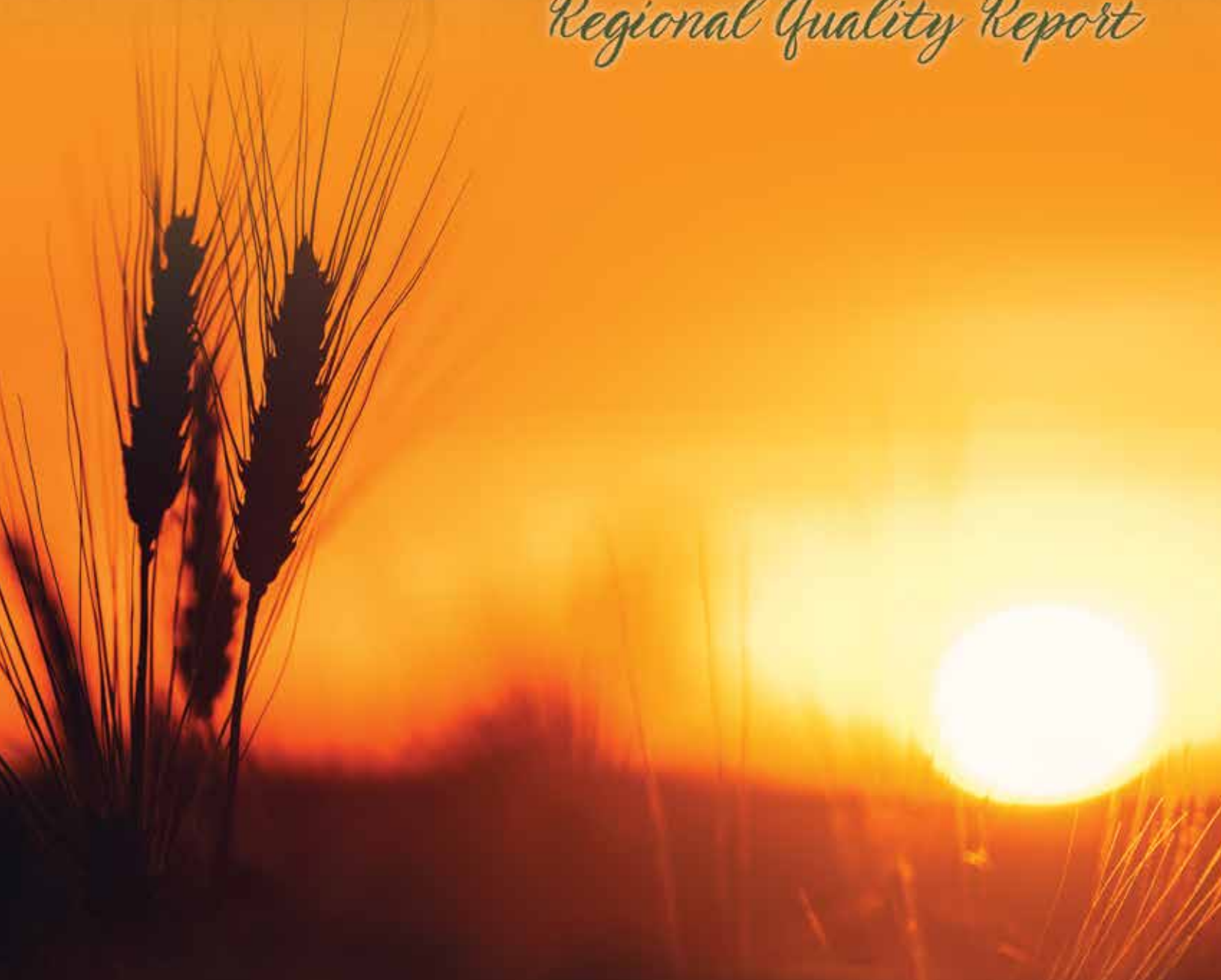




2018

# U.S. DURUM WHEAT

*Regional Quality Report*



# U.S. DURUM *Wheat*

MONTANA | NORTH DAKOTA

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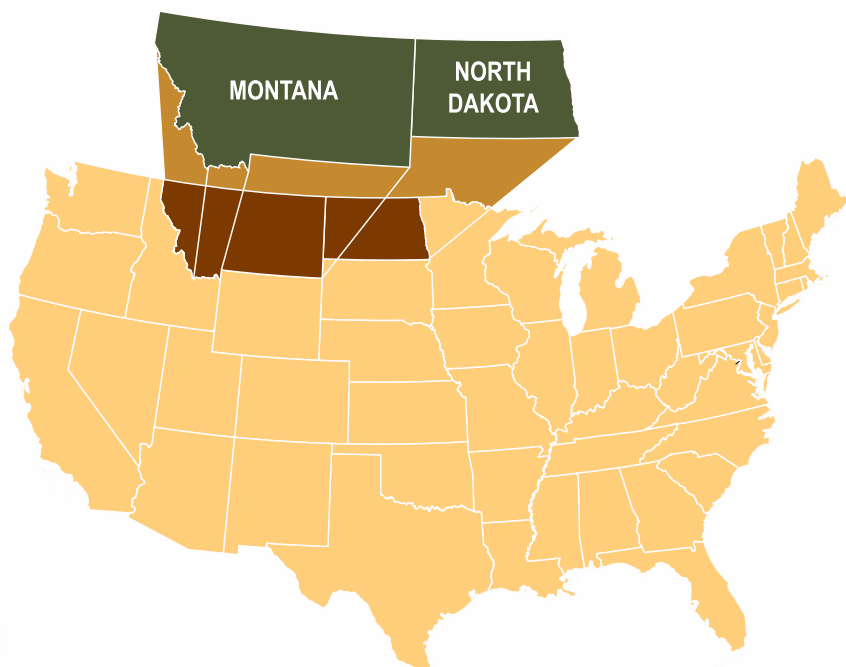
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## MAKING PREMIUM PASTA

**DURUM** is the hardest of all wheats. Its density, combined with its high protein content and gluten strength, make durum the wheat of choice for producing premium pasta and couscous products. Pasta made from durum is firm with consistent cooking quality. Durum kernels are amber colored and larger than those of other wheat classes. Also unique to durum is its yellow endosperm which gives pasta its golden hue and the best color for couscous.

When durum is milled, the endosperm is ground into a granular product called semolina. A mixture of water and semolina forms a stiff dough. Pasta dough is then forced through dies, or metal discs with holes, to create hundreds of different shapes.

Durum production is geographically concentrated to the Northern Plains because it demands a special ergonomic environment. In most years, the states of North Dakota and Montana produce 80 percent of the U.S. durum crop.





## 2018 OVERVIEW

**THE DURUM** crop produced in North Dakota and Montana in 2018 had above-average yields and possesses excellent kernel and grade characteristics. In laboratory testing, samples collected produced higher mill yields, with pasta quality parameters somewhat lower than the 2017 crop but near the 5-yr. average. Production is up nearly 60 percent from 2017, on 10 percent lower plantings. A much more favorable growing season, resulted in notably higher yields compared to last year's drought impacted crop. Regional production is estimated at 66 million bushels (1.8 MMT), compared to just 41 million bushels (1.1 MMT) in 2017.

**THE CROP** averages a No. 1 Hard Amber Durum (HAD), and 78 percent of the crop grades a No. 1 HAD, nearly double the 43 percent from a year ago. Only six percent of the samples analyzed were a No. 3 grade or lower, compared to 20 percent a year ago. The crop average test weight is 61.4 lbs/bu (79.9 kg/hl), and total kernel defects average one percent, both improved over last year. Test weight distributions show 88 percent of the crop above 60 lbs/bu (78.1 kg/hl), compared to just 61 percent last year. Kernel defects this year show lower shrunken and broken kernels, but slightly higher damaged kernels compared to a year ago. Of note in 2018 is that the percent of contrasting classes in some samples from Montana and northwest North Dakota is higher than average. The overly dry 2017 growing season likely contributed to this.

**VITREOUS KERNEL** levels are high on a majority of the crop, due to hot conditions in the latter half of the growing season, and mostly dry, favorable harvest conditions. The crop averages a 90 percent hard vitreous kernel level, up from both last year and the 5-yr average. Eighty-eight percent of the crop has vitreous levels of 75 percent or higher, but with the most appreciable improvement in the share of the crop above 90 percent vitreous. In 2018, nearly 60 percent of the crop is above 90 percent vitreous, compared to 45 percent of the crop a year ago. Some parts of the region, and the latter portion of the harvest did experience some rains during maturity, and those areas are showing slightly lower vitreous kernel levels. The crop average protein is 14.5 percent (12% basis), equal to 2017 but about one percentage point above average.

