PGI

PLAINS GRAINS INC.

Hard Red Winter Wheat

2019 Regional Quality Survey

Cover Photo: Todd Johnson, Oklahoma State University

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Colorado Wheat
Administrative Committee
coloradowheat.org

Idaho Wheat Commission
idahowheat.org

Oklahoma Wheat Commission
wheat.state.ok.us

Kansas Wheat Commission
kswheat.com

North Dakota
Wheat Commission
ndwheat.com

South Dakota
Wheat Commission
sdwheat.org

Nebraska Wheat Board
nebraskawheat.com

Washington Grain Commissio
washingtongrainalliance.com

Texas Wheat Producers
Board and Association
texaswheat.org

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

Oregon Wheat Commission
owgl.org

Wyoming Wheat
Growers Association
wyomingwheat.com

Plains Grains, Inc.

Plains Grains Inc. (PGI), a nonprofit, private quality-based marketing initiative, was formed in 2004 through the Oklahoma Wheat Commission, Oklahoma Department of Agriculture, Food and Forestry and 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 PGI's marketing goals to have quality data for the entire Hard Red Winter (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 now subscribes to the PGI crop quality survey.

Visit our website at **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% 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 States' 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 kernels' color and planting time. Other classes are Durum, Hard Red Spring, Soft Red Winter, Hard White and Soft White.

Almost 50% of the wheat produced in the U.S. is exported. Approximately one-third of the HRW produced is exported. Nigeria is the No. 1 importer of U.S. HRW, with a little more than 75% 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 versatile 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 improving blending.

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

National Wheat Overview

Wheat Major Classes

The six major classes of U.S. wheat are Hard Red Winter (HRW), Hard Red Spring, Soft Red Winter, Soft White, Hard White (HW) 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 (HRW) and Hard White wheat classes, therefore the data in this publication will focus on the quality of those classes for the current crop year.

HRW wheat accounts for about 40% 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% of total U.S. wheat production.

This fall-seeded wheat is versatile 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.

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 flatbreads.

Crop Production Review & Analysis

Overview

The 2019 Hard Red Winter (HRW) wheat crop was a sharp contrast to the 2018 crop when moisture was very limiting throughout the growing season, leading to a low production year but with protein concentration in the kernel. On the other hand, the 2019 crop was planted and developed in a favorable environment throughout the growing season including abundant rainfall late in the growing season. The growing season was so favorable the crop in most areas matured 10 days to two weeks later than normal. The environment effect was virtually no stress in the crop in the Northern, Central and Southern Plains while areas of the Pacific Northwest and Montana battled weather extremes. These conditions provided for record, or near-record, yields and larger-than-normal compact kernels (high TKW and kernel diameter). However, testing would also indicate that even though mix times and tolerances are shorter than the five-year averages, the loaf volumes achieved indicate adequate protein quality to make an excellent quality loaf of bread (exceeded the five-year average loaf volume). This crop meets or exceeds typical HRW contract specifications and provides high value to the customer.

Weather and Harvest

The 2019 U.S. HRW wheat crop planted area continues to hover at historic 100-year lows. However, the 2019 HRW production is estimated at 840 million bushels (22.9 MMT) and up 27% from the 2018 crop of 662 million bushels (18.0 MMT) while planted area remained virtually unchanged. Large beginning world stocks and low prices (still below the cost of production) partially offset the marked production increase. USDA estimated the HRW supply (excluding imports) at the third highest in the last 20 years. Variable conditions challenged this crop like most years, but moisture remained adequate or even excessive, in the central and southern production areas especially. This resulted generally in better-than-expected yields, lower-than-average protein but otherwise good milling and processing characteristics. Throughout the Southern, Central and Northern Plains, an unusually wet spring from late April to early June (many areas saw 20 inches/50 cm) or more over that period accompanied by severe weather) uniformly delayed harvest two weeks or more. At the same time the Pacific Northwest and Montana experienced abnormal swings in temperature and severe storms. Disease and insect pressure in most production areas were unusually low considering the intense and prolonged moisture received during the later stages of crop development. Overall, these conditions favored kernel size, weight and number of kernels developed.

Samples and Methods

Sample collection and analysis were conducted in a collaborative effort between the USDA ARS Hard Winter Wheat Quality Lab (Manhattan, Kansas), American Institute of Baking (AIB), Enid Grain Inspection and Plains Grains Inc. Overall, 494 (99% 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 Colorado, Idaho, Kansas, Montana, Nebraska, Oklahoma, Oregon, South Dakota, Texas, Washington and Wyoming.

Official grade and non-grade parameters were determined on each sample—106 composites were then formed based on production regions and protein ranges of <11.5%, 11.5%–12.5%, and >12.5% for overall kernel characteristics. Milling, dough-functionality and bake tests were run on 74 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 HRW wheat production in the 11 states referenced above with weighting factors applied based on production and protein ranges calculated. The analytical methods used to define the reported parameters are described in the Analysis Methods section of this book.

Crop Production Review & Analysis

Wheat and Grade Data

The overall composite 2019 Hard Red Winter (HRW) wheat crop official grade averaged 93% Grade No. 2 or better (Gulf tributary averaging 91% and PNW tributary averaging 97%) when considering all samples. The overall dockage level of 0.5% is comparable to last year's average of 0.5% and slightly better than the five-year average of 0.6%. Total defects of 1.3% are below last year's average of 1.4% and five-year average of 1.4%. Foreign material is 0.2% and is comparable to last year's 0.2% and the five-year average of 0.2% while shrunken and broken (0.8%) is significantly below last year's 1.1% and the five-year average of 1.0%. Wheat ash (14% mb) is 1.50% and comparable to last year's 1.49% and below the five-year average of 1.51%. Overall test weight averaged 60.6 lb/bu (79.6 kg/hl) and is below last year's 60.9 lb/bu (80.2 kg/hl) but is above the five-year average of 60.3 lb/bu (79.3 kg/hl). The overall average thousand kernel weight of 32.7 g significantly exceeds last year and the five-year average (both 30.7 g). Average kernel diameter is 2.66 mm is well above last year and five-year average (2.60 mm and 2.61 mm respectively). However, the average protein of 11.4% is significantly below last year's 12.4% and the five-year average of 12.2%. Overall kernel characteristics were outstanding in the 2019 crop with protein quantity (not quality) being of the most concern. Protein content splits varied across the testing region and by tributary with approximately 60% of samples being in the <11.5% protein content category, 28% in the 11.5%–12.5% category and 12% in the <12.5% category. The average wheat falling number for this crop is 378 seconds and is comparable to the 2018 average of 374 seconds and the five-year average of 384 seconds indicating sound wheat.

