PGI

PLAINS GRAINS INC.

Hard Red Winter Wheat

2018 Regional Quality Survey

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PGI
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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
Committee
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.

PLAINS GRAINS INC.

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 now subscribes to the PGI crop quality survey.

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 anti-oxidants 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 current 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 moderately high protein content and excellent milling and baking characteristics. 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.

Overview

Despite dry growing conditions in the southern states, the 2018 HRW crop has above average kernel characteristics and, in most cases, higher protein than the previous two crops. Quality attributes significantly exceed the last two years and many of the 5-year averages, results which indicate that this is one of the highest quality HRW crops in several years and will make high quality end products. This crop meets or exceeds typical HRW contract specifications and should provide high value to the customer.

Weather and Harvest

The 2018 hard red winter (HRW) planted area was 2.5% below the historically low planted area of the 2017 crop. With reduced yields and reduced area, 2018 HRW production is estimated to be 18.0 MMT (662 mil bu), down 12% from 2017's 20.4 MMT and 20% below the 5-year average production. Large beginning stocks offset the reduced production so the total HRW supply available for the 2018/19 marketing year is larger than three of the previous 5 years.

Conditions varied across the HRW growing regions. Texas, Oklahoma and Kansas were extremely dry during most of the growing season. By the time harvest started in early June USDA rated 85% of HRW in these three states to be in fair, poor or very poor condition. Late season precipitation helped to establish good kernel characteristics even though rains were too late and insufficient to improve yield. In contrast, 75% to 90% of the crop rated fair, good or excellent in the remaining HRW states north to eastern Montana. Because of dry conditions, disease and insect pressure was low.

Washington, Oregon, Idaho and central/north central Montana had adequate moisture throughout the year that helped maximize production. More than 90% of the HRW grown in these four states were rated fair, good or excellent in late June.

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. 478 (96% of the long-term average) samples were collected from grain elevators when at least 30% of the local harvest was completed in the 11 states of Texas, Oklahoma, Kansas, Colorado, Nebraska, Wyoming, South Dakota, Montana, Washington, Oregon and Idaho.

Official grade and non-grade parameters were determined on each sample. 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 11 states referenced above with weighting factors based on production calculated. The analytical methods used to define the reported parameters are described in the Methods section of this book.

Wheat and Grade Data

Despite challenging growing conditions in many areas, the 2018 crop has generally good kernel characteristics. Overall 93% of Composite, 91% of Gulf-Tributary and 98% of PNW-Tributary samples graded U.S. No. 2 or better. Test weight averages 60.9 lb/bu (80.2 kg/hl), above the

5-year average of 60.3 lb/bu (79.3 kg/hl) and above last year's average of 60.5 lb/bu (79.6 lb/bu). The total defects average of 1.4% is above last year's 1.2%, but below the 5-year average of 1.6%. Foreign material is 0.2%, slightly above last year's 0.1%, damaged kernels at 0.1% is below last year and the 5-year average, while shrunken and broken at 1.1% is above last year's 0.9% and equal to the 5-year average. Average thousand kernel weight of 30.7g exceeds the 5-year average of 29.8 g. The average wheat falling number 374 sec, comparable to the 2017 and 5-year averages, indicating sound wheat.

The average protein of 12.4% (12% mb) is significantly higher than last year and equal to the 5-year average. Protein content distribution varies by growing region; the Gulf-Tributary average is 12.7% and the PNW-Tributary average is 11.7%. Of the samples tested 12% were less than 11.5% protein, 29% between 11.5% to 12.5% and 59% greater than 12.5%.

Flour and Baking Data

The Buhler laboratory flour yield average is 75.1%, lower than the 2017 average of 78.1% and similar to the 5-year average of 75.7%. The 2018 flour ash of 0.44% (14% mb) is significantly lower than last year's 0.64% and the 5-year average of 0.59%. Composite average sedimentation and wet gluten values, 54.2 cc and 28.1%, respectively, are both higher than last year. Farinograph peak and stability times, 5.2 min and 12.2 min, respectively, are significantly higher than last year's 4.5 min and 6.1 min. The alveograph W value of 280 (10-4 J), extensograph resistance of 408 BU, extensograph area of 107 cm2 and loaf volume of 901 cc are all well above last year and the 5-year averages. Average bake absorption is 63.7%, above the 62.8% value for both 2017 and the 5-year average.

Hard Red Winter Wheat Production Charts

English Units

Hard Winter Wheat Production (1,000 bu.)

	2011	2012	2013	2014	2015	2016	2017	2018	Average
Colorado	78,000	83,250	43,500	89,300	79,180	105,120	86,860	70,200	79,426
Kansas	276,500	387,000	328,000	246,400	321,900	467,400	333,600	277,400	329,775
Montana	89,790	81,320	96,750	91,840	91,020	105,350	66,780	78,500	87,669
North Dakota	13,875	38,500	13,440	27,195	8,360	5,760	1,295	0	13,553
Nebraska	65,250	55,440	41,760	71,050	45,980	70,740	46,920	49,490	55,829
Oklahoma	70,400	155,400	115,500	47,600	98,800	136,500	98,600	70,000	99,100
Pacific NW	22,004	37,990	35,330	28,350	28,543	36,707	33,800	33,500	32,028
South Dakota	66,780	62,400	25,350	59,400	42,680	63,800	20,800	31,680	46,611
Texas	49,400	91,450	64,000	67,500	106,500	89,600	68,150	56,000	74,075
Wyoming	4,420	3,000	2,640	3,375	4,160	4,250	2,940	3,900	3,586
Regional Total	736,419	995,750	766,270	732,010	827,123	1,085,227	759,745	670,670	821,652

Hard Winter Wheat Harvested Acres (1,000 Acres)

