PGI

Plains Grains Inc.

Hard Red Winter Wheat

2021 Regional Quality Survey

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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

34 Star Publishing
thewheatfarmer.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 createunique 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.

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

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.

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 highextraction applications, pan breads or flatbreads.

Crop Production Review & Analysis

Overview

The 2021 hard red winter (HRW) wheat crop has been described as one of climatic extremes. Depending on geographic location, this included record temperatures (hot or cold) and record or near record drought conditions, especially during the final stages of crop development. These conditions significantly affected not only crop characteristics and quality, but also resulted in significant yield reductions across several production areas. However, the diversity in this crop will deliver value and opportunity to a wide range of customers world-wide.

As was the case last production year, high yielding areas resulted in lower wheat and flour proteins, while still exhibiting good milling and end-use product characteristics. Even though mixing times and tolerances are shorter than last year (they are longer than the 5-year averages) loaf volumes achieved indicate there is adequate protein quality to make quality bread and loaf volumes and actually exceeded accepted industry standards. This crop meets or exceeds typical HRW contract specifications and should provide value to the customer.

Overall, the 2021 crop has good milling and baking characteristics and should provide customers with a very good range of quality and value.

Weather and Harvest

The 2021 HRW planted area did recover many of the near historic 100-year lows seen last year. However, much like last year, moisture (lack of or too much during critical times in later stages of crop development) and temperatures and exceptional drought during the later stages of crop development defined the entire 2021 crop from the Great Plains through the Pacific Northwest. Much like last production year, eastern areas of the Southern and Central Great Plains experienced favorable growing conditions and realized near record yields (per unit area), very good kernel characteristics – but like last year, lower protein. At the same time, a lack of moisture and freeze events during the later stages of crop development did again adversely affect the crop on the western side of the Central and Southern Great Plains resulting in lower yields and smaller kernels, but higher protein. With very few exceptions, disease and insects were again not a major issue for the 2021 HRW crop.

Much of the Northern Great Plains and Pacific Northwest (PNW) faced record drought in 2021. extending into the harvest of 2021. Major reductions in yields have been experienced in those regions accompanied by the normal effects associated with drought on kernel characteristics (smaller).

Wheat and Grade Data

Overall 84% of Composite, 85% of Gulf Tributary and 83% of PNW Tributary samples graded U.S. No. 2 or better. Average test weight of 60.4 lb./bu. (79.5 kg/hl) is below 2020 and below the 5-year average. Average dockage (0.5%), total defects (1.7%) and foreign material (0.3%) is above 2020 and the 5-year averages. Average shrunken and broken is (0.8%) is above last year and above the 5-year average. Average thousand kernel weight of 30.5 g is below last year and the 5-year average. Protein is (11.9%), equal to last year and below the 5-year average. The average wheat falling number is 372 sec, indicative of sound wheat.

Flour and Baking Data

The Buhler laboratory mill flour yield average is 74.9% and above last year's average of 73.5% and below the 5-year average of 75.5%. The 2021 flour ash of 0.50% (14% mb) is comparable to last year's 0.49% and the 5-year average of 0.52%. The alveograph W value of 203 10-4 J is significantly lower than last year and to the 5-year average of 235 10-4 J.

Farinograph peak and stability times, 5.1 and 9.3 min, respectively, are lower than last year's 5.3 and 10.3 min, but higher than the 5-year average of 4.4 and 8.5. Average bake absorption is 62.1%, below the 63.1% value for 2020 but is comparable to the 5-year average of 63.0. Overall loaf volume averaged 877 cc, well above last year's 859 cc and the 5-year average of 850 cc.

Hard Red Winter Wheat Production Charts

English Units

Hard Red Winter Production (1,000 Bushels)