**OTHER NON-GRADE** kernel features, such as thousand kernel weight, kernel size distribution, falling number and DON all indicate the majority of the crop was not impacted by disease pressures, stress during the kernel fill period, or rains during harvest. The crop average thousand kernel weight is 41.2 grams, the heaviest in six crop years, and the percent of large kernels is notably higher than a year ago. Falling number analysis on the 2018 crop indicates very sound kernels, with a crop average falling number of 425 seconds. Nearly two-thirds of the crop is above 400 seconds, and just two percent below 300 seconds. Disease pressures were higher in 2018 compared to the drought year in 2017, but testing of samples for DON indicates

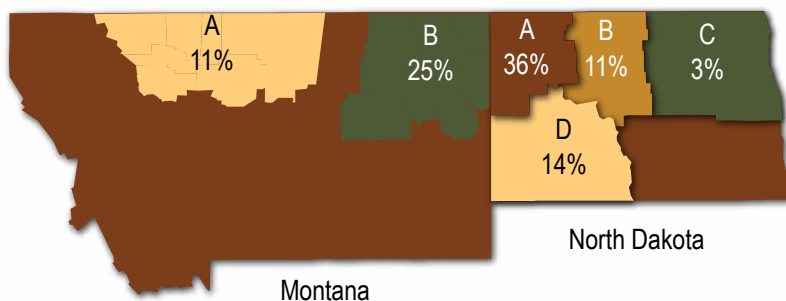
that all regions average <0.5 ppm, with the majority of samples showing non-detectable levels.

### PRODUCTION DATA

	2018	2017	2013-17 AVERAGE
<b>MILLION BUSHELS</b>			
Montana	23.3	12.6	18.3
North Dakota	42.5	28.8	37.4
<b>U.S. Total</b>	<b>77.3</b>	<b>54.8</b>	<b>69.8</b>
<b>MILLION METRIC TON</b>			
Montana	0.63	0.34	0.50
North Dakota	1.16	0.79	1.02
<b>U.S. Total</b>	<b>2.10</b>	<b>1.49</b>	<b>1.90</b>

Source: USDA 2018 Small Grains Summary

### APPROXIMATE SHARE OF REGIONAL PRODUCTION



# U.S. DURUM WHEAT

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**MILLING PERFORMANCE**, based on Buhler laboratory mill, shows a total extraction of 74 percent, above both last year and the 5-yr average. Semolina extraction is also appreciably higher at 69.3 percent, compared to 66.3 percent for the 5-yr average. The milled product is showing higher ash levels, and speck counts are higher than both last year and the 5-yr average. Gluten index values are down from 2017, averaging 57.1 percent, compared to 86.3 percent. Last year's drought conditions supported exceptionally high GI values, with the 2018 crop falling closer to a more typical value.

**SEMOLINA AND COOKED SPAGHETTI** evaluations show semolina color values similar to a year ago, but lower dry pasta color. Mixing properties are slightly weaker and cooked firmness values are also lower than a year ago, but similar to the 5-yr average. The higher extraction levels, and higher ash levels on the Buhler lab mill, may have contributed in part to the lower color scores on the cooked pasta.

**BUYERS WILL** find a larger supply of durum from the northern part of the U.S. in 2018, and a crop that touts excellent kernel and grade qualities. It is a sound crop, with high protein, high vitreous kernel levels and above-average kernel size. Quality is quite balanced across the region, as shown by the distribution data, but some variability does exist due to the delayed harvest in isolated areas. As with most years, diligent contract specifications are still the best way buyers can ensure they receive the quality they demand.

## SEASONAL CONDITIONS

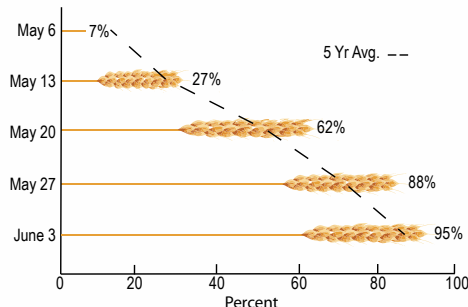
**PLANTING BEGAN** in late April, with slow progress initially, as a period of colder temperatures delayed soil warmup, and some northern areas were impacted by late season snow. Planting progress was slow throughout the first half of May, reaching 30 percent complete by mid-May. Progress accelerated rapidly in the second half of May, as hot, dry conditions prevailed, allowing the balance of the crop to be planted by early June, slightly ahead of normal.

**CROP EMERGENCE** and early development was hindered in parts of the region due to the lack of topsoil moisture, and hot temperatures in late May. A shift in weather patterns in June, with more frequent and abundant rain brought welcome relief to the region, and crops benefited, especially across later planted areas. Temperatures remained above normal during much of June, advancing crop development, and by early July, more than one-half of the

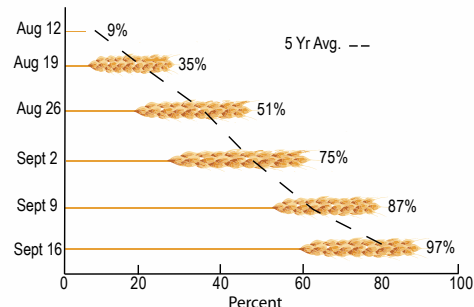
crop had headed, slightly ahead of average. High moisture levels elevated disease pressures in portions of the crop, but a drier moisture pattern in mid to late July limited the extent of disease pressures. Crops had above average yield potential as they advanced to maturity.

**HARVEST BEGAN** in early August, near the 5-year average, but initial progress was slow due to delayed ripening in many areas. One-half of the crop was harvested by late August, and harvest weather remained favorable for quality with no significant rains. In early September, periodic rain showers, and slow crop development continued to challenge harvest pace, especially across parts of Montana. Harvest reached 90 percent complete across the region by mid-September, ahead of average, but harvest was not completed in some areas until late September.

### PLANTING PROGRESS



### HARVEST PROGRESS



## WHEAT CHARACTERISTICS

### WHEAT GRADES

as defined by the Federal Grain Inspection Service (FGIS) of the USDA Grain Inspection, Packers and Stockyards Administration (GIPSA), reflect the general quality and condition of a representative sample. U.S. grades are based on test weight and include limits on damaged kernels, foreign material, shrunken and broken kernels, and wheat of contrasting classes. Each determination is made on the basis of the grain when free from dockage and shrunken and broken kernels.

**SUBCLASS** is as separate marketing factor based on the weight percentage of kernels with a complete, hard and vitreous endosperm, the portion that makes semolina. For durum wheat, the subclasses are:

- Hard Amber Durum (HAD) – at least 75 percent more hard, vitreous kernels;
- Amber Durum (AD) – between 60 and 74 percent hard, vitreous kernels;
- Durum (D) – less than 60 percent hard, vitreous kernels.

GRADING FACTORS	U.S. GRADES				
	1	2	3	4	5
<b>DURUM – MINIMUM TEST WEIGHTS</b>					
Pounds per bushel	60.0	58.0	56.0	54.1	51.0
Kilograms per hectoliter	78.2	75.6	73.0	70.4	66.5
<b>MAXIMUM PERCENT LIMITS OF:</b>					
Damaged kernels					
Heat (part of total)	0.2	0.2	0.	1.0	3.0
Total	2.0	4.0	7.0	10.0	15.0
Foreign material	0.4	0.7	1.3	3.0	5.0
Shrunken/broken kernels	3.0	5.0	8.0	12.0	20.0
Total <sup>1</sup>	3.0	5.0	8.0	12.0	20.0
Wheat of other class <sup>2</sup>					
Contrasting classes	1.0	2.0	3.0	10.0	10.0
Total <sup>3</sup>	3.0	5.0	10.0	10.0	10.0
Stones	0.1	0.1	0.1	0.1	0.1
<b>MAXIMUM COUNT LIMITS OF:</b>					
Other material					
Animal filth	1	1	1	1	1
Castor beans	1	1	1	1	1
Crotalaria seeds	2	2	2	2	2
Glass	0	0	0	0	0
Stones	3	3	3	3	3
Unknown foreign material	3	3	3	3	3
Total <sup>4</sup>	4	4	4	4	4
Insect-damaged kernels	31	31	31	31	31

U.S. sample grade is wheat that:

- Does not meet the requirements for U.S. Nos. 1, 2, 3, 4 or 5; or
- Has a musty, sour or commercially objectionable foreign odor (except smut or garlic odor); or
- Is heating or of distinctly low quality.
  - Includes damaged kernels (total, foreign material and shrunken and broken kernels).
  - Unclassed wheat of any grade may contain not more than 10.0 percent of wheat of other classes.
  - Includes contrasting classes.
  - Includes any combination of animal filth, castor beans, crotalaria seeds, glass, stones or unknown foreign substance.



