PGI

PLAINS GRAINS INC.

Hard Red Winter Wheat

2020 Regional Quality Survey

PGI

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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 2020 hard red winter (HRW) wheat crop was unique in several respects. This crop does hold value for about every customer. Overall, the crop had very few insect or disease issues throughout the entire growing season.

Most kernel characteristics are similar or equal better than last year. However, average test weight and thousand kernel weight exceeded the 5-year averages. Similarly, most flour, dough and bake data were equal to or better than last year, but again there were several exceptions that exceeded the 5-year averages. Those included the W-values, farinograph peak time, farinograph stability time, bake absorption and loaf volume.

Overall, the 2020 crop has good milling and processing characteristics and should provide customers with an exceptionally good range of quality and value.

Weather and Harvest

The 2020 HRW planted area was again near historic 100-year lows, continuing the trend of recent years, HRW production is estimated at 18.9 MMT (695 mil bu), a 3.8 MMT decrease from 2019.

Moisture (or lack of) and below freezing temperatures during the later stages of crop development defined the 2020 crop in the central and southern Great Plains. Eastern areas of that region experienced favorable growing conditions and subsequently realized near record yields (per unit area), particularly good kernel characteristics, but lower protein. At the same time western areas of the central and southern Great Plains experienced drought and freeze events during the later stages of crop development that adversely affected the crop resulting in lower yields and smaller kernels, but higher protein. With very few exceptions disease and insects were not a major issue for the 2020 HRW crop.

The northern Great Plains and Pacific Northwest (PNW) faced variable growing conditions as well. Washington, Montana, Idaho and South Dakota all harvested a crop that was at record or near record yields (per unit area) with generally particularly good kernel characteristics and protein. At the same time Oregon experienced a significant reduction in yield due to unseasonably dry weather.

Wheat and Grade Data

Overall 92% of Composite, 90% of Gulf Tributary and 96% of PNW Tributary samples graded U.S. No. 2 or better. Average test weight of 61.4 lb/bu (80.8 kg/hl) is above the 2019 average of 60.6 lb/bu (79.6 kg/hl) and above the 5-year average of 60.4 lb/bu (79.4 kg/hl). Average dockage (0.5%), total defects (1.4%) and foreign material (0.1%) are all equal to or like 2019 and the 5-year averages. Average shrunken and broken is (1.1%), above 2019 (0.8%) and above the 5-year average (1.0%). Average thousand kernel weight of 31.2g while less than 2019 (32.7g), is like the 5-year average (31.1g). Protein is (11.9%), above last year (11.4%) and slightly lower than the 5-year average (12.1%). The average wheat falling number is 369 sec, indicative of sound wheat.

Crop Production Review & Analysis

Flour and Baking Data

The Buhler laboratory mill flour yield average is 73.5%, slightly lower than the 2019 average (74.5%) and the 5-year average (75.4%). The 2020 flour ash of 0.49% (14% mb) is comparable to last year's 0.48%, but lower than the 5-year average of 0.54%. The alveograph W value of 261(10-4 J) is significantly higher than last year and the 5-year averages (223 and 232 10-4 J) respectively.

Farinograph peak time (5.3 minutes) is higher than in 2019 and 5-year respectfully (3.3 and 4.6) minutes. Stability time (10.3 minutes) is significantly higher than last year and the 5-year average of (7.3 minutes and 8.1 minutes) respectively. Average bake absorption is 63.1%, above the 62.7% value for 2019 and the 5-year average of 62.9%. Overall loaf volume averaged 859 cc and is comparable to last year's 863 cc and to the 5-year average of 853 cc.

Hard Red Winter Wheat Production Charts

English Units

Hard Red Winter Production (1,000 Bushels)

	2013	2014	2015	2016	2017	2018	2019	2020	Average
Colorado	43,500	89,300	79,180	105,120	86,860	70,200	98,000	46,500	77,333
Kansas	328,000	246,400	321,900	467,400	333,600	277,400	338,000	294,400	325,888
Montana	96,750	91,840	91,020	105,350	66,780	78,500	95,000	75,400	87,580
North Dakota	13,440	27,195	8,360	5,760	1,295	3,010	3,710	1,400	8,021
Nebraska	41,760	71,050	45,980	70,740	46,920	49,490	55,290	36,550	52,223
Oklahoma	115,500	47,600	98,800	136,500	98,600	70,000	110,000	113,400	98,800
Pacific NW	35,330	28,350	28,543	36,707	33,800	33,500	32,463	32,000	32,587
South Dakota	25,350	59,400	42,680	63,800	20,800	31,680	40,040	34,800	39,819
Texas	64,000	67,500	106,500	89,600	68,150	56,000	69,700	63,000	73,056
Wyoming	2,640	3,375	4,160	4,250	2,940	3,900	4,730	5,000	3,874
Regional Total	766,270	732,010	827,123	1,085,227	759,745	673,680	846,933	702,450	799,180

Hard Red Winter Harvested Acres (1,000 Acres)

	2013	2014	2015	2016	2017	2018	2019	2020	Average
Colorado	1,500	2,350	2,140	2,190	2,020	1,950	2,000	1,550	1,963
Kansas	8,200	8,800	8,700	8,200	6,950	7,300	6,500	6,400	7,631
Montana	2,150	2,240	2,220	2,150	1,590	1,570	1,900	1,450	1,909
North Dakota	320	555	190	120	35	70	70	35	174
Nebraska	1,160	1,450	1,210	1,310	1,020	1,010	970	850	1,123
Oklahoma	3,500	2,800	3,800	3,500	2,900	2,500	2,750	2,700	3,056
Pacific NW	530	417	434	456	451	431	432	423	447
South Dakota	650	1,080	970	1,100	520	660	770	580	791
Texas	2,000	2,250	3,550	2,800	2,350	1,750	2,050	2,100	2,356
Wyoming	120	125	130	125	105	115	110	110	118
Regional Total	20,130	22,067	23,344	21,951	17,941	17,356	17,552	16,198	19,567