	2014	2015	2016	2017	2018	2019	2020	2021	Average
Colorado	89,300		105,120	86,860	70,200	98,000	46,500	66,778	78,948
Kansas	246,400	321,900	467,400	333,600	277,400	338,000	294,400	342,160	339,266
Montana	91,840	91,020	105,350	66,780	78,500	95,000	75,400	53,630	80,811
North Dakota	27,195	8,360	5,760	1,295	3,010	3,710	1,400	1,980	3,645
Nebraska	71,050	45,980	70,740	46,920	49,490	55,290	36,550	41,160	49,447
Oklahoma	47,600	98,800	136,500	98,600	70,000	110,000	113,400	115,050	106,050
Pacific NW	28,350	28,543	36,707	33,800	33,500	32,463	32,000	18,780	30,828
South Dakota	59,400	42,680	63,800	20,800	31,680	40,040	34,800	27,360	37,309
Texas	67,500	106,500	89,600	68,150	56,000	69,700	63,000	69,560	74,644
Wyoming	3,375	4,160	4,250	2,940	3,900	4,730	5,000	3,040	4,003
Regional Total	732,010	827,123	1,085,227	759,745	673,680	846,933	702,450	739,498	804,951

Hard Red Winter Harvested Acres (1,000 Acres)

	2014	2015	2016	2017	2018	2019	2020	2021	Average
Colorado	2,350	2,140	2,190	2,020	1,950	2,000	1,550	1,880	2,010
Kansas	8,800	8,700	8,200	6,950	7,300	6,500	6,400	7,000	7,481
Montana	2,240	2,220	2,150	1,590	1,570	1,900	1,450	1,730	1,856
North Dakota	555	190	120	35	70	70	35	60	142
Nebraska	1,450	1,210	1,310	1,020	1,010	970	850	840	1,083
Oklahoma	2,800	3,800	3,500	2,900	2,500	2,750	2,700	2,950	2,988
Pacific NW	417	434	456	451	431	432	423	368	427
South Dakota	1,080	970	1,100	520	660	770	580	720	800
Texas	2,250	3,550	2,800	2,350	1,750	2,050	2,100	2,000	2,356
Wyoming	125	130	125	105	115	110	110	95	114
Regional Total	22,067	23,344	21,951	17,941	17,356	17,552	16,198	17,643	19,257

Hard Red Winter Yield (bu/ac)

	2014	2015	2016	2017	2018	2019	2020	2021	Average
Colorado	38	37	48	43	36	49	30	36	40
Kansas	28	37	57	48	38	52	46	49	44
Montana	41	41	49	42	50	50	43	31	43
North Dakota	49	44	48	37	43	53	40	33	43
Nebraska	49	38	54	46	49	57	43	49	48
Oklahoma	17	26	39	34	28	40	40	39	33
Pacific NW	66	70	82	75	79	75	74	51	72
South Dakota	55	44	58	40	48	52	60	38	49
Texas	30	30	32	29	32	34	30	35	31
Wyoming	27	32	34	28	34	43	43	32	34
Regional Total	40	40	50	42	44	51	45	39	44

**Some data derived from Crop Production report issued by USDA NASS updated October 12, 2021

Hard Red Winter Wheat Production Charts

Metric Units

Hard Red Winter Production (MMT)

	2014	2015	2016	2017	2018	2019	2020	2021	Average
Colorado	2.43	2.16	2.86	2.36	1.91	2.67	1.27	1.82	2.18
Kansas	6.71	8.76	12.72	9.08	7.55	9.20	8.01	9.31	8.92
Montana	2.50	2.48	2.87	1.82	2.14	2.59	2.05	1.46	2.24
North Dakota	0.74	0.23	0.16	0.04	0.08	0.10	0.04	0.05	0.18
Nebraska	1.93	1.25	1.93	1.28	1.35	1.50	0.99	1.12	1.42
Oklahoma	1.30	2.69	3.72	2.68	1.91	2.99	3.09	3.13	2.69
Pacific NW	0.77	0.78	1.00	0.92	0.91	0.88	0.87	0.51	0.83
South Dakota	1.62	1.16	1.74	0.57	0.86	1.09	0.95	0.74	1.09
Texas	1.84	2.90	2.44	1.85	1.52	1.90	1.71	1.89	2.01
Wyoming	0.09	0.11	0.12	0.08	0.11	0.13	0.14	0.08	0.11
Regional Total	19.92	22.51	29.54	20.68	18.34	23.05	19.12	20.13	21.66

Hard Red Winter Harvested (1,000 ha)

