U.S. WHEAT ASSOCIATES

Dependable People. Reliable Wheat.

CROP QUALITY REPORT

HIGH QUALITY WHEAT FOR EVERY NEED.

FROM THE PRESIDENT

Dear Friends:

As my U.S. Wheat Associates (USW) colleagues were preparing this 2023 U.S. Wheat Crop Quality Report, I took time to reflect on how the dramatic events of the past year have affected us all. Given all the disruptive factors in the global wheat market, I believe we can take pride in the fact that the farmers we represent, grain handlers, and our customers have, for the most part, weathered a stormy year.

Most U.S. wheat farmers saw opportunity for the 2023 crop. Planted area was up in all exportable classes except durum. Growing conditions turned dry, however, with extreme drought conditions affecting much of the central and southern plains for the third consecutive year. Fortunately, growers in the northern plains saw more rain that helped increase total HRW production. As this report was being completed, dry weather was also expected to affect yield potential in the 2023 hard red spring (HRS), soft white (SW), and Northern Durum crops. The U.S. soft red winter (SRW) crop bucked the trend, however, and the class is in a strong competitive position.

We urge you to carefully consider the quality data found in this report. We are confident you will see that the functional characteristics in each wheat class offer exceptional value. Yes, there are lower-priced alternatives, but none of them can match the versatility of U.S. wheat classes, nor do they come with the level of trade service and technical support you receive from your local USW representatives.

It would not be possible to present this report without the support of our state wheat commission members and our public and private partners who collect and analyze the samples and tabulate results. We also appreciate the sustained support of our respected partners at the USDA's Foreign Agricultural Service. And to our valued customers, thank you once again for your loyalty and friendship!

Sincerely,

Vince Peterson
USW President

U.S. WHEAT ASSOCIATES IS FUNDED BY THE U.S. DEPARTMENT OF AGRICULTURE'S FOREIGN AGRICULTURAL SERVICE, AND BY WHEAT PRODUCERS THROUGH THE FOLLOWING MEMBER ORGANIZATIONS:

- Arizona Grain Research and Promotion Council
- California Wheat Commission
- Colorado Wheat Administrative Committee
- Idaho Wheat Commission
- Kansas Wheat Commission
- Maryland Grain Producers Utilization Board
- Minnesota Wheat Research and Promotion Council
- Montana Wheat & Barley Committee
- Nebraska Wheat Board
- North Dakota Wheat Commission
- Ohio Small Grains Marketing Program
- Oklahoma Wheat Commission
- Oregon Wheat Commission
- South Dakota Wheat Commission
- Texas Wheat Producers Board
- Washington Grain Commission
- Wyoming Wheat Marketing Commission

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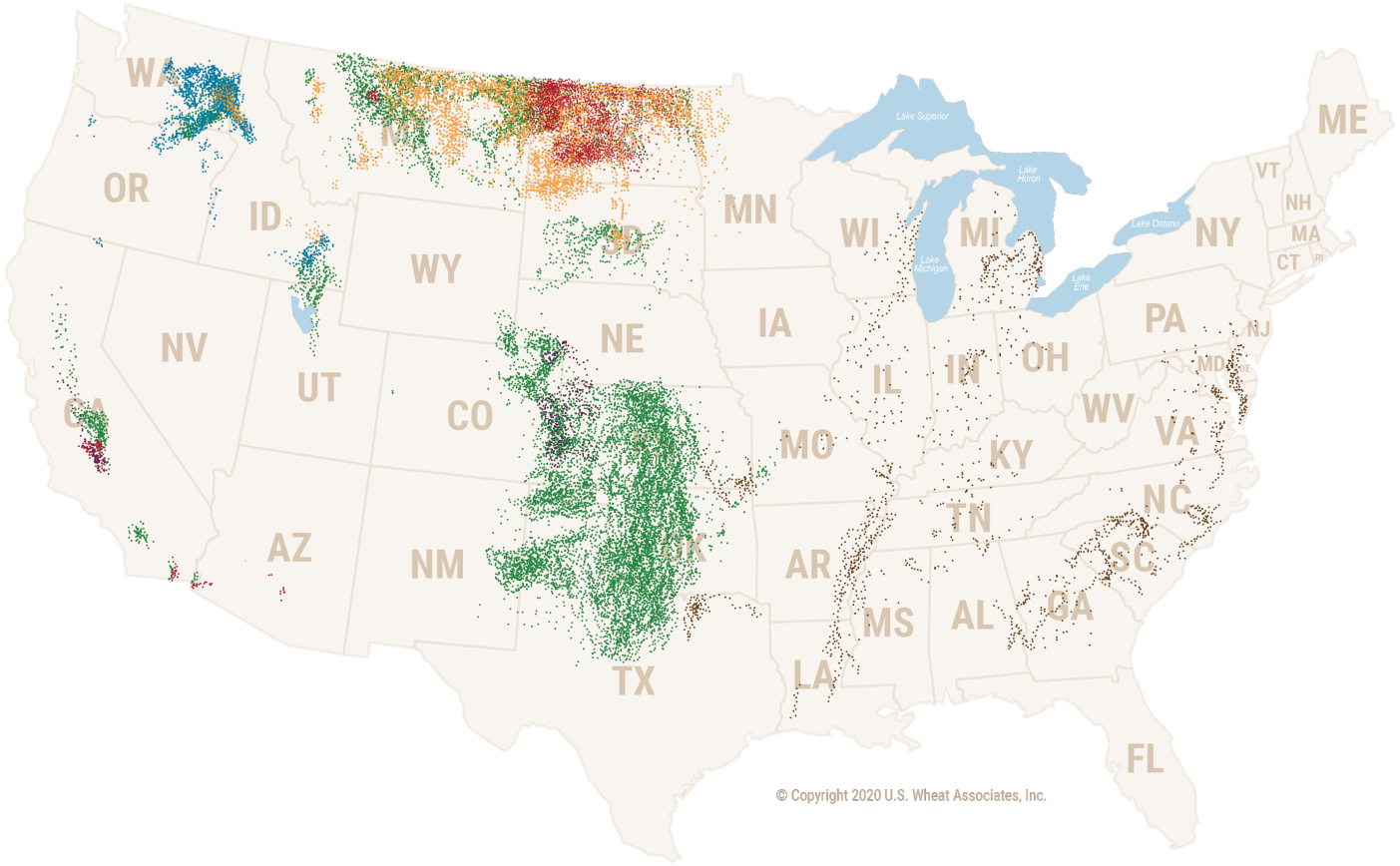
HARD WHITE REPORT

CALIFORNIA HARD RED WINTER REPORT

REGIONAL REPORTS

2023 CROP QUALITY OVERVIEW



Hard Red Winter | Hard Red Spring | Soft White | Soft Red Winter | Durum

PLANTING AND HARVEST DATES

	Wheat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HRW	Planting												
	Harvest												
HRS	Planting												
	Harvest												
Durum	Planting												
	Harvest												
SW	Planting												
	Harvest												
SRW	Planting												
	Harvest												

California-Arizona Planting | Other States Planting | California-Arizona Harvest | Other States Harvest

U.S. PRODUCTION BY CLASS

CROP YEAR (BEGINNING JUNE 1) (MMT)

	2023	2022	2021	2020	2019
Hard Red Winter	16.4	14.4	20.4	17.9	22.7
Hard Red Spring	12.7	12.1	8.1	14.4	15.2
Hard White	0.6	0.5	0.7	0.6	0.9
Durum	1.6	1.7	1.0	1.9	1.6
Soft White	5.8	6.9	4.8	7.6	6.6
Soft Red Winter	12.2	9.2	9.8	7.2	6.5
Total	**49.3**	**44.9**	**44.8**	**49.7**	**53.4**

Based on USDA crop estimates as of September 29, 2023.

U.S. SUPPLY AND DEMAND

ESTIMATED FOR 2023/24 (BEGINNING JUNE 1) (MMT)

	HRW	HRS	SRW	White[1]	Durum	Total
Beginning stocks	6.4	4.3	2.4	2.0	0.8	15.8
Production	16.4	12.7	12.2	6.4	1.6	49.3
Imports	0.5	1.6	0.1	0.1	1.2	3.7
Total Supply	**23.3**	**18.7**	**14.8**	**8.5**	**3.6**	**68.8**
Domestic Use	11.7	7.8	7.1	2.5	2.4	31.5
Exports	3.9	6.1	3.9	4.4	0.7	19.1
Total demand	**15.7**	**14.0**	**11.1**	**6.8**	**3.0**	**50.6**
Ending stocks	**7.6**	**4.7**	**3.7**	**1.7**	**0.5**	**18.2**
Stocks 5-year average	9.1	5.5	2.9	2.1	0.8	20.4

Based on USDA Supply/Demand estimates as of October 12, 2023.

[1]Includes both SW and HW.

SUMMARY OF CLASSES

	Hard Red Winter[1]		Hard Red Spring		Soft White		Soft Red Winter		Northern Durum[2]		Desert Durum®[2]	
	2023	5-Year Avg	2023	5-Year Avg	2023	5-Year Avg	2023	5-Year Avg	2023	5-Year Avg	2023	5-Year Avg
Test Weight (lb/bu)	59.8	60.9	61.2	61.6	60.3	61.1	60.3	59.1	61.3	61.4	63.0	63.2
(kg/hl)	78.7	80.0	80.5	81.0	79.3	80.3	79.3	77.8	79.8	79.9	82.0	82.3
Grade	2 HRW	1 HRW	1 NS	1 NS	1 SW	1 SW	1 SRW	2 SRW	1 HAD	1 HAD	1 HAD	1 HAD
Dockage (%)	0.6	0.5	0.7	0.6	0.4	0.5	0.4	0.3	1.1	0.9	0.3	0.3
Moisture (%)	11.5	11.1	12.2	11.9	9.1	9.1	13.3	13.2	11.5	11.2	7.6	7.1
Wheat Protein (%), 12% mb	12.7	11.6	14.2	14.6	11.1	10.0	9.3	9.5	13.9	13.9	13.6	13.8
Wheat Ash (%), 14% mb	1.58	1.52	1.48	1.56	1.38	1.40	1.40	1.62	1.43	1.59	1.65	1.68
1000 Kernel Weight (g)	29.7	31.3	34.3	30.7	32.5	34.4	35.9	32.6	40.9	42.8	48.8	47.1
Falling Number (sec)	355	370	379	376	336	328	320	311	394	410	607	643
Flour/Semolina Extraction (%)[2]	75.9	75.2	66.7	67.2	70.3	71.8	68.4	66.9	52.0	58.8	73.0	71.9
Flour/Semolina Ash (%)[2]	0.53	0.51	0.48	0.51	0.46	0.43	0.42	0.43	0.63	0.65	0.76	0.82
Wet Gluten (%) 14% mb	29.5	25.5	32.8	34.9	28.9	22.5	20.3	21.0	32.1	34.8	34.3	34.4
Farinograph:												
Peak Time (min)	4.8	5.1	7.9	8.1	2.5	1.9	1.2	1.2	–	–	–	–
Stability (min)	8.7	9.3	14.1	12.8	3.0	2.5	1.7	1.7	–	–	–	–
Absorption (%)	57.9	58.2	62.5	62.8	51.2	52.0	52.5	52.0	–	–	–	–
W (10^{-4} J)	268	203	397	391	92	83	88	81	–	–	–	–
Loaf Volume (cc)	920	877	983	973	696	–	602	655	–	–	–	–
Production (MMT)	16.4	18.4	12.7	12.5	5.8	6.3	12.2	9.0	1.4	1.3	0.2	0.2
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[1]HRW data does not include California.

[2]Durum extraction and ash values are for semolina.

GRADING, ABBREVIATIONS & CONVERSIONS

GRADES AND GRADE REQUIREMENTS

GRADING FACTORS:	GRADES U.S. NO.:				
	1	2	3	4	5
MINIMUM LIMITS:					
Test Weight (lb/bu)					
HRS or White Club	58.0	57.0	55.0	53.0	50.0
All other classes and subclasses	60.0	58.0	56.0	54.0	51.0
Test Weight (kg/hl)					
HRS or White Club	76.4	75.1	72.5	69.9	66.0
Durum	78.2	75.6	73.0	70.4	66.5
All other classes and subclasses	78.9	76.4	73.8	71.2	67.3
MAXIMUM PERCENT LIMITS:					
Defects					
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 and 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 (ALL GRADES):					
Other material (1,000 g sample)					
Animal filth	1				
Castor beans	1				
Crotalaria seeds	2				
Glass	0				
Stones	3				
Unknown foreign substance	3				
Total[4]	4				
Insect-damaged kernels in 100 g	31				

U.S. Sample Grade is wheat that:

(a) does not meet the requirements for U.S. Nos. 1, 2, 3, 4, 5; or
(b) has a musty, sour or commercially objectionable foreign odor (except smut or garlic odor);
(c) is heating or of distinctly low quality.

Notes:

[1] Includes damaged kernels (total), foreign material, and shrunken and broken kernels.
[2] Unclassed wheat of any grade may contain not more than 10.0% of wheat of other classes.
[3] Includes contrasting classes.
[4] Includes any combination of animal filth, caster beans, crotalaria seeds, glass, stones, or unknown foreign substance.

ABBREVIATIONS

°C	Celsius	in	inch
°F	Fahrenheit	J	joules
AACC	American Association of Cereal Chemists	kg	kilogram
AD	Amber Durum	kg/hl	Kilograms/Hectoliter
α-amylase	alpha-amylase	lb	pound
bu	Winchester bushel	lb/bu	pounds/bushel
BU	Brabender Unit	mb	moisture basis
cc	cubic centimeter (also cm³, ccm)	mg	milligram
Club	White Club	min	minute
cm	centimeter	mL	milliliter
cm²	square centimeters	mm	millimeter
cwt	quintal or hundredweight	MMT	million metric tons
db	Dry basis	MT	metric tons
DNS	Dark Northern Spring	NS	Northern Spring
DON	Deoxynivalenol (Vomitoxin)	PGI	Plains Grains Inc.
Durum	Durum	PNW	Pacific Northwest
FGIS	Federal Grain Inspection Service	ppm	parts per million
g	gram	PPO	polyphenol oxidase
GIPSA	Grain Inspection, Packers and Stockyards Administration	sec	second
GPAL	Great Plains Analytical Lab	SKCS	Single Kernel Characterization System
GPI	Gluten Performance Index	SRC	Solvent Retention Capacity
Gulf	Gulf of Mexico	SRW	Soft Red Winter
HAD	Hard Amber Durum	SW	Soft White
hl	hectoliter	TKW	1000 kernel weight or thousand kernel weight
hr	hour	USDA	United States Department of Agriculture
HRS	Hard Red Spring	WMC	Wheat Marketing Center
HRW	Hard Red Winter	WW	Western White
HW	Hard White		

UNIT CONVERSION FACTORS

The weight units conversion matrix should be read from the top, left.
For example: **1 MT** is equal to **1,000 kg**.

	1 bu	1 lb	**1 MT**	1 long ton	1 short ton	1 cwt	1 kg
bu	1	0.017	36.74	37.33	33.33	3.674	0.037
lb	60	1	2,204	2,240	2,000	100	2.205
MT	0.0272	0.0005	1	1.016	0.907	22.05	0.0010
long ton	0.0268	0.0004	0.984	1	0.893	0.045	0.0010
short ton	0.030	0.0005	1.102	1.12	1	0.05	0.0011
cwt	0.600	0.01	22.05	22.40	20.37	1	0.022
kg	27.2	0.45	1,000	1,016	907.2	45.36	1

LEGEND:
bu (*Winchester* bushel)
lb (pound)
MT (metric ton)
cwt (quintal or hundredweight)
kg (kilogram)

LAND AREA:
1 hectare (ha) = 2.47 acres (ac)
1 acre (ac) = 0.40 hectare (ha)

TEST WEIGHT:
Durum wheat: kg/hl = lb/bu x 1.292 + 0.630
Common wheat: kg/hl = lb/bu x 1.292 + 1.419

SOLVENT RETENTION CAPACITY:
GPI = Lactic Acid/(Sodium Carbonate + Sucrose)

FLOUR PROTEIN:
14% mb to db = Protein (14% mb) / 0.86
db to 14% mb = Protein (14% mb) x 0.86

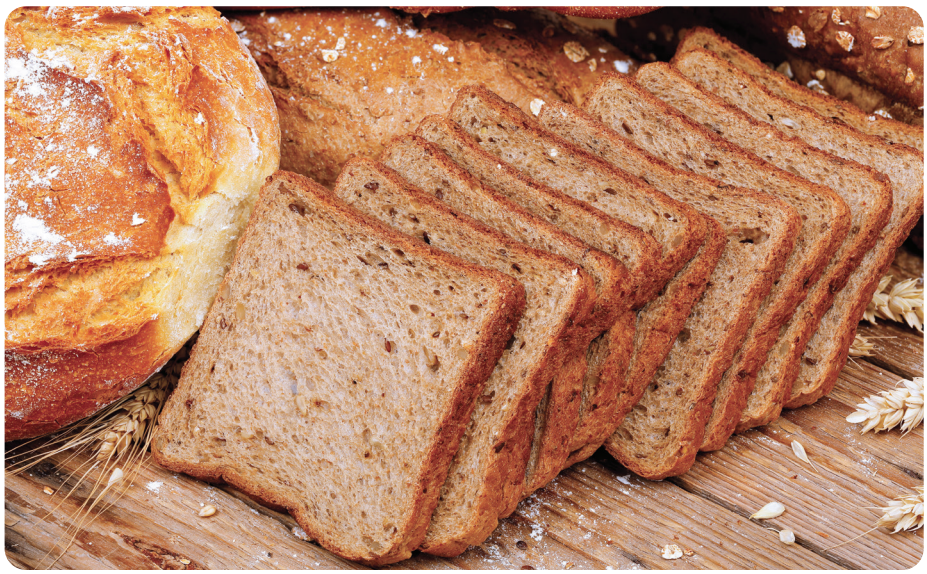
WHEAT PROTEIN:
12% mb to db = Protein (12% mb) / 0.88
db to 12% mb = Protein (12% mb) x 0.88

HARD RED WINTER

Grown in the Great Plains, Pacific Northwest (PNW) and California, hard red winter (HRW) is the most widely grown class in the United States. It is shipped via the Gulf and Pacific ports. It has medium to high protein of 10.0 to 13.0% (12% mb), medium hard endosperm, red bran, medium gluten content and mellow gluten.

For the miller, HRW brings consistency to the grist. A balanced mill optimizes flour extraction and helps maximize milling efficiency. Maintaining HRW as the foundation of the mill grist allows the miller to blend other U.S. classes, local wheat or wheat from other origins as cost advantages or product differentiation opportunities develop.

For the baker, HRW benefits include improved baking characteristics, including dough stability and water absorption, either alone or as part of a blend. HRW delivers consistency as it is always available and provides the most reliable foundational ingredient for most wheat-based products.



APPLICATIONS

With excellent milling and baking characteristics for wheat foods like pan breads, hard rolls, croissants and flat breads, HRW is an important and versatile wheat. It is also an ideal choice for some types of Asian noodles, general purpose flour and as an improver for blending.

Applications include:

- Baguettes
- Flatbreads, tortillas
- Pan breads
- Yeast breads and rolls
- Hard rolls
- Hearth breads
- Cereals
- Croissants
- Dumplings, Chinese
- Noodles, Asian-style
- Steamed bread (mushipan)
- Non-durum pasta
- Wide variety of other baked goods
- Flours (general-purpose, bread)
- Blending improver

SCAN THIS QR CODE for more information.

SURVEY METHODOLOGY

SAMPLE COLLECTION AND ANALYSIS

Plains Grains Inc. in Lincoln, Nebraska collaborated with USDA/ARS Hard Winter Wheat Quality Lab (HWWQL) in Manhattan, Kansas to collect samples and conduct quality analyses.

SAMPLE TESTING

Official grade and non-grade factors were determined on each sample. Functionality tests were conducted on 81 composite samples categorized by growing region and protein ranges of <11.5%, 11.5 to 12.5% and >12.5%. Production weighted results are presented as Overall, Gulf-exportable and Pacific Northwest (PNW)-exportable averages. The methods are described in the Analysis Methods section of this booklet.

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SAMPLES OF HARD RED WINTER

collected from grain elevators in 40 reporting areas after at least 30% of the local harvest was complete.

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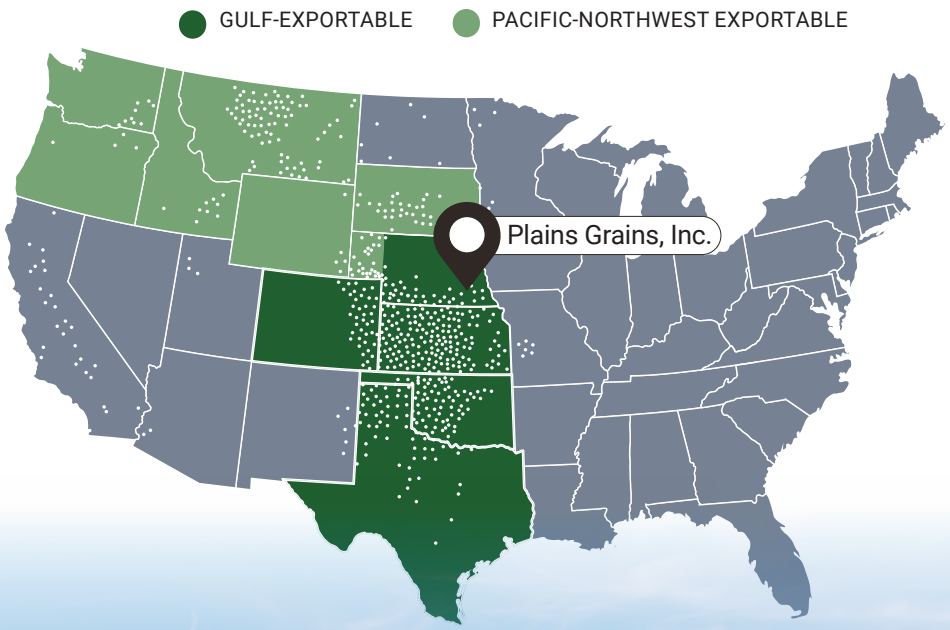
STATES SURVEYED

98%

OF TOTAL HRW PRODUCTION REPRESENTED



WEATHER AND HARVEST

PLANTED area for the 2023 HRW crop was estimated to be 25.7 million acres (10.4 million hectares) seeded in fall 2022, a 9% increase over the previous year.

GROWING conditions varied among the HRW production regions. The southern and central Great Plains experienced persistent drought and freeze events during key crop development stages, resulting in lower yields and higher protein. The northern Great Plains and PNW also experienced variability, with abnormally dry conditions and lower yields in Oregon and Washington while Montana had favorable June weather and near record yields.

HARVEST was delayed for much of the southern and central Great Plains due to late season rains that slowed harvest maturity, while the northern states and PNW mostly had an on-time harvest. With very few exceptions, disease and insects were not a major issue for the 2023 HRW crop.

PRODUCTION of the U.S. HRW crop, at 16.4 MMT, is up 13% from last year despite an abnormally high abandonment level, but total production remained historically low due to drought.

HARD RED WINTER PRODUCTION

FOR THE MAJOR PRODUCING STATES (MMT)

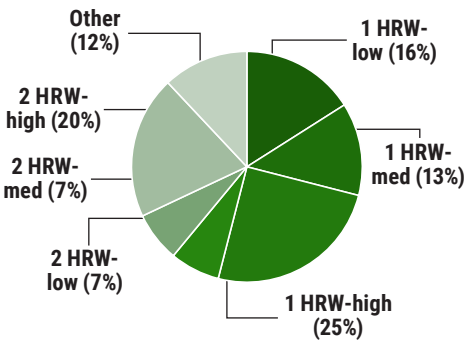
	2023	2022	2021	2020	2019
California	0.2	0.1	0.2	0.1	0.1
Colorado	1.9	0.9	1.8	1.1	2.5
Idaho	0.3	0.3	0.2	0.3	0.3
Kansas	5.1	6.2	9.3	7.3	8.8
Montana	2.3	1.6	1.5	2.1	2.6
Nebraska	0.9	0.7	1.1	0.9	1.4
Oklahoma	1.8	1.8	3.1	2.8	3.0
Oregon	0.1	0.1	0.1	0.1	0.1
South Dakota	0.9	1.0	0.7	0.9	1.1
Texas	2.1	1.0	1.9	1.6	1.8
Washington	0.3	0.3	0.2	0.3	0.5
Wyoming	0.1	0.0	0.1	0.1	0.1
Twelve-State Total	**16.0**	**14.1**	**20.1**	**17.7**	**22.3**
Gulf-Exportable	11.3	10.3	16.5	13.2	16.6
PNW-Exportable	4.5	3.8	3.5	4.4	5.6
Total HRW Production	**16.4**	**14.4**	**20.4**	**17.9**	**22.7**

Based on USDA crop estimates as of September 29, 2023.

