U.S. GRAINS
COUNCIL

2017/2018
CORN HARVEST QUALITY REPORT

ACKNOWLEDGEMENTS

Developing a report of this scope and breadth in a timely manner requires participation by a number of individuals and organizations. The U.S. Grains Council (Council) is grateful to Dr. Sharon Bard and Mr. Chris Schroeder of Centrec Consulting Group, LLC (Centrec) for their oversight and coordination in developing this report. They were supported by internal staff along with a team of experts that helped in data gathering, analysis and report writing. External team members include Drs. Tom Whitaker, Lowell Hill, Marvin R. Paulsen and Fred Below. In addition, the Council is indebted to the Illinois Crop Improvement Association's Identity Preserved Grain Laboratory (IPG Lab) and Champaign-Danville Grain Inspection (CDGI) for providing the corn quality testing services.

Finally, this report would not be possible without the thoughtful and timely participation by local grain elevators across the United States. We are grateful for their time and effort in collecting and providing samples during their very busy harvest time.

GREETINGS FROM THE COUNCIL

The U.S. Grains Council (USGC) has completed its seventh annual corn quality survey and is pleased to present the findings in this *2017/2018 Corn Harvest Quality Report*.

The majority of this year's corn crop had a Good or Excellent crop condition rating during reproductive growth. This signified strong plant health, which led to good photosynthesis, kernel size and yields. Overall, 2017 was characterized by an extended planting period; a warm, wet vegetative period; a cool, dry and prolonged grain-filling period; and a warm, wet and slow harvest. These weather conditions in the United States led to a projected record yield in 2017, with total U.S. corn production estimated to be 370.30 million metric tons (14.58 billion bushels), the second-largest crop on record. The United States is the top exporter of corn, with an estimated 32 percent of global corn exports during the 2017/2018 marketing year.

As in previous reports, the *2017/2018 Corn Harvest Quality Report* provides timely information about the quality of the current U.S. crop at harvest as it enters international merchandising channels. Corn quality observed by buyers will be further affected by subsequent handling, blending and storage conditions. A second Council report, the *2017/2018 Corn Export Cargo Quality Report*, will measure corn quality at export terminals at the point of loading for international shipment and will be available in early 2018. The Council's series of quality reports uses consistent and transparent methodology to allow for comparison with past years' quality. This enables buyers to make well-informed decisions, and have confidence in the capacity and reliability of the U.S. corn market.

The Council strives for global food security and mutual economic benefit by building relationships and increasing exports. These goals are facilitated by our global staff serving as a bridge between the world's largest and most sophisticated agricultural production and export system, and international corn buyers.

The Council's mission is one of developing markets, enabling trade and improving lives, and as part of this mission, the Council is pleased to offer this report as a service to our partners. We hope this report continues in its role of providing accurate and timely insight into the quality of the 2017 U.S. corn crop.

Sincerely,

Debra Keller
Chairman, U.S. Grains Council
December 2017

FRIENDS &
FRONTIERS

The representative samples tested for the *2017/2018 Corn Harvest Quality Report* indicate overall quality of the 2017 corn crop was better than the average of the previous five crop years (5YA[1]) on many attributes. Ninety-five percent of the samples met the standards for U.S. No. 2 grade. The 2017 U.S. corn crop is entering the market channel with lower average total damage, and higher average test weight, oil concentration, 100-k weight and kernel volume relative to 2016 and the 5YA. The following highlights the key harvest results from this year's crop:

Grade Factors and Moisture

- Average test weight of 58.4 lb/bu (75.2 kg/hl), with 92.2% above the limit for No. 1 grade corn, and 99.8% above the limit for No. 2 grade. Higher than 2016 and 5YA, this test weight indicates good kernel filling and maturation.
- Low levels of broken corn and foreign material (BCFM) (0.8%), slightly higher than 2016 but same as 5YA. In 2017, 97.9% of the samples were below the limit for No. 2 grade, which indicates little cleaning should be required. This is similar to 2016 and 2015, when 99% and 98% of samples, respectively, were below the limit for No. 2 grade for BCFM.
- Average total damage of 1.3% was lower than 2016, 2015 and 5YA, and 97.3% of the samples were below the total damage limit for No. 2 grade.
- No observed heat damage.
- Higher elevator moisture content (16.6%) than 2016, 2015 and 5YA. The distribution shows 36.2% of the samples were above 17% moisture content as compared to 29% and 19% in 2016 and 2015, respectively. This distribution indicates more samples required drying in 2017 than in 2016 and 2015.

Chemical Composition

- Protein concentration (8.6% dry basis) was the same as 2016, higher than 2015, and slightly lower than 5YA.
- Lower starch concentration (72.3% dry basis) than 2016, 2015 and 5YA.
- Average oil concentration of 4.1% (dry basis), higher than 2016, 2015 and 5YA.

U.S. Corn Grades and Grade Requirements

		Maximum Limits of		
		Damaged Kernels		
Grade	Minimum Test Weight per Bushel (Pounds)	Heat Damaged (Percent)	Total (Percent)	Broken Corn and Foreign Material (Percent)
U.S. No. 1	56.0	0.1	3.0	2.0
U.S. No. 2	54.0	0.2	5.0	3.0
U.S. No. 3	52.0	0.5	7.0	4.0
U.S. No. 4	49.0	1.0	10.0	5.0
U.S. No. 5	46.0	3.0	15.0	7.0

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[1] *5YA represents the simple average of the quality factor's average or standard deviation from the 2012/2013, 2013/2014, 2014/2015, 2015/2016 and 2016/2017 Harvest Reports.*

Physical Factors

- Low percentage of stress cracks (5%), slightly higher than 2016 and 2015, but lower than 5YA, with 86.8% of the samples having less than 10% stress cracks.
- Average stress crack index (13.7), higher than 2016 and 2015, but close to 5YA. Susceptibility to breakage may be slightly higher than 2016, but should still remain relatively low.
- Higher 100-k weight (36.07 g) than 2016, 2015 and 5YA, signifying larger kernels than in previous years.
- Average kernel volume of 0.29 cm^3, also higher than 2016, 2015 and 5YA.
- Average true density of 1.260 g/cm^3, higher than 2016 and 2015, but similar to 5YA.
- Lower average whole kernels (89.9%) than 2016, 2015 and 5YA. The low percentage of whole kernels may be due, in part, to the large kernel sizes leading to a weaker kernel structure than found with smaller kernels.
- Higher average horneous endosperm (81%) than 2016 and 2015, but slightly lower than 5YA. This indicates harder kernels compared to the last two years.

Mycotoxins

- All but two samples, or 98.9%, of the 2017 corn samples, tested below the U.S. Food and Drug Administration (FDA) action level for aflatoxin of 20 ppb.
- In 2017, 100% of the corn samples tested below the 5 ppm FDA advisory level for deoxynivalenol (DON) (same as in 2016 and 2015). In addition, 90.0% of the samples tested below the U.S. Department of Agriculture (USDA) Federal Grain Inspection Service (FGIS) "Lower Conformance Level," a much higher proportion than in 2016. This increase may be attributed to favorable weather conditions that were less conducive to DON development in 2017 than in 2016.

The *U.S. Grains Council 2017/2018 Corn Harvest Quality Report* has been designed to help international buyers of U.S. corn understand the initial quality of U.S. yellow commodity corn as it enters the merchandising channel. This is the seventh annual measurement survey of the quality of the U.S. corn crop at harvest. Seven years of results are showing patterns in the impact of weather and growing conditions on the quality of U.S. corn as it comes out of the field.

Spring 2017 was warmer than average for almost all of the United States, with unseasonably-late snow and heavy rain events in various areas. These factors led to delayed planting and emergence. On average, emergence was later than the 5-year average (5YA). Warm, wet weather during the vegetative stage encouraged rapid growth and healthy-looking plants. In June, the warm weather and dry conditions favored brisk plant growth and nitrogen fertilizer uptake, producing a crop with a combined Good to Excellent condition rating between 60-68% that remained all season. These Good to Excellent condition ratings were similar to the final 2015 crop. While July was characterized by average or above average temperatures, August brought cool temperatures to the entire U.S. Corn Belt, which mitigated normal environmental heat and drought stresses, and extended the time for grain-fill. Additionally, September was warmer than average, which the crop took advantage of by continuing grain-fill, especially with oil, increasing grain weight and volume, and delaying maturation.

Both this year's slow crop maturation and abundant rains hindered a timely harvest and dry-down in several regions, resulting in areas of high-moisture corn. Overall, the 2017 season experienced a delayed harvest and average moisture content that was higher than the 5YA. However, total damage levels remained low, below last year and 5YA, and there have been few incidences of aflatoxins and deoxynivalenol (DON). Overall, the weather in 2017 led to high yields, with high test weight averages, large kernels and high oil concentration averages. Percentages of whole kernels were lower than in previous years, but broken corn and stress cracks remained close to 5YA. True density and horneous endosperm were higher than last year, but were close to 5YA.

These observations show quality differences among the seven years, but overall, the *2017/2018 Harvest Report* indicates good quality corn entering the 2017/2018 market channel. About 79% of the samples met all requirements for No. 1 grade, and 95.1% met the requirements for No. 2 grade. Low total damage levels should be good for storability; however, higher moisture levels and greater moisture variability may indicate some care should be given to monitoring and properly aerating corn for safe storage.

Seven years of data have laid the foundation for evaluating trends and the factors that impact corn quality. In addition, the cumulative *Harvest Report* measurement surveys enable export buyers to make year-to-year comparisons and assess patterns of corn quality based on crop growing conditions across the years.

This *2017/2018 Harvest Report* is based on 627 yellow commodity corn samples taken from defined areas within 12 of the top corn-producing and exporting states. Inbound samples were collected from local grain elevators to observe quality at the point of origin and to provide representative information about the variability of the quality characteristics across the diverse geographic regions.

The sampling areas in the 12 states are divided into three general groupings that are labeled Export Catchment Areas (ECAs). These three ECAs are identified by the three major pathways to export markets:

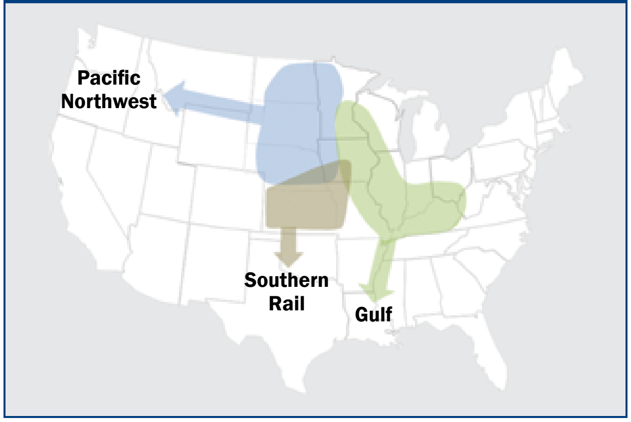
- The Gulf ECA consists of areas that typically export corn through U.S. Gulf ports;
- The Pacific Northwest (PNW) ECA includes areas exporting corn through Pacific Northwest and California ports; and
- The Southern Rail ECA comprises areas generally exporting corn to Mexico by rail from inland subterminals.

Sample test results are reported at the U.S. Aggregate level and for each of the three ECAs, providing a general perspective on the geographic variability of U.S. corn quality.

The quality characteristics of the corn identified at harvest establish the foundation for the quality of the grain ultimately arriving at the export customers' doors. However, as corn passes through the U.S. marketing system, it is mingled with corn from other locations; aggregated into trucks, barges and railcars; and stored, loaded and unloaded several times. Therefore, the quality and condition of the corn changes between the initial market entry and the export elevator. For this reason, the *2017/2018 Harvest Report* should be considered carefully in tandem with the *U.S. Grains Council 2017/2018 Corn Export Cargo Quality Report* that will follow early in 2018. As always, the quality of an export cargo of corn is established by the contract between buyer and seller, and buyers are free to negotiate any quality factor that is important to them.

This report provides detailed information on each of the quality factors tested, including averages and standard deviations for the aggregate of all samples, and for each of the three ECAs. The "Quality Test Results" section summarizes the following quality factors:

EXPORT CATCHMENT AREAS



- Grade Factors: test weight, broken corn and foreign material (BCFM), total damage and heat damage
- Moisture
- Chemical Composition: protein, starch and oil concentrations
- Physical Factors: stress cracks/stress crack index, 100-kernel weight, kernel volume, kernel true density, whole kernels and horneous (hard) endosperm
- Mycotoxins: aflatoxin and DON

In addition, this *Harvest Report* includes brief descriptions of the U.S. crop and weather conditions; U.S. corn production, usage and outlook; and detailed descriptions of survey, statistical analysis and testing analysis methods.

Included in this *2017/2018 Harvest Report* is a simple average of the quality factors' averages and standard deviations of the previous five *Harvest Reports (2012/2013, 2013/2014, 2014/2015, 2015/2016 and 2016/2017*). These simple averages are calculated for the U.S. Aggregate and each of the three ECAs, and are referred to as "5YA" in the report.

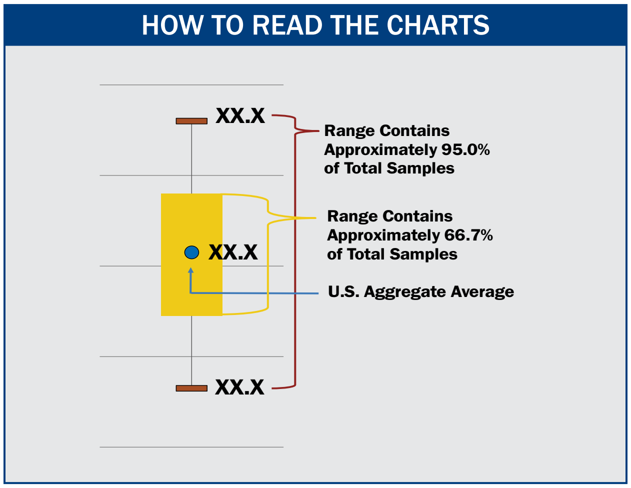
A. GRADE FACTORS

The U.S. Department of Agriculture (USDA) Federal Grain Inspection Service (FGIS) has established numerical grades, definitions and standards for measurement of many quality attributes. The attributes that determine the numerical grades for corn are test weight, broken corn and foreign material (BCFM), total damage and heat damage. The table for "U.S. Corn Grades and Grade Requirements" is provided on page 70 of this report.

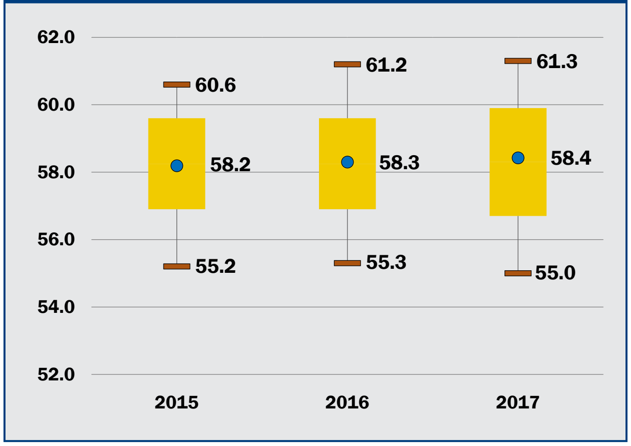
SUMMARY: GRADE FACTORS AND MOISTURE

- Average U.S. Aggregate test weight (58.4 lb/bu or 75.2 kg/hl) was slightly higher than in 2016, 2015 and 5YA. It was well above the limit for U.S. No. 1 grade corn.
- As in previous years, the average test weight was above the minimum for U.S. No. 1 grade in all ECAs.
- Average U.S. Aggregate broken corn and foreign material (BCFM) (0.8%) was higher than in 2016, the same as in 2015 and 5YA, and well below the maximum for U.S. No. 1 grade.
- BCFM levels in almost all (97.9%) of the corn samples were equal to or below the 3% maximum allowed for No. 2 grade.
- Average BCFM differed by no more than 0.1% between all three ECAs.
- Average U.S. Aggregate broken corn (0.6%) was higher than last year, but the same as 2015 and 5YA.
- Average U.S. Aggregate foreign material (0.2%) was higher than last year, but the same as 2015 and 5YA.
- Total damage in the U.S. Aggregate samples averaged 1.3% in 2017, lower than in 2016, 2015 and 5YA, and well below the limit for U.S. No. 1 grade (3%). Of the samples, 90.4% contained 3% or less damaged kernels.
- The Pacific Northwest ECA had the lowest total damage in 2017, 2016, 2015 and 5YA, while the Gulf ECA had the highest total damage for 2017, 2016, 2015 and 5YA. Average total damage values in all ECAs were well below the limit for U.S. No. 2 grade (5.0%).
- No heat damage was reported on any of the samples, the same as 2016, 2015 and 5YA.
- Average U.S. Aggregate moisture content in 2017 (16.6%) was higher than in 2016, 2015 and 5YA.
- The 2017 average moisture content value for the Gulf ECA (17.0%) was higher than the Pacific Northwest (16.1%) and the Southern Rail ECA (15.8%). Average moisture levels for the Gulf ECA were highest or tied for highest among all ECAs for 2017, 2016, 2015 and 5YA.
- There were more high moisture samples in the 2017 crop than in the 2016 and 2015 crops, with 36.2% of the samples containing more than 17% moisture, compared to 29% in 2016 and 19% in 2015. This distribution indicates more drying was required in 2017 than in the previous two years.
- Because of higher moistures in 2017 than in 2016 and several previous years, care should be taken to monitor and maintain moisture levels sufficiently low to prevent possible mold growth during storage.

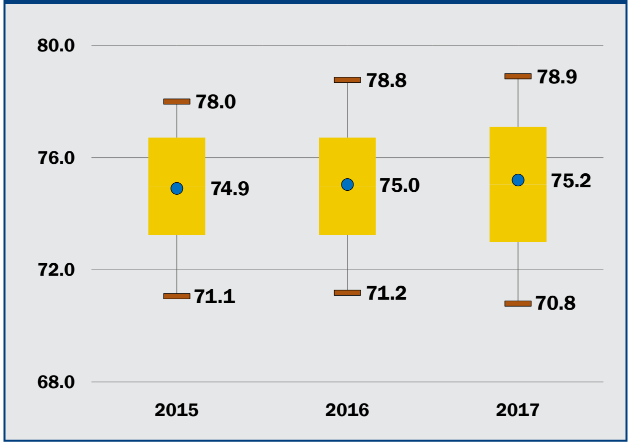
HOW TO READ THE CHARTS



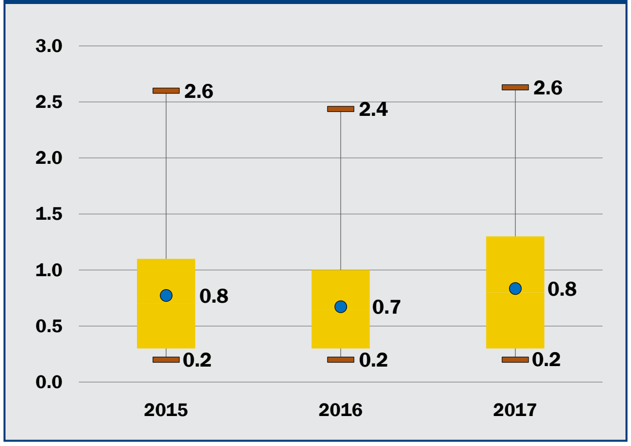
TEST WEIGHT (lb/bu)



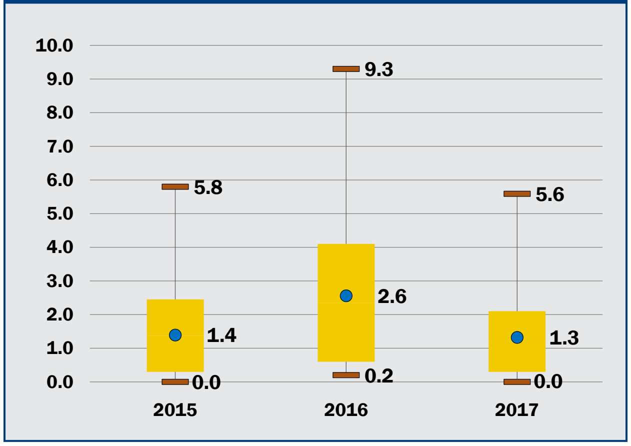
TEST WEIGHT (kg/hl)



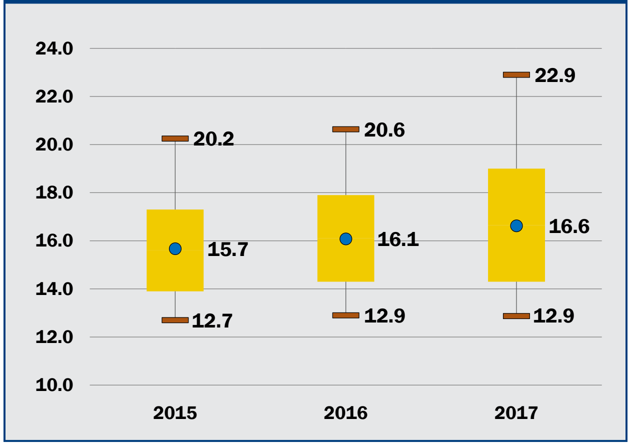
BCFM (%)



TOTAL DAMAGE (%)



MOISTURE (%)



Test Weight

Test weight (weight per volume) is a measure of bulk density and is often used as a general indicator of overall quality and as a gauge of endosperm hardness for alkaline cookers and dry millers. High test weight corn takes up less storage space than the same weight of corn with a lower test weight. Test weight is initially impacted by genetic differences in the structure of the kernel. However, it is also affected by moisture content, method of drying, physical damage to the kernel (broken kernels and scuffed surfaces), foreign material in the sample, kernel size, stress during the growing season, and microbiological damage. When sampled and measured at the point of delivery from the farm at a given moisture content, high test weight generally indicates high quality, high percent of horneous (or hard) endosperm, and sound, clean corn. Test weight is positively correlated with true density and reflects kernel hardness and good maturation conditions.

Results

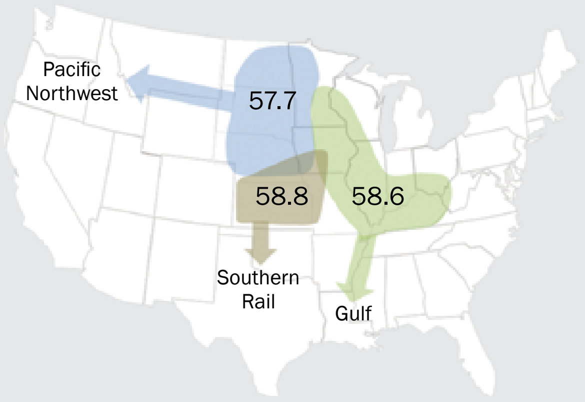
- Average U.S. Aggregate test weight in 2017 (58.4 lb/bu or 75.2 kg/hl) was slightly higher than in 2016 (58.3 lb/bu or 75.0 kg/hl), 2015 (58.2 lb/bu or 74.9 kg/hl) and 5YA (58.1 lb/bu or 74.8 kg/hl).
- Average U.S. Aggregate test weight in 2017 was well above the minimum for U.S. No. 1 grade (56 lb/bu).
- U.S. Aggregate test weight standard deviation in 2017 (1.21 lb/bu) was similar to 2016 (1.22 lb/bu) and 5YA (1.27 lb/bu), but greater than 2015 (1.08 lb/bu).

