PGI

Plains Grains Inc.

2014 Hard Red Winter Wheat Regional Quality Survey

127 Noble Research Center, Stillwater, OK 74078
Phone: (405) 744- 9333
pgiadmin@plainsgrains.org • www.plainsgrains.org

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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 website 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.

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 wheat accounts for about 40 percent of total U.S. wheat production*

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.

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

Even though drought conditions have persisted over the last 4 years in much of the southern and central Great Plains, early growth of the 2014 HRW wheat crop (root and tiller development) was generally very good across all planting regions. Wheat producers in most areas reported adequate moisture at planting which prevailed through late fall and early winter. However, through the remainder of growing season, most areas of Kansas southward received well below average precipitation and remained in severe to exceptional drought conditions. In contrast, Nebraska through the upper Great Plains and across the Pacific Northwest entered the winter with very good soil moisture conditions throughout the soil profile which extended into the spring.

The wheat crop in parts of southern Kansas, Oklahoma and Texas suffered a hard freeze on April 15, 2014. This coupled with the ongoing drought did extensive damage to the crop. As the crop matured in Texas and Oklahoma during late May USDA condition ratings fell to from between 67% -75% of the crop in those 2 states being rated in the poor to very poor categories. Just 2 weeks later in early June harvest was brought to a standstill in these same areas by relentless rain storms. While the rain was too late to help the majority of the crop in Texas, Oklahoma and southern Kansas, it was beneficial to northern Kansas, western Nebraska and Northeastern Colorado.

In July, as the Pacific Northwest and the Montana crops were reaching heading through the final stages of maturity (and during the highest water demands by the plant), hot temperatures caused excessive stress and shortened the grain filling period. However, much like the Great Plains area, as combines started cutting the rain started to fall across much of the northern US slowing harvest. Large areas of Montana and North Dakota received over 10" (25.4 cm) of rain during the last half of August.

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. 525 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. 79 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 2014 HRW crop official grade averaged 66% Grade #1 (Gulf tributary averaging 54% and PNW tributary averaging 84%) when considering all protein levels and weighting for and the production. The overall dockage level of 0.4% was below last year's average of 0.6% and the 5-year average of 0.5%.. Total defects of 1.4% are significantly below last year's average of 2.0% and 5-year average of 1.6%. Foreign material, shrunken and broken, and wheat ash contents were also equal to or exceeding the 5-year average. Overall test weight averaged 60.7 lbs/bu (79.9 kg/hl) which is equal to the 5-year average of 60.8 lbs/bu (79.9 kg/hl) and significantly above the

2013 average of 59.9 lbs/bu (78.8 kg/hl). The overall average thousand kernel weight of 30.7 g is significantly above (almost 6 grams) the 2013 average of 26.0 g and the 5-year average of 29.0 g. Average kernel diameter of 2.62 mm was slightly larger than the 2013 average of 2.50 mm, but similar to the 5-year average of 2.59 mm. The average protein of 13.3% is similar to the 2013 average of 13.4% and is almost a full percentage point above the 5-year average of 12.4%. The kernel characteristics were generally smaller in the higher protein southern region and larger with lower protein in the northern production region. Protein content splits varied across the testing region and by tributary with approximately 10% of samples being in the < 11.5% protein content category, 22% in the 11.5% – 12.5% category and 68% in the > 12.5% category. Average falling number for this crop was 385 sec., compared to a 2013 average of 421 sec., and comparable to the 5-year average of 410 sec. and indicative of sound wheat.

Flour and Baking Data

The Buhler flour yield overall averaged (73.9%), and is below the 2013 average of 76.1%, but above the 5-year average of 72.7%, the difference in the 5-year average is mostly attributable to the installation of a new tandem Buhler Experimental mill 2 years ago for testing. Flour ash contents are lower than 2013 and the 5-year average and within acceptable ranges. Protein loss during flour conversion averaged 0.7% (when wheat is converted to 14% mb), this was below the 5-year average of 1.1%.

Gluten index values averaged 92.1% which was lower than the 5-year average of 95.4%.

The W value of 266 (10-4 J) was comparable to 2013 and the 5-year average. Overall average water absorption (WA) was 60.3% which was higher than the 2013 absorption of 59.8% and is significantly higher than the 5-year average of 57.9%. Farinograph development time and stability were 6.2 min and 9.3 min. respectively, development time was comparable to 2013, but higher than the 5-year average. Stability time was lower than the 5-year average of 12.6 min. Overall loaf volume averaged 859 cc, this was comparable to 2013 (860 cc), but significantly higher than the 5 year average of 816 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 2014 HRW crop.

Summary

The 2014 HRW crop can be defined as unique, and like the 2013 crop has very good wheat protein that translates into high flour protein which has functionality. Water absorption is well over 2 percentage points higher than the high protein crop of last year. Loaf volumes are very good and again significantly exceed long-term averages. Kernel characteristics are average overall with significantly lower shrunken and broken as compared to short and long-term averages. This crop meets or exceeds typical HRW contract specifications and provides high value to the customer.

Hard Red Winter Wheat Production Charts

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English Units

Hard Winter Wheat Production (1,000 bu.)

	2007	2008	2009	2010	2011	2012	2013	2014	Average
Colorado	94,000	57,000	98,000	105,750	78,000	83,250	43,500	89,300	81,100
Kansas	283,800	356,000	369,600	360,000	276,500	387,000	328,000	246,400	325,913
Montana	83,220	94,380	89,540	93,600	89,790	81,320	96,750	91,840	90,055
North Dakota	22,250	22,550	26,160	17,600	13,875	38,500	13,440	27,195	22,696
Nebraska	84,280	73,480	76,800	64,070	65,250	55,440	41,760	71,050	66,516
Oklahoma	98,000	166,500	77,000	120,900	70,400	155,400	115,500	47,600	106,413
Pacific NW	17,841	16,246	16,194	19,869	22,004	37,990	35,330	28,350	24,228
South Dakota	95,040	103,950	64,260	63,700	66,780	62,400	25,350	59,400	67,610
Texas	140,600	99,000	61,250	127,500	49,400	91,450	64,000	67,500	87,588
Wyoming	3,250	3,780	5,016	4,640	4,420	3,000	2,640	3,375	3,765
Regional Total	922,281	992,886	883,820	977,629	736,419	995,750	766,270	732,010	875,883

Hard Winter Wheat Harvested Acres (1,000 Acres)

	2007	2008	2009	2010	2011	2012	2013	2014	Average
Colorado	2,350	1,900	2,450	2,350	2,000	2,250	1,500	2,350	2,144
Kansas	8,600	8,900	8,800	8,000	7,900	9,000	8,200	8,800	8,525
Montana	2,190	2,420	2,420	1,950	2,190	2,140	2,150	2,240	2,213
North Dakota	445	550	545	320	375	700	320	555	476
Nebraska	1,960	1,670	1,600	1,490	1,450	1,320	1,160	1,450	1,513
Oklahoma	3,500	4,500	3,500	3,900	3,200	4,200	3,500	2,800	3,638
Pacific NW	294	258	276	289	293	535	530	417	362
South Dakota	1,980	1,890	1,530	1,300	1,590	1,300	650	1,080	1,415
Texas	3,800	3,300	2,450	3,750	1,900	2,950	2,000	2,250	2,800
Wyoming	125	135	132	145	130	120	120	125	129
Regional Total	25,244	25,523	23,703	23,494	21,028	24,515	20,130	22,067	23,213

Hard Winter Wheat Yield (bu/ac)

