PGI

PLAINS GRAINS INC.

Hard Red Winter Wheat

2022 Regional Quality Survey

PGI

PLAINS GRAINS INC.

127 Noble Research Center
Stillwater, OK 74078
405.744.9333
pgiadmin@plainsgrains.org
plainsgrains.org

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 Commission
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

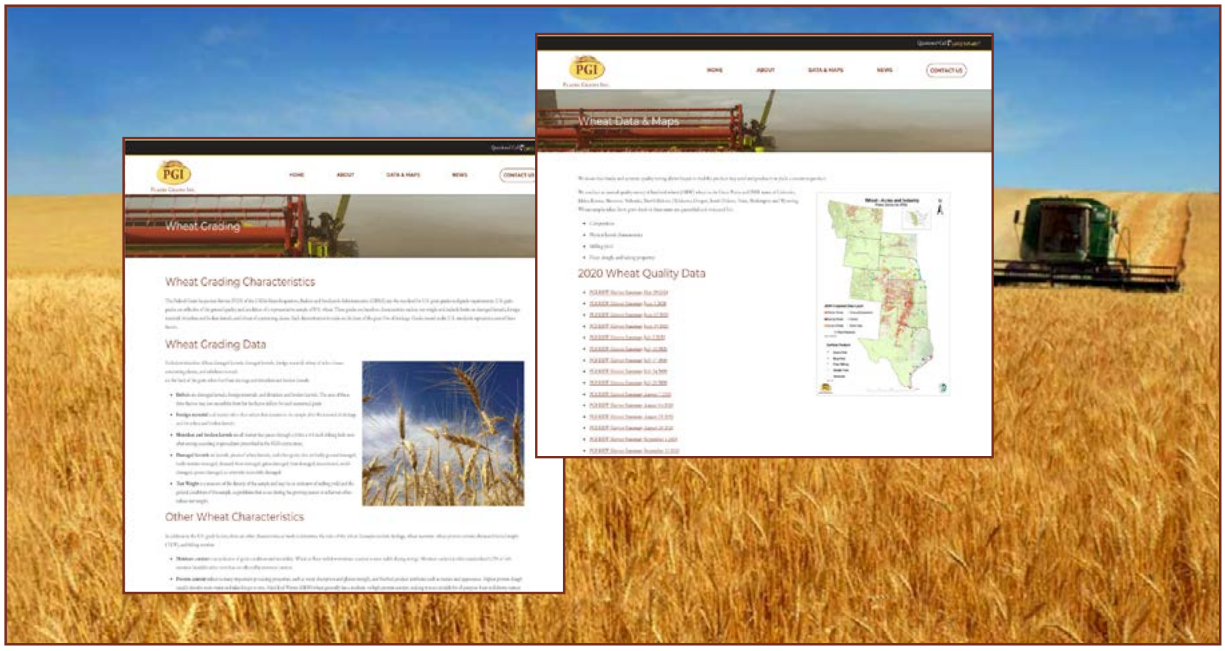
Plains Grains, Inc.

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 of a variety of wheat 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.

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.

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.

Overview

The 2021-22 (HRW) wheat crop faced challenges throughout the growing season, most notably beginning (and ending) with drought. While the majority of the crop did get planted within an acceptable planting window related to geographic location, limited soil moisture could only take the crop so far. The exceptionally dry conditions prevailed throughout the growing season with overall drought expanding another almost 4% from planting to harvest. This expansion added to an already extremely large geographic coverage which engulfed the majority of all wheat acres west of a line from Houston, TX straight north to the Canadian border. These dry conditions did not provide needed moisture for the development of an expanded root systems (primary and secondary) as a result this directly limited tillers produced per plant. Overall, this meant fewer heads per unit area and fewer kernels per head resulting in significantly lower yields.

Kernel (size, shape, weight, etc.) although small, was very consistent, which was favorable to increased mill yield. While overall grain yields were significantly lower than in 2021, grain quality improved. Generally, protein content was exceptional and exceeded the 2021 crop and the 5-year average by over one full percentage point. Farinograph peak time, stability, absorption, and loaf volume all exceed 2021 and the 5-year average. This is a strong indicator this crop will deliver value and opportunity to a wide range of customers world-wide.

Weather and Harvest

The 2022 HRW production was down over 6% from 2021 attributed primarily to widespread drought across all 11 HRW producing states in the US. Extraordinarily little moisture was available for plant development from the time seed was planted in the fall until harvest in late spring. The lack of tiller development (and very little deep root development were main contributors). In contrast, to 2020 and 2021 which were favorable to good growing conditions and produced near record yields (per unit area), very good kernel characteristics, but lower protein. The 2022 crop produced much smaller kernels (although very uniform in size) vs the previous years. However, average protein (13.0 %) is superior to the previous two crops. Additionally, with very few exceptions, disease and insects were again not a major issue for the 2022 HRW crop due to the same exceptionally dry conditions which limited production.

The majority of the HRW production area again saw record drought from planting in the fall of 2021 through the 2022 harvest. The result continues to be reductions in yields and the normal effects associated with drought on kernel characteristics (smaller).