U.S. Grade Minimum Test Weight
No. 1: 56.0 lbs
No. 2: 54.0 lbs
No. 3: 52.0 lbs

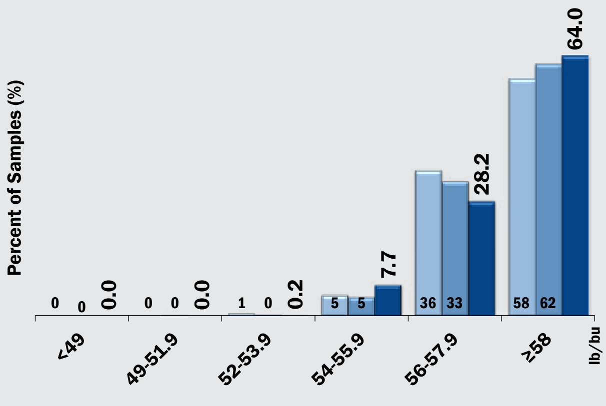
- The range in values among the 2017 harvest samples (10.6 lb/bu) was similar to 2016 (10.4 lb/bu), but wider than 2015 (8.1 lb/bu).
- The 2017 test weight values were distributed with 92.2% of the samples at or above the factor limit for U.S. No. 1 grade (56 lb/bu), This distribution was similar to 2016 (95%) and 2015 (94%). In 2017, 99.8% of the samples were above the limit for U.S. No. 2 grade (54 lb/bu), compared to 100% in 2016 and 99% in 2015.
- Average test weight was above the limit for U.S. No. 1 grade in all ECAs. The Gulf (58.6 lb/bu) and Southern Rail (58.8 lb/bu) ECAs had the highest average test weights. The Pacific Northwest ECA (57.7 lb/bu) had the lowest test weight in 2017, 2016, 2015 and 5YA.
- Besides having the lowest test weight in 2017, the Pacific Northwest ECA had the highest variability, as indicated by its higher standard deviation (1.28 lb/bu), compared to the Gulf (1.18 lb/bu) and Southern Rail (1.21 lb/bu) ECAs.

TEST WEIGHT (lb/bu)

EXPORT CATCHMENT AREA AVERAGE



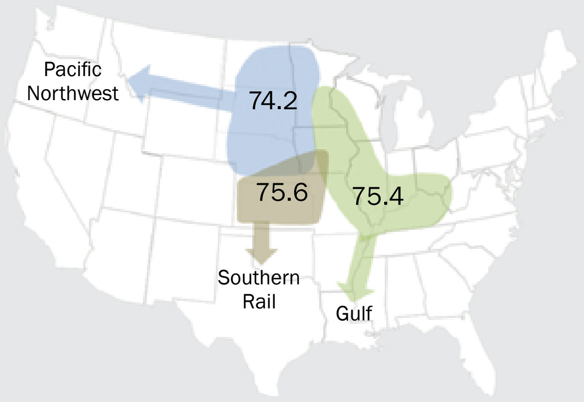
U.S. AGGREGATE



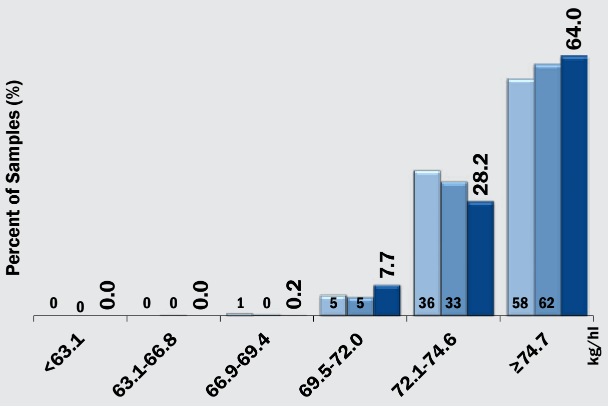
		Avg (lb/bu)	Std Dev (lb/bu)
■	2017	58.4	1.21
■	2016	58.3	1.22
■	2015	58.2	1.08

TEST WEIGHT (kg/hl)

EXPORT CATCHMENT AREA AVERAGE



U.S. AGGREGATE



		Avg (kg/hl)	Std Dev (kg/hl)
■	2017	75.2	1.55
■	2016	75.0	1.57
■	2015	74.9	1.38

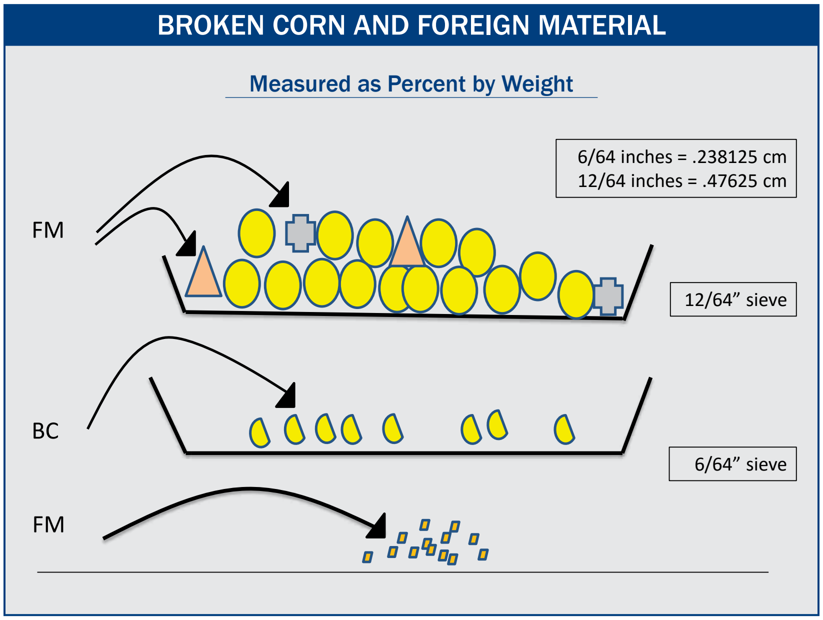
Broken Corn and Foreign Material (BCFM)

Broken corn and foreign material (BCFM) is an indicator of the amount of clean, sound corn available for feeding and processing. The lower the percentage of BCFM, the less foreign material and/or fewer broken kernels are in a sample. Higher levels of BCFM in farm-originated samples generally stem from harvesting practices and/or weed seeds in the field. BCFM levels will normally increase during drying and handling, depending on the methods used and the soundness of the kernels. More stress cracks at harvest will also result in an increase in broken kernels and BCFM during subsequent handling.

Broken corn (BC) is defined as corn and any other material (such as weed seeds) small enough to pass through a 12/64th-inch round-hole sieve, but too large to pass through a 6/64th-inch round-hole sieve.

Foreign material (FM) is defined as any non-corn material too large to pass through a 12/64th-inch round-hole sieve, as well as all fine material small enough to pass through a 6/64th-inch round-hole sieve.

The diagram shown below illustrates the measurement of broken corn and foreign material for the U.S. corn grades.



BROKEN CORN AND FOREIGN MATERIAL

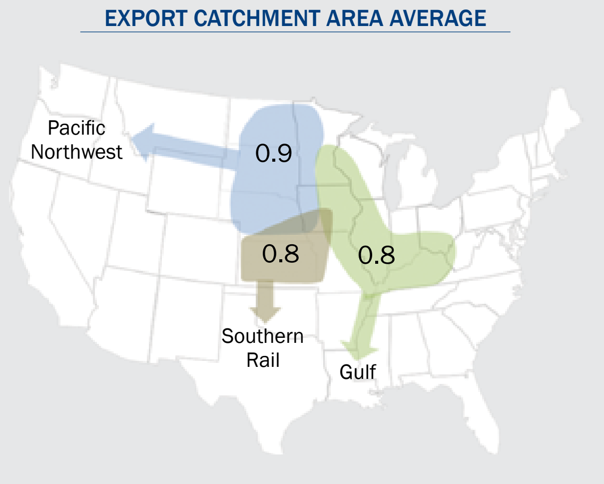
Measured as Percent by Weight

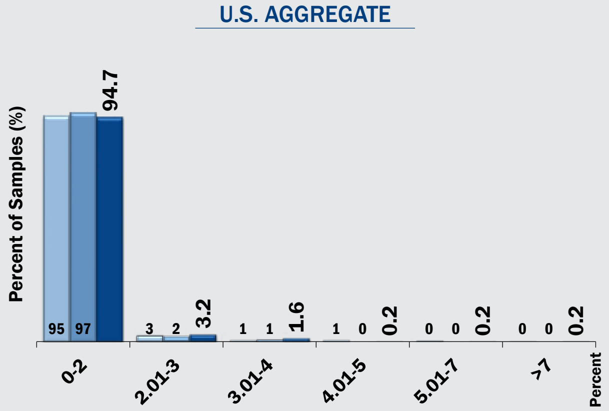
Results

- Average U.S. Aggregate BCFM in 2017 (0.8%) was slightly above 2016 (0.7%), the same as 2015 and 5YA (both 0.8%), and well below the maximum for U.S. No. 1 grade (2.0%).
- The variability of BCFM in the 2017 crop, based on standard deviation (0.57%), was slightly higher than 2016 (0.45%), lower than 2015 (0.61%) and similar to 5YA (0.54%).
- The range between minimum and maximum BCFM values in 2017 (7.3%) was higher than in 2016 (4.0%), but lower than in 2015 (11.9%).
- The 2017 samples were distributed with 94.7% of the samples below the maximum BCFM level for U.S. No. 1 grade (2%), compared to 97% in 2016 and 95% in 2015. BCFM levels in nearly all samples (97.9%) were equal to or below the maximum 3% limit for No. 2 grade.
- Average BCFM for the Gulf, Pacific Northwest and Southern Rail ECAs (0.8%, 0.9% and 0.8%, respectively) differed by only 0.1% across the ECAs. The difference in average BCFM across ECAs was 0.0%, 0.1% and 0.1% for 2016, 2015 and 5YA, respectively.

U.S. Grade BCFM Maximum Limits
No. 1: 2.0%
No. 2: 3.0%
No. 3: 4.0%

BROKEN CORN AND FOREIGN MATERIAL (%)





	Avg (%)	Std Dev (%)
2017	0.8	0.57
2016	0.7	0.45
2015	0.8	0.61

Broken Corn

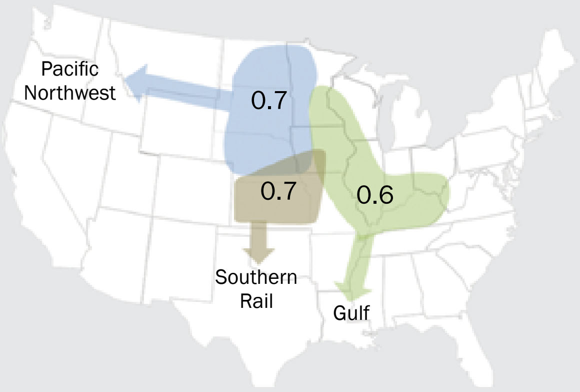
Broken corn in U.S. grades is based on particle size and usually includes a small percent of non-corn material. Broken corn is more subject to mold and insect damage than whole kernels, and it can cause problems in handling and processing. When not spread or stirred in a storage bin, broken corn tends to stay in the center of the bin, while whole kernels are likely to gravitate outward to the edges. The center area in which broken corn tends to accumulate is known as a "spout-line." If desired, the spout-line can be reduced by drawing this grain out of the center of the bin.

Results

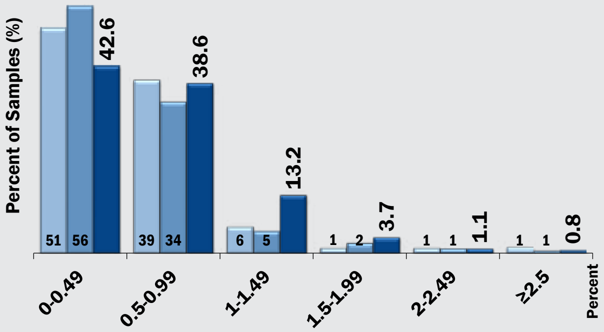
- Broken corn in the U.S. Aggregate samples averaged 0.6% in 2017, higher than 2016 (0.5%), but the same as 2015 and 5YA (both 0.6%).
- The variability of broken corn for the 2017 crop was similar to previous years and 5YA, as measured by standard deviations. Standard deviations for 2017, 2016, 2015 and 5YA were 0.39%, 0.34%, 0.42% and 0.40%, respectively.
- The range in broken corn values in 2017 (3.5%) and 2016 (3.8%) was narrower than in 2015 (7.5%).
- The 2017 samples were distributed with 18.8% having 1.0% or more broken corn, compared to 9% in 2016 and 2015. This higher proportion of samples with 1.0% or more broken corn in 2017 may have been a result of harvesting and slightly higher stress crack percentages and SCI in 2017 than in 2016 and 2015.
- The percentage of broken corn for the Gulf, Pacific Northwest and Southern Rail ECAs (with averages of 0.6%, 0.7% and 0.7%, respectively) differed by only 0.1% across the ECAs.
- The distribution chart on the next page, displaying broken corn as a percentage of BCFM, shows that in 61.3% of the samples, BCFM consisted of over 80% broken corn. These results were similar to what was found in previous years.

BROKEN CORN (%)

EXPORT CATCHMENT AREA AVERAGE



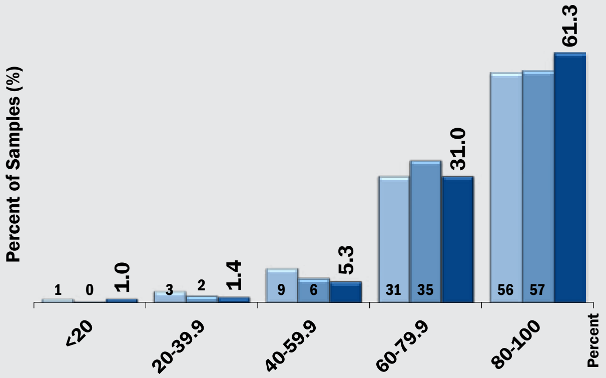
U.S. AGGREGATE



		Avg (%)	Std Dev (%)
■	2017	0.6	0.39
■	2016	0.5	0.34
■	2015	0.6	0.42

BROKEN CORN (%)

BROKEN CORN AS A % OF BCFM



Foreign Material

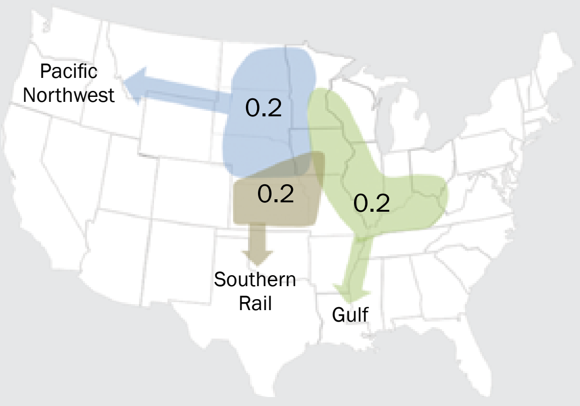
Foreign material is important because it has reduced feeding or processing value. It is also generally higher in moisture content than corn, and therefore creates a potential for deterioration of corn quality during storage. Additionally, foreign material contributes to the spout-line (as mentioned in Broken Corn). It also has the potential to create more quality problems than broken corn, due to its higher moisture level.

Results

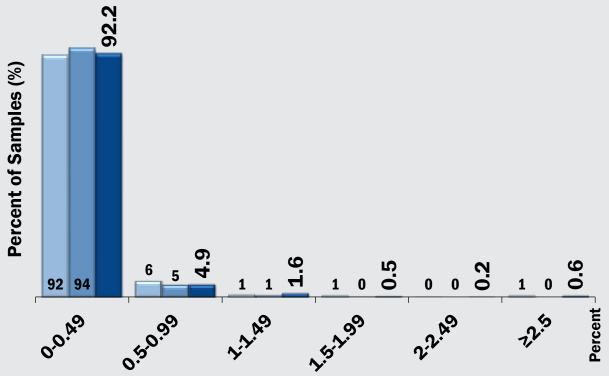
- Foreign material in the U.S. Aggregate samples averaged 0.2% in 2017, higher than in 2016 (0.1%), but the same as in 2015 and 5YA (both 0.2%). Combines, which are designed to remove most fine material, appear to be functioning very well, given the consistently low level of foreign material found across the years.
- Variability, measured by standard deviation, among the U.S. Aggregate samples in 2017 (0.25%) was higher than in 2016 (0.16%) but nearly the same as in 2015 (0.27%) and 5YA (0.21%).
- Foreign material in the 2017 samples showed a wider range (0.0 to 6.3%), than samples from 2016 (0 to 1.6%) and 2015 (0.0 to 4.5%).
- In the 2017 crop, 92.2% of the samples contained less than 0.5% foreign material, essentially the same as 2016 (94%) and 2015 (92%).
- All ECAs had average foreign material values of 0.2% in 2017, similar to 2016, 2015 and 5YA, which all had 0.2% or less.

FOREIGN MATERIAL (%)

EXPORT CATCHMENT AREA AVERAGE



U.S. AGGREGATE



	Avg (%)	Std Dev (%)
■ 2017	0.2	0.25
■ 2016	0.1	0.16
■ 2015	0.2	0.27

Total Damage

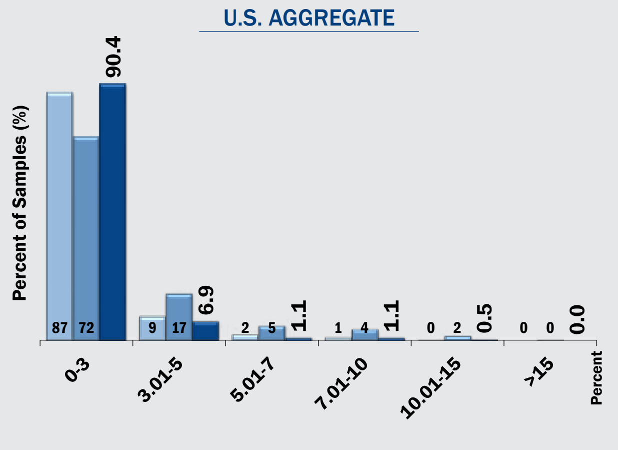
Total damage is the percentage of kernels and pieces of kernels that are visually damaged in some way, including damage from heat, frost, insects, sprouting, disease, weather, ground, germ and mold. Most of these types of damage result in some sort of discoloration or change in kernel texture. Damage does not include broken pieces of grain that are otherwise normal in appearance.

Mold damage is usually associated with higher moisture contents and warm temperatures during the growing season and/or during storage. There are several field molds, such as *Diplodia*, *Aspergillus*, *Fusarium* and *Gibberella*, that can lead to mold-damaged kernels during the growing season, if the weather conditions are conducive to their development. While some fungi that produce mold damage can also produce mycotoxins, not all fungi do produce mycotoxins. Chances of mold decrease as corn is dried and cooled to lower temperatures.

Results

- Average U.S. Aggregate total damage in 2017 (1.3%) was lower than in 2016 (2.6%), 2015 (1.4%) and 5YA (1.5%). The 2017 total damage average was well below the limit for U.S. No. 1 grade (3%).
- Total damage variability in the 2017 crop, as measured by the standard deviation (1.09%), was lower than 2016 (1.61%), but similar to 2015 (1.00%) and 5YA (1.11%).
- The range for total damage in 2017 (0.0 to 13.6%) was lower than in 2016 (0.0 to 23.1%) but similar to 2015 (0.0 to 13.2%).
- The histogram shows a larger percentage of 2017 samples having total damage at or below 3% than in 2016 but with total damage similar to 2015.
- Total damage in the 2017 samples was distributed with 90.4% of the samples having 3% or less and 97.3% having 5% or less damaged kernels, compared to 2016 with 72% and 89%, and 2015 with 87% and 96%, respectively.

TOTAL DAMAGE (%)



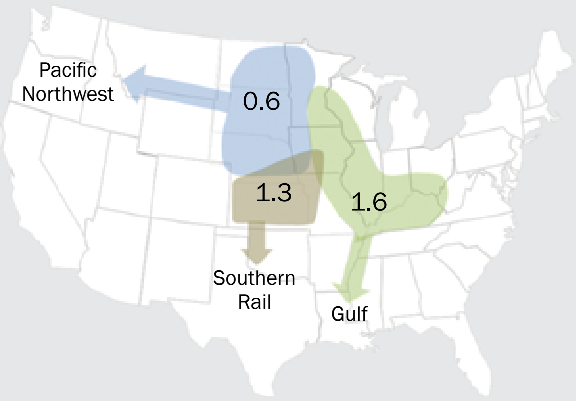
	Avg (%)	Std Dev (%)
■ 2017	1.3	1.09
■ 2016	2.6	1.61
■ 2015	1.4	1.00

- Average total damage by ECAs was 1.6% for Gulf, 0.6% for Pacific Northwest and 1.3% for Southern Rail. The Pacific Northwest ECA had the lowest average total damage, and the Gulf ECA had the highest total damage for 2017, 2016, 2015 and 5YA.
- Average total damage values in all ECAs were well below the limit for U.S. No. 2 grade (5.0%).

U.S. Grade Total Damage Maximum Limits
No. 1: 3.0%
No. 2: 5.0%
No. 3: 7.0%

TOTAL DAMAGE (%)

EXPORT CATCHMENT AREA AVERAGE



Heat Damage

Heat damage is a subset of total damage and has separate allowances in the U.S. Grade standards. Heat damage can be caused by microbiological activity in warm, moist grain or by high heat applied during drying. Heat damage is seldom present in corn delivered directly from farms at harvest.

Results

- There was no heat damage reported in any of the 2017 samples, the same results as 2016, 2015 and 5YA.
- The absence of heat damage likely was due in part to fresh samples coming directly from farm to elevator with minimal prior drying.

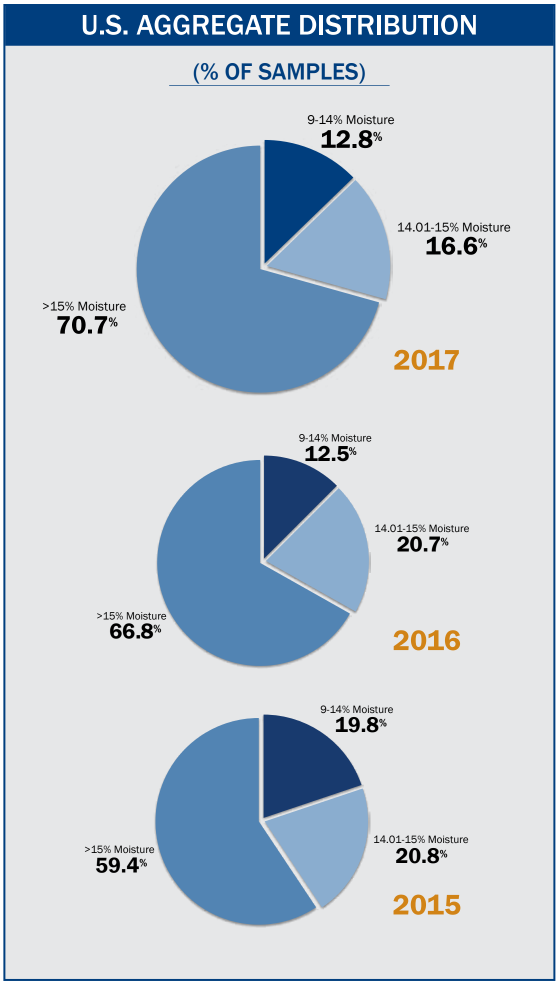
U.S. Grade Heat Damage Maximum Limits
No. 1: 0.1%
No. 2: 0.2%
No. 3: 0.5%

B. MOISTURE

Moisture content is reported on official grade certificates, and maximum moisture content is usually specified in the contract. However, moisture is not a grade factor, therefore, it does not determine which numerical grade will be assigned to the sample. Moisture content is important because it affects the amount of dry matter being sold and purchased. Moisture content is also an indicator of whether a need exists for drying, has potential implications for storability, and affects test weight. Higher moisture content at harvest increases the chance of kernel damage during harvesting and drying. Moisture content and the amount of drying required will also affect stress cracks, breakage and germination. Extremely wet grain may be a precursor to high mold damage later in storage or transport. While the weather during the growing season affects yield, grain composition and the development of the grain kernels, grain harvest moisture is influenced largely by crop maturation, the timing of harvest and harvest weather conditions. General moisture storage guidelines suggest that 14% is the maximum moisture content for storage up to 6 to 12 months for good quality, clean corn under aerated storage under typical U.S. Corn Belt conditions; and 13% or lower moisture content is recommended for storage of more than one year.[1]

Results

- The average U.S. Aggregate moisture content recorded at the elevator in the 2017 samples was 16.6%, which was higher than 2016 (16.1%), 2015 (15.7%) and 5YA (16.2%).
- U.S. Aggregate moisture standard deviation in 2017 (1.90%) was higher than in 2016 (1.47%) and 2015 (1.53%), but similar to 5YA (1.76%), indicating more variability in the 2017 samples than in 2016 but similar to 5YA.
- The range in moisture content values in 2017 (9.0 to 24.4%) was wider than in 2016 (11.2 to 23.7%) and 2015 (11.0 to 23.5%).
- The 2017 moisture values were distributed with 29.3%[2] of the samples containing 15% or less moisture. Fifteen percent is the base moisture used by most elevators for discounts and is a level considered safe for storage for short periods during low wintertime temperatures.


