7**	**0**
06-2402 Fuller	**0**	**0**	**1**	**1**	**3**	**8**	**0**
06-2403 KS990498-3-&-2	**0**	**0**	**0**	**1**	**3**	**7**	**2**
06-2404 KS970274-14*9	**0**	**0**	**2**	**2**	**6**	**3**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Kansas-Manhattan

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2401 Overley (check)	**423.0**	**134.9**	**141.6**	**419.5**	**472.0**	**144.6**	**500.0**		**150.3**	**473.0**	**155.9**	**461.7**	
06-2402 Fuller	**422.0**	**134.2**	**140.8**	**421.2**	**473.5**	**144.7**	**500.0**		**151.4**	**467.0**	**156.5**	**463.6**	
06-2403 KS990498-3-&~2	**426.0**	**134.3**	**138.6**	**417.5**	**472.8**	**142.2**	**500.0**		**148.5**	**472.0**	**149.9**	**466.1**	
06-2404 KS970274-14*9	**426.0**	**136.4**	**143.2**	**416.9**	**477.0**	**142.0**	**495.0**		**149.8**	**474.0**	**157.2**	**465.0**	

Raw Data

LOAF VOLUME, ACTUAL

(Small Scale) Kansas-Manhattan

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2401 Overley (check)	**2900**	**870**	**946**	**2300**	**3044**	**988**	**3300**	**1010**	**995**	**2925**	**958**	**2668**	**1080**
06-2402 Fuller	**2900**	**825**	**935**	**2210**	**3104**	**928**	**3200**	**975**	**1000**	**3125**	**988**	**2675**	**995**
06-2403 KS990498-3-&~2	**3000**	**850**	**943**	**2660**	**3104**	**1013**	**3050**	**968**	**1023**	**2725**	**1008**	**2738**	**1030**
06-2404 KS970274-14*9	**2900**	**825**	**873**	**2700**	**3162**	**983**	**3250**	**1040**	**885**	**3100**	**958**	**2713**	**975**

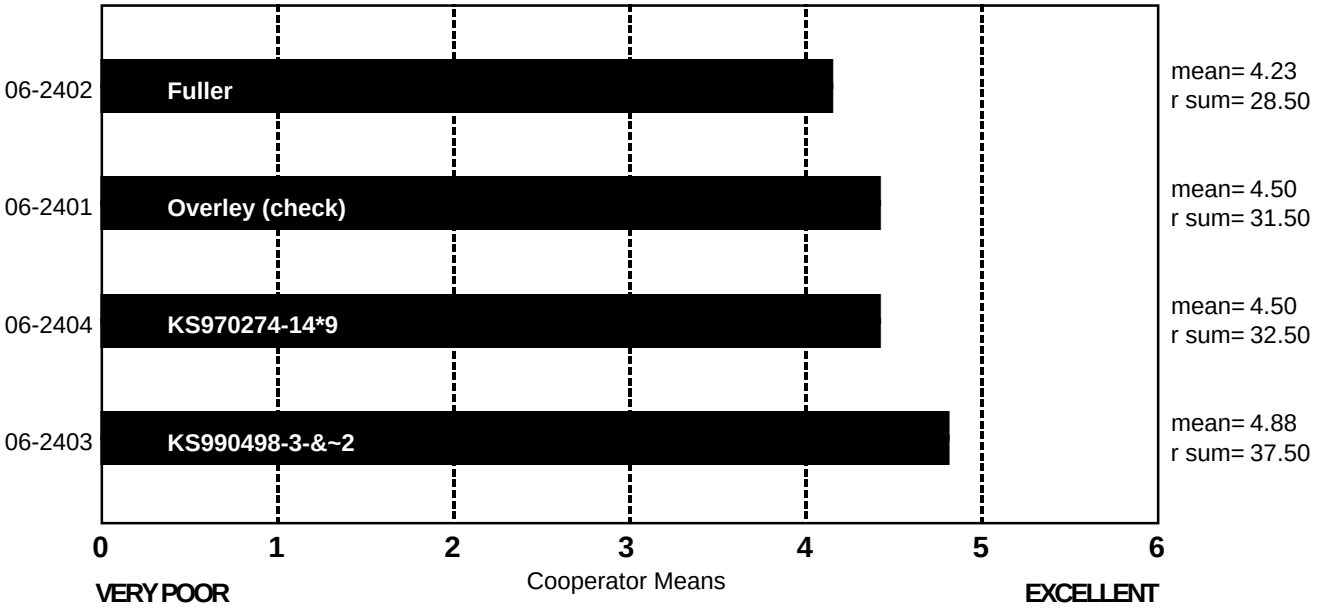
Raw Data

LOAF VOLUME

(Small Scale) Kansas-Manhattan

ncoop= 13
chisq= 1.94
chisqc= 2.57
cvchisq= 7.82
crdiff=

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

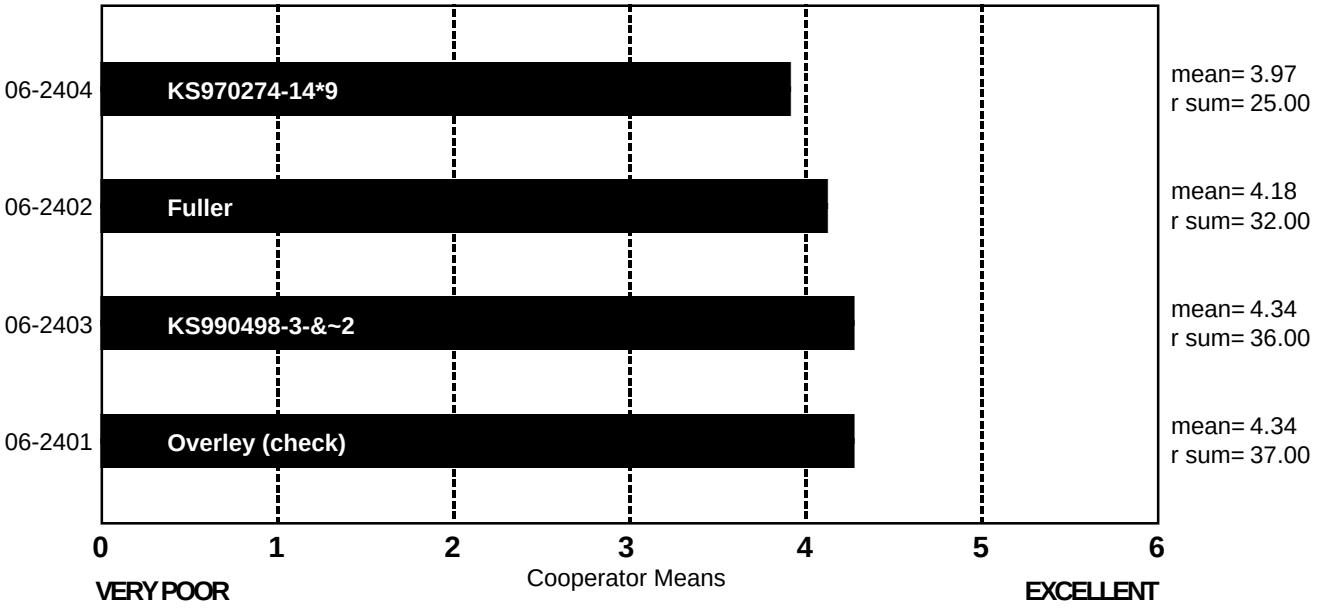


OVERALL BAKING QUALITY

(Small Scale) Kansas-Manhattan

ncoop= 13
chisq= 4.11
chisqc= 4.64
cvchisq= 7.82
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Kansas-Manhattan

COOP. 06-2401 (Overley (check))

A. Very open grain.
B. No comments.
C. No comments.
D. Poor mix tolerance, tough dough, open, harsh crumb grain, low volume.
E. Extremely strong flour, tight, consistent, smooth grain, very good volume.
F. No comments.
G. Strong, good color, and good bake.
H. Nice volume, good grain for such a high protein, lively doughs, excellent overall performance.
I. Good flour protein and absorption, excellent out of mix and pan, satisfactory crumb grain, long mix time.
J. Very white crumb.
K. No comments.
L. Good absorption, slightly long mix time, good grain, white crumb, and average volume.
M. Good loaf volume, silky white crumb.

COOP. 06-2402 (Fuller)

A. Strong dough.
B. No comments.
C. No comments.
D. Poor mix tolerance, tough dough, open, harsh crumb grain, low volume.
E. Extremely strong flour, slightly open, variable grain, excellent volume.
F. No comments.
G. Strong, good color, good bake.
H. Good bake performance. had slightly harsher texture and slightly more open grain, slightly less strength for such a high protein.
I. Same descriptors as 2401, excellent in dough and bread evaluations but long mix time.
J. No comments.
K. No comments.
L. High absorption, long mix time, good grain, white crumb, and average volume.
M. Loaf volume Ok, smooth white crumb, good mix tolerance.

COOPERATOR'S COMMENTS
(Small Scale) Kansas-Manhattan (Continued)

COOP. 06-2403 (KS990498-3-&~2)

A. Strong dough nice interior.
B. No comments.
C. No comments.
D. Poor mix tolerance, tough dough, nice grain and volume.
E. Good crumb color, fairly tight, consistent grain, excellent volume.
F. No comments.
G. Very low absorption, good and weaker at make up, white color, strong and good bake.
H. Good bake performance, needed slightly longer mixing time.
I. Excellent in flour protein, absorption, loaf volume, and crumb grain, but long mix time.
J. Very white crumb.
K. Good loaf volume for protein.
L. Very long mix time, very fine grain, white crumb, and good volume.
M. Good loaf volume, bright white crumb, low bake absorption.

COOP. 06-2404 (KS970274-14*9)

A. Strong dough nice interior.
B. No comments.
C. No comments.
D. Mediocre mix tolerance, tough dough, mice grain and volume.
E. Very open, irregular grain, excellent volume and strength.
F. No comments.
G. Creamy color, strong, good bake.
H. Biggest volumes, slightly open grain but excellent bake overall.
I. Satisfactory tolerance and dough handling and make-up, but not as good crumb grain and long mix time.
J. No comments.
K. No comments.
L. Long mix time and good loaf volume.
M. White crumb color, low bake absorption, high mix tolerance, slightly tough out of mixer.

Notes: **A, D, E H, and L** comments based on sponge and dough bake test.

Description of Test Plots and Breeder Entries

WestBred LLC – Reported by Sid Perry

Growing Conditions

The samples were produced at Haven, Kansas under dryland conditions. Pre-plant nitrogen was applied at a rate of 75 lb/acre, with an additional top-dress of 35 lb/acre. Production levels were 60 bu/acre, although temperatures were excessive during flowering/grain fill.

Overley (check) (2405)

Overley is a hard red winter wheat well adapted to south central Kansas, possessing excellent milling and baking characteristics.

HV9W99-1324R (Smoky Hill) (2406)

This is a hard red winter wheat from the population "97K 8/64 Masa 3" which was a bulk of several crosses all involving a strong gluten soft wheat variety called GSR2500. Notable varieties that were crossed with GSR2500 include Karl 92, Cossack, Tonkawa, and Custer. It has been tested by WestBred for the past 5 years, and in the 2005 SRPN. Smoky Hill is later maturing with good leaf and stripe rust protection, along with soil borne and spindle streak mosaic virus resistance.

HV9W96-1383W (Aspen) (2407)

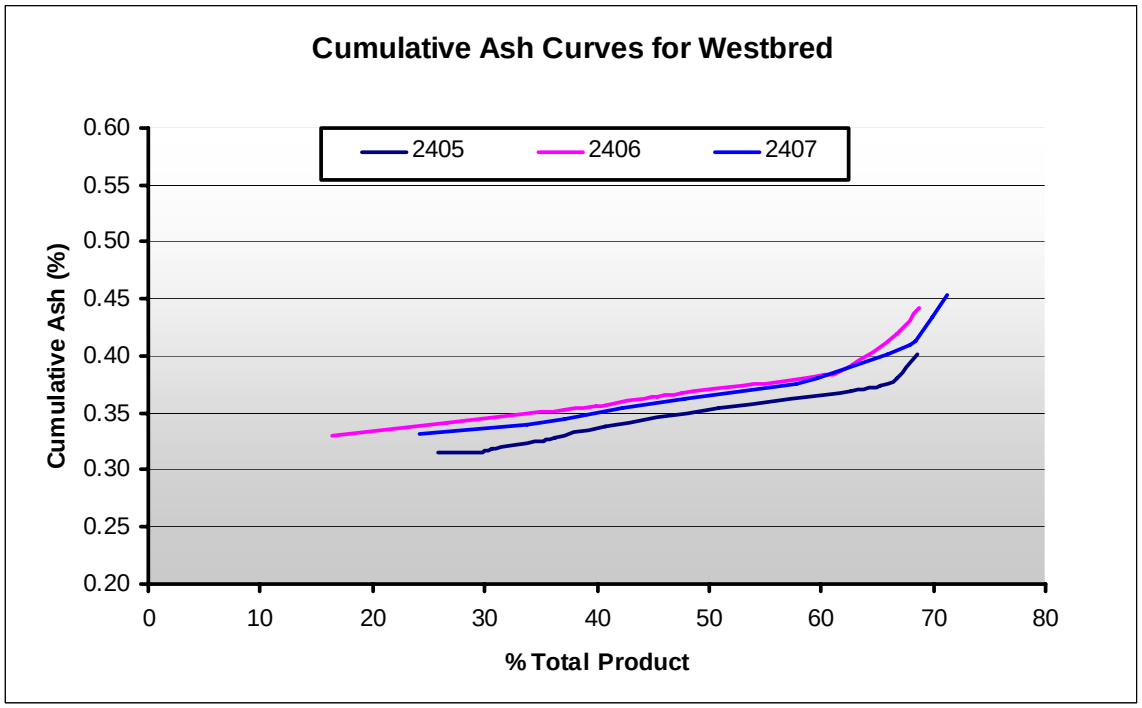
Aspen is a hard white winter wheat from the pedigree TX91D6913 (TAM 302)/B1551W. It has been tested by WestBred for the past four years, and in the 2006 SRPN. It will be tested in state performance trials in 2007. Aspen is early maturing, with good leaf and stripe rust protection, along with soil borne and spindle streak mosaic virus resistance. The sprout resistance is very good.

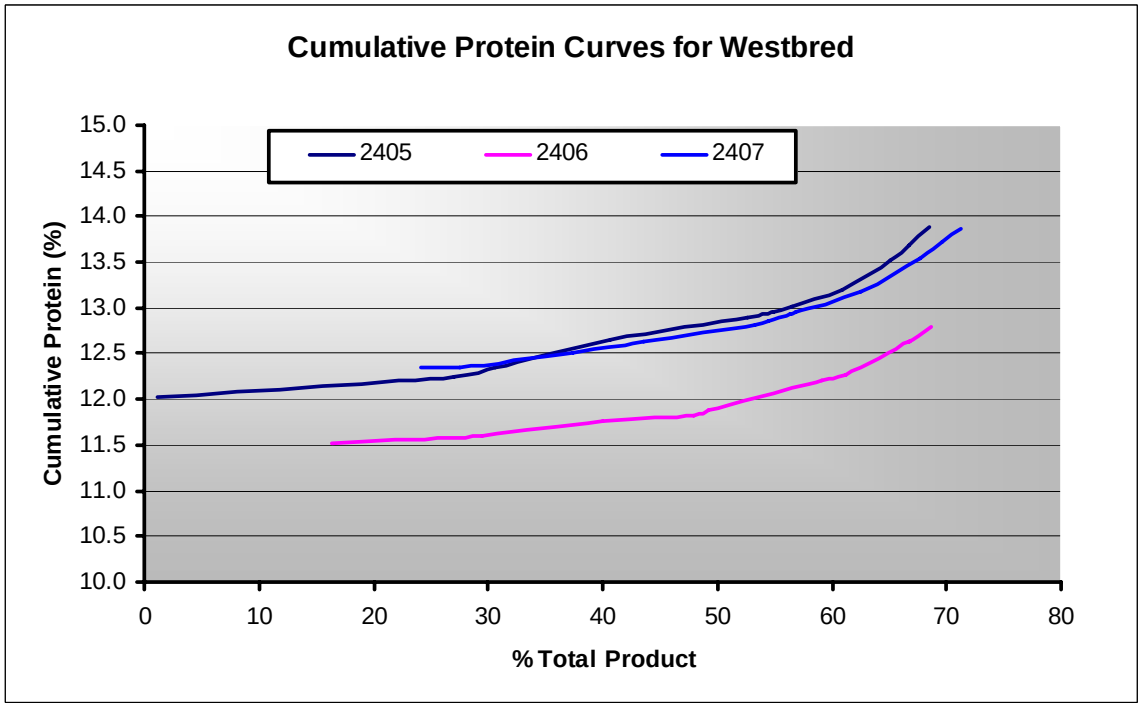
Westbred: 2006 (Small-Scale) Samples[a]

Test entry number	06-2405	06-2406	06-2407
Sample identification	Overley (Check)	Smoky Hill	Aspen
Wheat Data			
FGIS classification	1 HRW	1 HRW	2 HDWH
Test weight (lb/bu)	60.3	60.6	60.2
Hectoliter weight (kg/hl)	79.3	79.7	79.2
1000 kernel weight (gm)	33.4	30.0	36.4
NIR hardness	69.4	63.2	72.6
Wheat kernel size (Rotap)			
Over 7 wire (%)	83.5	64.7	86.4
Over 9 wire (%)	16.4	35.0	13.6
Through 9 wire (%)	0.1	0.3	0.0
Single kernel (skcs)			
Hardness (avg /s.d)	56.3/15.1	62.2/14.8	61.7/12.8
Weight (mg) (avg/s.d)	36.7/9.7	33.0/8.7	38.0/7.6
Diameter (mm)(avg/s.d)	2.63/0.52	2.41/0.48	2.57/0.43
SKCS distribution	04-20-36-40	03-07-32-58	01-08-34-57
Classification	Hard	Hard	Hard
Wheat moisture (%)	11.0	11.6	11.0
Wheat protein (12% mb)	14.5	14.2	14.3
Wheat ash (12% mb)	1.50	1.51	1.51
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	68.6	68.7	71.2
Quadrumat Sr. Mill	72.8	71.7	72.6
Flour moisture (%)	12.4	12.3	12.0
Flour protein (14% mb)	13.6	12.8	13.5
Flour ash (14% mb)	0.40	0.49	0.47
Glutomatic			
Wet gluten (%)	38.5	33.0	38.7
Dry gluten (%)	13.3	12.0	13.3
Gluten index	95.3	98.8	89.4
Flour color			
Agtron flour color	74	68	68
Simon/Kent-Jones flour color	0.80	2.23	1.70
Minolta color meter			
L*	92.47	91.89	91.65
a*	-1.42	-1.02	-1.43
b*	9.31	8.26	9.59
Falling number (sec)	427	549	518
Flour particle size (avg)			
Fisher sub sieve sizer	21	21	22

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

Westbred: Cumulative Ash and Protein Curves

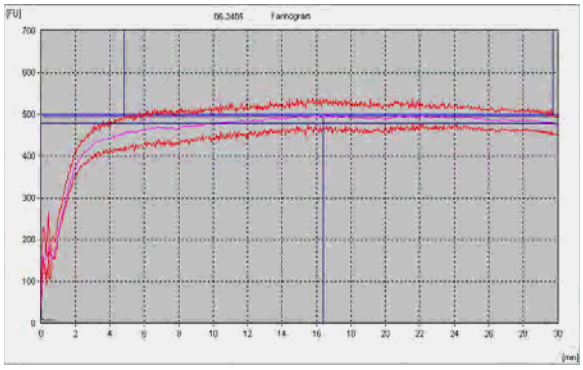




Physical Dough Tests

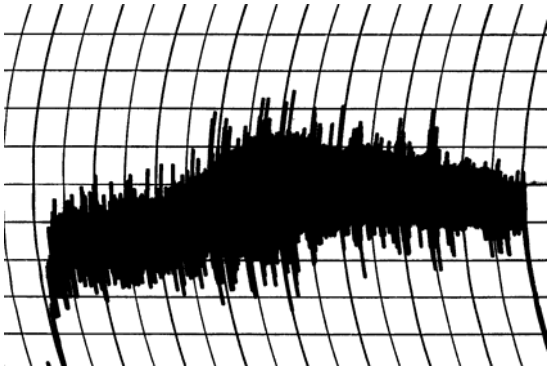
2006 (Small Scale) Samples - Westbred

Farinograms



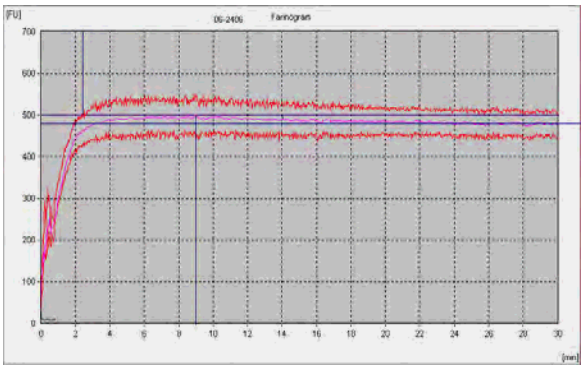
Abs. 62.3%, Peak 16.4 min, Stab. 24.9 min

Mixograms

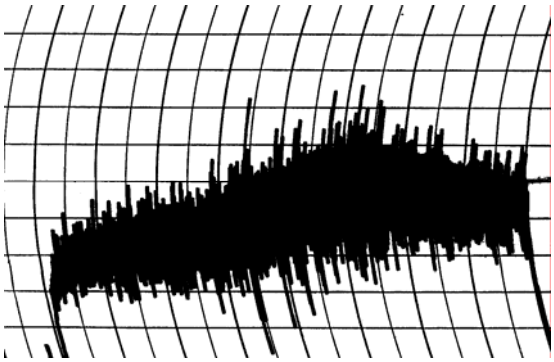


Abs. 65.7%, Mix time 4.3 min

06-2405, Overley (check)



Abs. 57.7%, Peak 9.0 min, Stab. 29.4 min



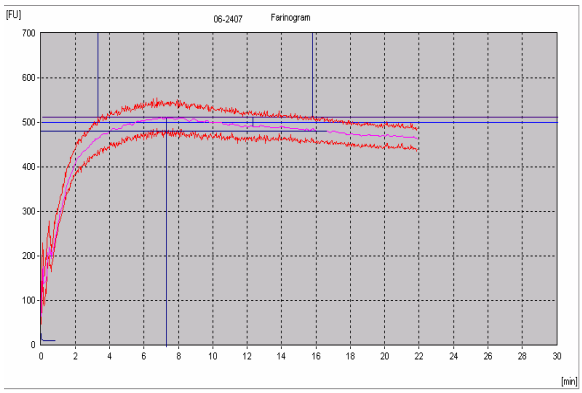
Abs. 62.8%, Mix time 5.4 min

06-2406, Smoky Hill

Physical Dough Tests

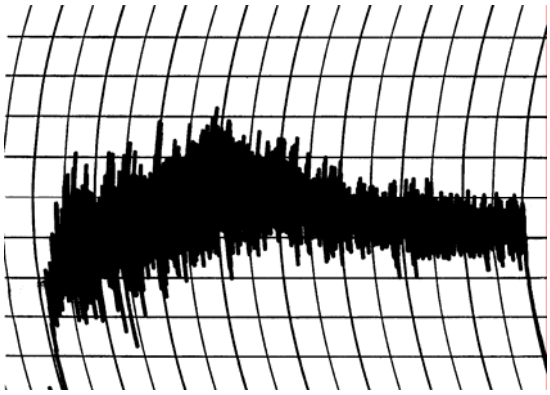
2006 (Small Scale) Samples - Westbred (continued)

Farinograms



Abs. 64.4%, Peak 7.3 min, Stab. 12.5 min

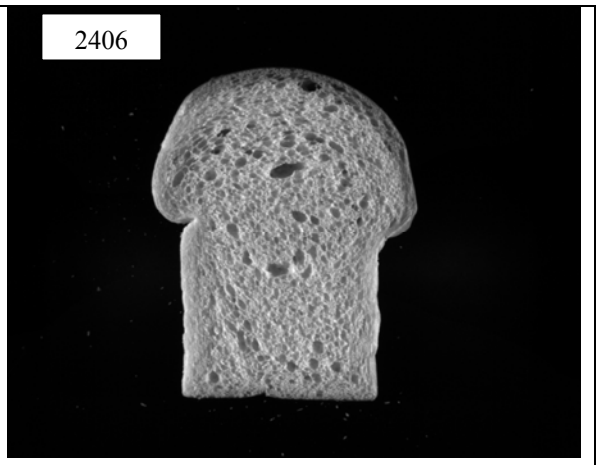
Mixograms



Abs. 65.4%, Mix time 3.0 min

06-2407, Aspen

Westbred: C-Cell Bread Images and Analysis for 2006(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	6696	146.9	3833	0.455	2.191	6.74	1.695	-17.2
2406	7012	139.7	4283	0.442	1.984	2.68	1.673	-15.1

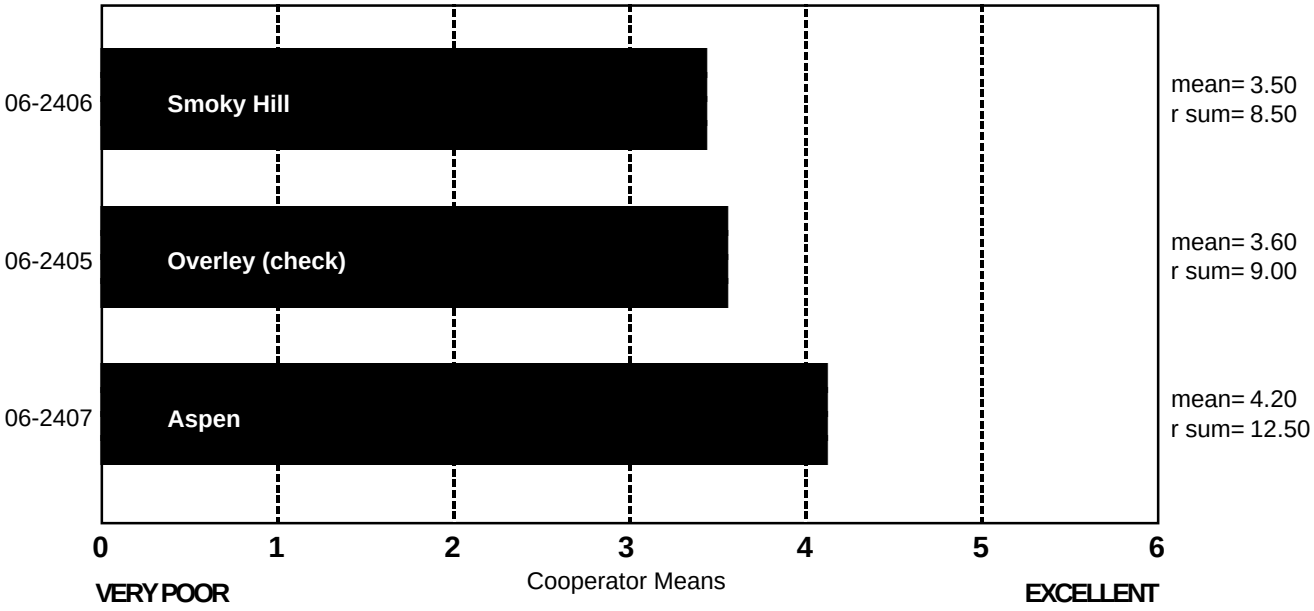
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2407	6238	147.7	3816	0.441	1.982	2.10	1.725	-18.1

SPONGE CHARACTERISTICS

(Small Scale) Westbred

ncoop= 5
chisq= 1.90
chisqc= 2.53
cvchisq= 5.99
crdiff=

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

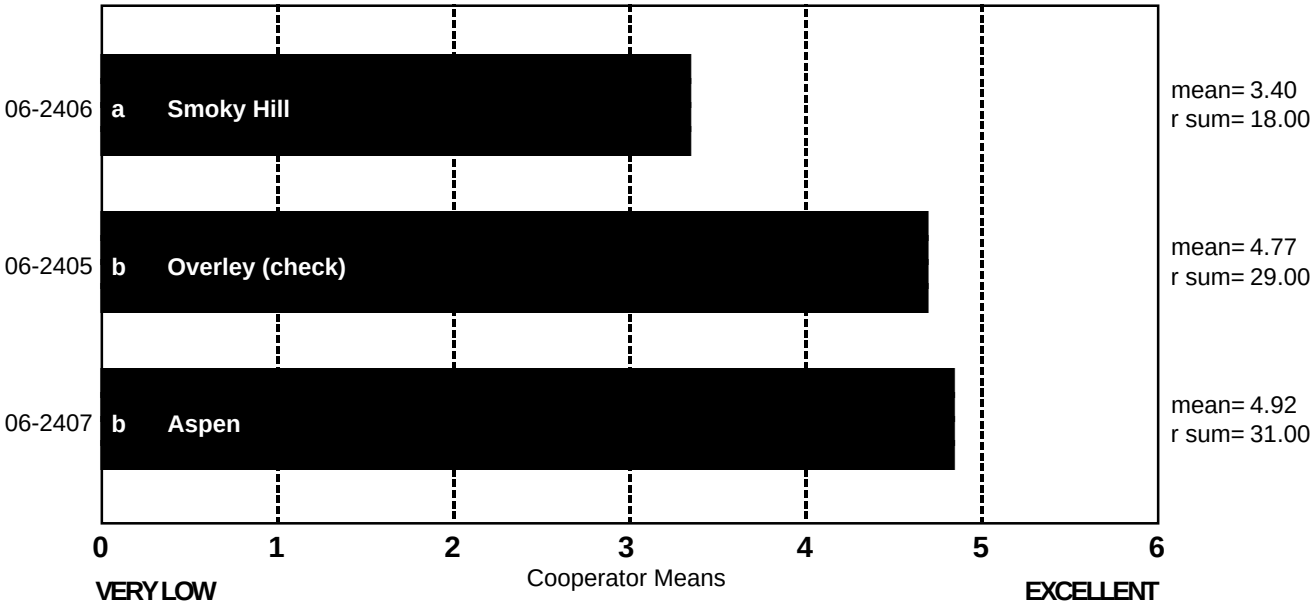


BAKE ABSORPTION

(Small Scale) Westbred

ncoop= 13
chisq= 7.54
chisqc= 10.32
cvchisq= 5.99
crdiff= 7.27

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Westbred

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2405 Overley (check)	**61.0**	**62.1**	**65.6**	**65.3**	**63.0**	**66.4**	**60.7**	**64.0**	**67.3**	**64.3**	**67.7**	**63.0**	**60.8**
06-2406 Smoky Hill	**60.0**	**59.6**	**62.6**	**60.7**	**60.0**	**63.5**	**55.7**	**64.0**	**62.8**	**59.7**	**67.6**	**62.0**	**56.2**
06-2407 Aspen	**60.0**	**63.7**	**65.1**	**67.4**	**66.0**	**65.9**	**61.4**	**64.0**	**63.0**	**66.4**	**68.9**	**66.0**	**62.9**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Westbred

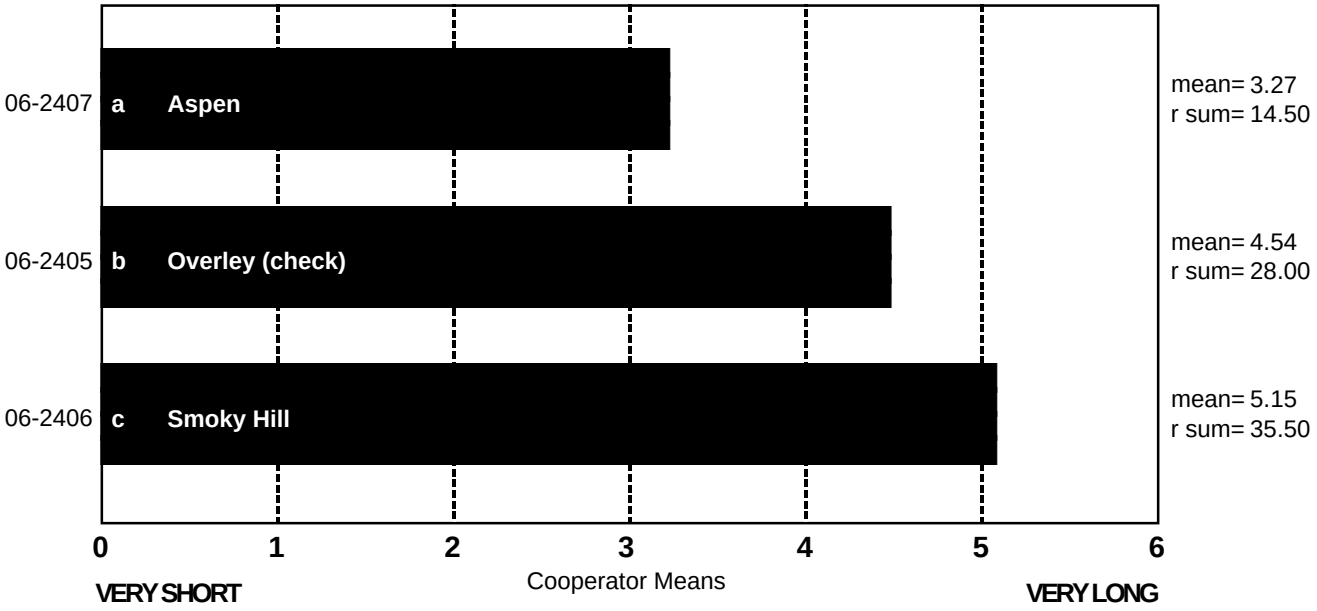
	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2405 Overley (check)	**9.0**	**2.0**	**7.0**	**22.0**	**25.0**	**4.3**	**6.0**	**9.0**	**5.9**	**8.5**	**5.4**	**12.0**	**3.3**
06-2406 Smoky Hill	**16.0**	**2.5**	**7.3**	**24.0**	**25.0**	**5.4**	**9.0**	**9.0**	**7.8**	**9.0**	**6.2**	**10.0**	**4.0**
06-2407 Aspen	**8.0**	**1.8**	**5.1**	**10.0**	**20.0**	**3.0**	**7.0**	**6.0**	**3.9**	**6.5**	**3.6**	**6.0**	**2.5**

BAKE MIX TIME

(Small Scale) Westbred

ncoop= 13
chisq= 17.42
chisqc= 18.88
cvchisq= 5.99
crdiff= 5.51

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

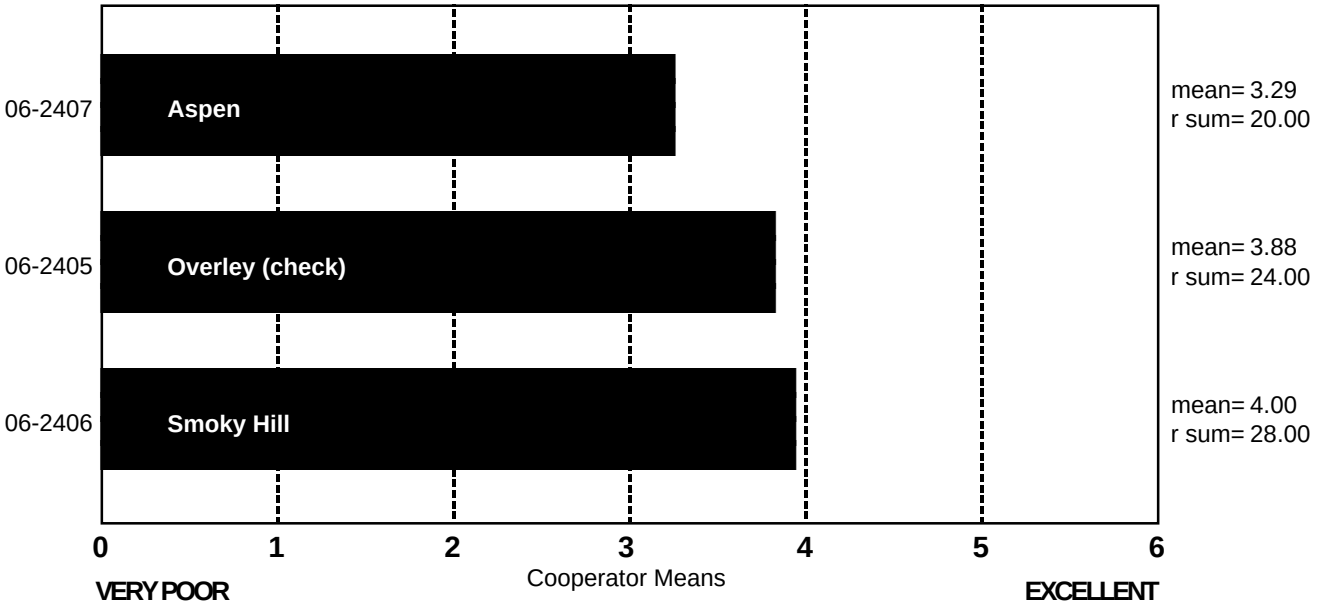


MIXING TOLERANCE

(Small Scale) Westbred

ncoop= 12
chisq= 2.67
chisqc= 3.20
cvchisq= 5.99
crdiff=

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

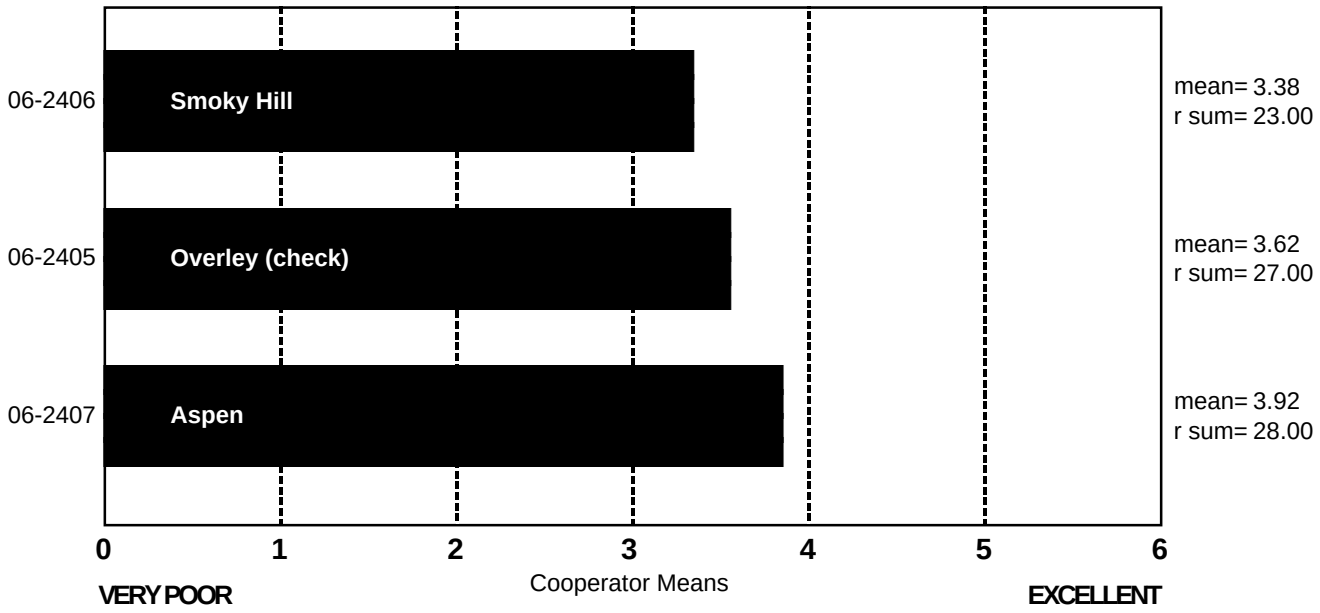


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Westbred

ncoop= 13
chisq= 1.08
chisqc= 2.07
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Westbred

	Sticky	Wet	Tough	Good	Excellent
06-2405 Overley (check)	**1**	**1**	**4**	**5**	**2**
06-2406 Smoky Hill	**1**	**1**	**5**	**6**	**0**
06-2407 Aspen	**1**	**0**	**2**	**10**	**0**

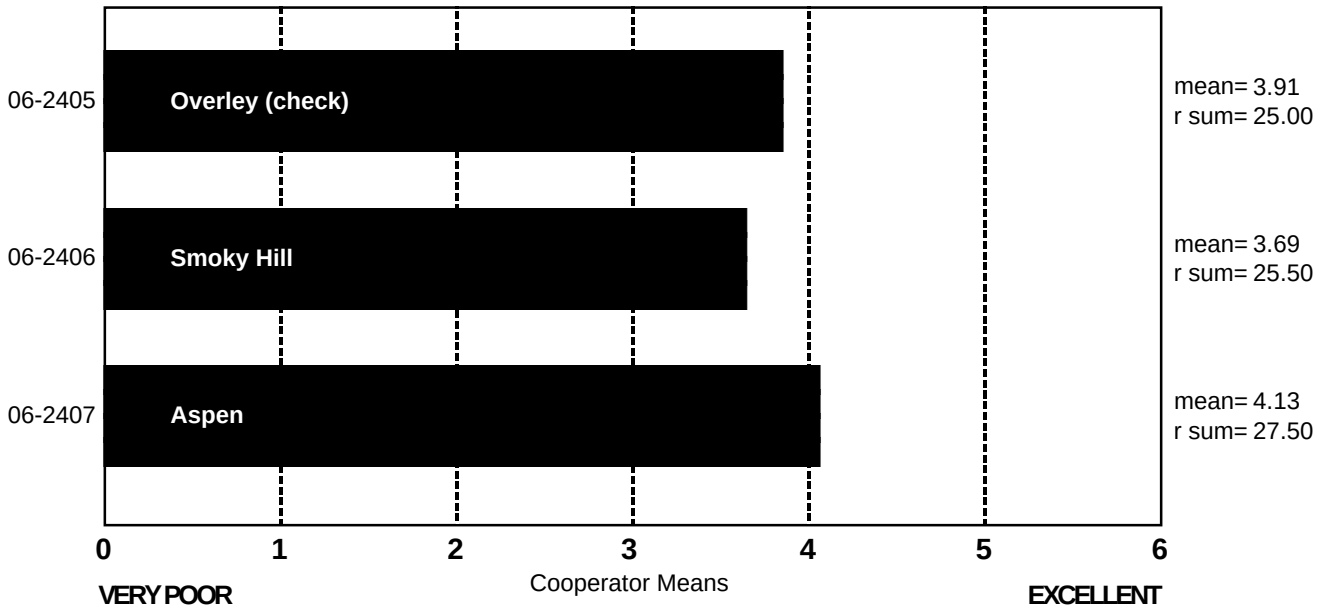
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Westbred

ncoop= 13
chisq= 0.27
chisqc= 0.38
cvchisq= 5.99
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Westbred

	Sticky	Wet	Tough	Good	Excellent
06-2405 Overley (check)	**2**	**0**	**4**	**4**	**3**
06-2406 Smoky Hill	**1**	**1**	**5**	**3**	**3**
06-2407 Aspen	**1**	**1**	**4**	**5**	**2**

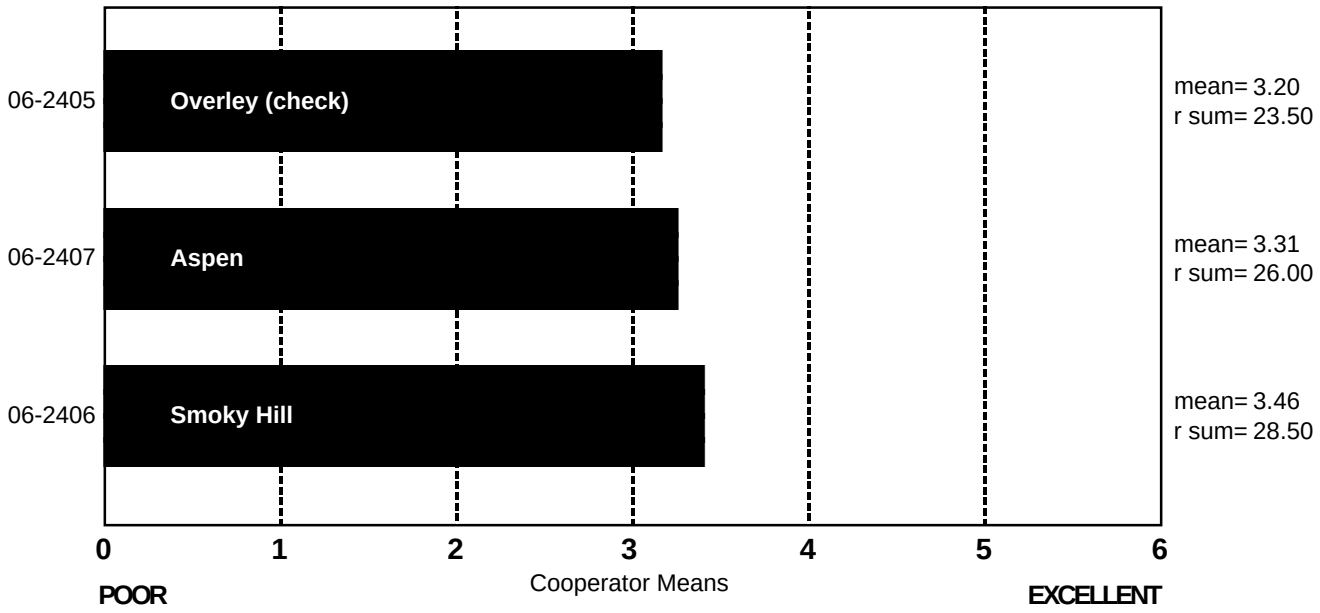
Frequency Table

CRUMB GRAIN

(Small Scale) Westbred

ncoop= 13
chisq= 0.96
chisqc= 1.19
cvchisq= 5.99
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Westbred