Wheat and Grade Data

Gulf Tributary Crop: Overall 60% of the Gulf Tributary crop is U.S. No. 1, 58% of the samples are high protein (>12.5 % protein) and 86% of the samples graded U.S. No. 2 or better. Average test weight of 60.4 lb./bu. (79.4 kg/hl) is below 2021 of 60.6 lb./bu. (79.7 kg/hl) and below the 5-year average of 60.5 lb./bu. (79.6 kg/hl). Average dockage (0.5%) and is equal to 2021 and the 5-year average of (0.5%), total defects of (2.3%) is above 2021 (1.8%) and the 5-year average of 1.5%, foreign material (0.2%) is below the 2021 average of (0.3%) and equal to and the 5-year average of (0.2%). Average shrunken and broken is (1.2%) is above last year (0.9%) and above the 5-year average of 1.0%). Average thousand kernel weight of 30.4 g is below last year (30.9%) and the 5-year average (30.7%). Protein is (13.0%), equal to last year (11.6%) and below the 5-year average (11.7%). The average wheat falling number is 337 sec, indicative of sound wheat.

PNW Tributary Crop: While it was a moderately dry year for HRW grown in the Northern Great Plains and Pacific Northwest, the northern region recovered from last year's historic drought. The 2022 PNW-tributary crop has sound kernel and milling characteristics, quality protein, and notable absorption levels. The loaf volumes achieved surpass U.S. quality targets. Overall, the 2022 PNW crop averaged No. 1 in the U.S. for HRW. Specifics include: 61.3 lb/bu (80.5 kg/hl), with an average protein content of 12.8%, an average wheat falling number of 370 sec. wet gluten average of 32.7% and is well above last year and the 5-year average, reflective of excellent gluten strength.

Kernels are larger and slightly softer than last year, but they are also uniform in shape resulting in higher lab mill extractions. Overall, this crop meets or exceeds typical HRW contract specifications and should provide high value to customers. indicative of sound wheat.

Flour and Baking Data

The Buhler laboratory mill flour yield average is 78.0% and significantly above last year's average of 75.1% and the 5-year average of 75.3%. The 2022 flour ash of 0.53% (14% mb) is comparable to last year's 0.53% and the 5-year average of 0.52%. The alveograph W value of (211 10-4 J) is significantly higher than last year (195), but lower than the 5-year average of (225 10-4 J). Farinograph peak and stability times, (5.5 min., and 8.9 min.) min, respectively, are comparable to last year's (4.8 min., 8.9 min)., but higher overall than the 5-year average of (4.6 min. and 8.9 min.,). Average bake absorption is 64.9%, significantly higher 61.6% value for 2021 and the 5-year average of 62.6%. Overall loaf volume averaged a very good 931 cc, well above last year's 867 cc and the 5-year average of 862 cc.

Hard Red Winter Wheat Production Charts

English Units

Hard Red Winter Production (1,000 Bushels)

	2015	2016	2017	2018	2019	2020	2021	2022	Average
Colorado	79,180	105,120	86,860	70,200	98,000	46,500	66,778	35,750	73,548
Kansas	321,900	467,400	333,600	277,400	338,000	294,400	342,160	244,200	327,383
Montana	91,020	105,350	66,780	78,500	95,000	75,400	53,630	59,400	78,135
North Dakota	8,360	5,760	1,295	3,010	3,710	1,400	1,980	5,700	3,902
Nebraska	45,980	70,740	46,920	49,490	55,290	36,550	41,160	26,240	46,546
Oklahoma	98,800	136,500	98,600	70,000	110,000	113,400	115,050	68,600	101,369
Pacific NW	28,543	36,707	33,800	33,500	32,463	32,000	18,780	29,775	30,696
South Dakota	42,680	63,800	20,800	31,680	40,040	34,800	27,360	37,960	37,390
Texas	106,500	89,600	68,150	56,000	69,700	63,000	69,560	39,000	70,189
Wyoming	4,160	4,250	2,940	3,900	4,730	5,000	3,040	1,615	3,704
Regional Total	827,123	1,085,227	759,745	673,680	846,933	702,450	739,498	548,240	772,862

Hard Red Winter Harvested Acres (1,000 Acres)

	2015	2016	2017	2018	2019	2020	2021	2022	Average
Colorado	2,140	2,190	2,020	1,950	2,000	1,550	1,880	1,430	1,895
Kansas	8,700	8,200	6,950	7,300	6,500	6,400	7,000	6,600	7,206
Montana	2,220	2,150	1,590	1,570	1,900	1,450	1,730	1,800	1,801
North Dakota	190	120	35	70	70	35	60	95	84
Nebraska	1,210	1,310	1,020	1,010	970	850	840	820	1,004
Oklahoma	3,800	3,500	2,900	2,500	2,750	2,700	2,950	2,450	2,944
Pacific NW	434	456	451	431	432	423	368	397	424
South Dakota	970	1,100	520	660	770	580	720	730	756
Texas	3,550	2,800	2,350	1,750	2,050	2,100	2,000	1,300	2,238
Wyoming	130	125	105	115	110	110	95	95	111
Regional Total	23,344	21,951	17,941	17,356	17,552	16,198	17,643	15,717	18,463

Hard Red Winter Yield (bu/ac)