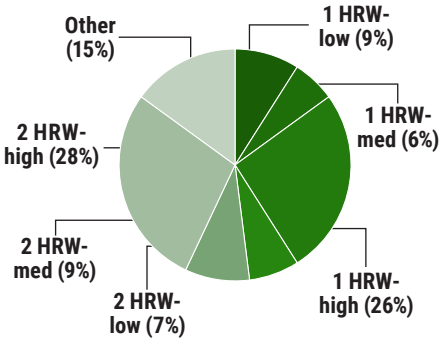
DISTRIBUTION BY GRADE

PROTEIN RANGE, 12% MB: LOW, <11.5%; MED, 11.5-12.5%; HIGH, >12.5%.

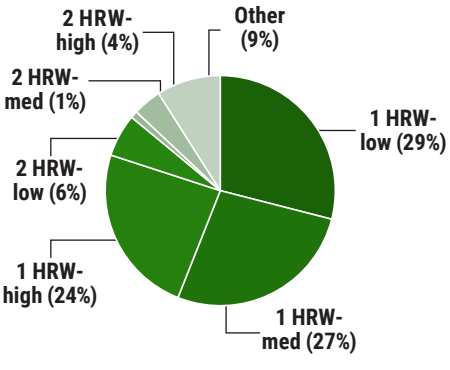
OVERALL



GULF



PACIFIC NORTHWEST



OVERALL HARVEST DATA

	2023 BY PROTEIN[1]			2023	2022	5-Year
	Low	Med	High	Avg	Avg	Avg
WHEAT GRADE DATA:						
Test Weight (lb/bu)	60.0	59.6	59.9	59.8	61.0	60.9
(kg/hl)	79.0	78.4	78.8	78.7	80.2	80.0
Damaged Kernels (%)	0.5	0.6	0.4	0.5	0.5	0.6
Foreign Material (%)	0.1	0.1	0.2	0.1	0.1	0.2
Shrunken & Broken (%)	1.2	1.0	0.8	0.9	1.1	0.9
Total Defects (%)	1.8	1.7	1.4	1.6	1.8	1.4
Grade	2 HRW	2 HRW	2 HRW	2 HRW	1 HRW	1 HRW
WHEAT NON-GRADE DATA:						
Dockage (%)	0.7	0.6	0.6	0.6	0.5	0.5
Moisture (%)	11.0	11.2	11.8	11.5	10.2	11.1
Protein (%) 12%/0% mb	10.7/12.1	12.0/13.7	13.7/15.6	12.7/14.4	13.0/14.8	11.6/13.2
Ash (%) 14%/0% mb	1.53/1.74	1.56/1.77	1.60/1.82	1.58/1.79	1.57/1.83	1.52/1.76
1000 Kernel Weight (g)	28.9	29.1	30.2	29.7	31.4	31.3
Kernel Size (%) lg/md/sm	69/30/1	68/31/1	68/31/1	68/30/1	58/40/2	66/32/2
Single Kernel: Hardness	58.6	59.3	59.7	59.3	66.4	62.7
Weight (mg)	31.7	31.9	32.3	32.0	31.4	31.4
Diameter (mm)	2.65	2.65	2.67	2.66	2.59	2.62
Sedimentation (cc)	44.0	49.1	61.1	52.5	57.2	47.1
Falling Number (sec)	344	363	354	355	361	370
DON (ppm)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FLOUR DATA:						
Lab Mill Extraction (%)[2]	76.1	75.7	75.9	75.9	78.1	75.2
Color: L*	90.9	90.7	90.5	90.6	90.4	90.9
a*	-1.6	-1.5	-1.4	-1.5	-1.6	-1.5
b*	10.3	10.2	9.9	10.1	10.0	10.1
Protein (%) 14%/0% mb	9.8/11.4	10.9/12.7	12.4/14.4	11.2/11.2	12.2/14.2	10.5/12.2
Ash (%) 14%/0% mb	0.52/0.60	0.53/0.61	0.54/0.62	0.53/0.61	0.52/0.60	0.51/0.59
Wet Gluten (%) 14% mb	24.6	28.8	33.1	29.5	32.3	25.5
Falling Number (sec)	384	390	392	389	404	377
Amylograph Viscosity: 65g (BU)	684	664	647	662	769	669
Damaged Starch (%)	5.9	5.8	5.7	5.8	6.7	6.4
SRC: Water/50% Sucrose (%)	64/112	65/116	66/123	65/118	65/112	64/108
5% Lactic Acid/5% Na_2CO_3 (%)	127/86	136/87	153/87	140/87	135/86	131/90
Gluten Performance Index (GPI)	0.64	0.67	0.72	0.69	0.69	0.67
DOUGH PROPERTIES:						
Farinograph: Peak Time (min)	3.5	4.8	5.7	4.8	5.8	5.1
Stability (min)	7.1	8.1	10.3	8.7	8.9	9.3
Absorption (%)	55.8	57.7	59.2	57.9	59.8	58.2
Alveograph: P (mm)	77	78	83	80	92	89
L (mm)	93	101	119	106	65	64
P/L Ratio	0.88	0.81	0.70	0.78	1.44	1.36
W (10^{-4} J)	225	246	316	268	216	203
Extensograph (45/135 min): Resistance (BU)	373/672	347/640	376/732	365/683	459/828	478/781
Extensibility (cm)	13.9/11.7	14.3/12.7	14.9/12.9	14.4/12.5	14.8/13.4	14.4/12.7
Area (cm^2)	87/114	86/123	100/148	92/131	89/133	90/121
BAKING EVALUATION:						
Pan Bread: Bake Absorption (%)	62.0	64.1	66.8	64.7	65.3	62.1
Loaf Volume (cc)	847	897	987	920	939	877
% OF SAMPLES:	24	22	53	100		

[1]Protein Range: Low, <11.5%; Med, 11.5 - 12.5%; High, >12.5%.

[2] The lab mill extraction calculation changed; 2023 values are not comparable to previous years. See analysis methods.

GULF-EXPORTABLE HARVEST SURVEY

The 2023 Gulf-exportable HRW crop experienced variable conditions. Persistent drought conditions, freeze damage and rain at harvest greatly impacted yields in Texas, Oklahoma and Kansas, while timely, late-stage moisture boosted yields in Colorado and western Nebraska. Despite the environmental challenges, this crop yielded better than expected. Flour and baking data indicate there is protein quantity and quality with very good processing characteristics. The loaf volumes achieved surpass U.S. quality targets. Overall, this crop meets or exceeds typical HRW contract specifications and should provide high value to customers.

GULF-EXPORTABLE CROP HIGHLIGHTS

The average **GRADE** for the 2023 Gulf-exportable crop is U.S. No. 2 HRW. Despite challenging growing conditions, 84% of the crop graded U.S. No. 2 or better.

Gulf **TEST WEIGHTS** trended lower this year with an overall average of 59.7 lb/bu (78.6 kg/hl).

KERNEL DATA indicate uniform and dense kernels with 69% exhibiting large size, a much higher level than in previous years.

WHEAT PROTEIN content average is 12.9% (12% mb), with 63% of Gulf samples 12.5% or higher.

WHEAT FALLING NUMBER average is 341 seconds, slightly higher than last year and indicative of sound wheat.

TANDEM LABORATORY MILL EXTRACTION average for the Gulf is 76.0%. Flour extractions should not be compared to last year or the 5-year average as the calculation has shifted from a total product weight basis to a tempered wheat weight basis.

SOLVENT RETENTION CAPACITY (SRC) GPI value of 0.69 is comparable to last year and indicates good flour performance in baking applications.

ALVEOGRAPH W average value of 260 (10^{-4} J) is exceptionally high for dough strength and an L value of 110 mm indicates very good extensibility.

FARINOGRAPH peak and stability averages of 4.9 and 8.9 minutes, respectively, are comparable to the 5-year average and well within industry target ranges.

Average **BAKE ABSORPTION** is 64.6%, significantly higher than the 5-year average.

Average **LOAF VOLUME** is 936 cc, comparable to last year and indicative of excellent baking quality.

"Three years of drought has challenged farmers who grow HRW wheat. But people might be surprised to know that Oklahoma farmers produced slightly more wheat in 2023 than we did in 2022. Protein was very good again this year, the crop is sound, and we almost made U.S. No. 1 HRW grade with test weight just under 60 lb/bu (78.9 kg/hl). Our customers should know there is very good HRW wheat available, and prices were trending down in early September."

— Dennis Schoenhals, Oklahoma wheat farmer

GULF-EXPORTABLE HARVEST DATA

	2023 BY PROTEIN[1]			2023	2022	5-Year
	Low	Med	High	Avg	Avg	Avg
WHEAT GRADE DATA:						
Test Weight (lb/bu)	59.9	59.1	59.8	59.7	60.4	60.5
(kg/hl)	78.7	77.8	78.7	78.6	79.4	79.6
Damaged Kernels (%)	0.6	0.7	0.5	0.5	0.9	0.3
Foreign Material (%)	0.1	0.1	0.2	0.2	0.2	0.2
Shrunken & Broken (%)	1.1	1.0	0.8	0.9	1.2	1.0
Total Defects (%)	1.8	1.8	1.4	1.6	2.3	1.5
Grade	2 HRW	2 HRW	2 HRW	2 HRW	1 HRW	1 HRW
WHEAT NON-GRADE DATA:						
Dockage (%)	0.6	0.6	0.6	0.6	0.5	0.5
Moisture (%)	11.4	11.5	11.9	11.7	10.7	11.3
Protein (%) 12%/0% mb	10.7/12.2	12.0/13.7	13.8/15.6	12.9/14.6	13.0/14.8	11.7/13.3
Ash (%) 14%/0% mb	1.55/1.76	1.59/1.80	1.60/1.82	1.59/1.81	1.57/1.83	1.53/1.78
1000 Kernel Weight (g)	28.8	28.9	30.3	29.8	30.4	30.7
Kernel Size (%) lg/md/sm	66/32/2	68/31/1	70/29/1	69/30/1	57/41/2	65/34/1
Single Kernel: Hardness	56.0	57.1	57.9	57.2	65.0	62.2
Weight (mg)	30.3	31.3	32.4	31.5	30.4	30.7
Diameter (mm)	2.59	2.63	2.68	2.64	2.56	2.58
Sedimentation (cc)	44.3	48.1	60.3	52.5	53.5	46.4
Falling Number (sec)	311	354	346	342	337	374
DON (ppm)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FLOUR DATA:						
Lab Mill Extraction (%)[2]	76.0	75.8	76.1	76.0	78.0	75.3
Color: L*	90.8	90.7	90.4	90.6	90.6	90.9
a*	-1.6	-1.5	-1.3	-1.5	-1.5	-1.5
b*	10.2	10.1	9.7	9.9	9.8	10.2
Protein (%) 14%/0% mb	9.8/11.4	10.9/12.7	12.4/14.5	11.3/13.2	12.0/13.9	10.6/12.3
Ash (%) 14%/0% mb	0.53/0.61	0.54/0.63	0.54/0.63	0.54/0.62	0.53/0.62	0.52/0.60
Wet Gluten (%) 14% mb	24.1	28.5	33.0	29.5	31.1	25.9
Falling Number (sec)	371	388	388	385	392	383
Amylograph Viscosity: 65g (BU)	644	645	618	633	633	685
Damaged Starch (%)	5.8	5.6	5.6	5.7	6.5	6.3
SRC: Water/50% Sucrose (%)	63/112	64/115	66/123	65/118	66/114	65/107
5% Lactic Acid/5% Na_2CO_3 (%)	127/84	134/85	152/86	140/86	135/86	130/88
Gluten Performance Index (GPI)	0.65	0.67	0.73	0.69	0.68	0.67
DOUGH PROPERTIES:						
Farinograph: Peak Time (min)	3.5	4.8	5.6	4.9	5.7	4.8
Stability (min)	7.4	8.2	10.2	8.9	9.1	8.9
Absorption (%)	54.9	57.1	59.0	57.5	59.5	57.9
Alveograph: P (mm)	69	72	80	75	89	87
L (mm)	98	105	120	110	70	64
P/L Ratio	0.73	0.70	0.67	0.69	1.28	1.36
W (10^{-4} J)	214	232	306	260	217	195
Extensograph (45/135 min): Resistance (BU)	380/664	346/625	377/724	366/675	460/828	462/761
Extensibility (cm)	14.1/11.7	14.5/12.9	14.9/13	14.6/12.7	14.8/13.4	14.3/12.6
Area (cm^2)	91/115	87/124	100/150	93/133	87/117	88/120
BAKING EVALUATION:						
Pan Bread: Bake Absorption (%)	61.6	63.9	66.7	64.6	65.1	61.6
Loaf Volume (cc)	868	907	995	936	940	867
% OF SAMPLES:	14	15	46	75		

[1]Protein Range: Low, <11.5%; Med, 11.5 - 12.5%; High, >12.5%.

[2] The lab mill extraction calculation changed; 2023 values are not comparable to previous years. See analysis methods.

PNW-EXPORTABLE HARVEST SURVEY

The 2023 PNW-exportable HRW crop experienced variable but generally favorable conditions for most of the growing season. Washington and Oregon started with adequate moisture that turned drier late and impacted yields, while Montana, Wyoming, Nebraska, South Dakota had good soil moisture and timely rains that contributed to above-average yields. Overall, the 2023 PNW-exportable crop has sound kernel and baking characteristics, a variety of protein levels, and notable absorption. The loaf volumes achieved surpass U.S. quality targets. Overall, this crop meets or exceeds typical HRW contract specifications and should provide high value to customers.

PNW-EXPORTABLE CROP HIGHLIGHTS

The average **GRADE** for the 2023 PNW-exportable crop is U.S. No. 1 HRW with 81% of samples grading No. 1 and 93% of the samples graded U.S. No. 2 or better.

PNW **TEST WEIGHTS** trended slightly lower this year with an overall average of 60.7 lb/bu (79.8 kg/hl).

WHEAT PROTEIN content average is 11.8% (12% mb) with 59% of the crop 11.5% or higher.

WHEAT MOISTURE average is 10.4%, adding additional value for milling customers.

KERNEL DATA indicate uniform and dense kernels with 69% exhibiting large size, which is much higher than last year and comparable to the 5-year average.

Dry conditions at harvest produced a very sound **WHEAT FALLING NUMBER** of 396 seconds, well above industry standards.

TANDEM LABORATORY MILL EXTRACTION average for the PNW is 75.7%. Flour extractions should not be compared to last year or the 5-year average as the calculation has shifted from a total product weight basis to a tempered wheat weight basis.

ALVEOGRAPH W values were exceptionally high for dough strength at 296 (10^{-4} J) and the extensibility L values are high at 95 mm.

DOUGH PROPERTIES suggest an acceptable crop that is comparable to the 5-year average.

LOAF VOLUME average is 868 cc, comparable to the 5-year average and above U.S. industry targets of 850 cc.

"Following two drought years, Montana's 2023 HRW wheat crop has been renewed showing superior quality and adequate volume. State-wide average yields are higher than the 10-year average. Expect to see a crop that works well in both the mill and the bakery. The top priority on my farm is to select varieties and production practices that meet the quality needs of end users. Overall, we are grateful for another successful crop year feeding the world."

— Denise Conover, Montana Wheat Farmer

PNW-EXPORTABLE HARVEST DATA

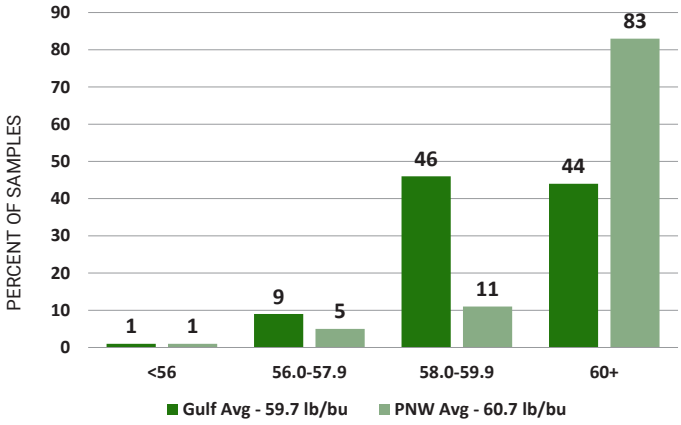
	2023 BY PROTEIN[1]			2023	2022	5-Year
	Low	Med	High	Avg	Avg	Avg
WHEAT GRADE DATA:						
Test Weight (lb/bu)	60.5	61.2	60.4	60.7	61.3	61.6
(kg/hl)	79.6	80.5	79.5	79.8	80.5	80.9
Damaged Kernels (%)	0.3	0.1	0.1	0.2	0.4	0.1
Foreign Material (%)	0.1	0.1	0.1	0.1	0.1	0.1
Shrunken & Broken (%)	1.4	1.0	1.1	1.2	1.1	0.6
Total Defects (%)	1.8	1.2	1.3	1.5	1.6	1.0
Grade	2 HRW	1 HRW	1 HRW	1 HRW	1 HRW	1 HRW
WHEAT NON-GRADE DATA:						
Dockage (%)	0.7	0.5	0.6	0.6	0.5	0.4
Moisture (%)	10.0	10.3	11.1	10.4	10.1	10.3
Protein (%) 12%/0% mb	10.6/12.0	12.0/13.7	13.5/15.3	11.8/13.4	12.8/14.6	12.2/13.9
Ash (%) 14%/0% mb	1.48/1.68	1.48/1.68	1.53/1.74	1.49/1.70	1.58/1.84	1.48/1.72
1000 Kernel Weight (g)	29.3	30.0	29.0	29.4	31.8	32.7
Kernel Size (%) lg/md/sm	74/25/1	70/29/1	62/37/2	69/30/1	60/39/1	68/31/1
Single Kernel: Hardness	63.3	66.4	68.1	65.8	67.0	67.1
Weight (mg)	34.4	33.7	32.0	33.5	31.8	32.7
Diameter (mm)	2.75	2.72	2.63	2.70	2.60	2.67
Sedimentation (cc)	43.6	52.4	65.2	52.8	58.5	54.8
Falling Number (sec)	404	392	393	396	370	363
DON (ppm)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FLOUR DATA:						
Lab Mill Extraction (%)[2]	76.3	75.5	75.0	75.7	78.1	74.7
Color: L*	91.0	90.8	90.8	90.9	90.4	91.0
a*	-1.6	-1.5	-1.5	-1.6	-1.6	-1.5
b*	10.6	10.7	10.6	10.6	10.1	10.0
Protein (%) 14%/0% mb	9.8/11.3	11.1/12.9	12.4/14.4	11.0/12.8	12.3/14.2	11.4/13.2
Ash (%) 14%/0% mb	0.51/0.59	0.49/0.56	0.52/0.61	0.50/0.58	0.52/0.61	0.49/0.58
Wet Gluten (%) 14% mb	25.5	29.8	33.8	29.3	32.7	28.4
Falling Number (sec)	406	397	414	405	408	372
Amylograph Viscosity: 65g (BU)	757	728	788	755	820	638
Damaged Starch (%)	6.2	6.2	5.8	6.1	6.7	6.7
SRC: Water/50% Sucrose (%)	65/112	68/118	68/126	67/118	65/109	67/108
5% Lactic Acid/5% Na_2CO_3 (%)	127/89	142/93	153/92	140/91	135/85	135/92
Gluten Performance Index (GPI)	0.63	0.68	0.70	0.67	0.70	0.68
DOUGH PROPERTIES:						
Farinograph: Peak Time (min)	3.3	4.8	6.2	4.7	5.8	5.2
Stability (min)	6.6	7.8	11.0	8.3	8.9	9.6
Absorption (%)	57.4	59.7	60.3	59.1	59.9	60.4
Alveograph: P (mm)	91	99	96	96	93	97
L (mm)	84	89	118	95	63	75
P/L Ratio	1.15	1.15	0.85	1.07	1.50	1.31
W (10^{-4} J)	245	292	369	296	216	263
Extensograph (45/135 min): Resistance (BU)	361/686	350/687	375/770	361/710	457/828	486/753
Extensibility (cm)	13.5/11.6	13.7/12	15.1/12.2	14/11.9	14.9/13.2	14.3/12.7
Area (cm^2)	80/113	81/119	100/137	86/122	106/142	94/127
BAKING EVALUATION:						
Pan Bread: Bake Absorption (%)	62.8	64.7	67.3	64.7	65.4	65.9
Loaf Volume (cc)	808	867	948	868	939	866
% OF SAMPLES:	10	8	7	25		

[1]Protein Range: Low, <11.5%; Med, 11.5 - 12.5%; High, >12.5%.

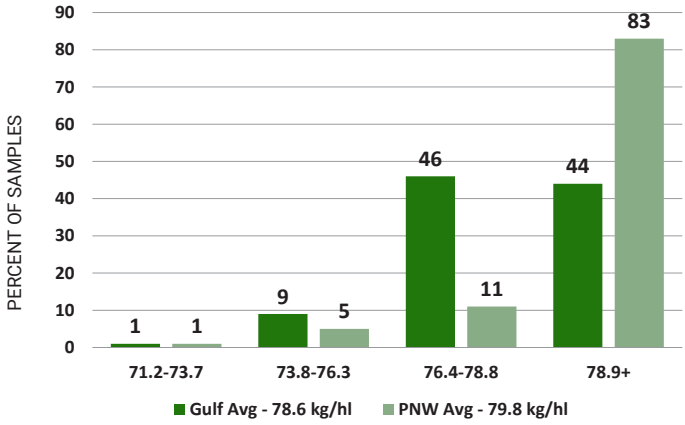
[2] The lab mill extraction calculation changed; 2023 values are not comparable to previous years. See analysis methods.

DISTRIBUTIONS

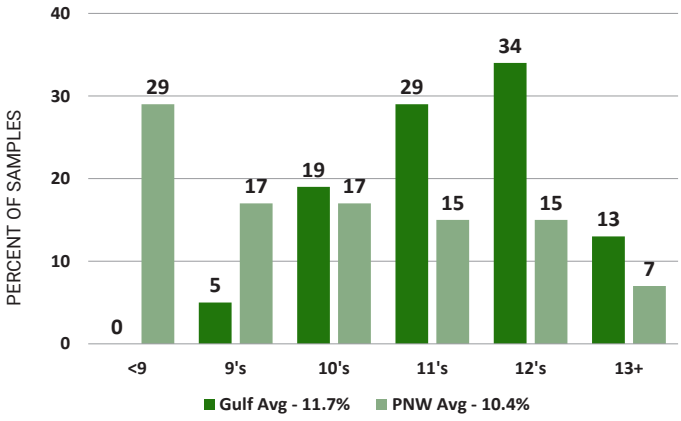
TEST WEIGHT | Pounds/Bushel



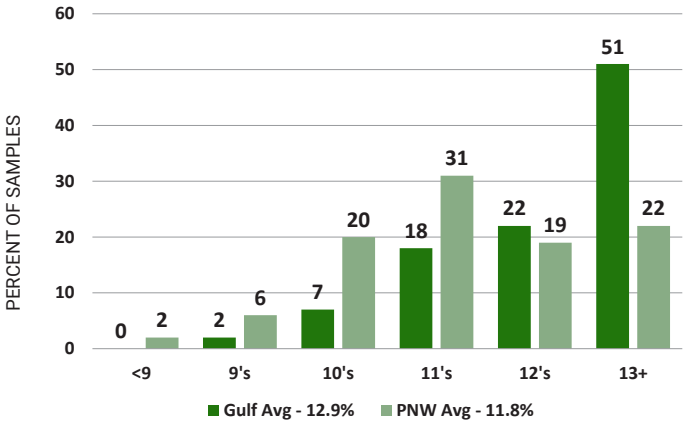
TEST WEIGHT | Kilograms/Hectoliter



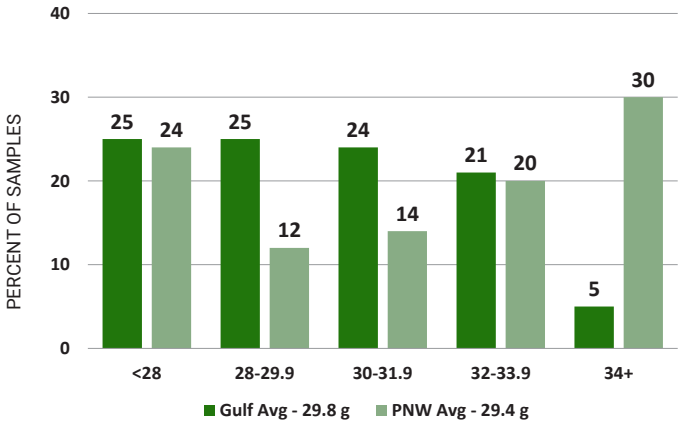
WHEAT MOISTURE | Percent



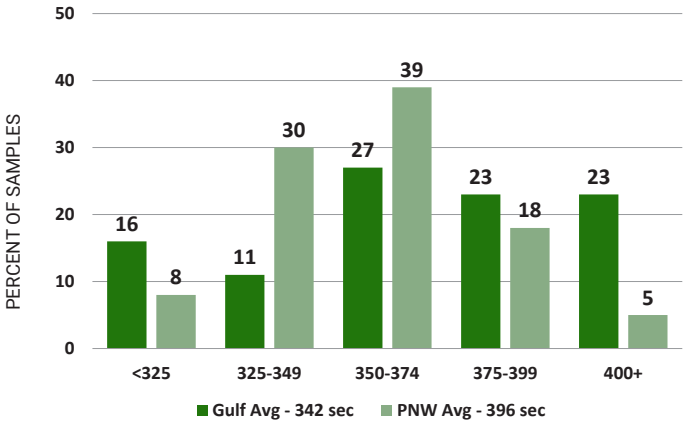
PROTEIN (12% MB) | Percent



THOUSAND KERNEL WEIGHT | Grams



FALLING NUMBER | Seconds



HARD RED SPRING

Grown primarily in the North Central region and shipped via the Pacific, Gulf and Great Lakes ports, hard red spring (HRS) wheat is the second largest class of U.S. wheat. It has high protein of 12.0 to 15.0% (12% mb), hard endosperm, red bran, strong gluten and high water absorption.