	Open	Fine	Dense
06-2405 Overley (check)	**11**	**2**	**0**
06-2406 Smoky Hill	**4**	**7**	**2**
06-2407 Aspen	**7**	**5**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Westbred

	Round	Irregular	Elongated
06-2405 Overley (check)	**1**	**9**	**3**
06-2406 Smoky Hill	**2**	**7**	**4**
06-2407 Aspen	**2**	**9**	**2**

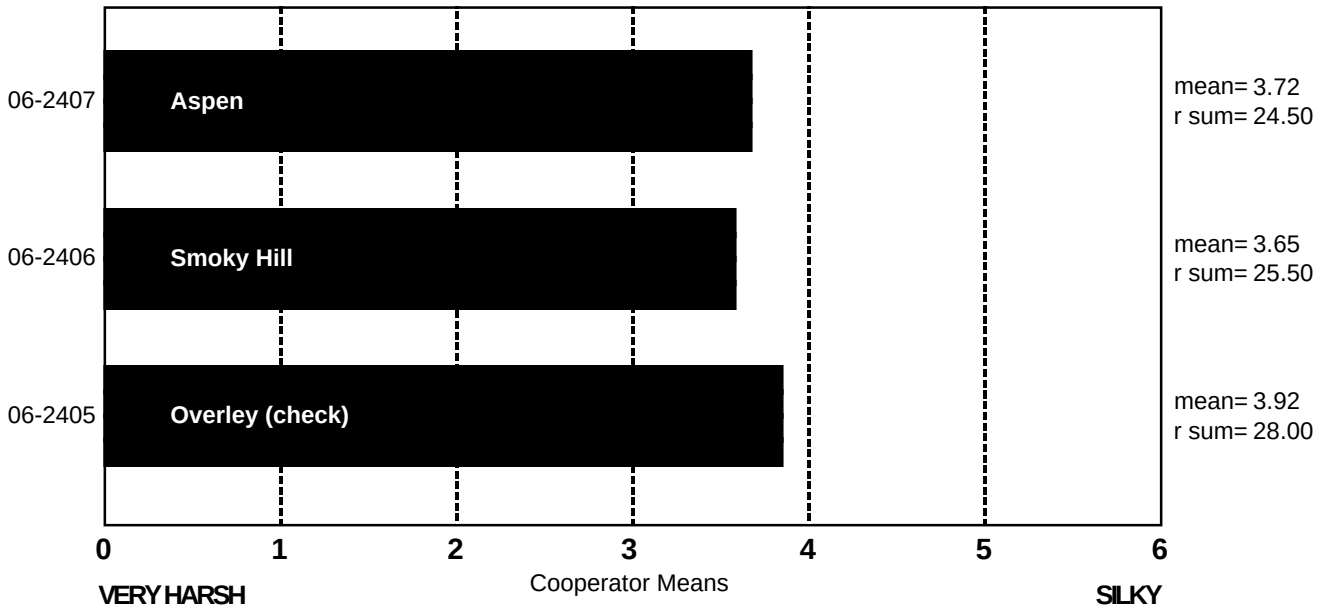
Frequency Table

CRUMB TEXTURE

(Small Scale) Westbred

ncoop= 13
chisq= 0.50
chisqc= 0.70
cvchisq= 5.99
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Westbred

	Harsh	Smooth	Silky
06-2405 Overley (check)	**2**	**9**	**2**
06-2406 Smoky Hill	**3**	**8**	**2**
06-2407 Aspen	**2**	**8**	**3**

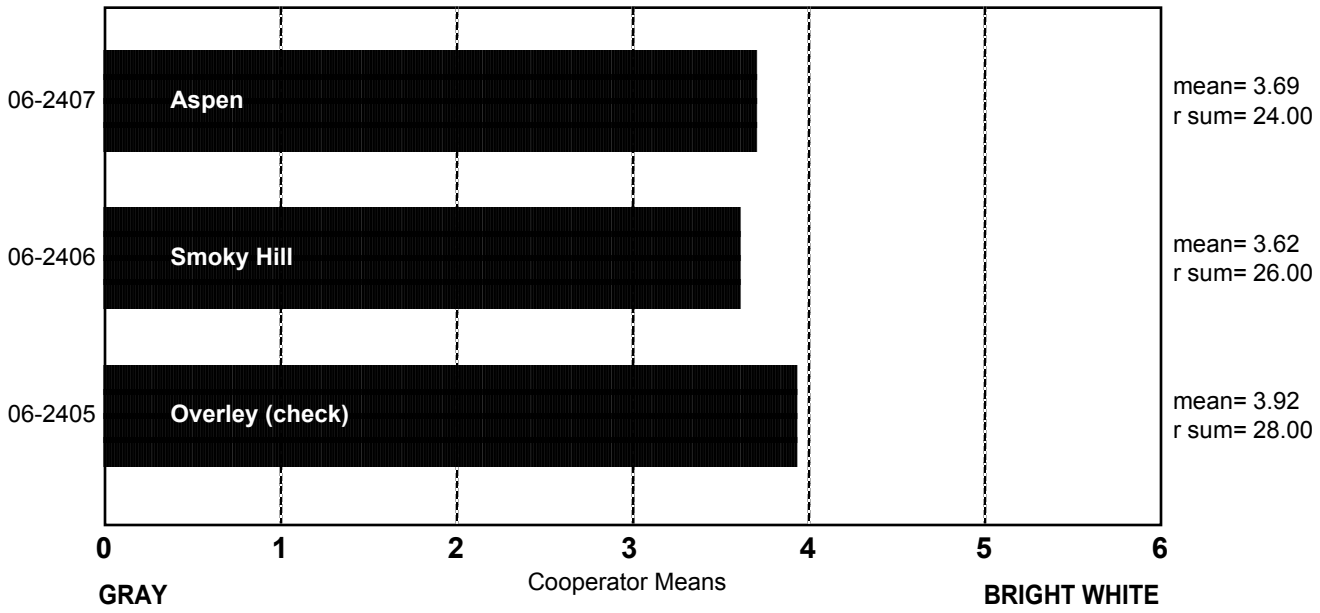
Frequency Table

CRUMB COLOR

(Small Scale) Westbred

ncoop= 13
chisq= 0.62
chisqc= 1.07
cvchisq= 5.99
crdiff=

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



CRUMB COLOR, DESCRIBED

(Small Scale) Westbred

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
06-2405 Overley (check)	**0**	**0**	**1**	**2**	**7**	**3**	**0**
06-2406 Smoky Hill	**1**	**0**	**1**	**3**	**4**	**4**	**0**
06-2407 Aspen	**0**	**0**	**1**	**3**	**7**	**2**	**0**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Westbred

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2405 Overley (check)	**427.0**	**137.3**	**140.8**	**420.3**	**476.2**	**141.6**	**500.0**		**151.2**	**479.0**	**159.0**	**460.4**	
06-2406 Smoky Hill	**419.0**	**137.4**	**141.3**	**425.7**	**477.2**	**142.7**	**495.0**		**148.1**	**474.0**	**157.3**	**462.6**	
06-2407 Aspen	**418.0**	**137.2**	**143.3**	**414.6**	**479.2**	**141.1**	**500.0**		**148.9**	**469.0**	**157.7**	**460.0**	

Raw Data

LOAF VOLUME, ACTUAL

(Small Scale) Westbred

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2405 Overley (check)	**2800**	**845**	**925**	**2390**	**3162**	**1030**	**3300**	**995**	**970**	**3025**	**1035**	**2788**	**1100**
06-2406 Smoky Hill	**3000**	**775**	**928**	**2130**	**2986**	**970**	**2950**	**958**	**983**	**2475**	**1015**	**2750**	**975**
06-2407 Aspen	**2900**	**800**	**885**	**2360**	**3045**	**973**	**3400**	**968**	**923**	**2675**	**928**	**2550**	**1000**

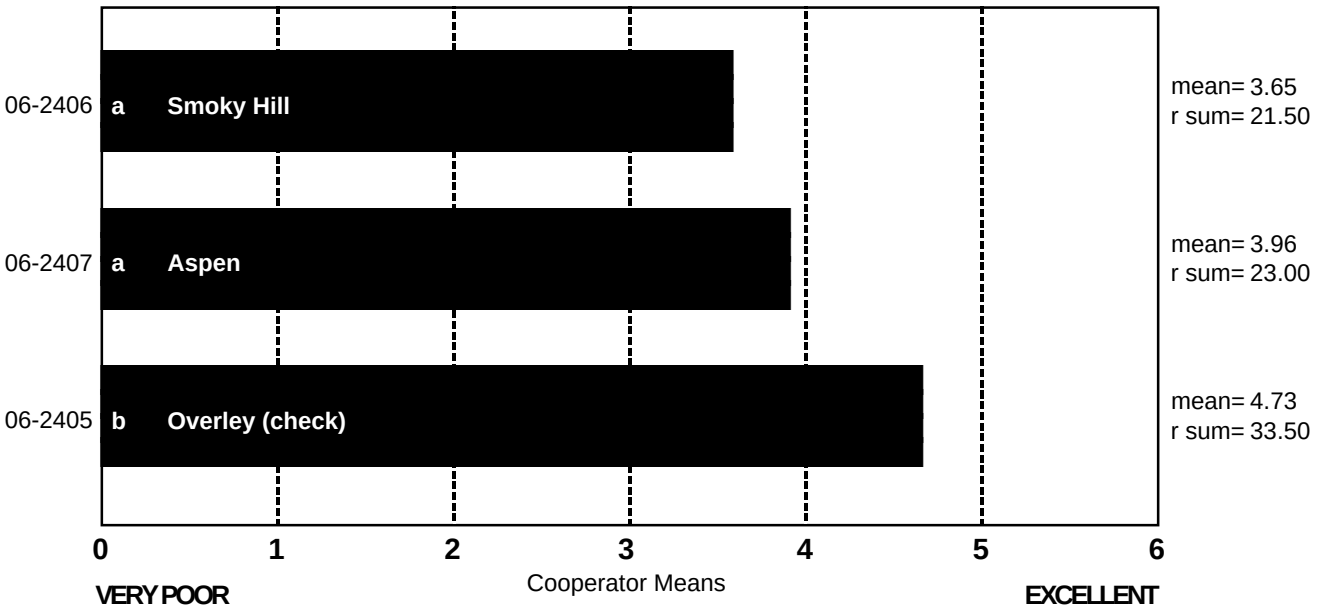
Raw Data

LOAF VOLUME

(Small Scale) Westbred

ncoop= 13
chisq= 6.58
chisqc= 8.14
cvchisq= 5.99
crdiff= 8.16

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

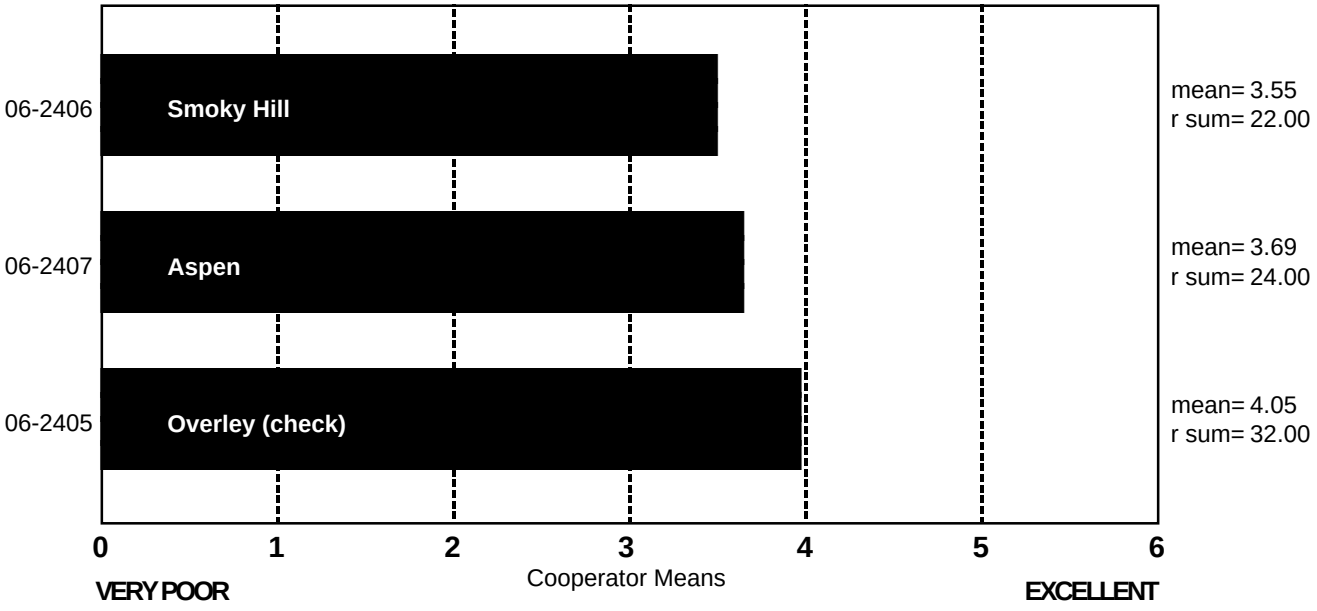


OVERALL BAKING QUALITY

(Small Scale) Westbred

ncoop= 13
chisq= 4.31
chisqc= 4.67
cvchisq= 5.99
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Westbred

COOP. 06-2405 (Overley (check))

A. Good interior and good volume.
B. No comments.
C. No comments.
D. Poor mix tolerance, tough dough, open crumb grain, and low volume.
E. Good absorption, strong dough strength, excellent volume, slightly open grain.
F. No comments.
G. Bucky dough and good volume.
H. Excellent dough, volume and tolerance, open grain.
I. Good flour protein, best in absorption, shorter mix time, and good loaf volume, questionable – satisfactory crumb grain.
J. Very open grain.
K. No comments.
L. Good absorption, slightly long mix time, white crumb and good volume.
M. Excellent loaf volume, creamy crumb color, and slightly open crumb grain.

COOP. 06-2406 (Smoky Hill)

A. Good interior and excellent volume.
B. No comments.
C. The best one in all of samples.
D. Poor mix tolerance, tough dough, open, harsh, dull crumb grain, very low volume.
E. Slightly open grain, good volume.
F. No comments.
G. Weak out of mixer, grey color, long proof, poor bake, and harsh grain.
H. Ok bake quality, needed longer mix time, nice white color.
I. Good flour protein and dough/make-up and good loaf volume, but more open crumb and long mix time.
J. No comments.
K. No comments.
L. Good absorption, good grain, and good loaf volume.
M. White crumb color, high mix tolerance, tough at make-up.

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

COOP. 06-2407 (Aspen)

A. Very open grain, and creamy crumb color.
B. No comments.
C. No comments.
D. Nice handling dough, open crumb and low volume.
E. Slightly open grain, good absorption, and very good volume.
F. No comments.
G. Strong out of mixer, good color, good bake.
H. Good bake quality, color creamy, dough slightly tough and strong sponge.
I. Questionable mixing tolerance, weaker dough at mix and pan, nice crumb grain.
J. Very open grain.
K. No comments.
L. Very high absorption, good grain and low loaf volume.
M. Good loaf volume, smooth crumb, and good bake absorption.

Notes: **A, D, E H, and L** comments based on sponge and dough bake test.

Description of Test Plots and Breeder Entries

Nebraska – Reported by Stephen P. Baenziger and Robert A. Graybosch

Growout Conditions

The samples were grown at Mead, North Platte, and in western NE. For the lines below, all of the samples came from Mead. Mead had good conditions for wheat growth and it looked like the most representative (good test weight, average protein, reasonable kernel size) sample for Millennium, NE01643, and NE02584. We tried to make the sample be similar to what a mill might expect in an average year.

Millennium (check) (2408)

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

NW98S097-ARS (2409)

Hard white winter wheat descended from the cross WA691213-27/N86L177//Platte. Most notable quality characteristic is the presence of low levels of grain polyphenol oxidase (PPO). Average PPO level from eight 2005 Nebraska locations of NW98S097 were statistically identical to that of Platte, and statistically lower than those of Trego and Nuplains. Based on misting chamber assays, sprouting tolerance of NW98S097 is identical to that of Trego. NW98S097 carries an unidentified gene characterizing resistance to wheat soilborne mosaic virus (WSBMV). It is resistant to prevalent races of stem rust, has demonstrated both seedling and adult plant resistance to leaf rust, but is moderately susceptible to field infections of stripe rust. NW98S097 was tested from 2004-2006 in the following districts of the Nebraska Statewide Variety Trial: Southeast (dryland), South Central (dryland), West Central (dryland), West (dryland) and West (irrigated). Three year average grain yield, bushel weight, and grain protein content of NW98S097 did not differ significantly in any district from the widely grown cultivars Millennium and Wesley, with the exception of West Central dryland locations. Under western Nebraska dryland environments, NW98S097 demonstrated significantly lower grain yields than Millennium and Wesley. However, under western Nebraska irrigated conditions, the three-year average grain performance of NW98S097 was statistically greater than that of Millennium, and equal to that of Wesley.

N02Y5117-ARS (2410)

Hard red winter wheat descended from the cross YUMA//T-57/3/CO850034/4/4*YUMA/5/KS91H184/ARLIN S/KS91HW29//NE89526). Carries the *Wsm-1* gene conditioning resistance to wheat streak mosaic virus (WSMV). *Wsm-1* is located on a 4DL chromosomal translocation from *Agropyron intermedium* (Horst.) Beauv. (=*Thinopyrum intermedium*). Field resistance to WSMV consistently has been demonstrated in naturally-infected multiple-year trials at Scottsbluff, NE. Rated as moderately resistant to moderately susceptible to field races of stripe rust. Resistant to various races of stem rust, including Ug99 (based on field observations from Kenya). Susceptible to most races of leaf rust, but does carry resistance gene *Lr14a*. N02Y5117 was tested in 2005 and 2006 in the following districts of the Nebraska Statewide Variety Trial: Southeast (dryland), South Central (dryland), West Central (dryland), West (dryland) and West (irrigated). Two year average grain yield, bushel weight, and grain protein content of N02Y5117 did not differ significantly in any district from the widely grown cultivars Millennium and Wesley.

NE01643-UNL (Millennium sib/ND8974) (2411)

This line will be released as NE01643 and marketed under the name Husker Genetics Brand Overland. It was co-released with South Dakota. It has a spectacular agronomic record in the northern Great Plains with excellent grain yield and test weight. Its disease resistance package is generally adequate. Its deficiencies are that it does not have as much stem rust resistance as we would like and we consider it minimally adequate for end-use quality.

NE02584-UNL (KS92H363-2//Abilene/Karl) (2412)

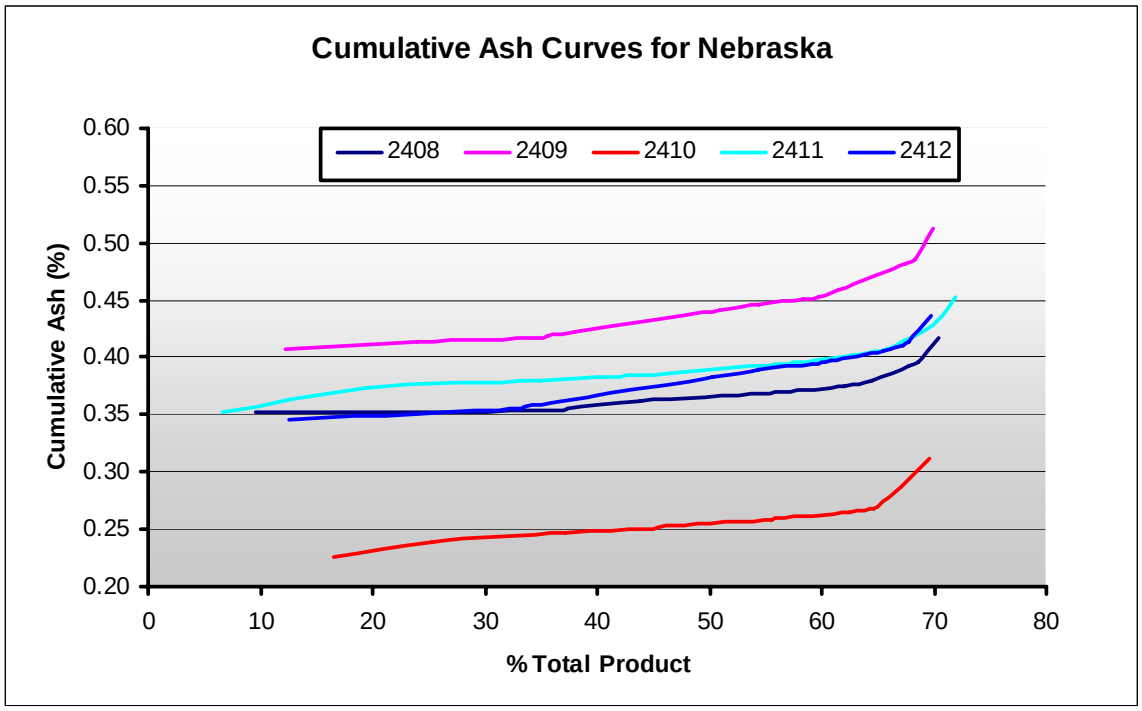
It is an experimental line under consideration for release. It has comparable agronomic performance to NE01643, but has better stem rust resistance, and in our trials, better end-use quality.

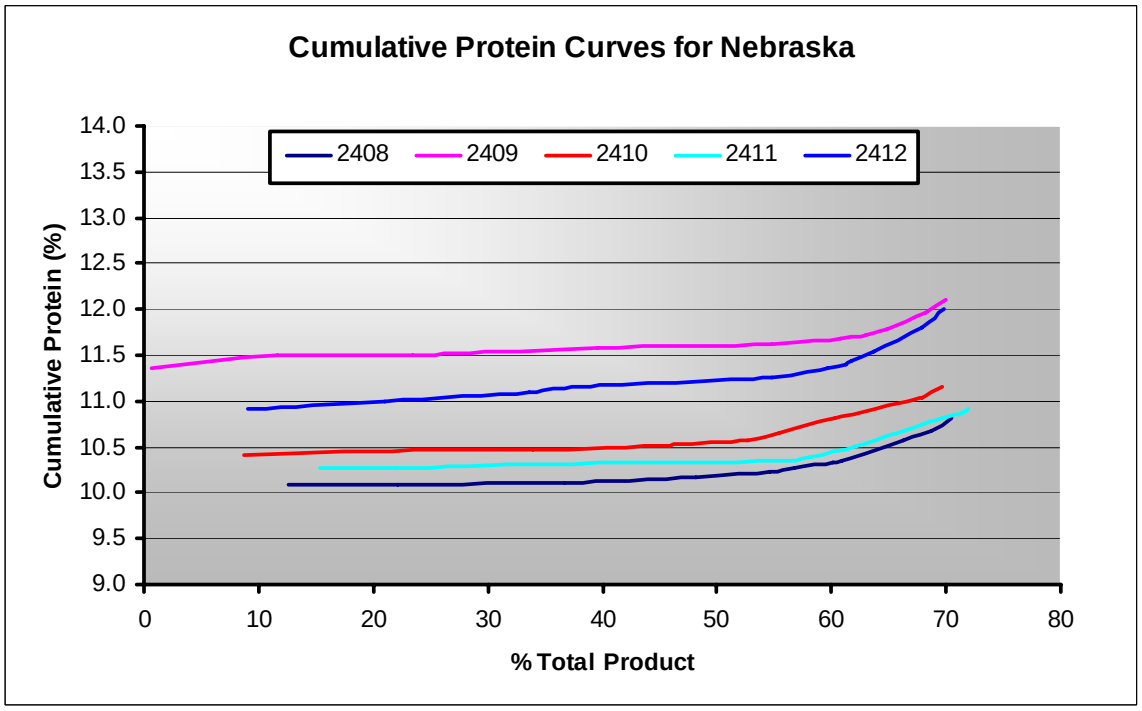
Nebraska: 2006 (Small-Scale) Samples[a]

Test entry number	06-2408	06-2409	06-2410	06-2411	06-2412
Sample identification	Millennium (ck)	NW98S097-ARS	NO2Y5117-ARS	NE01643-UNL	NE02584-UNL
Wheat Data					
FGIS classification	1 HRW	1 HDWH	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	62.6	63.1	61.6	63.0	64.4
Hectoliter weight (kg/hl)	82.3	82.9	81.0	82.8	84.6
1000 kernel weight (gm)	29.5	29.2	25.3	30.6	33.3
NIR hardness	74.4	76.6	46.2	69.0	67.3
Wheat kernel size (Rotap)					
Over 7 wire (%)	62.7	72.6	46.3	68.4	76.2
Over 9 wire (%)	36.7	26.9	52.8	31.2	23.6
Through 9 wire (%)	0.6	0.5	0.9	0.5	0.2
Single kernel (skcs)					
Hardness (avg /s.d)	76.0/15.8	84.1/13.3	60.6/15.9	71.9/15.3	72.5/13.1
Weight (mg) (avg/s.d)	29.8/9.0	30.7/7.3	28.2/8.9	31.6/7.5	34.2/7.9
Diameter (mm)(avg/s.d)	2.21/0.48	2.49/0.44	2.16/0.47	2.35/0.49	2.53/0.40
SKCS distribution	01-04-09-86	00-01-03-96	05-10-30-55	00-05-14-81	00-03-10-87
Classification	Hard	Hard	Hard	Hard	Hard
Wheat moisture (%)	11.5	10.6	11.0	10.9	11.4
Wheat protein (12% mb)	12.1	13.0	12.0	11.9	13.0
Wheat ash (12% mb)	1.58	1.57	1.44	1.59	1.60
Milling and Flour Quality Data					
Flour yield (%, str. grade)					
Miag Multomat Mill	70.4	70.0	69.7	72.0	69.8
Quadrumat Sr. Mill	74.5	73.9	73.1	76.0	76.1
Flour moisture (%)	11.8	11.79	12.7	12.9	13.0
Flour protein (14% mb)	10.7	12.09	11.1	10.4	11.3
Flour ash (14% mb)	0.45	0.50	0.38	0.46	0.43
Glutomatic					
Wet gluten (%)	30.3	31.7	30.0	30.1	33.4
Dry gluten (%)	10.6	11.7	10.3	10.3	11.4
Gluten index	98.7	99.4	97.7	94.4	98.2
Flour color					
Agtron flour color	74	78	79	77	78
Simon/Kent-Jones flour color	0.09	-1.36	0.00	-0.65	-1.63
Minolta color meter					
L*	92.23	92.33	92.61	92.45	92.43
a*	-1.57	-1.65	-1.18	-1.62	-1.53
b*	8.84	9.78	7.53	9.26	9.33
Falling number (sec)	459	469	417	424	416
Flour particle size (avg)					
Fisher sub sieve sizer	23	23	18	23	23

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

Nebraska: Cumulative Ash and Protein Curves

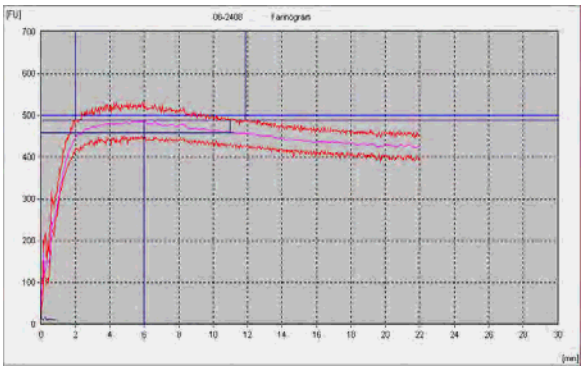




Physical Dough Tests

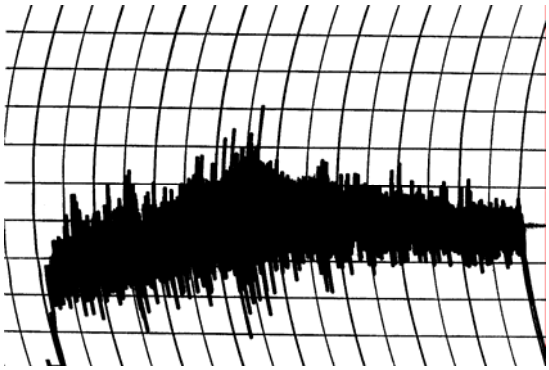
2006 (Small Scale) Samples - Nebraska

Farinograms



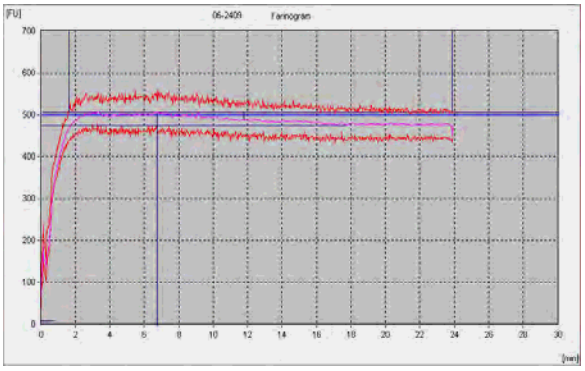
Abs. 56.2%, Peak 6.0 min, Stab. 9.9 min

Mixograms

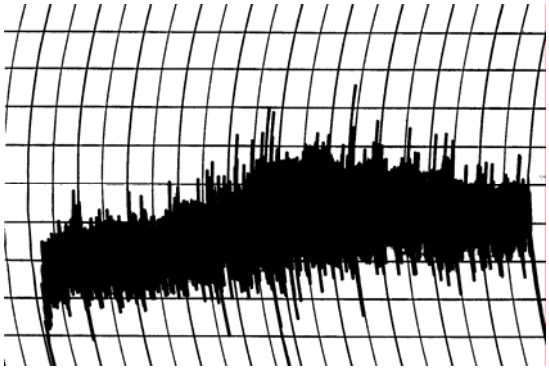


Abs. 60.7%, Mix time 3.5 min

06-2408, Millennium (check)



Abs. 58.1%, Peak 6.8 min, Stab. 22.3 min



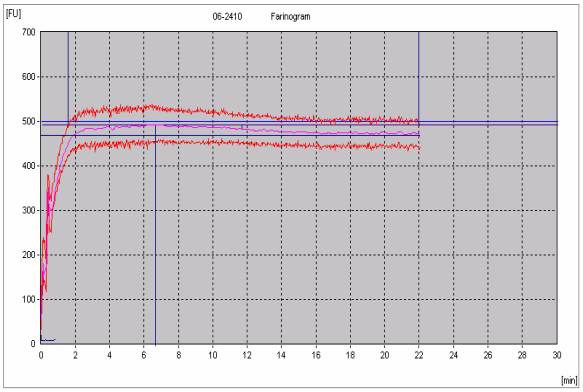
Abs. 64.1%, Mix time 5.9 min

06-2409, NW98S097-ARS

Physical Dough Tests

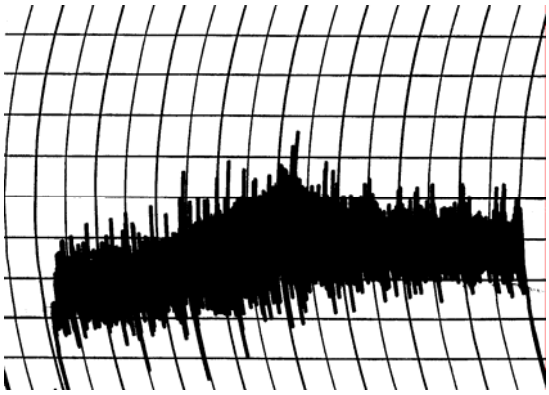
2006 (Small Scale) Samples - Nebraska (continued)

Farinograms



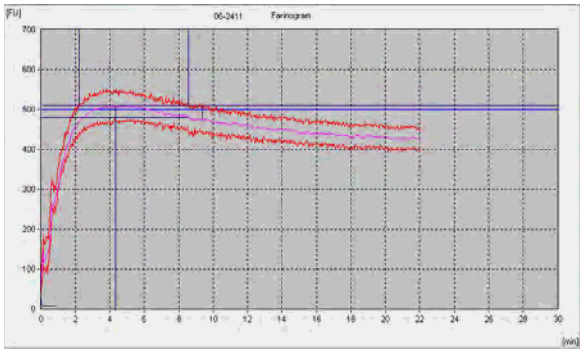
Abs. 55.8%, Peak 6.7 min, Stab. 20.4 min

Mixograms

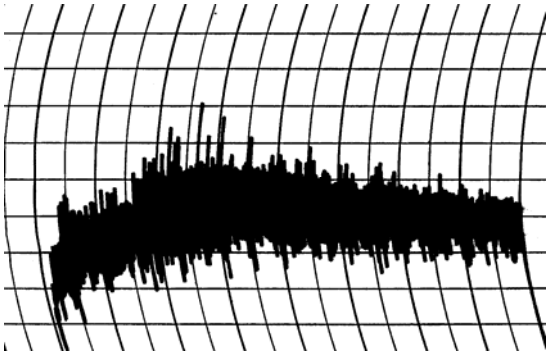


Abs. 61.5%, Mix time 4.3 min

06-2410, NO2Y5117-ARS



Abs. 56.6%, Peak 4.4 min, Stab. 6.3 min



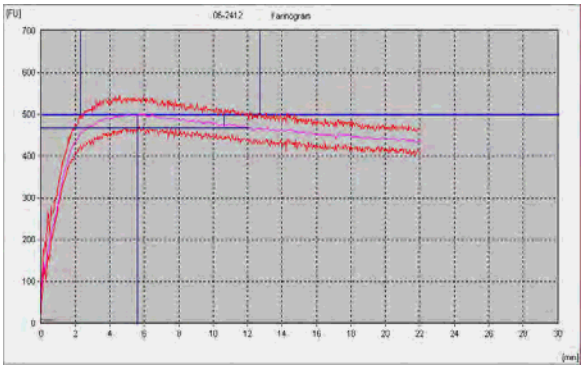
Abs. 62.2%, Mix time 2.9 min

06-2411, NEO1643-UNL

Physical Dough Tests

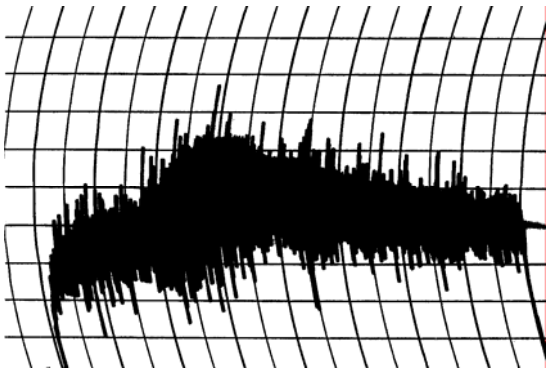
2006 (Small Scale) Samples - Nebraska (continued)

Farinograms



Abs. 60.2%, Peak 5.6 min, Stab. 10.4 min

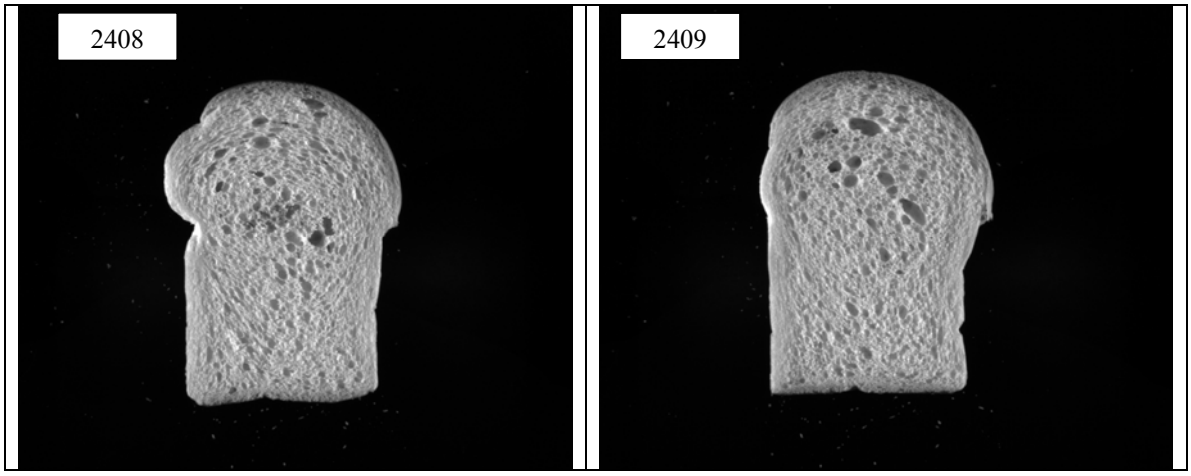
Mixograms



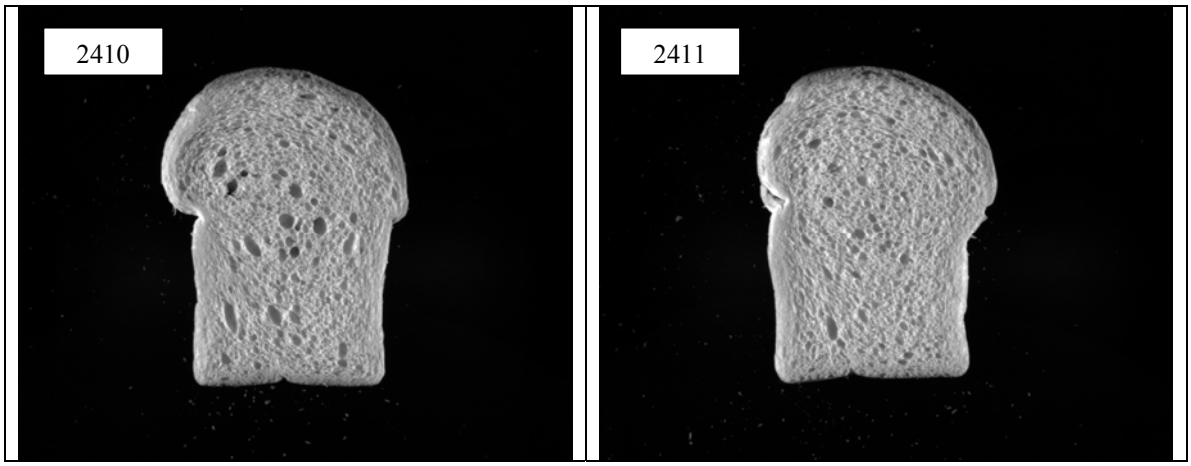
Abs. 66.3%, Mix time 3.3 min

06-2412, NEO2584-UNL

Nebraska: C-Cell Bread Images and Analysis for 2006(Small-Scale) Samples



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2408	6263	152.5	4086	0.435	1.880	4.59	1.690	-13.95
2409	6310	150.9	3999	0.437	1.901	2.47	1.695	-12.93



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2410	6313	152.3	4229	0.429	1.803	2.55	1.690	-16.35
2411	6054	153.2	4032	0.433	1.814	1.27	1.640	-16.85

Nebraska: C-Cell Bread Images and Analysis for 2006(Small-Scale) Samples (continued)

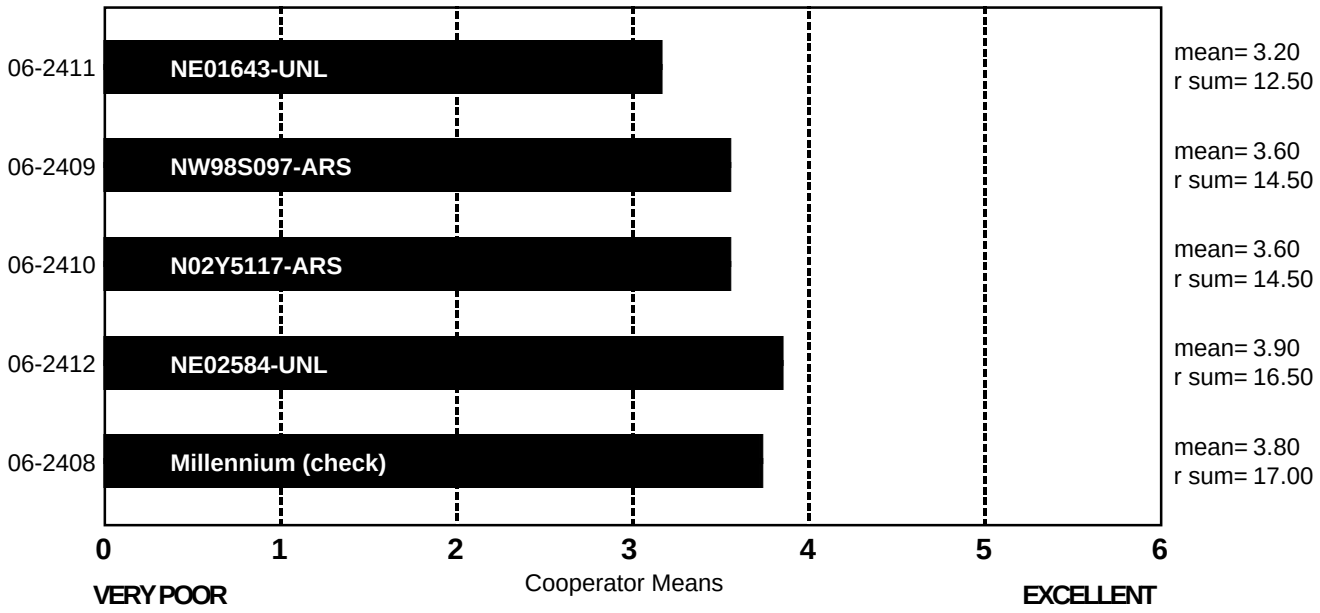
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2412	6841	154.2	4146	0.445	2.031	1.62	1.688	-20.83

SPONGE CHARACTERISTICS

(Small Scale) Nebraska

ncoop= 5
chisq= 1.04
chisqc= 1.89
cvchisq= 9.49
crdiff=

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

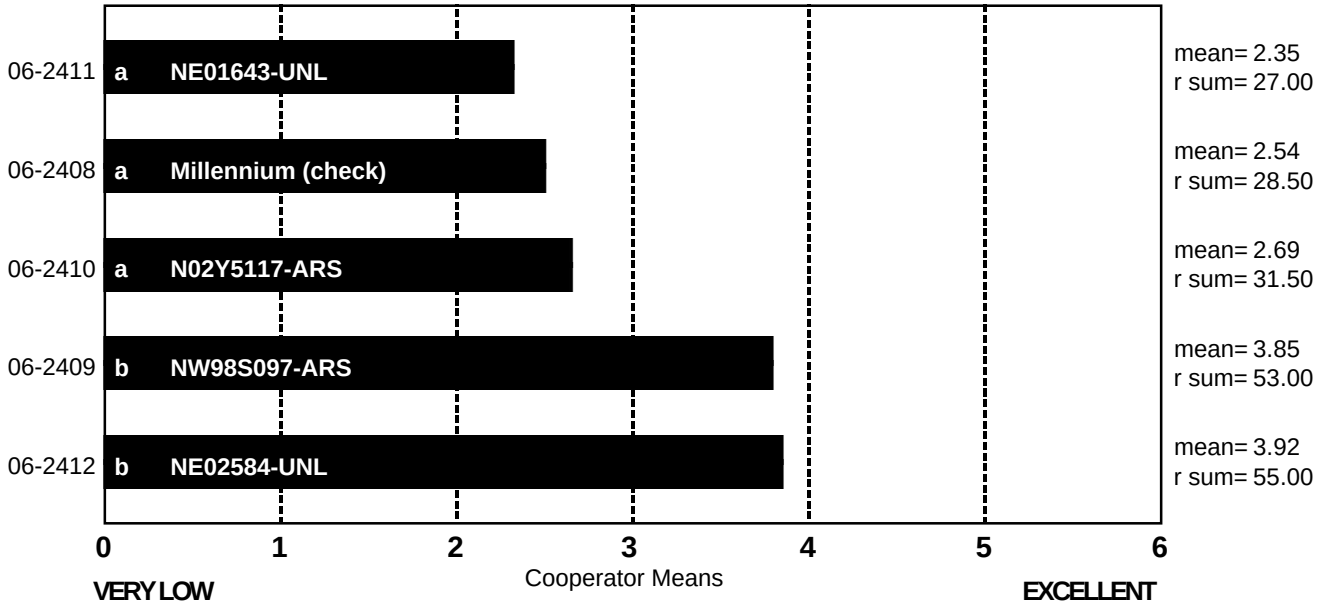


BAKE ABSORPTION

(Small Scale) Nebraska

ncoop= 13
chisq= 23.46
chisqc= 29.33
cvchisq= 9.49
crdiff= 9.97

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Nebraska

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2408 Millennium (check)	**58.0**	**58.7**	**60.6**	**59.2**	**59.0**	**61.1**	**55.0**	**60.0**	**59.6**	**58.4**	**63.0**	**59.0**	**54.7**
06-2409 NW98S097-ARS	**59.0**	**60.1**	**64.1**	**61.1**	**61.0**	**64.4**	**57.1**	**63.0**	**64.2**	**60.1**	**66.5**	**61.0**	**56.6**
06-2410 N02Y5117-ARS	**58.0**	**56.8**	**61.5**	**58.8**	**59.0**	**62.6**	**53.6**	**61.0**	**61.2**	**57.8**	**63.7**	**58.0**	**54.3**
06-2411 NE01643-UNL	**57.0**	**56.4**	**58.6**	**59.6**	**61.0**	**63.4**	**53.6**	**60.0**	**59.4**	**58.6**	**66.8**	**57.0**	**55.1**
06-2412 NE02584-UNL	**58.0**	**59.9**	**63.6**	**63.2**	**61.0**	**67.5**	**57.1**	**61.0**	**65.0**	**62.2**	**67.9**	**62.0**	**58.7**