U.S. AGGREGATE DISTRIBUTION

(% OF SAMPLES)

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[1] *WPS-13. 1988. Grain drying, handling and storage handbook. Midwest Plan Service No. 13. Iowa State University, Ames, IA 50011.*

[2] *The pie chart and the histogram show that 29.4% and 29.3%, respectively, of the samples contained 15% or less moisture. This difference is solely due to rounding.*

- There were more high moisture samples in the 2017 crop than in the 2016 crop, with 36.2% of the samples containing more than 17% moisture, compared to 29% in 2016 and 19% in 2015. This distribution indicates more drying may be required in 2017 than in 2016 and 2015.

- In the 2017 crop, 12.8% of the samples contained 14%[1]. or less moisture compared to 12.5% in the 2016 crop and 19.8% in 2015. Moisture content values of 14% and below are generally considered a safe level for longer–term storage and transport.

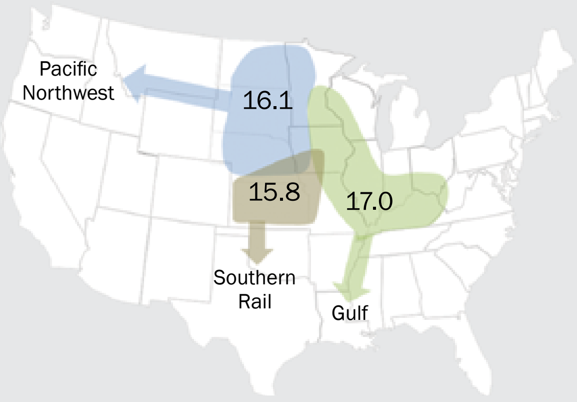
- The average moisture content for corn from the Gulf ECA (17.0%) was higher than that from the Pacific Northwest (16.1%) and the Southern Rail (15.8%) ECAs.

- Average moisture levels for the Gulf ECA were highest or tied for highest among all ECAs for 2017, 2016, 2015 and 5YA. Samples from the Gulf usually contain higher moisture content values as a result of weather and harvest conditions in that ECA.

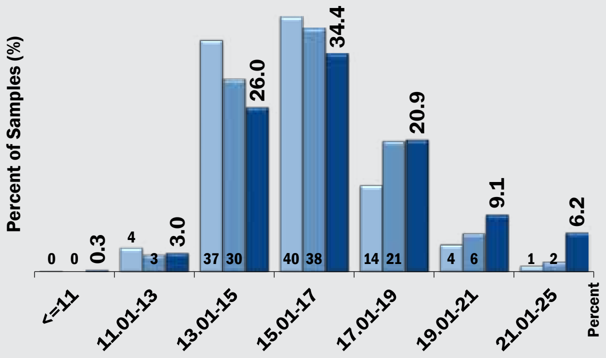
- Because of higher moistures in 2017 than in 2016 and several previous years, care should be taken to monitor and maintain moisture levels sufficiently low to prevent possible mold growth.

MOISTURE (%)

EXPORT CATCHMENT AREA AVERAGE



U.S. AGGREGATE



	Avg (%)	Std Dev (%)
■ 2017	16.6	1.90
■ 2016	16.1	1.47
■ 2015	15.7	1.53

SUMMARY: GRADE FACTORS AND MOISTURE

	2017 Harvest					2016 Harvest			2015 Harvest			5 Year Avg. (2012-2016)	
	No. of Samples[1]	Avg.	Std. Dev.	Min.	Max.	No. of Samples[1]	Avg.	Std. Dev.	No. of Samples[1]	Avg.	Std. Dev.	Avg.	Std. Dev.
U.S. Aggregate													
Test Weight (lb/bu)	627	58.4	1.21	52.1	62.7	624	58.3	1.22	620	58.2*	1.08	58.1	1.27
Test Weight (kg/hl)	627	75.2	1.55	67.1	80.7	624	75.0	1.57	620	74.9*	1.38	74.8	1.64
BCFM (%)	627	0.8	0.57	0.0	7.3	624	0.7*	0.45	620	0.8	0.61	0.8	0.54
Broken Corn (%)	627	0.6	0.39	0.0	3.5	624	0.5*	0.34	620	0.6*	0.42	0.6	0.40
Foreign Material (%)	627	0.2	0.25	0.0	6.3	624	0.1*	0.16	620	0.2	0.27	0.2	0.21
Total Damage (%)	627	1.3	1.09	0.0	13.6	624	2.6*	1.61	620	1.4	1.00	1.5	1.11
Heat Damage (%)	627	0.0	0.00	0.0	0.0	624	0.0	0.00	620	0.0	0.00	0.0	0.00
Moisture (%)	627	16.6	1.90	9.0	24.4	624	16.1*	1.47	620	15.7*	1.53	16.2	1.76
Gulf													
Test Weight (lb/bu)	612	58.6	1.18	52.1	62.7	612	58.4*	1.24	577	58.3*	1.10	58.3	1.28
Test Weight (kg/hl)	612	75.4	1.52	67.1	80.7	612	75.1*	1.59	577	75.0*	1.41	75.0	1.65
BCFM (%)	612	0.8	0.58	0.0	7.3	612	0.7*	0.45	577	0.8	0.63	0.8	0.53
Broken Corn (%)	612	0.6	0.39	0.0	3.5	612	0.5*	0.34	577	0.5*	0.41	0.6	0.40
Foreign Material (%)	612	0.2	0.27	0.0	6.3	612	0.2*	0.17	577	0.2	0.30	0.2	0.20
Total Damage (%)	612	1.6	1.33	0.0	13.6	612	3.2*	1.88	577	1.7	1.17	1.8	1.31
Heat Damage (%)	612	0.0	0.00	0.0	0.0	612	0.0	0.00	577	0.00	0.00	0.0	0.00
Moisture (%)	612	17.0	2.06	9.0	24.4	612	16.2*	1.48	577	15.7*	1.51	16.5	1.82
Pacific Northwest													
Test Weight (lb/bu)	291	57.7	1.28	52.1	62.7	301	58.0*	1.19	329	57.9*	1.02	57.6	1.26
Test Weight (kg/hl)	291	74.2	1.65	67.1	80.7	301	74.6*	1.53	329	74.6*	1.31	74.1	1.63
BCFM (%)	291	0.9	0.55	0.1	4.2	301	0.7*	0.45	329	0.8	0.66	0.9	0.60
Broken Corn (%)	291	0.7	0.40	0.1	3.0	301	0.6*	0.35	329	0.6	0.48	0.7	0.43
Foreign Material (%)	291	0.2	0.23	0.0	3.9	301	0.1*	0.13	329	0.2	0.25	0.2	0.23
Total Damage (%)	291	0.6	0.49	0.0	7.2	301	1.0*	0.75	329	0.5	0.53	0.6	0.54
Heat Damage (%)	291	0.0	0.00	0.0	0.0	301	0.0	0.00	329	0.00	0.00	0.0	0.00
Moisture (%)	291	16.1	1.78	11.3	24.4	301	15.9	1.50	329	15.7*	1.55	15.6	1.66
Southern Rail													
Test Weight (lb/bu)	393	58.8	1.21	52.1	62.7	395	58.5*	1.22	402	58.4*	1.08	58.4	1.27
Test Weight (kg/hl)	393	75.6	1.56	67.1	80.7	395	75.4*	1.57	402	75.1*	1.38	75.1	1.63
BCFM (%)	393	0.8	0.52	0.1	4.2	395	0.7*	0.43	402	0.7*	0.46	0.8	0.50
Broken Corn (%)	393	0.7	0.39	0.0	3.5	395	0.5*	0.31	402	0.5*	0.32	0.6	0.36
Foreign Material (%)	393	0.2	0.19	0.0	3.9	395	0.2*	0.16	402	0.2	0.20	0.2	0.20
Total Damage (%)	393	1.3	0.97	0.0	13.6	395	2.5*	1.78	402	1.5*	1.01	1.4	1.03
Heat Damage (%)	393	0.0	0.00	0.0	0.0	395	0.0	0.00	402	0.00	0.00	0.0	0.00
Moisture (%)	393	15.8	1.48	9.8	24.1	395	15.7	1.35	402	15.6*	1.57	15.7	1.59

Indicates averages in 2016 were significantly different from 2017, and 2015 averages were significantly different from 2017, based on a 2-tailed t-test at the 95% level of significance.

[1] *Due to the ECA results being composite statistics, the sum of the sample numbers from the three ECAs is greater than the U.S. Aggregate.*

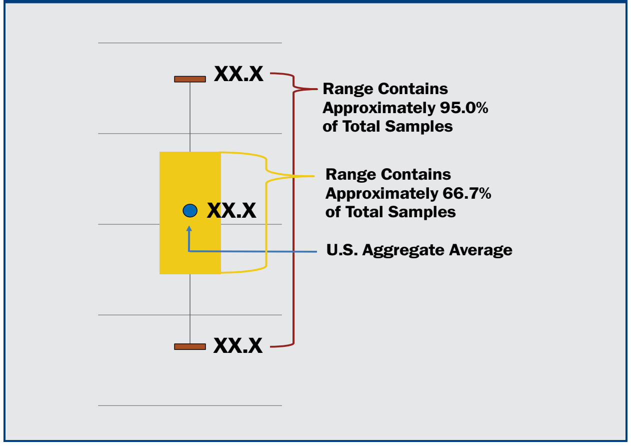
C. CHEMICAL COMPOSITION

The chemical composition of corn consists primarily of protein, starch and oil. While these attributes are not grade factors, they are of significant interest to end users. Chemical composition values provide additional information related to nutritional value for livestock and poultry feeding, for wet milling uses and other processing uses of corn. Unlike many physical attributes, chemical composition values are not expected to change significantly during storage or transit.

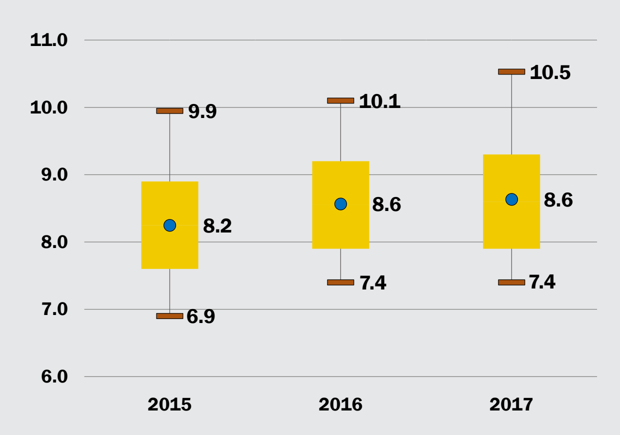
SUMMARY: CHEMICAL COMPOSITION

- Average U.S. Aggregate protein concentration in 2017 (8.6% dry basis) was the same as in 2016, higher than 2015, but similar to 5YA.
- The Pacific Northwest ECA had higher protein concentrations than the other ECAs in 2017, 2016, 2015 and 5YA.
- Average U.S. Aggregate starch concentration in 2017 (72.3% dry basis) was similar to 2016, but lower than 2015 and 5YA.
- The Gulf ECA had higher starch concentrations than the Pacific Northwest and Southern Rail ECAs in 2017, 2016, 2015 and 5YA.
- Average U.S. Aggregate oil concentration in 2017 (4.1% dry basis) was higher than in 2016, 2015 and 5YA.
- The variability in chemical concentrations was similar for 2017 and 2016, based on similar standard deviations for protein, starch and oil.

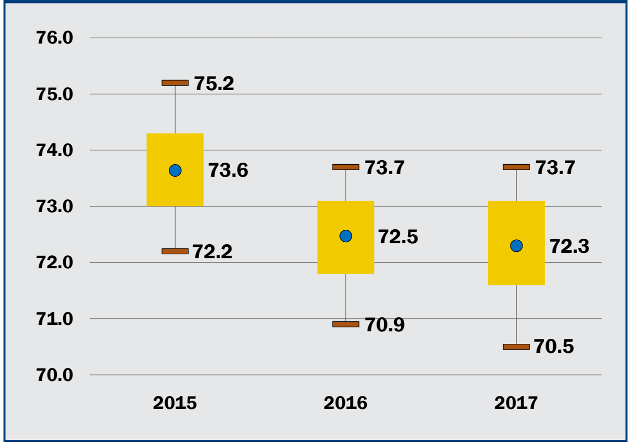
HOW TO READ THE CHARTS



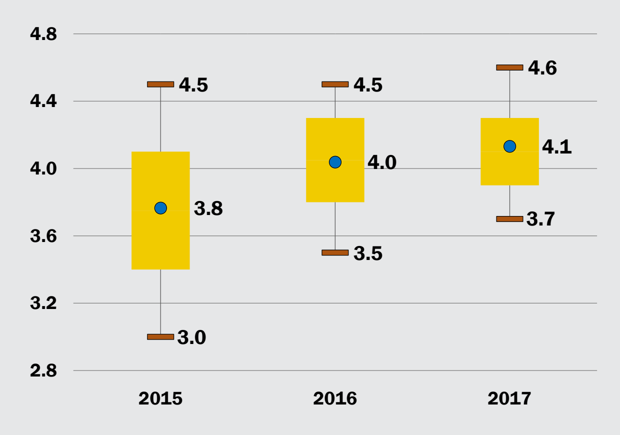
PROTEIN (Dry Basis %)



STARCH (Dry Basis %)



OIL (Dry Basis %)



Protein

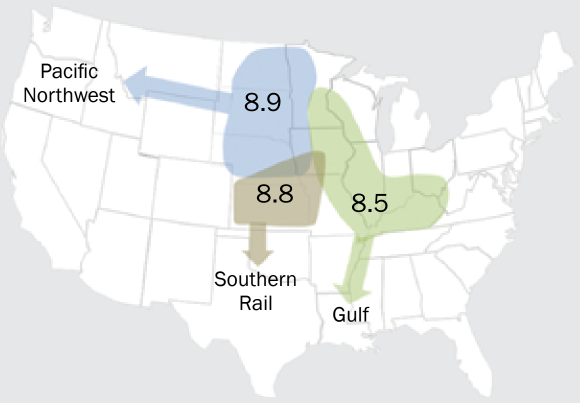
Protein is very important for poultry and livestock feeding because it supplies essential sulfur-containing amino acids and helps to improve feed conversion efficiency. Protein concentration tends to decrease with decreased available soil nitrogen and in years with high crop yields. Protein is usually inversely related to starch concentration. Results are reported on a dry basis.

Results

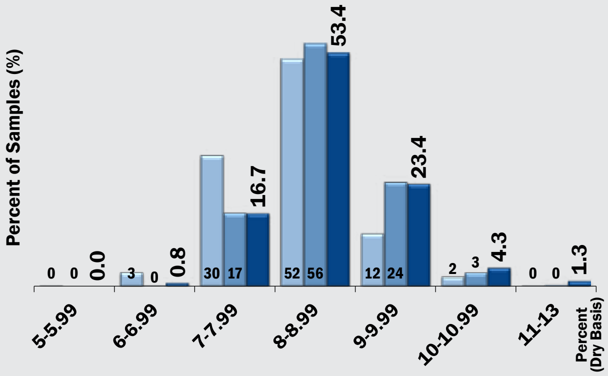
- Average U.S. Aggregate protein concentration in 2017 averaged 8.6%, the same as in 2016, higher than 2015 (8.2%), but slightly lower than 5YA (8.7%).
- Average U.S. Aggregate protein standard deviation in 2017 (0.55%) was similar to 2016 (0.50%) and 2015 (0.53%), but lower than 5YA (0.58%).
- The range in protein concentration in 2017 (6.4 to 12.2%) was similar to the ranges in 2016 (6.8 to 11.7%) and 2015 (5.6 to 11.3%).
- Protein concentrations in 2017 were distributed with 17.5% below 8.0%, 53.4% between 8.0 and 8.99%, and 29.0% at or above 9.0%. The protein distribution in 2017 was similar to 2016 and showed fewer samples with less than 8.0% protein than in 2015.
- Protein concentration averages for Gulf, Pacific Northwest and Southern Rail ECAs were 8.5%, 8.9% and 8.8%, respectively. The Pacific Northwest ECA had the highest protein for 2017, 2016, 2015 and 5YA.

PROTEIN (%)

EXPORT CATCHMENT AREA AVERAGE

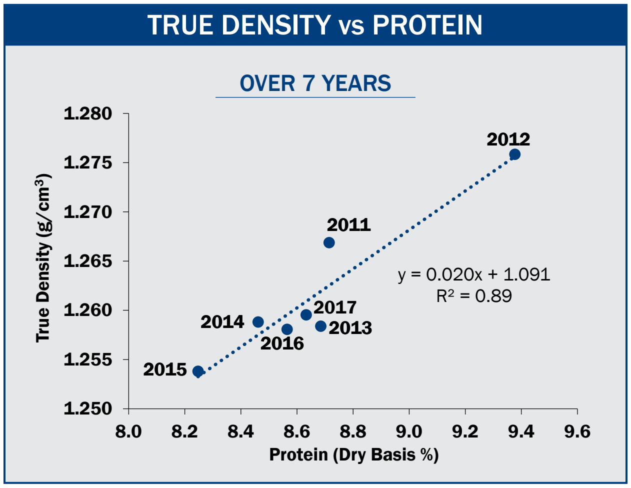


U.S. AGGREGATE



	Avg (%)	Std Dev (%)
■ 2017	8.6	0.55
■ 2016	8.6	0.50
■ 2015	8.2	0.53

- Based on U.S. Aggregate averages over the past seven years, as protein concentration increases, true density increases (resulting in a correlation coefficient of 0.94), as shown in the figure to the right. In general, protein concentration appears to be lower in years with lower true density and higher in years with higher true density.



Starch

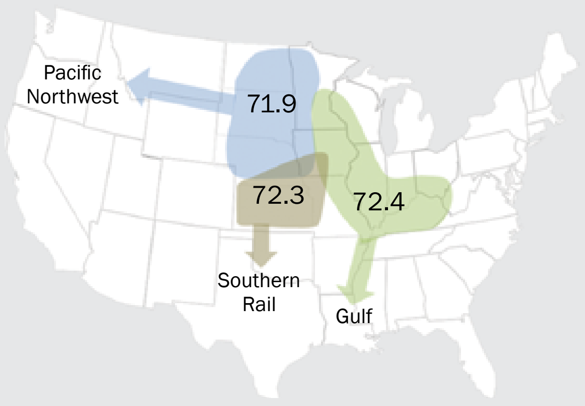
Starch is an important factor for corn used by wet millers and dry-grind ethanol manufacturers. High starch concentration is often indicative of good kernel growing/filling conditions and reasonably moderate kernel densities. Starch is usually inversely related to protein concentration. Results are reported on a dry basis.

Results

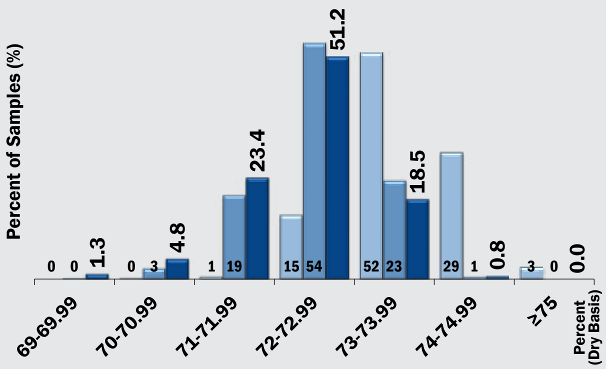
- Average U.S. Aggregate starch concentration in 2017 (72.3%) was similar to 2016 (72.5%), but lower than 2015 (73.6%) and 5YA (73.2%).
- U.S. Aggregate starch standard deviation in 2017 (0.65%) was similar to 2016 (0.59%), 2015 (0.61%) and 5YA (0.63%).
- Starch concentration range in 2017 (69.0 to 74.2%) was similar to 2016 (69.2 to 74.3%) and 2015 (70.5 to 76.3%).
- Starch concentrations in 2017 were distributed with 29.5% of the samples below 72.0%, 51.2% between 72.0 and 72.99%, and 19.3% at 73.0% and higher. The distribution is similar to 2016 but shows more samples with lower levels of starch in 2017 than in 2015.

STARCH (%)

EXPORT CATCHMENT AREA AVERAGE



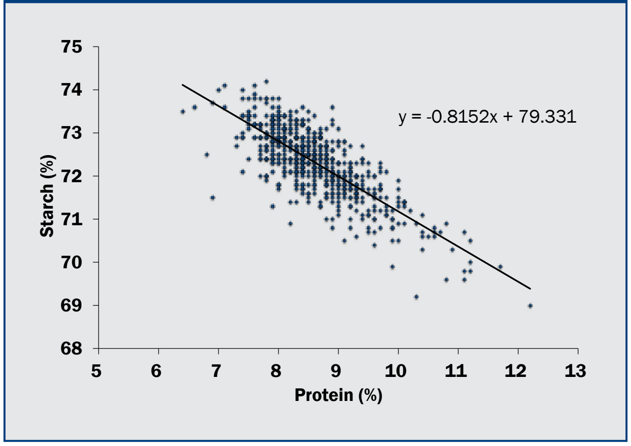
U.S. AGGREGATE



		Avg (%)	Std Dev (%)
■	2017	72.3	0.65
■	2016	72.5	0.59
■	2015	73.6	0.61

- Starch concentration averages for the Gulf, Pacific Northwest and Southern Rail ECAs were 72.4%, 71.9% and 72.3%, respectively. Starch concentration averages were highest in the Gulf ECA in 2017, 2016, 2015 and 5YA. Thus, the Gulf ECA had the highest starch and lowest protein in 2017, 2016, 2015 and 5YA.
- Since starch and protein are the two largest components in corn, when the percentage of one goes up, the other usually goes down. This relationship is illustrated in the adjacent figure showing a negative correlation (-0.78) between starch and protein.

STARCH vs PROTEIN



Oil

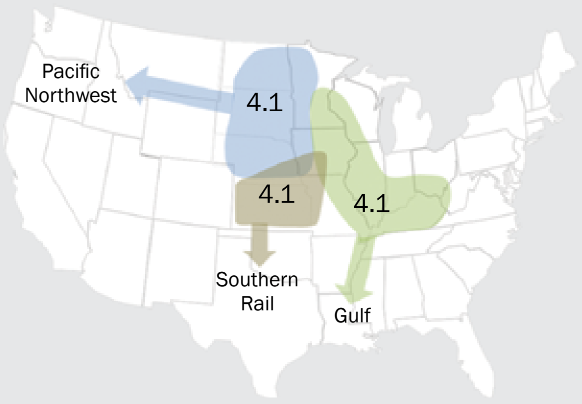
Oil is an essential component of poultry and livestock rations. It serves as an energy source, enables fat-soluble vitamins to be utilized, and provides certain essential fatty acids. Oil is also an important co-product of corn wet and dry milling. Results are reported on a dry basis.

Results

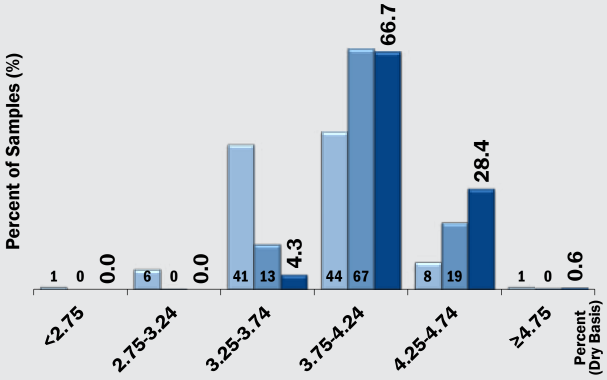
- Average U.S. Aggregate oil concentration in 2017 (4.1%) was higher than in 2016 (4.0%), 2015 (3.8%) and 5YA (3.8%).
- U.S. Aggregate oil standard deviation in 2017 (0.22%) was similar to 2016 (0.23%), but slightly lower than 2015 (0.30%) and 5YA (0.30%).
- Oil concentration range in 2017 (3.3 to 5.5%) was similar to 2016 (3.2 to 4.9%) and 2015 (2.5 to 5.4%).
- Oil concentrations in 2017 were distributed with 4.3% of the samples at 3.74% or lower, 66.7% of samples at 3.75 to 4.24%, and 29.0% at 4.25% and higher. The distribution showed a greater number of samples with oil concentrations at 4.25% or higher in 2017 than in 2016 and 2015.
- Oil concentration averages for Gulf, Pacific Northwest and Southern Rail ECAs were each 4.1%.