Flour and Baking Data

The Buhler flour yield overall averaged 74.0%, comparable to the 2018 average of 75.1% and the five-year average of 75.5%. However, flour ash is 0.48% (14% mb) and is comparable to 2018 (0.44%) but significantly lower than the five-year average (0.55%). The W value of 223 (10-4 J) is significantly lower than last year's 280 (10-4 J), but is comparable to the five-year average of 234 (10-4 J). Overall average bake absorption is 62.7% which is below the 2018 absorption of 63.7% and comparable to the five-year average of 63.0%. Farinograph development and stability times are 3.3 minutes and 7.3 minutes respectively as compared to last year's 5.2 minutes and 12.2 minutes respectively. Both are lower than the five-year averages of 4.9 minutes and 8.2 minutes respectively. Overall loaf volume averaged 863cc and while lower than 2018 (901cc), is comparable the five-year average of 851cc.

Hard Red Winter Wheat Production Charts

English Units

Hard Winter Wheat Production (1,000 bu.)

	2012	2013	2014	2015	2016	2017	2018	2019	Average
Colorado	83,250	43,500	89,300	79,180	105,120	86,860	70,200	98,000	81,926
Kansas	387,000	328,000	246,400	321,900	467,400	333,600	277,400	338,000	337,463
Montana	81,320	96,750	91,840	91,020	105,350	66,780	78,500	95,000	88,320
North Dakota	38,500	13,440	27,195	8,360	5,760	1,295	3,010	3,710	12,659
Nebraska	55,440	41,760	71,050	45,980	70,740	46,920	49,490	55,290	54,584
Oklahoma	155,400	115,500	47,600	98,800	136,500	98,600	70,000	110,000	104,050
Pacific NW	37,990	35,330	28,350	28,543	36,707	33,800	33,500	32,463	33,335
South Dakota	62,400	25,350	59,400	42,680	63,800	20,800	31,680	40,040	43,269
Texas	91,450	64,000	67,500	106,500	89,600	68,150	56,000	69,700	76,613
Wyoming	3,000	2,640	3,375	4,160	4,250	2,940	3,900	4,730	3,624
Regional Total	995,750	766,270	732,010	827,123	1,085,227	759,745	673,680	846,933	835,842

Hard Winter Wheat Harvested Acres (1,000 Acres)

	2012	2013	2014	2015	2016	2017	2018	2019	Average
Colorado	2,250	1,500	2,350	2,140	2,190	2,020	1,950	2,000	2,050
Kansas	9,000	8,200	8,800	8,700	8,200	6,950	7,300	6,500	7,956
Montana	2,140	2,150	2,240	2,220	2,150	1,590	1,570	1,900	1,995
North Dakota	700	320	555	190	120	35	70	70	258
Nebraska	1,320	1,160	1,450	1,210	1,310	1,020	1,010	970	1,181
Oklahoma	4,200	3,500	2,800	3,800	3,500	2,900	2,500	2,750	3,244
Pacific NW	535	530	417	434	456	451	431	432	461
South Dakota	1,300	650	1,080	970	1,100	520	660	770	881
Texas	2,950	2,000	2,250	3,550	2,800	2,350	1,750	2,050	2,463
Wyoming	120	120	125	130	125	105	115	110	119
Regional Total	24,515	20,130	22,067	23,344	21,951	17,941	17,356	17,552	20,607

Hard Winter Wheat Yield (bu/ac)

	2012	2013	2014	2015	2016	2017	2018	2019	Average
Colorado	37	29	38	37	48	43	36	49	40
Kansas	43	40	28	37	57	48	38	52	43
Montana	38	45	41	41	49	42	50	50	45
North Dakota	55	42	49	44	48	37	43	53	46
Nebraska	42	36	49	38	54	46	49	57	46
Oklahoma	37	33	17	26	39	34	28	40	32
Pacific NW	75	68	66	70	82	75	79	75	74
South Dakota	48	39	55	44	58	40	48	52	48
Texas	31	32	30	30	32	29	32	34	31
Wyoming	25	22	27	32	34	28	34	43	31
Regional Avg	43	39	40	40	50	42	44	51	44

*** 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)

	2012	2013	2014	2015	2016	2017	2018	2019	Average
Colorado	2.27	1.18	2.43	2.16	2.86	2.36	1.91	2.67	2.23
Kansas	10.53	8.93	6.71	8.76	12.72	9.08	7.55	9.20	9.19
Montana	2.21	2.63	2.50	2.48	2.87	1.82	2.14	2.59	2.40
North Dakota	1.05	0.37	0.74	0.23	0.16	0.04	0.08	0.10	0.34
Nebraska	1.51	1.14	1.93	1.25	1.93	1.28	1.35	1.50	1.49
Oklahoma	4.23	3.14	1.30	2.69	3.72	2.68	1.91	2.99	2.83
Pacific NW	1.03	0.96	0.77	0.78	1.00	0.92	0.91	0.88	0.91
South Dakota	1.70	0.69	1.62	1.16	1.74	0.57	0.86	1.09	1.18
Texas	2.49	1.74	1.84	2.90	2.44	1.85	1.52	1.90	2.09
Wyoming	0.08	0.07	0.09	0.11	0.12	0.08	0.11	0.13	0.10
Regional Total	2.71	2.09	1.99	2.25	2.95	2.07	1.83	2.31	2.28

Hard Winter Wheat Harvested Acres (1,000 ha)

	2012	2013	2014	2015	2016	2017	2018	2019	Average
Colorado	911	607	951	866	887	818	789	810	830
Kansas	3,644	3,320	3,563	3,522	3,320	2,814	2,955	2,632	3,221
Montana	866	870	907	899	870	644	636	769	808
North Dakota	283	130	225	77	49	14	28	28	104
Nebraska	534	470	587	490	530	413	409	393	478
Oklahoma	1,700	1,417	1,134	1,538	1,417	1,174	1,012	1,113	1,313
Pacific NW	217	215	169	176	185	183	174	175	187
South Dakota	526	263	437	393	445	211	267	312	357
Texas	1,194	810	911	1,437	1,134	951	709	830	997
Wyoming	49	49	51	53	51	43	47	45	48
Regional Total	9,925	8,150	8,934	9,451	8,887	7,264	7,027	7,106	8,343

Hard Winter Wheat Yield (tons/ha)

	2012	2013	2014	2015	2016	2017	2018	2019	Average
Colorado	2.49	1.95	2.56	2.49	3.23	2.89	2.42	3.30	2.66
Kansas	2.89	2.69	1.88	2.49	3.83	3.23	2.56	3.50	2.88
Montana	2.56	3.03	2.76	2.76	3.30	2.82	3.36	3.36	2.99
North Dakota	3.70	2.82	3.30	2.96	3.23	2.49	2.89	3.56	3.12
Nebraska	2.82	2.42	3.30	2.56	3.63	3.09	3.30	3.83	3.12
Oklahoma	2.49	2.22	1.14	1.75	2.62	2.29	1.88	2.69	2.14
Pacific NW	5.04	4.57	4.44	4.71	5.51	5.04	5.31	5.04	4.96
South Dakota	3.23	2.62	3.70	2.96	3.90	2.69	3.23	3.50	3.23
Texas	2.08	2.15	2.02	2.02	2.15	1.95	2.15	2.29	2.10
Wyoming	1.68	1.48	1.82	2.15	2.29	1.88	2.29	2.89	2.06
Regional Avg	2.90	2.60	2.69	2.68	3.37	2.84	2.94	3.40	2.93