For the miller, the reward for incorporating HRS into the grist includes a higher-than-average flour yield from its harder, more compact endosperm. This creates excellent granulation through the break system, providing an abundance of stock to the purifiers producing the maximum amount of low ash, bright color flour.

For the baker, HRS delivers strong dough characteristics used alone or as part of a blend to improve the overall performance of the desired dough. In markets where consumers are demanding a "clean label," HRS flour blended with HRW or other wheat flour can create better water absorption and loaf volume while reducing or eliminating the use of chemical improvers. And many pasta makers around the world know that when traditional durum wheat semolina is not needed, HRS wheat flour or semolina is a very acceptable alternative.

APPLICATIONS

The aristocrat of wheat when it comes to "designer" wheat foods like bagels, artisan hearth breads, pizza crust and other strong dough applications, HRS also has excellent milling and baking characteristics and is a valued improver in flour blends.

Applications include:

- Bagels
- Buns
- Croissants
- Frozen doughs
- Hard rolls
- Ramen noodles
- Pan breads
- Pizza crust
- Specialty/artisan breads
- Yeast breads and rolls
- Wide variety of other baked goods
- Blending improver
- Flours (general-purpose, bread)

SCAN THIS QR CODE for more information.

SURVEY METHODOLOGY

SAMPLE COLLECTION AND ANALYSIS

The HRS Wheat Quality Lab Department of Plant Sciences, North Dakota State University (NDSU) in Fargo, North Dakota, collected samples and conducted quality analyses.

SAMPLE TESTING

Official grade and non-grade factors were determined on 60% of samples. Functionality tests were conducted on 6 composite samples categorized by export region and protein ranges of <13.5%, 13.5 to 14.5% and >14.5%. Production-weighted results are presented as Overall, Gulf/Great Lakes-exportable and Pacific Northwest (PNW)-exportable averages based on composite samples. The methods are described in the Analysis Methods section of this booklet.

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SAMPLES OF HARD RED SPRING

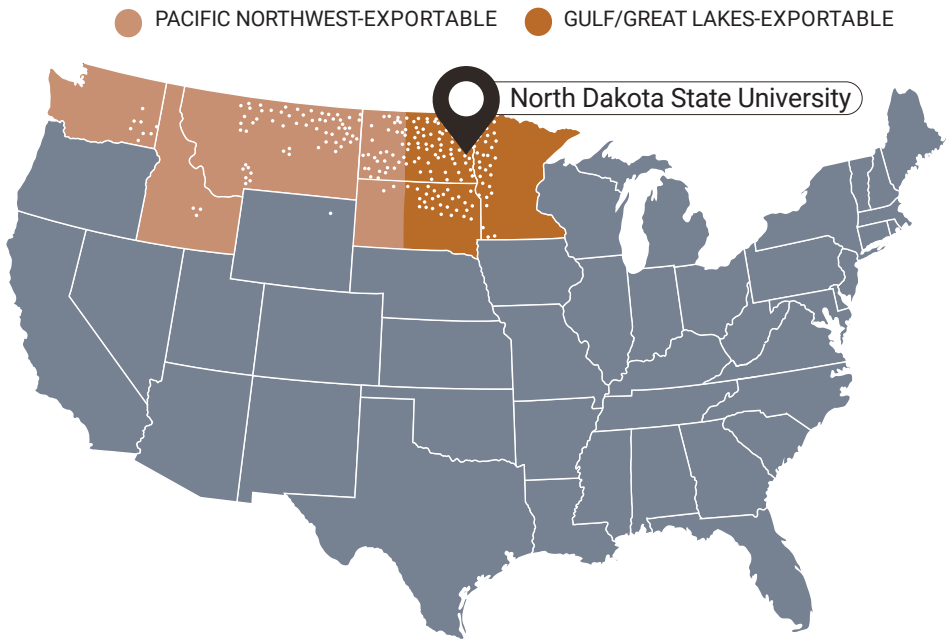
collected from fields, on-farm bins sites or elevators, and separated by export region.

6

STATES SURVEYED

100%

OF TOTAL HRS PRODUCTION REPRESENTED



SUBCLASSES

Under the Official United States Standards for Grain, hard red spring wheat is divided into the three subclasses based on vitreous kernel content:

DARK NORTHERN SPRING (DNS)

- Contains at least 75% or more dark, hard, vitreous kernels.

NORTHERN SPRING (NS)

- Contains between 25-74% dark, hard, vitreous kernels.

RED SPRING (RS)

- Contains less than 25% dark, hard, vitreous kernels.

HARD RED SPRING PRODUCTION

FOR THE MAJOR PRODUCING STATES (MMT)

	2023	2022	2021	2020	2019
Idaho	0.3	0.3	0.3	0.4	0.4
Minnesota	2.1	2.0	1.5	2.0	2.2
Montana	2.2	1.7	1.0	3.4	2.9
North Dakota	7.3	7.2	4.8	7.5	8.8
South Dakota	0.8	0.9	0.5	1.0	0.7
Washington	0.1	0.1	0.1	0.2	0.2
Six-State Total	**12.7**	**12.1**	**8.1**	**14.4**	**15.2**
PNW-Exportable	6.4	5.9	3.9	8.0	8.1
Gulf/Great Lakes-Exportable	6.3	6.3	4.2	6.4	7.1
Total HRS Production	**12.7**	**12.1**	**8.1**	**14.4**	**15.2**

Based on USDA crop estimates as of September 29, 2023.

WEATHER AND HARVEST

PLANTING of the 2023 HRS crop was behind average in most areas, but ahead of last year's slow pace. Delays were caused by cool, wet conditions and late season snow. Conditions improved mid-May and most of the crop was planted by the first week of June.

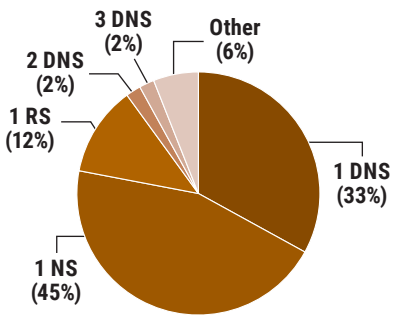
The crop **EMERGED** under mostly good conditions with adequate moisture. Most of the western areas had adequate early soil moisture while eastern areas were drier than normal. By early-June, conditions across the region turned hot and dry, stressing the crop and pushing crop development. Precipitation throughout the growing season was extremely variable and below average in much of the region. Disease pressure was very low.

HARVEST started dry but changed to rain and high humidity conditions that shortened mid- to late-harvest days and caused some color loss in areas. Harvest was mostly finished by the end of September.

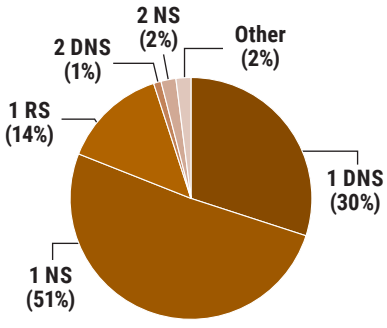
PRODUCTION of the U.S. HRS crop is 14% higher than last year at 12.7 MMT.

GRADE DISTRIBUTION

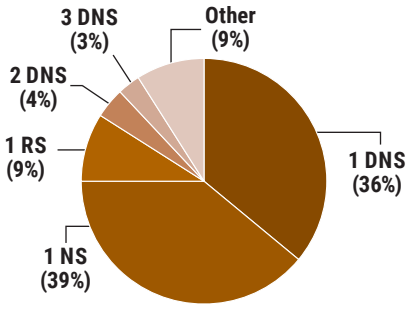
OVERALL



GULF/GREAT LAKES



PACIFIC NORTHWEST



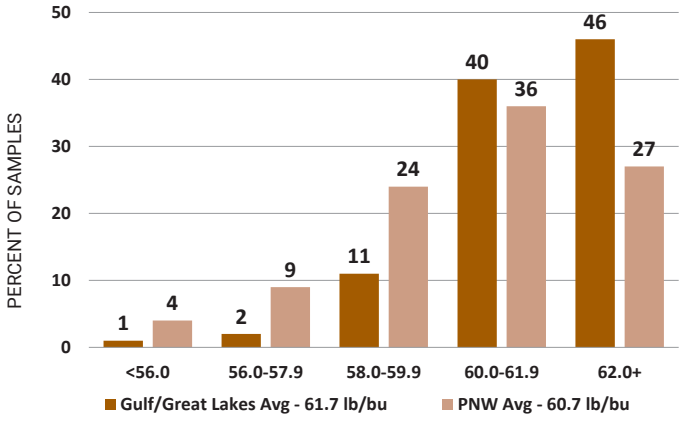
OVERALL HARVEST DATA

	2023 BY PROTEIN[1]			2023	2022	5-Year
	Low	Med	High	Avg	Avg	Avg
WHEAT GRADE DATA:						
Test Weight (lb/bu)	61.5	61.7	60.6	61.2	62.1	61.6
(kg/hl)	80.9	81.2	79.7	80.5	81.6	81.0
Damaged Kernels (%)	0.1	0.1	0.6	0.3	0.2	0.3
Foreign Material (%)	0.0	0.0	0.0	0.0	0.0	0.0
Shrunken & Broken (%)	0.6	0.8	0.9	0.8	1.0	0.9
Total Defects (%)	0.6	0.9	1.5	1.1	1.2	1.3
Vitreous kernels (%)	54	45	57	52	74	73
Grade	1 NS	1 NS	1 NS	1 NS	1 NS	1 NS
WHEAT NON-GRADE DATA:						
Dockage (%)	0.9	0.6	0.6	0.7	0.6	0.6
Moisture (%)	12.3	12.4	12.1	12.2	11.6	11.9
Protein (%) 12%/0% mb	12.5/14.2	14.1/16.0	15.4/17.6	14.2/16.2	14.3/16.2	14.6/16.6
Ash (%) 14%/0% mb	1.47/1.71	1.45/1.68	1.52/1.77	1.48/1.73	1.57/1.83	1.56/1.81
1000 Kernel Weight (g)	34.2	35.1	33.8	34.3	30.4	30.7
Kernel Size (%) lg/md/sm	53/45/2	55/44/1	46/50/3	51/47/2	42/54/4	43/53/3
Sedimentation (cc)	64.6	69.0	69.5	68.0	61.9	65.6
Falling Number (sec)	384	386	371	379	386	376
DON (ppm)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FLOUR DATA:						
Lab Mill Extraction (%)	67.7	66.7	66.1	66.7	66.2	67.2
Color: L*	90.2	90.3	89.8	90.0	90.4	90.4
a*	-1.4	-1.2	-1.1	-1.2	-1.2	-1.3
b*	9.8	9.3	9.5	9.5	9.4	9.4
Protein (%) 14%/0% mb	11.5/13.4	12.6/14.7	13.8/16.1	12.8/14.9	12.9/15.0	13.5/15.7
Ash (%) 14%/0% mb	0.47/0.55	0.45/0.53	0.49/0.58	0.48/0.55	0.49/0.57	0.51/0.59
Wet Gluten (%) 14% mb	27.9	31.3	37.2	32.8	34.5	34.9
Falling Number (sec)	381	383	392	386	397	392
Amylograph Viscosity: 65g (BU)	606	609	597	603	724	628
RVA: Pasting Temp. (°C)/Peak Visc. (cP)	91.4/2019	91/2006	91.2/1977	91.2/1997	84.6/2194	72.7/2226
Hot Paste Visc. (cP)/Final Visc. (cP)	1560/2405	1545/2399	1506/2322	1533/2369	1787/2602	1689/2552
Damaged Starch (%)	7.1	6.4	5.9	6.4	5.8	7.1
SRC: Water/50% Sucrose (%)	71/116	70/117	71/120	71/118	71/120	73/121
5% Lactic Acid/5% Na_2CO_3 (%)	145/101	153/98	158/97	153/99	145/101	148/104
Gluten Performance Index (GPI)	0.67	0.71	0.73	0.70	0.66	0.65
DOUGH PROPERTIES:						
Farinograph: Peak Time (min)	6.3	7.8	8.9	7.9	8.0	8.1
Stability (min)	12.4	15.1	14.4	14.1	12.2	12.8
Absorption (%)	61.1	62.0	63.7	62.5	63.1	62.8
Alveograph: P (mm)	98	93	86	91	94	88
L (mm)	101	125	144	126	127	134
P/L Ratio	0.97	0.74	0.59	0.72	0.74	0.66
W (10^{-4} J)	349	411	418	397	400	391
Extensograph (45/135 min): Resistance (BU)	561/830	623/1106	620/1230	606/1084	539/839	536/907
Extensibility (cm)	16.3/13.8	15.9/13.8	17.4/13.5	16.6/13.7	16.6/14.2	16.2/13.6
Area (cm^2)	159/154	127/175	140/192	141/176	116/154	114/156
BAKING EVALUATION:						
Pan Bread: Bake Absorption (%)	62.1	64.5	66.4	64.6	71.4	68.5
Loaf Volume (cc)	878	984	1050	983	938	973
SPAGHETTI EVALUATION:						
Color: L*	49.7	49.8	48.4	49.0	52.5	51.9
a*	4.2	4.3	4.6	4.0	4.2	4.1
b*	17.4	17.3	16.7	17.0	18.2	18.1
Cooked Weight (g)	32.6	32.1	31.5	32.0	32.0	31.3
Cooking Loss (%)	7.4	7.0	6.6	7.0	7.3	6.8
Cooked Firmness (g*cm)	3.2	3.7	3.6	3.5	3.6	3.5
% OF SAMPLES:	**27**	**32**	**41**	**100**		

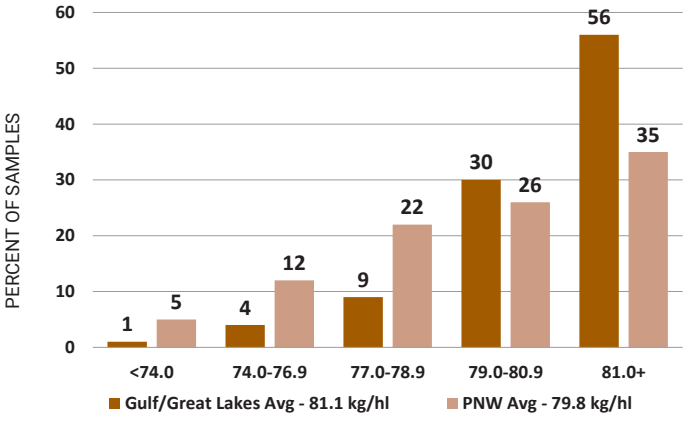
[1]Protein Range: Low, <13.5%; Med, 13.5 - 14.5%; High, >14.5%.

DISTRIBUTIONS

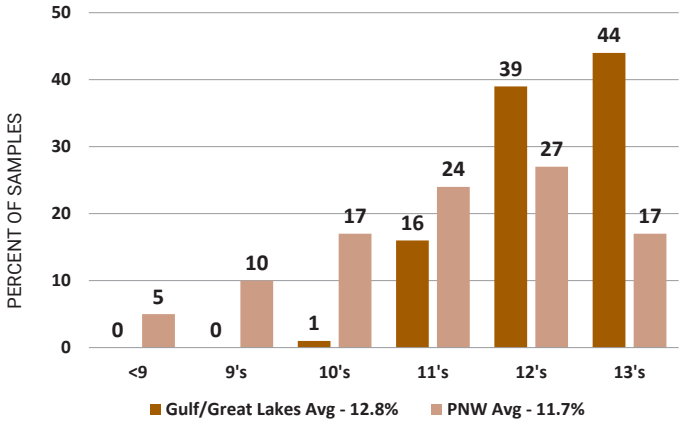
TEST WEIGHT | Pounds/Bushel



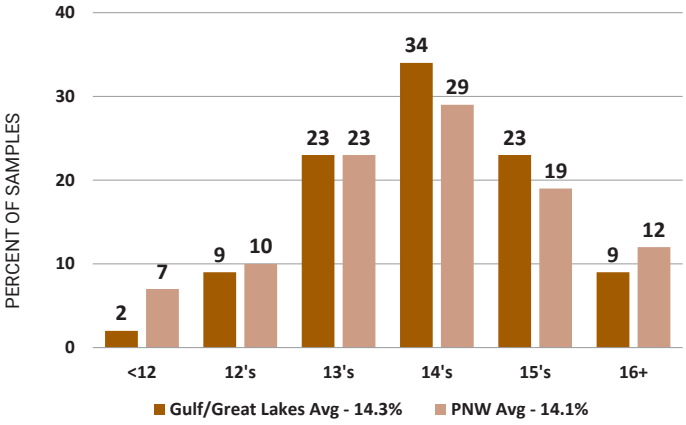
TEST WEIGHT | Kilograms/Hectoliter



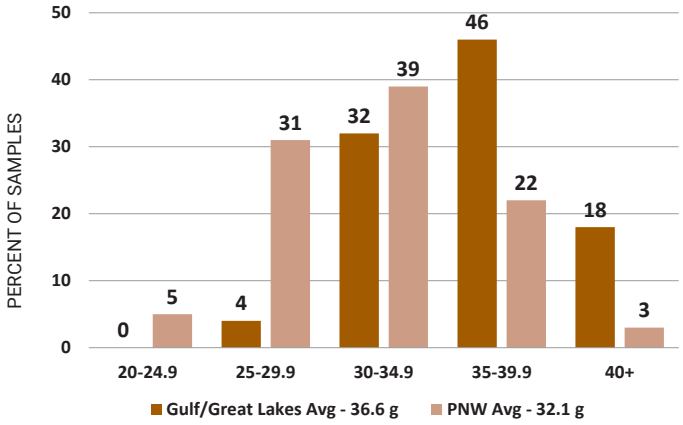
WHEAT MOISTURE | Percent



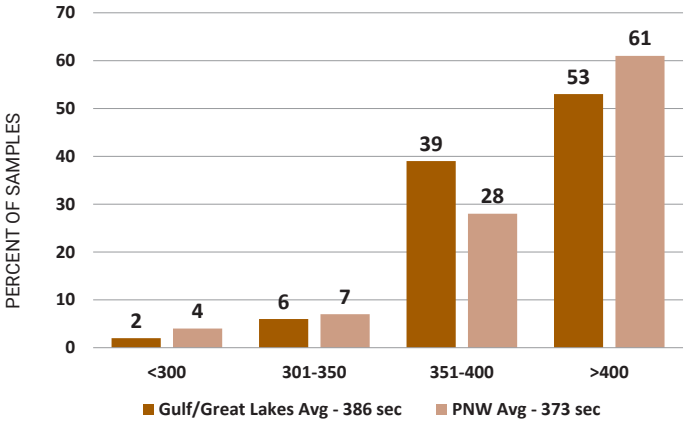
PROTEIN (12% MB) | Percent



THOUSAND KERNEL WEIGHT | Grams



FALLING NUMBER | Seconds



GULF/GREAT LAKES-EXPORTABLE HARVEST SURVEY

The 2023 U.S. hard red spring (HRS) wheat crop grown in the eastern (Gulf/Great Lakes-exportable) region offers a nice balance of protein, strong dough characteristics and very good bake parameters. The region experienced early season heat and limited precipitation. Cooler temperatures with more consistent rains later in the growing season and no disease pressure produced average to above-average yields with high grade characteristics and high protein levels. Rain and high humidity during harvest lowered vitreous kernel levels. Overall, this is a highly functional crop.

GULF/GREAT LAKES-EXPORTABLE CROP HIGHLIGHTS

The average **GRADE** for the 2023 Gulf/Great Lakes-exportable HRS harvest survey is U.S. No. 1 Northern Spring (NS), with 95% of samples grading U.S. No. 1.

Average **TEST WEIGHT** is 61.7 lb/bu (81.2 kg/hl), lower than 2022 but similar to the 5-year average.

Average **DAMAGE** is 0.1%, similar to 2022 and lower than the 5-year average, while **SHRUNKEN AND BROKEN KERNELS** at 0.5%, is similar to 2022 and the 5-year average.

Average **VITREOUS KERNEL (DHV)** content is 44%, much lower than last year's 59% and the 5-year average of 65%.

WHEAT PROTEIN averages 14.3% (12% mb), similar to 2022 and the 5-year average. Distribution of protein shows 21% of the surveyed crop below 13.5% protein, and 42% above 14.5% protein.

DON levels were near zero due to minimal disease pressure.

Average **1000 KERNEL WEIGHT (TKW)** is 36.6 g, well above 2022 and the 5-year average.

Average **WHEAT FALLING NUMBER** is 386 seconds, similar to 2022, indicating a sound crop with distributions trending lower due to the extended harvest period.

BUHLER LABORATORY MILL FLOUR YIELD averages 66.8, above 2022 but below the 5-year average%. Lab mill settings are not adjusted to account for kernel parameter shifts between crop years. The extraction is calculated on a tempered wheat basis.

Average **FLOUR ASH** is 0.47%, similar to 2002, and lower than the 5-year average of 0.51%.

WET GLUTEN averages 33.2%, slightly lower than 2022 and the 5-year average.

AMYLOGRAPH average of 566 BU is down from 2022 but similar to the 5-year average.

DOUGH PROPERTIES suggest a stronger, slightly less extensible crop as compared to last year and the 5-year average.

FARINOGRAPH peak and stability times of 8.2 and 16.1 minutes respectively indicate the Gulf/Great Lakes-exportable crop is much stronger than average. Absorption values average 62.1%, down slightly from 2022, and similar to the 5-year average.

The average **ALVEOGRAPH** P/L ratio is 0.78 compared to 0.63 for the 5-year average, and the W-value is 411 (10^{-4} J), compared to 388 for the 5-year average.

The overall extensibility and resistance to extension of the 135-min **EXTENSOGRAPH** are 14.0 cm and 1171 BU, compared to 15.6 cm and 743 BU last year indicating stronger, less extensible dough properties.

The average **LOAF VOLUME** is 971 cc, higher than 2022, and similar to the 5-year average.

Average **BAKE ABSORPTION** is 63.8%, significantly lower than 2022, and lower than the 5-year average.

"Although it was a very challenging year here in South Dakota in terms of acreage, drought, and subsequent yields, the harvested HRS crop exhibited strong protein and milling qualities."