Hard Red Winter Yield (bu/ac)

	2013	2014	2015	2016	2017	2018	2019	2020	Average
Colorado	29	38	37	48	43	36	49	30	39
Kansas	40	28	37	57	48	38	52	46	43
Montana	45	41	41	49	42	50	50	43	45
North Dakota	42	49	44	48	37	43	53	40	45
Nebraska	36	49	38	54	46	49	57	43	47
Oklahoma	33	17	26	39	34	28	40	40	32
Pacific NW	68	66	70	82	75	79	75	74	74
South Dakota	39	55	44	58	40	48	52	60	50
Texas	32	30	30	32	29	32	34	30	31
Wyoming	22	27	32	34	28	34	43	43	33
Regional Avg	39	40	40	50	42	44	51	45	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 Red Winter Production (MMT)

	2013	2014	2015	2016	2017	2018	2019	2020	Average
Colorado	1.18	2.43	2.16	2.86	2.36	1.91	2.67	1.27	2.10
Kansas	8.93	6.71	8.76	12.72	9.08	7.55	9.20	8.01	8.87
Montana	2.63	2.50	2.48	2.87	1.82	2.14	2.59	2.05	2.38
North Dakota	0.37	0.74	0.23	0.16	0.04	0.08	0.10	0.04	0.22
Nebraska	1.14	1.93	1.25	1.93	1.28	1.35	1.50	0.99	1.42
Oklahoma	3.14	1.30	2.69	3.72	2.68	1.91	2.99	3.09	2.69
Pacific NW	0.96	0.77	0.78	1.00	0.92	0.91	0.88	0.87	0.89
South Dakota	0.69	1.62	1.16	1.74	0.57	0.86	1.09	0.95	1.08
Texas	1.74	1.84	2.90	2.44	1.85	1.52	1.90	1.71	1.99
Wyoming	0.07	0.09	0.11	0.12	0.08	0.11	0.13	0.14	0.11
Regional Total	20.86	19.92	22.51	29.54	20.68	18.34	23.05	19.12	21.75

Hard Red Winter Harvested (1,000 ha)

	2013	2014	2015	2016	2017	2018	2019	2020	Average
Colorado	607	951	866	886	817	789	809	627	794
Kansas	3,318	3,561	3,521	3,318	2813	2,954	2,630	2,590	3,088
Montana	870	906	898	870	643	635	769	587	772
North Dakota	129	225	77	49	14	28	28	14	71
Nebraska	469	587	490	530	413	409	393	344	454
Oklahoma	1,416	1,133	1,538	1,416	1,174	1,012	1,113	1,093	1,237
Pacific NW	214	169	176	185	183	174	175	171	181
South Dakota	263	437	393	445	210	267	312	235	320
Texas	809	911	1,437	1,133	951	708	830	850	954
Wyoming	49	51	53	51	42	47	45	45	48
Regional Total	8,146	8,930	9,447	8,883	7,260	7,024	7,103	6,555	7,919

Hard Red Winter Yield (tons/ha)

	2013	2014	2015	2016	2017	2018	2019	2020	Average
Colorado	1.95	2.56	2.49	3.23	2.89	2.42	3.30	2.02	2.61
Kansas	2.69	1.88	2.49	3.84	3.23	2.56	3.50	3.10	2.91
Montana	3.03	2.76	2.76	3.30	2.83	3.37	3.37	2.89	3.04
North Dakota	2.83	3.30	2.96	3.23	2.49	2.89	3.57	2.69	2.99
Nebraska	2.42	3.30	2.56	3.63	3.10	3.30	3.84	2.89	3.13
Oklahoma	2.22	1.14	1.75	2.62	2.29	1.88	2.69	2.69	2.16
Pacific NW	4.58	4.44	4.71	5.52	5.05	5.32	5.05	4.98	4.95
South Dakota	2.62	3.70	2.96	3.90	2.69	3.23	3.50	4.04	3.33
Texas	2.15	2.02	2.02	2.15	1.95	2.15	2.29	2.02	2.09
Wyoming	1.48	1.82	2.15	2.29	1.88	2.29	2.89	2.89	2.21
Regional Avg	2.60	2.69	2.69	3.37	2.84	2.94	3.40	3.02	2.94

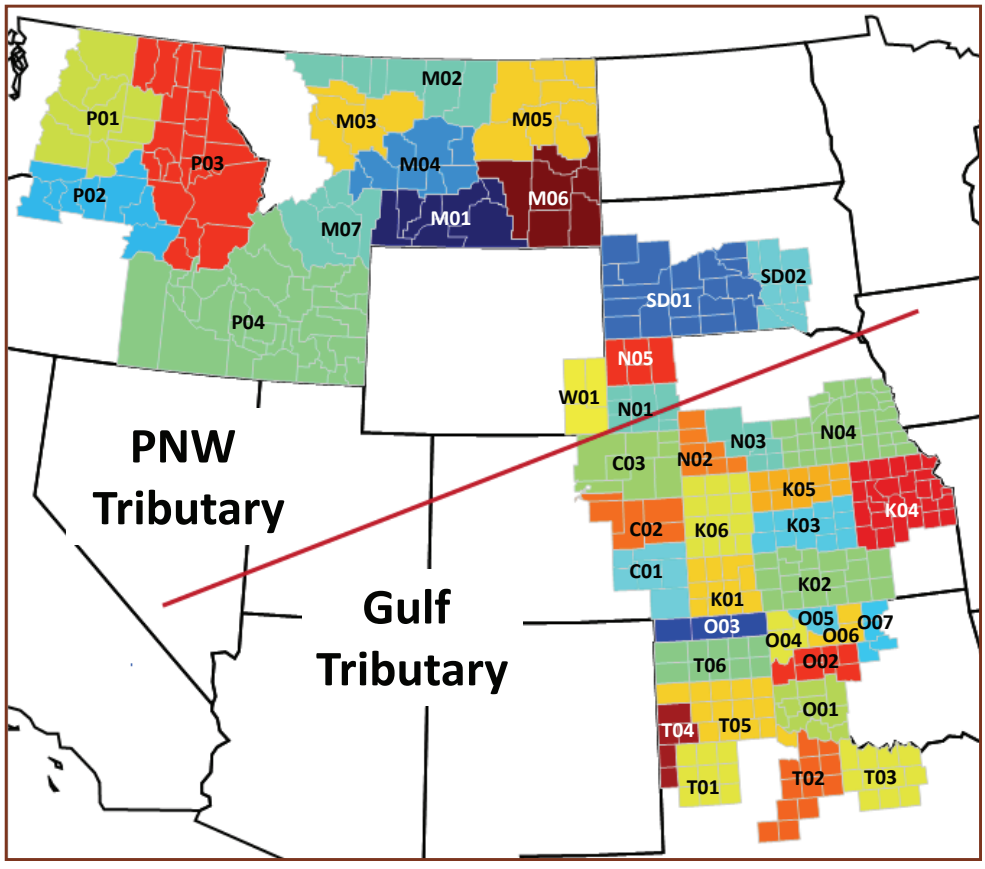
*** Some data derived from Crop Production report issued by USDA NASS updated September 30, 2018.*

