

A graphic design featuring stylized wheat stalks in a light yellow color against a solid yellow background. The stalks are arranged diagonally, creating a sense of movement and growth.

2017 U.S. HARD RED SPRING WHEAT REGIONAL QUALITY REPORT



U.S. HARD RED SPRING WHEAT

MINNESOTA • MONTANA • NORTH DAKOTA
SOUTH DAKOTA • IDAHO • OREGON • WASHINGTON

5-9

Grading & Kernel
Characteristics

10-11

Milling
Characteristics

12-15

Physical Dough
Characteristics

16

Baking
Characteristics

17

Summary
Information

18-20

Quality Factors by
Protein Range

21

Distributions by
Export Region

22

Handling &
Transportation

23

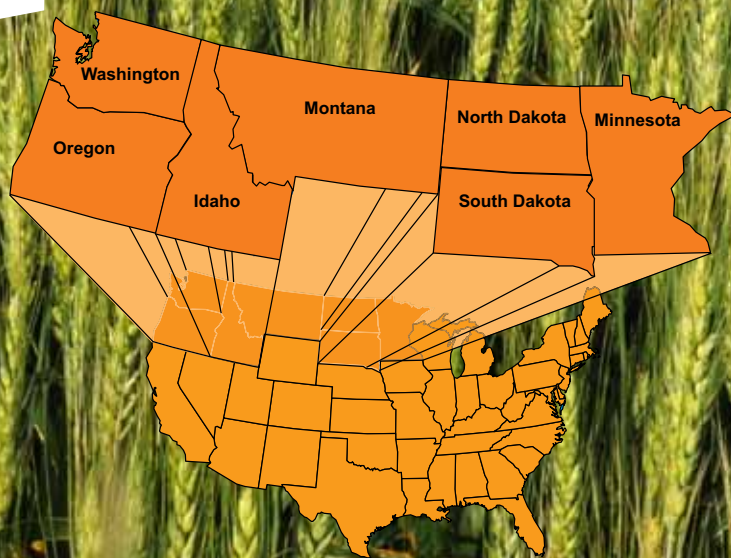
Laboratory
Analysis

23-25

Methods, Terms
and Symbols

26-31

Varietal
Information



THE ARISTOCRAT OF WHEAT

HARD RED SPRING—a specialty wheat grown primarily in the Northern Plains of the United States—stands out as the aristocrat of wheat when it comes to baking bread. The high protein content and superior gluten quality of hard red spring wheat make it ideal for use in some of the world's finest baked goods. Yeast breads, hard rolls and specialty products such as

hearth breads, whole grain breads, bagels and pizza crusts look and taste their best when baked with top quality spring wheat flour. Even frozen dough products are better with spring wheat because they can be stored longer than those made with lower protein wheats.

Flour mills in the United States and around the world also use hard

red spring wheat extensively as a blending wheat to increase the gluten strength in a batch of flour. Adding hard red spring to lower protein wheat improves dough handling and mixing characteristics as well as water absorption. The resulting flour can be used to make an assortment of bread products, as well as Chinese-type noodles.

U.S. HARD RED SPRING WHEAT

MINNESOTA • MONTANA • NORTH DAKOTA • SOUTH DAKOTA • IDAHO • OREGON • WASHINGTON

3

2017 OVERVIEW

The 2017 U.S. hard red spring wheat crop is lower in production, but features a high grade profile, high protein content, and very good functional performance. Production is down 21 percent from 2016, due to lower planted area, and severe drought conditions across the western portion of the main four-state production region. The impact from drought offset production gains in the Pacific Northwest and eastern half of the four-state region, where a more favorable growing season produced above average to record yields. Limited disease pressures and favorable harvest conditions secured a high quality crop with many positive features.

The crop averages a No. 1 Northern Spring compared to a No. 1 Dark Northern Spring a year ago, as average vitreous kernel levels fell from 77 percent to 71. Grade distributions show 91 percent of the crop is a No. 1, and only five percent a No. 3 or lower. Specifically, the crop average test weight is 61.7 lbs/bu (81.1 kg/hl) with nearly 90 percent of the crop above 60 lbs/bu (78.9 kg/hl). Damaged kernels are just 0.1 percent on average. Shrunken and broken kernel levels average similar to 2016 for the overall crop,

but greater variance is evident in 2017, with higher levels in areas impacted by drought.

Crop average protein is 14.5% (12% moisture basis), higher than 2016 and the 5-yr average. Drought conditions, and above-average temperatures led to the higher protein, with the most notable gains in protein in drought impacted areas. Forty-three percent of the crop exceeds 15% protein, up from just 25 percent in 2016. Twelve percent of the crop falls below 13 percent protein, similar to 2016.

Kernel moisture averages were a dry 12.1%, as generally dry harvest conditions supported the low moisture levels, and promoted sound kernel qualities. The average falling number is 389 seconds, down slightly from 2016, but similar to the 5-yr average. Some pockets in the region experienced heavier rains during harvest, but only 2 percent of the crop falls below 300 seconds.

Disease pressures were low to non-existent across most of the region. Fusarium Headblight pressures were most evident across the northeastern area where mid season moisture was more plentiful. The crop as a whole averaged 0.0 ppm for DON. Just one of the 18 crop

PRODUCTION DATA	2017	2016	2012-16 AVERAGE
MILLION BUSHELS			
Minnesota	76	74	73
Montana	48	74	92
North Dakota	208	269	274
South Dakota	21	47	54
ID/OR/WA	32	25	27
U.S. Total	385	489	521
MILLION METRIC TON			
Minnesota	2.07	2.01	1.99
Montana	1.31	2.01	2.49
North Dakota	5.66	7.32	7.47
South Dakota	0.57	1.28	1.99
ID/OR/WA	0.87	0.67	0.73
U.S. Total	10.5	13.3	14.16

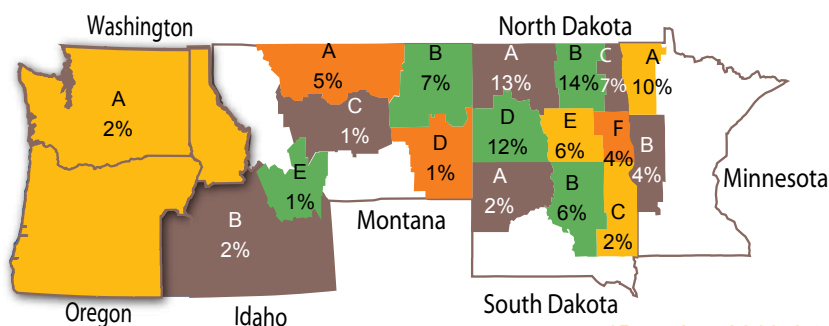
Source: USDA 2017 Small Grains Summary

reporting areas (CRA) tested above 0.0 ppm, recorded at 0.5 ppm. Thousand kernel weights average 31.5 grams, up from 2016, but differences across the region are more pronounced than recent years. Across western areas, most CRA's are showing lighter TKW's due to moisture stress during kernel fill.

Milling yields in 2017, are up by more than four percentage points from a year ago to 71.2%, based on a Buhler Lab Mill. Higher mill yields were reported across all areas, but average flour ash did increase as well, up to 0.57%, compared to 0.53% in 2016 and 0.50% on a 5-yr average. In the laboratory milling, flour protein recovery was notably improved over recent years. Reflective of the higher protein content in the crop, average wet gluten values are 35.6%, higher than 2016 and the 5-yr average.

Physical dough tests on the 2017 crop are showing slightly weaker, more extensible dough properties relative to the 2016 crop, but stronger dough properties compared to the 5-yr average.

Approximate Share of Regional Production by *Area



*Based on 2016 data

Farinograph stability times range from 7.9 to 13.7 minutes across the region, averaging 11.9 minutes. This compares to 13.2 in 2016, and 11 minutes for a 5-yr average. Stability times are generally stronger across the eastern production region. Absorption values are similar to a year ago with the highest levels across western areas. Dough properties as measured on the Extensograph and Alveograph parallel the farinograph, indicating a crop

that is similar to slightly weaker in strength, but expressing greater extensibility.

Baking evaluations show lower loaf volumes similar to 2016 and the 5-yr average, with an average of 951 cubic centimeters, ranging from 830 to 1040 cc's across the region. Dough handling properties are slightly poorer than 2016 with more extensibility, but overall bread scores are similar to higher than a year ago.

Buyers will find many positive attributes in the 2017 crop, including high grades, plentiful protein, little to no DON, and a crop that exhibits very good functional performance. Protein levels, shrunken and broken kernels, and thousand kernel weights are more variable than recent years, due to the vast differences in growing conditions across the region. Diligent contract specifications are still encouraged with this high quality crop, to ensure buyers get the quality demanded.

SEASONAL CONDITIONS

Planting began in early April, near normal, with adequate soil moisture in most areas. Progress was hindered by cool soil temperatures in parts of the region, falling behind normal into early May. Warmer temperatures accelerated progress during May, allowing completion to reach 80 percent by mid-May and more than 95 percent by the end of May.

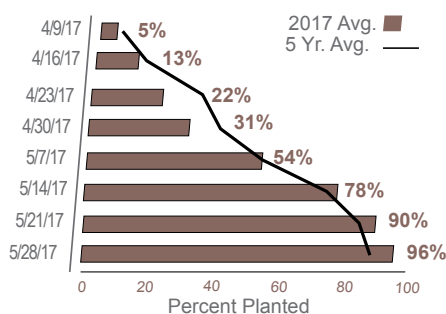
June, with central and eastern parts of the region having good stand establishment and timely rains. Crops in western and southern areas of the region were challenged in stand establishment and early growth by lack of rainfall, frequent winds and above normal temperatures.

The growing season, in late June and into July, maintained a similar pattern with timely precipitation promoting good to excellent plant growth across central and eastern parts. A drier period in July also kept disease threats low. However, moderate to severe drought conditions prevailed across large portions of the southern and western production areas in the four-state region throughout June and July, with many areas receiving less than 25 percent of normal precipitation. These conditions quickly diminished yield potential, and in pockets, a large percent of the crop was harvested for forage.



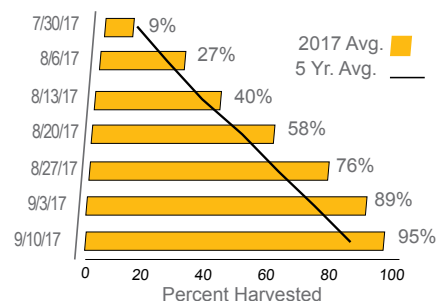
Harvest began in late July, and progressed steadily through August due to hastened crop maturity in drought impacted areas and generally dry conditions across the region. Rains did slow harvest in some areas in mid-August, but had minimal impact on crop quality. Harvest completion reached slightly more than one-half by mid-August, with more than 95 percent completed by mid-September.

HRS PLANTING PROGRESS



Crop emergence and early development was slower than normal early, due partly to cooler soil temps, and in other areas expansion of dry soil conditions. Warmer temps accelerated development in late May and early

HRS HARVEST PROGRESS



WHEAT CHARACTERISTICS

OFFICIAL U.S. GRADES AND GRADE REQUIREMENTS (Revised June 1993)

GRADING FACTORS	U.S. Grades				
	1	2	3	4	5
HARD RED SPRING - MINIMUM TEST WEIGHTS					
Pounds per bushel	58.0	57.0	55.0	53.0	50.0
Kilograms per hectoliter	76.4	75.1	72.5	69.9	66.0
MAXIMUM PERCENT LIMITS OF:					
Damaged kernels					
Heat (part of 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/broken kernels	3.0	5.0	8.0	12.0	20.0
Total ¹	3.0	5.0	8.0	12.0	20.0
Wheat of other classes ²					
Contrasting classes	1.0	2.0	3.0	10.0	10.0
Total ³	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					
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 material	3	3	3	3	3
Total ⁴	4	4	4	4	4
Insect-damaged kernels	31	31	31	31	31

U.S. sample grade is wheat that:

- Does not meet the requirements for U.S. Nos. 1, 2, 3, 4, or 5; or
- Has a musty, sour, or commercially objectionable foreign odor (except smut or garlic odor); or
- is heating or of distinctly low quality.
 - Includes damaged kernels (total), foreign material, and 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, glass, stones, or unknown foreign substance.

Wheat grades, as defined by the USDA Grain Inspection, Packers and Stockyards Administration (GIPSA), reflect the general quality and condition of a representative sample. U.S. grades are based on test weight and include limits on damaged kernels, foreign material, shrunken and broken kernels, and wheat of contrasting classes.

Subclass is a separate marketing factor based on the number of kernels that are dark, hard and vitreous. For hard red spring wheat the subclasses are:

- | Dark Northern Spring (DNS)—at least 75 percent or more dark, hard, vitreous kernels;
- | Northern Spring (NS)—between 25 and 74 percent dark, hard, vitreous kernels;
- | Red Spring (RS)—less than 25 percent dark, hard, vitreous kernels.

Other basic criteria not included as grading factors but important in the U.S. wheat marketing system.