	2015	2016	2017	2018	2019	2020	2021	2022	Average
Colorado	37	48	43	36	49	30	36	25	38
Kansas	37	57	48	38	52	46	49	37	45
Montana	41	49	42	50	50	43	31	33	42
North Dakota	44	48	37	43	53	40	33	60	45
Nebraska	38	54	46	49	57	43	49	32	46
Oklahoma	26	39	34	28	40	40	39	28	34
Pacific NW	70	82	75	79	75	74	51	75	73
South Dakota	44	58	40	48	52	60	38	52	49
Texas	30	32	29	32	34	30	35	30	31
Wyoming	32	34	28	34	43	43	32	17	33
Regional Total	40	50	42	44	51	45	39	39	44

**Some data derived from Crop Production report issued by USDA NASS updated October 12, 2022

Hard Red Winter Wheat Production Charts

Metric Units

Hard Red Winter Production (MMT)

	2015	2016	2017	2018	2019	2020	2021	2022	Average
Colorado	2.16	2.86	2.36	1.91	2.67	1.27	1.82	0.97	2.00
Kansas	8.76	12.72	9.08	7.55	9.20	8.01	9.31	6.65	8.91
Montana	2.48	2.87	1.82	2.14	2.59	2.05	1.46	1.62	2.13
North Dakota	0.23	0.16	0.04	0.08	0.10	0.04	0.05	0.16	0.11
Nebraska	1.25	1.93	1.28	1.35	1.50	0.99	1.12	0.71	1.27
Oklahoma	2.69	3.72	2.68	1.91	2.99	3.09	3.13	1.87	2.76
Pacific NW	0.78	1.00	0.92	0.91	0.88	0.87	0.51	0.81	0.84
South Dakota	1.16	1.74	0.57	0.86	1.09	0.95	0.74	1.03	1.02
Texas	2.90	2.44	1.85	1.52	1.90	1.71	1.89	1.06	1.91
Wyoming	0.11	0.12	0.08	0.11	0.13	0.14	0.08	0.04	0.10
Regional Total	22.51	29.54	20.68	18.34	23.05	19.12	20.13	14.92	21.04

Hard Red Winter Harvested (1,000 ha)

	2015	2016	2017	2018	2019	2020	2021	2022	Average
Colorado	866	886	817	789	809	627	761	579	767
Kansas	3521	3318	2813	2954	2630	2590	2833	2671	2,916
Montana	898	870	643	635	769	587	700	728	729
North Dakota	77	49	14	28	28	14	24	38	34
Nebraska	490	530	413	409	393	344	340	332	406
Oklahoma	1538	1416	1174	1012	1113	1093	1194	991	1,191
Pacific NW	176	185	183	174	175	171	149	161	172
South Dakota	393	445	210	267	312	235	291	295	306
Texas	1437	1133	951	708	830	850	809	526	905
Wyoming	53	51	42	47	45	45	38	38	45
Regional Total	9,447	8,883	7,260	7,024	7,103	6,555	7,140	6,360	7,472

Hard Red Winter Yield (tons/ha)

	2015	2016	2017	2018	2019	2020	2021	2022	Average
Colorado	2.49	3.23	2.89	2.42	3.30	2.02	2.39	1.68	2.55
Kansas	2.49	3.84	3.23	2.56	3.50	3.10	3.29	2.49	3.06
Montana	2.76	3.30	2.83	3.37	3.37	2.89	2.08	2.22	2.85
North Dakota	2.96	3.23	2.49	2.89	3.57	2.69	2.22	4.04	3.01
Nebraska	2.56	3.63	3.10	3.30	3.84	2.89	3.30	2.15	3.10
Oklahoma	1.75	2.62	2.29	1.88	2.69	2.69	2.62	1.88	2.30
Pacific NW	4.71	5.52	5.05	5.32	5.05	4.98	3.43	5.04	4.89
South Dakota	2.96	3.90	2.69	3.23	3.50	4.04	2.56	3.50	3.30
Texas	2.02	2.15	1.95	2.15	2.29	2.02	2.34	2.02	2.12
Wyoming	2.15	2.29	1.88	2.29	2.89	2.89	2.15	1.14	2.21
Regional Total	2.69	3.37	2.84	2.94	3.40	3.02	2.64	2.62	2.94

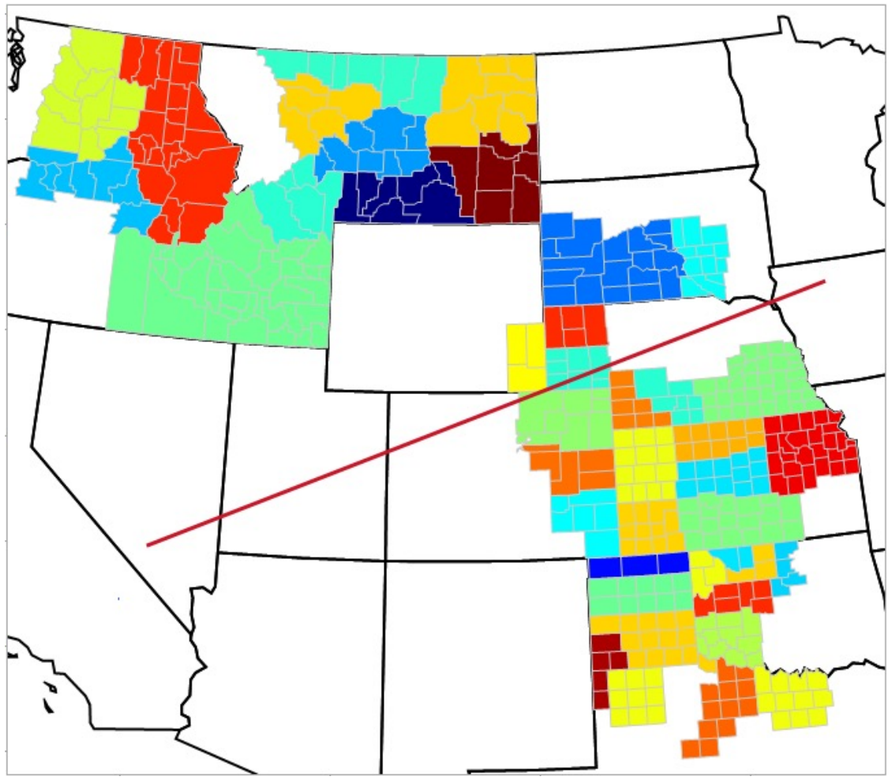
**Some data derived from Crop Production report issued by USDA NASS updated October 12, 2022