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.

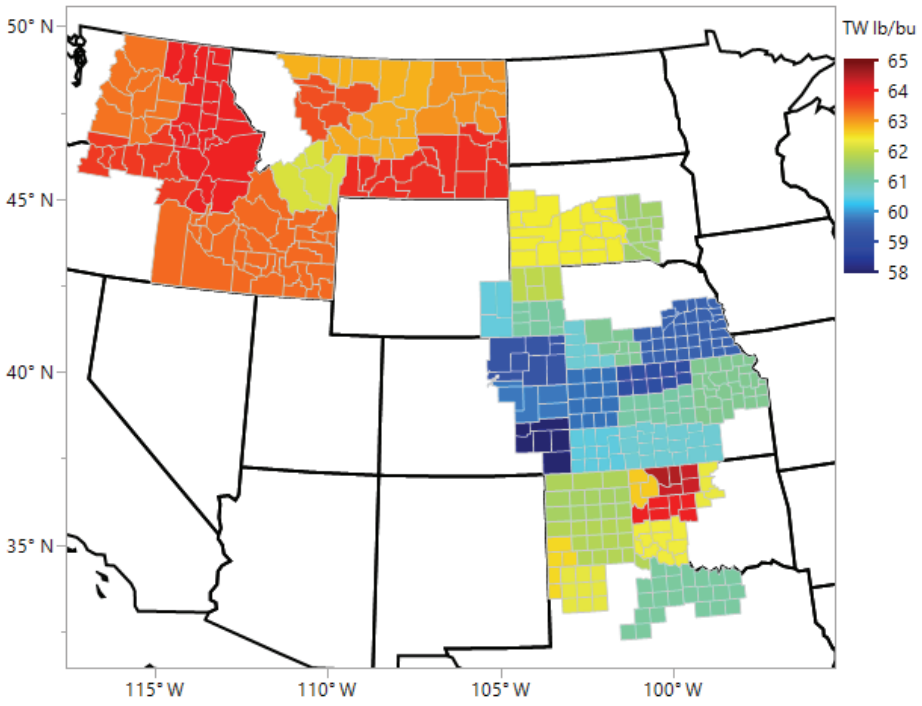
Foreign material is all matter other than wheat that remains in the sample after the removal of dockage and shrunken and broken kernels.

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.

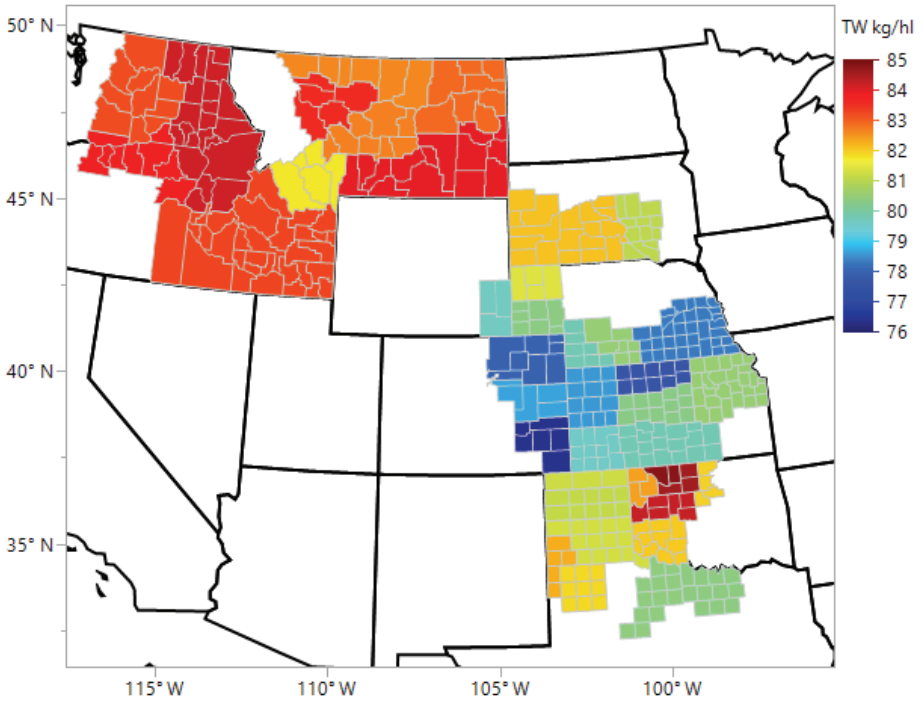
Damaged kernels are kernels, pieces of wheat kernels and other grains that are badly ground-damaged, badly weather damaged, diseased, frost-damaged, germ damaged, heat-damaged, insect-bored, mold-damaged, sprout-damaged or otherwise materially damaged.