	2014	2015	2016	2017	2018	2019	2020	2021	Average
Colorado	951	866	886	817	789	809	627	761	813
Kansas	3561	3521	3318	2813	2954	2630	2590	2833	3,028
Montana	906	898	870	643	635	769	587	700	751
North Dakota	225	77	49	14	28	28	14	24	57
Nebraska	587	490	530	413	409	393	344	340	438
Oklahoma	1133	1538	1416	1174	1012	1113	1093	1194	1,209
Pacific NW	169	176	185	183	174	175	171	149	173
South Dakota	437	393	445	210	267	312	235	291	324
Texas	911	1437	1133	951	708	830	850	809	954
Wyoming	51	53	51	42	47	45	45	38	46
Regional Total	8,930	9,447	8,883	7,260	7,024	7,103	6,555	7,140	7,793

Hard Red Winter Yield (tons/ha)

	2014	2015	2016	2017	2018	2019	2020	2021	Average
Colorado	2.56	2.49	3.23	2.89	2.42	3.30	2.02	2.39	2.66
Kansas	1.88	2.49	3.84	3.23	2.56	3.50	3.10	3.29	2.99
Montana	2.76	2.76	3.30	2.83	3.37	3.37	2.89	2.08	2.92
North Dakota	3.30	2.96	3.23	2.49	2.89	3.57	2.69	2.22	2.92
Nebraska	3.30	2.56	3.63	3.10	3.30	3.84	2.89	3.30	3.24
Oklahoma	1.14	1.75	2.62	2.29	1.88	2.69	2.69	2.62	2.21
Pacific NW	4.44	4.71	5.52	5.05	5.32	5.05	4.98	3.43	4.81
South Dakota	3.70	2.96	3.90	2.69	3.23	3.50	4.04	2.56	3.32
Texas	2.02	2.02	2.15	1.95	2.15	2.29	2.02	2.34	2.12
Wyoming	1.82	2.15	2.29	1.88	2.29	2.89	2.89	2.15	2.30
Regional Total	2.69	2.69	3.37	2.84	2.94	3.40	3.02	2.64	2.95

**Some data derived from Crop Production report issued by USDA NASS updated October 12, 2021

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 a nalyzed 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
Maxiumum 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 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	3	0.6	56.9	75.0	0.2	2.4	0.3
	C02	2	0.6	58.7	77.2	0.3	2.0	0.3
	C03	1	0.5	60.6	79.7	0.3	2.0	0.3
Kansas	K01	2	0.4	59.8	78.7	0.6	0.7	0.4
	K02	1	0.5	61.0	80.2	0.5	0.6	0.1
	K03	2	0.5	59.3	78.1	0.9	0.7	0.1
	K04	2	0.8	59.8	78.6	0.8	0.8	0.1
	K05	2	0.4	59.8	78.7	0.6	0.7	0.1
	K06	2	0.3	58.5	77.0	0.7	0.9	0.1
Montana	M01	1	0.2	61.5	80.8	0.4	1.1	0.1
	M02	2	0.7	59.7	78.5	0.2	1.3	0.1
	M03	1	0.5	60.1	79.0	0.2	1.4	0.1
	M04	2	0.5	59.0	77.7	0.1	2.0	0.2
	M05	2	0.4	59.3	78.1	0.1	2.4	0.2
	M06	2	0.2	59.4	78.1	0.2	1.8	0.1
	M07	1	0.2	60.1	79.0	0.3	1.4	0.1
Nebraska	N01	1	0.7	61.3	80.7	0.2	1.2	0.2
	N02	2	0.4	59.9	78.8	0.4	1.0	0.1
	N03	1	0.4	60.0	79.0	1.1	0.7	0.1
	N04	1	0.3	60.5	79.6	0.6	0.7	0.1
	N05	2	0.7	59.9	78.8	0.4	1.3	0.3
Oklahoma	O01	1	0.6	62.2	81.8	0.4	0.8	0.4
	O02	1	0.4	62.0	81.5	0.3	0.9	0.2
	O03	1	0.4	60.7	79.9	1.0	0.6	0.1
	O04	1	1.0	62.5	82.1	0.3	0.6	0.2
	O05	1	0.4	62.0	81.5	0.2	0.8	0.3
	O06	1	0.5	62.3	81.9	0.4	0.8	0.3
	O07	1	0.8	60.7	79.8	0.4	1.7	0.3
Pacific Northwest	PNW01	1	0.1	60.7	79.8	0.0	0.9	0.1
	PNW02	1	0.2	61.4	80.7	0.2	0.9	0.0
	PNW03	2	0.4	58.6	77.1	0.0	1.1	0.0
	PNW04	3	0.6	56.6	74.5	0.0	0.8	0.3
South Dakota	SD01	1	0.0	60.1	79.0	0.3	0.9	0.1
	SD02	2	0.2	59.7	78.6	0.4	1.1	0.1
Texas	T01	1	0.2	62.7	82.4	0.2	0.7	3.2
	T02	1	0.6	61.2	80.4	0.4	0.7	0.2
	T03	2	0.2	59.1	77.8	0.6	0.5	0.2
	T04	1	0.5	63.0	82.8	0.3	0.9	0.2
	T05	2	0.8	58.9	77.5	0.7	1.1	0.2
	T06	1	0.5	60.2	79.2	0.5	0.9	0.2
Wyoming	W01	1	0.5	60.5	79.6	0.5	1.5	1.1