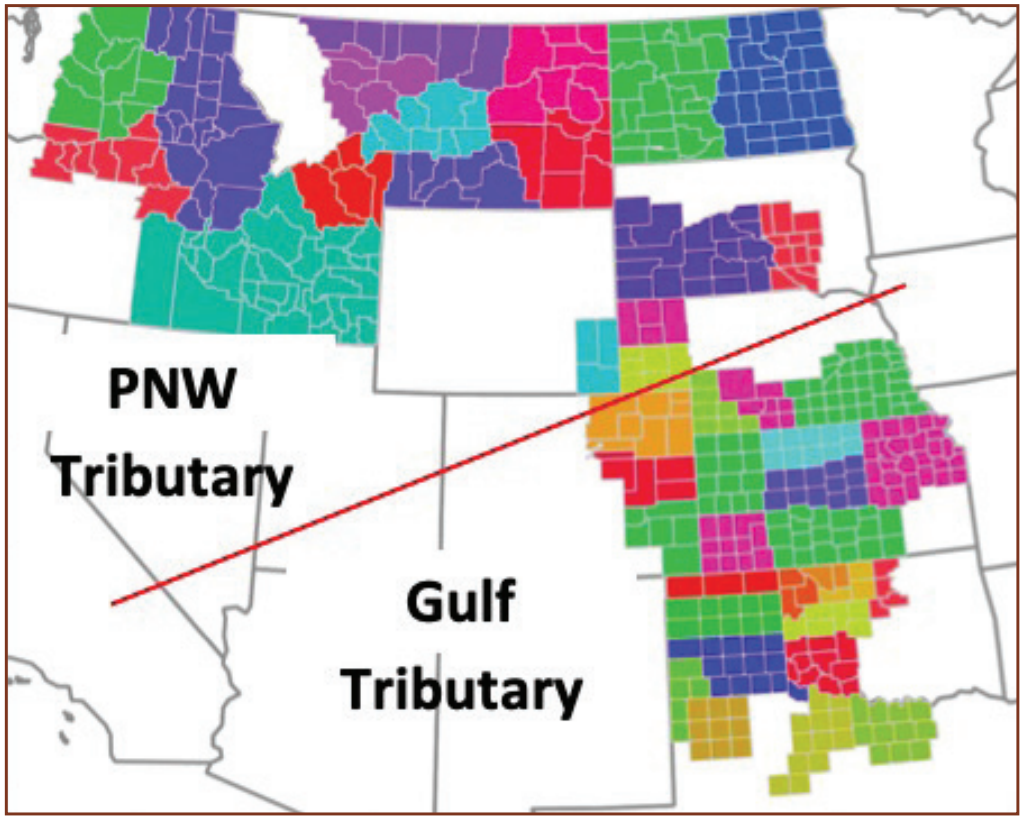
*** Some data derived from Crop Production report issued by USDA NASS updated September 30, 2018.*

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 Hard Red Winter (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% 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.

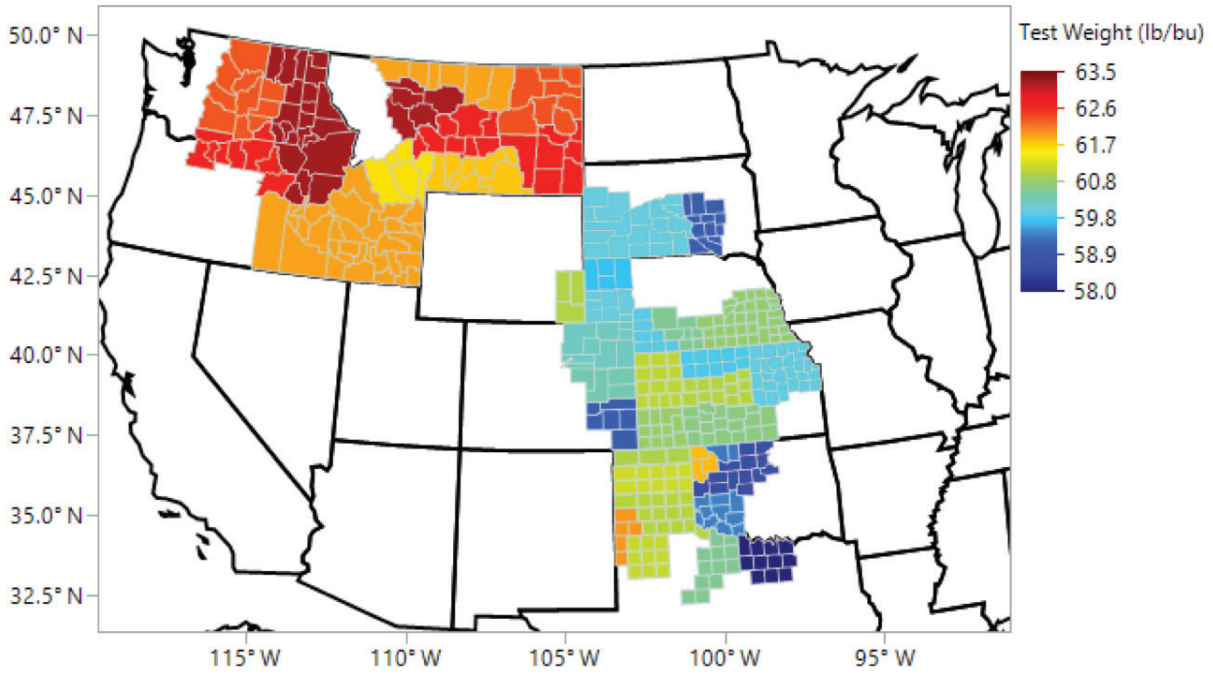
Foreign material is all matter other than wheat that remains in the sample after the removal of dockage and shrunken and broken kernels.

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.