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	CO1	3	0.4	57.7	75.9	0.2	2.2	0.1
	CO2	1	0.7	60.2	79.2	0.1	1.8	0.1
	CO3	2	0.5	59.3	78.0	0.1	4.9	0.2
Kansas	K01	1	0.3	60.3	79.3	0.2	1.3	0.1
	K02	1	0.4	60.4	79.5	0.2	0.9	0.1
	K03	1	0.4	60.8	80.0	0.2	0.6	0.1
	K04	1	0.7	60.9	80.1	0.6	0.5	0.1
	K05	2	0.4	58.8	77.4	0.1	0.9	0.1
	K06	2	0.6	59.5	78.3	0.2	1.7	0.1
Montana	M01	1	0.3	63.5	83.5	0.2	0.6	0.1
	M02	1	0.5	62.7	82.5	0.3	0.6	0.1
	M03	1	0.4	63.3	83.2	0.3	0.6	0.1
	M04	1	0.4	63.6	83.5	0.3	0.9	0.1
	M05	1	0.3	63.0	82.8	0.2	0.1	0.1
	M06	1	0.2	63.9	84.0	0.1	0.8	0.1
	M07	1	0.5	61.6	81.0	0.1	1.1	0.1
Nebraska	N01	1	0.5	60.9	80.1	0.1	1.2	0.1
	N02	1	0.6	60.3	79.3	0.1	1.8	0.1
	N03	1	0.3	61.0	80.3	0.1	0.8	0.1
	N04	1	0.4	61.2	80.5	0.2	1.0	0.3
	N05	1	0.4	61.8	81.2	0.1	0.8	0.2
Oklahoma	O01	1	0.5	62.2	81.7	0.3	0.9	0.5
	O02	1	0.5	63.8	83.8	0.3	0.9	0.2
	O03	1	0.3	61.6	81.1	0.2	0.6	0.1
	O04	1	0.6	62.7	82.5	0.1	0.6	1.3
	O05	1	0.4	64.4	84.6	0.1	0.4	0.2
	O06	1	0.4	64.3	84.5	0.2	0.5	0.3
	O07	1	0.4	62.3	81.9	0.2	0.6	0.2
Pacific Northwest	PNW01	1	0.3	63.1	82.9	0.0	0.4	0.0
	PNW02	1	0.4	62.6	82.3	0.0	0.4	0.0
	PNW03	1	0.2	63.7	83.7	0.0	0.3	0.0
	PNW04	1	0.5	62.1	81.7	0.0	0.6	0.0
South Dakota	SD01	1	0.3	62.2	81.8	0.3	0.6	0.1
	SD02	1	0.4	61.3	80.6	0.4	0.7	0.2
Texas	T01	1	0.6	62.2	81.8	0.0	0.6	0.1
	T02	1	0.7	61.3	80.6	0.1	0.7	0.1
	T03	1	0.6	61.0	80.2	0.7	1.5	0.1
	T04	1	0.8	62.4	82.0	0.1	1.2	0.4
	T05	1	0.6	61.6	81.0	0.3	1.2	0.1
	T06	1	0.5	61.8	81.3	0.2	1.2	0.3
Wyoming	W01	1	0.6	60.3	79.3	0.1	1.0	0.2

Kernel Quality Data

Location		Total Defects (%)	Kernel Size Large (%)	Kernel Size Med (%)	Kernel Size Small (%)	Thousand Kernel Wt (g)	SKCS Avg Diam (mm)
Colorado	CO1	2.5	35.3	61.4	3.3	25.8	2.37
	CO2	2.1	33.8	62.9	3.3	26.7	2.39
	CO3	5.1	27.8	62.7	8.0	25.2	2.30
Kansas	K01	1.5	56.6	41.9	1.4	29.9	2.54
	K02	1.2	65.6	33.2	1.2	30.8	2.59
	K03	0.9	69.3	30.0	0.6	31.7	2.64
	K04	1.2	68.5	31.0	0.5	30.4	2.63
	K05	1.1	60.6	38.2	1.2	29.2	2.58
	K06	2.0	45.4	52.1	2.8	28.2	2.45
Montana	M01	0.9	76.5	23.3	0.2	34.7	2.71
	M02	1.0	74.7	24.9	0.4	34.6	2.71
	M03	1.1	76.5	22.7	0.8	35.6	2.78
	M04	1.3	76.9	22.6	0.4	33.7	2.71
	M05	0.5	68.4	31.5	0.1	33.4	2.70
	M06	1.0	80.9	18.8	0.4	34.8	2.74
	M07	1.3	74.3	24.8	0.9	32.7	2.60
Nebraska	N01	1.4	46.0	52.0	2.0	28.1	2.45
	N02	2.0	42.3	54.8	2.9	27.8	2.45
	N03	1.0	56.9	36.6	1.1	30.1	2.59
	N04	1.5	57.6	36.1	1.6	29.2	2.57
	N05	1.1	59.2	40.1	0.7	31.1	2.57
Oklahoma	O01	1.7	65.9	33.1	1.0	31.9	2.63
	O02	1.4	78.1	21.5	0.4	34.5	2.76
	O03	0.9	61.0	38.2	0.9	31.2	2.63
	O04	2.0	61.6	37.8	0.6	31.3	2.63
	O05	0.7	79.2	20.5	0.3	35.0	2.79
	O06	1.0	80.9	18.6	0.5	35.0	2.78
	O07	1.0	69.6	29.3	1.2	31.1	2.64
Pacific Northwest	PNW01	0.4	87.4	12.4	0.3	40.1	2.91
	PNW02	0.4	82.2	17.5	0.3	37.5	2.85
	PNW03	0.3	94.0	5.7	0.2	40.2	2.97
	PNW04	0.6	89.2	10.5	0.3	38.9	2.90
South Dakota	SD01	1.0	64.4	35.0	0.6	30.6	2.58
	SD02	1.3	67.1	32.2	0.7	30.9	2.63
Texas	T01	0.7	49.0	49.8	1.2	30.1	2.51
	T02	0.9	69.6	29.7	0.7	31.4	2.63
	T03	2.3	66.8	32.2	1.1	30.1	2.60
	T04	1.7	42.2	56.0	1.9	28.8	2.46
	T05	1.6	37.5	60.4	2.2	27.4	2.45
	T06	1.7	42.6	55.5	1.9	27.4	2.49
Wyoming	W01	1.3	46.9	51.4	1.8	27.7	2.46

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.