OIL (%)

EXPORT CATCHMENT AREA AVERAGE



U.S. AGGREGATE



	Avg (%)	Std Dev (%)
■ 2017	4.1	0.22
■ 2016	4.0	0.23
■ 2015	3.8	0.30

SUMMARY: CHEMICAL FACTORS

	2017 Harvest					2016 Harvest			2015 Harvest			5 Year Avg. (2012-2016)	
	No. of Samples[1]	Avg.	Std. Dev.	Min.	Max.	No. of Samples[1]	Avg.	Std. Dev.	No. of Samples[1]	Avg.	Std. Dev.	Avg.	Std. Dev.
U.S. Aggregate						**U.S. Aggregate**			**U.S. Aggregate**			**U.S. Aggregate**	
Protein (Dry Basis %)	627	8.6	0.55	6.4	12.2	624	8.6*	0.50	620	8.2*	0.53	8.7	0.58
Starch (Dry Basis %)	627	72.3	0.65	69.0	74.2	624	72.5*	0.59	620	73.6*	0.61	73.2	0.63
Oil (Dry Basis %)	627	4.1	0.22	3.3	5.5	624	4.0*	0.23	620	3.8*	0.30	3.8	0.30
Gulf						**Gulf**			**Gulf**			**Gulf**	
Protein (Dry Basis %)	612	8.5	0.54	6.4	11.7	612	8.5	0.48	577	8.1*	0.52	8.6	0.57
Starch (Dry Basis %)	612	72.4	0.64	69.2	74.2	612	72.6*	0.59	577	73.7*	0.62	73.3	0.63
Oil (Dry Basis %)	612	4.1	0.22	3.3	5.5	612	4.0*	0.24	577	3.8*	0.32	3.8	0.31
Pacific Northwest						**Pacific Northwest**			**Pacific Northwest**			**Pacific Northwest**	
Protein (Dry Basis %)	291	8.9	0.58	6.9	12.2	301	8.8*	0.55	329	8.7*	0.58	8.9	0.61
Starch (Dry Basis %)	291	71.9	0.68	69.0	74.1	301	72.2*	0.60	329	73.5*	0.60	73.1	0.61
Oil (Dry Basis %)	291	4.1	0.21	3.3	4.7	301	4.1	0.22	329	3.7*	0.28	3.7	0.28
Southern Rail						**Southern Rail**			**Southern Rail**			**Southern Rail**	
Protein (Dry Basis %)	393	8.8	0.54	6.6	11.7	395	8.7*	0.51	402	8.3*	0.48	8.8	0.60
Starch (Dry Basis %)	393	72.3	0.62	69.6	74.1	395	72.4*	0.59	402	73.5*	0.60	73.1	0.62
Oil (Dry Basis %)	393	4.1	0.21	3.3	4.8	395	4.1*	0.23	402	3.8*	0.30	3.8	0.29

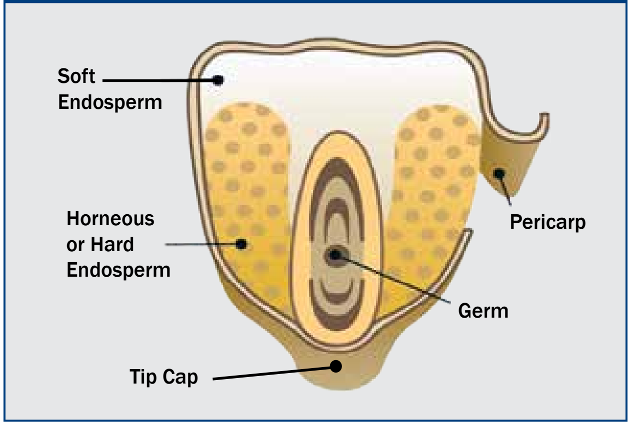
Indicates averages in 2016 were significantly different from 2017, and 2015 averages were significantly different from 2017, based on a 2-tailed t-test at the 95% level of significance.

[1] *Due to the ECA results being composite statistics, the sum of the sample numbers from the three ECAs is greater than the U.S. Aggregate.*

D. PHYSICAL FACTORS

Physical factors are other quality attributes that are neither grade factors nor chemical composition. Physical factors include stress cracks, kernel weight, kernel volume and true density, percent whole kernels, and percent horneous (hard) endosperm. Tests for these physical factors provide additional information about the processing characteristics of corn for various uses, as well as corn's storability and potential for breakage in handling. These quality attributes are influenced by the physical composition of the corn kernel, which is in turn affected by genetics and growing and handling conditions. Corn kernels are made up of four parts: the germ or embryo, the tip cap, the pericarp or outer covering, and the endosperm. The endosperm represents about 82% of the kernel, and consists of soft (also referred to as floury or opaque) endosperm and of horneous (also called hard or vitreous) endosperm, as shown above. The endosperm contains primarily starch and protein, the germ contains oil and some proteins, and the pericarp and tip cap are mostly fiber.

CORN KERNEL

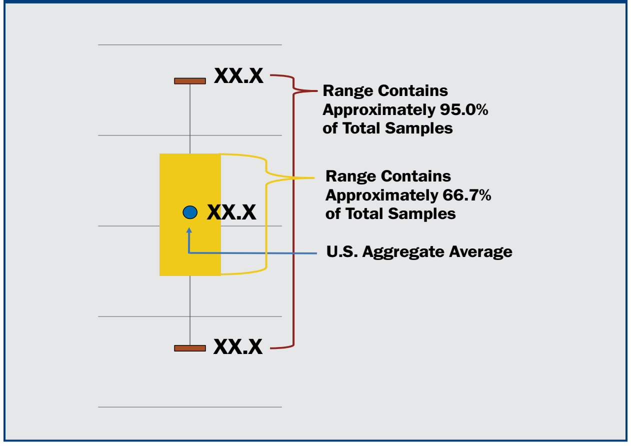


Source: Adapted from Corn Refiners Association, 2011

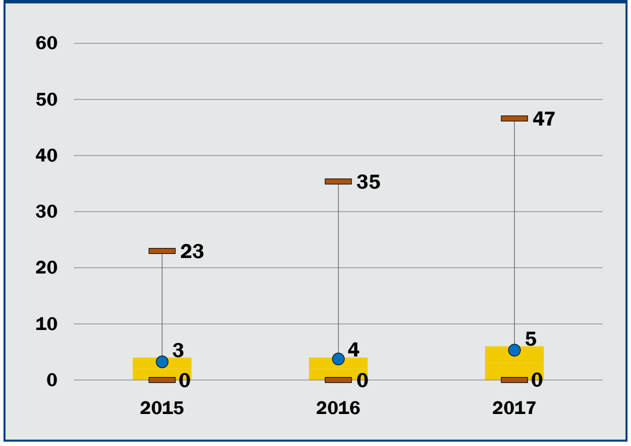
SUMMARY: PHYSICAL FACTORS

- Average U.S. Aggregate stress cracks (5%) and stress crack index (SCI) (13.7) were higher than 2016 and 2015, indicating corn's susceptibility to breakage may be higher than the previous two years.
- Among the ECAs, the Southern Rail ECA had the lowest SCI average in 2017, 2016, 2015 and 5YA. The Southern Rail ECA also had the lowest stress crack averages in 2017, 2016 and 5YA.
- Average U.S. Aggregate 100-k weight in 2017 (36.07 g) was higher than in 2016, 2015 and 5YA.
- Average U.S. Aggregate kernel volume in 2017 (0.29 cm^3) was higher than in 2016, 2015 and 5YA. There was also a higher percentage of large kernels in 2017, compared to the previous two years.
- The Pacific Northwest ECA had the lowest 100-k weight average of the ECAs in 2017, 2016, 2015 and 5YA.
- The Pacific Northwest ECA had the lowest kernel volume average of the ECAs in 2017, 2016, 2015 and 5YA.
- U.S. Aggregate kernel true density averaged 1.260 g/cm^3 in 2017, was higher than in 2016 and 2015, but similar to 5YA. Over the past seven years, true densities have tended to be higher in years with higher protein.
- True density kernel distributions above 1.275 g/cm^3 in 2017 indicate slightly harder corn in 2017 than in 2016 and 2015. Of the ECAs, the Pacific Northwest had the lowest true density and lowest test weights in 2017, 2016, 2015 and 5YA.
- U.S. Aggregate whole kernels averaged 89.9% in 2017, lower than in 2016, 2015 and 5YA.
- The lower percentage of whole kernels may be due, in part, to large kernel sizes that may be more susceptible to cracking, chipping and breakage during harvest and handling than in previous years.
- Average U.S. Aggregate horneous (hard) endosperm (81%) was higher than 2016 and 2015, but slightly lower than 5YA (82%). The distributions of horneous endosperm percentages indicate a lower percentage of corn samples with less than 80% hard endosperm in 2017 than in 2016 and 2015.
- Average U.S. Aggregate horneous endosperm tends to be higher in years when average true density is higher.

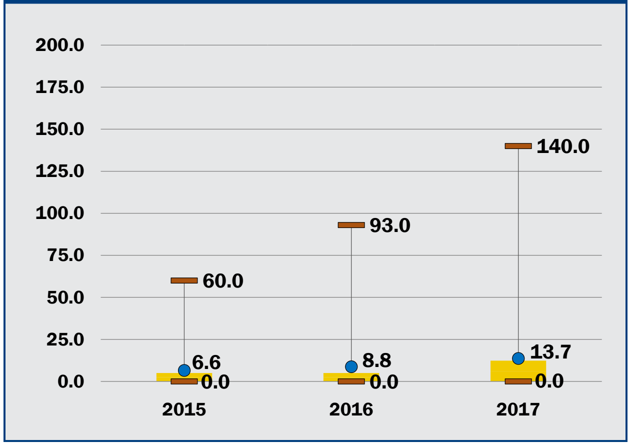
HOW TO READ THE CHARTS



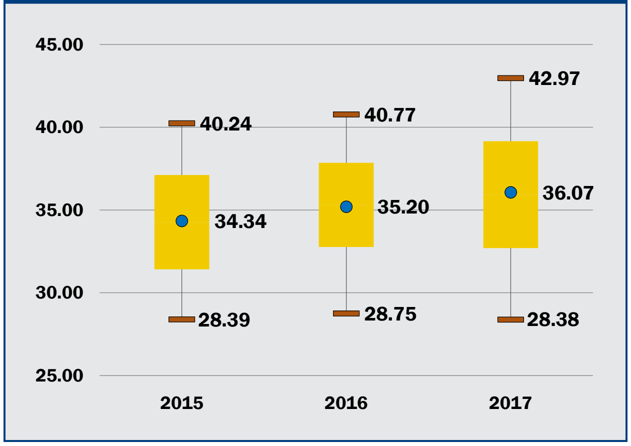
STRESS CRACKS (%)

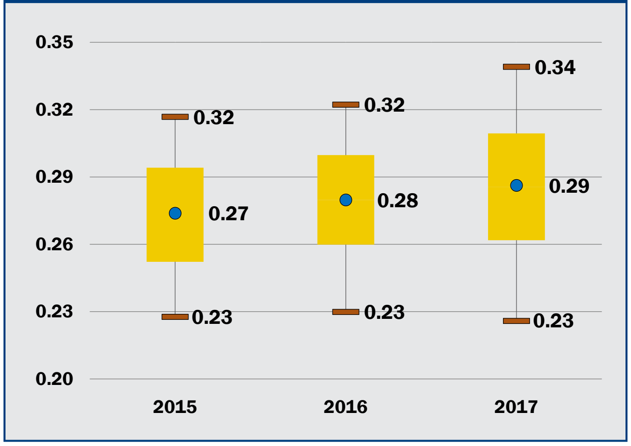


STRESS CRACK INDEX

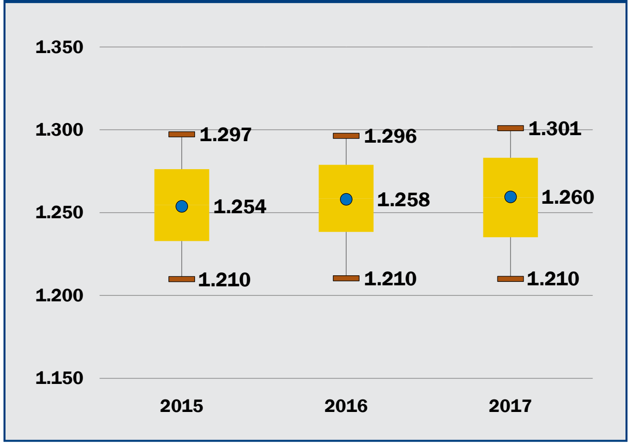


100-KERNEL WEIGHT (g)

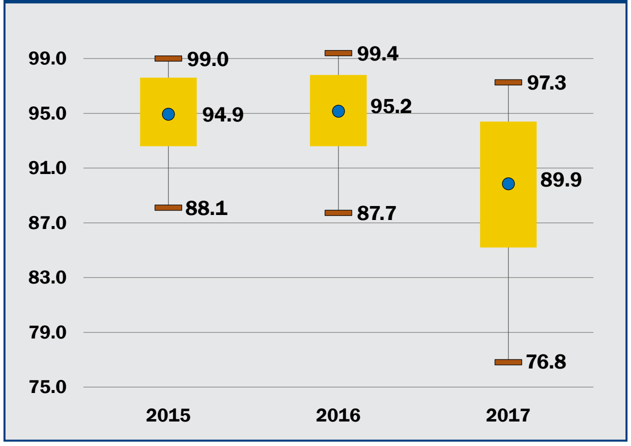




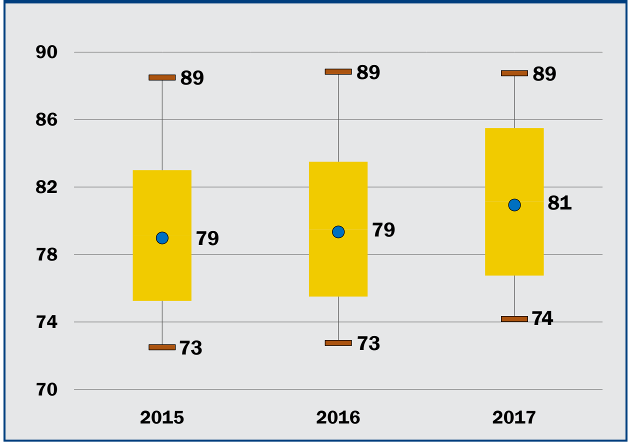
KERNEL VOLUME (cm³)



TRUE DENSITY (g/cm³)



WHOLE KERNELS (%)



HORNEOUS ENDOSPERM (%)

Stress Cracks

Stress cracks are internal fissures in the horneous (hard) endosperm of a corn kernel. The pericarp (or outer covering) of a stress-cracked kernel is typically not damaged, so the kernel may appear unaffected at first glance, even if stress cracks are present.

Stress crack measurements include "stress cracks" (the percentage of kernels with at least one crack) and stress crack index (SCI), which is the weighted average of single, double and multiple stress cracks. "Stress cracks" measures only the number of kernels with stress cracks, whereas SCI shows the severity of stress cracking. For example, if half the kernels have only single stress cracks, "stress cracks" is 50% and the SCI is 50 (50 x 1). However, if half the kernels have multiple stress cracks (more than two cracks), indicating a higher potential for handling breakage, "stress cracks" remains at 50%, but the SCI becomes 250 (50 x 5). Lower values for "stress cracks" and the SCI are always more desirable. In years with high levels of stress cracks, the SCI provides valuable information, because high SCI numbers (perhaps 300 to 500) indicate the sample had a very high percentage of multiple stress cracks. Multiple stress cracks are generally more detrimental to quality changes than single stress cracks.

The cause of stress cracks is pressure buildup due to moisture and temperature gradients within the kernel's horneous endosperm. This can be likened to the internal cracks that appear when an ice cube is dropped into a lukewarm beverage. The internal stresses do not build up as much in the soft, floury endosperm as in the hard, horneous endosperm; therefore, corn with a higher percentage of horneous endosperm is more susceptible to stress cracking than softer grain. A kernel may vary in severity of stress cracking and can have one, two, or multiple stress cracks. The most common cause of stress cracks is high-temperature drying that rapidly removes moisture. The impact of high levels of stress cracks on various uses includes:

- General: Increased susceptibility to breakage during handling. This may lead to processors needing to remove more broken corn during cleaning operations, and a possible reduction in grade and/or value.
- Wet Milling: Lower starch yields due to the increased difficulty in separating starch and protein. Stress cracks may also alter steeping requirements.
- Dry Milling: Lower yield of large flaking grits (the prime product of many dry milling operations).
- Alkaline Cooking: Non-uniform water absorption leading to overcooking or undercooking, which affects the process balance.

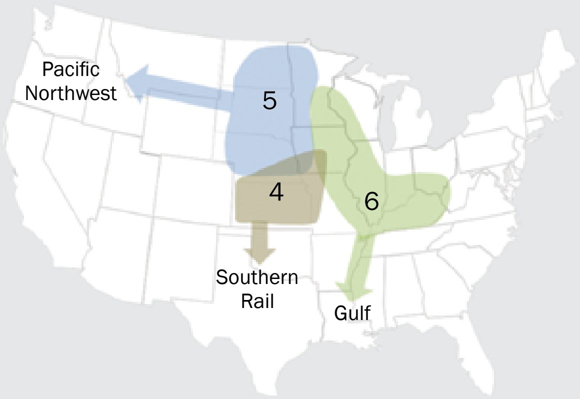
Growing conditions will affect crop maturity, timeliness of harvest and the need for artificial drying, which will influence the degree of stress cracking found from region to region. For example, late maturity or late harvest caused by weather-related factors, such as rain-delayed planting or cool temperatures, may increase the need for artificial drying, thus potentially increasing the occurrence of stress cracks.

Results

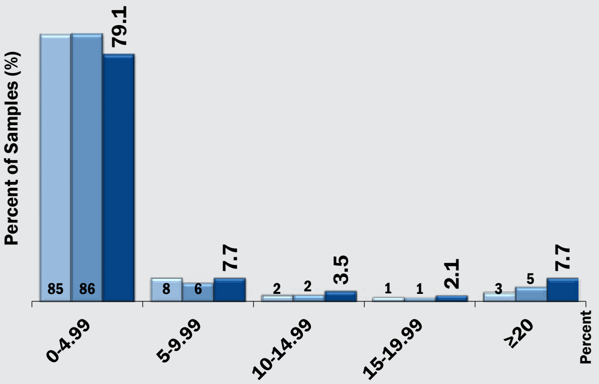
- U.S. Aggregate stress cracks in 2017 averaged 5%, higher than in 2016 (4%) and 2015 (3%), but lower than 5YA (6%).
- U.S. Aggregate stress cracks standard deviation in 2017 (8%) was higher than in 2016 (6%), 2015 (5%) and 5YA (7%).
- Stress cracks ranged from 0 to 90% in 2017, whereas the ranges were narrower with 0 to 84% in 2016 and 0 to 75% in 2015.
- There was a lower percentage of samples with less than 10% stress cracks in 2017 (86.8%) compared to 2016 (92%) and 2015 (93%). Also in 2017, 7.7% of the samples had stress cracks above 20%, which is higher than in 2016 (5%) and 2015 (3%).
- Stress crack distributions indicate that 2017 corn should be slightly higher in breakage susceptibility when compared to 2016 and 2015.
- Stress crack averages in 2017 for Gulf, Pacific Northwest and Southern Rail ECAs were 6%, 5% and 4%, respectively. Among all ECAs, the Southern Rail either had the lowest stress cracks or tied for lowest stress cracks in 2017, 2016, 2015 and 5YA.

STRESS CRACKS (%)

EXPORT CATCHMENT AREA AVERAGE



U.S. AGGREGATE

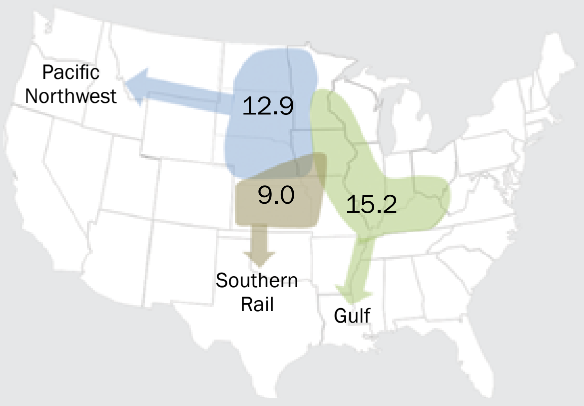


	Avg (%)	Std Dev (%)
■ 2017	5	8
■ 2016	4	6
■ 2015	3	5

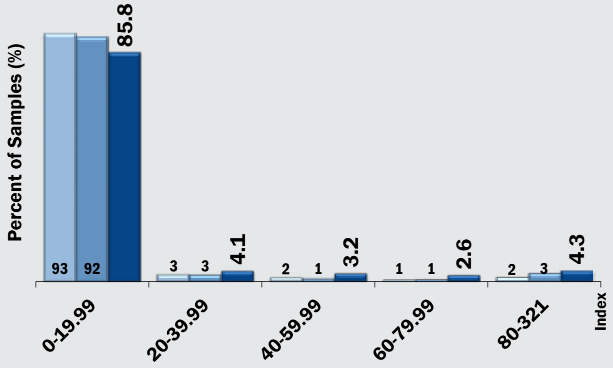
- U.S. Aggregate SCI in 2017 averaged 13.7, higher than in 2016 (8.8), 2015 (6.6) and 5YA (13.5).
- U.S. Aggregate SCI was more variable in 2017 (standard deviation of 23.6) than in 2016 (16.6) and 2015 (11.7), but was similar to 5YA (21.0).
- The 2017 SCI had a range of 0 to 321, wider than 2016 (0 to 268) and 2015 (0 to 180).
- Of the 2017 samples, 89.9% had SCI of less than 40, which is lower than 2016 (95%) and 2015 (96%). Of the 2017 samples, 4.3% had a SCI of 80 or higher, compared to 3% of the 2016 samples and 2% of the 2015 samples.
- SCI averages for the Gulf, Pacific Northwest and Southern Rail ECAs were 15.2, 12.9 and 9.0, respectively.
- The Southern Rail ECA had the lowest SCI in 2017, 2016, 2015 and 5YA. The lower SCI found for the Southern Rail ECA is likely related to greater field drying potential typically found in the states that constitute the Southern Rail ECA.
- The 2017 crop had a combined Good or Excellent condition rating that remained between 60 to 68% most of the season, enabling good maturation and grain-filling conditions. However, slight delays in crop maturation and a rain-delayed harvest in some areas led to higher average moisture and greater moisture variability than the previous two crops. This may have led to more artificial drying and slightly higher stress cracks and SCI in 2017 than in 2016 and 2015. However, stress crack percentages and SCI were still close to 5YA.

STRESS CRACK INDEX (SCI)

EXPORT CATCHMENT AREA AVERAGE



U.S. AGGREGATE



	Avg	Std Dev
■ 2017	13.7	23.6
■ 2016	8.8	16.6
■ 2015	6.6	11.7

100-Kernel Weight

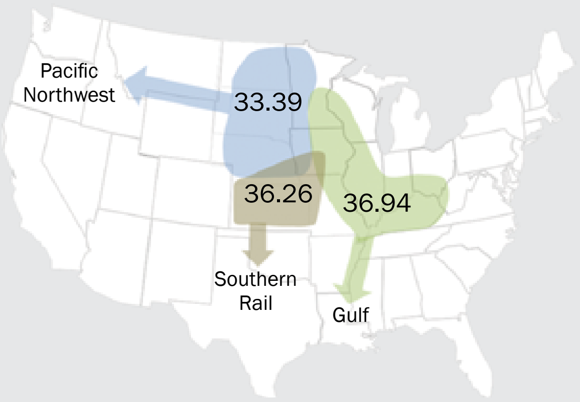
100-kernel (100-k) weight (reported in grams) indicates larger kernel size as 100-k weight increases. Kernel size affects drying rates. As kernel size increases, the volume-to-surface-area ratio becomes higher, and as the ratio gets higher, drying becomes slower. In addition, large, uniform-sized kernels often enable higher flaking grit yields in dry milling. Kernel weights tend to be higher for specialty varieties of corn that have high amounts of horneous (hard) endosperm.