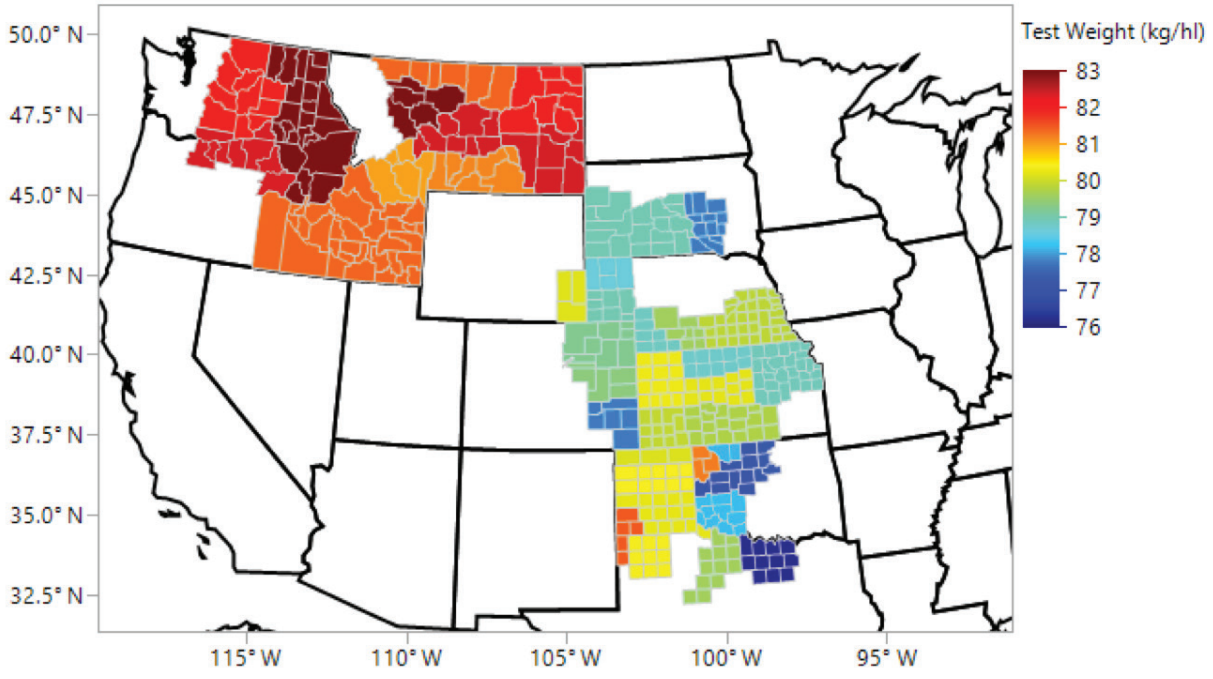
Damaged kernels are kernels, pieces of wheat kernels and other grains that are badly ground-damaged, badly weather damaged, diseased, frost-damaged, germ damaged, heat-damaged, insect-bored, mold-damaged, sprout-damaged or otherwise materially damaged.

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	2	0.1	59.1	77.8	0.2	0.4	0.4
	C02	1	0.5	60.4	79.4	0.4	1.0	0.1
	C03	1	0.7	60.2	79.3	0.5	2.0	0.2
Kansas	K01	1	0.4	60.8	80.0	0.4	0.5	0.1
	K02	1	0.4	60.6	79.8	0.5	0.7	0.2
	K03	1	0.5	61.0	80.2	0.5	0.7	0.1
	K04	1	0.5	60.0	78.9	0.6	0.8	0.2
	K05	2	0.3	59.9	78.8	0.8	0.7	0.2
	K06	1	0.4	61.1	80.3	0.2	0.9	0.1
Montana	M01	1	0.9	61.8	81.2	0.1	0.8	0.3
	M02	1	0.3	61.9	81.4	0.2	0.5	0.1
	M03	1	0.4	63.3	83.2	0.2	0.6	0.1
	M04	1	0.4	62.7	82.4	0.1	1.0	0.1
	M05	1	0.3	62.4	82.0	0.2	0.4	0.2
	M06	1	0.4	62.7	82.4	0.2	0.5	0.4
	M07	1	0.7	61.6	81.0	0	1.1	0.1
Nebraska	N01	1	0.7	60.0	79.0	0.2	0.8	0.3
	N02	2	0.5	59.9	78.9	0.5	0.9	0.2
	N03	1	0.2	60.5	79.6	0.4	0.8	0.1
	N04	1	0.3	60.7	79.9	0.5	0.8	0.1
	N05	2	0.8	59.8	78.6	0.3	1.2	0.3
Oklahoma	O01	2	0.5	59.4	78.2	0.3	0.8	0.2
	O02	2	0.5	58.7	77.2	0.5	0.9	0.3
	O03	1	0.4	61.0	80.2	0.7	0.5	0.1
	O04	1	0.2	61.8	81.3	0.1	0.6	0.1
	O05	2	0.6	59.4	78.2	0.3	0.9	0.2
	O06	2	0.4	58.7	77.2	0.3	0.9	0.2
	O07	2	0.4	58.7	77.3	0.1	0.8	0.1
Pacific Northwest	PNW01	1	0.5	62.4	82.0	0.0	0.5	0.0
	PNW02	1	0.5	62.7	82.4	0.0	0.5	0.0
	PNW03	1	0.3	63.3	83.2	0.0	0.4	0.0
	PNW04	1	0.2	61.9	81.4	0.0	0.5	0.0
South Dakota	SD01	1	0.8	60.0	79.0	0.4	0.9	0.1
	SD02	2	0.7	59.1	77.8	0.8	0.9	0.3
Texas	T01	1	0.8	61.1	80.4	0.6	1.0	0.1
	T02	1	0.4	60.5	79.6	0.1	0.8	0.1
	T03	2	0.4	58.0	76.2	0.0	0.7	0.1
	T04	1	0.7	62.0	81.5	0.4	1.1	0.1
	T05	1	0.9	61.0	80.3	0.4	1.1	0.3
	T06	1	0.4	61.2	80.5	0.4	0.8	0.1
Wyoming	W01	1	0.8	61.0	80.2	0.1	0.9	0.2