Protein is probably the most important factor in determining the value of hard red spring wheat since it relates to many processing properties. In the U.S. market HRS prices are usually quoted for 14.0 percent protein (on a 12.0 percent moisture basis). Price premiums or discounts may be specified for halves, fifths and tenths of a percentage point above and below 14.0 percent.

Moisture content is an indicator of grain storability. Wheat with lower moisture content is generally more stable during storage and more profitable to a miller. U.S. HRS ranges from 12 to 13 percent.

Dockage is any material easily removed from a wheat sample during cleaning using standard mechanical means. All U.S. grade and non-grade factors are determined only after dockage is removed.

Falling number indicates the soundness of wheat or its alpha-amylase activity. Falling numbers above 300 seconds are most desired for baking products.

WHEAT GRADING DATA

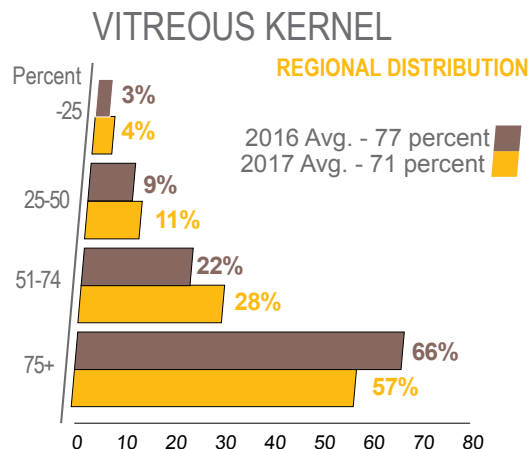
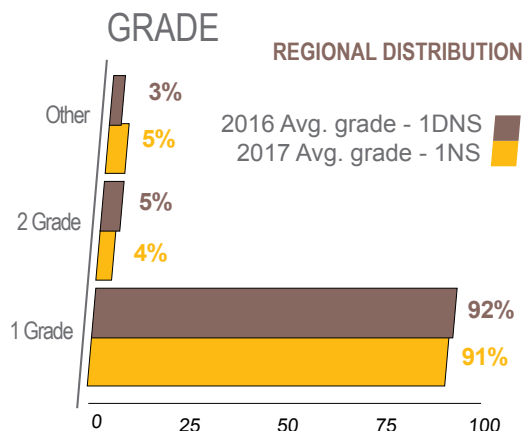


STATE AND CROP REPORTING AREA	TEST WEIGHT LBS/BU KG/HL		DAMAGE %	SHRUNKEN/ BROKEN KERNELS %	TOTAL DEFECTS %	U.S. GRADE SUBCLASS	VITREOUS KERNELS %
MINNESOTA							
Area A	62.5	82.2	0.0	0.6	0.6	1 NS	61
Area B	62.2	81.8	0.2	0.3	0.5	1 NS	57
State Avg. 2017	62.4	82.0	0.0	0.5	0.5	1 NS	60
State Avg. 2016	61.3	80.6	0.1	0.5	0.6	1 NS	72
MONTANA							
Area A	60.0	78.9	0.0	2.0	2.0	1 DNS	87
Area B	61.3	80.6	0.0	1.6	1.6	1 NS	68
Area C	60.8	80.0	0.1	2.8	2.9	1 DNS	80
Area D	60.0	78.9	0.0	1.7	1.7	1 DNS	83
Area E	62.1	81.7	0.2	0.8	1.0	1 DNS	86
State Avg. 2017	60.8	80.0	0.0	1.8	1.8	1 DNS	77
State Avg. 2016	61.4	80.7	0.0	1.1	1.1	1 DNS	93
NORTH DAKOTA							
Area A	61.8	81.3	0.0	1.2	1.2	1 NS	72
Area B	62.1	81.7	0.1	0.6	0.7	1 NS	72
Area C	62.5	82.2	0.3	0.4	0.7	1 NS	57
Area D	59.6	78.4	0.1	1.4	1.5	1 DNS	82
Area E	60.4	79.5	0.1	0.9	1.0	1 NS	73
Area F	61.1	80.4	0.0	0.5	0.5	1 NS	59
State Avg. 2017	61.4	80.7	0.1	0.9	1.0	1 NS	71
State Avg. 2016	61.6	81.0	0.1	0.7	0.8	1 NS	73
SOUTH DAKOTA							
Area A	59.7	78.6	0.0	1.4	1.4	1 DNS	78
Area B	60.8	80.0	0.0	1.0	1.0	1 NS	65
Area C	60.4	79.5	0.0	0.6	0.6	1 NS	65
State Avg. 2017	60.5	79.6	0.0	0.9	0.9	1 NS	67
State Avg. 2016	61.8	81.3	0.0	0.6	0.6	1 DNS	77
ID/OR/WA							
Area A	63.0	82.8	0.0	0.8	0.8	1 DNS	88
Area B	64.0	84.1	0.2	0.3	0.5	1 DNS	94
State Avg. 2017	63.6	83.6	0.1	0.5	0.6	1 DNS	91
State Avg. 2016	63.3	83.2	0.0	0.8	0.8	1 DNS	96
REGION AVERAGE							
Avg. 2017	61.7	81.1	0.1	0.9	1.0	1 NS	71
Avg. 2016	61.6	81.0	0.0	0.8	0.8	1 DNS	77
Five-Year Avg.	61.6	81.0	0.1	0.9	1.0	1 NS	71

U.S. HARD RED SPRING WHEAT

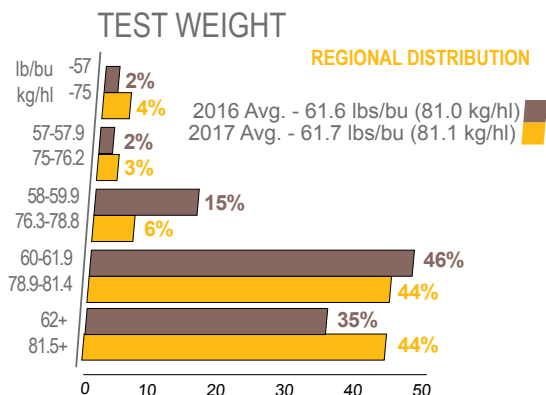
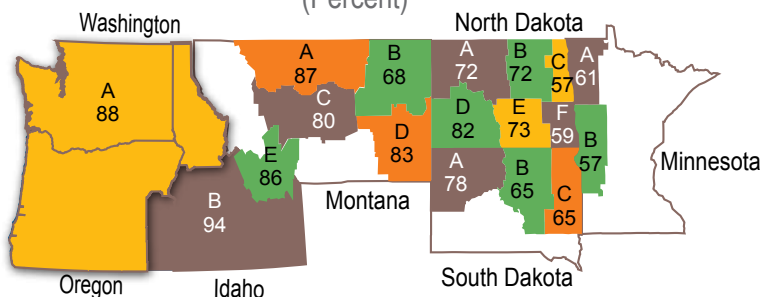
MINNESOTA • MONTANA • NORTH DAKOTA • SOUTH DAKOTA • IDAHO • OREGON • WASHINGTON

7

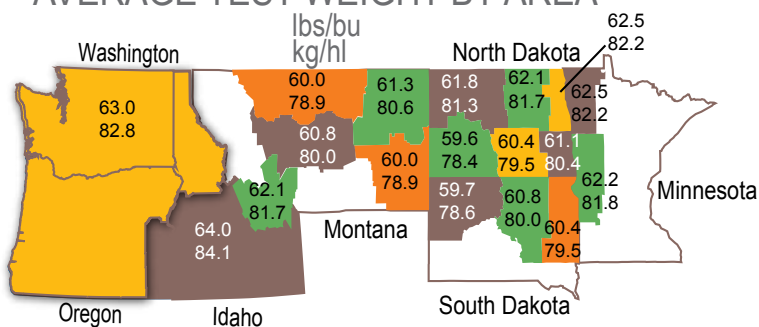


AVERAGE VITREOUS KERNEL BY AREA

(Percent)



AVERAGE TEST WEIGHT BY AREA



OTHER KERNEL QUALITY DATA

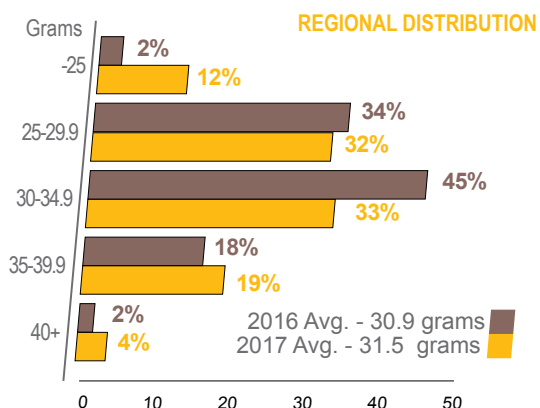
STATE AND CROP REPORTING AREA	Dockage %	Moisture %	1000 Kernel Weight G	Kernel Dist. Medium %	Kernel Dist. Large %	Protein (12%/0% moisture basis)	DON PPM	Wheat Ash %	Falling Number SEC	Zeleny Sed CC
MINNESOTA										
Area A	0.4	12.7	35.9	32	66	13.8/15.7	0.0	1.47	388	58
Area B	0.4	13.0	35.4	29	70	13.6/15.4	0.0	1.48	404	52
State Avg. 2017	0.4	12.7	35.8	31	67	13.8/15.7	0.0	1.47	391	57
State Avg. 2016	0.4	13.1	33.7	40	58	13.8/15.7	0.0	1.47	422	65
MONTANA										
Area A	0.7	10.0	27.5	76	15	14.9/16.9	0.0	1.56	394	64
Area B	0.4	11.3	26.9	77	18	14.9/16.9	0.0	1.49	401	57
Area C	0.5	9.2	26.4	65	25	14.3/16.2	0.0	1.66	357	57
Area D	0.3	10.3	25.8	79	15	14.3/16.2	0.0	1.59	387	60
Area E	0.4	10.1	31.4	51	46	14.4/16.3	0.0	1.45	369	64
State Avg. 2017	0.5	10.7	27.2	76	18	14.8/16.8	0.0	1.53	395	60
State Avg. 2016	0.5	11.1	29.7	63	33	13.6/15.5	0.0	1.52	370	65
NORTH DAKOTA										
Area A	0.4	12.4	29.1	63	34	14.8/16.8	0.0	1.50	353	66
Area B	0.4	12.8	32.3	49	49	13.9/15.8	0.0	1.52	402	64
Area C	0.5	12.9	34.3	37	62	14.0/15.9	0.5	1.49	414	63
Area D	0.6	12.0	26.2	80	14	15.7/17.8	0.0	1.47	370	66
Area E	0.7	12.7	28.2	65	32	15.4/17.5	0.0	1.54	361	66
Area F	0.4	12.9	32.6	43	55	14.2/16.2	0.0	1.57	382	65
State Avg. 2017	0.5	12.6	30.4	57	40	14.6/16.6	0.1	1.50	382	65
State Avg. 2016	0.5	12.5	30.4	54	44	14.4/16.4	0.0	1.54	407	66
SOUTH DAKOTA										
Area A	0.6	11.8	24.9	81	11	15.2/17.3	0.0	1.47	400	63
Area B	0.4	12.5	30.3	66	30	16.1/18.3	0.0	1.44	441	57
Area C	0.7	13.0	31.4	60	37	14.1/16.0	0.0	1.56	394	53
State Avg. 2017	0.5	12.6	29.8	66	29	15.4/17.4	0.0	1.48	421	57
State Avg. 2016	0.4	12.1	29.5	62	34	14.5/16.4	0.0	1.57	432	63
ID/OR/WA										
Area A	0.3	9.0	35.4	43	54	14.5/16.5	0.0	1.63	398	54
Area B	0.3	10.0	36.5	33	66	14.8/16.8	0.0	1.46	403	59
State Avg. 2017	0.3	9.6	36.0	37	61	14.7/16.7	0.0	1.54	401	57
State Avg. 2016	0.3	9.0	34.6	45	53	14.1/16.0	0.0	1.53	408	62
REGION AVERAGE										
Avg. 2017	0.5	12.1	31.5	53	44	14.5/16.5	0.0	1.50	389	62
Avg. 2016	0.5	12.1	30.9	53	44	14.2/16.1	0.0	1.53	406	65
Five-Year Avg.	0.6	12.1	31.3	49	48	14.0/15.9	0.2	1.52	388	62