	2011	2012	2013	2014	2015	2016	2017	2018	Average
Colorado	2,000	2,250	1,500	2,350	2,140	2,190	2,020	1,950	2,050
Kansas	7,900	9,000	8,200	8,800	8,700	8,200	6,950	7,300	8,131
Montana	2,190	2,140	2,150	2,240	2,220	2150	1,590	1,570	2,031
North Dakota	375	700	320	555	190	120	35	0	287
Nebraska	1,450	1,320	1,160	1,450	1,210	1,310	1,020	1,010	1,241
Oklahoma	3,200	4,200	3,500	2,800	3,800	3,500	2900	2,500	3,300
Pacific NW	293	535	530	417	434	456	451	431	443
South Dakota	1,590	1,300	650	1,080	970	1,100	520	660	984
Texas	1,900	2,950	2,000	2,250	3,550	2,800	2350	1,750	2,444
Wyoming	130	120	120	125	130	125	105	115	121
Regional Total	21,028	24,515	20,130	22,067	23,344	21,951	17,941	17,286	21,033

Hard Winter Wheat Yield (bu/ac)

	2011	2012	2013	2014	2015	2016	2017	2018	Average
Colorado	39	37	29	38	37	48	43	36	38
Kansas	45	43	40	28	37	57	48	38	42
Montana	41	38	45	41	41	49	42	38	42
North Dakota	37	55	42	49	44	48	37	0	39
Nebraska	45	42	36	49	38	54	46	49	45
Oklahoma	22	37	33	17	26	39	34	28	30
Pacific NW	76	75	68	66	70	82	75	32	68
South Dakota	42	48	39	55	44	58	40	78	51
Texas	26	31	32	30	30	32	29	44	32
Wyoming	34	25	22	27	32	34	28	34	30
Regional Avg	41	43	39	40	40	50	42	38	42

*** Some data derived from Crop Production report issued by USDA NASS updated September 30, 2018.*

Hard Red Winter Wheat Production Charts

Metric Units

Hard Winter Wheat Production (MMT)

	2011	2012	2013	2014	2015	2016	2017	2018	Average
Colorado	2.12	2.27	1.18	2.43	2.16	2.86	2.36	1.91	2.28
Kansas	7.53	10.53	8.93	6.71	8.76	12.72	9.08	7.55	9.26
Montana	2.44	2.21	2.63	2.50	2.48	2.87	1.82	2.14	2.44
North Dakota	0.38	1.05	0.37	0.74	0.23	0.16	0.04	0.00	0.43
Nebraska	1.78	1.51	1.14	1.93	1.25	1.93	1.28	1.35	1.57
Oklahoma	1.92	4.23	3.14	1.30	2.69	3.72	2.68	1.91	2.87
Pacific NW	0.60	1.03	0.96	0.77	0.78	1.00	0.92	0.91	0.83
South Dakota	1.82	1.70	0.69	1.62	1.16	1.74	0.57	0.86	1.38
Texas	1.34	2.49	1.74	1.84	2.90	2.44	1.85	1.52	2.26
Wyoming	0.12	0.08	0.07	0.09	0.11	0.12	0.08	0.11	0.10
Regional Total	26.61	20.04	27.10	20.86	19.92	22.51	29.54	20.68	23.41

Hard Winter Wheat Harvested Acres (1,000 ha)

	2011	2012	2013	2014	2015	2016	2017	2018	Average
Colorado	810	911	607	951	866	887	818	789	830
Kansas	3198	3644	3320	3563	3522	3320	2814	2955	3,292
Montana	887	866	870	907	899	870	644	636	822
North Dakota	0	283	130	225	77	49	14	0	97
Nebraska	587	534	470	587	490	530	413	409	503
Oklahoma	1296	1700	1417	1134	1538	1417	1174	1012	1,336
Pacific NW	119	217	215	169	176	185	183	174	180
South Dakota	644	526	263	437	393	445	211	267	398
Texas	769	1194	810	911	1437	1134	951	709	989
Wyoming	53	49	49	51	53	51	43	47	49
Regional Total	8,362	9,925	8,150	8,934	9,451	8,887	7,264	6,998	8,496

Hard Winter Wheat Yield (tons/ha)

	2011	2012	2013	2014	2015	2016	2017	2018	Average
Colorado	2.62	2.49	1.95	2.56	2.49	3.23	2.89	2.42	2.58
Kansas	3.03	2.89	2.69	1.88	2.49	3.83	3.23	2.56	2.82
Montana	2.76	2.56	3.03	2.76	2.76	3.30	2.82	2.56	2.82
North Dakota	2.62	3.70	2.82	3.30	2.96	3.23	2.49	0.00	2.62
Nebraska	3.03	2.82	2.42	3.30	2.56	3.63	3.09	3.30	3.02
Oklahoma	1.48	2.49	2.22	1.14	1.75	2.62	2.29	1.88	1.98
Pacific NW	5.11	5.04	4.57	4.44	4.71	5.51	5.04	2.15	4.57
South Dakota	2.82	3.23	2.62	3.70	2.96	3.90	2.69	5.25	3.40
Texas	1.75	2.08	2.15	2.02	2.02	2.15	1.95	2.96	2.14
Wyoming	2.29	1.68	1.48	1.82	2.15	2.29	1.88	2.29	1.98
Regional Avg	2.74	2.90	2.60	2.69	2.68	3.37	2.84	2.54	2.79

