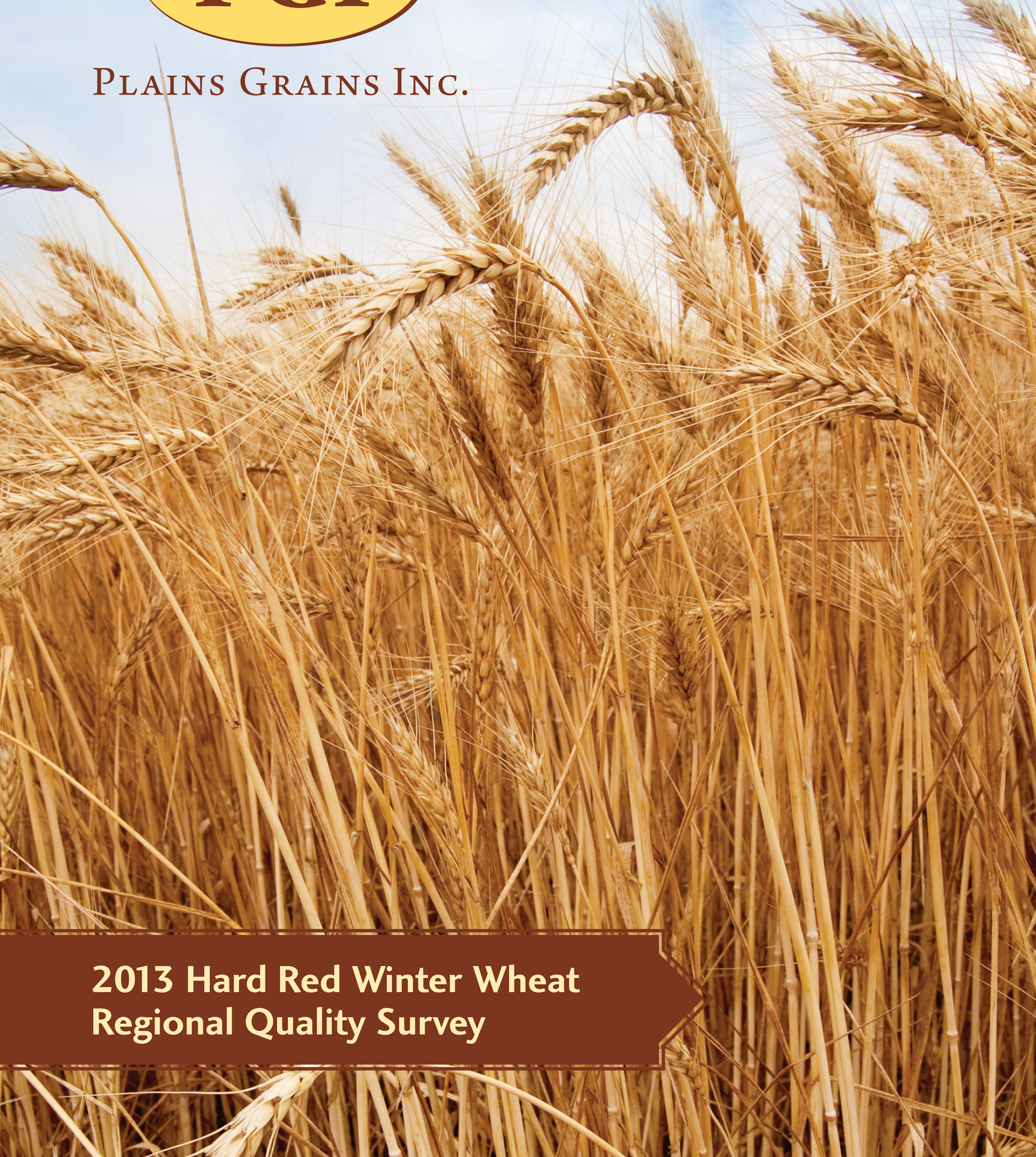
Plains Grains Inc.



2013 Hard Red Winter Wheat Regional Quality Survey

321 B CITD, Stillwater, OK 74078
Phone: (405) 744- 9333
pgiadmin@plainsgrains.org • www.plainsgrains.org

PGI
Plains Grains Inc.

Colorado Wheat
Administrative Committee
www.coloradowheat.org

Idaho Wheat Commission
www.idahowheat.org

Oklahoma Wheat Commission
www.wheat.state.ok.us

Kansas Wheat Commission
www.kswheat.com

North Dakota Wheat Commission
www.ndwheat.com

South Dakota Wheat Commission
www.sdwheat.org

Nebraska Wheat Board
www.nebraskawheat.com

Washington Grain Commission
www.washingtongrainalliance.com

Texas Wheat Producers
Board and Association
www.texaswheat.org

Montana Wheat & Barley Committe
wbc.agr.mt.gov

Oregon Wheat Commission
www.owgl.org

Wyoming Wheat Growers Association
www.wyomingwheat.com

Plains Grains, Inc.

Plains Grains, Inc., a non-profit, private quality based marketing initiative, was formed in 2004 through the Oklahoma Wheat Commission, the Oklahoma Department of Agriculture, Food and Forestry, the Oklahoma State University Division of Agricultural Sciences and Natural Resources.

PGI was designed to bridge the gap between wheat producers, grain companies and foreign and domestic flour millers to benefit all segments of the wheat industry.

PGI facilitates the appropriate wheat quality tracking needed to provide millers with the quality information they need to purchase U.S. wheat. While state data is important, it is critical to Plains Grains marketing goals to have quality data for the entire HRW wheat production area. Each state may be able to produce the quality needed by foreign buyers, but it will take multiple states to achieve the critical mass needed to meet the quantity needs. By working together as a region we can meet both quality and quantity demands.

In 2004, PGI's crop quality survey included the Oklahoma HRW wheat crop. Designed as a regional marketing entity, PGI then brought five other HRW wheat producing states on board for the crop quality survey in 2005. Due to the welcome reception and success of PGI in the foreign marketplace, the entire Great Plains HRW wheat production region subscribed to the PGI crop quality survey in 2006.

Visit our web site at www.plainsgrains.org for up-to-date information, interactive maps, and more!

Feeding the World

Wheat is one of the oldest and most widely used food crops in the nation and it supplies approximately 20 percent of food calories for the world's population. Whole grains contain protective antioxidants in amounts near or exceeding those in fruits and vegetables.

Wheat is the United State's leading export crop and the fourth leading field crop. The most common class produced in the United States is Hard Red Winter (HRW) wheat. The class a variety fits into is determined by its hardness, the color of its kernels and by its planting time. Other classes are: Durum, Hard Red Spring, Soft Red Winter, Hard White and Soft White.

Almost 50 percent of the U.S.'s total wheat production is exported. Approximately one-third of the HRW produced is exported. Nigeria is the number one importer of U.S. HRW, with a little over 75 percent of its total imports coming from the U.S.

Wheat flour is the major ingredient in many favorite foods found across the globe. More foods are made from wheat than any other cereal grain. Wheat has the ability to produce a widely diverse range of end-use products because each class of wheat has distinct characteristics that create unique functionality.

HRW wheat is a versatile wheat with excellent milling and baking characteristics for pan breads. Principally used to make bread flour, HRW is also a choice wheat for Asian noodles, hard rolls, flat breads and as a blending improver.

Hard Red Winter wheat accounts for about 40 percent of total U.S. wheat production and is grown primarily in the Great Plains states of Colorado, Kansas, Nebraska, Oklahoma, Texas, Montana, South Dakota , North Dakota, Wyoming, and the Pacific Northwest.

National Wheat Overview

Wheat Major Classes

The six major classes of U.S. wheat are Hard Red Winter, Hard Red Spring, Soft Red Winter, Soft White, Hard White and Durum. Each class has a somewhat different end use and production tends to be region-specific. This region is mostly limited to production of Hard Red Winter and Hard White wheat classes, therefore the data in this publication will focus on the quality of those classes for the 2009 crop year.

Hard Red Winter (HRW) wheat accounts for about 40 percent of total U.S. wheat production, dominates the U.S wheat export market and is grown primarily in the Great Plains, stretching from the Mississippi River to the Pacific Ocean and from Canada to Mexico.

Hard Red Winter wheat accounts for about 40 percent of total U.S. wheat production

This fall seeded wheat is a versatile wheat with moderatly high protein content and excellent milling and baking characteristicsD. Principally used to make bread flour, HRW is also a choice wheat for Asian noodles, hard rolls, flat breads and is commonly used as an improver for blending.

Hard White (HW) is the newest class of wheat, used for the same basic products as HRW wheat, can provide higher milling extraction and requires less sweetener in whole-wheat products due to its milder, sweeter flavor.

HW, which is closely related to Red wheats, receives enthusiastic reviews when used for Asian noodles, hard rolls, bulgar, tortillas, whole wheat or high extraction applications, pan breads or flat breads.

Weather and Harvest

Planting dates and crop conditions (especially early spring through grain maturity) for the 2013 HRW crop were again highly variable across the production region, as were the previous 2 crops. Generally, planting conditions and emergence were delayed in all areas due to an ongoing drought in all production areas with the exception of the Pacific Northwest. The drought of 2011 and 2012 spread northward out of the southern Great Plains into the central Plains and parts of Montana. Timely moisture extending from central Texas through central Nebraska during later stages of plant development helped boost final yields in those areas of Texas, Oklahoma, Kansas and Nebraska. However, the drought persisted in most areas of western Texas, eastern Colorado, western Nebraska, Wyoming and all of South Dakota.

Montana found some drought relief during the spring and summer, but that precipitation was accompanied by large areas of severe weather and hail during multiple storms. As a result, losses due to these storms were reported in many wheat producing areas of Montana ranging in magnitude from 30% to 50% of the crop. Many areas of northern Montana also experienced below normal temperatures during the final stages of maturity which significantly delayed HRW harvest.

Overall, these conditions significantly affected not only the final yield from all production regions (below average), but also had an impact on kernel characteristics and quality. Generally, kernels were smaller with lower test weight and thousand kernel weight when considering 2012 or the 5-year average. In contrast, overall protein in wheat and flour significantly exceeded last year and the 5-year average.

Samples and Methods

Sample collection and analysis were conducted in a collaborative effort between the USDA/ARS Hard Winter Wheat Quality Lab, Manhattan, Kansas and Plains Grains, Inc., a private non-profit company designed to do quality testing of the Hard Red Winter Wheat crop. 534 samples were collected from grain elevators when at least 30% of the local harvest was completed in the 12 states of Texas, Oklahoma, Kansas, Colorado, Nebraska, Wyoming, South Dakota, North Dakota, Montana, Washington, Oregon and Idaho.