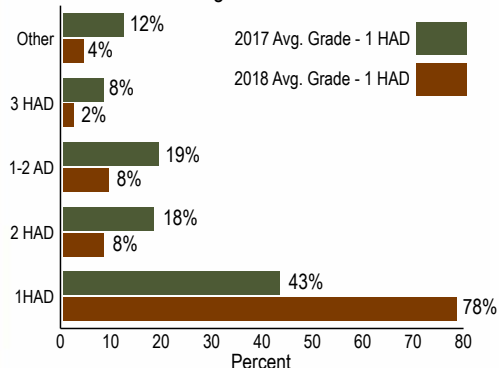
# U.S. DURUM WHEAT

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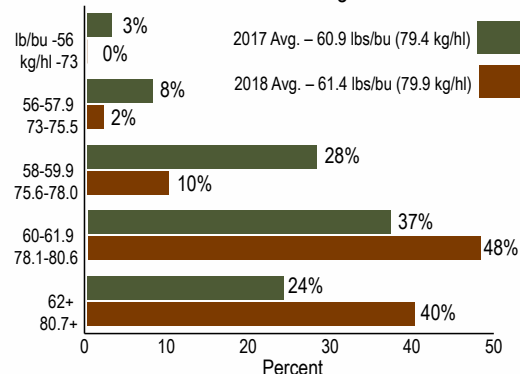
## WHEAT GRADING DATA

STATE AND CROP REPORTING AREA	TEST WEIGHT		DAMAGE	SHRUNKEN/ BROKEN KERNELS	TOTAL DEFECTS	CONTRASTING CLASSES	U.S. GRADE	VITREOUS KERNELS
	LBS/BU	KG/HL	%	%	%	%		%
<b>MONTANA</b>								
Area A	60.5	78.8	0.0	0.9	0.9	0.7	1 HAD	92
Area B	61.3	79.8	0.3	0.7	1.0	0.3	1 HAD	96
State Avg 2018	61.1	79.5	0.2	0.8	1.0	0.4	1 HAD	95
State Avg 2017	60.3	78.5	0.0	1.4	1.4	0.0	1 HAD	93
<b>NORTH DAKOTA</b>								
Area A	61.1	79.6	0.4	0.7	1.1	0.8	1 HAD	88
Area B	62.1	80.9	0.3	0.9	1.2	0.0	1 HAD	91
Area C	62.9	81.9	0.0	0.6	0.6	0.0	1 HAD	88
Area D	61.5	80.1	0.3	0.8	1.1	0.0	1 HAD	82
State Avg 2018	61.5	80.1	0.3	0.7	1.1	0.4	1 HAD	88
State Avg 2017	61.2	79.7	0.1	1.0	1.1	0.0	1 HAD	86
<b>TWO-STATE AVERAGE</b>								
Avg 2018	61.4	79.9	0.3	0.7	1.0	0.4	1 HAD	90
Avg 2017	60.9	79.4	0.1	1.1	1.2	0.0	1 HAD	88
Five-Year Avg	60.4	78.6	0.3	1.0	1.3	0.2	1 HAD	86

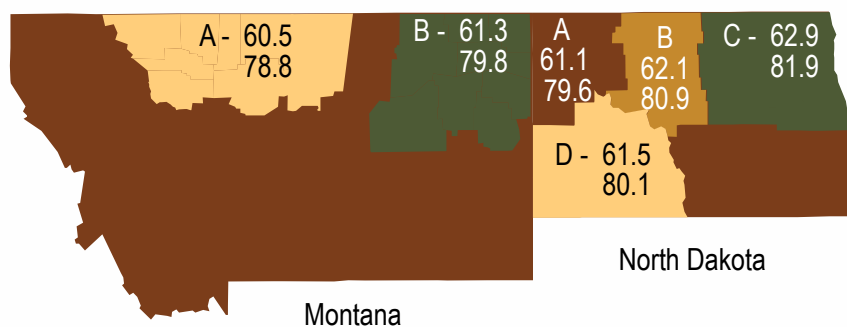
### GRADE – Regional Distribution



### TEST WEIGHT – Regional Distribution



### AVERAGE TEST WEIGHT BY AREA



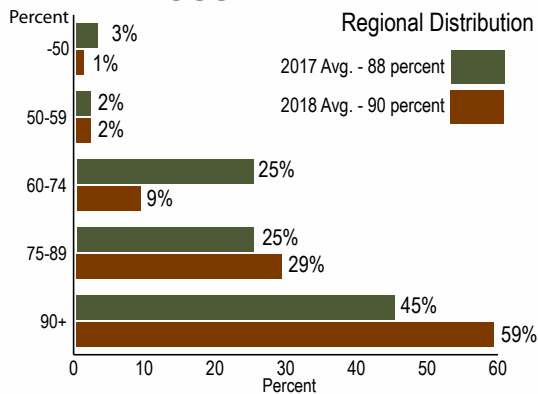


# U.S. DURUM WHEAT

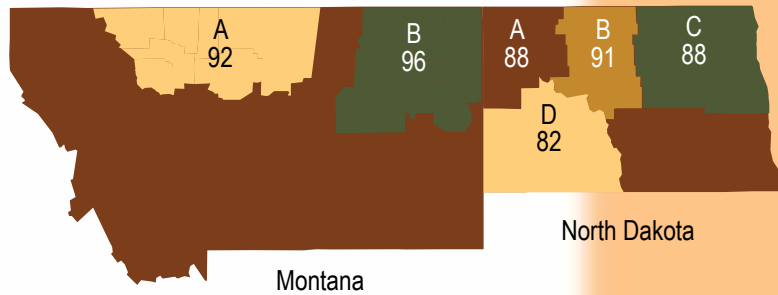
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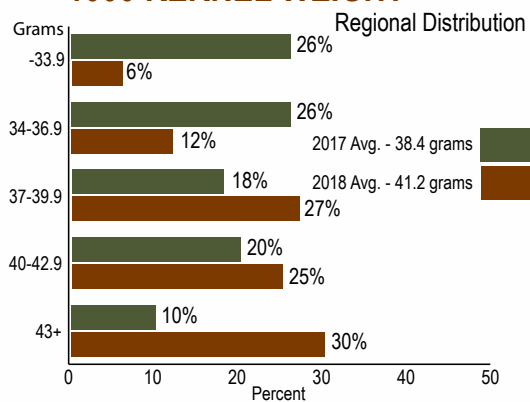
## VITREOUS KERNEL



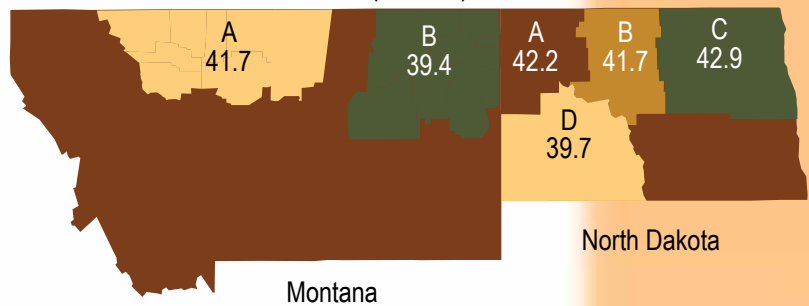
## AVERAGE VITREOUS KERNEL BY AREA (Percent)



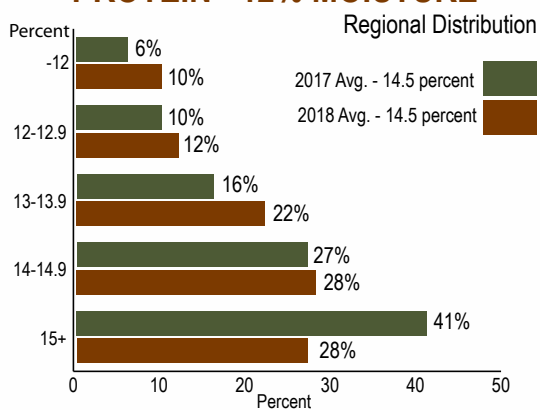
## 1000 KERNEL WEIGHT



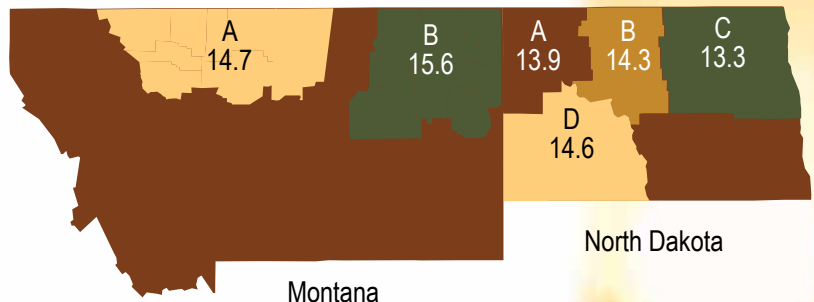
## AVERAGE 1000 KERNEL WEIGHT BY AREA (Grams)



## PROTEIN - 12% MOISTURE



## AVERAGE PROTEIN BY AREA 12% Moisture Basis-Percent



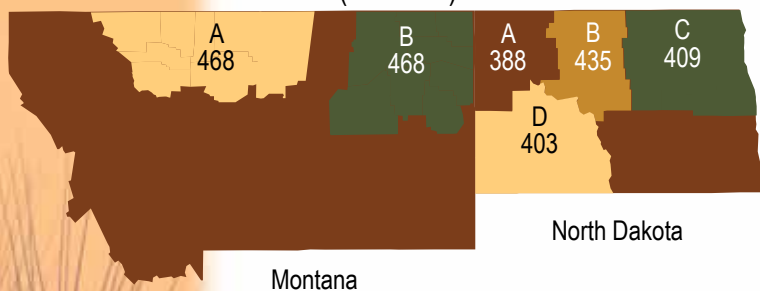
# U.S. DURUM WHEAT

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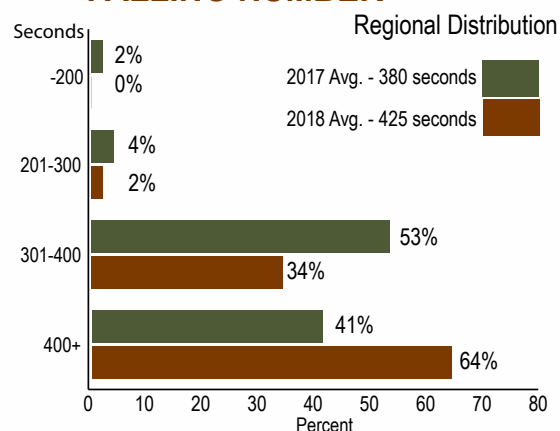
## OTHER KERNEL QUALITY DATA