	2007	2008	2009	2010	2011	2012	2013	2014	Average
Colorado	40	30	40	45	39	37	29	38	37
Kansas	33	40	42	45	45	43	40	28	40
Montana	38	39	37	48	41	38	45	41	41
North Dakota	50	41	48	55	37	55	42	49	47
Nebraska	43	44	48	43	45	42	36	49	44
Oklahoma	28	37	22	31	22	37	33	17	28
Pacific NW	59	57	58	68	76	75	68	66	66
South Dakota	48	55	42	49	42	48	39	55	47
Texas	37	30	25	34	26	31	32	30	31
Wyoming	26	28	38	32	34	25	22	27	29
Regional Total	40	40	40	45	41	43	39	40	41

*** Some data derived from Crop Production report issued by USDA NASS updated September 30, 2014.*

Hard Red Winter Wheat Production Charts

Metric Units

Hard Winter Wheat Production (MMT)	2007	2008	2009	2010	2011	2012	2013	2014	Average
Colorado	2.56	1.55	2.67	2.88	2.12	2.27	1.18	2.43	2.21
Kansas	7.72	9.69	10.06	9.80	7.53	10.53	8.93	6.71	8.87
Montana	2.27	2.57	2.44	2.55	2.44	2.21	2.63	2.50	2.45
North Dakota	0.61	0.61	0.71	0.48	0.38	1.05	0.37	0.74	0.62
Nebraska	2.29	2.00	2.09	1.74	1.78	1.51	1.14	1.93	1.81
Oklahoma	2.67	4.53	2.10	3.29	1.92	4.23	3.14	1.30	2.90
Pacific NW	0.49	0.44	0.44	0.54	0.60	1.03	0.96	0.77	0.66
South Dakota	2.59	2.83	1.75	1.73	1.82	1.70	0.69	1.62	1.84
Texas	3.83	2.69	1.67	3.47	1.34	2.49	1.74	1.84	2.38
Wyoming	0.09	0.10	0.14	0.13	0.12	0.08	0.07	0.09	0.10
Regional Total	25.10	27.02	24.06	26.61	20.04	27.10	20.86	19.92	23.84

Hard Winter Wheat Harvested Acres (1,000 ha)	2007	2008	2009	2010	2011	2012	2013	2014	Average
Colorado	951	769	992	951	810	911	607	951	868
Kansas	3,482	3,603	3,563	3,239	3,198	3,644	3,320	3,563	3,451
Montana	887	980	980	789	887	866	870	907	896
North Dakota	180	223	221	130	152	283	130	225	193
Nebraska	794	676	648	603	587	534	470	587	612
Oklahoma	1,417	1,822	1,417	1,579	1,296	1,700	1,417	1,134	1,473
Pacific NW	119	104	112	117	119	217	215	169	146
South Dakota	802	765	619	526	644	526	263	437	573
Texas	1,538	1,336	992	1,518	769	1,194	810	911	1,134
Wyoming	51	55	53	59	53	49	49	51	52
Regional Total	10,220	10,333	9,596	9,512	8,513	9,925	8,150	8,934	9,398

Hard Winter Wheat Yield (tons/ha)	2007	2008	2009	2010	2011	2012	2013	2014	Average
Colorado	2.69	2.02	2.69	3.03	2.62	2.49	1.95	2.56	2.51
Kansas	2.22	2.69	2.82	3.03	3.03	2.89	2.69	1.88	2.66
Montana	2.56	2.62	2.49	3.23	2.76	2.56	3.03	2.76	2.75
North Dakota	3.36	2.76	3.23	3.70	2.49	3.70	2.82	3.30	3.17
Nebraska	2.89	2.96	3.23	2.89	3.03	2.82	2.42	3.30	2.94
Oklahoma	1.88	2.49	1.48	2.08	1.48	2.49	2.22	1.14	1.91
Pacific NW	3.97	3.83	3.90	4.57	5.11	5.04	4.57	4.44	4.43
South Dakota	3.23	3.70	2.82	3.30	2.82	3.23	2.62	3.70	3.18
Texas	2.49	2.02	1.68	2.29	1.75	2.08	2.15	2.02	2.06
Wyoming	1.75	1.88	2.56	2.15	2.29	1.68	1.48	1.82	1.95
Regional Average	2.70	2.70	2.69	3.03	2.74	2.90	2.60	2.69	2.75

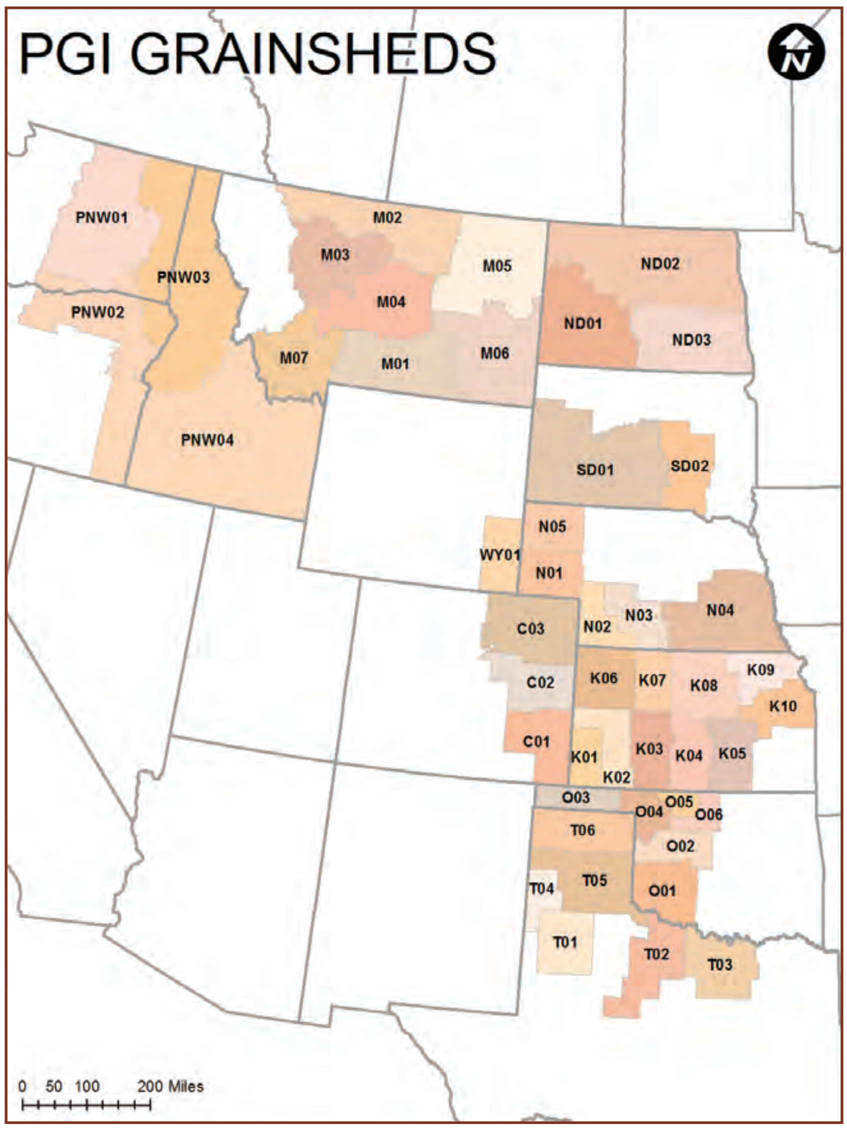
*** Some data derived from Crop Production report issued by USDA NASS updated September 30, 2014.*

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 foreign 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.