Official grade and non-grade parameters were determined on each sample. 68 composites were then formed based on production regions and protein ranges of < 11.5%, 11.5% - 12.5%, and >12.5% and milling, dough functionality and bake tests were run on each of the composites. Results by protein ranges were then segregated by export region and reported by tributary as well as overall. Sampling was targeted at testing over 80% of the Hard Red Winter Wheat production in the 12 states referenced above with weighting factors based on production calculated. The analytical methods used to define the reported parameters are described in the Analysis Methods section of this book.

Wheat and Grade Data

The overall composite 2013 HRW crop official grade averaged 49% Grade #1 (Gulf tributary averaging 45% and PNW tributary averaging 56%) when considering all protein levels and weighting for the production. The overall dockage level of 0.6% was slightly above last year's average and the 5-year average of 0.5%.. Total defects of 2.0% are significantly above last year's average of 1.4% and 5-year average of 1.5%. The increase can be attributed to the large area of adverse weather conditions that existed during final the final stages of crop maturity. Foreign material, shrunken and broken, and wheat ash contents were also equal to or exceeding the 5-year average for the same reason. Overall test weight averaged 59.9 lbs/bu (78.8 kg/hl) which is below the 5-year average of 60.8 lbs/bu (79.9 kg/hl) and below the 2012 average of 61.1 lbs/bu (80.4 kg/hl). The overall average thousand kernel weight of 26.0 g is significantly lower than the 2012 average of 29.0 g and the 5-year average of 29.8 g. Average kernel diameter of 2.50 mm was also smaller than the 2012 average of 2.60 mm, but similar to the 5-year average of 2.55 mm. The kernel characteristics were generally uniform across the production region. The average protein of 13.4% is almost a full point above the 2012 average of 12.6% and over a full percentage point above the 5-year average of 12.2%. Protein content splits across the testing region and tributaries were very consistent with approximately 15% of samples being in the < 11.5% protein content category, 25% in the 11.5% – 12.5% category and 60% in the < 12.5% category. Average falling number for this crop was 421 sec, comparable to the 5-year average of 414 sec and indicative of sound wheat.

Flour and Baking Data

The Buhler flour yield overall averaged (76.1%), and while above the 2012 average of 75.2% and significantly above the 5-year average, the difference in the 5-year average is mostly attributable to the instillation of a new tandem Buhler Experimental mill used for testing. The resulting flour ash contents, while higher than desired, are still within acceptable ranges. Protein loss during flour conversion averaged 1.1% (when wheat is converted to 14% mb), this was below the 5-year average of 1.3%. Gluten index values averaged 93.3% which was lower than the 5-year average of 95.1%. The W value of 250 (10-4 J) was comparable to 2012 and the 5-year average. Overall average water absorption (WA) was 59.8% which was higher than the 2012 absorption of 58.9% and is significantly higher than the 5-year average of 57.9%. Farinograph development time and stability were 5.6 min and 12.3 min respectively, and were comparable to 2012 and the 5-year average. Overall loaf volume averaged 860 cc, this was significantly higher than in 2012 (789 cc) and the 5 year average of 804 cc. When evaluating gluten index, W value, water absorption, development time, stability and loaf volume, it would appear there is protein quantity and quality present in the 2013 HRW crop.

Summary

This year's crop can be characterized as one with very good wheat protein that translates into high flour protein which has functionality. Water absorption and loaf volumes are very good and significantly exceed long-term averages. Kernel characteristics are average to slightly below average, but are still well within traditional typical HRW contract specs.

Hard Red Winter Wheat Production Charts

PGI

English Units

Hard Winter Wheat Production (1,000 bu.)	2006	2007	2008	2009	2010	2011	2012	2013	Average
Colorado	39,900	94,000	57,000	98,000	105,750	78,000	83,250	43,500	74,925
Kansas	291,200	283,800	356,000	369,600	360,000	276,500	387,000	328,000	331,513
Montana	82,560	83,220	94,380	89,540	93,600	89,790	81,320	96,750	88,895
North Dakota	7,920	22,250	22,550	26,160	17,600	13,875	38,500	13,440	20,287
Nebraska	61,200	84,280	73,480	76,800	64,070	65,250	55,440	41,760	65,285
Oklahoma	81,600	98,000	166,500	77,000	120,900	70,400	155,400	115,500	110,663
Pacific NW	19,368	17,841	16,246	16,194	19,869	22,004	37,990	35,330	23,105
South Dakota	41,400	95,040	103,950	64,260	63,700	66,780	62,400	25,350	65,360
Texas	33,600	140,600	99,000	61,250	127,500	49,400	91,450	64,000	83,350
Wyoming	3,645	3,250	3,780	5,016	4,640	4,420	3,000	2,640	3,799
Regional Total	662,393	922,281	992,886	883,820	977,629	736,419	995,750	766,270	867,181

Hard Winter Wheat Harvested Acres (1,000 Acres)	2006	2007	2008	2009	2010	2011	2012	2013	Average
Colorado	1,900	2,350	1,900	2,450	2,350	2,000	2,250	1,500	2,088
Kansas	9,100	8,600	8,900	8,800	8,000	7,900	9,000	8,200	8,563
Montana	1,920	2,190	2,420	2,420	1,950	2,190	2,140	2,150	2,173
North Dakota	180	445	550	545	320	375	700	320	429
Nebraska	1,700	1,960	1,670	1,600	1,490	1,450	1,320	1,160	1,544
Oklahoma	3,400	3,500	4,500	3,500	3,900	3,200	4,200	3,500	3,713
Pacific NW	299	294	258	276	289	293	535	530	347
South Dakota	1,150	1,980	1,890	1,530	1,300	1,590	1,300	650	1,424
Texas	1,400	3,800	3,300	2,450	3,750	1,900	2,950	2,000	2,694
Wyoming	135	125	135	132	145	130	120	120	130
Regional Total	21,184	25,244	25,523	23,703	23,494	21,028	24,515	20,130	23,103

Hard Winter Wheat Yield (bu/ac)	2006	2007	2008	2009	2010	2011	2012	2013	Average
Colorado	21	40	30	40	45	39	37	29	35
Kansas	32	33	40	42	45	45	43	40	40
Montana	43	38	39	37	48	41	38	45	41
North Dakota	44	50	41	48	55	37	55	42	47
Nebraska	36	43	44	48	43	45	42	36	42
Oklahoma	24	28	37	22	31	22	37	33	29
Pacific NW	60	59	57	58	68	76	75	68	65
South Dakota	36	48	55	42	49	42	48	39	45
Texas	24	37	30	25	34	26	31	32	30
Wyoming	27	26	28	38	32	34	25	22	29
Regional Total	35	40	40	40	45	41	43	39	40

*** Some data derived from Crop Production report issued by USDA NASS updated September 30, 2013.*

Hard Red Winter Wheat Production Charts

Metric Units

Hard Winter Wheat Production (MMT)

	2006	2007	2008	2009	2010	2011	2012	2013	Average
Colorado	1.09	2.56	1.55	2.67	2.88	2.12	2.27	1.18	2.04
Kansas	7.93	7.72	9.69	10.06	9.80	7.53	10.53	8.93	9.02
Montana	2.25	2.27	2.57	2.44	2.55	2.44	2.21	2.63	2.42
North Dakota	0.22	0.61	0.61	0.71	0.48	0.38	1.05	0.37	0.55
Nebraska	1.67	2.29	2.00	2.09	1.74	1.78	1.51	1.14	1.78
Oklahoma	2.22	2.67	4.53	2.10	3.29	1.92	4.23	3.14	3.01
Pacific NW	0.53	0.49	0.44	0.44	0.54	0.60	1.03	0.96	0.63
South Dakota	1.13	2.59	2.83	1.75	1.73	1.82	1.70	0.69	1.78
Texas	0.91	3.83	2.69	1.67	3.47	1.34	2.49	1.74	2.27
Wyoming	0.10	0.09	0.10	0.14	0.13	0.12	0.08	0.07	0.10
Regional Total	18.03	25.10	27.02	24.06	26.61	20.04	27.10	20.86	23.60

Hard Winter Wheat Harvested Acres (1,000 ha)

	2006	2007	2008	2009	2010	2011	2012	2013	Average
Colorado	769	951	769	992	951	810	911	607	845
Kansas	3,684	3,482	3,603	3,563	3,239	3,198	3,644	3,320	3,467
Montana	777	887	980	980	789	887	866	870	880
North Dakota	73	180	223	221	130	152	283	130	174
Nebraska	688	794	676	648	603	587	534	470	625
Oklahoma	1,377	1,417	1,822	1,417	1,579	1,296	1,700	1417	1,503
Pacific NW	121	119	104	112	117	119	217	215	140
South Dakota	466	802	765	619	526	644	526	263	576
Texas	567	1,538	1,336	992	1,518	769	1,194	810	1,091
Wyoming	55	51	55	53	59	53	49	49	53
Regional Total	8,577	10,220	10,333	9,596	9,512	8,513	9,925	8,150	9,353

Hard Winter Wheat Yield (tons/ha)

	2006	2007	2008	2009	2010	2011	2012	2013	Average
Colorado	1.41	2.69	2.02	2.69	3.03	2.62	2.49	1.95	2.36
Kansas	2.15	2.22	2.69	2.82	3.03	3.03	2.89	2.69	2.69
Montana	2.89	2.56	2.62	2.49	3.23	2.76	2.56	3.03	2.77
North Dakota	2.96	3.36	2.76	3.23	3.70	2.49	3.70	2.82	3.13
Nebraska	2.42	2.89	2.96	3.23	2.89	3.03	2.82	2.42	2.83
Oklahoma	1.61	1.88	2.49	1.48	2.08	1.48	2.49	2.22	1.97
Pacific NW	4.04	3.97	3.83	3.90	4.57	5.11	5.04	4.57	4.38
South Dakota	2.42	3.23	3.70	2.82	3.30	2.82	3.23	2.62	3.02
Texas	1.61	2.49	2.02	1.68	2.29	1.75	2.08	2.15	2.01
Wyoming	1.82	1.75	1.88	2.56	2.15	2.29	1.68	1.48	1.95
Regional Average	2.33	2.70	2.70	2.69	3.03	2.74	2.90	2.60	2.71

