PGI

PLAINS GRAINS INC

Hard Red Winter Wheat

2023 Regional Quality Survey

PGI

Plains Grains Inc.

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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

Oregon Wheat Commission
owgl.org

Washington Grain Commission
washingtongrainalliance.com

Texas Wheat Producers Board and Association
texaswheat.org

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

Nebraska Wheat Board
nebraskawheat.gov

Wyoming Wheat Growers Association
wyomingwheat.com

Plains Grains Inc.

Who We Are

Plains Grains Inc. (PGI) is not just an organization; it's a commitment to quality. Established in 2004 as a nonprofit initiative, PGI is the result of a collaborative effort involving the Oklahoma Wheat Commission, the Oklahoma Department of Agriculture, Food and Forestry, and Oklahoma State University Division of Agricultural Sciences and Natural Resources. Our mission is to bridge the gap between wheat producers, grain companies, and foreign and domestic flour millers.

Our journey began with the vision of Mark Hodges, our founding executive director, whose dedication, and innovation laid the foundation for PGI's success. While Mark has embarked on new endeavors, we express our gratitude for his unwavering commitment to turning this quality testing program into the benchmark it has become.

Today, PGI welcomes Royce Schaneman as the new executive director, and we've moved our base of operations to Lincoln, Nebraska. The philosophy and goals remain the same, as PGI looks to build upon this strong foundation.

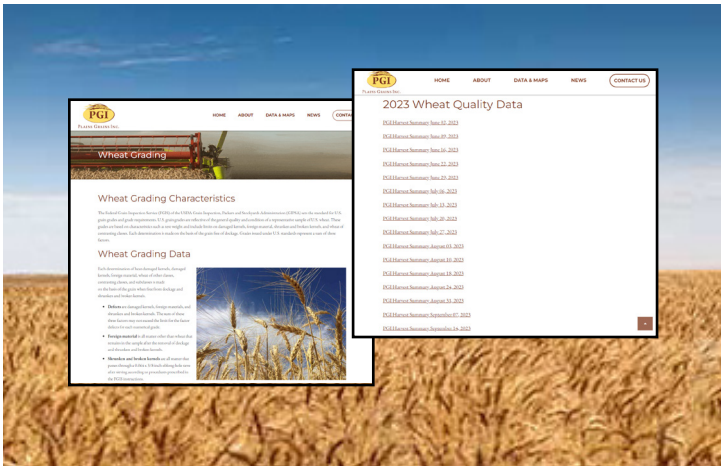
What We Do

At PGI, our focus is clear: to provide quality data and facilitate the necessary wheat-quality tracking that millers need to purchase U.S. wheat. While state-level data is essential, it's equally vital to aggregate quality information for the entire Hard Red Winter (HRW) wheat production area. We believe in the power of regional cooperation to meet the quality and quantity demands of the wheat industry. Together, we can achieve success on a global scale.

Our journey began with the Oklahoma HRW wheat crop in 2004. PGI quickly expanded its horizons, bringing five other HRW wheat-producing states on board for the crop quality survey in 2005. The warm reception and success in foreign markets have resulted in all 12 HRW wheat-producing states in the Great Plains and Pacific Northwest region subscribing to the PGI crop quality survey.

For real-time information and more, visit our website at plainsgrains.org, and register for our interactive dashboard.

Visit our website at **plainsgrains.org** for up-to-date information and to register for our interactive dashboard!



The Power of Wheat

Wheat is a cornerstone of global nutrition, providing approximately 20% of food protein and caloric intake. It's the United States' leading export crop and the fourth-leading field crop.

The most common class produced in the U.S. is Hard Red Winter (HRW) wheat, fitting into a variety of categories based on hardness, kernel color, and planting time.

Approximately half of the wheat produced in the U.S. is exported, with HRW making up approximately 58% of those exports. Mexico, Japan, and Nigeria are among the top importers of U.S. HRW wheat.

Wheat flour forms the backbone of numerous global dishes, making wheat one of the most versatile grains. Each class of wheat possesses unique characteristics that offer diverse functionality.

HRW wheat, representing 40% of total U.S. wheat production, boasts excellent milling and baking qualities, making it ideal for bread flour. It's also a preferred choice for Asian noodles, hard rolls, flatbreads, and blending.

National Wheat Overview

Wheat Major Classes

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

HRW wheat accounts for over 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 hard red winter wheats, receives enthusiastic reviews when used for Asian noodles, hard rolls, bulgur, tortillas, whole wheat, or higher extraction applications, pan breads or flatbreads.

Crop Production Review & Analysis

2023 HRW Wheat Crop: A Testament to Resilience

The 2023 HRW wheat crop is a testament to the tenacity of American wheat farming. Despite extreme climatic conditions, including record temperatures and droughts, the crop has delivered better-than-expected yields with superior baking quality. Regions with timely rains and moderate temperatures offer diverse protein levels and excellent baking performance.
Overall, the 2023 crop boasts good milling and baking characteristics, offering customers a wide range of quality and value.

The 2023 planting season faced severe drought conditions, especially in the Southern Plains. Some regions experienced cold temperatures with minimal snow cover. In contrast, the Northern Plains and Pacific Northwest enjoyed more favorable conditions. As the crop broke dormancy in the spring, challenges persisted, with some regions experiencing late freeze events.
The 2023 HRW wheat crop demonstrated remarkable resilience in the face of adversity. Despite harsh climatic conditions, many regions displayed superior crop performance with better-than-expected yields.
While late moisture improved the situation, it couldn't add substantial production value to the crop. However, the crop yielded better than expected, with large, dense kernels and higher protein levels. Disease and insect issues were minor in 2023.

Wheat & Grade Data

100% of the composite samples graded #2 or better. Average test weight of 60.4 lb./bu. (79.4 kg/hl). Average dockage (0.6%), total defects (1.4%) and foreign material (0.1%)
Average shrunken and broken is (0.8%)
Average thousand kernel weight of 30.4 g
Average Protein is (12.2%)

The average wheat falling number is 356 sec, is indicative of sound wheat. Large kernel size dominated the region with 69% testing as large, with higher SKCS kernel weights and diameters indicate uniform, dense kernels. This is a testament to wheat breeding targets.

Crop Production Review & Analysis

Flour & Baking Data

The Buhler laboratory mill flour yield average is 75.9% above the 5-year average. The 2023 flour ash of 0.50% (14% mb) is comparable to 5-year average.

The alveograph W value of 275 10^{-4} J is significantly higher than 5-year average. are exceptionally high for dough strength and an L value of 110 (mm) indicates very good extensibility.

Farinograph peak and stability times, 4.9 and 8.5 min are higher than the 5-year average, are well within industry target ranges. Average bake absorption is 58.4%.

The loaf volumes achieved an average of 914 cc well above the 5-year average and surpass U.S. quality targets. Overall, this crop meets or exceeds typical HRW contract specifications and should provide high value to customers.

Join Us in Nourishing the World

The 2023 HRW wheat crop underscores the remarkable adaptability and resilience of U.S. hard red winter wheat to deliver exceptional quality attributes and performance despite extreme climate challenges indicates the robust nature of HRW wheat.

