OKLAHOMA

18-2418	Jagalene (CC06)
18-2419	Ruby Lee
18-2420	OK12716-159319-13
18-2421	OK13621
18-2422	OK12206-127206-2
18-2423	OK1059018-129332-5

Description of Test Plots and Breeder Entries

Oklahoma – Brett Carver

The North Central Agronomy Research Station at Lahoma (12 miles west of Enid) normally plays sole host in Oklahoma to the WQC growout. Severe season-long drought, combined with an ill-timed reduction in plot size, created sample deficiencies for all entries submitted to the 2018 evaluation program. Thus, each entry except Ruby Lee was supplemented with grain harvested from other locations as tabulated below. The Lahoma location provided a significant source of grain for all entries, but contributions from other sites varied among entries. Caution should thereby be exercised in comparing quality attributes among entries. Due consideration was given to known or intended variety positioning when sourcing grain from locations other than Lahoma.

No location was impacted by foliar diseases due to the lack of natural infection or the use of a fungicide. All sites were fertilized to satisfy a yield goal of 60 bu/ac or more. Hence nitrogen supply probably exceeded crop use.

All samples were submitted on the blind, as no OSU WQL data could be generated prior to sample submission. What is news to the reader is news to the breeder.

Entry	*Source 1 Location*	*Pounds*	*Source 2 Location*	*Pounds*	*Source 3 Location*	*Pounds*
Jagalene	Lahoma	85	Goodwell	95		
Ruby Lee	Lahoma	180				
OK12716-159319-13	Lahoma	80	Perkins	100		
OK13621	Lahoma	100	Nerkirk	80		
OK12206-127206-2	Lahoma	65	Okmulgee	60	Goodwell	60
OK1059018-129332-5	Lahoma	100	Goodwell	80		

2018 Wheat Quality Council growout, Lahoma, OK, also site of the Lahoma Wheat Tour on 11 May 2018.

Ruby Lee (local check)

This 2011 release with pedigree KS94U275/Endurance is a proven winner in milling and baking performance and thus our gold standard against which other experimental lines are assessed for end-use quality. Acreage of Ruby Lee continues to drop from a peak of nearly 7% in 2016 to 2.4% in 2018. Ruby Lee is known to have excellent grazeability including grazing tolerance, but also cold tolerance, resilience to April freeze events, temperature-sensitive Hessian fly resistance, and the otherwise-dreaded 2+12 glutenin subunit pair. No new OSU variety is currently in sight having Ruby Lee as a parent.

OK12716-159319-13

Destined as an all-purpose variety, the composite line OK12716 features a relatively high yield ceiling in a grain-only production system but offers complete adaptation to a dual-purpose management system with good canopy closure at adequate seeding density, outstanding forage regeneration and grazing recovery, and Hessian fly resistance. OK12716 will be marketed by OGI with the **Graze*n*Grain**® brand under the name **Showdown**. Test weight is in the Endurance or higher range but certainly not as high as Doublestop CL Plus. Dough strength and kernel characteristics are acceptable but not stellar. Disease resistance is broad and strong, with the possible exception of leaf rust when the disease comes early at levels observed in 2017. Adaptation is very wide, extending from the Rolling Plains of Texas to central Kansas, including the Oklahoma panhandle. Its parentage includes an OK Bullet sister and an AgriPro experimental line.

OK13621

Stitched in the pattern of Ruby Lee and Doublestop CL+, OK13621 looks to be this program's next ambassador for fine quality. If it is not OK13621 it will be Skydance (OK13625).

Previously tested as sample 17-2429 in the 2017 WQC evaluation program, OK13621 is back for another checkup. Thanks to the USDA-ARS HWWQL, we have 'ograph data on statewide flour samples from two extremely bearish years, 2016 and 2017. Forget 2018 – it would make sooners look like saints. For the farinograph, OK13621 averaged 2.5 min peak time, 12.4 min stability, and 57.1% absorption. For the amylograph, OK13621 averaged 271 10E-4 J W value, 87 mm P value, 75 mm L value, and 1.18 P/L ratio. Mean statewide wheat protein content for OK13621 was 12.4% (2016) and 12.7% (2017). OK13621 produces smaller seed than Gallagher (similar to Iba) at about one-half percentage point higher wheat protein than Gallagher. For bonus, PPO is low but not zero.

In the field, OK13621 has shown a high level of adult-plant resistance from Oklahoma to Washington, though resistance to early infections of leaf rust may need to be bolstered with a fungicide application. OK13621 will fit best in the Oklahoma panhandle and north central

Oklahoma. Maturity is very early. Release approval was provided by OSU in September 2018, and the variety will be licensed as **Baker's Ann** by Oklahoma Genetics, Inc. (OGI) under a modified distribution and production system that places value on genetically conserved, quality-enhanced grain. TX00D1390 and Billings are the proud parents.

OK12206-127206-2

Whoever started the rumor that beardless wheats are made for grazing and not for baking should help rewrite the script. Branded in the hide of this beardless beast is *Steak*n*Bake*, as a tribute to its dual functionality in the pasture and the pan. OK12206-127206-2 exhibits an exceptional range of disease resistance (wheat soil-borne mosaic/wheat spindle streak mosaic, stripe rust, adult plant for leaf rust, powdery mildew, and tan spot) in addition to Hessian fly resistance, accelerated canopy closure, good grazing tolerance, and moderate acid soil tolerance. Tolerance also comes in the form of dough mixing, combined with above-average loaf volumes and crumb grain scores. In 2017, farinograph peak time was 7 min with a stability time of 16 min. Farinograph absorption tends to run below-average, but a history of wide variability in test weight from unacceptable to above average is what puts this line on a sticky wicket. Parentage of OK12206-127206-2 covers a lot of genetic ground: Y98-912, a soft red winter variety from WestBred; OK03716W that traces to Pioneer and Ukrainian germplasm; and a sister of OK Bullet. We find this line appealing for its ability to satisfy a growing demand for high-performing beardless wheat, where performance does not necessarily stop with a hay chop.

OK1059018-129332-5

A descendent of Billings/Duster, this re-selected and re-purified experimental line has the potential for a broad-utility release, if not another experimental line named OK14P212. OK1059018-129332-5 was chosen over OK14P212 for 2018 WQC testing because, while it may be slightly inferior in statewide yield ranking, its quality performance has been top-tier in the program. OK1059018-129332-5 is highly fit for dual-purpose graze-plus-grain systems, and it sports multiple resistances to Hessian fly, stripe rust (adult-plant), leaf rust (all-season), powdery mildew, acid soils, and barley yellow dwarf. What is even more impressive is a protein content record that even exceeds Doublestop CL+, a proportionately high absorption, and mixing tolerance that rivals OK13621. Straw strength may be its only non-strength.

Oklahoma: 2018 (Small-Scale) Samples

Test entry number	18-2418	18-2419	18-2420
Sample identification	**Jagalene (CC06)**	**Ruby Lee**	**OK12716-159319-13**
Wheat Data			
GIPSA classification	1 HRW	2 HRW	3 HRW
Test weight (lb/bu)	60.4	59.5	57.6
Hectoliter weight (kg/hl)	79.4	78.2	75.8
1000 kernel weight (gm)	29.6	28.6	25.9
Wheat kernel size (Rotap)			
Over 7 wire (%)	32.1	49.2	62.2
Over 9 wire (%)	66.8	49.7	37.3
Through 9 wire (%)	1.1	1.1	0.5
Single kernel (skcs)[a]			
Hardness (avg /s.d)	72.6/17.9	53.4/17.3	62.5/17.1
Weight (mg) (avg/s.d)	29.6/11.4	28.6/10.7	25.9/9.3
Diameter (mm)(avg/s.d)	2.58/0.37	2.49/0.43	2.34/0.35
Moisture (%) (avg/s.d)	12.7/0.4	12.4/0.3	11.9/0.4
SKCS distribution	02-05-14-79-01	13-20-31-36-03	04-12-27-57-01
Classification	Hard	Mixed	Hard
Wheat protein (12% mb)	14.1	13.6	15.2
Wheat ash (12% mb)	1.32	1.42	1.26
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	76.1	75.3	75.2
Quadrumat Sr. Mill	70.8	70.0	70.3
Flour moisture (%)	13.1	13.0	12.8
Flour protein (14% mb)	13.2	12.6	14.2
Flour ash (14% mb)	0.55	0.49	0.49
Rapid Visco-Analyser			
Peak time (min)	6.1	6.3	6.0
Peak viscosity (RVU)	212.5	262.3	251.9
Breakdown (RVU)	76.3	95.6	89.8
Final viscosity at 13 min (RVU)	252.5	293.2	292.3
Minolta color meter			
L*	91.05	91.41	90.63
a*	-1.25	-0.97	-1.07
b*	9.20	7.52	9.34
PPO	0.500	0.526	0.632
Falling number (sec)	446	473	546
Damaged Starch			
(AI%)	97.9	95.9	96.2
(AACC76-31)	7.8	6.2	6.4

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

Oklahoma: 2018 (Small-Scale) Samples (Continued)

Test entry number	18-2421	18-2422	18-2423
Sample identification	**OK13621**	**OK12206-127206-2**	**OK1059018-129332-5**
Wheat Data			
GIPSA classification	2 HRW	3 HRW	2 HRW
Test weight (lb/bu)	59.7	57.0	58.3
Hectoliter weight (kg/hl)	78.5	75.0	76.6
1000 kernel weight (gm)	26.9	27.9	27.9
Wheat kernel size (Rotap)			
Over 7 wire (%)	60.5	63.3	42.2
Over 9 wire (%)	38.0	36.5	57.1
Through 9 wire (%)	1.5	0.2	0.7
Single kernel (skcs)[a]			
Hardness (avg /s.d)	62.2/19.4	61.2/16.0	66.0/17.2
Weight (mg) (avg/s.d)	26.9/9.7	27.9/10.1	27.9/11.1
Diameter (mm)(avg/s.d)	2.38/0.37	2.44/0.40	2.41/0.40
Moisture (%) (avg/s.d)	12.0/0.5	12.5/0.5	11.9/0.6
SKCS distribution	07-14-24-55-01	05-11-30-54-01	13-08-27-62-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	13.3	14.0	14.5
Wheat ash (12% mb)	1.38	1.44	1.41
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	75.1	75.1	73.0
Quadrumat Sr. Mill	69.0	69.0	68.5
Flour moisture (%)	12.5	12.7	12.7
Flour protein (14% mb)	12.2	13.1	13.5
Flour ash (14% mb)	0.49	0.60	0.53
Rapid Visco-Analyser			
Peak time (min)	6.1	6.2	6.2
Peak viscosity (RVU)	258.8	216.9	211.8
Breakdown (RVU)	98.9	73.3	66.8
Final viscosity at 13 min (RVU)	288.1	263.3	268.0
Minolta color meter			
L*	91.34	91.27	90.56
a*	-1.09	-1.04	-1.03
b*	8.43	8.67	9.16
PPO	0.209	0.169	0.473
Falling number (sec)	515	465	484
Damaged Starch			
(AI%)	97.0	96.5	97.7
(AACC76-31)	7.1	6.7	7.7

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

Oklahoma: Physical Dough Tests and Gluten Analysis
2018 (Small-Scale) Samples

Test Entry Number	18-2418	18-2419	18-2420
Sample Identification	Jagalene (CC06)	Ruby Lee	OK12716-159319-13
MIXOGRAPH			
Flour Abs (% as-is)	66.8	66.6	69.1
Flour Abs (14% mb)	65.8	65.5	67.9
Mix Time (min)	4.3	5.0	4.5
Mix tolerance (0-6)	4	5	3
FARINOGRAPH			
Flour Abs (% as-is)	63.3	60.1	62.5
Flour Abs (14% mb)	62.3	59.1	61.5
Peak time (min)	9.3	5.5	7.5
Mix stability (min)	17.4	16.9	15.2
Mix Tolerance Index (FU)	16	20	16
Breakdown time (min)	19.6	13.5	16.5
ALVEOGRAPH			
P(mm): Tenacity	100	76	83
L(mm): Extensibility	95	131	137
G(mm): Swelling index	21.7	25.5	26.1
W(10^{-4} J): strength (curve area)	358	338	388
P/L: curve configuration ratio	1.05	0.58	0.61
Ie(P_{200}/P): elasticity index	65.2	62.6	64.8
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	443/524/542	438/576/601	413/682/751
Extensibility (mm at 45/90/135 min)	164/160/148	152/148/144	152/142/140
Energy (cm^2 at 45/90/135 min)	139/165/153	125/163/157	120/176/183
Resist $_{max}$ (BU at 45/90/135min)	663/859/846	664/920/894	634/1021/1103
Ratio (at 45/90/135 min)	2.7/3.3/3.7	2.9/3.9/4.2	2.7/4.8/5.4
PROTEIN ANALYSIS			
HMW-GS Composition	1,2*, 17+18, 5+10	2*, 7+8, 2+12	1, 7+9, 2+12
TMP/TPP	0.99	1.04	0.86
SEDIMENTATION TEST			
Volume (ml)	58.4	68.3	66.7

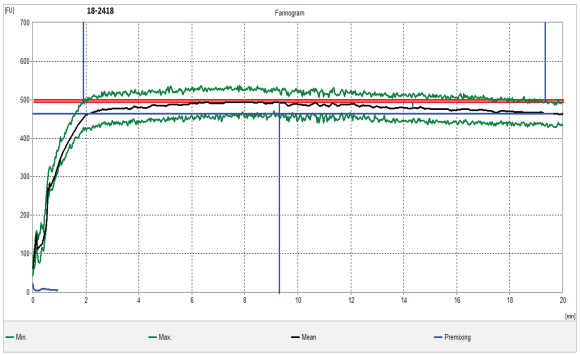
Oklahoma: Physical Dough Tests and Gluten Analysis 2018 (Small-Scale) Samples (continued)

Test Entry Number	18-2421	18-2422	18-2423
Sample Identification	OK13621	OK12206-127206-2	OK1059018-129332-5
MIXOGRAPH			
Flour Abs (% as-is)	65.8	67.0	69.1
Flour Abs (14% mb)	64.5	65.8	67.8
Mix Time (min)	6.8	4.6	3.5
Mix tolerance (0-6)	6	4	4
FARINOGRAPH			
Flour Abs (% as-is)	60.3	60.4	65.6
Flour Abs (14% mb)	59.0	59.2	64.3
Peak time (min)	4.0	7.5	6.0
Mix stability (min)	14.5	16.9	12.1
Mix Tolerance Index (FU)	21	15	21
Breakdown time (min)	12.5	18.5	12.7
ALVEOGRAPH			
P(mm): Tenacity	94	83	105
L(mm): Extensibility	79	117	110
G(mm): Swelling index	19.8	24.1	23.3
W(10^{-4} J): strength (curve area)	307	338	357
P/L: curve configuration ratio	1.19	0.71	0.95
Ie(P_{200}/P): elasticity index	68.1	63.1	56.1
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	563/839/852	457/565/608	373/421/443
Extensibility (mm at 45/90/135 min)	169/153/142	148/137/144	156/163/161
Energy (cm^2 at 45/90/135 min)	213/249/227	125/135/163	108/132/141
Resist $_{max}$ (BU at 45/90/135min)	1075/1355/1367	664/779/921	517/625/674
Ratio (at 45/90/135 min)	3.3/5.5/6.0	3.1/4.1/4.2	2.4/2.6/2.8
PROTEIN ANALYSIS			
HMW-GS Composition	1, 7+8, 5+10	1, 17+18, 5+10	1,2*, 7+9, 5+10
TMP/TPP	1.15	0.91	0.97
SEDIMENTATION TEST			
Volume (ml)	62.2	60.3	54.3

Physical Dough Tests

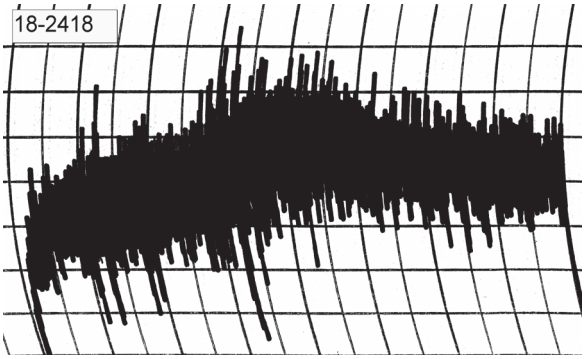
2018 (Small Scale) Samples - Oklahoma

Farinograms



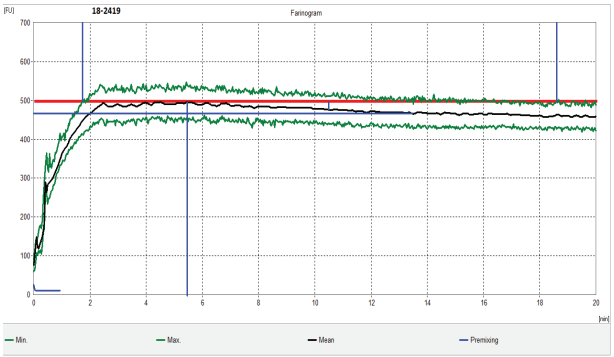
Water abs = 62.3%, Peak time = 9.3 min,
Mix stab = 17.4 min, MTI = 16 FU

Mixograms

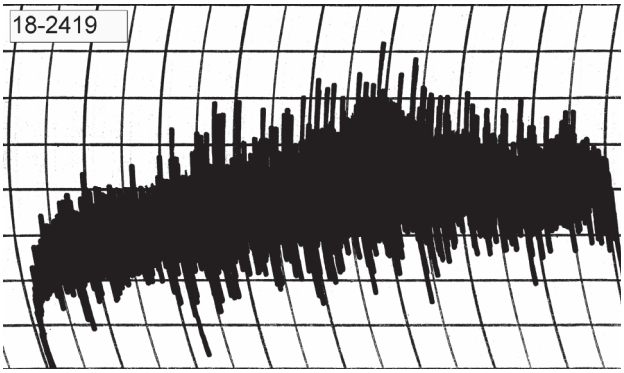


Water abs = 65.8%
Mix time = 4.3 min

18-2418, Jagalene (CC06)



Water abs = 59.1%, Peak time = 5.5 min,
Mix stab = 16.9 min, MTI = 20 FU



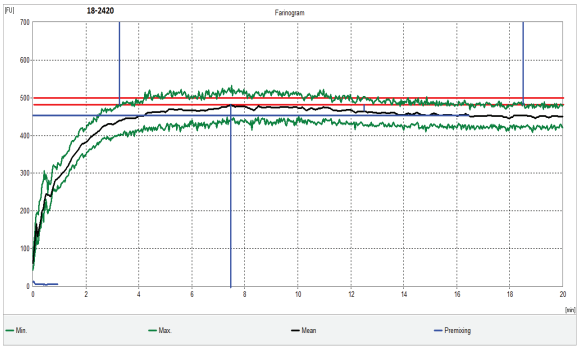
Water abs = 65.5%
Mix time = 5.0 min

18-2419, Ruby Lee

Physical Dough Tests

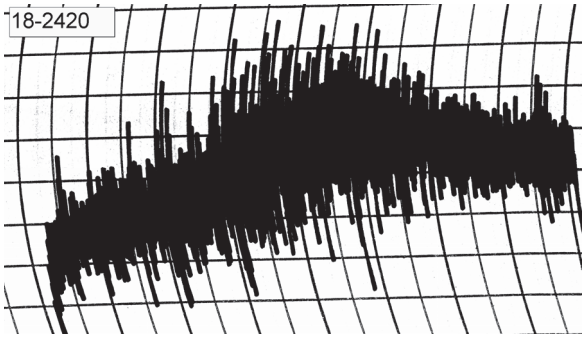
2018 (Small Scale) Samples - Oklahoma

Farinograms



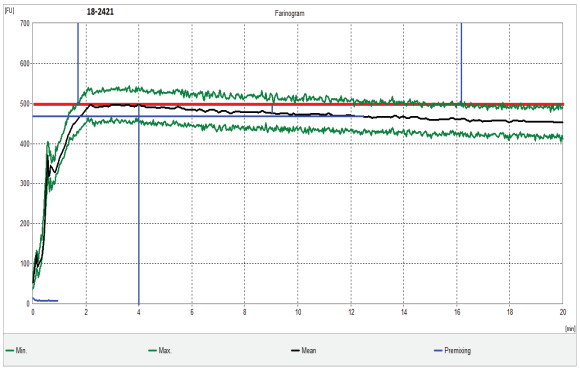
Water abs = 61.2%, Peak time = 7.5 min,
Mix stab = 15.2 min, MTI = 16 FU

Mixograms

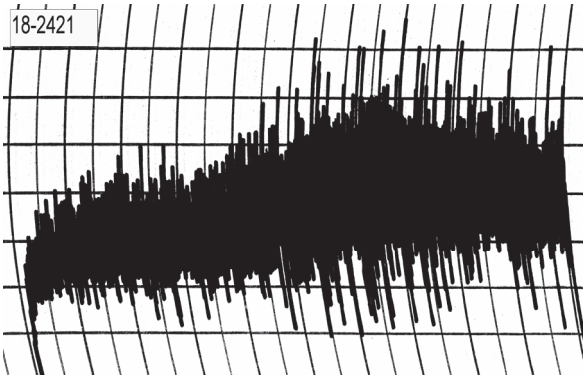


Water abs = 67.9%
Mix time = 4.5 min

18-2420, OK12716-159319-13



Water abs = 59.0%, Peak time = 4.0 min,
Mix stab = 14.5 min, MTI = 21 FU



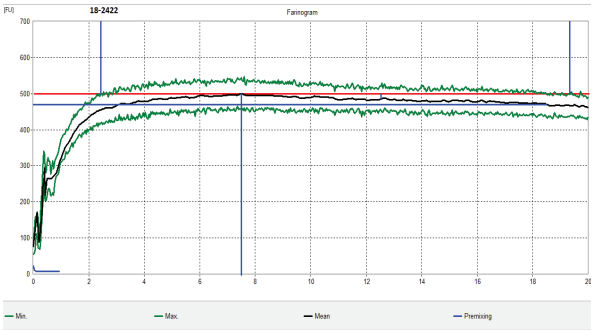
Water abs = 64.5%
Mix time = 6.8 min

18-2421, OK13621

Physical Dough Tests

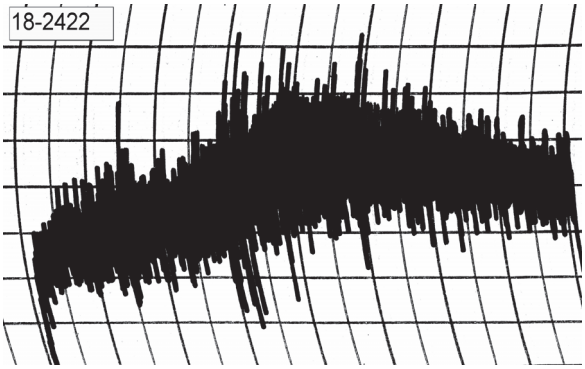
2018 (Small Scale) Samples - Oklahoma

Farinograms



Water abs = 59.2%, Peak time = 7.5 min,
Mix stab = 16.9 min, MTI = 15 FU

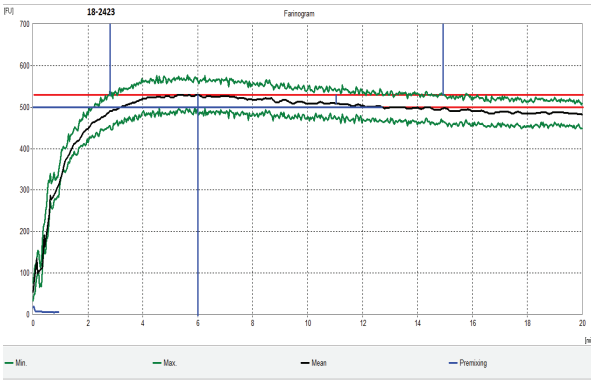
Mixograms



Water abs = 65.8%
Mix time = 4.6 min

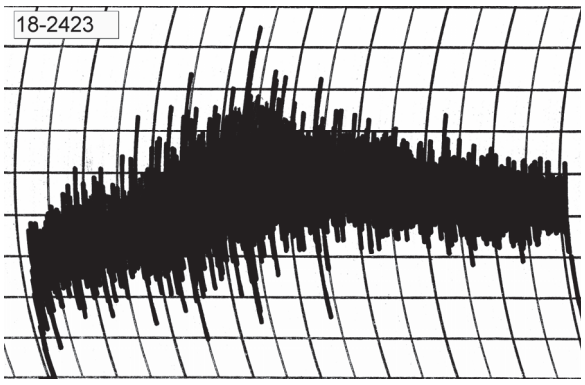
18-2422, OK12206-127206-2

Farinograms



Water abs = 64.3%, Peak time = 6.0 min,
Mix stab = 12.1 min, MTI = 21 FU

Mixograms

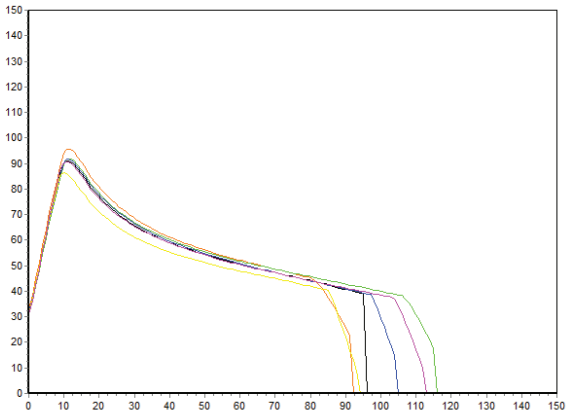


Water abs = 67.8%
Mix time = 3.5 min

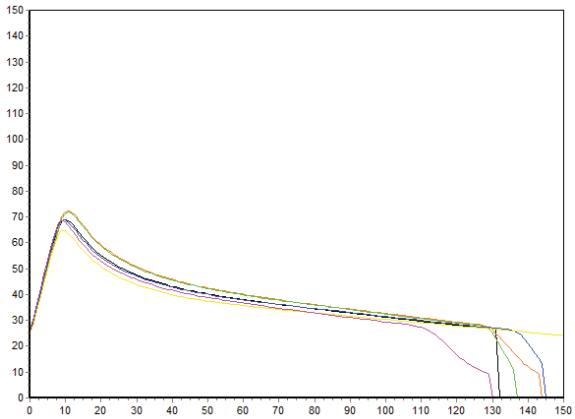
18-2423, OK1059018-129332-5

Physical Dough Tests - Alveograph

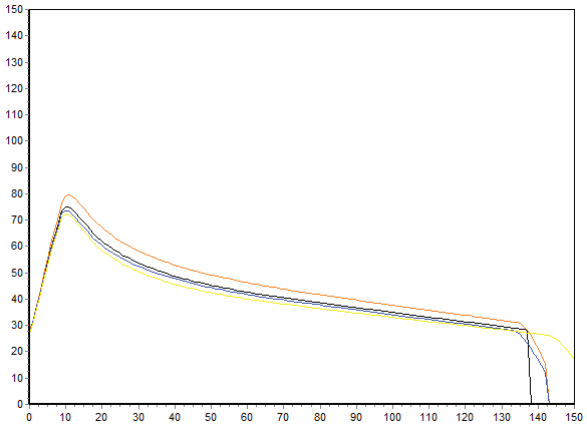
2018 (Small Scale) Samples – Oklahoma



18-2418, Jagalene (CC06)
P(mm H_20) =100, L(mm) = 95, W($10E^{-4}$ J) = 358



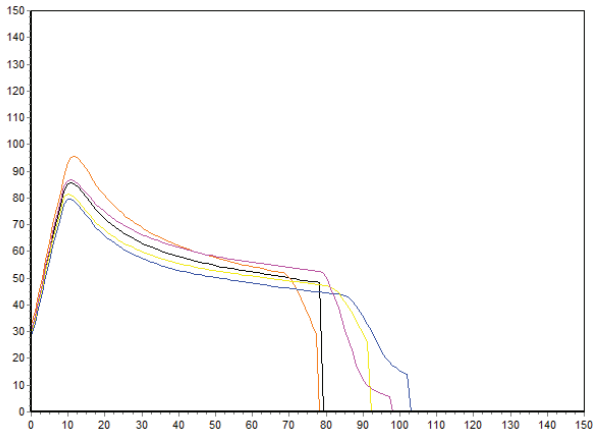
18-2419, Ruby Lee
P(mm H_20) = 76, L(mm) = 131, W($10E^{-4}$ J) = 338



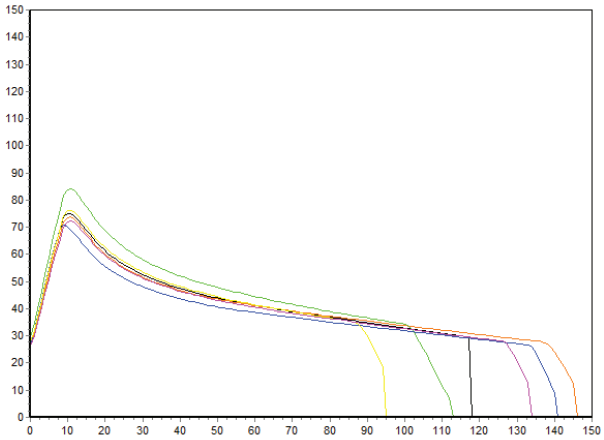
18-2420, OK12716-159319-13
P(mm H_20) =83, L(mm) = 137, W($10E^{-4}$ J) = 388

Physical Dough Tests - Alveograph

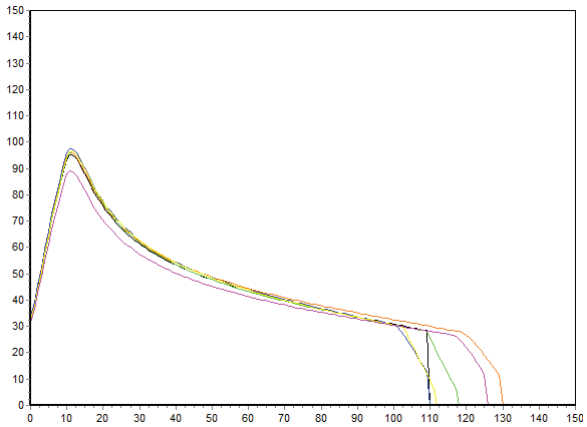
2018 (Small Scale) Samples – Oklahoma



18-2421, OK13621
P(mm H_20) =94, L(mm) = 79, W(10E^{-4} J) = 307



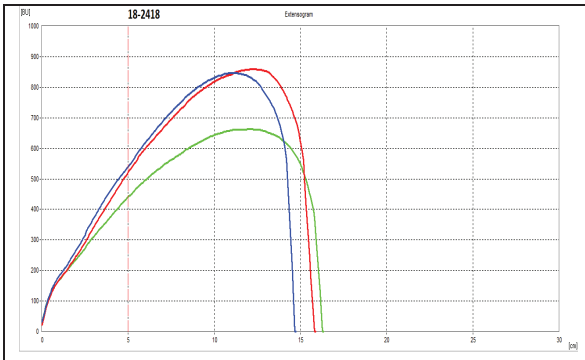
18-2422, OK12206-127206-2
P(mm H_20) = 83, L(mm) = 117, W(10E^{-4} J) = 338



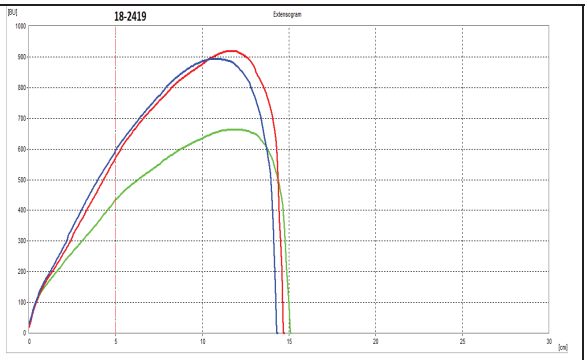
18-2423, OK1059018-129332-5
P(mm H_20) =105, L(mm) = 110, W(10E^{-4} J) = 357

Physical Dough Tests - Extensigraph

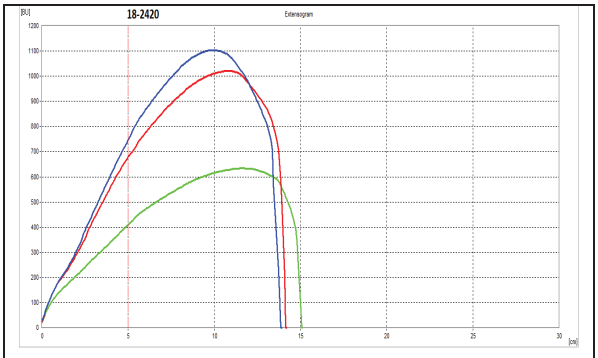
2018 (Small Scale) Samples – Oklahoma



18-2418, Jagalene (CC06)
R (BU) =524, E (mm) = 160, W (cm^2) = 165
Rmax (BU) = 859, Ratio = 3.3 at 90 min



18-2419, Ruby Lee
R (BU) = 576, E (mm) = 148, W (cm^2) = 163
Rmax (BU) = 920, Ratio = 3.9 at 90 min

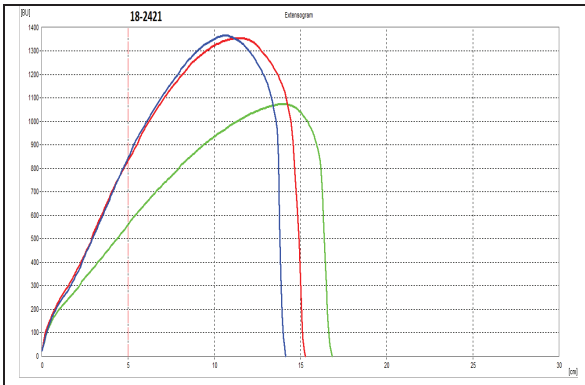


18-2420, OK12716-159319-13
R (BU) = 682, E (mm) = 143, W (cm^2) = 176
Rmax (BU) = 1021, Ratio = 4.8 at 90 min

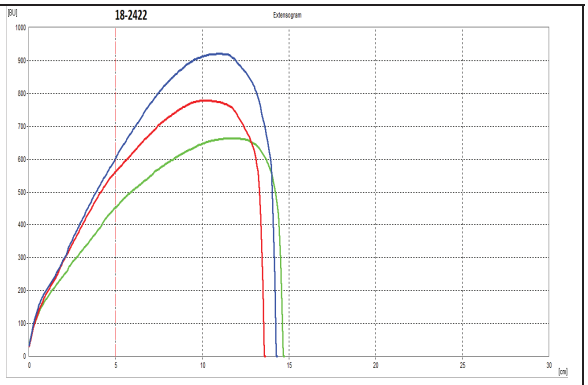
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigraph

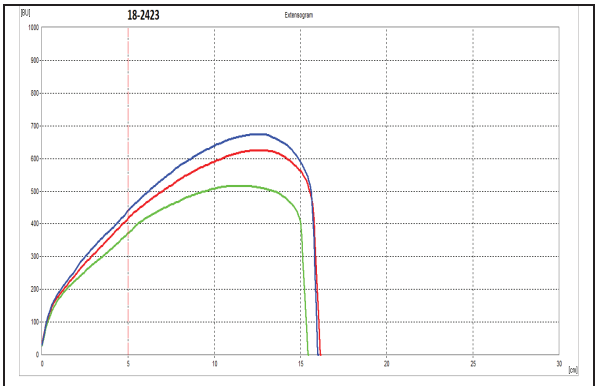
2018 (Small Scale) Samples – Oklahoma



18-2421, OK13621
R (BU) = 839, E (mm) = 153, W (cm^2) = 249
Rmax (BU) = 1355, Ratio = 5.5 at 90 min



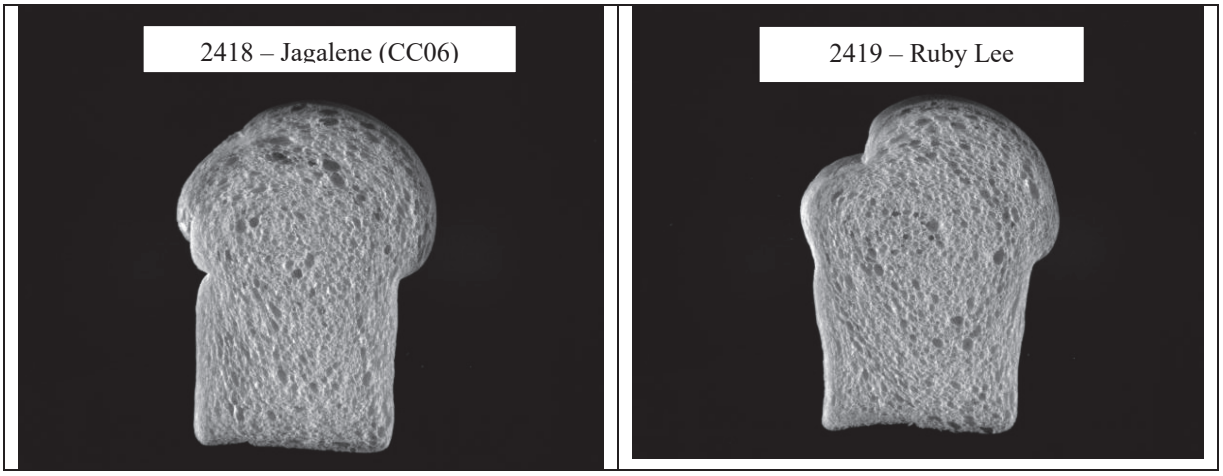
18-2422, OK12206-127206-2
R (BU) = 565, E (mm) = 137, W (cm^2) = 135
Rmax (BU) = 779, Ratio = 4.1 at 90 min



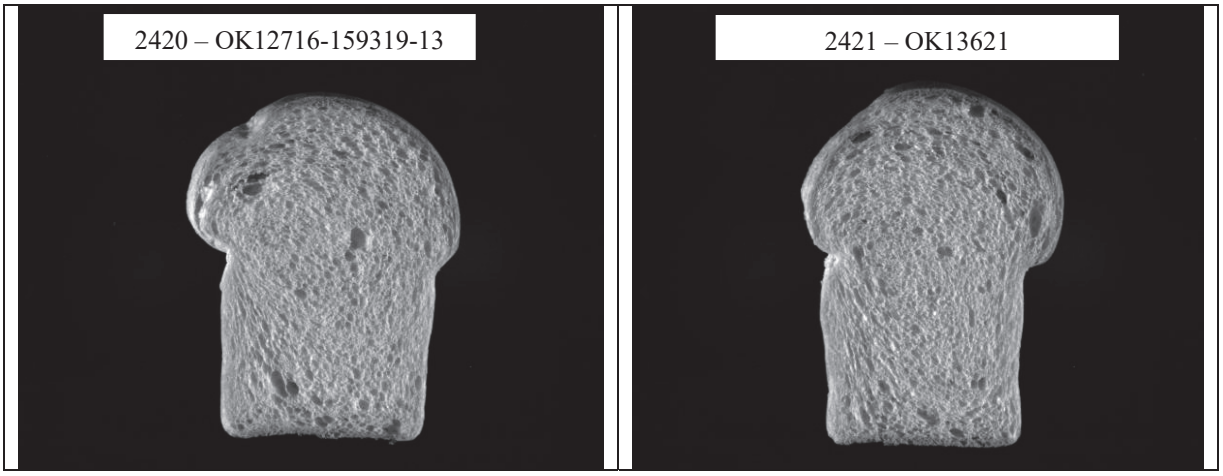
18-2423, OK1059018-129332-5
R (BU) = 421, E (mm) = 163, W (cm^2) = 132
Rmax (BU) = 625, Ratio = 2.6 at 90 min

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

Oklahoma: C-Cell Bread Images and Analysis
2018 (Small-Scale) Samples

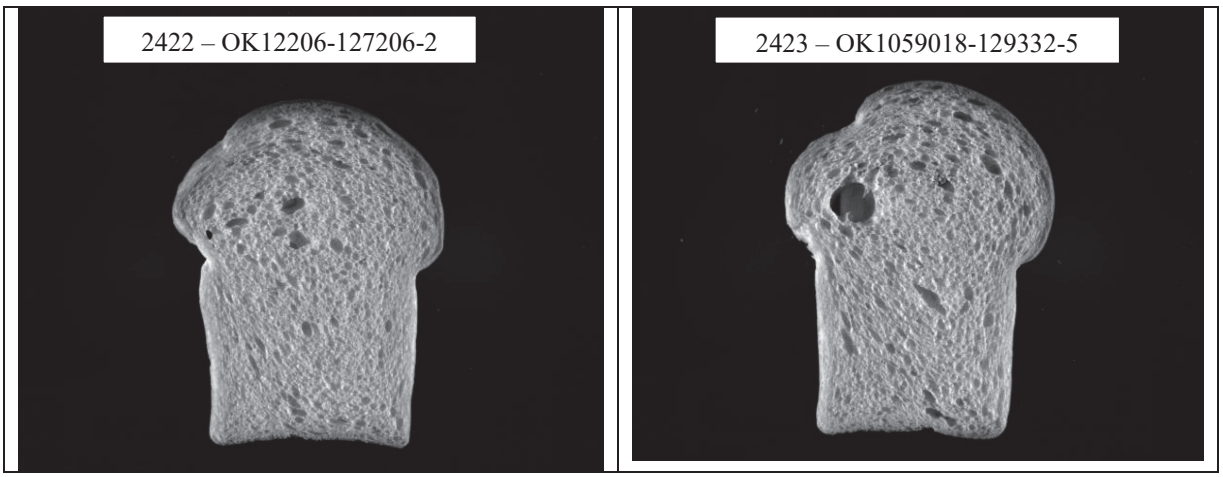


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2418	6974	142	4068	0.442	2.210	2.561	1.780	-13.90
2419	6908	145	4417	0.433	2.026	1.329	1.720	-15.00