Raw Data

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
06-2408 Millennium (check)	**12.0**	**2.3**	**5.2**	**10.0**	**25.0**	**3.8**	**7.0**	**6.0**	**5.6**	**5.5**	**4.1**	**6.0**	**3.3**
06-2409 NW98S097-ARS	**16.0**	**2.5**	**9.8**	**24.0**	**25.0**	**7.4**	**7.0**	**9.0**	**11.4**	**8.5**	**6.9**	**12.0**	**5.0**
06-2410 N02Y5117-ARS	**12.0**	**2.8**	**8.0**	**16.0**	**25.0**	**4.3**	**8.0**	**6.0**	**6.5**	**7.5**	**4.6**	**6.0**	**3.8**
06-2411 NE01643-UNL	**8.0**	**1.8**	**4.0**	**8.0**	**25.0**	**2.9**	**6.5**	**6.0**	**5.1**	**6.0**	**3.5**	**3.0**	**2.5**
06-2412 NE02584-UNL	**15.0**	**1.8**	**4.9**	**8.0**	**25.0**	**3.3**	**5.0**	**6.0**	**5.5**	**7.0**	**4.2**	**6.0**	**2.5**

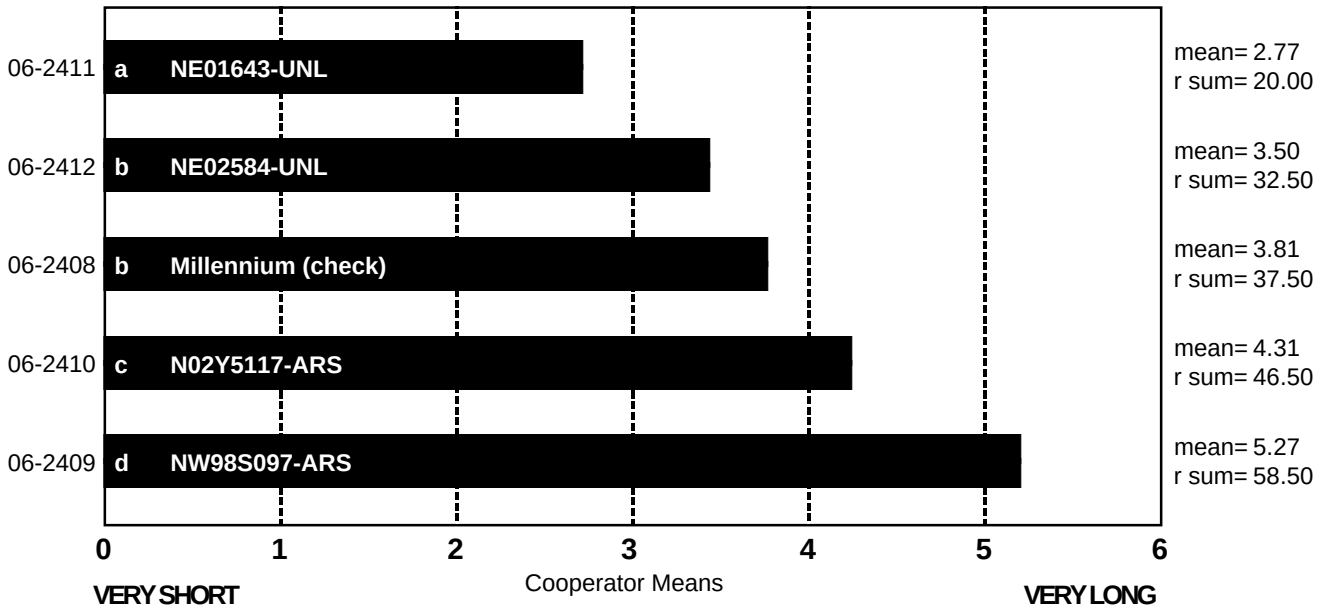
Raw Data

BAKE MIX TIME

(Small Scale) Nebraska

ncoop= 13
chisq= 25.91
chisqc= 33.85
cvchisq= 9.49
crdiff= 8.72

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

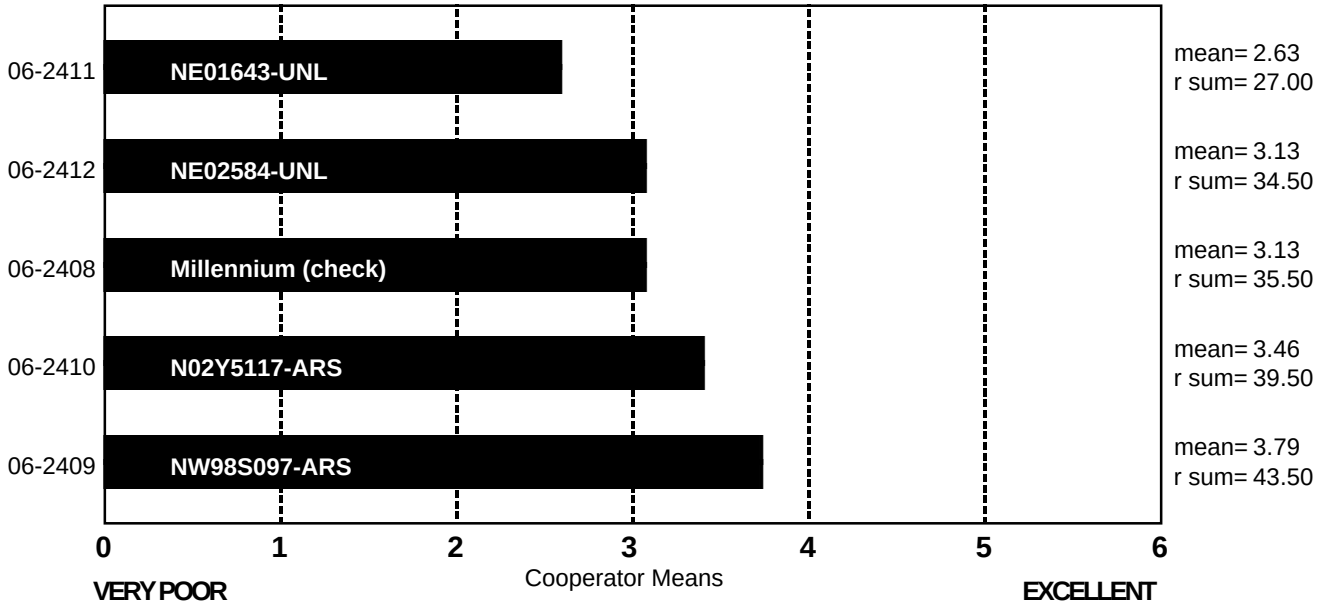


MIXING TOLERANCE

(Small Scale) Nebraska

ncoop= 12
chisq= 5.07
chisqc= 6.54
cvchisq= 9.49
crdiff=

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

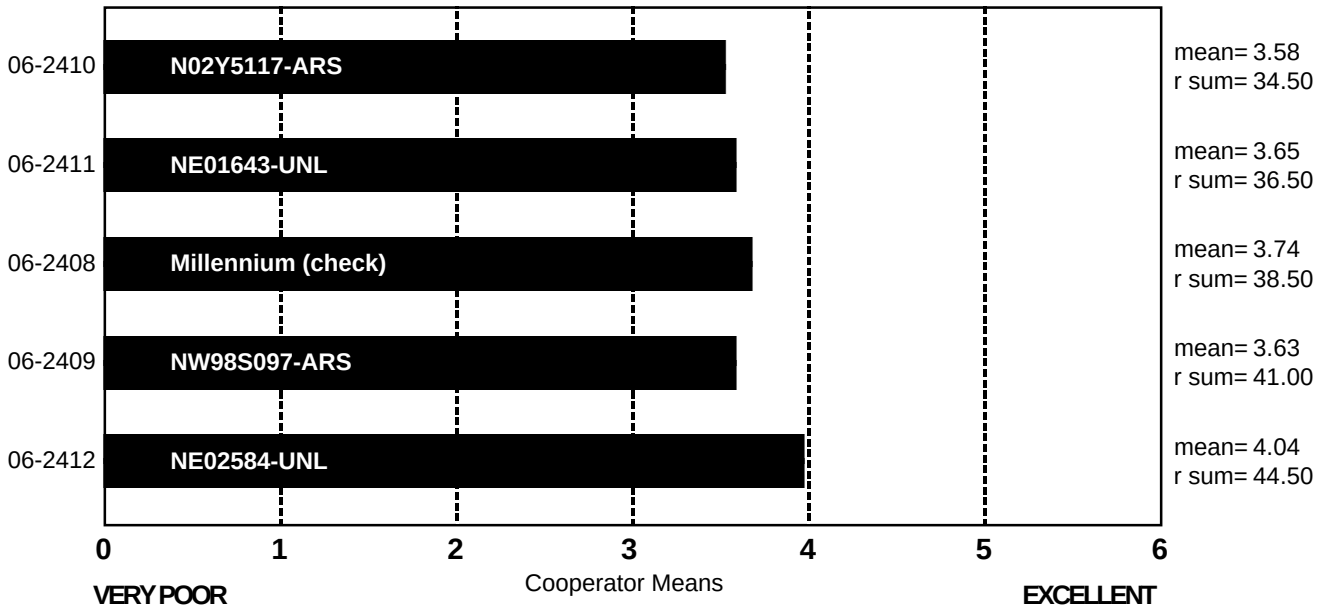


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Nebraska

ncoop= 13
chisq= 1.88
chisqc= 2.44
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) Nebraska

	Sticky	Wet	Tough	Good	Excellent
06-2408 Millennium (check)	**0**	**1**	**1**	**11**	**0**
06-2409 NW98S097-ARS	**0**	**0**	**5**	**8**	**0**
06-2410 N02Y5117-ARS	**0**	**1**	**5**	**7**	**0**
06-2411 NE01643-UNL	**0**	**2**	**1**	**10**	**0**
06-2412 NE02584-UNL	**0**	**0**	**4**	**9**	**0**

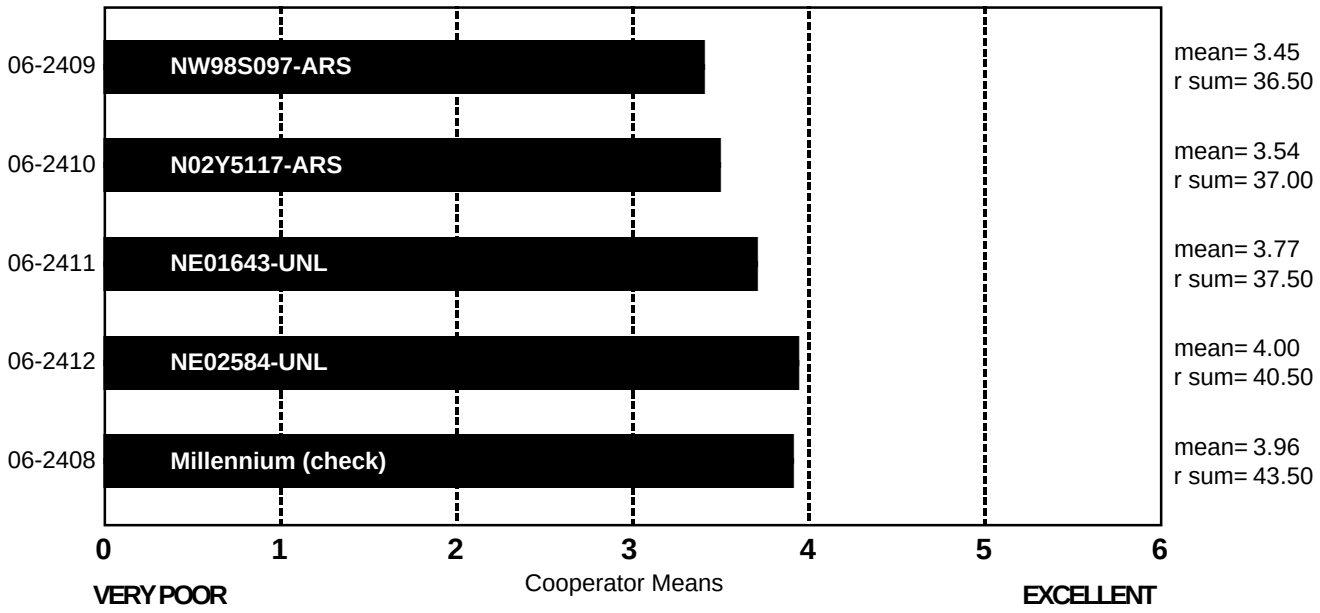
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Nebraska

ncoop= 13
chisq= 1.08
chisqc= 1.41
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) Nebraska

	Sticky	Wet	Tough	Good	Excellent
06-2408 Millennium (check)	**1**	**2**	**1**	**8**	**1**
06-2409 NW98S097-ARS	**1**	**0**	**6**	**5**	**1**
06-2410 N02Y5117-ARS	**1**	**2**	**3**	**7**	**0**
06-2411 NE01643-UNL	**2**	**1**	**1**	**8**	**1**
06-2412 NE02584-UNL	**3**	**0**	**3**	**7**	**0**

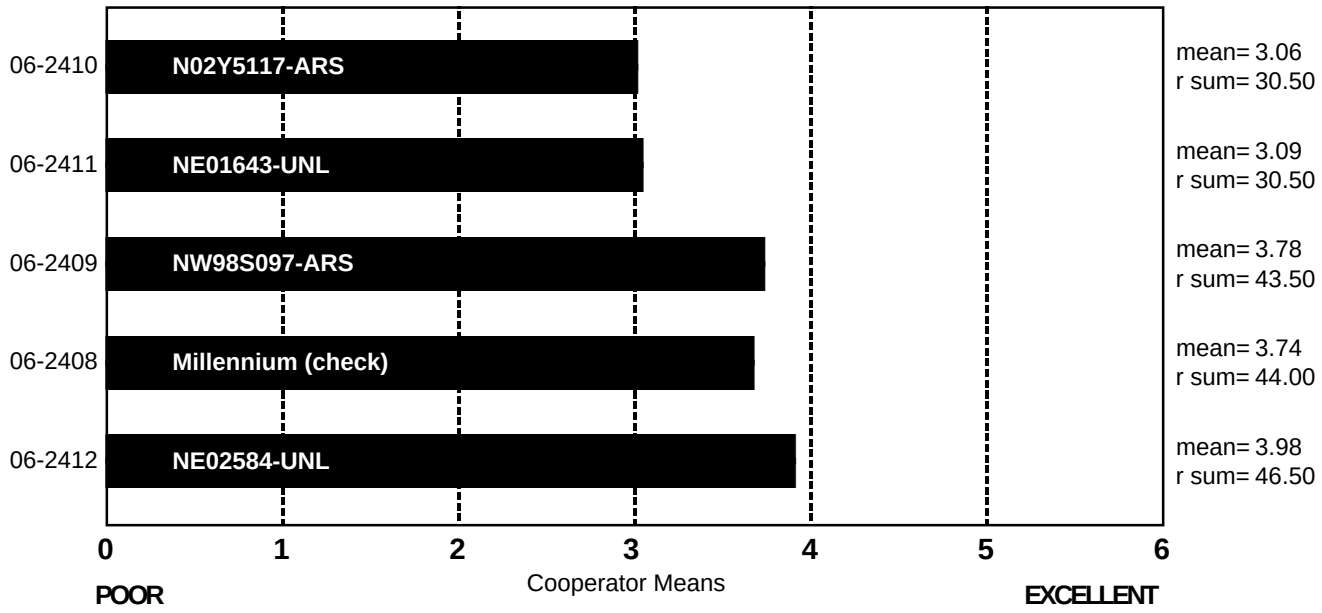
Frequency Table

CRUMB GRAIN

(Small Scale) Nebraska

ncoop= 13
chisq= 7.57
chisqc= 8.45
cvchisq= 9.49
crdiff=

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Nebraska

	Open	Fine	Dense
06-2408 Millennium (check)	**4**	**8**	**1**
06-2409 NW98S097-ARS	**8**	**5**	**0**
06-2410 N02Y5117-ARS	**5**	**7**	**1**
06-2411 NE01643-UNL	**4**	**5**	**4**
06-2412 NE02584-UNL	**4**	**8**	**1**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Nebraska

	Round	Irregular	Elongated
06-2408 Millennium (check)	**2**	**7**	**4**
06-2409 NW98S097-ARS	**2**	**7**	**4**
06-2410 N02Y5117-ARS	**3**	**6**	**4**
06-2411 NE01643-UNL	**4**	**6**	**3**
06-2412 NE02584-UNL	**1**	**8**	**4**

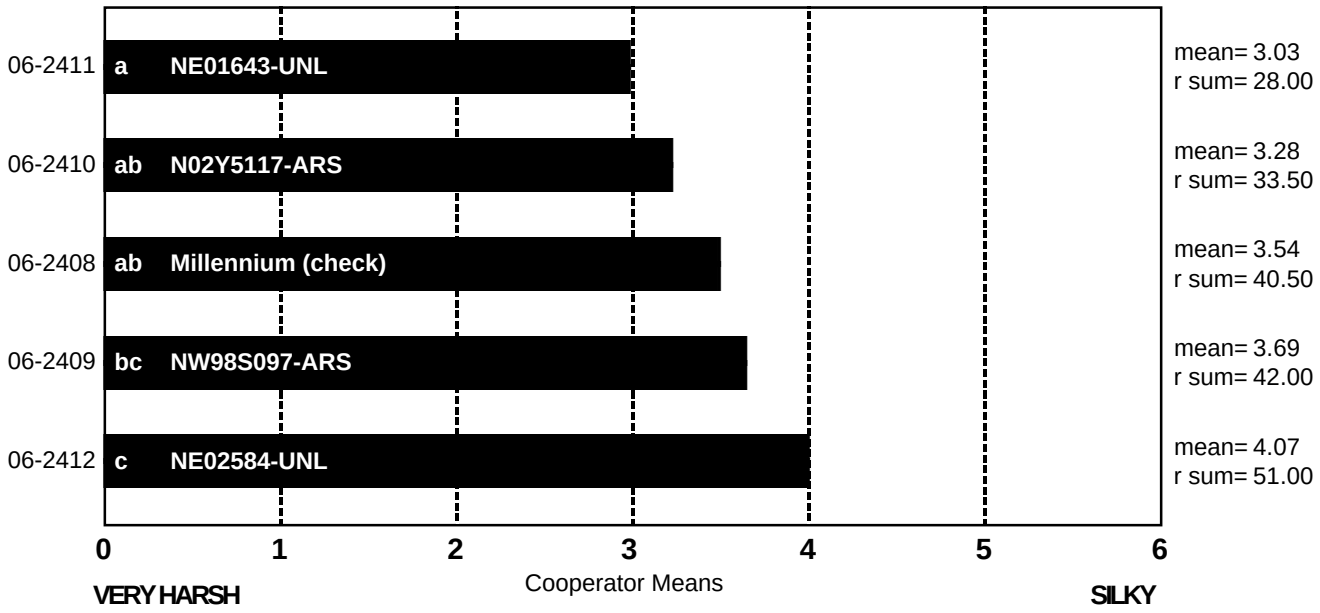
Frequency Table

CRUMB TEXTURE

(Small Scale) Nebraska

ncoop= 13
chisq= 9.43
chisqc= 12.45
cvchisq= 9.49
crdiff= 12.81

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
06-2408 Millennium (check)	**5**	**8**	**0**
06-2409 NW98S097-ARS	**4**	**7**	**2**
06-2410 N02Y5117-ARS	**8**	**5**	**0**
06-2411 NE01643-UNL	**8**	**4**	**1**
06-2412 NE02584-UNL	**1**	**8**	**4**

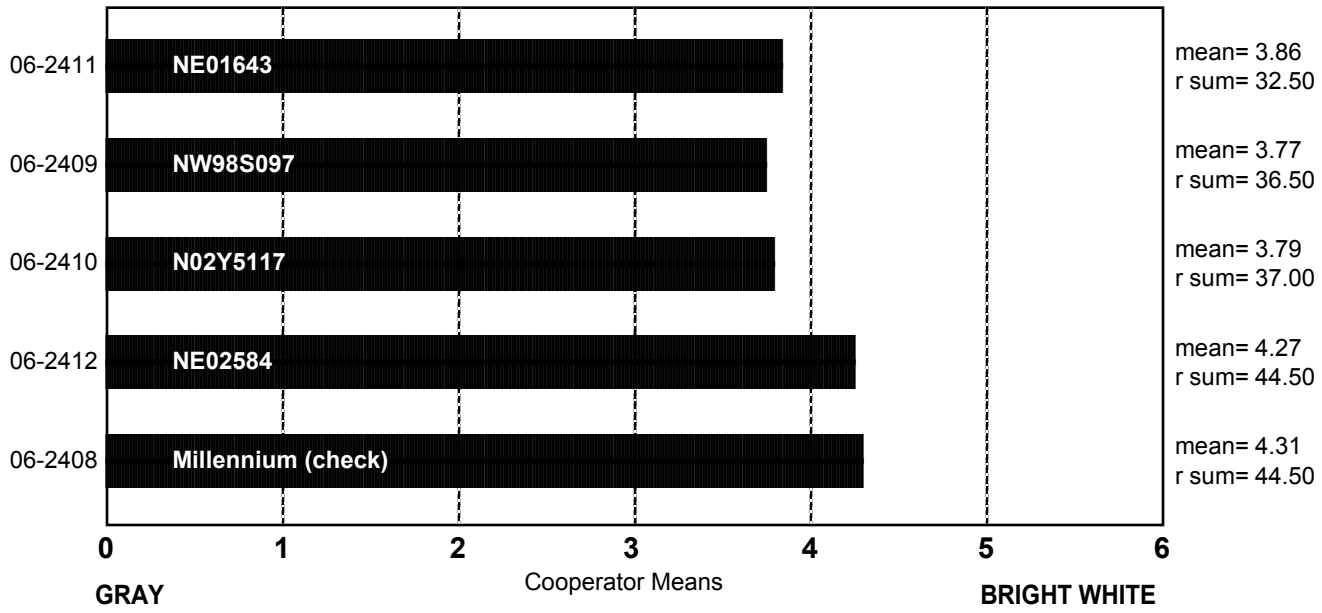
Frequency Table

CRUMB COLOR

(Small Scale) Nebraska

ncoop= 13
chisq= 3.48
chisqc= 5.29
cvchisq= 9.49
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
06-2408 Millennium (check)	**0**	**0**	**1**	**1**	**5**	**4**	**2**
06-2409 NW98S097	**0**	**1**	**2**	**1**	**5**	**2**	**2**
06-2410 N02Y5117	**1**	**0**	**1**	**2**	**3**	**5**	**1**
06-2411 NE01643	**0**	**0**	**3**	**2**	**4**	**4**	**0**
06-2412 NE02584	**0**	**0**	**1**	**0**	**7**	**3**	**2**

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
06-2408 Millennium (check)	**422.0**	**134.7**	**140.5**	**419.2**	**479.2**	**142.7**	**500.0**		**147.0**	**468.0**	**154.9**	**465.5**	
06-2409 NW98S097-ARS	**425.0**	**137.3**	**140.7**	**426.2**	**479.5**	**141.4**	**500.0**		**148.7**	**471.0**	**154.1**	**464.2**	
06-2410 N02Y5117-ARS	**422.0**	**133.4**	**140.5**	**422.6**	**478.8**	**140.5**	**495.0**		**148.1**	**472.0**	**152.1**	**465.6**	
06-2411 NE01643-UNL	**423.0**	**135.3**	**139.1**	**418.2**	**476.5**	**143.3**	**500.0**		**148.2**	**477.0**	**157.6**	**465.5**	
06-2412 NE02584-UNL	**426.0**	**137.3**	**142.0**	**410.9**	**479.9**	**147.2**	**500.0**		**151.2**	**473.0**	**159.8**	**462.7**	

Raw Data

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
06-2408 Millennium (check)	**2800**	**715**	**815**	**2200**	**3162**	**868**	**2750**	**935**	**855**	**2850**	**980**	**2675**	**915**
06-2409 NW98S097-ARS	**2900**	**655**	**915**	**2240**	**3000**	**878**	**2700**	**958**	**878**	**3025**	**975**	**2713**	**1055**
06-2410 N02Y5117-ARS	**2775**	**705**	**813**	**2160**	**2750**	**880**	**3200**	**908**	**863**	**2725**	**955**	**2550**	**900**
06-2411 NE01643-UNL	**2650**	**665**	**740**	**2200**	**3104**	**833**	**3100**	**900**	**830**	**2825**	**958**	**2525**	**850**
06-2412 NE02584-UNL	**2900**	**800**	**873**	**2780**	**3015**	**1015**	**3300**	**992**	**948**	**2725**	**1023**	**2668**	**950**

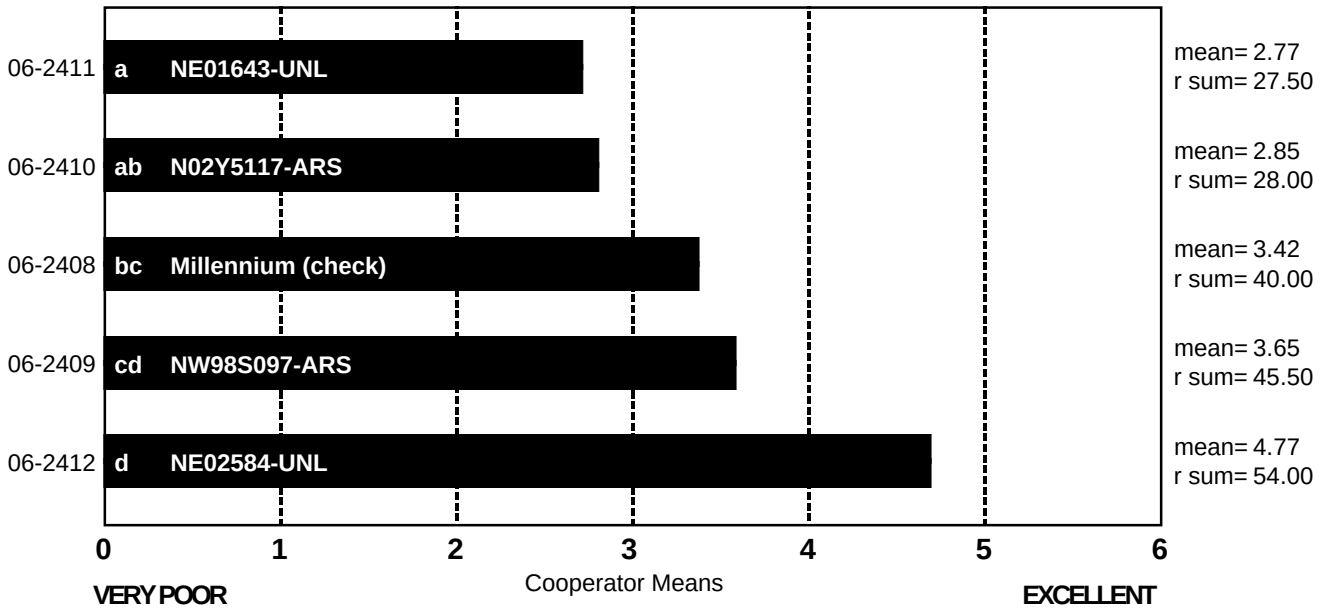
Raw Data

LOAF VOLUME

(Small Scale) Nebraska

ncoop= 13
chisq= 16.05
chisqc= 19.05
cvchisq= 9.49
crdiff= 12.33

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

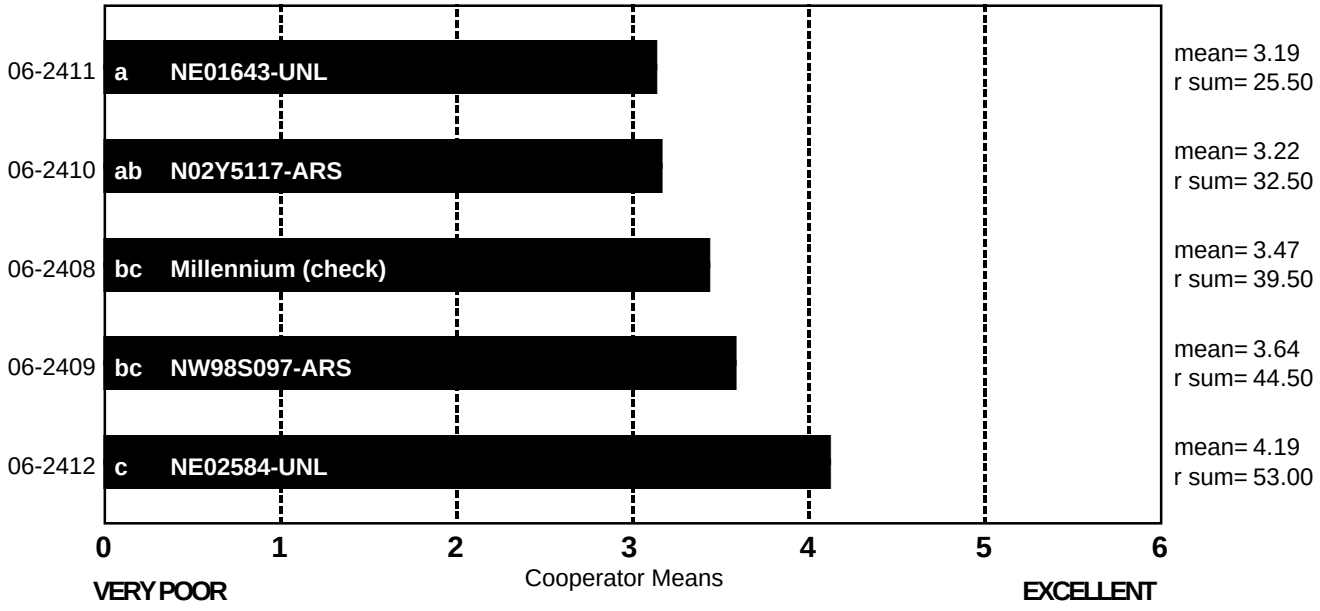


OVERALL BAKING QUALITY

(Small Scale) Nebraska

ncoop= 13
chisq= 13.88
chisqc= 14.67
cvchisq= 9.49
crdiff= 13.91

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



COOPERATOR'S COMMENTS
(Small Scale) Nebraska

COOP. 06-2408 (Millennium (check))

A. Good mix time nice interior, one of best in group overall.
B. No comments.
C. Second worst.
D. Nice handling dough, open, harsh crumb, low volume.
E. Slightly open, variable grain, very good volume.
F. No comments.
G. Low absorption, weak out of mixer, white color, long proof, poor bake, and harsh grain.
H. Good bake quality, especially for lower protein, sponge and doughs were at bit weak but tolerance is good.
I. Lower flour protein, low absorption, and low loaf volume but good at make-up and satisfactory crumb grain.
J. Very white crumb.
K. Excellent loaf volume for protein.
L. Low absorption, good grain, and average loaf volume.
M. Very low bake absorption, slightly harsh crumb texture.

COOP. 06-2409 (NW98S097-ARS)

A. Good mix time and nice interior.
B. No comments.
C. No comments.
D. Poor mix tolerance, tough dough, open, harsh crumb grain, low volume.
E. Slightly open, variable grain, and very good volume.
F. No comments.
G. Dough felt good all the way, no oven spring, poor volume, harsh grain.
H. Ok bake quality, slightly dull color, tolerance good.
I. Good absorption, good dough characteristics, and crumb grain, but long mix time, and low loaf volume.
J. No comments.
K. No comments.
L. Slightly long mix time, very fine grain, and good loaf volume.
M. Good loaf volume, low bake absorption, long mix time, and good mix tolerance.

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

COOP. 06-2410 (N02Y5117-ARS)

A. Bright crumb color.
B. Low bake water absorption.
C. No comments.
D. Mediocre mix tolerance, average dough, open, harsh, dull crumb grain, and very low volume.
E. Extremely open, very thick cell walls, poor volume.
F. No comments.
G. Very low absorption, grey color, weak dough, and good volume.
H. Marginal bake quality having low volumes, slightly open grain and harsh texture, and color is a nice white.
I. Good at make-up and above satisfactory crumb grain, and long mix time.
J. Open grain.
K. Good loaf volume for protein.
L. Low absorption, good grain, and low loaf volume.
M. White crumb color and low bake absorption.

COOP. 06-2411(NE01643-UNL)

A. Compact and squatty low loaf volume.
B. Low bake water absorption.
C. The worst one.
D. Good mix tolerance, nice dough (slightly stick), open, harsh, dull crumb grain, and low loaf volume.
E. Tight, consistent, silky grain, and excellent volume.
F. No comments.
G. Very low absorption, weak dough, and good volume.
H. Marginal bake quality having low volume, slightly open grain and harsh texture, color is a nice white.
I. Satisfactory crumb grain but low absorption and low loaf volume.
J. No comments.
K. Excellent loaf volume for protein.
L. Low absorption, very short mix time, poor grain, yellow crumb, and low volume.
M. Loaf volume low, slightly harsh crumb texture, very slack at make-up, and low bake absorption.

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

COOP. 06-2412 (NE02584-UNL)

A. Close grain and good mix time.
B. No comments.
C. A big hole on the edge.
D. Good mix tolerance, nice dough, nice crumb grain, and very good volume.
E. Slightly open, variable grain, and very good volume.
F. No comments.
G. Creamy color, strong, and good bake.
H. Good bake quality with good volume and tolerance, and grain slightly open.
I. Good absorption, good mixing tolerance and panning, excellent crumb grain and good loaf volume.
J. No comments.
K. Excellent loaf volume for protein.
L. Good absorption and average loaf volume.
M. White crumb color and silky crumb.

Notes: **A, D, E H, and L** comments based on sponge and dough bake test.

Description of Test Plots and Breeder Entries

Oklahoma State University - Reported by Brett Carver

Grain samples were produced only at the North Central Agronomy Research Station at Lahoma, OK in 2006, although another WQC grow-out was placed at the Oklahoma Panhandle Research and Extension Center at Goodwell, OK. Two hail events at Goodwell reduced grain supply to insufficient levels.

The dryland site at Lahoma was planted on 12 October 2005 and harvested on 2 June 2006. Grain yield at Lahoma was greatly reduced in 2006 due to season-long drought stress. A late-season spore shower caused intermittent infection from leaf rust, but was likely not influential in grain production among the entries submitted for testing. This site was lightly fertilized pre-plant to bring the total actual N up to 100 lb/ac (subsurface plus applied), according to a yield goal of 60 bu/ac. Wheat protein content was about one-half percentage point higher than the long-term average.

OK Bullet (check) **(2413)**

Two years after its release, OK Bullet (*KS96WGRC39/Jagger*) continues to occupy top-tier positions in the Oklahoma Wheat Variety Trials for grain yield, test weight, and wheat protein content. It should consume some of the state's acreage currently occupied by 2174 and Jagger. Reasons for its growing popularity, aside from yield and test weight, are that OK Bullet emerges rapidly (like Jagger; unlike 2174) when planted early for fall wheat pasture and provides ample pasture for an early grazing initiation date. If not managed properly, however, the tendency to over-produce on the vegetative side of the dual-purpose ledger may sacrifice its ability to produce on the reproductive side. Leaf rust resistance was broken in southern Texas in 2004, though resistance has held throughout Oklahoma even when leaf rust pressure was severe. OK Bullet is adapted statewide 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 profile of 1/17+18/5+10 (identical to Jagger). OK Bullet combines high test weight with large kernel size. OK Bullet tends to hit most quality targets dead-on, excelling in loaf-internal characteristics but sometimes lacking in mixing tolerance (in the form of high mixograph-stability value).

OK93P656H3299-2C04 (Duster) **(2414)**

This HRW wheat first appeared in the 2005 Wheat Quality Council Evaluation Program and has since been released as Duster (*W0405D/NE78488//W7469C/TX81V6187*). Initial population development occurred within the Pioneer HRW program before transferring to Oklahoma State University as a red-shirt F_3 population in 1990. It performed very favorably for grain yield in the 2005 and 2006 Southern Regional Performance Nurseries, particularly in Oklahoma and Kansas, though it showed an inconsistent reaction to stripe rust in 2005. High tillering capacity, good recovery from grazing, aluminum tolerance, Hessian fly resistance, wheat soilborne and spindle streak mosaic virus resistance, and adult-plant resistance to leaf rust are strengths. Duster combines the high forage capacity of OK Bullet with the grazing tenacity and endurance of Endurance. Wheat protein content may be moderately low (ca. 12%, slightly higher than Endurance) but strength is very good. Duster appears to defy farinograph logic by blending relatively short peak time (<5 min) with relatively long stability time (>15 min). Bake loaf volume is commensurate with its protein level, whereas visual ratings of bake performance have been above-average. Its HMW-GS signature is 2*/7+8/5+10. Duster was released to seed producers in the fall of 2006.

OK01420 (2415)

Cast from the same mold as OK Bullet (*KS96WGRC39/Jagger*), this HRW experimental holds a slight edge (5%, maybe) over OK Bullet for grain yield but takes a single-pound loss on test weight. Take away the bronze chaff of OK01420 and the higher protein content of OK Bullet, and these almost-twin sisters are almost difficult to tell apart in the quality lab or in the field. We have an interest in OK01420 not as a candidate cultivar per se, but as a source for electronically sorting out a white wheat version of OK01420, possibly with pre-harvest sprouting tolerance (courtesy of the USDA-ARS-ERU, Manhattan). The ERU guru has requested a full quality inspection before proceeding further.

OK02405 (2416)

The luck we had in producing an awnless wheat named ‘Deliver’ with above-average test weight, large kernel size, and attractive quality – putting hardness aside – had us wondering if that could be repeated. OK02405 (*Tonkawa/GK50*), an awnless HRW wheat that surpasses the yield of Deliver by 10%, will nevertheless keep us wondering. What OK02405 lacks is threshability, which may contribute to its below-average test weight. Otherwise, this line has excellent leaf rust resistance and stripe rust resistance apparently distinct from Jagger. Kernel size, dough strength, and absorption rank highly, though mixing time is too long. The Tonkawa/GK50 cross has produced a wealth of highly adapted materials, awned or awnless. 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.

OK02522W (2417)

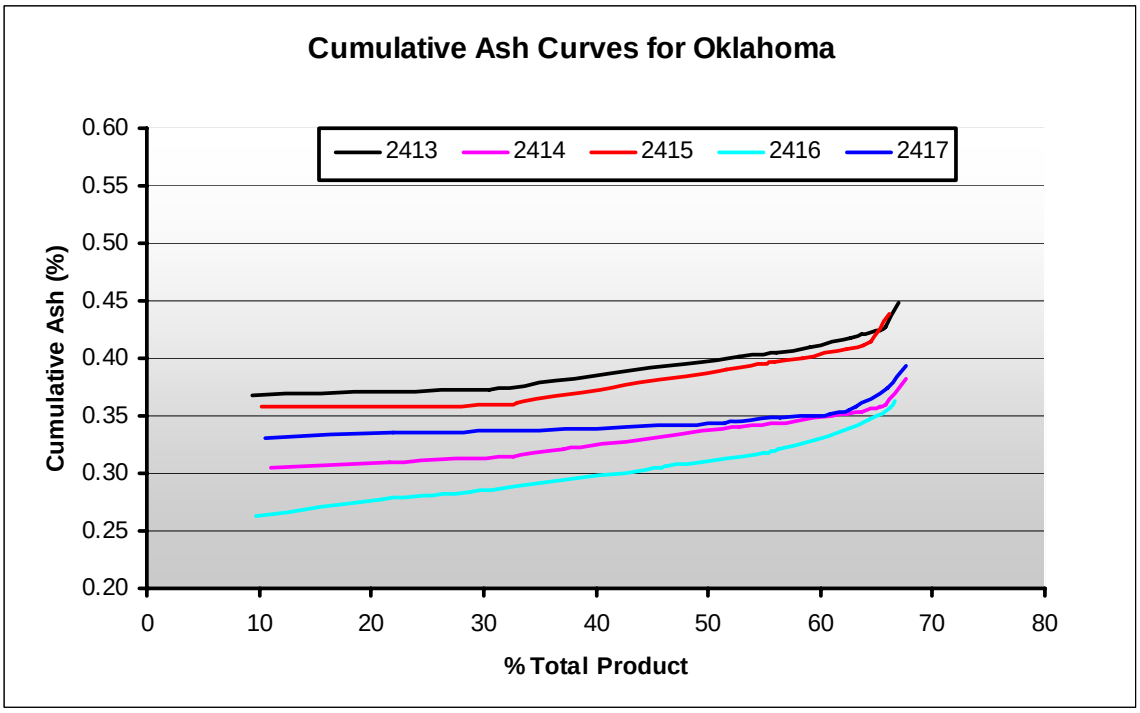
Yet another descendent of *KS96WGRC39/Jagger*, this HW experimental rose to the top of our yield charts in the stripe-rust year of 2005. It maintained a strong presence in 2006, yielding equivalent to OK Bullet. OK02522W is a white wheat that fits the central part of the state as well as any red candidate. Pre-harvest sprouting tolerance is intermediate to Danby and Intrada. It has excellent straw strength and resistance to acid soils and leaf rust. Septoria and tan spot reactions are less impressive, and test weight is 1.5 lb less than OK Bullet, or about average. We gambled on a breeder-seed increase of OK02522W in the Oklahoma panhandle in 2006 – but lost. Hence, we will continue to evaluate this line alongside OK00611W, a sister HW selection that was evaluated in the 2005 Wheat Quality Council Evaluation Program.