Kernel Quality Data

Location		Total Defects (%)	Kernel Size Large (%)	Kernel Size Med (%)	Kernel Size Small (%)	Thousand Kernel Wt (g)	SKCS Ave Diam (mm)
Colorado	C01	2.9	51.6	44.5	4.0	26.3	2.40
	C02	2.7	51.0	45.7	3.4	26.9	2.38
	C03	2.6	52.3	43.6	4.1	27.5	2.41
Kansas	K01	1.7	72.2	27.1	0.8	31.3	2.62
	K02	1.3	75.8	23.7	0.5	31.5	2.66
	K03	1.7	74.9	24.7	0.5	30.8	2.64
	K04	1.7	72.8	26.7	0.5	29.7	2.60
	K05	1.4	71.5	28.0	0.5	29.9	2.59
	K06	2.1	66.2	32.9	1.0	28.6	2.51
Montana	M01	1.6	52.5	45.9	1.7	27.5	2.37
	M02	1.6	43.0	52.9	4.1	27.2	2.42
	M03	1.7	51.7	47.0	1.3	28.3	2.45
	M04	2.3	36.6	60.8	2.6	26.2	2.33
	M05	2.8	41.1	56.5	2.5	26.5	2.36
	M06	2.1	47.9	50.5	1.6	26.7	2.38
	M07	1.7	68.1	31.2	0.6	31.8	2.60
Nebraska	N01	1.5	58.5	39.9	1.6	28.2	2.45
	N02	1.6	60.4	38.2	1.5	28.3	2.47
	N03	1.9	76.0	23.5	0.6	30.9	2.61
	N04	1.5	77.5	22.2	0.4	31.0	2.62
	N05	2.0	54.9	43.9	1.2	28.2	2.46
Oklahoma	O01	1.6	77.0	22.8	0.2	33.7	2.75
	O02	1.4	77.1	22.5	0.4	34.6	2.81
	O03	1.8	66.9	32.5	0.6	31.2	2.65
	O04	1.0	79.9	19.8	0.4	33.3	2.74
	O05	1.3	74.8	24.8	0.5	31.4	2.65
	O06	1.5	77.3	21.8	0.9	32.7	2.72
	O07	2.5	69.7	29.2	1.2	29.4	2.57
Pacific Northwest	PNW01	1.0	69.7	29.7	0.6	30.2	2.67
	PNW02	1.1	69.8	29.1	1.0	29.1	2.65
	PNW03	1.1	60.9	38.1	1.0	25.7	2.50
	PNW04	1.1	75.2	24.2	0.6	30.3	2.73
South Dakota	SD01	1.3	42.9	55.6	1.5	26.7	2.37
	SD02	1.6	58.5	40.5	1.0	28.6	2.48
Texas	T01	4.1	73.0	26.4	0.6	31.8	2.64
	T02	1.3	83.4	16.3	0.3	34.8	2.80
	T03	1.3	84.5	15.3	0.3	33.9	2.77
	T04	1.3	67.1	32.6	0.4	30.3	2.61
	T05	3.7	75.8	23.5	0.7	30.6	2.63
	T06	1.4	71.3	28.5	0.2	31.2	2.65
Wyoming	W01	3.1	71.0	27.9	1.1	30.7	2.52