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	7255	144	4619	0.433	2.020	2.184	1.775	-15.80
2421	7531	142	4494	0.436	2.029	0.769	1.735	-12.70

Oklahoma: C-Cell Bread Images and Analysis
2018 (Small-Scale) Samples

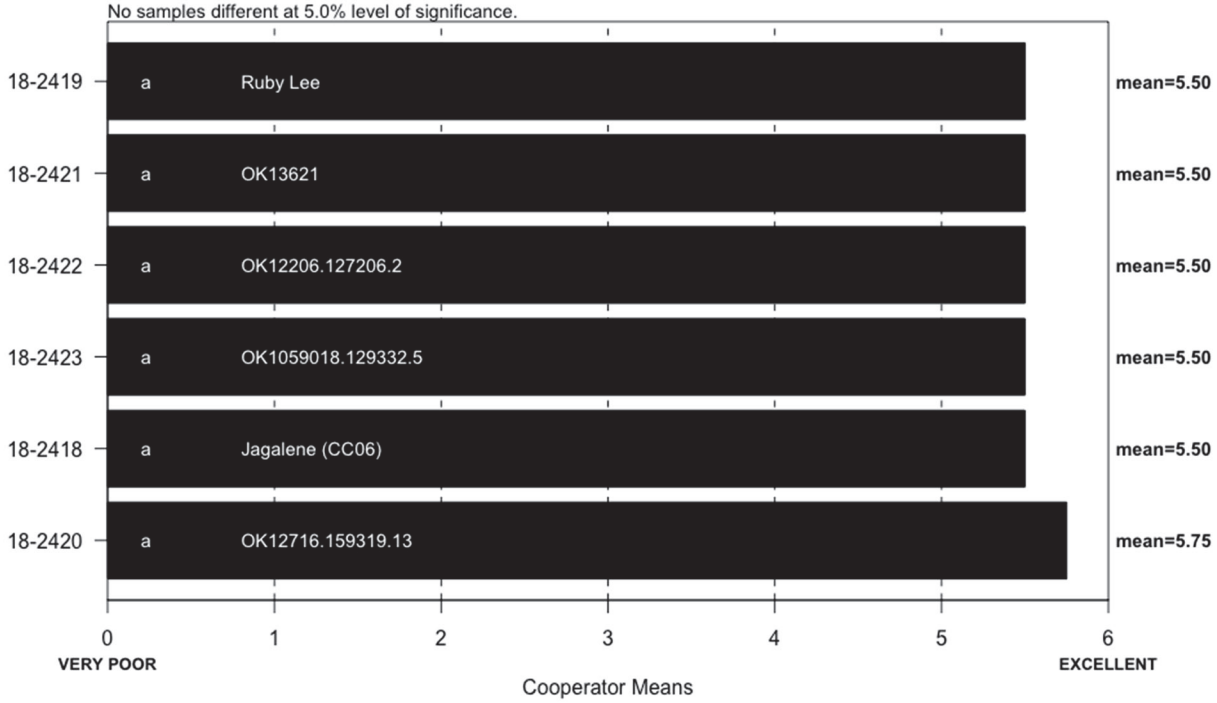


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2422	7166	143	4564	0.434	1.954	1.302	1.685	-15.65
2423	7142	140	4110	0.451	2.204	5.675	1.743	-10.50

SPONGE CHARACTERISTICS
(Small Scale) Oklahoma

Cooperators = 4
ChiSqCalc = 0.8
ChiSqTab = 11.1
P Value = 0.977

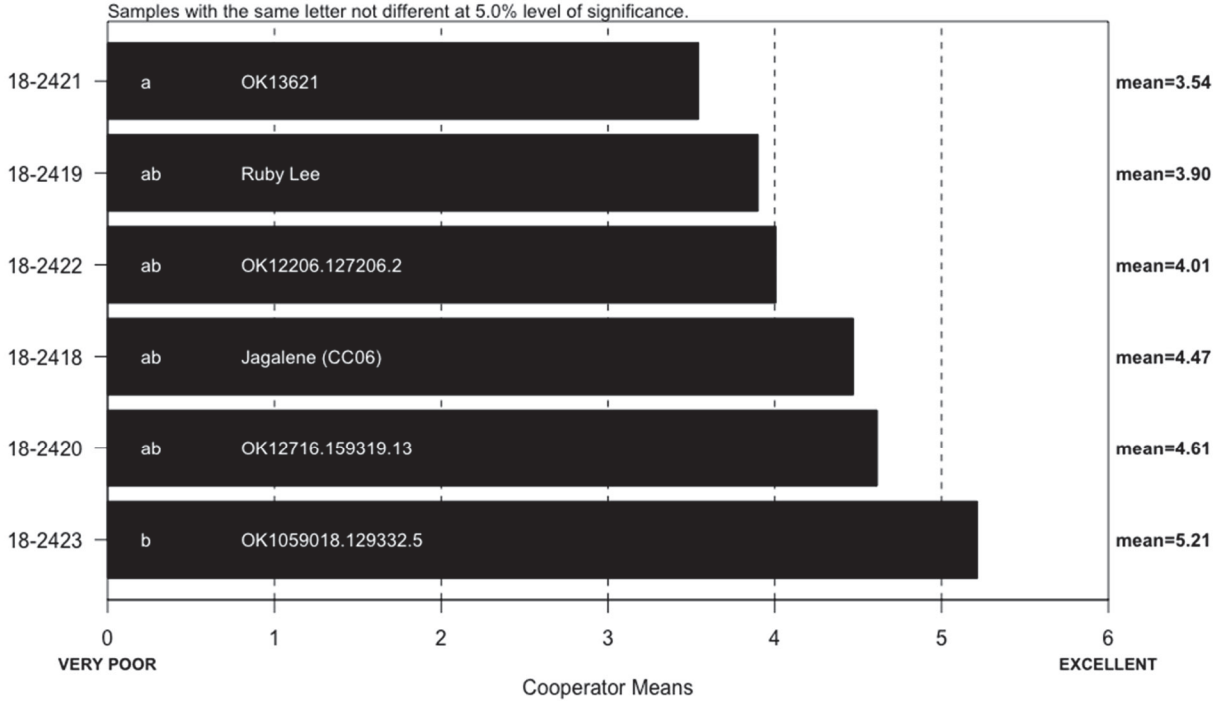
No samples different at 5.0% level of significance.



BAKE ABSORPTION
(Small Scale) Oklahoma

Cooperators = 14
ChiSqCalc = 15.3
ChiSqTab = 11.1
P Value = 0.009

Samples with the same letter not different at 5.0% level of significance.

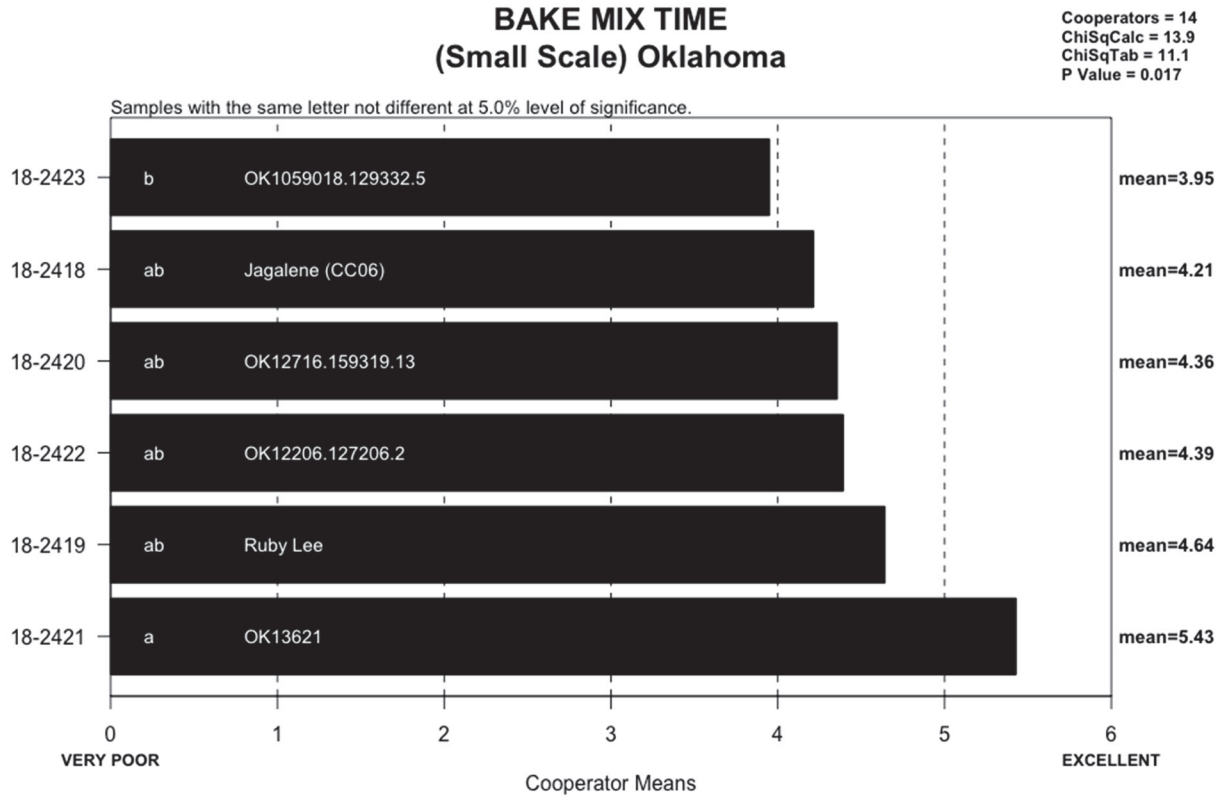


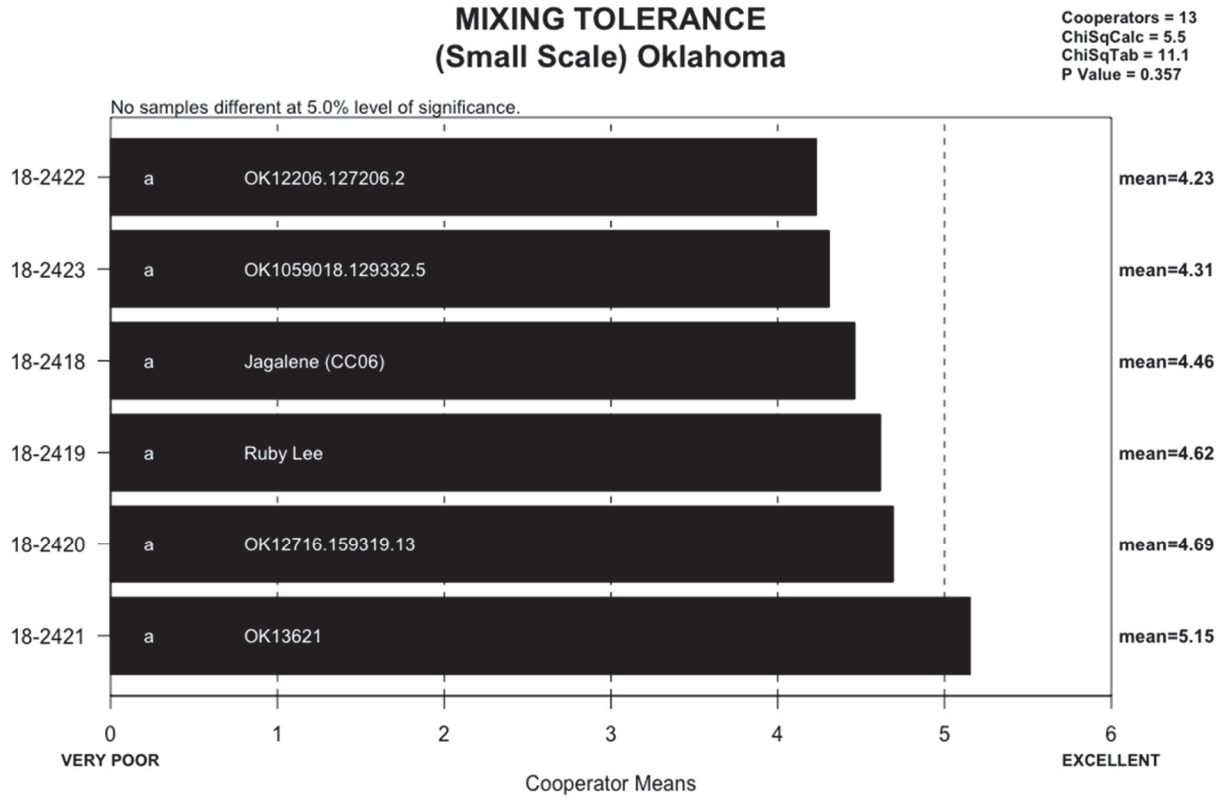
BAKE ABSORPTION, ACTUAL (14% MB)
(Small Scale) Oklahoma
Cooperators A – N

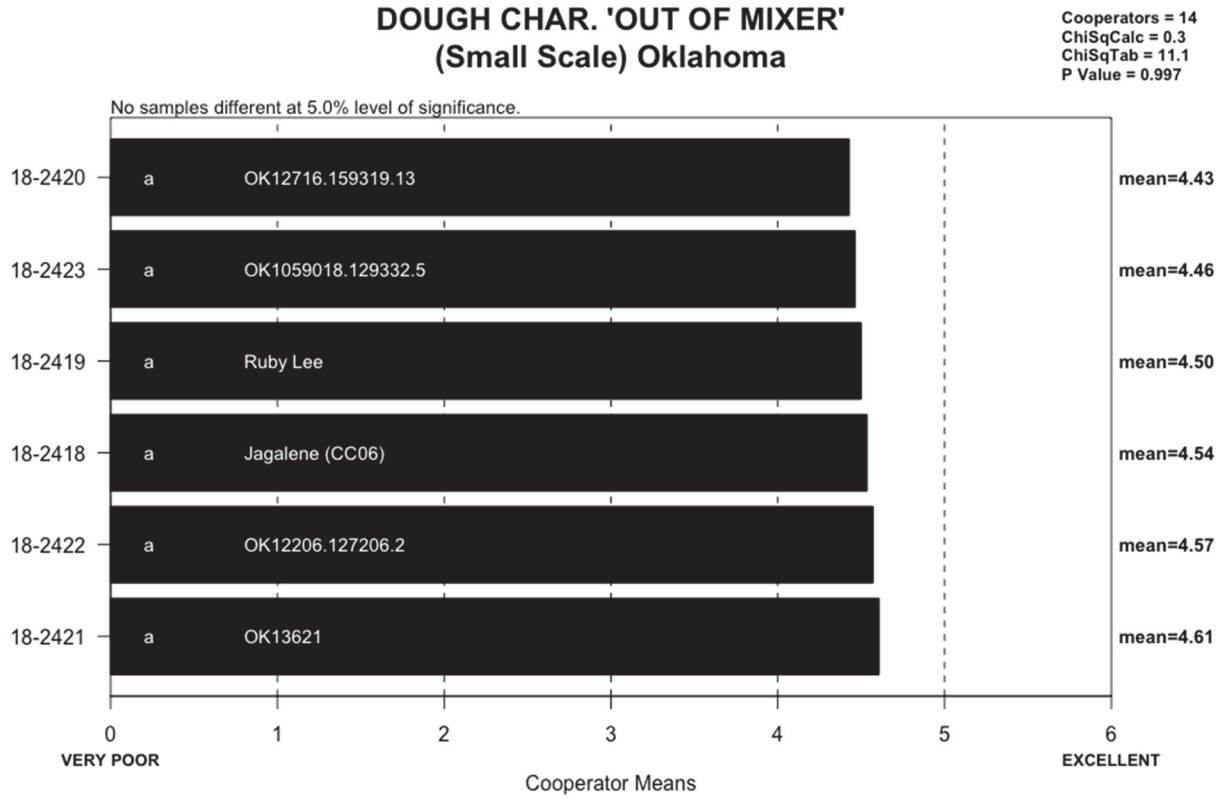
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2418	Jagalene (CC06)	65.4	65.1	65.4	63.6	60	62.3	62.8	68.7	64.5	66.0	65.8	66.3	57	66.7
18-2419	Ruby Lee	64.6	66.9	64.9	62.6	60	59.1	62.2	67.8	61.0	66.0	62.0	63.2	56	66.6
18-2420	OK12716-159319-13	67.0	67.8	66.9	64.6	61	61.2	64.3	69.0	62.4	68.5	64.0	64.9	57	67.5
18-2421	OK13621	63.6	64.4	66.0	62.6	59	59.0	61.2	67.3	60.9	66.5	62.7	63.3	56	65.4
18-2422	OK12206-127206-2	64.9	64.9	66.2	63.1	60	59.2	62.4	68.4	61.8	68.0	62.6	63.3	56	66.5
18-2423	OK1059018-129332-5	66.0	66.8	67.7	65.6	60	64.3	63.3	69.1	65.8	68.0	68.1	68.1	60	68.4

BAKE MIX TIME, ACTUAL
(Small Scale) Oklahoma
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2418	Jagalene (CC06)	5.2	4.0	5.0	5.5	11	8	4.5	4.3	4.0	3.6	14	4.0	25	5.3
18-2419	Ruby Lee	5.0	4.8	5.6	6.8	12	10	3.8	4.8	4.0	3.6	22	4.4	25	6.5
18-2420	OK12716-159319-13	5.0	4.0	4.8	6.0	12	10	4.2	4.0	3.5	3.0	22	3.9	25	11.0
18-2421	OK13621	8.3	8.0	9.5	10.8	20	10	6.1	7.0	6.8	3.8	22	7.0	25	5.0
18-2422	OK12206-127206-2	5.2	4.3	5.2	6.3	9	7	4.7	4.0	3.8	5.8	13	4.0	25	6.4
18-2423	OK1059018-129332-5	4.3	4.0	4.3	5.3	7	6	3.8	4.3	3.3	3.2	16	3.2	25	5.0

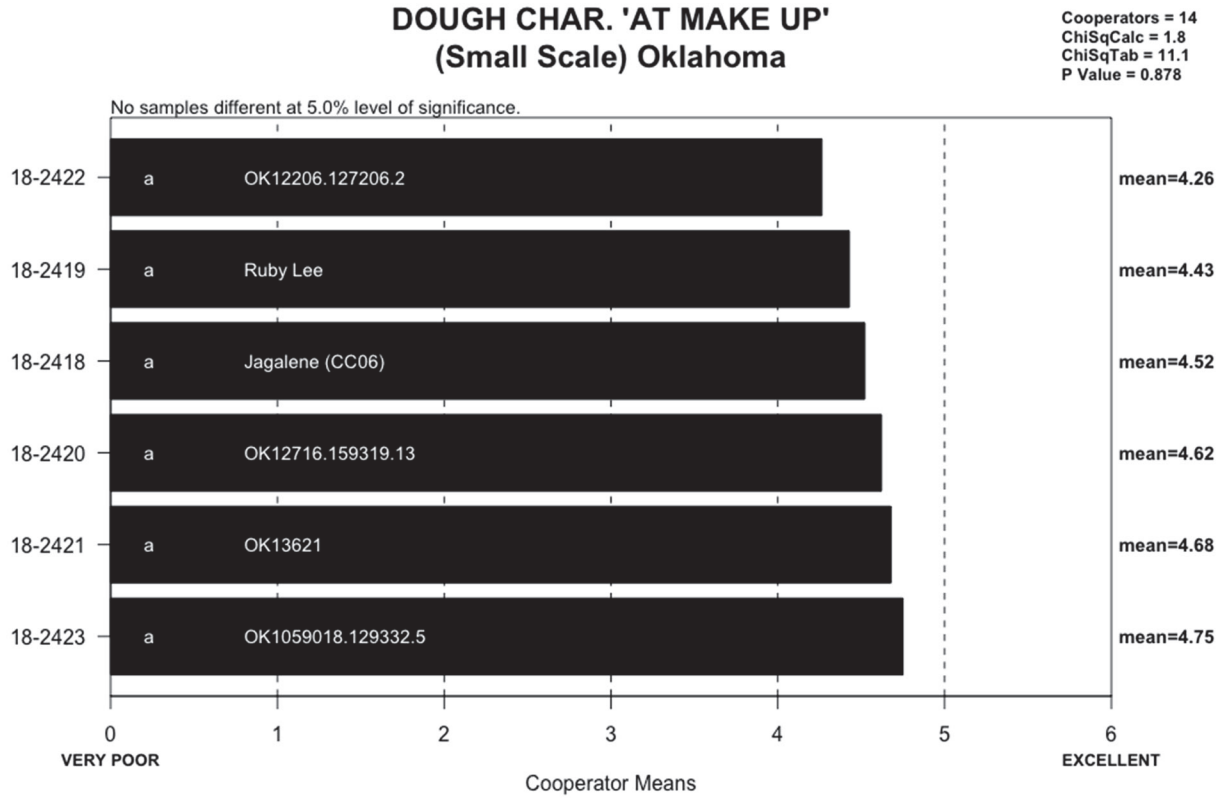

BAKE MIX TIME
(Small Scale) Oklahoma
Cooperators = 14
ChiSqCalc = 13.9
ChiSqTab = 11.1
P Value = 0.017
Samples with the same letter not different at 5.0% level of significance.
18-2423 b OK1059018.129332.5 mean=3.95
18-2418 ab Jagalene (CC06) mean=4.21
18-2420 ab OK12716.159319.13 mean=4.36
18-2422 ab OK12206.127206.2 mean=4.39
18-2419 ab Ruby Lee mean=4.64
18-2421 a OK13621 mean=5.43
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Small Scale) Oklahoma
Cooperators = 13
ChiSqCalc = 5.5
ChiSqTab = 11.1
P Value = 0.357
No samples different at 5.0% level of significance.
18-2422 a OK12206.127206.2 mean=4.23
18-2423 a OK1059018.129332.5 mean=4.31
18-2418 a Jagalene (CC06) mean=4.46
18-2419 a Ruby Lee mean=4.62
18-2420 a OK12716.159319.13 mean=4.69
18-2421 a OK13621 mean=5.15
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means



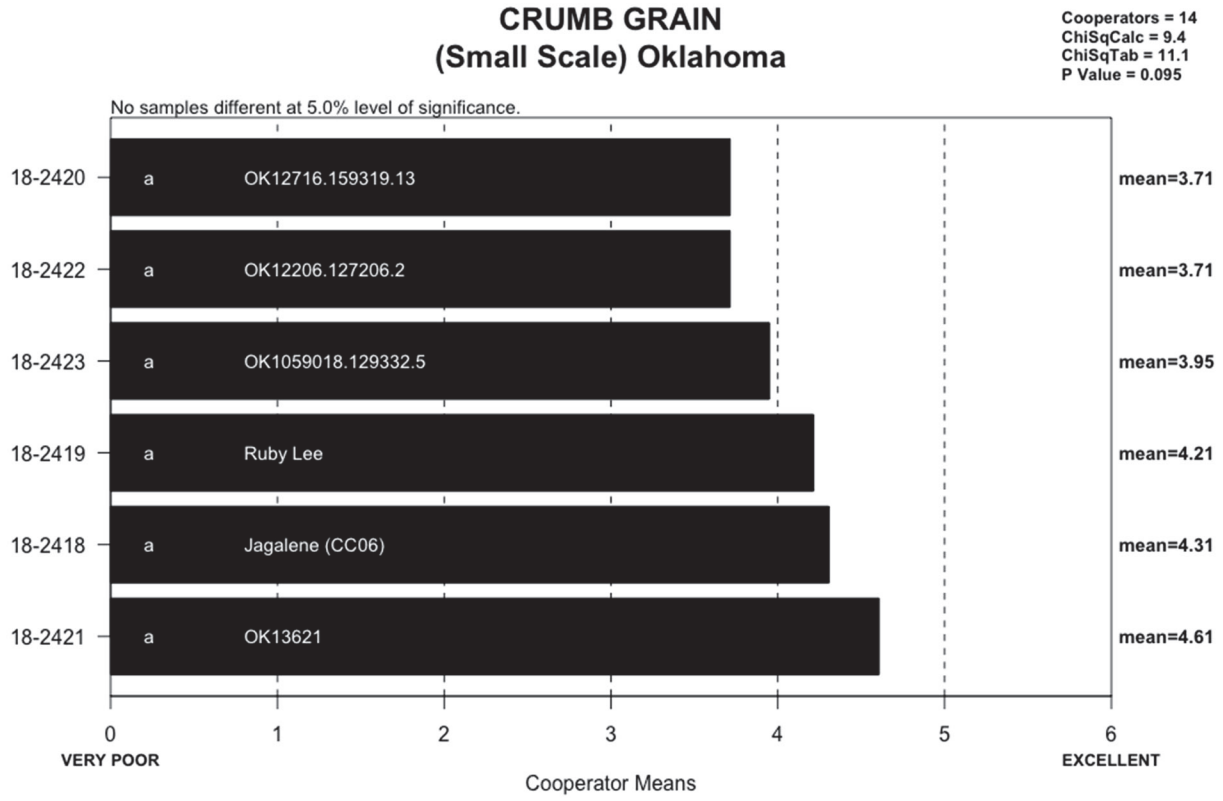
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Small Scale) Oklahoma

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2418	Jagalene (CC06)	1	0	4	7	2
18-2419	Ruby Lee	1	0	3	8	2
18-2420	OK12716-159319-13	2	1	3	6	2
18-2421	OK13621	0	0	6	6	2
18-2422	OK12206-127206-2	1	0	1	11	1
18-2423	OK1059018-129332-5	1	0	3	8	2



DOUGH CHAR. 'AT MAKE UP', DESCRIBED
(Small Scale) Oklahoma

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2418	Jagalene (CC06)	0	0	3	9	2
18-2419	Ruby Lee	0	1	4	7	2
18-2420	OK12716-159319-13	0	0	4	8	2
18-2421	OK13621	1	0	4	7	2
18-2422	OK12206-127206-2	1	0	3	9	1
18-2423	OK1059018-129332-5	0	0	3	8	3

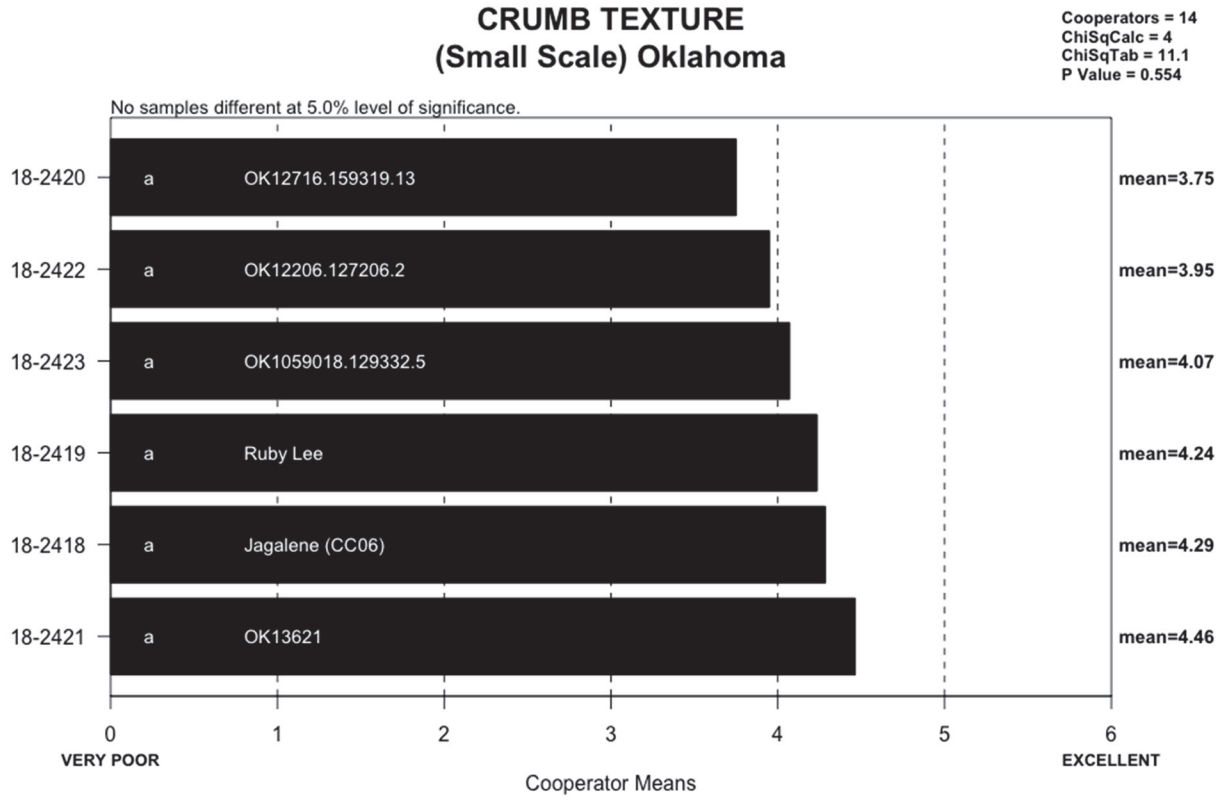


CRUMB GRAIN, DESCRIBED
(Small Scale) Oklahoma

IDCODE	ID	Open	Fine	Dense
18-2418	Jagalene (CC06)	5	8	1
18-2419	Ruby Lee	5	8	1
18-2420	OK12716-159319-13	6	6	2
18-2421	OK13621	4	8	2
18-2422	OK12206-127206-2	7	6	1
18-2423	OK1059018-129332-5	7	5	2

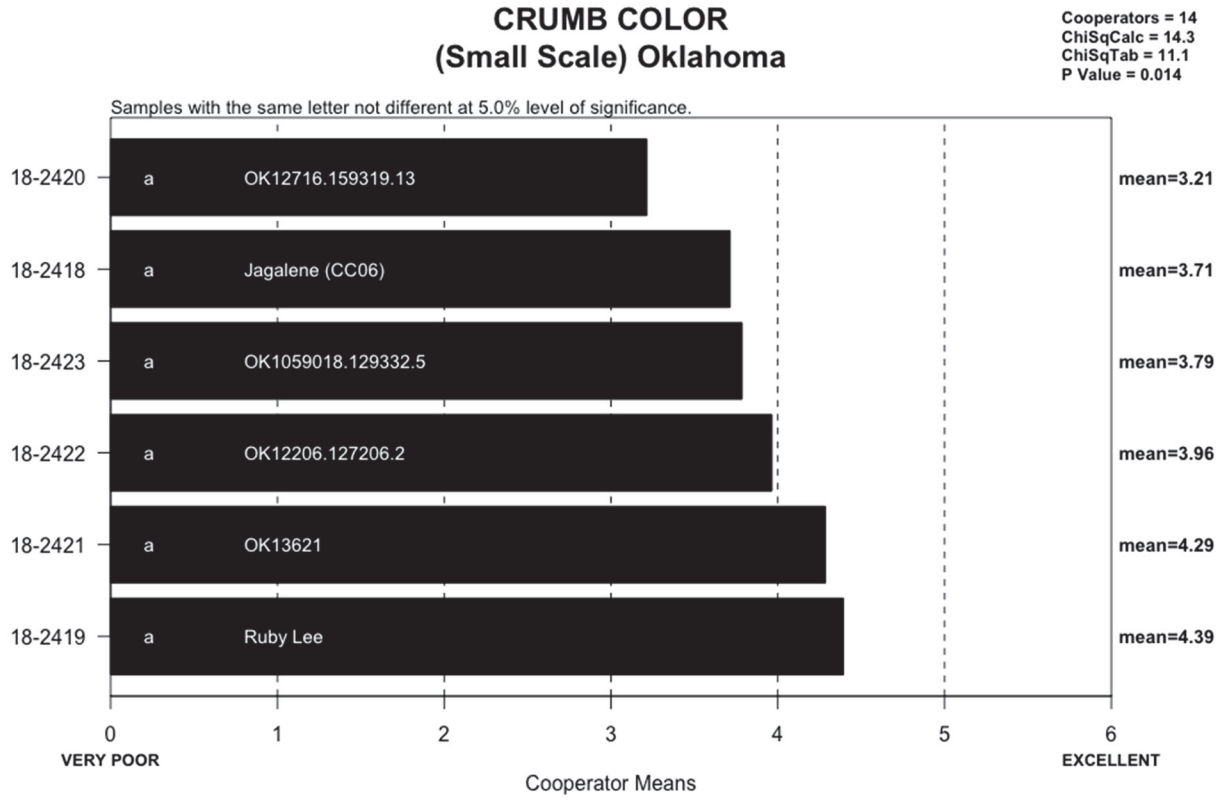
CELL SHAPE, DESCRIBED
(Small Scale) Oklahoma

IDCODE	ID	Round	Irregular	Elongated
18-2418	Jagalene (CC06)	2	3	9
18-2419	Ruby Lee	3	1	10
18-2420	OK12716-159319-13	7	3	4
18-2421	OK13621	2	4	8
18-2422	OK12206-127206-2	7	4	3
18-2423	OK1059018-129332-5	6	3	5



CRUMB TEXTURE, DESCRIBED
(Small Scale) Oklahoma

IDCODE	ID	Harsh	Smooth	Silky
18-2418	Jagalene (CC06)	1	8	5
18-2419	Ruby Lee	2	9	3
18-2420	OK12716-159319-13	3	6	5
18-2421	OK13621	1	6	7
18-2422	OK12206-127206-2	4	7	3
18-2423	OK1059018-129332-5	0	10	4



CRUMB COLOR, DESCRIBED
(Small Scale) Oklahoma

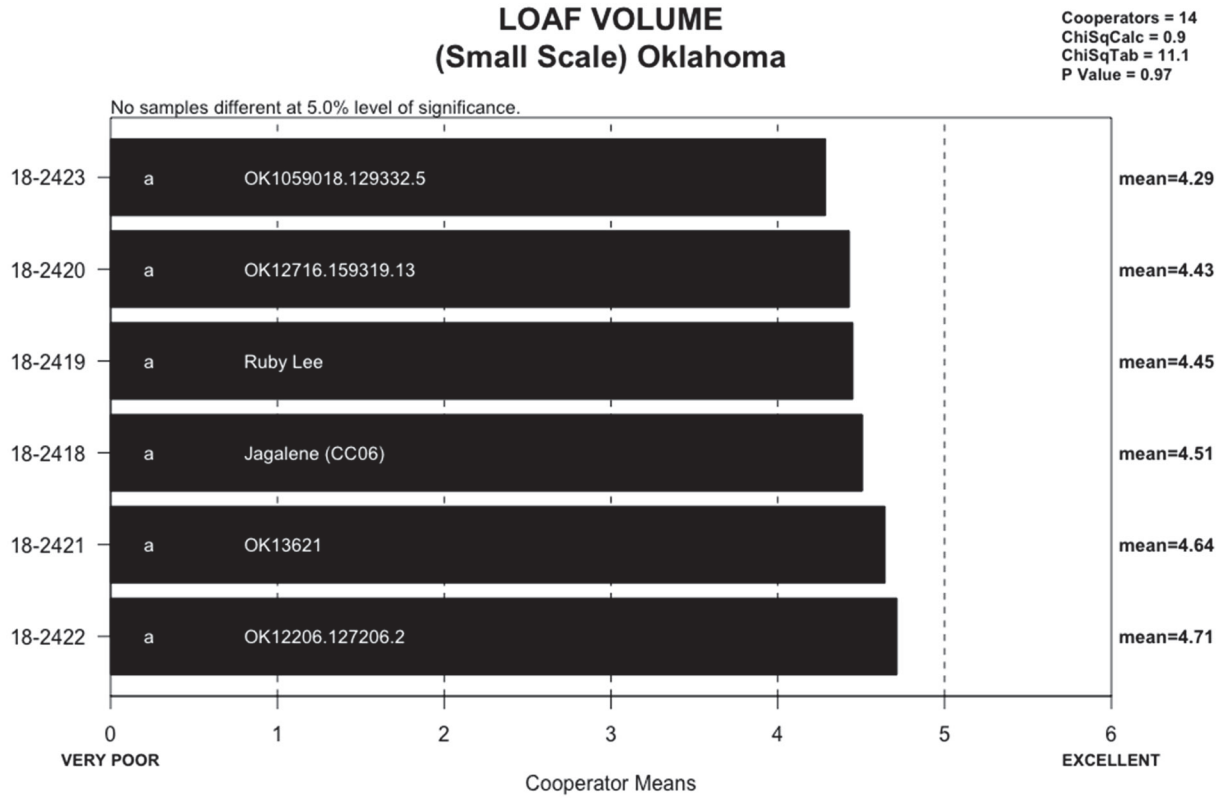
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	BrightWhite
18-2408	MOD14-4919	0	1	9	2	1	1	0
18-2409	Jagalene (CC03)	0	1	3	2	8	0	0
18-2410	H4N13-0253	0	0	4	5	5	0	0

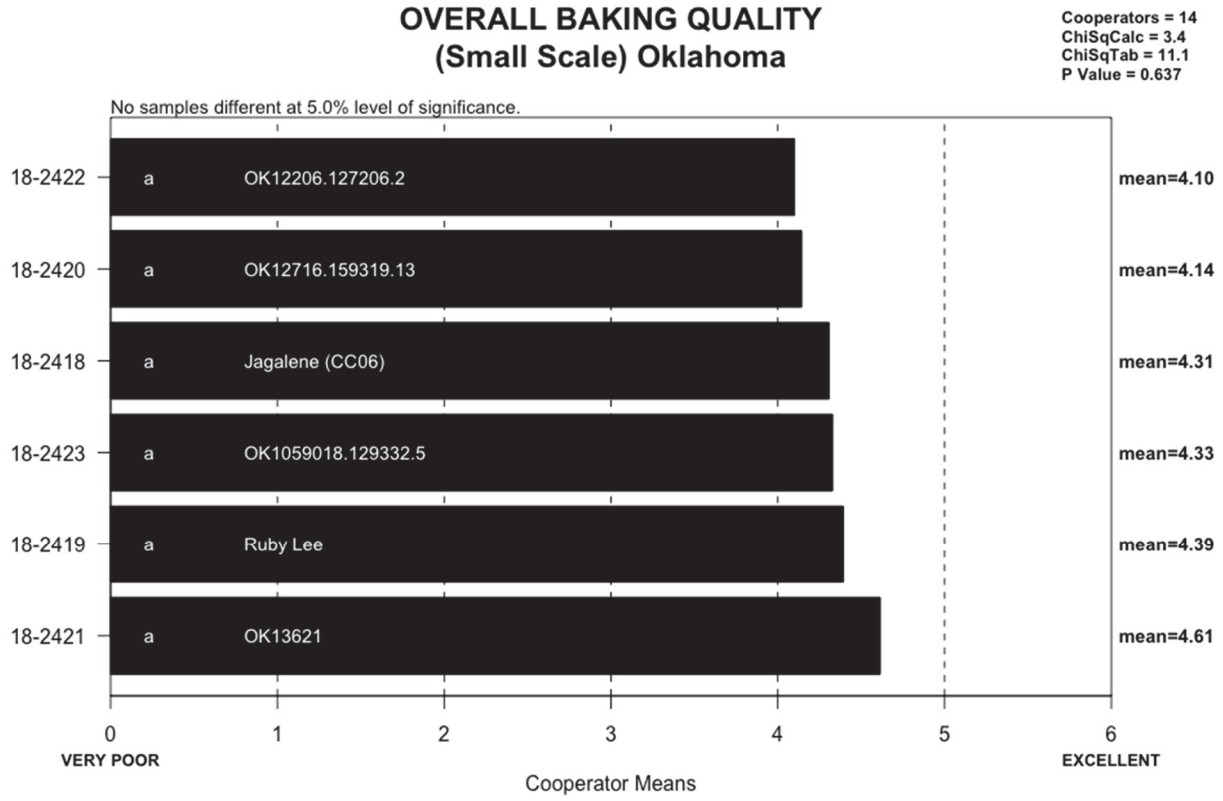
LOAF WEIGHT, ACTUAL
(Small Scale) Oklahoma
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2418	Jagalene (CC06)	141.6	141.6	155.3	147.1	418	461.4	131.5	137.8	130.0	144.3	443.3	138.0	487.1	152.1
18-2419	Ruby Lee	140.5	145.6	154.0	140.9	418	469.4	132.3	134.8	130.8	140.3	442.0	139.6	489.3	151.6
18-2420	OK12716-159319-13	140.7	146.3	153.7	144.3	418	468.1	131.7	137.9	132.0	143.5	437.8	139.8	484.1	152.5
18-2421	OK13621	139.4	140.8	154.0	140.9	418	468.8	129.4	135.0	129.4	146.3	447.5	140.8	488.8	150.1
18-2422	OK12206-127206-2	140.7	147.7	158.8	142.6	417	464.3	130.7	133.1	133.0	144.9	443.6	140.0	488.1	150.3
18-2423	OK1059018-129332-5	141.5	144.0	157.2	142.0	417	462.8	133.2	136.7	135.5	149.1	439.2	136.8	488.7	153.4

LOAF VOLUME, ACTUAL
(Small Scale) Oklahoma
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2418	Jagalene (CC06)	1075	1020	1003	958	2950	2338	890	940	1020	985	2725	885	2927	1010
18-2419	Ruby Lee	1050	920	1105	983	2900	2400	780	930	900	985	2675	860	2956	990
18-2420	OK12716-159319-13	1050	930	1048	1050	2900	2300	920	930	900	965	2600	873	2956	1010
18-2421	OK13621	1050	1105	1048	953	3100	2438	805	925	970	1055	2650	876	2956	1115
18-2422	OK12206-127206-2	1050	925	965	1050	3150	2450	930	980	910	1100	2700	860	2927	1000
18-2423	OK1059018-129332-5	1050	1015	1013	1050	3000	2325	830	935	908	915	2675	862	2927	1020


LOAF VOLUME
(Small Scale) Oklahoma
Cooperators = 14
ChiSqCalc = 0.9
ChiSqTab = 11.1
P Value = 0.97
No samples different at 5.0% level of significance.
18-2423 a OK1059018.129332.5 mean=4.29
18-2420 a OK12716.159319.13 mean=4.43
18-2419 a Ruby Lee mean=4.45
18-2418 a Jagalene (CC06) mean=4.51
18-2421 a OK13621 mean=4.64
18-2422 a OK12206.127206.2 mean=4.71
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Small Scale) Oklahoma
Cooperators = 14
ChiSqCalc = 3.4
ChiSqTab = 11.1
P Value = 0.637
No samples different at 5.0% level of significance.
18-2422 a OK12206.127206.2 mean=4.10
18-2420 a OK12716.159319.13 mean=4.14
18-2418 a Jagalene (CC06) mean=4.31
18-2423 a OK1059018.129332.5 mean=4.33
18-2419 a Ruby Lee mean=4.39
18-2421 a OK13621 mean=4.61
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Small Scale) Oklahoma

COOP. **18-2418 Jagalene (CC06)**

A. Loaf Volume better than protein predicted LV.
B. Excellent loaf externals.
C. Somewhat weaker dough strength but mixing tolerance good.
D. Average Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, High Volume, Creamy Crumb, Fine Elongated Cells, Resilient & Smooth Texture.
E. Good dough, Good volume, Slightly open grain.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. OK mixograph/protein, good grain-average loaf.
K. Good protein and slightly higher absorption. Average notes and characteristics. Good mixing tolerance. Great for Bread application.
L. No comment.
M. Low absorption, very good mix strength and good loaf volume.
N. High absorption, yellow crumb, high volume.