—Bryan Jorgensen, South Dakota wheat farmer

GULF/GREAT LAKES-EXPORTABLE HARVEST DATA

	2023 BY PROTEIN[1]			2023	2022	5-Year
	Low	Med	High	Avg	Avg	Avg
WHEAT GRADE DATA:						
Test Weight (lb/bu)	62.0	62.0	61.4	61.7	62.4	61.8
(kg/hl)	81.6	81.5	80.8	81.2	82.1	81.2
Damaged Kernels (%)	0.0	0.0	0.3	0.1	0.1	0.4
Foreign Material (%)	0.0	0.0	0.0	0.0	0.0	0.0
Shrunken & Broken (%)	0.2	0.7	0.4	0.5	0.5	0.6
Total Defects (%)	0.2	0.7	0.7	0.6	0.6	1.0
Vitreous kernels (%)	47	45	41	44	59	65
Grade	1 NS	1 NS	1 NS	1 NS	1 NS	1 NS
WHEAT NON-GRADE DATA:						
Dockage (%)	0.5	0.5	0.5	0.5	0.6	0.5
Moisture (%)	12.9	12.8	12.8	12.8	12.7	12.6
Protein (%) 12%/0% mb	12.7/14.4	14.1/16	15.3/17.4	14.3/16.3	14.2/16.1	14.4/16.4
Ash (%) 14%/0% mb	1.46/1.70	1.47/1.71	1.58/1.84	1.51/1.76	1.58/1.83	1.58/1.84
1000 Kernel Weight (g)	36.5	37.2	36.1	36.6	32.3	31.8
Kernel Size (%) lg/md/sm	63/36/1	64/35/1	62/36/2	63/36/1	55/43/2	51/46/2
Sedimentation (cc)	64.0	69.0	69.0	68.0	61.8	65.2
Falling Number (sec)	392	403	368	386	378	365
DON (ppm)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FLOUR DATA:						
Lab Mill Extraction (%)	69.1	66.6	65.8	66.8	66.7	67.7
Color: L*	90.0	90.3	89.9	90.1	90.3	90.3
a*	-1.4	-1.2	-1.0	-1.1	-1.2	-1.2
b*	9.8	9.1	9.0	9.2	9.3	9.1
Protein (%) 14%/0% mb	11.5/13.4	12.6/14.7	13.6/15.8	12.8/14.9	12.7/14.8	13.3/15.5
Ash (%) 14%/0% mb	0.47/0.55	0.45/0.52	0.49/0.57	0.47/0.55	0.48/0.56	0.51/0.59
Wet Gluten (%) 14% mb	29.3	31.0	37.1	33.2	33.9	34.3
Falling Number (sec)	391	376	374	378	381	380
Amylograph Viscosity: 65g (BU)	575	606	527	566	657	578
RVA: Pasting Temp. (°C)/Peak Visc. (cP)	90.9/1970	91.4/2012	90.4/1869	90.9/1942	88.2/2137	73.7/2233
Hot Paste Visc. (cP)/Final Visc. (cP)	1515/2386	1475/2410	1480/2210	1486/2320	1693/2524	1669/2531
Damaged Starch (%)	7.3	6.2	6.1	6.4	5.7	6.8
SRC: Water/50% Sucrose (%)	70/114	69/114	70/117	70/115	71/116	72/119
5% Lactic Acid/5% Na_2CO_3 (%)	142/100	151/95	156/94	151/96	145/100	146/102
Gluten Performance Index (GPI)	0.66	0.72	0.74	0.72	0.67	0.66
DOUGH PROPERTIES:						
Farinograph: Peak Time (min)	6.5	8.3	8.9	8.2	6.9	7.5
Stability (min)	13.8	17.5	16.0	16.1	11.9	13.0
Absorption (%)	60.7	61.5	63.4	62.1	62.8	62.1
Alveograph: P (mm)	102	96	89	94	94	86
L (mm)	99	121	133	121	127	136
P/L Ratio	1.03	0.79	0.67	0.78	0.74	0.63
W (10^{-4} J)	358	424	427	411	404	388
Extensograph (45/135 min): Resistance (BU)	586/779	675/1080	695/1442	665/1171	512/743	543/854
Extensibility (cm)	18.5/15.2	15.2/14.4	17.8/13.0	17/14.0	18.0/15.6	16.7/14.0
Area (cm^2)	147/163	130/206	158/200	145/194	121/151	117/153
BAKING EVALUATION:						
Pan Bread: Bake Absorption (%)	60.5	63.6	65.8	63.8	71.1	67.8
Loaf Volume (cc)	875	970	1020	971	937	983
SPAGHETTI EVALUATION:						
Color: L*	49.3	49.9	47.9	48.9	52.7	51.7
a*	4.4	4.3	4.6	4.5	4.2	4.1
b*	16.7	17.1	16.2	16.7	18.1	17.7
Cooked Weight (g)	32.2	31.9	31.0	31.6	30.8	31.3
Cooking Loss (%)	7.5	7.1	6.6	7.0	7.2	6.7
Cooked Firmness (g*cm)	3.4	3.9	3.7	3.7	4.3	3.8
% OF SAMPLES:	**10**	**18**	**21**	**49**		

[1]Protein Range: Low, <13.5%; Med, 13.5 - 14.5%; High, >14.5%.

PACIFIC NORTHWEST-EXPORTABLE HARVEST SURVEY

The 2023 U.S. hard red spring (HRS) wheat crop grown in the western (PNW-exportable) region offers strong grading characteristics, good protein content, typical dough strength, and improved bake parameters compared to recent years. This crop includes a wider range of yields and protein levels due to variable rainfall. Kernel size and quality are very good after minimal disease pressure and a cool kernel fill period. An extended harvest period with sporadic rains broadly lowered vitreous kernel levels and led to lower falling numbers in isolated areas. Overall, this is a highly functional crop.

PNW-EXPORTABLE CROP HIGHLIGHTS

The average **GRADE** for the 2023 PNW-exportable HRS harvest survey is U.S. No. 1 Northern Spring (NS), with 84% of samples grading U.S. No. 1.

Average **TEST WEIGHT** is 60.7 lb/bu (79.8 kg/hl), lower than 2022 and the 5-year average.

Average **DAMAGE** is 0.5%, slightly higher than the 5-year average, while **SHRUNKEN AND BROKEN** at 1.1, is similar to the 5-year average.

The PNW-exportable crop has lower **VITREOUS KERNEL (DHV)** content, averaging 61% compared to 88% in 2022 and 84% for a 5-year average.

WHEAT PROTEIN averages 14.1% (12% mb), below 2022 and the 5-year average due to very high yields in parts of the growing region, offsetting stressed areas which produced higher protein. Distribution of protein is 32% below 13.5% protein and 40% above 14.5% protein.

DON levels were near zero due to minimal disease pressure.

Average **1000 KERNEL WEIGHT (TKW)** is 32.1 g, well above 2022 and the 5-year average.

Average **WHEAT FALLING NUMBER** is 373 seconds, indicating a sound crop.

BUHLER LABORATORY MILL FLOUR YIELD averages 66.7%, above 2022 and the 5-year average. Lab mill settings are not adjusted to account for kernel parameter shifts between crop years. The extraction is calculated on a tempered wheat basis.

Average **FLOUR ASH** is 0.48%, lower than last year and the 5-year average.

WET GLUTEN averages 32.4%, lower than 2022 and the 5-year average.

AMYLOGRAPH average of 639 BU is much lower than 2022 and lower than the 5-year average, reflective of isolated areas impacted by rain at harvest.

DOUGH PROPERTIES suggest a crop that exhibits strong characteristics with greater extensibility, compared to 2022 and the 5-year average.

FARINOGRAPH peak and stability times of 7.6 and 12.2 min, respectively, indicate the PNW-exportable crop is similar in strength to 2022 and the 5-year average. Absorption values average 62.8%, down from 2022 and the 5-year average.

The average **ALVEOGRAPH** P/L ratio is 0.68 compared to 0.74 in 2022, and the W-value is 384 (10^{-4} J), down from 396 last year.

The overall extensibility and resistance to extension of the 135-min **EXTENSOGRAPH** are 13.4 cm and 1001 BU, compared to 12.9 cm and 927 BU last year indicating slightly stronger, yet more extensible dough properties compared to last year.

The average **LOAF VOLUME** is 993 cc, above 940 cc in 2022, and 962 for a 5-year average.

Average **BAKE ABSORPTION** is 65.4%, lower than 2022 and the 5-year average.

"The best word to describe this year's spring wheat crop is variable. On my farm, we had above average precipitation, but most areas did not. A later planting season combined with hot, dry conditions proved to be challenging. Some producers saw above average yields, but others saw their yield affected by dry conditions. This year's crop also has a wider than normal protein range due to variable growing conditions and yields. Overall, buyers should be happy with the quality of the 2023 crop."

—Jim Bahm, North Dakota wheat farmer

PACIFIC NORTHWEST-EXPORTABLE HARVEST DATA

	2023 BY PROTEIN[1]			2023	2022	5-Year
	Low	Med	High	Avg	Avg	Avg
WHEAT GRADE DATA:						
Test Weight (lb/bu)	61.1	61.4	59.8	60.7	61.8	61.4
(kg/hl)	80.4	80.8	78.7	79.8	81.2	80.8
Damaged Kernels (%)	0.1	0.3	1.0	0.5	0.2	0.3
Foreign Material (%)	0.0	0.0	0.0	0.0	0.0	0.0
Shrunken & Broken (%)	0.8	0.9	1.4	1.1	1.5	1.2
Total Defects (%)	0.9	1.2	2.4	1.6	1.8	1.5
Vitreous kernels (%)	59	44	74	61	88	81
Grade	1 NS	1 NS	1 NS	1 NS	1 DNS	1DNS
WHEAT NON-GRADE DATA:						
Dockage (%)	1.1	0.7	0.6	0.8	0.7	0.6
Moisture (%)	11.9	12.0	11.4	11.7	10.6	11.2
Protein (%) 12%/0% mb	12.4/14.1	14.0/15.9	15.6/17.7	14.1/16.0	14.4/16.3	14.7/16.7
Ash (%) 14%/0% mb	1.48/1.72	1.42/1.65	1.46/1.70	1.46/1.69	1.57/1.82	1.53/1.78
1000 Kernel Weight (g)	32.7	32.5	31.4	32.1	28.6	29.6
Kernel Size (%) lg/md/sm	47/50/3	43/55/2	30/65/5	39/57/4	31/64/5	36/60/4
Sedimentation (cc)	65.0	69.0	70.0	68.1	61.9	65.9
Falling Number (sec)	379	366	374	373	393	387
DON (ppm)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
FLOUR DATA:						
Lab Mill Extraction (%)	66.9	66.8	66.5	66.7	65.8	66.6
Color: L*	90.4	90.2	89.6	90.0	90.5	90.5
a*	-1.4	-1.2	-1.2	-1.2	-1.3	-1.4
b*	9.8	9.6	10.0	9.8	9.6	9.6
Protein (%) 14%/0% mb	11.5/13.4	12.6/14.7	14.1/16.4	12.8/14.9	13.1/15.3	13.6/15.8
Ash (%) 14%/0% mb	0.47/0.55	0.46/0.53	0.50/0.58	0.48/0.56	0.50/0.58	0.51/0.59
Wet Gluten (%) 14% mb	27.1	31.6	37.3	32.4	35.0	35.6
Falling Number (sec)	375	392	411	394	410	404
Amylograph Viscosity: 65g (BU)	626	613	667	639	785	679
RVA: Pasting Temp. (°C)/Peak Visc. (cP)	91.7/2050	90.5/1998	92.1/2086	91.5/2050	81.4/2246	73.1/2185
Hot Paste Visc. (cP)/Final Visc. (cP)	1588/2416	1631/2386	1532/2436	1578/2415	1871/2673	1717/2558
Damaged Starch (%)	7.0	6.6	5.7	6.4	6.0	6.8
SRC: Water/50% Sucrose (%)	71/118	71/121	72/123	71/121	71/123	74/124
5% Lactic Acid/5% Na_2CO_3 (%)	147/101	155/102	160/101	154/101	146/102	150/107
Gluten Performance Index (GPI)	0.67	0.70	0.71	0.69	0.65	0.65
DOUGH PROPERTIES:						
Farinograph: Peak Time (min)	6.2	7.1	9.0	7.6	8.9	8.7
Stability (min)	11.6	12.1	12.8	12.2	12.4	12.6
Absorption (%)	61.4	62.6	64.1	62.8	63.4	63.6
Alveograph: P (mm)	96	89	82	88	93	91
L (mm)	102	130	155	131	127	132
P/L Ratio	0.94	0.68	0.53	0.68	0.74	0.69
W (10^{-4} J)	343	396	409	384	396	394
Extensograph (45/135 min): Resistance (BU)	546/862	560/1138	545/1016	550/1001	564/927	526/958
Extensibility (cm)	14.9/12.9	16.8/13.0	16.9/14.0	16.2/13.4	15.4/12.9	15.8/13.1
Area (cm^2)	107/148	124/137	122/183	137/159	112/157	111/160
BAKING EVALUATION:						
Pan Bread: Bake Absorption (%)	63.0	65.6	67.1	65.4	71.6	69.2
Loaf Volume (cc)	880	1000	1080	993	940	962
SPAGHETTI EVALUATION:						
Color: L*	50.0	49.7	49.0	49.5	52.3	52.1
a*	4.1	4.3	4.6	4.5	4.1	4.0
b*	17.9	17.5	17.2	16.7	18.3	18.5
Cooked Weight (g)	32.9	32.4	31.9	32.4	31.2	31.1
Cooking Loss (%)	7.3	6.9	6.6	6.9	6.7	6.6
Cooked Firmness (g*cm)	3.1	3.5	3.4	3.3	4.2	3.7
% OF SAMPLES:	**16**	**15**	**20**	**51**		

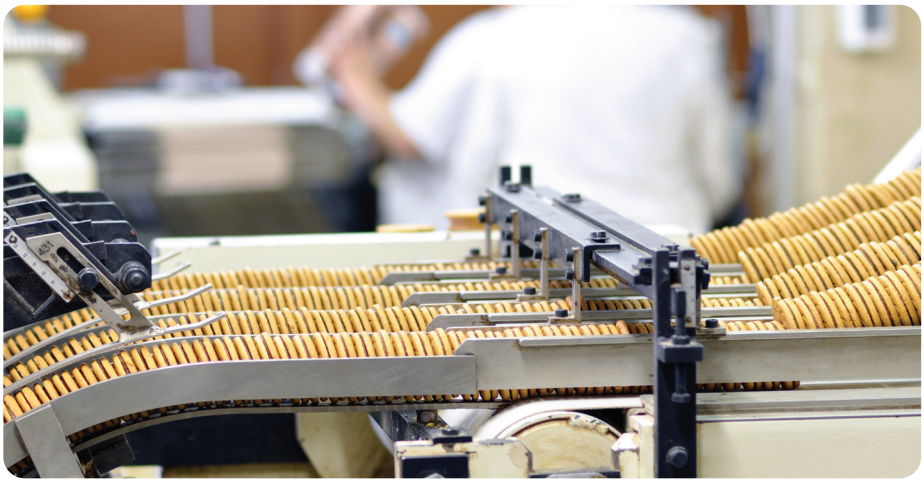
[1]Protein Range: Low, <13.5%; Med, 13.5 - 14.5%; High, >14.5%.

SOFT WHITE

Grown primarily in the Pacific Northwest (PNW) and shipped via Pacific ports, approximately 80% of soft white (SW) wheat is exported from the United States. It typically has a low protein of 8.5 to 10.5% (12% mb), low moisture and weak gluten. SW includes winter and spring varieties that provide a wide range of protein and functionality within the class.

For the miller, SW delivers excellent results. Arriving at the mill with an average moisture of less than 10%, an average test weight of more than 79 hectoliter mass and a low quantity of screenings, SW wheat provides the millers every opportunity for high flour extraction. The lower wheat moisture provides numerous financial and processing opportunities to the miller.

For the baker, the finer particle size may increase the rate of water absorption, decrease mix time and improve production efficiencies. With the fine particle size and starch characteristics, SW flour creates a unique and tender texture for many end-products.



APPLICATIONS

From specialty products such as sponge cakes to blending with HRS for improving bread color, U.S. SW wheat flour has the versatility to improve the quality of a wide variety of products.

Applications include:

- Quick breads
- Flat Breads
- Biscuits
- Sugar snap cookies
- Cakes
- Muffins
- Pastries
- Wafers/Ice cream cones
- Other confectionary products
- Cereals and cereal bars
- Crackers
- Snack foods
- Fried Spring Rolls
- Steamed bread, Chinese southern-type
- Tempura batter
- Flours (cake, pastry, self-rising)

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SURVEY METHODOLOGY

SAMPLE COLLECTION AND ANALYSIS

The Wheat Marketing Center (WMC) in Portland, Oregon conducted wheat and flour quality testing and analyses. Federal Grain Inspection Service (FGIS) graded and tested wheat protein content.

SAMPLE TESTING

Official grade, protein, moisture, 1000 kernel weight and falling number tests were determined on each sample. The remaining tests were conducted on 3 composite samples categorized by protein ranges of <9.0%, 9.0 to 10.5%, >10.5% and one composite of all White Club (Club) samples. The methods are described in the Analysis Methods section of this booklet.

385
SAMPLES OF SOFT WHITE

65
SAMPLES OF WHITE CLUB

collected from state, private grain inspection agencies and commercial wheat handling operations.

3
STATES SURVEYED

95%
OF TOTAL SW PRODUCTION REPRESENTED

SOFT WHITE PRODUCTION

FOR THE MAJOR PRODUCING STATES (MMT)

	2023		2022		2021		2020		2019	
	SW	CLUB	SW	CLUB	SW	CLUB	SW	CLUB	SW	CLUB
Washington	2.6	0.1	3.3	0.3	1.9	0.1	3.8	0.2	3.1	0.1
Oregon	1.0	0.0	1.3	0.0	0.8	0.0	1.2	0.0	1.2	0.0
Idaho	1.5	0.0	1.7	0.0	1.4	0.0	2.0	0.0	1.6	0.0
Three-State Total	**5.1**	**0.2**	**6.3**	**0.3**	**4.1**	**0.2**	**6.9**	**0.3**	**5.9**	**0.2**
Three-State SW Total	**5.3**		**6.6**		**4.3**		**7.2**		**6.0**	
Total SW Production	**5.8**		**6.9**		**4.8**		**7.6**		**6.6**	

Based on USDA crop estimates as of September 29, 2023.

HARVEST SURVEY

The Pacific Northwest (PNW) experienced drier growing conditions and moderate temperatures, contributing to a 2023 wheat crop with above average protein. The crop has appropriately weak to medium gluten strength and acceptable to good finished product characteristics. SW is especially suited for use in cakes, pastries, cookies and snack foods. The high protein segment of the SW crop provides opportunities in blends for crackers, Asian noodles, steamed breads, flat breads and pan breads. Club, with very weak gluten strength, is typically used in a Western White blend with SW for cakes and delicate pastries.

WEATHER AND HARVEST

PLANTING and emergence of the winter SW crop was delayed due to abnormally dry to moderate drought conditions. Soil moisture conditions improved with winter temperatures and snow coverage. At the same time, the extended winter weather resulted in delayed spring SW planting.

As the crop **DEVELOPED**, challenging heat and dryness from late spring to harvest accelerated crop development and resulted in lower yields. Harvest was generally on time for most of the PNW.

PRODUCTION of the 2023 PNW SW crop is estimated at 5.3 MMT, a 23% decrease from last year. Despite the low production, ample carryover stocks will provide blending opportunities and help meet customer specifications.

CROP HIGHLIGHTS

The overall average **GRADE** of the 2023 SW crop is U.S. No. 1 SW; the Club average is also U.S. No. 1.

TEST WEIGHT averages trended lower this year with an average of 60.3 lb/bu (79.3 kg/hl) for SW and 60.7 lb/bu (79.8 kg/hl) for Club.

WHEAT PROTEIN (12% mb) is higher this year with an average of 11.1% for SW and 10.6% for Club.

WHEAT FALLING NUMBER average is 336 seconds or higher for all SW composites and 327 seconds for Club.

Buhler **LABORATORY MILL** average extraction for SW is 70.3% and 72.1% for Club. Commercial mills should see better extractions, although some adjustments may be necessary for portions of the crop with lower test weights. Flour extractions should not be compared to last year or the 5-year average as the calculation has shifted from a total product weight basis to a tempered wheat weight basis.

SOLVENT RETENTION CAPACITY (SRC) lactic acid and water average values for SW are 105% and 51%, respectively, indicating weak to medium gluten strength. Overall, SW composites have SRC profiles suitable for good cookie and cracker performance. Lactic acid and water SRC average values for Club are 71% and 51%, respectively, and are indicative of very weak gluten with low water holding capacity.

STARCH PASTING PROPERTIES demonstrated by Amylograph and RVA viscosities for SW and Club indicate the crop is suitable for batter-based products. The low protein SW composite average of 368 BU/2122 cP peak viscosity is reflective of a slightly lower falling number (313 seconds). The overall SW and Club averages are similar to last year.

SW and Club **DOUGH PROPERTIES** are typical and suggest very weak to medium gluten strength and low water absorption values.

SPONGE CAKE volumes average 1089 cc for SW and 1110 cc for Club. Average hardness value for SW is 353 g and 337 g for Club. All SW and Club cakes were baked from an experimentally milled straight grade flour. For comparison, control cakes baked at the same time from a commercially milled short patent cake flour (2022 harvest) have an average volume of 1205 cc and an average firmness of 242 g.

COOKIE diameter values are 7.7 cm for SW and 7.9 cm for Club. Spread factor for SW is 8.2 and 8.8 for Club. These values should not be compared to 2022 or the 5-year average as the cookie method has changed as of 2023 (see analysis methods).

Average SW **PAN BREAD** bake absorption is 56.1% and loaf volume is 696 cc. Blends of hard wheat with up to 20% SW should produce acceptable pan breads, especially from higher protein SW.

CHINESE SOUTHERN-TYPE STEAMED BREAD values for Club, and medium and high protein SW composites scored similar to or better than the control due to greater volume and whiter internal crumb color. Specific volume and total score averages are SW 2.7 cc/g, 70.8 and Club 2.7 cc/g, 70.7, respectively.

HARVEST DATA

	2023					2022		5-Year	
	SW BY PROTEIN[1]			SW	Club	SW	Club	SW	Club
	Low	Med	High	Avg	Avg	Avg	Avg	Avg	Avg
WHEAT GRADE DATA:									
Test Weight (lb/bu)	61.0	61.1	59.8	60.3	60.7	61.0	60.6	61.1	60.6
(kg/hl)	80.2	80.4	78.7	79.3	79.8	80.2	79.8	80.3	79.7
Damaged Kernels (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Foreign Material (%)	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1
Shrunken & Broken (%)	0.5	0.5	0.7	0.6	1.2	0.5	1.1	0.6	0.9
Total Defects (%)	0.5	0.5	0.8	0.7	1.3	0.6	1.1	0.7	1.0
Grade	1 SW	1 SW	2 SW	1 SW	1 WC	1 SW	1 WC	1 SW	1 WC
WHEAT NON-GRADE DATA:									
Dockage (%)	0.3	0.4	0.4	0.4	0.6	0.5	0.8	0.5	0.6
Moisture (%)	10.0	9.4	8.9	9.1	8.6	8.9	7.8	9.1	8.4
Protein (%) 12%/0% mb	8.4/9.5	9.9/11.3	11.9/13.5	11.1/12.6	10.6/12.0	9.5/10.8	10.1/11.5	10.0/11.2	10.0/11.3
Ash (%) 14%/0% mb	1.43/1.66	1.36/1.58	1.38/1.60	1.38/1.60	1.26/1.47	1.47/1.71	1.36/1.58	1.40/1.61	1.32/1.51
1000 Kernel Weight (g)	37.7	35.6	30.4	32.5	29.9	34.8	30.2	34.4	30.8
Kernel Size (%) lg/md/sm	90/10/0	86/14/0	74/25/1	83/16/1	75/24/1	87/12/1	68/31/1	84/15/1	72/27/1
Single Kernel: Hardness	20.1	21.0	20.6	20.7	22.1	28.0	31.1	28.4	29.7
Weight (mg)	40.2	38.3	33.1	35.2	32.6	39.0	34.6	37.8	34.1
Diameter (mm)	2.81	2.70	2.56	2.70	2.49	2.74	2.55	2.72	2.55
Sedimentation (cc)	7.8	10.4	16.7	14.1	8.4	14.9	13.1	17.8	11.8
Falling Number (sec)	321	326	343	336	327	340	356	328	339
FLOUR DATA:									
Lab Mill Extraction (%)[2]	70.3	71.2	69.9	70.3	72.1	71.7	72.9	71.8	73.9
Color: L*	93.2	93.2	93.1	93.1	93.2	93.4	93.4	92.9	92.8
a*	-2.4	-2.2	-2.1	-2.2	-2.0	-2.1	-2.0	-2.1	-2.0
b*	8.6	8.0	8.1	8.1	7.8	7.3	7.1	8.1	8.1
Protein (%) 14%/0% mb	7.3/9.5	8.3/11.3	10.6/13.5	9.7/12.6	9.5/12	8.4/10.8	9.0/11.5	8.9/11.2	9.1/11.3
Ash (%) 14%/0% mb	0.47/0.55	0.46/0.53	0.46/0.53	0.46/0.54	0.48/0.56	0.40/0.47	0.43/0.50	0.43/0.5	0.44/0.51
Wet Gluten (%) 14% mb	20.2	25.0	31.7	28.9	–	19.9	14.5	22.5	14.3
Falling Number (sec)	318	361	377	369	346	351	378	356	365
Amylograph Viscosity: 65g (BU)	368	520	613	569	512	590	580	512	497
RVA: Pasting Temp. (°C)/Peak Visc. (cP)	83.1/2122	82.2/2211	80.7/2513	81.32/2393	71.0/2281	82.9/2328	71.0/2431	–	–
Hot Paste Visc. (cP)/Final Visc. (cP)	1482/2894	1580/3047	1742/3221	1675/3146	1611/3041	1681/3107	1771/3184	–	–
Damaged Starch (%)	4.3	3.8	3.4	3.6	3.4	3.8	3.4	3.8	3.5
SRC: Water/50% Sucrose (%)	52/95	50/97	51/97	51/97	51/93	55/96	55/93	53/94	52/92
5% Lactic Acid/5% Na_2CO_3 (%)	84/66	90/66	115/70	105/68	71/66	87/70	71/67	102/77	77/73
Gluten Performance Index (GPI)	0.52	0.56	0.69	0.64	0.44	0.52	0.44	0.58	0.47
DOUGH PROPERTIES:									
Farinograph: Peak Time (min)	–	1.6	3.0	2.5	–	1.4	1.1	1.9	1.3
Stability (min)	–	2.2	3.4	3.0	–	2.0	1.1	2.5	1.2
Absorption (%)	–	51.0	51.3	51.2	–	50.8	50.0	52.0	50.1
Alveograph: P (mm)	33	35	35	35	23	39	25	35	22
L (mm)	66	77	132	110	79	75	49	100	75
P/L Ratio	0.50	0.45	0.27	0.34	0.29	0.53	0.51	0.37	0.36
W (10^{-4} J)	55	66	109	92	34	79	33	83	33
Extensograph (45 min): Resistance (BU)	–	216	319	284	–	240	115	235	121
Extensibility (cm)	–	15.9	18.7	17.7	–	15.0	15.3	18.2	16.3
Area (cm^2)	–	53	85	74	–	54	26	64	26
BAKING EVALUATION:									
Sponge Cake: Volume (cc)	1143	1136	1059	1089	1110	1137	1150	1102	1121
Hardness (g)	284	309	383	353	337	278	296	–	–
Cookie: Diameter (cm)	7.9	7.9	7.6	7.7	7.9	8.3	8.7	8.7	9.1
Spread Factor (diameter/height)	8.7	8.6	8.0	8.2	8.8	8.3	9.8	9.7	11.4
Pan Bread: Bake Absorption (%)	55.1	56.1	56.2	56.1	–	56.0	–	–	–
Loaf Volume (cc)	583	633	739	696	–	641	–	–	–
CHINESE SOUTHERN-TYPE STEAMED BREAD EVALUATION:									
Specific Volume (cc/g)	2.5	2.6	2.7	2.7	2.7	2.4	2.9	2.1	2.3
Total Score	68.8	70.0	71.4	70.8	70.7	68.2	69.0	65.5	62.4
% OF PRODUCTION:	**6**	**32**	**62**	**100**	**100**				

[1]Protein Range: Low, <9.0%; Medium, 9.0 - 10.5%; High, >10.5%.