Our analysis underscores the potential of HRW wheat as a reliable source of high-quality flour for your wheat-based products. These findings suggest that HRW wheat is well-equipped to meet the stringent demands of the milling and baking industry.

As we celebrate the resilience of the 2023 HRW wheat crop, we invite you to be a part of our mission to provide high-quality wheat to the world. Wheat isn't just a crop; it's a symbol of sustenance and cooperation.

Hard Red Winter Wheat Production Charts

English Units

Hard Red Winter Production (1,000 Bushels)

	2016	2017	2018	2019	2020	2021	2022	2023	Average
Colorado	105,120	86,860	70,200	98,000	46,500	66,778	35,750	71,635	72,605
Kansas	467,400	333,600	277,400	338,000	294,400	342,160	244,200	187,162	273,040
Montana	105,350	66,780	78,500	95,000	75,400	53,630	59,400	85,680	77,467
North Dakota	5,760	1,295	3,010	3,710	1,400	1,980	5,700	8,120	3,871
Nebraska	70,740	46,720	49,490	55,290	36,550	41,160	26,240	34,742	45,116
Oklahoma	136,500	98,600	70,000	110,000	113,400	115,050	68,600	67,228	97,422
Pacific NW	36,707	33,800	33,500	32,463	32,000	18,780	29,775	23,100	30,015
South Dakota	63,800	20,800	31,680	40,040	34,800	27,360	37,960	32,900	36,167
Texas	89,600	68,150	56,000	69,700	63,000	69,560	39,000	75,369	66,297
Wyoming	4,250	2,940	3,900	4,730	5,000	3,040	1,615	2,646	3,515
Regional Total	1,085,227	759,745	673,680	846,933	702,450	739,489	548,240	588,582	705,515

Hard Red Winter Harvested Acres (1,000 Acres)

	2016	2017	2018	2019	2020	2021	2022	2023	Average
Colorado	2,190	2,200	1,950	2,000	1,550	1,880	1,430	1,747	1,868
Kansas	8,200	6,950	7,300	6,500	6,400	7,000	6,600	5,347	6,787
Montana	2,150	1,590	1,570	1,900	1,450	1,730	1,800	1,680	1,733
North Dakota	120	35	70	70	35	60	95	145	78
Nebraska	1,310	1,020	1,010	970	850	840	820	827	955
Oklahoma	3,500	2,900	2,500	2,750	2,700	2,950	2,450	2,401	2,768
Pacific NW	456	451	431	432	423	368	397	283	405
South Dakota	1,100	520	660	770	580	720	930	700	910
Texas	2,800	2,350	1,750	2,050	2,100	2,000	1,300	2,037	2,048
Wyoming	125	105	115	110	110	95	95	88	105
Regional Total	21,951	17,941	17,356	17,552	16,198	17,643	15,717	15,255	17,657

Hard Red Winter Yield (bu/ac)

	2016	2017	2018	2019	2020	2021	2022	2023	Average
Colorado	48	43	36	49	34	36	25	41	39
Kansas	57	48	38	52	46	49	37	35	45
Montana	49	42	50	50	43	30	33	52	43
North Dakota	48	37	43	53	40	33	60	56	46
Nebraska	54	46	49	57	43	49	32	42	46
Oklahoma	39	34	28	40	40	39	28	28	34
Pacific NW	82	75	79	75	74	51	75	66	72
South Dakota	58	40	48	52	60	38	52	47	49
Texas	32	29	32	34	30	35	30	37	32
Wyoming	34	28	34	43	43	32	17	30	32
Regional Average	50	42	44	51	45	39	39	43	43

Hard Red Winter Wheat Production Charts

Metric Units

Hard Red Winter Production (MMT)

	2016	2017	2018	2019	2020	2021	2022	2023	Average
Colorado	2.86	2.36	1.91	2.67	1.27	1.82	0.97	1.94	1.97
Kansas	12.72	9.08	7.55	9.20	8.01	9.31	6.65	5.09	7.43
Montana	2.87	1.82	2.14	2.59	2.05	1.46	1.62	2.33	2.10
North Dakota	0.16	0.04	0.08	0.10	0.04	0.05	0.16	0.22	0.11
Nebraska	1.93	1.28	1.35	1.50	0.99	1.12	0.71	094	1.22
Oklahoma	3.72	2.68	1.91	2.99	3.09	3.13	1.87	1.83	2.65
Pacific NW	1.00	0.92	0.91	0.88	0.87	0.51	0.81	0.63	0.81
South Dakota	1.74	0.57	0.86	1.09	0.95	0.74	1.03	0.89	0.98
Texas	2.44	1.85	1.52	1.90	1.71	1.89	1.06	2.05	1.80
Wyoming	0.12	0.08	0.11	0.13	0.14	0.08	0.04	0.07	0.09
Regional Total	22.51	20.68	18.34	23.05	19.12	20.13	14.92	15.99	19.16

Hard Red Winter Harvested (1,000 ha)

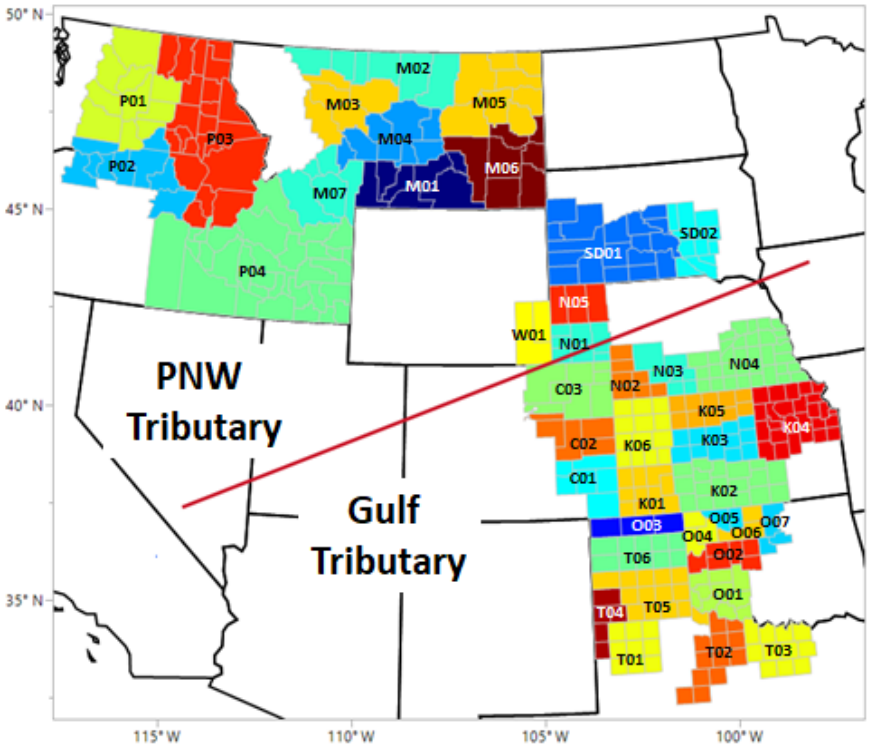
	2016	2017	2018	2019	2020	2021	2022	2023	Average
Colorado	886	817	789	809	627	761	579	706	755
Kansas	3318	2813	2954	2630	2590	2833	2671	2163	875
Montana	870	643	635	769	587	700	728	679	701
North Dakota	49	14	28	28	14	24	38	58	31
Nebraska	530	413	409	393	344	340	332	334	386
Oklahoma	1416	1174	1012	1113	1093	1194	991	971	1,120
Pacific NW	185	183	174	175	171	149	161	114	163
South Dakota	445	210	267	312	235	291	295	283	368
Texas	1133	951	708	830	850	809	526	824	828
Wyoming	51	42	47	45	45	38	38	35	42
Regional Total	8,883	7,260	7,024	7,103	6,555	7,140	6,360	6,173	7,145