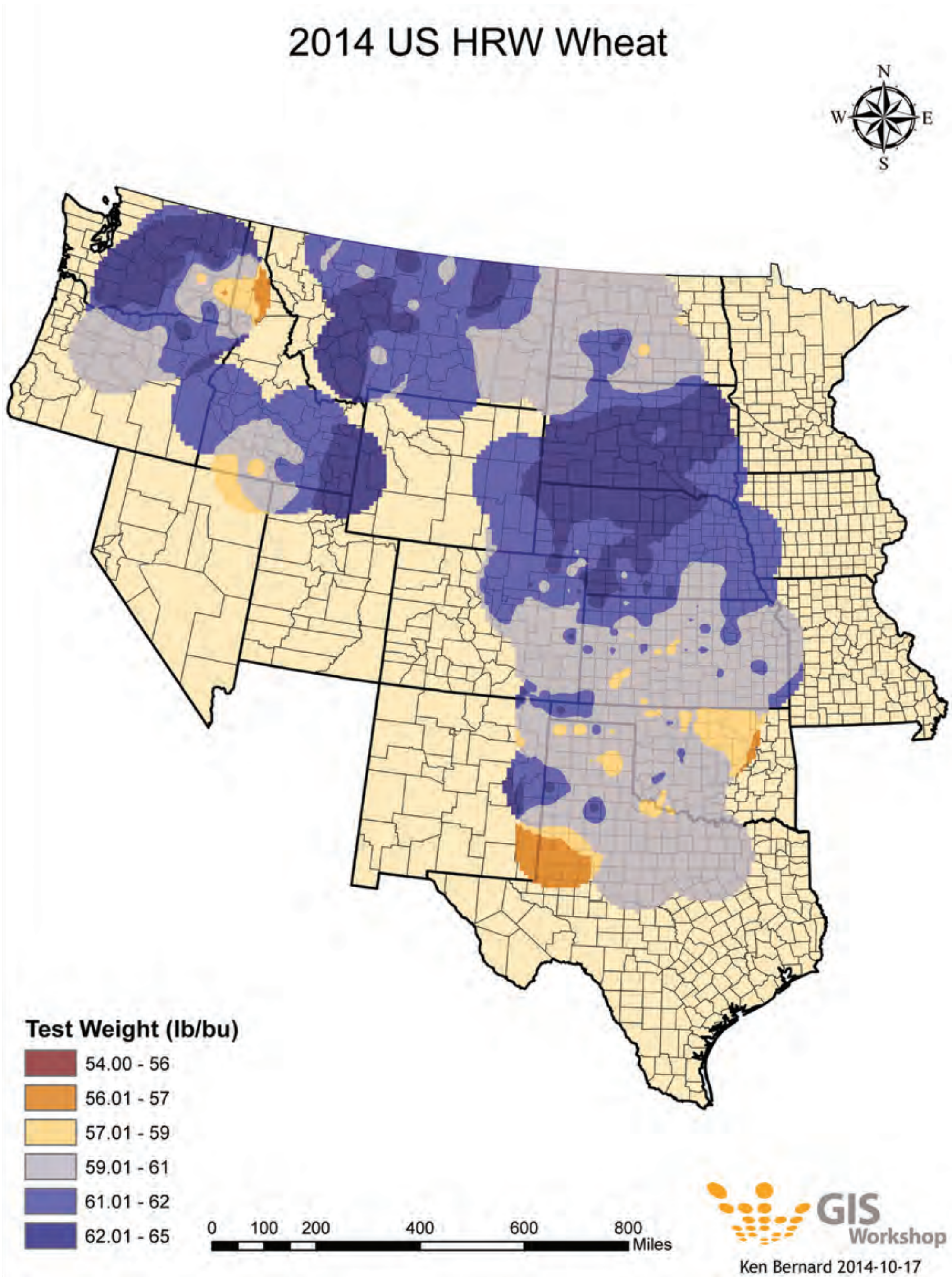
Defects are damaged kernels, foreign materials, and shrunken and broken kernels. The sum of these three factors may not exceed the limit for the factor defects for each numerical grade.

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

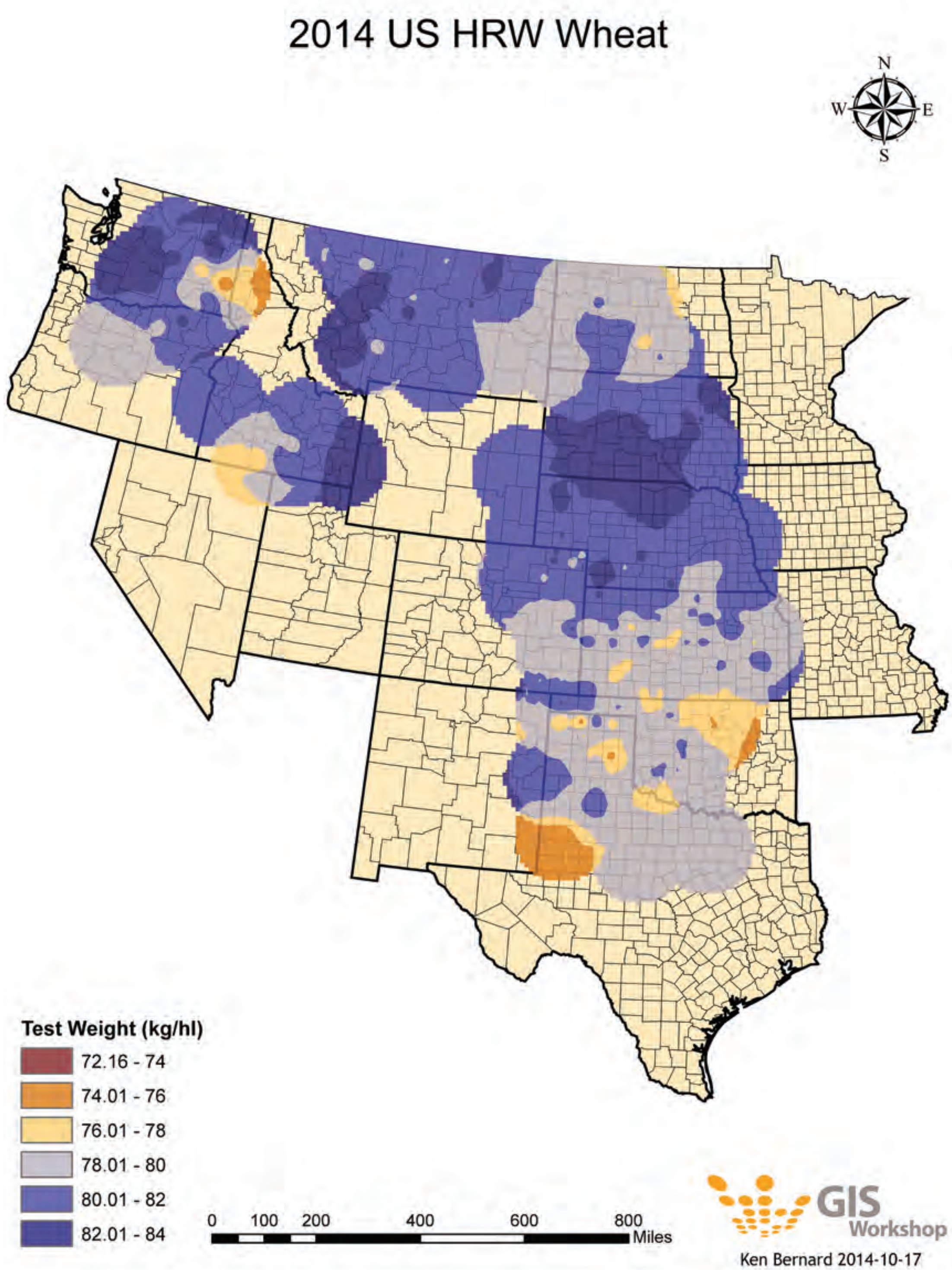
Shrunken and broken kernels are all matter that passes through a 0.064 x 3/8-inch oblong-hole sieve after sieving according to procedures prescribed in the FGIS instructions.