[2] The lab mill extraction calculation changed; 2023 values are not comparable to previous years. See analysis methods.

[3] The cookie methodology changed; 2023 values are not comparable to previous years. See analysis methods.

SUBCLASSES

Under the Official United States Standards for Grain, soft white wheat is divided into the following three subclasses:

SOFT WHITE (SW)

- Contains not more than 10% of white club wheat.
- SW, *Triticum aestivum* (common wheat), also known as "Common Soft White," has a white bran and soft endosperm. Soft white is often used for typical soft wheat applications and has low to medium-low gluten strength.

WHITE CLUB (WC)

- Contains not more than 10% of other soft white wheats.
- *Triticum compactum* (white club wheat) has a white bran and very soft endosperm and is known as the softest class of U.S. wheat. Club wheat has very weak gluten and its use results in excellent cake quality (high ratio sponge cake). It is normally exported as a component of Western White but can also be purchased separately.

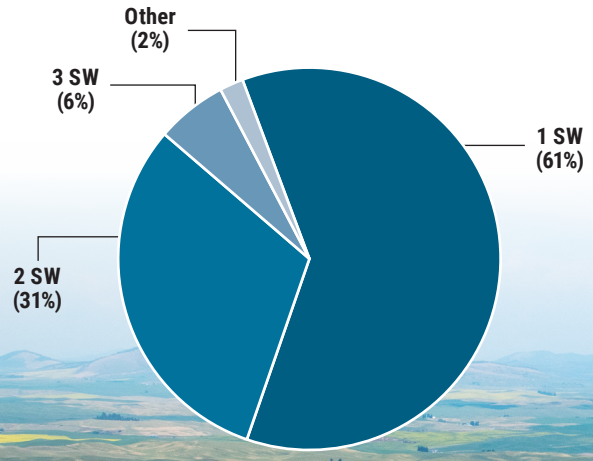
WESTERN WHITE (WW)

- Contains more than 10% of white club wheat and more than 10% of other soft white wheats.
- Some customers specify varying levels of the soft white wheat and white club wheat blend to take advantage of club wheat's weaker gluten characteristics for sponge cake and other confections. Western White is prized for its cake baking quality.

"Farming requires perseverance and adaptation to variable conditions. 2023 was a challenging year for many wheat producers due to drought and unusual temperatures. However, I believe that our investments into variety development and adoption of sustainable management practices have helped us ensure the best functionality for the flour made from PNW soft white wheat. Thanks to all our customers for your dedication in purchasing the wheat grown on our family farms."

— David Brewer, Oregon wheat farmer

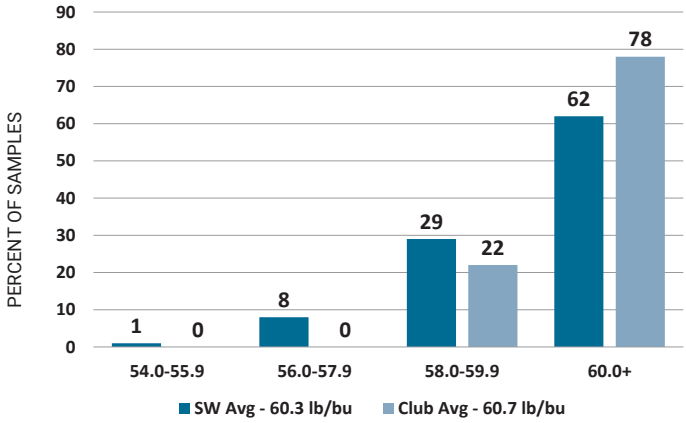
DISTRIBUTION BY GRADE



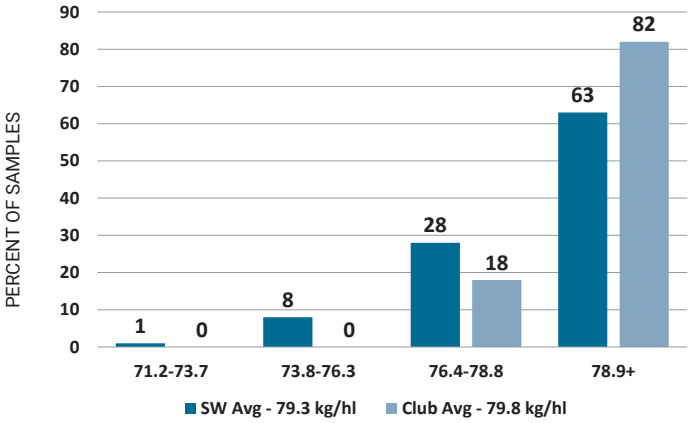
Lori J. Maricle, Washington Grain Commission

DISTRIBUTIONS

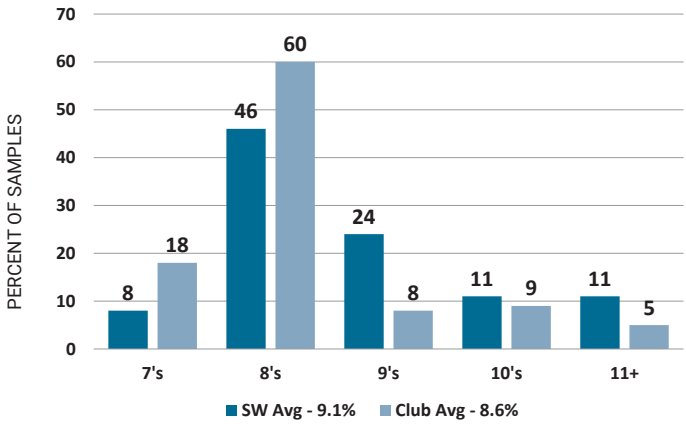
TEST WEIGHT | Pounds/Bushel



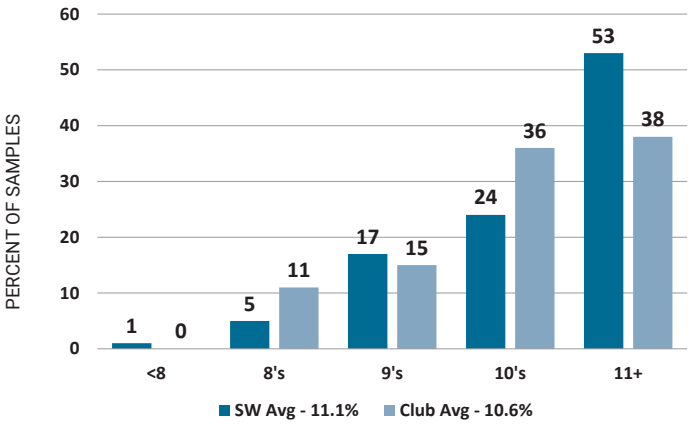
TEST WEIGHT | Kilograms/Hectoliter



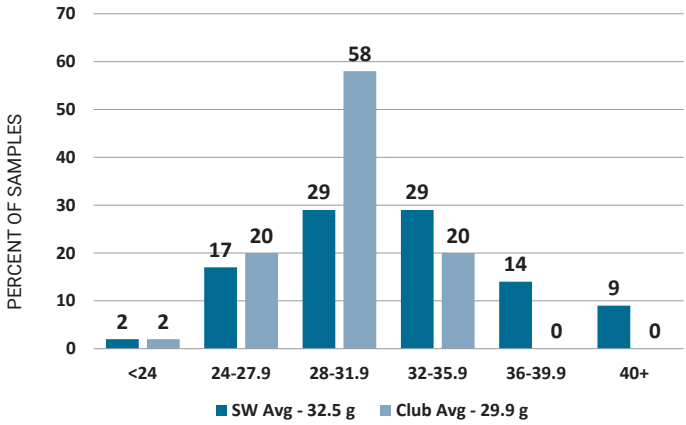
WHEAT MOISTURE | Percent



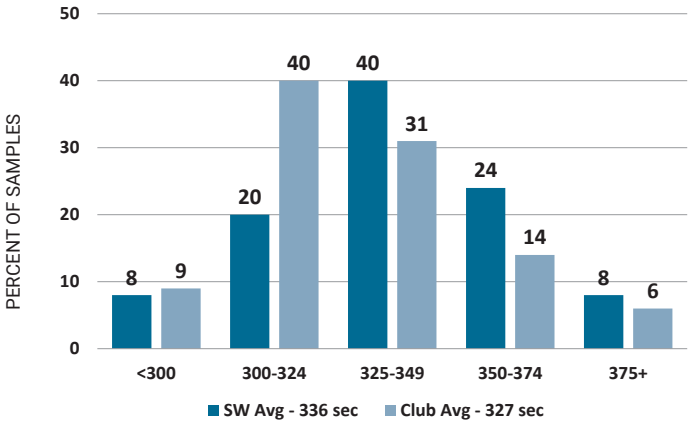
PROTEIN (12% MB) | Percent



THOUSAND KERNEL WEIGHT | Grams



FALLING NUMBER | Seconds



SOFT RED WINTER

Grown in the eastern third of the United States and shipped via Gulf, Atlantic, and Great Lakes ports, soft red winter (SRW) wheat is the third largest class of wheat grown in the United States. SRW is a high-yielding wheat with low protein of 8.5 to 10.5% (12% mb), soft endosperm, red bran, and weak gluten. It is used in pastries, cakes, cookies, crackers, pretzels, flat breads and for blending flours.

For the miller, SRW helps diversify the types of flour produced to improve the quality of many products. SRW blended with hard red spring (HRS) and hard red winter (HRW) wheat can lower grist cost and improve bread crumb texture or improve the quality and appearance of a wide variety of products.

For the baker, the lower moisture content of the flour produced with SRW creates an advantage by increasing the added water volume while optimizing water absorption and product quality to the consumer.

APPLICATIONS

U.S. SRW wheat, commonly used for specialty products such as sponge cakes, cookies, crackers and other confectionary products, also adds value to the miller and baker as a blending wheat.

Applications include:

- Baguettes
- Empanadas
- Flat breads
- Cookies
- Pastries
- Cakes
- Cereals or cereal bars
- Crackers
- Pretzels
- Snack foods
- Fried Spring Rolls
- Mooncake
- Flours (cake, pastry, self-rising, wafer)
- Blending wheat to improve extensibility

SCAN THIS QR CODE for more information.

SAMPLE COLLECTION AND ANALYSIS

Great Plains Analytical Laboratory in Kansas City, Missouri, collected the samples and conducted the quality analyses.

SAMPLE TESTING

Test weight, moisture, protein, 1000 kernel weight, wheat ash and falling number were determined on each sample, and DON on a portion of the samples. The remaining tests were determined on 18 composite samples. Results were weighted by estimated production for each reporting area and combined into Overall, East Coast-exportable and Gulf-exportable averages. The methods are described in the Analysis Methods section of this booklet.

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SAMPLES OF SOFT RED WINTER

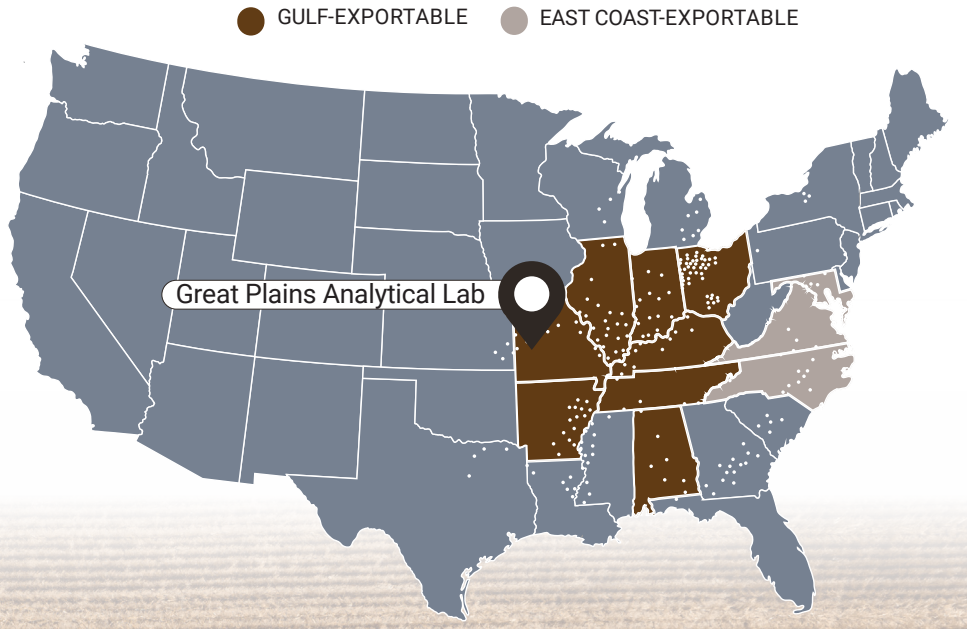
collected from elevators in 18 reporting areas.

11

STATES SURVEYED

76%

OF TOTAL SW PRODUCTION REPRESENTED



HARVEST SURVEY

SRW is grown over a wide area of the eastern United States. The production region experienced generally good growing conditions in the 2023 crop year. The crop is very sound with high test weight and falling number values, large kernel size, good milling characteristics, and is relatively free of DON. Processors will find a versatile crop with good qualities for cookies, cakes and crackers. With higher protein and good extensibility, the crop should also be valuable in blending for baking applications. Buyers are encouraged to review their quality specifications to ensure that purchases meet their expectations.

WEATHER AND HARVEST

PLANTING started at a normal pace the mid-September 2021, then progressed faster than average. The area seeded to SRW in fall 2022 for the 2023 harvest is estimated by USDA at 3.10 million hectares, up 12% seeded for the 2022 harvest and up 26% over the 5-year average, making this the most planted acres since 2014.

As the crop **DEVELOPED** much of the SRW growing area received plentiful moisture through the winter and spring with only Maryland seeing a decrease in soil moisture. Overall, timely mild temperatures and rainfall benefited critical kernel development.

HARVEST began in mid-May and picked up pace early-June with unusually dry conditions and below average temperatures. Weather patterns changed by mid-June with widespread rain causing harvest delays in North Carolina, Maryland and Ohio.

PRODUCTION the 2023 SRW crop is estimated to be 12.0 MMT, up from both 9.2 MMT in 2022 and the 5-year average of 8.1 MMT, making this the largest SRW production in 9 years and highest yield on record.

CROP HIGHLIGHTS

The overall **GRADE** sample average for the 2023 SRW harvest survey is U.S. No. 1 SRW; the Gulf average is U.S. No. 1 SRW, and East Coast is U.S. No. 2 SRW.

TEST WEIGHT averages trended higher and are indicative of a sound crop with Composite average 60.3 lb/bu (79.3 kg/hl), Gulf average 60.4 lb/bu (79.5 kg/hl) and East Coast 59.6 lb/bu (78.4 kg/hl).

WHEAT FALLING NUMBER overall average of 320 seconds is below 2022 but above the 5-year average and indicates there is very little sprout damage in the crop; the lower East Coast average is due to rainfall at harvest.

SINGLE KERNEL values reflect a consistent crop. Kernels are harder, heavier, and larger than last year and the 5-year average.

VOMITOXIN (DON) averages are well below the USDA threshold of 2.0 ppm and indicate that the sampled crop is relatively free of DON.

AMYLOGRAPH indicates starch characteristics that are suitable for batter-based products. The 2023 averages for Composite (655 BU) and Gulf (709 BU) are very sound, reinforce the high falling numbers, and indicate very low levels of amylase activity. The East Coast value of 401 BU reflects this year's slightly lower falling number values.

SOLVENT RETENTION CAPACITY (SRC) values for this crop indicate excellent quality for all typical applications. Sucrose values indicate cookies and crackers will benefit from reduced bake time and should not experience any excess water-holding issues.

DOUGH PROPERTIES suggest that this crop is weaker than the 5-year average and is typical for SRW.

COOKIE DIAMETER values are consistent across the crop (9.0 cm) and are higher than last year but similar to the 5-year average, indicating this crop has adequate to good spreadability.

LOAF VOLUMES averages are lower than last year and the 5-year average and indicate this crop is suitable for blending: Composite (602 cc), East Coast (587 cc) and Gulf (606 cc).

HARVEST DATA

	OVERALL			EAST COAST[1]			GULF[1]		
	2023 Avg	2022 Avg	5-Year Avg	2023 Avg	2022 Avg	5-Year Avg	2023 Avg	2022 Avg	5-Year Avg
WHEAT GRADE DATA:									
Test Weight (lb/bu)	60.3	60.1	59.1	59.6	59.7	58.2	60.4	60.3	59.3
(kg/hl)	79.3	79.1	77.8	78.4	78.5	76.7	79.5	79.3	78.1
Damaged Kernels (%)	0.3	0.2	0.4	0.3	0.5	0.9	0.3	0.1	0.3
Foreign Material (%)	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1
Shrunken & Broken (%)	0.6	0.6	0.6	0.4	0.5	0.7	0.6	0.6	0.5
Total Defects (%)	1.0	0.9	1.0	0.8	1.1	1.6	1.1	0.8	0.9
Grade	1 SRW	1 SRW	2 SRW	2 SRW	2 SRW	2 SRW	1 SRW	1 SRW	2 SRW
WHEAT NON-GRADE DATA:									
Dockage (%)	0.4	0.4	0.3	0.3	0.3	0.3	0.5	0.4	0.3
Moisture (%)	13.3	12.4	13.2	13.8	12.7	13.5	13.2	12.3	13.1
Protein (%) 12%/0% mb	9.3/10.6	9.6/10.9	9.5/10.8	9.4/10.7	10.1/11.5	9.8/11.1	9.3/10.6	9.4/10.7	9.5/10.8
Ash (%) 14%/0% mb	1.40/1.63	1.46/1.70	1.62/1.88	1.36/1.58	1.38/1.61	1.57/1.83	1.41/1.64	1.72/2.00	1.63/1.90
1000 Kernel Weight (g)	35.9	32.9	32.6	36.4	34.6	33.9	35.8	32.6	32.3
Kernel Size (%) lg/md/sm	89/10/1	85/14/1	85/14/1	90/09/1	87/13/00	84/14/1	89/10/1	85/14/1	85/14/1
Single Kernel: Hardness	24.5	23.4	21.7	24.6	24.1	21.8	24.5	23.3	21.6
Weight (mg)	36.4	32.5	33.7	37.0	34.4	34.7	36.3	32.1	33.4
Diameter (mm)	2.68	2.60	2.63	2.69	2.64	2.64	2.68	2.59	2.63
Sedimentation (cc)	12.6	11.1	10.8	12.7	12.1	11.6	12.6	10.9	10.6
Falling Number (sec)	320	327	311	293	336	292	326	325	315
DON (ppm)	0.3	0.7	0.8	0.2	0.4	0.5	0.3	0.8	0.9
FLOUR DATA:									
Lab Mill Extraction (%)	68.4	66.4	66.9	66.5	66.6	66.9	68.8	66.4	66.9
Color: L*	91.0	91.1	91.1	91.1	90.5	91.0	91.0	91.3	91.2
a*	-2.2	-2.4	-2.3	-2.1	-2.3	-2.3	-2.2	-2.4	-2.3
b*	8.6	9.3	9.1	8.1	9.3	8.9	8.8	9.3	9.1
Protein (%) 14%/0% mb	7.3/8.5	7.6/8.8	7.7/9.0	7.3/8.4	8.0/9.3	7.9/9.1	7.3/8.5	7.6/8.8	7.7/8.9
Ash (%) 14%/0% mb	0.42/0.49	0.41/0.48	0.43/0.50	0.38/0.44	0.41/0.48	0.43/0.50	0.43/0.50	0.41/0.48	0.42/0.49
Wet Gluten (%) 14% mb	20.3	20.7	21.0	20.5	22.8	21.8	20.3	20.3	20.9
Falling Number (sec)	320	326	339	287	313	294	328	329	350
Amylograph Viscosity: 65g (BU)	655	666	548	401	574	404	709	687	586
Damaged Starch (%)	3.3	3.4	3.4	3.4	4.4	3.4	3.3	3.2	3.5
SRC: Water/50% Sucrose (%)	51/85	51/90	54/93	50/84	50/86	54/96	51/86	52/91	54/93
5% Lactic Acid/5% Na_2CO_3 (%)	99/68	102/71	107/74	96/67	104/68	110/75	99/68	102/72	106/73
Gluten Performance Index (GPI)	0.64	0.64	0.64	0.64	0.67	0.65	0.64	0.63	0.64
DOUGH PROPERTIES:									
Farinograph: Peak Time (min)	1.2	1.2	1.2	1.2	1.4	1.3	1.2	1.1	1.1
Stability (min)	1.7	1.6	1.7	1.6	2.0	1.8	1.7	1.5	1.6
Absorption (%)	52.5	51.2	52.0	52.4	52.2	52.6	52.5	51.0	51.9
Alveograph: P (mm)	45	36	38	43	41	41	46	35	37
L (mm)	64	82	79	73	91	79	62	80	79
P/L Ratio	0.70	0.44	0.48	0.59	0.45	0.51	0.73	0.44	0.48
W (10^{-4} J)	88	85	81	90	103	86	88	81	80
Extensograph (45 min): Resistance (BU)	219	200	179	204	194	170	222	202	182
Extensibility (cm)	14.8	15.3	15.8	15.3	16.6	16.5	14.7	15.0	15.6
Area (cm^2)	55	53	49	53	58	50	56	52	49
BAKING EVALUATION:									
Cookie: Diameter (cm)	9.0	8.9	8.9	9.0	8.8	8.8	9.0	8.9	9.0
Spread Factor (diameter/height)	9.7	10.7	10.1	9.9	10.6	9.9	9.6	10.7	10.2
Pan Bread: Bake Absorption (%)	54.4	54.0	53.9	51.1	54.6	54.3	55.1	53.8	53.8
Loaf Volume (cc)	602	624	655	587	610	652	606	627	656
% OF PRODUCTION:	**100**			**16**			**84**		

[1]East Coast - Maryland, Virginia and North Carolina; Gulf - Alabama, Arkansas, Illinois, Indiana, Kentucky, Missouri, Ohio and Tennessee.

SOFT RED WINTER PRODUCTION

FOR THE MAJOR PRODUCING STATES (MMT)

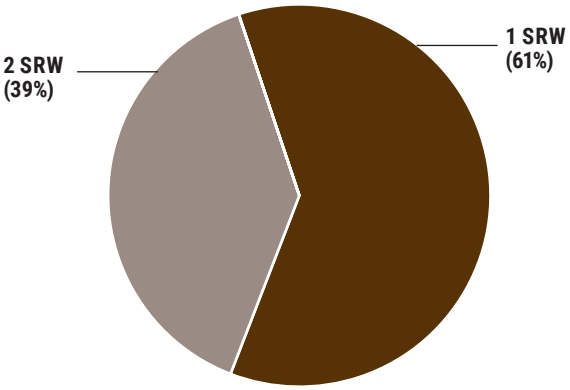
	2023	2022	2021	2020	2019
Alabama	0.3	0.2	0.2	0.1	0.2
Arkansas	0.3	0.2	0.2	0.1	0.1
Georgia	0.1	0.2	0.2	0.1	0.1
Illinois	1.8	1.2	1.3	1.0	1.0
Indiana	0.8	0.5	0.6	0.5	0.4
Kentucky	1.1	0.8	0.8	0.6	0.7
Maryland	0.5	0.4	0.3	0.3	0.3
Michigan	0.9	0.6	0.8	0.6	0.6
Missouri	1.1	0.7	0.9	0.6	0.7
North Carolina	0.8	0.7	0.5	0.6	0.3
New York	0.2	0.2	0.2	0.2	0.1
Ohio	1.4	1.0	1.2	0.9	0.6
Pennsylvania	0.5	0.4	0.4	0.4	0.3
Tennessee	0.8	0.7	0.6	0.4	0.4
Virginia	0.3	0.3	0.2	0.2	0.2
Wisconsin	0.5	0.5	0.5	0.2	0.3
Surveyed-States Total*	**9.3**	**6.6**	**7.0**	**5.3**	**4.8**
East Coast-Exportable	1.5	1.3	1.1	1.1	0.8
Gulf-Exportable	7.8	5.3	5.9	4.2	4.0
Sixteen-State Total	**11.4**	**8.5**	**9.1**	**6.8**	**6.1**
Total SRW Production	**12.2**	**9.2**	**9.8**	**7.2**	**6.5**

Based on USDA crop estimates as of September 29, 2023.