Hard Red Winter Yield (tons/ha)

	2016	2017	2018	2019	2020	2021	2022	2023	Average
Colorado	3.23	2.89	2.42	3.30	2.02	2.39	1.68	2.75	2.62
Kansas	3.84	3.23	2.56	3.50	3.10	3.29	2.49	2.35	3.02
Montana	3.30	2.83	3.37	3.37	2.89	2.08	2.22	3.49	2.89
North Dakota	3.23	2.49	2.89	3.57	2.69	2.22	4.04	3.76	3.09
Nebraska	3.63	3.10	3.30	3.84	2.89	3.30	2.15	2.82	3.09
Oklahoma	2.62	2.29	1.88	2.69	2.69	2.62	1.88	1.88	2.28
Pacific NW	5.52	5.05	5.32	5.05	4.98	3.43	5.04	4.43	4.84
South Dakota	3.90	2.69	3.23	3.50	4.04	2.56	3.50	3.16	3.29
Texas	2.15	1.95	2.15	2.29	2.02	2.34	2.02	2.48	2.15
Wyoming	2.29	1.88	2.29	2.89	2.89	2.15	1.14	2.01	2.15
Regional Average	3.37	2.84	2.94	3.40	3.02	2.64	2.62	2.89	2.89

Survey Methodology

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. KS, where they are analyzed and tested for more than 25 quality parameters. Official grade is determined at the Lincoln Grain Inspection Service office in Lincoln, NE.

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 used 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 Kenels					
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 MATIERIAL (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

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 odor) or
(c) Is heating or of distinctly low quality.

Includes damaged kernels (total), foreign material, shrunken and broken kernels.
Unclassed wheat of any grade may contain not more than 10.0 percent of wheat of other classes.
Includes contrasting classes.
Includes any combination of animal filth, castor beans, crotalaria seeds, gass, 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.

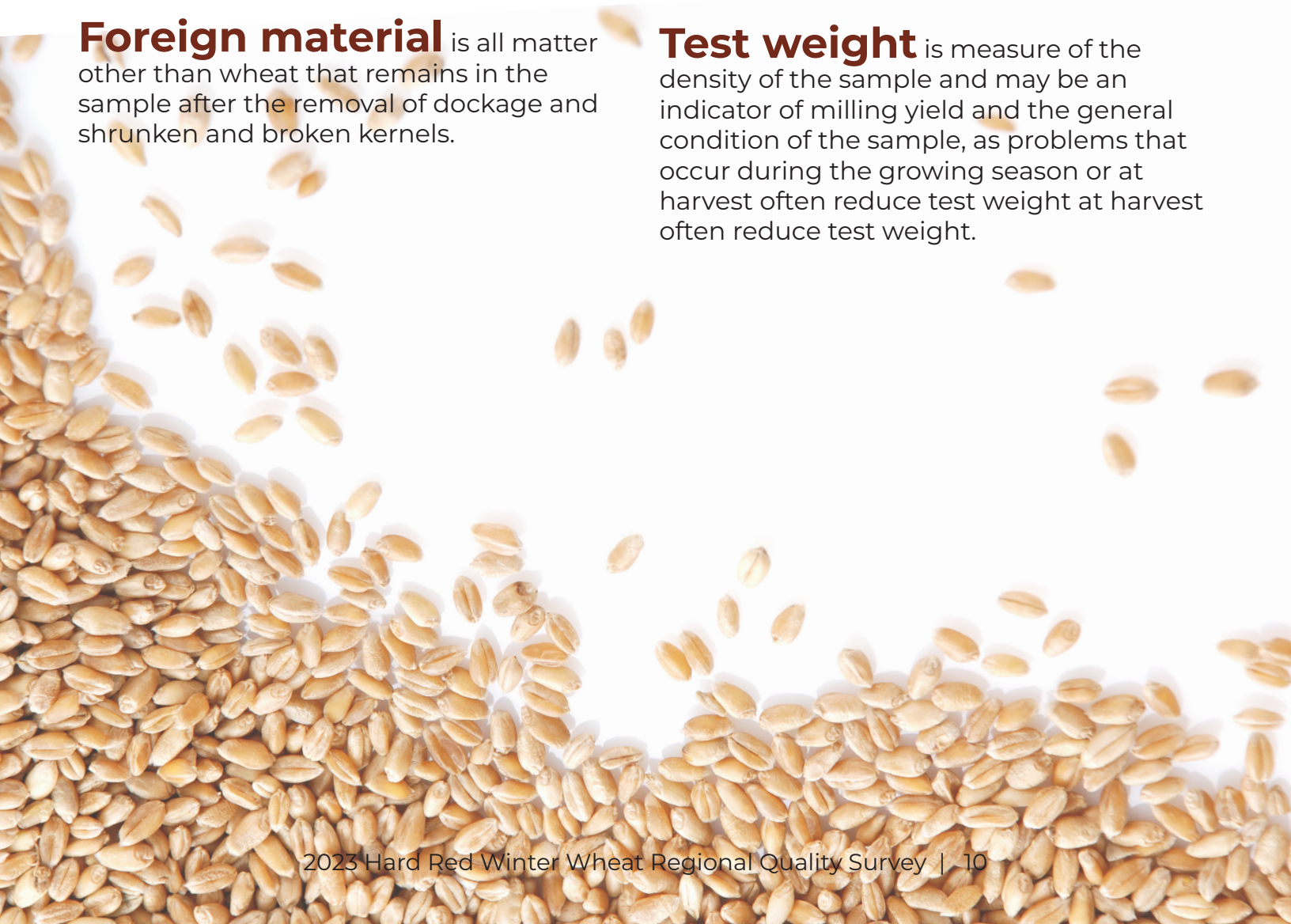
Defects are damaged kernels, foreign materials and shrunken and broken kernels. The sum of these three factors may not exceed the limit for the factor defects for each numerical grade.