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 conteant 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 forsize (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	C01	12.9	1.69	377	10.7	49.5
	C02	12.3	1.64	365	11.1	54.7
	C03	11.1	1.57	349	10.4	62.9
Kansas	K01	12.2	1.64	380	12.3	56.2
	K02	11.0	1.54	367	11.6	60.5
	K03	11.1	1.60	378	12.0	55.5
	K04	11.1	1.60	373	11.6	67.5
	K05	11.1	1.57	375	11.9	56.0
	K06	11.9	1.67	379	11.7	52.0
Montana	M01	13.4	1.67	362	9.2	66.0
	M02	13.5	1.62	372	10.1	75.7
	M03	13.1	1.59	369	9.6	70.2
	M04	14.9	1.65	373	9.6	67.5
	M05	14.5	1.73	359	8.5	70.1
	M06	13.7	1.71	380	9.4	64.8
	M07	13.6	1.53	364	7.3	70.6
Nebraska	N01	11.4	1.58	331	11.9	71.0
	N02	11.8	1.63	365	11.6	62.4
	N03	11.5	1.65	363	12.4	60.9
	N04	11.2	1.63	365	12.1	61.0
	N05	12.2	1.61	341	11.6	61.7
Oklahoma	O01	11.3	1.52	383	11.0	57.5
	O02	10.5	1.56	351	11.0	57.7
	O03	12.5	1.64	372	11.4	59.1
	O04	11.5	1.52	384	10.6	54.8
	O05	10.1	1.49	368	10.4	60.3
	O06	11.1	1.53	367	10.7	63.3
	O07	11.1	1.57	361	10.7	60.6
Pacific Northwest	PNW01	12.9	1.45	417	8.0	73.9
	PNW02	12.8	1.41	422	8.0	73.4
	PNW03	13.1	1.37	373	8.2	74.3
	PNW04	13.0	1.70	390	10.0	60.9
South Dakota	SD01	14.3	1.67	337	10.8	62.7
	SD02	13.7	1.63	359	13.1	59.2
Texas	T01	13.3	1.60	365	9.9	68.3
	T02	10.8	1.54	373	11.6	53.3
	T03	10.8	1.67	282	12.5	52
	T04	13.1	1.59	370	9.7	75.9
	T05	12.9	1.69	373	11.8	59.4
	T06	13.0	1.66	369	11.3	60.4
Wyoming	W01	11.5	1.59	308	10.8	65.6