Results

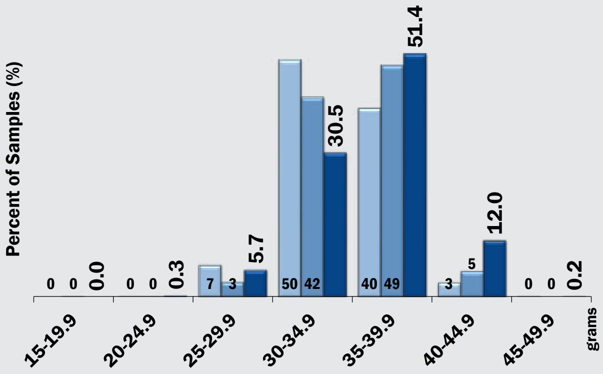
- U.S. Aggregate 100-k weight in 2017 averaged 36.07 g, higher than in 2016 (35.20 g), 2015 (34.34 g) and 5YA (34.30 g).
- Variability in the 2017 U.S. Aggregate 100-k weight (standard deviation of 2.53 g) was similar to 2016 and 2015 (both 2.43 g), and 5YA (2.67 g).
- 100-k weight range in 2017 (23.06 to 46.44 g) was intermediate between 2016 (18.91 to 44.17 g) and 2015 (24.90 to 45.64 g).
- The 100-k weights in 2017 were distributed with 63.6% of the samples having 100-k weight of 35 g or greater, compared to 54% in 2016 and 43% in 2015. This distribution indicates a higher percentage of large kernels was found in 2017 than in the previous two years.
- Average 100-k weight was lowest for the Pacific Northwest ECA (33.39 g), compared to the Gulf (36.94 g) and Southern Rail (36.26 g) ECAs. The Pacific Northwest ECA also had the lowest 100-k weight in 2016, 2015 and 5YA.

100-K WEIGHT (g)

EXPORT CATCHMENT AREA AVERAGE



U.S. AGGREGATE



	Avg (g)	Std Dev (g)
■ 2017	36.07	2.53
■ 2016	35.20	2.43
■ 2015	34.34	2.43

Kernel Volume

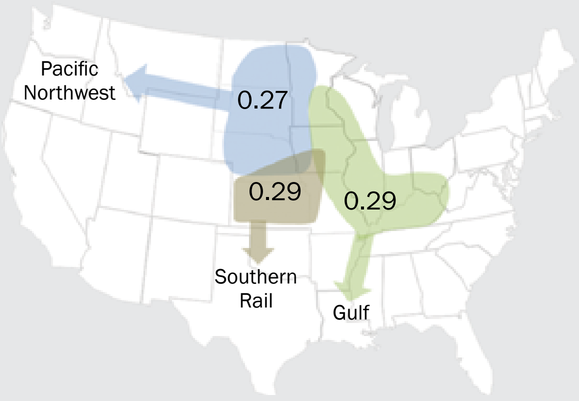
Kernel volume in cubic centimeters (cm^3) is often indicative of growing conditions. If conditions are dry, kernels may be smaller than average. If drought hits later in the season, kernels may have lower fill. Small or round kernels are more difficult to degerm. Additionally, small kernels may lead to increased cleanout losses for processors and higher yields of fiber.

Results

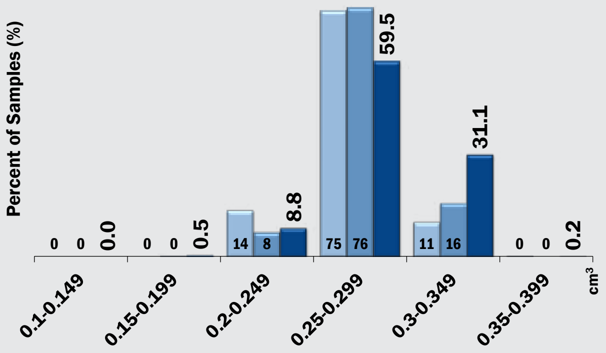
- U.S. Aggregate kernel volume averaged 0.29 cm^3 in 2017, which was higher than in 2016 (0.28 cm^3), and 2015 and 5YA (both 0.27 cm^3).
- Kernel volume variability was constant across the years. The standard deviation for U.S. Aggregate kernel volume was 0.02 cm^3 for 2017, 2016, 2015 and 5YA.
- Kernel volume range in 2017 (0.18 to 0.36 cm^3) was similar to 2016 (0.16 to 0.34 cm^3) and 2015 (0.21 to 0.36 cm^3).
- The kernel volumes in 2017 were distributed so that 31.3% of the samples had kernel volumes of 0.30 cm^3 or greater, compared to 2016 (16%) and 2015 (11%). This distribution indicates there was a higher percentage of large kernels in 2017 compared to the previous two years.
- Kernel volume for the Gulf, Pacific Northwest and Southern Rail ECAs averaged 0.29 cm^3, 0.27 cm^3 and 0.29 cm^3, respectively. Among the ECAs, the Pacific Northwest ECA had the lowest average kernel volume in 2017, 2016, 2015 and 5YA.

KERNEL VOLUME (cm^3)

EXPORT CATCHMENT AREA AVERAGE



U.S. AGGREGATE



		Avg (cm^3)	Std Dev (cm^3)
■	2017	0.29	0.02
■	2016	0.28	0.02
■	2015	0.27	0.02

Kernel True Density

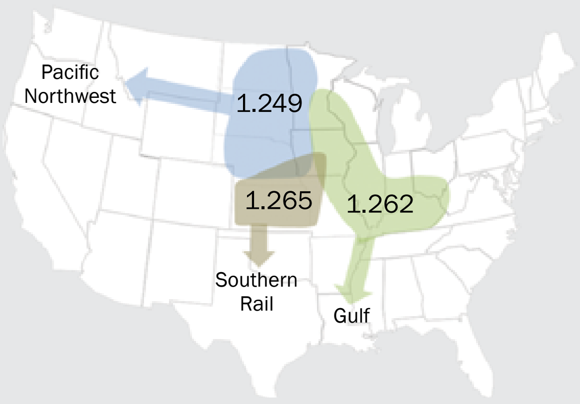
Kernel true density is calculated as the weight of a 100-k sample divided by the volume, or displacement, of those 100 kernels and is reported as grams per cubic centimeter (g/cm³). True density is a relative indicator of kernel hardness, which is useful for alkaline processors and dry millers. True density may be affected by the genetics of the corn hybrid and the growing environment. Corn with higher density is typically less susceptible to breakage in handling than lower density corn, but is also more at risk for the development of stress cracks if high-temperature drying is employed. True densities above 1.30 g/cm³ indicate very hard corn, which is typically desirable for dry milling and alkaline processing. True densities near the 1.275 g/cm³ level and below tend to be softer, but process well for wet milling and feed use.

Results

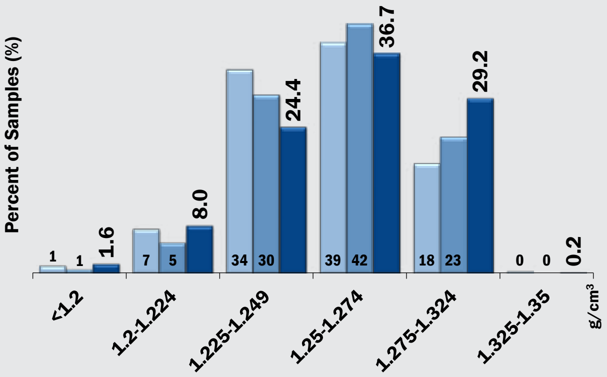
- Average U.S. Aggregate kernel true density in 2017 (1.260 g/cm³) was higher than in 2016 (1.258 g/cm³) and 2015 (1.254 g/cm³), but similar to 5YA (1.261 g/cm³).
- Variability, based on the standard deviation, in 2017 (0.018 g/cm³) was similar to 2016 (0.018 g/cm³), 2015 (0.017 g/cm³) and 5YA (0.018 g/cm³).
- True densities ranged from 1.135 to 1.332 g/cm³ in 2017, 1.162 to 1.320 g/cm³ in 2016, and 1.166 to 1.327 g/cm³ in 2015.
- About 29.4% of the 2017 samples had true densities at or above 1.275 g/cm³, compared to 23% in 2016 and 18% of the samples in 2015. Since corn with values above 1.275 g/cm³ is often considered to represent hard corn and that with values below 1.275 g/cm³ is often considered to represent soft corn, this kernel distribution indicates slightly harder corn in 2017 than in 2016 and 2015.
- In 2017, kernel true densities for the Gulf, Pacific Northwest and Southern Rail ECAs averaged 1.262 g/cm³, 1.249 g/cm³ and 1.265 g/cm³, respectively. The Pacific Northwest ECA average true density and test weight were lower than the other ECAs' values in 2017, 2016, 2015 and 5YA.

KERNEL TRUE DENSITY (g/cm³)

EXPORT CATCHMENT AREA AVERAGE



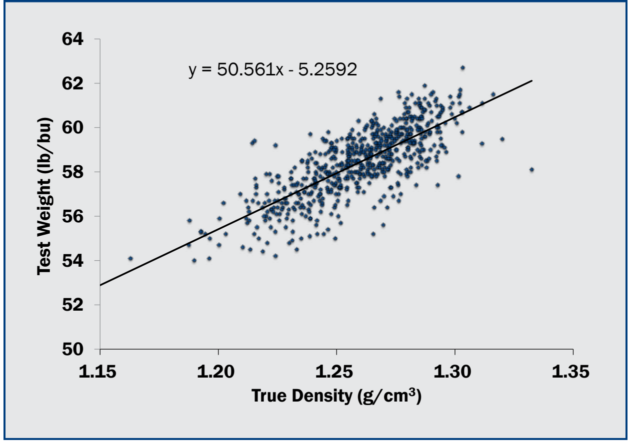
U.S. AGGREGATE



	Avg (g/cm³)	Std Dev (g/cm³)
■ 2017	1.260	0.018
■ 2016	1.258	0.018
■ 2015	1.254	0.017

- Test weight, also known as bulk density, is based on the amount of mass contained in a quart cup. While test weight is influenced by true density, as shown in the adjacent figure (resulting in a correlation coefficient of 0.78), it is also affected by moisture content, pericarp damage (whole kernels), breakage and other factors. In 2017, test weight was 58.4 lb/bu, which was higher than the 58.3 lb/bu found in 2016 and higher than the 58.2 lb/bu found in 2015.

TEST WEIGHT vs TRUE DENSITY



Whole Kernels

Though the name suggests some inverse relationship between whole kernels and BCFM, the whole kernels test conveys different information than the broken corn portion of the BCFM test. Broken corn is defined solely by the size of the material. Whole kernels, as the name implies, is the percent of fully intact kernels in the sample with no pericarp damage or kernel pieces chipped away.

The exterior integrity of the corn kernel is very important for two key reasons. First, it affects water absorption for alkaline cooking and steeping operations. Kernel nicks or pericarp cracks allow water to enter the kernel faster than intact or whole kernels. Too much water uptake during cooking can result in loss of solubles, non-uniform cooking, expensive shutdown time and/or products that do not meet specifications. Some companies pay contracted premiums for corn delivered above a specified level of whole kernels.

Second, intact whole kernels are less susceptible to storage molds and breakage in handling. While hard endosperm lends itself to preservation of more whole kernels than soft corn, the primary factor in delivering whole kernels is harvesting and handling. This begins with proper combine adjustment followed by the severity of kernel impacts due to conveyors and number of handlings required from the farm field to the end user. Each subsequent handling will generate additional breakage. Actual amounts of breakage increase exponentially as moisture decreases, drop heights increase, and/or a kernel's velocity at impact increases.[3] In addition, harvesting at higher moisture contents (e.g., greater than 25%) will usually lead to soft pericarps and more pericarp damage to corn than when harvesting at lower moisture levels.

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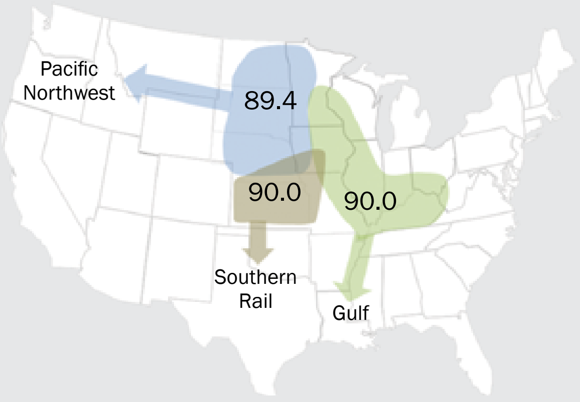
[3] *Foster, G. H. and L. E. Holman. 1973. Grain Breakage Caused by Commercial Handling Methods. USDA. ARS Marketing Research Report Number 968.*

Results

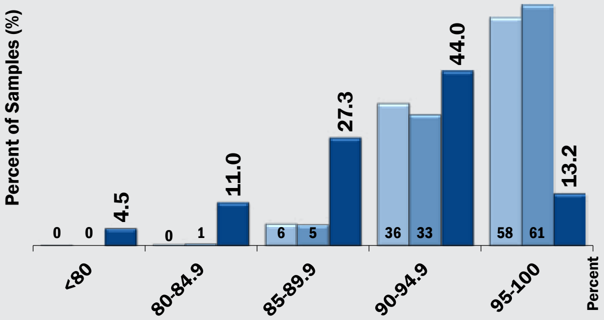
- U.S. Aggregate whole kernels averaged 89.9% in 2017, lower than in 2016 (95.2%), 2015 (94.9%) and 5YA (94.1%).
- The whole kernel standard deviation (4.6%) was higher than 2016 and 2015 (both 2.7%), and 5YA (3.2%).
- Whole kernel range in 2017 (67.0 to 99.2%) was much wider than in 2016 (80.6 to 100.0%) and 2015 (78.4 to 99.8%).
- Of the 2017 samples, 57.2% had 90% or higher whole kernels, compared to 2016 and 2015 (both 94%). This distribution indicates 2017 had a lower percentage of whole kernels than the samples for 2016 and 2015. The lower percentage of whole kernels in 2017 may in part be due to the exceptionally large kernel sizes found in 2017, which may have a kernel structure weaker than that of small kernels, leading to more susceptibility to cracking and chipping during combining and handling.
- Whole kernel averages for Gulf, Pacific Northwest and Southern Rail ECAs were 90.0%, 89.4% and 90.0%, respectively.

WHOLE KERNELS (%)

EXPORT CATCHMENT AREA AVERAGE



U.S. AGGREGATE



	Avg (%)	Std Dev (%)
■ 2017	89.9	4.6
■ 2016	95.2	2.7
■ 2015	94.9	2.7

Horneous (Hard) Endosperm

The horneous (hard) endosperm test measures the percent of horneous or hard endosperm out of the total endosperm in a kernel, with a potential value from 70 to 100%. The greater the amount of horneous endosperm relative to soft endosperm, the harder the corn kernel is said to be. The degree of hardness is important depending on the type of processing. Hard corn is needed to produce high yields of large flaking grits in dry milling. Hard to medium hardness is desired for alkaline cooking. Medium to soft hardness is used for wet milling and livestock feeding.

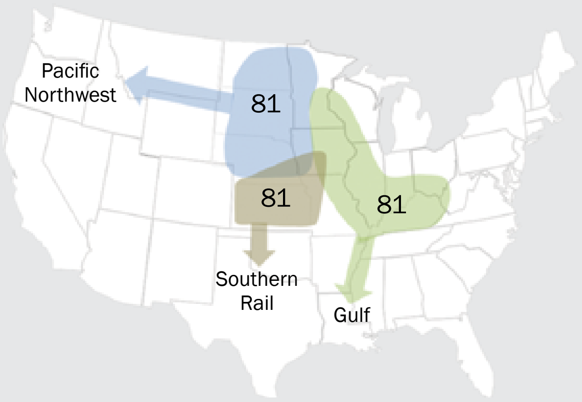
Hardness has been correlated to breakage susceptibility, feed utilization/efficiency and starch digestibility. As a test of overall hardness, there is no good or bad value for horneous endosperm; there is only a preference by different end users for particular ranges. Many dry millers and alkaline cookers would like greater than 90% horneous endosperm, while wet millers and feeders would typically like values between 70 and 85%. However, there are certainly exceptions in user preference.

Results

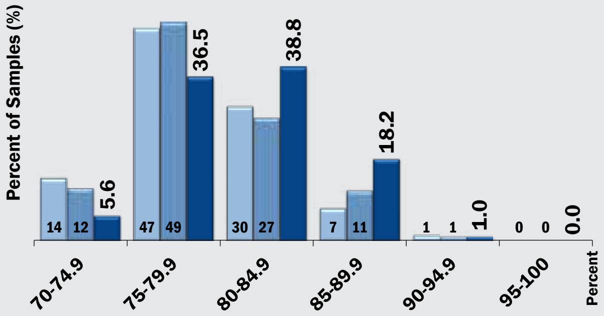
- Average U.S. Aggregate horneous endosperm in 2017 (81%) was higher than in 2016 and 2015 (both 79%), but slightly lower than 5YA (82%).
- U.S. Aggregate standard deviation for horneous endosperm was 4%, the same as 2016 and 5YA (both 4%), and similar to 2015 (3%).
- The 2017 horneous endosperm range (71 to 92%) was similar to 2016 (71 to 93%) and 2015 (71 to 95%).
- Of the 2017 samples, 42.1% contained less than 80% horneous endosperm, which was lower than 2016 and 2015 (both 61%).
- Average horneous endosperm was uniform across the Gulf, Pacific Northwest and Southern Rail ECAs, with an average of 81% for all three ECAs in 2017. Average horneous endosperm varied by no more than 0 to 1.0% across all ECAs during 2016, 2015 and 5YA.
- The figure on the adjacent page shows a weak but positive relationship (a correlation coefficient of 0.63) between horneous endosperm and true density for the 2017 samples.
- The next figure shows the average U.S. Aggregate horneous endosperm and true density values over the past seven years. This illustrates that average U.S. Aggregate horneous endosperm increases with true density (with a correlation coefficient of 0.88); thus, horneous endosperm tends to be higher in years when average true density is higher.

HORNEOUS ENDOSPERM (%)

EXPORT CATCHMENT AREA AVERAGE

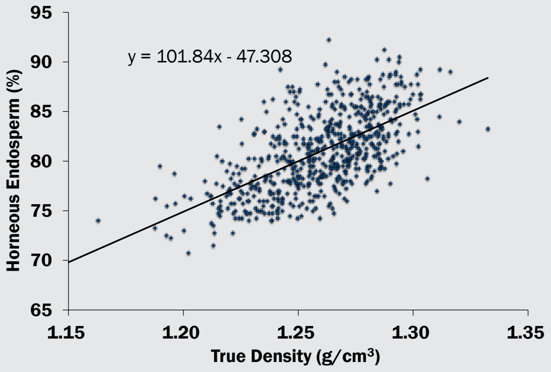


U.S. AGGREGATE



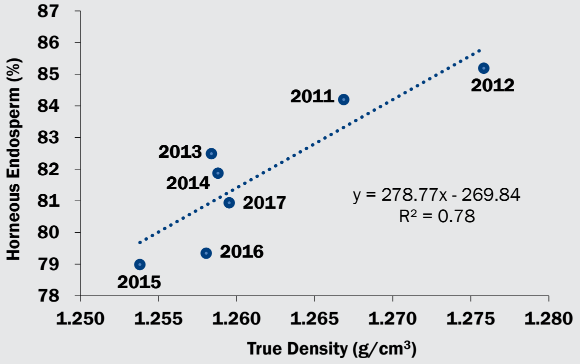
	Avg (%)	Std Dev (%)
■ 2017	81	4
■ 2016	79	4
■ 2015	79	3

HORNEOUS ENDOSPERM vs TRUE DENSITY



HORNEOUS ENDOSPERM vs TRUE DENSITY

OVER 7 YEARS



SUMMARY: PHYSICAL FACTORS

	2017 Harvest					2016 Harvest			2015 Harvest			5 Year Avg. (2012-2016)	
	No. of Samples[1]	Avg.	Std. Dev.	Min.	Max.	No. of Samples[1]	Avg.	Std. Dev.	No. of Samples[1]	Avg.	Std. Dev.	Avg.	Std. Dev.
U.S. Aggregate						**U.S. Aggregate**			**U.S. Aggregate**			**U.S. Aggregate**	
Stress Cracks (%)[2]	627	5	8	0	90	624	4*	6	620	3*	5	6	7
Stress Crack Index[2]	627	13.7	23.6	0	321	624	8.8*	16.6	620	6.6*	11.7	13.5	21.0
100-Kernel Weight (g)	627	36.07	2.53	23.06	46.44	624	35.20*	2.43	620	34.34*	2.43	34.30	2.67
Kernel Volume (cm^3)	627	0.29	0.02	0.18	0.36	624	0.28*	0.02	620	0.27*	0.02	0.27	0.02
True Density (g/cm^3)	627	1.260	0.018	1.135	1.332	624	1.258	0.018	620	1.254*	0.017	1.261	0.018
Whole Kernels (%)	627	89.9	4.6	67.0	99.2	624	95.2*	2.7	620	94.9*	2.7	94.1	3.2
Horneous Endosperm (%)	627	81	4	71	92	624	79*	4	620	79*	3	82	4
Gulf						**Gulf**			**Gulf**			**Gulf**	
Stress Cracks (%)[2]	612	6	8	0	90	612	4*	6	577	3*	5	6	8
Stress Crack Index[2]	612	15.2	26.5	0	321	612	8.9*	17.6	577	7.0*	12.4	14.7	23.7
100-Kernel Weight (g)	612	36.94	2.45	23.06	46.44	612	35.54*	2.49	577	34.64*	2.47	34.79	2.72
Kernel Volume (cm^3)	612	0.29	0.02	0.18	0.36	612	0.28*	0.02	577	0.28*	0.02	0.28	0.02
True Density (g/cm^3)	612	1.262	0.018	1.135	1.332	612	1.259*	0.018	577	1.255*	0.017	1.263	0.018
Whole Kernels (%)	612	90.0	4.7	67.0	99.2	612	95.0*	2.7	577	95.0*	2.8	94.1	3.2
Horneous Endosperm (%)	612	81	4	71	92	612	79*	4	577	79*	3	82	4
Pacific Northwest						**Pacific Northwest**			**Pacific Northwest**			**Pacific Northwest**	
Stress Cracks (%)[2]	291	5	7	0	78	301	5	7	329	3*	4	6	6
Stress Crack Index[2]	291	12.9	20.2	0	278	301	10.3	17.5	329	6.6*	11.9	13.1	17.8
100-Kernel Weight (g)	291	33.39	2.68	23.06	44.75	301	33.96*	2.21	329	33.08	2.29	32.47	2.46
Kernel Volume (cm^3)	291	0.27	0.02	0.18	0.35	301	0.27*	0.02	329	0.26	0.02	0.26	0.02
True Density (g/cm^3)	291	1.249	0.018	1.135	1.320	301	1.253*	0.016	329	1.249	0.017	1.253	0.018
Whole Kernels (%)	291	89.4	4.8	67.2	98.4	301	95.7*	2.7	329	94.8*	2.6	93.9	3.2
Horneous Endosperm (%)	291	81	4	71	90	301	79*	3	329	79*	3	81	3
Southern Rail						**Southern Rail**			**Southern Rail**			**Southern Rail**	
Stress Cracks (%)[2]	393	4	6	0	90	395	3*	4	402	3*	3	4	5
Stress Crack Index[2]	393	9.0	16.8	0	321	395	5.8*	11.0	402	4.7*	8.2	8.2	12.3
100-Kernel Weight (g)	393	36.26	2.65	25.10	44.75	395	35.67*	2.50	402	35.09*	2.49	34.67	2.75
Kernel Volume (cm^3)	393	0.29	0.02	0.20	0.35	395	0.28*	0.02	402	0.28*	0.02	0.27	0.02
True Density (g/cm^3)	393	1.265	0.018	1.135	1.320	395	1.261*	0.018	402	1.255*	0.017	1.264	0.018
Whole Kernels (%)	393	90.0	4.3	67.0	99.2	395	95.1*	2.6	402	94.9*	2.8	94.2	3.0
Horneous Endosperm (%)	393	81	3	71	91	395	80*	4	402	79*	3	82	4

**Indicates averages in 2016 were significantly different from 2017, and 2015 averages were significantly different from 2017, based on a 2-tailed t-test at the 95% level of significance.*

[1] Due to the ECA results being composite statistics, the sum of the sample numbers from the three ECAs is greater than the U.S. Aggregate.