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.


2014 US HRW Wheat
N
W
E
S
Test Weight (lb/bu)
54.00 - 56
56.01 - 57
57.01 - 59
59.01 - 61
61.01 - 62
62.01 - 65
0
100
200
400
600
800
Miles
GIS
Workshop
Ken Bernard 2014-10-17

TEST WEIGHT (kg/hl)



Wheat Grading Data

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	1	60.0	79.0	0.3	0.6	1.0	1.7
	C02	1	60.8	80.0	0.4	0.5	0.8	1.4
	C03	1	61.5	80.9	0.3	0.3	0.7	1.1
Kansas	K01	1	60.7	79.8	0.4	0.5	0.9	1.5
	K02	2	59.7	78.5	0.3	0.6	0.7	1.5
	K03	2	59.7	78.6	0.2	0.4	0.7	1.2
	K04	2	59.5	78.2	0.4	0.4	0.7	1.3
	K05	1	60.0	78.9	0.2	0.5	0.8	1.5
	K06	1	61.2	80.5	0.4	0.9	0.5	1.5
	K07	1	60.4	79.4	0.3	0.9	0.6	1.7
	K08	1	60.0	78.9	0.4	1.2	0.8	2.2
	K09	1	61.1	80.4	0.3	0.6	0.7	1.5
	K10	1	60.8	80.0	0.2	0.6	0.5	1.3
Montana	M01	1	61.4	80.7	0.5	0.1	1.4	1.6
	M02	1	61.3	80.6	0.8	0.1	1.0	1.1
	M03	1	62.1	81.6	0.5	0.1	1.0	1.1
	M04	1	61.7	81.1	0.5	0.0	0.8	0.9
	M05	1	61.2	80.5	0.3	0.3	0.7	1.1
	M06	1	60.2	79.2	0.5	0.1	0.8	0.9
	M07	1	61.9	81.4	0.9	0.0	0.6	0.6
Nebraska	N01	1	62.0	81.5	0.4	0.4	0.6	1.1
	N02	1	62.4	82.1	0.3	0.6	0.5	1.1
	N03	1	61.6	80.9	0.3	0.7	0.5	1.3
	N04	1	61.4	80.8	0.4	0.3	0.8	1.3
	N05	1	62.2	81.8	0.6	0.2	0.9	1.2
North Dakota	ND01	1	61.3	80.6	0.4	0.9	0.7	1.7
	ND02	1	60.4	79.4	0.6	1.6	0.8	2.6
	ND03	2	59.6	78.4	0.6	1.1	0.9	2.2
Oklahoma	O01	2	59.6	78.4	0.5	0.3	1.2	1.6
	O02	1	60.4	79.5	0.5	0.1	1.7	1.9
	O03	1	61.5	80.9	0.4	0.3	0.6	1.0
	O04	2	59.9	78.9	0.5	0.1	1.1	1.4
	O05	2	59.4	78.1	0.4	0.1	1.6	1.8
	O06	2	59.0	77.7	0.4	0.3	1.8	2.3
	O07	2	57.2	75.3	0.6	0.6	1.5	2.6
Pacific Northwest	PNW01	1	62.1	81.6	0.4	0.0	0.6	0.6
	PNW02	1	62.3	81.9	0.5	0.1	0.6	0.7
	PNW03	1	61.5	80.8	0.6	0.0	0.8	0.8
	PNW04	1	61.0	80.2	0.6	0.0	0.9	1.0
South Dakota	SD01	1	62.5	82.1	0.5	0.2	0.7	0.9
	SD02	1	62.5	82.1	0.4	0.3	0.4	0.8
Texas	T01	2	59.4	78.2	0.3	0.3	0.9	1.4
	T02	2	59.2	78.0	0.6	0.7	1.2	2.3
	T03	2	59.9	78.8	0.4	1.0	0.8	1.9
	T04	1	62.0	81.5	0.3	0.4	0.5	0.9
	T05	2	59.3	78.1	0.4	0.1	0.9	1.2
	T06	2	59.7	78.6	0.5	0.3	0.8	1.3
Wyoming	W01	1	61.3	80.6	0.4	0.2	0.9	1.2

Kernel Quality Data

Location		Foreign Material (%)	Kernel Size Large (%)	Kernel Size Med (%)	Kernel Size Small (%)	Thousand Kernel Wt (g)	Avg Diam (mm)
Colorado	C01	0.1	70	29	1	31.4	2.68
	C02	0.1	67	32	1	30.9	2.65
	C03	0.1	72	28	1	32.1	2.68
Kansas	K01	0.1	66	33	1	31.5	2.64
	K02	0.1	44	55	1	29.4	2.57
	K03	0.1	39	60	1	28.3	2.51
	K04	0.2	35	64	1	30.2	2.60
	K05	0.2	42	57	1	28.6	2.54
	K06	0.1	54	45	0	33.0	2.71
	K07	0.2	55	44	0	30.8	2.63
	K08	0.3	63	36	1	30.1	2.62
	K09	0.3	72	27	1	31.2	2.65
	K10	0.2	72	28	0	32.6	2.67
Montana	M01	0.1	59	39	1	30.5	2.58
	M02	0.1	59	40	1	31.0	2.60
	M03	0.2	62	37	1	31.0	2.60
	M04	0.1	58	42	1	30.7	2.60
	M05	0.1	70	29	1	32.2	2.65
	M06	0.0	59	40	1	29.6	2.57
	M07	0.1	71	28	0	34.9	2.73
Nebraska	N01	0.2	74	25	0	33.1	2.70
	N02	0.1	78	21	0	33.6	2.74
	N03	0.1	78	22	0	32.7	2.70
	N04	0.1	71	28	1	31.9	2.66
	N05	0.1	71	29	1	31.9	2.65
North Dakota	ND01	0.2	79	21	0	33.7	2.72
	ND02	0.2	72	27	1	31.9	2.66
	ND03	0.2	68	31	1	30.8	2.63
Oklahoma	O01	0.1	22	75	3	25.6	2.44
	O02	0.2	29	68	3	26.2	2.46
	O03	0.1	66	34	1	32.6	2.68
	O04	0.2	44	54	2	28.5	2.54
	O05	0.1	19	77	4	25.5	2.41
	O06	0.3	24	73	3	25.6	2.43
	O07	0.4	24	73	3	25.6	2.43
Pacific Northwest	PNW01	0.0	76	24	0	34.6	2.78
	PNW02	0.0	81	18	0	36.1	2.80
	PNW03	0.0	67	32	1	30.3	2.63
	PNW04	0.1	72	28	1	31.0	2.64
South Dakota	SD01	0.1	74	26	0	32.5	2.69
	SD02	0.1	77	23	0	33.5	2.72
Texas	T01	0.1	51	47	1	29.0	2.55
	T02	0.3	39	59	2	27.9	2.52
	T03	0.1	56	42	1	30.0	2.61
	T04	0.1	79	21	0	33.8	2.77
	T05	0.1	48	51	1	28.6	2.53
	T06	0.2	62	37	1	30.9	2.63
Wyoming	W01	0.1	63	36	1	31.1	2.62

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.