STATE AND CROP REPORTING AREA	DOCKAGE %	MOISTURE %	1000 KERNEL WEIGHT G	KERNEL DIST. MED/LGE %	PROTEIN 12%/0% MOISTURE BASIS %	DON (PPM)	WHEAT ASH %	FALLING NUMBER (SEC)	MICRO SED (CC)
<b>MONTANA</b>									
Area A	0.4	10.6	41.7	49/47	14.7/16.7	<0.5	1.52	468	71
Area B	0.5	10.1	39.4	47/51	15.6/17.7	<0.5	1.56	468	59
State Avg 2018	0.5	10.3	40.1	47/49	15.3/17.4	<0.5	1.55	468	62
State Avg 2017	1.6	10.8	35.8	61/34	14.7/16.7	<0.5	1.45	383	96
<b>NORTH DAKOTA</b>									
Area A	0.9	11.8	42.2	42/55	13.9/15.8	<0.5	1.49	388	60
Area B	0.6	11.8	41.7	38/60	14.3/16.3	<0.5	1.57	435	61
Area C	0.6	12.1	42.9	37/61	13.3/15.1	<0.5	1.56	409	62
Area D	0.9	11.3	39.7	42/54	14.6/16.6	<0.5	1.63	403	62
State Avg 2018	0.8	11.8	41.8	41/57	14.0/15.9	<0.5	1.54	401	61
State Avg 2017	0.9	11.5	39.5	53/43	14.4/16.4	<0.5	1.47	379	83
<b>TWO-STATE AVERAGE</b>									
State Avg 2018	0.7	11.2	41.2	43/54	14.5/16.4	<0.5	1.54	425	61
State Avg 2017	1.1	11.3	38.4	55/40	14.5/16.5	<0.5	1.46	380	87
Five-State Avg	0.8	11.7	39.9	47/50	13.6/15.4	1.0	1.57	374	62

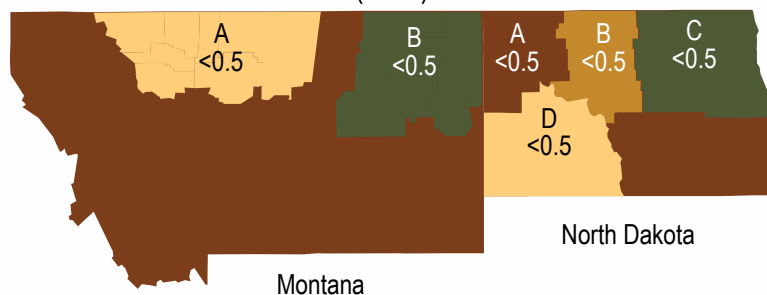
### AVERAGE FALLING NUMBER BY AREA (Seconds)



### FALLING NUMBER



### AVERAGE DON BY AREA (PPM)





## MILLING CHARACTERISTICS

**TOTAL EXTRACTION** represents the portion of the kernel that can be milled into flour and semolina.

**SEMOLINA** extraction is the portion milled into semolina only.

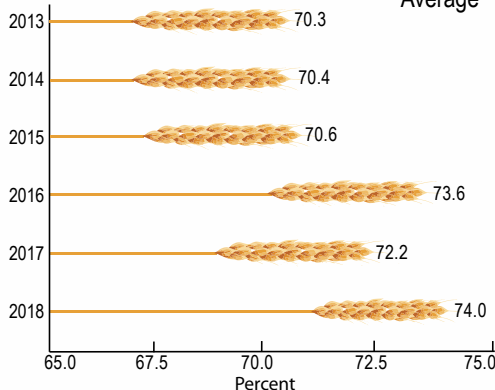
**ASH CONTENT** in the endosperm of durum is inherently higher than in the endosperm of other hard wheats, but can still be used as a relative measure of bran or mineral content in the flour and semolina.

**SPECKS** appear in semolina when small particles of bran or other material escape the cleaning and purifying process. Millers can control speck count by selecting durum that is free of disease and foreign material, thoroughly cleaning the durum, properly tempering and conditioning the wheat before milling, and by using purifiers to remove small bran particles from the semolina.

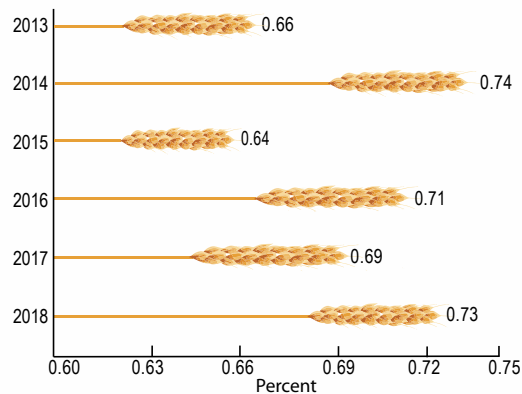
**PROTEIN CONTENT** in semolina has a high correlation with gluten content and, in turn, mechanical strength and cooking quality. Wet gluten is a quantitative measure of the gluten forming proteins in semolina that are primarily responsible for its mechanical strength and pasta quality.

**MIXOGRAM** curves reveal important information about the dough quality of semolina and ultimately about the potential cooked firmness of pasta. Mixograms are rated on a scale of 1 to 8, with the higher values indicating stronger mixing characteristics.

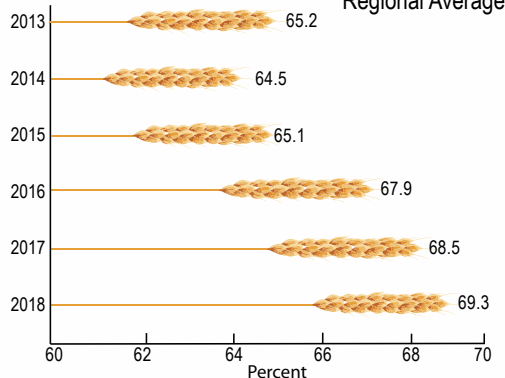
**TOTAL EXTRACTION** – Regional Average



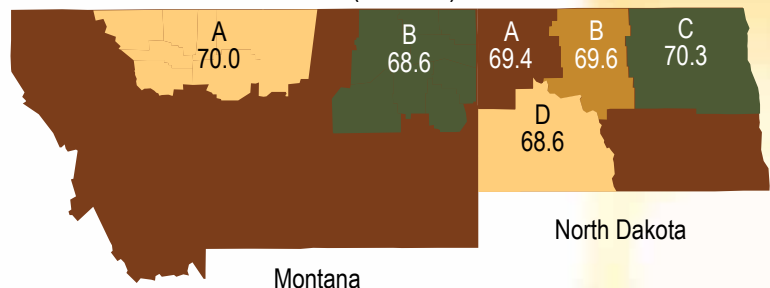
**ASH CONTENT** – Regional Average



**SEMOLINA EXTRACTION** – Regional Average



**AVERAGE SEMOLINA EXTRACTION BY AREA**  
(Percent)



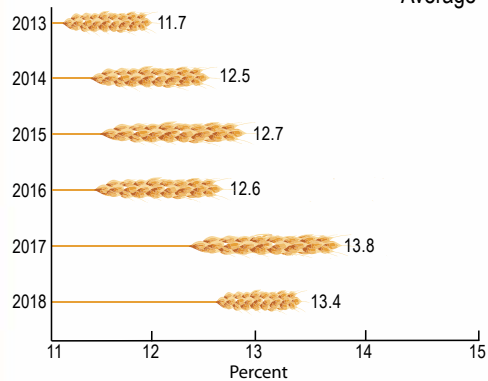
# U.S. DURUM WHEAT

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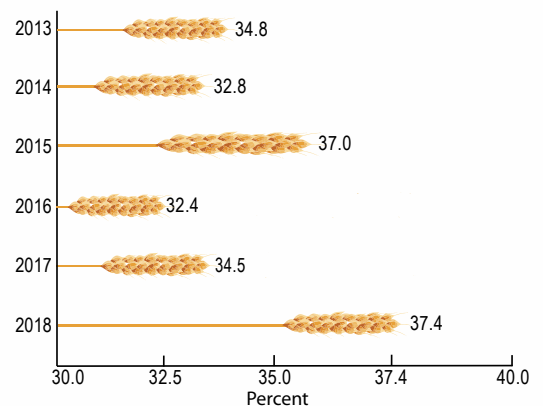
## SEMOLINA QUALITY DATA