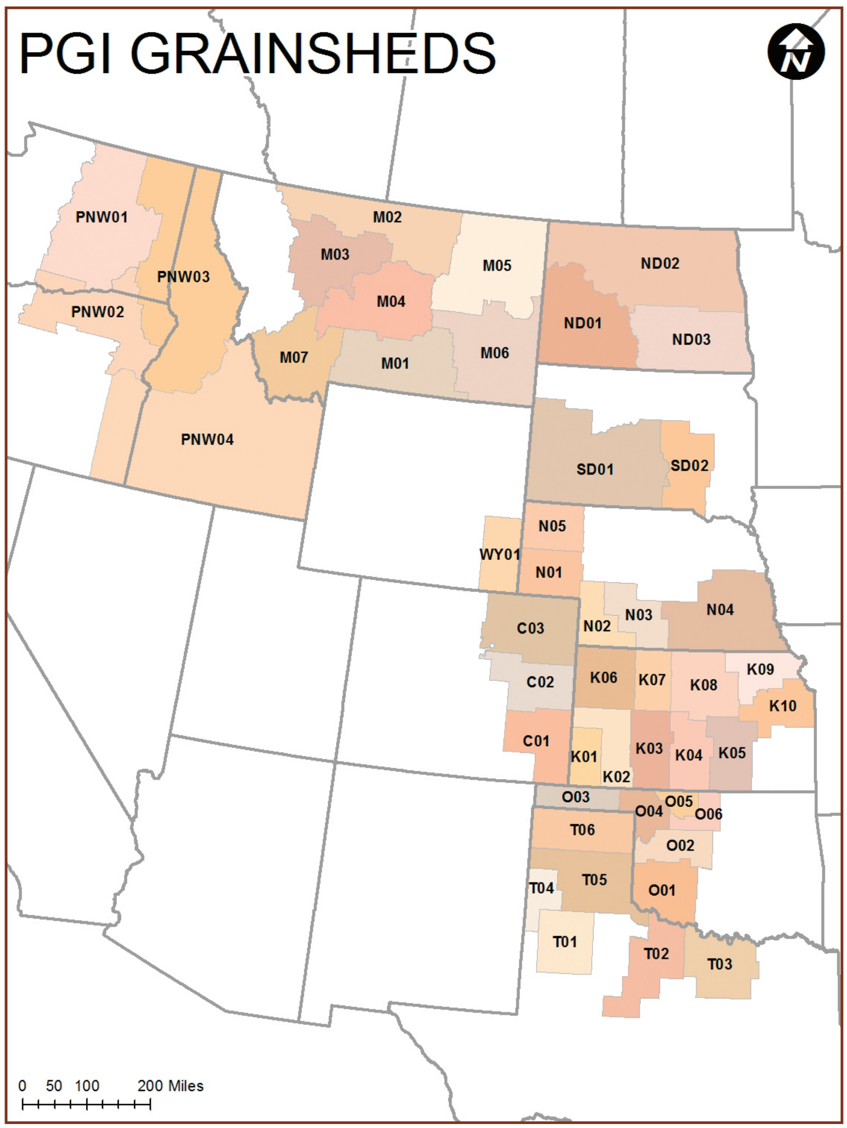
*** Some data derived from Crop Production report issued by USDA NASS updated September 30, 2013.*

Survey Methodology

Plains Grains Inc. (PGI) is an Oklahoma-based regional wheat marketing entity that has designed a wheat quality survey to provide end-use quality information to the U.S. wheat buyer. PGI facilitates collection and testing of wheat samples at harvest in order to provide data that specifically describes the quality of U.S. wheat.

PGI facilitates quality testing on a "grainshed" basis. Grainsheds are defined by identifying key loading facilities and outlining the production region which contributes to that facility's grain supply. By defining the production areas in this manner, PGI's survey is able to more accurately represent and determine the quality of wheat that will come from a specific regional terminal, thereby giving buyers a truer picture of the product available to compose a shipment of HRW wheat.

The quality of wheat originating from a grainshed is determined by pulling samples from country and terminal elevators located within each defined grainshed. These samples are then immediately sent to the USDA, ARS Hard Winter Wheat Quality Lab in Manhattan, Kan., where they are analyzed and tested for more than 25 quality parameters. Official grade is determined at the Federal Grain Inspection Service office in Enid, Oklahoma.



Wheat Grading Characteristics

The Federal Grain Inspection Service (FGIS) of the USDA Grain Inspection, Packers and Stockyards Administration (GIPSA) sets the standard for U.S. grain grades and grade requirements. U.S. grain grades are reflective of the general quality and condition of a representative sample of U.S. wheat. These grades are based on characteristics such as test weight and include limits on damaged kernels, foreign material, shrunken and broken kernels, and wheat of contrasting classes. Each determination is made on the basis of the grain free of dockage. Grades issued under U.S. standards represent a sum of these factors.

Official U.S. Grades and Grade Requirements

Grading Factors	Grades				
	No. 1	No. 2	No. 3	No. 4	No. 5
Hard Red Winter – Minimum Test Weights					
LB/BU	60.0	58.0	56.0	54.0	51.0
Maximum Percent Limits Of:					
DEFECTS					
Damaged Kernels					
Heat (part total)	0.2	0.2	0.5	1.0	3.0
Total	2.0	4.0	7.0	10.0	15.0
Foregin Material	0.4	0.7	1.3	3.0	5.0
Shrunken and Broken Kernels	3.0	5.0	8.0	12.0	20.0
Total*	3.0	5.0	8.0	12.0	20.0
WHEAT OF OTHER CLASSES**					
Contrasting classes	1.0	2.0	3.0	10.0	10.0
Total***	3.0	5.0	10.0	10.0	10.0
Stones	0.1	0.1	0.1	0.1	0.1
Maximum Count Limits Of:					
OTHER MATERIAL (1,000 gram sample)					
Animal Filth	1	1	1	1	1
Castor Beans	1	1	1	1	1
Crotalaria Seeds	2	2	2	2	2
Glass	0	0	0	0	0
Stones	3	3	3	3	3
Unkown Foregin Substance	3	3	3	3	3
Total****	4	4	4	4	4
INSECT DAMAGED KERNELS (in 100 grams)	31	31	31	31	31

Note: U.S. Sample grade is wheat that:
(a) Does not meet the requirements for U.S. Nos. 1, 2, 3, 4, or 5; or
(b) Has a musty, sour, or commercially obkectionable foregin odor (except smut or garlic); or
(c) Is heating or of distinctly low quality.

*Includes damaged kernels (total), foregin materials, and shurken and broken kernels.
**Unclassed wheat of any grade may contain not more than 10.0 percent of wheat of other classes.
***Includes contrasting classes.
****Includes any combination of animal filth, castor beans, crotalaria seeds, glass, stones, or unknown forgin substance.

Wheat Grading Data

Each determination of heat-damaged kernels, damaged kernels, foreign material, wheat of other classes, contrasting classes, and subclasses is made on the basis of the grain when free from dockage and shrunken and broken kernels.

Defects are damaged kernels, foreign materials, and shrunken and broken kernels. The sum of these three factors may not exceed the limit for the factor defects for each numerical grade.

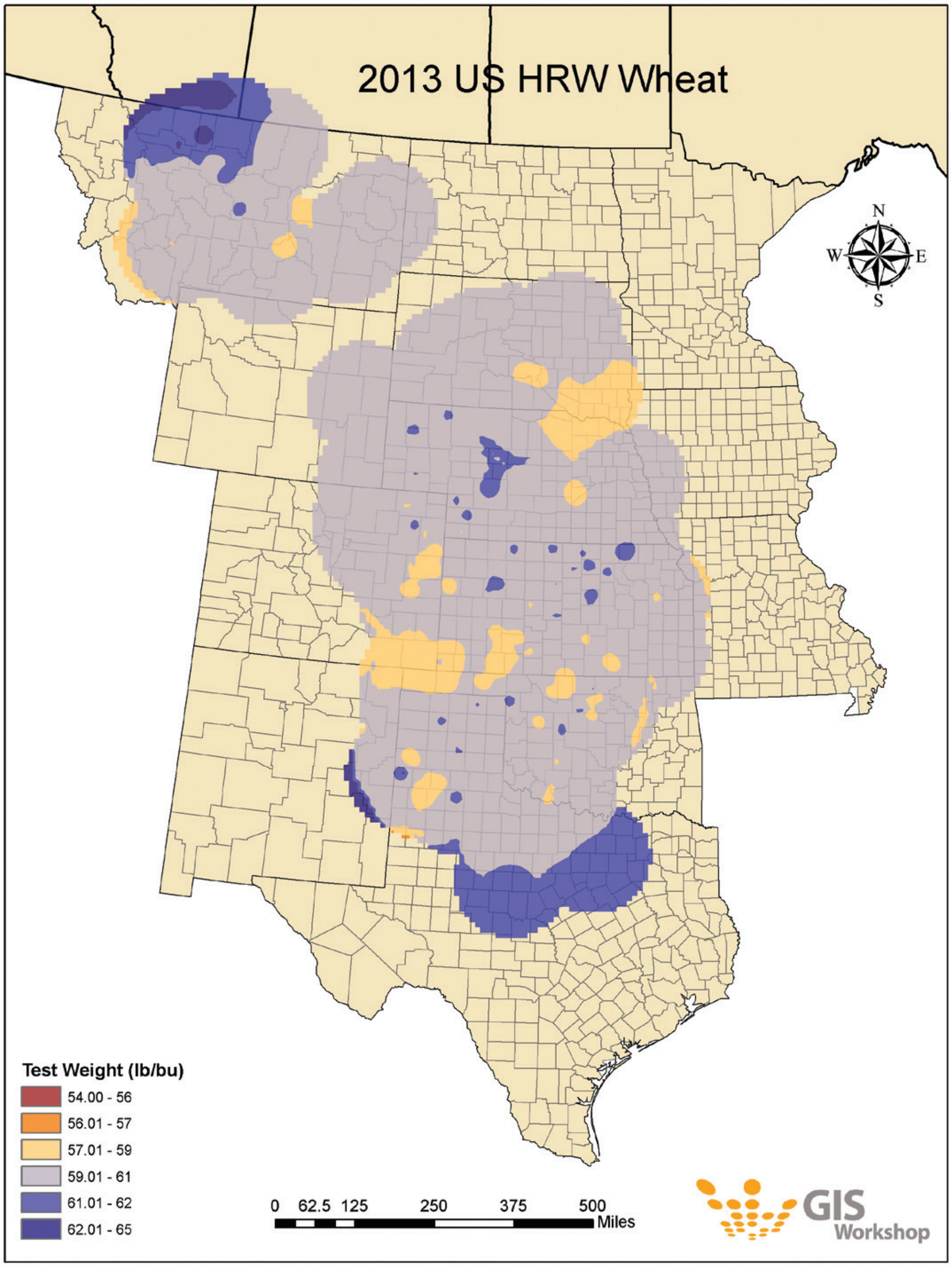
Foreign material is all matter other than wheat that remains in the sample after the removal of dockage and shrunken and broken kernels.