COOP. **18-2419 Ruby Lee**

A. Loaf Volume better than protein predicted LV.
B. Slight cap.
C. Generally good dough strength. Excellent bread quality.
D. Average Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, Very High Volume, Gray White Crumb, Slight Open Elongated Cells, Resilient & Smooth Texture.
E. Slightly open grain, Slightly creamy.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Average protein, excellent color.
K. High protein. Long mix time, high tolerance, and strong notes and dough characteristics. Great for blending.
L. No comment.
M. Low absorption, very good mix strength and good loaf volume.
N. High absorption, good grain, good volume, strong mixing tolerance.

COOP. 18-2420 OK12716-159319-13

A. No comment.
B. No comment.
C. Good dough properties and bread performance.
D. High Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, Extreme High Volume, Yellow Crumb, Open Round Cells, Resilient & Less Smooth Texture.
E. Average mix for protein, Open grain, Very creamy.
F. No comment.
G. No comment.
H. Even crumb.
I. No comment.
J. Excellent protein, nice mixograph, but did not perform.
K. High protein. Long mix time and tolerance but average notes and characteristics. Great for bread application or blending.
L. No comment.
M. Low absorption, very good mix strength and good loaf volume.
N. High absorption, fine grain, high volume.

COOP. 18-2421 OK13621

A. Loaf Volume better than protein predicted LV.
B. Long time to pick up, excellent loaf externals.
C. Generally good dough strength. Excellent bread quality.
D. Average Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, High Volume, Creamy Crumb, Fine Elongated Cells, Resilient & Very Smooth Texture.
E. Strong dough and mix, Excellent volume, Slightly creamy, Open grain.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Average protein, ok color, irregular cells.
K. High protein. Long mix time, high tolerance, and strong notes and dough characteristics. Great for blending.
L. No comment.
M. Low absorption, very good mix strength and good loaf volume.
N. Good grain, high volume, strong mixing tolerance.

COOP. **18-2422 OK12206-127206-2**

A. Loaf Volume better than protein predicted LV.
B. No comment.
C. Very good dough properties and good bread performance.
D. Average Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, Extreme High Volume, Yellow Crumb, Open Round Cells, Resilient & Less Smooth Texture.
E. Good out of mixer and makeup, Excellent volume, Slightly creamy interior, Open grain.
F. No comment.
G. No comment.
H. Even crumb.
I. Crumb slightly crumbles.
J. Excellent abs/volume; longer mixing, white.
K. Good protein. Average notes and characteristics. Good mixing tolerance. Great for Bread application.
L. No comment.
M. Low absorption, very good mix strength and good loaf volume.
N. High absorption, high volume.

COOP. **18-2423 OK1059018-129332-5**

A. No comment.
B. Excellent loaf externals.
C. Very good dough properties and good bread performance.
D. Average Protein, Large Water Abs, Normal MT, Slight Sticky & Strong Dough, Extreme High Volume, Yellow Crumb, Open Elongated Cells, Resilient & Smooth Texture.
E. Short mix for protein level, Good dough out of mixer.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Lower volume, but good mixograph and average.
K. High protein and absorption. Great characteristics and notes. Great for bread application or blending.
L. No comment.
M. Fair absorption, very good mix strength and good loaf volume. High ash.
N. High absorption, high volume.

Notes: **E, F, K and M** conducted sponge and dough bake tests

NORTHERN PLAINS

18-2424	Jagalene (CC07)
18-2425	NE10478-1
18-2426	NHH144913-3
18-2427	MT1564
18-2428	MTS1588
18-2429	NORD58
18-2430	NORD62
18-2431	SD09227
18-2432	SD14115-5

Description of Test Plots and Breeder Entries

Northern States (NE, MT, SD and ND)

NEBRASKA by Stephen Baenziger

Growing Conditions:
In 2018, we used a multistate grow out system. For Nebraska and for convenience we did our grow out at Lincoln, NE. There were a total of 13 lines (3 per state and the check Jagalene). Before submission, one line per state was dropped. For Nebraska, NE13493 was dropped and NE10478-1 and NHH 144913-3 were retained. The grow outs were planted a little later than desired due to rain. The winter was mild and winter killing was minimal. The early spring was cool and dry leading to slow growth and what we though would be a late crop. However, just before flowering, the season changed to very hot (~100°F at flowering) with little moisture. The crop wilted every afternoon and recovered every evening. Enough rainfall occurred that drought stress was heat related and not due to true lack of moisture.
Yield of some lines at the grow out site in Lincoln, NE (Lancaster Country) from the State Variety Trial.

Lancaster County Winter Wheat Variety Test - 2018

Brand	Variety	Grain Yield (bu/a)	Moisture (%)	Plant Height (inches)	Protein (%)	Kernel Weight (1000/lb)
WestBred	WB4458	110	12	35	13.2	15
WestBred	WB4303	108	11	32	12.7	15
AgriPro Syngenta	SY Monument	105	11	34	12.9	16
AgriPro Syngenta	SY Wolf	104	14	33	13.2	15
Limagrain Cereal Seeds	LCS Link	104	12	34	13.0	15
WestBred	WB4721	103	12	33	13.1	16
WestBred	WB-Grainfield	102	11	35	13.0	16
AgriMAXX	AM Eastwood	102	11	32	12.8	16
-----	Ruth	100	11	35	12.8	17
AgriPro Syngenta	SY Benefit	100	12	35	12.9	16
-----	NE10478-1	100	12	34	13.0	14
WestBred	WB4269	99	11	30	13.0	15
Limagrain Cereal Seeds	LCS Chrome	99	12	35	12.9	17
WestBred	WB4418	99	12	32	13.0	15
Dyna-Gro Seeds	Long Branch	98	11	34	12.9	15
-----	NHH144913-3	98	12	33	13.1	15
-----	NW13493	98	12	35	13.0	17
Husker Genetics	Freeman	90	11	34	13.0	15
----	Scout 66	75	11	44	13.1	14
----	Turkey	72	12	43	13.0	16
Average of all entries		**97**	**12**	**35**	**13.0**	**15**
Difference required for significance at 5%		**6.0**	**0.9**	**1.0**	**0.3**	**NS**

NE10478-1: In 2018, NE10478-1 was tested in the Kansas and in Nebraska State Variety Trials. It has done well across Nebraska and in western Kansas. The pedigree of NE10478-1 is that it was a selection (for uniformity and grain yield) from NE10478 which was derived from the cross NI03418/Camelot where the pedigree of NI03418 is W91-248/NE95544 (=MCVEY 78015/NE88521)//Thunderbird. The main interest in NE10478-1 is that it is one of the earliest flowering and maturing lines developed recently from our program. As such, it provides a nice complementation to our later maturing lines and extends its area of adaptation into western Kansas. For example, it is 2 days earlier than Overland in Nebraska. It is moderately resistant to resistant to wheat soil borne mosaic virus, stem rust, leaf rust, and Hessian fly. It is moderately susceptible to Fusarium head blight. In Nebraska, it is susceptible to stripe rust (fungicide sprays are recommended whenever heavy disease is present though the line has some tolerance to stripe rust infection), wheat streak mosaic virus, and to wheat stem sawfly. It is a semi-dwarf with good straw strength, consistent high grain yield, and good test weight. Its end-use quality is acceptable. The line has been licensed to Limagrain Cereal Seeds and will be marketed as LCS Valiant.

NHH14491`3-3: The pedigree of NHH144913-3 is that it is a single head selection form NHH144913 whose pedigree was SETTLER CL/NE07457//BRAWL CL Plus and where the pedigree of NE07457 is CO970498 (=Ogalla/Halt)/NE00403 (=PRONGHORN/ARLIN//ABILENE). NHH144913-3 seems to have very broad adaptation to the Northern Great Plains where it was the third highest yielding lines in the 2017 Northern Regional Performance Nursery. It is resistant to wheat soilborne mosaic virus, moderately resistant to stem and stripe rust, moderately susceptible to leaf rust and susceptible to Hessian fly, wheat streak mosaic virus, and to wheat stem sawfly. It is moderately susceptible to Fusarium head blight. It is genetically lower in test weight. This line was “fast-tracked” due to our interest in its herbicide tolerance. However, the greatest concern with NHH144913-3 is that in our preliminary tests, it generally graded as a mixed hardness wheat. This grading was not considered unusual as some lines grown in eastern NE tend to be graded as mixed, but are harder when grown under drier conditions in western NE. However, with additional testing, this line grades mixed to soft depending upon the environment. Based on its softness and the small amount of quality data that we have, at best it will be a niche market wheat or more likely will be dropped.

Both **NE10478-1** and **NHH144913-3** are superior to very susceptible FHB lines such as Overley, but inferior to moderately resistant FHB lines such as Overland.

Jagalene was the quality control line.

Note: Of the lines tested last year, NE12561 was released as NuPride Seige and NI13706 was dropped.

MONTANA by Phil Buckner/Jim Berg

Growing Location & Conditions

The Northern WQC Grow Out, from which the Montana samples were submitted, was planted at the Post Agronomy Farm, west of Bozeman. Strips (6' x 120') were planted in on September 30, 2017 into above average fall moisture. There was above normal snow cover during winter months and no winterkill was observed. Heading (June 14) was earlier than the 66 year average by 6 days. Temperatures from March to August were average, except for above average in May. Above average moisture was recorded in all months except October and July. Stripe rust, which is often a major factor in yield and test weight reduction, was minimal and late in occurrence. Harvest of all WQC lines, for the 2018 submitted samples, occurred on Aug 30.

The Montana Intrastate Winter Wheat Test (varieties and elite lines, planted nearby), which includes Montana lines grown in the WQC drill strips, had yields (average = 132 bu/a, range 114 – 150 bu/a) and test weights (average = 64.1 lb/bu, range 61.4 – 65.5 lb/bu) which were both records for Bozeman. Proteins were 12.3% (range 11.1 to 13.7%).

MT1564 – an early, short, hollow stemmed hard red winter wheat line derived from a composite cross, comprised of 2 experimental lines, with common parentage Yellowstone*2/PI 640431. PI 640431 is a stripe rust resistant line with a pedigree = BC_4F_4 line derived from WA007900*5/4/WA007900// Yr5/6*Avocet/3/ WA007900//Yr15/ 6*Avocet. MT1564 has average yield, high test weight and average protein. Over 23 location-years, yield of MT1564 was 2 bu/a lower than Yellowstone (non-significant difference) and 3 bu/a greater than Brawl CL Plus (a very early heading and maturing variety in Montana). MT1564 has average winter hardiness in limited testing in eastern Montana. MT1564 has early heading date (6d earlier than Yellowstone, 2d later than Brawl CL Plus) and is 3 in. shorter and 1 inch taller than Yellowstone and Brawl CL Plus, respectively. MT1564 is moderately susceptible to stem rust (Yellowstone is susceptible) and resistant to stripe rust. MT1564 had low dwarf bunt % infection in Utah tests.

MT1564 is a medium PPO line with high flour yield and flour protein in MSU tests. Ash is good and lower than Yellowstone. Mix times are medium-long, similar to most Montana varieties. Mixing tolerance is very good. Mix and bake absorption is above average (greater than Yellowstone). Loaf volume is above average and exceeds Yellowstone.

MTS1588 – a solid stemmed hard red winter wheat line derived from a composite cross, comprised of 2 experimental lines, with a common hollow stemmed parent, MT0598 (= (SMN82164 / SMN82140 // Rocky / Tiber, MT9659) /3/ S87-101 /4/ Pronghorn) crossed to two possible solid stemmed lines containing Heyne, Rampart, and BigSky sib or Rampart sib, Judith, Arapahoe, Pryor, and Genou. MTS1588 is a high yielding line similar to both Yellowstone and Loma and higher than Warhorse and Judee. MTS1588 test weight is high (comparable to Judee) and has average protein (similar to Yellowstone). MTS1588 has average winter hardiness (similar to Warhorse) in limited testing in eastern Montana. MTS1588 has medium heading date (similar to Warhorse, earlier than Loma and Yellowstone, and later than Judee). MTS1588 is a short line, for Montana, around 4 inches shorter than Yellowstone. MTS1588 is moderately susceptible to stem rust (Yellowstone is susceptible) and resistant to stripe rust.

MTS1588 has high stem solidness, scoring 23 on the 5-25 scale (5 = hollow at all internodes, 25 = completely solid at all internodes), which is greater than Warhorse

(solidness score = 22, and currently, the leading winter wheat variety grown in Montana). MTS1588 yield under sawfly pressure (test average greater than 10% cutting) is greater than all other varieties (solid or hollow stemmed) in the past 2 years, while % of cut stems, in these same tests, is the lowest (comparable to Warhorse).

MTS1588 is a high PPO line with high flour yield and flour protein in MSU tests. Ash is good and lower than Yellowstone. Mix times are long, similar to most Montana varieties. Mixing tolerance is good. Mix and bake absorption is average. Loaf volume is acceptable (similar to Yellowstone).

NORTH DAKOTA by Frans Gideon

We seeded the 2018 WQC Northern Grow-out entries at the Casselton Research Extension Center (CREC) on 9/22/17. The CREC is located 25 miles to the west of Fargo. We planted (no-till) into soybean stubble and applied urea at the 4-5 leaf stage on 5/6/18 (100 lbs of actual N per acre). In addition the plots were sprayed with Wolverine Advanced (1.7 pts/acre) on 5/22/18 when the plants were around jointing stage. Harvesting occurred on 7/27/18.
Varying degrees of winterkill occurred; however, in general plant stands were adequate with respect to all entries. Severe bacterial leaf streak developed around flowering which differentially affected the lines and reduced test weights. Heavy Fusarium Head Blight infections appeared in spring wheat; however, due to its late arrival the winter wheat plots largely escaped damage by this pest. In the nearby winter wheat Elite yield trial, yields ranged from 28-78 bu/acre; test weights ranged from 57.4-63.6 lbs/bu and grain protein contents ranged from 9.6% to 12.9%. Similar variation likely occurred in the grow-out strips.
The nine Northern grow-out entries included two new hard white winter wheat breeding lines (2nd year Regional Tests) from NDSU. Detail on these lines are as follows:

16NORD-58 (= SD07W083-4/Jerry). This line has intermediate winter-hardiness and its height is comparable to that of Jerry (88 cm at Casselton in 2018). Has *Yr17* and has good stripe rust resistance. It showed seedling susceptibility to leaf rust races TBJQ, MFPS and TDBG, but had intermediate resistance to THBL, MCDL and an unknown race that occurred at Casselton in 2017. Marker data indicated that it possibly has *Lr46*. 16NORD-56 showed strong seedling resistance to four prevalent US stem rust races (QFCK, QTHJ, TPMKC and TMLK). The line showed very good bacterial leaf streak resistance at Casselton in 2018. 16NORD-58 has average yield and satisfactory milling and baking quality.

16NORD-62 (= OK00611W/SD97W609/3/MT0423//MT0419/KS00F5-20-3). 16NORD-62 has intermediate winter-hardiness; it has good stem rust resistance yet the gene(s) involved are unknown; it is seedling resistant to the most prevalent leaf rust races in ND, barring THBL. It has *Lr34* and tested positive (markers) for minor leaf rust resistance genes *Lr46* and *Lr68*; yet adult plant resistance in the field remains unconfirmed. It has *Yr17*+ and showed strong resistance to the stripe rust epidemic that occurred in Langdon this year where it yielded 86 bu/acre compared to Jerry (highly susceptible) that yielded only 7.3 bu/acre. 16NORD-62 has the *tsn1* insensitivity gene that gives some protection against leaf spot diseases. Its FHB resistance in the field is unknown, as this disease did not significantly affect our nurseries in the past two seasons; however, marker data showed that it has *Fhb1*. 16NORD-62 has similar plant height to Jerry. It gives good test weights. Its milling yield is only average, yet it showed good loaf volume potential. It was an average yielder in the past season, which was probably due to its lower level of winter-hardiness.

SOUTH DAKOTA by Sunish Sehgal

Note: 2017-2018 is the first year of northern states wheat quality council grow outs. Each of the twelve entries and Jagalene (check) were planted in~ 200 feet long 5-feet wide strips at four locations, one in each of the four states; North Dakota, Montana, Nebraska, and South Dakota. Planting (October 18th) was delayed way beyond the last recommended day in Brookings, SD due to very wet fall. The plants did not emerge before ground froze and it was -25°F on 12/26/2017 with no snow cover. Further, brief snow melts and freezing of water in February-March also contributed to very poor and uneven stand at the SD location and therefore, South Dakota location was abandoned. The samples submitted for South Dakota entries are combined pool of harvest from North Dakota, Montana, and Nebraska trials.

SD9227

SD09227 (Thompson) is a hard red winter wheat cultivar developed and released in November 2017 by the South Dakota Agricultural Experiment Station (SDAES). It was derived as a single spike from within an F_3 population (SD97088/KS920709-B-5-2//Jagalene). Thompson is medium to late maturity and with medium tall height. It has excellent winter hardiness and very good straw strength. The yield data can be attained from 2014 to 2016 USDA Northern Regional Performance Nursery and South Dakota Crop Performance Trials (2014 to 2018). Thompson is a high yielding cultivar adapted to central and eastern South Dakota. Thompson known to carry *Lr16*, *Lr24/Sr24* and *Lr37/Sr38/Yr17* and has shown moderate resistance to stripe, leaf and stem rust .

Milling and baking quality data from Thompson shows acceptable overall milling and baking qualities. Across multiple trial locations (2015-2017), Thompson had an average flour protein of 11.8%, 61.5% water absorption, and a mixograph mid-line peak time of 3.1 minutes. Loaf volume on average was 855 cc.

SD14115-5

SD14115-5 was developed from the cross T154/SD07165 and has medium height and medium maturity, similar to Lyman. It has very good winter hardiness and straw strength. SD14115-5 has demonstrated an excellent yield potential (ranked in top five) in 2017 and 2018 USDA Northern Regional Performance Nursery as well as South Dakota Crop Performance Trials. SD14115-5 has good test weight and moderate protein concentration. SD14115-5 showed moderate resistance to stem rust and intermediate reaction to stripe and leaf rust.

Milling and baking quality data from SD14115-5 shows acceptable overall milling and baking qualities. Across multiple trial locations (2015-2017), SD14115-5 had an average flour protein of 12.1%, 62.2% water absorption, and a mixograph mid-line peak time of 3.6 minutes. Loaf volume was good at 900 cc.

Northern States: 2018 (Small-Scale) Samples

Test entry number	18-2424	18-2425	18-2426	18-2427	18-2428
Sample identification	**Jagalene (CC07)**	**NE10478-1**	**NHH144913-3**	**MT1564**	**MTS1588**
Wheat Data					
GIPSA classification	2 HRW	1 HRW	3 SRW	3 HDWH	2 HRW
Test weight (lb/bu)	59.8	60.0	57.4	59.0	58.8
Hectoliter weight (kg/hl)	78.6	78.9	75.5	77.6	77.3
1000 kernel weight (gm)	32.5	34.9	33.8	37.0	31.5
Wheat kernel size (Rotap)					
Over 7 wire (%)	71.7	70.3	82.5	73.0	45.4
Over 9 wire (%)	27.8	29.6	17.4	26.7	52.1
Through 9 wire (%)	0.5	0.1	0.1	0.3	2.5
Single kernel (skcs)[a]					
Hardness (avg /s.d)	62.8/18.1	62.6/18.9	15.9/16.3	58.6/17.2	52.5/19.3
Weight (mg) (avg/s.d)	32.5/12.5	34.9/12.1	33.8/9.8	37.0/13.7	31.5/12.0
Diameter (mm)(avg/s.d)	2.66/0.44	2.69/0.39	2.65/0.36	2.67/0.41	2.45/0.37
Moisture (%) (avg/s.d)	11.8/0.6	11.6/0.7	12.0/0.5	11.8/0.7	11.6/0.5
SKCS distribution	05-14-23-57-01	06-15-21-58-01	84-11-03-02-05	07-18-27-48-01	15-22-26-37-03
Classification	Hard	Hard	Soft	Hard	Mixed
Wheat protein (12% mb)	13.9	14.0	13.9	14.1	14.6
Wheat ash (12% mb)	1.66	1.67	1.66	1.64	1.74
Milling and Flour Quality Data					
Flour yield (%, str. grade)					
Miag Multomat Mill	74.2	73.7	68.4	74.2	75.3
Quadrumat Sr. Mill	69.3	69.3	69.9	70.3	69.7
Flour moisture (%)	12.2	12.3	12.4	12.6	12.5
Flour protein (14% mb)	12.9	12.8	12.3	13.1	13.4
Flour ash (14% mb)	0.59	0.58	0.52	0.50	0.52
Rapid Visco-Analyser					
Peak time (min)	6.1	6.1	6.1	5.1	5.9
Peak viscosity (RVU)	200.8	172.5	209.8	78.2	165.0
Breakdown (RVU)	73.2	60.9	86.2	58.7	68.9
Final viscosity at 13 min (RVU)	239.3	215.8	230.3	47.3	193.1
Minolta color meter					
L*	90.74	91.00	91.87	91.31	90.86
a*	-1.13	-0.85	-1.30	-0.93	-1.59
b*	8.72	7.36	7.53	7.16	10.18
PPO	0.529	0.724	0.847	0.780	0.757
Falling number (sec)	377	398	349	221	346
Damaged Starch					
(AI%)	98.0	97.6	94.7	96.4	95.9
(AACC76-31)	7.9	7.6	5.3	6.6	6.2

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

Northern States: 2018 (Small-Scale) Samples (continued)

Test entry number	18-2429	18-2430	18-2431	18-2432
Sample identification	NORD58	NORD62	SD09227	SD14115-5
Wheat Data				
GIPSA classification	2 HDWH	2 HDWH	2 HRW	2 HRW
Test weight (lb/bu)	58.7	59.5	58.8	58.9
Hectoliter weight (kg/hl)	77.3	78.2	77.3	77.5
1000 kernel weight (gm)	31.6	36.2	30.2	33.3
Wheat kernel size (Rotap)				
Over 7 wire (%)	66.0	82.0	54.2	63.7
Over 9 wire (%)	33.4	17.8	45.0	35.5
Through 9 wire (%)	0.6	0.2	0.8	0.8
Single kernel (skcs)[a]				
Hardness (avg /s.d)	40.9/17.3	54.5/15.2	57.8/19.2	52.3/18.8
Weight (mg) (avg/s.d)	31.6/11.0	36.2/11.5	30.2/10.0	33.3/12.2
Diameter (mm)(avg/s.d)	2.51/0.41	2.78/0.39	2.58/0.36	2.63/0.40
Moisture (%) (avg/s.d)	11.5/0.6	11.7/0.6	12.1/0.5	12.2/0.5
SKCS distribution	31-32-23-14-03	06-26-33-35-01	11-17-29-43-03	14-28-26-32-03
Classification	Mixed	Hard	Mixed	Mixed
Wheat protein (12% mb)	13.8	14.9	13.5	13.5
Wheat ash (12% mb)	1.63	1.67	1.69	1.74
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	75.6	69.3	73.6	71.7
Quadrumat Sr. Mill	69.6	66.5	69.0	66.1
Flour moisture (%)	13.5	13.5	13.1	12.8
Flour protein (14% mb)	12.5	13.4	12.3	12.4
Flour ash (14% mb)	0.50	0.51	0.55	0.58
Rapid Visco-Analyser				
Peak time (min)	4.2	4.0	5.5	5.9
Peak viscosity (RVU)	44.3	37.8	106.0	149.8
Breakdown (RVU)	39.2	33.3	63.7	61.9
Final viscosity at 13 min (RVU)	11.9	10.0	97.6	176.7
Minolta color meter				
L*	91.40	91.71	90.90	90.91
a*	-1.00	-0.96	-1.18	-1.03
b*	7.45	7.13	8.96	7.71
PPO	0.800	0.718	0.713	0.697
Falling number (sec)	142	138	278	344
Damaged Starch				
(AI%)	95.3	96.3	96.9	96.8
(AACC76-31)	5.7	6.5	7.0	6.9

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

Northern States: Physical Dough Tests and Gluten Analysis
2018 (Small-Scale) Samples

Test Entry Number	18-2424	18-2425	18-2426	18-2427	18-2428
Sample Identification	Jagalene (CC07)	NE10478-1	NHH144913-3	MT1564	MTS1588
MIXOGRAPH					
Flour Abs (% as-is)	68.8	67.4	65.1	68.3	68.8
Flour Abs (14% mb)	66.9	65.6	63.3	66.8	67.3
Mix Time (min)	4.1	3.3	2.3	7.0	4.4
Mix tolerance (0-6)	4	4	0	6	4
FARINOGRAPH					
Flour Abs (% as-is)	64.2	65.5	58.6	61.0	61.7
Flour Abs (14% mb)	62.3	63.8	56.8	59.5	60.2
Peak time (min)	5.4	5.4	2.9	3.8	7.3
Mix stability (min)	11.7	8.5	2.1	8.0	11.5
Mix Tolerance Index (FU)	18	33	75	29	27
Breakdown time (min)	13.4	10.0	3.9	8.3	13.0
ALVEOGRAPH					
P(mm): Tenacity	96	101	39	75	71
L(mm): Extensibility	87	96	94	114	146
G(mm): Swelling index	20.8	21.8	21.6	23.8	26.9
W(10^{-4} J): strength (curve area)	311	328	90	330	330
P/L: curve configuration ratio	1.10	1.05	0.41	0.66	0.49
Ie(P_{200}/P): elasticity index	62.2	58.2	38.3	68.2	61.7
EXTENSIGRAPH					
Resist (BU at 45/90/135 min)	371/488/531	334/383/397	146/163/210	573/827/899	334/472/500
Extensibility (mm at 45/90/135 min)	154/166/172	160/168/169	215/207/210	151/134/125	163/159/174
Energy (cm^2 at 45/90/135 min)	108/167/188	102/132/132	59/63/68	164/183/165	106/145/175
Resist $_{max}$ (BU at 45/90/135min)	552/806/870	478/604/589	181/205/221	886/1121/1114	511/727/791
Ratio (at 45/90/135 min)	2.4/2.9/3.1	2.1/2.3/2.4	0.7/0.8/0.8	3.8/6.2/7.2	2.1/3.0/2.9
PROTEIN ANALYSIS					
HMW-GS Composition	1,2*, 17+18, 5+10	1,2*, 20a+20b, 5+10	1,2*, 7+8, 2+12	1, 7+8, 5+10	2*, 7+8, 2+12
TMP/TPP	1.03	0.93	0.96	0.83	1.00
SEDIMENTATION TEST					
Volume (ml)	65.7	62.4	40.3	64.0	66.0

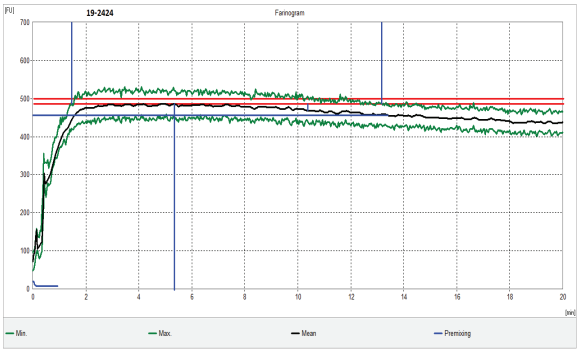
Northern States: Physical Dough Tests and Gluten Analysis 2018 (Small-Scale) Samples (continued)

Test Entry Number	18-2429	18-2430	18-2431	18-2432
Sample Identification	NORD58	NORD63	SD09227	SD14115-5
MIXOGRAPH				
Flour Abs (% as-is)	64.7	66.5	65.6	66.3
Flour Abs (14% mb)	64.2	66.1	64.8	65.0
Mix Time (min)	3.4	2.6	3.0	3.4
Mix tolerance (0-6)	2	2	3	3
FARINOGRAPH				
Flour Abs (% as-is)	58.0	61.7	60.5	62.2
Flour Abs (14% mb)	57.4	61.2	59.7	60.9
Peak time (min)	3.7	4.5	4.2	6.0
Mix stability (min)	7.1	5.9	6.6	10.8
Mix Tolerance Index (FU)	31	47	49	25
Breakdown time (min)	8.2	7.8	7.5	11.3
ALVEOGRAPH				
P(mm): Tenacity	54	62	76	87
L(mm): Extensibility	128	138	101	111
G(mm): Swelling index	25.6	26.1	22.4	23.5
W(10^{-4} J): strength (curve area)	211	249	242	297
P/L: curve configuration ratio	0.42	0.45	0.76	0.78
Ie(P_{200}/P): elasticity index	57.5	56.9	54.3	54.6
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	278/321/331	307/348/363	267/341/339	305/424/493
Extensibility (mm at 45/90/135 min)	165/186/202	167/164/177	168/163/160	151/156/162
Energy (cm^2 at 45/90/135 min)	87/127/147	94/107/127	82/103/101	84/124/151
Resist $_{max}$ (BU at 45/90/135min)	399/528/545	413/498/554	357/467/471	418/624/728
Ratio (at 45/90/135 min)	1.7/1.7/1.6	1.8/2.1/2.1	1.6/2.1/2.1	2.0/2.7/3.0
PROTEIN ANALYSIS				
HMW-GS Composition	2*, 17+18, 5+10	1, 7+9, 2+12	1, 7+9, 2+12	2*, 7+8, 5+10
TMP/TPP	0.88	0.79	0.88	0.91
SEDIMENTATION TEST				
Volume (ml)	57.7	63.2	47.6	62.7

Physical Dough Tests

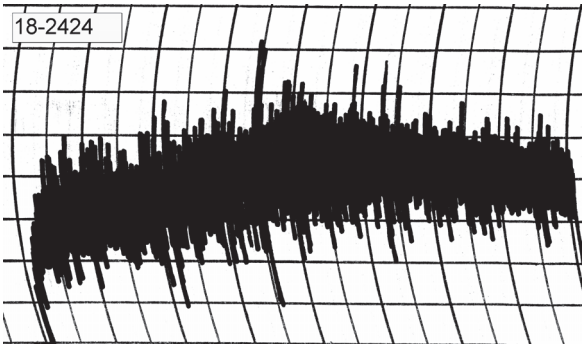
2018 (Small Scale) Samples – Northern States

Farinograms



Water abs = 62.3%, Peak time = 5.4 min,
Mix stab = 11.7 min, MTI = 18 FU

Mixograms



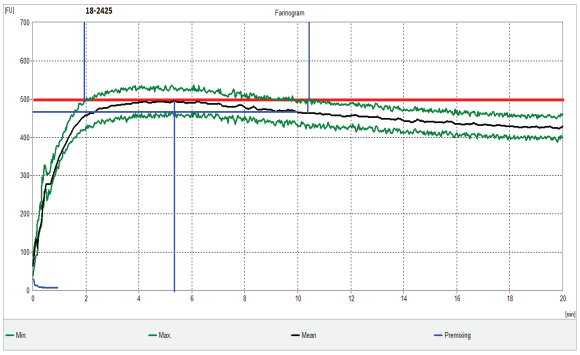
Water abs = 66.9%
Mix time = 4.1 min

18-2424, Jagalene (CC07)

Physical Dough Tests

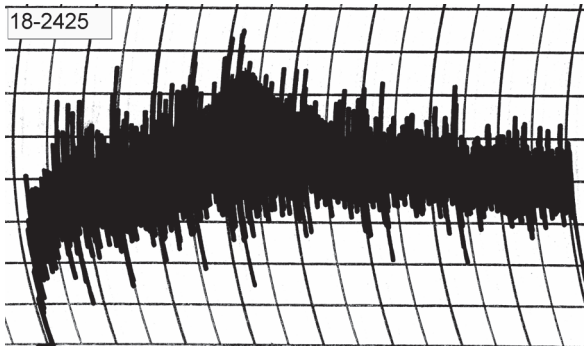
2018 (Small Scale) Samples – Northern States

Farinograms



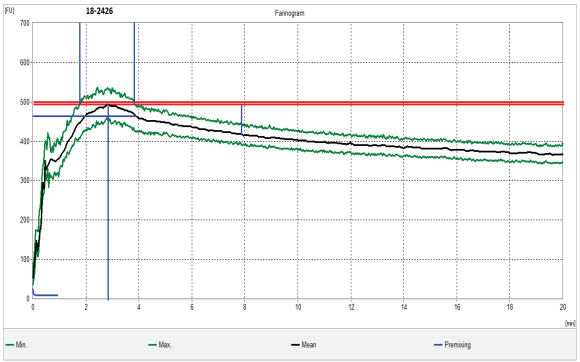
Water abs = 63.8%, Peak time = 5.4 min,
Mix stab = 8.5 min, MTI = 33 FU

Mixograms

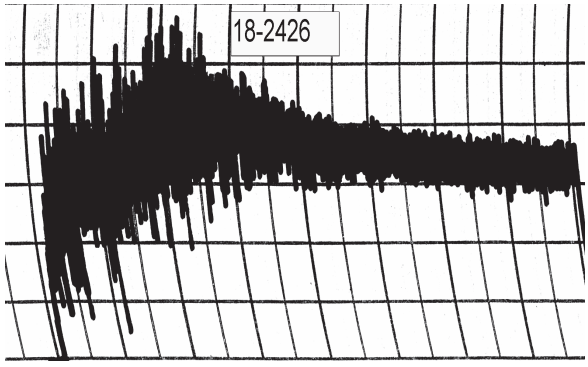


Water abs = 65.6%
Mix time = 3.3 min

18-2425, NE10478-1



Water abs = 56.8%, Peak time = 2.9 min,
Mix stab = 2.1 min, MTI = 75 FU



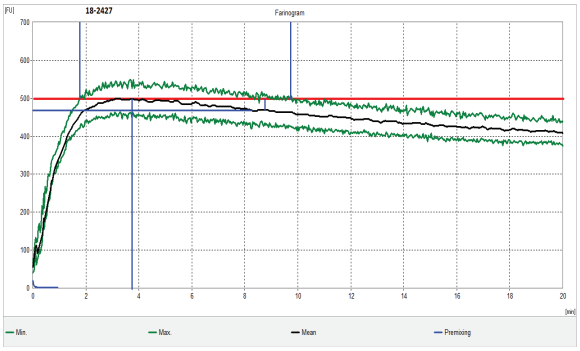
Water abs = 63.3%
Mix time = 2.3 min

18-2426, NHH144913-3

Physical Dough Tests

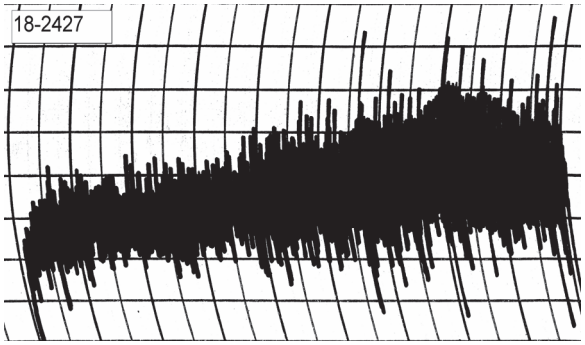
2018 (Small Scale) Samples – Northern States

Farinograms



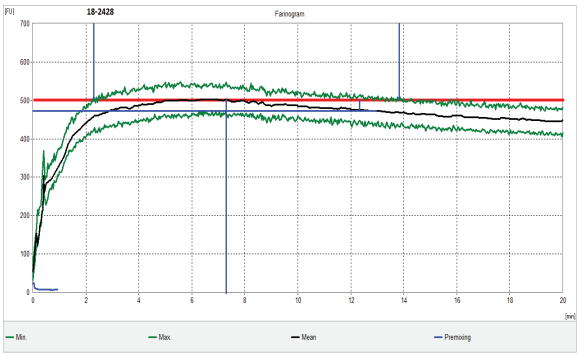
Water abs = 59.5%, Peak time = 3.8 min,
Mix stab = 8.0 min, MTI = 29 FU

Mixograms

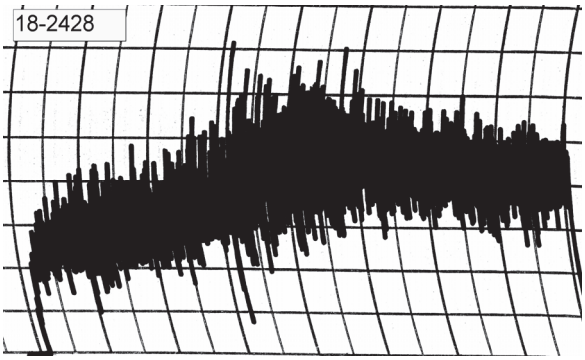


Water abs = 66.8%
Mix time = 7.0 min

18-2427, MT1564



Water abs = 60.2%, Peak time = 7.3 min,
Mix stab = 11.5 min, MTI = 27 FU



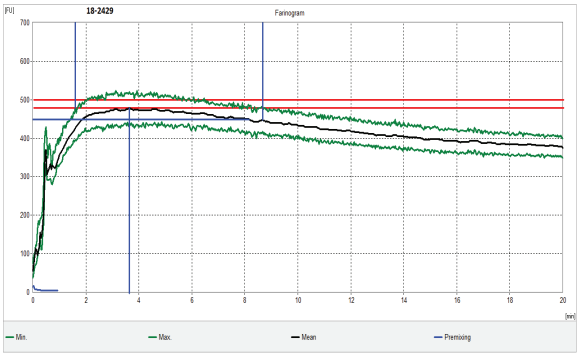
Water abs = 67.3%
Mix time = 4.4 min

18-2428, MTS1588

Physical Dough Tests

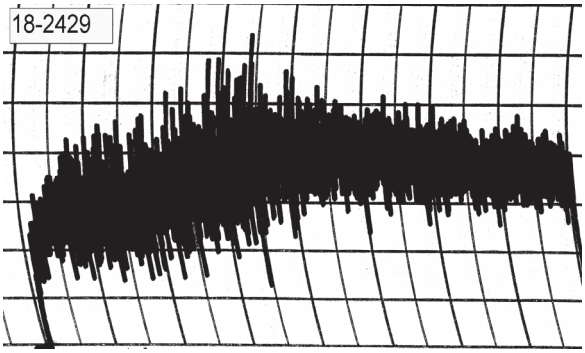
2018 (Small Scale) Samples – Northern States

Farinograms



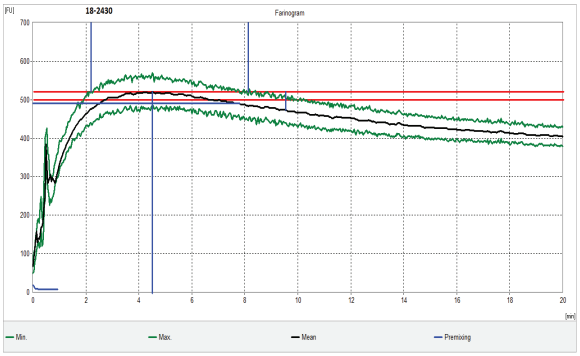
Water abs = 57.4%, Peak time = 3.7 min,
Mix stab = 7.1 min, MTI = 31 FU