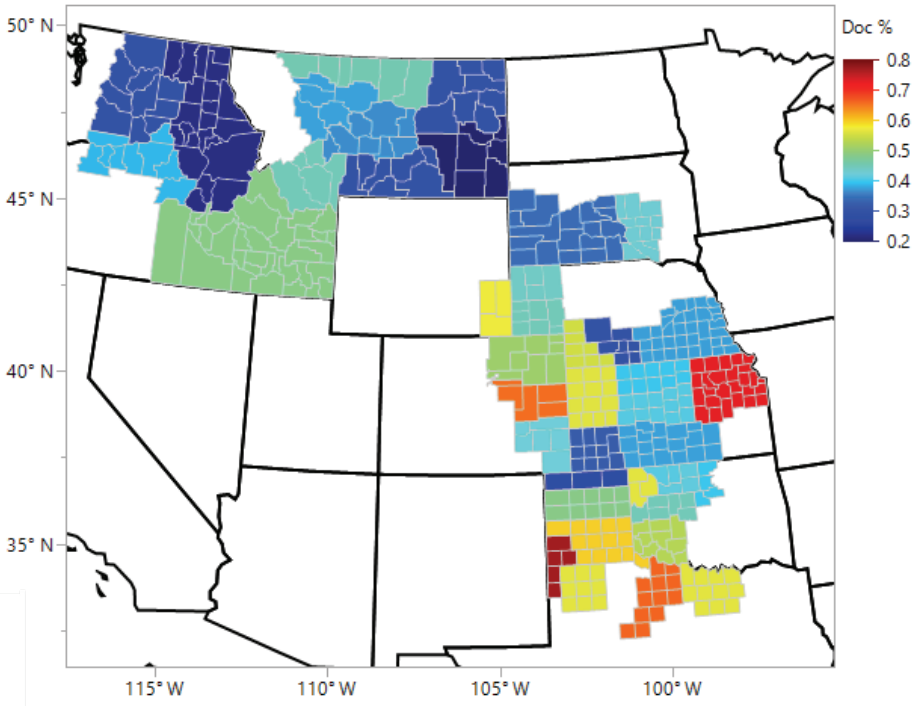
Falling number is an index of enzyme activity in wheat or flour and is expressed in seconds. Falling numbers above 300 are desirable, as they indicate little enzyme activity and a sound, quality product. Falling numbers below 300 are indicative of more substantial enzyme activity and sprout damage.

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.

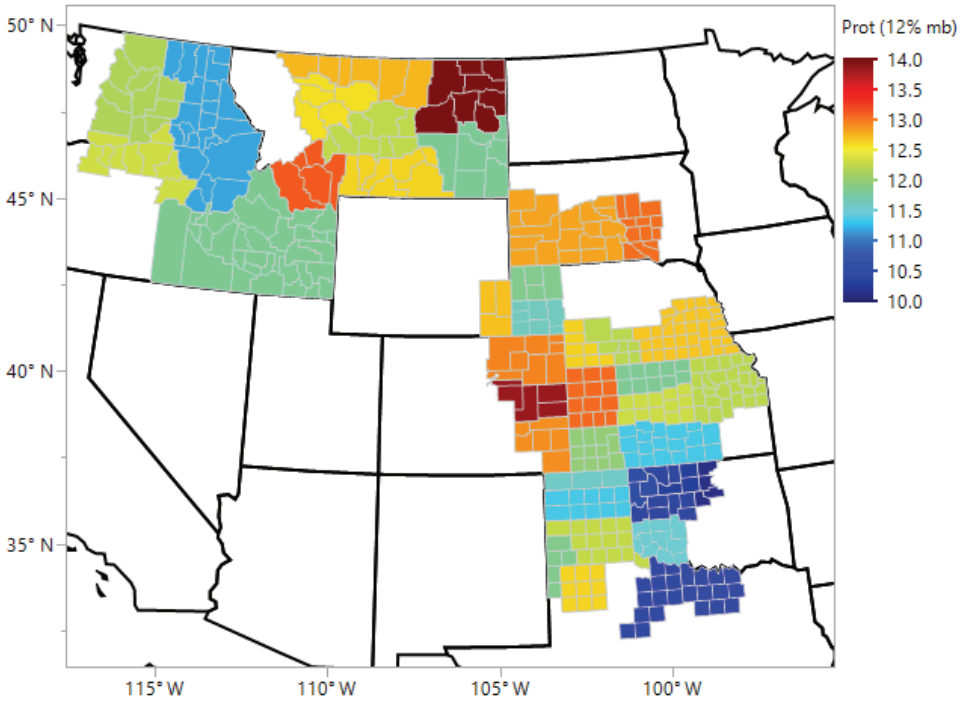
Kernel size is a measure of the percentage by weight of large, medium and small kernels in a sample. Large kernels or more uniform kernel size may help improve milling yield.

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.