Kernel Quality Data

Location		Total Defects (%)	Kernel Size Large (%)	Kernel Size Med (%)	Kernel Size Small (%)	Thousand Kernal Wt (g)	SKCS Avg Diam (mm)
Colorado	CO1	1.0	73.9	25.2	0.9	33.0	2.65
	CO2	1.6	65.6	33.0	1.4	31.0	2.55
	CO3	2.8	65.3	32.5	2.2	31.0	2.55
Kansas	K01	1.0	79.2	20.4	0.4	34.2	2.69
	K02	1.4	73.3	25.9	0.9	32.7	2.66
	K03	1.4	70.8	28.3	0.9	33.2	2.68
	K04	1.5	73.6	25.7	0.8	31.7	2.63
	K05	1.8	71.7	27.5	0.8	30.8	2.59
	K06	1.2	70.1	28.8	1.1	32.4	2.61
Montana	M01	1.2	77.6	22.0	0.5	34.7	2.70
	M02	0.8	78.5	21.3	0.2	36.0	2.75
	M03	0.9	78.6	21.0	0.4	36.3	2.74
	M04	1.2	75.9	23.7	0.4	33.7	2.66
	M05	0.8	84.6	15.2	0.3	36.3	2.75
	M06	1.1	79.5	20.2	0.4	33.7	2.70
	M07	1.2	77.9	21.9	0.3	37.2	2.74
Nebraska	N01	1.4	70.5	28.4	1.1	32.2	2.63
	N02	1.5	76.6	22.5	0.9	33.5	2.69
	N03	1.0	74.3	24.7	1.0	31.3	2.64
	N04	1.2	70.2	28.8	1.1	31.9	2.62
	N05	1.8	72.8	26.1	1.1	32.0	2.64
Oklahoma	O01	1.3	67.0	31.8	1.2	31.5	2.63
	O02	1.6	71.5	27.6	0.9	31.6	2.64
	O03	1.3	76.9	22.6	0.5	34.5	2.71
	O04	0.7	75.6	23.7	0.7	33.9	2.69
	O05	1.3	71.7	27.4	0.8	32.1	2.63
	O06	1.4	67.6	31.2	1.2	30.9	2.61
	O07	1.1	68.4	30.6	1.1	31.0	2.61
Pacific Northwest	PNW01	0.5	82.4	17.3	0.3	36.3	2.84
	PNW02	0.6	83.3	16.2	0.5	35.3	2.84
	PNW03	0.4	88.8	11.1	0.2	36.7	2.89
	PNW04	0.5	86.4	13.3	0.4	35.7	2.91
South Dakota	SD01	1.2	66.4	32.5	1.1	31.5	2.57
	SD02	1.9	64.2	34.6	1.3	30.5	2.57
Texas	T01	1.7	68.7	30.3	1.1	31.2	2.57
	T02	1.0	75.1	23.8	1.1	33.6	2.70
	T03	0.7	65.5	32.9	1.5	33.1	2.64
	T04	1.6	65.9	33.1	1.1	32.7	2.58
	T05	1.7	67.0	32.0	1.0	31.4	2.58
	T06	1.3	75.4	23.8	0.8	34.1	2.72
Wyoming	W01	1.2	71.6	27.6	0.8	31.9	2.59

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% 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 finished product attributes such as texture and appearance. Higher-protein dough usually absorbs more water and takes longer to mix. Hard Red Winter (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.

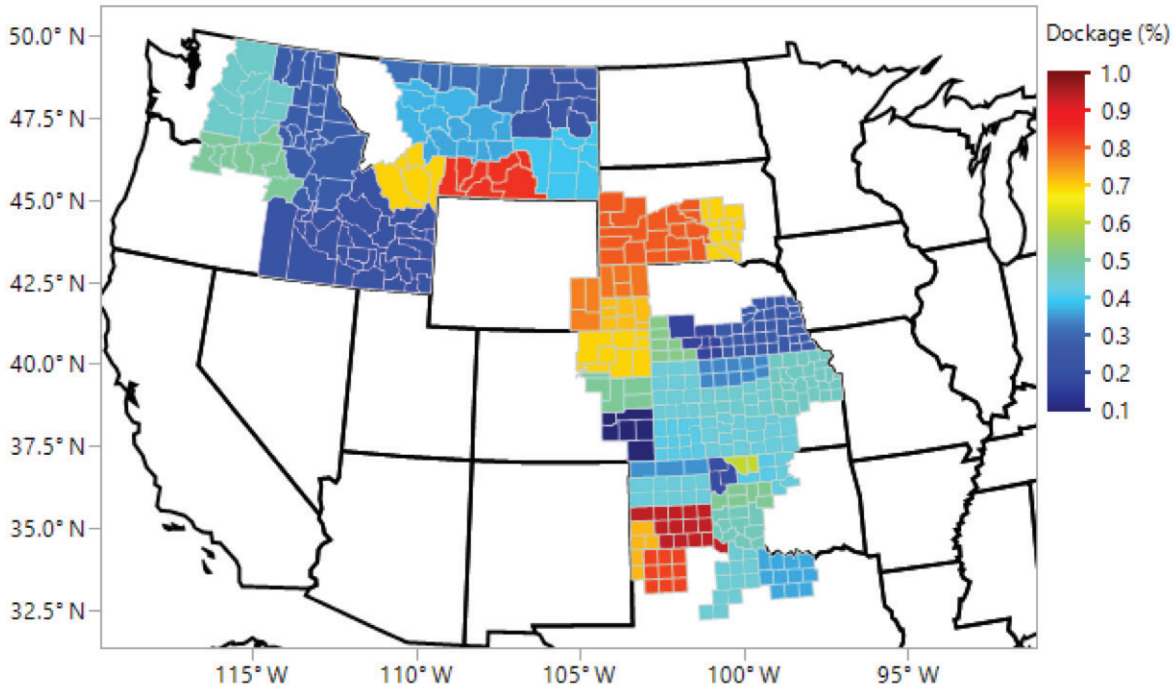
Falling number is an index of enzyme activity in wheat or flour and is expressed in seconds. Falling numbers above 300 are desirable, as they indicate little enzyme activity and a sound, quality product. Falling numbers below 300 are indicative of more substantial enzyme activity and sprout damage.

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.

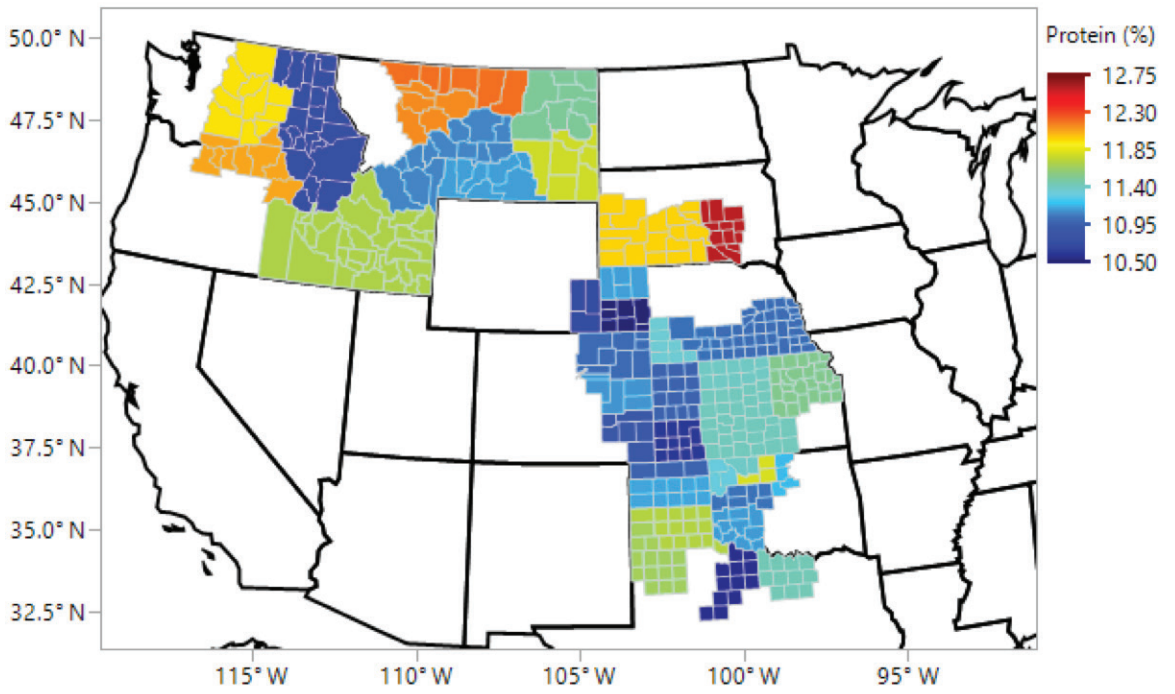
Kernel size is a measure of the percentage by weight of large, medium and small kernels in a sample. Large kernels or more uniform kernel size may help improve milling yield.