Mixograms

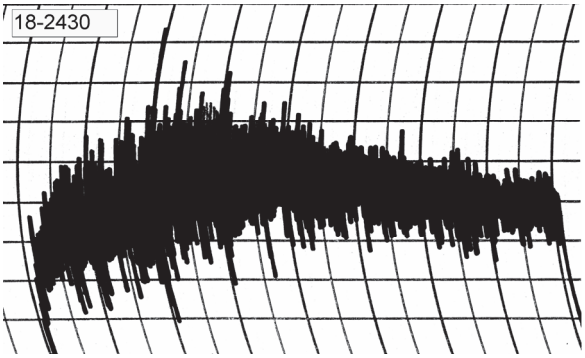


Water abs = 64.2%
Mix time = 3.4 min

18-2429, NORD58



Water abs = 61.2%, Peak time = 4.5 min,
Mix stab = 5.9 min, MTI = 47 FU



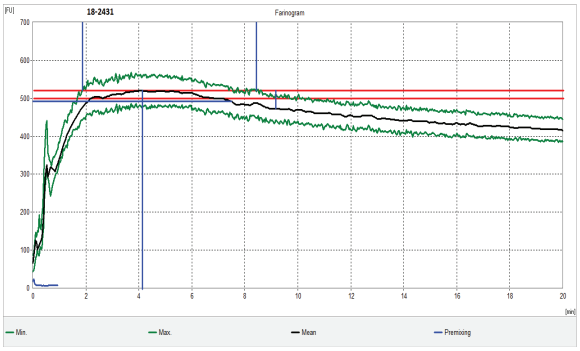
Water abs = 66.1%
Mix time = 2.6 min

18-2430, NORD62

Physical Dough Tests

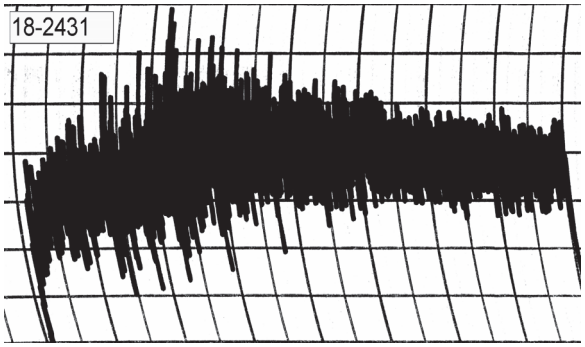
2018 (Small Scale) Samples – Northern States

Farinograms



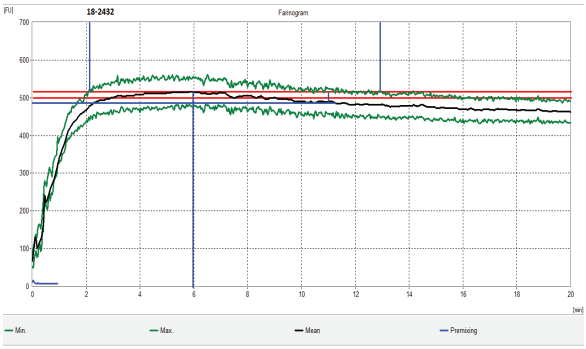
Water abs = 59.7%, Peak time = 4.2 min,
Mix stab = 6.6 min, MTI = 49 FU

Mixograms

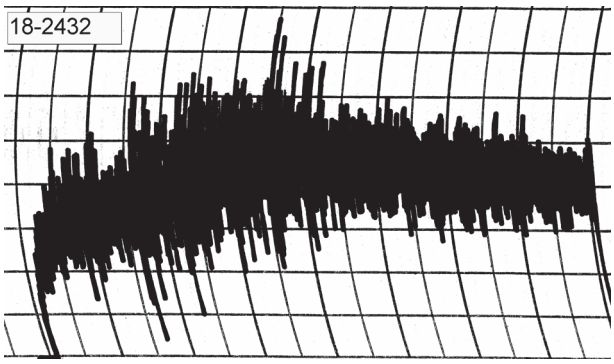


Water abs = 64.8%
Mix time = 3.0 min

18-2431, SD09227



Water abs = 60.9%, Peak time = 6.0 min,
Mix stab = 10.8 min, MTI = 25 FU

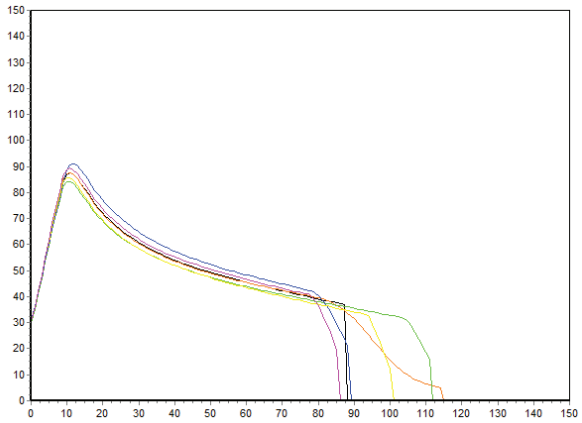


Water abs = 65.0%
Mix time = 3.4 min

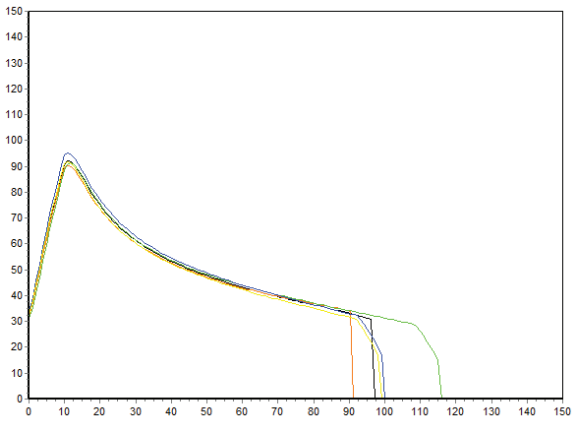
18-2432, SD14115-5

Physical Dough Tests - Alveograph

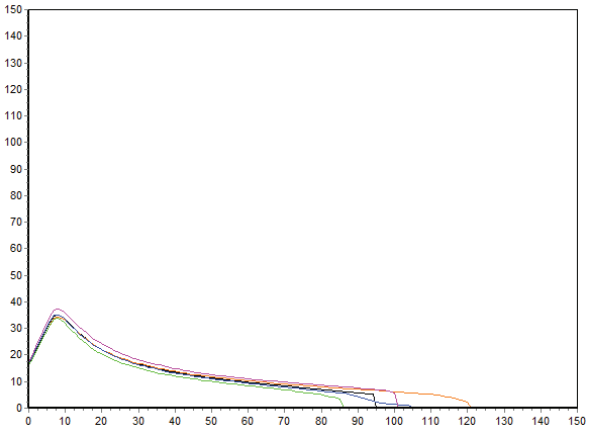
2018 (Small Scale) Samples – Northern States



18-2424, Jagalene (CC07)
P(mm H_20) =96, L(mm) = 87, W($10E^{-4}$ J) = 311



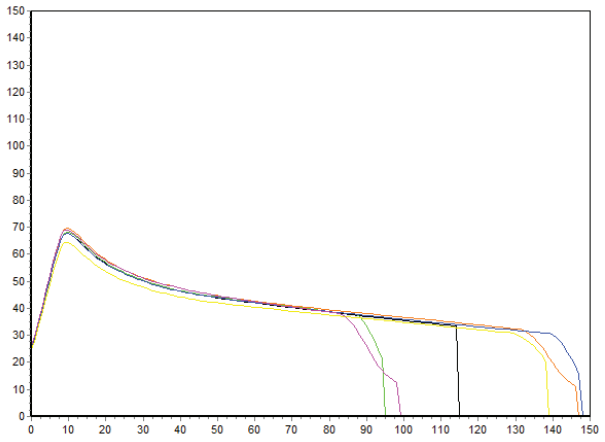
18-2425, NE10478-1
P(mm H_20) = 101, L(mm) = 96, W($10E^{-4}$ J) = 328



18-2426, NHH144913-3
P(mm H_20) =39, L(mm) = 94, W($10E^{-4}$ J) = 90

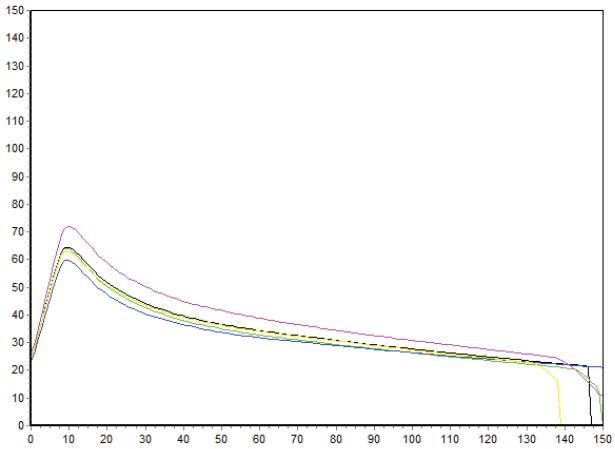
Physical Dough Tests - Alveograph

2018 (Small Scale) Samples – Northern States



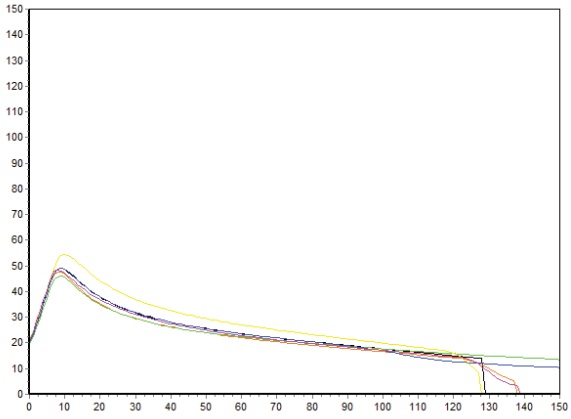
18-2427, MT1564

P(mm H_20) =75, L(mm) = 114, W(10E^{-4} J) = 330



18-2428, MTS1588

P(mm H_20) = 71, L(mm) = 146, W(10E^{-4} J) = 330

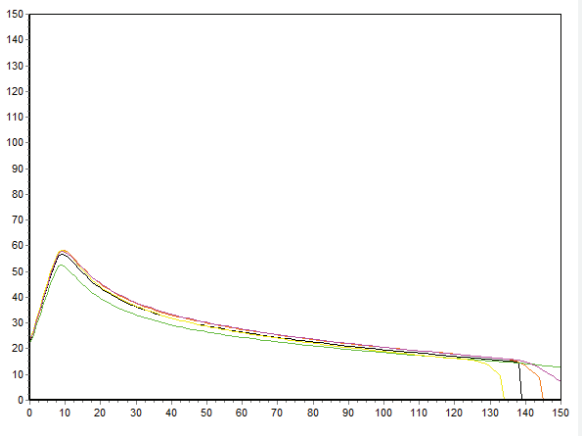


18-2429, NORD58

P(mm H_20) =54, L(mm) = 128, W(10E^{-4} J) = 211

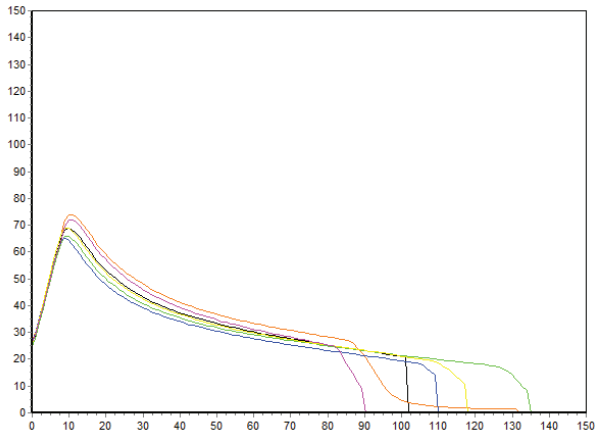
Physical Dough Tests - Alveograph

2018 (Small Scale) Samples – Northern States



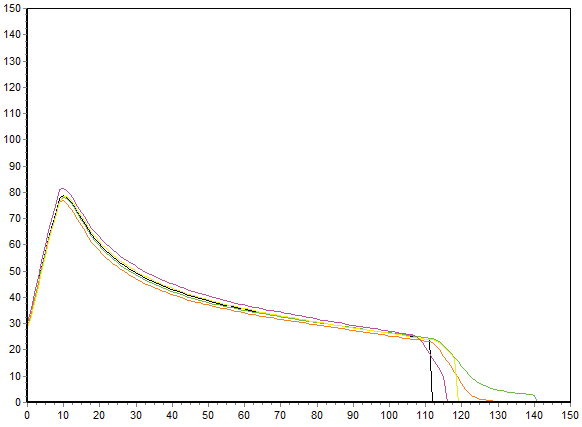
18-2430, NORD62

P(mm H_20) =62, L(mm) = 138, W($10E^{-4}$ J) = 249



18-2431, SD09227

P(mm H_20) = 76, L(mm) = 101, W($10E^{-4}$ J) = 242

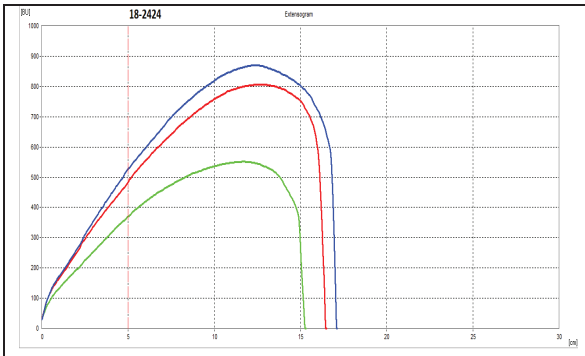


18-2432, SD14115-5

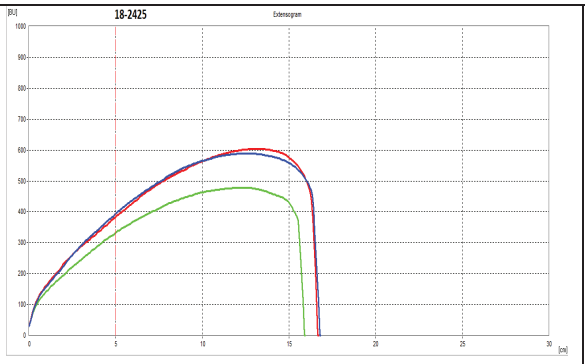
P(mm H_20) =87, L(mm) = 111, W($10E^{-4}$ J) = 297

Physical Dough Tests - Extensigraph

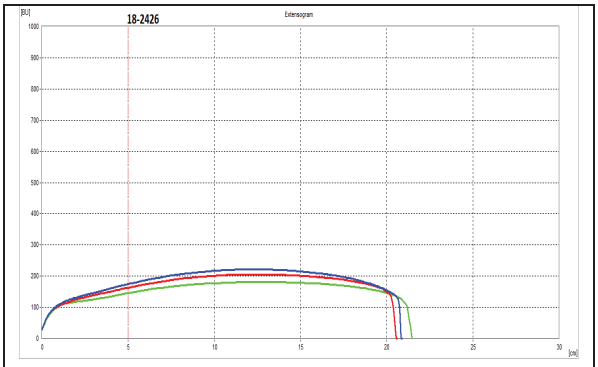
2018 (Small Scale) Samples – Northern States



18-2424, Jagalene (CC07)
R (BU) =488, E (mm) = 166, W (cm^2) = 167
Rmax (BU) = 806, Ratio = 2.9 at 90 min



18-2425, NE10478-1
R (BU) = 383, E (mm) = 168, W (cm^2) = 132
Rmax (BU) = 604, Ratio = 2.3 at 90 min

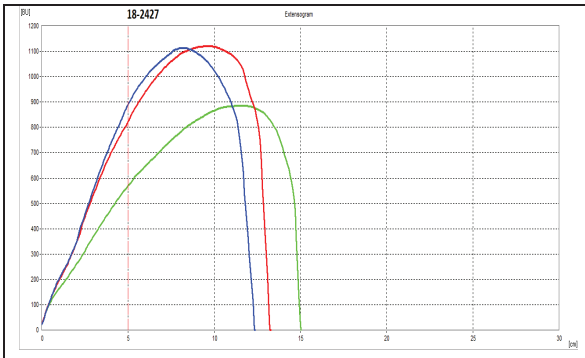


18-2426, NHH144913-3
R (BU) = 163, E (mm) = 207, W (cm^2) = 63
Rmax (BU) = 205, Ratio = 0.8 at 90 min

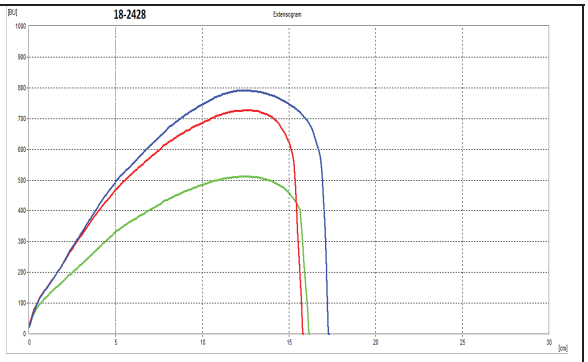
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigraph

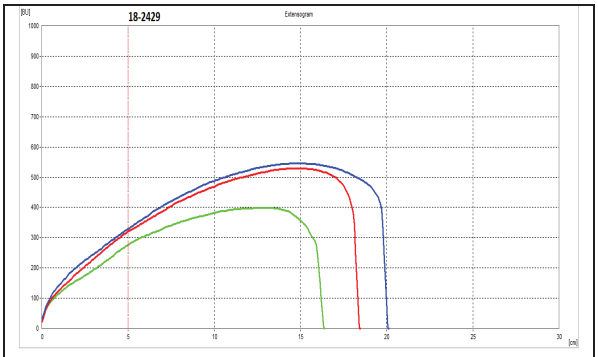
2018 (Small Scale) Samples – Northern States



18-2427, MT1564
R (BU) = 827, E (mm) = 134, W (cm^2) = 183
Rmax (BU) = 1121, Ratio = 6.2 at 90 min



18-2428, MTS1588
R (BU) = 472, E (mm) = 159, W (cm^2) = 145
Rmax (BU) = 727, Ratio = 3.0 at 90 min

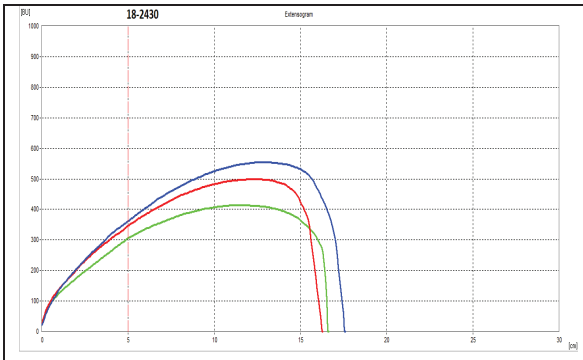


18-2429, NORD58
R (BU) = 321, E (mm) = 186, W (cm^2) = 127
Rmax (BU) = 528, Ratio = 1.7 at 90 min

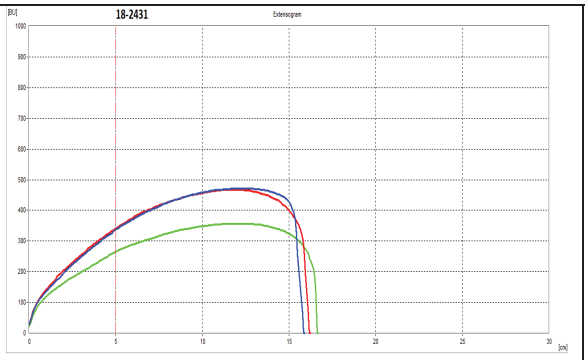
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigraph

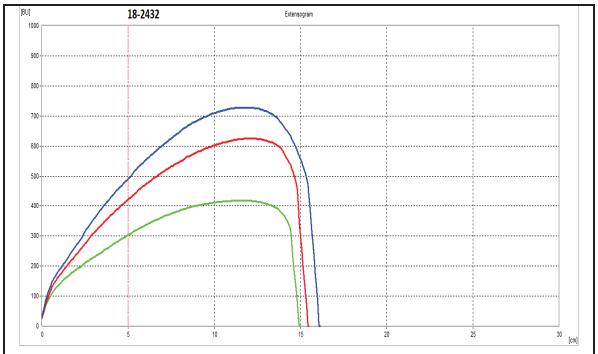
2018 (Small Scale) Samples – Northern States



18-2430, NORD62
R (BU) =348, E (mm) = 164, W (cm^2) = 107
Rmax (BU) = 498, Ratio = 2.1 at 90 min



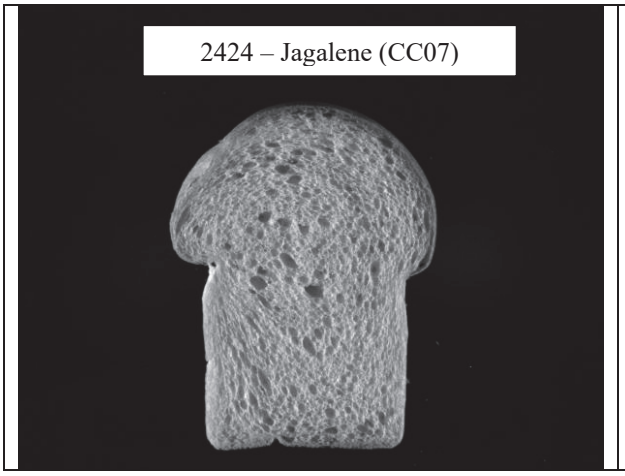
18-2431, SD09227
R (BU) = 341, E (mm) = 163, W (cm^2) = 103
Rmax (BU) = 457, Ratio = 2.1 at 90 min



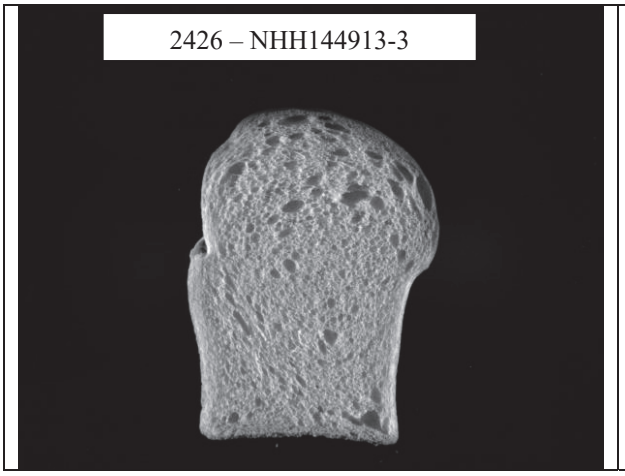
18-2432, SD14115-5
R (BU) = 424, E (mm) = 156, W (cm^2) = 124
Rmax (BU) = 624, Ratio = 2.7 at 90 min

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

Northern States: C-Cell Bread Images and Analysis
2018 (Small-Scale) Samples

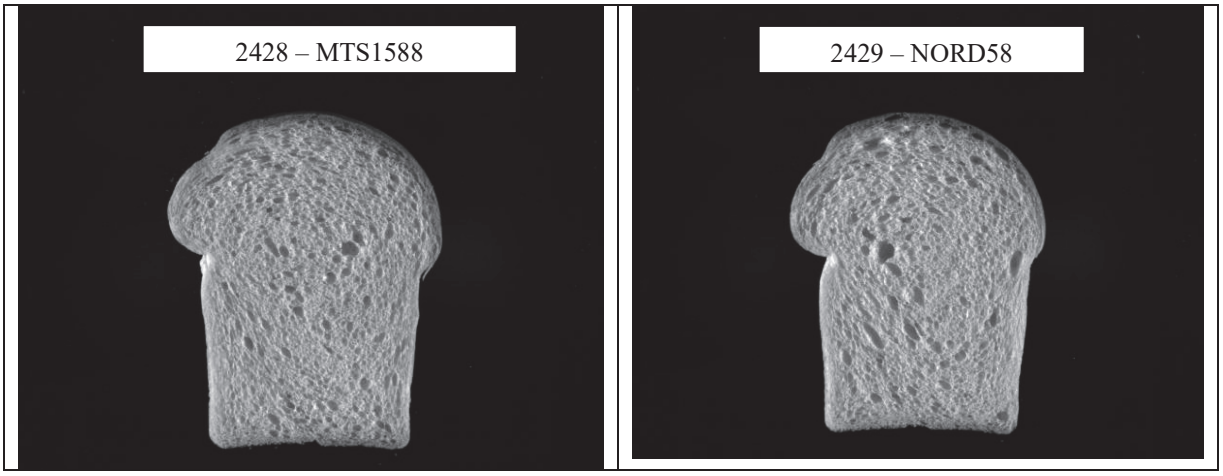


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2424	7041	138	4207	0.442	2.085	3.383	1.773	-10.63
2425	6728	144	4130	0.439	2.007	0.497	1.750	-17.70

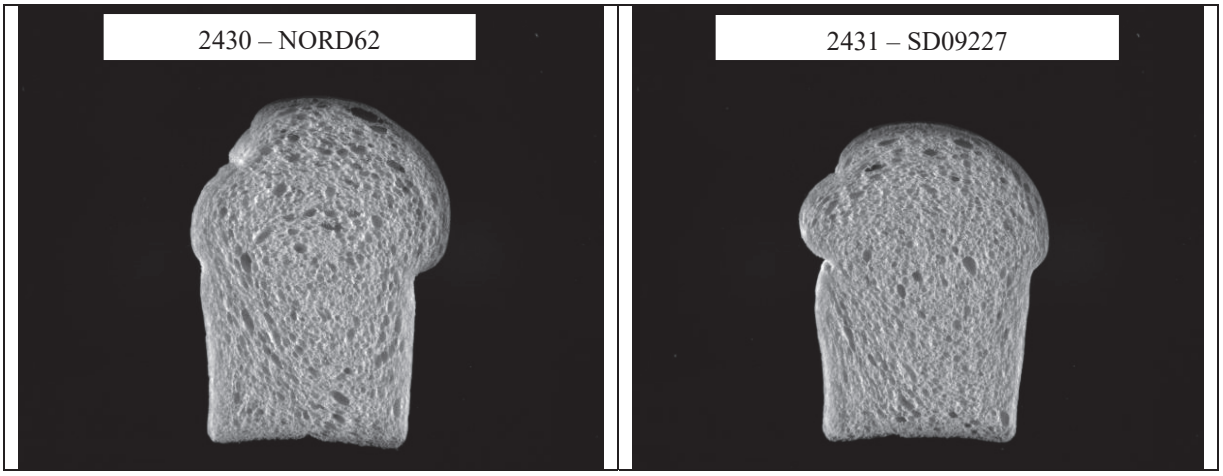


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2426	6618	142	4113	0.437	2.001	2.127	1.650	-12.0
2427	7165	142	4411	0.439	2.035	0.835	1.740	-12.65

Northern States: C-Cell Bread Images and Analysis
2018 (Small-Scale) Samples



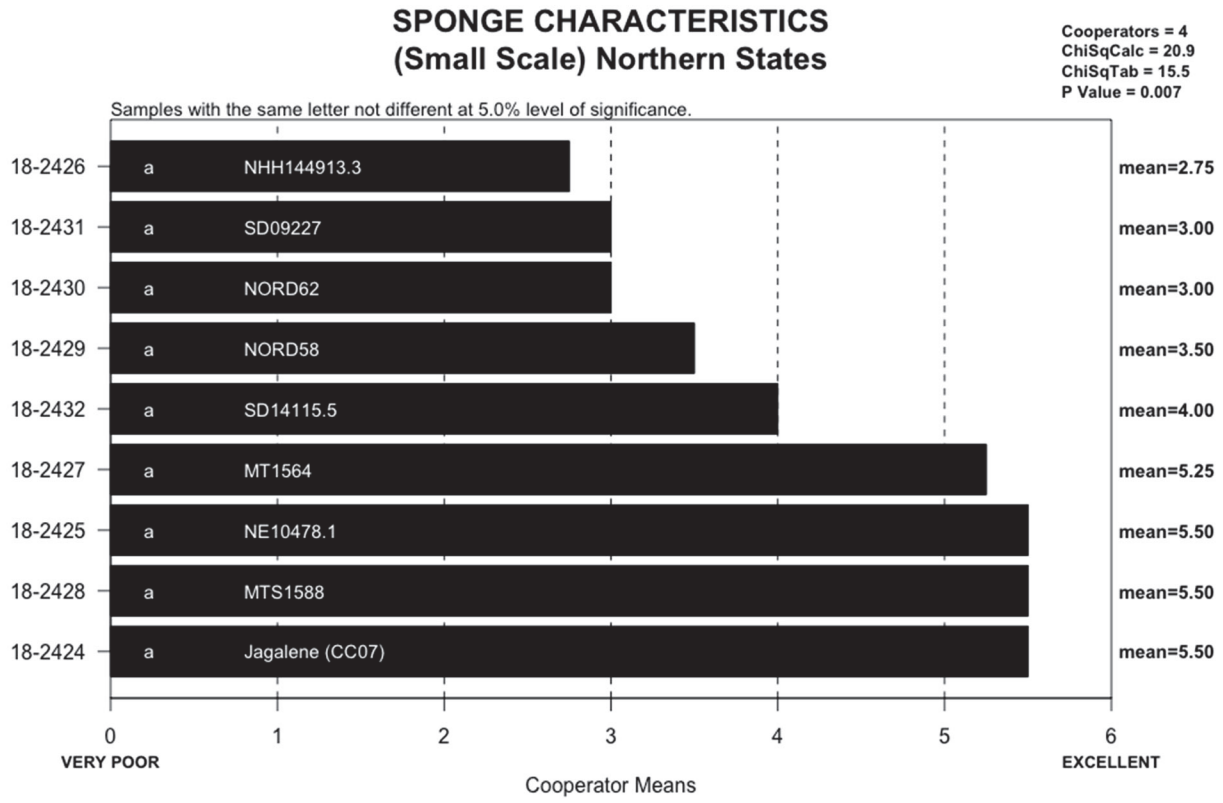
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2428	6949	143	4363	0.435	1.918	0.593	1.715	-14.30
2429	6598	146	4206	0.440	2.039	2.321	1.680	-13.80

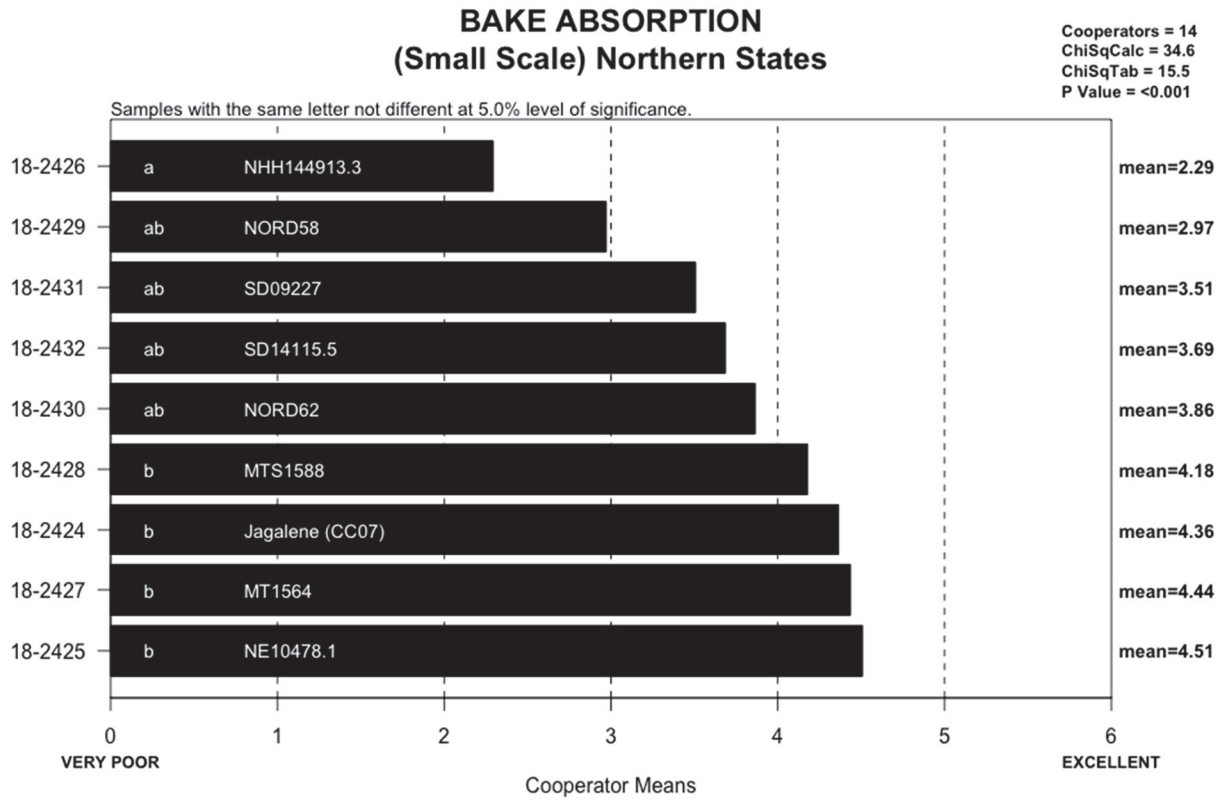


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2430	6985	146	4000	0.451	2.191	1.821	1.740	-14.50
2431	6359	145	4152	0.431	1.921	1.252	1.690	-13.35

Northern States: C-Cell Bread Images and Analysis
2018 (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})
2432	6537	137	4069	0.440	2.023	3.229	1.745	-13.00


SPONGE CHARACTERISTICS
(Small Scale) Northern States
Cooperators = 4
ChiSqCalc = 20.9
ChiSqTab = 15.5
P Value = 0.007
Samples with the same letter not different at 5.0% level of significance.
18-2426 a NHH144913.3 mean=2.75
18-2431 a SD09227 mean=3.00
18-2430 a NORD62 mean=3.00
18-2429 a NORD58 mean=3.50
18-2432 a SD14115.5 mean=4.00
18-2427 a MT1564 mean=5.25
18-2425 a NE10478.1 mean=5.50
18-2428 a MTS1588 mean=5.50
18-2424 a Jagalene (CC07) mean=5.50
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

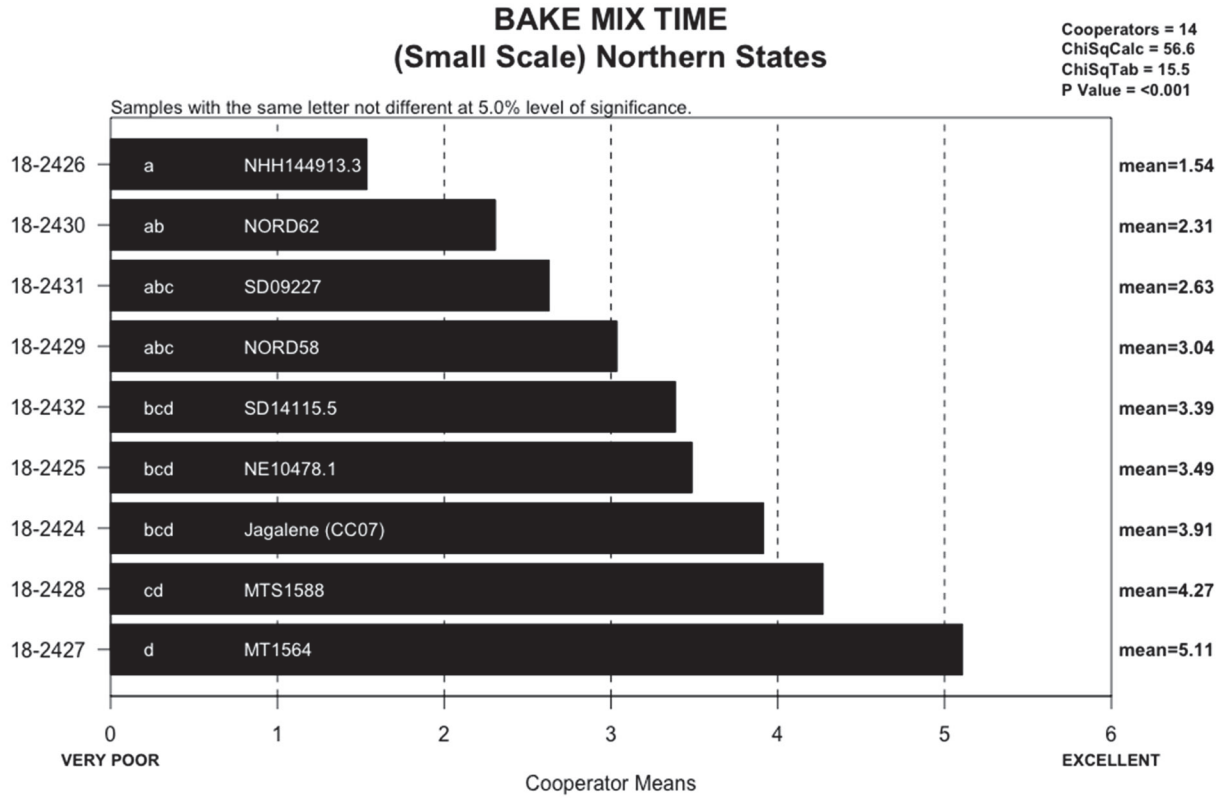

BAKE ABSORPTION
(Small Scale) Northern States
Cooperators = 14
ChiSqCalc = 34.6
ChiSqTab = 15.5
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2426 a NHH144913.3 mean=2.29
18-2429 ab NORD58 mean=2.97
18-2431 ab SD09227 mean=3.51
18-2432 ab SD14115.5 mean=3.69
18-2430 ab NORD62 mean=3.86
18-2428 b MTS1588 mean=4.18
18-2424 b Jagalene (CC07) mean=4.36
18-2427 b MT1564 mean=4.44
18-2425 b NE10478.1 mean=4.51
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

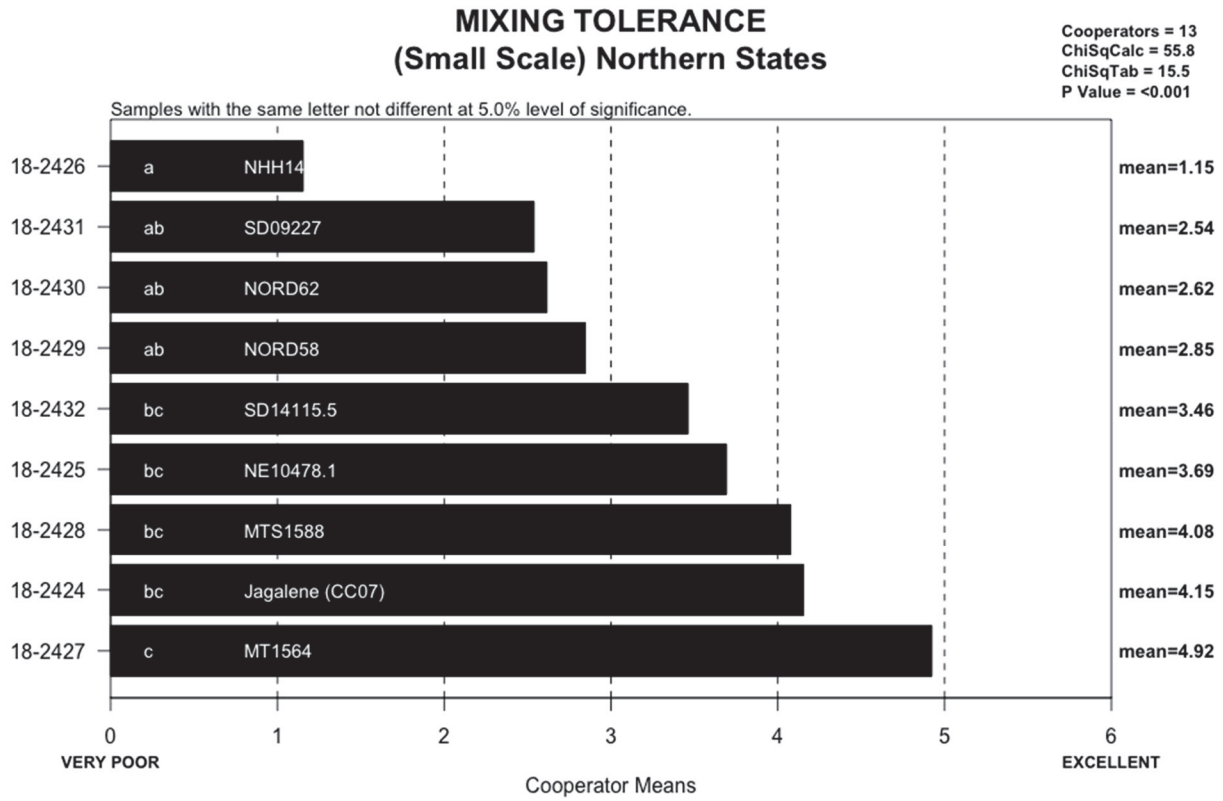
BAKE ABSORPTION, ACTUAL (14% MB)
(Small Scale) Northern States
Cooperators A – N