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

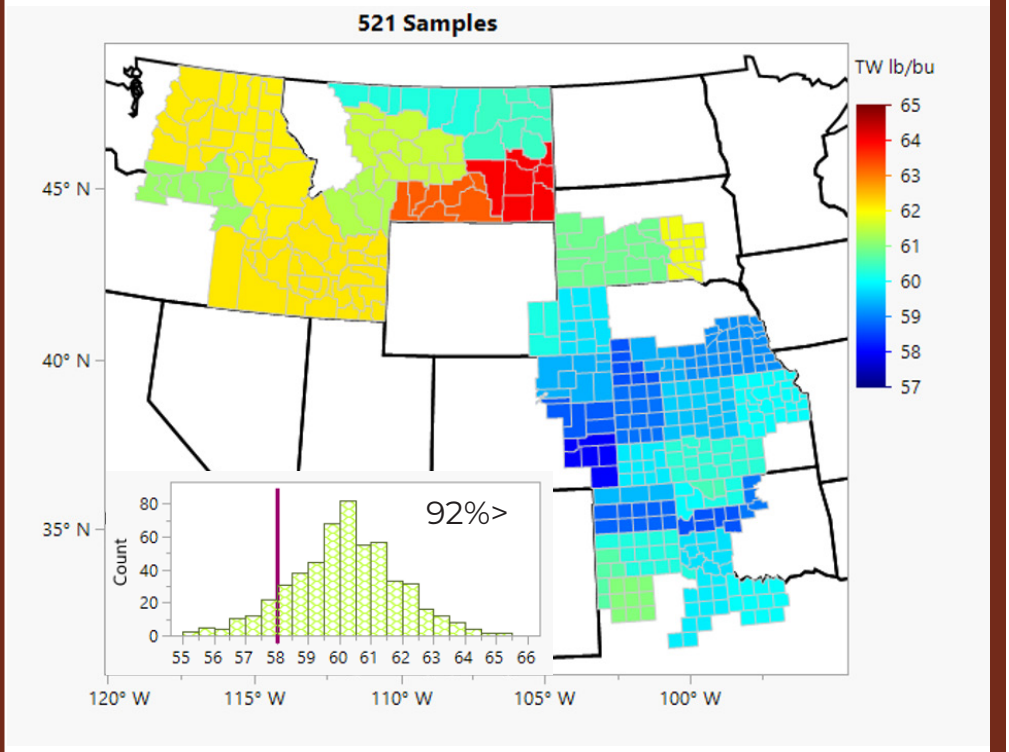
Shrunken and broken kernels are all matter that passes through a 0.0064 x 3/8 - inch oblong-hole sieve after sieving according to procedures prescribed in the FGIS instructions.

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

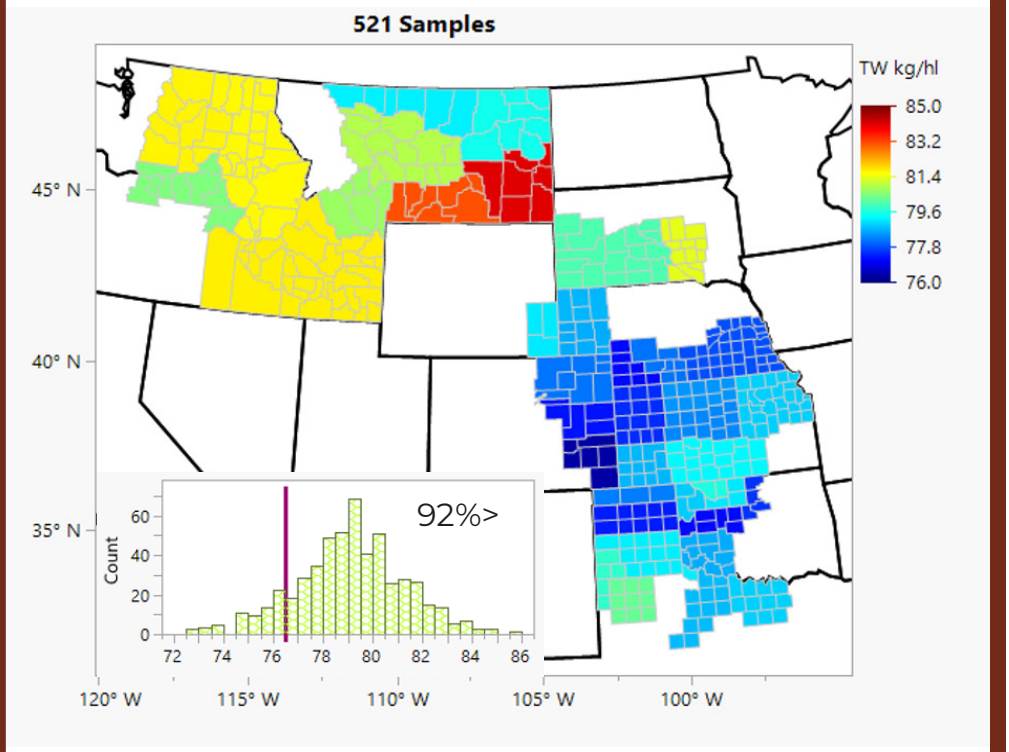
Test weight is measure of the density of the sample and may be an indicator of milling yield and the general condition of the sample, as problems that occur during the growing season or at harvest often reduce test weight at harvest often reduce test weight.



Test Weight (lb/bu)



Test Weight (kg/bu)



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	0.62	58.16	76.56	0.62	1.74	0.08
	C02	2	0.40	58.72	77.28	1.02	1.40	0.06
	C03	2	0.59	59.40	78.16	0.25	1.42	0.13
Kansas	K01	2	0.57	59.85	78.75	0.55	0.70	0.04
	K02	1	0.52	60.31	79.33	0.38	0.81	0.09
	K03	2	0.45	59.53	78.33	0.43	0.81	0.12
	K04	2	0.70	60.02	78.96	0.36	0.66	0.12
	K05	2	0.86	59.63	78.45	0.21	0.74	0.09
	K06	2	0.44	58.90	77.51	0.60	1.29	0.03
Montana	M01	1	0.50	63.28	83.17	0.03	0.73	0.03
	M02	1	0.54	60.24	79.25	0.06	1.39	0.03
	M03	1	0.49	61.56	80.96	0.05	0.82	0.01
	M04	1	0.33	61.57	80.96	0.00	1.00	0.00
	M05	2	0.46	60.45	79.52	0.08	1.06	0.09
	M06	1	0.37	64.03	84.15	0.00	0.60	0.00
	M07	1	0.30	61.40	80.75	0.50	0.70	0.10
Nebraska	N01	2	0.78	59.78	78.65	0.46	1.72	0.17
	N02	2	0.89	58.65	77.19	1.64	1.36	0.10
	N03	2	0.77	59.39	78.15	0.76	0.78	0.04
	N04	2	0.72	59.12	77.80	0.31	0.83	0.09
	N05	2	1.22	59.96	78.88	0.22	0.72	0.18
Oklahoma	O01	2	0.71	59.78	78.66	0.28	0.62	0.25
	O02	2	1.06	58.66	77.21	0.41	0.80	0.28
	O03	2	0.78	59.58	78.40	1.08	0.70	0.10
	O04	2	0.90	60.00	78.94	0.57	1.57	0.40
	O05	2	0.66	60.63	79.75	0.47	0.89	0.76
	O06	2	1.14	60.32	79.35	0.32	0.58	0.51
	O07	2	0.50	59.74	78.61	0.34	0.77	0.24
Pacific Northwest	PNW01	1	0.32	62.15	81.72	0.00	0.45	0.01
	PNW02	1	0.39	61.21	80.51	0.24	1.03	0.06
	PNW03	1	0.19	62.11	81.67	0.00	0.42	0.00
	PNW04	1	0.31	62.18	81.75	0.01	0.81	0.02
South Dakota	SD01	1	0.45	60.87	80.07	0.21	1.01	0.11
	SD02	1	0.21	61.90	81.39	0.15	0.31	0.03
Texas	T01	1	0.33	61.04	80.29	0.27	0.43	0.10
	T02	2	0.51	59.88	78.78	0.84	0.56	0.06
	T03	2	0.50	60.03	78.97	0.28	0.63	0.00
	T04	1	0.86	61.62	81.03	0.28	0.68	0.22
	T05	1	0.70	60.24	79.24	0.96	0.86	0.13
	T06	2	0.59	58.79	77.37	1.55	1.00	0.09
Wyoming	W01	1	1.02	60.20	79.20	0.14	0.66	0.16