U.S. HARD RED SPRING WHEAT

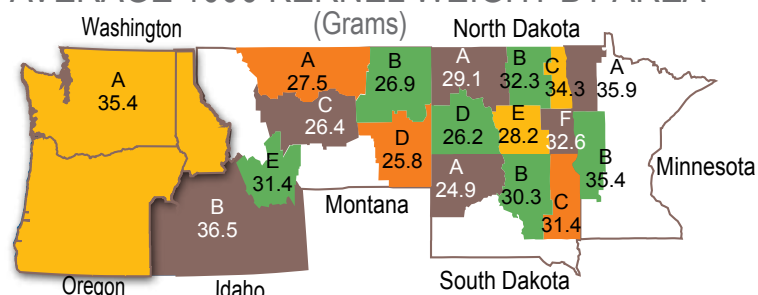
MINNESOTA • MONTANA • NORTH DAKOTA • SOUTH DAKOTA • IDAHO • OREGON • WASHINGTON

9

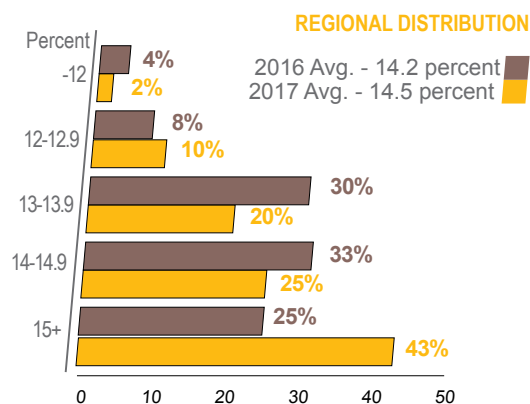
1000 KERNEL WEIGHT



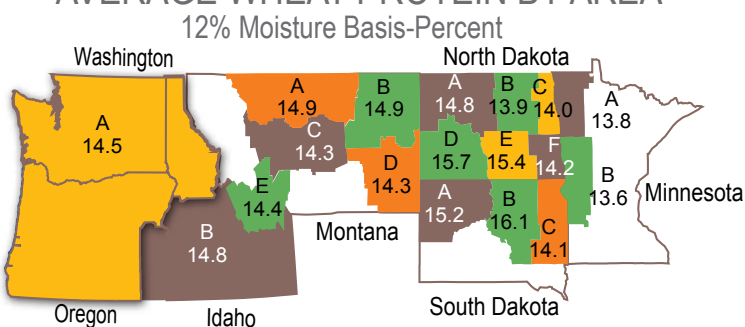
AVERAGE 1000 KERNEL WEIGHT BY AREA



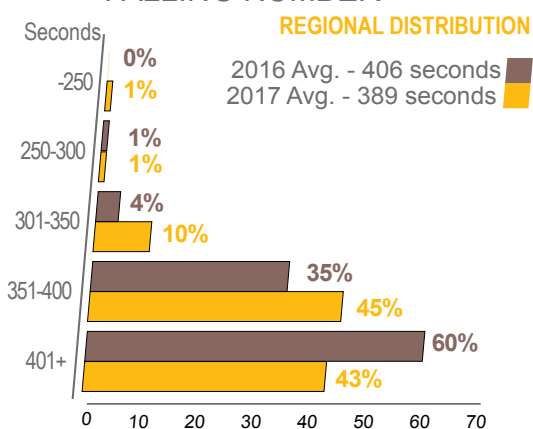
PROTEIN - 12% MOISTURE



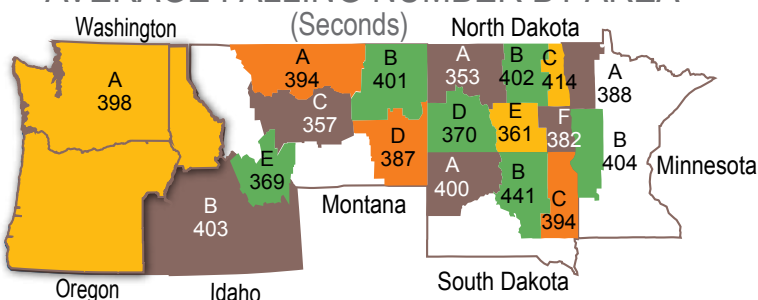
AVERAGE WHEAT PROTEIN BY AREA



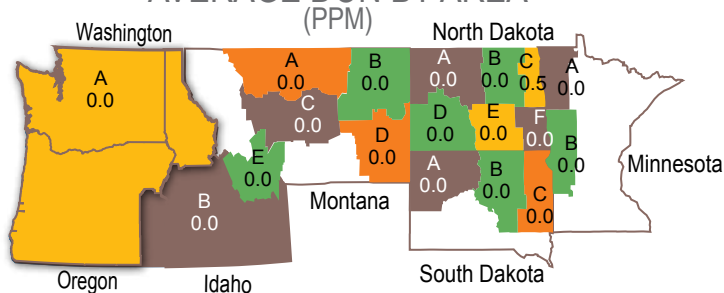
FALLING NUMBER



AVERAGE FALLING NUMBER BY AREA



AVERAGE DON BY AREA



FLOUR QUALITY DATA

Flour is evaluated for several factors to determine overall milling efficiency, grade, soundness and functional properties.

Extraction, or the proportion of the wheat kernel that can be milled into flour, is important to mill profitability. For purposes of this survey, test milling was conducted with a Buhler laboratory mill. Results are suitable for comparison between crop years, however yields are lower than those obtained in commercial mills.

Another measure of milling efficiency and of flour grade is the ash content, or mineral residue, remaining after incineration of a sample.

Starch damage measures physical damage to a proportion of the starch granules of flour. The level directly affects water absorption and dough mixing properties.

Wet gluten provides a quantitative measure of the gluten forming proteins in flour that are primarily responsible for its dough mixing and baking properties.

Falling number measures enzyme activity in flour. A fast time indicates high activity, revealing too much sugar and too little starch. Since starch provides bread's supporting structure, too much activity results in sticky dough and poor texture in finished products.

STATE AND CROP REPORTING AREA	FLOUR EXTRACTION %	FLOUR ASH %	FLOUR PROTEIN (14% MOISTURE) %	STARCH DAMAGE %	SRC: GPI	WATER/ 50% SUCROSE	5% LACTIC ACID/5% Na_2CO_3
MINNESOTA							
Area A	72.7	0.57	13.3	8.4	0.66	70/117	144/99
Area B	71.8	0.56	12.7	6.5	0.67	67/111	134/90
State Avg. 2017	72.5	0.57	13.2	8.0	0.66	69/116	142/97
State Avg. 2016	66.8	0.56	12.7	6.8	0.66	69/119	143/98
MONTANA							
Area A	70.7	0.57	14.1	6.5	0.66	70/118	144/101
Area B	69.5	0.58	14.0	5.7	0.64	68/116	135/96
Area C	70.0	0.55	13.4	5.9	0.64	71/118	138/100
Area D	67.9	0.53	13.3	6.6	0.68	67/115	141/90
Area E	71.0	0.56	13.6	5.5	0.61	72/123	141/106
State Avg. 2017	70.0	0.57	14.0	6.1	0.65	69/117	139/98
State Avg. 2016	66.4	0.55	12.7	6.6	0.65	68/120	143/99
NORTH DAKOTA							
Area A	71.6	0.57	14.0	6.3	0.73	68/117	154/95
Area B	71.9	0.56	13.0	6.0	0.67	70/115	142/98
Area C	71.4	0.57	13.2	7.0	0.66	68/115	139/95
Area D	68.8	0.58	15.0	6.6	0.68	69/118	144/93
Area E	70.9	0.59	14.7	6.3	0.69	69/116	145/93
Area F	71.5	0.59	13.6	6.2	0.69	69/113	141/93
State Avg. 2017	71.1	0.57	13.8	6.4	0.69	69/116	145/95
State Avg. 2016	67.0	0.51	13.2	6.8	0.66	69/118	142/96
SOUTH DAKOTA							
Area A	69.5	0.58	14.5	6.9	0.64	71/118	137/96
Area B	71.5	0.62	15.2	6.1	0.64	69/113	130/89
Area C	72.1	0.58	13.3	6.5	0.64	65/108	125/87
State Avg. 2017	71.4	0.60	14.5	6.3	0.64	68/113	129/90
State Avg. 2016	68.0	0.55	13.2	6.6	0.67	69/115	139/93
ID/OR/WA							
Area A	70.0	0.58	13.8	6.2	0.61	71/120	132/97
Area B	70.4	0.57	14.0	6.2	0.59	73/123	133/102
State Avg. 2017	70.2	0.57	13.9	6.2	0.60	72/122	133/100
State Avg. 2016	65.8	0.56	13.1	7.3	0.59	73/124	143/102
REGION AVERAGE							
Avg. 2017	71.2	0.57	13.8	6.7	0.67	69/116	142/96
Avg. 2016	66.9	0.53	13.0	6.8	0.66	69/118	142/96
Five-Year Avg.	67.6	0.50	12.9	7.1	0.64	73/127	145/98

U.S. HARD RED SPRING WHEAT

MINNESOTA • MONTANA • NORTH DAKOTA • SOUTH DAKOTA • IDAHO • OREGON • WASHINGTON

11

STATE AND CROP REPORTING AREA	WET GLUTEN %	GLUTEN INDEX	FALLING NUMBER	AMLYLOGRAPH PEAK VISCOSITY 65 G FL B.U.
MINNESOTA				
Area A	33.7	97	412	597
Area B	32.7	96	419	696
State Avg. 2017	33.5	97	413	616
State Avg. 2016	31.5	97	433	684

MONTANA				
Area A	37.9	87	427	724
Area B	39.2	75	429	676
Area C	36.9	85	412	735
Area D	35.3	81	410	710
Area E	35.5	91	412	597
State Avg. 2017	38.4	81	427	696
State Avg. 2016	34.7	90	382	741

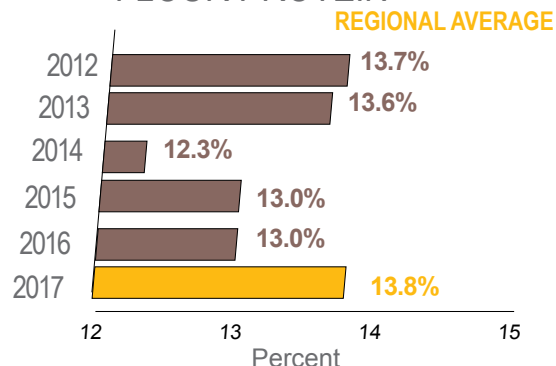
NORTH DAKOTA				
Area A	35.2	95	360	356
Area B	32.7	94	398	584
Area C	33.0	95	412	627
Area D	39.4	85	416	582
Area E	37.1	93	376	401
Area F	33.0	96	364	350
State Avg. 2017	35.0	93	390	505
State Avg. 2016	35.5	91	409	620

SOUTH DAKOTA				
Area A	38.1	85	449	640
Area B	40.9	80	487	587
Area C	34.2	92	414	497
State Avg. 2017	38.5	85	459	568
State Avg. 2016	34.4	94	444	667

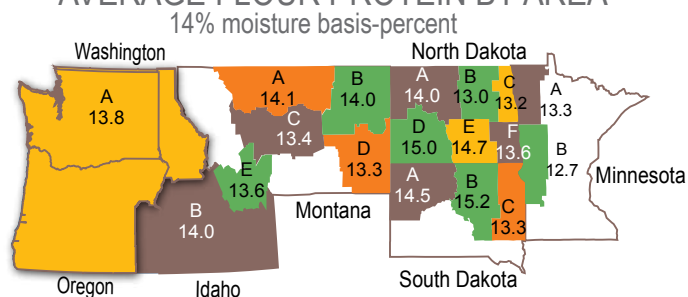
ID/OR/WA				
Area A	38.0	76	439	647
Area B	38.7	82	432	735
State Avg. 2017	38.4	79	435	697
State Avg. 2016	35.2	86	461	728

REGION AVERAGE				
Avg. 2017	35.6	91	407	570
Avg. 2016	34.7	92	415	659
Five-Year Avg.	34.5	92	402	635

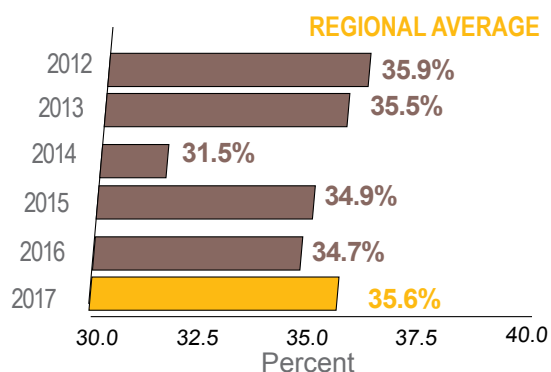
FLOUR PROTEIN



AVERAGE FLOUR PROTEIN BY AREA



WET GLUTEN



PHYSICAL DOUGH QUALITY

Physical characteristics of dough are evaluated to reveal useful information about variations in flour types, processing requirements and expected end-product quality.

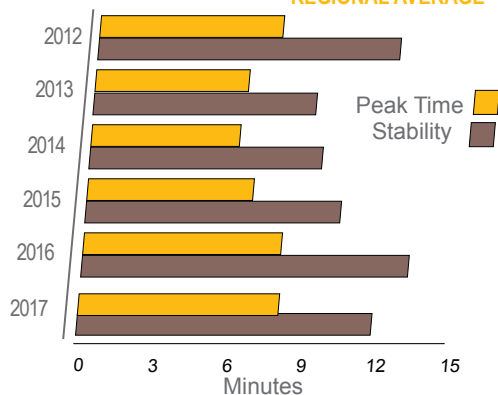
A farinograph traces a curve during the dough mixing process to record variations in gluten development and the breakdown of gluten proteins over time. Water absorption indicates the amount of water that can be added to the flour until the dough reaches a definite consistency. Peak time indicates the number of minutes required to achieve this level of dough consistency and mixing tolerance indicates the stability of the dough. Both peak time and stability are related to dough strength. The extensigraph measures dough strength by stretching a piece of dough on a hook until it breaks. The apparatus traces a curve that measures extensibility, resistance to extension and the area beneath the curve, or energy value.