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.

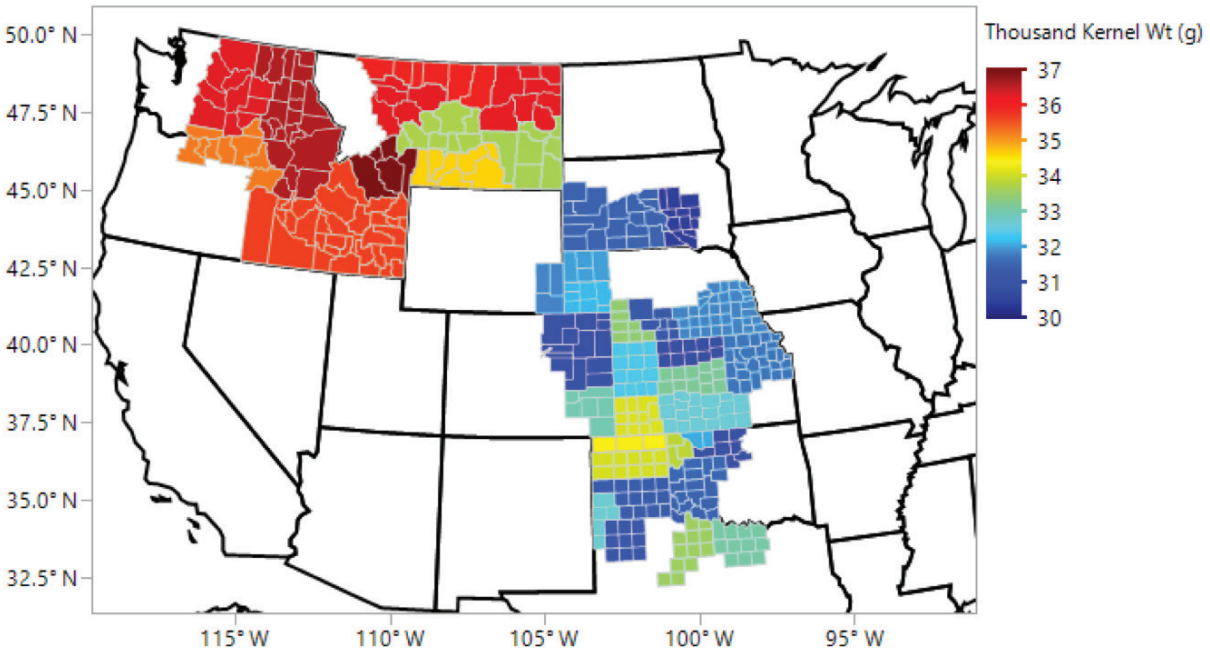
Dockage (%)



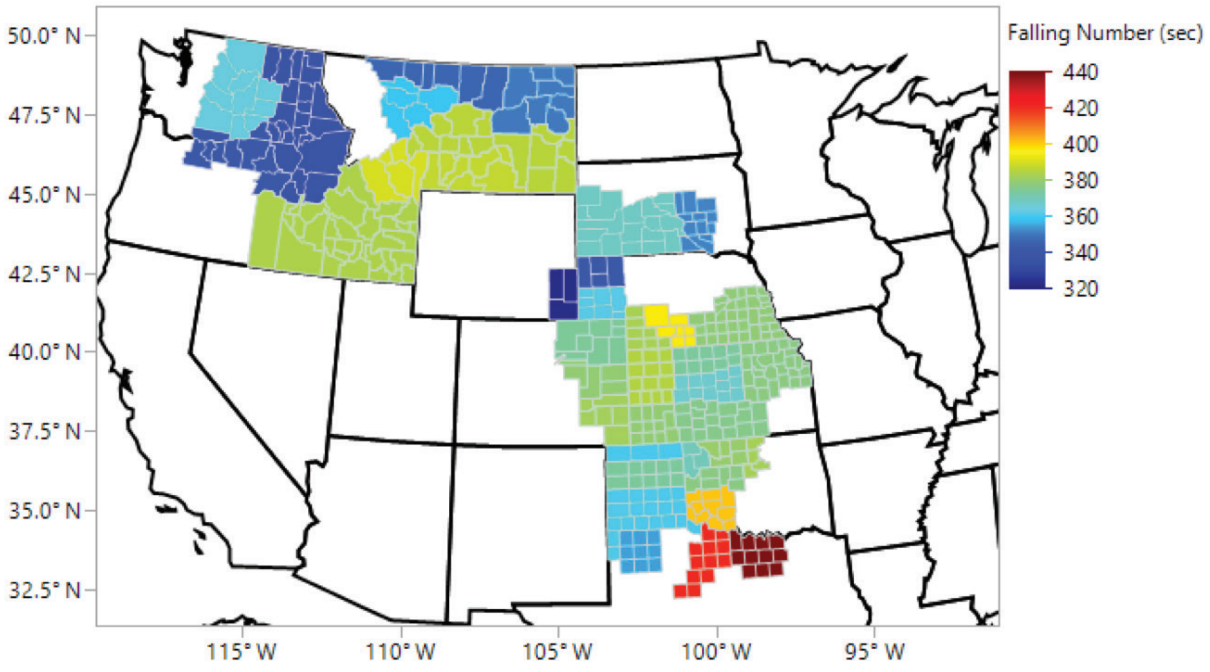
Protein (%)