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
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.

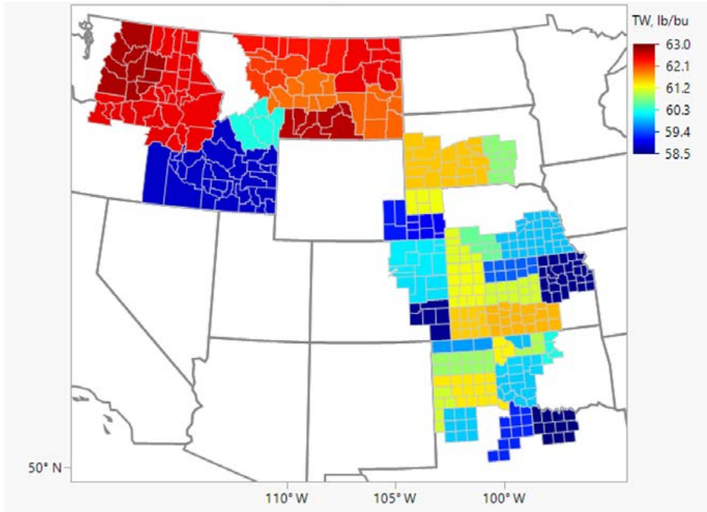
Foreign material is all matter other than wheat that remains in the sample after the removal of dockage and shrunken and broken kernels.

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.

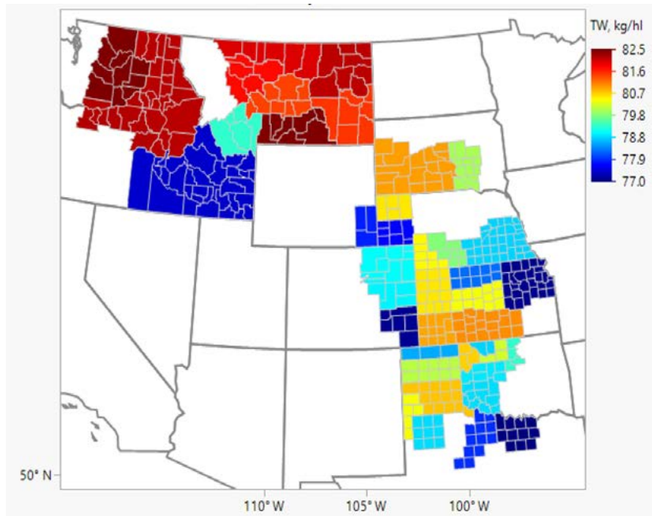
Damaged kernels are kernels, pieces of wheat kernels and other grains that are badly ground-damaged, badly weather damaged, diseased, frost-damaged, germ damaged, heat damaged, insect-bored, mold-damaged, sprout-damaged or otherwise materially damaged.

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	2	0.4	58.6	77.1	0.6	1.6	0.1
	C02	1	0.5	60.1	79.0	0.7	1.3	0.1
	C03	1	0.5	60.3	79.3	0.5	1.4	0.1
Kansas	K01	1	0.4	61.5	80.9	0.5	1.1	0.1
	K02	1	0.4	61.7	81.1	0.6	0.9	0.2
	K03	1	0.4	61.1	80.4	0.7	0.8	0.2
	K04	2	0.3	58.6	77.1	0.9	0.6	0.2
	K05	2	0.2	59.5	78.3	0.6	0.7	0.1
	K06	1	0.5	61.3	80.6	0.5	1.2	0.1
Montana	M01	1	0.7	62.8	82.5	0.1	0.6	0.1
	M02	1	0.5	62.4	82.0	0.5	0.7	0.1
	M03	1	0.5	62.2	81.8	0.3	0.9	0.1
	M04	1	0.3	62.0	81.5	0.2	1.2	0.1
	M05	1	0.3	62.5	82.2	0.1	1.2	0.2
	M06	1	0.5	62.0	81.5	0.6	1.1	0.1
	M07	1	0.9	60.3	79.3	0.5	1.1	0.1
Nebraska	N01	1	0.6	59.1	77.8	0.5	1.9	0.2
	N02	1	0.5	61.2	80.5	0.3	1.1	0.1
	N03	1	0.5	60.7	79.8	0.6	1.1	0.1
	N04	1	0.6	60.3	79.3	0.5	0.8	0.1
	N05	1	0.6	61.3	80.6	0.5	1.4	0.2
Oklahoma	O01	1	0.4	60.0	78.9	3.8	0.9	0.2
	O02	1	0.3	60.0	78.9	4.4	1.0	0.4
	O03	2	0.3	59.8	78.6	0.4	1.2	0.1
	O04	1	0.5	61.1	80.3	0.6	2.0	0.6
	O05	2	0.7	59.9	78.8	0.9	1.5	0.4
	O06	1	0.3	61.0	80.2	0.9	0.9	0.4
	O07	1	0.7	60.3	79.3	0.6	1.2	0.3
Pacific Northwest	PNW01	1	0.4	61.8	81.3	0.0	0.8	0.1
South Dakota	SD01	1	0.4	61.6	81.0	0.4	1.1	0.1
	SD02	1	0.4	60.8	80.0	0.5	0.7	0.1
Texas	T01	1	0.5	60.0	78.9	0.5	1.5	0.1
	T02	2	0.2	59.2	77.9	1.3	1.3	0.1
	T03	2	0.3	58.8	77.3	1.2	1.0	0.1
	T04	1	0.7	61.1	80.4	0.5	0.8	0.1
	T05	1	0.4	61.4	80.7	0.5	1.9	1.2
	T06	1	0.6	61.1	80.3	0.6	1.5	0.6
Wyoming	W01	2	0.3	59.2	77.9	0.4	1.1	0.3