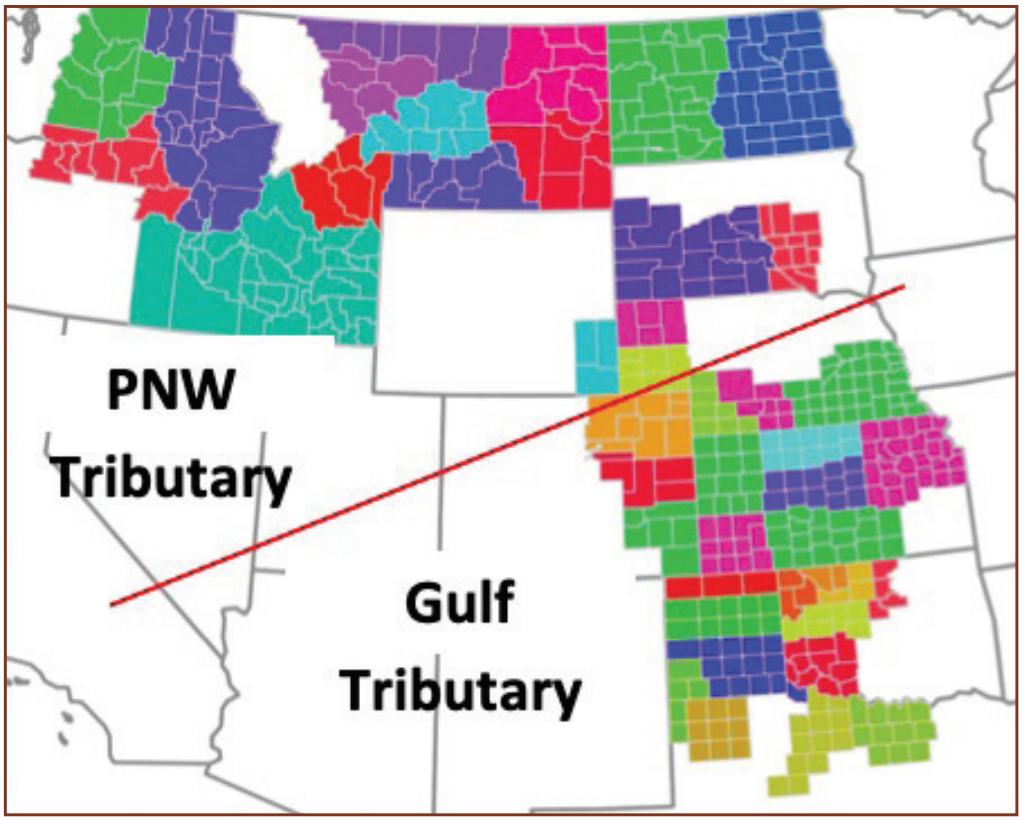
*** Some data derived from Crop Production report issued by USDA NASS updated September 30, 2018.*

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, Kansas, 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
Foreign 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
Unknown Foreign 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 objectionable foreign odor (except smut or garlic); or
(c) Is heating or of distinctly low quality.

*Includes damaged kernels (total), foreign materials, and shrunken 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.

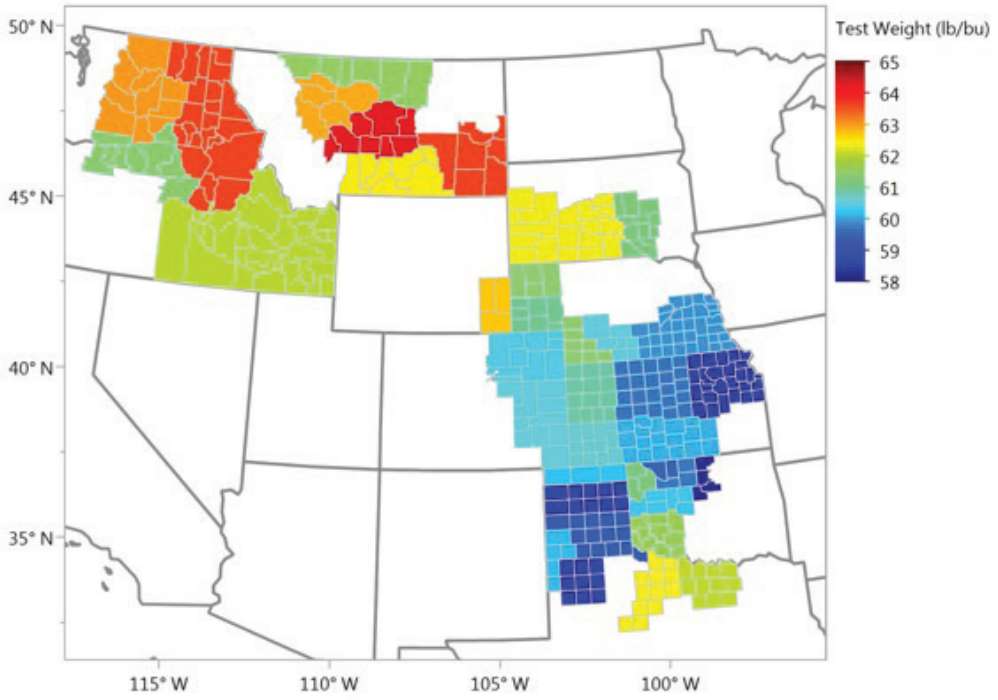
Foreign material is all matter other than wheat that remains in the sample after the removal of dockage and shrunken and broken kernels.

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.

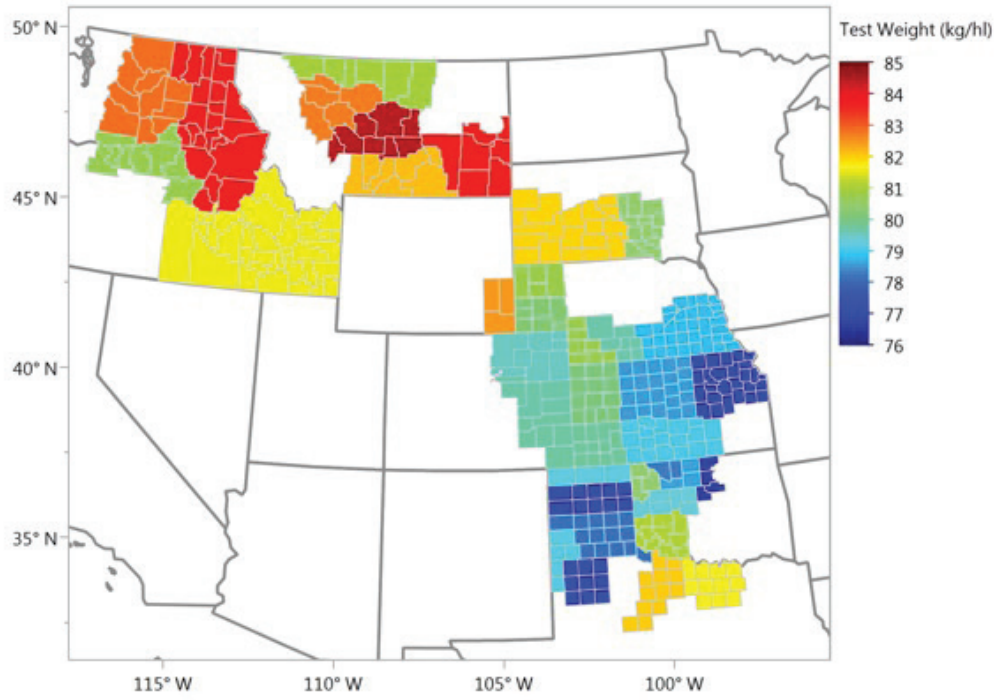
Damaged kernels are kernels, pieces of wheat kernels, and other grains that are badly ground-damaged, badly weather damaged, diseased, frost-damaged, germ damaged, heat-damaged, insect-bored, mold-damaged, sprout-damaged, or otherwise materially damaged.