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	C01	73.1	47.9	11.0	0.51	89.4	90.9	-1.6	9.4
	C02	73.7	57.4	11.2	0.50	97.5	90.9	-1.4	9.1
	C03	75.0	52.3	10.9	0.50	95.2	91.0	-1.5	9.8
Kansas	K01	75.6	43.4	10.8	0.51	78.5	90.4	-1.5	10.1
	K02	74.6	41.5	10.1	0.48	74.6	90.6	-1.5	10.2
	K03	75.7	37.6	9.9	0.48	90.4	90.8	-1.6	10.3
	K04	76.9	33.8	10.0	0.55	99.2	89.9	-1.4	10.5
	K05	74.5	37.7	10.5	0.50	98.8	90.6	-1.5	10.1
	K06	74.5	45.6	10.8	0.49	95.8	90.8	-1.5	9.8
Montana	M01	72.9	57.8	12.9	0.55	95.7	90.4	-1.3	9.7
	M02	72.1	61.6	12.1	0.55	98.6	90.6	-1.5	10.2
	M03	74.1	62.8	11.7	0.51	98.2	91.2	-1.6	9.9
	M04	71.1	69.7	14.0	0.52	97.7	90.7	-1.5	10.6
	M05	71.7	68.8	13.9	0.54	95.4	90.7	-1.3	9.5
	M06	74.9	67.1	13.9	0.60	97.6	90.1	-1.1	9.6
	M07	75.2	69.2	13.5	0.48	96.5	90.8	-1.4	10.5
Nebraska	N01	75.1	51.8	11.0	0.48	94.1	91.0	-1.4	9.6
	N02	75.2	52.0	10.9	0.51	95.2	90.7	-1.4	9.8
	N03	74.6	41.3	10.6	0.50	98.5	90.5	-1.3	9.4
	N04	75.6	38.6	9.8	0.49	98.0	90.5	-1.4	9.6
	N05	74.4	50.5	11.0	0.51	98.1	90.6	-1.4	9.5
Oklahoma	O01	76.4	46.7	10.7	0.50	97.5	90.4	-1.5	9.6
	O02	73.3	45.8	10.1	0.52	98.4	90.7	-1.5	9.7
	O03	75.2	48.1	11.3	0.50	98.1	90.5	-1.6	10.7
	O04	75.8	42.3	10.9	0.49	95.9	90.8	-1.6	10.2
	O05	75.4	39.0	9.0	0.48	98.4	90.9	-1.6	9.8
	O06	75.6	48.5	10.3	0.50	97.0	90.4	-1.4	9.8
	O07	75.2	41.7	10.1	0.49	93.7	90.3	-1.4	9.9
Pacific Northwest	PNW01	73.9	52.8	12.3	0.53	99.2	90.8	-1.4	10.3
	PNW02	75.6	51.2	11.9	0.50	92.9	90.9	-1.5	10.3
	PNW03	73.4	61.8	11.9	0.52	99.2	90.6	-1.5	10.9
	PNW04	75.6	55.0	12.6	0.51	98.5	90.1	-1.4	10.5
South Dakota	SD01	73.2	58.6	12.1	0.52	97.6	90.4	-1.4	9.2
	SD02	75.9	59.7	11.6	0.47	98.7	90.6	-1.3	8.2
Texas	T01	76.2	50.1	11.7	0.55	94.0	90.5	-1.4	10.0
	T02	75.6	41.5	10.0	0.50	95.6	90.6	-1.4	9.3
	T03	75.9	38.8	9.7	0.51	94.0	90.6	-1.5	9.3
	T04	75.4	46.8	12.3	0.56	98.2	90.4	-1.3	10.2
	T05	74.3	45.2	11.9	0.54	92.5	90.3	-1.4	9.7
	T06	74.5	42.7	10.9	0.54	97.6	90.3	-1.5	10.0
Wyoming	W01	74.1	49.4	11.7	0.51	96.1	90.6	-1.5	10.3

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. Farinographresults are used to determine doughstrength 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.

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 times indicate strong gluten and dough properties while short peak times mayindicate 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	C01	63	84	182	0.77	55.6	5.5	10.3	25.7
	C02	87	73	246	1.20	56.6	4.9	11.2	24.0
	C03	97	57	211	1.71	58.3	5.5	9.2	30.3
Kansas	K01	86	61	178	1.51	58.4	5.4	9.3	24.7
	K02	102	63	230	1.63	58.7	4.5	9.9	22.0
	K03	85	64	190	1.34	57.4	5.3	11.4	18.5
	K04	93	43	148	2.15	59.4	4.8	7.3	42.0
	K05	73	63	164	1.18	56.8	4.6	9.4	25.0
	K06	61	77	165	0.81	55.3	5.7	9.8	30.7
Montana	M01	118	57	259	2.11	62.4	6.4	9.8	30.5
	M02	115	65	274	1.78	61.2	6.6	10.2	31.0
	M03	109	67	268	1.65	60.4	6.2	11.0	25.5
	M04	111	61	284	1.82	61.7	8.0	13.3	21.0
	M05	108	64	283	1.69	61.5	8.5	17.6	14.0
	M06	125	66	341	1.89	63.8	7.7	17.3	17.0
	M07	121	53	268	2.28	62.6	7.0	13.8	20.0
Nebraska	N01	98	53	203	1.90	58.3	6.3	10.8	28.3
	N02	84	66	209	1.28	57.3	5.4	10.7	21.7
	N03	79	57	167	1.38	57.2	4.4	8.3	28.0
	N04	85	45	151	1.92	56.3	4.0	8.2	26.5
	N05	86	59	198	1.68	58.3	5.4	8.5	37.0
Oklahoma	O01	89	74	222	1.21	58.7	4.8	8.3	34.3
	O02	85	74	204	1.16	58.0	4.3	7.0	38.5
	O03	98	64	223	1.54	59.8	5.7	9.4	27.7
	O04	113	55	220	2.07	60.9	4.9	8.1	33.0
	O05	99	53	188	1.87	57.9	4.6	7.9	37.0
	O06	101	71	240	1.46	59.1	3.8	8.7	24.3
	O07	101	58	208	1.80	58.5	4.2	9.9	21.5
Pacific Northwest	PNW01	103	54	211	2.12	62.1	6.9	11.2	26.5
	PNW02	128	47	244	2.72	61.8	6.2	11.6	19.0
	PNW03	109	53	231	2.06	60.1	5.8	9.3	32.5
	PNW04	113	57	253	1.98	60.9	6.1	13.7	18.0
South Dakota	SD01	83	67	208	1.26	58.5	5.7	10.3	25.5
	SD02	78	87	242	0.90	58.2	5.8	10.1	32.5
Texas	T01	87	95	245	0.92	60.8	4.6	7.4	31.5
	T02	87	71	208	1.25	58.0	3.8	7.8	32.5
	T03	86	66	201	1.30	57.5	3.5	8.2	27.0
	T04	98	60	191	1.65	62.7	4.8	5.4	42.0
	T05	76	59	146	1.33	59.9	4.9	6.7	36.0
	T06	77	83	212	0.93	58.2	5.1	8.0	29.5
Wyoming	W01	113	46	196	2.51	63.0	5.2	6.3	36.5