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	2.3	55	43	2	29.8	2.53
	C02	2.1	55	44	1	30.6	2.50
	C03	2.0	48	51	2	29.7	2.47
Kansas	K01	1.8	58	41	1	31.5	2.54
	K02	1.7	62	38	0	31.2	2.60
	K03	1.8	68	31	0	31.9	2.65
	K04	1.7	72	27	1	30.5	2.62
	K05	1.4	65	34	1	30.3	2.59
	K06	1.7	56	43	1	31.1	2.53
Montana	M01	0.8	61	38	1	30.8	2.57
	M02	1.3	66	34	0	33.7	2.65
	M03	1.4	65	34	1	31.7	2.60
	M04	1.5	64	35	1	32.1	2.59
	M05	1.5	57	42	1	28.1	2.49
	M06	1.8	70	29	1	31.9	2.59
	M07	1.8	67	32	1	31.1	2.61
Nebraska	N01	2.6	47	51	2	28.1	2.46
	N02	1.5	58	41	1	31.3	2.52
	N03	1.8	68	31	1	31.4	2.59
	N04	1.4	74	26	0	31.5	2.62
	N05	2.1	61	37	1	31.2	2.62
Oklahoma	O01	4.9	59	40	1	30.5	2.59
	O02	5.7	69	30	1	31.7	2.67
	O03	1.7	61	38	1	30.8	2.56
	O04	2.8	60	39	1	31.9	2.59
	O05	2.7	53	46	1	30.2	2.53
	O06	2.3	66	34	0	32.7	2.67
	O07	2.2	62	38	1	30.0	2.55
Pacific Northwest	PNW01	0.9	78	21	1	34.9	2.74
South Dakota	SD01	1.7	60	39	1	30.2	2.53
	SD02	1.3	62	37	1	30.5	2.53
Texas	T01	2.1	54	44	2	30.0	2.54
	T02	2.8	54	45	1	29.9	2.56
	T03	2.4	71	28	1	30.1	2.59
	T04	1.4	62	37	1	30.9	2.59
	T05	3.5	54	44	2	29.8	2.52
	T06	2.6	51	47	2	30.6	2.52
Wyoming	W01	1.8	58	40	1	31.7	2.56

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.

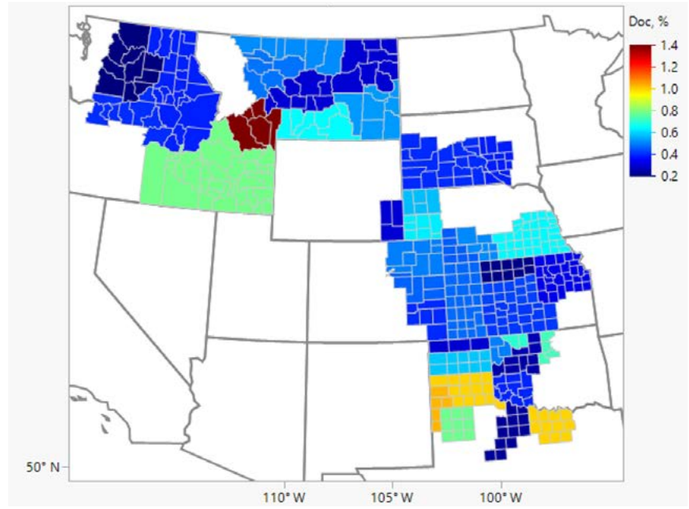
Falling number is an index of enzyme activity in wheat or flour and is expressed in seconds. Falling numbers above 300 are desirable, as they indicate little enzyme activity and a sound, quality product. Falling numbers below 300 are indicative of more substantial enzyme activity and sprout damage.

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.