STATE AND CROP REPORTING AREA	TOTAL EXTRACTION %	SEMOLINA EXTRACTION %	ASH %	SPECKS NO/10 SQ IN %	PROTEIN (14% MOISTURE) %	WET GLUTEN %	GLUTEN INDEX %	MIXOGRAM CLASSIFICATION SCALE 1-8
<b>MONTANA</b>								
Area A	74.3	70.0	0.78	24	13.6	38.1	74.0	6.5
Area B	73.2	68.6	0.73	29	14.6	41.3	58.3	5.0
State Avg 2018	73.5	69.0	0.75	28	14.3	40.3	63.0	5.5
State Avg 2017	71.2	67.7	0.71	24	14.1	35.3	87.9	5.9
<b>NORTH DAKOTA</b>								
Area A	74.1	69.4	0.72	31	12.9	36.0	46.8	5.0
Area B	74.3	69.6	0.70	28	13.1	35.6	60.9	5.0
Area C	75.4	70.3	0.72	24	11.9	33.1	64.1	5.5
Area D	73.8	68.6	0.78	29	13.5	37.4	63.4	6.0
State Avg 2018	74.2	69.4	0.72	29	12.9	35.9	53.9	5.2
State Avg 2017	72.6	68.9	0.68	27	13.6	34.1	85.6	5.7
<b>TWO-STATE AVERAGE</b>								
State Avg 2018	74.0	69.3	0.73	29	13.4	37.4	57.1	5.3
State Avg 2017	72.2	68.5	0.69	26	13.8	34.5	86.3	5.7
Five-Year Avg	71.5	66.3	0.69	27	12.6	33.8	59.4	5.4

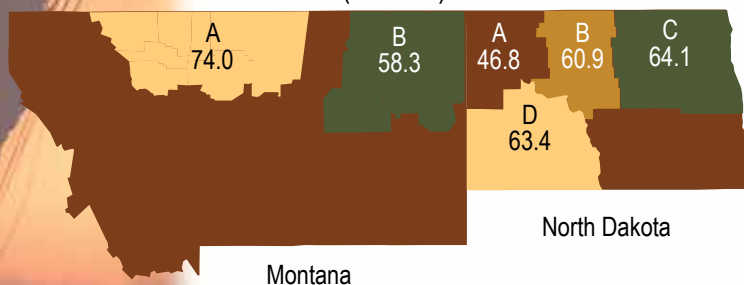
**SEMOLINA PROTEIN** – Regional Average



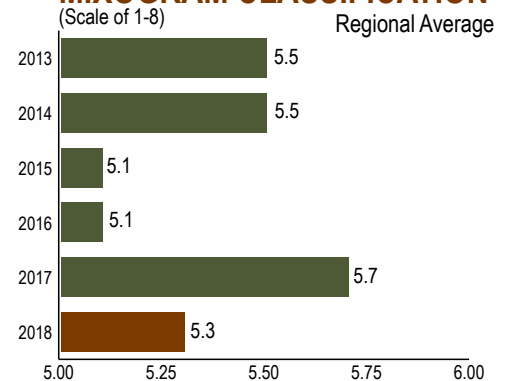
**WET GLUTEN** – Regional Average



**AVERAGE GLUTEN INDEX BY AREA**  
(Percent)



**MIXOGRAM CLASSIFICATION**



## SEMOLINA & SPAGHETTI DATA

STATE AND CROP REPORTING AREA	SEMOLINA COLOR L (BLACK-WHITE)	SEMOLINA COLOR A (GREEN-RED)	SEMOLINA COLOR B (BLUE-YELLOW)	SPAGHETTI COLOR SCORE (1-12)	SPAGHETTI COOKED WEIGHT G	SPAGHETTI COOKING LOSS %	SPAGHETTI COOKED FIRMNESS G CM
<b>MONTANA</b>							
Area A	84.0	-2.5	30.9	8.5	30.1	5.7	4.8
Area B	83.6	-2.4	29.4	8.5	30.5	6.0	4.8
State Avg 2018	83.7	-2.5	29.8	8.5	30.3	5.9	4.8
State Avg 2017	83.2	-2.2	29.7	9.4	30.2	5.8	5.5
<b>NORTH DAKOTA</b>							
Area A	83.6	-2.5	29.9	8.0	30.7	5.4	4.4
Area B	83.4	-2.6	29.3	8.5	30.4	5.7	4.3
Area C	83.7	-2.7	30.0	8.5	31.6	6.6	3.9
Area D	83.4	-2.4	30.5	8.5	30.2	5.3	4.6
State Avg 2018	83.5	-2.5	29.9	8.2	30.7	5.5	4.4
State Avg 2017	83.4	-2.3	29.2	8.9	31.4	5.9	4.6
<b>TWO-STATE AVERAGE</b>							
State Avg 2018	83.6	-2.5	29.9	8.3	30.5	5.7	4.5
State Avg 2017	83.3	-2.3	29.4	9.0	31.0	5.9	4.9
Five-Year Avg	84.2	-3.1	29.1	8.8	31.2	6.3	4.3

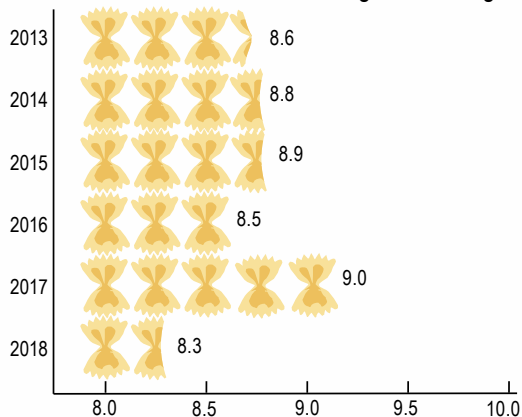
## PASTA CHARACTERISTICS

**DRY PASTA PROCESSORS** want a finished product that is visually appealing, elastic and strong enough to resist breakage during cutting, packaging, handling and shipping, able to withstand the rigors of cooking, and satisfying to the consumer palate.

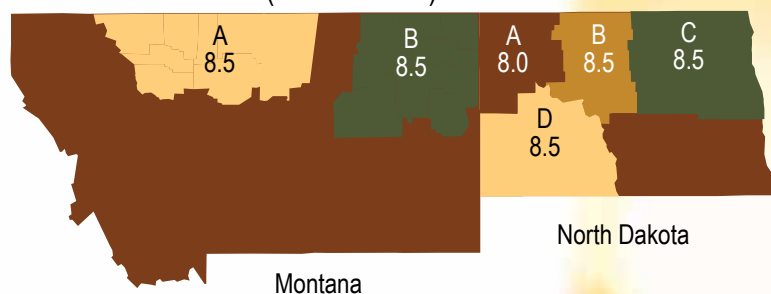
Yellow color in semolina and pasta is a traditional, rather than functional, mark of quality. In the early days of the pasta industry, before sophisticated testing evolved, consumers assumed that a yellow pasta was made from durum wheat, which is known to make pasta with superior cooking quality compared to that made from other hard wheats.

Most consumers prefer pasta that is “al dente,” meaning it has some firmness to the bite. Good quality pasta that is cooked according to package directions should not be sticky or mushy when eaten.

### COLOR SCORE – Regional Average



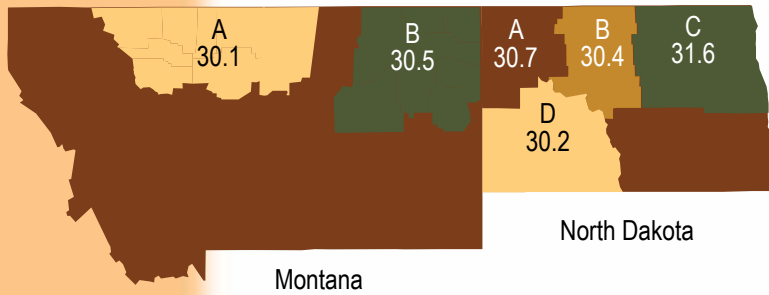
### AVERAGE COLOR SCORE BY AREA (Scale of 1-12)



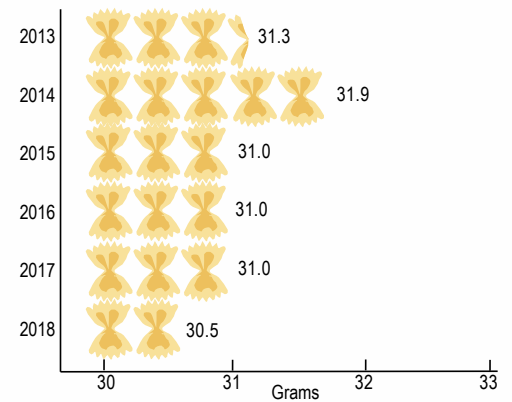
# U.S. DURUM WHEAT

MONTANA | NORTH DAKOTA

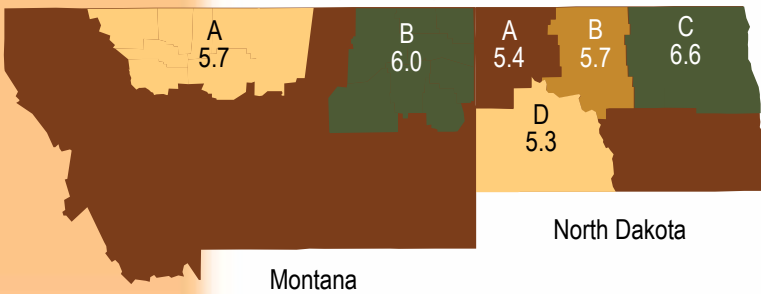
## AVERAGE COOKED WEIGHT BY AREA (Grams)