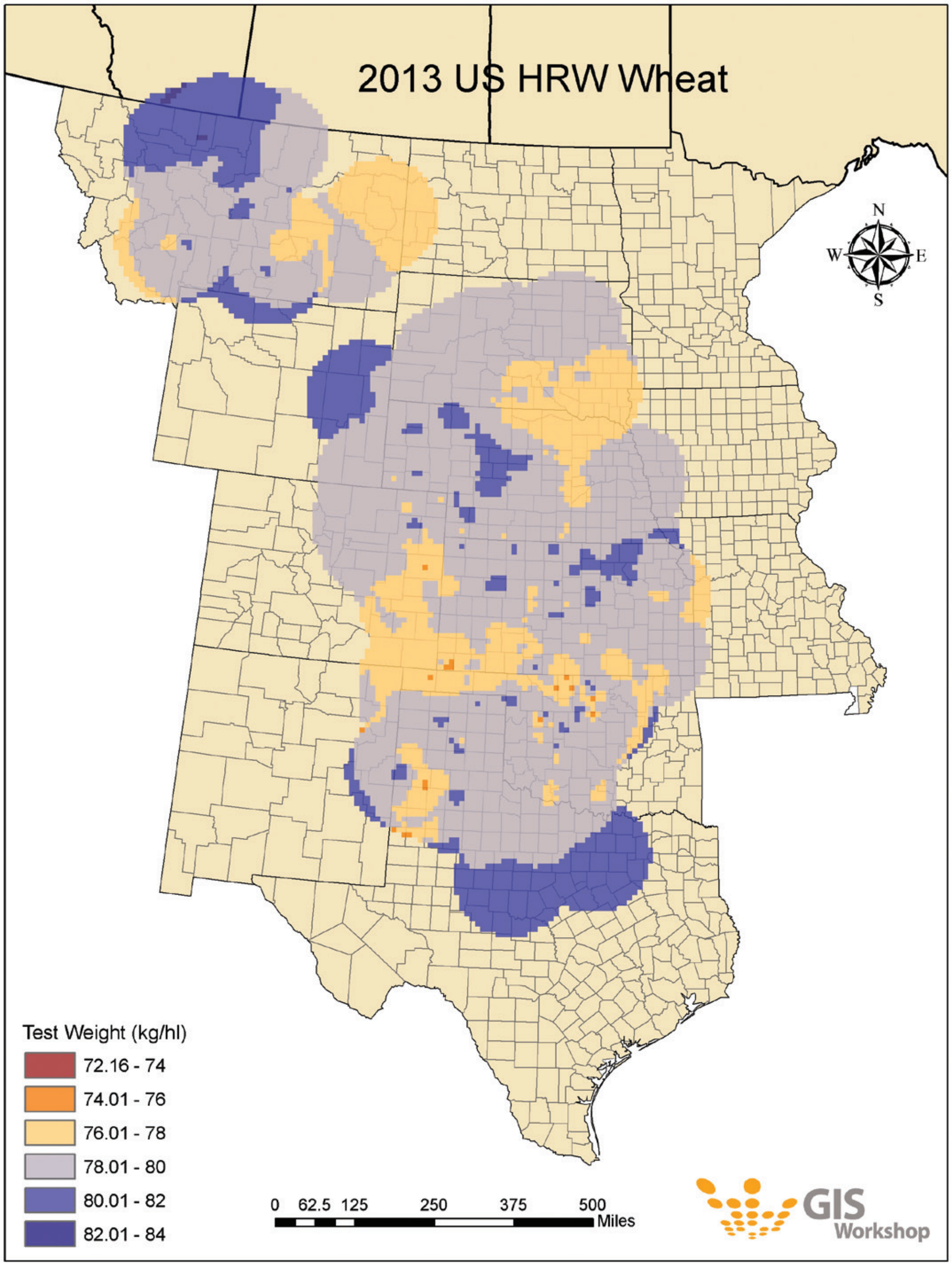
Shrunken and broken kernels are all matter that passes through a 0.064 x 3/8-inch oblong-hole sieve after sieving according to procedures prescribed in the FGIS instructions.

Damaged kernels are kernels, pieces of wheat kernels, and other grains that are badly ground-damaged, badly weatherdamaged, diseased, frost-damaged, germdamaged, heat-damaged, insect-bored, mold-damaged, sprout-damaged, or otherwise materially damaged.

Test Weight is a measure of the density of the sample and may be an indicator of milling yield and the general condition of the sample, as problems that occur during the growing season or at harvest often reduce test weight.

Test Weight (lb/bu)





2013 US HRW Wheat
N
W
E
S
Test Weight (kg/hl)
72.16 - 74
74.01 - 76
76.01 - 78
78.01 - 80
80.01 - 82
82.01 - 84
0 62.5 125 250 375 500
Miles
GIS
Workshop

Wheat Grading Data

PGI

Location		Official Grade (U.S. NO.)	Test Wt (lb/bu)	Test Wt (kg/hl)	Dockage (%)	Damage Kernels Total (%)	Shrunken & Broken Kernels (%)	Total Defects (%)
Colorado	C01	2	59.2	77.9	0.4	0.0	1.2	1.3
	C02	2	59.3	78.0	0.6	0.1	1.7	1.9
	C03	2	59.9	78.8	0.5	0.1	1.6	1.9
Kansas	K01	2	59.7	78.6	1.0	0.2	2.6	2.9
	K02	2	59.3	78.1	0.4	0.2	1.8	2.0
	K03	2	59.5	78.3	0.4	0.1	2.1	2.3
	K04	1	60.1	79.0	0.4	0.1	1.9	2.3
	K05	2	59.4	78.2	0.9	0.2	2.1	2.5
	K06	1	60.3	79.3	0.5	0.2	1.6	1.9
	K07	1	60.3	79.4	0.3	0.3	1.6	2.0
	K08	1	60.8	80.0	0.5	0.2	1.4	1.7
	K09	1	61.3	80.6	0.1	0.1	1.1	1.2
	K10	1	60.0	79.0	1.0	0.7	1.2	2.0
Montana	M01	2	59.8	78.6	0.9	0.0	1.4	1.5
	M02	1	61.6	81.0	0.6	0.1	1.0	1.2
	M03	1	60.9	80.2	0.7	0.1	1.4	1.6
	M04	1	60.6	79.8	0.6	0.0	1.2	1.2
	M05	2	59.1	77.8	0.4	0.2	2.4	2.7
	M06	2	59.4	78.2	1.4	0.2	0.5	0.9
	M07	1	60.0	78.9	1.0	0.4	2.4	2.9
Nebraska	N01	1	60.2	79.3	0.5	0.2	1.1	1.7
	N02	1	60.6	79.7	0.4	0.1	1.5	1.7
	N03	2	59.9	78.8	0.4	0.1	1.1	1.4
	N04	2	59.7	78.6	0.7	0.3	1.4	1.8
	N05	1	60.9	80.1	0.7	0.2	1.1	1.5
North Dakota	ND01	2	58.9	77.5	1.0	1.0	1.0	2.2
	ND02	1	60.5	79.5	0.9	1.4	1.0	2.6
	ND03	1	60.0	78.9	0.7	0.7	1.1	1.9
Oklahoma	O01	2	59.8	78.7	0.8	0.2	1.7	2.1
	O02	2	60.5	79.6	0.6	0.2	1.7	2.4
	O03	2	58.3	76.8	0.8	0.2	2.0	2.4
	O04	2	59.9	78.8	0.8	0.5	0.9	1.1
	O05	2	58.7	77.3	0.9	0.1	2.3	2.7
	O06	1	60.1	79.0	0.8	0.2	1.9	2.4
	O07	2	58.3	76.7	0.2	0.1	2.0	2.3
Pacific Northwest	PNW01	1	61.2	80.4	0.3	0.0	0.7	0.8
	PNW02	1	62.4	82.1	0.4	0.0	0.8	0.9
	PNW03	1	61.9	81.4	0.5	0.1	0.6	0.7
	PNW04	1	61.5	80.9	0.4	0.0	1.2	1.2
South Dakota	SD01	2	59.3	78.0	0.8	0.6	1.2	2.0
	SD02	2	59.1	77.8	0.5	0.6	1.2	2.0
Texas	T01	2	58.9	77.5	0.7	0.2	2.8	3.3
	T02	1	60.1	79.0	0.5	0.0	2.1	2.2
	T03	2	61.9	81.4	0.6	0.3	3.1	3.5
	T04	2	59.8	78.6	0.6	0.1	2.2	2.4
	T05	2	59.7	78.6	0.8	0.3	2.0	2.5
	T06	1	60.3	79.4	0.4	0.2	1.7	2.0
Wyoming	W01	2	60.1	79.1	0.5	0.1	1.1	1.8