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	10.9	1.71	383	12.4	54.4
	CO2	11.1	1.62	380	11.5	57.8
	CO3	11.0	1.59	375	11.6	58.3
Kansas	KO1	10.6	1.47	380	11.2	52.1
	KO2	11.4	1.54	377	12.2	60.7
	KO3	11.4	1.56	367	11.9	61.9
	KO4	11.6	1.66	378	12.1	58.1
	KO5	11.4	1.61	374	12.0	55.0
	KO6	11.0	1.55	385	10.7	54.2
Montana	MO1	11.2	1.51	388	11.1	67.0
	MO2	12.2	1.40	346	12.1	75.5
	MO3	12.2	1.43	360	11.1	72.2
	MO4	11.1	1.47	386	11.5	71.4
	MO5	11.5	1.45	351	12.2	60.8
	MO6	11.8	1.48	386	11.3	77.2
	MO7	11.1	1.49	391	11.9	77.4
Nebraska	NO1	10.5	1.58	362	12.3	57.5
	NO2	11.4	1.62	384	11.7	59.2
	NO3	11.0	1.61	398	10.7	58.5
	NO4	11.0	1.64	379	11.2	58.4
	NO5	11.2	1.65	342	12.7	56.6
Oklahoma	OO1	11.1	1.52	402	12.0	55.3
	OO2	11.1	1.55	378	11.7	55.5
	OO3	11.0	1.54	361	10.9	53.4
	OO4	11.3	1.54	370	10.8	56.4
	OO5	11.4	1.57	381	12.2	54.1
	OO6	11.8	1.52	380	12.5	53.9
	OO7	11.2	1.49	383	12.1	51.9
Pacific Northwest	PNWO1	12.0	1.38	365	9.7	65.2
	PNWO2	12.1	1.41	342	9.6	65.3
	PNWO3	10.8	1.31	339	9.3	59.2
	PNWO4	11.7	1.51	384	9.2	68.2
South Dakota	SDO1	12.0	1.62	368	12.4	56.1
	SDO2	12.6	1.67	352	12.5	55.0
Texas	TO1	11.7	1.65	355	10.8	66.8
	TO2	10.6	1.52	422	12.6	52.4
	TO3	11.5	1.55	443	13.3	53.7
	TO4	11.7	1.55	361	10.3	63.3
	TO5	11.7	1.57	361	11.1	65.1
	TO6	11.2	1.57	374	11.1	59.6
Wyoming	WO1	10.7	1.48	323	12.3	63.6

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% 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	72.8	39.5	9.8	0.52	99.3	90.8	-1.6	9.8
	CO2	72.8	50.6	9.8	0.60	99.6	91.7	-1.7	9.6
	CO3	75.1	45.1	9.3	0.51	99.5	91.9	-1.8	9.9
Kansas	KO1	75.2	40.1	9.1	0.51	99.5	91.7	-1.8	10.3
	KO2	74.7	42.7	10.0	0.51	97.9	91.2	-1.7	10.3
	KO3	74.7	45.8	10.0	0.48	95.2	91.1	-1.7	10.2
	KO4	73.7	42.9	10.1	0.50	97.7	91.0	-1.5	10.0
	KO5	75.3	42.0	10.1	0.51	99.4	90.6	-1.4	10.0
	KO6	74.2	45.3	9.5	0.48	99.7	91.3	-1.7	10.5
Montana	MO1	75.8	49.0	10.6	0.45	96.5	91.1	-1.7	10.4
	MO2	73.9	58.0	11.2	0.43	97.1	91.5	-1.7	10.2
	MO3	74.3	56.9	11.5	0.42	89.0	91.8	-1.7	10.1
	MO4	74.0	50.4	10.4	0.47	96.8	91.9	-1.7	10.1
	MO5	75.1	55.1	11.2	0.46	99.2	91.4	-1.5	9.2
	MO6	77.1	56.6	10.9	0.47	99.1	91.2	-1.6	10.0
	MO7	74.6	66.1	12.1	0.51	99.4	91.1	-1.6	10.9
Nebraska	NO1	74.0	42.2	9.6	0.48	98.4	91.6	-1.7	10.0
	NO2	74.6	39.2	9.1	0.48	98.1	91.1	-1.7	9.7
	NO3	73.7	39.9	9.8	0.51	98.9	91.2	-1.6	9.9
	NO4	75.7	41.1	9.9	0.55	99.0	90.9	-1.6	9.8
	NO5	74.4	44.1	10.2	0.49	95.8	91.4	-1.6	9.4
Oklahoma	OO1	75.4	45.8	10.0	0.49	99.3	91.2	-1.8	10.3
	OO2	74.1	42.0	9.7	0.51	98.8	91.3	-1.8	10.5
	OO3	74.8	43.8	9.8	0.49	97.3	91.4	-1.7	10.1
	OO4	74.9	48.3	10.2	0.49	97.9	91.3	-1.7	10.1
	OO5	74.2	45.6	10.2	0.50	98.2	90.8	-1.7	10.4
	OO6	74.9	48.4	10.9	0.49	99.0	90.9	-1.7	10.2
	OO7	73.6	42.2	10.1	0.47	97.1	91.1	-1.7	10.1
Pacific Northwest	PNWO1	74.6	62.0	11.1	0.43	98.6	91.7	-1.5	9.6
	PNWO2	75.5	50.7	10.8	0.46	96.2	91.2	-1.5	9.5
	PNWO3	76.0	54.1	9.6	0.45	99.6	91.8	-1.6	9.7
	PNWO4	75.5	50.1	11.2	0.51	99.5	90.8	-1.6	10.5
South Dakota	SDO1	74.2	55.6	11.2	0.48	98.3	91.3	-1.5	9.5
	SDO2	74.0	47.0	11.2	0.50	97.2	90.6	-1.3	8.9
Texas	TO1	72.0	48.8	10.3	0.52	96.8	91.2	-1.7	9.9
	TO2	75.3	39.1	9.3	0.49	100.0	91.3	-1.7	9.9
	TO3	73.6	42.9	10.7	0.53	98.2	90.9	-1.6	9.6
	TO4	73.9	48.5	10.7	0.50	95.2	90.9	-1.6	9.5
	TO5	75.0	50.8	10.7	0.50	95.6	91.3	-1.7	9.9
	TO6	74.0	46.3	10.3	0.51	96.3	91.2	-1.7	10.0
Wyoming	WO1	73.2	44.9	9.5	0.47	98.7	91.6	-1.8	10.1

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.