[2] The Relative ME for predicting the harvest population average exceeded ±10%.

E. MYCOTOXINS

Mycotoxins are toxic compounds produced by fungi that occur naturally in grains. When consumed at elevated levels, mycotoxins may cause sickness in humans and animals. While several mycotoxins have been found in corn grain, aflatoxins and deoxynivalenol (DON) or vomitoxin are considered to be two of the important mycotoxins.

As in the previous *Harvest Reports*, the 2017 harvest samples were tested for aflatoxins and DON for this year's report. Since the production of mycotoxins is heavily influenced by growing conditions, the objective of the *Harvest Report* is strictly to report on instances when aflatoxins or DON are detected in the corn crop at harvest. No specific levels of the mycotoxins are reported.

The *Harvest Report* review of mycotoxins is NOT intended to predict the presence or level at which mycotoxins might appear in U.S. corn exports. Due to the multiple stages of the U.S. grain merchandising channel and the laws and regulations guiding the industry, the levels at which mycotoxins appear in corn exports are less than what might first appear in the corn as it comes out of the field. In addition, this report is not meant to imply that this assessment will capture all the instances of mycotoxins across the 12 states or three Export Catchment Areas (ECAs) surveyed. The *Harvest Report's* results should be used only as one indicator of the potential for mycotoxin presence in the corn as the crop comes out of the field. As the Council accumulates several years of the *Harvest Reports*, year-to-year patterns of mycotoxin presence in corn at harvest will be seen. The *U.S. Grains Council 2017/2018 Corn Export Cargo Quality Report* will report corn quality at export points and will be a more accurate indication of mycotoxin presence in the 2017/2018 U.S. corn export shipments.

Assessing the Presence of Aflatoxins and DON

At least 25% of the 627 samples that were proportionately collected across the sampling area were tested to assess the impact of the 2017 growing conditions on total aflatoxins and DON development in the U.S. corn crop. The sampling criteria, described in the “Survey and Statistical Analysis Methods” section, resulted in a total number of 180 samples tested for mycotoxins.

A threshold established by the U.S. Department of Agriculture (USDA) Federal Grain Inspection Service (FGIS) as the “Lower Conformance Level” (LCL) was used to determine if a detectable level of the mycotoxin appeared in the sample. The LCLs for the FGIS-approved analytical kits and used for this 2017/2018 report were 5.0 parts per billion (ppb) for aflatoxins and 0.5 parts per million (ppm) for DON. The FGIS LCL was higher than the Limit of Detection (LOD) specified by the kit manufacturer of 2.5 ppb and 0.3 ppm for aflatoxin and DON, respectively. Details on the testing methodology employed in this study for the mycotoxins are in the “Testing Analysis Methods” section.

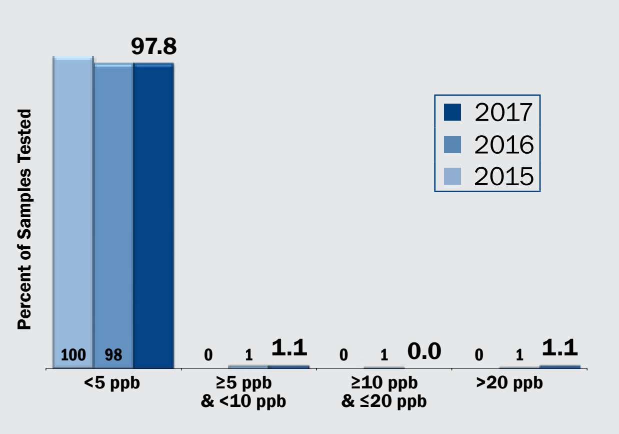
Results: Aflatoxins

A total of 180 samples was analyzed for aflatoxins in 2017, compared to 177 and 185 samples tested for aflatoxins in 2016 and 2015, respectively. Results of the 2017 survey are as follows:

- One hundred seventy-six (176) samples, or 97.8% of the 180 samples, had no detectable levels of aflatoxins (below the FGIS LCL of 5.0 ppb). This is almost identical to 2016 (98%), and slightly below 2015, when 100% of the samples tested had no detectable levels of aflatoxins.
- Two samples (2), or 1.1% of the 180 samples, showed aflatoxin levels greater than or equal to 5 ppb, but less than 10 ppb.
- No samples (0), or 0.0% of the 180 samples, showed an aflatoxin level greater than or equal to 10 ppb, but less than or equal to the U.S. Food and Drug Administration (FDA) action level of 20 ppb.
- Two samples (2), or 1.1% of the 180 samples, showed an aflatoxin level greater than the FDA action level of 20 ppb.
- These results denote that 178 samples, or 98.9% of the 180 sample test results in 2017, were below or equal to the FDA action level of 20 ppb, compared to 99.4% and 100% of the samples tested in 2016 and 2015, respectively.

The fact that the 2017 crop season percentage (97.8%) of samples below the FGIS LCL of 5.0 ppb was similar to 2016 (97.7%) and 2015 (100%) may be due, in part, to favorable weather conditions in 2017 (see the “Crop and Weather Conditions” section for more information on 2017 growing conditions). Most of the growing area received ample moisture during pollination and grain-fill in 2017, and as a result, the corn plants were not under stress.

AFLATOXINS TESTING RESULTS



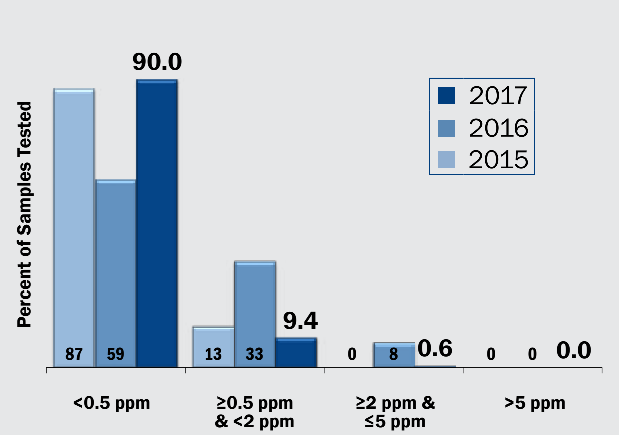
Results: Deoxynivalenol (DON) or Vomitoxin

A total of 180 samples was analyzed collectively for DON in 2017, compared to 177 and 185 samples tested for DON in 2016 and 2015, respectively. Results of the 2017 survey are as follows:

- One hundred sixty-two (162) samples, or 90.0% of the 180 samples, had no detectable levels of DON (below the FGIS LCL of 0.5 ppm). This is much higher than 2016 (59%), and slightly higher than 2015, when 87.0% of the samples tested had no detectable levels of DON.
- Seventeen (17) samples, or 9.4% of the 180 samples, tested greater than or equal to 0.5 ppm, but less than 2 ppm.
- One (1) sample, or 0.6% of the 180 samples, tested greater than or equal to 2 ppm, but less than or equal to the FDA advisory level of 5 ppm.
- All 180 samples, or 100%, tested below or equal to the FDA advisory level of 5 ppm, which was the same as was observed in 2016 and 2015.

While the samples in the 2017, 2016 and 2015 surveys were all below 5 ppm, the significant increase in the percentage of samples below 0.5 ppm in 2017, compared to 2016, may be attributed to favorable weather conditions that were less conducive to DON development in 2017.

DON TESTING RESULTS



Background: Mycotoxins General

The levels at which fungi produce mycotoxins are impacted by the fungus type and the environmental conditions under which the corn is produced and stored. Because of these differences, mycotoxin production varies across the U.S. corn-producing areas and across years. In some years, the growing conditions across the corn-producing regions might not produce elevated levels of any mycotoxins. In other years, the environmental conditions in a particular area might be conducive to production of a particular mycotoxin to levels that impact the corn's use for human and livestock consumption. Humans and livestock are sensitive to mycotoxins at varying levels. As a result, the U.S. Food and Drug Administration (FDA) has issued action levels for aflatoxins and advisory levels for DON by intended use.

Action levels specify precise limits of contamination above which the agency is prepared to take regulatory action. Action levels are a signal to the industry that the FDA believes it has scientific data to support regulatory and/or court action if a toxin or contaminant is present at levels exceeding the action level, if the agency chooses to do so. If imports or domestic feed supplements are analyzed in accordance with valid methods and found to exceed applicable action levels, they are considered adulterated and may be seized and removed from interstate commerce by the FDA.

Advisory levels provide guidance to the industry concerning levels of a substance present in food or feed that are believed by the agency to provide an adequate margin of safety to protect human and animal health. While the FDA reserves the right to take regulatory enforcement action, enforcement is not the fundamental purpose of an advisory level.

A source of additional information is the National Grain and Feed Association (NGFA) guidance document titled "FDA Mycotoxin Regulatory Guidance" found at *http://www.ngfa.org/wp-content/uploads/NGFAComplianceGuide-FDARegulatoryGuidanceforMycotoxins8-2011.pdf*.

Background: Aflatoxins

The most important type of mycotoxin associated with corn grain is aflatoxin. There are several types of aflatoxin produced by different species of *Aspergillus*, with the most prominent species being *A. flavus*. Growth of the fungus and aflatoxin contamination of grain can occur in the field prior to harvest or in storage. However, contamination prior to harvest is considered to cause most of the problems associated with aflatoxin. *A. flavus* grows well in hot, dry environmental conditions or where drought occurs over an extended period of time. It can be a serious problem in the southern United States, where hot and dry conditions are more common. The fungus usually attacks only a few kernels on the ear and often penetrates kernels through wounds produced by insects. Under drought conditions, it also grows down silks into individual kernels.

There are four types of aflatoxin naturally found in foods – aflatoxins B1, B2, G1 and G2. These four aflatoxins are commonly referred to as “aflatoxins” or “total aflatoxins.” Aflatoxin B1 is the most commonly found aflatoxin in food and feed and is also the most toxic. Research has shown that B1 is a potent, naturally-occurring carcinogen in animals, with a strong link to human cancer incidence. Additionally, dairy cattle will metabolize aflatoxin to a different form of aflatoxin called aflatoxin M1, which may accumulate in milk.

Aflatoxins express toxicity in humans and animals primarily by attacking the liver. The toxicity can occur from short-term consumption of very high doses of aflatoxin-contaminated grain or long-term ingestion of low levels of aflatoxins, possibly resulting in death for poultry, the most sensitive of the animal species. Livestock may experience reduced feed efficiency or reproduction, and both human and animal immune systems may be suppressed as a result of ingesting aflatoxins.

The FDA has established action levels for aflatoxin M1 in milk intended for human consumption and aflatoxins in human food, grain and livestock feed (see table below).

The FDA has established additional policies and legal provisions concerning the blending of corn with levels of aflatoxins exceeding these threshold levels. In general, the FDA currently does not permit the blending of corn containing aflatoxin with uncontaminated corn to reduce the aflatoxin content of the resulting mixture to levels acceptable for use as human food or animal feed.

Corn exported from the United States must be tested for aflatoxins according to federal law. Unless the contract exempts this requirement, testing must be conducted by FGIS. Corn above the FDA action level of 20 ppb cannot be exported unless other strict conditions are met. This results in relatively low levels of aflatoxins in exported grain.

Aflatoxins Action Level	Criteria
0.5 ppb (Aflatoxin M1)	Milk intended for human consumption
20 ppb	For corn and other grains intended for immature animals (including immature poultry) and for dairy animals, or when the animal’s destination is not known
20 ppb	For animal feeds, other than corn or cottonseed meal
100 ppb	For corn and other grains intended for breeding beef cattle, breeding swine or mature poultry
200 ppb	For corn and other grains intended for finishing swine of 100 pounds or greater
300 ppb	For corn and other grains intended for finishing (i.e., feedlot) beef cattle and for cottonseed meal intended for beef cattle, swine or poultry

Source: FDA and USDA GIPSA, http://www.gipsa.usda.gov/Publications/fgis/broch/b-aflatox.pdf

Background: Deoxynivalenol (DON) or Vomitoxin

Deoxynivalenol (DON) or vomitoxin is another mycotoxin of concern to some importers of corn grain. It is produced by certain species of *Fusarium*, the most important of which is *Fusarium graminearum* (*Gibberellazeae*) which also causes Gibberella ear rot (or red ear rot). *Gibberellazeae* can develop when cool or moderate and wet weather occurs at flowering. The fungus grows down the silks into the ear, and in addition to producing DON, it produces conspicuous red discoloration of kernels on the ear. The fungus can also continue to grow and rot ears when corn is left standing in the field. Mycotoxin contamination of corn caused by *Gibberellazeae* is often associated with excessive postponement of harvest and/or storage of high-moisture corn.

DON is mostly a concern with monogastric animals, where it may cause irritation of the mouth and throat. As a result, the animals may eventually refuse to eat the DON-contaminated corn and may have low weight gain, diarrhea, lethargy and intestinal hemorrhaging. It may cause suppression of the immune system, resulting in susceptibility to a number of infectious diseases.

The FDA has issued advisory levels for DON. For products containing corn, the advisory levels are:

- 5 ppm in grains and grain co-products for swine, not to exceed 20% of their diet;
- 10 ppm in grains and grain co-products for chickens and cattle, not to exceed 50% of their diet; and
- 5 ppm in grains and grain co-products for all other animals, not to exceed 40% of their diet.

FGIS is not required to test for DON on corn bound for export markets, but will perform either a qualitative or quantitative test for DON at the buyer’s request.

A. 2017 HARVEST HIGHLIGHTS

Weather plays a large role in the corn planting process, growing conditions and grain development in the field, which, in turn, impacts final grain yield and quality. Overall, 2017 was characterized by a warm, wet vegetative period (the period of growth between germination and pollination), followed by a cool and dry, but prolonged, grain-filling period, and a warm, mostly wet, slow harvest. This crop had a slow start, with a crop condition rating[1] below the five-year average (5YA) most of the season, but improved during the mid-to late reproductive growth stages (from doughing through physiological maturity). In addition to the U.S. Department of Agriculture (USDA) predicting a record corn yield for 2017, the crop had higher test weight, oil concentrations, 100-k weight and kernel volume than the 2016 crop. The following highlights the key events of the 2017 growing season:

- Planting season was prolonged, and significant replanting was necessary due to flooding.
- Vegetative period in June and July was warm and dry in the Pacific Northwest and Southern Rail ECAs, while the north and eastern Gulf ECA experienced more rain in July than the other two ECAs.
- The early reproductive period is critical for grain production. July's heavy rains in the Gulf ECA led to pollination stresses that may have limited kernel numbers, but allowed the remaining kernels to fill more.
- Cool conditions in August across the three ECAs allowed for maximum grain-fill. Newer drought-resistant varieties were key to good yields in the Gulf ECA, while the Pacific Northwest and Southern Rail ECAs received late, but appreciated, rains.
- The combination of late planting and a cool August delayed maturation, dry-down and harvest.

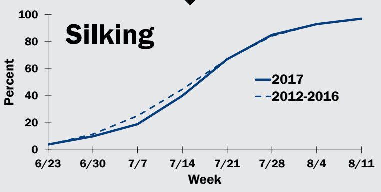
The following sections describe how the 2017 growing season weather impacted corn yield and grain quality in the U.S. Corn Belt.

GROWING CONDITIONS AND IMPACT ON CROP DEVELOPMENT

Mostly wet, warm spring, uneven planting and emergence

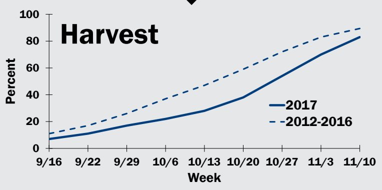
Large variation in crop development at any given time

Cool, very extended grain filling



Good kernel weight, protein and oil concentration, with minor disease pressure

Warm, mostly wet, slow harvest progress



Good test weight, hard endosperm and oil

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[1] *The U.S. Department of Agriculture (USDA) rates the U.S. corn crop weekly during the production cycle. The rating is based on yield potential and plant stress due to a number of factors, including extreme temperatures, excessive or insufficient moisture, disease, insect damage and/or weed pressure.*

B. PLANTING AND EARLY GROWTH CONDITIONS

Warm, wet April led to wide variation in planting time

Weather factors impacting corn yield and quality include the amount of precipitation and the temperature just prior to and during the corn-growing season. These weather factors interact with the corn variety planted and the soil fertility. Grain yield is a function of the number of plants per acre, the number of kernels per plant and the weight of each kernel. Cold or wet weather at planting could reduce plant numbers or hinder plant growth, which may result in lower yields per area. Some dryness at planting and early growth time is beneficial, as it promotes a deeper root system to access water better later in the season.

Overall in 2017, the spring was warmer than average for almost the entire United States. However, planting and final emergence was delayed from the 5YA due to a late-April storm bringing snow to the Pacific Northwest and Southern Rail ECAs, and heavy rains in the Gulf ECA. Flooding sets up differences in plant development within and between fields, which may lead to poor pollination and more variation in field maturity. Typically, later planted fields also have less than average yields.

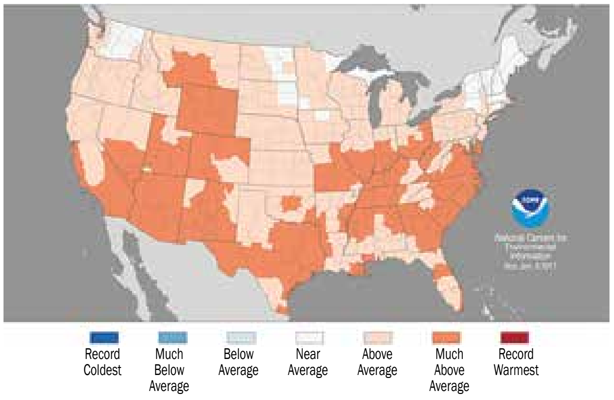
In the Pacific Northwest ECA, relatively warm temperatures in March and early April changed to average-to-cool temperatures in May. The northern areas were in a drought, while in April, the south (Nebraska) and eastern areas were much wetter than normal, leading to many areas with delayed planting, or with early- and late-planted fields.

The majority of the Gulf ECA experienced excessive rainfall at some point in the spring, but warmer-than-average temperatures during March and April. Many areas in the central portion of the Gulf ECA flooded after initial planting, which led to a second, or even a third, round of planting, especially in Illinois and Indiana.

DIVISIONAL AVERAGE TEMPERATURE RANKS

(Period: 1895-2017)

MARCH-MAY 2017

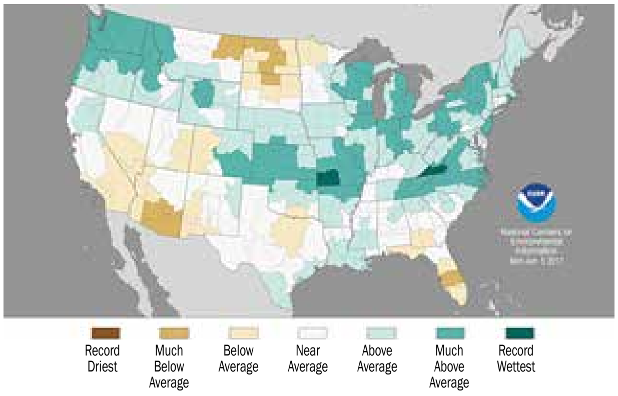


Source: Regional Climate Centers

DIVISIONAL PRECIPITATION RANKS

(Period: 1895-2017)

MARCH-MAY 2017



Source: Regional Climate Centers

While the Southern Rail ECA had weather patterns similar to the Gulf ECA (such as excessive rainfall), it experienced slightly cooler temperatures than the Gulf ECA. As a result, some corn fields in the Southern Rail ECA were either planted late or replanted.

C. POLLINATION AND GRAIN-FILL CONDITIONS

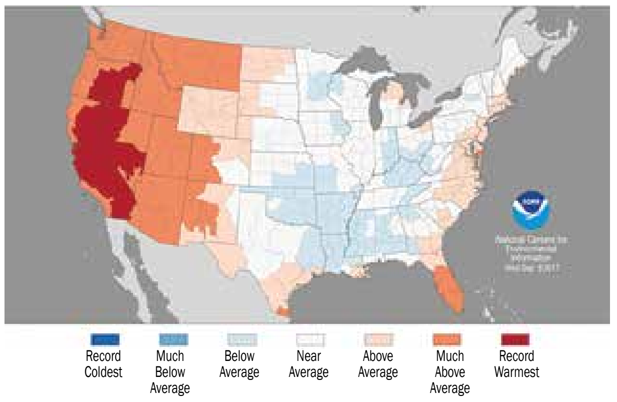
Extended grain-fill favored high yields

Corn pollination typically occurs in July, and at pollination time, greater-than-average temperatures or lack of rain typically reduce the number of kernels. The weather conditions during the grain-filling period in July and August are critical to determining final grain composition. During this time, moderate rainfall and cooler-than-average temperatures, especially overnight temperatures, promote starch and oil accumulation and increased yields. Moderate rainfall and warm temperatures in the second half of grain-fill (August to September) also aid continued nitrogen uptake and photosynthesis. Nitrogen also remobilizes from the leaves to the grain during late grain-filling, leading to increases in grain protein and hard endosperm.

DIVISIONAL AVERAGE TEMPERATURE RANKS

(Period: 1895-2017)

JUNE-AUGUST 2017



Source: Regional Climate Centers

In 2017, some areas in all of the ECAs changed from a very wet emergence period to a dry vegetative period, followed by abundant rains during the grain-filling period. In June and July, the warm weather and dry conditions favored rapid plant growth and nitrogen fertilizer uptake, producing a crop with a combined Good or Excellent condition rating that remained between 60-68% all season, finishing similar to the 2015 crop. August brought cool temperatures to the whole U.S. Corn Belt, which mitigated normal environmental stresses and extended the time for grain-fill. Additionally, September was warmer than average, which the crop took advantage of by continuing grain-fill and oil accumulation, increasing grain weight and delaying maturation.

In the Pacific Northwest ECA, June and July were warm. There was a moderate drought in the central portion for most of the summer, with rains coming in August and September during grain-fill. Conditions were good for increasing grain weight, volume and oil concentration.

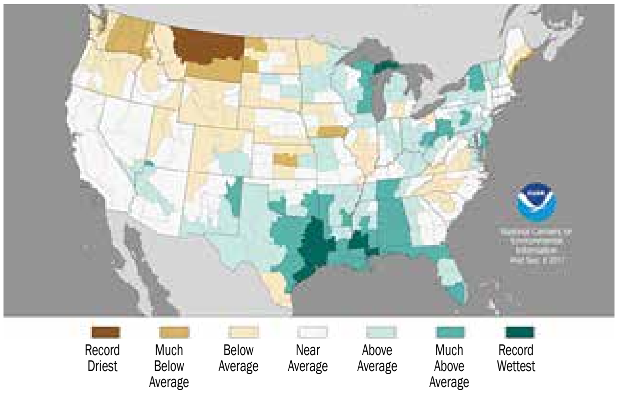
While the northern and eastern portions of the Gulf ECA experienced heavy rains in July, August was quite dry for this ECA, with the dry period extending into September and expanding to cover the entire Gulf ECA. Modern hybrids were able to tap into sub-surface water to continue grain-fill during this time.

Overall, the Southern Rail ECA had weather similar to the Pacific Northwest ECA in the summer, with slightly less rains in August and September. Growing conditions in the Southern Rail ECA were good for increasing grain weight, volume and oil concentration.

DIVISIONAL PRECIPITATION RANKS

(Period: 1895-2017)

JUNE-AUGUST 2017



Source: Regional Climate Centers

D. HARVEST CONDITIONS

Extended wet, but warm, weather delayed harvest progress

At the end of the growing season, the rate of dry-down of the grain depends on sunshine, temperature, humidity levels and soil moisture. Corn can most effectively dry down with the least adverse impact on quality amid sunny, warm and dry days. One weather concern at the end of the growing season is freezing temperatures. Early freezing before the grain can sufficiently dry down may lead to lower yield, test weight and/or stress cracking. Also, if harvested prematurely, higher moisture grain may be susceptible to greater breakage than drier grain.

Typically, 80% of the U.S. corn crop is harvested by the end of October. However, 2017 was one of only six years out of the past 20 that were delayed from this harvest progress average. This year's corn crop was about a week behind schedule for maturity, and rain further hindered a timely harvest. The variation within fields has also led to greater variation than normal in kernel composition and quality.