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)	Bak Abs (14% mb)	Loaf Volume (cc)	Crumb Grain (1-10)	Crumb Texture (1-10)	Crumb Color
Colorado	C01	4.8	62.4	963	8.3	8.0	Yellow
	C02	5.7	63.1	942	7.3	8.0	Yellow
	C03	4.8	62.5	893	5.5	7.5	Yellow
Kansas	K01	4.3	62.2	908	6.0	8.0	Yellow
	K02	4.7	60.9	835	4.8	7.0	Tan
	K03	4.6	61.2	843	5.9	6.3	Yellow
	K04	4.5	62.9	815	5.2	5.5	Tan
	K05	4.4	61.3	862	6.8	6.5	Yellow
	K06	4.6	61.9	928	7.3	7.0	sl Yellow
Montana	M01	4.7	65.6	928	6.7	7.8	sl Yellow
	M02	5.4	64.2	930	5.9	8.5	Yellow
	M03	5.0	63.8	850	4.8	5.5	Yellow
	M04	6.4	67.8	990	7.0	7.0	Yellow
	M05	6.3	67.4	1010	6.3	7.0	Creamy
	M06	6.0	66.8	975	5.5	7.0	Creamy
	M07	5.1	66.0	1015	6.3	7.0	sl Yellow
Nebraska	N01	5.1	63.0	883	5.8	7.0	sl Yellow
	N02	6.5	62.5	885	6.3	8.0	sl Yellow
	N03	4.8	61.4	848	5.5	6.5	Yellow
	N04	5.0	60.8	820	5.9	7.0	sl Yellow
	N05	4.9	62.5	867	6.8	8.0	sl Yellow
Oklahoma	O01	4.9	64.3	908	6.8	8.5	Tan
	O02	4.4	61.9	853	5.5	7.4	D. Yellow
	O03	4.1	62.8	902	5.3	7.5	Yellow
	O04	4.0	62.9	863	5.3	6.5	Yellow
	O05	4.5	60.7	800	4.8	5.5	Yellow
	O06	4.4	62.1	853	5.8	6.5	Tan
	O07	4.4	61.1	838	4.8	7.0	Yellow
Pacific Northwest	PNW01	4.3	64.3	903	6.7	6.3	Yellow
	PNW02	4.8	64.0	870	5.5	7.0	Yellow
	PNW03	5.1	64.3	898	6.3	7.0	Yellow
	PNW04	5.3	64.7	930	7.0	8.5	Yellow
South Dakota	SD01	6.4	62.7	903	7.1	7.8	sl Yellow
	SD02	5.9	63.6	943	7.8	8.5	sl Yellow
Texas	T01	3.8	64.5	910	6.3	8.5	Yellow
	T02	5.4	61.1	818	5.2	6.3	Tan
	T03	5.5	62.1	820	4.8	5.5	D. Yellow
	T04	2.9	64.3	870	4.8	6.7	D. Yellow
	T05	3.5	63.6	888	5.2	7.8	Tan
	T06	4.4	62.4	918	5.9	7.8	Yellow
Wyoming	W01	3.9	64.6	885	5.6	7.0	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% 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.