An alveograph traces a curve that measures the air pressure necessary to inflate a piece of dough to the point of rupture. The overpressure (P) value reflects the maximum pressure needed to deform the piece of dough during the inflation process and is an indication of resistance, or dough stability. The length (L) measurement reflects dough extensibility. The deformation energy (W) measurement is the amount of energy needed to inflate the dough to the point of rupture and is indicative of dough strength.

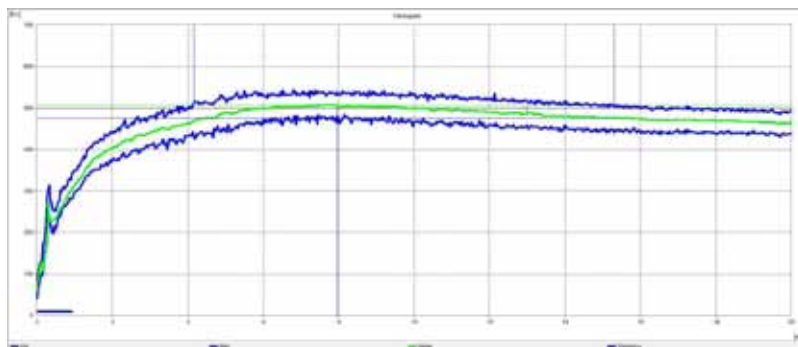
FARINOGRAPH					
STATE AND CROP REPORTING AREA	ABSORPTION %	PEAK TIME MIN	STABILITY MIN	MTI B.U.	QUALITY NUMBER MM
MINNESOTA					
Area A	62.0	7.0	13.3	16	156
Area B	61.0	8.8	13.3	25	156
State Avg. 2017	61.8	7.3	13.3	18	156
State Avg. 2016	61.1	7.1	17.6	16	182
MONTANA					
Area A	62.9	7.7	10.0	25	139
Area B	64.2	6.5	10.2	20	145
Area C	63.6	6.9	7.9	32	118
Area D	61.9	7.4	10.0	22	141
Area E	65.2	7.2	10.0	22	141
State Avg. 2017	63.6	7.0	10.0	22	142
State Avg. 2016	62.5	7.5	10.3	23	146
NORTH DAKOTA					
Area A	62.0	9.0	13.7	19	166
Area B	61.7	8.7	11.4	24	149
Area C	61.8	8.0	13.0	16	162
Area D	63.7	8.7	12.6	16	171
Area E	62.2	9.0	11.6	27	146
Area F	61.8	8.5	10.5	26	143
State Avg. 2017	62.2	8.7	12.4	20	159
State Avg. 2016	63.3	8.5	13.2	19	179
SOUTH DAKOTA					
Area A	64.1	8.0	11.1	19	155
Area B	64.7	9.0	12.4	20	171
Area C	60.9	8.0	9.6	34	124
State Avg. 2017	63.5	8.6	11.4	24	155
State Avg. 2016	61.4	8.0	12.8	18	159
ID/OR/WA					
Area A	63.9	6.8	8.4	28	126
Area B	65.8	7.8	8.6	35	121
State Avg. 2017	65.0	7.4	8.5	32	123
State Avg. 2016	63.8	7.1	10.0	22	139
REGION AVERAGE					
Avg. 2017	62.6	8.1	11.9	21	153
Avg. 2016	62.7	8.0	13.2	19	170
Five-Year Avg.	62.8	6.9	11.0	29	133

FARINOGRAPH RESULTS

REGIONAL AVERAGE

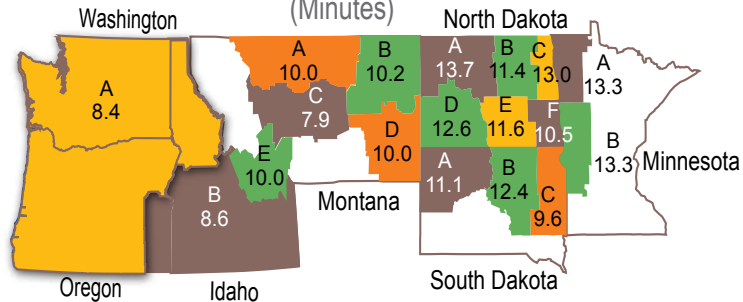


2017 AVERAGE FARINOGRAM



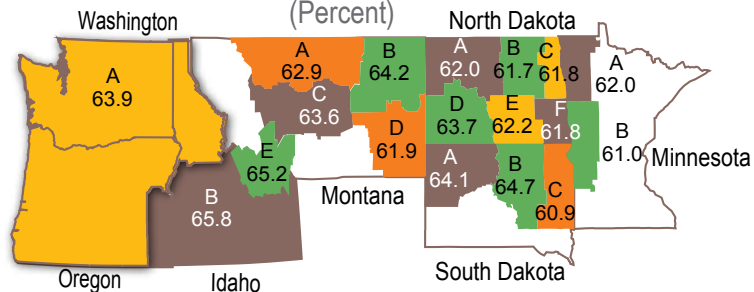
AVERAGE STABILITY BY AREA

(Minutes)



AVERAGE FARINOGRAM ABSORPTION BY AREA

(Percent)



PHYSICAL DOUGH QUALITY

STATE AND CROP REPORTING AREA	EXTENSOGGRAPH						ALVEOGRAPH			
	EXTENSIBILITY 45 MIN CM	RESISTANCE 45 MIN B.U.	AREA SQ CM	EXTENSIBILITY 135 MIN CM	RESISTANCE 135 MIN B.U.	AREA SQ CM	P MM	L MM	P/L RATIO	W JOULES X 10 ⁴
MINNESOTA										
Area A	16.0	596	127	14.3	1041	195	88	132	0.67	410
Area B	16.5	574	127	13.2	903	159	80	138	0.58	375
State Avg. 2017	16.1	592	127	14.1	1015	188	86	133	0.65	403
State Avg. 2016	17.3	689	154	12.9	1053	178	88	135	0.65	437
MONTANA										
Area A	16.9	491	108	13.7	836	153	76	132	0.58	325
Area B	16.2	420	90	10.6	921	129	78	131	0.59	320
Area C	15.9	421	90	14.4	670	133	88	111	0.79	326
Area D	15.3	486	100	11.4	898	138	79	129	0.61	343
Area E	18.6	439	113	15.6	669	139	86	153	0.56	383
State Avg. 2017	16.5	451	98	12.1	871	139	78	131	0.59	325
State Avg. 2016	15.9	459	97	11.9	975	150	80	137	0.58	353
NORTH DAKOTA										
Area A	17.9	589	132	13.8	873	160	76	157	0.48	411
Area B	17.0	520	118	13.4	723	132	78	141	0.55	356
Area C	16.2	513	105	14.7	829	163	79	140	0.56	361
Area D	16.7	510	108	14.6	872	170	82	146	0.56	393
Area E	18.6	488	120	16.4	738	161	75	145	0.51	376
Area F	18.0	548	133	15.8	759	163	72	152	0.48	360
State Avg. 2017	17.2	533	119	14.3	809	155	78	147	0.53	379
State Avg. 2016	16.5	516	109	12.2	969	154	84	127	0.66	366
SOUTH DAKOTA										
Area A	15.9	485	102	14.3	760	149	88	135	0.65	403
Area B	16.6	433	96	13.8	632	115	82	141	0.58	380
Area C	17.5	458	106	13.4	701	129	70	149	0.47	321
State Avg. 2017	16.8	448	100	13.8	672	124	79	143	0.56	366
State Avg. 2016	17.5	586	132	13.5	1029	184	82	135	0.61	381
ID/OR/WA										
Area A	16.2	373	79	14.7	670	132	77	149	0.52	333
Area B	15.7	303	65	15.2	633	130	86	125	0.68	323
State Avg. 2017	15.9	333	71	15.0	649	131	82	135	0.61	327
State Avg. 2016	16.4	434	95	13.1	672	117	86	125	0.69	351
REGION AVERAGE										
Avg. 2017	16.8	513	113	14.0	836	156	80	141	0.57	372
Avg. 2016	16.6	536	115	12.4	973	158	84	130	0.64	376
Five-Year Avg.	16.6	469	101	13.6	774	139	90	116	0.80	355

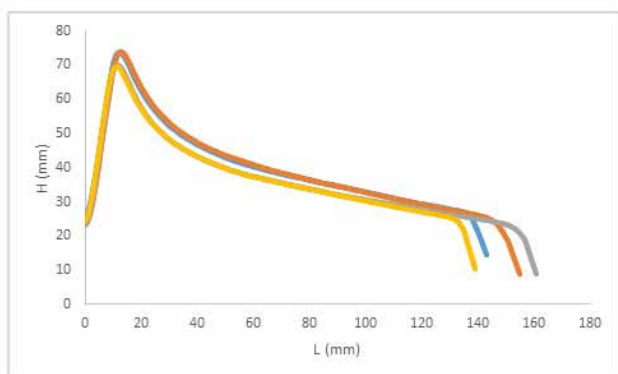
2017 AVERAGE EXTENSOGRAM



Indicates extensibility and resistance to extension. Area beneath curve indicates the energy or work required.



2017 AVERAGE ALVEOGRAM



P-curve height shows maximum pressure needed to deform dough, indicating stability.
L-length of curve reflects extensibility.
W- measurement of total energy or work needed to inflate dough.



U.S. HARD RED SPRING WHEAT

MINNESOTA • MONTANA • NORTH DAKOTA • SOUTH DAKOTA • IDAHO • OREGON • WASHINGTON

16

BAKING DATA

STATE AND CROP REPORTING AREA	BAKING ABSORPTION %	DOUGH HANDLING PROPERTIES	LOAF VOLUME CC	GRAIN AND TEXTURE	CRUMB COLOR	CRUST COLOR	SYMMETRY
MINNESOTA							
Area A	64.6	9.0	920	7.5	7.5	9.0	9.0
Area B	63.9	9.0	830	7.0	7.0	9.0	8.0
State Avg. 2017	64.4	9.0	903	7.4	7.4	9.0	8.8
State Avg. 2016	65.7	9.9	1008	7.5	7.6	9.9	8.9

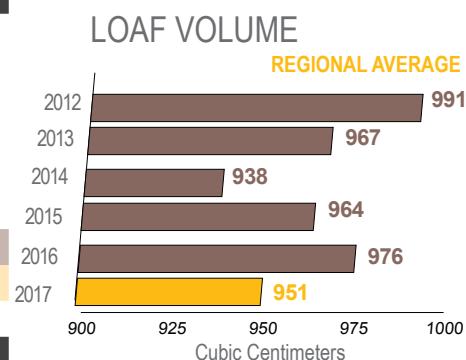
MONTANA							
Area A	67.3	9.0	965	7.5	7.0	10.0	10.0
Area B	68.8	9.0	995	8.0	7.5	10.0	9.0
Area C	66.8	9.0	975	7.5	7.5	10.0	8.0
Area D	65.7	9.0	890	7.5	7.0	10.0	8.0
Area E	70.9	9.0	950	8.0	8.0	10.0	10.0
State Avg. 2017	68.1	9.0	978	7.8	7.3	10.0	9.4
State Avg. 2016	67.9	9.5	897	7.8	7.5	9.7	8.7

NORTH DAKOTA							
Area A	64.8	9.0	965	8.0	8.0	10.0	10.0
Area B	64.7	9.0	920	7.5	8.0	10.0	9.0
Area C	66.2	9.0	885	8.0	8.0	10.0	8.0
Area D	67.9	9.0	1040	8.0	8.0	10.0	9.0
Area E	66.7	9.0	1010	8.0	7.5	9.0	9.0
Area F	65.6	9.0	960	8.0	8.0	10.0	9.0
State Avg. 2017	65.8	9.0	957	7.9	8.0	9.9	9.1
State Avg. 2016	67.9	9.2	997	7.5	7.7	9.8	9.3

SOUTH DAKOTA							
Area A	66.4	9.0	925	7.5	7.5	10.0	8.0
Area B	69.6	9.0	1005	8.0	8.5	10.0	10.0
Area C	65.7	8.0	935	7.5	8.0	10.0	9.0
State Avg. 2017	68.0	8.7	972	7.8	8.2	10.0	9.4
State Avg. 2016	67.4	9.0	963	8.0	8.2	9.7	9.0

ID/OR/WA							
Area A	68.4	9.0	950	7.5	8.0	10.0	10.0
Area B	69.0	9.0	1000	8.0	8.0	10.0	9.0
State Avg. 2017	68.7	9.0	979	7.8	8.0	10.0	9.4
State Avg. 2016	68.4	8.9	926	8.1	8.3	10.0	9.3