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)



Test Weight (kg/hl)



Wheat Grading Data

Location		Official Grade (U.S. NO.)	Dockage (%)	Test Wt (lb/bu)	Test Wt (kg/hl)	Damage Kernels Total (%)	Shrunken & Broken Kernels (%)	Foreign Material (%)
Colorado	C01	1	0.3	60.6	79.7	0.0	1.2	0.1
	C02	1	0.4	60.6	79.7	0.1	1.4	0.1
	C03	1	0.4	60.6	79.7	0.1	1.1	0.3
Kansas	K01	1	0.3	60.7	79.8	0.3	1.0	0.1
	K02	1	0.6	60.2	79.2	0.2	1.5	0.2
	K03	2	0.4	59.7	78.6	0.1	1.4	0.2
	K04	2	0.3	58.6	77.1	0.1	1.4	0.1
	K05	2	0.3	59.7	78.6	0.1	1.3	0.1
	K06	1	0.4	60.9	80.1	0.1	0.8	0.1
Montana	M01	1	0.6	62.5	82.2	0.4	0.5	0.1
	M02	1	0.4	61.6	81.0	0.3	0.6	0.0
	M03	1	0.4	63.0	82.8	0.2	0.7	0.1
	M04	1	0.5	64.3	84.5	0.2	1.3	0.1
	M06	1	0.4	63.7	83.7	0.0	0.6	0.3
Nebraska	N01	1	0.4	60.9	80.2	0.2	0.8	0.2
	N02	1	0.4	61.3	80.6	0.2	0.9	0.1
	N03	1	0.2	60.5	79.6	0.3	1.1	0.2
	N04	2	0.3	59.9	78.8	0.3	1.2	0.2
	N05	1	0.8	61.4	80.8	0.1	0.9	0.2
Oklahoma	O01	1	0.6	61.7	81.1	0.1	1.3	0.2
	O02	1	0.8	60.1	79.1	0.2	1.8	0.2
	O03	1	0.4	60.2	79.2	0.0	1.3	0.1
	O04	1	0.3	61.2	80.5	0.2	1.7	0.1
	O05	2	0.3	59.5	78.3	0.1	1.8	0.1
	O06	2	0.6	59.8	78.7	0.2	2.0	0.3
	O07	2	2.5	58.3	76.7	0.0	2.1	0.2
Pacific Northwest	PNW01	1	0.3	63.1	82.9	0.0	0.4	0.0
	PNW02	1	0.9	61.4	80.8	0.0	0.5	0.1
	PNW03	1	0.3	63.7	83.7	0.0	0.4	0.0
	PNW04	1	0.3	62.1	81.6	0.0	0.8	0.0
South Dakota	SD01	1	0.4	62.4	82.0	0.2	0.7	0.1
	SD02	1	0.4	61.8	81.3	0.2	0.8	0.1
Texas	T01	2	0.4	58.7	77.2	0.0	1.9	0.2
	T02	1	0.8	62.4	82.1	0.1	0.8	0.1
	T03	1	1.2	62.1	81.7	0.1	1.2	0.3
	T04	1	0.6	60.2	79.2	0.2	1.2	0.1
	T05	2	0.4	59.4	78.2	0.1	1.4	0.2
	T06	2	0.5	58.7	77.2	0.7	1.3	0.3
Wyoming	W01	1	0.5	62.8	82.5	0.1	1.6	0.4

Kernel Quality Data

Location		Total Defects (%)	Kernel Size Large (%)	Kernel Size Med (%)	Kernel Size Small (%)	Thousand Kernal Wt (g)	SKCS Avg Diam (mm)
Colorado	C01	1.2	58.4	39.7	1.9	29.6	2.56
	C02	1.5	49.5	48.1	2.4	29.6	2.53
	C03	1.5	60.4	38.1	1.5	29.6	2.53
Kansas	K01	1.4	60.5	37.8	1.7	29.3	2.53
	K02	1.9	53.6	44.7	1.7	29.4	2.51
	K03	1.6	53.0	44.9	2.1	28.6	2.49
	K04	1.6	59.6	38.5	1.9	30.0	2.54
	K05	1.5	53.8	44.2	2.0	29.1	2.52
	K06	1.0	63.2	35.6	1.2	29.2	2.51
Montana	M01	1.0	79.0	20.7	0.3	34.6	2.73
	M02	1.0	63.1	36.0	0.9	32.9	2.63
	M03	1.0	72.8	26.6	0.6	34.0	2.68
	M04	1.6	80.0	18.8	1.3	33.9	2.75
	M06	0.9	82.1	17.1	0.8	33.1	2.70
Nebraska	N01	1.1	65.1	33.8	1.1	29.4	2.52
	N02	1.2	61.9	37.1	1.0	28.9	2.51
	N03	1.6	59.7	39.0	1.3	30.0	2.54
	N04	1.8	57.9	40.5	1.6	29.6	2.52
	N05	1.1	62.7	36.2	1.1	30.0	2.54
Oklahoma	O01	1.5	50.2	48.0	1.8	29.2	2.50
	O02	2.2	34.7	62.3	3.0	29.2	2.54
	O03	1.5	52.1	46.4	1.5	28.3	2.47
	O04	2.0	28.8	67.2	4.0	32.3	2.61
	O05	2.0	33.7	63.2	3.1	29.5	2.54
	O06	2.4	46.4	50.4	3.3	30.6	2.58
	O07	2.3	38.3	58.5	3.3	27.9	2.45
Pacific Northwest	PNW01	0.4	86.4	13.3	0.3	36.7	2.92
	PNW02	0.5	73.1	26.1	0.8	31.6	2.77
	PNW03	0.5	91.9	7.7	0.4	38.7	2.97
	PNW04	0.9	86.7	13.0	0.3	35.1	2.88
South Dakota	SD01	1.0	60.6	38.5	1.0	30.2	2.54
	SD02	1.1	61.0	38.0	1.0	30.3	2.55
Texas	T01	2.1	36.7	60.4	2.9	27.7	2.46
	T02	1.1	64.9	34.0	1.2	29.2	2.52
	T03	1.5	66.8	31.9	1.3	27.7	2.45
	T04	1.4	56.5	41.8	1.7	29.6	2.54
	T05	1.6	46.1	52.1	1.8	27.7	2.45
	T06	2.2	59.3	39.2	1.5	28.5	2.48
Wyoming	W01	2.1	71.9	27.0	1.1	31.3	2.61