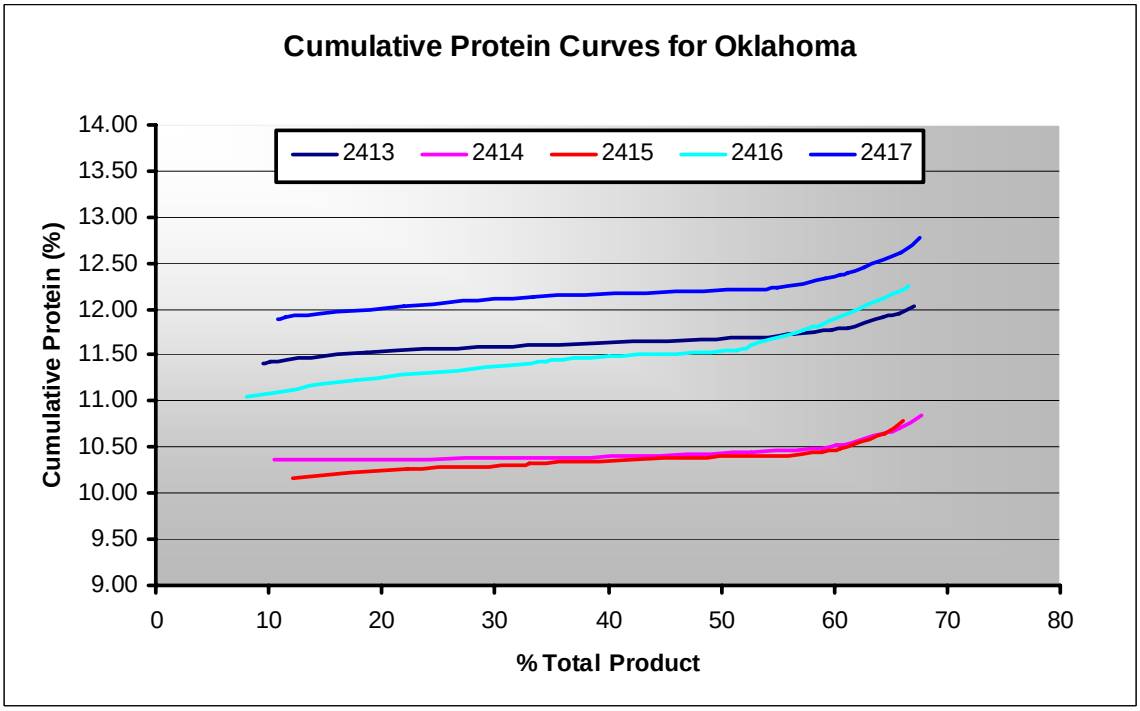
Oklahoma: 2006 (Small-Scale) Samples[a]

Test entry number	06-2413	06-2414	06-2415	06-2416	06-2417
Sample identification	OK Bullet	**Duster**	OK01420	OK02405	OK02522W
Wheat Data					
FGIS classification	2 HRW	1 HRW	2 HRW	1 HRW	4 HDWH
Test weight (lb/bu)	62.9	63.5	62.4	60.6	60.7
Hectoliter weight (kg/hl)	82.7	83.5	82.0	79.7	79.8
1000 kernel weight (gm)	32.2	29.0	35.0	31.9	32.4
NIR hardness	93.8	83.8	90.0	82.1	86.5
Wheat kernel size (Rotap)					
Over 7 wire (%)	78.0	56.8	82.1	73.4	78.5
Over 9 wire (%)	21.6	43.0	17.8	26.5	21.3
Through 9 wire (%)	0.4	0.2	0.1	0.1	0.2
Single kernel (skcs)					
Hardness (avg /s.d)	80.1/14.0	86.6/14.6	85.4/15.3	84.9/13.5	79.6/15.8
Weight (mg) (avg/s.d)	32.1/8.4	30.0/6.4	34.8/8.8	32.4/7.8	32.7/7.4
Diameter (mm)(avg/s.d)	2.49/0.59	2.32/0.40	2.57/0.54	2.57/0.54	2.48/0.44
SKCS distribution	00-02-05-93	00-01-02-97	00-01-04-95	00-00-04-96	01-01-06-92
Classification	Hard	Hard	Hard	Hard	Hard
Wheat moisture (%)	9.9	11.3	10.9	10.6	10.1
Wheat protein (12% mb)	12.7	11.8	11.9	12.8	13.6
Wheat ash (12% mb)	1.20	1.21	1.25	1.34	1.30
Milling and Flour Quality Data					
Flour yield (%, str. grade)					
Miag Multomat Mill	67.0	67.7	66.1	66.6	67.6
Quadrumat Sr. Mill	75.2	73.4	73.9	72.7	74.4
Flour moisture (%)	12.6	12.2	12.4	12.4	12.8
Flour protein (14% mb)	11.6	10.6	10.6	12.0	12.4
Flour ash (14% mb)	0.42	0.38	0.42	0.45	0.44
Glutomatic					
Wet gluten (%)	33.0	28.4	30.0	32.4	34.5
Dry gluten (%)	11.0	9.6	9.7	11.0	11.4
Gluten index	81.4	98.2	98.0	94.6	88.4
Flour color					
Agtron flour color	65	72	67	69	68
Simon/Kent-Jones flour color	0.58	-0.05	2.01	0.44	1.06
Minolta color meter					
L*	91.33	92.0	91.42	91.45	91.86
a*	-1.56	-1.76	-1.51	-1.57	-1.37
b*	10.31	10.68	10.35	10.52	9.69
Falling number (sec)	583	624	508	592	665
Flour particle size (avg)					
Fisher sub sieve sizer	28	25	26	25	25

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

Oklahoma: Cumulative Ash and Protein Curves

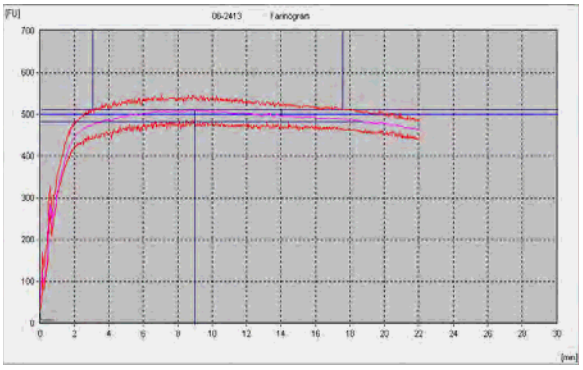




Physical Dough Tests

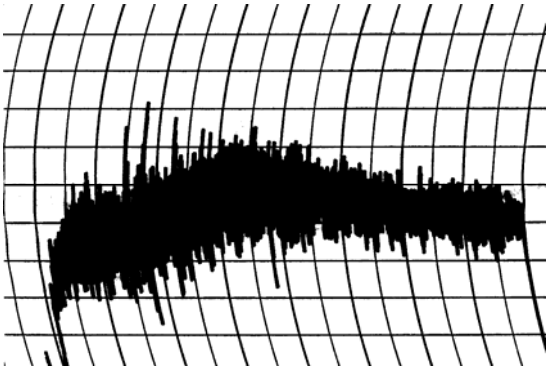
2006 (Small Scale) Samples - Oklahoma

Farinograms



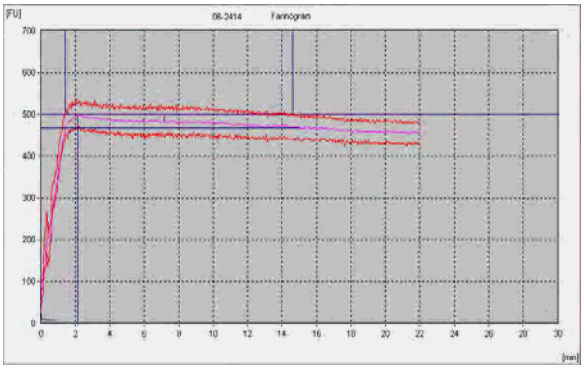
Abs. 62.7%, Peak 9.0 min, Stab. 14.3 min

Mixograms

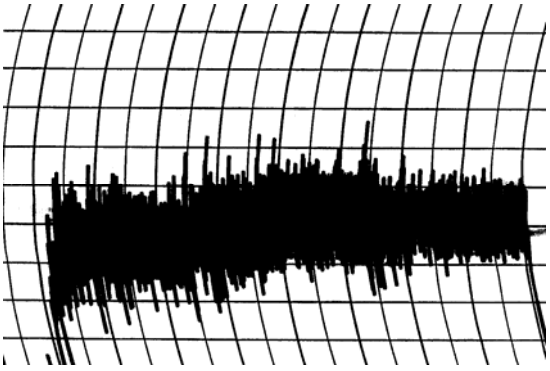


Abs. 63.2%, Mix time 3.4 min

06-2413, OK Bullet (check)



Abs. 61.7%, Peak 2.2 min, Stab. 13.2 min



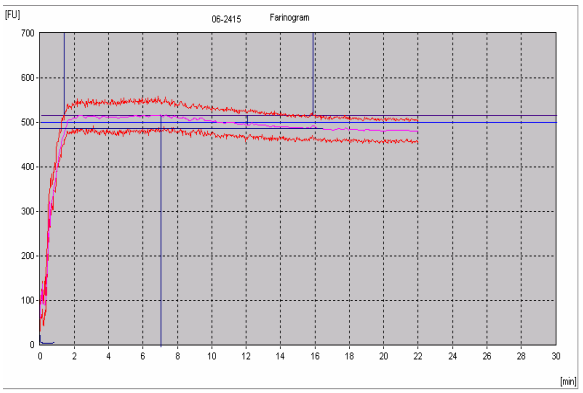
Abs. 61.7%, Mix time 4.4 min

06-2414, Duster

Physical Dough Tests

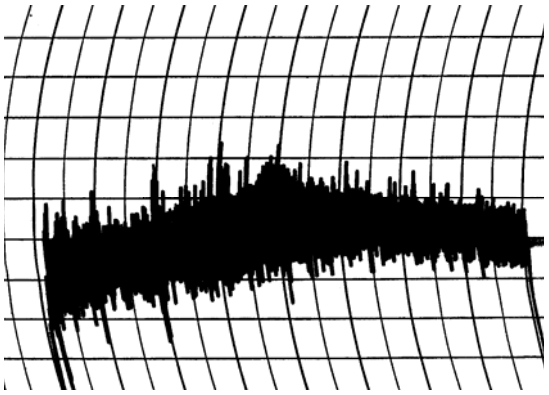
2006 (Small Scale) Samples - Oklahoma (continued)

Farinograms



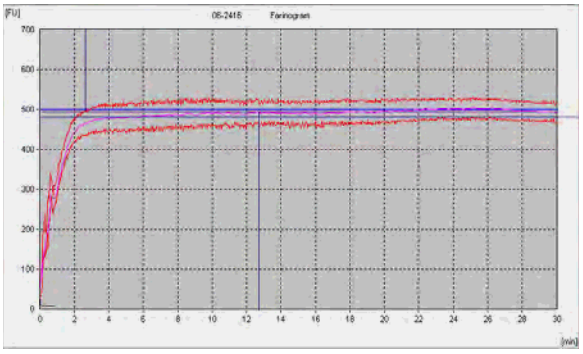
Abs. 64.8%, Peak 7.1 min, Stab. 14.5 min

Mixograms

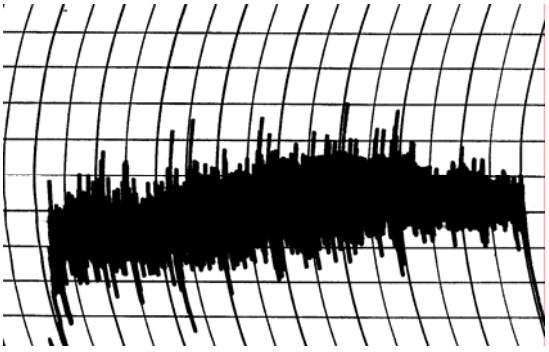


Abs. 65.6%, Mix time 4.0 min

06-2415, OK01420



Abs. 61.9%, Peak 12.7 min, Stab. 29.4 min



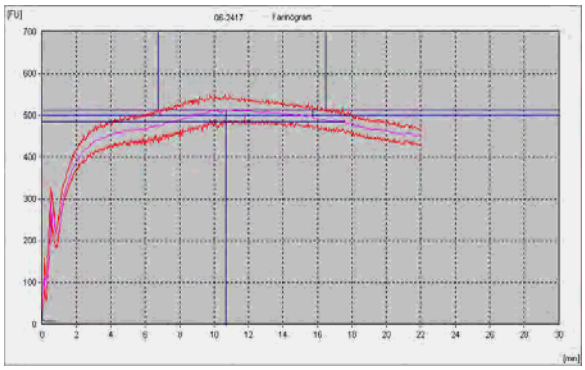
Abs. 62.9%, Mix time 5.0 min

06-2416, OK02405

Physical Dough Tests

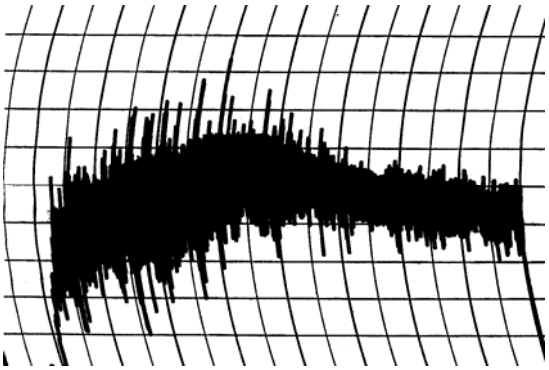
2006 (Small Scale) Samples - Oklahoma (continued)

Farinograms



Abs. 68.0%, Peak 10.7 min, Stab. 9.7 min

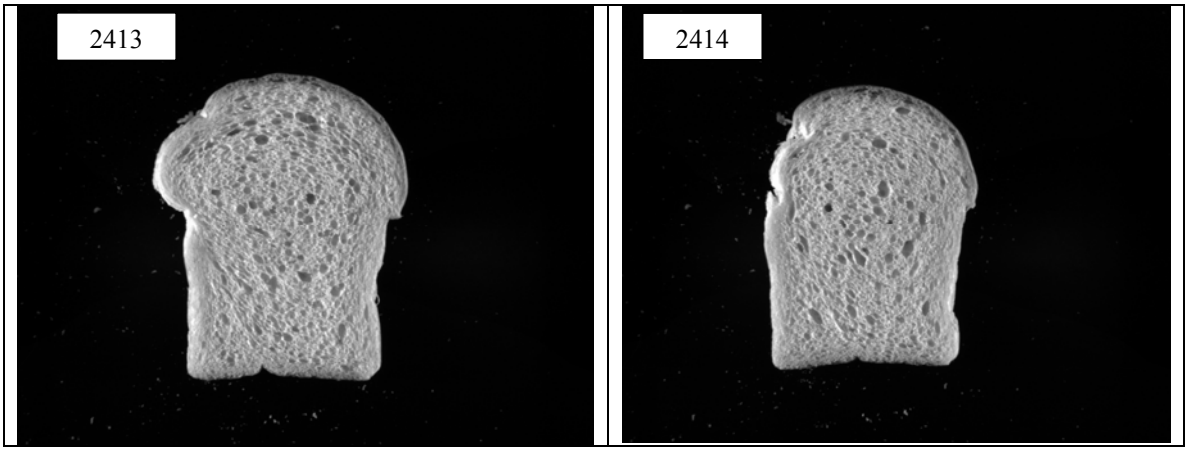
Mixograms



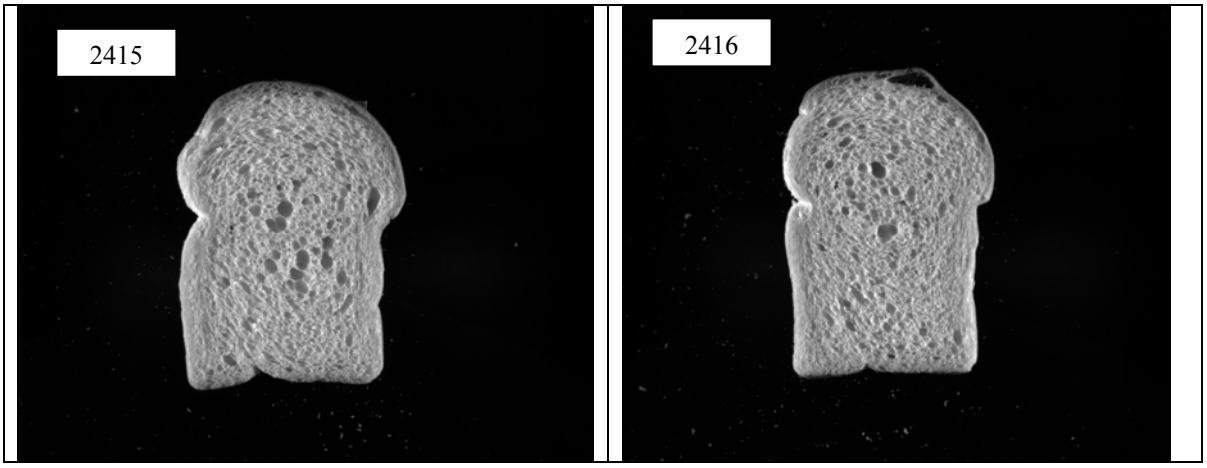
Abs. 63.6%, Mix time 3.4 min

06-2417, OK02522W

Oklahoma: C-Cell Bread Images and Analysis for 2006(Small-Scale) Samples

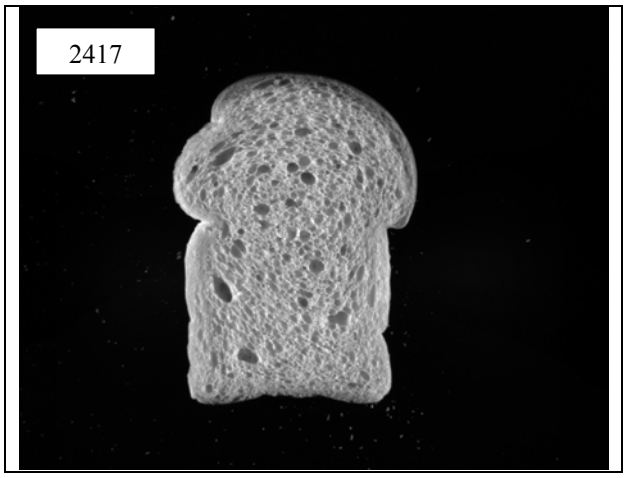


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2413	6111	151.7	3753	0.447	1.962	4.83	1.695	-22.93
2414	5598	150.6	3844	0.427	1.789	4.16	1.665	-24.38



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2415	5787	149.0	3770	0.435	1.881	0.94	1.673	-13.58
2416	5716	144.8	3515	0.445	1.899	1.14	1.668	-19.78

Oklahoma: C-Cell Bread Images and Analysis for 2006(Small-Scale) Samples (continued)



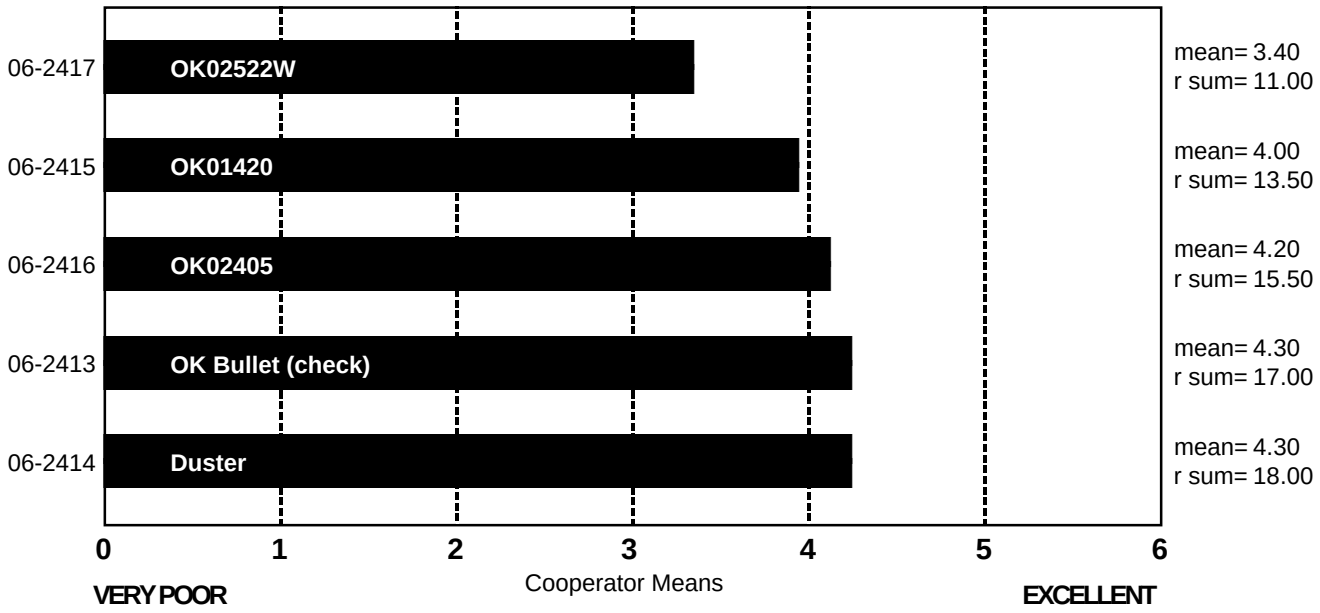
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2417	6288	149.9	3834	0.444	1.997	2.78	1.690	-16.53

SPONGE CHARACTERISTICS

(Small Scale) Oklahoma

ncoop= 5
chisq= 2.52
chisqc= 3.76
cvchisq= 9.49
crdiff=

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

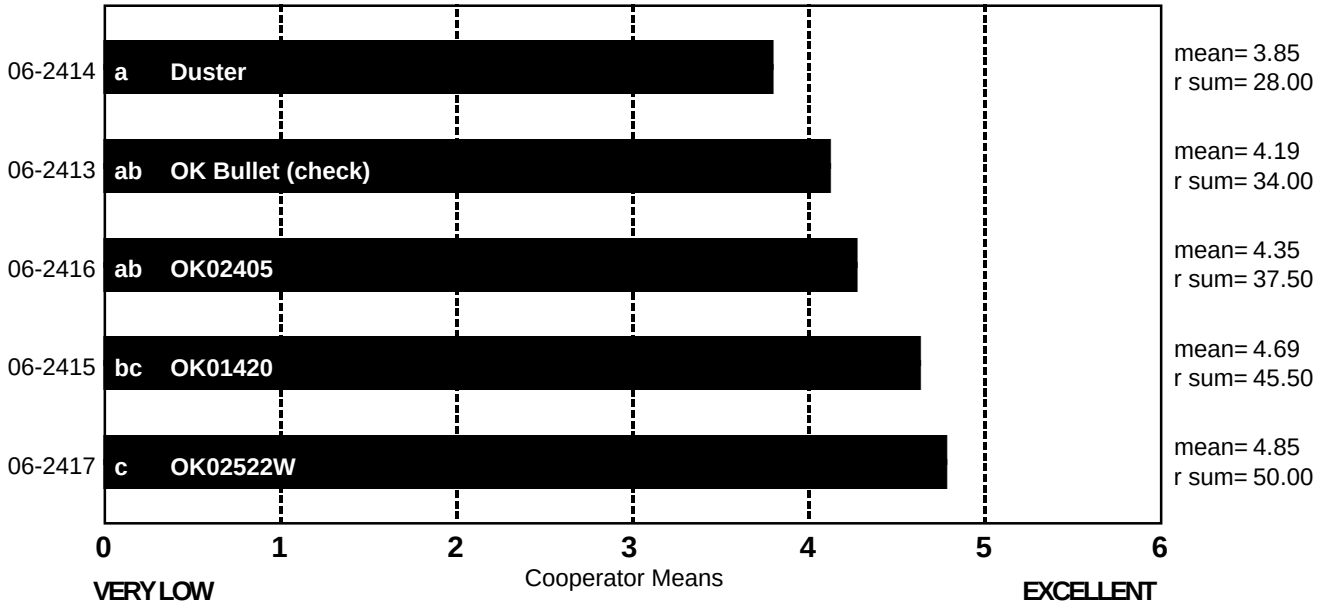


BAKE ABSORPTION

(Small Scale) Oklahoma

ncoop= 13
chisq= 9.58
chisqc= 14.49
cvchisq= 9.49
crdiff= 11.66

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2413 OK Bullet (check)	**58.0**	**61.8**	**62.1**	**65.7**	**65.0**	**64.1**	**60.0**	**62.0**	**61.8**	**64.7**	**69.0**	**62.0**	**61.2**
06-2414 Duster	**57.0**	**62.8**	**61.7**	**64.7**	**61.0**	**62.4**	**59.3**	**60.0**	**61.6**	**63.7**	**66.5**	**63.0**	**60.2**
06-2415 OK01420	**57.0**	**64.6**	**65.6**	**67.8**	**63.0**	**66.3**	**60.7**	**60.0**	**61.8**	**66.8**	**66.7**	**64.0**	**63.3**
06-2416 OK02405	**59.0**	**62.2**	**62.9**	**64.9**	**63.0**	**63.7**	**60.0**	**62.0**	**64.3**	**63.9**	**65.2**	**62.0**	**60.4**
06-2417 OK02522W	**59.0**	**66.4**	**63.6**	**71.0**	**66.0**	**64.7**	**61.4**	**63.0**	**63.3**	**70.0**	**66.7**	**65.0**	**66.5**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2413 OK Bullet (check)	**9.0**	**2.0**	**4.3**	**7.0**	**17.0**	**3.1**	**5.0**	**3.0**	**4.1**	**7.5**	**4.6**	**5.0**	**2.8**
06-2414 Duster	**8.0**	**1.8**	**5.7**	**8.0**	**25.0**	**4.4**	**5.0**	**6.0**	**7.5**	**5.5**	**4.8**	**6.0**	**4.0**
06-2415 OK01420	**10.0**	**2.3**	**5.1**	**8.0**	**21.0**	**4.0**	**6.0**	**6.0**	**5.0**	**6.0**	**4.3**	**4.0**	**3.5**
06-2416 OK02405	**12.0**	**2.0**	**6.0**	**14.0**	**25.0**	**5.0**	**6.0**	**6.0**	**7.1**	**8.5**	**6.0**	**6.0**	**4.0**
06-2417 OK02522W	**10.0**	**2.0**	**4.2**	**7.0**	**16.0**	**3.4**	**8.0**	**9.0**	**4.5**	**5.0**	**4.1**	**4.0**	**3.0**

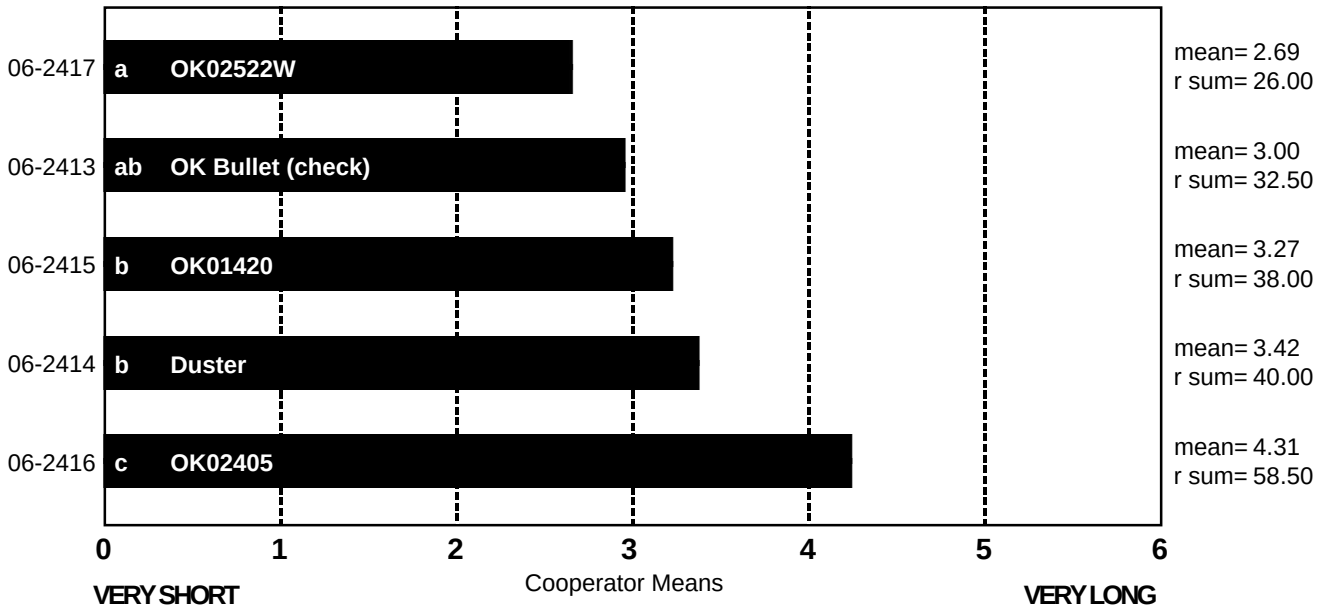
Raw Data

BAKE MIX TIME

(Small Scale) Oklahoma

ncoop= 13
chisq= 18.26
chisqc= 24.35
cvchisq= 9.49
crdiff= 10.66

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

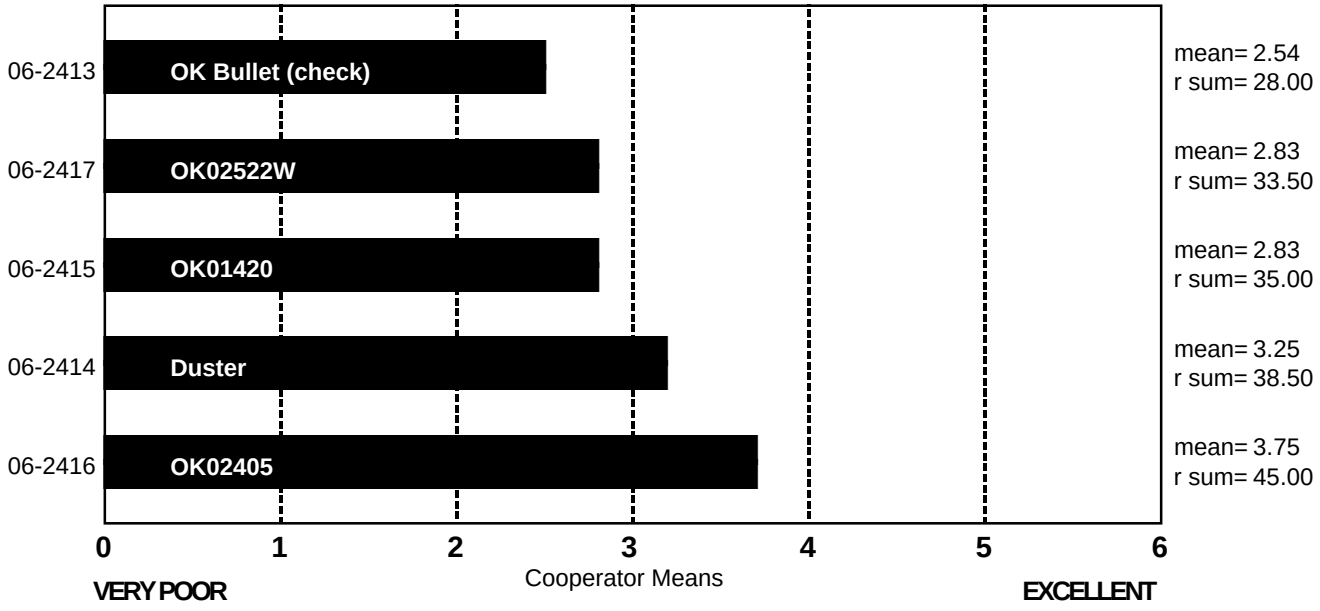


MIXING TOLERANCE

(Small Scale) Oklahoma

ncoop= 12
chisq= 5.28
chisqc= 6.22
cvchisq= 9.49
crdiff=

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

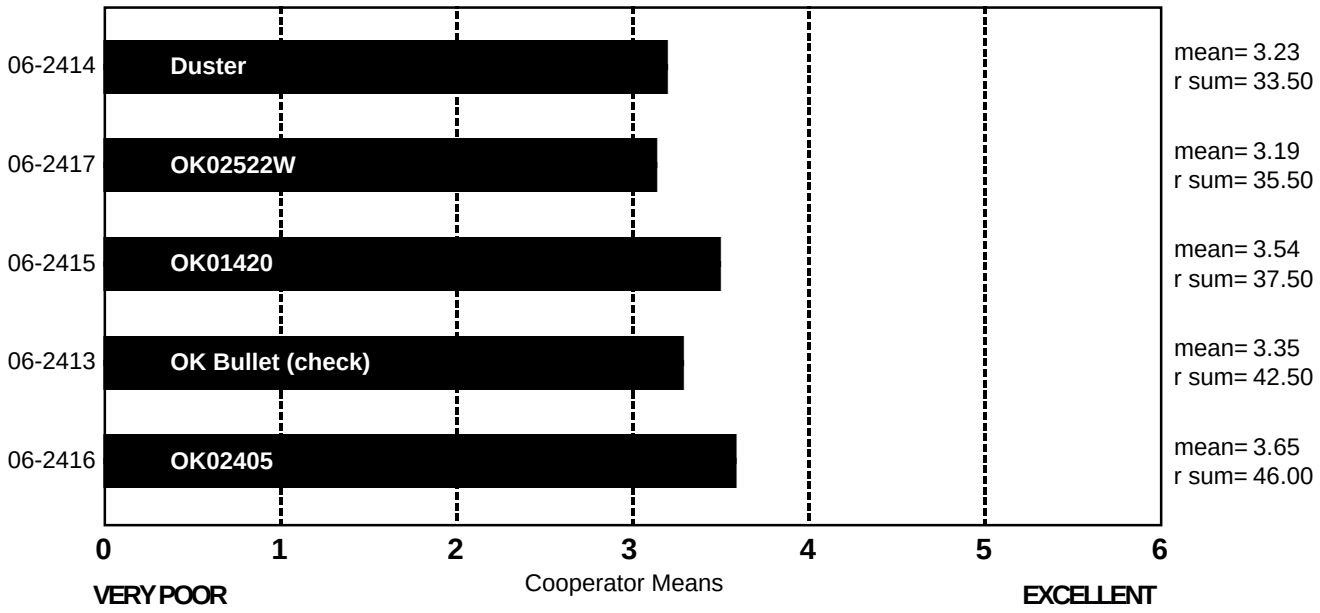


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Oklahoma

ncoop= 13
chisq= 3.26
chisqc= 4.16
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
06-2413 OK Bullet (check)	**4**	**0**	**2**	**7**	**0**
06-2414 Duster	**2**	**3**	**3**	**5**	**0**
06-2415 OK01420	**2**	**0**	**3**	**8**	**0**
06-2416 OK02405	**1**	**0**	**3**	**9**	**0**
06-2417 OK02522W	**3**	**2**	**5**	**3**	**0**

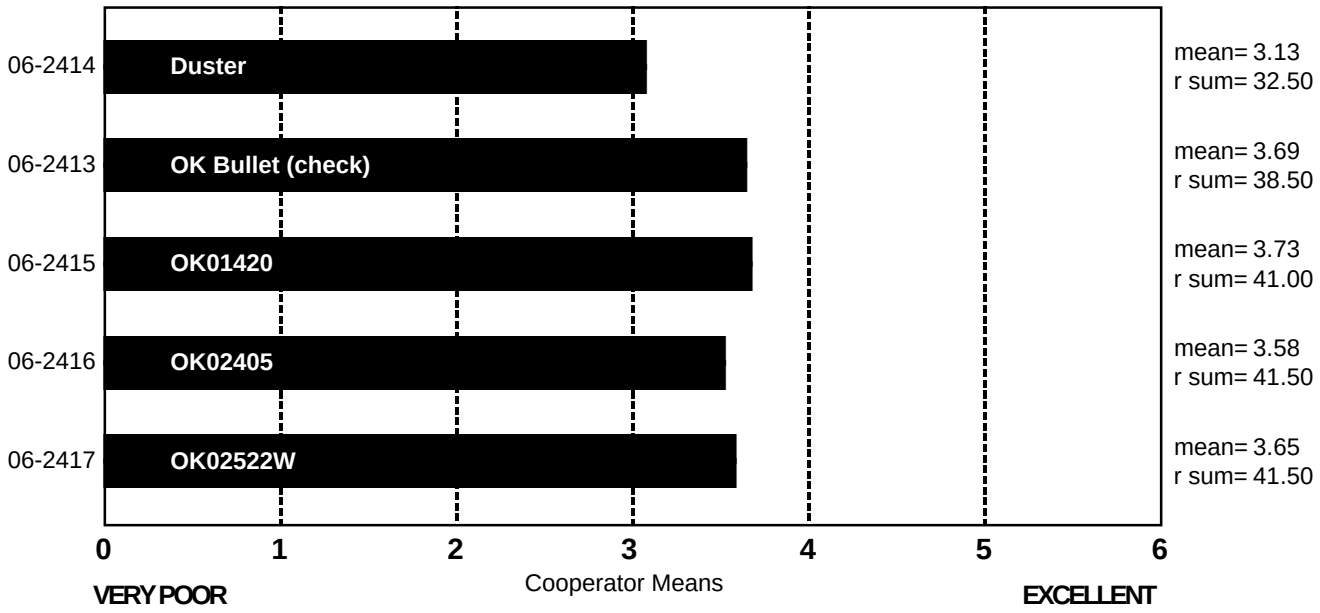
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Oklahoma

ncoop= 13
chisq= 1.82
chisqc= 2.74
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
06-2413 OK Bullet (check)	**5**	**0**	**0**	**7**	**1**
06-2414 Duster	**1**	**0**	**5**	**6**	**1**
06-2415 OK01420	**2**	**1**	**3**	**6**	**1**
06-2416 OK02405	**1**	**0**	**4**	**7**	**1**
06-2417 OK02522W	**4**	**1**	**3**	**4**	**1**

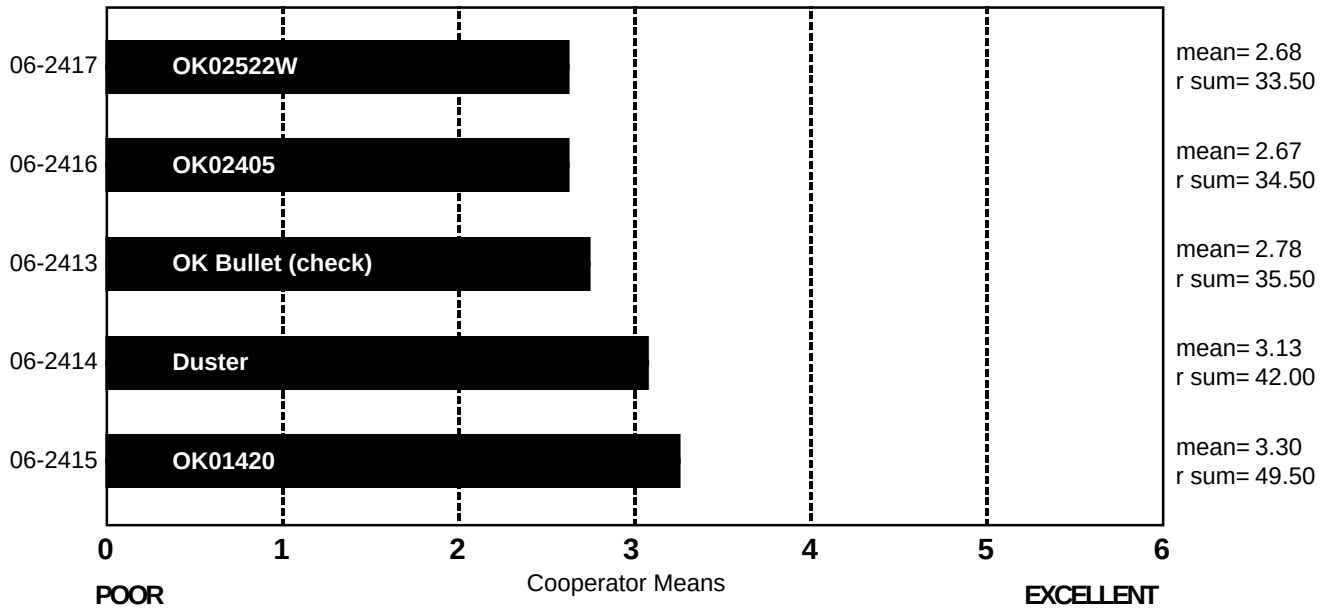
Frequency Table

CRUMB GRAIN

(Small Scale) Oklahoma

ncoop= 13
chisq= 5.60
chisqc= 7.47
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
06-2413 OK Bullet (check)	**8**	**3**	**2**
06-2414 Duster	**2**	**5**	**6**
06-2415 OK01420	**4**	**4**	**5**
06-2416 OK02405	**6**	**2**	**5**
06-2417 OK02522W	**9**	**2**	**2**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Oklahoma

	Round	Irregular	Elongated
06-2413 OK Bullet (check)	**4**	**7**	**2**
06-2414 Duster	**4**	**8**	**1**
06-2415 OK01420	**4**	**7**	**2**
06-2416 OK02405	**7**	**5**	**1**
06-2417 OK02522W	**5**	**6**	**2**

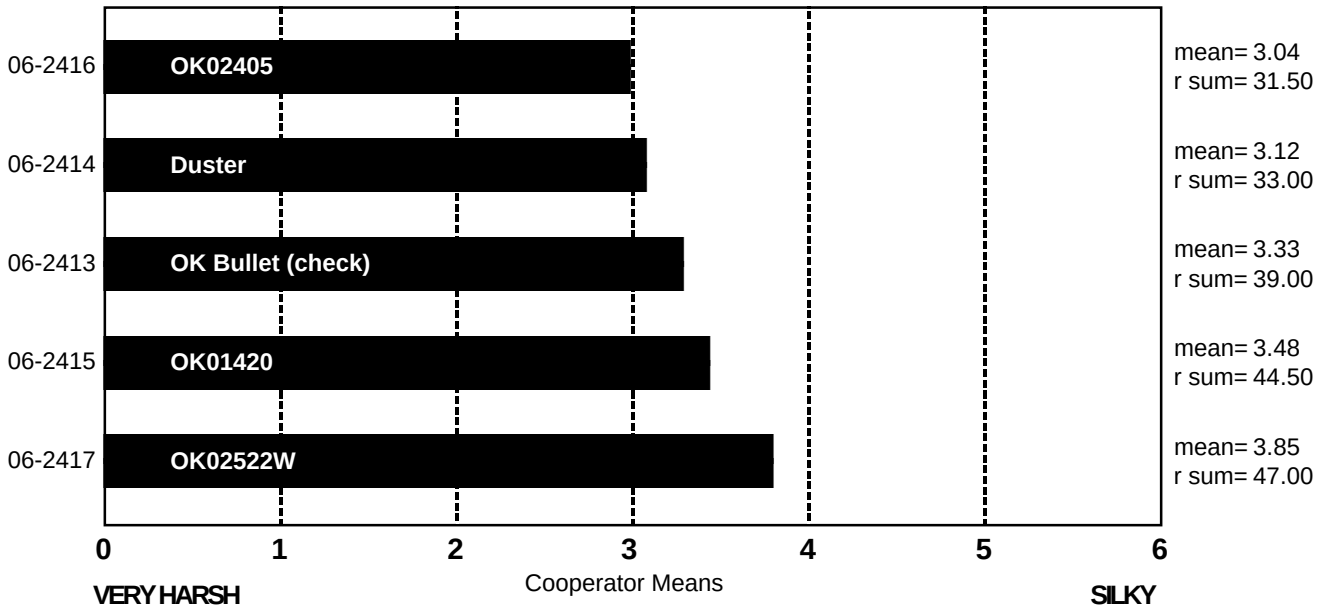
Frequency Table

CRUMB TEXTURE

(Small Scale) Oklahoma

ncoop= 13
chisq= 5.74
chisqc= 8.57
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
06-2413 OK Bullet (check)	**6**	**6**	**1**
06-2414 Duster	**8**	**4**	**1**
06-2415 OK01420	**5**	**6**	**2**
06-2416 OK02405	**6**	**7**	**0**
06-2417 OK02522W	**2**	**6**	**5**

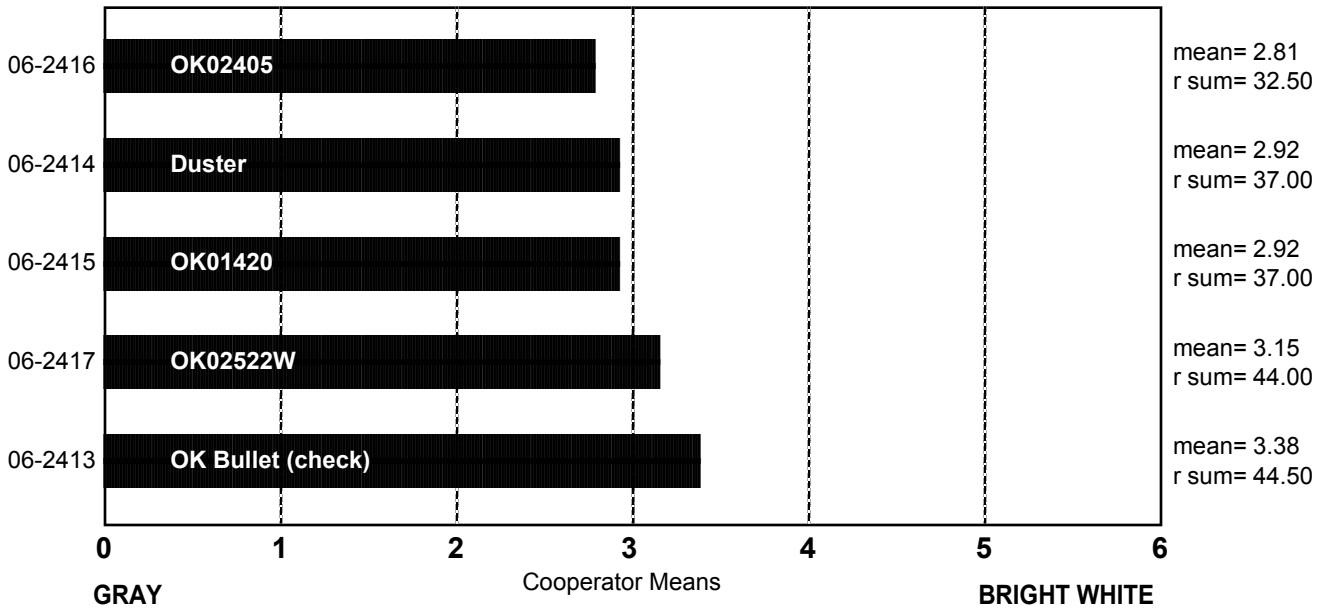
Frequency Table

CRUMB COLOR

(Small Scale) Oklahoma

ncoop= 13
chisq= 3.25
chisqc= 6.98
cvchisq= 9.49
crdiff=

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



CRUMB COLOR, DESCRIBED

(Small Scale) Oklahoma

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
06-2413 OK Bullet (check)	**0**	**1**	**1**	**3**	**5**	**3**	**0**
06-2414 Duster	**0**	**1**	**4**	**3**	**4**	**1**	**0**
06-2415 OK01420	**0**	**1**	**5**	**1**	**5**	**1**	**0**
06-2416 OK02405	**0**	**1**	**5**	**3**	**3**	**1**	**0**
06-2417 OK02522W	**0**	**0**	**5**	**2**	**3**	**2**	**1**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Oklahoma

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2413 OK Bullet (check)	**421.0**	**137.4**	**139.2**	**415.5**	**478.2**	**146.1**	**500.0**		**149.2**	**472.0**	**160.0**	**462.5**	
06-2414 Duster	**423.0**	**139.1**	**143.3**	**419.2**	**479.0**	**144.1**	**495.0**		**149.9**	**466.0**	**156.2**	**464.0**	
06-2415 OK01420	**427.0**	**140.8**	**142.8**	**415.4**	**479.4**	**143.5**	**500.0**		**150.3**	**467.0**	**161.4**	**465.0**	
06-2416 OK02405	**426.0**	**140.0**	**142.5**	**415.2**	**477.0**	**146.0**	**500.0**		**152.7**	**464.0**	**155.1**	**465.7**	
06-2417 OK02522W	**420.0**	**140.2**	**139.3**	**410.0**	**476.9**	**146.6**	**500.0**		**150.0**	**461.0**	**155.1**	**463.1**	