REGION AVG							
Avg. 2017	66.2	9.0	951	7.8	7.8	9.8	9.1
Avg. 2016	67.6	9.3	976	7.6	7.7	9.8	9.1
Five-Year Avg.	66.3	9.2	967	7.8	7.8	9.7	8.7



RECENT QUALITY TRENDS

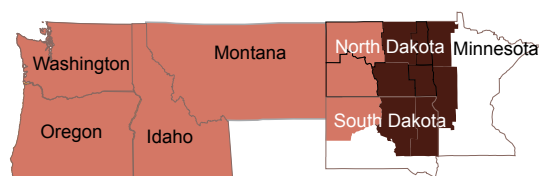
SUMMARY INFORMATION							
CROP YEAR	2017	2016	2015	2014	2013	2012	Five-year Average
WHEAT GRADING							
Test Weight (lb/bu)	61.7	61.6	61.6	61.4	62.5	60.8	61.6
Test Weight (kg/hl)	81.1	81.0	81.0	80.7	82.2	80.0	81.0
Vitreous Kernels (%)	71	77	83	53	68	75	71
1000 Kernel Weight (gm)	31.5	30.9	31.3	32.4	32.9	29.2	31.3
Protein: 12%/0% moisture	14.5/16.5	14.2/16.1	14.1/16.0	13.6/15.4	13.5/15.4	14.6/16.6	14.0/15.9
Ash: 14% moisture (%)	1.50	1.53	1.53	1.46	1.54	1.56	1.52
Falling Number (sec)	389	406	372	339	403	421	388
FLOUR DATA							
Extraction (%)	71.2	66.9	67.1	66.0	69.1	69.0	67.6
Ash: 14% moisture (%)	0.57	0.53	0.52	0.45	0.53	0.49	0.50
Protein: 14% moisture (%)	13.8	13.0	13.0	12.3	12.6	13.7	12.9
Wet Gluten (%)	35.6	34.7	34.9	31.5	35.5	35.9	34.5
Falling Number (sec)	407	415	386	370	417	424	402
AMYLOGRAPH PEAK VISCOSITY							
65g FL (B.U.)	570	659	676	518	590	733	635
PHYSICAL DOUGH PROPERTIES							
*FARINOGRAPH:							
Absorption (%)	62.6	62.7	61.9	61.9	63.0	63.3	62.8
Peak Time (min)	8.1	8.0	6.7	6.0	6.2	7.4	6.9
Stability (min)	11.9	13.2	10.3	9.4	9.0	12.2	11.0
EXTENSOGRAPH:							
Extensibility-45 min (cm)	16.8	16.6	16.5	16.2	17.2	16.3	16.6
Resistance-45 min (B.U.)	513	536	442	475	413	481	469
Area-45 min (sq cm))	113	115	95	100	94	103	101
ALVEOGRAPH:							
P (mm)	80	84	80	103	89	94	90
L (mm)	141	130	120	101	116	115	116
W (joules X 10 ⁴)	372	376	324	364	335	376	355
BAKING DATA							
Absorption (%)	66.2	67.6	67.5	67.2	66.1	62.9	66.3
Dough Handling Properties	9.0	9.3	9.5	8.6	9.1	9.5	9.2
Loaf Volume (CC)	951	976	964	938	967	991	967
Grain and Texture	7.8	7.6	7.4	7.9	8.0	8.0	7.8
Crumb Color	7.8	7.7	7.5	7.8	7.9	8.0	7.8
Crust Color	9.8	9.8	9.4	9.7	9.8	10.0	9.7
Symmetry	9.1	9.1	9.0	9.3	8.0	8.2	8.7

2017 QUALITY FACTORS BY PROTEIN RANGE

WEST

Samples in this region were collected from Montana, North Dakota areas A and D, South Dakota area A, and Idaho, Oregon and Washington.

WEST-PNW EXPORT TRIBUTARY
EAST - GULF/GREAT LAKES EXPORT TRIBUTARY



Performance characteristics often improve as buyers increase their protein specifications. To illustrate the correlation between higher protein and other quality parameters, samples of the regional crop were segregated by protein levels (all based on 12 percent moisture content):

LOW (less than 13.5 percent),

MEDIUM (13.5 to 14.5 percent), and

HIGH (more than 14.5 percent).

WHEAT GRADING DATA	Protein Ranges		
	Low	Medium	High
Test Weight (lb/bu)/kg/hl)	62.9/82.6	62.2/81.8	60.5/79.5
Damage (%)	0.0	0.0	0.0
Shrunken/Broken (%)	1.2	0.8	1.0
Total Defects (%)	1.2	0.8	1.0
Vitreous Kernels (%)	69	80	85
Grade	1 NS	1 DNS	1 DNS
WHEAT DATA			
Dockage (%)	0.5	0.4	0.5
Moisture (%)	11.0	11.0	11.4
Protein: 12%/0% moisture (%)	12.9/14.6	14.2/16.1	15.5/17.6
Ash: 14%/0% moisture (%)	1.56/1.82	1.50/1.74	1.51/1.76
1000 Kernel Weight	30.8	30.0	27.8
Falling Number (sec)	364	401	365
Sedimentation (cc)	61	65	68
FLOUR DATA			
Extraction (%)	71.4	71.9	70.0
Color: L	90.3	90.2	89.8
a/b	-1.1/9.9	-1.1/9.9	-1.0/10.0
Protein: 14%/0% moisture (%)	12.1/14.1	13.5/15.7	14.8/17.2
Ash: 14%/0% moisture (%)	0.57/0.66	0.57/0.67	0.58/0.68
Wet Gluten (%)	30.3	34.7	39.3
Gluten Index (%)	96	91	82
Falling Number (sec)	389	425	393
Amylograph Viscosity: 65g FL (BU)	588	640	568
DOUGH PROPERTIES			
Farinograph: Absorption (%)	61.5	63.3	64.2
Peak Time (min)	6.8	6.2	8.3
Stability (min)	8.5	8.0	10.3
Alveograph: P (mm)	77	76	76
L (mm)	122	153	153
P/L Ratio	0.63	0.49	0.50
W (10 ⁻⁴ joules)	320	348	364
Extensograph (45/135 min): Resistance	441/679	414/724	421/806
Extensibility (cm)	15.7/12.8	16.3/12.8	17.0/13.7
Area (sq cm)	90/112	87/121	93/148
BAKING DATA			
Absorption (%)	65.5	67.5	68.5
Crumb Grain and Texture	8.0	8.0	8.5
Loaf Volume (cc)	915	910	1030
PRODUCTION %			
	15	21	64

U.S. HARD RED SPRING WHEAT

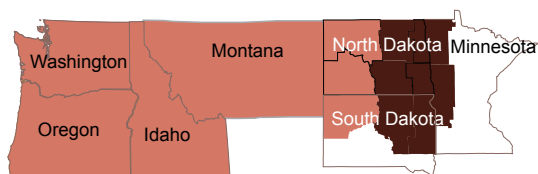
MINNESOTA • MONTANA • NORTH DAKOTA • SOUTH DAKOTA • IDAHO • OREGON • WASHINGTON

19

Samples in this region were collected from North Dakota areas B, C, E and F, South Dakota areas B and C, and Minnesota.

EAST

WEST-PNW EXPORT TRIBUTARY
EAST - GULF/GREAT LAKES EXPORT TRIBUTARY



Performance characteristics often improve as buyers increase their protein specifications. To illustrate the correlation between higher protein and other quality parameters, samples of the regional crop were segregated by protein levels (all based on 12 percent moisture content):

LOW (less than 13.5 percent),

MEDIUM (13.5 to 14.5 percent), and

HIGH (more than 14.5 percent).

Protein Ranges			
WHEAT GRADING DATA	Low	Medium	High
Test Weight (lb/bu)/kg/hl)	62.9/82.7	62.6/82.3	61.1/80.3
Damage (%)	0.0	0.0	0.0
Shrunken/Broken (%)	0.6	0.8	0.8
Total Defects (%)	0.6	0.8	0.8
Vitreous Kernels (%)	59	62	65
Grade	1 NS	1 NS	1 NS
WHEAT DATA			
Dockage (%)	0.5	0.3	0.5
Moisture (%)	12.7	12.8	12.7
Protein: 12%/0% moisture (%)	13.0/14.8	14.0/15.9	15.5/17.7
Ash: 14%/0% moisture (%)	1.51/1.76	1.50/1.74	1.51/1.76
1000 Kernel Weight	35.8	33.0	31.0
Falling Number (sec)	372	421	397
Sedimentation (cc)	60	67	67
FLOUR DATA			
Extraction (%)	72.4	73.0	71.0
Color: L	90.3	90.2	89.8
a/b	-1.0/9.3	-0.9/9.3	-0.9/9.6
Protein: 14%/0% moisture (%)	12.0/14.0	13.3/15.5	14.7/17.1
Ash: 14%/0% moisture (%)	0.56/0.65	0.58/0.67	0.59/0.69
Wet Gluten (%)	29.8	33.2	38.3
Gluten Index (%)	97	96	91
Falling Number (sec)	393	411	427
Amylograph Viscosity: 65g FL (BU)	640	666	513
DOUGH PROPERTIES			
Farinograph: Absorption (%)	61.1	61.9	63.5
Peak Time (min)	6.5	7.5	7.8
Stability (min)	9.9	11.5	13.8
Alveograph: P (mm)	80	79	81
L (mm)	117	145	141
P/L Ratio	0.69	0.54	0.57
W (10 ⁻⁴ joules)	315	377	394
Extensograph (45/135 min): Resistance	456/645	541/836	556/813
Extensibility (cm)	16.0/13.7	15.4/14.4	16.8/13.3
Area (sq cm)	99/116	108/160	122/139
BAKING DATA			
Absorption (%)	63.6	65.6	68.4
Crumb Grain and Texture	8.0	8.0	8.0
Loaf Volume (cc)	845	950	1010
PRODUCTION %			
	29	26	45

U.S. HARD RED SPRING WHEAT

MINNESOTA • MONTANA • NORTH DAKOTA • SOUTH DAKOTA • IDAHO • OREGON • WASHINGTON

20

OVERALL

WHEAT GRADING DATA	Protein Ranges		
	Low	Medium	High
Test Weight (lb/bu)/kg/hl	62.9/82.7	62.4/82.0	60.7/79.8
Damage (%)	0.0	0.0	0.0
Shrunken/Broken (%)	0.8	0.8	0.9
Total Defects (%)	0.8	0.8	0.9
Vitreous Kernels (%)	62	71	77
Grade	1 NS	1 NS	1 DNS
WHEAT DATA			
Dockage (%)	0.5	0.3	0.5
Moisture (%)	12.2	12.0	11.9
Protein: 12%/0% moisture (%)	13.0/14.7	14.1/16.0	15.5/17.6
Ash: 14%/0% moisture (%)	1.53/1.78	1.50/1.74	1.51/1.76
1000 Kernel Weight	34.1	31.5	29.0
Falling Number (sec)	369	411	377
Sedimentation (cc)	60	66	67
FLOUR DATA			
Extraction (%)	72.0	72.5	70.4
Color: L	90.3	90.2	89.8
a/b	-1.0/9.4	-1.0/9.6	-1.0/9.9
Protein: 14%/0% moisture (%)	12.0/14.0	13.4/15.6	14.8/17.2
Ash: 14%/0% moisture (%)	0.56/0.65	0.58/0.67	0.59/0.68
Wet Gluten (%)	29.9	33.9	38.9
Gluten Index (%)	97	94	86
Falling Number (sec)	392	418	406
Amylograph Viscosity: 65g FL (BU)	623	654	547
DOUGH PROPERTIES			
Farinograph: Absorption (%)	61.2	62.6	63.9
Peak Time (min)	6.6	6.9	8.1
Stability (min)	9.4	9.8	11.6
Alveograph: P (mm)	79	78	78
L (mm)	119	149	148
P/L Ratio	0.67	0.52	0.52
W (10 ⁻⁴ joules)	317	363	375
Extensograph (45/135 min): Resistance	451/656	480/782	472/809
Extensibility (cm)	15.9/13.4	15.8/13.6	16.9/13.5
Area (sq cm)	96/115	98/141	104/145
BAKING DATA			
Absorption (%)	64.2	66.5	68.5
Crumb Grain and Texture	8.0	8.0	8.3
Loaf Volume (cc)	868	931	1022
PRODUCTION %			
	22	23	55

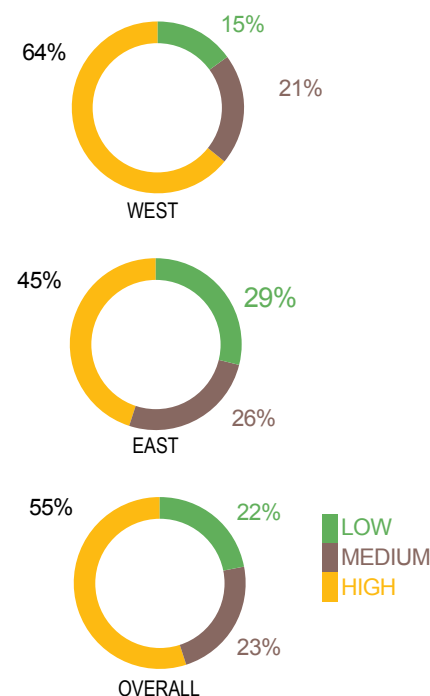
Performance characteristics often improve as buyers increase their protein specifications. To illustrate the correlation between higher protein and other quality parameters, samples of the regional crop were segregated by protein levels (all based on 12 percent moisture content):

LOW (less than 13.5 percent),

MEDIUM (13.5 to 14.5 percent), and

HIGH (more than 14.5 percent).