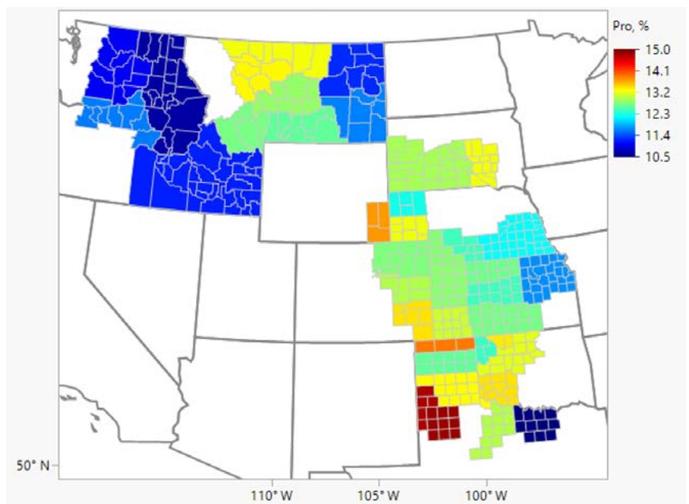
Kernel size is a measure of the percentage by weight of large, medium and small kernels in a sample. Large kernels or more uniform kernel size may help improve milling yield.

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.

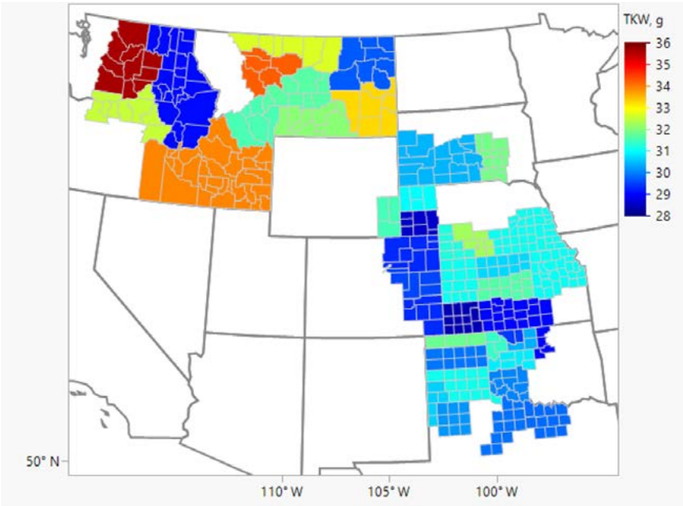
Dockage (%)



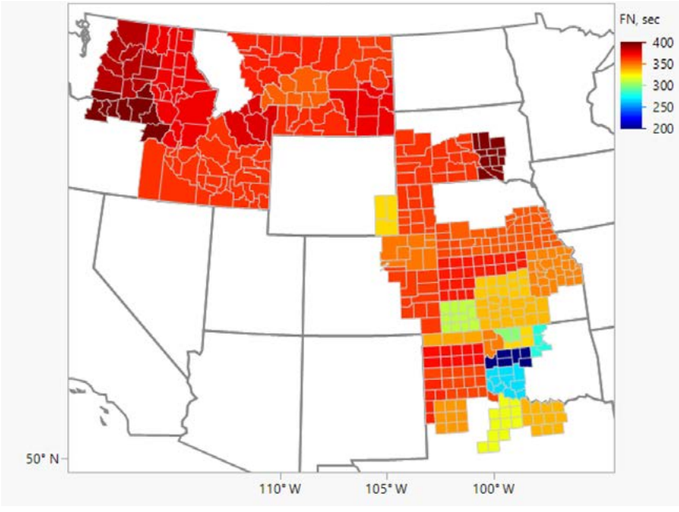
Protein (%)



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	13.4	1.70	374	10.8	51
	C02	13.0	1.63	351	11.5	58
	C03	12.8	1.65	351	10.8	61
Kansas	K01	13.1	1.64	327	10.9	74
	K02	12.7	1.66	351	11.2	75
	K03	12.5	1.61	335	11.1	72
	K04	11.7	1.63	388	11.3	62
	K05	12.7	1.62	417	9.9	59
	K06	12.8	1.62	405	11.0	67
Montana	M01	12.6	1.67	376	10.2	61
	M02	13.3	1.56	373	10.2	72
	M03	13.3	1.55	363	9.3	72
	M04	12.9	1.59	360	10.0	71
	M05	11.3	1.56	372	10.4	72
	M06	11.6	1.46	392	9.4	68
	M07	12.7	1.60	383	9.0	74
Nebraska	N01	13.2	1.65	350	10.4	62
	N02	12.8	1.62	355	11.0	64
	N03	12.5	1.72	346	12.4	67
	N04	12.0	1.61	369	11.9	63
	N05	12.3	1.55	348	9.0	60
Oklahoma	O01	13.4	1.67	181	11.2	67
	O02	13.2	1.60	166	10.7	58
	O03	13.9	1.69	342	11.6	71
	O04	12.5	1.57	327	10.2	65
	O05	13.4	1.61	301	10.2	62
	O06	13.2	1.56	334	10.7	59
	O07	13.2	1.69	291	11.6	58
Pacific Northwest	PNW01	12.6	1.43	380	8.7	72
South Dakota	SD01	12.9	1.66	367	11.3	67
	SD02	13.3	1.65	375	11.4	61
Texas	T01	14.9	1.56	369	8.7	68
	T02	13.0	1.60	328	10.6	59
	T03	10.4	1.58	313	12.1	45
	T04	14.8	1.66	342	8.8	73
	T05	13.3	1.66	366	10.2	68
	T06	12.9	1.73	341	10.9	66
Wyoming	W01	13.8	1.74	339	11.2	66