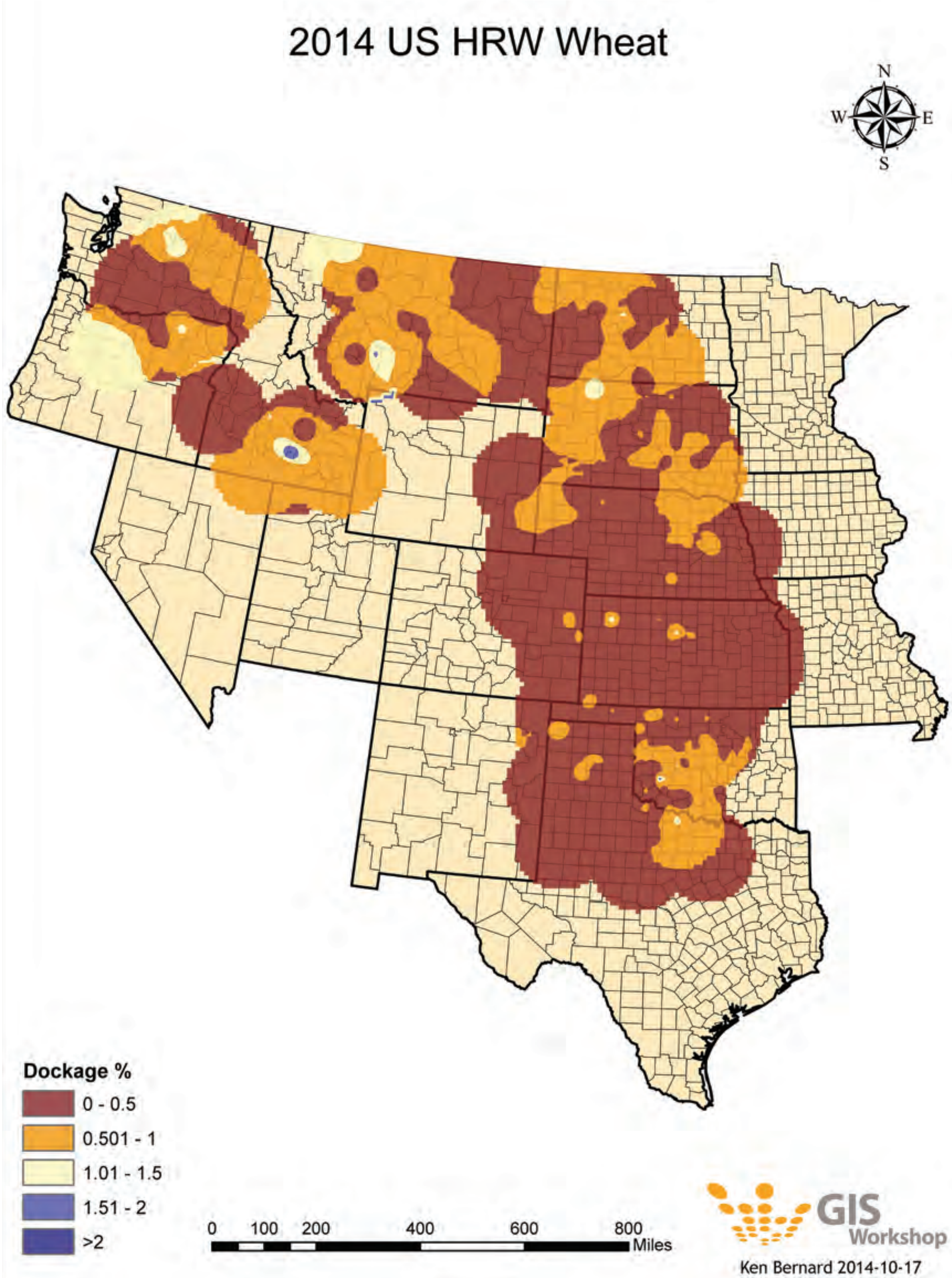
Thousand-kernel weight and kernel diameter provide measurements of kernel size and density important for milling quality. Simply put, it measures the mass of the wheat kernel. Millers tend to prefer larger berries, or at least berries with a consistent size. wheat with a higher TKW can be expected to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

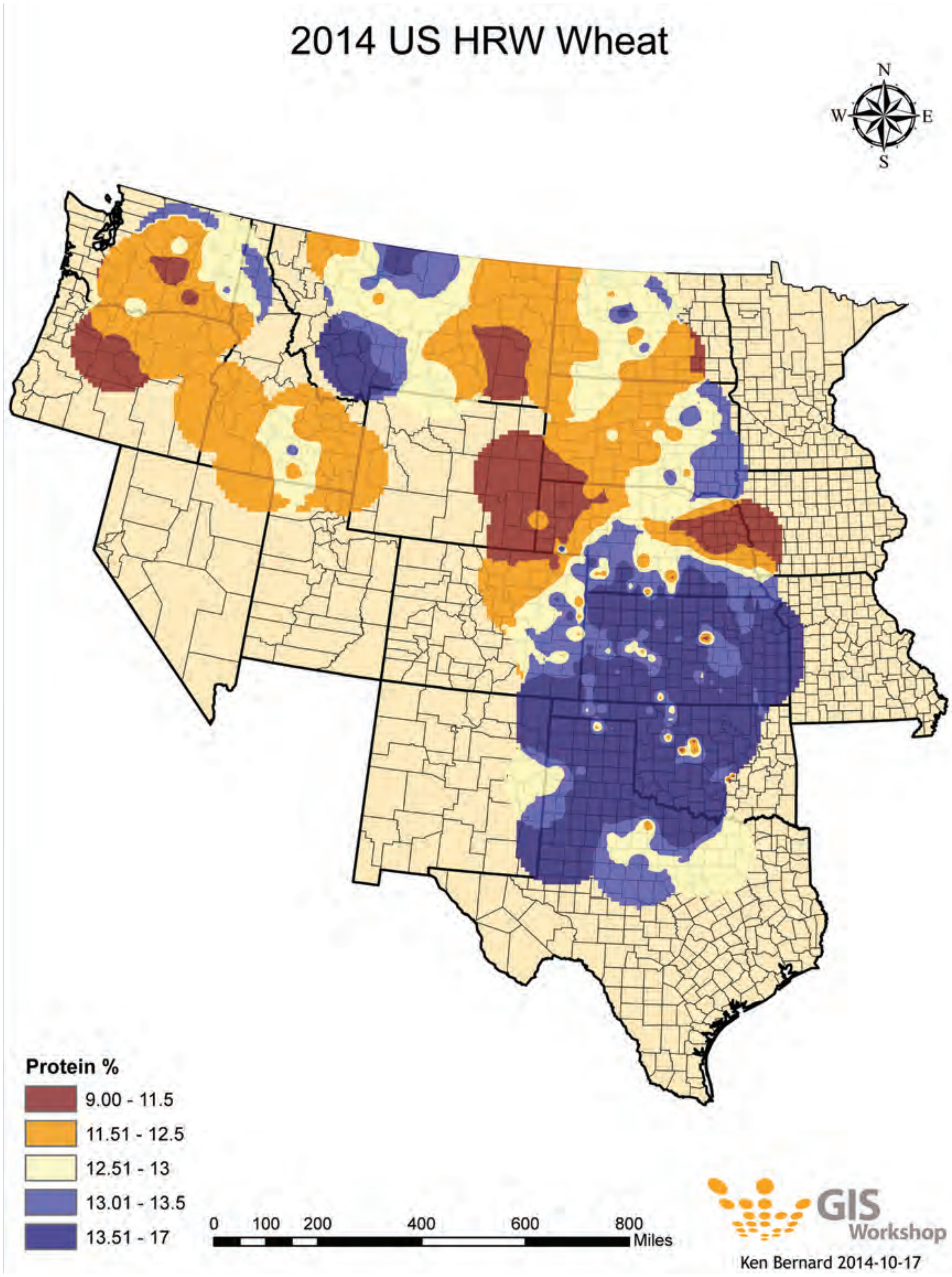
Falling number is an index of enzyme activity in wheat or flour and is expressed in seconds. Falling numbers above 300 are desirable, as they indicate little enzyme activity and a sound quality product. Falling numbers below 300 are indicative of more substantial enzyme activity and sprout damage.