Raw Data

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
06-2413 OK Bullet (check)	**2825**	**760**	**848**	**2430**	**2927**	**898**	**3150**	**898**	**838**	**2700**	**855**	**2638**	**840**
06-2414 Duster	**2575**	**700**	**823**	**2150**	**2897**	**803**	**3000**	**810**	**745**	**2775**	**825**	**2588**	**760**
06-2415 OK01420	**2600**	**700**	**865**	**2320**	**2986**	**860**	**3000**	**828**	**800**	**2400**	**803**	**2563**	**820**
06-2416 OK02405	**2700**	**685**	**830**	**2460**	**2986**	**883**	**3000**	**843**	**768**	**2675**	**800**	**2675**	**790**
06-2417 OK02522W	**2800**	**785**	**915**	**2560**	**2986**	**960**	**3200**	**852**	**893**	**2925**	**825**	**2575**	**900**

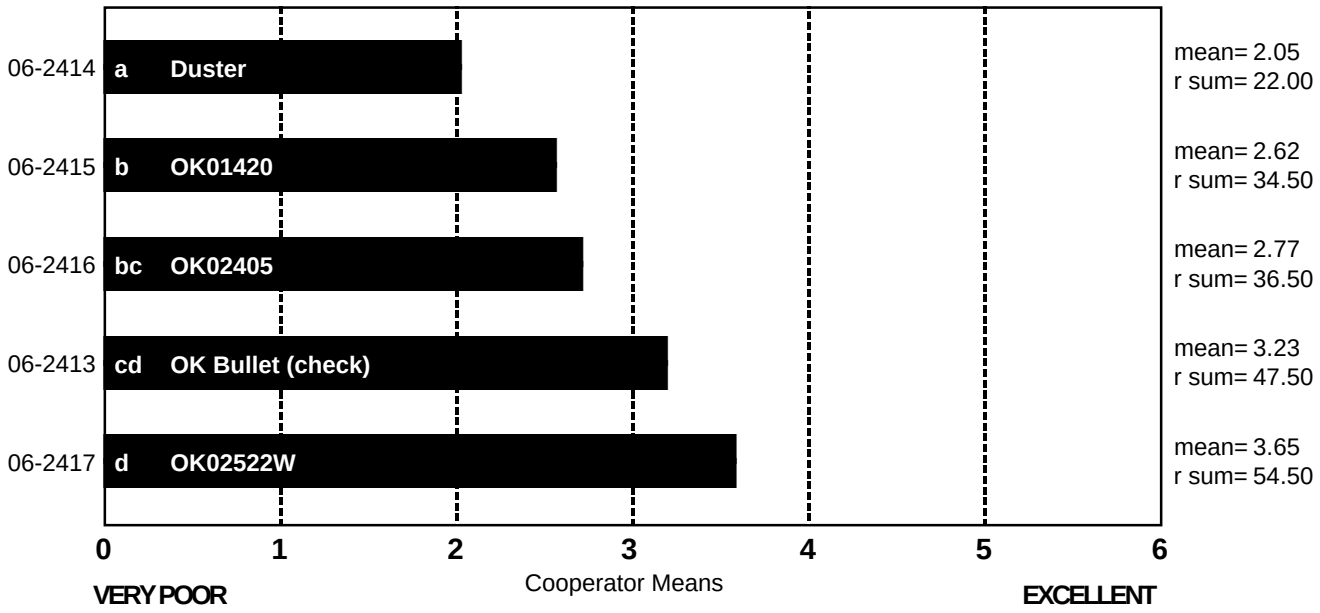
Raw Data

LOAF VOLUME

(Small Scale) Oklahoma

ncoop= 13
chisq= 19.32
chisqc= 22.43
cvchisq= 9.49
crdiff= 11.81

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

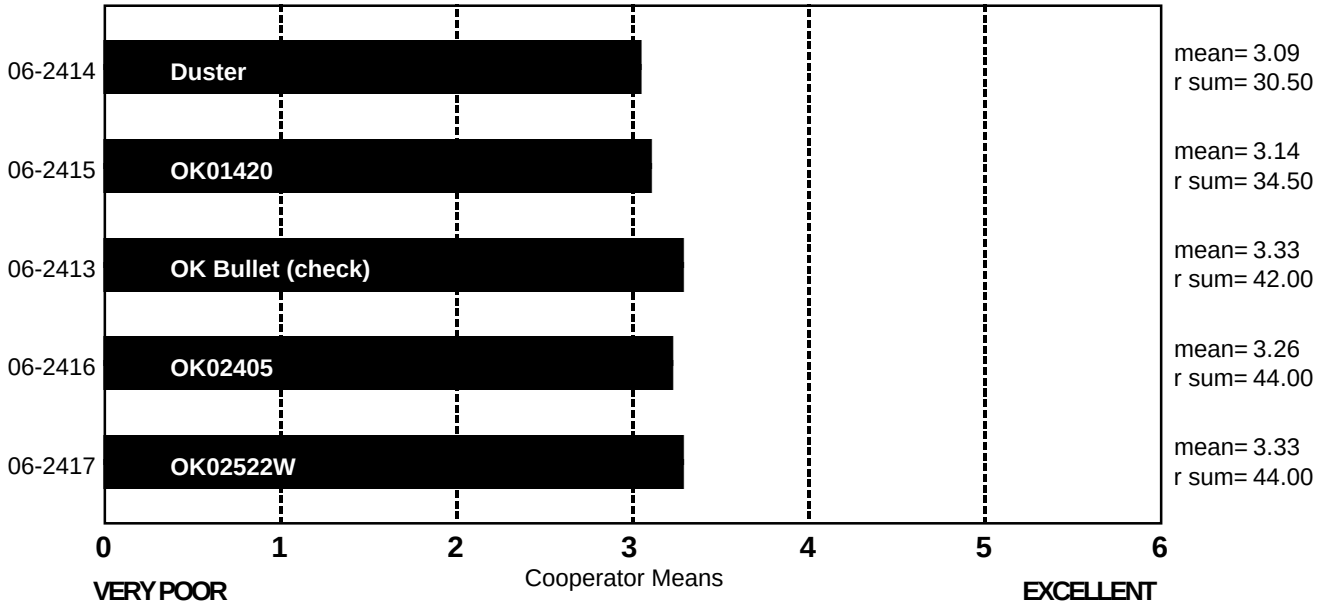


OVERALL BAKING QUALITY

(Small Scale) Oklahoma

ncoop= 13
chisq= 4.66
chisqc= 5.29
cvchisq= 9.49
crdiff=

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



COOPERATOR'S COMMENTS
(Small Scale) Oklahoma

COOP. 06-2413 (OK Bullet (check))

A. Good volume and slightly open grain.
B. No comments.
C. A big hole on the edge.
D. Mediocre mix tolerance, sticky dough, open grain, and slightly low volume.
E. Very open, very irregular, harsh grain, and above average volume.
F. No comments.
G. Creamy color, strong, and good bake.
H. Dull color, open grain, and slightly small volume produce a marginal bread product.
I. Low bake absorption, poor tolerance, questionable crumb grain, low loaf volume, yellow crumb grain, and mix time good.
J. Open grain.
K. Weak crumb grain.
L. Good absorption, short mix time, good crumb grain, and average loaf volume.
M. Dull crumb color, loaf volume low, slightly harsh crumb, and slack at make-up.

COOP. 06-2414 (Duster)

A. Squatty loaf and low loaf volume.
B. Crust has rough break and shred.
C. Holes on the edge.
D. Good mix tolerance, nice dough, nice crumb grain, and very low loaf volume.
E. Very open grain, harsh texture, and average volume.
F. No comments.
G. Bucky, creamy, and harsh grain.
H. Poor bake quality all around, very small volume, and low protein as well.
I. Low bake absorption, tough dough characteristics, questionable crumb, low loaf volume, and long mix time.
J. No comments.
K. Weak crumb grain.
L. Good absorption, fine grain, yellow crumb, and low loaf volume.
M. Very low volume, harsh yellow crumb, and sticky out of mixer.

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

COOP. 06-2415 (OK01420)

A. Low volume, but had nice interior.
B. Crust has rough break and shred.
C. The third best.
D. Average mix tolerance, good dough, open grain, and low volume.
E. Slightly open grain, good volume, and good absorption.
F. No comments.
G. Dough felt good, poor volume, and harsh grain.
H. Poor bake quality all around, very small volume, and low protein as well.
I. Low bake absorption, tough dough characteristics, questionable crumb, yellow crumb grain.
J. Creamy color, strong, and good bake.
K. Weak crumb grain.
L. High water absorption, short mix time, yellow crumb, and low volume.
M. Loaf volume low, harsh yellow crumb, and poor crumb grain.

COOP. 06-2416 (OK02405)

A. Creamy crumb color and open grain.
B. Crust has rough break and shred.
C. Small holes on the edge.
D. Mediocre mix tolerance, sticky dough out of mixer, open grain, and slightly low loaf volume.
E. Very open, harsh grain, and poor crumb color.
F. No comments.
G. Bucky dough, poor loaf volume, and harsh grain.
H. Poor bake quality all around, very small volume, and yellow color.
I. Good absorption, but long mix time, tough dough characteristics, questionable crumb grain with dull crumb color and low loaf volume.
J. No comments.
K. Weak crumb grain and poor loaf volume for protein.
L. Good absorption, yellow crumb, and average volume.
M. Very low loaf volume, harsh yellow crumb, and good out of mixer and at make-up.

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

COOP. 06-2417 (OK02522W)

A. Bright crumb color and good volume.
B. No comments.
C. A big hole on the edge.
D. Mediocre mix tolerance, sticky dough, open grain, and good volume.
E. Slack, runny dough, poor dough feel, and good volume.
F. No comments.
G. Strong dough and good bake.
H. Marginal bake quality with slightly small volumes, open grain, and tough doughs.
I. Good mix time, but tough dough characteristics, and open yellow crumb.
J. No comments.
K. Weak crumb grain and poor loaf volume for protein.
L. Very high absorption, short mix time, poor grain, yellow crumb, and low volume.
M. Crumb color yellow, smooth crumb texture, high bake absorption, and sticky at make-up.

Notes: **A, D, E H, 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 four samples was made of a composite from Wall (two-thirds) and Winner (one-third) sites located in western South Dakota. Fall stand establishment and growth were excellent. A mild winter was followed by spring drought, especially at the Winner site. Average grain yield at Wall and Winner was 43 and 37 bushel per acre, respectively.

Tandem (check) (2418)

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.

SD96240-3-1 (2419)

SD96240-3 HRWW was developed from the cross NE87513/USSR#67 and is in its third year of testing in the CPT. It has good resistance to stem and stripe rusts but it is moderately susceptible to leaf rust. It has fair to poor baking quality.

SD01122 (2420)

SD01122 HRWW was developed from the cross Harding/KS84063-9-39-3-4W and is in its third year of testing in the advanced yield trials. It has good resistance to stem, leaf, and stripe rusts in addition to excellent baking and milling quality.

SD01W064 (2421)

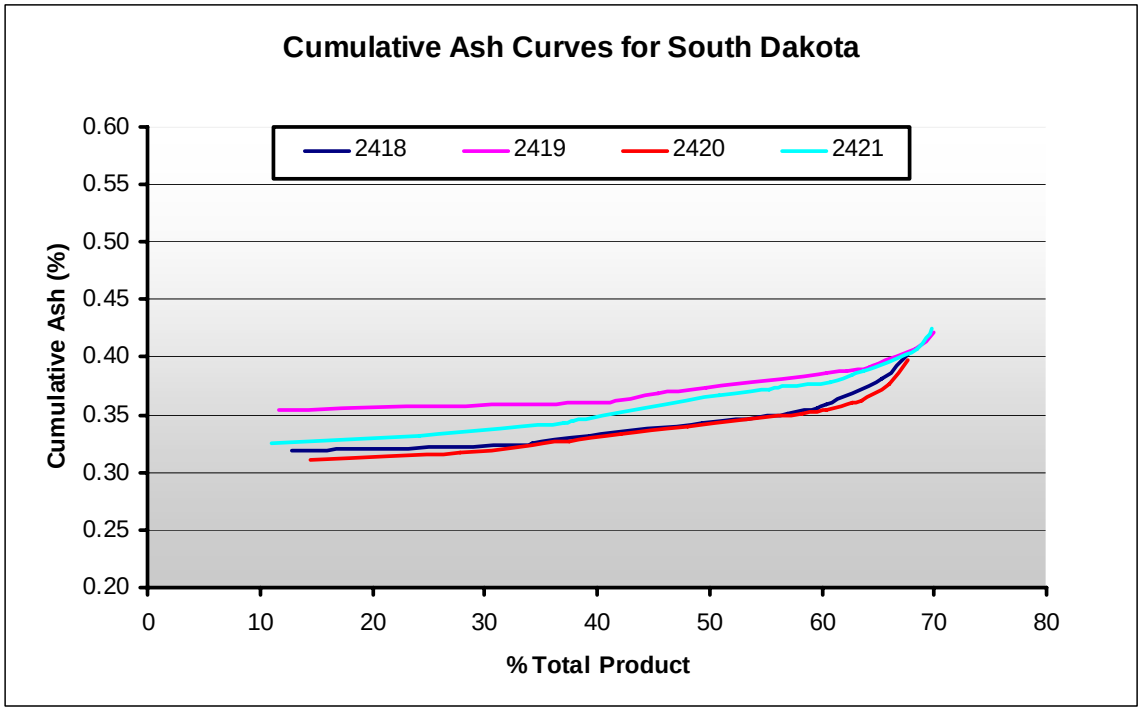
SD01W064 hard white winter wheat was developed from the cross RussianPI592033/NE92458//Nekota. It is in its third year of testing in the CPT Variety Trial. It was the highest yielding line in 2004 AY, ranked 9th in 2005 CPT, and 19th in 2006 CPT. It has average to good baking and noodle quality based on preliminary testing. It has good resistance to stem, leaf, and stripe rusts, in addition to tan spot. It has been shown to possess the Lr34 gene that contributes to durable resistance to leaf rust. It is susceptible to scab. SD01W064 is a potential release in 2007.

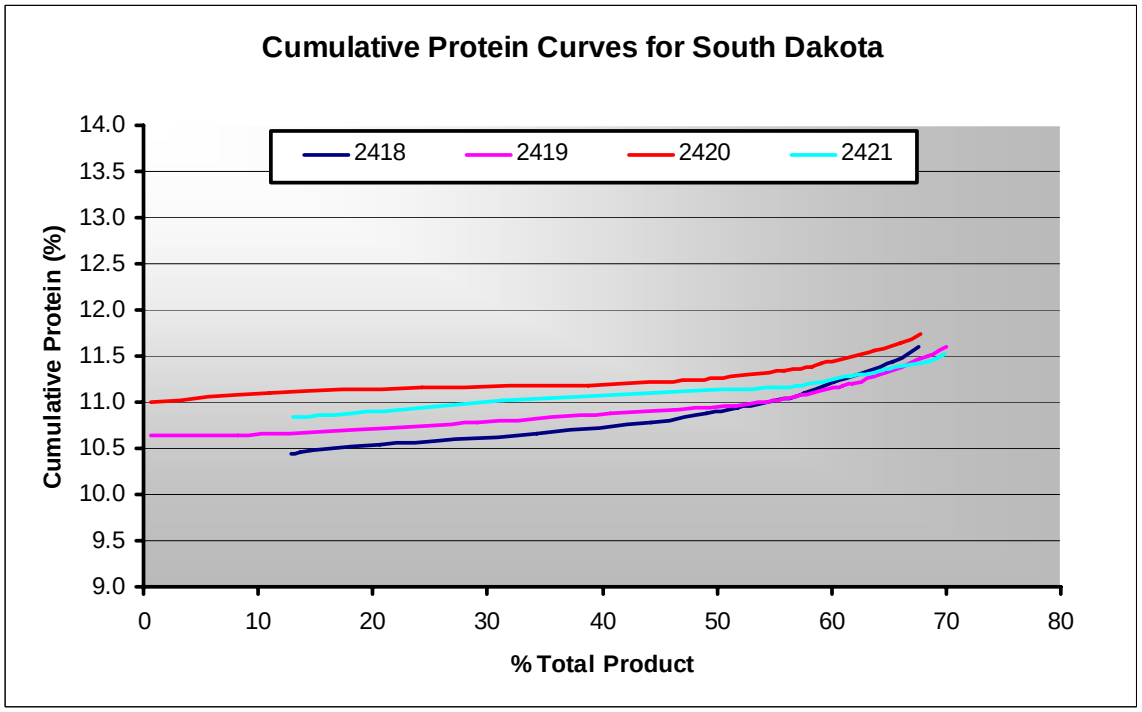
South Dakota: 2006 (Small-Scale) Samples[a]

Test entry number	06-2418	06-2419	06-2420	06-2421
Sample identification	Tandem (check)	SD96240-3-1	SD01122	SD01W064
Wheat Data				
FGIS classification	1 HRW	2 HRW	1 HRW	4 HDWH
Test weight (lb/bu)	62.6	59.8	60.8	62.8
Hectoliter weight (kg/hl)	82.3	78.7	80.0	82.6
1000 kernel weight (gm)	29.3	27.4	24.6	22.7
NIR hardness	70.8	67.6	66.9	71.9
Wheat kernel size (Rotap)				
Over 7 wire (%)	53.9	49.0	36.7	28.9
Over 9 wire (%)	46.1	50.3	61.3	69.1
Through 9 wire (%)	0.1	0.6	2.0	2.0
Single kernel (skcs)				
Hardness (avg /s.d)	67.2/13.9	63.3/15.1	68.8/16.5	70.3/16.4
Weight (mg) (avg/s.d)	31.9/8.6	28.6/7.6	26.6/8.7	25.8/8.0
Diameter (mm)(avg/s.d)	2.32/0.43	2.14/0.42	2.04/0.46	2.04/0.47
SKCS distribution	01-06-17-76	03-09-24-64	03-06-15-76	02-06-16-76
Classification	Hard	Hard	Hard	Hard
Wheat moisture (%)	10.9	10.4	10.9	10.8
Wheat protein (12% mb)	12.1	12.1	12.7	12.4
Wheat ash (12% mb)	1.62	1.62	1.74	1.55
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	67.7	70.0	67.7	69.8
Quadrumat Sr. Mill	72.2	70.6	72.1	72.9
Flour moisture (%)	13.3	11.9	13.0	12.6
Flour protein (14% mb)	11.4	11.5	11.7	11.5
Flour ash (14% mb)	0.41	0.43	0.45	0.46
Glutomatic				
Wet gluten (%)	32.4	35.8	33.9	33.0
Dry gluten (%)	11.6	12.5	11.7	11.5
Gluten index	98.5	80.9	95.0	94.5
Flour color				
Agtron flour color	82	77	76	78
Simon/Kent-Jones flour color	-1.65	-0.91	0.34	-1.15
Minolta color meter				
L*	93.31	92.70	92.43	92.72
a*	-1.59	-1.56	-0.25	0.03
b*	8.74	9.14	8.65	8.29
Falling number (sec)	462	438	538	488
Flour particle size (avg)				
Fisher sub sieve sizer	18	21	20	23

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

South Dakota: Cumulative Ash and Protein Curves

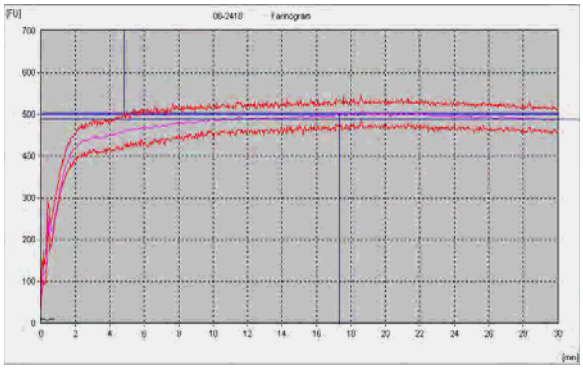




Physical Dough Tests

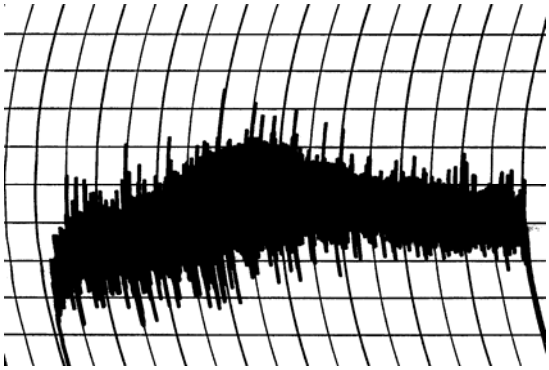
2006 (Small Scale) Samples – South Dakota

Farinograms



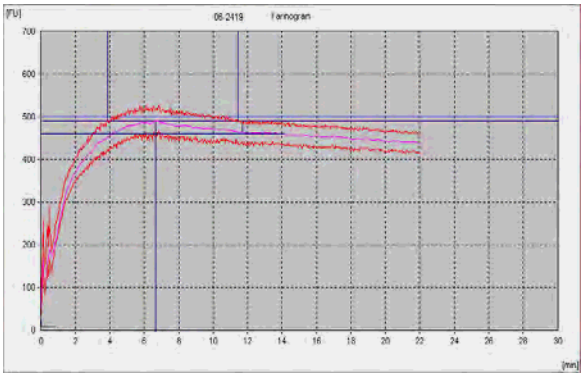
Abs. 60.3%, Peak 17.4 min, Stab. 27.1 min

Mixograms

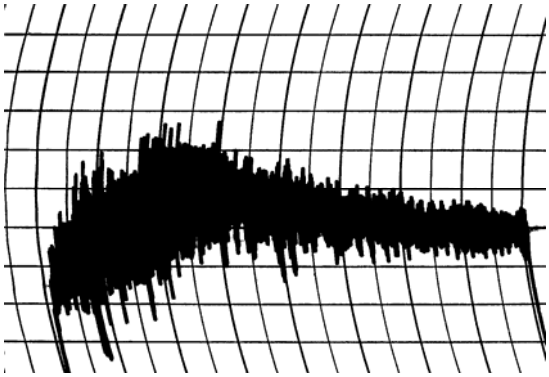


Abs. 61.9%, Mix time 3.6 min

06-2418, Tandem (check)



Abs. 58.4%, Peak 6.7 min, Stab. 7.6 min



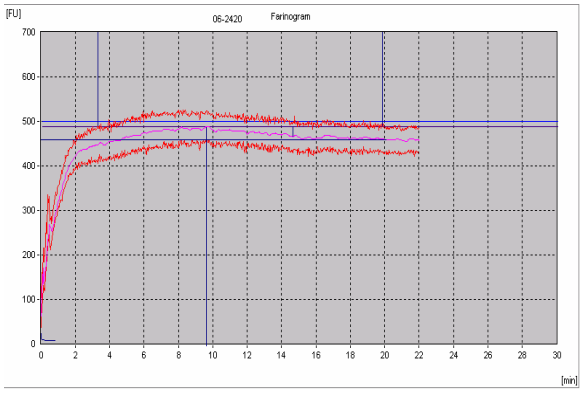
Abs. 62.1%, Mix time 2.5 min

06-2419, SD96240-3-1

Physical Dough Tests

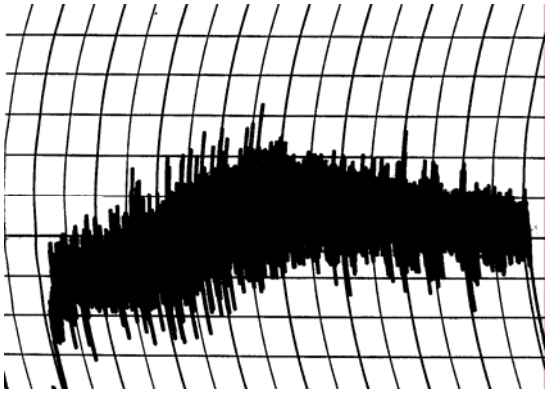
2006 (Small Scale) Samples – South Dakota (continued)

Farinograms



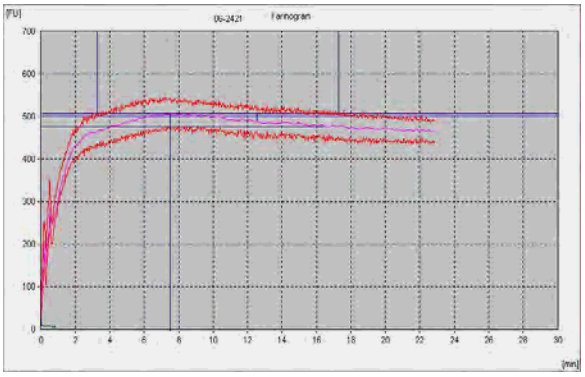
Abs. 59.6%, Peak 9.7 min, Stab. 16.5 min

Mixograms

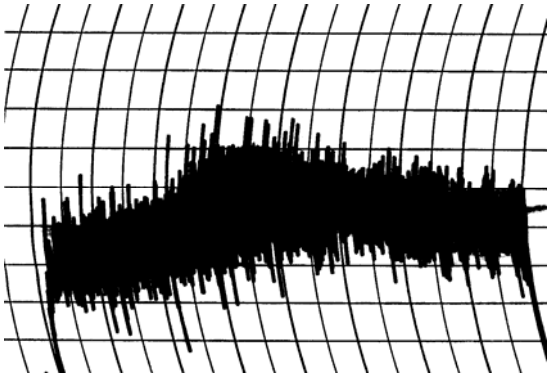


Abs. 62.4%, Mix time 4.0 min

06-2420, SD01122



Abs. 60.0%, Peak 7.5 min, Stab. 14.0 min



Abs. 63.0%, Mix time 3.8 min

06-2421, SD01W064

South Dakota: C-Cell Bread Images and Analysis for 2006(Small-Scale) Samples

Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2418	6473	155.9	3828	0.449	2.065	5.41	1.703	-18.48
2419	6241	157.5	3871	0.446	2.010	2.37	1.633	-21.30

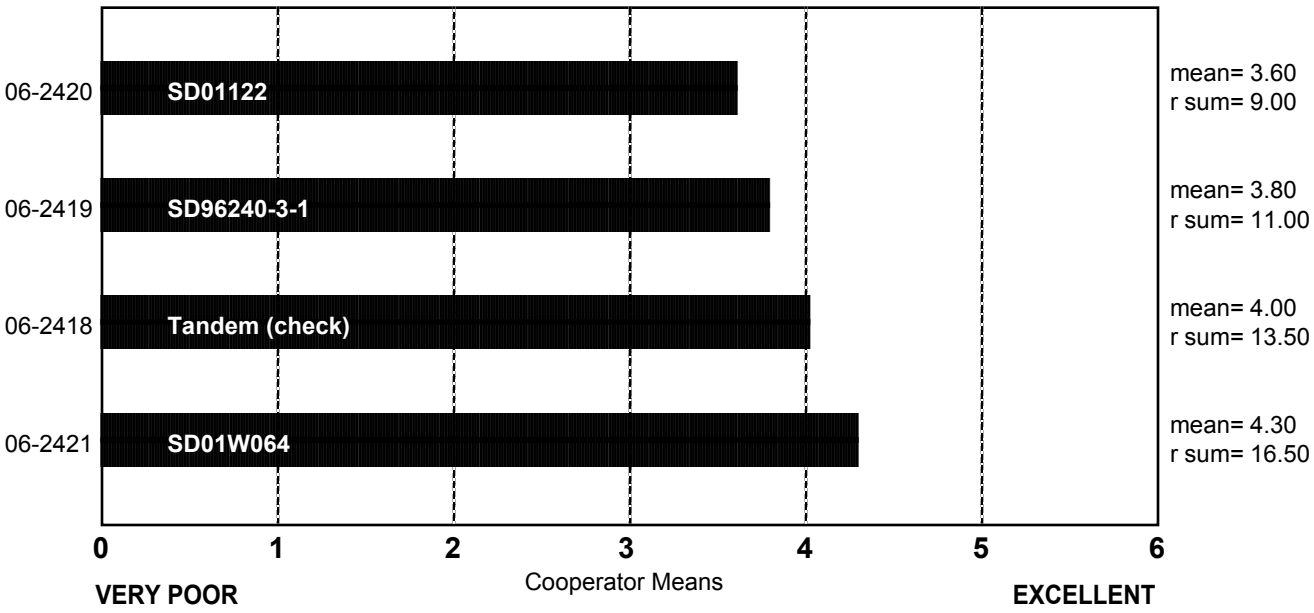
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2420	6336	147.5	3949	0.442	1.932	1.22	1.675	-20.28
2421	6512	154.7	3902	0.451	2.097	1.55	1.648	-19.85

SPONGE CHARACTERISTICS

(Small Scale) South Dakota

ncoop= 5
chisq= 3.78
chisqc= 6.10
cvchisq= 7.82
crdiff=

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

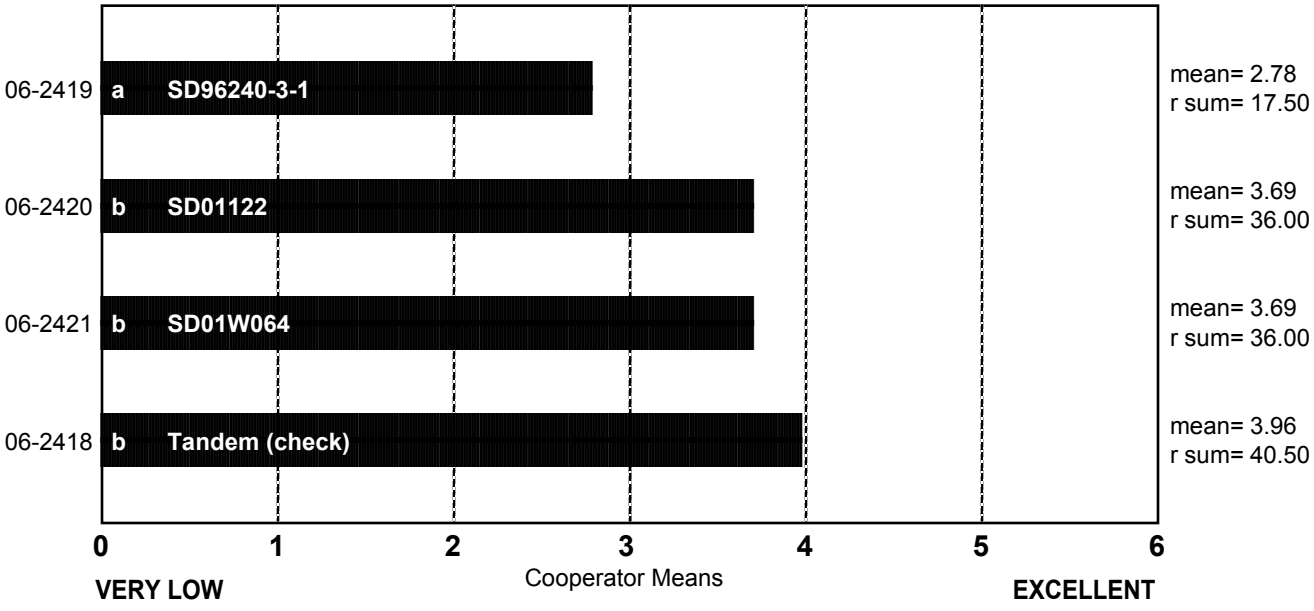


BAKE ABSORPTION

(Small Scale) South Dakota

ncoop= 13
chisq= 14.47
chisqc= 20.67
cvchisq= 7.82
crdiff= 7.97

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) South Dakota

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2418 Tandem (check)	**58.0**	**59.1**	**61.9**	**63.3**	**61.0**	**63.4**	**58.6**	**61.0**	**65.4**	**62.3**	**66.4**	**61.0**	**58.8**
06-2419 SD96240-3-1	**58.0**	**58.8**	**61.1**	**61.4**	**60.0**	**62.6**	**55.7**	**62.0**	**57.9**	**60.4**	**63.8**	**62.0**	**56.9**
06-2420 SD01122	**59.0**	**59.0**	**61.9**	**62.6**	**61.0**	**63.7**	**57.9**	**62.0**	**62.6**	**61.6**	**68.5**	**62.0**	**58.1**
06-2421 SD01W064	**58.0**	**59.6**	**61.5**	**63.0**	**61.0**	**64.0**	**58.6**	**61.0**	**62.8**	**62.0**	**65.6**	**61.0**	**58.5**

Raw Data

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
06-2418 Tandem (check)	**20.0**	**2.5**	**5.5**	**25.0**	**25.0**	**3.9**	**6.0**	**9.0**	**6.4**	**8.0**	**4.8**	**9.0**	**3.0**
06-2419 SD96240-3-1	**14.0**	**2.0**	**4.9**	**6.0**	**19.0**	**2.8**	**6.0**	**3.0**	**3.6**	**5.5**	**3.2**	**4.0**	**2.5**
06-2420 SD01122	**20.0**	**2.3**	**6.0**	**16.0**	**25.0**	**4.0**	**7.0**	**6.0**	**7.0**	**7.0**	**5.0**	**10.0**	**3.3**
06-2421 SD01W064	**13.0**	**2.3**	**5.3**	**16.0**	**25.0**	**3.8**	**7.0**	**9.0**	**5.9**	**6.0**	**5.0**	**8.0**	**3.3**

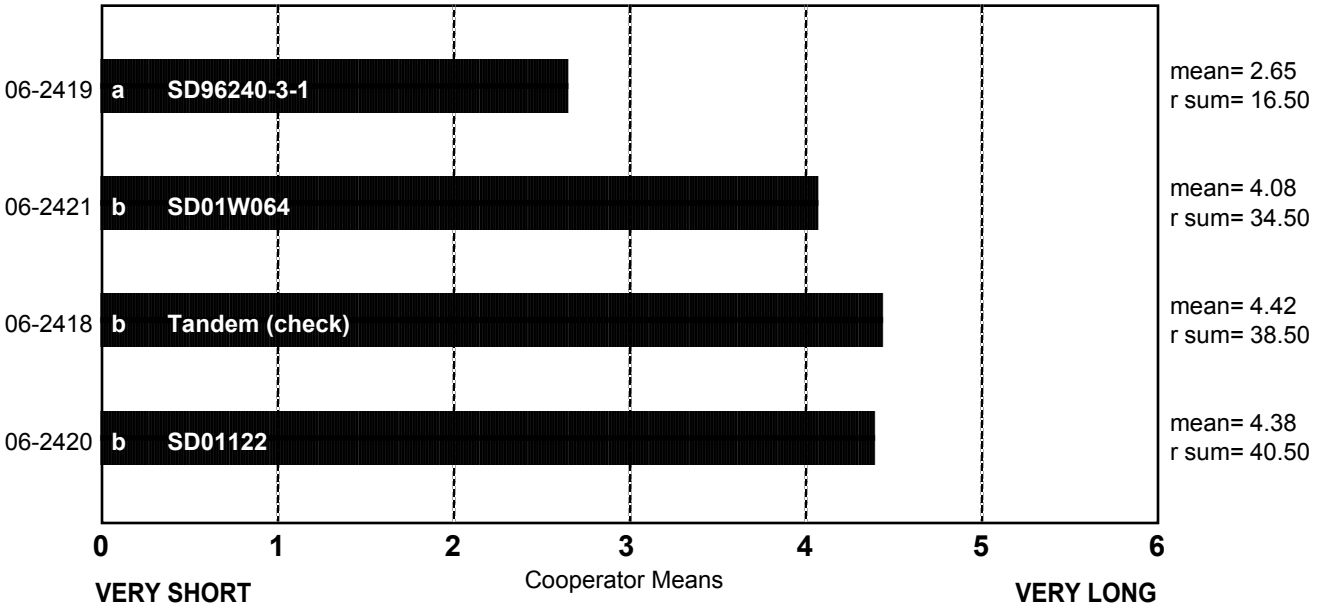
Raw Data

BAKE MIX TIME

(Small Scale) South Dakota

ncoop= 13
chisq= 16.62
chisqc= 22.74
cvchisq= 7.82
crdiff= 7.67

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

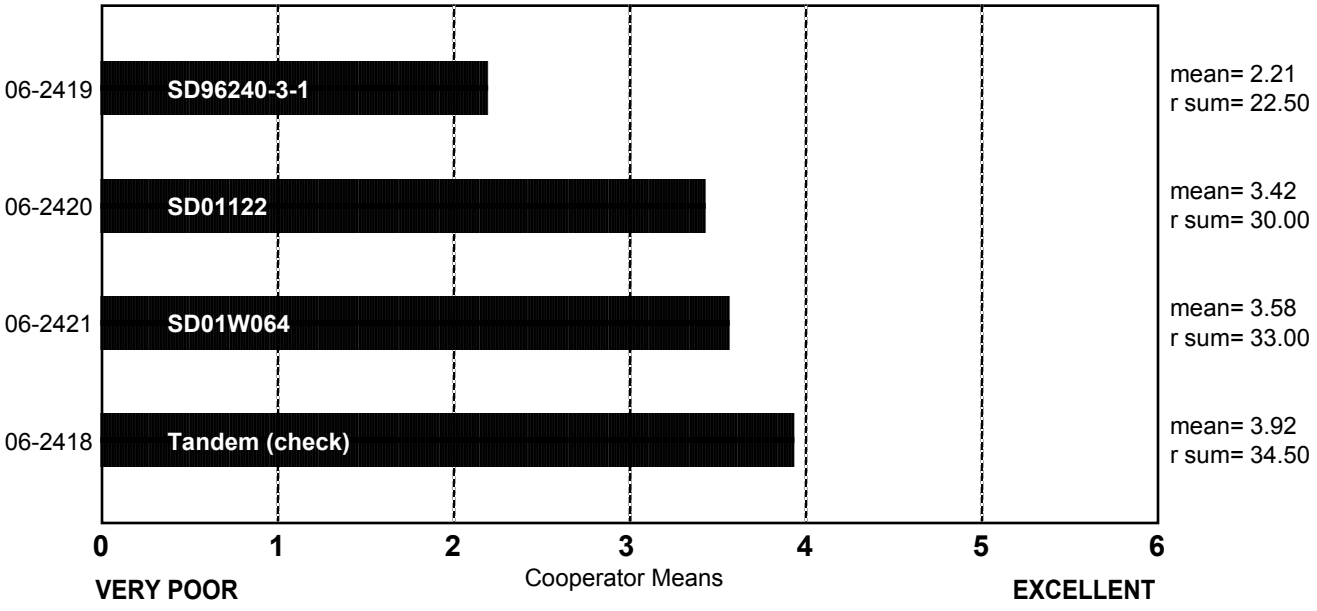


MIXING TOLERANCE

(Small Scale) South Dakota

ncoop= 12
chisq= 4.28
chisqc= 6.04
cvchisq= 7.82
crdiff=

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

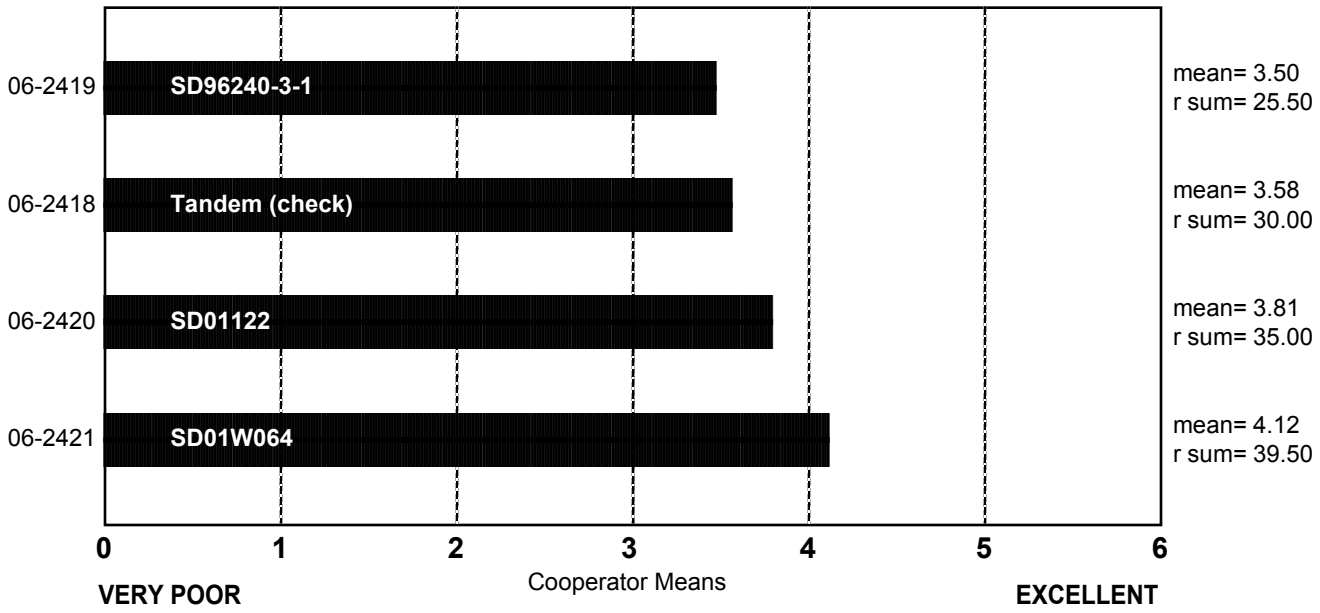


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) South Dakota

ncoop= 13
chisq= 5.10
chisqc= 6.98
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) South Dakota

	Sticky	Wet	Tough	Good	Excellent
06-2418 Tandem (check)	**1**	**1**	**6**	**4**	**1**
06-2419 SD96240-3-1	**3**	**1**	**2**	**7**	**0**
06-2420 SD01122	**1**	**0**	**4**	**7**	**1**
06-2421 SD01W064	**1**	**0**	**2**	**8**	**2**

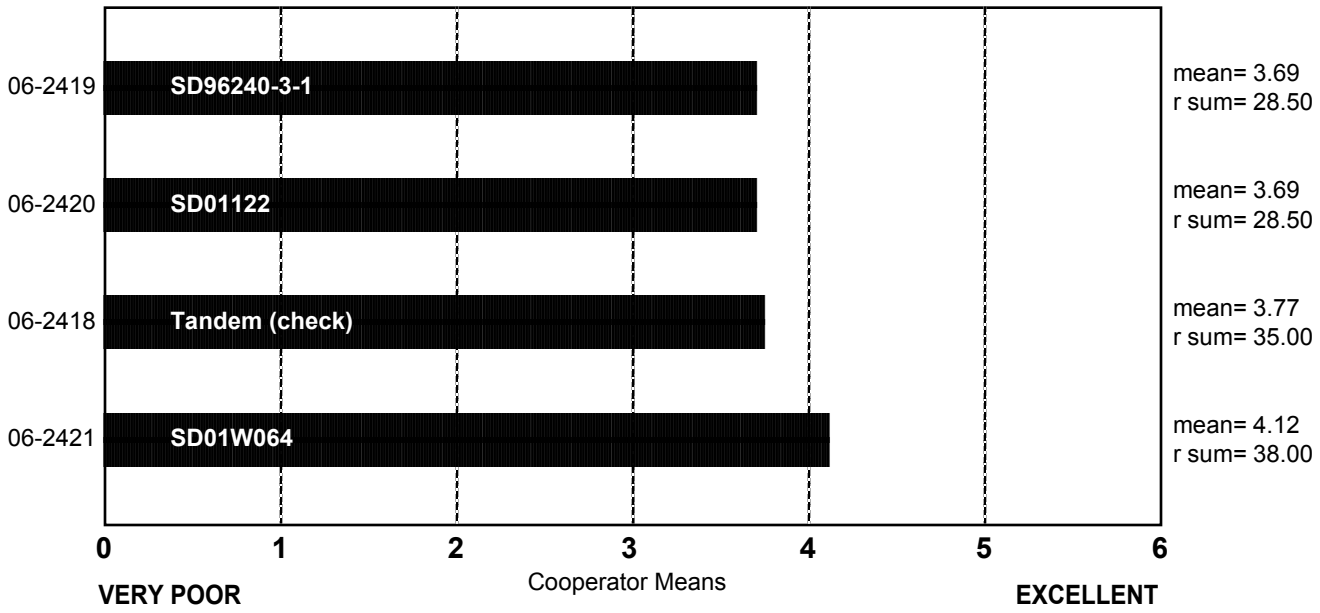
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) South Dakota

ncoop= 13
chisq= 3.16
chisqc= 4.19
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) South Dakota

	Sticky	Wet	Tough	Good	Excellent
06-2418 Tandem (check)	**2**	**1**	**3**	**5**	**2**
06-2419 SD96240-3-1	**2**	**2**	**2**	**7**	**0**
06-2420 SD01122	**2**	**0**	**4**	**7**	**0**
06-2421 SD01W064	**1**	**0**	**2**	**8**	**2**