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 all purpose 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.

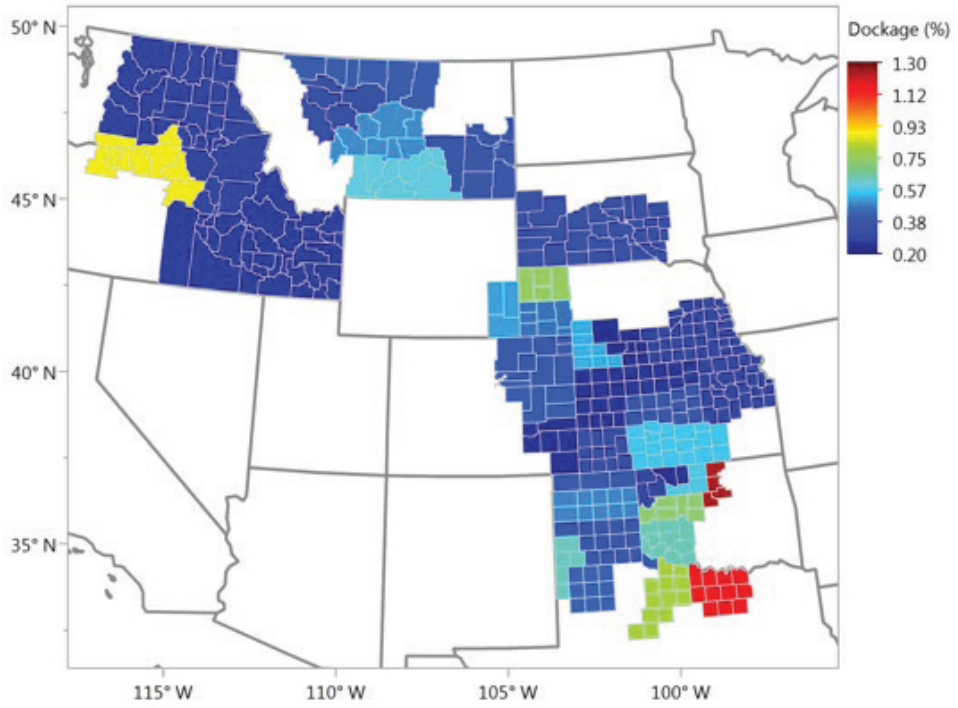
Falling number is an index of enzyme activity in wheat or flour and is expressed in seconds. Falling numbers above 300 are desirable, as they indicate little enzyme activity and a sound quality product. Falling numbers below 300 are indicative of more substantial enzyme activity and sprout damage.

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.

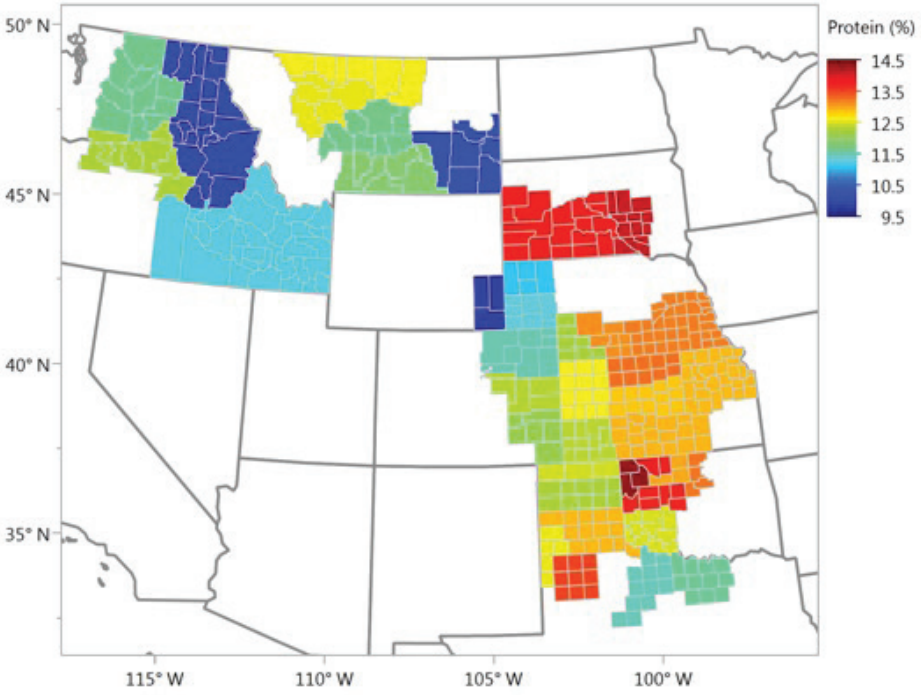
Kernel Size is a measure of the percentage by weight of large, medium and small kernels in a sample. Large kernels or more uniform kernel size may help improve milling yield.

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.