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.


2014 US HRW Wheat
N
W
E
S
Dockage %
0 - 0.5
0.501 - 1
1.01 - 1.5
1.51 - 2
>2
0 100 200 400 600 800
Miles
GIS Workshop
Ken Bernard 2014-10-17


2014 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
0 100 200 400 600 800
Miles
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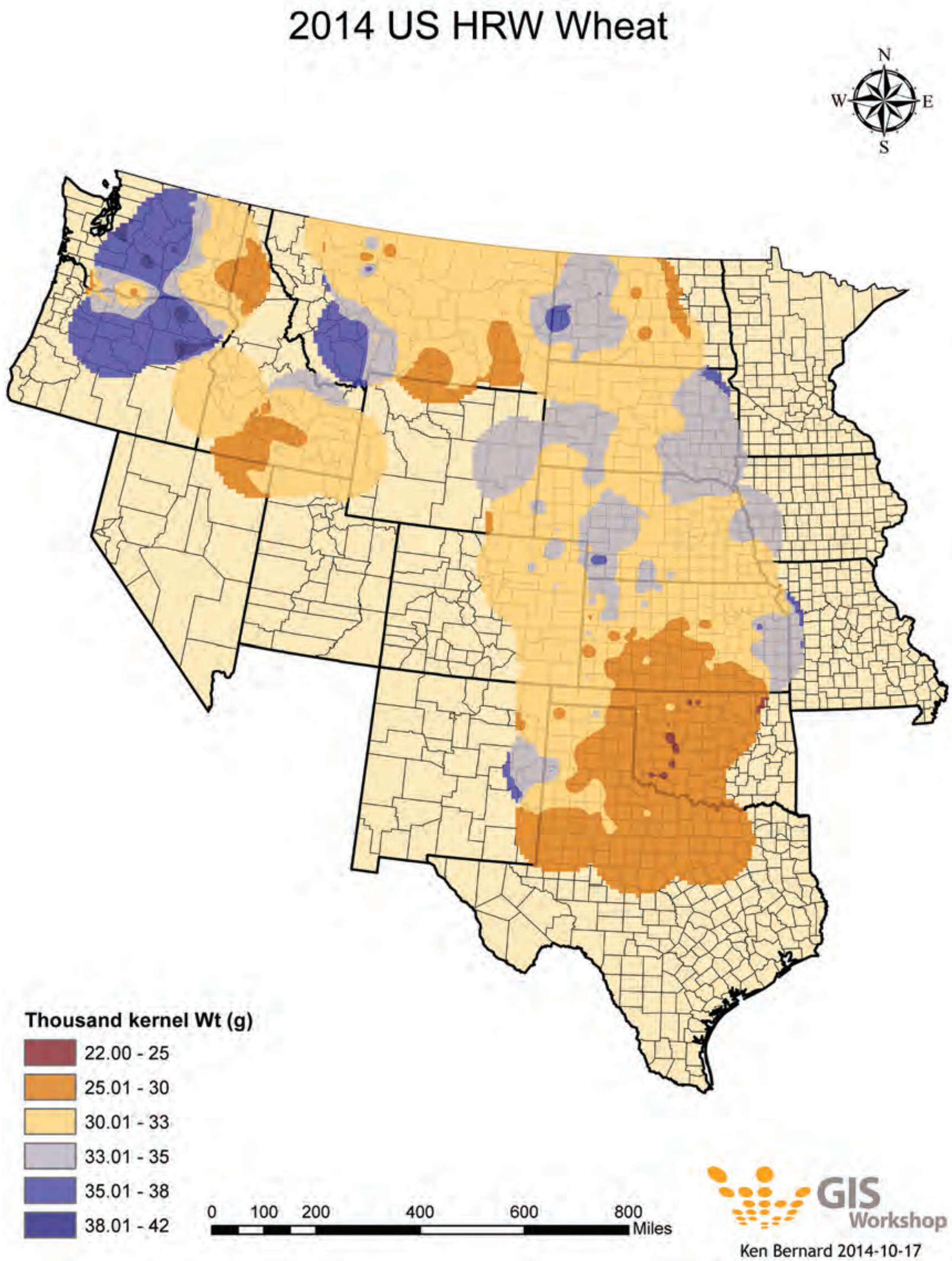
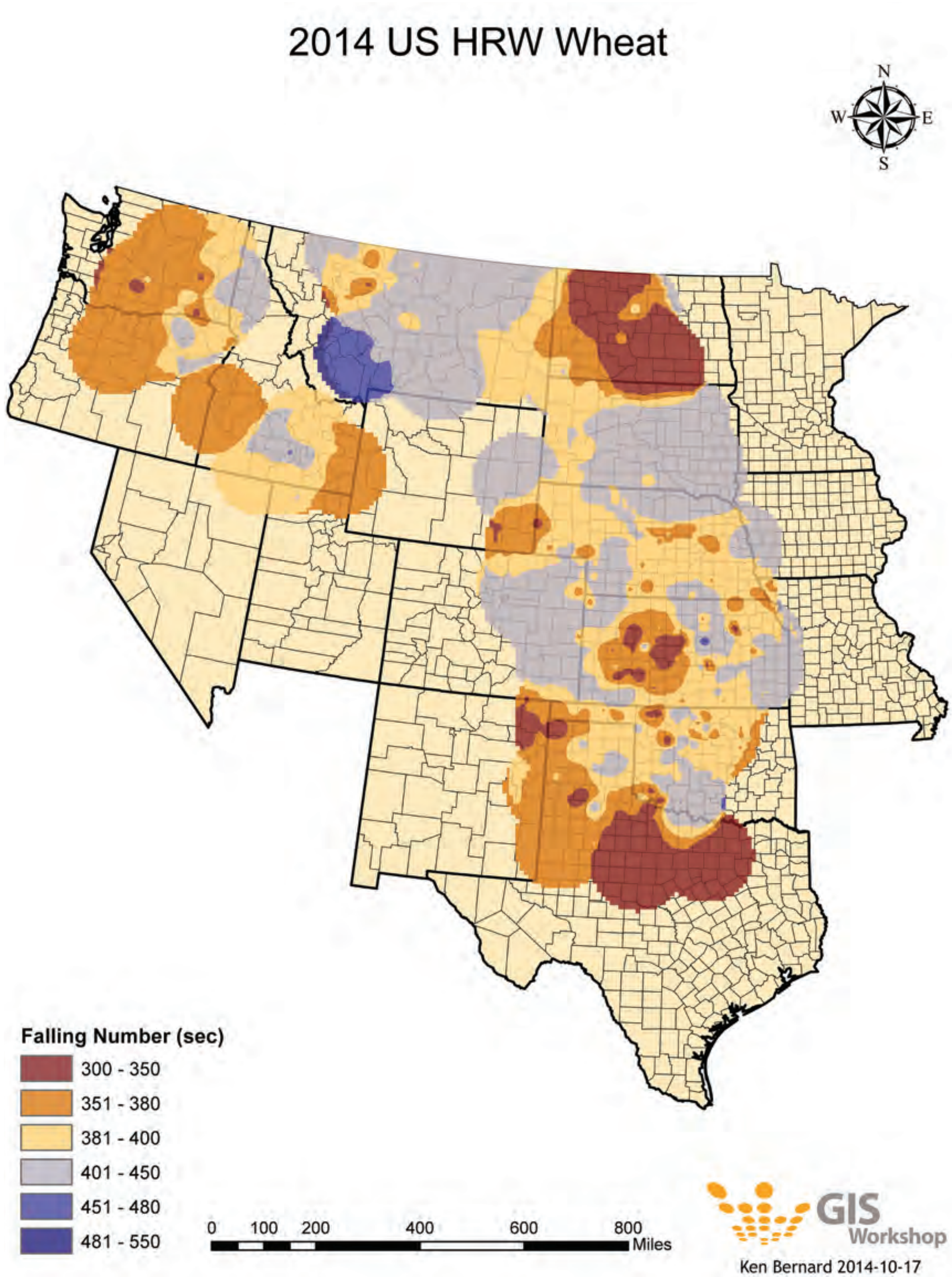
Thousand Kernel Weight (g)