Kernel Quality Data

Location		Foreign Material (%)	Kernel Size Large (%)	Kernel Size Med (%)	Kernel Size Small (%)	Thousand Kernel Wt (g)	SKCS Avg Diam (mm)
Colorado	C01	0.1	30	67	3	24.3	2.38
Colorado	C02	0.1	40	58	2	24.7	2.42
Colorado	C03	0.2	46	51	3	25.7	2.45
Kansas	K01	0.1	33	63	5	23.4	2.41
Kansas	K02	0.1	33	64	3	23.4	2.41
Kansas	K03	0.1	34	63	3	23.9	2.43
Kansas	K04	0.3	39	59	2	24.6	2.47
Kansas	K05	0.2	47	51	3	24.8	2.49
Kansas	K06	0.1	42	56	2	25.5	2.49
Kansas	K07	0.1	41	57	2	24.7	2.47
Kansas	K08	0.2	43	54	2	25.0	2.47
Kansas	K09	0.0	51	47	1	26.0	2.52
Kansas	K10	0.2	54	44	2	26.0	2.56
Montana	M01	0.1	58	41	1	28.0	2.59
Montana	M02	0.1	62	37	1	28.8	2.57
Montana	M03	0.1	57	41	2	27.5	2.55
Montana	M04	0.0	46	51	2	25.6	2.49
Montana	M05	0.1	44	53	3	24.7	2.44
Montana	M06	0.2	69	30	1	29.9	2.58
Montana	M07	0.1	35	59	6	24.0	2.41
Nebraska	N01	0.4	60	39	1	28.0	2.54
Nebraska	N02	0.1	54	44	1	27.1	2.52
Nebraska	N03	0.1	53	45	1	26.6	2.51
Nebraska	N04	0.1	48	50	2	25.9	2.48
Nebraska	N05	0.2	68	31	1	30.1	2.63
North Dakota	ND01	0.2	59	40	1	29.3	2.59
North Dakota	ND02	0.2	68	31	1	31.2	2.68
North Dakota	ND03	0.1	57	41	2	28.6	2.58
Oklahoma	O01	0.2	36	61	3	24.1	2.44
Oklahoma	O02	0.5	46	52	2	25.1	2.52
Oklahoma	O03	0.1	32	64	4	23.1	2.39
Oklahoma	O04	0.1	35	62	3	23.8	2.42
Oklahoma	O05	0.3	37	60	3	23.4	2.44
Oklahoma	O06	0.2	46	51	3	25.3	2.51
Oklahoma	O07	0.2	40	57	3	24.6	2.47
Pacific Northwest	PNW01	0.0	77	22	1	33.7	2.79
Pacific Northwest	PNW02	0.1	73	27	0	33.1	2.79
Pacific Northwest	PNW03	0.0	83	17	0	36.0	2.84
Pacific Northwest	PNW04	0.1	69	28	1	31.3	2.74
South Dakota	SD01	0.2	56	42	2	28.5	2.58
South Dakota	SD02	0.2	57	42	1	28.1	2.58
Texas	T01	0.2	33	62	5	22.8	2.40
Texas	T02	0.1	31	65	4	24.0	2.43
Texas	T03	0.1	36	61	4	24.9	2.49
Texas	T04	0.1	39	58	3	23.0	2.43
Texas	T05	0.3	40	57	3	23.9	2.45
Texas	T06	0.1	43	54	3	24.4	2.47
Wyoming	W01	0.7	53	45	2	26.7	2.50

Other Wheat Characteristics

In addition to the U.S. grade factors, there are other characteristics at work to determine the value of the wheat. Examples include dockage, wheat moisture, wheat protein content, thousand-kernel weight (TKW), and falling number.

Moisture content is an indicator of grain condition and storability. Wheat or flour with low moisture content is more stable during storage. Moisture content is often standardized (12 or 14 percent moisture basis) for other tests that are affected by moisture content.

Protein content relates to many important processing properties, such as water absorption and gluten strength, and to finished product attributes such as texture and appearance. Higher protein dough usually absorbs more water and takes longer to mix. HRW wheat generally has a medium to high protein content, making it most suitable for allpurpose flour and chewy-texture breads.

Ash content also indicates milling performance and how well the flour separates from the bran. Millers need to know the overall mineral content of the wheat to achieve desired or specified ash levels in flour. Ash content can affect flour color. White flour has low ash content, which is often a high priority among millers.

Thousand-kernel weight and kernel diameter provide measurements of kernel size and density important for milling quality. Simply put, it measures the mass of the wheat kernel. Millers tend to prefer larger berries, or at least berries with a consistent size. wheat with a higher TKW can be expected to have a greater potential flour extraction.

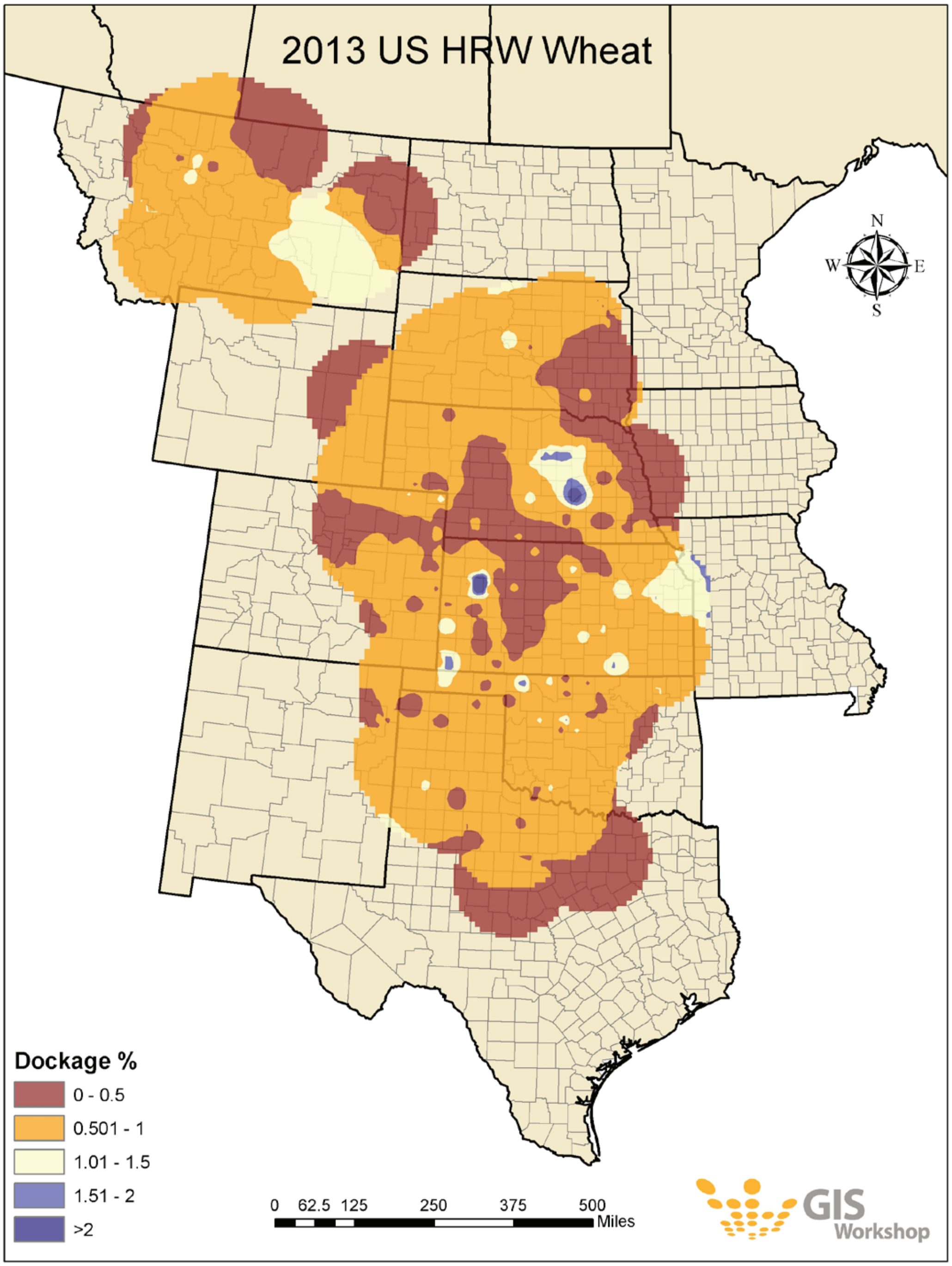
Falling number is an index of enzyme activity in wheat or flour and is expressed in seconds. Falling numbers above 300 are desirable, as they indicate little enzyme activity and a sound quality product. Falling numbers below 300 are indicative of more substantial enzyme activity and sprout damage.

Dockage is all matter other than wheat that can be removed from the original sample by use of an approved device according to procedures prescribed in FGIS instructions.

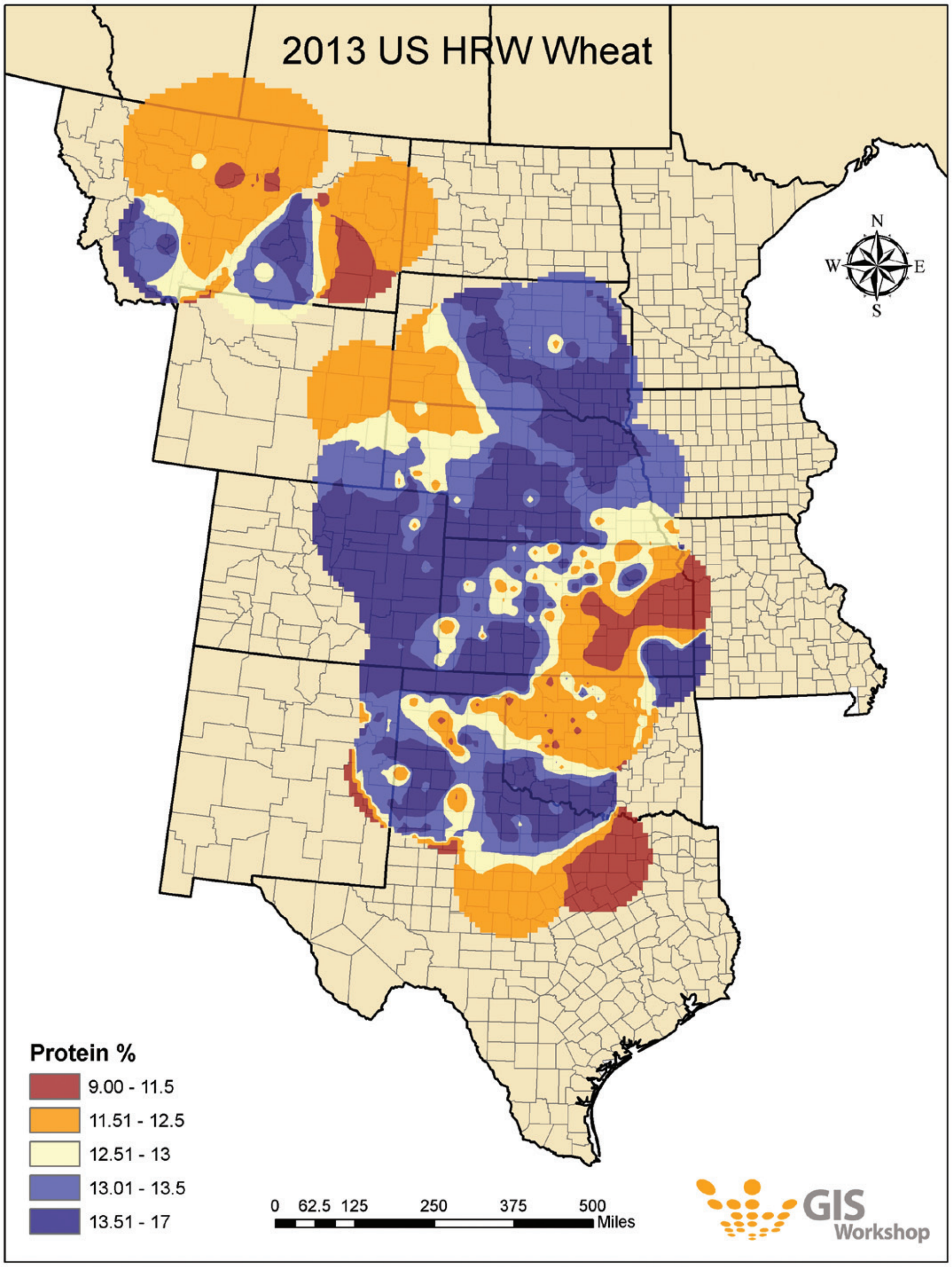
Kernel Size is a measure of the percentage by weight of large, medium and small kernels in a sample. Large kernels or more uniform kernel size may help improve milling yield.