PRODUCTION DISTRIBUTION BY PROTEIN



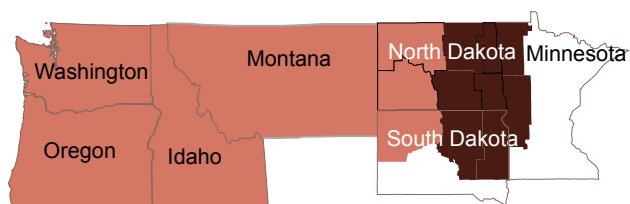
In 2017, absorption, dough strength and loaf volume all improved as protein increased.

U.S. HARD RED SPRING WHEAT

MINNESOTA • MONTANA • NORTH DAKOTA • SOUTH DAKOTA • IDAHO • OREGON • WASHINGTON

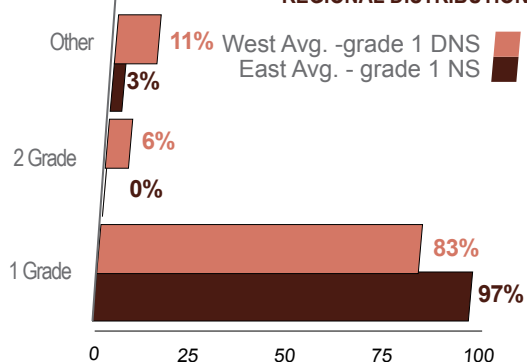
21

DISTRIBUTIONS BY EAST/WEST PRODUCTION REGIONS



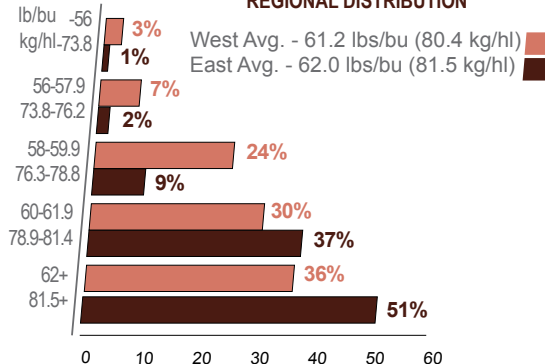
GRADE

REGIONAL DISTRIBUTION



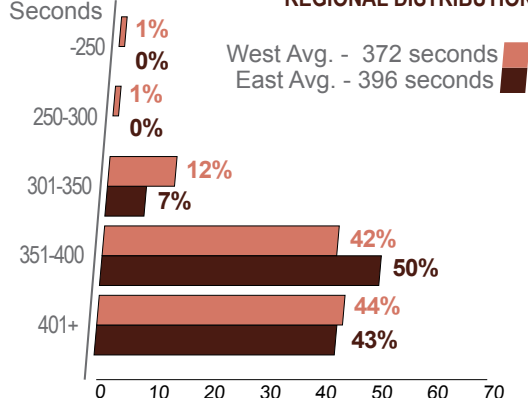
TEST WEIGHT

REGIONAL DISTRIBUTION



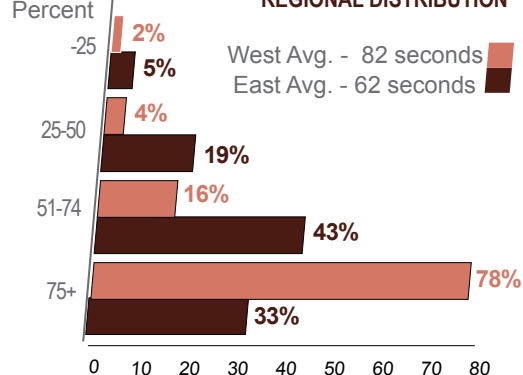
FALLING NUMBER

REGIONAL DISTRIBUTION



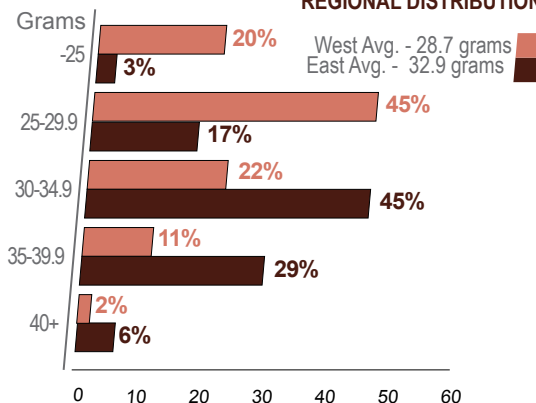
VITREOUS KERNEL

REGIONAL DISTRIBUTION



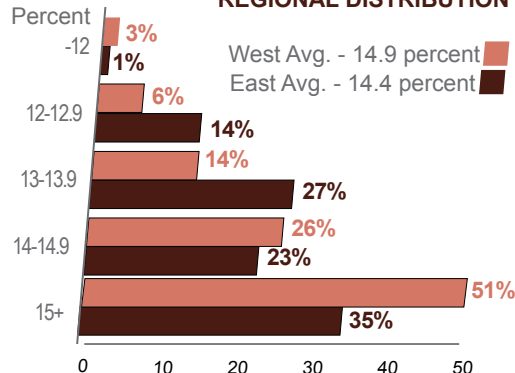
1000 KERNEL WEIGHT

REGIONAL DISTRIBUTION



PROTEIN - 12% MOISTURE

REGIONAL DISTRIBUTION



Data contained on pages 18-20 represent the composites of samples by West and East production region and a low, medium and high protein range.

The same base collection samples as shown in the area specific data displayed on previous pages were used for the West/East and protein splits.

HANDLING AND TRANSPORTATION

The hard red spring wheat growing region utilizes truck, rail and water to get wheat from farms to export facilities. The Northern Plains has a vast network of country elevators to facilitate efficient and precise movement to domestic and export markets. On average, nearly 80 percent of the region's wheat moves to markets by rail. The dominant railroads are the Burlington Northern Santa Fe, the Union Pacific and the Canadian Pacific.

In the Pacific Northwest, a large

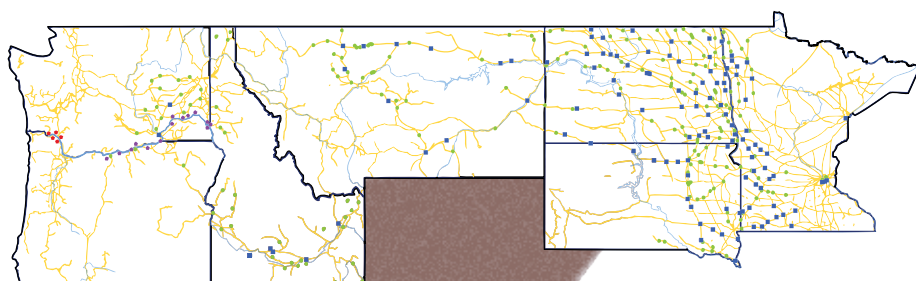
river system is used along with rail to move wheat to export points.

An increasing number of the elevators in the region are investing in facilities and rail capacity to ship 100-110 car units in "shuttle" trains. Each rail car holds approximately 3,500 bushels (95 metric tons) of wheat. Shuttle-equipped facilities receive the lowest rates, sharing volume and transaction efficiencies with the railroad.

The diverse rail and water shipping capacities and a widespread

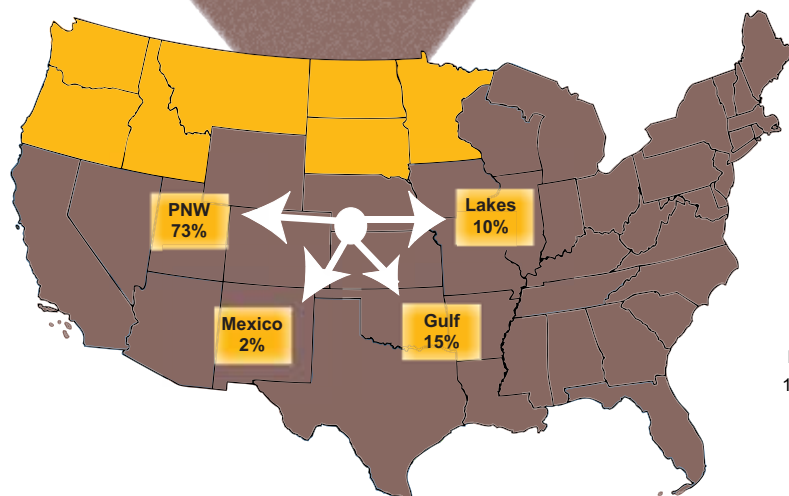
network of elevators are strengths that buyers can capitalize on, especially as their demand heightens for more precise quality specifications and consistency between shipments. Buyers are encouraged to explore origin-specific shipments to optimize the quality and value of wheat they purchase.

The elevator network in the U.S. hard red spring wheat region is well suited for meeting the increasing quality demands of both domestic and international customers.



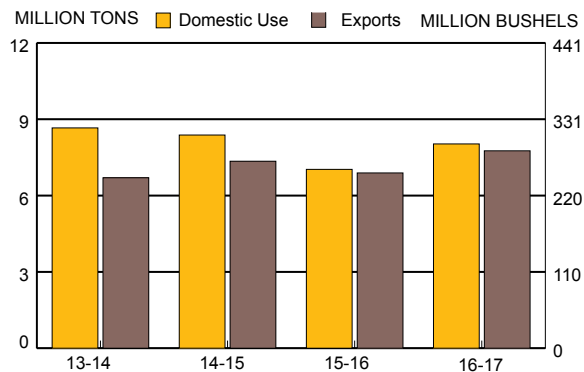
Grain Handling and Transportation Facilities in the U.S. HRS Region

- 100+ rail car track
- 50 - 99 rail car track
- ◆ Export terminals
- ◆ River terminals
- River system
- Rail network



AVERAGE SHARE OF U.S. HRS EXPORTS BY PORT (2013-2016)

2013-2016 U.S. HRS DOMESTIC USE AND EXPORTS



2017 SURVEY BACKGROUND



Kristin Whitney, Chris Cosette and Karen Dickey with the Hard Red Spring Wheat Quality Laboratory in the Department of Plant Science at North Dakota State University, Fargo, USA.

Collection - The North Dakota, South Dakota, Montana and Minnesota state offices of the National Agricultural Statistics Service obtained wheat samples during harvest directly from growers either in the fields or farm bins and local elevators. These samples reflect the condition of the grain at the point of origin. Collection began in early August when approximately 10 percent of the hard red spring wheat had been harvested and

continued until mid September when about 95 percent of the region's crop was harvested.

Sample collection was weighted by county production histories

with a total of 799 samples being collected during harvest from Minnesota (115), Montana (155), North Dakota (380), South Dakota (75) and PNW (74).

Analysis - Approximately 60 percent of the total wheat samples collected were analyzed for grade and other physical kernel characteristics. Distributions as a percentage of the harvested crop were calculated for key factors including test weight, thousand kernel weight, protein, falling number, and overall grade. Distribution results may differ from data presented in the various tables, because the latter are derived from production adjusted averages, rather than simple averages.

Quality tests, including milling, flour evaluation, physical dough and bread properties, were conducted on composite samples representing each crop reporting area. Again, all state and regional averages have been adjusted to reflect production as opposed to simple averaging.

All quality data contained in this report are the result of testing and analysis conducted under the supervision of Dr. Senay Simsek, Wheat Quality Specialist, and by her team members Kaitlin Beck, DeLane Olsen, Kelly McMonagle,

METHODS, TERMS, SYMBOLS

WHEAT

SAMPLE COLLECTION • Each sample contained approximately 2 to 3 pounds of wheat, stored in sealed, moisture proof plastic bags.

MOISTURE • Official USDA procedure using Dickey-John Moisture Meter.

GRADE • Official United States Standards for Grain, as determined

by a licensed grain inspector. North Dakota Grain Inspection Service, Fargo, ND, provided grades for composite wheat samples representing each crop reporting area.

VITREOUS KERNELS • Approximate percentage of kernels having vitreous endosperm.

DOCKAGE • Official USDA procedure. All matter other than

wheat which can be removed readily from a test portion of the original sample by use of an approved device (Carter Dockage Tester). Dockage may also include underdeveloped, shriveled and small pieces of wheat kernels removed in properly separating the material other than wheat and which cannot be recovered by properly rescreening or recleaning.

TEST WEIGHT • American Association of Cereal Chemists Method 55-10. Measured as pounds per bushel (lb/bu), kilograms per hectoliter (kg/hl) = (lbs/bu X 1.292) + 1.419. *Approved Methods of the American Association of Cereal Chemists International Approved Methods (11th Edition), St. Paul, MN.