2014 US HRW Wheat
N
W
E
S
Falling Number (sec)
300 - 350
351 - 380
381 - 400
401 - 450
451 - 480
481 - 550
0 100 200 400 600 800
Miles
GIS
Workshop
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Other Wheat Characteristics (non-grade data)

Location		Wheat Protein (12% mb)	Wheat Ash (12% mb)	Falling Number (sec)	Moisture (%)	Ave Hard
Colorado	C01	13.2	1.55	423	10.3	54
	C02	12.8	1.55	408	11.1	59
	C03	12.4	1.53	401	11.2	60
Kansas	K01	13.4	1.48	411	11.5	59
	K02	14.0	1.48	357	11.7	59
	K03	13.5	1.42	369	11.7	63
	K04	13.9	1.46	330	11.9	60
	K05	13.6	1.41	398	11.6	61
	K06	14.1	1.60	389	12.5	59
	K07	13.5	1.51	353	11.8	57
	K08	13.2	1.61	420	12.1	59
	K09	13.9	1.63	407	12.7	61
	K10	13.6	1.57	392	12.8	59
Montana	M01	12.3	1.45	410	10.7	65
	M02	13.2	1.43	401	11.7	67
	M03	12.8	1.42	388	10.9	67
	M04	12.9	1.41	400	10.9	70
	M05	11.7	1.47	397	11.9	61
	M06	11.2	1.46	394	10.6	61
	M07	13.7	1.43	462	10.1	72
Nebraska	N01	11.9	1.55	388	11.7	59
	N02	13.4	1.62	401	12.1	62
	N03	13.5	1.61	395	11.9	57
	N04	12.8	1.64	403	12.2	60
	N05	11.2	1.56	392	11.2	64
North Dakota	ND01	12.2	1.50	372	12.6	60
	ND02	12.7	1.52	344	13.4	58
	ND03	12.7	1.59	333	13.8	56
Oklahoma	O01	14.8	1.51	387	12.2	76
	O02	13.0	1.48	396	12.7	76
	O03	13.6	1.68	375	12.0	66
	O04	14.2	1.60	364	11.9	65
	O05	13.5	1.50	397	12.0	72
	O06	14.8	1.48	397	12.7	71
	O07	16.0	1.53	374	12.7	64
Pacific Northwest	PNW01	12.2	1.35	378	8.9	70
	PNW02	12.1	1.46	358	9.3	67
	PNW03	12.1	1.32	416	9.1	73
	PNW04	12.1	1.60	396	8.8	73
South Dakota	SD01	12.4	1.64	414	11.7	67
	SD02	12.8	1.69	419	12.3	65
Texas	T01	14.0	1.57	357	11.8	60
	T02	13.8	1.54	352	12.9	70
	T03	12.9	1.38	327	13.3	70
	T04	12.7	1.62	380	10.6	62
	T05	14.8	1.65	395	12.3	65
	T06	13.7	1.64	367	12.0	61
Wyoming	W01	11.6	1.48	401	12.5	65

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)	Flour Protein (14% mb)	Flour Ash (14% mb)	Gluten Index	Flour Color L*	Flour Color a*	Flour Color b*
Colorado	C01	71.8	52.0	12.0	0.50	94.0	91.30	-2.0	9.4
	C02	73.8	51.3	11.7	0.52	93.0	91.12	-2.0	9.8
	C03	73.4	55.6	11.2	0.48	95.4	91.38	-2.1	9.6
Kansas	K01	73.2	56.4	12.6	0.55	82.7	91.39	-2.0	9.5
	K02	73.9	64.4	13.2	0.56	92.8	91.06	-1.9	9.5
	K03	72.9	62.3	12.6	0.53	91.3	91.36	-2.0	9.6
	K04	74.2	63.1	12.9	0.54	93.7	91.13	-2.1	9.6
	K05	73.9	62.5	12.8	0.54	92.2	91.14	-2.1	9.8
	K06	74.1	58.0	12.8	0.53	86.5	91.03	-2.0	9.7
	K07	74.8	58.7	12.4	0.50	91.2	91.15	-2.0	9.5
	K08	74.8	48.5	12.2	0.55	89.5	90.85	-2.1	9.8
	K09	75.1	51.9	12.8	0.58	91.3	90.80	-2.0	9.7
	K10	75.5	57.2	12.5	0.54	84.5	90.94	-2.0	9.6
Montana	M01	73.6	53.7	11.2	0.48	96.5	91.48	-1.9	9.8
	M02	74.5	67.4	12.2	0.46	98.2	91.66	-2.0	9.7
	M03	76.4	58.9	11.9	0.52	96.3	91.66	-2.2	10.4
	M04	74.4	64.1	12.0	0.51	97.1	91.79	-2.1	10.3
	M05	75.1	59.2	11.0	0.50	98.6	91.54	-1.9	9.6
	M06	74.1	55.2	10.6	0.51	98.4	91.76	-1.9	9.1
	M07	76.1	65.7	12.7	0.52	96.9	91.14	-2.0	10.6
Nebraska	N01	74.4	46.3	10.7	0.50	94.5	91.39	-2.1	9.8
	N02	76.3	53.5	12.1	0.54	92.2	90.94	-1.9	9.8
	N03	74.7	52.4	12.2	0.52	93.2	91.31	-2.0	9.5
	N04	73.4	53.5	11.6	0.52	97.5	91.35	-2.0	9.5
	N05	75.2	48.0	10.2	0.52	96.5	91.44	-1.9	9.5
North Dakota	ND01	74.3	59.6	11.3	0.51	97.8	91.33	-2.1	9.9
	ND02	76.3	62.7	11.6	0.49	98.6	91.46	-2.1	9.6
	ND03	72.0	63.4	11.4	0.49	98.1	91.61	-2.1	9.6
Oklahoma	O01	73.9	64.3	13.9	0.63	91.0	91.02	-2.1	10.1
	O02	71.0	58.7	11.9	0.50	97.4	91.62	-2.1	9.6
	O03	74.7	51.5	12.7	0.59	80.2	91.03	-1.9	9.7
	O04	74.2	52.3	13.4	0.62	82.1	90.93	-1.9	9.8
	O05	69.8	56.5	12.6	0.56	93.1	91.47	-2.1	9.6
	O06	71.3	67.3	13.7	0.53	95.3	91.31	-2.0	9.5
	O07	71.2	70.8	14.8	0.54	92.5	91.15	-1.9	9.3
Pacific Northwest	PNW01	76.4	52.3	11.5	0.49	95.3	91.50	-2.2	10.5
	PNW02	75.4	48.3	11.2	0.50	97.7	91.41	-1.9	9.7
	PNW03	75.8	60.2	11.3	0.52	97.9	91.67	-2.0	10.4
	PNW04	75.8	44.5	11.2	0.53	97.0	91.42	-2.0	10.6
South Dakota	SD01	75.6	52.8	11.3	0.52	98.7	91.25	-2.1	10.3
	SD02	78.0	51.0	11.9	0.57	94.1	90.78	-1.9	10.2
Texas	T01	76.9	56.8	13.3	0.62	81.6	90.40	-2.0	9.5
	T02	74.4	58.1	13.0	0.63	88.6	90.87	-2.0	10.4
	T03	74.8	60.3	12.0	0.58	97.0	90.77	-2.2	10.2
	T04	77.8	40.3	11.8	0.60	79.9	90.35	-1.8	10.0
	T05	73.2	66.6	14.2	0.66	85.3	90.57	-1.9	9.7
	T06	75.9	51.9	12.8	0.60	79.1	90.68	-1.8	9.9
Wyoming	W01	74.1	49.3	10.5	0.51	98.9	91.65	-2.0	9.6