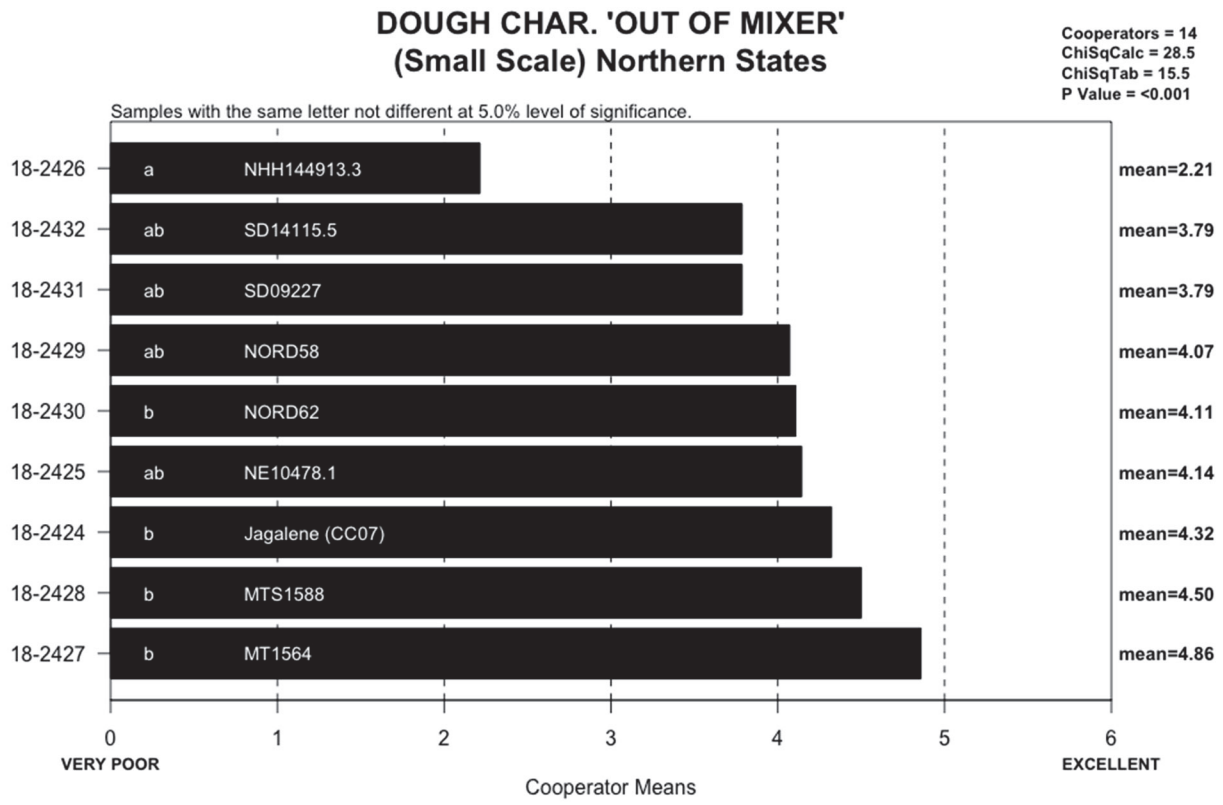
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2424	Jagalene (CC07)	65.1	65.2	64.4	63.1	60	62.3	61.9	71.0	63.6	68.5	64.6	67.0	58	68.8
18-2425	NE10478-1	65.1	65.1	64.0	62.6	60	63.8	61.8	70.7	64.7	67.0	66.2	67.0	60	65.9
18-2426	NHH144913-3	63.0	60.5	62.2	62.1	59	56.8	60.5	66.1	59.0	64.0	58.2	61.0	57	61.9
18-2427	MT1564	65.6	66.5	67.7	63.1	60	59.5	62.6	67.8	61.0	69.0	61.9	64.0	57	68.2
18-2428	MTS1588	66.1	65.5	66.8	63.5	60	60.2	63.0	68.1	61.3	67.0	63.7	63.6	58	67.2
18-2429	NORD58	63.0	64.5	67.0	61.6	59	57.4	61.9	65.9	60.6	64.5	60.3	61.8	56	64.2
18-2430	NORD62	66.0	64.8	65.6	63.1	60	61.2	61.4	67.6	63.7	67.0	63.6	65.5	60	66.3
18-2431	SD09227	64.1	64.1	65.7	61.6	59	59.7	61.3	67.1	61.9	66.0	63.9	64.6	57	64.9
18-2432	SD14115-5	64.2	63.9	64.4	61.6	59	60.9	61.2	68.6	62.9	66.0	65.0	65.1	58	66.4

BAKE MIX TIME, ACTUAL
(Small Scale) Northern States
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2424	Jagalene (CC07)	5.0	4.3	4.2	4.8	6	5	3.6	4.8	3.8	3.6	16	3.2	25	6.3
18-2425	NE10478-1	4.0	3.5	4.0	3.8	8	5	3.4	4.0	3.0	2.7	18	3.2	25	4.0
18-2426	NHH144913-3	2.3	2.3	1.7	3.0	4	3	2.3	2.5	2.0	2.1	6	3.5	5	2.8
18-2427	MT1564	7.2	5.8	6.8	7.3	15	7	5.0	5.0	5.0	4.6	22	4.9	25	9.0
18-2428	MTS1588	5.2	4.3	5.5	5.3	7	7	2.8	5.0	3.5	3.4	21	3.8	25	6.3
18-2429	NORD58	3.5	3.5	4.6	4.0	4	4	3.4	4.8	2.8	3.1	9	3.0	14	4.5
18-2430	NORD62	3.3	3.0	3.4	3.8	3	4	2.8	3.0	2.5	2.7	9	2.5	10	3.5
18-2431	SD09227	4.0	3.3	3.5	3.3	3	4	2.8	3.5	3.0	3.0	9	2.5	10	4.5
18-2432	SD14115-5	3.5	3.5	4.6	5.4	4	6	2.7	4.5	2.8	3.1	10	4.0	14	5.0

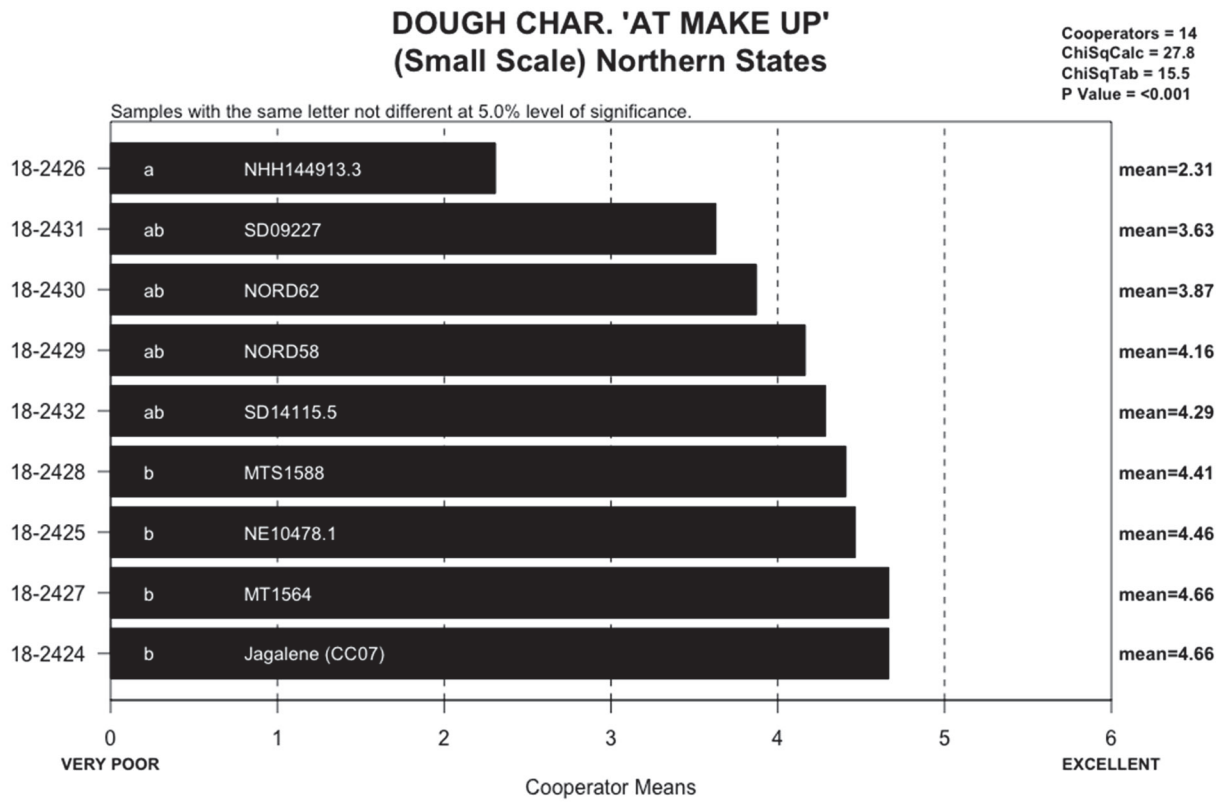

BAKE MIX TIME
(Small Scale) Northern States
Cooperators = 14
ChiSqCalc = 56.6
ChiSqTab = 15.5
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2426 a NHH144913.3 mean=1.54
18-2430 ab NORD62 mean=2.31
18-2431 abc SD09227 mean=2.63
18-2429 abc NORD58 mean=3.04
18-2432 bcd SD14115.5 mean=3.39
18-2425 bcd NE10478.1 mean=3.49
18-2424 bcd Jagalene (CC07) mean=3.91
18-2428 cd MTS1588 mean=4.27
18-2427 d MT1564 mean=5.11
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Small Scale) Northern States
Cooperators = 13
ChiSqCalc = 55.8
ChiSqTab = 15.5
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2426 a NHH14 mean=1.15
18-2431 ab SD09227 mean=2.54
18-2430 ab NORD62 mean=2.62
18-2429 ab NORD58 mean=2.85
18-2432 bc SD14115.5 mean=3.46
18-2425 bc NE10478.1 mean=3.69
18-2428 bc MTS1588 mean=4.08
18-2424 bc Jagalene (CC07) mean=4.15
18-2427 c MT1564 mean=4.92
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means



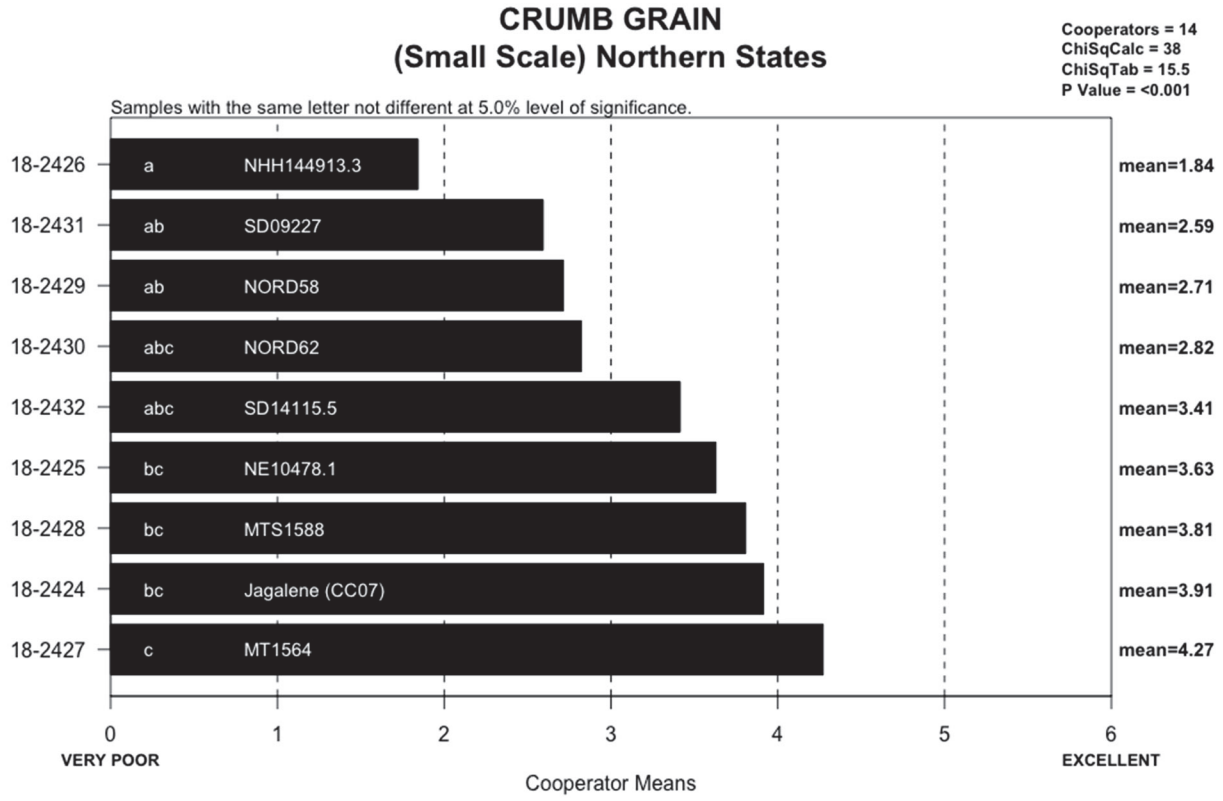
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Small Scale) Northern States

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2424	Jagalene (CC07)	0	0	4	10	0
18-2425	NE10478-1	0	0	5	9	0
18-2426	NHH144913-3	10	3	0	1	0
18-2427	MT1564	0	0	3	8	3
18-2428	MTS1588	0	2	1	8	3
18-2429	NORD58	3	1	1	7	2
18-2430	NORD62	2	0	2	9	1
18-2431	SD09227	3	0	2	9	0
18-2432	SD14115-5	4	0	4	6	0



DOUGH CHAR. 'AT MAKE UP', DESCRIBED
(Small Scale) Northern States

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2424	Jagalene (CC07)	1	0	1	11	1
18-2425	NE10478-1	1	1	3	7	2
18-2426	NHH144913-3	7	3	1	3	0
18-2427	MT1564	0	0	4	8	2
18-2428	MTS1588	0	2	2	8	2
18-2429	NORD58	1	2	1	8	2
18-2430	NORD62	2	1	1	10	0
18-2431	SD09227	4	1	1	8	0
18-2432	SD14115-5	1	0	2	9	2

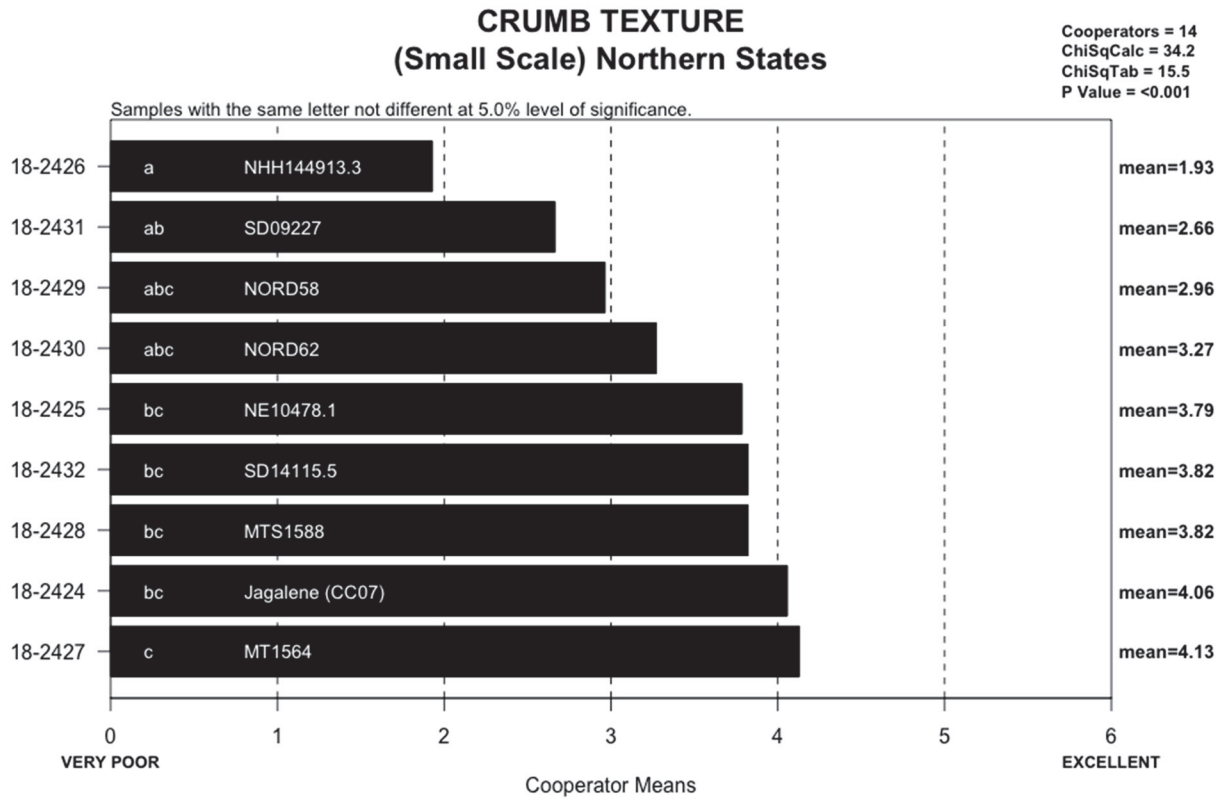


CRUMB GRAIN, DESCRIBED
(Small Scale) Northern States

IDCODE	ID	Open	Fine	Dense
18-2424	Jagalene (CC07)	6	6	2
18-2425	NE10478-1	7	6	1
18-2426	NHH144913-3	5	4	5
18-2427	MT1564	6	6	2
18-2428	MTS1588	7	4	3
18-2429	NORD58	8	4	2
18-2430	NORD62	9	3	2
18-2431	SD09227	8	4	2
18-2432	SD14115-5	7	7	0

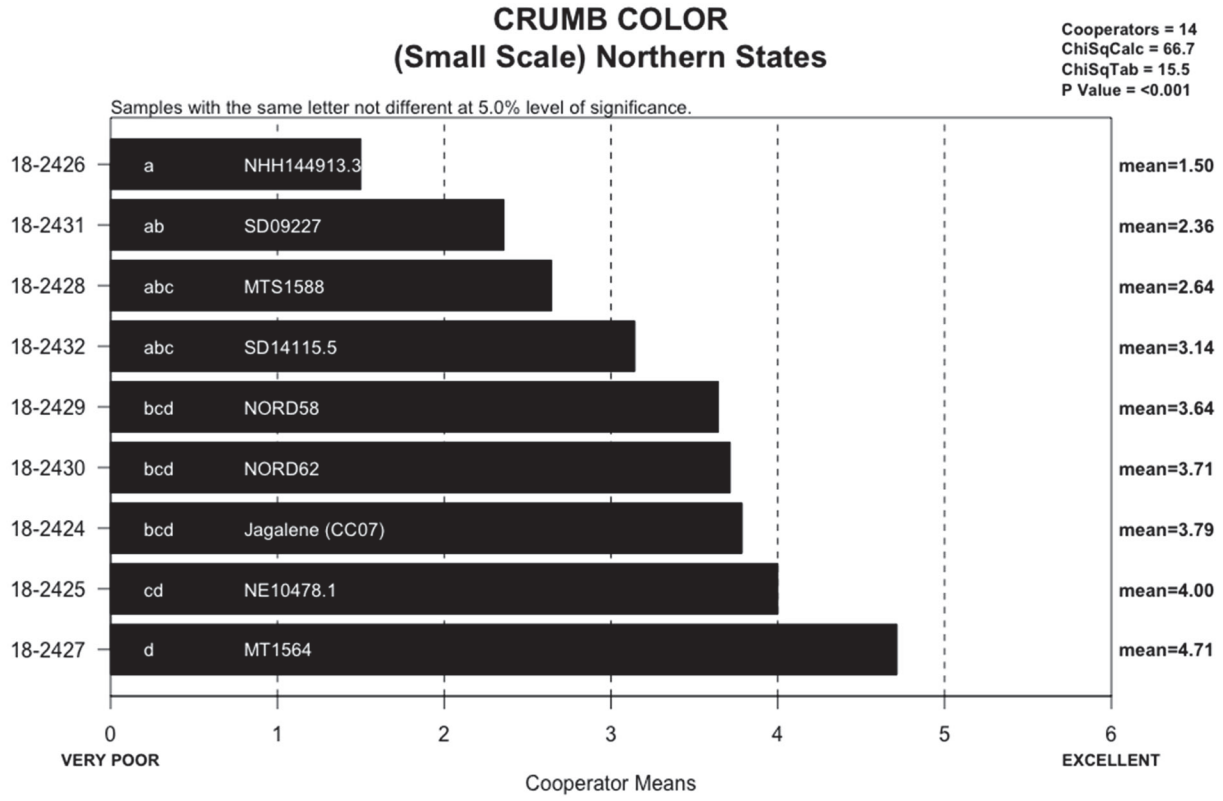
CELL SHAPE, DESCRIBED
(Small Scale) Northern States

IDCODE	ID	Round	Irregular	Elongated
18-2424	Jagalene (CC07)	2	6	6
18-2425	NE10478-1	4	5	5
18-2426	NHH144913-3	8	6	0
18-2427	MT1564	4	4	6
18-2428	MTS1588	4	5	5
18-2429	NORD58	7	4	3
18-2430	NORD62	7	4	3
18-2431	SD09227	6	6	2
18-2432	SD14115-5	2	7	5



CRUMB TEXTURE, DESCRIBED
(Small Scale) Northern States

IDCODE	ID	Harsh	Smooth	Silky
18-2424	Jagalene (CC07)	3	8	3
18-2425	NE10478-1	4	7	3
18-2426	NHH144913-3	11	2	1
18-2427	MT1564	3	6	5
18-2428	MTS1588	3	8	3
18-2429	NORD58	7	5	2
18-2430	NORD62	5	7	2
18-2431	SD09227	9	4	1
18-2432	SD14115-5	3	8	3



CRUMB COLOR, DESCRIBED
(Small Scale) Northern States

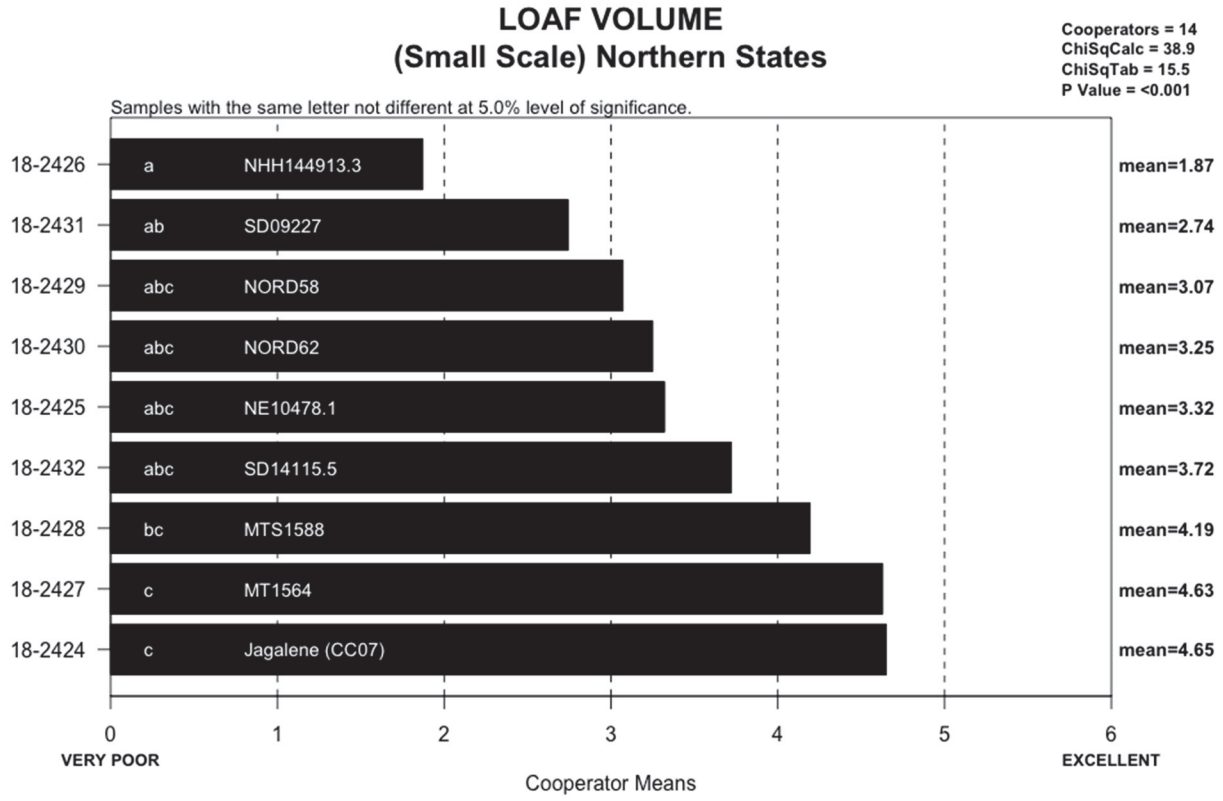
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	BrightWhite
18-2424	Jagalene (CC07)	0	1	0	1	10	2	0
18-2425	NE10478-1	0	1	0	2	7	4	0
18-2426	NHH144913-3	2	4	5	3	0	0	0
18-2427	MT1564	0	0	0	0	5	9	0
18-2428	MTS1588	0	0	8	3	3	0	0
18-2429	NORD58	1	0	1	0	9	3	0
18-2430	NORD62	0	0	0	3	10	1	0
18-2431	SD09227	1	0	6	4	3	0	0
18-2432	SD14115-5	1	0	0	6	7	0	0

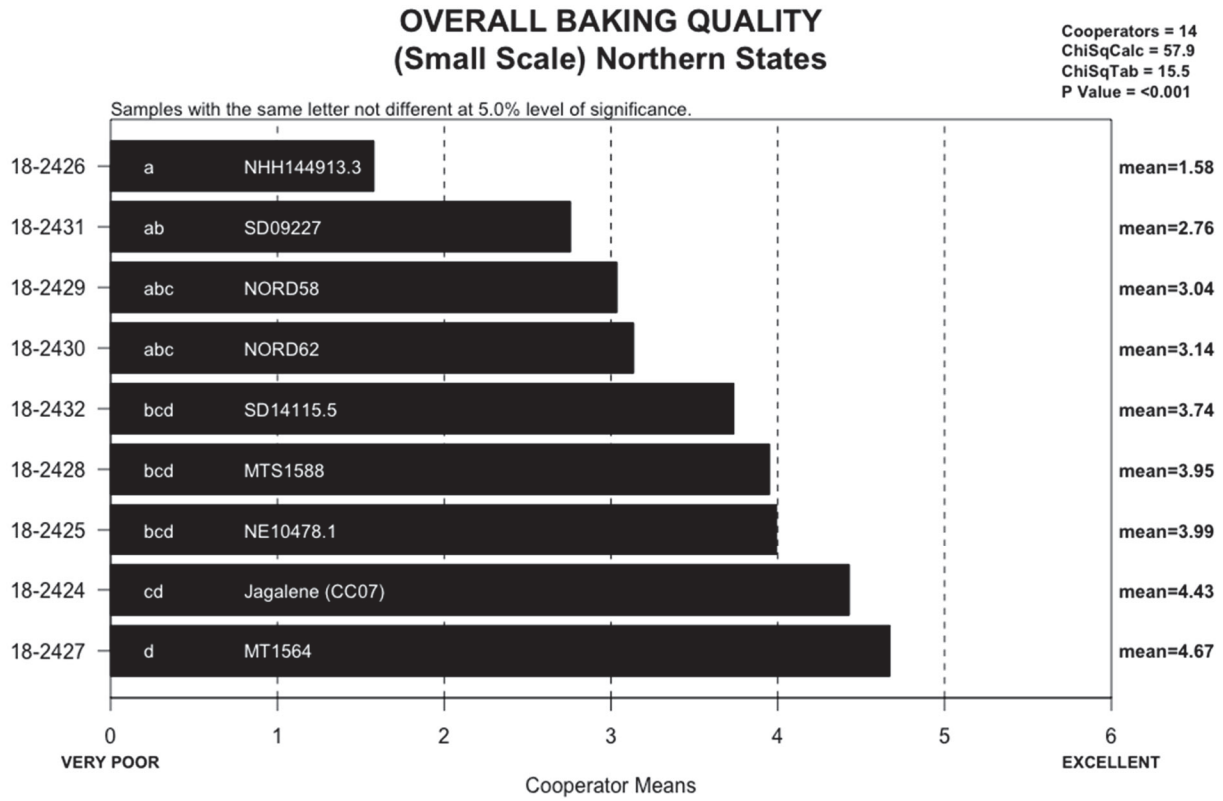
LOAF WEIGHT, ACTUAL
(Small Scale) Northern States
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2424	Jagalene (CC07)	140.6	145.3	156.0	143.1	419	468.3	132.7	134.4	132.6	149.1	447.1	139.3	480.1	154.4
18-2425	NE10478-1	143.0	147.7	156.2	142.4	420	471.3	133.5	137.6	133.6	150.2	445.6	142.1	487.1	152.2
18-2426	NHH144913-3	143.7	142.6	158.4	141.0	415	474.2	132.4	135.4	133.7	150.2	445.2	143.4	479.2	148.9
18-2427	MT1564	140.2	146.2	155.2	140.7	417	475.2	128.4	130.5	129.8	146.6	450.2	140.5	480.7	151.5
18-2428	MTS1588	141.2	148.5	162.1	144.6	415	469.5	133.9	136.0	131.1	145.9	442.7	140.0	483.3	153.5
18-2429	NORD58	141.2	145.7	157.5	140.7	412	467.8	131.5	137.5	132.4	143.1	444.3	141.2	484.1	150.8
18-2430	NORD62	143.6	147.6	154.4	143.2	412	466.3	132.6	135.8	132.9	146.9	446.2	141.1	480.9	151.9
18-2431	SD09227	143.3	148.2	159.7	142.3	415	467.4	132.8	136.5	133.6	148.8	446.0	140.5	496.0	152.0
18-2432	SD14115-5	141.2	144.8	152.7	141.1	415	466.7	134.7	131.9	132.6	145.7	441.6	141.2	490.6	152.7

LOAF VOLUME, ACTUAL
(Small Scale) Northern States
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2424	Jagalene (CC07)	1050	950	1048	963	3050	2400	920	990	988	975	2800	897	2986	1025
18-2425	NE10478-1	950	800	940	948	2650	2250	815	870	850	900	2625	794	2927	925
18-2426	NHH144913-3	685	720	873	970	2525	2038	685	715	715	760	2500	770	2485	910
18-2427	MT1564	1050	990	1023	930	2950	2350	935	1060	1065	1065	2425	884	2986	1025
18-2428	MTS1588	1040	840	1010	1015	2950	2288	730	1030	908	980	2700	850	2927	965
18-2429	NORD58	875	780	963	998	2625	2138	835	810	850	940	2425	802	2750	875
18-2430	NORD62	1000	840	962	1000	2450	2150	805	840	868	1015	2475	764	2750	1000
18-2431	SD09227	870	795	978	935	2350	2125	765	845	788	875	2425	744	2750	880
18-2432	SD14115-5	1000	895	973	1005	2600	2475	775	960	893	980	2675	810	2927	925


LOAF VOLUME
(Small Scale) Northern States
Cooperators = 14
ChiSqCalc = 38.9
ChiSqTab = 15.5
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2426 a NHH144913.3 mean=1.87
18-2431 ab SD09227 mean=2.74
18-2429 abc NORD58 mean=3.07
18-2430 abc NORD62 mean=3.25
18-2425 abc NE10478.1 mean=3.32
18-2432 abc SD14115.5 mean=3.72
18-2428 bc MTS1588 mean=4.19
18-2427 c MT1564 mean=4.63
18-2424 c Jagalene (CC07) mean=4.65
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Small Scale) Northern States
Cooperators = 14
ChiSqCalc = 57.9
ChiSqTab = 15.5
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2426 a NHH144913.3 mean=1.58
18-2431 ab SD09227 mean=2.76
18-2429 abc NORD58 mean=3.04
18-2430 abc NORD62 mean=3.14
18-2432 bcd SD14115.5 mean=3.74
18-2428 bcd MTS1588 mean=3.95
18-2425 bcd NE10478.1 mean=3.99
18-2424 cd Jagalene (CC07) mean=4.43
18-2427 d MT1564 mean=4.67
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Small Scale) Northern States

COOP. **18-2424 Jagalene (CC07)**

A. Loaf Volume better than protein predicted LV.
B. No comment.
C. Very good dough properties and good bread performance.
D. Average Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, Very High Volume, Gray Yellow Crumb, Fine Elongated Cells, Resilient & Smooth Texture.
E. Good dough at makeup, Good volume, Very open grain, Slightly Creamy.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Average loaf of bread.
K. High protein and good absorption. Great characteristics and notes. Great for bread application or blending.
L. No comment.
M. Slightly low absorption, very good mix strength and good loaf volume. High ash.
N. High absorption, high volume.

COOP. **18-2425 NE10478-1**

A. Nice out of mixer.
B. No comment.
C. Very good dough properties and good bread performance.
D. Average Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, High Volume, Gray Yellow Crumb, Slight Open Elongated Cells with Keyhole, Resilient & Smooth Texture.
E. Good dough out of mixer, Average mix, Very open grain, Low volume.
F. No comment.
G. No comment.
H. No comment.
I. Nice crumb color.
J. Average protein and bake.
K. High protein and absorption. Long mix time. Great notes and characteristics. Great for bread application or blending.
L. No comment.
M. Fair absorption, very good mix strength and good loaf volume.
N. Fine grain, white crumb.

COOP. 18-2426 NHH144913-3

A. Sticky, the mix time does not meet target range of 3-5mins.
B. Flour looked like soft wheat flour, light crust with no rounded top. Very poor.
C. Very poor dough strength properties and bread crumb grain type.
D. Medium Protein, Normal Water Abs, Short MT, Sticky & Weak Dough, High Volume, Yellow Crumb, Open Round Cells with Keyhole, Resilient & Slight Harsh Texture.
E. Very soft and sticky dough, Short mix, Dull Brown interior, Soft sponge.
F. No comment.
G. No comment.
H. Poor crumb and volume, tough to handle.
I. Crumb has a gray-yellow color.
J. Extremely weak/short. Unacceptable flour.
K. High protein. Short mix time and not a great mixing tolerance. Notes and Characteristics unfavorable. Gray in color and harsh texture. Would not recommend.
L. No comment.
M. Low absorption, very low mix strength and loaf volume.
N. Low absorption, poor dense grain, dark yellow crumb, poor tolerance.

COOP. 18-2427 MT1564

A. Loaf Volume better than protein predicted LV.
B. Right side break.
C. Very good dough properties and good bread performance.
D. Average Protein, Normal Water Abs, Long MT, Slight Sticky & Strong Dough, High Volume, Creamy Crumb, Fine Elongated Cells, Resilient & Very Smooth Texture.
E. Strong dough, Good mix time, excellent volume, Nice interior, Very open grain.
F. No comment.
G. No comment.
H. Good crumb.
I. No comment.
J. Overall good bake.
K. Average absorption and protein. Long mix time and strong dough notes. Good for blending.
L. No comment.
M. Low absorption, very good mix strength and good loaf volume.
N. High absorption, good grain, white crumb, high volume, strong mixing tolerance.

COOP. 18-2428 MTS1588

A. No comment.
B. No comment.
C. Generally good dough properties and good bread performance.
D. Average Protein, Normal Water Abs, Long MT, Slight Sticky & Strong Dough, Very High Volume, Yellow Crumb, Slight Open Elongated Cells with Keyhole, Resilient & Smooth Texture.
E. Good dough but short mix time for protein. Good volume, Creamy interior, Very open grain.
F. No comment.
G. No comment.
H. No comment.
I. No comment.
J. Yellow crumb, good protein, gluten strength, average loaf.
K. High protein. Long mix time and strong notes and characteristics. Yellow in color. Great for blending.
L. No comment.
M. Slightly low absorption, very good mix strength and good loaf volume.
N. High absorption, good grain, yellow crumb, good volume.

COOP. 18-2429 NORD58

A. Nice out of mixer.
B. No comment.
C. Generally good dough properties and average bread performance.
D. Average Protein, Low Water Abs, Normal MT, Slight Sticky & Strong Dough, Very High Volume, Creamy Crumb, Open Elongated Cells with Keyhole, Resilient & Less Smooth Texture.
E. Soft sticky sponge, Very soft dough, Short mix, No mixing tolerance.
F. No comment.
G. No comment.
H. Low absorption.
I. Crumbly crumb.
J. Average protein and average to slightly below average bake.
K. High protein and low absorption. Lower mix tolerance and shorter mix time. Unfavorable color, crumb, and volume. Would not recommend.
L. No comment.
M. Low absorption, fair mix strength and low loaf volume.
N. Open grain, white crumb.

COOP. 18-2430 NORD62

A. No comment.
B. White dough.
C. Somewhat weaker dough properties and average bread performance.
D. Average Protein, Normal Water Abs & MT, Slight Sticky & Strong Dough, Very High Volume, Creamy Crumb, Open Elongated Cells, Resilient & Smooth Texture.
E. Same as above.
F. No comment.
G. No comment.
H. No comment.
I. Crumb slightly crumbles.
J. Average loaf volume but very open.
K. Short mix time, unfavorable dough characteristics, and undesirable color and texture. All around problematic. Would not recommend.
L. No comment.
M. Fair absorption, low mix strength and loaf volume.
N. High absorption, high volume.

COOP. 18-2431 SD09227

A. No comment.
B. No comment.
C. Somewhat weaker dough properties and good bread performance.
D. Medium Protein, Low Water Abs, Short MT, Slight Sticky & Strong Dough, High Volume, Yellow Crumb, Open Irregular Cells, Resilient & Harsh Texture.
E. Sticky sponge, Very short mix, No mixing tolerance, Very open grain.
F. No comment.
G. No comment.
H. No comment.
I. Crumb has an off-color.
J. Lower loaf volume, weaker, poor crumb, open irregular.
K. Short mix time, unfavorable dough characteristics, and undesirable color and texture. All around problematic. Would not recommend.
L. No comment.
M. Low absorption, low mix strength and loaf volume.
N. Average overall.

COOP. 18-2432 SD14115-5

A. Nice out of mixer, Loaf Volume better than protein predicted LV.
B. Nice loaf externals.
C. Somewhat weaker dough properties and good bread performance.
D. Medium Protein, Low Water Abs, Normal MT, Slight Sticky & Strong Dough, Very High Volume, Gray Yellow Crumb, Open Elongated Cells, Resilient & Less Smooth Texture.
E. Same as above.
F. No comment.
G. No comment.
H. No comment.
I. Crumb has an off-color.
J. Average loaf.
K. Good protein and absorption. Shorter mix time but good notes, characteristics, and volume. Great for bread application or blending.
L. No comment.
M. Slightly low absorption, fair mix strength and good loaf volume.
N. High absorption.