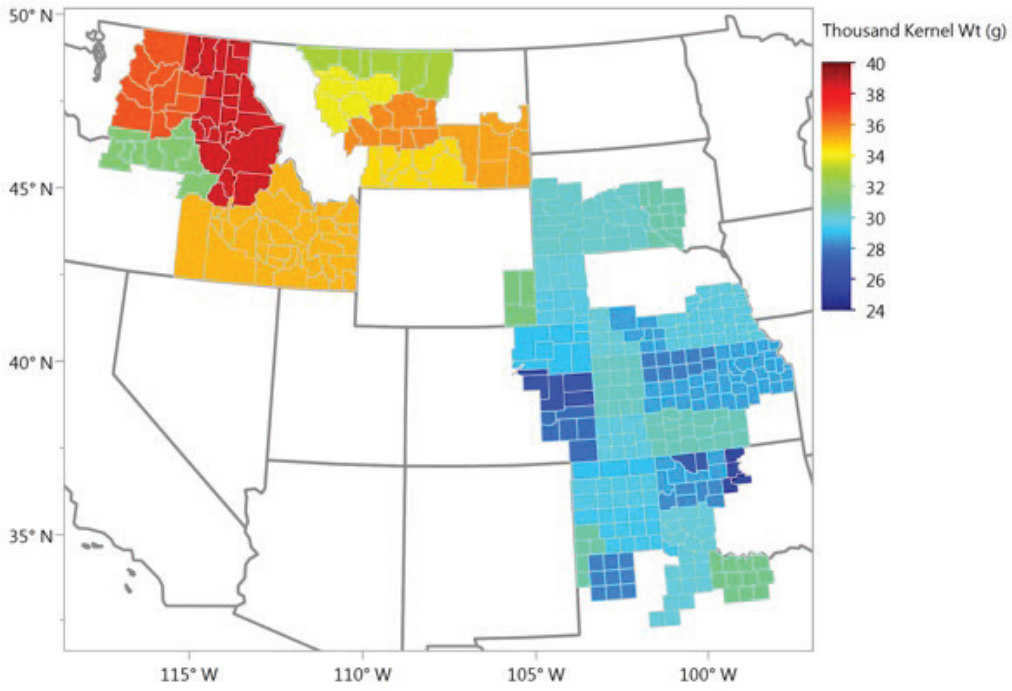
Dockage (%)



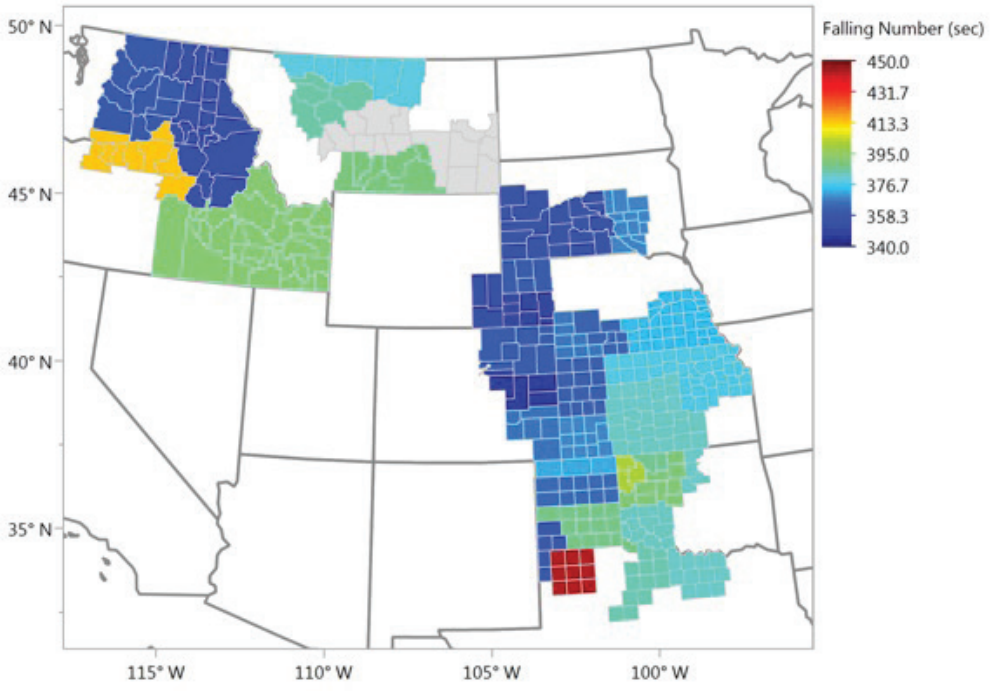
Protein (%)



Thousand Kernel Weight (g)



Falling Number (seconds)



Other Wheat Characteristics (non-grade data)

Location		Wheat Protein (12% mb)	Indv Wheat Ash (12% mb)	Falling Number (sec)	Moisture (%)	SKCS Avg Hard
Colorado	CO1	12.2	1.61	367	10.2	65.7
	CO2	12.4	1.63	347	10.6	67.6
	CO3	11.4	1.60	360	12.1	67.6
Kansas	K01	12.4	1.47	369	11.0	65.8
	K02	13.0	1.61	383	12.2	63.6
	K03	12.9	1.58	382	12.3	64.1
	K04	13.0	1.54	378	13.0	65.7
	K05	13.3	1.56	378	11.8	62.2
	K06	12.7	1.49	363	10.6	65.6
Montana	M01	11.9	1.54	390	12.5	76.1
	M02	12.6	1.37	379	10.9	74.0
	M03	12.6	1.38	385	11.6	80.6
	M04	11.7	1.38	369	10.2	65.7
	M06	10.3	1.47	379	11.4	72.1
Nebraska	N01	11.5	1.61	350	11.8	64.3
	N02	12.3	1.56	375	11.1	64.8
	N03	13.3	1.59	372	10.7	61.8
	N04	13.3	1.60	374	11.0	62.5
	N05	11.1	1.58	362	12.6	69.4
Oklahoma	O01	12.5	1.51	383	11.1	67.2
	O02	14.0	1.55	387	11.5	66.6
	O03	12.5	1.53	373	11.5	65.9
	O04	14.4	1.68	402	10.2	78.0
	O05	13.8	1.55	387	10.9	61.7
	O06	12.9	1.52	392	11.4	66.6
	O07	13.3	1.53	383	12.7	67.8
Pacific Northwest	PNW01	11.7	1.44	361	8.6	66.3
	PNW02	12.3	1.36	415	7.8	68.0
	PNW03	10.1	1.30	357	8.3	63.2
	PNW04	11.3	1.43	392	7.9	66.4
South Dakota	SD01	13.8	1.67	358	11.5	73.3
	SD02	13.9	1.69	363	11.8	69.4
Texas	T01	13.6	1.47	445	12.3	66.6
	T02	11.5	1.43	384	10.8	61.0
	T03	11.6	1.43	382	10.8	59.9
	T04	12.6	1.63	361	11.4	61.6
	T05	13.0	1.55	388	12.2	67.3
	T06	12.3	1.60	365	11.5	63.3
Wyoming	W01	9.9	1.48	355	11.3	71.7