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	2.42	65.98	31.82	2.20	27.22	2.58
	C02	2.48	63.43	34.40	2.18	27.00	2.53
	C03	1.80	58.55	39.10	2.35	26.33	2.50
Kansas	K01	1.29	74.05	24.85	1.10	31.72	2.67
	K02	1.28	65.58	33.08	1.35	28.77	2.67
	K03	1.37	66.30	32.55	1.15	29.33	2.65
	K04	1.14	69.12	29.80	1.08	28.89	2.63
	K05	1.04	67.30	31.30	1.40	27.60	2.68
	K06	1.92	64.42	33.92	1.67	26.78	2.58
Montana	M01	0.78	67.83	30.47	1.70	30.78	2.68
	M02	1.48	51.73	45.73	2.55	26.90	2.57
	M03	0.88	65.87	33.33	0.80	30.50	2.71
	M04	1.00	69.05	29.78	1.18	30.95	2.66
	M05	1.23	72.23	26.68	1.08	30.37	2.71
	M06	0.60	75.30	24.18	0.52	33.31	2.68
	M07	1.30	84.25	15.35	0.40	36.53	2.85
Nebraska	N01	2.35	71.55	26.85	1.60	30.02	2.58
	N02	3.09	66.67	31.48	1.85	27.71	2.55
	N03	1.58	74.00	25.15	0.85	30.52	2.66
	N04	1.23	63.00	35.85	1.15	28.58	2.60
	N05	1.13	78.78	20.63	0.60	32.23	2.70
Oklahoma	O01	1.15	66.62	32.33	1.05	29.05	2.65
	O02	1.41	72.48	26.50	1.03	29.75	2.69
	O03	1.88	78.18	20.55	1.28	30.72	2.78
	O04	2.53	73.35	24.95	1.70	29.67	2.72
	O05	2.11	69.88	28.95	1.18	29.49	2.75
	O06	1.41	74.60	24.15	1.25	31.00	2.74
	O07	1.36	63.40	35.15	1.45	25.70	2.67
Pacific Northwest	PNW01	0.45	87.32	12.43	0.25	39.69	2.90
	PNW02	1.33	72.70	26.23	1.08	31.49	2.71
	PNW03	0.42	85.15	14.65	0.20	36.27	2.85
	PNW04	0.84	84.25	15.35	0.40	38.13	2.82
South Dakota	SD01	1.33	71.98	27.13	0.90	33.00	2.57
	SD02	0.49	70.55	28.75	0.70	31.93	2.73
Texas	T01	0.83	75.45	24.00	0.55	32.55	2.74
	T02	1.46	76.82	22.75	0.43	31.47	2.70
	T03	0.90	78.15	21.30	0.55	31.70	2.73
	T04	1.18	61.25	37.55	1.20	25.53	2.63
	T05	2.17	70.30	28.88	0.82	29.42	2.69
	T06	2.65	69.67	29.23	1.10	28.26	2.65
Wyoming	W01	0.96	74.93	24.23	0.85	30.40	2.69

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.

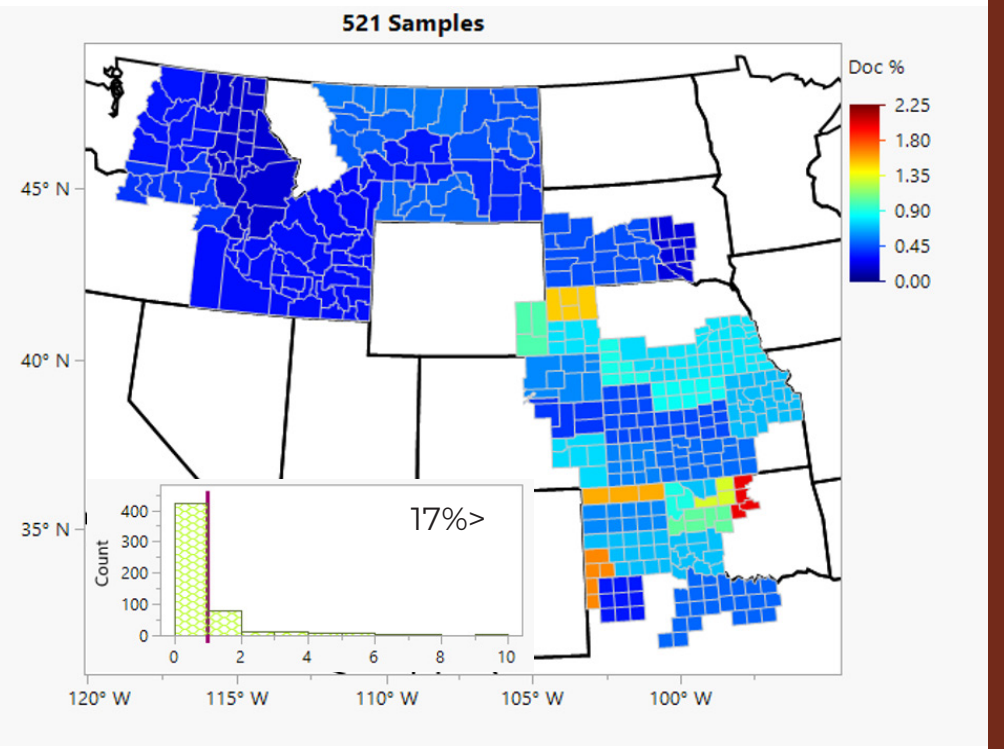
Falling number is an index of enzyme activity in wheat or flour and is expressed in seconds. Falling numbers above 300 are desirable, as they indicate little enzyme activity and a sound, quality product. Falling numbers below 300 are indicative of more substantial enzyme activity and sprout damage.

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.