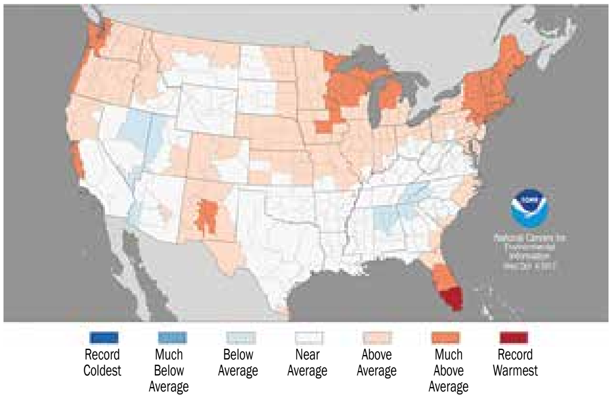
Fusarium-based ear mold (Gibberella ear rot) is promoted by cool and/or wet conditions soon after pollination, which was generally not the case in 2017. The mycotoxin deoxynivalenol (DON) or vomitoxin that is produced by *Fusarium* is often associated with harvest delay or storage of high-moisture corn. Only a small section of the Gulf ECA was wet during pollination, but the harvest delays were due more to producers not wanting to compact the soil with their heavy equipment, than due to major flooding that would promote DON.

Additionally, aflatoxin production is favored by hot temperatures, low precipitation and drought conditions. While it was warm in a large central portion of the corn-growing region during vegetative growth, the plants had few extreme high-temperature days when the grain was developing. Therefore, based on weather, aflatoxin should not be a problem this year.

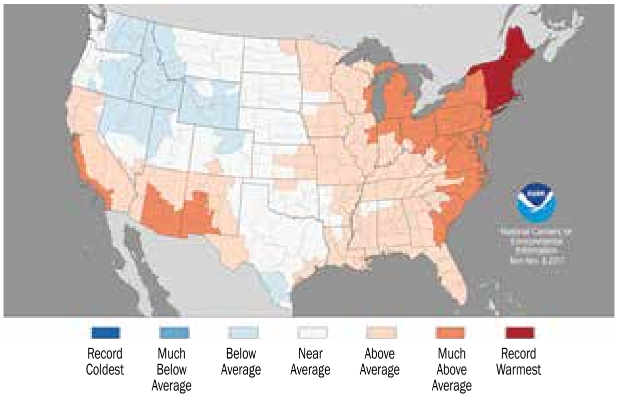
DIVISIONAL AVERAGE TEMPERATURE RANKS

(Period: 1895-2017)

SEPTEMBER 2017



OCTOBER 2017

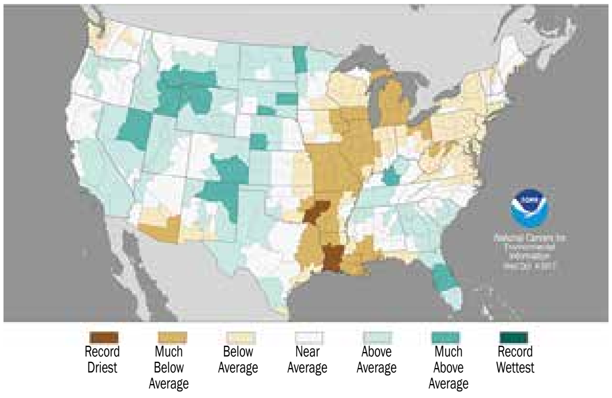


Source: Regional Climate Centers

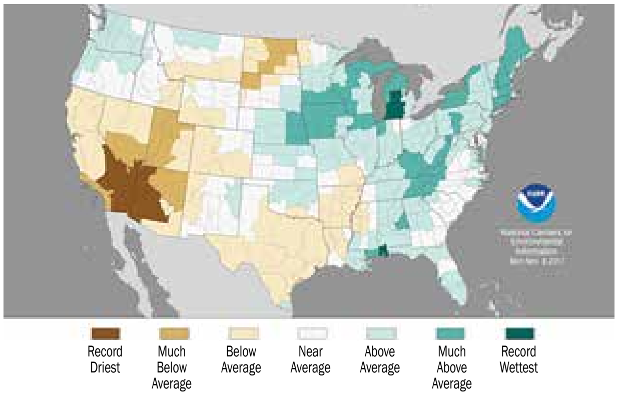
DIVISIONAL PRECIPITATION RANKS

(Period: 1895-2017)

SEPTEMBER 2017



OCTOBER 2017

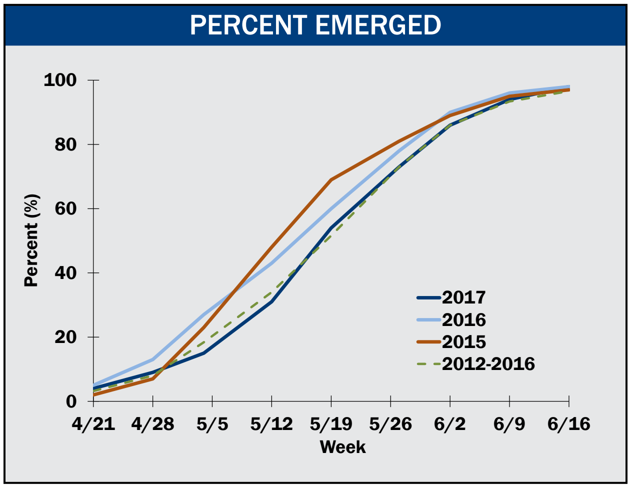


Source: Regional Climate Centers

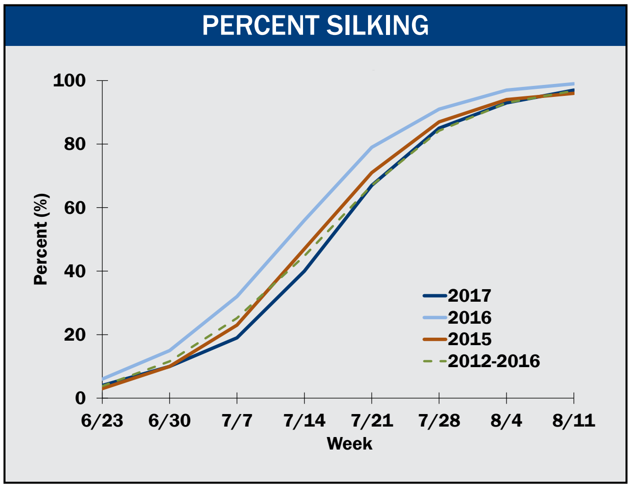
E. COMPARISON OF 2017 TO 2016, 2015 AND 5YA

2017 had extended moderate temperatures at grain-fill, creating record yields

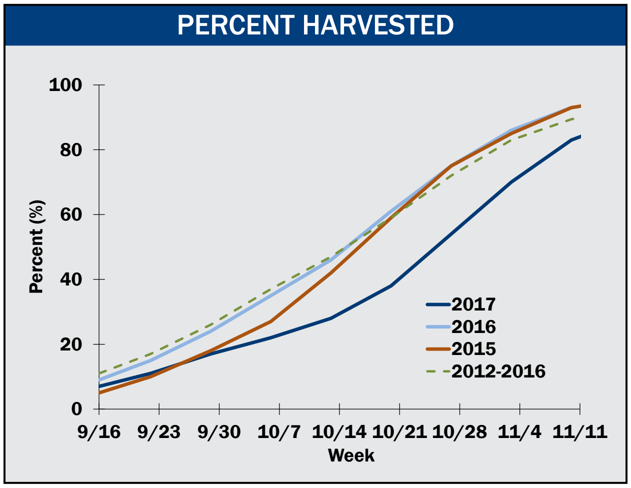
In 2015 and 2016, emergence was earlier than average. However, due to wet conditions and re-planting, emergence of the 2017 crop was delayed from the average pace. This pattern of delayed development continued through the silking stage. Rains mostly tapered off in the Pacific Northwest and Southern Rail ECAs in July 2017, similar to 2015, which helped to maximize pollination, while the Gulf ECA in July 2017 was similar to 2016, with plentiful rains during early grain-fill.


PERCENT EMERGED

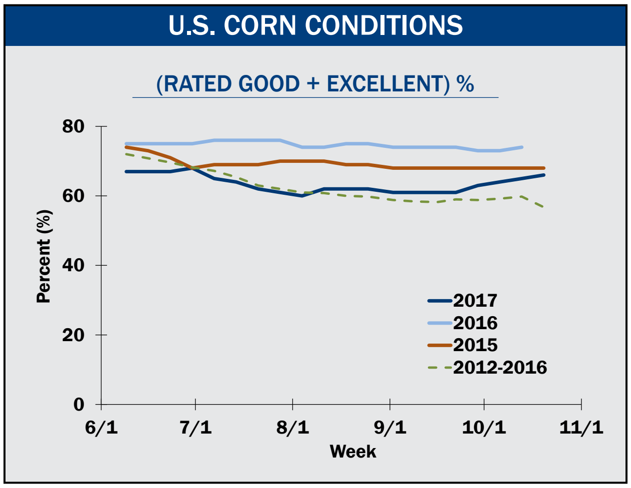
As grain-fill continued into August 2017, there was cool weather throughout the Corn Belt, similar to 2015, but in contrast to a very warm August 2016, which inhibited maximum starch accumulation. In 2017, the moderate temperatures and delayed maturity allowed for grain-fill to continue through September, about 10% behind the 5YA.


PERCENT SILKING

The slow start of the 2017 harvest was greatly delayed compared to the 5YA by late maturation of the plants. Harvest was further delayed by wet weather preventing farmers from getting equipment into the fields. In contrast, 2016 harvest was similar to the 5YA, and the 2015 harvest had a slow start, but eventually reached 5YA harvest progress.



Throughout 2017, the corn crop had a combined Good or Excellent condition rating[1] remaining between 60-68%. The 2017 corn crop conditions finished similar to 2015 and the 5YA, signifying good plant health, which then led to good photosynthesis, kernel size and yield. In 2014 and 2016, the crops had near 75% Good or Excellent condition ratings. In contrast, poorer growing conditions in 2012 through 2013 are reflected in the decreased 5YA, as shown on the graph. The corn crop in 2013 was less healthy than in 2014-2016, due to heat and drought. Additionally, in 2012, the severe drought and heat wave rapidly decreased the crop condition, starch accumulation and yield, but increased grain test weight and protein concentration.



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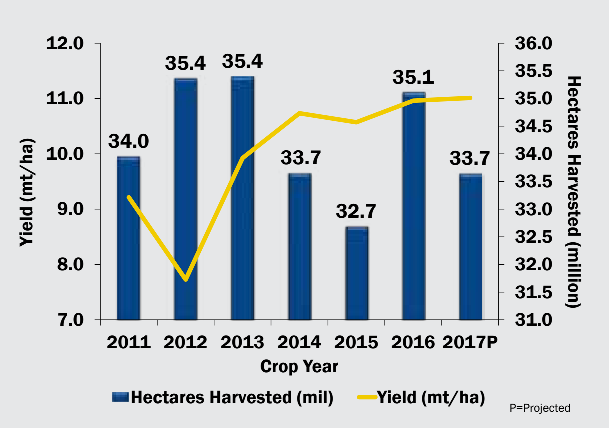
[2] *A 'Good' rating means that yield prospects are normal. Moisture levels are adequate and disease, insect damage, and weed pressures are minor. An 'Excellent' rating means that yield prospects are above normal, and the crop is experiencing little or no stress. Disease, insect damage and weed pressures are insignificant.*

A. U.S. CORN PRODUCTION[1]

U.S. Average Production and Yields

- According to the November 2017 U.S. Department of Agriculture (USDA) World Agricultural Supply and Demand Estimates (WASDE) report, average U.S. corn yield for the 2017 crop is projected to be 11.01 mt/ha (175.4 bu/ac). This is 0.05 mt/ha (0.8 bu/ac) higher than the average yield for the 2016 corn crop and the highest average yield on record.
- The number of hectares harvested in 2017 is projected to be 33.65 million (83.1 mil ac). This is 1.47 mil ha (3.6 mil ac) less than in 2016. The projected 33.65 mil ha harvested in 2017 is comparable to the average number of hectares harvested from 2007 through 2016 (33.82 mil ha).
- While 2017 saw the fifth-highest number of harvested hectares in the past decade, the 2017 crop experienced the highest average yield on record, thereby producing a crop estimated to be the second-largest U.S. corn crop on record at 370.30 mmt (14,578 mil bu). This crop was about 14.48 mmt (570 mil bu) smaller than 2016's record crop (384.78 mmt or 15,148 mil bu).

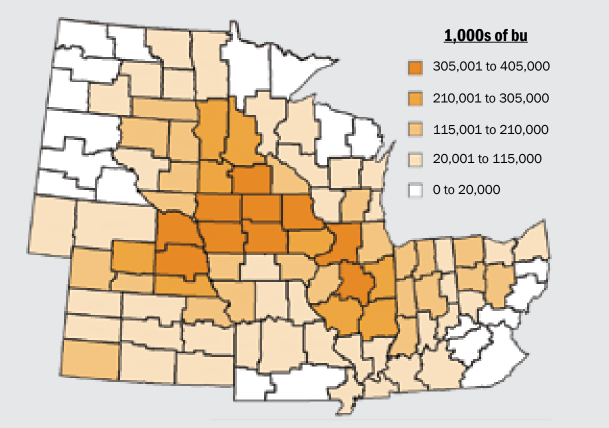
U.S. CORN YIELD AND HARVESTED AREA



ASD and State-Level Production

The geographic areas included in the *2017/2018 Corn Harvest Quality Report* encompass the highest corn-producing areas in the United States. This can be seen on the map showing projected 2017 corn production by USDA Agricultural Statistical District (ASD). These states represent 93.1% of U.S. corn exports.[1]

U.S. CORN PRODUCTION BY ASD (2017P)



Source: USDA NASS and Centrec Estimates

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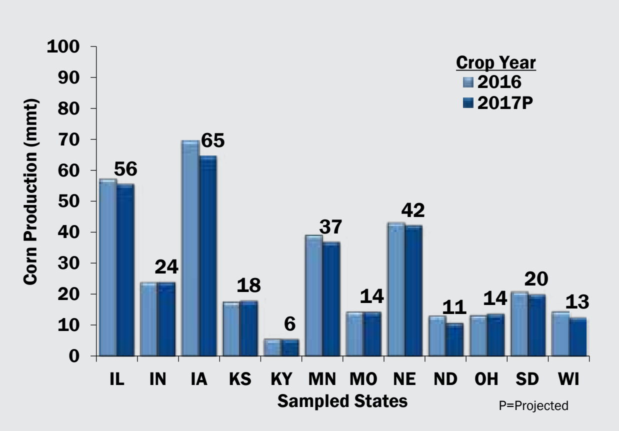
[1] *mt - metric ton; mmt - million metric tons; ha - hectare; bu - bushel; mil bu - million bushels; ac - acre.*

[2] *Source: USDA NASS, USDA GIPSA and Centrec estimates.*

Mostly slight differences in state-level yields and harvested acres were observed between the record corn crop produced in 2016 and the slightly smaller 2017 crop. While production decreased or remained the same from 2016 in 10 of the 12 key corn-producing states, only North Dakota and Wisconsin experienced decreases in production greater than 10% compared to their 2016 crops.

U.S. CORN PRODUCTION BY STATE



Source: USDA NASS

The U.S. Corn Production table summarizes the differences in both quantity (mmt) and percentages between 2016 and projected 2017 corn production for each state. Also included is an indication of the relative changes in harvested acres and yield between 2016 and projected 2017. The green bar indicates a relative increase and the red bar indicates a relative decrease from 2016 to projected 2017. With the exceptions of South Dakota and Kansas, this illustrates that 2017 harvested acres were generally slightly lower compared to 2016. Only Kentucky saw a decrease in harvested acres of greater than 10% compared to its 2016 crop. Yield changes in 2017 were mixed, but only two states experienced a large change (greater than 10%) in yield relative to 2016. Kentucky experienced an 11.3% increase while North Dakota experienced a 15.2% decrease in yield compared to 2016.

U.S. CORN PRODUCTION

			Difference		Relative % Change*	
State	**2016**	**2017P**	**MMT**	**Percent**	**Acres**	**Yield**
Illinois	57	56	(2)	-3%	🟥	
Indiana	24	24	(0)	0%	🟥	🟩
Iowa	70	65	(5)	-7%	🟥	🟥
Kansas	18	18	0	1%	🟩	🟥
Kentucky	6	6	(0)	-1%	🟥	🟩
Minnesota	39	37	(2)	-6%	🟥	🟥
Missouri	14	14	(0)	0%	🟥	🟩
Nebraska	43	42	(1)	-2%	🟥	
North Dakota	13	11	(2)	-17%	🟥	🟥
Ohio	13	14	0	3%	🟥	🟩
South Dakota	21	20	(1)	-5%	🟩	🟥
Wisconsin	15	13	(2)	-14%	🟥	🟥
Total U.S.	385	370	(14)	-4%		

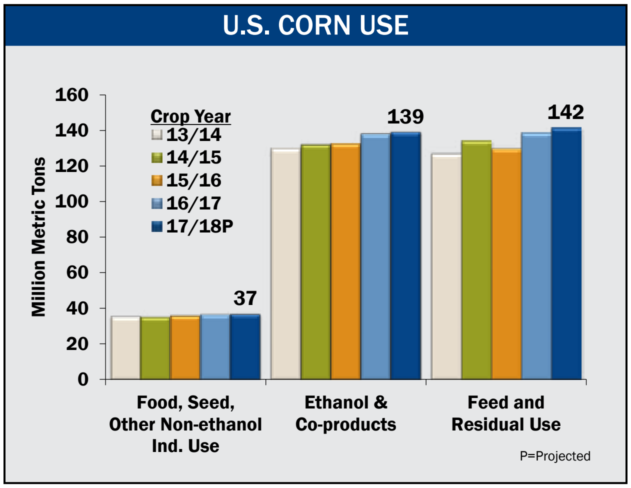
[*] Green indicates 2017 is higher than 2016 and red indicates 2017 is lower than 2016; bar height indicates the relative amount.

P=Projected, Source: USDA NASS

B. U.S. CORN USE AND ENDING STOCKS

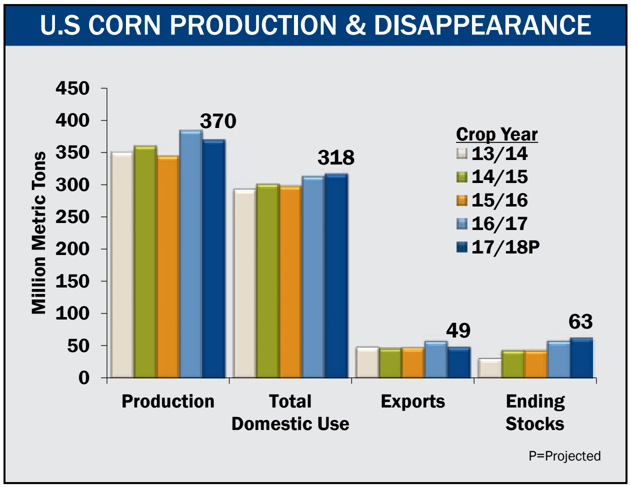
- U.S. corn use for food, seed and other non-ethanol industrial purposes has remained fairly consistent over the past four completed marketing years.
- While the amount of corn used for ethanol production was fairly stable for MY13/14 through MY15/16, there was a slight increase in corn used for ethanol production in MY16/17 due to a slight increase in domestic consumption of gasoline and ethanol exports.
- Direct consumption of corn as a feed ingredient in domestic livestock and poultry rations has remained strong, due to ample corn supplies and lower corn prices relative to other feed ingredients.
- U.S. corn exports in the three marketing years prior to MY16/17 were generally consistent but spiked in MY16/17 due to competitive prices, strong export demand and the plentiful supply created by the record 2016 U.S. crop.
- Large U.S. corn crops since MY13/14 have helped rebuild ending stocks since the 2012 drought drew down the MY12/13 ending stocks to the lowest level in many years.

U.S. CORN USE



Source: USDA WASDE and ERS

U.S CORN PRODUCTION & DISAPPEARANCE



Source: USDA WASDE and ERS

C. OUTLOOK

U.S. Outlook

- The projected second-largest U.S. corn crop on record has created an abundant supply of corn for MY17/18. This ample supply has continued to keep downward pressure on corn prices since their peak in MY12/13. The ample supply and low prices are major factors driving the projected domestic use of corn in MY17/18 to be the highest on record.
- Corn use for food, seed and non-ethanol industrial (FSI) purposes is expected to remain largely unchanged in MY17/18 compared to MY16/17, continuing the pattern of the previous four marketing years.
- Projected MY17/18 corn use for ethanol is slightly higher than MY16/17, making it the largest on record. Strong projected domestic ethanol use

is influenced, in part, by low gasoline prices supporting increased domestic gasoline demand, thereby expanding the domestic ethanol market. Other factors impacting projected ethanol use include competitive ethanol blend prices, strong export ethanol demand and moderate increases in substitution of corn as an ethanol feedstock due to decreased sorghum production.

- Domestic corn use for feed and residual use is expected to be 2.82 mmt higher (2.0% increase) in MY17/18 than in MY16/17. Feed demand for corn is expected to be supported by low corn prices, thereby decreasing the feed costs, and a large inventory of livestock and poultry.
- U.S. corn exports during MY17/18 are projected to be about 16% lower than MY16/17. However, exports in MY16/17 were the highest since MY07/08, and the projected exports for MY17/18 are similar to exports in the three marketing years prior to MY16/17.
- MY17/18 corn ending stocks are projected to be 8.4% higher than the previous marketing year, primarily due to large corn crops in consecutive years. This is the highest level seen since MY87/88. The stocks-to-use ratio is projected to be 17.2%, an increase for the fifth year in a row and a level not seen since MY05/06.

International Outlook

Global Supply

- Global corn production during MY17/18 is expected to be slightly lower than MY16/17's record-setting production due to slightly smaller crops in the United States and other major corn-producing countries.
- Higher production for MY17/18 in Argentina, Canada and a few minor corn-producing countries will be offset by lower production in Brazil, China, Serbia, South Africa, Ukraine and the United States.
- In addition to lower projected U.S. exports, total non-U.S. exports are expected to be slightly lower in MY17/18 than in MY16/17.
- Exports from key non-U.S. exporting countries are expected to increase from Argentina and decrease from Brazil, South Africa and Ukraine.

Global Demand

- Global corn use is expected to rise from 1,062.61 mmt in MY16/17 to 1,066.62 mmt in MY17/18, a 0.4% annual increase.
- With the exception of Japan, corn use is anticipated to be higher in MY17/18 than in MY16/17 for the major importing countries and areas (Egypt, the European Union, Mexico, Southeast Asia and South Korea).
- Corn use is projected to increase from MY16/17 to MY17/18 in the world's four highest corn-producing countries (Argentina, Brazil, China and the United States).
- An increase in year-over-year imports is expected globally in MY17/18. Decreases in imports by Israel, Turkey and Zimbabwe will be countered by increases in projected MY17/18 corn imports by Egypt, the European Union, Iran, Mexico and Saudi Arabia.