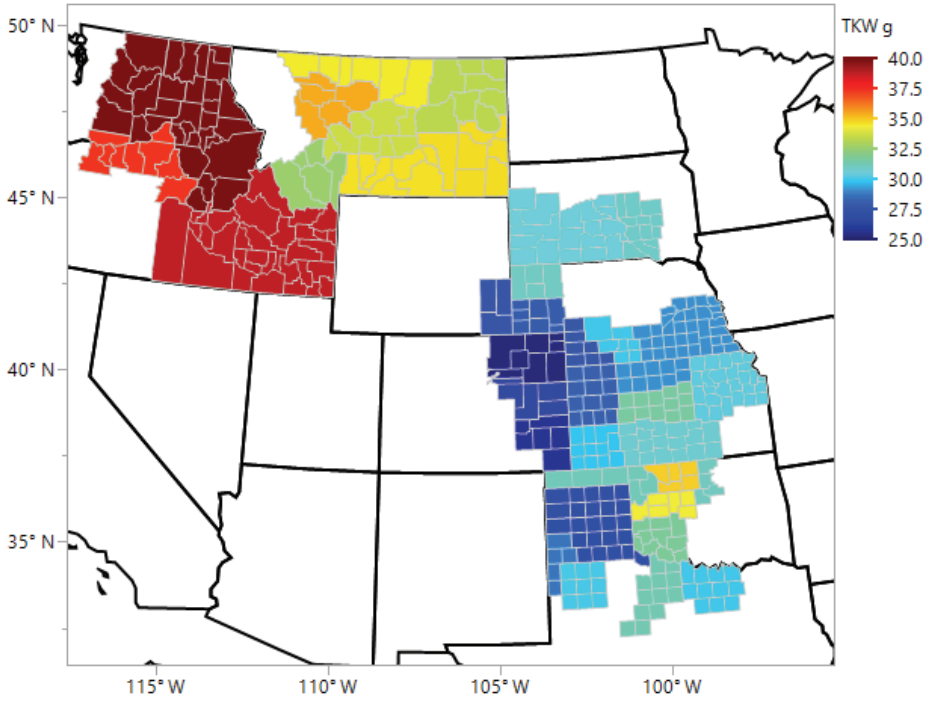
Dockage (%)



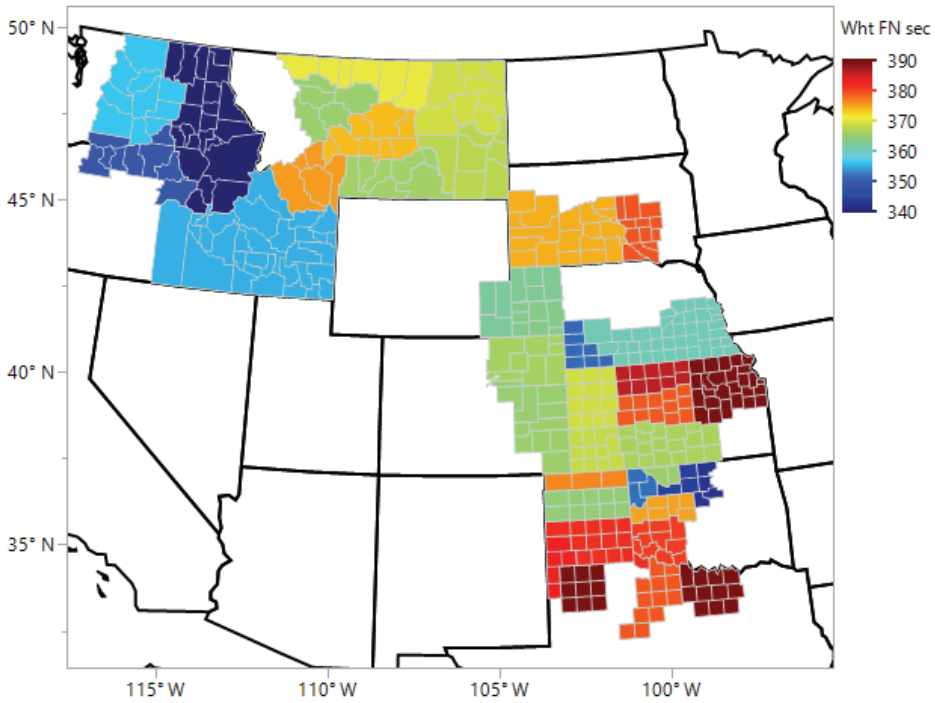
Protein (%)



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	12.9	1.56	366	11.5	58.3
	CO2	13.9	1.64	366	11.5	69.1
	CO3	13.0	1.64	367	10.6	68.2
Kansas	KO1	12.0	1.59	369	10.5	63.7
	KO2	11.4	1.58	367	11.6	61.2
	KO3	12.3	1.58	379	11.4	58.2
	KO4	12.3	1.64	391	12.4	66.8
	KO5	11.8	1.66	387	12.1	52.2
	KO6	13.1	1.59	369	11.4	62.7
Montana	MO1	12.6	1.57	366	11.2	67.5
	MO2	12.8	1.51	371	10.6	76.6
	MO3	12.6	1.49	366	9.8	72.2
	MO4	12.3	1.51	374	10.2	76.7
	MO5	14.0	1.57	370	12.2	69.3
	MO6	11.8	1.49	368	9.8	68.0
	MO7	13.2	1.60	376	9.3	69.2
Nebraska	NO1	11.6	1.61	364	11.3	66.9
	NO2	12.6	1.60	352	11.0	71.2
	NO3	12.2	1.58	361	12.1	65.7
	NO4	12.7	1.61	361	12.8	68.4
	NO5	11.9	1.56	363	11.1	67.4
Oklahoma	OO1	11.5	1.55	381	11.7	70.1
	OO2	10.4	1.45	376	10.6	74.1
	OO3	11.6	1.55	377	10.1	70.7
	OO4	10.6	1.50	352	11.2	73.7
	OO5	10.4	1.45	366	10.6	75.4
	OO6	10.3	1.46	344	10.9	73.1
	OO7	10.1	1.52	342	10.2	69.1
Pacific Northwest	PNWO1	12.2	1.44	357	9.4	66.2
	PNWO2	12.4	1.48	349	8.9	71.3
	PNWO3	11.2	1.36	339	9.3	66.7
	PNWO4	11.9	1.50	355	9.3	64.0
South Dakota	SDO1	12.8	1.64	375	12.6	65.6
	SDO2	13.1	1.64	380	12.8	59.9
Texas	TO1	12.6	1.56	390	9.9	70.2
	TO2	10.4	1.58	380	11.7	58.6
	TO3	10.5	1.63	391	10.6	53.3
	TO4	11.9	1.60	384	9.3	71.5
	TO5	12.3	1.60	382	8.9	71.5
	TO6	11.4	1.58	365	9.0	74.7
Wyoming	WO1	12.7	1.62	363	12.4	77.7

Flour Characteristics

Flour is analyzed for indicators of milling efficiency and functionality properties. These include: flour yield, ash content, falling number and flour protein.