**Eleven states denoted by italics were surveyed accounting for 76% of 2023 SRW production.*

DISTRIBUTION BY GRADE

(BASED ON 18 COMPOSITE SAMPLES)

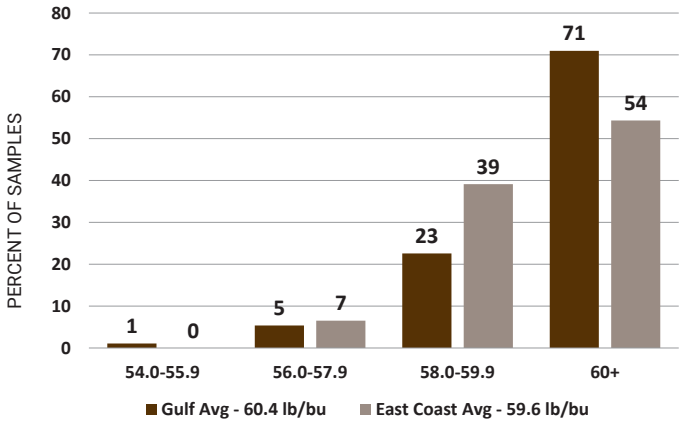


"Wheat acres are up in Illinois and farmers are actively managing the crop for better yields and quality. With favorable conditions we saw really good yields in 2023 here and in a lot of other states. Total SRW production was up 48% in Illinois over 2022. Test weight was over 60 lb/bu (78.8 kg/hl), protein was normal for SRW, and there was no problem with vomitoxin levels. So, with higher supplies and lower export prices, overseas buyers should be very happy with this SRW crop."

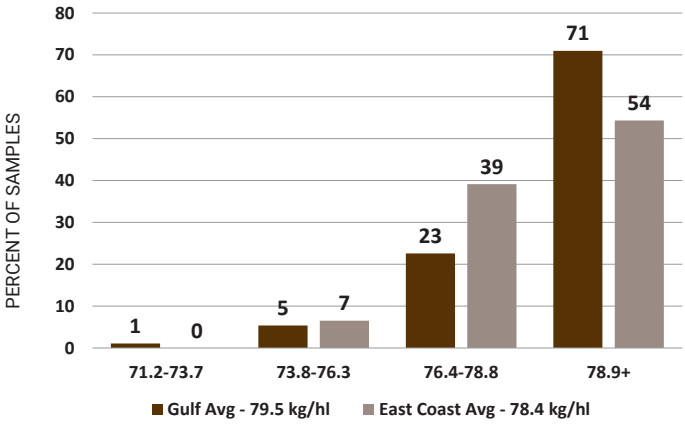
—John Howell, Illinois wheat farmer

DISTRIBUTIONS

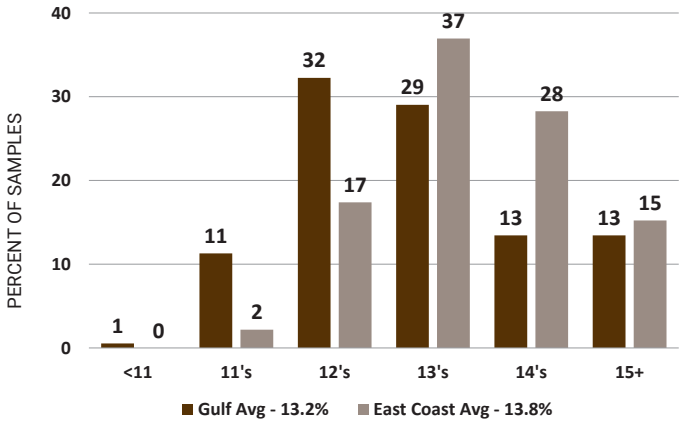
TEST WEIGHT | Pounds/Bushel



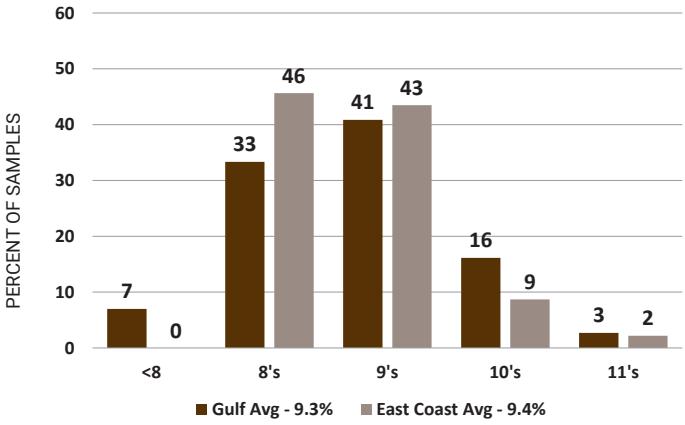
TEST WEIGHT | Kilograms/Hectoliter



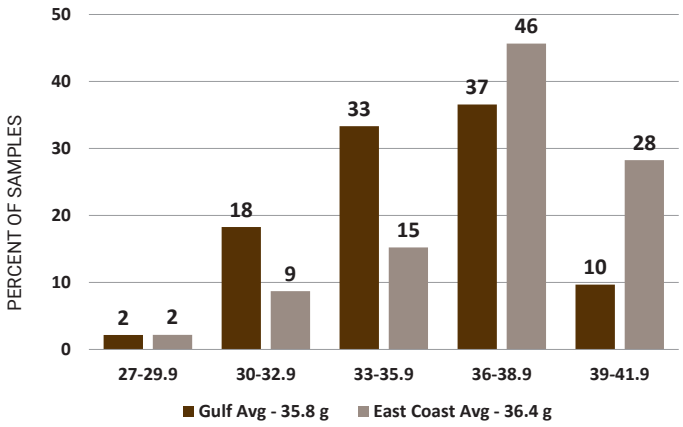
WHEAT MOISTURE | Percent



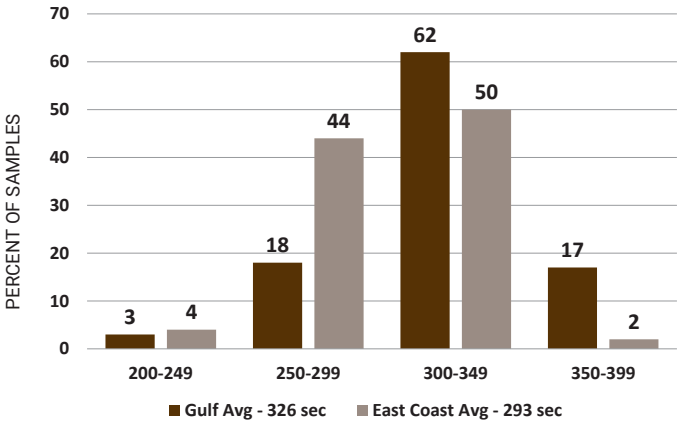
PROTEIN (12% MB) | Percent



THOUSAND KERNEL WEIGHT | Grams



FALLING NUMBER | Seconds



DURUM

Northern Durum is grown primarily in the North Central region and shipped via Gulf, Great Lakes and Pacific ports, while Desert Durum®, is grown primarily under contract in the desert Southwest (Arizona and California) and shipped via the Gulf or West Coast. Durum is the fifth largest class of wheat grown in the United States and has a high protein content of 12.0% to 15.0% (12% mb), rich amber color, yellow endosperm, high gluten and white bran.

For the miller, durum is a large, very hard kernel with the potential for very high extraction of high quality, low ash semolina that is ideal for fine pasta. Desert Durum® is harvested and shipped at a very low moisture content, an advantage to millers that contributes to efficient transportation costs and high extraction rates.

For consumers of pasta, couscous and Mediterranean breads, durum helps deliver excellent color and texture.

APPLICATIONS

Hard Amber Durum (HAD) sets the "gold standard" for premium pasta products, couscous and some Mediterranean breads and cakes.

Applications include:

- Premium quality long and short goods pasta
- Blends (with HRS) for pizza doughs
- Durum semolina
- Couscous
- Mediterranean breads and cakes

SCAN THIS QR CODE for more information.

SURVEY METHODOLOGY

NORTHERN DURUM SAMPLE COLLECTION AND ANALYSIS

The Durum Quality Lab, North Dakota State University, Fargo, North Dakota, conducted the quality analyses.

NORTHERN DURUM SAMPLE TESTING

Official grade, test weight, vitreous kernel, 1000 kernel weight, protein and falling number were determined on each sample. The remaining tests were conducted on 6 composite samples categorized by growing region for Northern Durum. The methods are described in the Analysis Methods section of this booklet.

225

SAMPLES OF NORTHERN DURUM

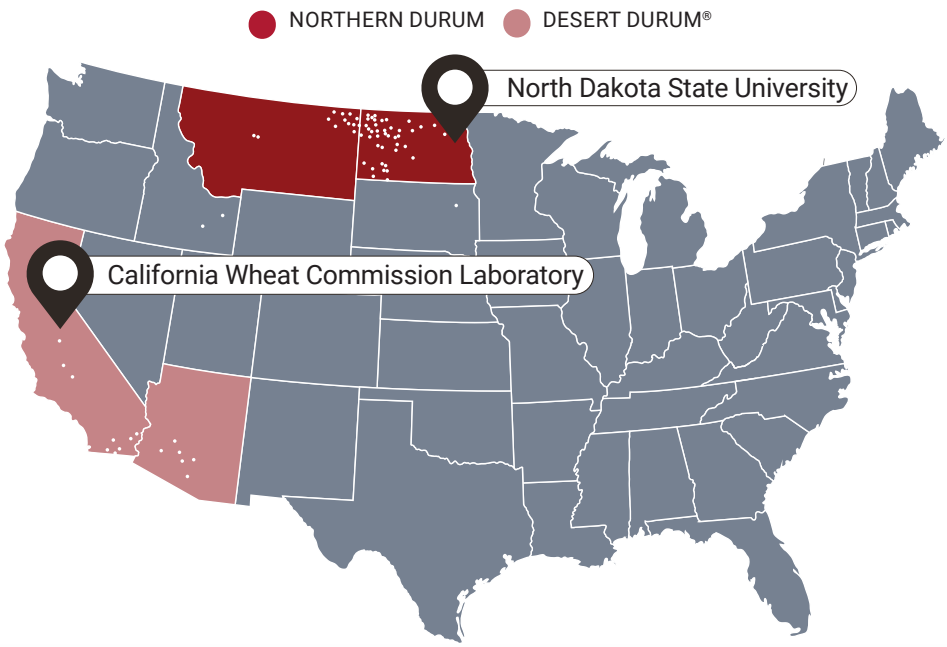
collected from fields, farm bins and local elevators by the National Agricultural Statistics Service.

4

STATES SURVEYED

99%

OF TOTAL DURUM PRODUCTION REPRESENTED



7

SAMPLES OF DESERT DURUM®

collected by a Federal Grain Inspection Service (FGIS) licensed inspection agency or submitted by handlers to a licensed agency.

DESERT DURUM® SAMPLE COLLECTION AND ANALYSIS

California Wheat Commission Laboratory conducted the quality analyses.

DESERT DURUM® SAMPLE TESTING

All tests were conducted on each sample. Production-weighted results are reported. The Desert Durum® production area is highlighted on the map above. The methods are described in the Analysis Methods section of this booklet.

DURUM PRODUCTION

FOR THE MAJOR PRODUCING STATES (MMT)

	2023	2022	2021	2020	2019
Arizona	0.1	0.3	0.1	0.1	0.1
California	0.1	0.1	0.1	0.0	0.1
Montana	0.6	0.5	0.3	0.7	0.6
North Dakota	0.9	0.8	0.5	1.0	0.8
Four-State Total	1.6	1.7	1.0	1.9	1.6
Northern Durum	1.4	1.4	0.8	1.7	1.4
Desert Durum®	0.2	0.4	0.2	0.2	0.2
Total Durum Production	**1.6**	**1.7**	**1.0**	**1.9**	**1.6**

Based on USDA crop estimates as of September 29, 2023.

SUBCLASSES

Under the Official United States Standards for Grain, durum wheat is divided into the following three subclasses based on vitreous kernel content:

HARD AMBER DURUM (HAD)

- Contains at least 75% hard, vitreous kernels of amber color.

AMBER DURUM (AD)

- Contains between 60-74% hard, vitreous kernels of amber color.

DURUM (D)

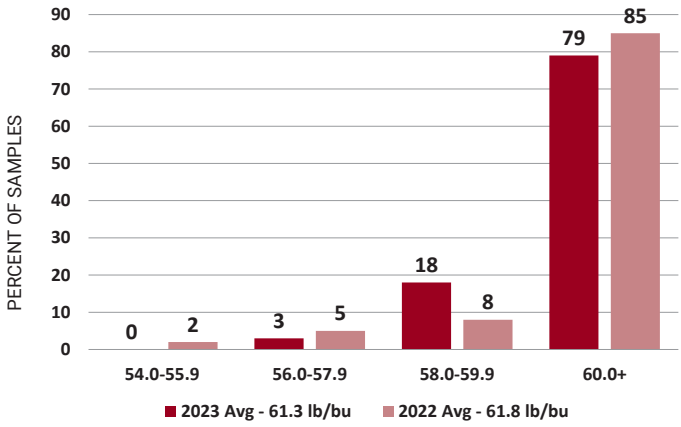
- Contains less than 60% hard, vitreous kernels of amber color.

"I am pleasantly surprised by the durum yields on my farm this year, given how dry and hot it was. Some fields were impacted by hail, but even those yielded above my expectations. Every year brings challenges beyond our control, and we do the best we can to produce a good quantity and quality crop. There is definitely variability in the quality of this year's crop, but I'm extremely happy and I think our customers will be too."

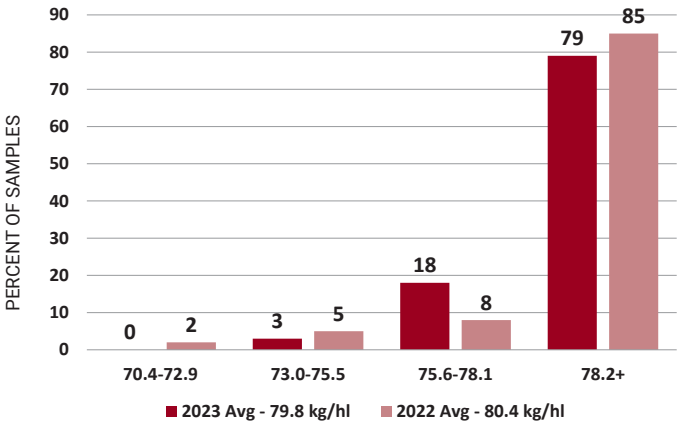
— Dustin Johnsrud, North Dakota wheat farmer

NORTHERN DURUM DISTRIBUTIONS

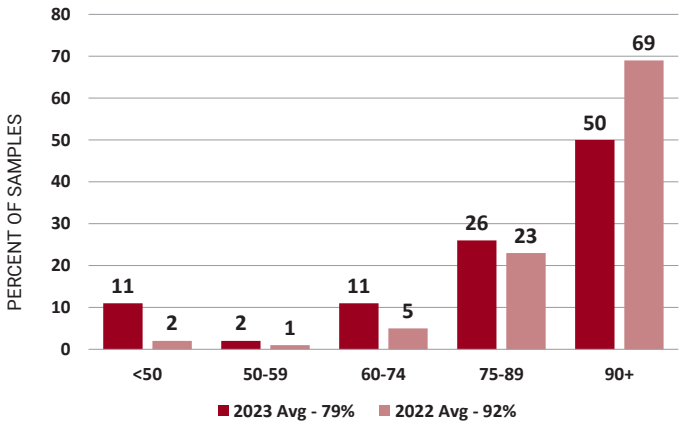
TEST WEIGHT | Pounds/Bushel



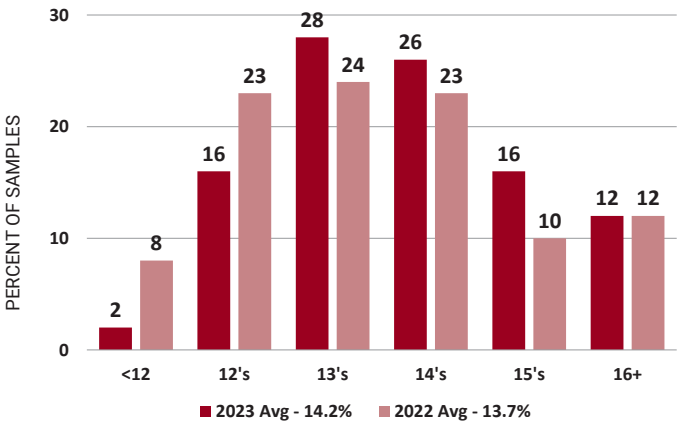
TEST WEIGHT | Kilograms/Hectoliter



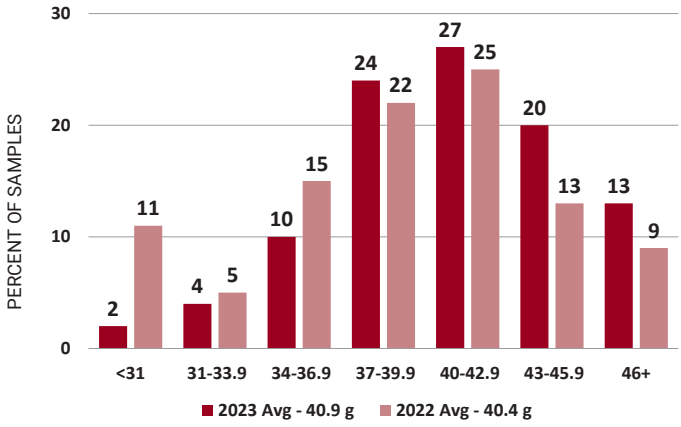
VITREOUS KERNELS | Percent



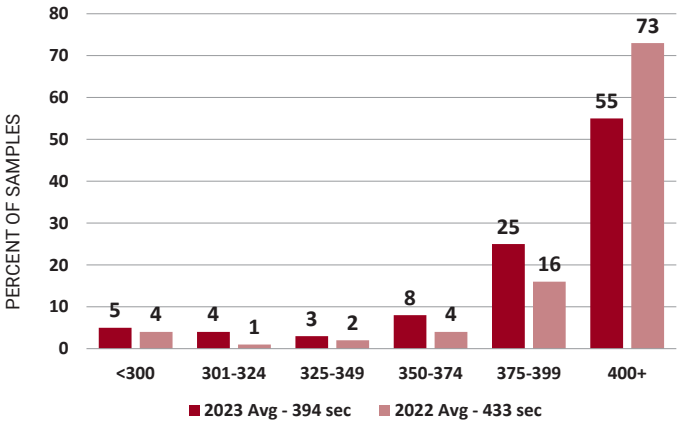
PROTEIN (12% MB) | Percent



THOUSAND KERNEL WEIGHT | Grams



FALLING NUMBER | Seconds



NORTHERN DURUM HARVEST SURVEY

Strong features of the 2023 Northern Durum crop include higher protein, strong grades, low damage, good test weights, and sound kernel characteristics. Diligent contract specifications will help manage some variable quality parameters, especially vitreous kernel content. The crop shows increased gluten strength and end-use characteristics similar to an average crop. Overall, this crop will meet the needs of customers.

WEATHER AND HARVEST

PLANTING started slightly later than average due to cold, wet conditions, but was well ahead of last year's pace. Moisture conditions at planting were adequate in most areas. The majority of the crop was planted mid-May through mid-June.

The crop **EMERGED** under mostly good moisture and growing conditions, but hot, dry weather in June impacted crop stands and yield potential. Precipitation during the rest of the growing season ranged widely from above- to below-average rainfall. Disease pressure was very low. Yields and crop quality were quite variable.

HARVEST started in early August under dry conditions. Some of the later harvest was delayed due to rain, heavy dews and fog. Less-than-ideal conditions slowed the last portion of the harvest.

Durum **PRODUCTION** in the U.S. Northern Plains, at 1.4 MMT, is slightly above last year on increased planted area in spite of somewhat lower yields.

NORTHERN DURUM CROP HIGHLIGHTS

The average **GRADE** of the 2023 crop is U.S. No. 1 Hard Amber Durum (HAD); 51% of the crop grades U.S. No. 1 HAD, down from 75% in 2022.

Average **TEST WEIGHT** of 61.3 lb/bu (79.8 kg/hl), similar to last year with pockets of lower test weights.

DAMAGED KERNELS at 0.4% was slightly higher than last year but lower than the 5-year average due to minimal disease pressure.

The average **VITREOUS KERNEL (HVAC)** content is 79%, lower than last year and the five-year average, however nearly half of the crop has 90% HVAC or higher. Approximately one-fourth of the samples were below 75% HVAC.

WHEAT PROTEIN averages 14.2% (12% mb), higher than last year and equal to the 5-year average. Some portions of the crop had unusually low protein levels due to very high yields, but more than 80% of the samples are above 13.0% protein.

The average **1000 KERNEL WEIGHT (TKW)** is 40.9 g, slightly higher than last year with 60% of the crop above 40.0 g.

KERNEL MOISTURE at 11.5% is slightly higher than average due to some wet conditions at harvest.

WHEAT FALLING NUMBER values are strong, with the average being 394 seconds; approximately 5% of samples fall below 300 seconds.

For a third consecutive year, **DON** is nearly non-existent in the Northern Durum crop due to limited disease pressure.

MILLING for the 2023 survey was performed on a Quadromat® Junior mill, the same as the previous four years. Semolina extraction is 52.0%, indicating a reduction in extraction from last year; commercial mills are likely to see higher extraction values. Larger kernel size and strong 1000 kernel weights are positive milling attributes, but the lower vitreous kernel levels may impact semolina yields. Some adjustment for crop variability may be required.

SEMOLINA ASH at 0.63% and **SPECK COUNTS** are both similar to last year.

SEMOLINA PROTEIN is 12.4%, higher than last year due to higher kernel protein.

Similarly, **GLUTEN INDEX** at 91% is much higher than last year.

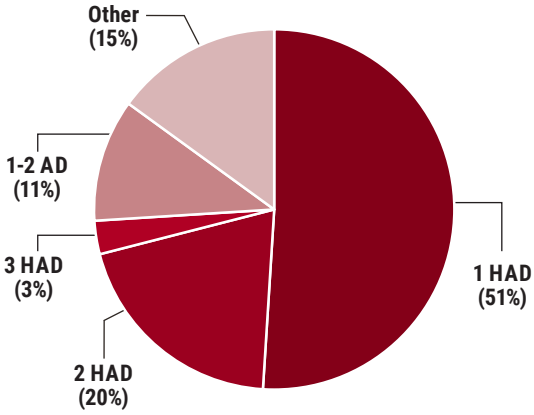
SEMOLINA COLOR shows a slight decline in the b* value (yellow color) at 30.1, but is similar to the 5-year average.

SPAGHETTI EVALUATIONS show color similar to the average, with higher cooked weight, higher cooked loss, and lower cooked firmness.

NORTHERN DURUM HARVEST DATA

	2023 Avg	2022 Avg	5-Year Avg
WHEAT GRADE DATA:			
Test Weight (lb/bu)	61.3	61.8	61.4
(kg/hl)	79.8	80.4	79.9
Damaged Kernels (%)	0.4	0.1	0.7
Foreign Material (%)	0.0	0.0	0.0
Shrunken & Broken (%)	0.6	1.0	0.8
Total Defects (%)	1.0	1.1	1.5
Vitreous kernels (%)	79	92	84
Grade	1 HAD	1HAD	1 HAD
WHEAT NON-GRADE DATA:			
Dockage (%)	1.1	1.1	0.9
Moisture (%)	11.5	11.0	11.2
Protein (%) 12%/0% mb	13.9/16.1	13.7/15.6	13.9/16.1
Ash (%) 14%/0% mb	1.43/1.66	1.64/1.91	1.59/1.85
1000 Kernel Weight (g)	40.9	40.4	42.8
Kernel Size (%) lg/md/sm	56/42/2	43/52/5	50/46/4
Falling Number (sec)	394	433	410
Sedimentation (cc)	81	61	65
DON (ppm)	<0.5	<0.5	<0.5
SEMOLINA DATA:			
Lab Mill Extraction (%)	—	—	—
Semolina Extraction (%)	52.0	53.9	58.8
Color: L*	83.4	83.3	83.4
a*	-2.5	-2.5	-2.4
b*	30.1	31.2	30.2
Protein (%) 14%/0% mb	12.4/14.4	12.0/14.0	12.8/14.9
Ash (%) 14%/0% mb	0.63/0.73	0.64/0.74	0.65/0.76
Specks (no/10 in²)	27	27	28
Wet Gluten (%) 14% mb	32.1	33.4	34.8
Gluten Index (%)	91	72	70
SPAGHETTI EVALUATION:			
Color: L*	60.3	60.8	60.5
a*	3.5	3.6	3.9
b*	44.6	44.9	45.1
Cooked Weight (g)	31.6	29.7	31.2
Cooking Loss (%)	7.3	6.7	6.9
Cooked Firmness (g*cm)	3.9	4.5	4.2
SAMPLE COUNT:	**225**	**234**	

NORTHERN DURUM GRADE DISTRIBUTION



DESERT DURUM® HARVEST SURVEY

Desert Durum® is a registered certification mark of the Arizona Grain Research and Promotion Council and the California Wheat Commission, which authorize its use only to designate durum grown under irrigation in the desert valleys and lowlands of Arizona and California.