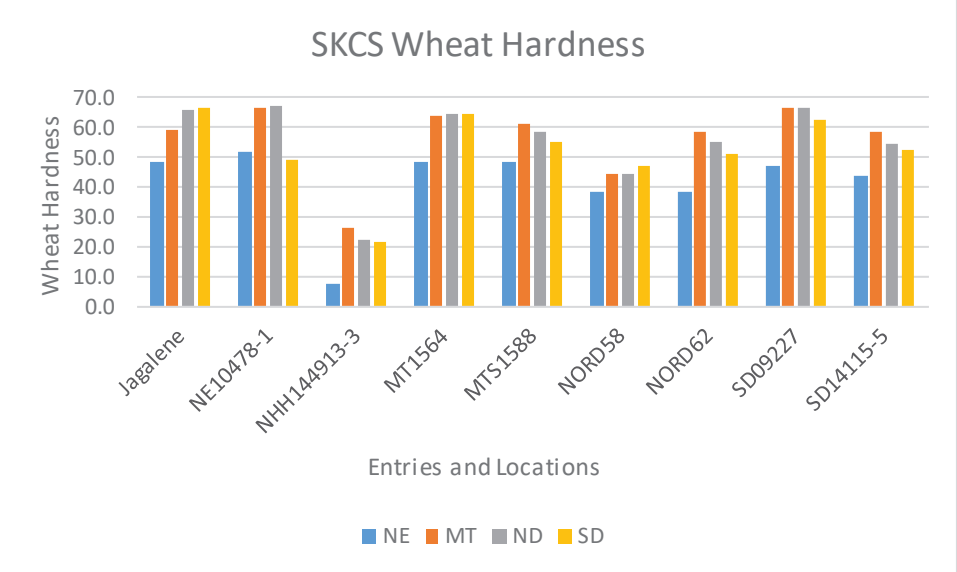
Notes: **E, F, K and M** conducted sponge and dough bake tests

MICRO-QUALITY ANALYSIS

1. SKCS SINGLE KERNEL INFORMATION

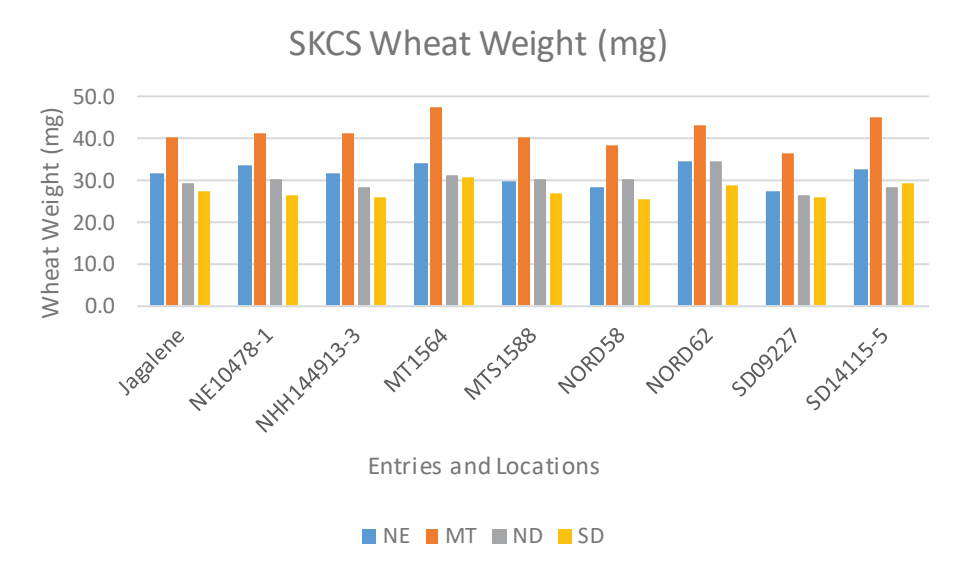
   A. Kernel Hardness

SKCS Wheat Kernel Hardness						
	LOCATIONS					
Sample ID	NE	MT	ND	SD	Avg	Std
Jagalene	48.4	59.5	66.1	66.9	60.2	8.53
NE10478-1	51.7	66.3	67.4	48.9	58.6	9.65
NHH144913-3	7.3	26.3	22.5	21.6	19.4	8.33
MT1564	48.6	64.2	64.9	64.9	60.6	8.01
MTS1588	48.8	61.3	58.9	55.4	56.1	5.43
NORD58	38.3	44.3	44.4	47.2	43.6	3.74
NORD62	38.8	58.5	55.2	51.2	50.9	8.61
SD09227	47.1	66.8	66.5	62.5	60.7	9.26
SD14115-5	43.7	58.5	54.4	52.6	52.3	6.24
Avg.	41.4	56.2	55.6	52.3		
Std	13.60	13.04	14.51	13.54		



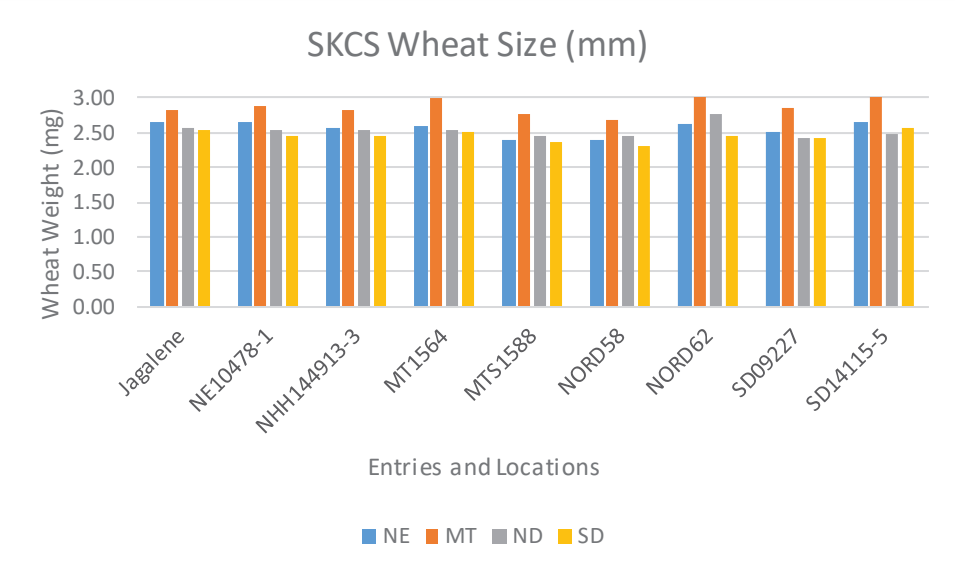
B. Kernel Weight (mg)

SKCS Wheat Kernel Weight (mg)						
	LOCATIONS					
Sample ID	NE	MT	ND	SD	Avg	Std
Jagalene	31.7	40.4	29.3	27.7	32.3	5.69
NE10478-1	33.5	41.6	30.4	26.3	32.9	6.47
NHH144913-3	31.7	41.1	28.5	26.1	31.9	6.59
MT1564	34.2	47.5	31.1	30.9	35.9	7.89
MTS1588	30.0	40.6	30.5	27.0	32.1	5.92
NORD58	28.6	38.7	30.1	25.6	30.8	5.61
NORD62	34.7	43.2	34.4	28.9	35.3	5.90
SD09227	27.7	36.7	26.5	26.1	29.2	5.01
SD14115-5	32.9	45.2	28.2	29.5	34.0	7.76
Avg.	31.7	41.7	29.9	27.6		
Std	2.45	3.28	2.23	1.83		



C. Kernel Size

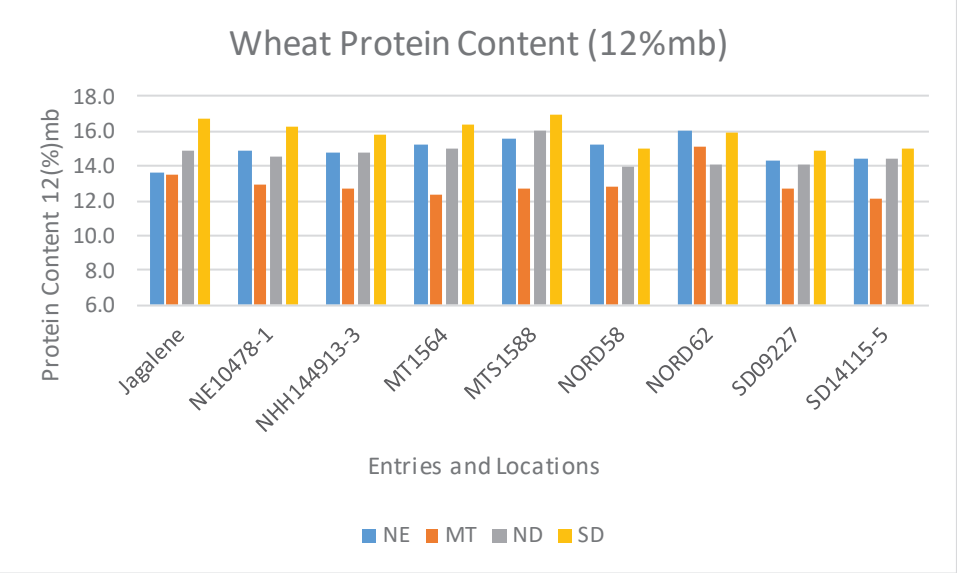
SKCS Wheat Kernel Size (mm)						
	LOCATIONS					
Sample ID	NE	MT	ND	SD	Avg	Std
Jagalene	2.65	2.82	2.56	2.54	2.64	0.12
NE10478-1	2.66	2.89	2.55	2.44	2.64	0.19
NHH144913-3	2.57	2.82	2.53	2.44	2.59	0.16
MT1564	2.59	2.99	2.54	2.51	2.66	0.22
MTS1588	2.38	2.75	2.46	2.37	2.49	0.18
NORD58	2.40	2.67	2.45	2.30	2.46	0.16
NORD62	2.62	3.03	2.76	2.46	2.72	0.24
SD09227	2.50	2.84	2.42	2.43	2.55	0.20
SD14115-5	2.67	3.02	2.48	2.58	2.69	0.24
Avg.	2.56	2.87	2.53	2.45		
Std	0.11	0.12	0.10	0.09		



2. Protein Content

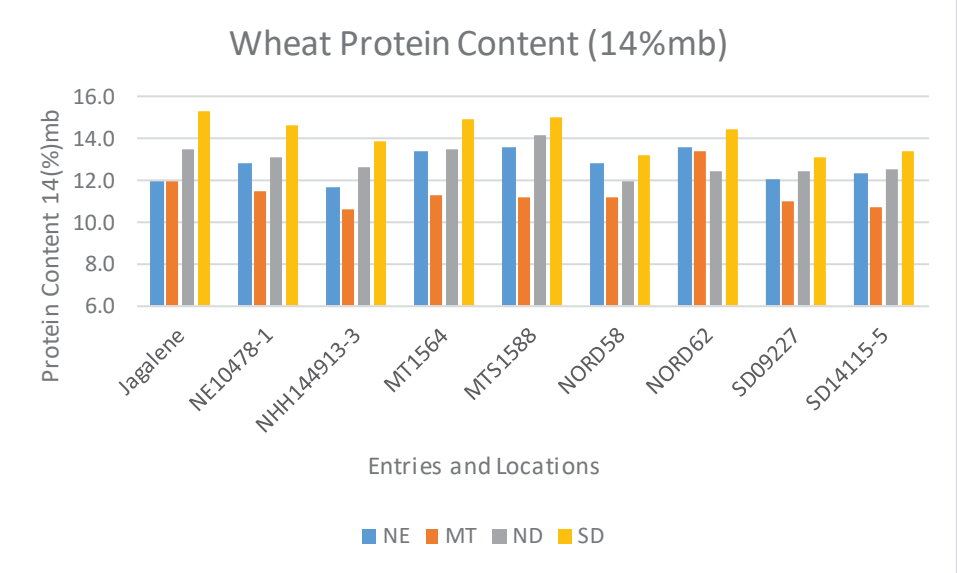
A. Wheat Protein

Wheat Protein Content						
	LOCATIONS					
Sample ID	NE	MT	ND	SD	Avg	Std
Jagalene	13.6	13.5	14.9	16.7	14.7	1.48
NE10478-1	14.8	12.9	14.6	16.3	14.6	1.36
NHH144913-3	14.8	12.7	14.8	15.8	14.5	1.31
MT1564	15.3	12.4	15.0	16.4	14.8	1.70
MTS1588	15.6	12.7	16.0	16.9	15.3	1.83
NORD58	15.2	12.9	13.9	15.0	14.3	1.09
NORD62	16.0	15.1	14.1	15.9	15.3	0.89
SD09227	14.3	12.7	14.1	14.9	14.0	0.93
SD14115-5	14.4	12.2	14.5	15.1	14.0	1.27
Avg.	14.9	13.0	14.6	15.9		
Std	0.74	0.86	0.63	0.76		



B. Flour Protein

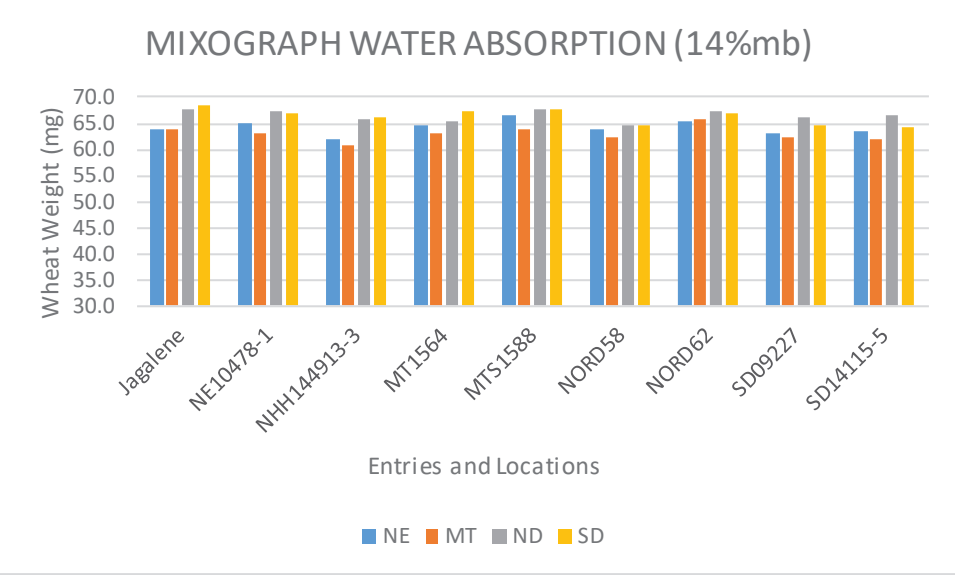
Flour Protein Content						
	LOCATIONS					
Sample ID	NE	MT	ND	SD	Avg	Std
Jagalene	11.9	11.9	13.5	15.3	13.2	1.61
NE10478-1	12.9	11.5	13.1	14.6	13.0	1.30
NHH144913-3	11.6	10.6	12.7	13.9	12.2	1.43
MT1564	13.4	11.3	13.5	15.0	13.3	1.52
MTS1588	13.6	11.2	14.2	15.1	13.5	1.64
NORD58	12.9	11.2	11.9	13.2	12.3	0.93
NORD62	13.6	13.4	12.5	14.4	13.5	0.80
SD09227	12.0	11.0	12.4	13.1	12.2	0.87
SD14115-5	12.4	10.7	12.5	13.4	12.2	1.12
Avg.	12.7	11.4	12.9	14.2		
Std	0.74	0.85	0.70	0.84		



3. Mixograph Test Information

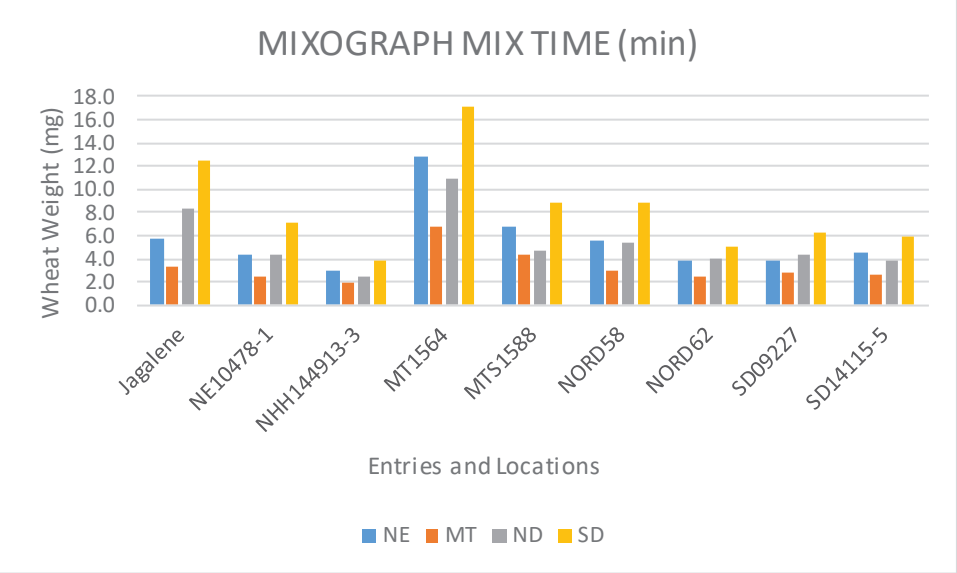
A. Mixograph Water Absorption

Mixograph Water Absorption (14%mb)						
	LOCATIONS					
Sample ID	NE	MT	ND	SD	Avg	Std
Jagalene	63.7	63.8	67.8	68.3	65.9	2.49
NE10478-1	65.1	63.1	67.3	67.1	65.7	1.97
NHH144913-3	62.0	60.7	65.7	66.0	63.6	2.65
MT1564	64.6	62.9	65.4	67.2	65.0	1.79
MTS1588	66.4	63.7	67.5	67.8	66.4	1.87
NORD58	63.7	62.5	64.7	64.7	63.9	1.05
NORD62	65.3	65.8	67.3	66.8	66.3	0.91
SD09227	62.9	62.4	66.3	64.8	64.1	1.79
SD14115-5	63.4	61.9	66.4	64.3	64.0	1.88
Avg.	64.1	63.0	66.5	66.3		
Std	1.35	1.42	1.07	1.45		



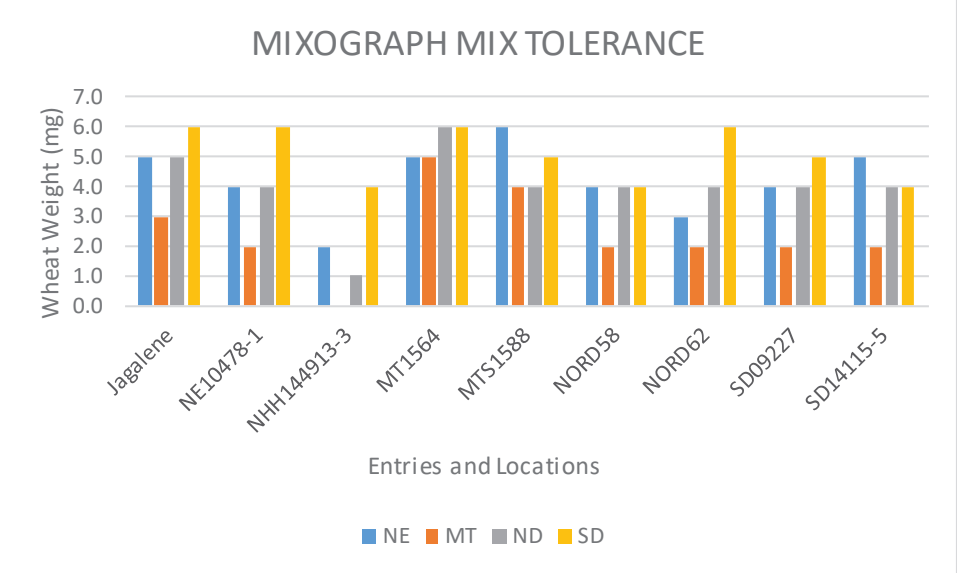
B. Mixograph Mix Time

Mixograph Mix Time (min)						
	LOCATIONS					
Sample ID	NE	MT	ND	SD	Avg	Std
Jagalene	5.8	3.4	8.4	12.5	7.5	3.89
NE10478-1	4.4	2.5	4.3	7.1	4.6	1.90
NHH144913-3	3.0	2.0	2.5	3.9	2.9	0.81
MT1564	12.8	6.8	10.9	17.1	11.9	4.28
MTS1588	6.8	4.3	4.8	8.8	6.2	2.06
NORD58	5.5	3.0	5.4	8.8	5.7	2.38
NORD62	3.8	2.5	4.1	5.0	3.9	1.03
SD09227	3.8	2.8	4.3	6.3	4.3	1.47
SD14115-5	4.6	2.6	3.9	6.0	4.3	1.42
Avg.	5.6	3.3	5.4	8.4		
Std	2.94	1.46	2.61	4.13		



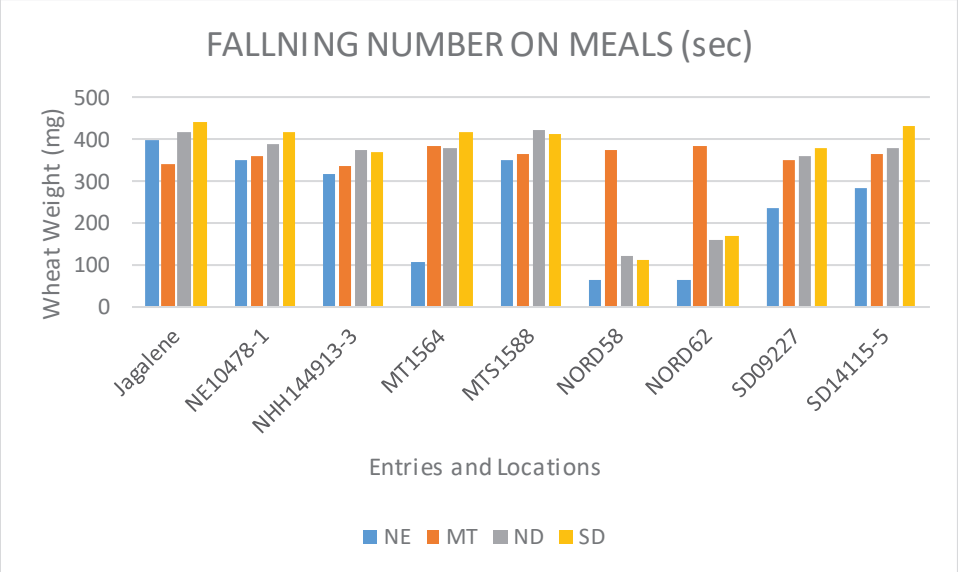
C. Mixograph Mix Tolerance

Mixograph Mix Tolerance						
	LOCATIONS					
Sample ID	NE	MT	ND	SD	Avg	Std
Jagalene	5.0	3.0	5.0	6.0	4.8	1.26
NE10478-1	4.0	2.0	4.0	6.0	4.0	1.63
NHH144913-3	2.0	0.0	1.0	4.0	1.8	1.71
MT1564	5.0	5.0	6.0	6.0	5.5	0.58
MTS1588	6.0	4.0	4.0	5.0	4.8	0.96
NORD58	4.0	2.0	4.0	4.0	3.5	1.00
NORD62	3.0	2.0	4.0	6.0	3.8	1.71
SD09227	4.0	2.0	4.0	5.0	3.8	1.26
SD14115-5	5.0	2.0	4.0	4.0	3.8	1.26
Avg.	4.2	2.4	4.0	5.1		
Std	1.20	1.42	1.32	0.93		



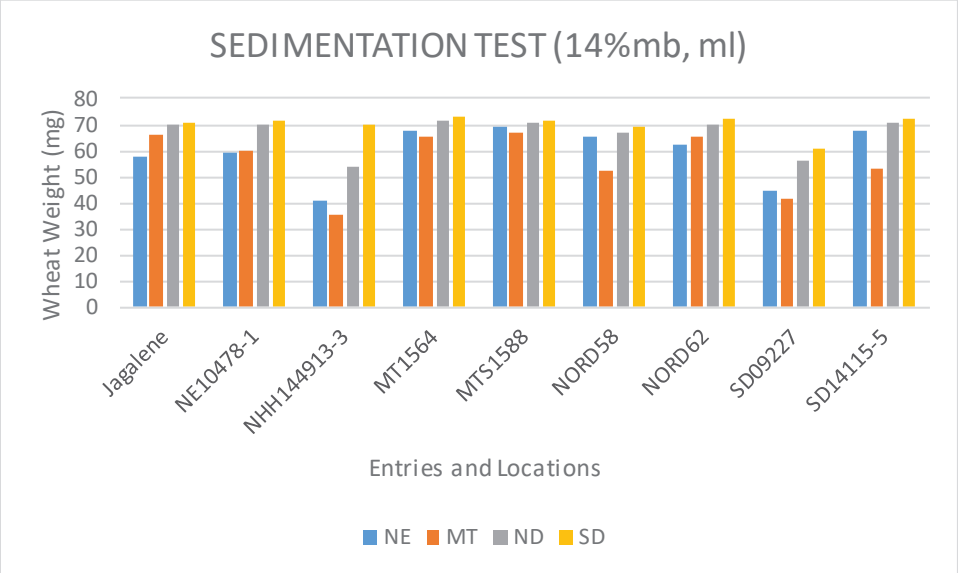
4. FALLING NUMBER TEST

Falling Number on Meals (sec)						
	LOCATIONS					
Sample ID	NE	MT	ND	SD	Avg	Std
Jagalene	400	341	416	441	400	42
NE10478-1	353	360	388	417	380	29
NHH144913-3	316	337	374	369	349	27
MT1564	105	385	378	420	322	146
MTS1588	353	364	423	414	389	35
NORD58	66	376	122	114	170	140
NORD62	62	386	162	170	195	136
SD09227	235	351	362	382	333	66
SD14115-5	283	368	381	432	366	62
Avg.	241	363	334	351		
Std	132	18	111	121		



5. SEDIMENTATION TEST

Sedimentation Test (14%mb, ml)						
	LOCATIONS					
Sample ID	NE	MT	ND	SD	Avg	Std
Jagalene	58	66	70	71	66	6
NE10478-1	59	60	70	72	65	7
NHH144913-3	41	35	54	70	50	16
MT1564	68	65	72	73	69	4
MTS1588	69	67	71	72	70	2
NORD58	65	52	67	69	63	8
NORD62	62	65	70	72	67	5
SD09227	45	41	56	61	51	9
SD14115-5	67	53	71	72	66	9
Avg.	59	56	67	70		
Std	10	12	7	4		



COMMOM CHECK

18-2401	Jagalene (CC01)
18-2405	Jagalene (CC02)
18-2409	Jagalene (CC03)
18-2412	Jagalene (CC04)
18-2414	Jagalene (CC05)
18-2418	Jagalene (CC06)
18-2424	Jagalene (CC07)

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

Common Check – Jagalene

General Information

A Hard Red Winter Wheat variety, Jagalene, was used as a common check for each of breeding programs in 2018. Eight breeding programs submitted their common checks with their breeding lines for WQC baking evaluation. They were:

18-2401	Jagalene (CC01)	Texas
18-2405	Jagalene (CC02)	Limagrain
18-2409	Jagalene (CC03)	Monsanto (Westbred)
18-2412	Jagalene (CC04)	Kansas-Hays
18-2414	Jagalene (CC05)	Syngenta (Agripro)
18-2418	Jagalene (CC06)	Oklahoma
18-2424	Jagalene (CC07)	Northern States

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

Wheat and Flour Quality Characteristics of the Common Checks

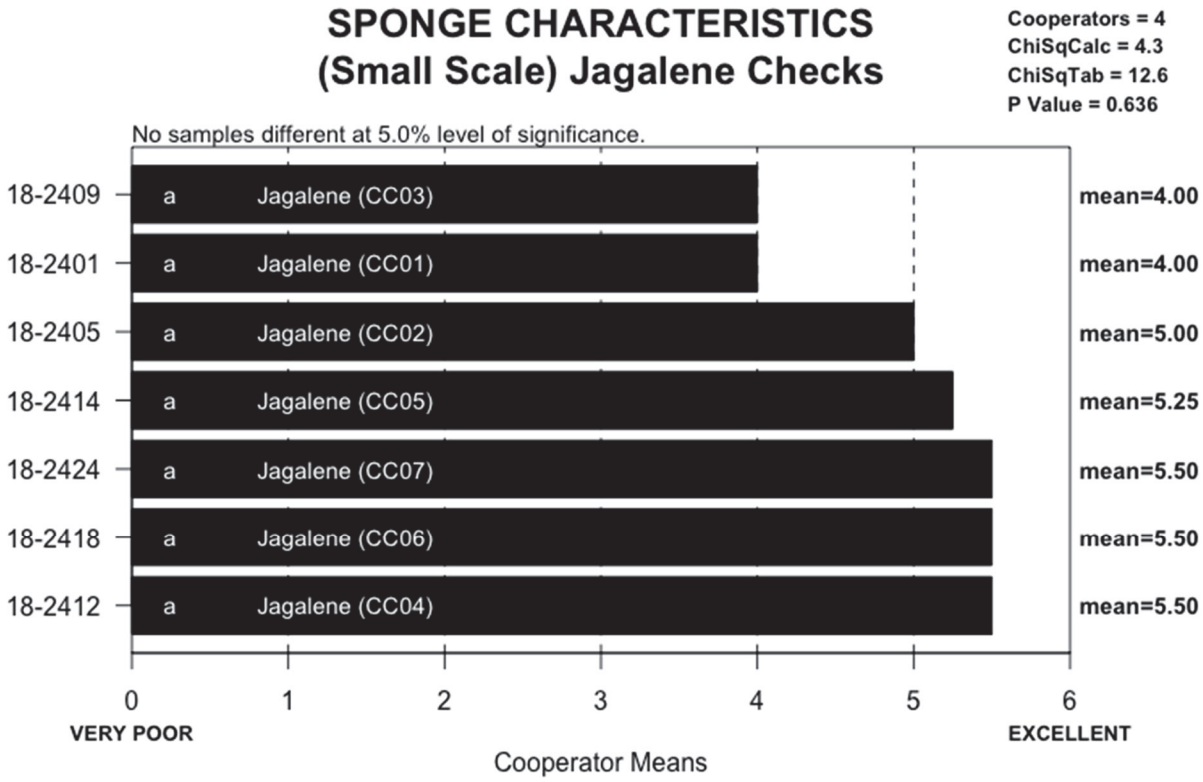
Entry No.	18-2401	18-2405	18-2409	18-2412	18-2414	18-2418	18-2424
Breeding Programs	Texas	Limagrain	Monsanto	Kansas-Hays	Syngenta	Oklahoma	Northern States
Wheat Protein (14%mb)	12.4	14.2	11.3	14.8	12.2	13.8	13.5
Flour Protein (14%mb)	12.0	13.6	10.5	14.1	11.5	13.2	12.9
Flour Ash (14%mb)	0.53	0.62	0.53	0.55	0.60	0.55	0.59
TPP/TMP*	1.02	1.02	1.02	0.97	1.11	0.99	1.03
Sedimentation (ml 14%mc)	49.4	66.3	37.0	66.1	45.4	58.4	65.7
Mixograph Abs (14%mb)	65.2	67.9	62.1	67.2	63.9	65.8	66.9
Mix Time (min)	3.1	4.5	2.4	4.4	3.9	4.3	4.1
Tolerance	3	5	1	3	3	4	4
Farinograph Abs (14%mb)	64.8	61.9	66.7	63.5	60.6	62.3	62.3
Peak time (min)	6.8	4.7	4.2	8.0	4.4	9.3	5.4
Stability (min)	10.4	23.5	6.3	16.9	11.1	17.4	11.7
MTI (FU)	27	10	38	12	19	16	18
Bake Abs (14%mb)	65.6	67.0	63.5	67.0	63.9	65.5	65.8
Bake Mix Time (min)	4.0	5.5	2.8	4.7	4.5	4.5	4.3
Loaf Volume (cc)	921	1020	782	1006	906	1000	995
Crumb Color Rating (0-5)	4.1	3.6	2.9	4.0	3.4	3.6	3.4
Crumb Grain Rating (0-5)	3.8	3.9	2.3	4.0	3.4	4.3	4.0
Crumb Texture Rating (0-5)	3.8	3.9	2.2	3.8	3.8	3.9	3.8

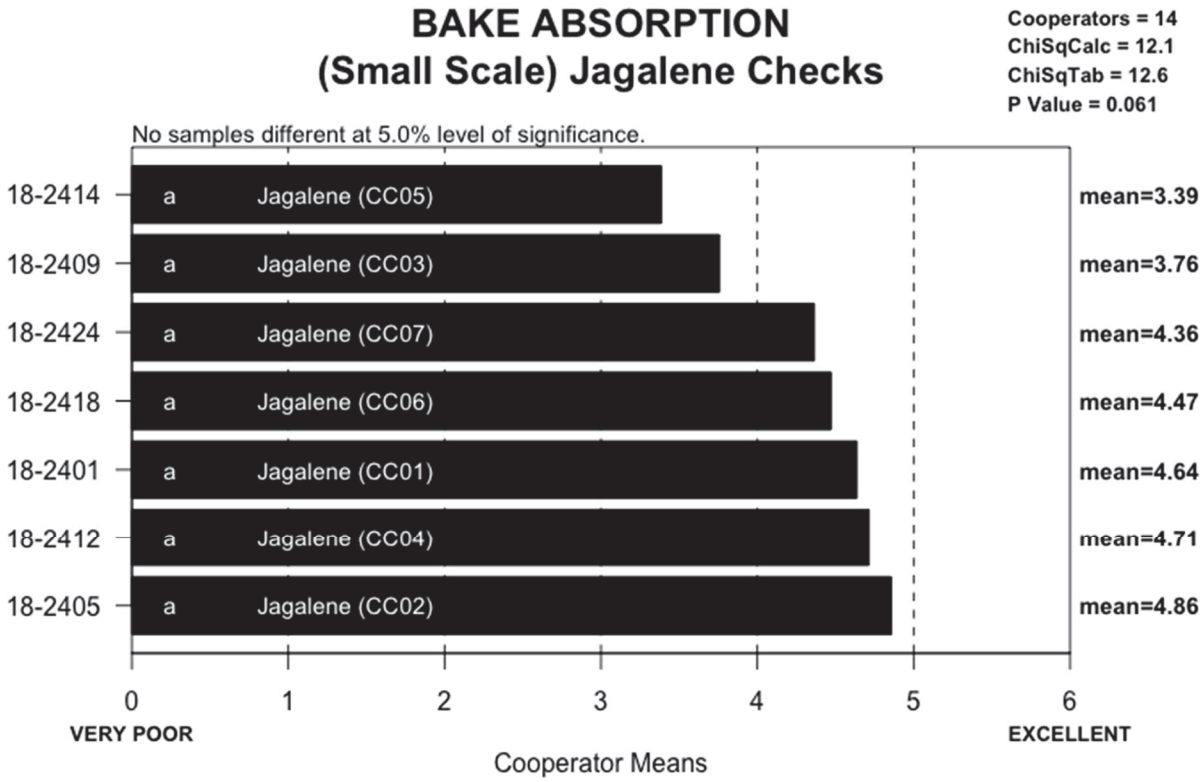
Bake data average based on 7 cooperators' pop loaf straight grade dough method

[1] CC = Common Check.
* TPP/TMP= total polymeric protein/total monomeric protein.
[+] The bake data is an average on 7 cooperators who conducted pup-loaf straight dough bake tests.

Brief Conclusions

Four of 14 cooperators conducted the sponge-and-dough baking test and didn't find any statistically significant differences in the sponge dough characteristics and bake absorption of the common checks at the 5% level of signficance. However, other baking performance quality characteristics evaluated by the 14 cooperators were found to be significantly different (at the 0.5% level) among the common checks. These characteristics included bake mix time, mixing tolerance, dough properties (out of mixer and at make-up), crumb grain, crumb texture, loaf volume, and overall baking quality.


SPONGE CHARACTERISTICS
(Small Scale) Jagalene Checks
Cooperators = 4
ChiSqCalc = 4.3
ChiSqTab = 12.6
P Value = 0.636
No samples different at 5.0% level of significance.
18-2409 a Jagalene (CC03) mean=4.00
18-2401 a Jagalene (CC01) mean=4.00
18-2405 a Jagalene (CC02) mean=5.00
18-2414 a Jagalene (CC05) mean=5.25
18-2424 a Jagalene (CC07) mean=5.50
18-2418 a Jagalene (CC06) mean=5.50
18-2412 a Jagalene (CC04) mean=5.50
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

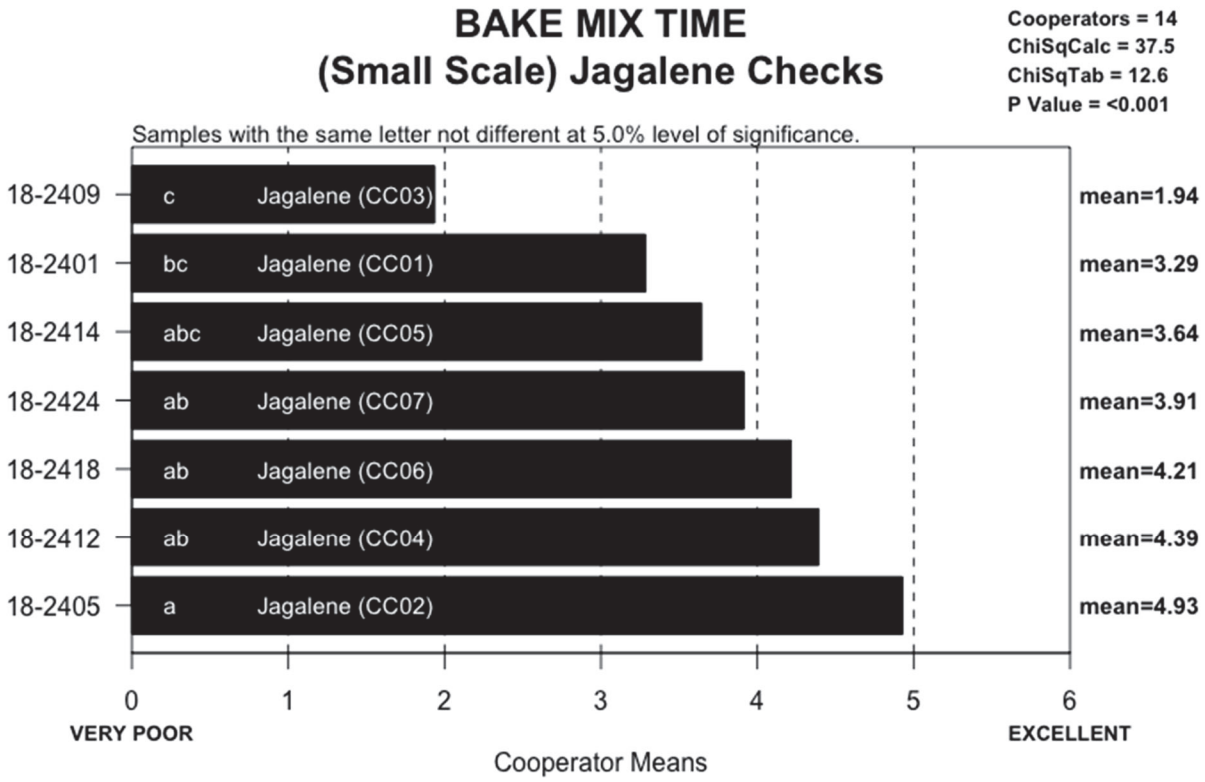

BAKE ABSORPTION
(Small Scale) Jagalene Checks
Cooperators = 14
ChiSqCalc = 12.1
ChiSqTab = 12.6
P Value = 0.061
No samples different at 5.0% level of significance.
18-2414 a Jagalene (CC05) mean=3.39
18-2409 a Jagalene (CC03) mean=3.76
18-2424 a Jagalene (CC07) mean=4.36
18-2418 a Jagalene (CC06) mean=4.47
18-2401 a Jagalene (CC01) mean=4.64
18-2412 a Jagalene (CC04) mean=4.71
18-2405 a Jagalene (CC02) mean=4.86
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

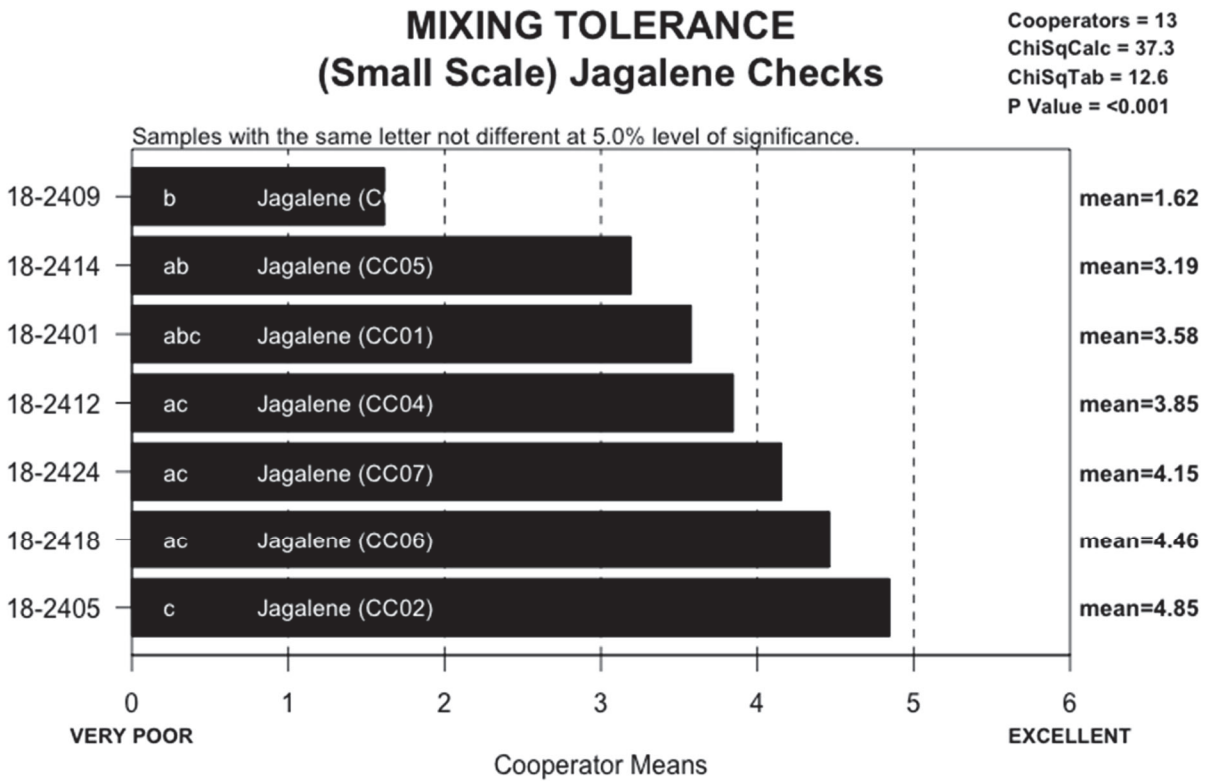
BAKE ABSORPTION, ACTUAL (14% MB)
(Small Scale) Jagalene Checks
Cooperators A – N