Flour yield is expressed as a percentage and represents the portion of the wheat kernel that can be milled into flour, which is a significant indicator of milling profitability. Millers need to know the mineral content in wheat to achieve the desired ash levels in flour.

Ash content is an indication of how well flour separates from the bran. Flour ash is expressed as a percentage of the initial sample weight and is usually expressed on a 14% 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	73.7	64.6	12.0	0.53	99.3	91.3	-1.5	9.6
	CO2	73.3	66.7	13.0	0.54	99.2	91.0	-1.5	9.9
	CO3	72.0	62.2	12.6	0.55	98.9	90.9	-1.6	10.5
Kansas	KO1	74.7	52.2	11.4	0.49	94.5	91.2	-1.6	10.4
	KO2	70.3	44.3	10.2	0.47	98.8	91.3	-1.7	10.4
	KO3	73.1	50.5	11.2	0.48	97.5	91.3	-1.5	9.7
	KO4	71.8	42.1	10.9	0.50	85.3	91.2	-1.5	9.7
	KO5	75.4	42.2	10.5	0.54	98.1	90.9	-1.6	10.2
	KO6	73.2	58.2	11.7	0.53	99.2	91.0	-1.4	10.0
Montana	MO1	75.6	56.9	11.7	0.46	90.4	91.0	-1.6	9.6
	MO2	70.8	65.8	11.9	0.42	95.4	90.9	-1.7	10.4
	MO3	75.2	55.9	12.4	0.54	91.7	90.3	-1.4	9.9
	MO4	78.5	47.2	11.2	0.57	93.8	90.3	-1.5	10.2
	MO5	72.5	68.8	12.7	0.41	99.0	90.7	-1.2	8.3
	MO6	75.9	50.7	10.5	0.47	97.5	91.1	-1.5	9.9
	MO7	73.1	65.2	12.1	0.48	98.1	91.0	-1.6	10.6
Nebraska	NO1	70.8	51.5	10.4	0.49	98.9	91.6	-1.7	10.3
	NO2	73.5	56.5	11.5	0.52	98.2	91.0	-1.5	10.6
	NO3	75.7	48.2	11.2	0.54	98.5	90.9	-1.4	10.0
	NO4	74.4	49.7	11.3	0.52	97.8	90.8	-1.5	9.8
	NO5	76.0	44.5	9.9	0.47	98.8	91.2	-1.7	10.2
Oklahoma	OO1	74.8	44.8	10.4	0.53	98.9	90.9	-1.6	10.1
	OO2	74.9	43.8	9.7	0.51	98.9	91.1	-1.7	10.4
	OO3	75.0	46.0	11.0	0.49	98.1	91.1	-1.6	10.4
	OO4	74.7	41.0	9.4	0.46	98.8	91.2	-1.7	10.5
	OO5	73.8	42.0	9.6	0.44	98.1	91.4	-1.7	10.6
	OO6	75.2	39.1	9.7	0.48	98.8	90.9	-1.8	10.7
	OO7	75.6	36.3	9.7	0.44	94.4	91.2	-1.8	10.6
Pacific Northwest	PNW01	75.4	55.1	11.0	0.45	97.1	91.0	-1.4	9.8
	PNW02	76.0	57.0	11.3	0.44	98.8	91.0	-1.5	9.7
	PNW03	76.3	50.9	9.9	0.40	98.9	90.9	-1.5	10.1
	PNW04	76.4	40.9	10.2	0.48	96.6	90.8	-1.5	10.1
South Dakota	SD01	75.9	49.5	11.7	0.54	97.9	90.7	-1.6	10.1
	SD02	74.1	49.9	11.9	0.53	98.1	90.6	-1.4	9.6
Texas	TO1	72.2	58.7	11.9	0.45	98.6	90.8	-1.7	10.6
	TO2	73.3	39.2	9.7	0.51	98.8	91.2	-1.7	9.8
	TO3	74.7	34.1	9.6	0.48	96.5	91.3	-1.6	9.3
	TO4	74.2	48.1	11.3	0.47	97.8	91.3	-1.8	10.8
	TO5	73.8	56.2	11.9	0.50	98.3	91.2	-1.8	11.0
	TO6	72.6	48.7	10.8	0.52	98.8	91.2	-1.7	10.7
Wyoming	WO1	71.7	57.0	11.6	0.56	97.7	91.0	-1.7	10.5

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.