Desert Durum® can be produced and delivered "identity preserved" to domestic and export markets, which allows customers to purchase grain with quality traits specific to their processing needs. Annual requirements can be pre-contracted with grain merchandisers ahead of the fall-winter planting season for harvest in late May through early July. Varietal identity is maintained by experienced growers planting certified seed and merchandisers who store and ship according to customers' preferred delivery schedules.

Desert Durum® exhibits consistently large kernels and low moisture, traits that contribute to efficient transportation costs and high extraction rates. The 2023 crop will deliver the valuable milling, semolina and pasta quality traits that customers have learned to expect and appreciate.

DESERT DURUM® CROP HIGHLIGHTS

Desert Durum® **PRODUCTION** acreage in 2023 was lower than 2022. According to USDA, yields were 3.10 tons/acre, and quality was uniformly good. Based on our 2023 variety survey, Desert Gold was the most widely grown variety in California. Tiburon was the second most grown durum variety in California.

The overall **GRADE** sample average for the 2023 Desert Durum® harvest survey is U.S. No. 1 Hard Amber Durum (HAD).

TEST WEIGHT is indicative of sound wheat and a uniform crop with an average of 63.0 lb/bu (82.0 kg/hl).

The average **VITREOUS KERNEL (HVAC)** content is 98%, a high average typical of Desert Durum®.

Average **DAMAGED KERNELS** are 0.1% and **TOTAL DEFECTS** are 0.5%.

Kernel **MOISTURE** content is low at 7.3%, a characteristic of Desert Durum®.

WHEAT PROTEIN content average is 13.9% (12% mb).

The **SEMOLINA COLOR** b* value is 32.9, slightly higher compared to 2022.

The **WET GLUTEN** average is 34.3% and **GLUTEN INDEX** average is 79%.

Spaghetti **COOKED FIRMNESS** average is 7.4 g*cm, higher than last year's 6.8.

"Desert Durum® continues to provide reliable and consistent crops. The 2023 crop produced above average yields with ideal growing conditions throughout the season. Many fields yielded above 130 bu/ac (8.7 mt/ha). Over 99% of the Imperial Valley crop graded U.S. No. 1 HAD with an average protein of 13.3% (12% MB). Harvesting in May and June, the desert has the ability to fill a quality or quantity gap in the market when adverse conditions develop in other production regions."

— Ron Rubin, California wheat farmer

DESERT DURUM® HARVEST DATA

	2023 Avg	2022 Avg	5-Year Avg
WHEAT GRADE DATA:			
Test Weight (lb/bu)	63.0	64.1	63.2
(kg/hl)	82.0	83.4	82.3
Damaged Kernels (%)	0.1	0.0	0.1
Foreign Material (%)	0.1	0.0	0.0
Shrunken & Broken (%)	0.3	0.4	0.4
Total Defects (%)	0.5	0.5	0.6
Vitreous kernels (%)	98	98	98
Grade	1 HAD	1 HAD	1 HAD
WHEAT NON-GRADE DATA:			
Dockage (%)	0.3	0.2	0.3
Moisture (%)	7.6	7.3	7.1
Protein (%) 12%/0% mb	13.6/15.8	13.2/15.3	13.8/16.0
Ash (%) 14%/0% mb	1.65/1.91	1.58/1.84	1.68/1.95
1000 Kernel Weight (g)	48.8	51.9	47.1
Kernel Size (%) lg/md/sm	92/8/0	96/4/0	91/9/0
Falling Number (sec)	607	713	643
Sedimentation (cc)	62	59	64
DON (ppm)	—	—	—
SEMOLINA DATA:			
Lab Mill Extraction (%)	78.8	79.7	77.8
Semolina Extraction (%)	73.0	74.2	71.9
Color: L*	86.0	86.5	85.9
a*	-4.2	-3.9	-3.8
b*	32.9	30.9	31.6
Protein (%) 14%/0% mb	13.1/15.2	11.9/13.8	12.9/15.0
Ash (%) 14%/0% mb	0.76/0.88	0.79/0.92	0.82/0.95
Specks (no/10 in²)	30	21	22
Wet Gluten (%) 14% mb	34.3	33.4	34.4
Gluten Index (%)	79	62	75
SPAGHETTI EVALUATION:			
Color: L*	55.0	57.1	56.6
a*	0.2	-0.1	0.0
b*	44.1	44.3	43.4
Cooked Weight (g)	29.0	29.6	29.7
Cooking Loss (%)	6.2	6.3	5.7
Cooked Firmness (g*cm)	7.4	6.8	7.1
SAMPLE COUNT:	**7**	**13**	

ANALYSIS METHODS

WHEAT GRADE FACTORS

U.S. Wheat Grade is a numeric value from 1 to 5 or the designation "Sample Grade," which reflects the physical condition of a sample and thus may indicate its general suitability for milling. All numeric factors other than test weight are reported as a percentage by weight of the sample. (See table on page 4.) Unless otherwise noted, all Wheat Grade Factor methodology can be found in the Official U.S. Standards for Grain. Grade determining factors include:

TEST WEIGHT is a measure of density in pounds per bushel (lb/bu) or kilograms per hectoliter (kg/hl). Test weight may indicate potential milling yield and the general condition of the sample. Problems during the growing season or at harvest often reduce test weight.

- **Method:** AACCI 55-10.01. The official USDA measurement is in lb/bu. • For converting to kg/hl, see Unit Conversion Factors on page 5.

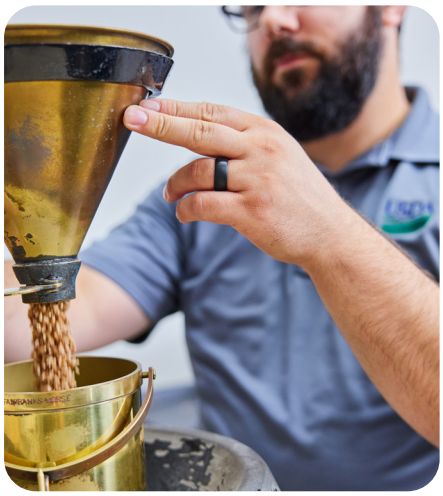
DAMAGED KERNELS show signs of disease, insect activity, frost or sprouting and may adversely affect milling and flour quality.

FOREIGN MATERIAL is any material other than wheat that remains after dockage is removed. Because foreign material can be a similar size and weight as wheat and is not easily removed, it may adversely affect milling and flour quality.

SHRUNKEN AND BROKEN kernels have a shrunken or shriveled appearance or were broken in handling that may reduce milling yield.

TOTAL DEFECTS is the sum of damaged kernels, foreign material and shrunken and broken kernels.

VITREOUS KERNELS in HRS wheat are uniformly dark and have no spots that appear chalky or soft. In durum, vitreous kernels have a glassy and translucent appearance without any spots that appear chalky. Vitreous kernel is the percentage handpicked from a 15 gram (g) clean wheat sub-sample. Vitreous kernel will not determine numeric grade value but will affect subclass designation.



Cereals & Grains Association (formerly American Association of Cereal Chemists International, AACCI) publishes approved methods for determining kernel, flour and end-product testing.

Scan this QR code for more information.

WHEAT NON-GRADE FACTORS

Non-grade factors do not affect numerical grades but can be used to determine the quality of the wheat. All non-grade factors, except moisture, are measured after dockage is removed. Non-grade testing services are available from FGIS or private unofficial inspection companies if requested in the sales contract. Flour based specifications cannot be tested by FGIS at the time of loading and must be contracted out to a private laboratory, normally on composite samples provided by FGIS at the time of loading.

DOCKAGE is the percentage by weight of material removed from a sample by the Carter Dockage Tester and does not influence the numerical grade. Being easy to remove, dockage should not affect milling quality but may have other economic effects for buyers. U.S. Wheat Grade Factors are determined after dockage is removed.

- **Method:** Official USDA procedures.

MOISTURE content is the percentage of water by weight in a sample and is an important indicator of profitability in milling. Flour millers add water to adjust wheat moisture to a standard level before milling. Lower wheat moisture allows more water to be added, increasing the weight of grain to be milled at virtually no cost. Moisture content is also an indicator of grain storability as wheat and flour with low moisture are more stable during storage. Because moisture can be readily added to or removed from a sample, other analysis results should be mathematically converted to a standard moisture basis (mb), such as 14%, 12% or dry matter (0%), so test results can be consistently evaluated (see page 5). Moisture is measured before removing dockage from the sample.

- **Methods:** HRW, HRS, SW: AACC 39-01.01, 39-10.01 and 39-11.01, Near-Infrared Reflectance (NIR) method. • Northern Durum: AACCI 44-11.01, Dielectric meter method, Motomco Moisture Meter. • SRW, Desert Durum®: AACCI 44-15.02, Air-oven method.

PROTEIN content is the percentage of protein by weight in a sample. Because there is no rapid way to measure wheat protein quality, protein quantity is used in trade and by millers as an indicator of the suitability of wheat or flour for various products and is an important factor in determining wheat value. High protein is usually desired for products such as pan breads, pasta, buns and frozen yeast-raised products. Low protein and low gluten are usually desired for products such as cookies, wafers, snacks or cakes.

- **Wheat Protein (12% mb) Methods:** HRW, HRS, Northern Durum, SW: AACCI 39-25.01, NIR method, whole kernels.
- **Flour and Semolina Protein (14% mb) Methods:** HRW, HRS, Northern Durum: AACCI 39-10.01, NIR method. • SW, SRW, Desert Durum®: AACCI 46-30.01, Dumas CAN method.

ASH content is the percentage of minerals by weight in wheat or flour. In wheat, minerals are primarily concentrated in the bran. Ash content indicates milling performance by indirectly revealing the amount of mineral content (bran) contamination in flour. Ash in flour can impart a darker color to finished products. Products requiring white (bright) color call for low ash content, while whole wheat flour has higher ash content. Wheat grown under irrigation and high levels of flour fortification can have higher ash levels due to higher mineral content in the flour. Readers are encouraged to look at flour color in conjunction with ash content.

- **Method:** AACCI 08-01.01 expressed on a 14% mb for all classes. Methodology is same for wheat and flour/semolina.

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

WHEAT NON-GRADE FACTORS CONTINUED

- **Methods:** Shuey, W. 1960. Cereal Sci. Today. 5(3):71-75 for all classes. • Wheat is sifted with a RoTap sifter. Kernels remaining over a U.S. Standard Sieve No. 7 (2.80 mm opening) are "large"; passing through the No. 7 screen but not the Tyler No. 9 or US No. 10, are "medium," and passing through the Tyler No. 9 or US No. 10 screen are "small." • HRW, HRS, SW, Northern Durum: Tyler No. 7 (2.80 mm) and No. 9 (2.00 mm) screens. • Desert Durum®: U.S. No. 7 (2.82 mm) and No. 10 (2.00 mm). Note: Desert Durum® sieve openings are narrower for large and medium kernels than the openings for Northern Durum.

SINGLE KERNEL CHARACTERIZATION SYSTEM (SKCS) measures 300 individual kernels from a sample for size (diameter), weight, hardness (based on the force needed to crush) and moisture. Detailed SKCS results (not reported in this booklet) include the distribution of these factors, which may indicate the uniformity of the sample and help millers experienced with the system to optimize flour milling yields. Kernel characteristics may help millers optimize tempering and adjust roll gap settings.

- **Methods:** HRW, SRW, SW, Durum (Northern, Desert Durum®): AACCI 54-31.01 using Perten SKCS 4100. • Note: as of 2022, the SKCS test is no longer performed on HRS.

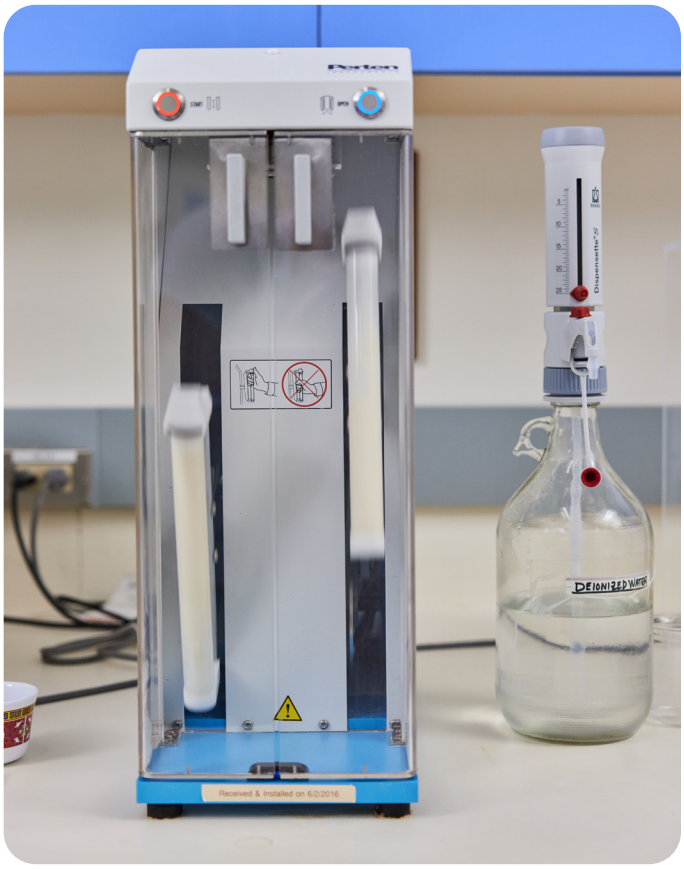
1000 KERNEL WEIGHT (or thousand kernel weight, TKW) is the weight in grams of 1,000 kernels of wheat and may indicate specific kernel weight and expected milling yield.

- **Methods:** HRS, Durum (Northern, Desert Durum®), SRW: based on a 10 g clean wheat sample counted by an electronic counter, results converted to express weight by 1,000 kernels. • SW: based on the average weight of three 100-kernel samples multiplied by 10, expressed on a 14% mb. • HRW: average of SKCS kernel weight in milligrams (mg) x 1,000 equals in g.

SEDIMENTATION value is a measure of the volume of sediment that results when lactic acid is added to a sifted, ground wheat sample. High sedimentation volume indicates high molecular weight glutenin sub-units (strong gluten) while low sedimentation volume indicates weaker gluten.

- **Methods:** HRW, HRS, SW, SRW: AACCI 56-61.02, Sedimentation. • Northern Durum: Micro sedimentation, Dick, J.W. and Quick, J.S. 1983. Cereal Chem. 60(4):315-318. • Desert Durum®: AACCI 56-70.01, Sodium Dodecyl Sulfate (SDS) sedimentation.

FALLING NUMBER is the time required for a plunger to fall through a boiling (100°C) heated mixture of flour and water and is an indirect measure of enzyme activity.



Sprouted wheat releases alpha-amylase (α-amylase), which breaks down starch into sugars. High falling number values indicate low α-amylase activity. Some α-amylase is required for certain products such as yeast-raised bread. However, excessive α-amylase in wheat cannot be removed and is difficult to reduce by blending. Flour with excessive amylase activity produces a sticky dough that can cause processing problems and products with poor color, poor crumb grain and weak texture. Falling number usually correlates closely with amylograph peak viscosity results.

- **Methods:** AACCI 56-81.04 for all classes. Methodology is same for flour and wheat falling number. • SW, SRW, HRW and HRS use the 2019 USDA/FGIS barometric pressure correction modification procedure; average value is a simple means of sample results.

DON (DEOXYNIVALENOL), or vomitoxin, produced by Fusarium fungi, is the most common mycotoxin in wheat.

- **Methods:** All analysis is on ground wheat. • HRS, Northern Durum: gas chromatograph with electron capture detector as described by Tacke, B.K., Casper, H.H. 1996. J. AOAC Int. 79(2):472-5. • SRW: Neogen ELISA. • HRW: Charm ROSA DonQ2 Quantitative Test.

FLOUR AND SEMOLINA FACTORS

Flour and semolina tests are used to measure specific properties of flour or semolina to determine how flour or semolina will perform during processing, and thus ensuring the flour or semolina has desirable characteristics for an end-product. It is important to remember that all testing reported in this book is conducted on lab-milled wheat.

SEE "WHEAT NON-GRADE FACTORS" FOR PROTEIN, ASH AND FALLING NUMBER.

LABORATORY MILLING EXTRACTION is the percentage by weight of flour/semolina obtained from a wheat sample. The extraction rate is always significantly lower from a laboratory mill than the rate that can be obtained on a commercial mill. Lab milling is done mainly to obtain flour/semolina for other tests. Settings are not optimized and remain the same year-to-year.

- **Methods:** Laboratory samples are cleaned and tempered according to AACCI 26-10.02. As of 2023, all extraction rates are calculated as tempered wheat basis [flour extraction = (weight of flour recovered/ weight of tempered wheat milled)*100]. Prior to 2023, HRW, HW and SW were reported as total product yield; extraction will report slightly lower than previously. • HRS flour is aged 10 days before analysis. Due to timing, no other classes are aged before analysis. • SW, SRW: AACCI 26-31.01, Buhler Laboratory Mill (MLU 202). • HRS, HW: AACCI 26-21.02, Buhler Laboratory Mill (MLU 202). • HRW: Tandem Buhler Mill. • Northern Durum: Brabender® Quadrumat Junior Semolina Mill; grain is tempered to 15.5% moisture one day before milling. • Desert Durum®: Modified Roller Mill.

COLOR measures a sample's lightness (L*) on a scale of 0 to 100 and "chromaticity" or hue on two scales from -60 to +60 for green to red (a*) and blue to yellow (b*). High L* values indicate a bright color and higher b* values indicate more yellow. Durum semolina and flour color are influenced by endosperm color, particle size and ash content and often affects finished product color.

- **Methods:** CIE 1976 L*a*b* color system. • Minolta method using Minolta Chroma Meter with Granular-Materials attachment CR-A50 • Desert Durum®: CR-200 colorimeter. • Northern Durum, HRS, SW, SRW: CR-410 colorimeter.

WET GLUTEN is a measure of the quantity of gluten in ground wheat (whole meal) or flour as determined using the Glutomatic System. Wet gluten forms when 2% salt water is added to the protein in ground wheat or flour and is responsible for the elasticity and extensibility characteristics of dough.

- **Methods:** All classes: AACCI 38-12.02 (Glutomatic procedure) performed on flour (14% mb). Less initial salt water is used for soft wheat, more initial salt water is used for hard wheat. • As of 2023, wet gluten values are no longer reported for Club wheat.

GLUTEN INDEX is also determined by the Glutomatic System and is a measure of gluten strength regardless of the quantity of gluten present. Gluten index is used commercially to select durum samples with strong gluten characteristics. As of 2023 gluten index values are no longer reported for HRW, HRS, SW and SRW.

AMYLOGRAPH VISCOSITY measures flour starch pasting properties that are important to products such as sheeted Asian noodles. Amylograph also measures enzyme (α-amylase) activity indirectly, which is usually from sprout damage.

- **Methods:** HRW, SRW: AACCI 22-10.01. • HRS, SW: AACCI 22-10.01 modified to use 65 g flour (14% mb) and 450 ml distilled water. • HRS uses paddle; SW uses pins.

RAPID VISCO ANALYZER (RVA) generates a curve indicating the viscosity during controlled heating, holding, cooling temperature cycles as a paddle rotates at a constant speed, measuring the functional and pasting properties of starch and cereal flours. Values reported include:

PASTING TEMPERATURE is the temperature at which starch begins to gelatinize.

PEAK VISCOSITY is a measurement of the greatest

FLOUR AND SEMOLINA FACTORS CONTINUED

viscosity achieved during heating. More viscous slurries may indicate lower enzyme activity in flour. Less viscous slurries may indicate less swelling capacity and lower water-holding capacity. Higher values usually result in softer, more cohesive product texture while lower values result in firmer, "clean break" type textures.

HOT PASTE VISCOSITY or Trough Viscosity is the minimum viscosity achieved after the peak viscosity and can indicate shear thinning (starch granule breakdown during shearing). Lower values usually imply greater potential for starch granule deformation, while stable values imply less potential for starch granule deformation.

FINAL VISCOSITY or Cold Paste Viscosity is the viscosity at the end of the cooling stage and may indicate the tendency for the gelatinized starch to gel or retrograde after cooling.

- **Methods:** HRS and SW: AACCI 76-21.01, STD1 pasting profile. RVA data are not yet available for HRW or SRW.

DAMAGED STARCH, the percentage by weight of damaged starch in a flour sample, is a measure of the physical damage done to starch granules during milling. Hard wheat flour typically has higher starch damage than soft wheat flour. Damaged starch granules readily absorb more water, which affects dough mixing and other processing properties. Because starch damage depends on how the sample was milled, this factor is important for interpreting other reported results.

- **Methods:** SRW, HRW (CA): AACCI 76-30.02, Enzymatic hydrolysis. • HRS: AACC method 76-31.01, Megazyme. • SW: AACCI 76-33.01, SDmatic.

SOLVENT RETENTION CAPACITY (SRC) is the amount of a solvent retained by flour after a period of solvation, and then centrifugation. The weight of the gel created

by the solvation process is expressed as percentage of the weight of flour used in each test, corrected to 14% moisture basis. Four solvents are commonly used – deionized water (measuring overall water absorption/ control solvent), sucrose (measuring arabinoxylan content), lactic acid (high molecular weight glutenins) and sodium carbonate (starch damage) – present a profile of water absorption and retention of the flour measured. Specific ranges of lower SRC values are desirable for specific soft wheat products, while higher SRC values are desirable for bread products. Gluten performance index (GPI), a calculation of three SRC values – [lactic acid/(sodium carbonate + sucrose)] – is a good predictor of overall performance of flour in baking applications.

- **Methods:** HRW, HRS, SW, SRW: AACCI 56-11.02. • HRS uses modified rocker shaker. • SRW, SW, and HRW use manual method.

SUGGESTED SOLVENT RETENTION CAPACITY (SRC) VALUES ARE AS FOLLOWS:

Type of SRC Solvent:	100% Water	50% Sucrose	5% Sodium Carbonate (pH 11)	5% Lactic Acid (pH 2)	Gluten performance index (GPI)
Cracker Flour	50 - 70	80 - 110	60 - 85	100 - 120	
Cookie Flour	50 - 70	80 - 110	60 - 85	85 - 100	
Wafer Flour	50 - 70	80 - 110	60 - 85	80 - 100	
Cake Flour	50 - 70	80 - 110	60 - 85	60 - 80	
Generic Pan Bread Flour	65 - 70	105 - 115	80 - 90	>130	Min. 0.60
Very Strong Bakers Flour	65 - 70	105 - 115	80 - 90	>140	Min. 0.75

Products made with soft wheat flour (cookies, crackers and wafers) are very sensitive to Lactic Acid SRC values but share similar profiles for the other solvents. A precise Lactic Acid profile with the other solvents in the recommended ranges will go a long way towards eliminating in-plant process problems.

For bread flour, sodium carbonate (Na_2CO_3) maximum value at 88 is recommended. If excessive damaged starch is present (Na_2CO_3> 90), bread staling will be accelerated with reduced shelf life. Higher Sucrose SRC values indicate higher water retention capacity in the finished bread. GPI is highly correlated to bread volume. For generic pan bread flour, GPI values of =>0.65 are recommended for optimum pan bread loaf volume; for very strong bakers flour, GPI values of =>0.75 are recommended. Higher Lactic Acid SRC values and lower Na_2CO_3 values will increase GPI. Na_2CO_3 values can be modified in the milling process.

SPECKS in a semolina sample are small particles of bran or other material that escaped the wheat cleaning and semolina purifying process. Millers can control speck count by thoroughly cleaning and properly tempering and conditioning the wheat before milling. Specks can detract from pasta appearance and desirability.

- **Methods:** A random sample is pressed under a clear plate and the specks (brown and black particles) are counted. This is a subjective measurement unless using an objective imaging machine. • Desert Durum®: Count 1 in^2 and multiply a factor [(no. of specks x 3) + 2] to get total specks for 10 in^2. • Northern Durum: Average of three separate 1in^2 determinations is expressed as specks per 10 in^2.