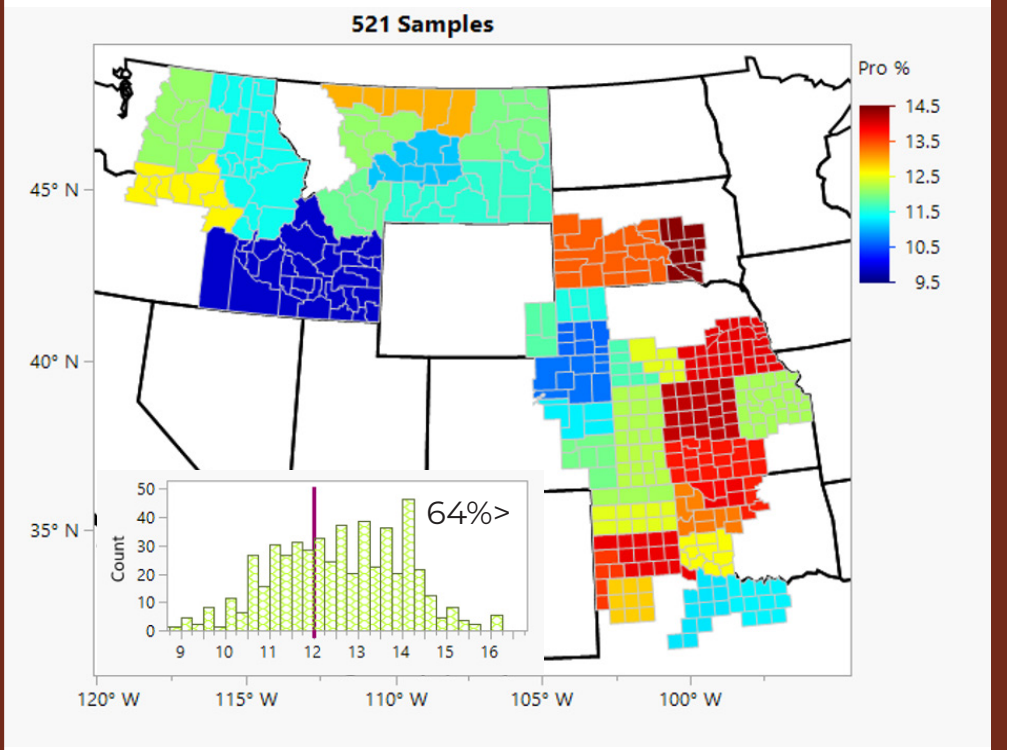
Kernel size is a measure of the percentage by weight of large, medium and small kernels in a sample. Large kernels or more uniform kernel size may help improve milling yield.

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.

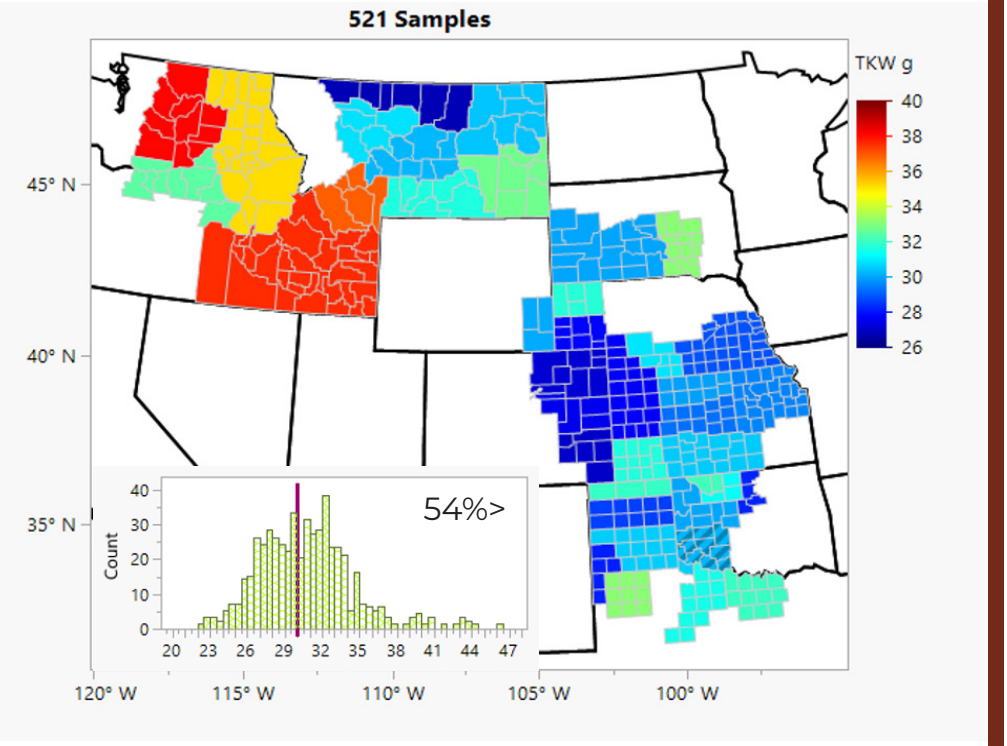
Dockage (%)



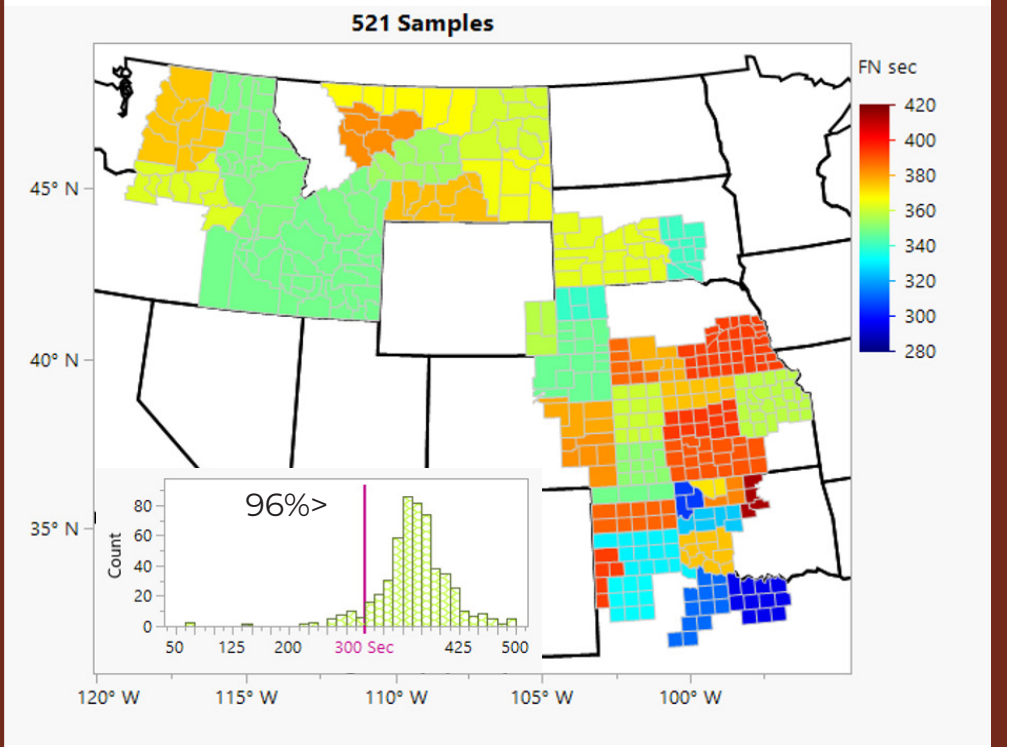
Protein (%)



Thousand Kernel Weight (g)



Falling Number (seconds)