THOUSAND KERNEL WEIGHT

• Based on 10 gram sample of cleaned wheat (free of foreign material and broken kernels) counted by electronic seed counter.

KERNEL SIZE DISTRIBUTION

Percentages of the size of kernels (large, medium, small) were determined using a wheat sizer equipped with the following sieve openings:

- top sieve—Tyler #7 with 2.92 mm opening;
- middle sieve—Tyler #9 with 2.24 mm opening; and
- bottom sieve—Tyler #12 with 1.65 mm opening.

PROTEIN • American Association of Cereal Chemists (NIR) Method: 39.10.01 expressed on dry basis and 12 percent moisture basis.

ASH • American Association of Cereal Chemists Method 08.01, expressed on a 14 percent moisture basis.

DON • Analysis was done on ground wheat using a gas chromatograph with an electron capture detector as described in J. Assoc. Official Anal. Chem 79,472 (1996)

FALLING NUMBER • American Association of Cereal Chemists

Method 56.81.03; units of seconds (14 percent moisture basis).

SEDIMENTATION • American Association of Cereal Chemists Method 56.61.01, expressed in centimeters.

FLOUR

EXTRACTION • Thoroughly cleaned wheat is tempered to 16 percent moisture for 16 hours and add an additional 0.5 percent water 15 minutes prior to milling. The milling laboratory is controlled at 68 percent relative humidity and 72°F to 74°F. Milling is performed on a Buhler laboratory mill (Type MLU-202). Straight grade flour (of all six flour streams) is blended and reported as “flour extraction.” The blended flour is rebolted through an 84 SS sieve to remove any foreign material. This product is used for the other flour quality determinations.

ASH • American Association of Cereal Chemists Method 08.01, expressed on a 14 percent moisture basis.

PROTEIN • American Association of Cereal Chemists Method 39.10.01 (NIR Method), expressed on a 14 percent moisture basis.

WET GLUTEN • American Association of Cereal Chemists Method 38.12.02, expressed on a 14 percent moisture basis determined with the glutomatic instrument.

GLUTEN INDEX • American Association of Cereal Chemists Method 38.12.02, determined with the glutomatic instrument as an indication of gluten strength.

FLOUR FALLING NUMBER

• American Association of Cereal Chemists Method 56.81.03, units of seconds. Determination is performed on 7.0 g of Buhler milled flour (14 percent moisture basis).

AMYLOGRAM • (65 g) American Association of Cereal Chemists Method 22.10.01, modified as follows: 65 g of flour (14 percent moisture basis) are slurried in 450 ml distilled water, paddle stirrers are used with the Brabender Amylograph. Peak viscosity reported in Brabender units (B.U.), on a 14 percent moisture basis.

STARCH DAMAGE • American Association of Cereal Chemists Method 76.31.02. Proportion of starch granules that have incurred physical damage from milling.

SOLVENT RETENTION

CAPACITY (SRC) • AACC 56-11.02, expressed on a 14 percent moisture basis. SRC is used to predict commercial baking performance. Flour is shaken with excess of four types of solvent, to determine the amount of solvent held by the flour. The four solvents used relate to the functionality to flour components as follows:

Water – Water absorption

Sucrose – Non-starch polysaccharides

Lactic Acid – Glutenins

Sodium Carbonate – Damaged Starch

Gluten Performance Index (GPI) – is a ratio of the solvents and used as an overall performance of flour glutenins especially in relation to bread wheat flour.

PHYSICAL DOUGH PROPERTIES

FARINOGRAM • American Association of Cereal Chemists Method 54-21.02; constant flour weight method, small (50 g) mixing bowl. (Flour weight 14 percent moisture basis). Farinograph-E.

ABSORPTION • Amount of water required to center curve peak on the 500 Brabender unit line, expressed on 14 percent moisture basis.

PEAK TIME • The interval, to the nearest 0.5 min, from the first addition of water to the maximum consistency immediately prior to the first indication of weakening. Also known as dough development time.

STABILITY • The time interval, to the nearest 0.5 min, between the point where the top of the curve that first intersects the 500-BU line and the point where the top of the curve departs the 500-BU line.

MIXING TOLERANCE INDEX • The difference, in Brabender units, from the top of the curve at the peak to the top of the curve measured five minutes after the peak.

QUALITY NUMBER • International Cereal Chemists Method 115. The length, expressed in mm, along the time axis, between the point of water addition and the point where the height in the center of the curve decreased by 30 BU compared to the height of the center of the curve at development time. Stronger flours have a higher quality number.

EXTENSOGRAM • American Association of Cereal Chemists Method 54-10.01; modified as follows: (a) 100 grams of flour (14 percent moisture basis), 2.0 percent

sodium chloride (U.S.P.) and water (equal to farinograph absorption minus 2 percent) are mixed to optimum development in a National pin dough mixer; (b) doughs are scaled to 150 grams, rounded, moulded, placed in extensigram holders, and rested for 45 minutes and 135 minutes, respectively, at 30°C and 78 percent relative humidity. The dough is then stretched as described in the procedure referenced above. For conversion purposes, 500 grams equals 400 B.U.

EXTENSIBILITY • Total length of the curve at the base line in centimeters.

RESISTANCE • Maximum curve height, reported in Brabender units (B.U.).

AREA • The area under the curve is measured and reported in square centimeters.

ALVEOGRAPH • AACC Method 54.30.02. Measurement of dough extensibility and resistance to extension.

“P” • Maximal overpressure; related to dough’s resistance to deformation.

“L” • Dough extensibility.

“W” • The “work” associated with dough deformation.

BAKING

PROCEDURE • American Association of Cereal Chemists Method 10-09.01, modified as follows: (a) fungal amylase (SKB 15) replacing malt dry powder, (b) Instant dry yeast (1 percent) in lieu of compressed yeast, (c) 5 to 10 ppm ammonium phosphate, where added oxidants are required, (d) 2

percent shortening added. Doughs are mechanically punched using 6-inch rolls, and mechanically moulded using a National Laboratory Test moulder. Baking is accomplished in “Shogren-type” pans.

BAKING ABSORPTION • Water required for optimum dough baking performance, expressed as a percent of flour weight on a 14 percent moisture basis.

DOUGH CHARACTER • Handling conversion assessed at panning on a scale of 1 to 10 with higher scores preferred.

LOAF VOLUME • Rapeseed displacement measurement made 30 minutes after bread is removed from the oven.

CRUMB GRAIN AND TEXTURE • Visual comparison to standard using a constant illumination source. Scale of 1 to 10, the higher scores preferred.

CRUMB COLOR • Visual comparison with a standard using a constant illumination source on a scale of 1 to 10, the higher scores preferred.

CRUST COLOR • Visual comparison with a standard using a constant illumination source on a scale of 1 to 10, the higher scores preferred.

SYMMETRY • Visual comparison with a standard using a constant illumination source on a scale of 1 to 10, the higher scores preferred.

VARIETAL INFORMATION

MAJOR VARIETIES PRODUCED ACROSS ND, SD AND MN • AGRONOMIC FACTORS										
	Agent or Origin ¹	Year Released	Agronomic Description			Reaction to Disease ²			Average Yield	
			Straw Strength	Maturity	Leaf Rust	Head (Scab)	Eastern, North Dakota ³ BU/Acre	North Dakota ³ MT/Hect	Western, North Dakota ⁴ BU/Acre	North Dakota ⁴ MT/Hect
Barlow	ND	2009	med.	m. early	MS	M	68.0	4.57	59.3	3.99
Bolles	MN	2015	med.	m. late	MR	M	66.6	4.48	60.3	4.05
Elgin-ND	ND	2012	med.	med.	MS	M	69.7	4.69	63.7	4.28
Faller	ND	2007	med.	med.	S	M	73.3	4.93	65.8	4.42
Glenn	ND	2005	strg.	m. early	MS	MR	66.1	4.44	59.2	3.98
Linkert	MN	2013	strg.	m. early	MR	M	69.7	4.69	61.0	4.10
Prevail	SD	2014	med. strg.	med.	MR	M	74.6	5.02	63.3	4.26
Prosper	ND	2011	med.	med.	MS	M	71.3	4.79	64.9	4.36
Shelly	MN	2016	med.	med.	MR/MS	M	n/a	n/a	n/a	n/a
SY Ingmar	AgriPro/Syngenta	2014	m. strg.	med.	MR	M	71.5	4.81	65.0	4.37
SY Soren	AgriPro/Syngenta	2011	m. strg.	m. early	MR	M	67.0	4.50	61.9	4.16
SY Valda	AgriPro/Syngenta	2015	med.	med.	R	MR	n/a	n/a	n/a	n/a
WB Mayville	Westbred	2011	m. strg.	m. early	R	S	65.6	4.41	61.3	4.12

1. ND=North Dakota State University (Public), SD=South Dakota State University (Public), MN=University of Minnesota (Public), Westbred (Private) and AgriPro/Syngenta (Private).
2. Reaction to Disease: resistant (R), moderately resistant (MR), intermediate (M), moderately susceptible (MS), susceptible (S), very susceptible (VS).
3. 2014-16 ND average yield data from Carrington, Casselton, Langdon and Prosper, ND.
4. 2014-16 ND average yield data from Dickinson, Hettinger, Minot and Williston, ND.



U.S. HARD RED SPRING WHEAT

MINNESOTA • MONTANA • NORTH DAKOTA • SOUTH DAKOTA • IDAHO • OREGON • WASHINGTON

27

MAJOR VARIETIES PRODUCED ACROSS ND, SD AND MN • QUALITY & END-USE FACTORS								
Variety	Test Weight LB/BU	Test Wheat KG/HL	Wheat Protein %	Quality Factors ⁵			Loaf Volume CC	Mill & Bake Quality Rating ⁶
				Wheat Falling # Seconds	Farinogram Stability (Min)	Absorption %		
Barlow	62.3	82.0	14.4	389	12.1	64.3	993	★★★
Bolles	61.1	80.4	15.2	425	19.8	62.5	1007	★★★★
Elgin-ND	61.0	80.2	14.2	410	9.0	63.3	969	★★★
Faller	60.8	80.0	13.3	400	9.0	61.8	942	★★★
Glenn	64.1	84.2	14.8	387	14.9	63.3	1001	★★★★★
Linkert	61.4	80.8	14.7	428	25.0	61.9	991	★★★★
Prevail	60.9	80.1	13.4	390	9.9	59.3	934	★★
Prosper	60.7	79.9	13.5	398	10.0	60.8	968	★★★
Shelly	62.4	82.0	13.1	425	10.9	59.3	905	★★★
SY Ingmar	62.0	81.5	14.2	414	11.1	61.0	1009	★★★
SY Soren	61.9	81.4	14.3	443	11.6	61.3	963	★★★
SY Valda	61.3	80.6	13.3	394	7.0	60.6	872	★★★
WB Mayville	61.1	80.4	14.2	430	13.5	62.2	938	★★

5 Source: NDSU Plant Science Department, Hard Red Spring Wheat Quality Laboratory, 2012-2016 drill strip trials across ND locations.

6 Mill and bake quality rating based on protein content, milling performance, flour attributes, dough characteristics and baking performance. Five stars = superior, four stars = excellent, three stars = good, two stars = average, one star = poor.



QUALITY COMPARISON OF POPULAR VARIETIES

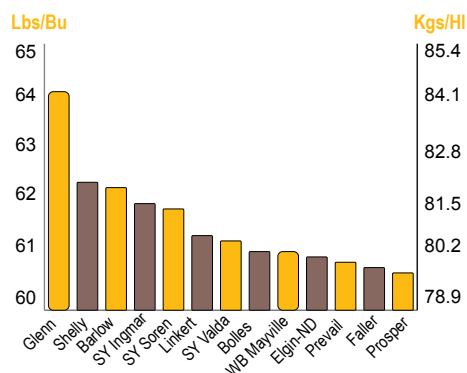
The annual quality characteristics of the U.S. Hard Red Spring (HRS) wheat crop are influenced by the growing season environment and variety or genetics. Within the HRS class, different varieties are available for producers – to fit the broad climatic conditions and to meet varying disease and pest challenges across the region.

To enhance uniform functional quality among the varieties designed to meet multiple growing regions, kernel and end-use quality targets have been developed. These targets are industry agreed upon values that provide guidance to wheat breeders.

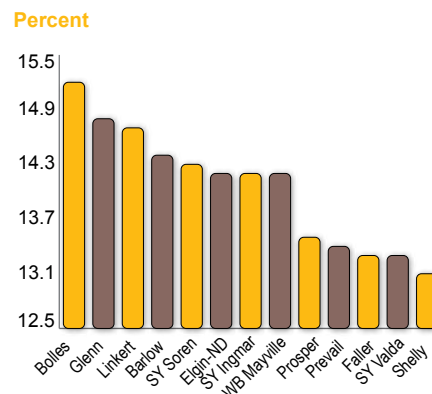
Variety development is carried out through public and private breeding programs. Major public programs are North Dakota State University, the University of Minnesota, South Dakota State University, University of Idaho, and Washington State University. Major private breeding programs include Westbred, Limagrain, AgriPro/Syngenta, Bayer and others.