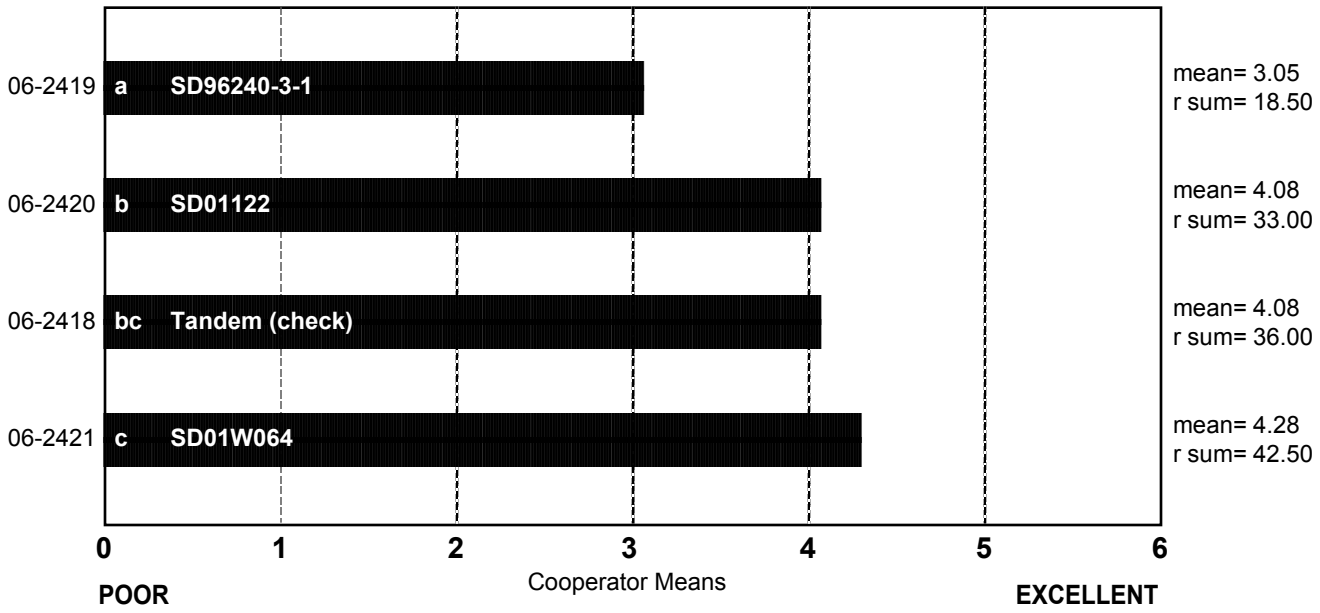
Frequency Table

CRUMB GRAIN

(Small Scale) South Dakota

ncoop= 13
chisq= 14.24
chisqc= 17.14
cvchisq= 7.82
crdiff= 9.48

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



CRUMB GRAIN, DESCRIBED

(Small Scale) South Dakota

	Open	Fine	Dense
06-2418 Tandem (check)	**6**	**6**	**1**
06-2419 SD96240-3-1	**5**	**5**	**3**
06-2420 SD01122	**6**	**6**	**1**
06-2421 SD01W064	**2**	**8**	**3**

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) South Dakota

	Round	Irregular	Elongated
06-2418 Tandem (check)	**3**	**7**	**3**
06-2419 SD96240-3-1	**5**	**6**	**2**
06-2420 SD01122	**2**	**7**	**4**
06-2421 SD01W064	**1**	**8**	**4**

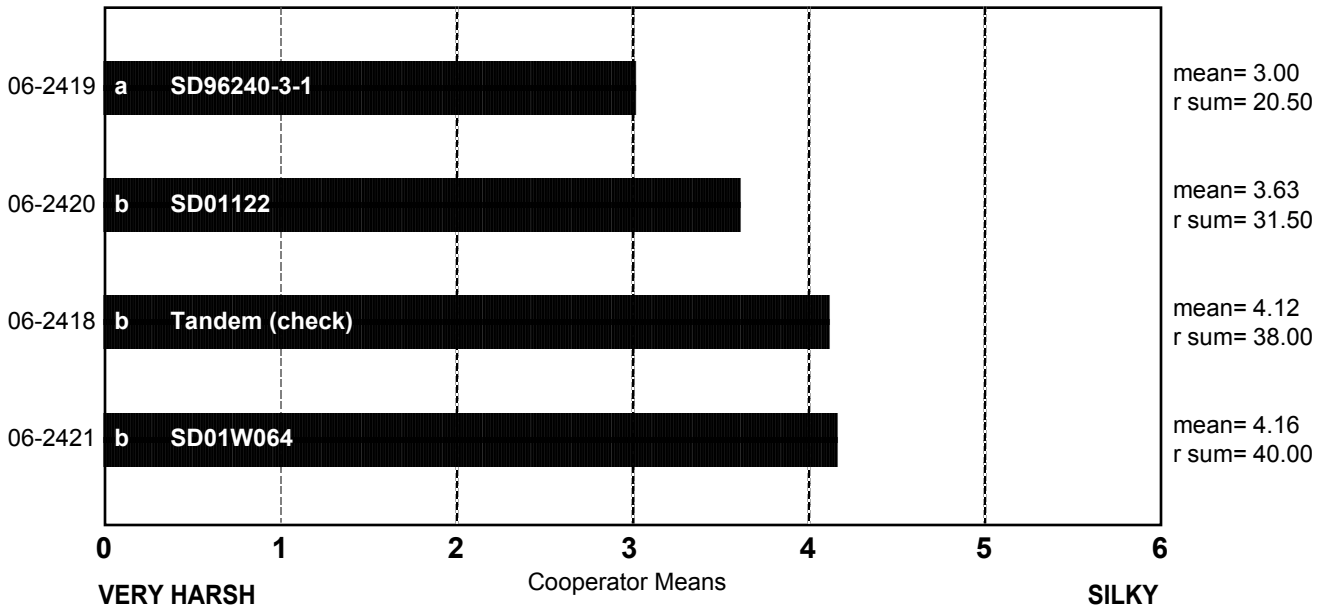
Frequency Table

CRUMB TEXTURE

(Small Scale) South Dakota

ncoop= 13
chisq= 10.68
chisqc= 14.78
cvchisq= 7.82
crdiff= 9.31

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) South Dakota

	Harsh	Smooth	Silky
06-2418 Tandem (check)	**3**	**5**	**5**
06-2419 SD96240-3-1	**6**	**5**	**2**
06-2420 SD01122	**3**	**7**	**3**
06-2421 SD01W064	**2**	**9**	**2**

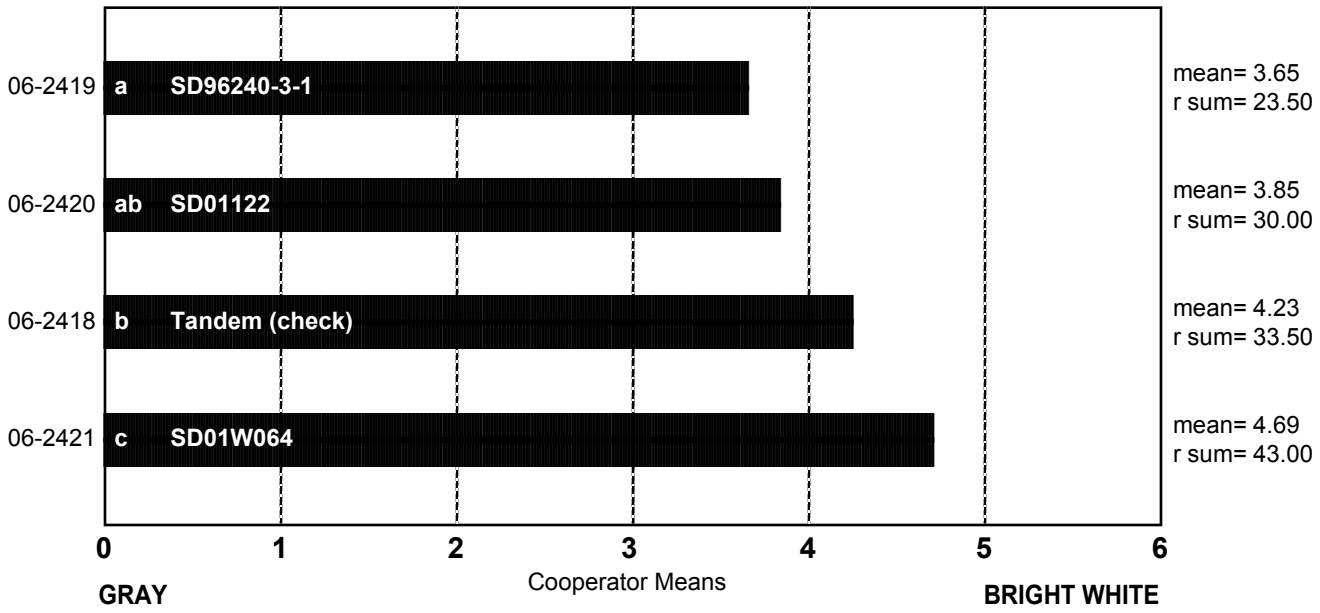
Frequency Table

CRUMB COLOR

(Small Scale) South Dakota

ncoop= 13
chisq= 9.16
chisqc= 14.52
cvchisq= 7.82
crdiff= 8.74

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
06-2418 Tandem (check)	**0**	**0**	**1**	**0**	**5**	**5**	**2**
06-2419 SD96240-3-1	**0**	**1**	**2**	**1**	**5**	**2**	**2**
06-2420 SD01122	**1**	**0**	**0**	**3**	**5**	**2**	**2**
06-2421 SD01W064	**0**	**0**	**0**	**0**	**4**	**7**	**2**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) South Dakota

	Coop. A	Coop. B	Coop. C	Coop. D	Coop. E	Coop. F	Coop. G	Coop. H	Coop. I	Coop. J	Coop. K	Coop. L	Coop. M
06-2418 Tandem (check)	**430.0**	**137.1**	**141.6**	**420.6**	**478.0**	**140.9**	**495.0**		**152.2**	**464.0**	**156.8**	**465.7**	
06-2419 SD96240-3-1	**427.0**	**134.6**	**141.4**	**418.3**	**479.5**	**142.3**	**495.0**		**147.8**	**468.0**	**156.0**	**464.1**	
06-2420 SD01122	**420.0**	**136.3**	**141.8**	**419.9**	**476.5**	**144.2**	**500.0**		**150.0**	**461.0**	**157.6**	**464.8**	
06-2421 SD01W064	**428.0**	**136.9**	**139.8**	**417.4**	**479.7**	**141.8**	**500.0**		**149.9**	**460.0**	**156.1**	**464.4**	

Raw Data

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
06-2418 Tandem (check)	**2750**	**760**	**918**	**2420**	**3015**	**933**	**3000**	**903**	**910**	**2850**	**913**	**2700**	**990**
06-2419 SD96240-3-1	**2700**	**725**	**830**	**2220**	**2927**	**915**	**3100**	**795**	**835**	**2725**	**883**	**2450**	**870**
06-2420 SD01122	**2800**	**710**	**848**	**2160**	**2986**	**965**	**3150**	**948**	**895**	**2900**	**898**	**2725**	**950**
06-2421 SD01W064	**2850**	**725**	**900**	**2510**	**3104**	**968**	**3000**	**933**	**925**	**3050**	**923**	**2625**	**1075**

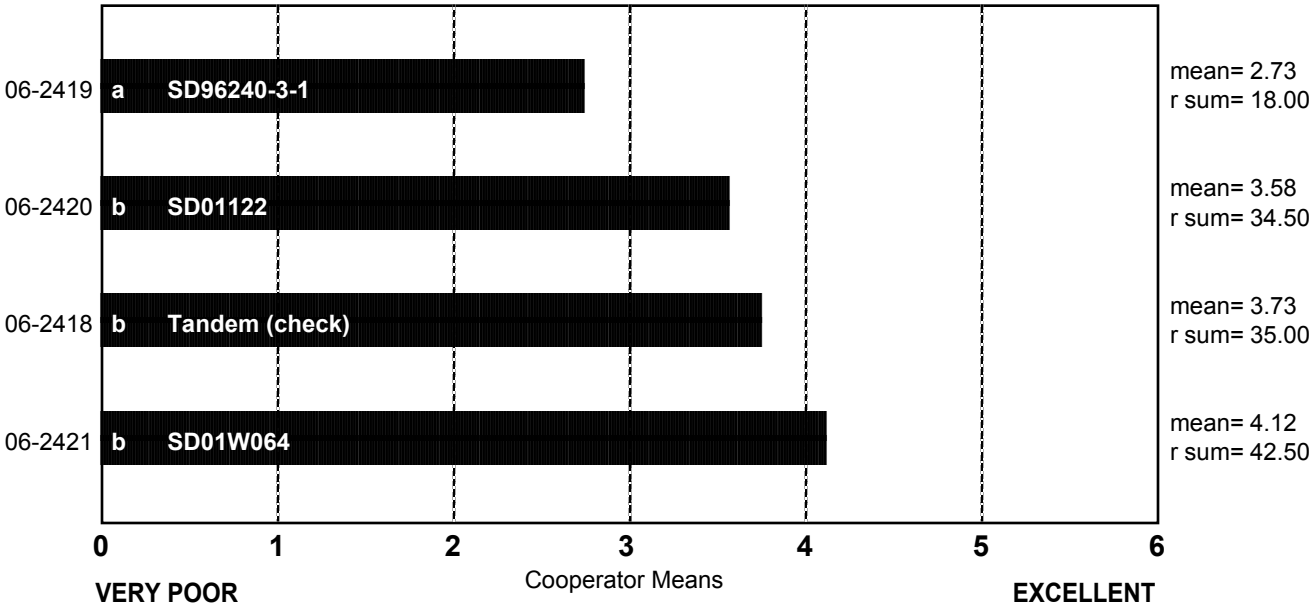
Raw Data

LOAF VOLUME

(Small Scale) South Dakota

ncoop= 13
chisq= 14.79
chisqc= 17.64
cvchisq= 7.82
crdiff= 9.42

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

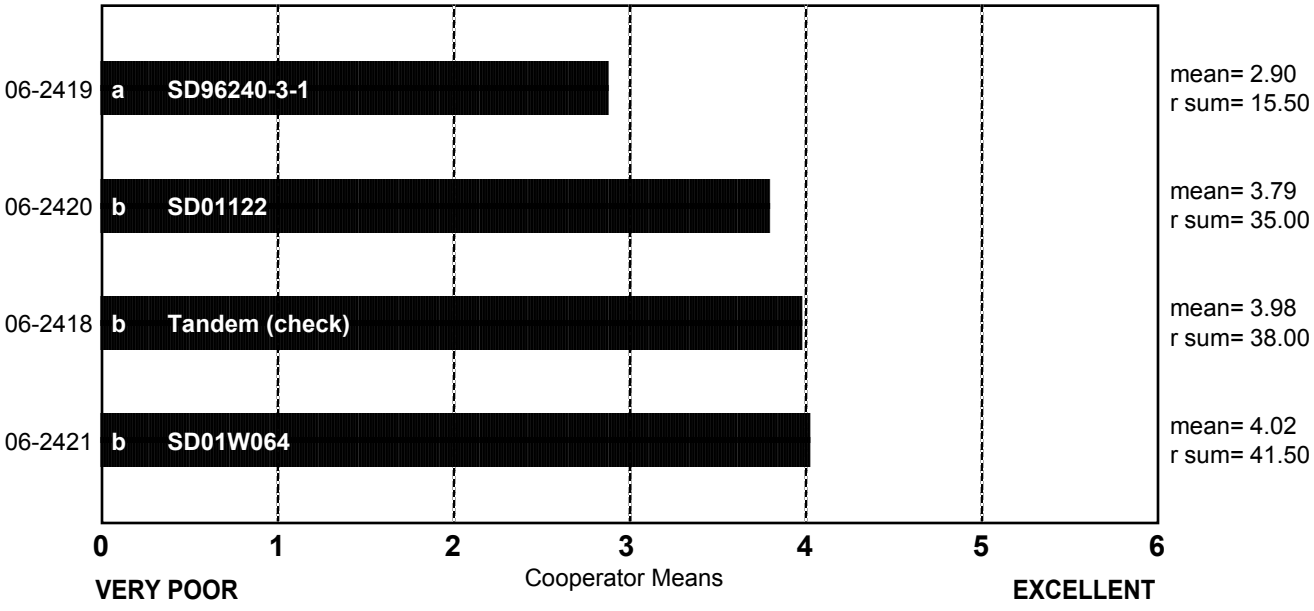


OVERALL BAKING QUALITY

(Small Scale) South Dakota

ncoop= 13
chisq= 18.76
chisqc= 21.21
cvchisq= 7.82
crdiff= 8.83

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. 06-2418 (Tandem (check))

A. Nice interior, strong dough, machined well.
B. No comments.
C. A big hole on the edge.
D. Poor mix tolerance, tough dough, open crumb grain, and slightly low volume.
E. Tight, consistent grain, silky texture, very good volume.
F. No comments.
G. Good color and good bake.
H. OK bake quality with slightly small volume, nice white color, good grain, slightly tough dough.
I. Good bake absorption and tolerance, excellent dough and make-up, satisfactory crumb grain and good loaf volume.
J. No comments.
K. No comments.
L. Good grain, yellow crumb, and good volume.
M. Creamy crumb color, good volume, and good mix tolerance.

COOP. 06-2419 (SD96240-3-1)

A. Close grain and bright crumb color.
B. No comments.
C. A big hole on the edge.
D. Nice handling dough, open crumb and low loaf volume.
E. Yellow crumb grain, very open, thick cell walls.
F. No comments.
G. Low absorption and tough dough.
H. Very poor tolerance, worst sample for weak dough, and dull color.
I. Very low bake absorption, poor tolerance, tough dough handling, questionable-satisfactory crumb grain, dull crumb color.
J. No comments.
K. No comments.
L. Good absorption, short mix time, very poor grain, dark yellow crumb, and very low loaf volume.
M. Bake absorption low, sticky out of mixer, slack at make-up, and low mix tolerance.

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

COOP. 06-2420 (SD01122)

A. Bright white crumb color, strong dough, good interior, one of best in group overall.
B. No comments.
C. Holes one the edge.
D. Poor mix tolerance, tough dough out of mixer, open crumb grain, and very low volume.
E. Fairly consistent, smooth grain, and good volume.
F. No comments.
G. Bucky dough and grey color.
H. Good bake quality overall, nice texture and grain.
I. Long mix time, but excellent dough handling, questionable-satisfactory crumb grain with dull crumb color.
J. No comments.
K. No comments.
L. Good absorption, good grain, and good volume.
M. White crumb color, smooth crumb texture, loaf volume OK, and bake absorption low.

COOP. 06-2421 (SD01W064)

A. Nice interior, white crumb color, good volume, and one of best in group overall.
B. No comments.
C. Second best.
D. Nice handling dough, nice crumb, and good volume.
E. Tight, consistent grain, silky texture, and excellent loaf volume.
F. No comments.
G. Strong dough, good bake, and good volume.
H. Good overall tolerance but slightly smaller volume, good color, grain and texture.
I. Excellent dough to panning characteristics, satisfactory crumb grain with good loaf volume.
J. No comments.
K. No comments.
L. Fine grain and average in other categories.
M. White crumb color, good loaf volume, and bake absorption low.

Notes: **A, D, E H, and L** comments based on sponge and dough bake test.

Description of Test Plots and Breeder Entries

Texas A&M - Reported by Jackie Rudd

The Wheat Quality Council samples submitted by Texas A&M were harvested from strips planted adjacent to our irrigated yield trials at Bushland (near Amarillo in the Texas Panhandle). We fertilized for a yield goal of 100 bu/a. The grain yields of TAM 111, TAM 112, TX01A5936, TX01D3232, and TX01V5314 were 73, 85, 68, 85, and 77 bu/a respectively. As through most of the Great Plains in 2006, the temperatures were above average and the rainfall was way below average (total rain from planting to harvest was 3.2 inches). The crop was flood irrigated four times from early March to early May. There was no significant disease pressure.

TAM 111 (check variety released in 2003) **(2422)**

TAM 112 (check variety released in 2005) **(2423)**

TX01A5936 (2424)

This hard white winter wheat line was selected by the TAM Wheat program in Amarillo from the cross Jagger/3/PSN 'S'/BOW 'S'//TAM 200. It is resistant to stripe rust, susceptible to leaf rust, and has some wheat streak mosaic virus resistance (similar to Jagger). Performance has been best under High Plains dryland and limited irrigation conditions. TX01A5936 is relatively large seeded with a good test weight. Baking data generally indicates a relatively short mixing time, average stability, and good loaf volume.

TX01D3232 (2425)

This hard red winter wheat was selected from the TAM Wheat program in Dallas from the cross TX92U3060/TX91D6564. It is resistant to leaf rust and moderately susceptible to stripe rust. The relative performance of this line has been best in the Blacklands and south central areas of Texas. It also performs well under irrigation in the High Plains. TX01D3232 is relatively small seeded with a less than average test weight. Baking data generally indicates a relatively long mixing time, good stability, and good loaf volume.

TX01V5314 (2426)

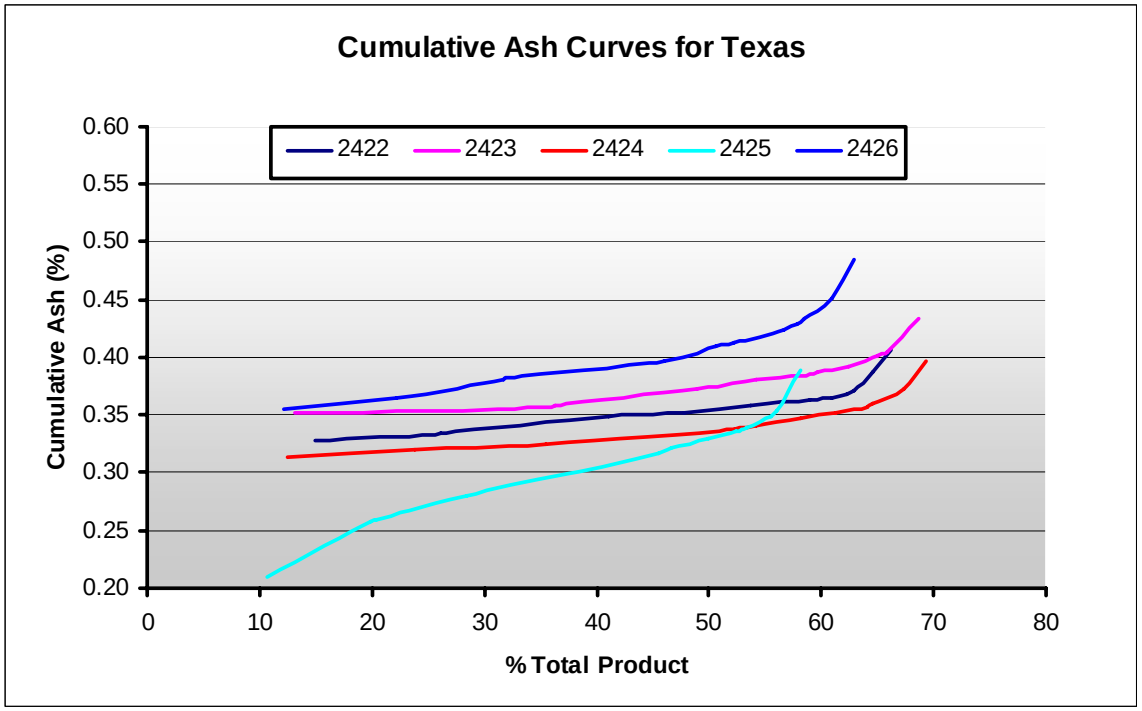
This hard red winter wheat was selected from the TAM Wheat program in Vernon from the cross TX89V4132/704 L I-2221. It is resistant to leaf rust and stripe rust. The performance of this line has been excellent throughout the Great Plains. Due to its high level of foliar disease resistance, it is particularly well suited for the warmer and more humid wheat growing areas of Texas. TX01V5314 has an average seed size and a less than average test weight. Baking data generally indicates a relatively short mixing time, average stability, and average loaf volume.

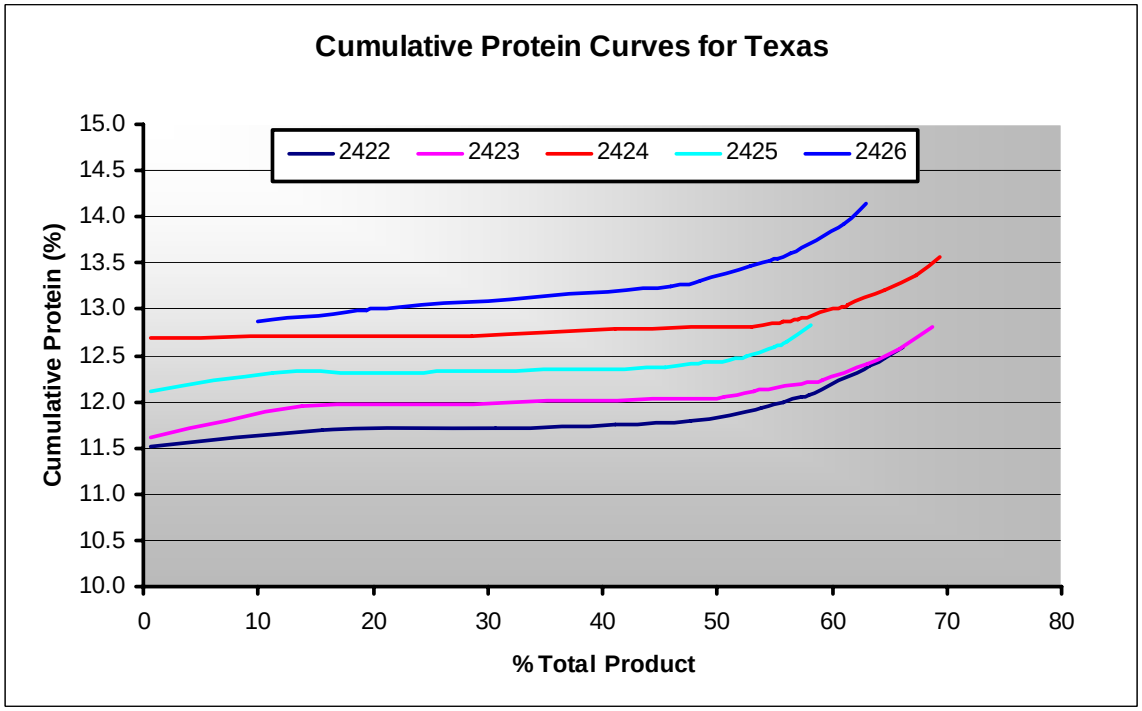
Texas: 2006 (Small-Scale) Samples[a]

Test entry number	06-2422	06-2423	06-2424	06-2425	06-2426
Sample identification	Tam 111	Tam 112	TX01A5936	TX01D3232	TX01V5314
Wheat Data					
FGIS classification	1 HRW	1 HRW	2 HDWH	2 HRW	3 HRW
Test weight (lb/bu)	60.1	60.9	61.7	58.1	56.9
Hectoliter weight (kg/hl)	79.1	80.1	81.1	76.5	74.9
1000 kernel weight (gm)	28.9	30.1	32.6	28.6	27.1
NIR hardness	63.6	73.9	79.4	80.4	83.4
Wheat kernel size (Rotap)					
Over 7 wire (%)	62.8	67.5	72.6	65.7	52.2
Over 9 wire (%)	36.8	32.3	27.3	34.2	47.4
Through 9 wire (%)	0.4	0.2	0.2	0.1	0.4
Single kernel (skcs)					
Hardness (avg /s.d)	61.7/14.8	69.6/15.1	60.5/13.6	68.0/15.9	63.7/15.6
Weight (mg) (avg/s.d)	29.8/7.1	30.4/7.3	34.1/8.3	28.2/7.4	29.2/6.9
Diameter (mm)(avg/s.d)	2.20/0.45	2.20/0.47	2.41/0.38	2.19/0.43	2.11/0.42
SKCS distribution	03-10-29-58	01-05-18-76	02-12-32-54	01-06-22-71	02-08-30-60
Classification	Hard	Hard	Hard	Hard	Hard
Wheat moisture (%)	12.0	11.8	11.9	10.9	11.0
Wheat protein (12% mb)	14.3	14.4	14.7	13.9	15.2
Wheat ash (12% mb)	1.54	1.57	1.47	1.51	1.58
Milling and Flour Quality Data					
Flour yield (%, str. grade)					
Miag Multomat Mill	66.1	68.7	69.3	58.1	63.0
Quadrumat Sr. Mil	73.7	72.6	74.9	73.7	72.6
Flour moisture (%)	12.3	12.4	12.6	12.0	12.2
Flour protein (14% mb)	12.2	12.7	13.4	12.6	14.0
Flour ash (14% mb)	0.41	0.44	0.39	0.40	0.48
Glutomatic					
Wet gluten (%)	37.8	35.6	41.1	35.4	40.5
Dry gluten (%)	12.6	11.7	14.0	12.5	13.5
Gluten index	78.3	89.5	78.4	96.0	82.0
Flour color					
Agtron flour color	75	74	79	75	69
Simon/Kent-Jones flour color	-0.18	0.24	-1.74	-0.86	0.30
Minolta color meter					
L*	92.26	92.11	92.67	92.19	91.47
a*	-1.45	0.02	0.01	-0.03	0.00
b*	9.06	8.84	9.00	9.17	9.00
Falling number (sec)	458	470	487	434	474
Flour particle size (avg)					
Fisher sub sieve sizer	22	23	23	25	25

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

Texas: Cumulative Ash and Protein Curves

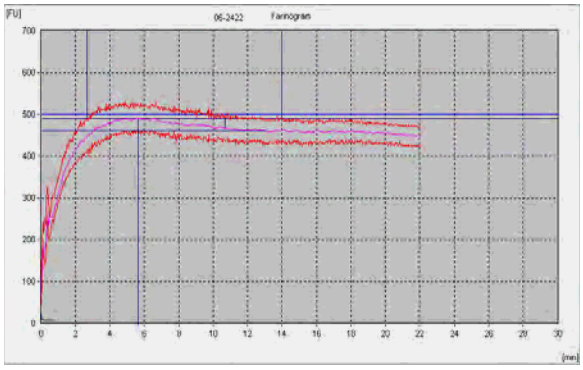




Physical Dough Tests

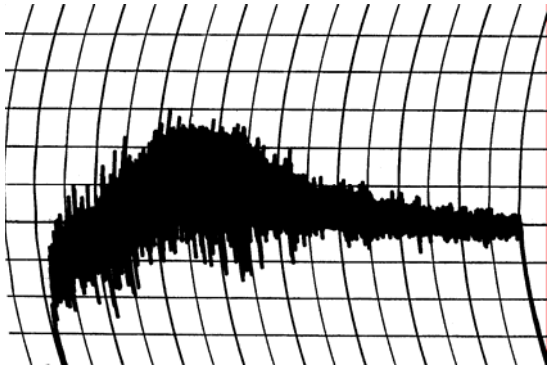
2006 (Small Scale) Samples – Texas

Farinograms



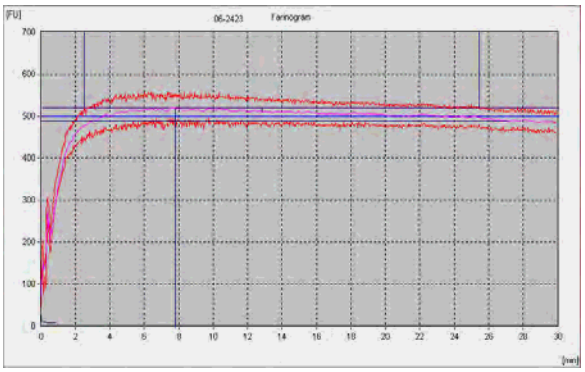
Abs. 58.7%, Peak 5.7 min, Stab. 11.3 min

Mixograms

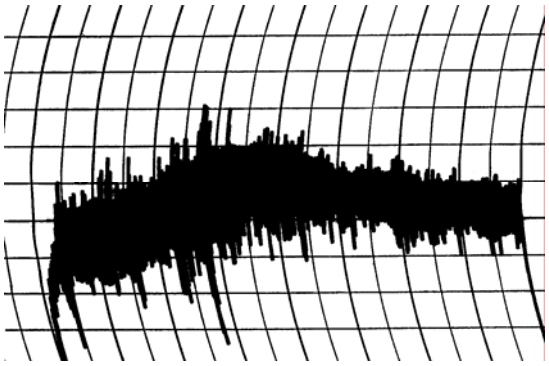


Abs. 63.2%, Mix time 2.6 min

06-2422, Tam 111 (check)



Abs. 61.2%, Peak 7.8 min, Stab. 23.0 min



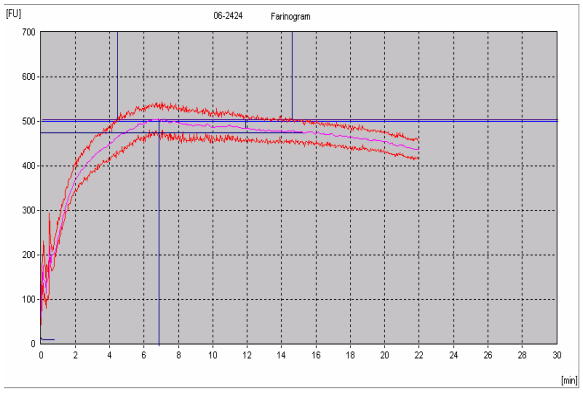
Abs. 64.2%, Mix time 3.5 min

06-2423, Tam 112 (check)

Physical Dough Tests

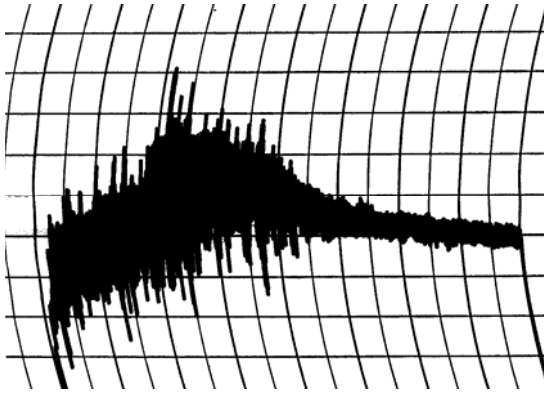
2006 (Small Scale) Samples - Texas (continued)

Farinograms



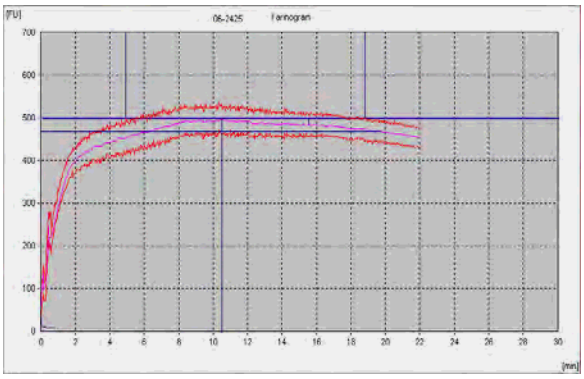
Abs. 61.7%, Peak 6.9 min, Stab. 10.1 min

Mixograms

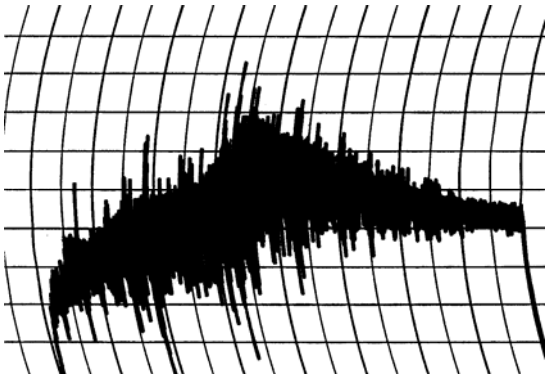


Abs. 65.2%, Mix time 2.9 min

06-2424, TX01A5936



Abs. 60.1%, Peak 10.5 min, Stab. 13.9 min



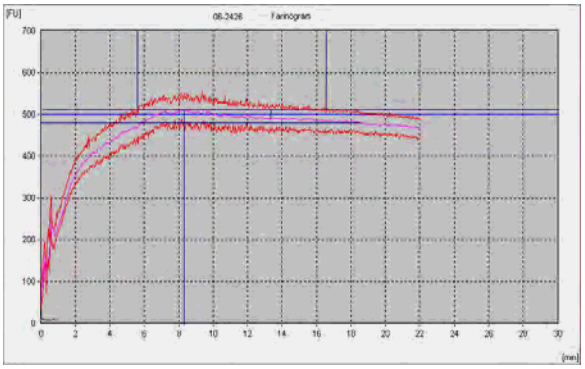
Abs. 63.9%, Mix time 3.6 min

06-2425, TX01D3232

Physical Dough Tests

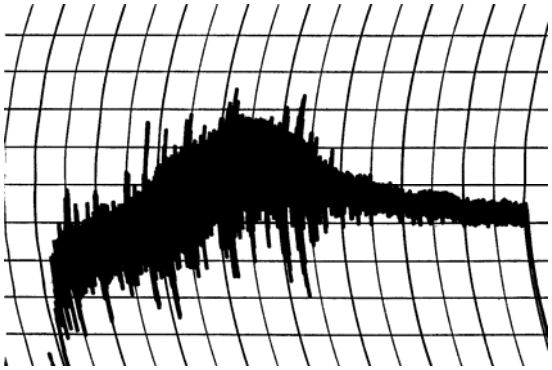
2006 (Small Scale) Samples - Texas (continued)

Farinograms



Abs. 62.8%, Peak 8.4 min, Stab. 11.0 min

Mixograms



Abs. 66.2%, Mix time 3.5 min

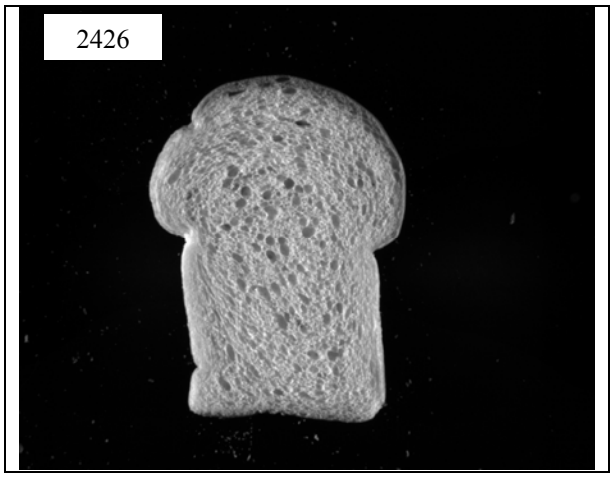
06-2426, TX01V5314

Texas: C-Cell Bread Images and Analysis for 2006(Small-Scale) Samples

Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2422	6393	157.2	4179	0.431	1.871	1.14	1.620	-18.33
2423	7155	151.5	4112	0.457	2.159	1.22	1.705	-17.90

Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2424	6714	155.7	4123	0.443	2.055	2.07	1.678	-20.83
2425	6709	149.7	3852	0.452	2.108	2.67	1.685	-19.98

Texas: C-Cell Bread Images and Analysis for 2006(Small-Scale) Samples (continued)



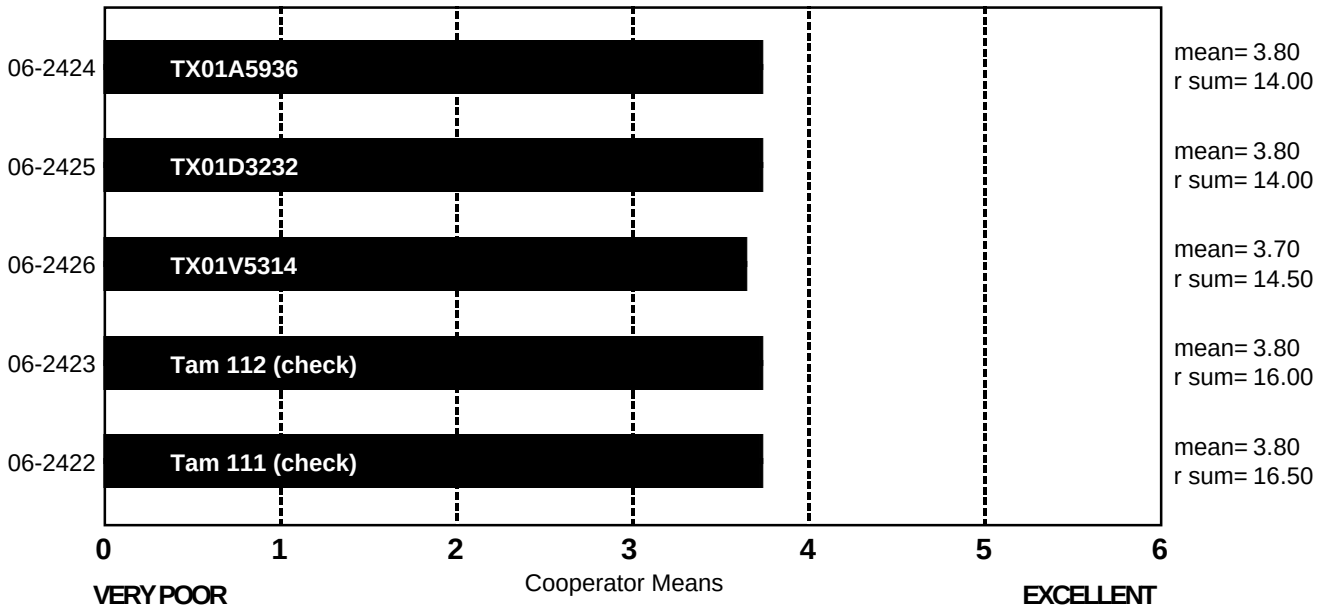
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2426	6656	148.5	4081	0.441	2.031	1.05	1.660	-19.15

SPONGE CHARACTERISTICS

(Small Scale) Texas

ncoop= 5
chisq= 0.44
chisqc= 0.75
cvchisq= 9.49
crdiff=

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

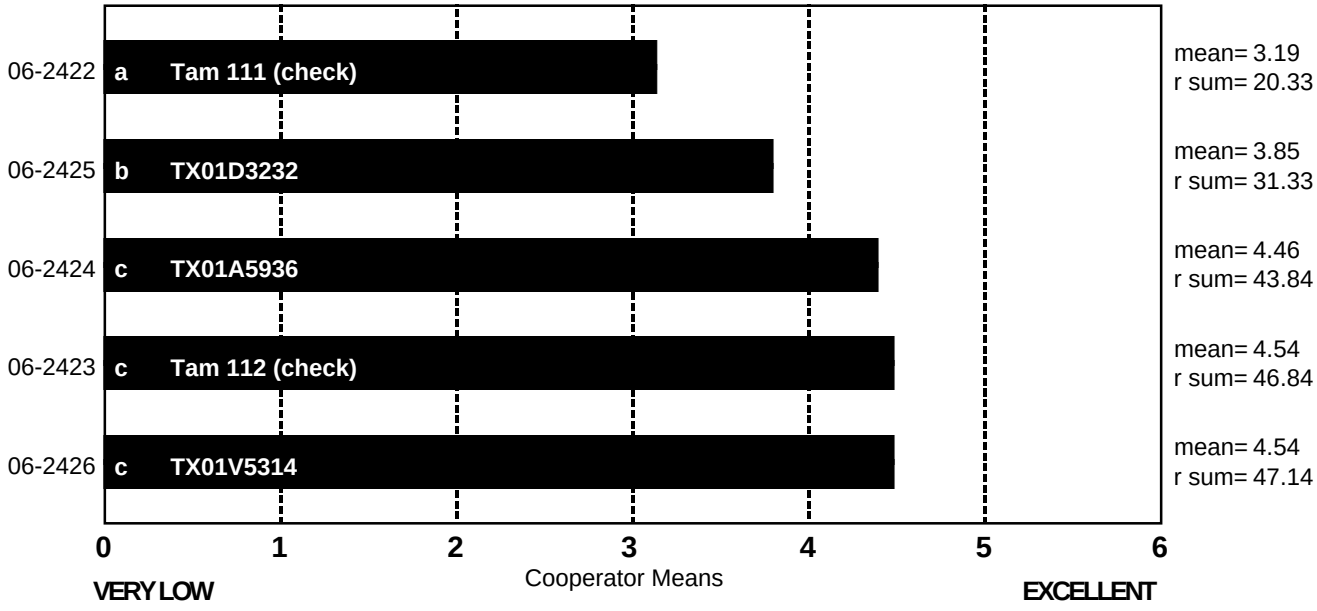


BAKE ABSORPTION

(Small Scale) Texas

ncoop= 13
chisq= 3.97
chisqc= 44.64
cvchisq= 9.49
crdiff= 9.56

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



BAKE ABSORPTION, ACTUAL (14% MB)

(Small Scale) Texas

	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
06-2422 Tam 111 (check)	**59.0**	**58.6**	**62.2**	**61.7**	**61.0**	**63.9**	**57.1**	**63.0**	**58.8**	**60.7**	**66.2**	**61.0**	**57.2**
06-2423 Tam 112 (check)	**60.0**	**61.6**	**62.6**	**64.2**	**63.0**	**65.0**	**59.3**	**64.0**	**63.8**	**63.2**	**67.7**	**63.0**	**59.7**
06-2424 TX01A5936	**60.0**	**61.3**	**63.6**	**64.7**	**63.0**	**66.1**	**59.3**	**64.0**	**61.9**	**63.7**	**67.5**	**63.0**	**60.2**
06-2425 TX01D3232	**60.0**	**60.9**	**62.1**	**63.1**	**61.0**	**64.4**	**58.6**	**63.0**	**62.9**	**62.1**	**66.3**	**61.0**	**58.6**
06-2426 TX01V5314	**61.0**	**61.9**	**64.4**	**65.8**	**63.0**	**66.8**	**60.7**	**64.0**	**62.6**	**64.8**	**68.0**	**64.0**	**61.3**