DOUGH PROPERTY FACTORS

Physical dough tests are used to provide information about the rheological properties of flour and dough, which aid in determining how dough will perform during mixing and further processing. This information is essential for knowing the suitability of dough for different end-products and how the dough will perform during the manufacturing process.

FARINOGRAPH generates a curve that indicates the resistance of dough to mixing (the power used over time) as flour and water are mixed into dough. The results describe the mixing properties of the dough and include:

PEAK TIME is the time interval from the first addition of water to the maximum curve-center consistency of 500 Brabender Units (BU) immediately prior to the first indication of weakening. Long peak times indicate strong gluten and dough properties while short peak times may indicate weak gluten.

STABILITY is the time interval between the point where the top of the curve first intersects the 500-BU line (called the “arrival time”) and the point where the top of the curve departs the 500 BU line (“departure time”). Long stability times also indicate strong gluten and dough properties, useful in products such as yeast-raised breads, while short stability times indicate weaker gluten useful in many other products.

ABSORPTION is the amount of water (as a percent by weight on a 14% mb) required to center the curve peak on the 500-BU line. High water absorption in bread products provides economic advantages by producing more dough pieces with the same amount of flour compared to lower water absorption. Low water absorption is ideal for cookie and cracker products because water has to be baked off for stable finished products.

- **Methods:** HRW, HRS, SW, SRW: AACCI 54-21.02, Constant Flour Weight Procedure. • SW modifies with 50 g bowl; starting in 2023, only medium and high protein SW are tested.

DOUGH PROPERTY FACTORS CONTINUED

ALVEOGRAPH generates a curve indicating the air pressure necessary to inflate a piece of dough like a bubble to the point of rupture and indicates the gluten strength and extensibility of dough. This method determines deformation resistance of the gluten macropolymer through poly-dimensional deformation, unlike the Extensograph which measures uni-directional gluten deformation. Values reported include:

P ("overpressure" or resistance), measured in millimeters of water to the maximum height of the curve, reflects the maximum pressure while blowing the bubble of dough and indicates dough resistance to extension.

L (length), the length of the curve measured in millimeters, reflects the size of the bubble and indicates dough extensibility.

W (the area under the curve), measured in 10^{-4} J, reflects the amount of energy needed to inflate the dough to the point of rupture and indicates dough strength.

The alveograph is well-suited for measuring the dough characteristics of weaker gluten wheat and, with adapted hydration using a Consistograph, for stronger wheats including durum. Requirements differ depending on intended flour use. Low P values (indicating weak gluten) and short L values (low extensibility) are preferred for cakes and confectionery products; P/L close to 1 and high W values (strong gluten) are preferred for pan breads; and P/L values close to 0.75 are favored for durum for pasta.

- **Methods:** HRW, HRS, SW, SRW and Durum (Northern, Desert Durum®): AACCI 54-30.02, constant hydration method, Chopin-Alveolab.

EXTENSOGRAPH measures the elasticity and stretch resistance of dough, generating a force-time curve for a piece of dough that is unilaterally stretched until it breaks. Results include:

RESISTANCE, measured as the height of the curve 5 cm after the curve has started to rise, reflects the force counteracting the stretching.

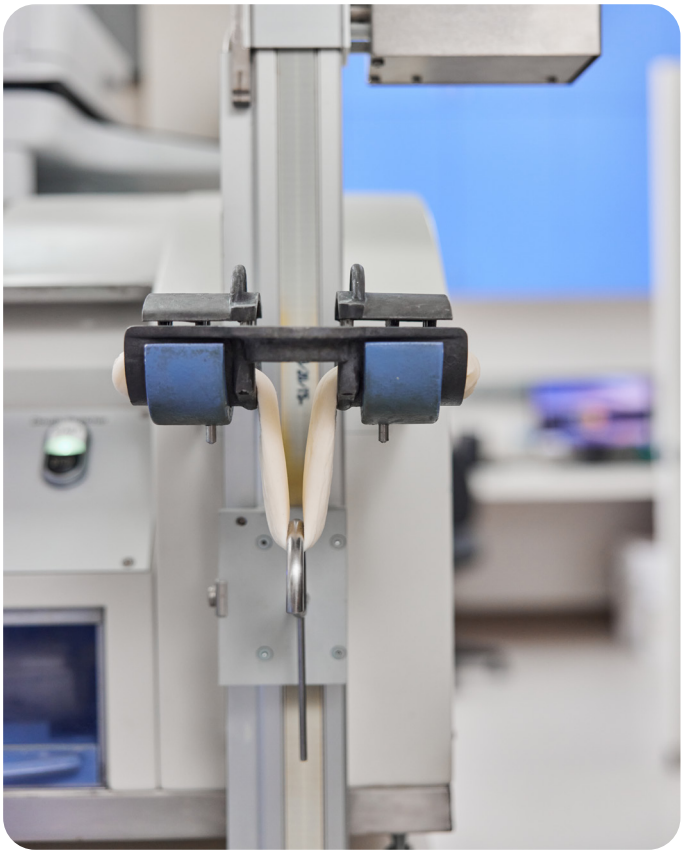
MAXIMUM, measured at the maximum curve height in Brabender Units (BU), reflects the maximum force applied and indicates the resistance of the dough to extension.

EXTENSIBILITY, measured as the total length of the curve at the baseline in centimeters, reflects how far the dough was stretched.

AREA is the area under the curve reported in cm^2.

These factors help describe the gluten strength and dough extensibility characteristics of flour for a wide range of end-products. The extensograph can also evaluate the effects of fermentation time and additives on dough performance.

- **Methods:** HRS, HRW: AACCI 54-10.01, modified 45 and 135-min rest. • SW, SRW: AACCI 54-10.01, 45-min rest.



EVALUATION OF END-PRODUCTS

End-product tests are the final laboratory testing in the evaluation of wheat quality. Standardized methods are used to evaluate the suitability of the sample for that product or similar products.

BREAD

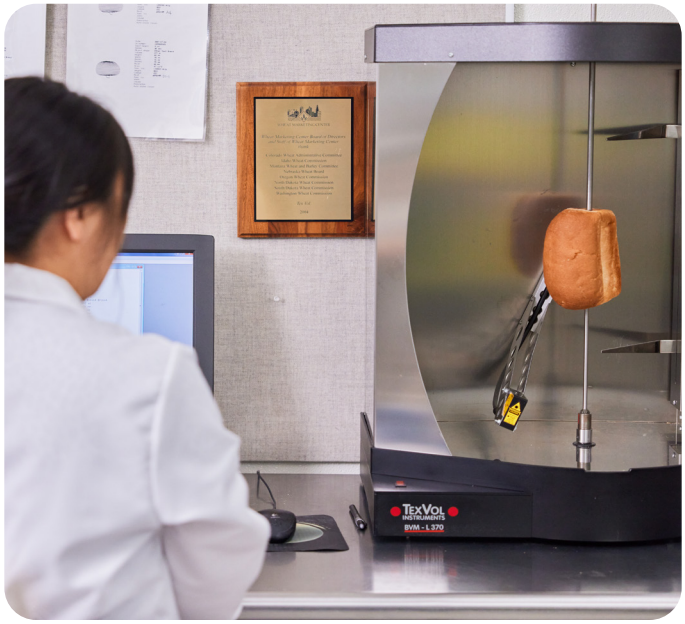
BAKING ABSORPTION is the water required for optimum dough mixing performance, expressed as a percent of flour weight on a 14% mb.

CRUMB GRAIN AND TEXTURE is determined on a scale of 1 to 10 by visual comparison to a standard using a constant illumination source. Higher scores are preferred.

LOAF VOLUME is the volume of a test loaf after baking. Higher loaf volumes indicate better baking performance for pan breads.

METHODS:

- **HRW:** AACCI 10-10.03 (“pup loaf” method); 100 g flour at 14% mb with optimized water absorption is mixed to optimum development with other ingredients (6% sugar, 3% shortening, 1.5% salt, 1.0% instant dry yeast, 50 ppm ascorbic acid and 0.25% malted barley flour) in a 100 g pin mixer with head speed of 100 to 125 rpm. The dough is fermented for 60 min, punched two times, then molded, panned and proofed for 60 min before baking at 218°C (425°F) for 18 min. Loaf volume is measured by rapeseed displacement immediately after baking. Crumb grain and texture are evaluated on a 0 to 6 scale, which for this booklet is converted to a 1 to 10 scale.
- **SRW:** AACCI 10-10.03 (“pup loaf” method); producing two loaves per batch using dry yeast and ascorbic acid. After mixing, the dough is divided into two equal portions, fermented for 160 min, molded and panned in pup loaf pans before proofing and baking. Loaf volume is measured by rapeseed displacement immediately after baking.



- **HRS:** AACCI 10-09.01 (long fermentation method) modified: 15 SKB units (fungal amylase/100 g flour, 1% instant dry yeast, 10 ppm ammonium phosphate, 2% added shortening). Dough is mechanically punched, molded and baked in “Shogren-type” pans. Scoring is based on a 1 to 10 scale with higher numbers indicating preferred quality attributes.
- **SW:** AACCI 10-10.03 (“pup loaf” method) with 180 min fermentation measured by laser light using a Tex Vol Instrument (BVM-L370).

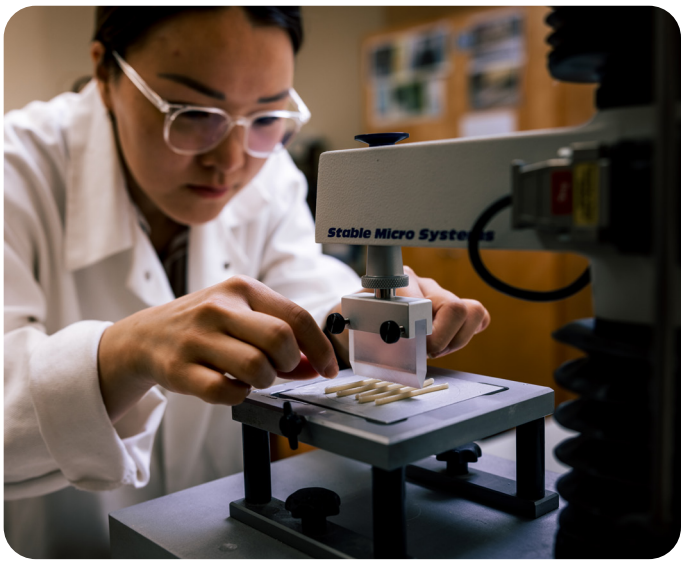
EVALUATION OF END-PRODUCTS CONTINUED

SPAGHETTI

Spaghetti (or pasta) was made using the laboratory procedure described by Walsh, Ebeling, and Dick, Cereal Sci. Today: 16(11) 385, 1971. A 1-Kg semolina was mixed with the appropriate amount of water that gave a dough consistency of 30-32% total water absorption.

The other processing conditions used were:

- **Northern Durum, HRS:** Water temperature, 40 C, extruder shaft speed 25 rpm and vacuum, 18 in. Hg; the dough was pressed through an 84-strand teflon-coated spaghetti die with 1.57 mm openings. Semolina-water mixture is extruded using a DeMaco laboratory pasta extruder. The extruded spaghetti samples were dried at high temperature (70-90 C) for 12 hrs, using maximum temperature and relative humidity of 73 C and 83%, respectively.
- **Desert Durum®:** Water temperature, 40 C, extruder shaft speed 29 rpm and vacuum, 18 in. Hg; the dough was pressed through an 96-strand teflon-coated spaghetti die with 1.78 mm openings. Semolina-water mixture is extruded using a Standard Industry laboratory pasta extruder. The extruded spaghetti samples were dried at low temperature (40 C) for 18 hrs, using maximum temperature and relative humidity of 40 C and 95%, respectively.



COOKED WEIGHT is the increase in weight of pasta by cooking and is best used in conjunction with firmness values to determine the cooking qualities of a spaghetti sample. The increase in cooked weight should be approximately three times or 300%.

- **Method**: 10 g of dry spaghetti are placed in 300-350 ml boiling distilled water and cooked for 12 min. The cooked and drained spaghetti sample is weighed, and the results are reported in grams.

COOKING LOSS is a measure of the amount of soluble components that leach from pasta during cooking.

- **Method:** AACC Method 66-50.01. After drying the residue is weighed and reported as percentage of the original dry sample.

FIRMNESS is a measure of the amount of work required to bite through a strand of spaghetti.

- **Method:** AACCI Method 66-50.01 with a Plexiglas tooth attached to a Texture Analyzer (Model TA-XT2, Texture Technology Corp., Scarsdale, New York). Firmness values will differ due to variance in dry spaghetti diameter ranges: Desert Durum® is 1.60-1.65 mm and Northern Durum is 1.35 to 1.45 mm.

COLOR is the measure of finished spaghetti color after the drying process.

- **Method**: CIE 1976 L*a*b* color system. See "color" under Flour and Semolina Factors. • High L* values indicate a bright color and higher b* values indicate more yellow. • Desert Durum® is measured with a CR-200 colorimeter and Northern Durum is measured with a CR-410 colorimeter.

SPONGE CAKE

VOLUME is measured by Tex-Vol Volumeter. Larger volume indicates better flour.

Cake **HARDNESS** measured by TA-XT Plus texture analyzer for hardness in grams of resistance during compression. Lower number means softer texture.

- **Method:** SW, SRW: volume (measured by laser scanning topography using a Tex Vol Instrument (BVM-L370)) and hardness is measured by TA-XT Plus texture analyzer. Flour with low protein content, weak gluten characteristics and low ash content make good quality sponge cake.

Note: Total Score is a subjective measurement and as of 2023 is no longer reported.

SUGAR-SNAP COOKIES (BISCUITS)

DIAMETER (d), or width, is a static measurement of spread and set time during baking and is an indicator of good pastry-making and specifically cookie-baking potential. Larger diameter is preferred.

HEIGHT (h), or thickness, is closely related to diameter with larger diameters typically leading to reduced height.

SPREAD FACTOR is determined by d/h ratio with adjustments to constant atmospheric pressure and conditions depending on elevation and barometric pressure reading corrected to sea level.

- **Method:** SW, SRW: AACCI 10-50.05, macro-method.

Note: Prior to 2023, SW cookie testing was conducted according to micro-method AACCI 10-52.02. Diameter and height of cookies made with both AACCI 10-52.02 and 10-50.05 are different due to changes in formulation and procedure; however, the overall trend is similar.

STEAMED BREAD (CHINESE SOUTHERN-TYPE)

SPECIFIC VOLUME is defined as the ratio of volume in milliliters to the weight in grams. Larger specific volume is usually preferred.

TOTAL SCORE comprises volume (measured by laser light using a Tex Vol Instrument (BVM-L370), external characteristics, internal characteristics, eating quality and flavor. Each property is rated compared with a control sample. The control flour is scored 70.

- **Method:** Steam bread was prepared using no-time dough methods (WMC procedures) • SW, white club (WC, Club): flour 100% (400 g), sugar 15%, shortening 4%, baking powder 1.2%, instant yeast 0.8%, nonfat dry milk powder 3% and water 39 to 43%. Yeast is dissolved in water before use.

LABORATORY TESTING

The data in this report are derived from sample testing and analysis conducted at partner laboratories across the United States. Their locations and the wheat class that each laboratory tests is noted below.

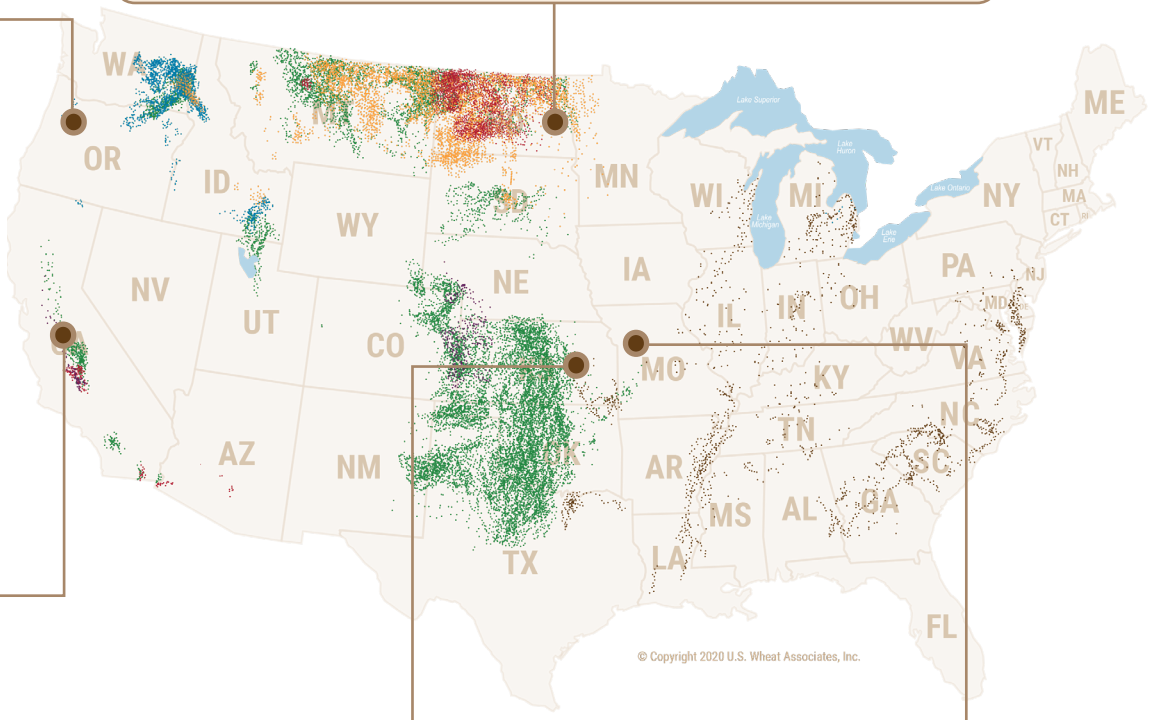
NDSU NORTH DAKOTA STATE UNIVERSITY

The HRS Wheat Quality Lab at NDSU in Fargo, North Dakota, conducted quality testing and analyses on **hard red spring (HRS)**.

The Durum Quality Lab at NDSU conducted quality testing and analyses on **Northern Durum**.

WHEAT MARKETING CENTER

The WMC in Portland, Oregon conducted quality testing and analyses on **soft white (SW)**.



California WHEAT COMMISSION

The CWC Laboratory in Woodland, California conducted quality testing and analyses on **Desert Durum®**.

USDA Agricultural Research Service

PGI PLAINS GRAINS INC.

The USDA/ARS Hard Winter Wheat Quality Lab (HWWQL) in Manhattan, Kansas conducted the quality testing for **hard red winter (HRW)**. Plains Grains Inc. in Lincoln, Nebraska provided analyses.

GPAL

Great Plains Analytical Laboratory in Kansas City, Missouri, conducted quality testing on **soft red winter (SRW)**.

STORIES OF STEWARDSHIP

Farmers are called to wisely use the gifts of soil, water, and seed to produce a crop and a living. They nourish and improve the land for the next generation, working every day to provide a sustainable source of high-quality wheat for the world.

SCAN THIS QR CODE OR VISIT USWHEAT.ORG FOR STORIES OF STEWARDSHIP

DEPENDABLE PEOPLE. RELIABLE WHEAT.

The U.S. farm families who produce the wheat and the industry that supplies it remain committed to operating a transparent and open market. Here are some of the reasons why our overseas customers know they can depend on the integrity of our supply chain, the quality of U.S. wheat and our unmatched reliability as a supplier.

THE U.S. WHEAT "STORE" IS ALWAYS OPEN.

U.S. farmers overcome significant risk every year to meet domestic wheat demand and still provide half their crop for export markets. Farmers and commercial warehouses can store and efficiently transport wheat in top condition to meet overseas demand when needed and throughout the marketing year.

PRICES ARE TRANSPARENT AND HONORED.

U.S. wheat export prices are discovered openly through futures exchanges and basis costs and are always available to customers. Private exporters use risk management tools to honor sales contract prices often made months in advance of vessel loading.

QUALITY IS ASSURED.

USW publishes weekly reports during harvest that summarize initial wheat quality findings. USW works with several organizations and laboratories to analyze hundreds of wheat samples for all six U.S. wheat classes and publishes all results in the annual Crop Quality Report. Our staff, farmers and industry experts then travel the world to present the results to our customers and end users. U.S. country elevators and export elevators inspects and tests wheat as it arrives and segregates each class by quality to meet customer requirements. The Federal Grain Inspection Service (FGIS) independently inspects wheat at vessel loading to certify that the quality loaded matches the customer's specifications.

EXPORT LOGISTICS DEEMED ESSENTIAL.

In the COVID-19 outbreak, all farmers and food distribution industries were deemed essential. Export grain systems and FGIS inspections have continued operating with little or no interruption.

DIRECT GOVERNMENT EXPORT INTERVENTION IS BANNED.

Several U.S. federal laws protect the sanctity of all export contracts. The only exception is a declared national emergency.

BUYERS RECEIVE UNMATCHED TRADE SERVICING AND TECHNICAL SUPPORT.

With funding from U.S. wheat farm families and USDA's Foreign Agricultural Service, experienced USW staff and consultants add exceptional value to all U.S. wheat class imports.

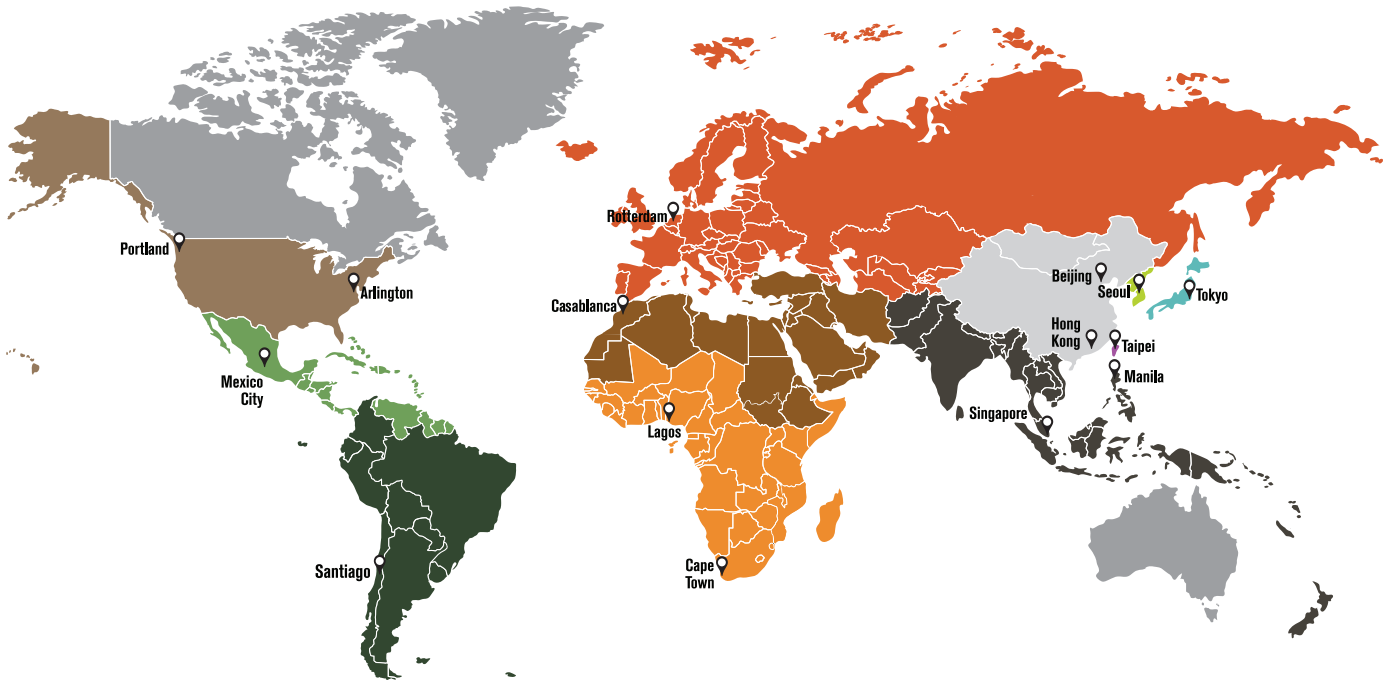
FOSTERING TRADE.

USW invests substantial funding from farmers and federal programs to help overcome trade or technical barriers that would otherwise keep end-users from realizing the highest value and most revenue from using U.S. wheat.

U.S. WHEAT ASSOCIATES

Dependable People. Reliable Wheat.

www.uswheat.org



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U.S. Wheat Associates (USW) is the industry's market development organization working in more than 100 countries. Its mission is to "develop, maintain and expand international markets to enhance wheat's profitability for U.S. wheat producers and its value for their customers." USW activities are funded by producer checkoff dollars managed by 17 state wheat commissions and USDA Foreign Agricultural Service cost-share programs. For more information, visit www.uswheat.org or contact your state wheat commission.

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