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

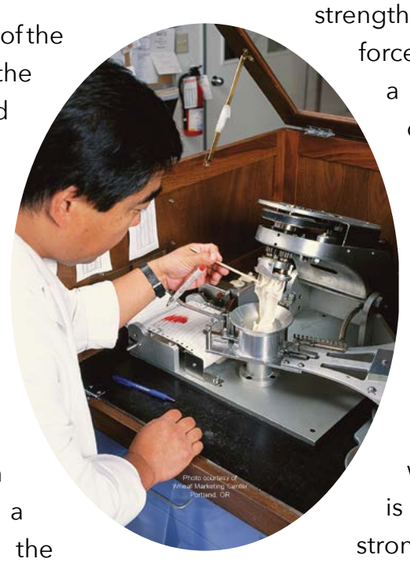
Location		Buhler Flour Yield (%)	Zeleny Sedimen Test (cc)	NIR Flour Protein (14% mb)	Flour Ash (14% mb)	Gluten Index	Flour Color L*	Flour Color a*	Flour Color b*
Colorado	C01	78.2	57.8	12.7	0.54	99.4	90.2	-1.6	9.7
	C02	77.9	65.5	12.2	0.52	99.2	90.8	-1.5	9.5
	C03	77.0	58.1	11.7	0.50	98.2	91.0	-1.6	9.7
Kansas	K01	78.3	52.7	12.1	0.55	86.7	90.7	-1.5	9.9
	K02	78.3	56.2	11.7	0.53	91.9	90.6	-1.5	9.9
	K03	78.5	49.6	11.3	0.53	99.6	90.4	-1.5	9.9
	K04	77.6	38.0	10.2	0.52	98.2	90.5	-1.6	9.8
	K05	78.3	47.4	11.6	0.53	98.3	90.3	-1.4	9.7
	K06	78.4	50.3	11.8	0.51	96.6	90.6	-1.5	10.2
Montana	M01	77.9	58.3	12.9	0.50	71.5	90.9	-1.7	10.0
	M02	79.0	65.5	12.5	0.53	98.1	90.6	-1.6	10.5
	M03	78.2	65.9	12.7	0.54	93.5	90.2	-1.5	9.9
	M04	78.9	64.3	12.1	0.52	95.5	90.5	-1.6	10.4
	M05	78.0	58.2	10.3	0.48	98.9	91.4	-1.4	8.6
	M06	77.9	47.9	10.8	0.50	96.0	90.7	-1.7	10.5
	M07	77.6	63.2	12.1	0.51	96.7	90.5	-1.7	10.9
Nebraska	N01	77.0	58.4	12.2	0.53	98.4	90.3	-1.5	9.7
	N02	77.7	50.6	11.7	0.52	95.3	90.4	-1.6	10.2
	N03	77.5	46.7	11.3	0.50	98.2	90.6	-1.6	10.0
	N04	78.3	45.6	10.7	0.50	99.0	90.6	-1.6	9.9
	N05	77.4	53.6	11.4	0.51	96.4	90.8	-1.7	10.0
Oklahoma	O01	78.2	52.8	12.2	0.54	90.3	90.0	-1.5	10.0
	O02	78.4	53.9	11.8	0.53	95.6	90.3	-1.4	8.9
	O03	78.6	53.2	12.5	0.55	91.9	90.4	-1.5	10.2
	O04	78.7	48.8	11.5	0.54	96.8	90.4	-1.4	9.4
	O05	78.0	64.7	12.4	0.54	96.4	90.5	-1.3	8.8
	O06	77.2	63.2	12.2	0.53	96.9	90.5	-1.3	8.7
	O07	77.7	57.0	11.8	0.52	97.1	90.5	-1.3	8.9
Pacific Northwest	PNW01	78.6	53.5	11.4	0.51	98.0	90.6	-1.7	10.8
South Dakota	SD01	78.6	53.4	11.9	0.52	97.2	90.1	-1.4	9.3
	SD02	78.0	53.6	12.1	0.53	95.6	90.5	-1.4	8.7
Texas	T01	77.0	55.0	14.1	0.57	59.3	90.8	-1.4	10.7
	T02	78.5	42.1	11.7	0.57	88.3	90.5	-1.5	9.9
	T03	78.3	27.8	9.1	0.54	96.0	90.9	-1.6	9.2
	T04	77.3	58.5	14.0	0.56	68.3	90.4	-1.3	10.1
	T05	78.0	51.9	12.6	0.56	91.3	90.3	-1.4	10.2
	T06	77.6	52.3	12.4	0.57	83.1	90.5	-1.5	10.6
Wyoming	W01	77.9	48.4	12.8	0.58	88.4	89.8	-1.4	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 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) valueat 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 P (mm)	ALVEOGRAPH L (mm)	ALVEOGRAPH W (10-4 J)	ALVEOGRAPH P/L Ratio	FARINOGRAPH Abs (14%mb)	FARINOGRAPH Development Time (min)	FARINOGRAPH Stability (min)	FARINOGRAPH MTI (BU)
Colorado	C01	80	86	243	0.9	58.4	6.2	10.8	22.0
	C02	75	77	217	1.0	57.1	5.7	9.8	25.9
	C03	79	70	212	1.1	56.9	6.6	10.6	27.9
Kansas	K01	110	56	228	2.0	61.2	6.2	7.9	33.5
	K02	95	86	267	1.1	61.6	5.6	9.9	29.2
	K03	107	78	291	1.4	60.8	5.7	11.7	18.9
	K04	93	53	181	1.8	58.5	4.0	8.3	28.4
	K05	95	70	248	1.4	58.9	6.5	12.8	20.3
	K06	86	62	200	1.4	58.5	6.6	9.3	32.7
Montana	M01	89	50	164	1.8	60.1	4.3	5.9	34.3
	M02	105	59	243	1.8	59.5	7.0	9.6	31.1
	M03	105	63	252	1.7	60.6	5.8	11.0	27.4
	M04	97	62	233	1.6	60.3	6.0	9.7	29.5
	M05	98	53	220	1.8	56.5	4.4	12.9	15.0
	M06	94	61	209	1.5	58.1	5.5	7.9	39.0
	M07	105	62	257	1.7	60.3	6.0	11.5	25.3
Nebraska	N01	84	76	228	1.1	59.0	6.3	9.6	28.4
	N02	77	65	177	1.2	58.4	6.0	7.4	35.7
	N03	88	53	186	1.6	58.4	6.3	10.2	29.5
	N04	76	61	178	1.3	56.3	4.9	9.1	28.4
	N05	85	61	192	1.4	58.7	5.5	8.1	33.7
Oklahoma	O01	84	75	222	1.1	59.5	5.6	8.6	34.1
	O02	69	83	184	0.8	57.6	4.4	7.8	31.5
	O03	108	59	220	1.8	62.5	5.7	7.0	37.3
	O04	108	44	188	2.5	60.3	5.7	6.8	44.0
	O05	82	72	206	1.1	59.2	4.9	9.3	29.0
	O06	92	69	219	1.3	59.5	4.8	9.3	26.8
	O07	71	77	191	0.9	57.0	5.2	8.7	29.0
Pacific Northwest	PNW01	109	62	250	1.8	60.6	4.9	8.7	29.5
South Dakota	SD01	82	72	213	1.1	58.7	5.8	9.1	29.9
	SD02	74	66	173	1.1	58.2	5.3	9.5	26.0
Texas	T01	96	71	216	1.4	64.1	5.7	6.5	32.0
	T02	83	73	204	1.1	58.7	5.3	9.0	26.4
	T03	59	37	81	1.6	53.6	2.8	5.7	42.0
	T04	99	57	197	1.7	63.7	6.5	7.7	29.0
	T05	102	69	239	1.5	61.7	5.2	7.0	34.0
	T06	98	73	234	1.3	61.4	5.6	7.3	35.2
Wyoming	W01	92	50	167	1.8	62.1	5.0	5.3	40.0