Single Kernel Characterization System (SKCS) measures 300 individual kernels from a sample for size (diameter), weight, hardness (based on the force needed to crush) and moisture.

Dockage (%)

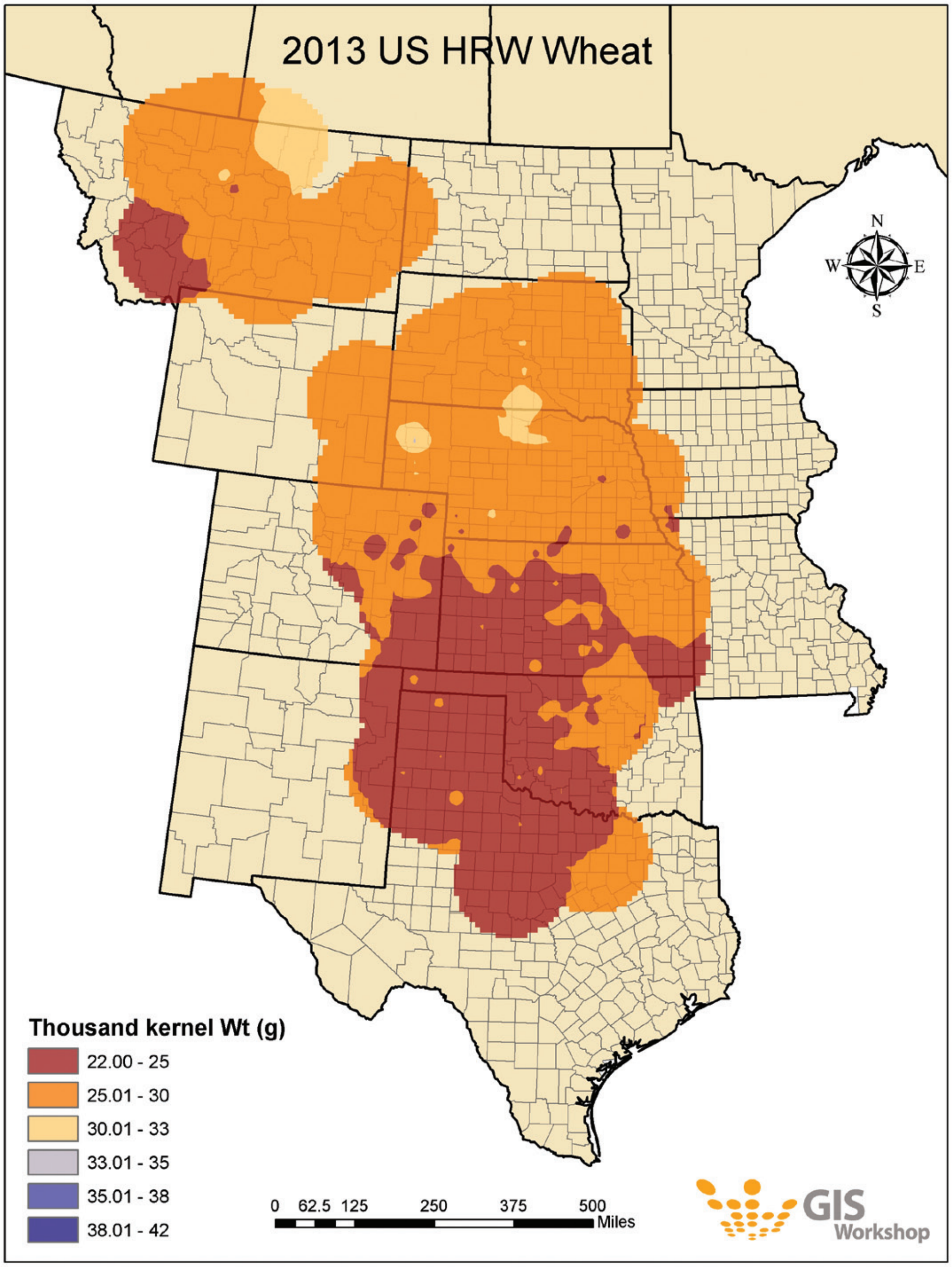

2013 US HRW Wheat
N
W
E
S
Dockage %
0 - 0.5
0.501 - 1
1.01 - 1.5
1.51 - 2
>2
0 62.5 125 250 375 500
Miles
GIS
Workshop

Protein (%)

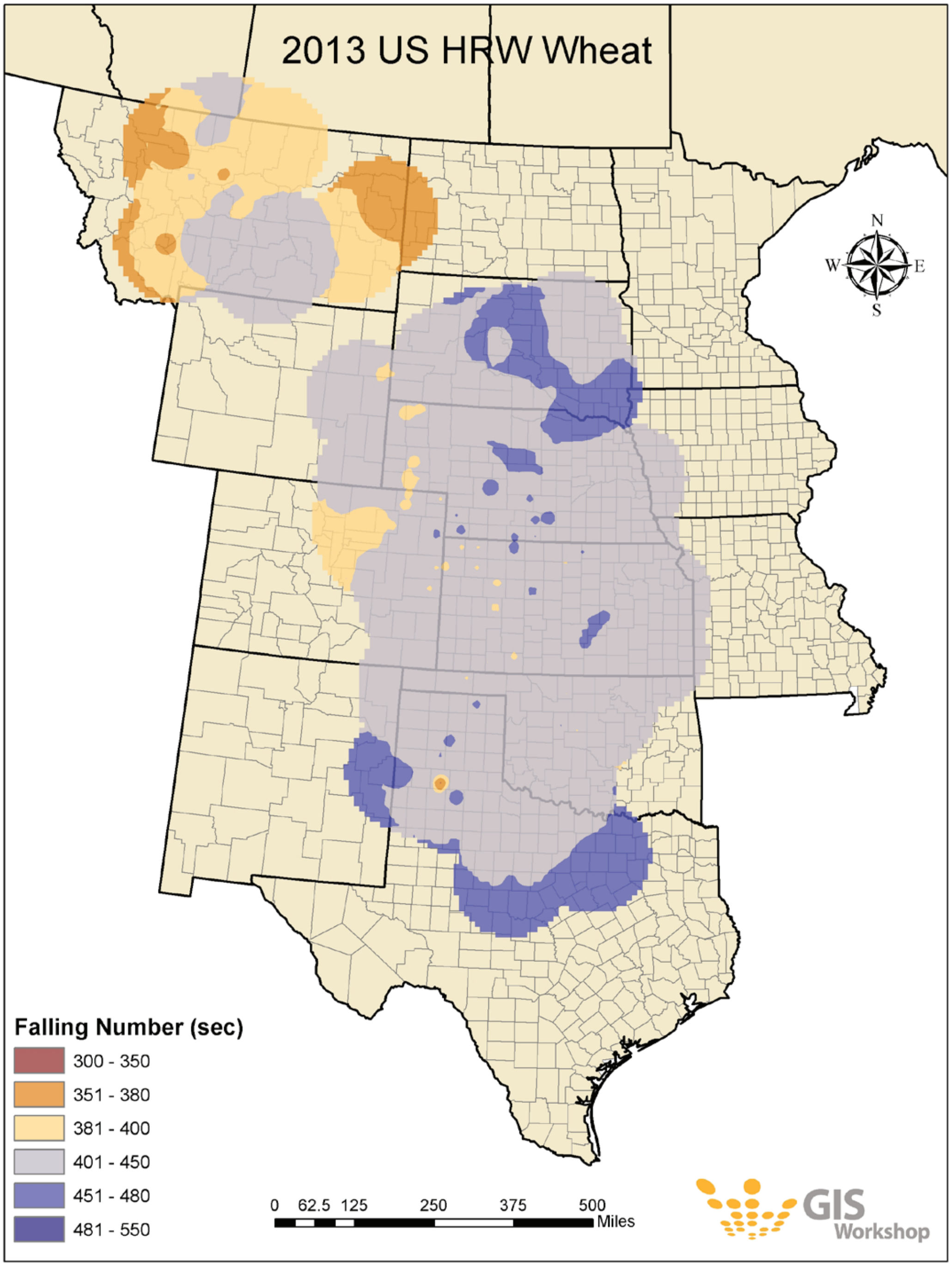


2013 US HRW Wheat
N
W
E
S
Protein %
9.00 - 11.5
11.51 - 12.5
12.51 - 13
13.01 - 13.5
13.51 - 17
0 62.5 125 250 375 500
Miles
GIS
Workshop

Thousand Kernel Weight (g)



Falling Number (seconds)



Other Wheat Characteristics (non-grade data)