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			
Location		P (mm)	L (mm)	W (10-4 J)	P/L Ratio	Abs (14%mb)	Development Time (min)	Stability (min)	MTI (BU)
Colorado	C01	84	102	269	0.82	59.9	5.7	9.1	25
	C02	68	114	224	0.60	59.4	5.2	6.2	39
	C03	81	104	271	0.78	59.2	5.2	6.0	46
Kansas	K01	67	130	228	0.52	60.6	5.7	6.2	40
	K02	71	121	243	0.59	61.2	5.9	8.2	29
	K03	75	135	310	0.56	59.5	5.4	8.7	29
	K04	71	130	278	0.55	59.7	5.8	10.0	21
	K05	69	132	274	0.52	59.4	5.5	8.5	28
	K06	78	111	256	0.70	61.5	5.2	7.3	31
	K07	70	107	256	0.71	60.0	6.3	9.7	25
	K08	74	109	250	0.68	59.0	4.7	8.6	25
	K09	73	115	246	0.63	60.9	6.2	7.5	35
	K10	72	115	230	0.63	61.3	5.3	6.6	35
Montana	M01	75	103	262	0.73	59.9	5.4	5.1	52
	M02	86	118	364	0.73	59.6	6.4	11.4	27
	M03	77	105	262	0.73	59.7	6	7.9	29
	M04	80	117	314	0.68	59.4	6.2	8.0	34
	M05	78	95	257	0.82	58.2	5.9	8.2	41
	M06	72	101	258	0.71	57.2	4.5	9.7	26
	M07	91	97	315	0.94	61.5	4.8	6.9	36
Nebraska	N01	71	104	222	0.68	58.1	4.7	5.2	48
	N02	70	118	240	0.59	60.7	5.7	8.9	26
	N03	71	106	234	0.67	59.6	6.8	9.8	23
	N04	76	108	258	0.70	59.4	5.2	7.9	33
	N05	81	93	245	0.87	57.7	4.2	7.7	31
North Dakota	ND01	72	107	243	0.67	59.0	4.7	6.9	33
	ND02	58	138	237	0.42	58.5	4.7	6.4	42
	ND03	67	122	268	0.55	57.9	5.5	8.5	37
Oklahoma	O01	85	114	295	0.75	62.0	8.5	13.0	25
	O02	77	107	273	0.72	60.3	3.0	9.8	19
	O03	77	100	211	0.77	62.2	5.4	6.4	34
	O04	81	112	254	0.72	61.5	5.5	5.9	38
	O05	96	108	324	0.89	61.9	5.3	11.1	24
	O06	95	114	353	0.83	62.5	6.2	12.0	17
	O07	88	137	385	0.64	63.1	26.0	29.1	18
Pacific Northwest	PNW01	90	103	292	0.87	61.4	4.5	7.3	31
	PNW02	88	99	286	0.89	60.8	4.8	11.7	8
	PNW03	102	84	314	1.21	61.5	5.7	8.9	31
	PNW04	96	82	277	1.17	60.9	5	12.1	15
South Dakota	SD01	64	128	240	0.50	58.6	4.3	6.4	34
	SD02	61	126	211	0.48	58.7	4.4	7.4	24
Texas	T01	74	119	235	0.62	60.9	5.5	6.1	34
	T02	80	112	264	0.71	60.2	6.7	8.6	30
	T03	73	126	272	0.58	59.2	6.0	11.4	24
	T04	62	96	154	0.65	59.4	4.2	3.9	47
	T05	83	129	315	0.64	62.3	8.0	16.1	12
	T06	71	118	218	0.60	61.0	5.4	7.0	30
Wyoming	W01	80	102	269	0.78	58.7	6.8	12.9	20

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	3.8	62.7	865	6.3	7.0	dull
	C02	4.1	61.4	855	5.5	7.0	dull
	C03	4.5	62.0	815	5.5	7.0	dull
Kansas	K01	3.5	64.2	885	6.3	7.0	dull
	K02	4.0	62.7	875	4.8	5.5	dull
	K03	4.8	62.7	930	6.3	7.0	dull
	K04	4.5	64.5	920	7.8	7.0	dull
	K05	4.3	63.9	900	6.3	7.0	dull
	K06	3.9	62.8	830	5.5	5.5	dull
	K07	4.5	63.2	850	6.3	7.0	dull
	K08	4.5	62.7	870	6.3	7.0	dull
	K09	4.3	63.5	850	6.3	5.5	dull
	K10	3.5	62.3	830	4.8	5.5	dull
Montana	M01	5.8	62.3	830	5.5	7.0	dull
	M02	6.4	64.1	915	7.0	7.0	dull
	M03	5.1	61.8	840	5.5	7.0	dull
	M04	6.0	62.6	855	5.5	7.0	dull
	M05	6.8	61.4	825	8.5	7.0	dull
	M06	8.3	61.3	805	7.8	7.0	dull
	M07	6.6	63.8	850	6.3	7.0	dull
Nebraska	N01	4.5	61.2	805	7.0	7.0	dull
	N02	4.0	62.7	865	7.0	7.0	dull
	N03	4.1	63.6	850	5.5	7.0	dull
	N04	5.0	62.4	850	6.3	7.0	dull
	N05	5.0	60.8	780	6.3	7.0	dull
North Dakota	ND01	4.8	62.1	830	6.3	7.0	dull
	ND02	5.1	62.2	900	7.0	7.0	dull
	ND03	5.5	63.5	875	7.0	7.0	dull
Oklahoma	O01	5.0	65.6	905	7.0	7.0	dull
	O02	5.8	64.2	830	5.5	7.0	dull
	O03	3.3	63.2	825	5.5	5.5	dull
	O04	3.3	63.4	885	5.5	8.5	dull
	O05	4.8	66.3	875	7.0	8.5	dull
	O06	5.3	66.4	945	7.0	7.0	dull
	O07	4.8	67.4	980	7.0	8.5	dull
Pacific Northwest	PNW01	4.5	61.4	845	7.0	7.0	dull
	PNW02	4.6	61.2	800	6.3	7.0	dull
	PNW03	6.0	63.4	810	6.3	7.0	dull
	PNW04	5.0	61.5	815	5.5	7.0	dull
South Dakota	SD01	3.8	61.8	825	5.5	7.0	dull
	SD02	3.8	62.2	850	6.3	7.0	dull
Texas	T01	3.6	63.5	810	4.0	5.5	tan
	T02	4.0	63.1	910	4.8	5.5	tan
	T03	4.5	63.0	930	6.3	7.0	tan
	T04	3.1	60.0	790	4.8	5.5	tan
	T05	4.1	66.1	940	7.0	8.5	tan
	T06	3.0	62.5	845	5.5	7.0	tan
Wyoming	W01	5.3	61.3	775	7.0	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 38-12

Farinograph: 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.