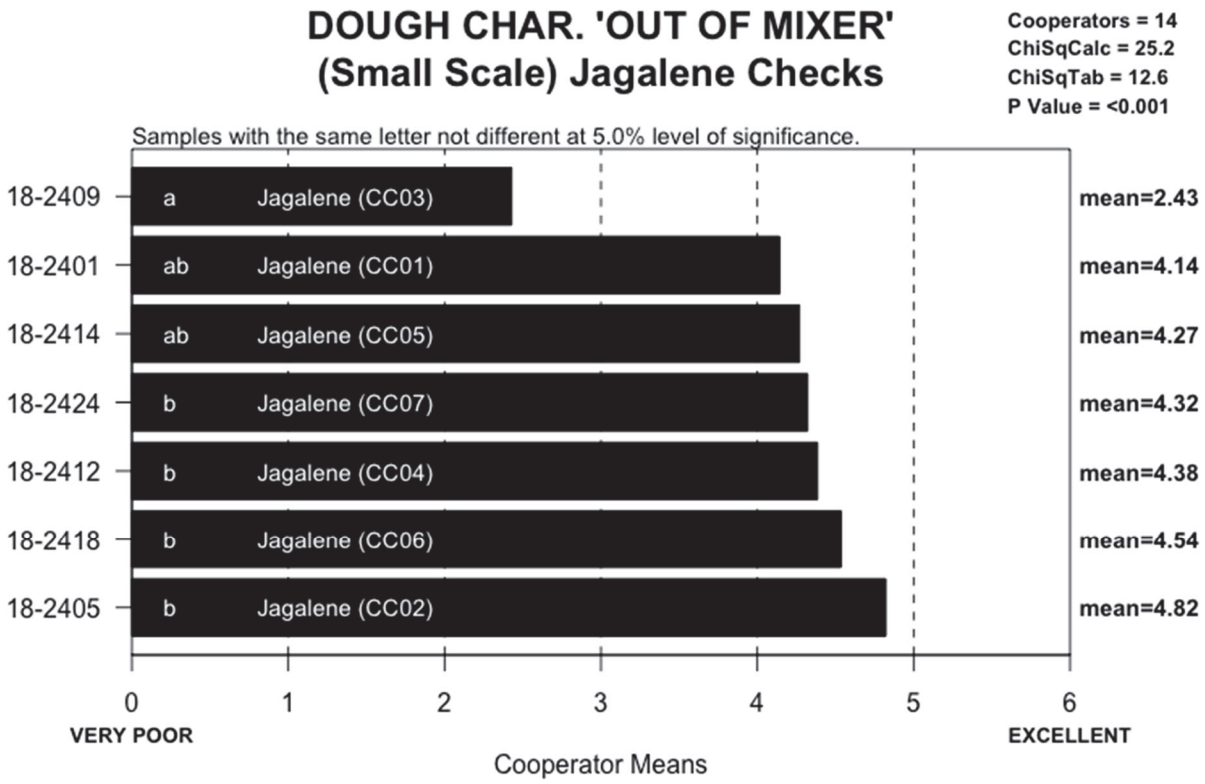
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2401	Jagalene (CC01)	63.2	64.9	68.2	63.4	59	64.8	60.8	70.0	66.4	63.0	67.6	65.2	61	66.4
18-2405	Jagalene (CC02)	66.1	67.0	67.5	66.1	60	61.9	63.2	70.1	64.4	68.0	65.8	63.9	59	68.6
18-2409	Jagalene (CC03)	60.0	58.9	65.2	62.1	57	66.7	57.7	69.1	67.4	62.0	70.0	68.1	62	61.3
18-2412	Jagalene (CC04)	66.9	65.7	66.3	66.6	61	63.5	63.9	70.2	65.4	68.0	65.9	66.5	58	67.4
18-2414	Jagalene (CC05)	61.0	60.7	63.8	64.9	58	60.6	60.1	70.1	64.2	63.0	63.0	65.4	57	63.5
18-2418	Jagalene (CC06)	65.4	65.1	65.4	63.6	60	62.3	62.8	68.7	64.5	66.0	65.8	66.3	57	66.7
18-2424	Jagalene (CC07)	65.1	65.2	64.4	63.1	60	62.3	61.9	71.0	63.6	68.5	64.6	67.0	58	68.8

BAKE MIX TIME, ACTUAL
(Small Scale) Jagalene Checks
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2401	Jagalene (CC01)	4.2	3.8	4.0	5.0	8	6	3.5	4.5	3.5	3.0	9	3.3	10	4.3
18-2405	Jagalene (CC02)	6.0	5.0	5.8	7.8	19	11	4.0	5.5	4.5	3.8	24	4.5	25	6.8
18-2409	Jagalene (CC03)	3.3	2.8	2.9	3.1	4	4	3.4	3.3	2.3	2.3	6	2.8	5	3.0
18-2412	Jagalene (CC04)	5.2	4.3	5.8	6.3	6	8	4.9	4.5	3.5	3.5	17	3.7	25	5.3
18-2414	Jagalene (CC05)	4.5	4.3	4.0	6.6	5	4	3.5	5.0	3.8	3.4	14	3.6	20	6.0
18-2418	Jagalene (CC06)	5.2	4.0	5.0	5.5	11	8	4.5	4.3	4.0	3.6	14	4.0	25	5.3
18-2424	Jagalene (CC07)	5.0	4.3	4.2	4.8	6	5	3.6	4.8	3.8	3.6	16	3.2	25	6.3

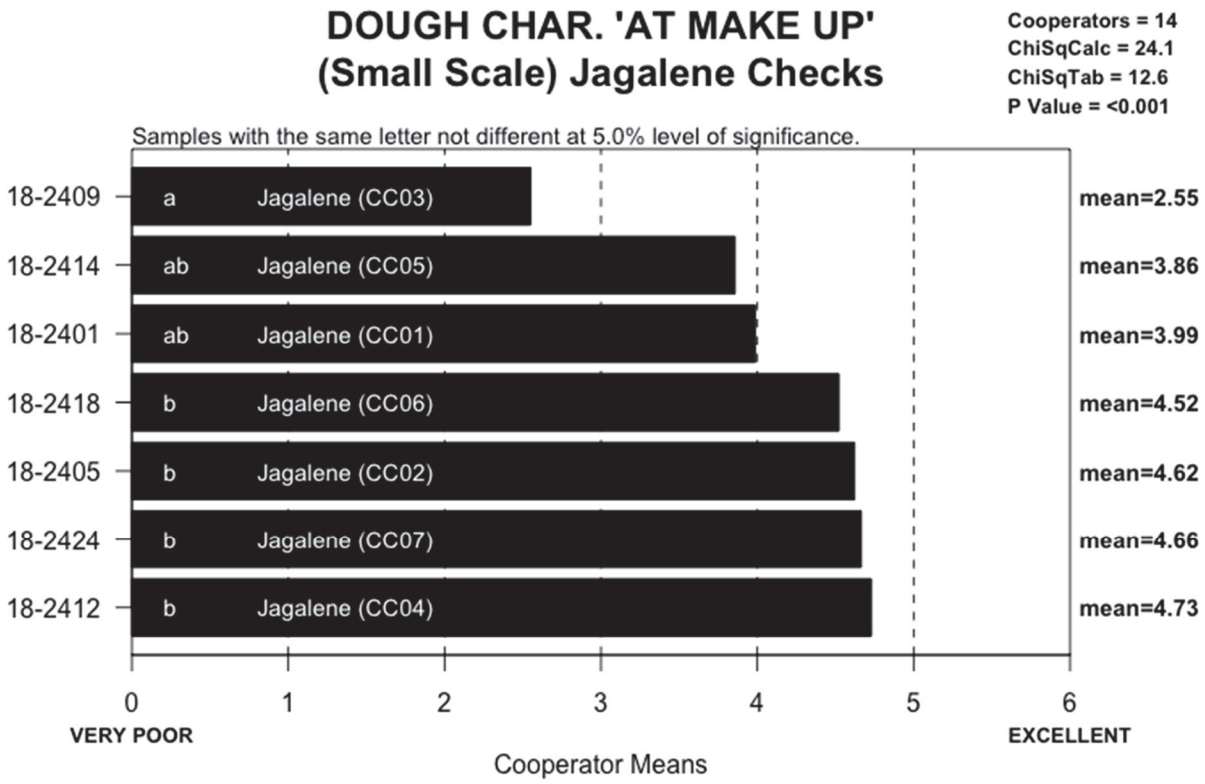

BAKE MIX TIME
(Small Scale) Jagalene Checks
Cooperators = 14
ChiSqCalc = 37.5
ChiSqTab = 12.6
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2409 c Jagalene (CC03) mean=1.94
18-2401 bc Jagalene (CC01) mean=3.29
18-2414 abc Jagalene (CC05) mean=3.64
18-2424 ab Jagalene (CC07) mean=3.91
18-2418 ab Jagalene (CC06) mean=4.21
18-2412 ab Jagalene (CC04) mean=4.39
18-2405 a Jagalene (CC02) mean=4.93
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Small Scale) Jagalene Checks
Cooperators = 13
ChiSqCalc = 37.3
ChiSqTab = 12.6
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2409 b Jagalene (C mean=1.62
18-2414 ab Jagalene (CC05) mean=3.19
18-2401 abc Jagalene (CC01) mean=3.58
18-2412 ac Jagalene (CC04) mean=3.85
18-2424 ac Jagalene (CC07) mean=4.15
18-2418 ac Jagalene (CC06) mean=4.46
18-2405 c Jagalene (CC02) mean=4.85
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means



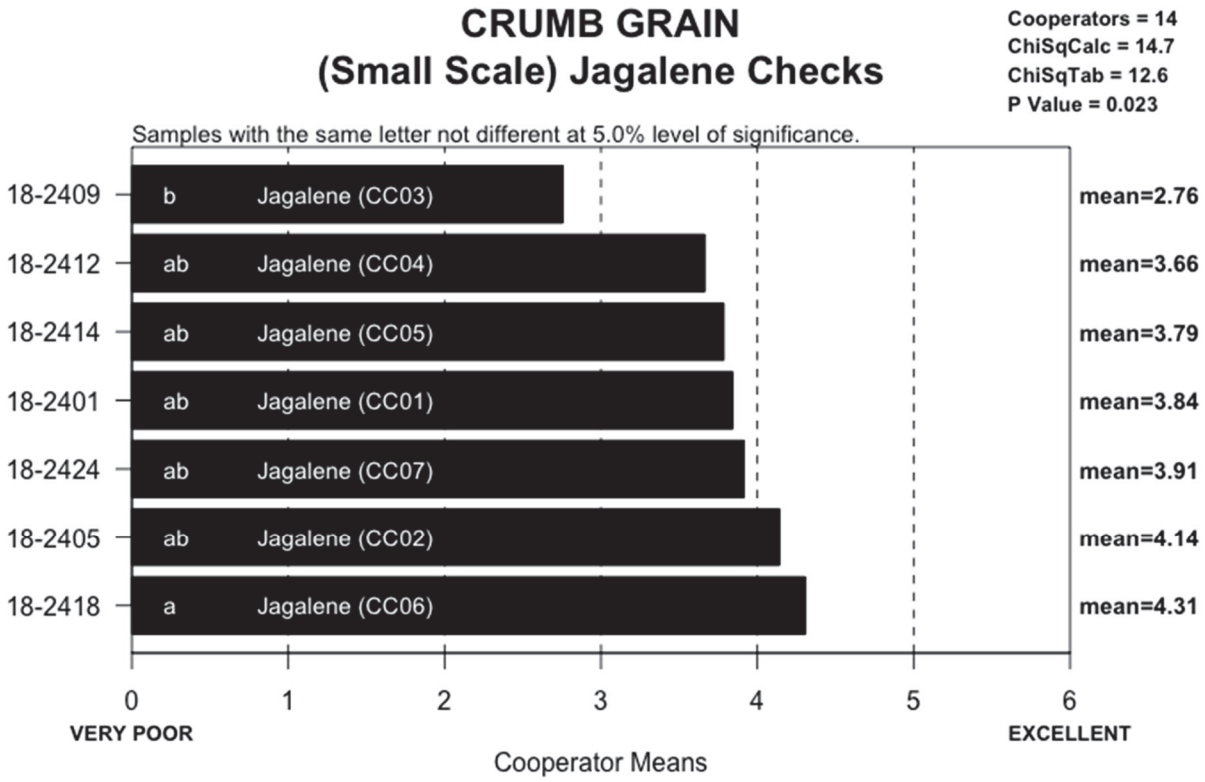
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Small Scale) Jagalene Checks

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2401	Jagalene (CC01)	2	0	2	9	1
18-2405	Jagalene (CC02)	0	1	2	8	3
18-2409	Jagalene (CC03)	5	2	4	3	0
18-2412	Jagalene (CC04)	2	1	1	8	1
18-2414	Jagalene (CC05)	2	0	3	7	1
18-2418	Jagalene (CC06)	1	0	4	7	2
18-2424	Jagalene (CC07)	0	0	4	10	0



DOUGH CHAR. 'AT MAKE UP', DESCRIBED
(Small Scale) Jagalene Checks

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
18-2401	Jagalene (CC01)	2	0	1	9	2
18-2405	Jagalene (CC02)	1	1	3	6	3
18-2409	Jagalene (CC03)	4	3	2	5	0
18-2412	Jagalene (CC04)	1	0	1	10	2
18-2414	Jagalene (CC05)	1	3	1	9	0
18-2418	Jagalene (CC06)	0	0	3	9	2
18-2424	Jagalene (CC07)	1	0	1	11	1

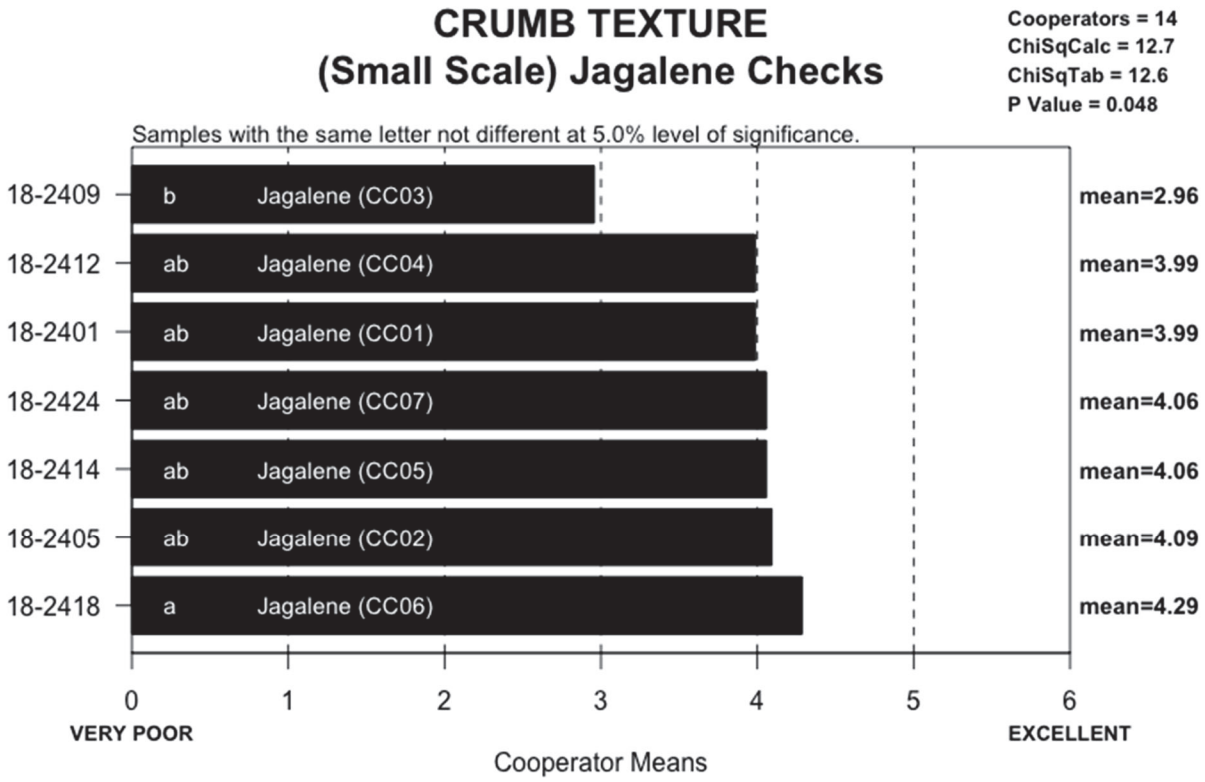


CRUMB GRAIN, DESCRIBED
(Small Scale) Jagalene Checks

IDCODE	ID	Open	Fine	Dense
18-2401	Jagalene (CC01)	6	7	1
18-2405	Jagalene (CC02)	5	8	1
18-2409	Jagalene (CC03)	7	4	3
18-2412	Jagalene (CC04)	9	5	0
18-2414	Jagalene (CC05)	5	6	3
18-2418	Jagalene (CC06)	5	8	1
18-2424	Jagalene (CC07)	6	6	2

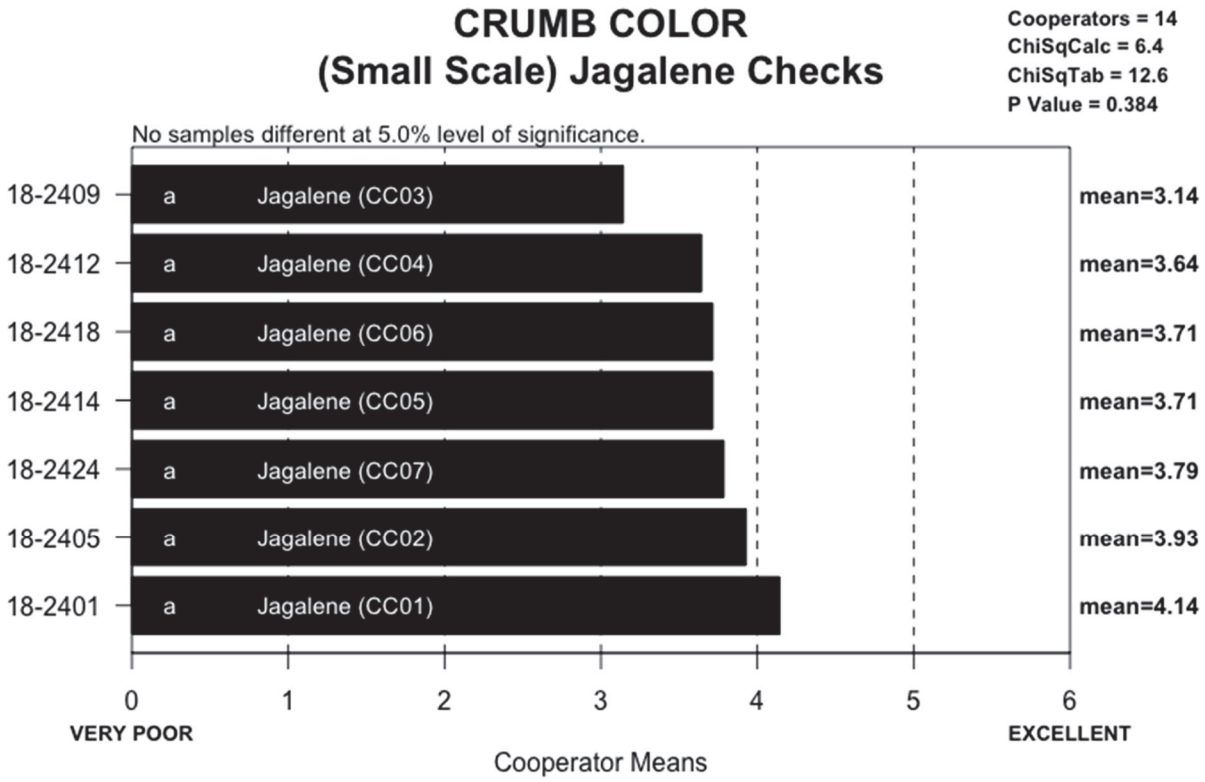
CELL SHAPE, DESCRIBED
(Small Scale) Jagalene Checks

IDCODE	ID	Round	Irregular	Elongated
18-2401	Jagalene (CC01)	5	4	5
18-2405	Jagalene (CC02)	4	6	4
18-2409	Jagalene (CC03)	10	2	2
18-2412	Jagalene (CC04)	5	2	7
18-2414	Jagalene (CC05)	3	4	7
18-2418	Jagalene (CC06)	2	3	9
18-2424	Jagalene (CC07)	2	6	6



CRUMB TEXTURE, DESCRIBED
(Small Scale) Jagalene Checks

IDCODE	ID	Harsh	Smooth	Silky
18-2401	Jagalene (CC01)	3	7	4
18-2405	Jagalene (CC02)	3	8	3
18-2409	Jagalene (CC03)	8	5	1
18-2412	Jagalene (CC04)	3	9	2
18-2414	Jagalene (CC05)	3	7	4
18-2418	Jagalene (CC06)	1	8	5
18-2424	Jagalene (CC07)	3	8	3



CRUMB COLOR, DESCRIBED
(Small Scale) Jagalene Checks

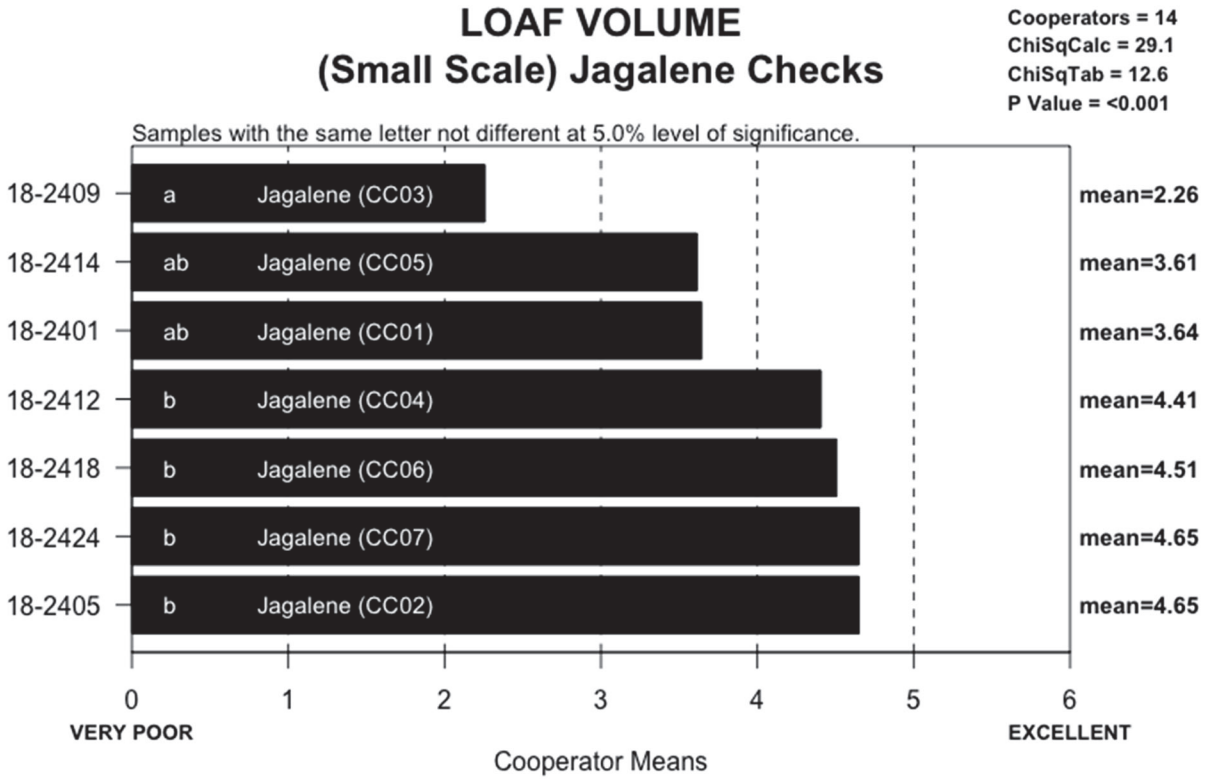
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
18-2401	Jagalene (CC01)	0	0	3	1	4	5	1
18-2405	Jagalene (CC02)	0	1	0	4	5	4	0
18-2409	Jagalene (CC03)	0	1	3	2	8	0	0
18-2412	Jagalene (CC04)	0	1	2	2	5	4	0
18-2414	Jagalene (CC05)	0	0	3	1	9	1	0
18-2418	Jagalene (CC06)	0	1	2	2	8	1	0
18-2424	Jagalene (CC07)	0	1	0	1	10	2	0

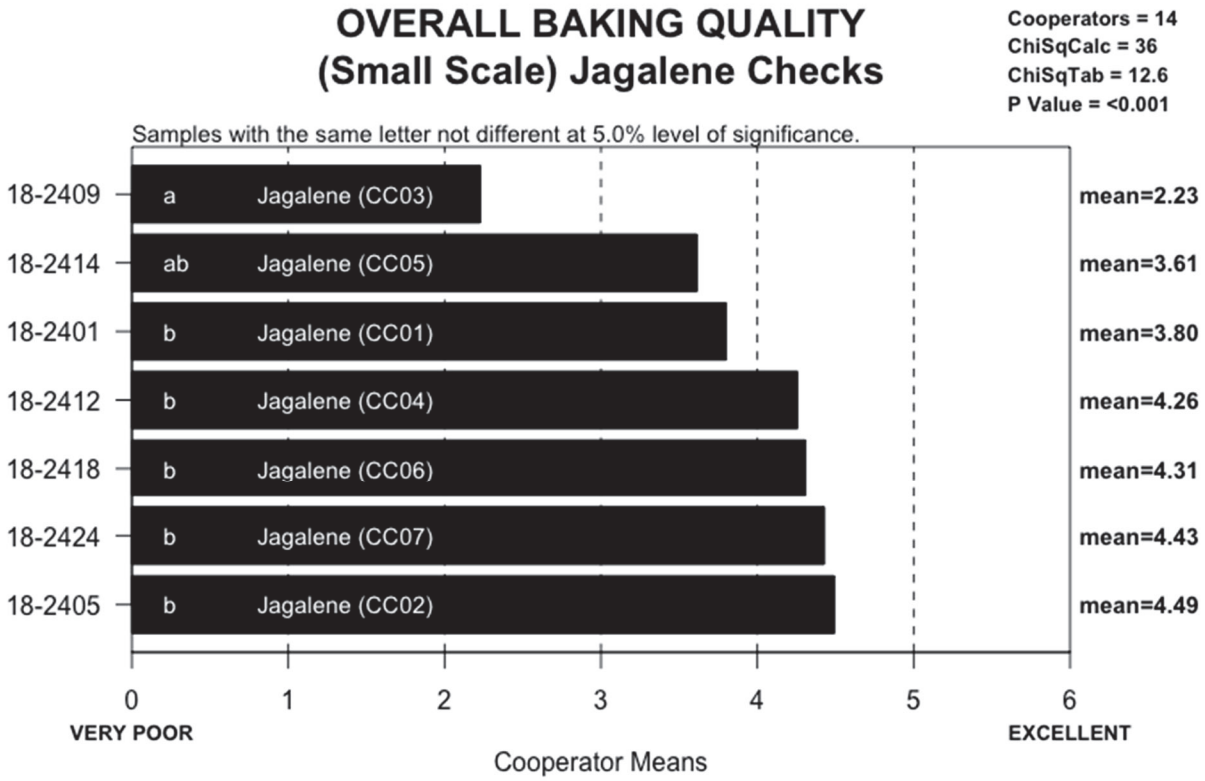
LOAF WEIGHT, ACTUAL
(Small Scale) Jagalene Checks
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2401	Jagalene (CC01)	141.4	143.3	156.7	141.3	412	458.7	132.9	133.5	132.6	145.1	432.9	142.2	483.3	150.5
18-2405	Jagalene (CC02)	141.9	143.7	159.3	141.5	410	466.7	132.9	135.0	133.0	146.5	438.0	140.4	497.4	153.7
18-2409	Jagalene (CC03)	139.8	142.6	157.0	139.7	414	463.4	129.7	137.2	137.5	148.5	440.6	139.4	483.3	149.4
18-2412	Jagalene (CC04)	141.9	143.5	159.1	141.9	410	460.8	129.4	138.8	133.7	144.5	441.0	139.9	480.7	153.0
18-2414	Jagalene (CC05)	137.4	141.1	151.9	141.6	418	463.3	132.9	134.3	133.7	143.2	443.5	138.9	466.7	149.5
18-2418	Jagalene (CC06)	141.6	141.6	155.3	147.1	418	461.4	131.5	137.8	130.0	144.3	443.3	138.0	487.1	152.1
18-2424	Jagalene (CC07)	140.6	145.3	156.0	143.1	419	468.3	132.7	134.4	132.6	149.1	447.1	139.3	480.1	154.4

LOAF VOLUME, ACTUAL
(Small Scale) Jagalene Checks
Cooperators A – N

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N
18-2401	Jagalene (CC01)	985	940	943	948	2925	2188	755	825	900	905	2600	806	2868	920
18-2405	Jagalene (CC02)	1075	1065	983	960	3100	2400	730	950	1055	1050	2775	894	3045	1065
18-2409	Jagalene (CC03)	730	765	820	913	2650	2363	780	755	845	645	2575	738	2780	810
18-2412	Jagalene (CC04)	1050	1040	1040	1035	2900	2288	945	885	990	1000	2650	851	2927	1020
18-2414	Jagalene (CC05)	965	875	980	906	2850	2450	715	880	860	875	2700	842	2986	870
18-2418	Jagalene (CC06)	1075	1020	1003	958	2950	2338	890	940	1020	985	2725	885	2927	1010
18-2424	Jagalene (CC07)	1050	950	1048	963	3050	2400	920	990	988	975	2800	897	2986	1025

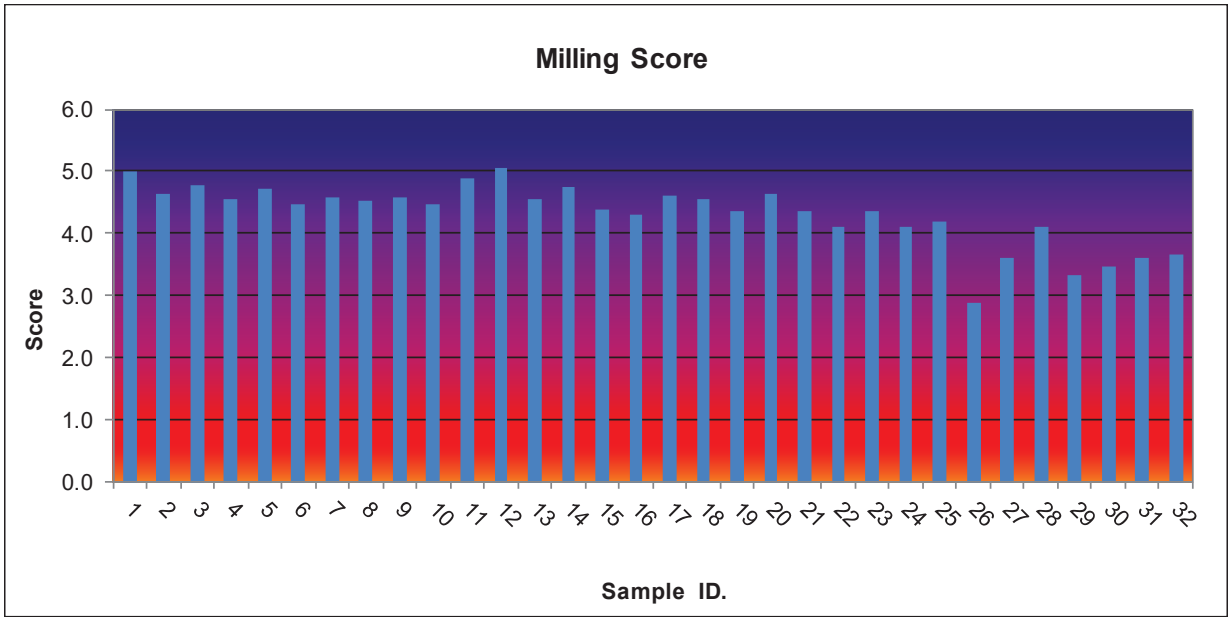

LOAF VOLUME
(Small Scale) Jagalene Checks
Cooperators = 14
ChiSqCalc = 29.1
ChiSqTab = 12.6
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2409 a Jagalene (CC03) mean=2.26
18-2414 ab Jagalene (CC05) mean=3.61
18-2401 ab Jagalene (CC01) mean=3.64
18-2412 b Jagalene (CC04) mean=4.41
18-2418 b Jagalene (CC06) mean=4.51
18-2424 b Jagalene (CC07) mean=4.65
18-2405 b Jagalene (CC02) mean=4.65
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

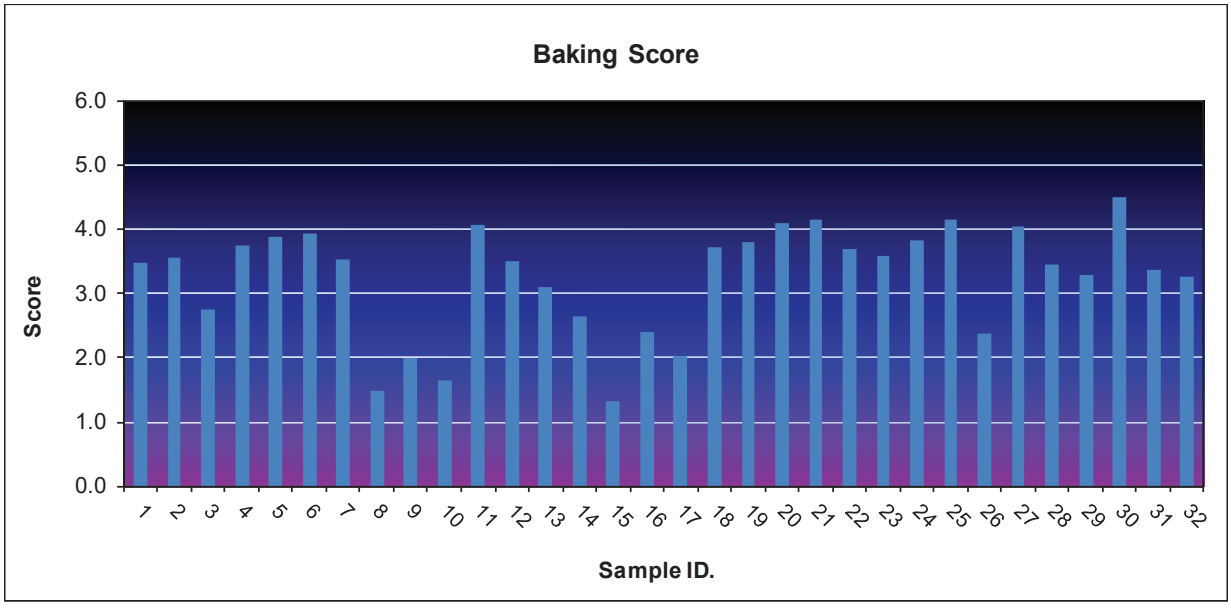

OVERALL BAKING QUALITY
(Small Scale) Jagalene Checks
Cooperators = 14
ChiSqCalc = 36
ChiSqTab = 12.6
P Value = <0.001
Samples with the same letter not different at 5.0% level of significance.
18-2409 a Jagalene (CC03) mean=2.23
18-2414 ab Jagalene (CC05) mean=3.61
18-2401 b Jagalene (CC01) mean=3.80
18-2412 b Jagalene (CC04) mean=4.26
18-2418 b Jagalene (CC06) mean=4.31
18-2424 b Jagalene (CC07) mean=4.43
18-2405 b Jagalene (CC02) mean=4.49
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

2018 WQC Milling and Baking Marketing Scores

2018 WQC Milling & Baking Marketing Scores

(Based upon HWWQL Quality Data and KSU Milling Data)



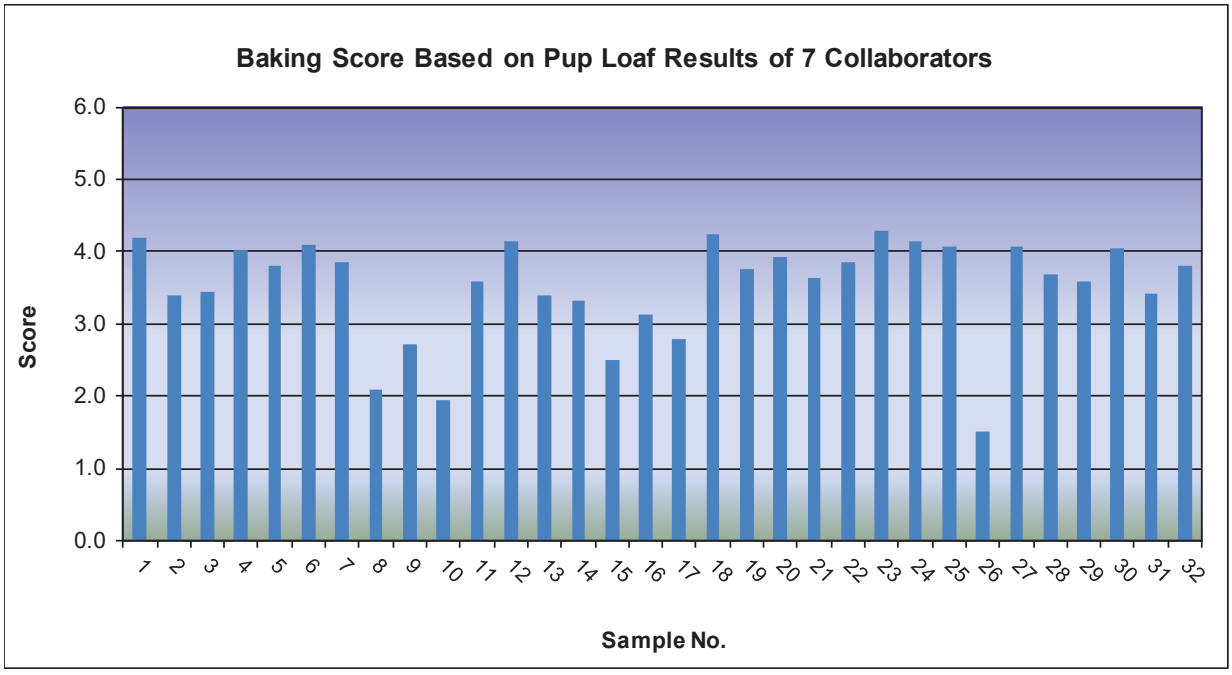


2018 WQC Milling & Baking Marketing Scores

(Based upon HWWQL Quality Data and KSU Milling Data)

2018 WQC Baking Marketing Scores

(Based upon Average Baking Data of Collaborators Pup-Loaf Straight Dough)



Marketing Scores

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

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

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

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

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

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

Alkaline Noodle Quality Tests of 2018 WQC Hard Winter Wheat Entries

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Alkaline Noodle Quality Report

Objectives: Evaluate alkaline noodle color and cooking characteristics.

Materials: 32 WQC hard winter wheat samples harvested in 2018.

Methods:

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

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

Noodle Making:

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

Procedure:

100 g flour ← 1 g Na_2CO_3 + 35 mL Water

↓

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

↓

Rest for 30 min in a plastic bag

↓

Plug roll gap with plastic tubing and pour mixed dough

↓

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

↓

Cutting

Measurement of Noodle Dough Color:

Noodle dough color (*L**, lightness; *a**, redness-greenness; *b**, yellowness-blueness) was measured by Minolta Colorimeter (Model CR-410) at 0 and 24 hr.

Cooking Noodles:

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

Measurement of Cooking Loss and Water Uptake:

Cooking Loss:

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

Water Uptake:

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

Texture Profile Analysis (TPA) of Noodle:

Immediately after cooking, noodle TPA was conducted using a TA-XTplus (Texture Technologies, NY) on 3 strings of noodle with 1-mm flat Perspex Knife Blade (A/LKB-F). TPA provides objective sensory results on various parameters as follows:

- **Hardness (N):** maximum peak force during the first compression cycle (first bite) and often substituted by the term "firmness".

- **Springiness (elasticity, ratio):** ratio related to the height that the food recovers during the time that elapses between the end of the first bite and the start of the second bite.

- **Chewiness:** hardness x cohesiveness x springiness.

- **Resilience (ratio):** measurement of how the sample recovers from deformation both in terms of speed and forces derived.

- **Cohesiveness (ratio):** ratio of the positive force area during the second compression to that during the first compression.

Results:

Top 3 samples showing desirable properties were selected in each category.

Table I shows the following:

Noodle Color (*L* value, Higher is better.) ***at 0 hr***: 2408 (80.12), 2410 (79.59), 2414 (79.18)

Noodle Color (*L* value, Higher is better.) ***at 24 hr***: 2408 (66.19), 2410 (66.06), 2407 (65.51)

Delta L (Change of *L* value, Lower absolute value is better.)
2421 (-11.93), 2422 (-12.32), 2426 (-12.65)

PPO (Lower is better.): 2422 (0.169), 2421 (0.209), 2410 (0.292)

Table II shows the following:

Hardness: 2428(3.096), 2426 (3.017), 2429 (2.976)

Springiness: 2404 (0.911), 2422 (0.911), 2406 (0.907)

Chewiness: 2420 (1.802), 2428 (1.779), 2430 (1.728)

Resilience: 2406 (0.446), 2420 (0.422), 2404 (0.418)

Cohesiveness: 2406 (0.710), 2404 (0.691), 2420 (0.689)

Water Uptake: 2423 (94.12), 2402 (93.68), 2426 (92.88)

Cooking Loss: 2423 (5.48), 2420 (5.80), 2428 (5.88)

Discussion

Sample 2408 had the highest L-value (brightness) at 0 hrs and at 24 hrs respectively, and higher b-value at 24 hrs. This sample also had the lower hardness and chewiness after cooking. Therefore, sample 2408 would be considered the most favorable variety overall for white salted

noodles quality (Japanese Udon-type), which are preferred to have a bright, creamy white color, and smooth, soft texture.

Sample 2410 had second highest L-value (brightness) at 0 hrs and at 24 hrs respectively. And had third lowest PPO value.

Sample 2422 had the lowest PPO value, second lowest delta L value, and second highest springiness.