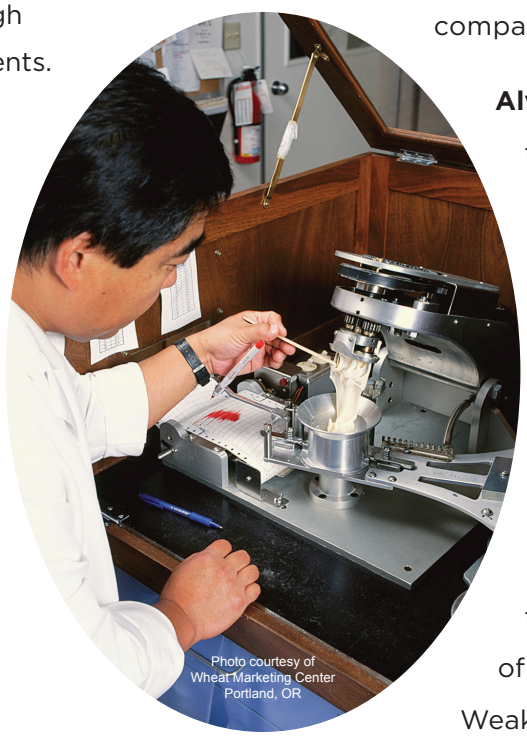


Photo courtesy of Wheat Marketing Center Portland, OR

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	81	66	198	1.23	57.7	2.3	5.0	42.0
	CO2	85	69	226	1.23	56.9	2.4	9.6	19.0
	CO3	87	76	244	1.14	56.1	2.2	6.6	30.0
Kansas	KO1	71	83	200	0.86	56.6	2.0	5.6	36.0
	KO2	70	86	196	0.81	57.5	4.1	7.0	36.5
	KO3	75	87	223	0.86	57.3	3.0	7.2	27.0
	KO4	76	79	215	0.96	57.6	2.2	6.6	33.5
	KO5	72	73	193	0.99	57.4	1.9	5.3	36.0
	KO6	88	82	243	1.07	56.8	2.0	6.6	28.0
Montana	MO1	94	83	268	1.13	59.7	4.5	8.2	27.0
	MO2	102	77	297	1.32	60.9	4.0	10.6	20.3
	MO3	88	97	275	0.91	61.3	5.4	9.2	23.0
	MO4	99	63	244	1.58	58.9	4.9	10.5	19.5
	MO5	85	88	268	0.97	59.2	5.6	11.0	19.0
	MO6	101	81	298	1.25	60.7	3.0	9.1	19.0
	MO7	97	90	334	1.08	62.6	4.5	9.6	22.0
Nebraska	NO1	84	80	244	1.05	57.8	2.1	6.2	32.0
	NO2	67	83	184	0.81	55.8	1.8	5.7	32.0
	NO3	84	70	220	1.19	57.8	1.9	4.1	46.5
	NO4	80	70	204	1.14	57.0	2.3	7.2	25.0
	NO5	73	82	206	0.89	56.8	3.5	7.1	36.7
Oklahoma	OO1	77	86	221	0.90	57.0	3.5	7.9	29.5
	OO2	77	80	211	0.96	57.7	2.9	8.4	23.0
	OO3	81	77	205	1.06	57.5	4.6	7.9	32.0
	OO4	74	94	227	0.78	58.1	4.5	8.0	32.3
	OO5	79	88	234	0.89	57.8	3.5	8.1	28.3
	OO6	76	97	243	0.78	58.2	5.0	8.7	32.0
	OO7	77	80	219	0.96	56.7	2.9	9.9	15.0
Pacific Northwest	PNW01	99	81	295	1.22	61.5	4.9	9.4	28.7
	PNW02	86	89	266	0.97	59.5	4.0	6.9	38.0
	PNW03	111	66	281	1.68	60.7	2.5	7.2	28.0
	PNW04	114	67	275	1.70	63.4	4.3	6.5	37.0
South Dakota	SD01	77	83	239	0.93	57.0	4.0	10.2	19.5
	SD02	59	113	213	0.52	56.9	4.0	6.6	36.0
Texas	TO1	82	85	238	0.96	59.2	5.6	8.2	40.0
	TO2	79	73	209	1.08	56.9	1.7	5.5	37.0
	TO3	91	92	285	0.99	59.0	3.2	7.1	33.5
	TO4	81	98	239	0.82	59.3	4.0	6.4	39.0
	TO5	86	95	254	0.90	59.9	4.6	6.9	43.0
	TO6	82	89	228	0.92	59.3	4.1	7.0	37.3
Wyoming	WO1	78	81	214	0.96	57.5	3.7	6.7	35.5

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	5.8	61.7	830	4.8	5.5	tan
	C02	6.3	61.8	840	6.3	5.5	yellow
	C03	6.0	61.9	835	4.8	5.5	yellow
Kansas	K01	5.3	62.0	815	5.5	5.5	yellow
	K02	4.5	62.1	873	6.3	7.0	slightly yellow
	K03	4.6	61.8	893	5.9	5.5	slightly yellow
	K04	5.2	62.7	890	5.9	7.0	slightly yellow
	K05	5.9	62.7	878	5.2	6.7	slightly yellow
	K06	6.8	62.3	850	5.5	7.0	yellow
Montana	M01	4.3	62.1	875	4.8	6.3	yellow
	M02	5.2	66.0	893	4.8	5.8	yellow
	M03	3.6	63.5	905	4.4	5.5	slightly yellow
	M04	5.0	63.0	828	4.8	5.5	yellow
	M05	5.4	65.2	940	6.3	6.3	tan
	M06	5.0	64.8	895	4.8	6.3	slightly yellow
	M07	6.4	66.9	895	5.5	6.3	slightly yellow
Nebraska	N01	5.6	62.3	825	4.8	6.3	yellow
	N02	5.3	62.1	810	5.5	6.3	tan
	N03	5.9	62.6	858	5.2	6.7	yellow
	N04	5.3	62.3	880	5.6	7.0	yellow
	N05	5.3	63.0	858	5.8	6.3	yellow
Oklahoma	O01	5.3	62.4	868	6.6	7.8	yellow
	O02	5.4	62.3	870	7.0	7.0	yellow
	O03	4.9	62.3	848	7.0	7.0	dull
	O04	4.7	62.9	880	7.0	7.0	creamy
	O05	5.4	62.7	868	6.0	6.8	yellow
	O06	4.6	63.6	890	6.3	7.0	yellow
	O07	5.0	62.1	810	5.5	5.5	tan
Pacific Northwest	PNW01	5.5	65.3	873	5.0	5.8	yellow
	PNW02	4.8	65.2	880	5.0	6.3	slightly yellow
	PNW03	6.5	63.9	750	4.0	4.8	yellow
	PNW04	3.5	66.8	840	4.8	7.0	tan
South Dakota	SD01	6.0	64.1	923	6.3	6.7	creamy
	SD02	4.3	62.2	970	6.3	7.0	tan
Texas	T01	4.3	63.8	853	5.5	6.3	tan
	T02	5.5	62.0	790	5.5	5.5	tan
	T03	5.6	64.3	895	4.0	7.0	tan
	T04	4.1	63.2	893	5.9	7.8	tan
	T05	4.3	63.4	875	6.5	7.0	tan
	T06	4.0	63.9	872	6.8	6.5	tan
Wyoming	W01	5.1	62.2	813	5.6	6.3	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 in^3) 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% 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% 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% moisture basis.

Alveograph: AACC Method 54-30A.

Loaf Volume: AACC Method 10-10B producing 2 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.