Prior to the release of a variety for commercial production, breeding programs evaluate varieties for desired milling and baking characteristics, as well as yield, protein content, disease and pest resistance, straw strength and other traits. This testing typically takes place across multiple years and growing locations to account for environmental influences. These charts illustrate key quality traits of popular varieties for the 2012-2016 growing seasons.

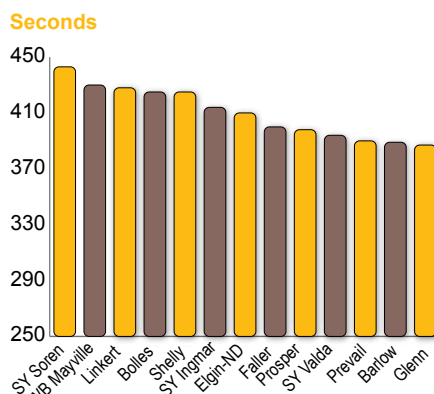
TEST WEIGHT



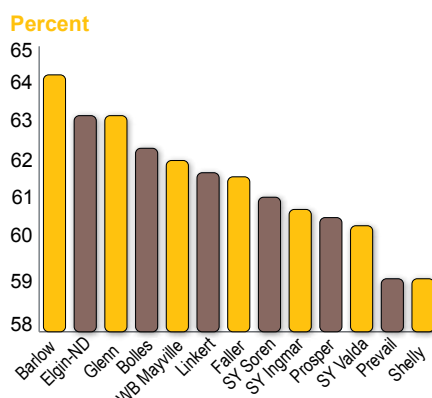
PROTEIN (12% moisture basis)



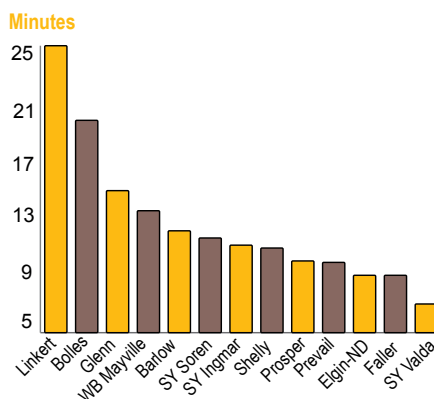
FALLING NUMBER



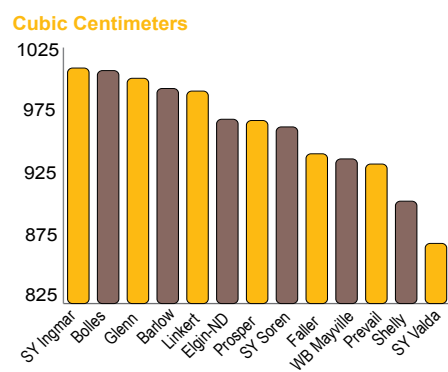
FARINOGRAPH ABSORPTION



FARINOGRAPH STABILITY



LOAF VOLUME



NORTH DAKOTA

SY INGMAR advanced to the top position in 2017 with nearly 18 percent of the acres, up from second in 2016 with 11.5 percent. It has broad appeal state wide and has risen quickly in acreage share, up from just 3 percent in 2015. SY Ingmar is the leading variety in 5 of the 9 districts. It is a 2014 release from AgriPro/Syngenta with high yield potential, very good straw strength, a high level of disease

NORTH DAKOTA VARIETY SHARE OF PLANTED ACRES³

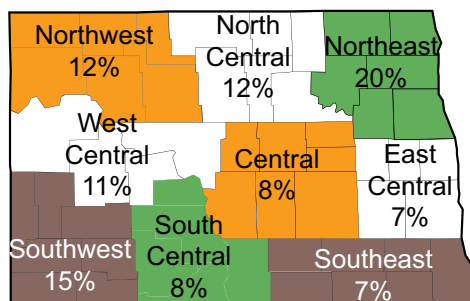
Variety	2017% ¹	2016% ¹
SY Ingmar	17.8	11.5
SY Soren	10.8	15.4
Linkert	6.9	4.0
Barlow	6.8	8.0
Elgin-ND	5.6	8.7
SY Valda	5.0	1.7
Glenn	4.9	7.9
Prosper	4.5	6.6
Faller	3.8	7.3
Bolles	3.3	0.5
Other ²	30.6	28.4

1. Percentages may not add to 100 due to rounding.

2. Includes varieties with less than 1% of acreage and unknown varieties.

3. (1 acre = 0.405 hectare)
2017 - 5,350,000 planted acres
2016 - 6,000,000 planted acres

NORTH DAKOTA 2017 SHARE OF PLANTED ACRES BY NASS DISTRICT



Estimated planted acres in 2017 are 5,350,000

resistance and moderate protein levels. SY Ingmar is rated as good for milling and baking quality.

SY SOREN fell to second place in 2017 with 11 percent of the acres, down from 15 percent in 2016, after five straight years of gains. It continues to be most popular in southern and central districts, and is the leading variety in the southeast district. A 2011 release from AgriPro/Syngenta, it provides producers with a balance of yield potential, moderately high protein levels, disease resistance and straw strength. SY Soren is rated as good for milling and baking quality.

BARLOW and **ELGIN-ND** are the fourth and fifth most popular varieties in North Dakota in 2017 with 6.8 and 5.6 percent of the

acres, respectively. The acreage shares for both are down slightly from the previous years, but they remain the top two varieties in the southwest production district. Barlow is a 2009 NDSU release, and Elgin-ND is a 2012 NDSU release. Barlow provides producers with a good balance of test weight, protein and leaf disease resistance, and Elgin-ND tout's higher protein potential compared to other high yielding varieties. Both varieties are rated as good for milling and baking quality.

TOP 3 ND VARIETIES BY CROP DISTRICT

	First	Second	Third
percentage (%)			
Northwest	SY Ingmar (30.7)	Barlow (11.2)	Glenn (9.2)
North Central	SY Ingmar (24.0)	SY Soren (13.5)	Prosper (9.1)
Northeast	Linkert (15.9)	Faller (14.2)	SY Ingmar (12.1)
West Central	SY Ingmar (17.5)	SY Soren (14.6)	Barlow (10.4)
Central	SY Ingmar (19.5)	SY Soren (18.6)	Elgin-ND (8.0)
East Central	Linkert (22.8)	SY Ingmar (10.2)	WB Mayville (10.1)
Southwest	Barlow (17.1)	Elgin-ND (16.4)	SY Soren (14.7)
South Central	SY Ingmar (25.2)	SY Soren (15.9)	Glenn (8.3)
Southeast	SY Soren (13.5)	Prosper (11.5)	Linkert (10.1)

SOUTH DAKOTA

PREVAIL and **ADVANCE** are the top two varieties planted in South Dakota in 2017, with 21 and 11 percent of the acres, respectively. Both are releases from South Dakota State University, Prevail in 2014 and Advance in 2011, with elite yield potential. Prevail and Advance have a high level of disease resistance, low to average protein, and are rated as average for milling and baking quality.

SOUTH DAKOTA VARIETY SHARE OF SURVEYED ACRES

Variety	State%	Year Released
Prevail	21.0	2013
Advance	11.0	2011
Surpass	8.0	2012
Focus	7.0	2015
SY Rowen	6.0	2013

*2017 survey completed "in-house" based on voluntary producer responses representing 7 percent of 2017 acres.

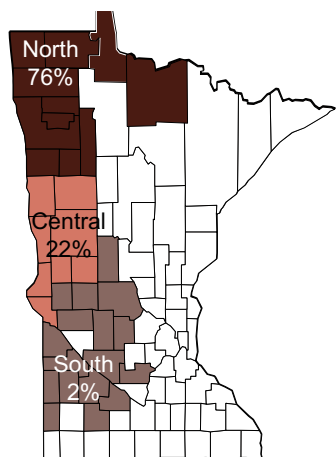
MONTANA - Did not conduct a survey in 2017

VIDA was the most popular variety in Montana in 2016 with 18.8 percent of the acres, it has been the leading variety for six straight years. It is a high yielding variety with moderate resistance to leaf and stripe rust. A 2005 release from the Montana Agricultural Experiment Station, Vida is rated good for milling and baking quality.

REEDER, CORBIN AND MOTT were the other top varieties in Montana in 2016, ranging from 7 to 10 percent of the acres individually. Reeder is popular in the eastern third of the state, with Mott and Corbin finding favor with producers in the central and north central parts of the state due to their genetic tolerance to the wheat stem sawfly.

MINNESOTA

MINNESOTA 2017 SHARE OF PLANTED ACRES



Estimated planted acres in 2017 are 1,300,000.

LINKERT remained the dominant variety in Minnesota in 2017 with 28.2 percent of the acres, up marginally from 27.8 in 2016. It also made another year of acreage gains in North Dakota, moving into third place with 6.9 percent. Linkert is a 2013 release from the University of Minnesota with very strong straw, high protein levels and good disease resistance. It is rated excellent for milling baking quality, with strong dough properties.

BOLLES jumped into second place with a 14.4 percent acreage share, up from 8.8 percent in 2016 and only 0.4 in 2015. It also moved into the top ten in North Dakota with 3.3 percent of the acres. Bolles is a 2015 release from the University of Minnesota that is gaining popularity for its high protein content and competitive agronomic traits. It is rated as excellent for milling and baking qualities and also has strong dough properties.

WB MAYVILLE fell to third place in 2017, down from second in 2016 although its share of acres held steady at slightly more than 13 percent. A 2011 release from WestBred, it provides producers with higher protein potential compared to other high yielding varieties, and also finds favor for its straw strength. WB Mayville is rated as average for milling and baking quality.

TOP 3 MINNESOTA VARIETIES BY CROP DISTRICT

	First	Second	Third
percentage (%)			
North	Linkert (29.7)	WB Mayville (15.7)	Bolles (11.0)
Central	Bolles (25.9)	Linkert (24.3)	SY Valda (7.3)
South	Faller (18.9)	Bolles (18.5)	Linkert (14.8)

MINNESOTA VARIETIES SHARE OF SURVEYED ACRES³

Variety	2017% ¹	2016% ¹
Linkert	28.2	27.8
Bolles	14.4	8.8
WB-Mayville	13.5	13.1
SY Valda	6.6	3.0
Shelly	5.6	0.5
Prosper	4.6	10.2
TCG Spitfire	4.2	1.5
SY Ingmar	4.0	3.1
Faller	2.5	6.0
Samson	2.4	4.7
Other ²	14.0	21.3

1. Percentages may not add to 100 due to rounding.

2. Includes varieties with less than 1% of acreage and unknown varieties.

3. (1 acre = 0.405 hectares)

2017 - 1,160,000 planted acres

2016 - 1,310,000 planted acres

PNW VARIETAL INFORMATION

POPULAR VARIETIES GROWN IN WA/OR AND ID • QUALITY AND END-USE FACTORS									
Variety	Agent or Origin ¹	Year Released	End Use ³				Quality Factors ²		
			Test Weight LB/BU	Test Weight KG/HL	Wheat Protein %	Farinogram Stability (Min)	Absorption %	Loaf Volume CC	Mill/Bake Quality Rating
Buck Pronto	Buck Semillas S.A.	2001	61.5	80.9	15.3	21.7	67.9	937	A
Expresso	Westbred	2007	62.6	82.2	14.7	5.1	68.5	1032	A
Glee	WSU	2012	62.4	82.0	14.2	16.0	66.4	1104	MD
Jefferson	ID	1997	62.3	82.0	13.7	20.9	66.1	977	D
Kelse	WSU	2008	61.7	81.1	14.9	19.8	68.3	1113	D
Solano	Westbred	2006	63.1	83.0	14.8	6.5	67.9	1095	A
Steelhead	Syngenta	2013	63.1	82.9	15.2	30.3	68.8	1041	MD
SY605CL	Syngenta	2010	62.4	82.0	15.8	n/a	68.6	1049	MD
WB9518	Westbred	2014	61.9	81.4	14.9	12.7	69.4	1144	*Not Rated

1. ID=University of Idaho (Public), WSU=Washington State University (Public), AgriPro (Private), Buck Semillas S.A. (Private), Resource Seeds (Private), Syngenta (Private) and Westbred (Private).
2. Western Wheat Quality Lab, Pullman, WA.
3. Mill and bake quality rating based on protein content, milling performance, flour attributes, dough characteristics and baking. Western Wheat Quality Lab. Most Desirable (MD), Desirable (D), Acceptable (A).

* Insufficient data exists to produce rating score





2017

U.S. HARD RED SPRING WHEAT

REGIONAL QUALITY REPORT

FUNDING & SUPPORT PROVIDED BY

U.S. Wheat Associates
North Dakota Wheat Commission
Montana Wheat and Barley Committee
Minnesota Wheat Research and Promotion Council
South Dakota Wheat Commission
Washington Grain Commission
Idaho Wheat Commission
Oregon Wheat Commission
North Dakota State University Plant Sciences Department