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	CO1	75.6	47.1	10.7	0.44	97.8	91.5	-1.8	10.1
	CO2	74.2	57.9	11.2	0.45	97.9	91.6	-1.7	10.0
	CO3	74.4	50.2	10.1	0.43	98.8	91.8	-1.8	10.2
Kansas	KO1	75.8	55.0	13.6	0.44	98.5	91.7	-1.8	10.5
	KO2	74.6	53.4	16.6	0.47	98.4	91.6	-1.8	10.5
	KO3	74.8	53.2	11.6	0.46	96.7	91.2	-1.7	10.3
	KO4	74.3	52.3	11.6	0.44	96.7	91.7	-1.8	10.3
	KO5	75.1	53.3	11.8	0.45	98.8	91.5	-1.7	10.1
	KO6	75.7	59.0	11.2	0.42	98.1	91.5	-1.7	10.0
Montana	MO1	76.1	48.4	10.8	0.44	94.6	91.8	-1.8	10.3
	MO2	73.8	64.9	11.7	0.42	99.2	91.7	-1.7	10.3
	MO3	74.5	57.4	10.8	0.39	98.5	92.0	-1.7	10.1
	MO4	75.7	52.7	10.6	0.42	94.3	91.8	-1.7	10.1
	MO6	75.7	43.9	9.4	0.43	99.7	92.0	-1.8	10.0
Nebraska	NO1	74.6	50.0	10.5	0.44	97.6	91.8	-1.8	10.3
	NO2	74.7	50.8	11.0	0.43	94.4	91.8	-1.8	10.2
	NO3	73.4	59.5	11.8	0.44	98.1	91.7	-1.7	9.9
	NO4	75.0	54.9	11.8	0.43	98.1	91.3	-1.6	9.7
	NO5	74.4	46.5	9.7	0.45	98.4	91.9	-1.9	10.6
Oklahoma	OO1	75.5	52.5	11.9	0.44	94.4	91.2	-1.7	10.3
	OO2	73.7	56.9	12.4	0.45	96.9	91.1	-1.6	10.2
	OO3	74.7	51.5	11.4	0.47	98.0	91.8	-1.8	10.4
	OO4	73.9	55.8	13.2	0.48	91.0	91.3	-1.6	10.3
	OO5	75.2	60.4	12.6	0.47	98.2	91.3	-1.6	10.2
	OO6	74.9	55.4	12.2	0.46	98.1	91.3	-1.6	10.2
	OO7	75.3	51.9	11.9	0.48	98.0	91.5	-1.6	9.7
Pacific Northwest	PNW01	77.1	52.3	10.4	0.44	99.4	91.7	-1.5	9.6
	PNW02	75.7	56.6	11.2	0.43	98.1	91.8	-1.5	9.7
	PNW03	77.3	43.8	8.8	0.39	99.7	92.0	-1.7	10.0
	PNW04	77.5	41.3	10.0	0.44	95.4	91.6	-1.6	10.3
South Dakota	SD01	76.9	63.2	12.1	0.45	94.4	91.7	-1.7	10.2
	SD02	74.6	67.3	12.7	0.44	97.3	91.7	-1.4	9.1
Texas	TO1	74.6	59.2	12.3	0.46	97.2	90.8	-1.6	10.3
	TO2	77.0	40.2	9.9	0.46	99.1	91.5	-1.9	10.6
	TO3	76.1	39.7	10.3	0.44	95.3	91.8	-1.9	10.4
	TO4	73.8	43.4	11.4	0.47	92.1	91.2	-1.7	9.9
	TO5	74.6	56.1	11.7	0.46	98.1	91.4	-1.8	10.5
	TO6	74.4	47.8	11.5	0.46	90.2	91.4	-1.7	10.2
Wyoming	WO1	74.9	40.2	8.7	0.44	99.0	92.2	-2.0	10.6

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.