PGI

Location		NIR Wheat Protein (12% mb)	Indv Wheat Ash (12% mb)	Falling Number (sec)	Moisture (%)	SKCS Ave Hard
Colorado	C01	14.0	1.58	420	11.2	66
	C02	14.0	1.67	417	11.3	68
	C03	14.0	1.56	412	11.3	65
Kansas	K01	13.3	1.77	434	11.1	72
	K02	14.3	1.66	416	9.9	73
	K03	14.3	1.62	417	10.2	69
	K04	13.3	1.58	432	10.6	68
	K05	11.6	1.67	448	11.1	65
	K06	14.5	1.65	405	10.1	73
	K07	13.1	1.60	430	10.0	70
	K08	13.6	1.66	424	10.5	71
	K09	12.2	1.64	443	10.9	68
	K10	12.3	1.64	418	10.6	65
Montana	M01	12.8	1.51	431	11.9	72
	M02	11.8	1.41	401	12.5	69
	M03	12.3	1.46	386	12.1	70
	M04	11.9	1.45	404	12.9	72
	M05	13.9	1.54	409	12.5	71
	M06	11.5	1.31	399	12.8	55
	M07	14.2	1.52	395	11.4	73
Nebraska	N01	12.9	1.52	405	12.3	59
	N02	14.1	1.57	441	11.2	64
	N03	14.0	1.64	436	11.6	63
	N04	14.1	1.71	434	11.5	66
	N05	12.4	1.53	418	12.8	59
North Dakota	ND01	14.7	1.57	417	12.7	57
	ND02	13.7	1.61	399	13.4	64
	ND03	14.3	1.66	443	13.5	66
Oklahoma	O01	13.9	1.65	423	11.6	73
	O02	11.7	1.62	428	10.9	72
	O03	15.3	1.79	420	10.3	73
	O04	15.1	1.72	432	10.1	66
	O05	12.4	1.60	420	11.3	70
	O06	12.6	1.56	421	11.6	73
	O07	13.3	1.57	440	11.2	68
Pacific Northwest	PNW01	12.7	1.52	375	8.7	71
	PNW02	13.9	1.38	362	8.0	70
	PNW03	11.5	1.28	384	9.0	62
	PNW04	13.1	1.62	393	8.2	74
South Dakota	SD01	13.8	1.76	450	13.4	64
	SD02	13.8	1.80	452	13.6	63
Texas	T01	13.8	1.80	426	10.5	70
	T02	13.8	1.67	422	10.6	75
	T03	11.7	1.63	484	10.3	74
	T04	13.8	1.74	454	10.3	72
	T05	14.5	1.79	438	9.9	73
	T06	12.7	1.73	429	10.4	70
Wyoming	W01	13.3	1.46	423	13.6	59

Flour Characteristics

Flour is analyzed for indicators of milling efficiency and functionality properties. These include: flour yield, ash content, falling number and flour protein.

Flour yield is expressed as a percentage and represents the portion of the wheat kernel that can be milled into flour, which is a significant indicator of milling profitability. Millers need to know the mineral content in wheat to achieve the desired ash levels in flour.

Ash content is an indication of how well flour separates from the bran. Flour ash is expressed as a percentage of the initial sample weight, and is usually expressed on a 14 percent moisture basis.

Flour falling number is an index of undesirable enzyme activity that normally occurs when the kernel sprouts or germinates. A high falling number indicates minimal activity, whereas a low falling number indicates more substantial enzyme activity. Too much activity means that too much sugar and too little starch are present in the flour. Starch provides the supporting structure of bread, so high activity results in sticky dough and poor texture in the finished product.

Wet Gluten Index is a measurement that indicates whether the gluten is weak, normal or strong. A weak gluten would be represented by a gluten index of 0 and the strongest gluten index is 100.

Minolta Color results are reported with the values L*, a*, and b*. L* ranges from 100 (white) to 0 (black) a* ranges from +60 (red) to -60 (green) b* ranges from +60 (yellow) to -60 (blue).

Flour Data

Location		Buhler Flour Yield (%)	Zeleny Sedimen Test (cc)	NIR Flour Protein (14% mb)	Flour Ash (14% mb)	Gluten Index	Flour Color L*	Flour Color a*	Flour Color b*
Colorado	C01	69.4	54.5	13.2	0.57	94.3	90.9	-1.6	10.0
	C02	77.5	57.6	12.7	0.60	93.3	91.1	-1.9	10.1
	C03	75.4	58.6	13.1	0.63	87.3	90.7	-1.7	10.2
Kansas	K01	74.7	51.6	12.5	0.69	94.9	90.4	-1.2	10.5
	K02	76.2	51.4	13.1	0.67	94.8	90.8	-2.0	10.8
	K03	76.7	51.7	13.0	0.63	94.1	90.5	-1.9	10.7
	K04	75.9	48.4	12.9	0.61	83.9	90.7	-1.9	10.8
	K05	78.8	36.4	10.5	0.67	93.9	90.0	-1.8	11.2
	K06	76.9	54.3	13.2	0.61	91.6	90.6	-2.0	10.9
	K07	75.6	46.0	11.8	0.63	93.8	91.1	-2.1	10.9
	K08	77.2	50.9	12.6	0.66	93.7	90.4	-1.8	10.8
	K09	78.1	40.6	10.8	0.64	76.7	90.4	-1.8	10.9
	K10	77.7	41.4	11.2	0.62	94.7	90.9	-2.1	10.7
Montana	M01	75.2	65.7	11.6	0.51	95.5	91.2	-1.8	9.8
	M02	75.1	59.9	10.6	0.44	97.3	91.7	-2.2	9.7
	M03	75.5	58.0	11.2	0.52	97.0	91.4	-2.1	10.0
	M04	74.8	57.8	10.7	0.51	98.9	91.6	-2.0	10.2
	M05	75.7	62.4	11.1	0.48	97.2	91.1	-1.9	10.0
	M06	77.6	57.7	10.5	0.45	98.5	91.5	-2.1	10.4
	M07	76.8	66.6	12.9	0.53	97.2	90.7	-1.9	10.9
Nebraska	N01	78.5	49.2	11.7	0.64	98.1	90.6	-1.7	9.8
	N02	77.9	55.9	13.0	0.58	94.2	90.7	-1.7	10.2
	N03	76.6	52.0	13.0	0.61	94.6	90.8	-1.7	10.1
	N04	76.5	50.4	12.7	0.60	93.1	90.9	-1.8	10.3
	N05	75.4	47.8	11.1	0.49	91.7	91.4	-2.0	9.8
North Dakota	ND01	74.2	63.5	12.3	0.51	96.6	90.9	-1.8	9.4
	ND02	75.4	64.6	12.3	0.56	95.5	91.0	-1.8	9.3
	ND03	77.0	51.8	12.5	0.58	96.2	90.2	-1.8	9.9
Oklahoma	O01	76.5	52.5	13.0	0.66	87.8	90.8	-1.9	10.8
	O02	76.9	39.3	10.1	0.57	95.5	91.1	-2.2	11.2
	O03	75.5	56.3	14.0	0.71	82.7	90.6	-1.9	10.8
	O04	75.6	65.5	15.1	0.60	84.3	90.4	-1.8	10.7
	O05	75.6	47.1	11.9	0.60	97.8	91.0	-2.2	11.2
	O06	77.1	44.8	11.4	0.57	98.0	90.8	-2.1	11.2
	O07	76.8	47.2	12.0	0.58	97.2	90.9	-2.0	11.0
Pacific Northwest	PNW01	78.4	50.5	11.9	0.56	98.0	90.2	-1.6	10.1
	PNW02	78.5	65.9	13.0	0.51	96.7	90.6	-1.6	10.0
	PNW03	76.7	43.1	10.0	0.46	96.6	91.1	-1.7	9.6
	PNW04	77.1	46.3	12.2	0.53	91.6	90.7	-1.6	10.0
South Dakota	SD01	77.1	51.7	12.3	0.59	97.0	90.5	-1.8	10.2
	SD02	75.2	51.3	12.3	0.57	90.7	90.4	-1.8	9.9
Texas	T01	73.6	62.8	13.8	0.69	87.8	90.6	-1.8	10.3
	T02	78.8	47.6	12.5	0.64	95.8	91.2	-1.9	10.5
	T03	77.2	32.4	10.6	0.61	96.7	90.9	-1.9	10.2
	T04	76.0	61.3	13.8	0.69	96.0	90.3	-1.8	10.7
	T05	77.4	59.7	13.6	0.67	92.8	90.5	-1.8	10.6
	T06	76.6	44.1	12.2	0.68	87.8	90.5	-1.9	10.8
Wyoming	W01	74.9	63.6	12.1	0.52	96.1	91.4	-2.0	9.7

Dough Characteristics

The strength and mixing properties of dough help the baker determine the value of the flour they purchase. Flour specifications often require specialized testing to determine how flour will perform during processing.

Farinograph testing is one of the most common flour quality tests in the world. Farinograph results are used to determine dough strength and processing requirements.

Absorption is a measurement of the amount of water required for the flour to be optimally processed into the finished product. Peak time indicates the time it takes for the dough to develop from the moment the water is added until maximum consistency is achieved. This measurement is expressed in minutes.

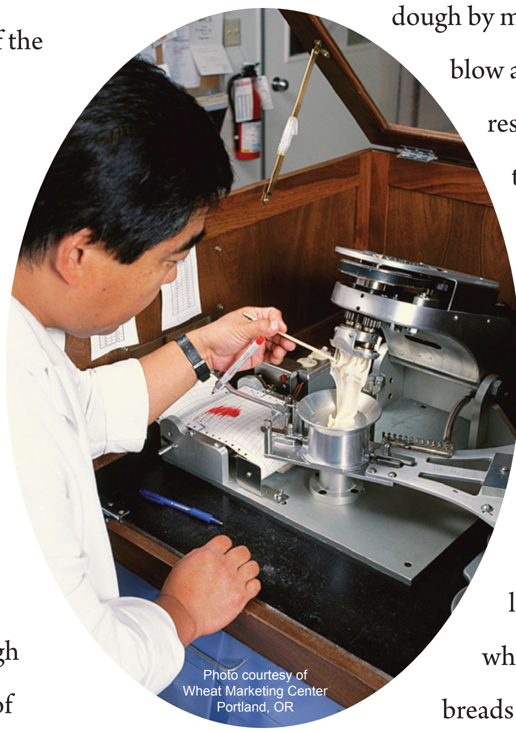


Photo courtesy of
Wheat Marketing Center
Portland, OR

Stability is an indication of dough strength, as it is a measurement of how long the dough maintains maximum consistency. Stability is also expressed in minutes. Weak gluten flour has a lower water absorption and shorter stability time than strong gluten flour.

Peak time represents dough development time by measuring the length of time from the moment water is added until the dough reaches maximum consistency. This measurement indicates optimum mixing time for the dough under standardized conditions.

Mixing Tolerance Index is the resistance of the dough to breakdown during continued mixing. It is the difference in Brabender Unit (BU) value at the top of the curve at peak time and the value at the top of the curve five minutes after the peak. This indicates tolerance to over-mixing and is expressed as a numerical score based on comparison to a control.