Table I. Noodle Color and PPO Level

Sample ID	*L** @ 0	*L** @ 24	*a** @ 0	*a** @ 24	*b** @ 0	*b**@ 24	delta *L**	delta *a**	delta *b**	PPO
2401	76.36	62.73	-0.85	1.58	23.20	24.19	-13.63	2.42	0.99	0.440
2402	77.67	64.38	-1.02	1.59	23.36	26.58	-13.29	2.61	3.22	0.461
2403	78.43	64.80	-1.56	1.07	23.16	26.19	-13.64	2.63	3.03	0.474
2404	75.55	61.74	-0.39	2.14	22.48	23.90	-13.81	2.53	1.42	0.643
2405	73.41	59.73	0.24	2.63	23.10	23.88	-13.68	2.39	0.79	0.737
2406	75.25	61.46	0.28	2.82	20.71	23.40	-13.79	2.54	2.69	0.946
2407	79.07	65.51	-1.17	1.30	21.71	25.13	-13.56	2.47	3.43	0.708
2408	80.12	66.19	-1.44	0.70	22.13	25.10	-14.44	2.14	2.97	0.358
2409	79.04	63.73	-1.33	0.98	22.11	23.30	-15.32	2.31	1.20	0.300
2410	79.59	66.06	-1.26	0.78	22.10	24.79	-13.53	2.03	2.69	0.292
2411	78.29	64.09	-1.56	1.04	23.40	24.45	-14.20	2.60	1.06	0.497
2412	76.88	60.46	-0.35	2.07	20.09	22.57	-16.42	2.42	2.49	0.455
2413	78.38	65.17	-0.85	1.32	20.54	23.74	-13.21	2.17	3.20	0.529
2414	79.18	63.53	-1.11	1.05	20.59	23.33	-15.65	2.16	2.74	0.389
2415	78.72	63.82	-1.24	1.04	21.11	23.43	-14.90	2.28	2.32	0.500
2416	78.69	65.11	-0.82	0.93	21.09	23.89	-13.58	1.75	2.80	0.233
2417	79.17	63.37	-1.34	0.76	21.60	24.17	-15.80	2.10	2.57	0.473
2418	76.82	61.47	-0.81	1.47	21.42	23.55	-15.35	2.27	2.13	0.500
2419	76.44	62.15	-0.11	2.22	19.29	22.98	-14.29	2.33	3.69	0.526
2420	74.30	60.82	-0.33	1.82	23.14	24.35	-13.48	2.14	1.21	0.632
2421	77.05	65.12	-0.63	1.12	23.16	26.06	-11.93	1.75	2.90	0.209
2422	77.42	65.10	-0.68	1.28	23.02	26.33	-12.32	1.96	3.31	0.169
2423	76.17	61.52	-0.58	1.71	22.26	23.46	-14.65	2.29	1.21	0.473
2424	76.05	61.70	-0.49	1.92	20.91	24.22	-14.35	2.41	3.31	0.529
2425	76.99	61.89	-0.30	2.09	19.75	23.02	-15.10	2.38	3.27	0.724
2426	74.17	61.52	-0.58	1.94	22.46	24.29	-12.65	2.52	1.84	0.847
2427	76.12	61.69	-0.41	2.06	19.73	22.70	-14.43	2.47	2.98	0.780
2428	74.30	58.98	-0.65	1.79	23.00	25.20	-15.32	2.44	2.20	0.757
2429	75.43	59.92	-0.36	2.04	19.41	22.59	-15.52	2.40	3.18	0.800
2430	77.14	60.28	-0.75	1.84	18.95	22.10	-16.86	2.59	3.15	0.718
2431	74.95	60.60	-0.10	2.69	21.71	25.34	-14.35	2.79	3.64	0.713
2432	74.95	59.47	-0.04	2.63	20.30	22.98	-15.49	2.67	2.68	0.697

Avg	76.94	62.63	-0.71	1.64	21.59	24.10	-14.33	2.34	2.51	0.547

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

Sample ID	Springiness	Hardness	Chewiness	Resilience	Cohesiveness	Water Uptake (%)	cooking loss(%)
2401	0.898	2.391	1.433	0.387	0.667	89.88	6.64
2402	0.894	2.471	1.427	0.387	0.646	93.68	7.32
2403	0.896	2.539	1.488	0.399	0.654	89.80	7.88
2404	0.911	2.443	1.537	0.418	0.691	88.16	6.20
2405	0.867	2.624	1.543	0.410	0.678	79.92	7.56
2406	0.907	2.483	1.598	0.446	0.710	79.76	6.52
2407	0.890	2.574	1.546	0.413	0.675	87.68	6.88
2408	0.873	2.359	1.329	0.393	0.645	90.52	8.64
2409	0.886	2.310	1.316	0.374	0.643	90.80	7.44
2410	0.890	2.227	1.254	0.372	0.632	90.40	8.20
2411	0.873	2.501	1.458	0.415	0.667	86.80	6.76
2412	0.873	2.614	1.571	0.418	0.688	88.28	6.24
2413	0.871	2.490	1.448	0.404	0.667	83.16	8.20
2414	0.878	2.581	1.461	0.373	0.645	91.88	7.20
2415	0.865	2.671	1.432	0.340	0.620	87.28	9.00
2416	0.886	2.657	1.522	0.377	0.647	85.40	8.36
2417	0.851	2.525	1.314	0.351	0.612	81.12	8.56
2418	0.907	2.802	1.709	0.402	0.673	88.20	6.20
2419	0.869	2.703	1.589	0.398	0.676	83.00	6.36
2420	0.898	2.912	1.802	0.422	0.689	87.20	5.80
2421	0.888	2.679	1.600	0.412	0.672	87.40	6.28
2422	0.911	2.467	1.537	0.406	0.684	86.56	6.56
2423	0.888	2.667	1.611	0.408	0.680	94.12	5.48
2424	0.880	2.836	1.657	0.400	0.664	87.68	7.12
2425	0.902	2.812	1.705	0.390	0.672	82.20	6.52
2426	0.836	3.017	1.558	0.349	0.618	92.88	6.48
2427	0.822	2.777	1.522	0.398	0.667	79.84	6.80
2428	0.855	3.096	1.779	0.404	0.672	84.60	5.88
2429	0.878	2.976	1.714	0.382	0.657	83.76	7.12
2430	0.884	2.883	1.728	0.400	0.678	85.04	6.40
2431	0.871	2.960	1.658	0.372	0.643	85.04	7.36
2432	0.865	2.688	1.561	0.410	0.671	85.24	7.24
Avg	0.880	2.648	1.544	0.395	0.663	86.79	7.04

2018 WQC HARD WINTER WHEAT FLOUR PROTEIN ANALYSIS

Michael Tilley, Ph.D.

USDA, CGAHR, Manhattan, KS

Procedures

1. Determination of polymeric to monomeric protein ratio

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

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

- Protein extraction (Bean et al, 1998): 10 mg flour + 1 ml 50% 1-propanol- vortex for 5 min, centrifuge for 5 min at 12,000 x g. Discard supernatant. Repeat two times.
- Lyophylize the pellet, which contains the insoluble polymeric proteins.
- Determine pellet protein content by Nitrogen combustion (LECO analysis).
- Insoluble polymeric protein percentage (%IPP) is calculated by multiplying nitrogen values by a conversion factor of 5.7 and dividing by total flour protein.

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

Sequential protein extraction:

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

References

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

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

Results of Flour Protein Analysis

Winter WQC 2018 Crop Protein Analysis				
	HMW Glutenin Subunits			Polymeric:Monomeric protein
	Glu-A1	**Glu-B1**	**Glu-D1**	**Ratio of PP/MP**
18-2401	1,2*	17+18	5+10	1.02
18-2402	2*	7+9	2+12	0.89
18-2403	2*	7+8	5+10	0.97
18-2404	2*	7+8	5+10	0.87
18-2405	1,2*	17+18	5+10	1.02
18-2406	2*	7+8	5+10	0.97
18-2407	2*	17+18	5+10	0.78
18-2408	2*	20a+20b	5+10	0.86
18-2409	1,2*	17+18	5+10	1.02
18-2410	2*	7+9	2+12	0.77
18-2411	2*	7+8/7+9	5+10	0.95
18-2412	1,2*	17+18	5+10	0.97
18-2413	2*	7+8/7+9	5+10	0.92
18-2414	1,2*	17+18	5+10	1.11
18-2415	1	7+9	5+10	0.85
18-2416	2*	7+9	5+10	0.99
18-2417	2*	7+9	5+10	0.77
18-2418	1,2*	17+18	5+10	0.99
18-2419	2*	7+8	2+12	1.04
18-2420	1	7+9	2+12	0.86
18-2421	1	7+8	5+10	1.20
18-2422	1	17+18	5+10	0.91
18-2423	1,2*	7+9	5+10	0.97
18-2424	1,2*	17+18	5+10	1.03
18-2425	1,2*	20a+20b	5+10	0.93
18-2426	1,2*	7+8	2+12	0.96
18-2427	1	7+8	5+10	0.83
18-2428	2*	7+8	2+12	1.00
18-2429	2*	17+18	5+10	0.88
18-2430	1	7+9	2+12	0.79
18-2431	1	7+9	2+12	0.88
18-2432	2*	7+8	5+10	0.91

APPENDIX A
Credits and Methods

CREDITS

Milling, Sample Analysis, Ingredients and Report Preparation

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

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Ardent Mills 3794 Williston, Rd., Minnetonka, MN 55345	Miller	**Chloe Jiang** (225) 405-4086 Chloe.Jiang@ardentmills.com
Grain Craft 701 E. 17th Street Wichita, KS 67214	Miller	**Reuben McLean** (208) 785-6293 rmclean@graincraft.com
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Wheat Marketing Center 1200 NW Naito PRKWY STE 230 Portland, OR 97209	Wheat Quality Lab	**Bon Lee** (503)295-0823 blee@wmcinc.org

METHODS

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

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

1000 Kernel Weight - The weight in grams of 300 kernels of wheat, determined by SKCS, and converted to 1000.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Cumulative Ash and Protein Curves

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

center of the kernel and increases toward the outer parts because the bran layer contains several times more minerals than pure endosperm.

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

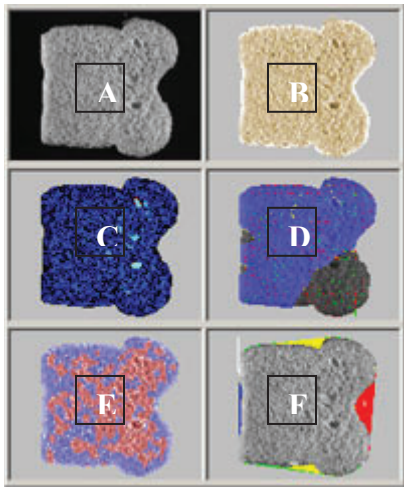
Similarly, cumulative protein curves are determined by arranging millstreams in ascending order of protein content, and tabulating the protein content of the total flour produced with the addition of successive millstreams. Wheat that gives high protein content at low extraction, and a fast rate of protein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

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

C-Cell Image Analysis

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

Images:



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

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

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

Data:

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

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

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

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

Brightness: Sample brightness and cell contrast.

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

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

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

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

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

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

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

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

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

Collaborators' Baking Test Profiles and Other Information

2018 WQC COLLABORATORS' BAKING TEST PROFILES AND OTHER INFORMATION

Coop	No.	Test Methods	Est. Flour and Dough Wt (g)	Mixing Tolerance	Fermentation time (min)	Oven Temp	Baking Time
A	1	Pup-loaf straight dough	100 g	Mixograph	90 min	400	25
B	2	Pup-loaf straight dough	100 g, approx 170 g	Mixograph	90 min	400	25
C	3	Pup-loaf straight dough	100 g flour, approx 175 g dough	Mixograph	90 min	425	21
D	4	Pup-loaf straight dough	100 g flour, approx. 175 g dough	Farinograph and Mixograph	180 fermentation and 60 min proof time	400	25
E	5	Sponge and dough	600 g flour, 480 g dough	Other	240 min (sponge time) and 45 min (fermentation)	420	20
F	6	No time dough	700 g flour, 524 g dough	Farinograph	10 min floor time, proof to height, no sponge time	420	20
G	7	Pup-loaf straight dough	100 g		90 min	401	22
H	8	Pup-loaf straight dough	100 g flour, approx 160 g dough	Farinograph	120 min	425	20
I	9	Pup-loaf straight dough	100 g flour	Farinograph	120 min	390	25
J	10	Pup-loaf straight dough	100 g	Mixograph	90 min	400	25
K	11	Sponge and dough	600 g flour, 160 g dough	Mixing series	240 min	425	16
L	12	Pup-loaf straight dough	200g, 170 g dough	Mixograph	180 min	419	24
M	13	Sponge and dough	540 g dough	Mixing series	210 min	430	23
N	14	Pup-loaf straight dough	100 g flour, approx 170 g dough	Mixograph	120 min	420	18

APPENDIX B

HWWQC Technical Board and Goals for HWW Breeders

Hard Winter Wheat Quality Council

2018 Technical Board Officers

CHAIR:	**Scott Baker,** Ardent Mills
VICE CHAIR:	**Reuben McLean,** Grain Craft
SECRETARY:	**Mike Wolt,** Bimbo
MEMBER:	**Stephen Baenziger,** University of Nebraska
MEMBER:	**Tess Brensing,** ADM Milling

2018 Quality Evaluation & Advisory Committee

Brad Seabourn, USDA/ARS/HWWQL

Terry Selleck, Bay State Milling

Jon Rich, Syngenta/AgriPro

Craig Warner, BIMBO Bakeries USA

Richard Chen, USDA/ARS/HWWQL

Hard Winter Wheat Quality Council (HWWQC)

Charter
Revised and Approved (February 20, 2003)

Mission, Policy, and Operating Procedure

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

Objectives

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

Membership

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

HWWQC Technical Board

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

Duties of the Technical Board

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

Compensation

- Technical Board members shall serve without compensation.

Expenses

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

Hard Winter Wheat Quality Evaluation and Advisory Committee

Committee Purpose

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

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

Evaluation and Responsibilities

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

Sample/Locations

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

Annual Meeting

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

Finances and Budget

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

Amendments

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

Outlined Goals for Hard Winter Wheat Breeders

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

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

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

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

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

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

Performance on KSU Pilot Mill

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

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

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

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

APPENDIX C

Hard Red Winter Wheat Quality Targets

RECOMMENDED*
QUALITY TARGETS FOR HARD RED WINTER WHEAT

HWW Quality Targets Committee
Approved February, 2006

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

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

CONTACT:
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Hard Winter Wheat Quality Laboratory
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APPENDIX D

Hard White Wheat Quality Targets
Adopted from PNW for Great Plains

Hard White Wheat Quality Targets

Dual Purpose -- Chinese Noodles and Western Pan Bread

Updated on March 1, 2002 at Hard White Wheat Quality Targets Meeting
Wheat Marketing Center, Portland, Oregon

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

Notes:

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

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

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

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

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

Wheat Marketing Center, Portland, Oregon

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

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

APPENDIX E

WQC Business Meeting Minutes

by Scott Baker

Feb. 21, 2018

Hard Winter Wheat Quality Council Meeting Minutes
Annual Meeting February 21, 2018

Meeting Minutes of the Hard Winter Wheat Quality Council
February 21, 2018 Kansas City, Missouri

Dave Green opened and conducted this year's meeting (Sid Perry the out- going chairman was unable to attend due to weather related travel issues)

Review of 2017 Minutes – approved as-is

Nomination and Election for 2 new members:

Tess Brensing	ADM Milling	nominated and elected
Rueben McLean	GrainCraft	nominated and elected

Board for 2018:

Chairman	Scott Baker, Ardent Mills
Vice Chairman	Reuben McLean, GrainCraft
Secretary	Mike Wolt, Bimbo
Member	Stephen Baenziger, University of Nebraska
Member	Tess Brensing, ADM Milling

Overview of Milling of Wheat Samples (Dave Green presented slides from Shawn Thiele, KSU Mill)

- 2017 Repairs on Miag (continuation of repairs over last 2 years)
  - New air locks
  - New cyclone and air handling system to eliminate filter stock flour
- 2018 Repairs on Miag (on- going maintenance)
  - Change ducting and adjusting air-balance

- Sample Milling
  - 32 wheat samples received in late September and milling was started in early October and the flour samples sent to the collaborators to arrive by November 1
  - Miag mill functioned well with flour samples having ash levels in the low 0.50's

WQC Report for 2017 Richard Chen USDA / RS Manhattan

- 32 entries, 8 programs, 17 cooperators
- Jagalene was used as a common check
- Results from cooperators received by Dec 17

- It was brought-up that descriptors on bake comments need to be updated / standardized

HWW WQC Grow-outs

Dave Green gave introduction on the importance of replicated trails under commercial conditions to provide consistency over time

- Northern Plain Grow-out Steve Baenziger , University of Nebraska
    - Four public programs involved (NE, SD, MT, ND) targeting 3 lines per program and 2 lines selected for WQC Evaluation
    - Common check and local check
    - Total of 13 lines entered this year
    - Location covers a large geographic area (Bozeman, Fargo, Brookings, Lincoln) and were selected for convenience
    - This is a start of a journey and many improvements are needed : 1) incorporate commercial partners 2) align grow-out management of fungicides, nitrogen , irrigation 3) revisit where are optimal grow-out locations

- Production Zones for Grow-outs Alan Fritz Kansas State University
    - Detail proposal was made last year on transitioning to production zones (Northern Plains , Central Plains, High Plains) to facilitate a more direct comparison of varieties and better sense of the environmental stability of lines ; some details need to be revised however general framework is in place
    - Would like to use of some contracted grow-outs to take some of the burden off breeders
    - Challenges to get MTA's in place and trying to avoid complicated 3 way MTA's (breeders/ ARS / contract growers)
    - Looking at revising / defining maximum number of entries per program and maximum number of entries per location

Mark Hodges, Review of 2017 Crop

- Another challenging crop year
    - Crop started good in most locations with acceptable moisture at planting however there was very little additional moisture until close to harvest
    - TX / OK the moisture was too late to help the crop
    - KS/ NE benefit from late moisture
    - Crop showed generally good quality protein but limited protein quantity

APPENDIX F

Historical WQC Hard Winter
Wheat Entries
from 2001 to 2018

A History of WQC Hard Winter Wheat Entries

2018

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Jagalene (CC01)	18-2401					Texas
TAM 111	18-2402					Texas
TX12V7415	18-2403	HRW	Under consideration			Texas
LINK	18-2404					Limagrain
Jagalene (CC02)	18-2405					Limagrain
DH11HRW53-34	18-2406					Limagrain
LCI13DH-22-22	18-2407					Limagrain
MOD14-4919	18-2408				TBD	Monsanto
Jagalene (CC03)	18-2409					Monsanto
H4N13-0253	18-2410	HRW	yes	N/A	2017	Monsanto
Danby	18-2411					Kansas-Hays
Jagalene (CC04)	18-2412					Kansas-Hays
KS14H180-4-63	18-2413		no			Kansas-Hays
Jagalene (CC05)	18-2414					Syngenta
10BC107#115	18-2415					Syngenta
SY Monument	18-2416					Syngenta
08BC379-40-1	18-2417					Syngenta
Jagalene (CC06)	18-2418					Oklahoma
Ruby Lee	18-2419					Oklahoma
OK12716-159319-13	18-2420	HRW	yes	Showdown	2018	Oklahoma
OK13621	18-2421	HRW	yes	Baker's Ann	2018	Oklahoma
OK12206-127206-2	18-2422	HRW	Under consideration			Oklahoma
OK1059018-129332-5	18-2423	HRW	Under consideration			Oklahoma
Jagalene (CC07)	18-2424					Northern States
NE10478-1	18-2425					Nebraska
NHH144913-3	18-2426					Nebraska
MT1564	18-2427					Montana
MTS1588	18-2428					Montana
NORD58	18-2429	HWW	no			North Dakota
NORD62	18-2430	HWW	no			North Dakota
SD09227	18-2431					Sourth Dakota
SD14115-5	18-2432					Sourth Dakota

2017

SY Monument	17-2401	HRW				Syngenta
SY Achieve CL2	17-2402	XWHT	Yes		2017	Syngenta
SY 517 CL2	17-2403	HRW	Yes		2017	Syngenta
Jagalene (CC01)	17-2404	HRW				Syngenta
Jagalene (CC02)	17-2405	HRW				Texas
TAM 111	17-2406	HRW				Texas
TX11A001295	17-2407	HRW	no			Texas
TX12M4068	17-2408	HRW	no			Texas
Byrd	17-2409	HRW				Colorado
CO12D1770	17-2410	HRW				Colorado
Jagalene (CC03)	17-2411	HRW				Colorado
CO13D1783	17-2412	HRW				Colorado

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
CO12D2011	17-2413	HDWH	Yes	Breck	2017	Colorado
Jagalene (CC04)	17-2414	HRW				Kansas-Hays
KS13HW92-3	17-2415	HDWH	yes	Venada	2018	Kansas-Hays
Danby	17-2416	HDWH				Kansas-Hays
KS14HW106-6-6	17-2417	HDWH	not yet			Kansas-Hays
Yellowstone	17-2418	HRW				Montana
MT1465	17-2419	HRW	Yes	FourOsix	2018	Montana
Jagalene (CC05)	17-2420	HRW				Montana
MTW1491	17-2421	HDWH				Montana
NI13706	17-2422	HRW				Nebraska
NE12561	17-2423	HRW				Nebraska
Jagalene (CC06)	17-2424	HRW				Nebraska
Jagalene (CC07)	17-2425	HRW				Monsanto
WB4623CLP	17-2426	HRW	yes	WB4623CLP	2014	Monsanto
WB4721	17-2427	HRW	Yes	WB4721	2015	Monsanto
Ruby Lee	17-2428	HRW				Oklahoma
OK13621	17-2429	HRW	Yes	Baker's Ann	2018	Oklahoma
OK12D22004-016	17-2430	HRW	No			Oklahoma
OCW04S7171T-6W	17-2431	HDWH	Under Consideration			Oklahoma
Jagalene (CC08)	17-2432	HRW				Oklahoma
2016						
LCH13-048	16-2401	HRW				Limagrain
LCH13NEDH-12-27	16-2402	HRW				Limagrain
Jagalene (CC01)	16-2403	HRW				Limagrain
PSB13NEDH-11-26	16-2404	HRW				Limagrain
LCI13-069	16-2405	HWW				Limagrain
PSB13NEDH-14-83	16-2406	HWW				Limagrain
KS1256-6-4	16-2407	HRW	yes	Tatanka	2016	Kansas-Hays
Danby	16-2408	HWW				Kansas-Hays
Jagalene (CC02)	16-2409	HRW				Kansas-Hays
LCH13NEDH-14-53	16-2410	HWW				Nebraska
Jagalene (CC03)	16-2411	HRW				Nebraska
LCHNEDH-4-16	16-2412	HWW				Nebraska
Postrock	16-2413	HRW				Syngenta
Jagalene (CC04)	16-2414	HRW				Syngenta
AP11T2409	16-2415	HRW				Syngenta
Jagalene (CC05)	16-2416	HRW				Monsanto
HV9W10-0458	16-2417	HRW	yes	WB4515	2015	Monsanto
Jagalene (CC06)	16-2418	HRW				Oklahoma
Ruby Lee	16-2419	HRW				Oklahoma
OK10126	16-2420	HRW	yes	Spirit Rider	2017	Oklahoma
OK12D22004-016	16-2421	HRW	no			Oklahoma
OK12912C	16-2422	HRW	Under Consideration			Oklahoma
OK13209	16-2423	HRW	yes	Green Hammer	2018	Oklahoma
Everest	16-2424	HRW				Kansas-Manhattan
Jagalene (CC07)	16-2425	HRW				Kansas-Manhattan
Larry	16-2426	HRW				Kansas-Manhattan

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Zenda	16-2427	HRW				Kansas-Manhattan
2015						
Jagalene (CC01)	15-2401	HRW				Kansas-Hays
Danby (IC)	15-2402	HRW				Kansas-Hays
KS11HW39-5	15-2403	HRW	yes	Joe	2015	Kansas-Hays
Jagalene (CC04)	15-2404	HRW				Nebraska
NE1059	15-2405	HRW	yes	Ruth	2016	Nebraska
Jagalene (CC06)	15-2406	HRW				Monsanto
BZ9W09-2075	15-2407	HWW	yes	WB4575	2015	Monsanto
HV9W10-1002	15-2408	HWW	yes	WB4303	2015	Monsanto
Jagalene (CC09)	15-2409	HRW				Colorado
Byrd (IC)	15-2410	HRW				Colorado
CO11D1397	15-2411	HRW				Colorado
CO11D1539	15-2412	HRW				Colorado
CO11D1767	15-2413	HRW				Colorado
Jagalene (CC14)	15-2414	HRW				Oklahoma
Gallagher (IC)	15-2415	HRW				Oklahoma
OK11D25056	15-2416	HRW	yes	Smith's Gold	2017	Oklahoma
OK13625	15-2417	HRW	yes	Skydance	2017	Oklahoma
OK10728W	15-2418	HWW	yes	Stardust	2017	Oklahoma
Jagalene (CC19)	15-2419	HRW				Montana
Yellowstone (IC)	15-2420	HRW				Montana
MTS1224	15-2421	HRW	yes	Loma	2016	Montana
MT1265	15-2422	HRW				Montana
Ideal (IC)	15-2423	HRW				South Dakota
SD10257-2	15-2424	HRW	yes	Oahe	2016	South Dakota
LCH13DH-20-87	15-2425	HRW	yes	LCS Chrome	2015	Limagrain
2014						
Jagalene (CC01)	14-2401	HRW				Kansas_Hays
Danby (IC)	14-2402	HWW				Kansas_Hays
KS11HW15-4	14-2403	HWW				Kansas_Hays
KS11W39-5	14-2404	HWW				Kansas_Hays
Jagalene (CC05)	14-2405	HRW				Texas_Amarillo
TAM 111 (IC)	14-2406	HRW				Texas_Amarillo
TX08A001249	14-2407	HRW				Texas_Amarillo
TX09A001194	14-2408	HRW				Texas_Amarillo
TX09D1172	14-2409	HRW				Texas_Amarillo
Jagalene (CC10)	14-2410	HRW				Colorado
Byrd (IC)	14-2411	HRW				Colorado
CO11D174	14-2412	HRW	yes	Avery	2014	Colorado
CO11D446	14-2413	HRW				Colorado
Jagalene (CC)	14-2414	HRW				Nebraska
Camelot (IC)	14-2415	HRW				Nebraska
NE07531	14-2416	HRW				Nebraska
NE09521	14-2417	HRW				Nebraska
Jagalene (CC18)	14-2418	HRW				Montana
Yellowstone (IC)	14-2419	HRW				Montana

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
MT1078	14-2420	HRW				Montana
MT1138	14-2421	HRW				Montana
Jagalene (CC22)	14-2422	HRW				Oklahoma
Ruby Lee (IC)	14-2423	HRW				Oklahoma
OK09125	14-2424	HRW	yes	Bentley	2015	Oklahoma
OK10126	14-2425	HRW	yes	Spirit Rider	2017	Oklahoma
Jagalene (CC26)	14-2426	HRW				Kansas_Manhattan
KanMark	14-2427	HRW				Kansas_Manhattan
06BC722#25	14-2428	HRW	yes	SY Flint	2015	Agripro
06BC796#68	14-2429	HRW	yes	SY Sunrise	2015	Agripro
2013						
Check Blend (check)	13-2401	HRW				Limagrain
LCH08-80	13-2402	HRW				Limagrain
lCS Mint	13-2403	HRW				Limagrain
Danby (check)	13-2404	HWW				Kansas-Hays
Oakley CL	13-2405	HRW	yes	Oakley CL	2013	Kansas-Hays
KS10HW78-1	13-2406	HWW				Kansas-Hays
Lyman (check)	13-2407	HRW				South Dakota
SD08200	13-2408	HRW				South Dakota
SD09192	13-2409	HRW				South Dakota
Postorock (check)	13-2410	HRW				Agripro
04BC574-2	13-2411	HRW	yes	SY Monument	2014	Agripro
Millennium (check)	13-2412	HRW				Nebraska
NE09521	13-2413	HRW				Nebraska
NE08499	13-2414	HRW				Nebraska
Yellowstone (check)	13-2415	HRW				Montana
MT1090	13-2416	HRW				Montana
MTW08168	13-2417	HWW	yes	WB3768	2013	Montana
Ruby Lee (check)	13-2418	HRW				Oklahoma
Doublestop CL+	13-2419	HRW	yes	Doublestop CL+	2013	Oklahoma
OK09125	13-2420	HRW	yes	Bentley	2015	Oklahoma
2012						
WB-Stout (check)	12-2401	HRW				Westbred
HV9W07-1028	12-2402	HRW				Westbred
Millennium (check)	12-2403	HRW				Nebraska
NW07505	12-2404	HWW				Nebraska
NE06545	12-2405	HRW	yes	Freeman	2012	Nebraska
NE06607	12-2406	HRW				Nebraska
Byrd (check)	12-2407	HRW				Colorado
Snowmass (check)	12-2408	HWW				Colorado
CO07W245	12-2409	HWW	Yes	Antero	2012	Colorado
CO07W722-F5	12-2410	HWW				Colorado
Billings (check)	12-2411	HRW				Oklahoma
Ruby Lee	12-2412	HRW				Oklahoma
Gallagher (OK07214)	12-2413	HRW	yes		2012	Oklahoma
Iba (OK07209)	12-2414	HRW	yes		2012	Oklahoma
OK09634	12-2415	HRW	no			Oklahoma

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Lyman (check)	12-2416	HRW				South Dakota
SD08080	12-2417	HRW				South Dakota
SD06158	12-2418	HRW	yes	Redfield	2013	South Dakota
Yellowstone (check)	12-2419	HRW				Montana
MT08172	12-2420	HRW	yes	Colter	2012	Montana
MT0978	12-2421	HRW	yes	Northern	2015	Montana
TAM 111 (check)	12-2422	HRW				Texas
TX07A001505	12-2423	HRW				Texas
TX03A0563-07	12-2424	HRW				Texas
2011						
Danby (check)	11-2401	HWW				Kansas-Hays
Tiger	11-2402	HWW	yes			Kansas-Hays
KS08HW35-1	11-2403	HWW	yes	Clara CL	2011	Kansas-Hays
PostRock (check)	11-2404	HRW				AgriPro
SY Wolf	11-2405	HRW	yes			AgriPro
Syngenta Exp 138-45	11-2406	HRW	yes	SY Southwind	2012	AgriPro
Fuller (check)	11-2407	HRW				Kansas-Manhattan
KS020319-7-3	11-2408	HRW	yes	1863	2012	Kansas-Manhattan
KS020633M-13	11-2409	HRW	no			Kansas-Manhattan
McGill (check)	11-2410	HRW				Nebraska
NE05496	11-2411	HRW	no			Nebraska
NE05548	11-2412	HRW	no			Nebraska
NI08708	11-2413	HRW	no			Nebraska
Jagalene (check)	11-2414	HRW				Westbred
HV9W06-509	11-2415	HWW	yes	WB-Grainfield	2012	Westbred
Yellowstone (check)	11-2416	HRW				Montana
MTS0808	11-2417	HRW	yes	Warhorse	2013	Montana
MT0871	11-2418	HRW	no			Montana
Lyman (check)	11-2419	HRW				South Dakota
SD06158	11-2420	HRW	yes	Redfield		South Dakota
SD07184	11-2421	HRW	no			South Dakota
2010						
Lyman (check)	10-2401	HRW				SDSU
SD05118-1	10-2402	HRW	yes	Ideal	2011	SDSU
SD06158	10-2403	HRW	yes	Redfield		SDSU
Hatcher (check)	10-2404	HRW				CSU
CO050303-2	10-2405	HRW	yes	Denali	2011	CSU
CO06052	10-2406	HRW	yes	Brawl CL Plus	2011	CSU
CO06424	10-2407	HRW	yes	Byrd	2011	CSU
Millennium (check)	10-2408	HRW				NU
NE03490	10-2409	HRW	no			NU
NE04490	10-2410	HRW	no			NU
Billings (check)	10-2411	HRW				OSU
OK05526	10-2412	HRW	yes	Ruby Lee	2011	OSU
OK05212	10-2413	HRW	yes	Garrison	2011	OSU
OK07231	10-2414	HRW	no			OSU
Smoky Hill (check)	10-2415	HRW				Westbred

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
HV9W06-262R	10-2416	HRW	no			Westbred
HV9W06-218W	10-2417	HWW	no			Westbred
Yellowstone (check)	10-2418	HRW				MSU
MTS0721	10-2419	HRW	yes	Bearpaw	2011	MSU
TAM 111 (check)	10-2420	HRW				TAMU
TX05A001822	10-2421	HRW	no			TAMU
TX06A001263	10-2422	HRW	no			TAMU

2009

Smoky Hill (check)	09-2401	HRW				Westbred
Stout (HV9W03-539R)	09-2402	HRW	yes	WB-Stout	2009	Westbred
RonL (check)	09-2403	HWW				KSU-Hays
Tiger	09-2404	HWW	yes			KSU-Hays
Hatcher (check)	09-2405	HRW				CSU
CO04393	09-2406	HRW	no			CSU
CO04499	09-2407	HRW	no			CSU
OK Bullet (check)	09-2408	HRW				OSU
Billings	09-2409	HRW	yes			OSU
OK05526	09-2410	HRW	yes	Ruby Lee	2011	OSU
PostRock (check)	09-2411	HRW				AgriPro
CJ	09-2412	HRW	yes			AgriPro
SY Gold (AP00x0100-51)	09-2413	HRW	yes	SY Gold	2010	AgriPro
Yellowstone (check)	09-2414	HRW				MSU
MT06103	09-2415	HRW	no			MSU
MTS0713	09-2416	HRW	yes	Judee	2011	MSU
TAM 111 (check)	09-2417	HRW				TAMU
TX02A0252	09-2418	HRW	yes	TAM 113	2010	TAMU
Millennium (check)	09-2419	HRW				NU
NE01481	09-2420	HRW	yes	McGill	2010	NU
NI04421	09-2421	HRW	yes	Robidoux	2010	NU

2008

Jagalene (check)	08-2401	HRW				AgriPro
Art	08-2402	HRW	yes			AgriPro
Hawken	08-2403	HRW	yes			AgriPro
NuDakota	08-2404	HRW	yes			AgriPro
Hatcher (check)	08-2405	HRW				CSU
Thunder CL	08-2406	HWW	yes			CSU
CO03W054	08-2407	HWW	yes	Snowmass		CSU
CO03064	08-2408	HRW	no			CSU
Danby (check)	08-2409	HWW				KSU-Hays
Tiger	08-2410	HWW	yes			KSU-Hays
Karl 92 (check)	08-2411	HRW				KSU-Manhattan
KS970093-8-9-#1	08-2412	HRW	yes	Everest	2009	KSU-Manhattan
OK Bullet (check)	08-2413	HRW				OSU
OK03305	08-2414	HRW	yes	Pete	2009	OSU
OK03522	08-2415	HRW	yes	Billings	2009	OSU

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
OK03825-5403-6	08-2416	HRW				OSU
Tandem (check)	08-2417	HRW	yes	STARS0601W	2006	SDSU
SD05W030	08-2418	HWW	no			SDSU

2007

Hatcher (check)	07-2401	HRW				CSU
CO03W239	07-2402	HWW	yes	Thunder CL	2008	CSU
CO03W054	07-2403	HWW	yes	Snowmass		CSU
CO02W237	07-2404	HWW	no			CSU
Millennium (check)	07-2405	HRW				NU
NH03614	07-2406	HRW	yes	Settler CL	2008	NU
OK Bullet (check)	07-2407	HRW				OSU
OK00514-05806	07-2408	HRW	no			OSU
OK05737W	07-2409	HWW	no			OSU
OK03522	07-2410	HRW	yes	Billings	2009	OSU
OK02405	07-2411	HRW	no			OSU
Tandem (check)	07-2412	HRW				SDSU
SD98W175-1	07-2413	HRW	no			SDSU
SD01058	07-2414	HRW	no			SDSU
SD0111-9	07-2415	HRW	yes	Lyman	2008	SDSU
SD01273	07-2416	HRW	no			SDSU
Genou (check)	07-2417	HRW				MSU
MT0495	07-2418	HRW	no			MSU
MTS04114	07-2419	HRW	no			MSU

2006

Overley (check)	06-2401	HRW				KSU-Manhattan
Fuller	06-2402	HRW	yes			KSU-Manhattan
KS990498-3-&~2	06-2403	HRW	no			KSU-Manhattan
KS970274-14*9	06-2404	HRW	no			KSU-Manhattan
Overley (check)	06-2405	HRW				Westbred
Smoky Hill	06-2406	HRW	yes			Westbred
Aspen	06-2407	HRW	yes			Westbred
Millennium (check)	06-2408	HRW				NU
NW98S097	06-2409	HRW	yes	Anton	2008	NU
N02Y5117	06-2410	HRW	yes	Mace	2007	NU
NE01643	06-2411	HRW	yes	Overland	2007	NU
NE02584	06-2412	HRW	no			NU
OK Bullet (check)	06-2413	HRW				OSU
Duster	06-2414	HRW	yes			OSU
OK01420	06-2415	HRW	no			OSU
OK02405	06-2416	HRW	no			OSU
OK02522W	06-2417	HWW	yes	OK Rising	2008	OSU
Tandem (check)	06-2418	HRW				SDSU
SD96240-3-1	06-2419	HRW	no			SDSU
SD01122	06-2420	HRW	no			SDSU
SD01W065	06-2421	HWW	no			SDSU
TAM 111 (check)	06-2422	HRW				TAMU
TAM 112	06-2423	HRW	yes			TAMU

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
TX01A5936	06-2424	HRW	no			TAMU
TX01D3232	06-2425	HRW	yes	TAM 304	2006	TAMU
TX01V5314	06-2426	HRW	yes	TAM 203	2007	TAMU
2005						
Akron (check)	05-2401	HRW				CSU
CO00016	05-2402	HRW	yes	Ripper	2006	CSU
Jagger (check)	05-2403	HRW				KSU-Hays
2137	05-2404	HRW	yes			KSU-Hays
KS03HW6-6	05-2405	HWW	no			KSU-Hays
KS03HW158-1	05-2406	HWW	yes	RonL		KSU-Hays
Jagger (check)	05-2407	HRW				AgriPro
Neosho	05-2408	HRW	yes			AgriPro
W03-20	05-2409	HRW	yes	Postrock	2005	AgriPro
Goodstreak (check)	05-2410	HRW				NU
Infinity CL	05-2411	HRW	yes			NU
OK Bullet (check)	05-2412	HRW				OSU
OK93p656H3299-2c04	05-2413	HRW	yes	Duster	2006	OSU
OK01307	05-2414	HRW	no			OSU
OK03918C	05-2415	HRW	yes	Centerfield	2006	OSU
OK00611W	05-2416	HWW	no			OSU
Tandem (check)	05-2417	HRW				SDSU
Crimson	05-2418	HRW	yes			SDSU
SD97059-2	05-2419	HRW	no			SDSU
SD01W064	05-2420	HWW	no			SDSU
2004						
Jagger (check)	04-2401	HRW				KSU-Hays
2137	04-2402	HRW	yes			KSU-Hays
KS02HW34	04-2403	HWW	yes	Danby	2005	KSU-Hays
KS02HW35-5	04-2404	HWW	no			KSU-Hays
KS03HW158	04-2405	HWW	yes	RonL	2006	KSU-Hays
Antelope (check)	04-2406	HRW				NE-USDA-ARS
Arrowsmith	04-2407	HRW	yes			NE-USDA-ARS
NW99L7068	04-2408	HRW	no			NE-USDA-ARS
Millennium (check)	04-2409	HRW				NU
NE99495	04-2410	HRW	yes	NE99495	2005	NU
OK102 (check)	04-2411	HRW				OSU
OK00618W	04-2412	HWW	yes	Guymon	2005	OSU
OK99212	04-2413	HRW	no			OSU
OK00514	04-2414	HRW	yes	OK Bullet	2005	OSU
OK02909C	04-2415	HRW	yes	Okfield	2005	OSU
Tandem (check)	04-2416	HRW				SDSU
SD97W609	04-2417	HWW	yes	Alice	2006	SDSU
SD97538	04-2418	HRW	no			SDSU
SD98102	04-2419	HRW	yes	Darrell	2006	SDSU
2003						
Akron (check)	03-2401	HRW				CSU

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

2002

Jagger (check)	02-2401	HRW				AgriPro
Cutter	02-2402	HRW	yes			AgriPro
Dumas	02-2403	HRW	yes			AgriPro
Jagalene	02-2404	HRW	yes			AgriPro
G1878 (check)	02-2405	HRW				Cargill
G980723	02-2406	HRW	no			Cargill
G970252W	02-2407	HWW	no			Cargill
Prowers (check)	02-2408	HRW				CSU
CO980376	02-2409	HRW	no			CSU
CO980607	02-2410	HRW	yes	Hatcher	2004	CSU
CO980630	02-2411	HRW	no			CSU
Jagger (check)	02-2412	HRW				KSU-Manhattan
KS940748-2-2	02-2413	HRW	no			KSU-Manhattan
KS940786-6-7	02-2414	HRW	yes	Overley	2003	KSU-Manhattan
KS940786-6-9	02-2415	HRW	no			KSU-Manhattan
Millennium (check)	02-2416	HRW				NU
NE97V121	02-2417	HRW	no			NU
NE98466	02-2418	HRW	no			NU
NE98471	02-2419	HRW	yes	Hallam	2004	NU
NI98439	02-2420	HRW	no			NU
2174 (check)	02-2421	HRW				OSU
OK102	02-2422	HRW	yes			OSU
OK95548-54	02-2423	HRW	no			OSU
OK95616-56	02-2424	HRW	no			OSU
OK96705-38	02-2425	HRW	no			OSU
OK98699	02-2426	HRW	no			OSU

2001

Jagger (check)	01-2401	HRW				Cargill
G970380A	01-2402	HRW	no			Cargill
G970209W	01-2403	HWW	no			Cargill

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Prowers 99 (check)	01-2404	HRW				CSU
CO970547	01-2405	HRW	no			CSU
Millennium (check)	01-2406	HRW				NU
NE97426	01-2407	HRW	no			NU
NE97465	01-2408	HRW	yes	Goodstreak	2002	NU
NE97638	01-2409	HRW	yes	Empire	2002	NU
NE97669	01-2410	HRW	no			NU
NE97689	01-2411	HRW	yes	Harry	2002	NU
2174 (check)	01-2412	HRW				OSU
OK96717-99-6756	01-2413	HRW	no			OSU
OK97508	01-2414	HRW	yes	Ok102	2002	OSU

Thank you for reviewing this report of 2018 WQC Hard Winter Wheat milling and baking. Please let me know if you have any comments on this report. I can be reached at (785)776-2750 or by email, Richard.chen@ars.usda.gov