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	5.1	66.1	980	5.0	5.6	Yellow
	C02	5.0	65.4	949	6.4	6.3	Yellow
	C03	5.6	64.2	933	6.8	6.4	Yellow
Kansas	K01	3.8	65.3	933	5.4	6.8	Yellow
	K02	4.5	64.9	938	6.1	6.9	Yellow
	K03	4.7	64.5	918	4.7	6.4	Yellow
	K04	4.5	61.5	852	4.7	6.2	Yellow
	K05	5.2	64.4	945	6.3	6.8	Yellow
	K06	4.6	64.3	945	7.0	6.5	V Yellow
Montana	M01	3.4	65.9	911	5.0	6.3	Yellow
	M02	4.5	65.6	963	6.4	5.6	Yellow
	M03	5.0	67.0	976	6.3	7.0	Yellow
	M04	5.1	65.3	958	7.4	6.7	Yellow
	M05	7.8	65.0	840	6.3	6.3	Yellow
	M06	4.5	63.0	875	6.3	6.3	Yellow
	M07	5.1	65.1	946	5.7	7.0	Yellow
Nebraska	N01	4.9	65.3	966	6.6	7.0	sl Yellow
	N02	4.3	64.5	923	7.2	6.6	sl Yellow
	N03	4.8	63.1	901	6.5	6.5	Yellow
	N04	5.7	62.9	888	7.5	7.0	Yellow
	N05	4.5	63.7	893	5.5	5.7	Yellow
Oklahoma	O01	4.1	66.2	951	5.1	6.2	Yellow
	O02	4.5	65.1	955	6.7	7.0	D. Yellow
	O03	3.6	66.9	951	3.6	6.3	Yellow
	O04	4.0	64.4	900	4.8	6.3	Yellow
	O05	4.8	65.8	982	7.3	6.9	Yellow
	O06	5.0	65.8	977	6.3	6.3	Yellow
	O07	5.0	64.7	965	6.3	5.5	Yellow
Pacific Northwest	PNW01	4.5	64.0	874	6.1	5.8	Yellow
South Dakota	SD01	5.4	64.5	936	6.3	6.7	Yellow
	SD02	4.5	65.0	955	7.0	5.5	Yellow
Texas	T01	3.0	67.6	960	4.0	4.0	Yellow
	T02	5.1	64.3	933	6.3	5.9	Yellow
	T03	4.0	58.9	810	4.0	4.0	Yellow
	T04	3.0	67.6	965	4.8	6.3	Yellow
	T05	4.0	66.5	965	6.3	7.0	Yellow
	T06	3.8	66.0	937	5.5	6.7	Yellow
Wyoming	W01	3.8	66.5	930	4.0	5.5	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.