Alveograph testing determines the gluten strength of dough by measuring the force required to blow and break a bubble of dough. The results of the test are used by millers to ensure a more consistent product. "P" elates to the force required to blow the bubble of dough; "L" relates to the extensibility of the dough; "W" is a combination of dough strength and extensibility. Weak gluten flour with low P value and long L value is preferred for cakes, where as strong gluten flour used for breads will have a higher P value.

Development Time is the time interval from the first addition of water to the maximum consistency immediately prior to the first indication of weakening. Long peak times indicate strong gluten and dough properties while short peak times may indicate weak gluten.

Dough Data

Location		Alveograph				Farinograph			
		P (mm)	L (mm)	W (10-4 J)	P/L Ratio	Abs (14%mb)	Devlopmt Time (min)	Stability (min)	MTI (BU)
Colorado	C01	81	90	236	0.90	60.7	5.5	13.8	30
	C02	81	99	267	0.82	59.8	6.0	16.9	19
	C03	85	88	244	0.97	62.2	7.0	13.2	24
Kansas	K01	90	96	269	0.94	60.1	5.3	14.1	28
	K02	85	90	242	0.94	61.4	6.0	10.6	33
	K03	91	89	265	1.02	61.0	6.1	11.8	31
	K04	94	98	289	0.96	60.9	6.7	12.7	30
	K05	79	73	175	1.08	58.7	4.7	7.7	42
	K06	80	85	218	0.94	60.8	6.0	10.9	31
	K07	93	88	257	1.06	60.8	5.2	9.8	37
	K08	88	92	248	0.96	60.5	5.7	10.1	33
	K09	68	87	182	0.78	57.7	4.0	7.6	40
	K10	74	95	222	0.78	57.4	5.7	12.0	30
Montana	M01	94	92	325	1.02	59.8	5.2	14.8	27
	M02	78	99	269	0.79	58.1	5.4	11.8	34
	M03	76	109	286	0.72	58.3	5.4	10.5	33
	M04	86	89	284	0.97	57.8	5.2	12.1	27
	M05	75	98	255	0.77	57.5	5.5	11.8	34
	M06	68	125	268	0.54	59.2	4.9	9.6	41
	M07	84	94	296	0.89	59.6	5.7	14.5	24
Nebraska	N01	70	101	221	0.69	57.8	5.5	12.8	24
	N02	73	87	198	0.84	60.1	6.8	10.7	36
	N03	84	76	219	1.11	60.5	7.7	12.9	28
	N04	91	74	229	1.23	60.3	5.8	10.7	35
	N05	65	94	204	0.69	57.7	5.3	10.2	32
North Dakota	ND01	65	128	270	0.51	57.8	5.5	14.8	21
	ND02	71	135	285	0.53	60.2	5.4	10.9	34
	ND03	54	128	195	0.42	58.3	5.7	11.4	30
Oklahoma	O01	83	104	285	0.80	60.8	5.0	15.9	17
	O02	65	102	191	0.64	55.8	4.3	7.4	46
	O03	76	111	236	0.68	62.4	5.7	11.3	27
	O04	84	111	286	0.76	63.8	7.5	16.9	19
	O05	72	104	222	0.69	56.3	4.3	12.5	22
	O06	75	108	236	0.69	56.9	4.7	9.1	35
	O07	68	113	227	0.60	58.7	5.5	12.6	24
Pacific Northwest	PNW01	93	95	291	1.02	61.8	4.3	9.9	28
	PNW02	94	120	349	0.78	63.5	7.2	15.7	19
	PNW03	104	63	244	1.65	61.5	4.0	7.9	36
	PNW04	96	78	258	1.22	63.1	7.2	17.2	13
South Dakota	SD01	71	99	241	0.72	59.9	6.8	12.0	36
	SD02	70	91	216	0.77	58.5	5.3	13.0	24
Texas	T01	92	110	330	0.84	61.1	7.5	17.9	22
	T02	81	115	298	0.70	60.2	4.8	12.5	24
	T03	85	78	229	1.09	57.4	5.2	10.0	39
	T04	79	129	297	0.61	60.8	6.2	16.7	23
	T05	79	127	289	0.62	61.5	5.2	11.3	32
	T06	73	99	211	0.74	59.1	5.7	8.2	42
Wyoming	W01	84	103	282	0.82	59.8	7.2	16.9	17

Baking Characteristics

Baking tests are the final laboratory testing method in the evaluation of wheat quality. Generally, the amount and type of protein present determines baking performance, though starch quality can also have an influence.

Technicians evaluate loaves for their volume, or size, and the interior appearance of the loaf such as crumb grain and crumb color. Other performance factors include dough absorption, or bake absorption, and the optimum mixing time of the dough.

Baking Absorption is the amount of water added to achieve properly hydrated dough. It is expressed as a percentage, with higher values being better.

Crumb Grain and Texture measures the cell size and shape. It is rated on a scale of one to 10 and higher numbers are preferred.

Bake Mix Time represents mixing time when all normal ingredients are added for producing an end product (in addition to water and flour) prior to baking.

Baking Data

Location		Bake Mix (min)	Bake Abs (14% mb)	Loaf Volume (cc)	Crumb Grain (1-10)	Crumb Texture (1-10)	Crumb Color
Colorado	C01	4.3	63.0	885	7.0	7.0	Dull
	C02	4.3	64.1	865	5.5	7.0	Dull
	C03	4.4	62.5	880	5.5	7.0	Dull
Kansas	K01	4.5	63.4	895	5.5	7.0	Dull
	K02	3.8	64.5	830	5.5	7.0	Dull
	K03	4.0	63.1	910	6.3	7.0	Dull
	K04	4.3	63.4	920	7.8	7.0	Dull
	K05	5.0	59.6	790	5.5	7.0	Dull
	K06	4.3	63.6	900	7.8	7.0	Creamy
	K07	4.0	61.7	850	7.0	7.0	Dull
	K08	4.0	63.2	875	7.0	7.0	Dull
	K09	4.5	60.4	810	7.0	7.0	Dull
	K10	5.1	60.3	850	7.0	7.0	Dull
Montana	M01	6.3	62.2	900	7.0	7.0	Dull
	M02	6.5	60.9	795	7.8	7.0	Dull
	M03	6.0	60.9	835	7.0	7.0	Dull
	M04	6.8	63.3	845	7.0	7.0	Dull
	M05	6.8	61.2	810	7.0	7.0	Dull
	M06	6.4	61.7	835	7.0	7.0	Dull
	M07	6.6	64.4	885	6.3	7.0	Dull
Nebraska	N01	5.4	60.1	800	7.0	7.0	Dull
	N02	4.5	63.6	910	7.8	7.0	Dull
	N03	3.3	62.7	925	7.8	7.0	Dull
	N04	4.5	63.0	840	5.5	7.0	Dull
	N05	4.4	61.3	860	7.8	7.0	Dull
North Dakota	ND01	5.8	63.4	850	7.0	7.0	Dull
	ND02	5.1	63.6	870	7.0	7.0	Dull
	ND03	5.0	62.4	850	7.0	7.0	Dull
Oklahoma	O01	4.6	65.8	865	7.8	8.5	Dull
	O02	4.8	58.9	775	6.3	7.0	Dull
	O03	3.5	62.6	885	6.3	7.0	Dull
	O04	3.5	66.9	930	7.8	7.0	Dull
	O05	4.5	62.8	860	7.0	7.0	Dull
	O06	4.6	62.2	835	7.0	7.0	Dull
	O07	4.5	60.7	890	7.0	7.0	Dull
Pacific Northwest	PNW01	5.3	63.7	805	5.5	7.0	Dull
	PNW02	4.8	62.8	870	7.8	7.0	Dull
	PNW03	3.3	60.7	740	4.8	7.0	Dull
	PNW04	3.5	63.2	850	4.8	7.0	Dull
South Dakota	SD01	5.3	62.2	850	7.0	7.0	Dull
	SD02	4.8	63.2	905	7.0	7.0	Dull
Texas	T01	5.0	66.4	965	7.0	8.5	Dull
	T02	4.8	61.9	910	7.0	8.5	Dull
	T03	5.0	62.0	810	7.8	7.0	Dull
	T04	4.8	65.8	900	7.0	8.5	Dull
	T05	4.1	65.0	880	7.0	8.5	Dull
	T06	3.8	62.8	840	7.0	8.5	Dull
Wyoming	W01	4.5	62.1	885	5.5	7.0	Dull

Methods

The harvest samples were evaluated using these methods:

Grade: Official U.S. Standards for Grain.

Dockage: Official USDA procedure using the Carter Dockage Tester.

Test Weight: AACC Method 55-10; the weight Per Winchester Bushel (2150.42 in3) as determined using an approved device, USDA approved. The test weight is mathematically converted to hectoliter weight: kg/hl = lb/bu x 1.292 + 1.419.

Moisture: DJ Gac 2100.

Protein: NIRT method

Ash: AACC Method 08-01 expressed on a 14 percent moisture basis.

Falling Number: AACC Method 56-81B. An average value is a simple mean of sample results.

Kernel Size Distribution: Cereal Foods World (Cereal Science Today) 5:71-71, 75 (1960). Wheat is sifted with a RoTap sifter using a Tyler No. 7 screen (2.82 mm) and a Tyler No. 9 Screen (2.00 mm).

Kernels retained on the No. 7 screen are classified as "Large." Kernels passing through the No. 7 screen and retained on the No. 9 screen are "Medium." Kernels passing through the No. 9 screen are "Small".

Single Kernel Characterization: AACC Method 55-31 using SKCS Model 4100.

Extraction: Samples cleaned and tempered according to AACC Method 26-10A. All were milled with

identical mill settings on a Buhler laboratory mill as follows: AACC Method 26-21A.

Moisture: NIR Protein: NIR Ash: AACC Method 08-01 expressed on a 14 percent moisture basis.

Falling Number: AACC Method 56-81B.

Wet Gluten & Gluten Index: AACC Method 38-12Farinograph: AACC Method 54-21 with 50-gram bowl.

Absorption is reported on 14 percent moisture basis.

Alveograph: AACC Method 54-30A.

Loaf Volume: AACC Method 10-10B producing two loaves per batch using wet compressed yeast and ascorbic acid. After mixing, dough is divided into two equal portions, fermented for 160 minutes, proofed and baked in "pup loaf" pans. Loaf volume is measured immediately after baking by rapeseed displacement.