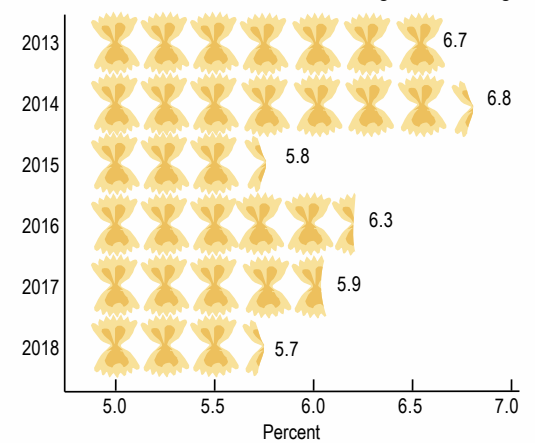
## COOKED WEIGHT – Regional Average



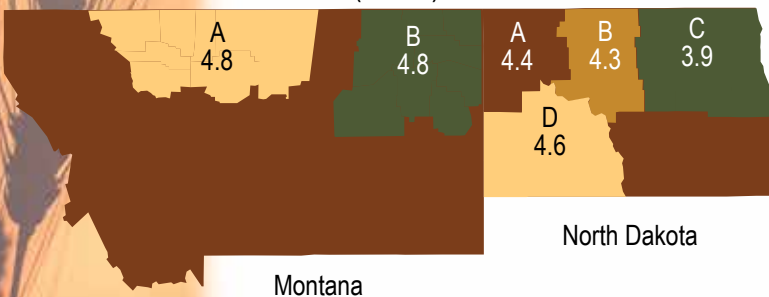
## AVERAGE COOKING LOSS BY AREA (Percent)



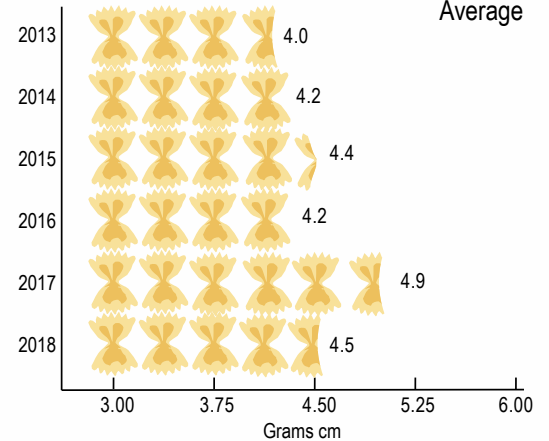
## COOKING LOSS – Regional Average



## AVERAGE COOKED FIRMNESS BY AREA (G CM)



## COOKED FIRMNESS – Regional Average





## RECENT QUALITY TRENDS

	2018	2017	2016	2015	2014	2013	FIVE-YEAR AVERAGE
GRADING AND WHEAT DATA							
Total Weight (lbs/bu)	61.4	60.9	61.2	60.6	59.0	60.7	60.4
Test Weight (kg/hl)	79.9	79.4	79.7	78.9	76.8	79.0	78.6
Total Defects (%)	1.0	1.2	1.2	1.3	1.6	1.0	1.3
Vitreous Kernels (%)	90	88	90	91	74	85	86
Grades	1 HAD	1 HAD	1 HAD	1 HAD	2 AD	1 HAD	1 HAD
OTHER WHEAT DATA							
Dockage (%)	0.7	1.1	0.2	0.9	0.7	0.9	0.8
Protein: 12% moisture	14.5	14.5	13.4	13.9	13.2	12.8	13.6
1000 Kernel Weight (gm)	41.2	38.4	40.0	38.5	38.0	44.1	39.9
Moisture (%)	11.2	11.3	11.4	11.2	12.4	12.1	11.7
DON	<0.5	<0.5	1.0	0.8	2.1	1.0	1.0
Ash (%)	1.54	1.46	1.61	1.57	1.64	1.57	1.57
Falling Number (sec)	425	380	423	414	276	375	374
Sedimentation (cc)	61	87	54	62	60	43	62
SEMOLINA DATA							
Total Extraction (%)	74.0	72.2	73.6	70.6	70.4	70.3	71.5
Semolina Extraction (%)	69.3	68.5	67.9	65.1	64.5	65.2	66.3
Ash (%)	0.73	0.69	0.71	0.64	0.74	0.66	0.69
Wet Gluten (%)	37.4	34.5	32.4	37.0	32.8	34.8	33.8
Specks (no/10 sq in)	29	26	30	24	26	26	27
Protein (%)	13.4	13.8	12.6	12.7	12.5	11.7	12.6
Gluten Index (%)	57.1	86.3	60.8	50.2	45.1	55.1	59.4
Mixograph Classification	5.3	5.7	5.1	5.1	5.5	5.5	5.4
*Color: L (black-white)	83.6	83.3	84.3	84.4	84.9	84.6	84.2
*a (green-red)	-2.5	-2.3	-2.8	-3.1	-4.0	-3.2	-3.1
*b (blue-yellow)	29.9	29.4	30.3	30.1	27.9	27.7	29.1
SPAGHETTI PROCESSING DATA							
Color Score (scale of 1-12)	8.3	9.0	8.5	8.9	8.8	8.6	8.8
*L (black-white)	52.8	54.4	53.5	54.5	53.5	56.4	54.5
*b (blue-yellow)	25.6	27.1	26.4	27.3	36.6	27.4	27.0
Cooked Weight (gm)	30.5	31.0	31.0	31.0	31.9	31.3	31.2
Cooking Loss (%)	5.7	5.9	6.3	5.8	6.8	6.7	6.3
Cooked Firmness (g cm)	4.5	4.9	4.2	4.4	4.2	4.0	4.3

\* Semolina color performed on CIE color scale. Granulation size is approximately 40 percent above 425 microns and 12 percent below 180 microns. Spaghetti color is performed on Hunter color scale.

# U.S. DURUM WHEAT

MONTANA | NORTH DAKOTA

## HANDLING & TRANSPORTATION

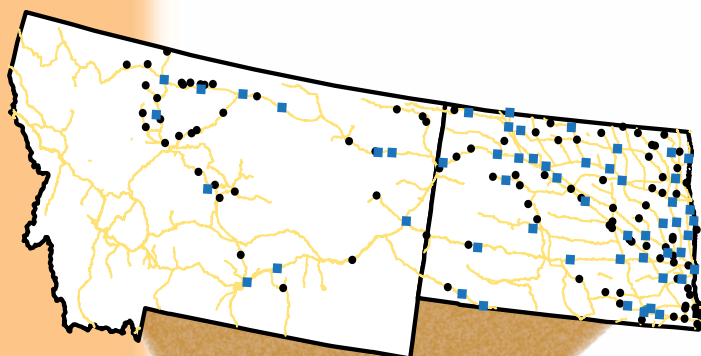
The durum wheat growing region in the Northern Plains has a vast network of country elevators to facilitate efficient and precise movement to domestic and export markets. On average, nearly 80 percent of the region's wheat moves to markets by rail. Duluth is the only export market easily serviced by trucks. Shipments to the Pacific Northwest and Gulf export markets are almost entirely by rail, with some barge movement to the Gulf. The dominant railroad is the Burlington Northern Santa Fe, followed by the Canadian Pacific.

A growing number of elevators in the region are investing to ship 100-110 car units in "shuttle" trains. Each rail car holds approximately 3,500 bushels

(95 metric tons) of wheat. Shuttle-equipped facilities receive the lowest rates, sharing volume and transaction efficiencies with the railroad.

The diverse rail shipping capacities and widespread network of elevators are strengths buyers can capitalize on, especially as their demand heightens for more precise quality specifications and consistency between shipments. Buyers are encouraged to explore origin-specific shipments to optimize quality and value.

The rail and elevator network in the U.S. northern grown durum region is well suited for meeting the increasing quality demands of both domestic and international customers.



- Track for 50 to 99 rail cars
- Track for 100 or more cars

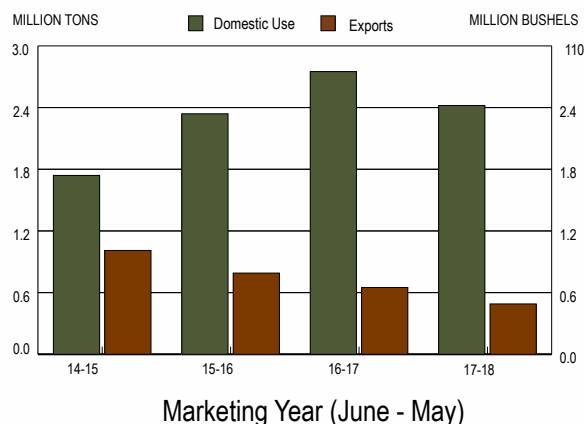
Source: Upper Great Plains Transportation Institute

### Grain Handling and Transportation Facilities in the Two-State Region



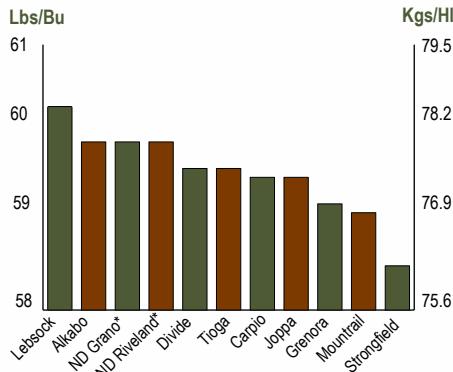
AVERAGE SHARE OF U.S. DURUM EXPORTS BY PORT (2014-2017)