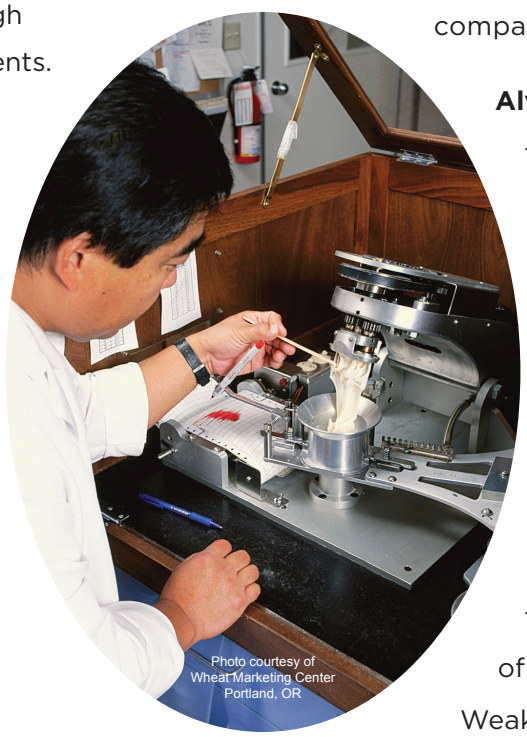


Photo courtesy of Wheat Marketing Center Portland, OR

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	74	103	284	0.71	56.8	7.0	13.9	19.0
	CO2	96	92	347	1.04	57.5	5.9	15.8	11.0
	CO3	90	104	349	0.87	57.9	6.2	15.0	18.0
Kansas	K01	83	81	229	1.02	58.2	5.4	8.5	35.0
	K02	90	72	231	1.24	57.3	4.1	8.9	28.0
	K03	83	96	271	0.86	57.3	6.5	11.5	28.5
	K04	90	68	215	1.32	58.8	4.5	7.4	39.0
	K05	96	73	259	1.32	57	6.5	12.0	26.0
	K06	86	93	287	0.93	57.5	5.7	13.5	19.5
Montana	M01	105	88	321	1.19	61.3	6.4	10.0	30.0
	M02	116	88	362	1.32	62.1	6.3	12.6	24.0
	M03	114	67	271	1.69	62.8	6.0	8.7	31.0
	M04	125	54	249	2.31	63.5	5.1	7.1	36.0
	M05	115	85	379	1.35	61.2	8.5	14.3	25.0
	M06	124	62	295	2.00	61	5.0	8.9	35.0
	M07	125	68	329	1.84	62.0	5.4	11.5	22.0
Nebraska	N01	100	74	268	1.35	57.3	3.6	12.1	16.0
	N02	101	83	306	1.22	58.6	7.2	12.2	25.5
	N03	79	94	248	0.84	57.8	4.9	9.9	27.5
	N04	90	75	242	1.19	58.0	5.5	10.7	29.5
	N05	97	70	243	1.40	58.0	4.6	8.7	31.0
Oklahoma	O01	104	69	249	1.50	60.0	4.1	8.5	28.0
	O02	109	67	249	1.63	60.2	3.9	8.1	26.0
	O03	102	82	265	1.24	59.7	5.5	8.6	27.0
	O04	112	58	231	1.93	59.7	3.7	7.5	31.0
	O05	120	47	215	2.55	59.6	4.3	8.1	27.0
	O06	110	51	212	2.16	59	3.9	11.2	9.0
	O07	105	55	197	1.91	59.3	5.5	6.7	47.0
Pacific Northwest	PNW01	120	70	300	1.71	62.0	5.9	9.5	32.3
	PNW02	108	80	311	1.35	61.2	5.2	9.3	29.0
	PNW03	133	46	250	2.89	62.2	3.5	7.1	37.0
	PNW04	115	58	234	1.97	61.7	5.2	6.0	50.0
South Dakota	SD01	81	73	198	1.11	58.6	5.1	7.2	38.0
	SD02	73	76	178	0.96	58.8	4.8	5.9	48.0
Texas	T01	124	79	369	1.57	60.8	6.8	14.7	23.0
	T02	94	68	230	1.38	57.8	3.9	9.1	26.0
	T03	101	62	225	1.63	56.6	4.9	9.3	27.0
	T04	107	89	302	1.20	60	5.4	8.1	36.0
	T05	103	95	325	1.08	60.6	6.3	10.5	20.0
	T06	96	85	282	1.14	58.7	6.1	10.5	28.5
Wyoming	W01	111	79	315	1.40	60.4	6.9	12.3	22.3

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	6.5	64.5	995	7.8	7.0	Slightly Yellow
	C02	7.0	66.3	1005	8.5	7.0	Creamy
	C03	6.5	65.2	1040	7.0	7.0	Slightly Yellow
Kansas	K01	4.4	63.2	925	6.7	7.0	Slightly Yellow
	K02	4.8	62.4	838	5.9	6.7	Yellow
	K03	5.3	63.2	883	5.5	6.3	Slightly Yellow
	K04	4.5	63.0	825	4.8	6.3	Yellow
	K05	5.8	62.2	825	7.8	6.3	Yellow
	K06	6.0	64.1	898	6.7	6.7	Yellow
Montana	M01	4.3	63.6	888	5.9	7.0	Slightly Yellow
	M02	4.8	65.0	893	4.8	6.7	Yellow
	M03	4.1	65.6	915	5.9	6.3	Yellow
	M04	4.1	63.0	800	5.2	7.0	Dull
	M05	5.5	66.5	985	7.0	6.3	Slightly Yellow
	M06	4.5	62.1	805	5.5	5.5	Yellow
	M07	5.1	65.8	930	6.7	6.3	Yellow
Nebraska	N01	5.3	61.6	828	5.9	6.3	Yellow
	N02	5.6	64.1	888	6.3	5.9	Yellow
	N03	4.9	62.9	868	6.7	6.3	Slightly Yellow
	N04	5.7	63.2	880	7.4	6.7	Slightly Yellow
	N05	5.4	61.3	803	5.2	5.9	Yellow
Oklahoma	O01	4.3	62.2	818	5.5	5.9	Yellow
	O02	4.3	61.6	760	6.3	5.5	Yellow
	O03	4.0	62.8	895	5.5	7.0	Yellow
	O04	4.0	61.7	760	6.3	6.3	Yellow
	O05	4.0	61.7	785	6.3	5.5	Yellow
	O06	4.0	60.9	755	5.5	5.5	Yellow
	O07	3.5	62.5	775	6.3	7.0	Yellow
Pacific Northwest	PNW01	4.2	64.0	837	5.8	5.5	Yellow
	PNW02	5.1	63.7	860	7.0	6.3	Yellow
	PNW03	5.0	62.9	750	4.0	4.8	Yellow
	PNW04	3.9	61.9	795	4.4	5.2	Yellow
South Dakota	SD01	5.0	64.2	910	8.2	6.3	Creamy
	SD02	4.0	64.6	945	7.8	7.0	Creamy
Texas	T01	5.1	64.7	875	5.5	7.0	Yellow
	T02	4.3	60.1	740	4.0	5.5	Yellow
	T03	4.3	60.5	775	5.5	5.5	Slightly Yellow
	T04	3.9	63.0	860	6.3	7.0	Yellow
	T05	4.3	64.6	903	6.7	6.7	Yellow
	T06	4.6	62.7	873	6.3	6.3	Yellow
Wyoming	W01	5.0	64.0	882	5.5	6.5	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 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.