Other Wheat Characteristics (non-grade data)

Location		Wheat Protein (12% mb)	Indiv. Wheat Ash (12% mb)	Falling Number (sec)	Moisture (%)	SKCS Avg Hard
Colorado	C01	11.78	1.57	370	11.68	50.38
	C02	11.08	1.55	356	11.37	53.19
	C03	11.94	1.54	328	11.20	54.27
Kansas	K01	12.60	1.57	283	11.78	57.22
	K02	12.00	1.58	352	12.67	58.41
	K03	12.12	1.62	348	14.44	62.54
	K04	12.01	1.60	355	11.98	67.39
	K05	12.84	1.61	376	14.08	67.35
	K06	11.88	1.60	330	12.00	56.86
Montana	M01	11.26	1.44	401	11.97	60.27
	M02	12.88	1.51	370	10.51	70.57
	M03	12.07	1.46	430	9.43	70.42
	M04	11.17	1.41	407	10.37	69.63
	M05	11.94	1.47	402	12.14	68.83
	M06	11.74	1.42	407	9.91	61.38
	M07	11.95	1.39	286	10.88	66.92
Nebraska	N01	11.21	1.51	359	10.60	56.49
	N02	13.31	1.57	365	11.90	58.68
	N03	13.58	1.57	367	12.60	62.83
	N04	14.11	1.63	373	12.92	69.11
	N05	11.65	1.52	373	12.31	53.15
Oklahoma	O01	12.21	1.57	352	12.18	57.48
	O02	12.74	1.68	296	12.59	52.72
	O03	11.84	1.58	353	12.50	55.16
	O04	11.68	1.56	293	13.44	55.79
	O05	13.20	1.57	379	12.14	53.15
	O06	13.89	1.60	342	12.79	57.11
	O07	14.10	1.63	363	12.19	55.01
Pacific Northwest	PNW01	12.10	--	368	9.35	58.54
	PNW02	12.92	--	354	9.00	67.48
	PNW03	11.72	--	373	8.87	65.70
	PNW04	10.12	--	367	9.30	60.73
South Dakota	SD01	12.34	1.57	382	12.34	64.71
	SD02	14.36	1.55	362	12.15	61.08
Texas	T01	12.89	1.54	324	11.59	59.34
	T02	12.25	1.57	297	12.61	54.54
	T03	11.32	1.54	291	12.35	49.82
	T04	13.60	1.65	365	10.89	65.59
	T05	10.39	1.61	380	13.35	57.12
	T06	11.15	1.62	381	12.14	54.64
Wyoming	W01	11.25	1.46	357	14.76	64.83

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	75.46	49.84	10.75	0.48	97.90	90.63	-1.53	9.80
	C02	75.63	50.79	10.28	0.50	97.90	90.95	-1.65	10.11
	C03	75.61	50.29	10.08	0.51	99.20	91.09	-1.74	10.48
Kansas	K01	76.13	52.56	11.27	0.54	95.20	90.71	-1.48	10.00
	K02	76.60	53.77	11.71	0.55	92.20	90.59	-1.52	10.15
	K03	76.60	67.93	13.35	0.58	97.50	90.39	-1.38	9.87
	K04	75.44	51.77	11.05	0.55	96.60	90.64	-1.52	10.08
	K05	76.33	63.05	13.00	0.58	99.30	90.24	-1.31	9.63
	K06	75.56	51.19	10.93	0.54	97.20	90.57	-1.51	10.09
Montana	M01	76.91	46.71	10.93	0.49	83.27	91.11	-1.44	9.95
	M02	75.03	65.27	11.85	0.49	98.05	91.22	-1.77	11.62
	M03	75.10	56.70	13.01	0.50	96.23	90.89	-1.60	10.85
	M04	75.63	45.60	11.96	0.48	98.35	90.97	-1.67	11.32
	M05	76.23	54.78	13.02	0.52	97.27	90.24	-1.46	10.44
	M06	76.70	44.87	12.76	0.46	83.60	90.82	-1.51	10.32
	M07	75.42	58.42	12.68	0.49	99.30	90.72	-1.48	10.37
Nebraska	N01	75.38	43.00	10.04	0.51	94.70	90.63	-1.56	10.30
	N02	75.82	46.04	10.66	0.56	94.67	90.50	-1.55	10.78
	N03	76.97	55.30	11.40	0.56	96.55	90.56	-1.48	9.90
	N04	74.88	62.49	12.97	0.60	95.00	90.47	-1.23	9.55
	N05	75.37	44.13	10.50	0.56	90.45	90.56	-1.56	10.33
Oklahoma	O01	75.45	51.46	11.03	0.51	98.03	90.75	-1.47	9.72
	O02	75.09	59.56	11.71	0.52	97.45	90.61	-1.28	9.21
	O03	75.74	44.77	11.35	0.56	90.95	90.29	-1.44	10.03
	O04	75.88	55.04	12.25	0.52	98.60	89.97	-1.36	9.56
	O05	78.02	57.04	12.16	0.57	94.50	90.28	-1.34	9.62
	O06	76.57	65.95	12.79	0.52	95.20	90.49	-1.19	9.31
	O07	74.24	59.92	12.71	0.53	95.60	90.36	-1.22	9.34
Pacific Northwest	PNW01	76.60	54.99	11.29	0.49	92.97	90.89	-1.35	10.14
	PNW02	75.20	55.81	12.03	0.49	89.05	90.45	-1.50	11.04
	PNW03	76.93	52.32	10.76	0.48	97.20	90.65	-1.57	11.35
	PNW04	77.42	36.51	9.25	0.47	97.10	90.49	-1.57	10.99
South Dakota	SD01	76.29	53.47	11.23	0.57	91.45	90.72	-1.42	9.66
	SD02	76.69	63.67	13.43	0.54	95.60	90.20	-1.11	8.92
Texas	T01	75.75	58.11	11.72	0.51	98.80	90.73	-1.30	9.53
	T02	76.42	51.39	11.04	0.51	97.33	90.61	-1.36	9.34
	T03	76.08	40.50	10.12	0.52	98.50	90.89	-1.39	9.31
	T04	73.83	50.93	12.61	0.58	80.70	90.39	-1.23	9.86
	T05	75.37	56.24	12.29	0.54	85.20	90.62	-1.24	9.62
	T06	77.54	40.86	10.85	0.57	88.43	89.90	-1.51	10.74
Wyoming	W01	75.24	44.92	9.77	0.51	95.80	91.00	-1.66	10.38