### 2014-17 U.S. DURUM DOMESTIC USE AND EXPORTS

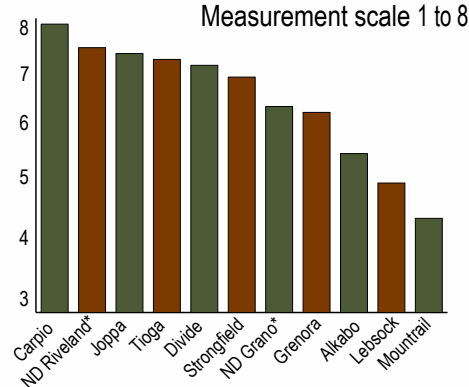


## VARIETAL INFORMATION

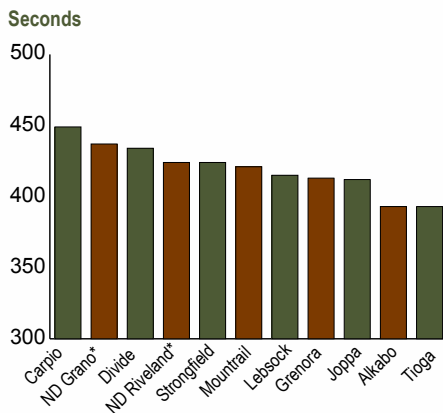
### TEST WEIGHT



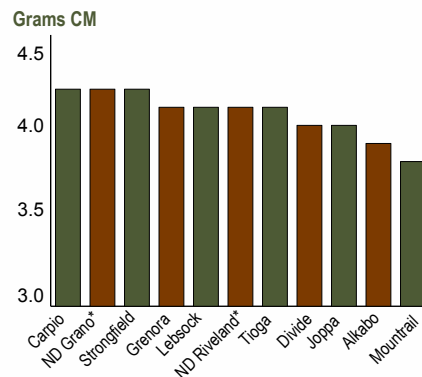
### MIXOGRAPH



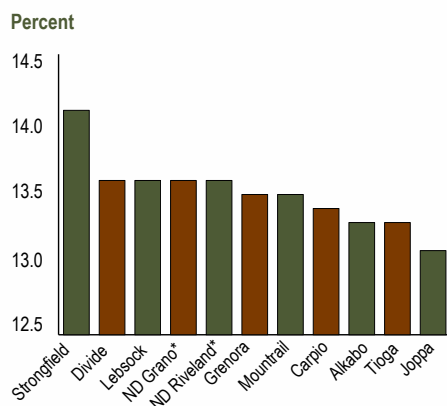
### FALLING NUMBER



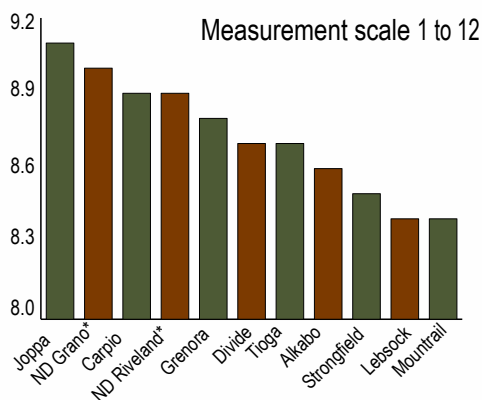
### COOKED FIRMNESS



### KERNEL PROTEIN



### PASTA COLOR



**THESE TABLES** illustrate the quality evaluation of some of the most popular varieties (cultivars), for key kernel and end-use parameters during the 2013-2017 growing seasons. A commitment to extensive end-use quality testing of new cultivars during the development stages is a major priority for producers in the region. The goal is to develop and release cultivars that excel in numerous kernel, milling and end-product parameters, across a broad environment.

\* Low Cadmium Varieties

# U.S. DURUM WHEAT

MONTANA | NORTH DAKOTA

## MAJOR VARIETIES PRODUCED IN REGION • AGRONOMIC FACTORS

VARIETY	AGRONOMIC DESCRIPTION			REACTION TO DISEASE <sup>2</sup>		AVERAGE YIELD WESTERN, ND	
	AGENT OR ORIGIN <sup>1</sup>	YEAR RELEASED	STRAW STRENGTH	LEAF RUST	FOLIAR DISEASE	BUSHELS PER ACRE	MT PER HEAD
Alkabo	ND	2005	strg.	R	M	57.3	3.85
Carpio	ND	2012	med.	R	M	57.4	3.86
Divide	ND	2005	med.	R	M	58.0	3.90
Genora	ND	2005	med.	R	M	57.4	3.86
Joppa	ND	2013	med.	R	M	60.2	4.05
Lebsock	ND	1999	strg.	R	M	56.7	3.81
Mountrail	ND	1998	med.	R	M	59.2	3.98
ND Grano*	ND	2017	med.	R	M	60.1	4.04
ND Riveland*	ND	2017	med.	R	M	61.6	4.14
Strongfield	CAN	2004	med. weak	R	MS	53.7	3.61
Tioga	ND	2010	med. strg.	R	M	58.2	3.92

## GROWN AND TESTED ACROSS NORTH DAKOTA • QUALITY & END-USE FACTORS

VARIETY	QUALITY FACTORS <sup>2</sup>								OVERALL PASTA QUALITY RATING <sup>5</sup>
	TEST WEIGHT LB/BU	TEST WHEAT KG/HL	WHEAT PROTEIN %	WHEAT FALLING # SECONDS	MIXOGRAM SCORE (SCALE 1-8)	PASTA COLOR (SCALE 1-12)	GLUTEN INDEX %	COOKED FIRMNESS G CM	
Alkabo	59.9	78.3	13.3	393	5.7	8.6	49	3.9	good
Carpio	59.5	77.8	13.4	449	7.9	8.9	93	4.2	good
Divide	59.6	77.9	13.6	434	7.2	8.7	77	4.0	good
Genora	59.2	77.3	13.5	413	6.4	8.8	68	4.1	good
Joppa	59.5	77.8	13.1	412	7.4	9.1	85	4.0	good
Lebsock	60.3	78.8	13.6	415	5.2	8.4	41	4.1	average
Mountrail	59.1	77.2	13.5	421	4.6	8.4	24	3.8	average
ND Grano*	59.9	78.2	13.6	437	6.5	9.0	67	4.2	excellent
ND Riveland*	59.9	78.3	13.6	424	7.5	8.9	84	4.1	excellent
Strongfield	58.5	76.5	14.1	424	7.0	8.5	66	4.2	good
Tioga	59.6	77.9	13.3	393	7.3	8.7	79	4.1	good

\* Low Cadmium

Source: 2018 North Dakota Durum Wheat Variety Performance Descriptions

1. ND – North Dakota State University, WB – Westbred and CAN – Canada
2. Reaction to Disease: resistant (R), moderately resistant (MR), intermediate (M), moderately susceptible (MS), susceptible (S)
3. Yield trials 2013-17 crop years across five North Dakota Locations
4. Based on NDSU Durum Quality Lab testing of 2013-17 samples grown at multiple North Dakota locations.
5. Based on kernel attributes, milling and semolina processing, pasta color and spaghetti cooking performance. Ratings can be excellent, good, average, fair and poor.



## NORTH DAKOTA AND MONTANA

**THE TOP** four durum varieties grown in North Dakota in 2018 are Joppa, Divide, Carpio and Alkabo. They account for nearly two-thirds of the planted acreage. In Montana, the top four varieties in 2018 are Joppa, Alzada, Tioga and Divide. They account for more than 80 percent of acres.

**JOPPA HAS** held the top position in North Dakota for two straight years, accounting for 24 percent acreage share and up from 2017. In Montana, it accounts for nearly 38 percent of the acres. Released from NDSU in 2013, it is popular with producers for its high-end yield potential and positive agronomic characteristics. Joppa is rated good for end-use quality.

**DIVIDE REMAINS** in second place in North Dakota with an 18 percent share, and is fourth in Montana with nearly 12 percent of the acres. It was the leading variety in North Dakota from 2009-2016. Divide was released in 2005 from NDSU, and remains popular with producers for its high yield potential and higher ratings for disease tolerance. It is rated good for end-use quality.

### NORTH DAKOTA VARIETY SHARE OF PLANTED ACRES<sup>3</sup>

VARIETY	2018% <sup>1</sup>	2017% <sup>1</sup>
Joppa	24.1	18.0
Divide	18.3	16.8
Carpio	11.6	14.9
Alkabo	9.2	11.1
VT Peak	6.3	4.1
Mountrail	5.1	4.6
Grenora	3.5	4.2
DG Max	2.8	0.0
Lebsock	2.7	3.5
Tioga	2.4	7.9
Other <sup>2</sup>	14.9	14.0

1. Percentage may not add to 100 due to rounding.
2. Includes varieties with less than 1% of acreage in 2018 and unknown varieties.
3. 1,000 acres (1 acre = 0.405 hectares)  
2018 – 1,100,000 acres  
2017 – 1,260,000 acres

### CARPIO ACCOUNTS

for roughly 12 percent of the acreage in North Dakota, down slightly from 15 percent the previous year. Carpio was released from NDSU in 2012, and is rated excellent for end-use quality with strong gluten properties, and high scores for color and cooked firmness.