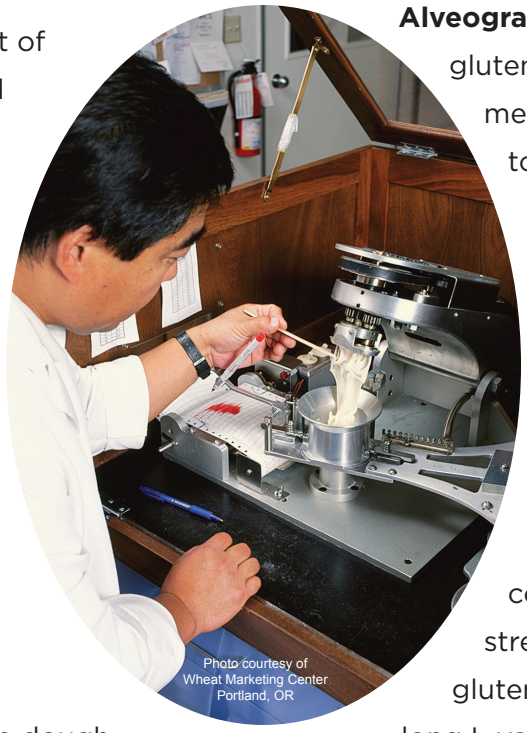


Photo courtesy of Wheat Marketing Center Portland, OR

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” relates 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)	Development Time (min)	Stability (min)	MTI (BU)
Colorado	CO1	79	102	277	0.77	57.2	5.0	10.9	28
	CO2	80	88	263	0.92	57.2	5.4	13.3	9
	CO3	86	73	240	1.26	57.0	3.4	10.4	22
Kansas	KO1	75	97	265	0.78	57.6	7.3	14.4	18
	KO2	78	101	278	0.80	58.3	6.3	13.4	19
	KO3	75	93	266	0.81	57.5	4.1	16.4	5
	KO4	80	97	277	0.82	57.9	7.0	14.2	20
	KO5	87	82	279	1.06	58.6	4.0	13.6	7
	KO6	76	96	271	0.80	57.2	3.7	11.3	16
Montana	MO1	96	70	252	1.37	60.5	4.5	9.6	19
	MO2	94	99	357	0.95	60.9	4.4	13.0	17
	MO3	107	69	282	1.55	60.9	3.0	12.0	4
	MO4	91	80	273	1.14	59.4	2.7	7.8	30
	MO6	86	74	246	1.16	58.6	2.0	7.0	35
Nebraska	NO1	79	91	254	0.87	57.9	4.8	11.9	17
	NO2	82	90	268	0.96	57.8	5.9	12.7	20
	NO3	80	89	273	0.90	58.1	6.3	12.6	16
	NO4	67	95	247	0.71	57.7	4.1	12.6	15
	NO5	94	70	248	1.36	58.0	3.2	11.4	18
Oklahoma	OO1	80	116	317	0.69	59.1	7.4	13.7	22
	OO2	87	119	362	0.73	59.9	7.2	14.2	16
	OO3	79	98	271	0.81	57.9	6.7	12.0	29
	OO4	89	121	359	0.74	61.2	6.0	13.2	17
	OO5	82	97	308	0.85	58.8	7.9	16.3	17
	OO6	80	102	313	0.78	58.5	7.4	12.8	22
	OO7	71	100	256	0.71	56.9	5.4	14.2	14
Pacific Northwest	PNW01	99	80	293	1.26	60.1	3.9	9.0	28
	PNW02	90	94	298	1.01	59.6	5.2	12.4	19
	PNW03	109	48	212	2.27	60.5	1.8	2.0	54
	PNW04	103	68	252	1.53	60.8	4.1	6.5	38
South Dakota	SD01	79	108	305	0.73	59.6	8.3	15.0	22
	SD02	74	108	289	0.75	59.7	6.5	12.8	17
Texas	TO1	91	74	283	1.23	58.2	4.9	18.2	7
	TO2	87	74	247	1.17	57.6	4.4	11.1	20
	TO3	87	73	240	1.20	58.3	4.7	9.9	37
	TO4	83	94	243	0.88	60.3	4.5	6.1	40
	TO5	81	98	290	0.83	57.7	5.7	12.7	14
	TO6	67	117	247	0.57	57.2	6.0	10.4	27
Wyoming	WO1	92	54	192	1.70	57.7	2.0	8.7	21

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	5.0	62.0	895	7.0	7.0	Yellow
	C02	5.2	62.9	902	6.1	7.0	Yellow
	C03	5.5	62.1	848	6.1	5.4	S. Yellow
Kansas	K01	5.4	64.5	937	6.5	7.0	Creamy
	K02	5.5	67.6	927	8.0	7.0	Creamy
	K03	5.5	64.0	970	7.0	7.0	S. Yellow
	K04	4.8	63.2	975	6.3	5.5	S. Yellow
	K05	5.5	63.2	975	8.5	7.0	S. Yellow
	K06	5.1	62.9	915	6.8	5.7	S. Yellow
Montana	M01	4.5	63.4	815	5.5	7.0	S. Yellow
	M02	5.3	63.6	840	6.3	7.0	Yellow
	M03	5.0	61.6	790	4.0	5.5	Yellow
	M04	5.0	63.2	815	7.8	7.0	Yellow
	M06	5.5	61.4	720	5.5	4.0	Creamy
Nebraska	N01	4.9	62.8	868	7.0	6.5	S. Yellow
	N02	5.1	62.4	861	6.6	6.4	S. Yellow
	N03	5.8	63.7	915	6.3	7.0	Yellow
	N04	5.8	63.4	935	6.3	7.0	Creamy
	N05	5.9	63.2	820	5.9	6.3	S. Yellow
Oklahoma	O01	4.8	63.6	890	7.0	7.0	Creamy
	O02	5.3	65.5	985	7.8	7.0	S. Yellow
	O03	4.5	62.8	910	7.0	7.0	S. Yellow
	O04	4.5	65.4	975	6.3	7.0	Creamy
	O05	5.5	64.5	1000	8.5	7.0	Creamy
	O06	5.6	64.5	962	5.7	7.0	S. Yellow
	O07	5.9	63.5	960	7.0	7.0	Creamy
Pacific Northwest	PNW01	4.8	63.7	815	5.9	6.3	Creamy
	PNW02	5.0	63.8	863	5.0	6.0	Creamy
	PNW03	5.3	61.9	675	4.0	4.0	Yellow
	PNW04	4.4	64.1	825	5.2	6.3	Yellow
South Dakota	SD01	4.3	64.1	950	4.8	5.5	Yellow
	SD02	4.8	65.7	975	8.5	7.0	Creamy
Texas	T01	7.3	64.2	980	7.0	7.0	Creamy
	T02	5.3	60.0	811	6.1	5.9	S. Yellow
	T03	4.6	61.3	809	6.1	6.0	S. Yellow
	T04	3.5	62.5	900	7.0	7.0	Creamy
	T05	5.8	63.2	963	7.9	7.0	S. Yellow
	T06	4.5	62.7	950	7.8	7.0	S. Yellow
Wyoming	W01	5.3	61.1	735	5.5	4.0	Yellow

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.