Raw Data

BAKE MIX TIME, ACTUAL

(Small Scale) Texas

	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
06-2422 Tam 111 (check)	**12.0**	**1.3**	**4.4**	**8.0**	**25.0**	**2.6**	**6.0**	**6.0**	**3.5**	**5.5**	**3.1**	**5.0**	**2.0**
06-2423 Tam 112 (check)	**20.0**	**1.8**	**5.3**	**16.0**	**25.0**	**3.5**	**6.0**	**6.0**	**4.9**	**8.5**	**4.4**	**6.0**	**3.0**
06-2424 TX01A5936	**14.0**	**1.5**	**4.4**	**8.0**	**25.0**	**2.9**	**6.0**	**6.0**	**3.5**	**6.0**	**3.2**	**10.0**	**2.5**
06-2425 TX01D3232	**11.0**	**2.0**	**5.3**	**11.0**	**25.0**	**3.6**	**6.0**	**6.0**	**4.8**	**6.5**	**4.8**	**8.0**	**3.0**
06-2426 TX01V5314	**9.0**	**1.5**	**5.7**	**10.0**	**25.0**	**3.5**	**5.0**	**6.0**	**4.0**	**6.0**	**4.2**	**5.0**	**2.8**

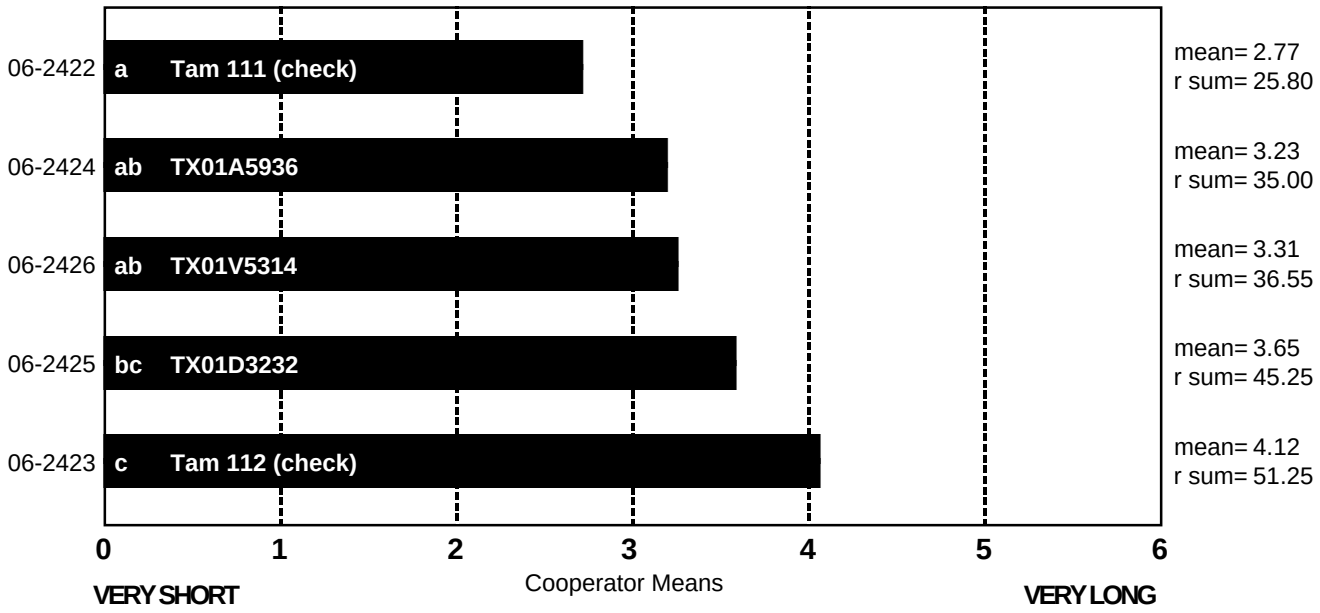
Raw Data

BAKE MIX TIME

(Small Scale) Texas

ncoop= 13
chisq= 9.10
chisqc= 20.54
cvchisq= 9.49
crdiff= 10.89

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

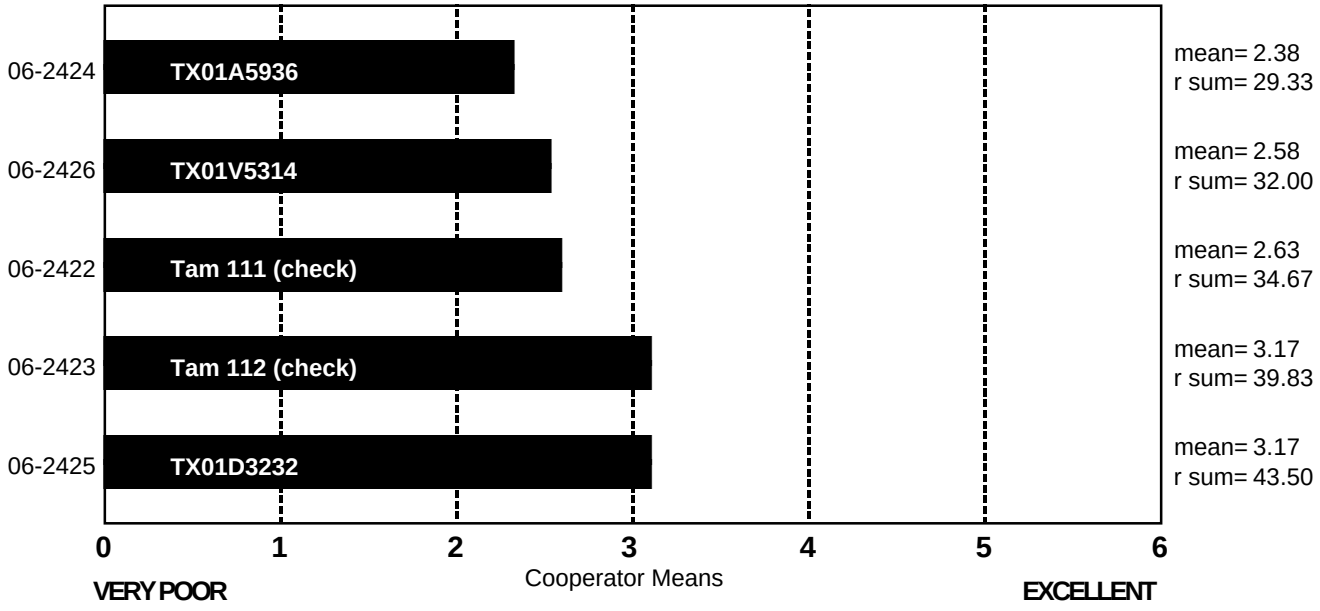


MIXING TOLERANCE

(Small Scale) Texas

ncoop= 12
chisq= 2.84
chisqc= 6.23
cvchisq= 9.49
crdiff=

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

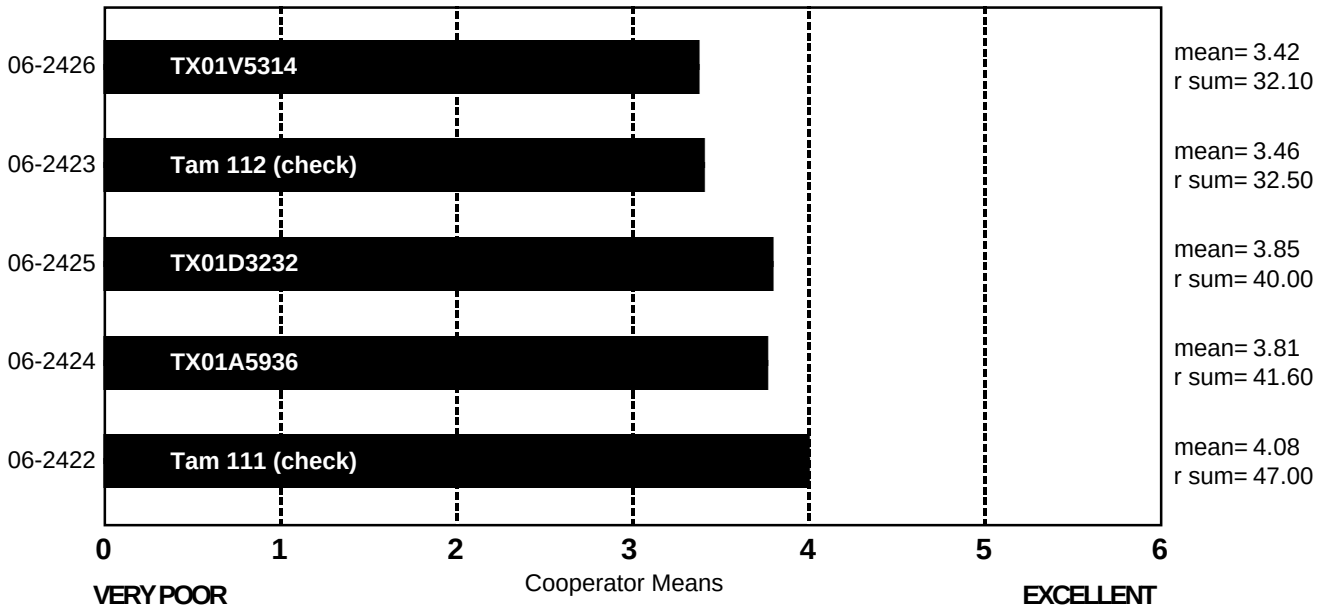


DOUGH CHAR. 'OUT OF MIXER'

(Small Scale) Texas

ncoop= 13
chisq= 0.65
chisqc= 8.59
cvchisq= 9.49
crdiff=

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



DOUGH CHAR. 'OUT OF MIXER', DESCRIBED

(Small Scale) Texas

	Sticky	Wet	Tough	Good	Excellent
06-2422 Tam 111 (check)	**0**	**1**	**0**	**12**	**0**
06-2423 Tam 112 (check)	**1**	**1**	**5**	**6**	**0**
06-2424 TX01A5936	**3**	**0**	**1**	**9**	**0**
06-2425 TX01D3232	**0**	**0**	**2**	**10**	**1**
06-2426 TX01V5314	**0**	**1**	**5**	**7**	**0**

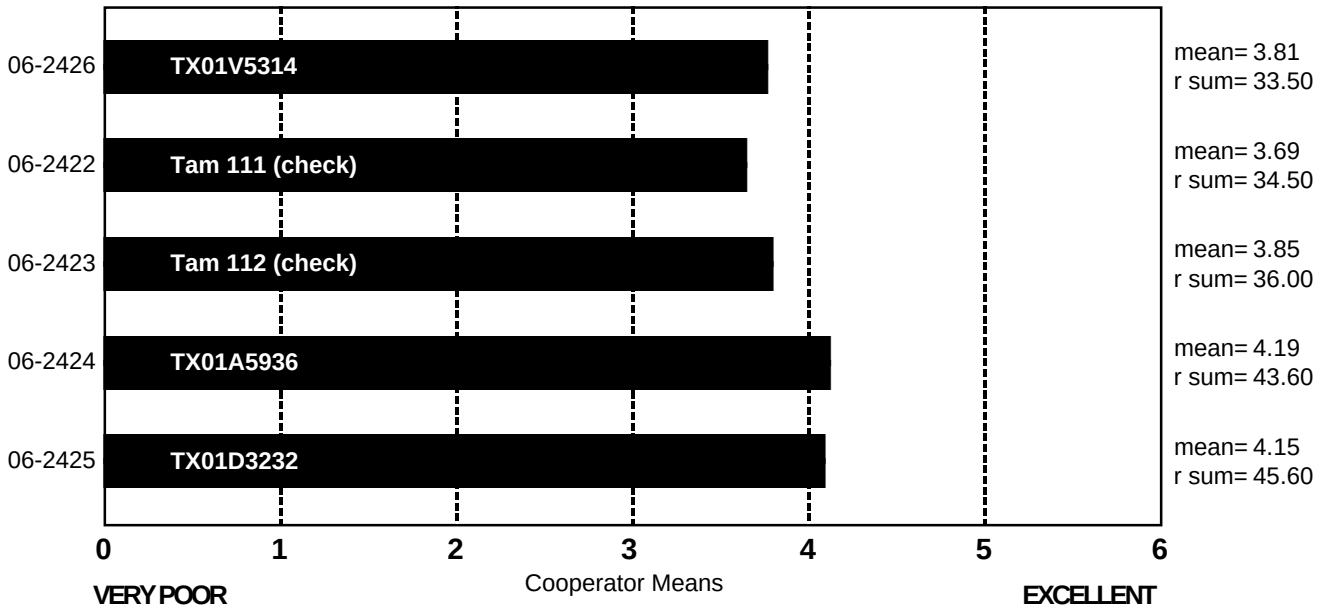
Frequency Table

DOUGH CHAR. 'AT MAKE UP'

(Small Scale) Texas

ncoop= 13
chisq= -0.50
chisqc= 6.18
cvchisq= 9.49
crdiff=

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



DOUGH CHAR. 'AT MAKE UP', DESCRIBED

(Small Scale) Texas

	Sticky	Wet	Tough	Good	Excellent
06-2422 Tam 111 (check)	**2**	**2**	**0**	**9**	**0**
06-2423 Tam 112 (check)	**1**	**0**	**3**	**9**	**0**
06-2424 TX01A5936	**3**	**0**	**2**	**7**	**1**
06-2425 TX01D3232	**0**	**1**	**1**	**10**	**1**
06-2426 TX01V5314	**3**	**0**	**2**	**7**	**1**

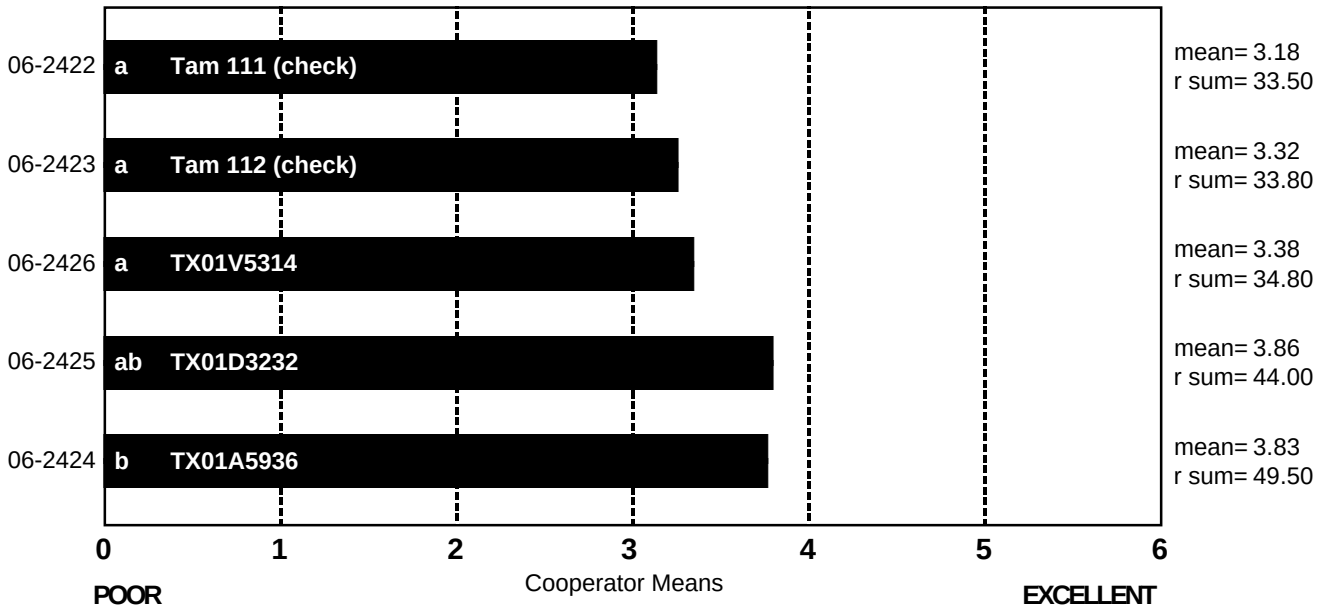
Frequency Table

CRUMB GRAIN

(Small Scale) Texas

ncoop= 13
chisq= 7.91
chisqc= 10.84
cvchisq= 9.49
crdiff= 12.42

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



CRUMB GRAIN, DESCRIBED

(Small Scale) Texas

	Open	Fine	Dense
06-2422 Tam 111 (check)	3	8	2
06-2423 Tam 112 (check)	10	3	0
06-2424 TX01A5936	7	6	0
06-2425 TX01D3232	5	6	2
06-2426 TX01V5314	7	5	1

Frequency Table

CELL SHAPE, DESCRIBED

(Small Scale) Texas

	Round	Irregular	Elongated
06-2422 Tam 111 (check)	**3**	**8**	**2**
06-2423 Tam 112 (check)	**1**	**8**	**4**
06-2424 TX01A5936	**3**	**5**	**5**
06-2425 TX01D3232	**5**	**5**	**3**
06-2426 TX01V5314	**5**	**7**	**1**

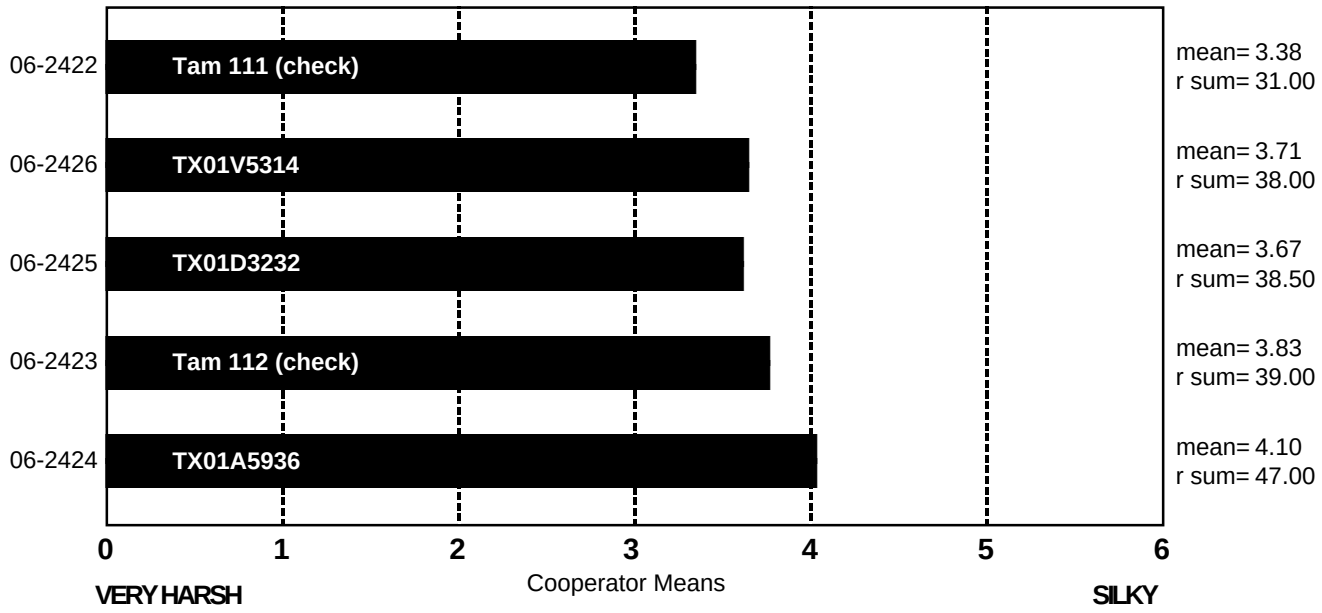
Frequency Table

CRUMB TEXTURE

(Small Scale) Texas

ncoop= 13
chisq= 0.38
chisqc= 6.06
cvchisq= 9.49
crdiff=

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



CRUMB TEXTURE, DESCRIBED

(Small Scale) Texas

	Harsh	Smooth	Silky
06-2422 Tam 111 (check)	**3**	**9**	**1**
06-2423 Tam 112 (check)	**3**	**9**	**1**
06-2424 TX01A5936	**3**	**6**	**4**
06-2425 TX01D3232	**4**	**6**	**3**
06-2426 TX01V5314	**3**	**7**	**3**

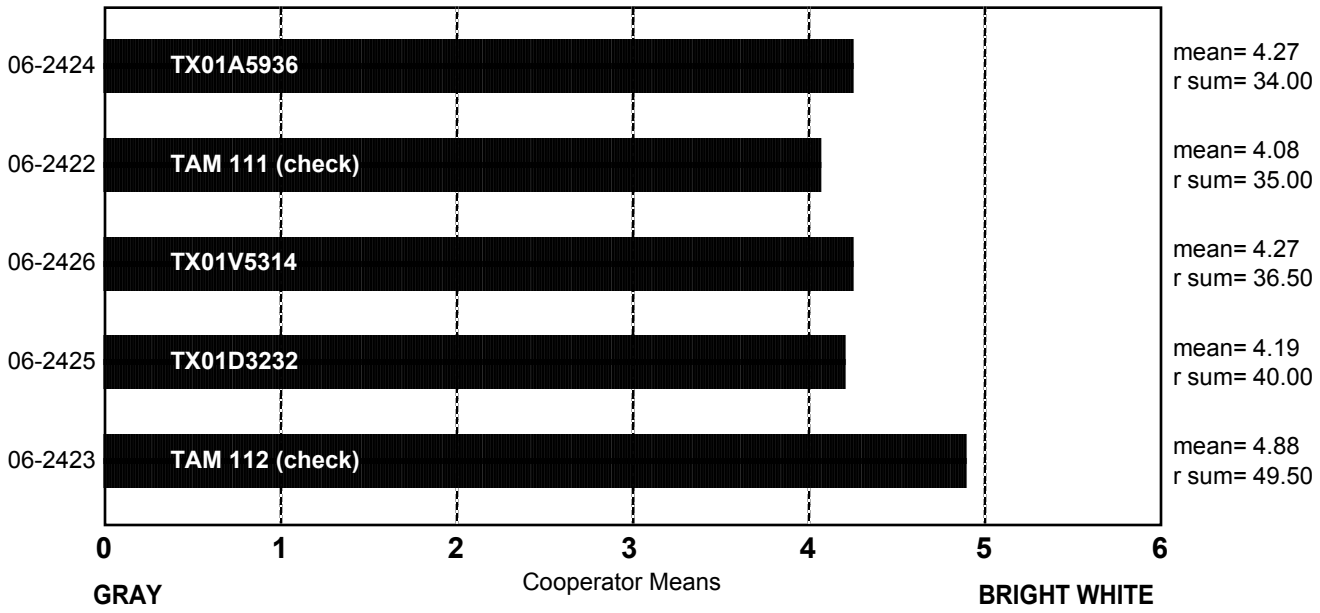
Frequency Table

CRUMB COLOR

(Small Scale) Texas

ncoop= 13
chisq= 4.88
chisqc= 8.23
cvchisq= 9.49
crdiff=

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



CRUMB COLOR, DESCRIBED

(Small Scale) Texas

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
06-2422 TAM 111 (check)	**0**	**1**	**1**	**0**	**6**	**3**	**2**
06-2423 TAM 112 (check)	**0**	**0**	**0**	**0**	**4**	**6**	**3**
06-2424 TX01A5936	**0**	**0**	**1**	**0**	**7**	**3**	**2**
06-2425 TX01D3232	**1**	**0**	**1**	**0**	**3**	**6**	**2**
06-2426 TX01V5314	**0**	**0**	**1**	**1**	**6**	**3**	**2**

Frequency Table

LOAF WEIGHT, ACTUAL

(Small Scale) Texas

	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
06-2422 Tam 111 (check)	**425.0**	**137.6**	**138.3**	**417.0**	**477.9**	**142.0**	**495.0**		**147.6**	**461.0**	**158.3**	**469.2**	
06-2423 Tam 112 (check)	**415.0**	**137.5**	**136.0**	**418.2**	**476.8**	**138.7**	**500.0**		**149.1**	**459.0**	**155.8**	**463.0**	
06-2424 TX01A5936	**417.0**	**138.5**	**140.5**	**418.1**	**476.2**	**144.3**	**495.0**		**149.8**	**461.0**	**153.6**	**463.3**	
06-2425 TX01D3232	**430.0**	**135.6**	**145.8**	**417.9**	**476.8**	**141.1**	**500.0**		**149.4**	**458.0**	**155.2**	**463.6**	
06-2426 TX01V5314	**431.0**	**136.5**	**140.9**	**412.1**	**475.9**	**140.0**	**500.0**		**149.0**	**459.0**	**157.4**	**463.7**	

Raw Data

LOAF VOLUME, ACTUAL

(Small Scale) Texas

	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
06-2422 Tam 111 (check)	**2800**	**660**	**910**	**2300**	**2750**	**950**	**3000**	**908**	**893**	**3025**	**1003**	**2538**	**925**
06-2423 Tam 112 (check)	**2950**	**840**	**968**	**2450**	**3104**	**1030**	**3600**	**1020**	**1018**	**3100**	**1030**	**2788**	**990**
06-2424 TX01A5936	**2900**	**780**	**950**	**2360**	**2839**	**1030**	**3400**	**993**	**940**	**3125**	**1015**	**2850**	**1005**
06-2425 TX01D3232	**2850**	**795**	**973**	**2440**	**2986**	**1030**	**2850**	**933**	**965**	**2775**	**983**	**2675**	**990**
06-2426 TX01V5314	**2700**	**800**	**920**	**2720**	**2780**	**1030**	**3300**	**953**	**948**	**3025**	**1005**	**2663**	**1000**

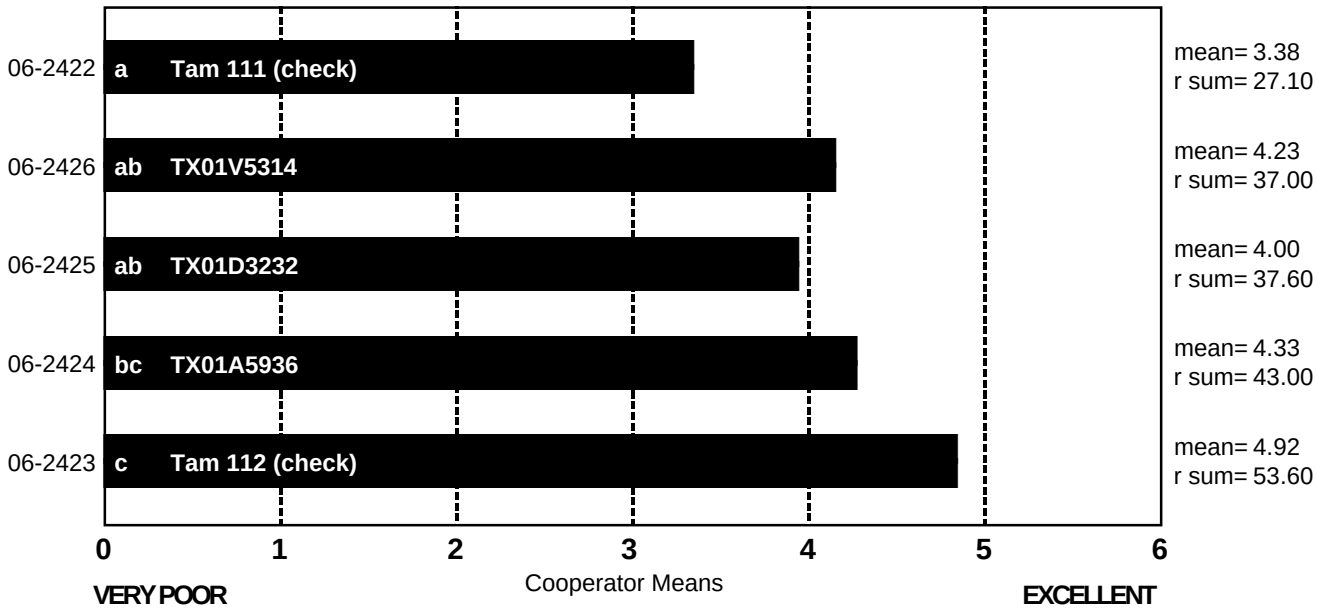
Raw Data

LOAF VOLUME

(Small Scale) Texas

ncoop= 13
chisq= 19.51
chisqc= 15.53
cvchisq= 9.49
crdiff= 12.36

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

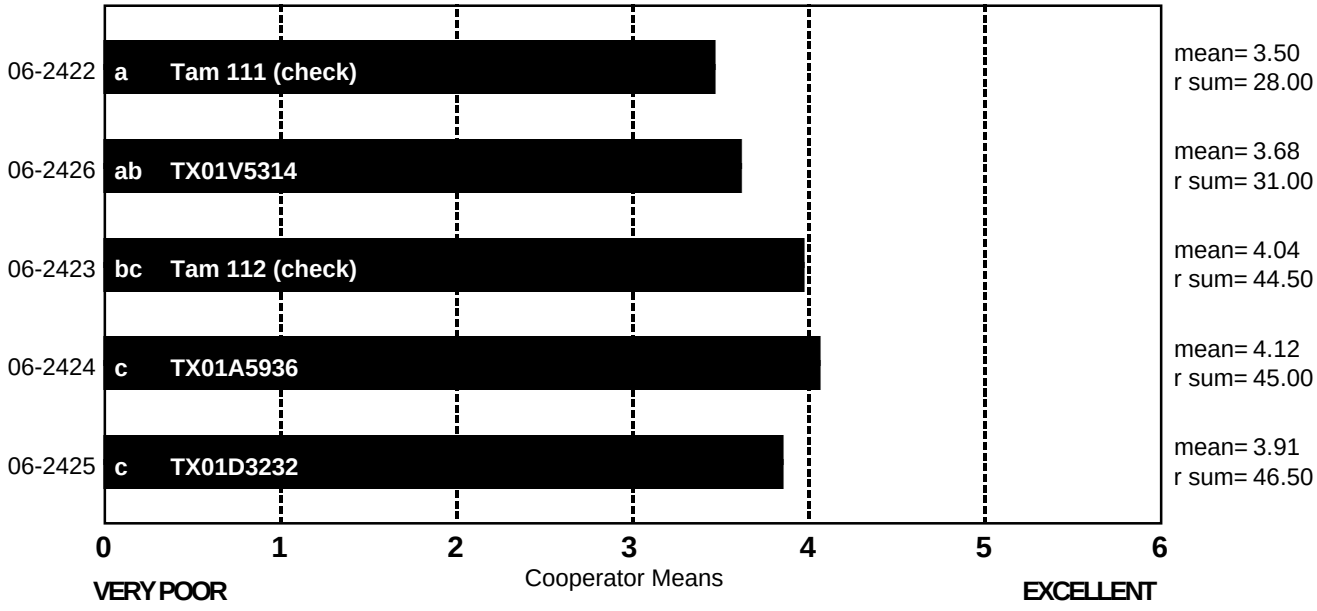


OVERALL BAKING QUALITY

(Small Scale) Texas

ncoop= 13
chisq= 9.46
chisqc= 10.93
cvchisq= 9.49
crdiff= 13.95

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



COOPERATOR'S COMMENTS
(Small Scale) Texas

COOP. 06-2422 (Tam111 (check))

A. Creamy crumb color and nice interior.
B. Dough weak at panning, and short mix time.
C. A hole on edge.
D. Average dough handling, open crumb, and low volume.
E. Fairly tight grain, and low loaf volume.
F. No comments.
G. No oven spring and poor bake.
H. Poor tolerance, small volume, dough slightly weak, does not live up to protein level.
I. Low bake absorption, poor tolerance but satisfactory crumb grain.
J. Very white crumb.
K. No comments.
L. Short mix time, very poor grain, dark yellow crumb, and low volume.
M. White crumb color, short mix time, and low bake absorption.

COOP. 06-2423 (Tam 112 (check))

A. Good volume, but open grain, and strong dough.
B. No comments.
C. A big hole on the edge.
D. Good dough handling properties, open, harsh crumb, and slightly low volume.
E. Good crumb color, open, and irregular grain.
F. No comments.
G. Bucky dough, very good volume, and open grain.
H. Very nice tolerance and dough quality. Bread has excellent volume, but open grain.
I. Good mix time, good dough and panning, excellent crumb grain with good loaf volume.
J. Very white crumb.
K. No comments.
L. Good absorption, bright white crumb, and good volume.
M. Loaf volume Ok, smooth crumb texture, and sticky out of mixer.

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

COOP. 06-2424 (TX01A5936)

A. Good volume, nice interior, bright crumb, and good mix time.
B. No comments.
C. A big hole on the edge.
D. Average dough handling, open, harsh crumb, and low loaf volume.
E. Open, slightly round grain, and slightly low loaf volume.
F. No comments.
G. Strong dough, good bake, and good volume.
H. Good overall tolerance and good volume. Protein is higher.
I. Poor mix tolerance, low bake absorption yet rated good in dough and make-up, excellent crumb grain and good loaf volume.
J. No comments.
K. No comments.
L. Good absorption, good grain, white crumb, and excellent volume.
M. Good loaf volume, silk crumb texture, and sticky out of mixer.

COOP. 06-2425 (TX01D3232)

A. Close grain, bright crumb color, and good loaf volume.
B. No comments.
C. A big hole one the edge.
D. Good dough handling properties, nice crumb and slightly low volume.
E. Slightly open grain, good loaf volume, and good crumb color.
F. No comments.
G. No spring, poor volume, poor bake, and harsh grain.
H. Good overall bake quality and grain opens up in the long mix.
I. Poor mix tolerance but good mix time, and good crumb grain and loaf volume.
J. Very white crumb.
K. No comments.
L. Good grain, white crumb, and average volume.
M. Loaf volume ok, white crumb color, tough out of mixer, and low bake absorption.

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

COOP. 06-2426 (TX01V5314)

A. Short mix for protein level, had nice interior, dull crumb color, and lowest score overall.
B. No comments.
C. A big hole on the edge.
D. Nice handling dough, open crumb, and very nice volume.
E. Very open grain, thick cell walls, and low loaf volume.
F. No comments.
G. Bucky dough, good loaf volume, and harsh grain.
H. OK bake quality, but not for such a high protein, and open grain.
I. Poor mix tolerance, but good mix time, good loaf volume with open crumb grain.
J. Very white crumb.
K. No comments.
L. High absorption, short mix time, and average volume.
M. Loaf volume good and white silky crumb.

Notes: **A, D, E H, and L** comments based on sponge and dough bake test.

Wheat Classification Results from FGIS

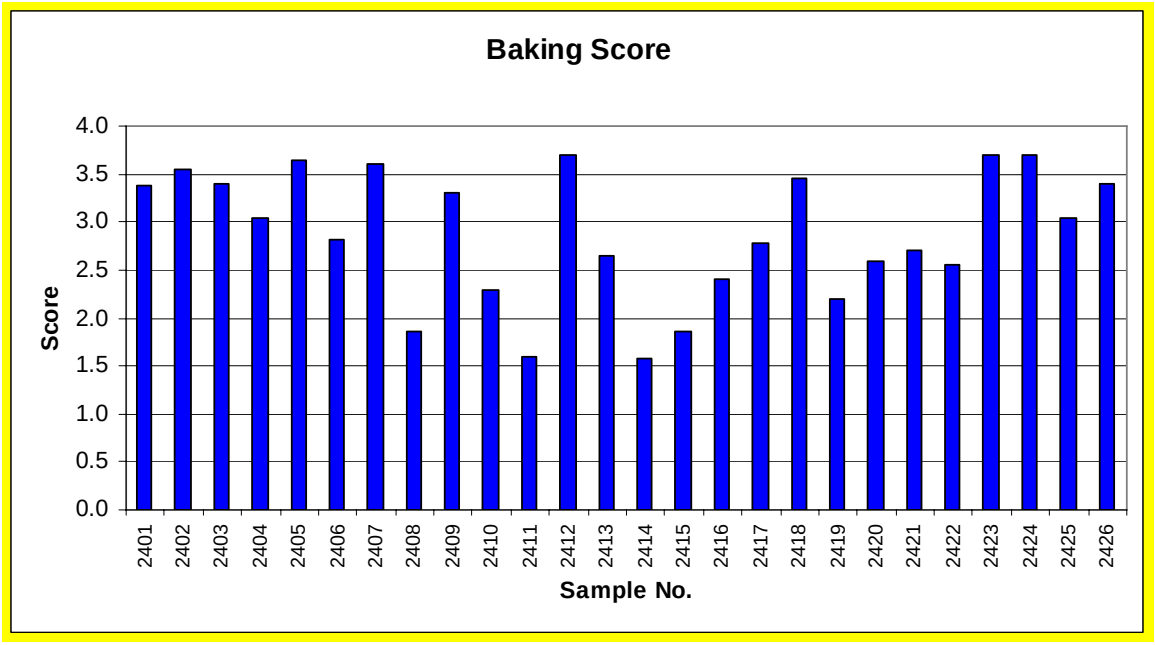
FGIS WHEAT CLASSIFICATION/2006 WHEAT QUALITY COUNCIL

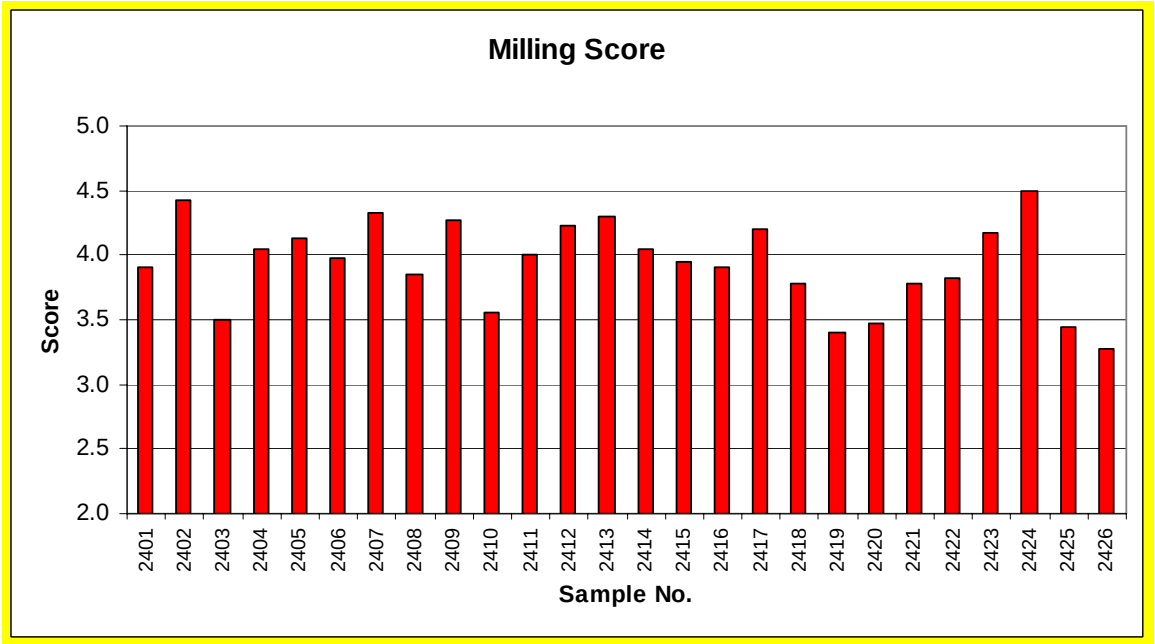
ID	CL	DKG	TW	M	ODOR	HT	DKT	FM	SHBN	DEF	CCL	WOCL	VARIETY	GRADE
06-0002401	HRW	0.00	60.0	11.6	OK	0.0	0.2	0.0	0.0	0.2	0.0	0.0	**OVERLEY**	U. S. NO. 1 HRW, DKG 0.0%
06-0002402	HRW	0.00	60.1	11.8	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.3	**FULLER**	U. S. NO. 1 HRW, DKG 0.0%
06-0002403	HRW	0.00	57.8	11.6	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	**KS990498-3-&-2**	U. S. NO. 3 HRW, DKG 0.0%
06-0002404	HRW	0.00	61.0	12.2	OK	0.0	0.0	0.0	0.1	0.1	0.0	0.0	**KS970274-14-*9**	U. S. NO. 1 HRW, DKG 0.0%
06-0002405	HRW	0.00	60.3	11.0	OK	0.0	0.1	0.0	0.3	0.4	0.0	0.0	**OVERLEY**	U. S. NO. 1 HRW, DKG 0.0%
06-0002406	HRW	0.00	60.6	11.6	OK	0.0	0.1	0.0	0.2	0.3	0.0	0.0	**SMOKEY HILL**	U. S. NO. 1 HRW, DKG 0.0%
06-0002407	HDWH	0.00	60.2	11.0	OK	0.0	0.2	0.0	0.1	0.3	1.8	1.8	**1383W**	U. S. NO. 2 HDWH, DKG 0.0%
06-0002408	HRW	0.02	62.6	11.5	OK	0.0	0.1	0.0	0.4	0.5	0.0	0.3	**MILLENNIUM**	U. S. NO. 1 HRW, DKG 0.0%
06-0002409	HDWH	0.01	63.1	10.6	OK	0.0	0.0	0.0	0.6	0.6	0.0	0.0	**NW98S097**	U. S. NO. 1 HDWH, DKG 0.0%
06-0002410	HRW	0.00	61.6	11.0	OK	0.0	0.1	0.0	0.6	0.7	0.0	1.1	**NO2Y5117**	U. S. NO. 1 HRW, DKG 0.0%
06-0002411	HRW	0.00	63.0	10.9	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	**NE01643**	U. S. NO. 1 HRW, DKG 0.0%
06-0002412	HRW	0.00	64.4	11.4	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.2	**NE02584**	U. S. NO. 1 HRW, DKG 0.0%
06-0002413	HRW	0.00	62.9	9.9	OK	0.0	0.0	0.0	0.6	0.6	0.0	3.7	**OK BULLET**	U. S. NO. 2 HRW, DKG 0.0%
06-0002414	HRW	0.04	63.5	11.3	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	**OK93P656H3299-2C04**	U. S. NO. 1 HRW, DKG 0.0%
06-0002415	HRW	0.00	62.4	10.9	OK	0.0	0.4	0.0	0.2	0.6	0.0	3.9	**OK01420**	U. S. NO. 2 HRW, DKG 0.0%
06-0002416	HRW	0.03	60.6	10.6	OK	0.0	0.0	0.1	0.1	0.2	0.0	0.0	**OK02405**	U. S. NO. 1 HRW, DKG 0.0%
06-0002417	HDWH	0.00	60.7	10.1	OK	0.0	0.0	0.0	0.2	0.2	3.9	3.9	**OK02522W**	U. S. NO. 4 HDWH, DKG 0.0%
06-0002418	HRW	0.00	62.6	10.9	OK	0.0	0.0	0.0	1.3	1.3	0.0	0.0	**TANDEM**	U. S. NO. 1 HRW, DKG 0.0%
06-0002419	HRW	0.00	59.8	10.4	OK	0.0	0.3	0.0	1.0	1.3	0.0	0.0	**SD96240-3-1**	U. S. NO. 2 HRW, DKG 0.0%
06-0002420	HRW	0.02	60.8	10.9	OK	0.0	0.0	0.0	1.8	1.8	0.0	0.0	**SD01122**	U. S. NO. 1 HRW, DKG 0.0%
06-0002421	HDWH	0.01	62.8	10.8	OK	0.0	0.0	0.0	1.1	1.1	5.0	5.0	**SD01W064**	U. S. NO. 4 HDWH, DKG 0.0%
06-0002422	HRW	0.00	60.1	12.0	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.2	**TAM 111**	U. S. NO. 1 HRW, DKG 0.0%
06-0002423	HRW	0.00	60.9	11.8	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	**TAM 112**	U. S. NO. 1 HRW, DKG 0.0%
06-0002424	HDWH	0.00	61.7	11.9	OK	0.0	0.0	0.0	0.2	0.2	1.8	1.8	**TX01A5936**	U. S. NO. 2 HDWH, DKG 0.0%
06-0002425	HRW	0.00	58.1	10.9	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	**TX01D3232**	U. S. NO. 2 HRW, DKG 0.0%
06-0002426	HRW	0.00	56.9	11.0	OK	0.0	0.1	0.0	0.2	0.3	0.0	0.0	**TX01V5314**	U. S. NO. 3 HRW, DKG 0.0%
06-0002427	HRW	0.00	61.0	9.7	OK	0.0	3.2	0.1	0.0	3.3	0.0	0.0	**HATCHER**	U. S. NO. 2 HRW, DKG 0.0%
06-0002428	HRW	0.00	63.8	10.3	OK	0.0	0.3	0.0	0.0	0.3	0.0	0.0	**RIPPER**	U. S. NO. 1 HRW, DKG 0.0%
06-0002429	HRW	0.07	63.7	9.5	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	**GENOU**	U. S. NO. 1 HRW, DKG 0.1%

2006 WQC Milling and Baking Score

2006 WQC Milling & Baking Scores

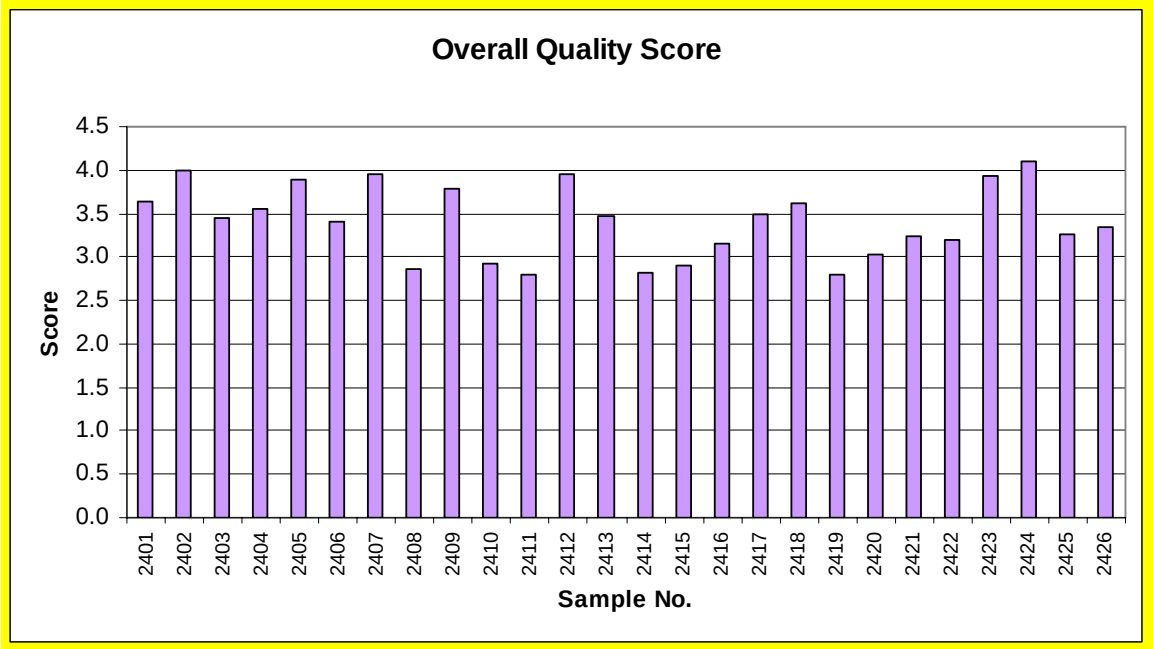
(Based upon HWWQL Quality Data)





2006 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 has 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).