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 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	C01	68.33	116.33	240.67	0.59	56.40	4.40	8.60	27.00
	C02	67.00	118.50	243.50	0.57	55.60	4.85	8.20	35.50
	C03	70.50	99.50	222.50	0.73	55.35	2.50	7.45	25.00
Kansas	K01	81.50	98.50	264.00	0.83	58.90	4.55	8.65	28.50
	K02	78.50	111.50	282.00	0.70	58.80	5.30	9.15	32.50
	K03	84.00	142.00	407.00	0.59	59.80	6.30	13.60	14.00
	K04	93.67	89.00	296.67	1.09	57.97	5.77	11.37	22.67
	K05	90.00	120.00	387.00	0.75	58.20	6.50	11.50	31.00
	K06	63.33	113.67	225.67	0.56	55.33	4.67	8.53	34.33
Montana	M01	70.00	117.67	234.67	0.60	59.00	4.33	6.23	47.67
	M02	110.50	95.00	384.50	1.18	60.15	6.05	12.10	22.00
	M03	110.67	89.00	346.00	1.27	59.30	4.50	8.73	30.67
	M04	105.50	75.50	283.50	1.47	59.30	3.75	7.85	30.50
	M05	82.00	124.00	316.33	0.70	59.43	4.80	7.03	38.33
	M06	68.50	103.00	193.00	0.67	59.70	4.00	4.15	57.50
	M07	88.00	110.00	310.00	0.80	59.90	5.30	8.50	38.00
Nebraska	N01	72.00	93.50	207.50	0.78	57.05	3.70	7.05	34.00
	N02	63.67	111.33	214.33	0.59	56.63	5.20	7.87	39.67
	N03	82.00	103.00	302.00	0.80	56.75	5.35	10.75	25.50
	N04	83.00	126.00	336.00	0.66	60.10	5.90	11.50	23.00
	N05	69.50	95.50	192.00	0.73	57.75	4.45	6.50	46.00
Oklahoma	O01	73.33	113.00	265.67	0.65	56.57	5.57	10.13	30.33
	O02	77.00	121.50	295.50	0.66	58.15	5.50	11.45	25.50
	O03	71.00	103.00	215.00	0.69	58.45	4.95	6.75	42.00
	O04	92.00	105.00	306.00	0.88	60.40	5.20	8.50	34.00
	O05	77.50	136.00	294.00	0.59	59.30	5.45	9.40	30.50
	O06	85.00	132.00	350.00	0.64	60.50	5.20	7.90	37.00
	O07	80.00	136.00	336.00	0.59	59.70	6.80	13.40	21.0
Pacific Northwest	PNW01	97.33	97.67	304.00	1.05	60.33	4.97	7.73	35.67
	PNW02	85.00	109.50	284.50	0.80	59.25	4.85	6.55	40.00
	PNW03	106.00	84.00	304.00	1.26	60.50	5.70	8.60	34.00
	PNW04	108.00	57.00	222.00	1.89	59.10	3.70	6.70	39.00
South Dakota	SD01	81.50	109.50	259.00	0.81	58.60	5.70	8.80	36.00
	SD02	71.00	142.00	303.00	0.50	57.70	5.00	6.60	40.00
Texas	T01	96.50	90.50	298.50	1.14	58.95	4.45	8.45	31.00
	T02	69.67	106.00	242.67	0.66	55.53	4.60	9.73	25.67
	T03	85.00	88.00	263.00	0.97	56.10	4.30	9.80	25.00
	T04	79.00	95.00	208.00	0.83	61.80	4.50	5.60	40.00
	T05	80.50	111.00	253.50	0.73	60.35	4.45	6.05	46.00
	T06	68.33	100.00	184.00	0.69	57.60	4.17	5.53	52.00
Wyoming	W01	92.50	76.00	231.00	1.22	56.45	4.00	7.10	40.50

Baking Characteristics

Baking tests are the final laboratory testing method in the evaluation of wheat quality. Generally, the amount and type of protein present determines baking performance, though starch quality can also have an influence.

Technicians evaluate loaves for their volume, or size, and the interior appearance of the loaf such as crumb grain and crumb color.

Other performance factors include dough absorption, or bake absorption, and the optimum mixing time of the dough.

Baking absorption is the amount of water added to achieve properly hydrated dough. It is expressed as a percentage, with higher values being better.

Crumb grain and texture measures the cell size and shape. It is rated on a scale of one to 10 and higher numbers are preferred.

Bake mix time represents mixing time when all normal ingredients are added for producing an end product (in addition to water and flour) prior to baking.

Baking Data

Location		Bake Mix (min)	Bake Abs (14%mb)	Loaf Volume (cc)	Crumb Grain (1-10)	Crumb Texture (1-10)	Crumb Color
Colorado	C01	5.38	63.53	931.67	5.77	6.03	Yellow
	C02	5.32	62.25	925.00	5.90	6.30	Yellow
	C03	5.44	62.05	877.50	5.90	5.90	Yellow
Kansas	K01	5.50	64.85	935.00	6.30	7.00	Tan
	K02	5.00	65.25	937.50	5.50	6.65	sl Yellow
	K03	7.00	68.60	1045.00	6.30	6.30	Tan
	K04	5.54	63.93	901.67	6.03	6.03	Yellow
	K05	6.00	67.80	1065.00	5.50	7.00	Yellow
	K06	5.83	63.40	930.00	6.27	6.03	Yellow
Montana	M01	3.42	63.67	876.67	5.27	6.03	Yellow
	M02	5.75	65.35	905.00	5.15	5.90	Yellow
	M03	5.75	66.47	885.00	5.53	5.27	Yellow
	M04	6.00	64.35	812.50	4.75	5.15	very Yellow
	M05	5.83	66.37	905.00	5.77	5.50	Tan
	M06	3.44	65.30	847.50	5.15	5.55	Yellow
	M07	5.50	64.70	860.00	7.00	6.30	sl Yellow
Nebraska	N01	4.75	61.55	842.50	4.40	4.80	Yellow
	N02	5.13	62.10	908.33	5.27	6.50	Yellow
	N03	6.75	65.30	960.00	7.40	6.30	Tan
	N04	5.00	67.70	980.00	7.00	7.00	Tan
	N05	4.25	62.85	835.00	4.40	4.80	Tan
Oklahoma	O01	5.92	64.60	931.67	5.77	6.27	Tan
	O02	6.00	65.55	1010.00	5.90	7.00	Tan
	O03	4.25	64.75	917.50	5.90	5.90	sl Yellow
	O04	4.50	66.80	955.00	6.30	6.30	Tan
	O05	5.38	66.80	985.00	6.65	7.05	Tan
	O06	6.00	67.60	1055.00	7.00	7.80	Tan
	O07	5.50	67.60	955.00	4.80	7.00	Tan
Pacific Northwest	PNW01	4.58	64.47	853.33	6.03	6.03	Yellow
	PNW02	4.19	65.00	890.00	5.15	5.90	sl Yellow
	PNW03	5.50	63.40	830.00	5.50	5.50	Yellow
	PNW04	4.75	60.90	755.00	4.00	5.50	Yellow
South Dakota	SD01	4.50	64.25	890.00	4.75	5.15	sl Yellow
	SD02	4.75	68.20	1025.00	7.00	6.30	sl Yellow
Texas	T01	6.13	66.95	932.50	6.25	7.40	Tan
	T02	6.17	64.07	916.67	6.53	7.27	Tan
	T03	6.00	62.70	880.00	7.00	7.00	Tan
	T04	3.25	66.60	910.00	5.50	6.30	Tan
	T05	4.25	67.20	940.00	5.15	5.50	Tan
	T06	4.00	63.40	916.67	5.53	6.53	Tan
Wyoming	W01	4.32	61.85	800.00	4.05	5.15	sl 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.

PGI

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