**ALKABO'S SHARE** of North Dakota acreage is at 9 percent, down from its peak of 21 percent in 2015. A 2005 release from NDSU, it remains popular for its stronger straw properties. Alkabo possesses good end-use quality traits.

**ALZADA IS** the second most popular variety in Montana with 20 percent of the acres in 2018. It is most popular in the North Central region where it is primarily grown under contracted production for its uniquely strong gluten properties and excellent cooking quality. Alzada is a

2004 release from Westbred. It possess good yield and agronomic traits but is constrained to western areas for production because of limited disease resistance.

**TIOGA IS** the third most popular variety in Montana with a 13.5 percent share. This is up from previous years. Tioga was released in 2010 from NDSU and is popular for its balance of yield, strong straw and good end-use quality traits.

**TWO RECENT** NDSU releases, RIVELAND AND GRANO, were developed as low Cadmium lines, and are expected to gain in acres in both states over the next few years.

*2018 Regional Quality Report*

### NORTH DAKOTA VARIETY SHARE OF 2018 PLANTED ACRES BY CROP DISTRICT

VARIETY	NORTH WEST	WEST CENTRAL	SOUTH WEST	COMBINED DISTRICTS <sup>1</sup>	TOTAL STATE
PERCENTAGE (%) <sup>2</sup>					
Joppa	20.0	32.7	45.7	20.8	24.1
Divide	19.5	28.2	11.1	14.7	18.3
Carpio	13.4	11.4	14.8	5.6	11.6
Alkabo	11.9	1.1	14.0	3.2	9.2
VT Peak	9.3	2.4	0.5	2.8	6.3
Mountrail	8.9	0.0	0.0	0.0	5.1
Grenora	5.7	0.0	1.7	0.0	3.5
DG Max	0.0	0.0	0.0	12.2	2.8
Lebsock	2.3	9.8	0.0	2.0	2.7
Tioga	2.0	3.5	8.9	0.0	2.4
Other <sup>3</sup>	7.0	10.8	3.3	38.7	14.0

### 1,000 ACRES (1 ACRE = 0.4 HECTARES)

Total Acres <sup>3</sup>	572	91	108	229	1,000 <sup>4</sup>
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1. Data from North Central, Northeast, Central, East Central, South Central and Southeast districts are combined to avoid disclosure of individual operations..
2. Percentages may not add to 100 due to rounding
3. Includes varieties with less than 1% acreage in 2018 and unknown varieties.
4. September 30, 2018 small grain estimate was 1,100,000 acres.

### MONTANA VARIETY SHARE OF PLANTED ACRES<sup>3</sup>

VARIETY	2018% <sup>1</sup>	2016% <sup>1</sup>
Joppa	37.6	1.8
Alzada	20.2	15.2
Tioga	13.5	8.6
Divide	11.8	27.1
Transcend	5.3	n/a
Mountrail	5.3	20.7
Carpio	2.7	0.5
Klye	1.1	5.9
Other <sup>2</sup>	2.7	20.2

1. Percentage may not add to 100 due to rounding.
2. Includes varieties with less than 1% of acreage in 2018 and unknown varieties.
3. 1,000 acres (1 acre = 0.405 hectares)  
2018 – 840,000 acres  
2016 – 780,000 acres

## LABORATORY ANALYSIS

All quality data contained in this report is the result of testing and analysis conducted by or under the supervision of Dr. Frank Manthey, professor and Yu Liu, food technologist of the Durum Wheat Quality and Pasta Processing Laboratory in the Department of Plant Science at North Dakota State University, Fargo, North Dakota, USA.

**COLLECTION** • The North Dakota and Montana state offices of the National Agricultural Statistics Service obtained durum wheat samples during harvest directly from growers, farm bins and local elevators. These samples reflect the condition of the grain at the point of origin. Collection began in early August when approximately 20 percent of the regional durum crop had been harvested and continued through the end of September. A total of 241 samples were collected during harvest from Montana (64) and North Dakota (177).

**ANALYSIS** • Half of the total wheat samples collected were analyzed for grade and other physical kernel characteristics. The data obtained from the analyses was used to generate frequency distributions as a percentage of the harvested crop. Distribution results may differ from data presented in the various tables, because the latter are derived from production adjusted averages, rather than simple averages.

All samples received in the laboratory were sub-sampled to obtain one composite sample for each of the four areas in North Dakota and one composite each of two areas for Montana. These were analyzed for grade and physical characteristics as well as milling performance and spaghetti processing qualities. Again, all state and regional averages have been adjusted to reflect production as opposed to simple averaging.

## METHODS, TERMS, SYMBOLS

### WHEAT

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

**MOISTURE** • Official USDA procedure using Motomco Moisture Meter.

**GRADE** • Official United States Standards for Grain, as determined by a licensed grain inspector. North Dakota Grain Inspection Service, Fargo, ND, provided grades for composite wheat samples representing each crop reporting area.

**VITREOUS KERNELS** • Approximate percentage of kernels having vitreous endosperm, based on weights.

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

**TEST WEIGHT** • American Association of Cereal Chemists Method 55-10.01 approved April 1961, re-

vised October 1999. Measured as pounds per bushel (lb/bu), kilograms per hectoliter (kg/hl) = (lbs/bu X 1.292) + 0.630. Approved Methods of the American Association of Cereal Chemists, Cereal Laboratory Methods (10th Edition), St. Paul, MN (2000).

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

**KERNEL SIZE DISTRIBUTION** • Determinations made according to the procedure described in Cereal Science Today 5:(3), 71 (1960). Kernels remaining over a Tyler No. 7 (2.92 mm opening) are classified as "large;" kernels passing through the top sieve but remaining on a Tyler No. 9 (2.24 mm opening) are classified as "medium" size kernels. Kernels passing through the second sieve are classed as "small." Size is reported as percentage of large, medium, and small kernels.

**PROTEIN** • American Association of Cereal Chemists (AACC) Method: 46-30.01 (Combustion Method), expressed on dry basis and 12 percent moisture basis.

**ASH** • American Association of Cereal Chemists Method 08-01.01, approved April 1961, revised October 1999; expressed on a 14 percent moisture basis.

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

**FALLING NUMBER** • American Association of Cereal Chemists Method 56-81.03, approved November 1972, revised September 1999; units of seconds (14 percent moisture basis).

**MICRO SEDIMENTATION** • Determined as described by Dick, J.W. and Quick, J.S. Cereal Chem. 60(4):315-318, 1983.

**WET GLUTEN** • American Association of Cereal Chemists Method 38-12.01, approved October 1999; expressed on a 14 percent moisture basis determined with the glutomatic instrument.

**GLUTEN INDEX** • American Association of Cereal Chemists Method 38-12.02, approved October 1999; determined with the glutomatic instrument as an indication of gluten strength.

## SEMOLINA

**EXTRACTION** • AACC Method 26-41.01 (modified for the Buhler Mill). Expressed on a total product basis.

**ASH** • AACC Method 08-01.01, approved April 1961, revised October 1999; expressed on a 14 percent moisture basis.

**PROTEIN** • AACC Method 46-30.01 (combustion method), approved September 1995, revised October 1999, N x 5.7, expressed on a 14 percent moisture basis.

**SPECKS** • The number of specks in semolina was determined on a flat surface under a constant light source, and counting the visible specks (brown and black particles) in three different one-inch square areas. The average of the three readings was converted to the number of specks per 10 square inches.

**MIXOGRAPH** • Mixograph evaluation of semolina was performed according to the AACC Method 54-40.02 with some modifications: Ten grams of semolina (weighed on 14 percent moisture basis)

were mixed for 8 min at constant water absorption of 5.8 ml, using a spring setting of 8. The mixograms were scored by comparing them to reference mixograms. A scale of 1 to 8 is employed, higher values indicate strong mixing characteristics (see reference mixogram chart).

## SPAGHETTI

**PROCESSING** • 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 32 percent total water absorption. The other processing conditions used were: 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 0.157 cm openings. The extruded spaghetti samples were dried at high temperature for 12 hrs, using maximum temperature and relative humidity of 73 C and 83 percent, respectively.

**COLOR** • Color scores were determined by light reflectance (AACC Method 14-22.01, 1983), using a Minolta Color Difference Meter (Model CR 410, Minolta Camera Co., Japan). The scores were generated according to the new color map designed by Debbouz (Pasta J. vol 6, No 6, 1994). A spaghetti sample with a score of 8.0 or higher is considered to have good color.

**COOKED WEIGHT** • 10 g of dry spaghetti were placed in 300 ml boiling distilled water and cooked for 12 min. The cooked and drained spaghetti sample was weighed and the results were reported in grams.

**COOKING LOSS** • AACC Method 66-50.01. Solids lost to the cooking water. After drying the residue was weighed and reported as percentage of the original dry sample.

**FIRMNESS** • AACC Method 66-50.01 with a Plexiglas tooth attached to a Texture Analyzer (Model TA-XT2, Texture Technology Corp., Scarsdale, New York).



2018

NORTH DAKOTA AND MONTANA

# U.S. DURUM WHEAT

## *Regional Quality Report*

*Funding & Support Provided by*

**U.S. Wheat Associations**

**North Dakota Wheat Commission**

**Montana Wheat and Barley Committees**

**North Dakota State University Plant Sciences Department**