Milling and baking marketing scores for the ’05 hard winter wheat samples submitted to the WQC are shown in this report.

Alkaline Noodle Tests for 2006 WQC

Hard Winter Wheat Samples

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

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Alkaline Noodle Test Report for 2006 WQC Samples

Objectives: Evaluate the alkaline raw noodle color and determine the cooking and eating characteristics of the alkaline noodles made from 2006 WQC Hard Winter Wheat flours.

Materials: 26 WQC Hard Winter Wheat samples, harvested in 2006, were milled at K-State using a Miag mill. And a Hard White Winter Wheat, Lakin, harvested in 2003, was used as a reference and the data for Lakin in this year report was used from last year because the flour extraction this year was higher than previous years by more than 10%. Therefore the flour color and noodle appearance of the reference are not satisfying.

Methods:

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

1. Grind wheat in an Udy grinder and blend the meal thoroughly using tumbling equipment.
2. Weigh 75 mg of the 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 the absorbance at 475 nm.

Noodle Making:

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

Procedures:

100-g flour ← 1-g Na_2CO_3 + 35-mL Water (an alkaline solution)

↓

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 (noodle machine maker, model)

↓

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*, whiteness-blackness (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 with shaking the colander 20 times and weigh the cooked noodles for determination of the water uptake- one of the cooking characteristics by the fresh raw noodles.
7. Measure noodle eating characteristics immediately using TA-XTplus.

Measurement of Cooking Loss and Water Uptake:

Cooking Loss:

1. Pre-weigh an empty 500-mL beaker to 0.01 g.
2. Quantitatively transfer the cooking/rinse water to the beaker.
3. Evaporate to dryness (constant weight) in air oven at 95 $\pm$5^{o}C.
   Drying time is about 20 hr.
4. Cool the beaker 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 the cooked noodles with 1-mm flat perspex Knife Blade (A/LKB-F). TPA generates objective measurements of the eating characteristics of the cooked noodle, which may be theoretically related to sensory evaluations. Each of those parameters is listed 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.
- **Adhesiveness (N.sec):** negative force area for the first bite and represents the work required to overcome the attractive forces between the surface of a food and the surface of other materials.

Results:

Top 3 samples with desirable cooking and eating properties were selected in each category.

Table I shows the raw noodle color at 0 hr and 24 hr and the color stability after 24 hrs.

Noodle Color (L value, Higher is better.) **at 0 hr:** 2414 (83.9), 2415 (83.6), 2409 (83.3)
Noodle Color (L value, Higher is better.) **at 24 hr:** 2414 (73.7), 2409 (72.7), 2415 (72.6)
Color stability (L at 0 hr- L at 24 hr, Smaller is better):
2414 (10.3), 2409 (10.6), 2415 (11.0)

PPO (Lower is better.): 2409 (0.14), 2413 (0.32), 2425 (0.33)

Table II shows the cooked noodle quality including cooking and eating characteristics

Hardness : 2408 (2.904), 2423 (2.883), 2406 (2.803)

Springiness : 2422 (0.987), 2424 (0.981), 2425 (0.978)

Chewiness : 2423 (1.880), 2402 (1.775), 2406 (1.772)

Resilience : 2424 (0.430), 2426 (0.422), 2423 (0.413)

Cohesiveness : 2426 (0.689), 2424 (0.685), 2402 and 2405 (0.676)

Adhesiveness : 2422 and 2424 (-0.011), 2420 (-0.012), 2404 (-0.013),

Water Uptake : 2410 (91.4), 2414 (91.0), 2411 (89.7)

Cooking Loss : 2426 (5.3), 2423 (5.5), 2424 (5.9)

Discussion

The sample, 2409, showed bright raw noodle color (*L* value) at 0 hr with very low PPO level (0.14), but had slightly darker color after 24 hrs compared with Lakin 03 (reference sample, harvested in 2003). The samples, 2414 and 2415, showed a similar trend that had bright noodle color at 0 hr, but slightly darker color after 24 hr. One interesting thing is that samples, 2414 and 2415, had medium levels of PPO (0.42 and 0.47, respectively) (Table 1).

Texture Profile Analysis (TPA) was used for evaluating cooked alkaline noodle easting quality. The TPA provides objective data that mimic sensory evaluation. Good alkaline noodle cooking characteristics are supposed to be firm and elastic, have higher chewiness in the mouth compared with white salted noodles (Udon-type). Thus, alkaline noodles with high hardness, springiness, resilience, and cohesiveness are usually satisfying to consumers, whereas the soft texture for Undon-type noodles is desirable. It is very hard to rank the overall quality of noodles made from each of flour samples. Therefore, the best way is to rank samples based on each of parameters. More studies and information are needed to achieve the proper Quality Targets and Quality Ranking Parameters of Alkaline Noodles.

References:

Epstein, J., Morris, C. F., and Huber, K. C. 2002. Instrumental texture of white salted noodles prepared from recombinant inbred lines of wheat differing into three granule bound starch synthase (waxy) genes. J. Cereal Sci. 35:51-63.

Manual of TA-XTplus (Texture Technologies, NY).

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
06-2401	79.8	66.9	-1.51	0.05	22.5	23.7	-12.9	1.6	1.3	0.54
06-2402	80.5	67.1	-1.21	0.19	20.2	23.0	-13.4	1.4	2.7	0.72
06-2403	81.0	68.4	-1.58	-0.39	20.9	23.6	-12.6	1.2	2.7	0.67
06-2404	80.6	69.4	-1.89	-0.70	22.5	25.5	-11.2	1.2	3.1	0.63
06-2405	79.7	67.3	-1.37	0.05	22.8	25.3	-12.4	1.4	2.5	0.44
06-2406	77.5	61.4	-0.76	0.46	21.2	23.7	-16.2	1.2	2.5	0.55
06-2407	78.2	64.8	-1.14	0.35	22.3	25.8	-13.4	1.5	3.5	0.50
06-2408	82.9	69.9	-1.57	-0.49	17.7	24.1	-13.0	1.1	6.4	0.48
06-2409	83.3	72.7	-2.26	-1.31	22.4	26.3	-10.6	1.0	3.9	0.14
06-2410	80.8	68.2	-1.59	0.40	21.5	24.5	-12.6	2.0	3.0	0.52
06-2411	81.6	70.1	-1.77	-0.47	20.4	24.4	-11.4	1.3	4.0	0.45
06-2412	81.8	69.8	-1.86	-0.40	21.8	25.4	-11.9	1.5	3.6	0.40
06-2413	80.1	66.8	-1.56	-0.14	22.1	25.0	-13.4	1.4	2.9	0.32
06-2414	83.9	73.7	-1.75	-0.96	20.4	25.8	-10.3	0.8	5.4	0.42
06-2415	83.6	72.6	-1.43	-0.63	19.1	23.8	-11.0	0.8	4.7	0.47
06-2416	80.9	69.3	-1.55	-0.70	23.2	27.5	-11.5	0.8	4.4	0.48
06-2417	80.4	66.2	-1.42	0.14	21.2	23.7	-14.2	1.6	2.6	0.43
06-2418	81.0	68.5	-2.09	-0.58	23.8	24.7	-12.6	1.5	0.9	0.39
06-2419	80.4	65.4	-1.94	-0.30	23.4	24.3	-15.0	1.6	0.9	0.37
06-2420	79.8	66.2	-1.27	0.57	22.6	24.3	-13.6	1.8	1.7	0.39
06-2421	81.8	66.8	-1.78	0.00	20.5	22.5	-15.0	1.8	2.0	0.39
06-2422	79.7	67.8	-1.49	-0.04	22.0	24.9	-11.9	1.5	2.9	0.51
06-2423	79.8	65.6	-1.28	0.45	21.3	23.4	-14.2	1.7	2.1	0.45
06-2424	81.7	68.0	-1.83	-0.78	21.2	22.9	-13.7	1.1	1.7	0.56
06-2425	80.9	67.7	-1.32	0.01	21.0	23.6	-13.2	1.3	2.6	0.33
06-2426	78.7	62.3	-1.24	0.50	20.9	22.5	-16.4	1.7	1.6	0.68
Average	80.8	67.8	-1.56	-0.18	21.5	24.4	-13.0	1.4	2.9	0.47
LSD	0.7	1.0	0.23	0.49	1.2	0.7	1.2	0.5	1.3	0.03
Lakin 03	83.6	75.7	-2.20	-1.66	20.8	24.7	-8.0	0.5	3.9	0.19

LSD=Least significant difference at P = 0.05.

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

Sample	Hardness N	Springiness ratio	Chewiness no unit	Resilience ratio	Cohesiveness ratio	Adhesiveness N.sec	Water Uptake %	Cooking Loss %
06-2401	2.663	0.953	1.679	0.386	0.662	-0.024	76.9	7.1
06-2402	2.752	0.954	1.775	0.402	0.676	-0.019	79.0	6.8
06-2403	2.502	0.962	1.602	0.390	0.666	-0.015	80.9	6.6
06-2404	2.521	0.963	1.610	0.405	0.663	-0.013	83.2	6.9
06-2405	2.707	0.959	1.755	0.399	0.676	-0.017	81.0	6.7
06-2406	2.803	0.947	1.772	0.388	0.668	-0.019	76.8	7.2
06-2407	2.728	0.961	1.731	0.393	0.660	-0.018	83.8	6.6
06-2408	2.904	0.964	1.743	0.357	0.623	-0.017	85.2	7.6
06-2409	2.686	0.977	1.770	0.411	0.675	-0.015	85.3	6.7
06-2410	2.586	0.966	1.585	0.353	0.634	-0.019	91.4	7.2
06-2411	2.668	0.970	1.615	0.354	0.624	-0.023	89.7	7.3
06-2412	2.595	0.962	1.620	0.387	0.649	-0.019	84.0	6.9
06-2413	2.672	0.949	1.602	0.374	0.632	-0.014	89.0	7.0
06-2414	2.697	0.953	1.582	0.354	0.616	-0.015	91.0	7.1
06-2415	2.429	0.956	1.539	0.398	0.663	-0.022	88.2	7.3
06-2416	2.570	0.938	1.531	0.371	0.635	-0.015	84.3	7.1
06-2417	2.612	0.948	1.613	0.386	0.651	-0.016	87.0	6.3
06-2418	2.470	0.967	1.571	0.377	0.658	-0.020	84.4	7.0
06-2419	2.587	0.952	1.567	0.356	0.637	-0.015	84.5	7.1
06-2420	2.544	0.954	1.580	0.366	0.651	-0.012	83.3	7.5
06-2421	2.654	0.963	1.619	0.358	0.634	-0.020	87.3	7.2
06-2422	2.670	0.987	1.692	0.377	0.643	-0.011	88.4	6.6
06-2423	2.883	0.966	1.880	0.413	0.675	-0.017	87.1	5.5
06-2424	2.537	0.981	1.702	0.430	0.685	-0.011	85.1	5.9
06-2425	2.522	0.978	1.647	0.399	0.669	-0.017	82.5	7.0
06-2426	2.647	0.962	1.754	0.422	0.689	-0.021	89.3	5.3
Average	2.639	0.961	1.659	0.385	0.654	-0.017	85.0	6.8
LSD	0.202	0.024	0.148	0.031	0.025	0.011	3	0.7
Lakin 03	2.41	0.958	1.44	0.38	0.63	-0.018	84	7.1

LSD=Least significant difference at P = 0.05.

TORTILLA BAKING TEST

Dr. Ralph Waniska

Department of Soil and Crop Sciences

Texas A&M University

Procedures to Produce and Evaluate Wheat Flour Tortillas

(The Tortilla Bake Test using Lawrence Equipment)

Tortilla Formulation

Ingredients	Amount
Wheat flour	100%
Salt	1.5%
Sodium Stearoyl Lactylate	0.5%
Sodium Propionate	0.5%
Potassium Sorbate	0.4%
All purpose Shortening	6.0%
Sodium Bicarbonate	0.6%
Fumaric Acid - encapsulated	0.24%
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 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, Dutchness 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 was 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 395^0C temperature for the top and bottom platens, 1.35 sec cycle time and 1100 psi hydraulic pressure.

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

8. Cooling
Tortillas are cooled 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. 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 nontypical 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, 5 =less viscous, 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 immedi.	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 five tortillas measurements 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, 1995).

6. Opacity
Ten tortillas are evaluated subjectively for opacity using a continuous scale of 0-100: 100% translucent to 0% translucent (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: = π * (Diameter/2)^2 * height * 1000 / weight. [mm.cm.mm/g]

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

10. Tortilla Rollability Score
Two tortillas are removed from the plastic bag on 4, 8, 12, and 16 days of storage and evaluated according to the following procedure. An average of the two measurements is taken. 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. A continuous scale of 1-5 is used:
5 = no cracking
4 = signs of cracking, but no braking
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 tortillas 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.

Force at 2 mm deformation, modulus, and force, work and distance required to rupture are measured.

WHEAT QUALITY COUNCIL - 2006 DATA WORKSHEET

COOPERATOR NAME:	Ralph Waniska
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 / 395^0 F
Hot-Press Time:	1.35 sec
Hot-Press Pressure:	1100 psi
OVEN TEMPERATURE:	355^0 F
BAKE TIME:	30 sec

2006 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.	51.0	27.9	2.0	2.4	3.5	3.3	2.3
2401	49.0	29.8	2.0	2.0	3.5	3.3	2.2
2402	50.0	30.1	2.0	2.0	3.7	3.5	2.0
2403	47.5	30.0	2.3	2.0	3.0	3.0	2.2
2404	48.5	29.6	2.0	2.0	3.3	3.3	2.2
2405	52.0	30.7	2.0	2.0	3.0	3.5	2.0
2406	48.5	30.3	2.2	2.3	3.5	3.3	2.2
2407	52.5 +	29.8	1.8	2.3	3.5	3.8	2.0
2408	46.5	28.6	2.0	2.3	3.0	2.5	2.3
2409	49.0	29.5	2.0	2.0	3.0	3.0	1.8
2410	46.5	28.6	1.5	2.0	3.0	3.5	2.0
2411	47.0 -	30.6	2.0	2.3	3.0	3.0	2.3
2412	49.0	29.8	1.8	2.2	3.3	3.3	2.2
2413	52.0	28.7	2.0	2.3	3.2	3.5	2.2
2414	51.0	25.9	2.0	2.5	3.5	2.5	2.3
2415	52.0 +	28.5	2.0	2.2	3.3	2.5	2.3
2416	51.0	29.4	2.2	2.4	3.5	3.0	2.3
2417	53.0 +	28.2	2.0	2.4	3.5	3.0	2.3
2418	50.0	30.3	1.5	2.0	3.3	3.5	2.0
2419	48.0	32.1	1.5	2.0	3.0	3.5	2.0
2420	49.0	30.4	2.0	2.0	3.2	3.0	2.0
2421	50.0	29.5	2.0	2.0	3.5	3.3	2.2
2422	48.0	31.1	1.5	2.0	4.0	3.0	2.0
2423	51.0	29.0	2.0	2.2	3.5	3.3	2.2
2424	51.0	30.8	1.5	2.0	3.5	3.5	2.0
2425	50.0	29.8	2.0	2.2	3.5	3.3	2.2
2426	52.0	28.8	2.2	2.2	3.5	3.5	1.9
Average	49.8	29.5	1.9	2.1	3.3	3.2	2.1
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

2006 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	pHinit	Diam	Opacity	Sp.Vol.
Tortilla Ref.	34.0	41.7	3.1	5.6	158	83	1.47
2401	33.0	40.8	3.0	5.5	154	59	1.38
2402	33.4	40.9	3.1	5.5	153	63	1.40
2403	32.0	41.5	3.4	5.5	151	74	1.46
2404	33.1	41.1	3.1	5.5	158	72	1.47
2405	34.9	40.1	3.0	5.6	152	62	1.34
2406	32.4	42.3	3.1	5.6	150	53	1.32
2407	33.4	39.5	3.0	5.5	161	81	1.53
2408	31.2	38.4	3.1	5.5	161	87	1.64
2409	30.3	40.3	3.2	5.6	167	77	1.72
2410	31.6	39.3	3.1	5.6	160	81	1.60
2411	31.3	40.8	3.1	5.6	164	83	1.58
2412	31.8	39.1	3.1	5.4	167	84	1.72
2413	34.3	40.9	3.0	5.6	163	84	1.53
2414	32.4	42.7	3.2	5.3	161	82	1.50
2415	33.5	42.0	2.9	5.5	166	88	1.50
2416	33.7	42.3	3.2	5.6	160	82	1.50
2417	34.4	42.3	3.1	5.5	161	80	1.48
2418	32.8	39.8	3.0	5.5	168	81	1.66
2419	31.4	41.2	2.9	5.5	167	84	1.53
2420	32.1	40.8	3.0	5.6	163	75	1.52
2421	33.0	38.7	3.0	5.5	159	78	1.55
2422	29.5	39.3	3.0	5.6	176	92	1.87
2423	33.3	40.0	3.0	5.4	160	79	1.52
2424	33.1	40.1	3.0	5.6	166	74	1.60
2425	32.8	41.6	3.1	5.4	160	77	1.47
2426	32.6	40.7	3.0	5.6	173	85	1.69
Average	32.6	40.7	3.1	5.5	161	78	1.54
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 = cm3 / g

2006 Tortilla TEST No.	Rollability Score 4 day	Rollability Score 8 day	Rollability Score 12 day	Rollability Score 16 day	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.	4.5	3.5	3.0	2.5	363	302	308	Poor	
2401	5.0	4.9	4.6	4.1	378	337	479	Poor	
2402	5.0	5.0	5.0	4.5	439	395	528	Poor	
2403	5.0	4.3	3.6	3.1	390	336	387	Poor	
2404	5.0	5.0	4.9	4.1	516	436	517	Fair	
2405	-	4.8	4.5	4.0	370	329	441	Poor	
2406	5.0	4.8	4.8	4.4	330	304	471	Poor	
2407	4.8	4.6	4.0	3.6	499	452	464	Fair	50 ppm cysteine
2408	5.0	4.0	3.5	3.3	497	462	459	Fair	
2409	5.0	4.8	4.5	3.5	595	463	513	Good	
2410	4.8	4.5	3.3	2.5	422	325	342	Poor	
2411	-	3.3	2.5	1.8	326	228	237	Poor	0 ppm cysteine
2412	4.8	4.1	3.6	2.8	522	396	410	Fair	
2413	5.0	3.6	3.0	2.6	383	335	340	Poor	
2414	2.0	1.3	1.0	1.0	123	123	128	Poor	
2415	3.8	3.3	2.9	2.4	378	312	302	Poor	50 ppm cysteine
2416	4.0	2.4	1.9	1.4	231	170	173	Poor	
2417	4.3	3.5	3.1	2.9	370	340	360	Poor	50 ppm cysteine
2418	-	4.5	4.0	3.3	534	434	463	Good	
2419	-	4.8	4.3	3.8	547	483	496	Good	
2420	5.0	4.9	4.8	4.6	536	522	593	Good	
2421	5.0	4.8	4.3	3.6	515	439	485	Fair	
2422	-	4.0	3.8	3.5	645	602	563	Good	
2423	4.5	4.4	4.1	3.9	494	464	501	Fair	
2424	-	4.8	4.5	4.3	533	504	590	Good	
2425	4.8	4.5	4.1	3.8	467	425	470	Fair	
2426	5.0	5.0	4.1	3.6	591	519	519	Good	
Average	4.6	4.2	3.8	3.3	444	387	427		
Descript. or Scale	1 = none to 5 = breaks 4 day	1 = none to 5 = breaks 8 day	1 = none to 5 = breaks 12 day	1 = none to 5 = breaks 16 day	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 (radius * radius * height * pi)

2006 Tortilla TEST No.	Modulus 2-D 12 day	Force 2-D 12 day	Distance 2-D 12 day	Work 2-D 12 day	Lightness 2-baked side	Lightness 1-baked Side	"b" 2-baked side	"b" 1-baked Side
ID CODE	Mod12	Force12	Dist12	Work12	Light-2	Light-1	b-2	b-1
Tortilla Ref.	0.8	6.7	11.8	32.6	85.1	84.1	16.0	18.0
2401	0.8	8.9	13.8	51.2	85.8	84.2	16.2	19.1
2402	0.8	8.8	14.7	52.8	84.9	83.9	15.7	17.5
2403	0.8	9.1	15.0	58.5	85.6	84.9	16.2	18.0
2404	0.8	8.0	14.1	44.9	86.4	85.4	17.2	19.8
2405	0.9	7.9	12.5	37.9	84.5	82.6	17.5	20.3
2406	0.9	9.3	14.4	57.7	83.0	81.8	16.0	18.1
2407	0.8	7.6	13.0	38.4	84.6	83.4	17.0	19.1
2408	0.7	6.1	12.4	32.5	86.3	85.9	15.4	16.8
2409	0.7	8.4	15.2	56.6	86.1	85.2	17.6	20.5
2410	0.6	6.6	13.7	38.6	86.5	85.3	15.2	17.9
2411	0.7	6.9	12.7	33.1	86.1	85.7	16.5	17.8
2412	0.5	7.3	14.7	41.6	86.7	86.4	17.0	18.5
2413	0.7	7.0	12.2	33.2	85.8	84.8	16.9	19.2
2414	0.8	6.3	11.0	27.3	86.3	85.7	18.3	19.5
2415	0.8	6.1	11.4	28.0	85.0	84.6	17.7	19.7
2416	0.7	6.4	11.6	27.7	85.0	83.7	18.6	20.8
2417	0.7	7.0	12.2	31.8	85.7	84.5	17.2	19.6
2418	0.6	6.6	13.7	35.4	86.5	85.8	18.3	20.0
2419	0.7	7.1	13.1	37.2	86.4	86.2	17.8	19.1
2420	0.6	6.6	14.7	41.6	85.7	84.6	16.5	19.1
2421	0.6	7.2	14.4	42.2	87.1	86.4	15.9	17.7
2422	0.6	6.6	13.7	34.6	86.9	86.0	15.9	17.8
2423	0.7	8.0	14.0	45.7	86.5	85.3	15.9	18.0
2424	0.5	7.3	15.4	42.2	87.0	86.7	17.1	18.4
2425	0.6	7.3	14.4	42.1	86.4	85.6	16.4	18.6
2426	0.6	6.5	14.0	35.5	85.3	84.4	16.7	18.8
Average	0.7	7.3	13.5	40.0	85.8	84.9	16.8	18.8
Descriptors or Scale	Modulus N/mm 12 day	Force to Rupture N 12 day	Distance to Rupture mm 12 day	Work to Rupture N.mm 12 day				

APPENDIX A
Credits and Methods

CREDITS

Milling, Sample Analysis, Ingredients and Report Preparation

Mixograms and Farinograms	USDA/ARS//HWWQL Manhattan, KS
Falling Number	Kansas Wheat Quality Lab KSU Dept. Grain Science & Ind. Manhattan, KS
C-cell Test and Marketing Scores	USDA/ARS/HWWQL Manhattan, KS
Glutomatic, Agtron Flour Color	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

Address	Collaborator Type	Contact
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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	**Ron Moline** (507)452-1770 ronmo.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
Kansas State University Dept of Grain Science Shellenberger Hall Manhattan, KS 66506	Wheat Quality Lab	**Becky Miller** (785)532-6194 beckym@ksu.edu

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 209 Fargo, ND 58105	Wheat Quality Lab	**Kelly McMonagle** (701)231-9655 kelly.j.mcmonagle@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.

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

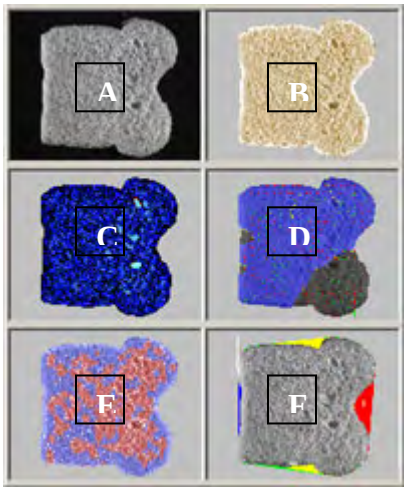
extraction rate, has a high milling value because high protein flour typically sells for a premium in many markets.

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

WQC Business Meeting Minutes

by Tim Aschbrenner

Annual Meeting Feb. 21-23, 2006

Hard Winter Wheat Quality Council Meeting Minutes
Annual Meeting February 21 – 23, 2006

The meeting was called to order at 8:08 am CST by Brad Seabourn, Chair of the Hard Winter Wheat Quality Council Technical Board.

1. Minutes of the previous meeting were read by Sec. Tim Aschbrenner. Dave Katzke made a motion to approve the minutes, which was seconded by Steve Baenziger. Motion passed by voice vote.

2. Nomination for the new slate of Technical Board officers for the 2006 crop year were announced by Brad Seabourn and included the following:

    - Chair: Brett Carver
    - V. Chair: Tim Aschbrenner
    - Sec.: Rollie Sears
    - Member: Kendall McFall (continuing member)
    - Member: Margo Caley (new member)

    John Ross made a motion to approve the proposed slate of officers. Greg Fox seconded the motion. The motion passed by voice vote.

3. Continuing members of the Hard Winter Wheat Quality Evaluation and Advisory Committee were announced by Brad Seabourn and included the following:

    - Okky Chung, Director of the HWWQL (continuing member)
    - Richard Chen, GMPRC Scientist and Editor of the WQC Annual Report (continuing member)
    - Ken Ulbrich, Bay State Milling (continuing member)
    - Brian Stouts, AIB (continuing member)
    - Alan Fritz, KSU wheat breeder (continuing member)

4. Brad Seabourn presented the draft of the Hard Winter Wheat Quality Targets. Many of these quality parameters were set using the Data Means from Nursery Data (1990-2002), USWA Data (1999 – 2003) and FGIS Data (2002). Discussions about adjusting the protein target down by 1.0% and the pup loaf volume down by 50cc. Steve Baenziger suggested that the mixograph tolerance should be a range (< 3.0). Brett Carver expressed concern that the SKCS diameter might be too restrictive. Brad Seabourn said that we should look at industry data for real life characteristics. The concept is the quality parameters should remain flexible and dynamic by relying on industry data. Dan Romig made the motion to accept the changes to the Hard Winter Wheat Quality Targets and that the Targets will be reviewed and adjustments be allowed as deemed by the Hard Winter Wheat Quality Targets

Committee (HWWQTC). Laurie Murphy seconded the motion. The motion passed by hand vote.

5. Kendall McFall gave a review of the sample milling process for the 2005 crop. He reported that the sample milling was performed on the Miag mill at the KSU Department of Grain Science and Industry. He felt the samples results were typical. They utilized a 16 hour temper, and did not see any major problems (chokes, etc.). He noted that the flour yields were relative. The mill was set up to be uniform for all samples, and was not optimized for each sample. He would expect a 0.5% standard deviation. He commented that the mill has no humidity control. Brad Seabourn noted that the first sample showed low yield, and questioned if there was a correlation to sample order. Kendall noted that the first sample was small with small kernels and low TW. They mill 2-3 samples per day, depending on sample size. It takes about 15 days to mill all of the samples. The samples are milled in the order that they are received from Brad's lab. No control samples were run this year to warm up the mill. A control would add too much time to the process. Stephen Baenziger recommends running the big samples first, because these are usually the checks samples. The plan is to use the Miag mill indefinitely. Speculation is that it will eventually be relocated to the new class rooms in the future.

6. Richard Chen (Report Book Editor) gave a review of the Report Book. This year, the book was about 50-60 pages larger than previous books. Items that were added this year are: 1) analyzed bread quality using C-Cell images; 2) cumulative ash and protein curves; 3) a section on WQC Milling and Baking Score comparison; 4) an Appendix explaining the new methods; and 5) an Appendix on End-Use Quality Targets for HRW. Richard noted that improvements are needed from Collaborators, as not all blanks are always filled in on the Data Report Sheet. Comments were not always noted by the Colabs as well. The Colabs need to use their knowledge and experience to show more difference between samples. The ability for the breeders to see differences between the samples is important. Colabs help in this matter is greatly appreciated.

7. Ben Handcock and Dave Katzke reported that the Board of Trustees discussed not printing the book. Dave reported that over $4,000 is spent to print the book. Dave suggested the idea to move to an electronic version, since funding, timing and storage are issues. The electronic version could be received one week prior to the meeting based on registration payment. Power Point presentations could be utilized. Research is still needed to investigate implementation issues (i.e. web based, etc.). Dave request that these issues be researched by the HWWQC Technical Board.

8. John Oades gave a short overview of the Overseas Varietal Analysis (OVA) program. The OVA remains as an interface for overseas users and breeders.

This year six samples were submitted. Thanks to the breeders involved. They are surveyed by breeders to make this a more dynamic tool. Stephen Baenziger suggested that the overseas cooperatives relate what products that they make and use and report result differences as they are identified.

9. Ben Handcock thanked the KSU department of Grain Science and Industry for milling the samples and Richard Chen and Brad Seabourn for their services in compiling the final report.

10. Stephen Baenziger moved that the meeting be adjourned. Richard Kendrick seconded the motion. The motion passed by voice vote.

Respectfully submitted,
Tim Aschbrenner, Sec.

APPENDIX C

Hard Winter Wheat Quality Council Goals for Hard Winter Wheat Breeders

Hard Winter Wheat Quality Council

2006 Technical Board Officers

CHAIR: Brett Carver, Oklahoma State University

VICE CHAIR: Tim Aschbrenner, Cereal Food Processors

SECRETARY: Rollie Sears, AgriPro Wheat

MEMBER: Kendall McFall, Kansas State University

MEMBER: Margo Caley, USDA/ARS/HWWQL

2006 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.

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 in 1988

Operative Millers Subcommittee of the Technical Committee:

Definition: It is the millers' job to select and blend wheat in conjunction with the mill cereal chemist and then process the wheat into flours that meet the wide variety of user specifications for their particular products and operations.

Scope: The committee will cover the concerns of wheat quality from reception at the mill elevator through the milling process into finished flour. This includes identifying, grading, binning, storage, blending, cleaning, tempering and milling of the wheat, plus stream selection and treatment of finished flours to meet flour quality specifications.

Objectives: To improve the milling quality of developing wheat varieties through dialogue and cooperation with wheat breeders and other parties concerned with wheat and wheat products. Toward this end, the committee members will bring to the Technical Committee and Council, reports of quality characteristics that are helping or hurting their operations, or the operation of their associates in the industry. We will also point out positive and negative characteristics that we see in developing varieties with the intent of keeping wheat varieties with poor milling characteristics form being released.

Specifically the committee will work to define wheat quality, explain the importance of wheat quality to the council and establish objective standards and goals for measurable wheat characteristics.

Milling Quality of Wheat

Definition: Wheat of good milling quality is made up of sound, plump kernels of uniform size that mill easily, producing a high extraction rate of quality flour.

It is the position of the Operative Milling Subcommittee that good milling quality in wheat benefits the entire industry, from the breeder to the consumer, including the farmer, miller, and baker. This is based on the fact that virtually all Hard Red Winter Wheat is milled either domestically or overseas. Good or superior milling characteristics in wheat obviously benefit the U.S. flour millers in terms of daily capacity and yield, and in turn their customers. (i.e. if it takes 3 bushels of wheat to produce a cwt. of flour, the miller is going to have to pass this cost on to their customers or go out of business). Good milling characteristics also make marketing wheat to foreign countries much easier while poor milling qualities makes the job very difficult. This eventually backs up to the farmer in the form of reduced demand for their product. This in turn encourages increased farm storage which frequently has a very negative effect on the milling quality of wheat as well as the general quality of the grain, and further compounds the problems of the entire wheat flour industry.

Measurable Objectives for the Milling Quality of Wheat:

1. Kernel characteristics that are readily identifiable as to class. (i.e. Hard Red Winter, Hard Red Spring, etc). Historically identification has been by the physical shape and color of the kernel; in the future it will probably be by some standardized physical test.

2. Kernel characteristics for milling, particularly as they relate to yield or extraction. Large, plump kernels of uniform size with a minimum of shrunken and broken kernels.

Measurable Objectives:	30 gram TKW Over 7W-60% 0.5% Thru 9W
Minimum Acceptable:	24 gram TKW Over 7W-50% 1% Thru 9W

3. Test Weight: In the breeding program, test weight is less of a factor on milling quality than kernel characteristics. However, test weight has always been and most likely always will be part of our grain standards. Also, test weight is affected by shrunken and broken kernels as well as foreign material form the field which do have an effect on milling results. Therefore test weight should always be given consideration when developing new varieties.

Measurable Objective:	60 lbs./bu. or Better
Minimum Acceptable:	57 lbs./bu.

4. Desirable Milling Qualities: Thinner, stronger bran coats. Good bran endosperm separation with good protein recovery. Hardness, sifting and handling characteristics consistent with class history.

Measurable Objective:	76% Minimum Extraction at 0.48% on KSU pilot mill
Minimum Acceptable:	74% Extraction @0.48% ash on KSU pilot mill

5. Flour Color and Ash Content: As operating millers we want to emphasize the importance of “Bright” color and “Low” ash in the finished flour. The miller cannot improve the color of, nor reduce the ash of, the endosperm. If these qualities are not inherent in the wheat, they have a tremendous negative impact on all milling operations therefore should always be addressed in variety development.

Measurable Objective:	0.46% ash at 75% Extraction 50 Agtron at 75% Extraction
Unacceptable:	More than 0.5% ash at 75% Extraction Less than 40 Agtron at 75% Extraction

For your information: New form for 1989 crop samples

COOPERATOR BAKING FORM

SAMPLE GROUP _____ REPORTED BY: _____

SAMPL I.D. _____ COMPANY: _____

RECORD DATA IN APPROPRIATE BLANKS.
TO RESPOND DRAW A LINE THROUGH THE SCALE AT THE DESIRED LEVEL.

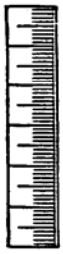
1 BAKE ABSORPTION (14% MB)

_____ %

Too High

Satisfactory

Too Low



2 LOAF VOLUME (c.c.)

_____ c.c.

Excellent

Very Poor

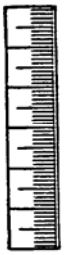
3 LOAF WEIGHT (grams)

_____ grams

4 SPONGE CHARACTERISTICS (for sponge dough only)

Satisfactory

Unsatisfactory



COMMENT _____

_____

_____

DOUGH CHARACTERISTICS

5 OUT OF MIXER

Excellent

Very Poor

If rated poor, was it:

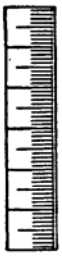
☐ Bucky-Tough ☐ Weak, Short-Sticky

COMMENT _____

6 AT MAKE UP

Excellent

Very Poor



If rated poor, was it:

☐ Bucky-Tough ☐ Weak, Short-Sticky

COMMENT _____

For your information: New form for 1989 crop samples

SAMPLE I.D. _____

MIXING CHARACTERISTICS

7 BAKE MIXING TIME

Very Long

Medium

Very Short

_____ min.

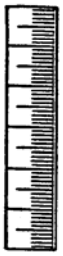
COMMENT _____

8 MIXING TOLERANCE

Excellent

Average

Very Poor



COMMENT _____

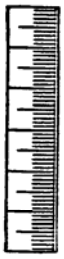
INTERNAL CHARACTERISTICS

9 CRUMB COLOR

Excellent

Average

Very Poor

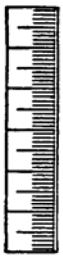


COMMENT _____

10 GRAIN

Close

Open

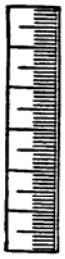


COMMENT _____

11 TEXTURE

Silky

Very Harsh



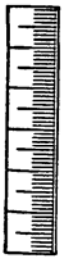
COMMENT _____

12 OVERALL BAKING QUALITY

Excellent

Average

Very Poor



COMMENT _____

March 20, 1989
BOB BEQUETTE
CHAIRPERSON, TECHNICAL COMMITTEE
WHEAT QUALITY COUNCIL

DEAR BOB;

Please note below the revised goals and objectives of the flour mill chemists subcommittee, which are to be submitted to the wheat breeders.

1. Adaptability over a large geographic area.
   Wheat varieties should be adaptable over a large geographic area retaining their integrity. Current economics and trends suggests that good producing wheats will not and can not be restricted to small geographic regions.

2. More quality evaluation in early generation stage.
   More and better testing should be developed and done at the early generation level to screen varieties before the F7. Unfortunately by the F7 generation there is too much investment not to release a variety.

3. Emphasize protein quality, not just quantity.
   Protein quantity is important to a certain level, beyond which gluten or protein quality is of greatest concern.

4. Gluten strength – mixing time
   It has been suggested that the varietal mix with respect to gluten strength should be approximately 60% strong/40% mellow. This is acceptable as long as the seeded acreage represents this approximate mix. It is important to note that a reasonably broad range of gluten characteristics is needed in order to meet the current demands placed on flour by the various end users. A wheat supply of one variety or gluten type is undesirable.

5. Improved mixing tolerance “extensible gluten”
   We need improve mixing tolerance but with an “extensible gluten” rather than that of bucky and tough. It must also be able to withstand the abnormal and mechanical conditions of today’s plants and baking systems.

6. Grain and texture – Not just volume
   In quality testing it is important to evaluate grain and texture in addition to volume and oxidation requirements. It is very important to strive to achieve a close, even grain, elongated cell structure, and a smooth silky texture.

Sincerely,

Keith Ehmke
CC: Members of mill chemists subcommittee
Bob Reid, Chairperson Millers Subcommittee

Wheat Quality Council – Wheat Breeders Subcommittee

Report to Technical Advisory Committee – February 22, 1989

The Wheat breeding subcommittee met during the meeting of the Hard Red Winter Wheat Improvement Committee at Dallas, TX on February 1, 1989. The breeders would like to thank Campbell-Taggart for inviting a group of public breeders that this type of interaction is critical to a real understanding of the problems encountered in a commercial baking situation and the importance of specific functional dough properties at every stage of the production line. We encourage the membership of the Wheat Quality Council to continue to participate in these interactive activities and to include all breeders, public and private, in the future.

Breeders have, for many years, asked the Wheat Quality Council to provide them with specific guidance about aspects of wheat quality which the council considers important. Generally, this guidance has been from a negative point of view, i.e. what millers and bakers did not like about a specific variety. We need positive targets toward which we can work. The breeders in the region suggest that the Board of Directors of the Wheat Quality Council appoint a committee to investigate the possibility of developing a set of milling and baking targets for use by breeders. These targets should include the ranges of acceptability for individual characteristics rather than specific numeric goals and they should represent the realistic expectations of millers and bakers rather than the "ideal" situation.

The wheat breeders in the hard wheat region appreciate the suggestions offered them by the millers subcommittee and look forward to closer interaction with them in the future. Responses to specific suggestions follow:

1. Millers are concerned that wheat varieties bred for specific adaptation might leave their area of adaptation and hurt wheat quality. Breeders feel that breeding for specific adaptation is one of the most rapid routes to improvement and that if varieties are widely adapted for other agronomic characteristics, they also will be widely adapted for milling and baking quality. Results from the uniform grow-out system being used by the Wheat Quality Council should determine how wide this "quality" adaptation is.

2. Millers would like to see wider use of early generation quality evaluations. This concern is shared by many of the breeders in the region but, in most cases, is unrealistic due to shrinking research dollars and small quantities of seed.

3. Millers encourage breeders to consider protein quality as much as protein quantity. Further, millers believe there should be a mix of varieties in the region such that 60% of the varieties are strong gluten types and 40% have mellow gluten. Breeders appreciate the need for more emphasis on protein quality but feel that it would be very difficult to base decisions on variety releases by the need for greater or fewer numbers of strong or mellow gluten wheats. Breeders recognize producers as the

ultimate decision makers in the acceptance and spread of new wheat varieties under the current system of marketing. Should the marketing system change to an identity preserved system or some other system of producer rewards for specific quality characteristics, then it might be somewhat less difficult to maintain a regional variety mix based on gluten strength.

4. Millers wish to encourage breeders to place more emphasis on grain and texture and less emphasis on loaf volume. Breeders appreciate the suggestion and will work with their respective wheat quality labs in that regards.

Finally, there is concern among breeders that a perception exists within the Wheat Quality Council that breeders pay little heed to the advice of the Wheat Quality Council membership. Specific examples from recent WQC annual meetings can be cited by breeders as major factors in decisions not to release varieties. Breeders consider the WQC tests an important part in the final development of improved varieties of wheat.

Report submitted by W. David Worrall, Chairman of Wheat Breeders Subcommittee.

Mr. Robert K. Bequette
Chairman, Technical Committee
Wheat Quality Council
Manhattan, Kansas 66502

Dear Mr. Chairman,

The following constitutes the consensus of the grain trade Subcommittee of the Wheat Quality Council's Technical Committee.

Subcommittee members share a perception that other interest groups (millers, bakers, and breeders) represented in the Council fail to recognize the grain trade as an integral link in the wheat quality chain. The absence of the grain trade is apparent on the many talk panels which purport to draw industry wide input and often include a 1). farmer, 2.) wheat breeder, 3.) miller, etc., but most often exclude the grain trades point of view.

The subcommittee would like to see the Chairman actively seek a place for representation of the grain trade point of view on future panels sponsored by the Council. Certainly, wheat production, milling, and baking as they exist today would not be possible except for such manifestations of the Grain Trade as the U.S. wheat futures markets. Subcommittee members believe this is true also of other manifestations of the Grain Trade such as the ability to store and maintain wheat, ship appropriate quantities, and the willingness to take the risk of cash ownership.

Responding to an earlier request for input from the Grain Trade, one representative cited these areas in which support from the Council (and breeders) would be helpful to the grain trade.

1. Conformation to class. Spring wheat should look like spring wheat. It should behave like spring wheat when baked.

2. Feed Wheat. We are interested in feeding wheat, but not in "feed wheat". HRW wheat should make a good loaf of bread. Farmers who want to raise "feed wheat" should grow sorghum.

3. Kernel Hardness. Resistance to breakage during transfer is a quality concern.

4. Protein Content is a quality concern.

5. Uniformity of Coat Color a deep read color, (no bleached out white wheat) vitreousness, and absence of yellow berries are quality concern.

6. Resistance to Sprouting is a concern.

7. Resistance to insect infestation including stored grain insects is a concern.

8. Disease resistance is a concern.

9. Test Weight is a critical index of wheat quality for the Grain Trade and its customers.

10. Cleanliness, wholesomeness, and freshness are also quality concerns which may not enter the province of the Council, however, ease of harvesting without dockage contamination (shattering) may perhaps be a goal for breeders.

To this earlier list, the Subcommittee adds a concern for uniformity of kernel size and enhanced kernel size.

We endorse the OTA report and the importance of variety (and perhaps variety control) to the enhancing of future U.S. wheat exports. Subcommittee members agree it is time for USDA to change its production/marketing posture to concern for quality and food safety.

Sincerely,

J.R. Coughenour, Subcommittee Chairman

APPENDIX D

End-Use Quality Targets for Hard Red Winter Wheat

RECOMMENDED* QUALITY TARGETS FOR HARD RED WINTER WHEAT

HWW Quality Targets Committee
Approved February, 2006

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

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

CONTACT:
USDA/ARS Grain Marketing and Production Research Center
Hard Winter Wheat Quality Laboratory
1515 College Avenue, Manhattan, KS 66502-2796
VOICE: (785) 776-2751 FAX: (785) 537- 5534 EMAIL: bradford.seabourn@gmprc.ksu.edu

APPENDIX E

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.

Thank you very much for reviewing the report. Please let Brad Seabourn and Richard Chen know if you have any suggestions or recommendations for improving quality of the report for WQC hard winter wheat. Richard can be reached at (785)776-2750 or by email, Richard.chen@gmprc.ksu.edu; and Brad can be reached at (785)776-2751 or by email, Bradford.seabourn@gmprc.ksu.edu.