U.S. CORN SUPPLY AND USAGE SUMMARY BY MARKETING YEAR

Metric Units	13/14	14/15	15/16	16/17	17/18P
Acreage (million hectares)					
Planted	38.61	36.68	35.64	38.06	36.61
Harvested	35.41	33.66	32.69	35.12	33.65
Yield (mt/ha)	9.92	10.73	10.57	10.96	11.01
Supply (million metric tons)					
Beginning stocks	20.86	31.29	43.97	44.12	58.30
Production	351.27	361.09	345.51	384.78	370.30
Imports	0.91	0.80	1.72	1.45	1.27
Total Supply	**373.04**	**393.19**	**391.20**	**430.35**	**429.87**
Usage (million metric tons)					
Food, seed, other non-ethanol ind. use	35.74	35.48	36.19	36.89	37.09
Ethanol and co-products	130.15	132.09	132.69	138.13	139.07
Feed and residual	127.07	134.23	129.91	138.79	141.61
Exports	48.79	47.42	48.29	58.24	48.90
Total Use	**341.75**	**349.22**	**347.07**	**372.06**	**366.67**
Ending Stocks	31.29	43.97	44.12	58.30	63.17
Average Farm Price ($/mt*)	175.58	145.66	142.12	132.28	110.23-141.72

English Units	12/13	13/14	14/15	15/16	16/17P
Acreage (million acres)					
Planted	95.4	90.6	88.0	94.0	90.4
Harvested	87.5	83.1	80.8	86.7	83.1
Yield (bu/ac)	158.1	171.0	168.4	174.6	175.4
Supply (million bushels)					
Beginning stocks	821	1,232	1,731	1,737	2,295
Production	13,829	14,216	13,602	15,148	14,578
Imports	36	32	68	57	50
Total Supply	**14,686**	**15,479**	**15,401**	**16,942**	**16,923**
Usage (million bushels)					
Food, seed, other non-ethanol ind. use	1,407	1,397	1,425	1,452	1,460
Ethanol and co-products	5,124	5,200	5,224	5,438	5,475
Feed and residual	5,002	5,284	5,114	5,464	5,575
Exports	1,921	1,867	1,901	2,293	1,925
Total Use	**13,454**	**13,748**	**13,664**	**14,647**	**14,435**
Ending Stocks	1,232	1,731	1,737	2,295	2,487
Average Farm Price ($/bu*)	4.46	3.70	3.61	3.36	2.80-3.60

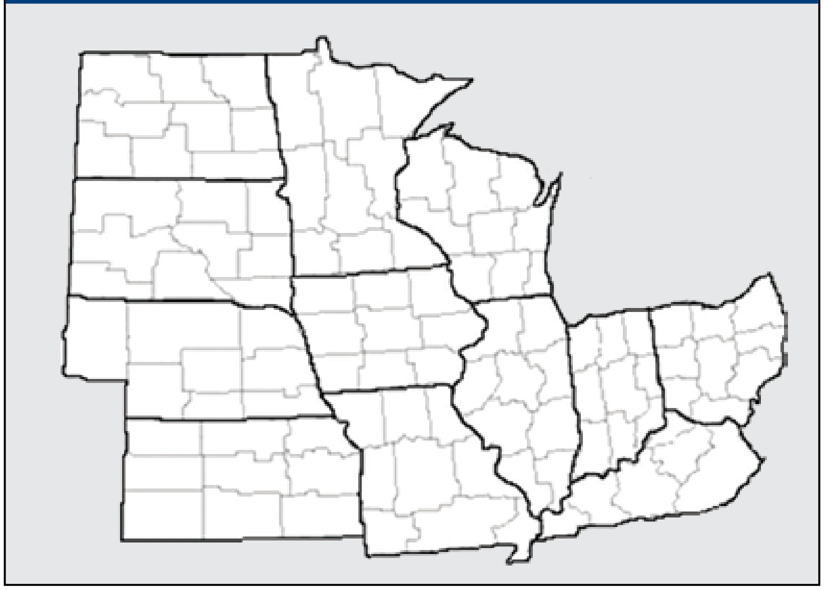
P-Projected
**Farm prices are weighted averages based on volume of farm shipment.*
Average farm price for 17/18P based on WASDE November projected price.
Source: USDA WASDE and ERS

A. OVERVIEW

The key points for the survey design and sampling and statistical analysis for this *2017/2018 Harvest Report* are as follows:

- Following the methodology developed for the previous six *Harvest Reports*, the samples were proportionately stratified according to Agricultural Statistical Districts (ASDs) across 12 key corn-producing states representing 93.1% of U.S. corn exports.
- A total of 620 samples collected from the 12 states was targeted to achieve a maximum ±10% relative margin of error (Relative ME) at the 95% confidence level.
- A total of 627 unblended corn samples pulled from inbound farm-originated trucks were received from local elevators from August 30 through November 18, 2017, and tested.
- A proportionate stratified sampling technique was used for the mycotoxin testing across the ASDs in the 12 states surveyed for the other quality factors. This sampling resulted in 180 samples being tested for aflatoxins and deoxynivalenol (DON).
- Weighted averages and standard deviations following standard statistical techniques for proportionate stratified sampling were calculated for the U.S. Aggregate and the three Export Catchment Areas (ECAs).
- To evaluate the statistical validity of the samples, the Relative ME was calculated for each of the quality attributes at the U.S. Aggregate and the three ECA levels. The Relative ME for the quality factor results was less than ±10% except for two attributes – stress cracks and stress crack index (SCI). While the lower level of precision for these quality factors is less than desired, these levels of Relative ME do not invalidate the estimates.
- Two-tailed t-tests at the 95% confidence level were calculated to measure statistical differences between the 2017 and 2016 and the 2017 and 2015 quality factor averages.

AGRICULTURAL STATISTICAL DISTRICTS (ASDs)



B. SURVEY DESIGN AND SAMPLING

Survey Design

For this *2017/2018 Harvest Report*, the target population was yellow commodity corn from the 12 key U.S. corn-producing states representing about 93.1% of U.S. corn exports.[1] A ***proportionate stratified, random sampling*** technique was applied to ensure a sound statistical sampling of the U.S. corn crop at the first stage of the market channel. Three key characteristics define the sampling technique: the ***stratification*** of the population to be sampled, the ***sampling proportion*** per stratum and the ***random sample*** selection procedure.

Stratification involves dividing the survey population of interest into distinct, non-overlapping subpopulations called strata. For this study, the survey population was corn produced in areas likely to export corn to foreign markets. The U.S. Department of Agriculture (USDA) divides each state into several Agricultural Statistical Districts (ASDs) and estimates corn production for each ASD. The USDA corn production data, accompanied by foreign export estimates, were used to define the survey population in the 12 key corn-producing states. The ASDs were the subpopulations or strata used for this corn quality survey. From those data, the Council calculated each ASD's proportion of the total production and foreign exports to determine the ***sampling proportion*** (the percent of total samples per ASD) and ultimately, the number of corn samples to be collected from each ASD. The number of samples collected for the *2017/2018 Harvest Report* differed among the ASDs, due to their different shares of estimated production and foreign export levels.

The ***number of samples collected was established*** so the Council could estimate the true averages of the various quality factors with a certain level of precision. The level of precision chosen for the *2017/2018 Harvest Report* was a relative margin of error (Relative ME) no greater than ±10%, estimated at a 95% level of confidence. A Relative ME of ±10% is a reasonable target for biological data such as these corn quality factors.

To determine the number of samples for the targeted Relative ME, ideally the population variance (i.e., the variability of the quality factor in the corn at harvest) for each of the quality factors should be used. The more variation among the levels or values of a quality factor, the more samples needed to estimate the true mean with a given confidence limit. In addition, the variances of the quality factors typically differ from one another. As a result, different sample sizes for each of the quality factors would be needed for the same level of precision.

Since the population variances for the 17 quality factors evaluated for this year's corn crop were not known, the variance estimates from the *2016/2017 Harvest Report* were used as proxies. The variances and ultimately the estimated number of samples needed for the Relative ME of ±10% for 14 quality factors were calculated using the 2016 results of 624 samples. Broken corn, foreign material and heat damage were not examined. Stress cracks and stress crack index (SCI), with a Relative ME of 12% and 15%, respectively, were the only quality factors for which the Relative ME exceeded ±10% for the U.S. Aggregate. Based on these data, a minimum sample size of 600 would allow the Council to estimate the true averages of the quality characteristics with the desired level of precision for the U.S. Aggregate, with the exception of stress cracks and SCI. However, the targeted number of samples became 620, due to the rounding of targeted numbers of samples per ASD, and the criterion of a minimum of two samples per ASD.

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[1] *Source: USDA NASS, USDA GIPSA and Centrec estimates.*

The same approach of proportionate stratified sampling was used for the mycotoxin testing of the corn samples as for the testing of the grade, moisture, chemical and physical characteristics. In addition to using the same sampling approach, the same level of precision of a Relative ME of ±10%, estimated at a 95% level of confidence, was desired. Testing at least 25% of the minimum number of samples (600) was estimated to provide that level of precision. In other words, testing at least 150 samples would provide a 95% confidence level that the percent of tested samples with aflatoxin results below the U.S. Food and Drug Administration (FDA) action level of 20 parts per billion (ppb) would have a Relative ME of ±10%. In addition, it was estimated that the percent of tested samples with DON results below the FDA advisory level of 5 parts per million (ppm) would also have a Relative ME of ±10%, estimated at a 95% level of confidence. The proportionate stratified sampling approach also required testing at least one sample from each ASD in the sampling area. To meet the sampling criteria of testing 25% of the minimum number of samples (600) and at least one sample from each ASD, the targeted number of samples to test for mycotoxins was 180 samples.

Sampling

The ***random selection*** process was implemented by soliciting local grain elevators in the 12 states by email and phone. Postage-paid sample kits were mailed to elevators agreeing to provide the 2050- to 2250-gram corn samples requested. Elevators were told to avoid sampling loads of old crop corn from farmers cleaning out their bins for the current crop. The individual samples were pulled from inbound farm-originated trucks when the trucks underwent the elevators' normal testing procedures. The number of samples each elevator provided for the survey depended on the targeted number of samples needed from the ASD along with the number of elevators willing to provide samples. A maximum of four samples from each physical location was collected. A total of 627 unblended corn samples pulled from inbound farm-originated trucks was received from local elevators from August 30 through November 18, 2017, and tested.

C. STATISTICAL ANALYSIS

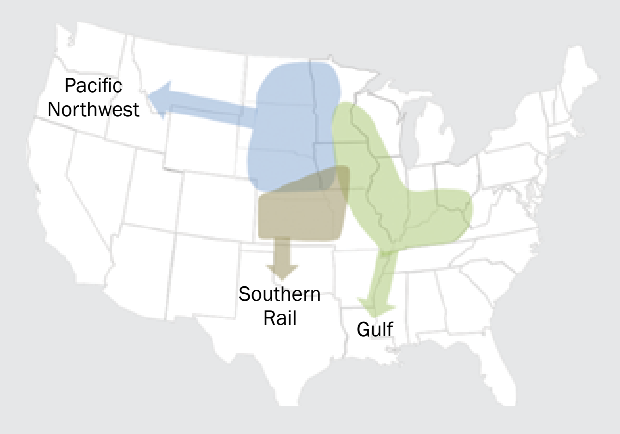
The sample test results for the grade factors, moisture, chemical composition and physical factors were summarized as the U.S. Aggregate and also by three composite groups that supply corn to each of three major export channels, labeled Export Catchment Areas (ECAs), as follows:

- The Gulf ECA consists of areas that typically export corn through the U.S. Gulf ports;
- The Pacific Northwest (PNW) ECA includes areas that export corn through Pacific Northwest and California ports; and
- The Southern Rail ECA comprises areas generally exporting corn to Mexico by rail from inland subterminals.

In analyzing the sample test results, the Council followed the standard statistical techniques employed for proportionate stratified sampling, including ***weighted averages*** and ***standard deviations***. In addition to the weighted averages and standard deviations for the U.S. Aggregate, weighted averages and standard deviations were estimated for the composite ECAs. The geographic areas from which exports flow to each of these ECAs overlap due to available transportation modes. Therefore, composite statistics for each ECA were calculated based on estimated proportions of grain flowing to each ECA. As a result, corn samples could be reported in more than one ECA. These estimations were based on industry input, export data and evaluation of studies of grain flow in the United States.

The *2017/2018 Harvest Report* contains a simple average of the quality factors' averages and standard deviations of the previous five *Harvest Reports (2012/2013, 2013/2014, 2014/2015, 2015/2016 and 2016/2017)*. These simple averages are calculated for the U.S. Aggregate and each of the three ECAs and are referred to as "5YA" in the text and summary tables of the report.

EXPORT CATCHMENT AREAS



The Relative ME was calculated for each of the quality factors for the U.S. Aggregate and each of the ECAs. The Relative ME was less than ±10% for all the quality attributes, except for stress cracks and SCI, for the U.S. Aggregate and the Gulf, Pacific Northwest and Southern Rail ECAs. The Relative MEs for stress cracks and SCI are shown in the table below.

	Relative ME	
	Stress Cracks	SCI
U.S. Aggregate	11%	13%
Gulf ECA	12%	14%
Pacific Northwest ECA	15%	18%
Southern Rail ECA	15%	18%

While the lower level of precision for these quality factors is less than desired, these levels of Relative ME do not invalidate the estimates. A footnote in the summary table for "Physical Factors" indicates the attributes for which the Relative ME exceeds ±10%.

References in the "Quality Test Results" section to statistical and/or significant differences between results in the *2016/2017 Harvest Report* and the *2017/2018 Harvest Report*, and in the *2015/2016 Harvest Report* and the *2017/2018 Harvest Report*, were validated by two-tailed t-tests at the 95% confidence level.

The *2017/2018 Corn Harvest Quality Report* samples (each about 2200 grams) were sent directly from the local grain elevators to the Illinois Crop Improvement Association's Identity Preserved Grain Laboratory (IPG Lab) in Champaign, Illinois. Upon arrival, the samples were dried, if needed, to a suitable moisture content to prevent any subsequent deterioration during the testing period. Next, the samples were split into two 1100-gram subsamples using a Boerner divider, while keeping the attributes of the grain sample evenly distributed between the two subsamples. One subsample was delivered to the Champaign-Danville Grain Inspection (CDGI), Urbana, Illinois, for grading. CDGI is the official grain inspection service provider for east-central Illinois as designated by U.S. Department of Agriculture (USDA) Federal Grain Inspection Service (FGIS). The grade testing procedures were in accordance with FGIS's *Grain Inspection Handbook* and are described in the following section. The other subsample was analyzed at IPG Lab for the chemical composition and other physical factors, following either industry norms or well-established procedures in practice for many years. IPG Lab has received accreditation under the ISO/IEC 17025:2005 International Standard for many of the tests. The full scope of accreditation is available at *http://www.ilcrop.com/labservices*.

A. GRADE FACTORS

Test Weight

Test weight is a measure of the volume of grain that is required to fill a Winchester bushel (2,150.42 cubic inches) to capacity. Test weight is a part of the FGIS Official U.S. Standards for Corn grading criteria.

The test involves filling a test cup of known volume through a funnel held at a specific height above the test cup to the point where grain begins to pour over the sides of the test cup. A strike-off stick is used to level the grain in the test cup, and the grain remaining in the cup is weighed. The weight is then converted to and reported in the traditional U.S. unit, pounds per bushel (lb/bu).

Broken Corn and Foreign Material (BCFM)

Broken corn and foreign material (BCFM) is part of the FGIS Official U.S. Standards for Grain and grading criteria.

The BCFM test determines the amount of all matter that passes through a 12/64th-inch round-hole sieve and all matter other than corn that remains on the top of the sieve. BCFM measurement can be separated into broken corn and foreign material. Broken corn is defined as all material passing through a 12/64th-inch round-hole sieve and retained on a 6/64th-inch round-hole sieve. Foreign material is defined as all material passing through the 6/64th-inch round-hole sieve and the coarse non-corn material retained on top of the 12/64th-inch round-hole sieve. BCFM is reported as a percentage of the initial sample by weight.

Total Damage/Heat Damage

Total damage is part of the FGIS Official U.S. Standards for Grain grading criteria.

A representative working sample of 250 grams of BCFM-free corn is visually examined by a trained and licensed inspector for content of damaged kernels. Types of damage include blue-eye mold, cob rot, dryer-damaged kernels (different from heat-damaged kernels), germ-damaged kernels, heat-damaged kernels, insect-bored kernels, mold-damaged kernels, mold-like substance, silk-cut kernels, surface mold (blight), mold (pink *Epicoccum*) and sprout-damaged kernels. Total damage is reported as the weight percentage of the working sample that is total damaged grain.

Heat damage is a subset of total damage and consists of kernels and pieces of corn kernels that are materially discolored and damaged by heat. Heat-damaged kernels are determined by a trained and licensed inspector visually inspecting a 250-gram sample of BCFM-free corn. Heat damage, if found, is reported separately from total damage.

B. MOISTURE

The moisture recorded by the elevators' electronic moisture meters at the time of delivery is reported. Electronic moisture meters sense an electrical property of grains called the dielectric constant that varies with moisture. The dielectric constant rises as moisture content increases. Moisture is reported as a percent of total wet weight.

C. CHEMICAL COMPOSITION

NIR Proximate Analysis

The chemical composition (protein, oil and starch concentrations) of corn is measured using near-infrared (NIR) transmission spectroscopy. The technology uses unique interactions of specific wavelengths of light with each sample. It is calibrated to traditional chemistry methods, to predict the concentrations of oil, protein and starch in the sample. This procedure is nondestructive to the corn.

Chemical composition tests for protein, oil and starch were conducted using a 550- to 600-gram sample in a whole-kernel Foss Infratec 1241 Near-Infrared Transmittance (NIR) instrument. The NIR was calibrated to chemical tests, and the standard errors of predictions for protein, oil and starch were about 0.27%, 0.25% and 0.66%, respectively. Comparisons of the Foss Infratec 1229 used in *Harvest Reports* prior to 2016 to the Foss Infratec 1241 on 21 laboratory check samples showed the instruments averaged within 0.25%, 0.26% and 0.25% points of each other for protein, oil and starch, respectively. Results are reported on a dry basis percentage (percent of non-water material).

D. PHYSICAL FACTORS

100-Kernel Weight, Kernel Volume and Kernel True Density

The 100-kernel weight is determined from the average weight of two 100-kernel replicates using an analytical balance that measures to the nearest 0.1 mg. The averaged 100-kernel weight is reported in grams.

The kernel volume for each 100-kernel replicate is calculated using a helium pycnometer and is expressed in cubic centimeters (cm^3) per kernel. Kernel volumes usually range from 0.14 to 0.36 cm^3 per kernel for small and large kernels, respectively.

True density of each 100-kernel sample is calculated by dividing the mass (or weight) of the 100 externally sound kernels by the volume (displacement) of the same 100 kernels. The two replicate results are averaged. True density is reported in grams per cubic centimeter (g/cm^3). True densities typically range from 1.15 to 1.35 g/cm^3 at "as is" moisture contents of about 12 to 15%.

Stress Crack Analysis

Stress cracks are evaluated by using a backlit viewing board to accentuate the cracks. A sample of 100 intact kernels with no external damage is examined kernel by kernel. The light passes through the horneous or hard endosperm so the severity of the stress crack damage in each kernel can be evaluated. Kernels are sorted into four categories: (1) no cracks; (2) one crack; (3) two cracks; and (4) more than two cracks. Stress cracks, expressed as a percent, are all kernels containing one, two, or more than two cracks divided by 100 kernels. Lower levels of stress cracks are always better since higher levels of stress cracks lead to more breakage in handling. If stress cracks are present, singles are better than doubles or multiples. Some corn end users will specify by contract the acceptable level of cracks based on the intended use.

Stress crack index (SCI) is a weighted average of the stress cracks. This measurement indicates the severity of stress cracking. SCI is calculated as:

$$SCI = [SSC \times 1] + [DSC \times 3] + [MSC \times 5]$$

Where

- SSC is the percentage of kernels with only one crack;
- DSC is the percentage of kernels with exactly two cracks; and
- MSC is the percentage of kernels with more than two cracks.

The SCI can range from 0 to 500, with a high number indicating numerous multiple stress cracks in a sample, which is undesirable for most uses.

Whole Kernels

In the whole kernels test, 50 grams of cleaned (BCFM-free) corn are inspected kernel by kernel. Cracked, broken, or chipped grain, along with any kernels showing significant pericarp damage, are removed. The whole kernels are then weighed, and the result is reported as a percentage of the original 50-gram sample. Some companies perform the same test, but report the "cracked & broken" percentage. A whole kernels score of 97% equates to a cracked & broken rating of 3%.

Horneous (Hard) Endosperm

The horneous (or hard) endosperm test is performed by visually rating 20 externally sound kernels, placed germ facing up, on a backlit viewing board. Each kernel is rated for the estimated portion of the kernel's total endosperm that is horneous endosperm. Soft endosperm is opaque and will block light, while horneous endosperm is translucent. The rating is made from standard guidelines based on the degree to which the soft endosperm at the crown of the kernel extends down toward the germ. The average of horneous endosperm ratings for the 20 externally sound kernels is reported. Ratings of horneous endosperm are made on a scale of 70 to 100%, though most individual kernels fall in the 70 to 95% range.

E. MYCOTOXINS

Detection of mycotoxins in corn is complex. The fungi producing the mycotoxins often do not grow uniformly in a field or across a geographic area. As a result, the detection of any mycotoxin in corn, if present, is highly dependent upon the concentration and distribution of the mycotoxin among kernels in a lot of corn, whether a truck load, a storage bin, or a railcar.

The objective of the FGIS sampling process is to minimize underestimating or overestimating the true mycotoxin concentration, since accurate results are imperative for corn exports. However, the objective of the *2017/2018 Corn Harvest Quality Report* assessment of mycotoxins is only to report the frequency of occurrences of the mycotoxin in the current crop, and not to report specific levels of the mycotoxin in corn exports.

To report the frequency of occurrences of aflatoxins and deoxynivalenol (DON) for the *2017/2018 Corn Harvest Quality Report*, IPG Lab performed the mycotoxin testing using FGIS protocol and approved test kits. FGIS's protocol requires a minimum of a 908-gram (2-pound) sample from trucks to grind for aflatoxin testing and approximately a 200-gram sample to grind for DON testing. For this study, a 1000-gram laboratory sample was subdivided from the 2-kg survey sample of shelled kernels for the aflatoxin analysis. The 1-kg survey sample was ground in a Romer Model 2A mill so that 60-75% would pass a 20-mesh screen. From this well-mixed ground material, a 50-gram test portion was removed for each mycotoxin tested. EnviroLogix AQ 109 BG and AQ 254 BG quantitative test kits were used for the aflatoxin and DON analysis, respectively. The DON was extracted with water (5:1), while the aflatoxins were extracted with 50% ethanol (2:1). The extracts were tested using the Envirologix QuickTox lateral flow strips, and the mycotoxins were quantified by the QuickScan system.

The EnviroLogix quantitative test kits report specific concentration levels of the mycotoxin if the concentration level exceeds a specific level called a "Limit of Detection" (LOD). The LOD is defined as the lowest concentration level that can be measured with an analytical method that is statistically different from measuring an analytical blank (absence of a mycotoxin). The LOD will vary among different types of mycotoxins, test kits and commodity combinations. The LODs for the EnviroLogix AQ 109 BG and AQ 254 BG are 2.5 parts per billion (ppb) for aflatoxins and 0.3 parts per million (ppm) for DON.

A letter of performance has been issued by FGIS for the quantification of aflatoxins and DON using the Envirologix AQ 109 BG and AQ 254 BG kits, respectively.

U.S. CORN GRADES AND GRADE REQUIREMENTS

		Maximum Limits of		
		Damaged Kernels		
Grade	Minimum Test Weight per Bushel (Pounds)	Heat Damaged (Percent)	Total (Percent)	Broken Corn and Foreign Material (Percent)
U.S. No. 1	56.0	0.1	3.0	2.0
U.S. No. 2	54.0	0.2	5.0	3.0
U.S. No. 3	52.0	0.5	7.0	4.0
U.S. No. 4	49.0	1.0	10.0	5.0
U.S. No. 5	46.0	3.0	15.0	7.0

U.S. Sample Grade is corn that: (a) Does not meet the requirements for the grades U.S. Nos. 1, 2, 3, 4, or 5; or (b) Contains stones with an aggregate weight in excess of 0.1 percent of the sample weight, 2 or more pieces of glass, 3 or more crotalaria seeds (*Crotalaria spp.*), 2 or more castor beans (*Ricinus communis L.*), 4 or more particles of an unknown foreign substance(s) or a commonly recognized harmful or toxic substance(s), 8 or more cockleburs (*Xanthium spp.*), or similar seeds singly or in combination, or animal filth in excess of 0.20 percent in 1,000 grams; or (c) Has a musty, sour, or commercially objectionable foreign odor; or (d) Is heating or otherwise of distinctly low quality.

Source: Code of Federal Regulations, Title 7, Part 810, Subpart D, United States Standards for Corn

U.S. AND METRIC CONVERSIONS

Corn Equivalents		Metric Equivalents	
1 bushel =	56 pounds (25.40 kilograms)	1 pound =	0.4536 kg
39.368 bushels =	1 metric ton	1 hundredweight =	100 pounds or 45.36 kg
15.93 bushels/acre =	1 metric ton/hectare	1 metric ton =	2204.6 lbs
1 bushel/acre =	62.77 kilograms/hectare	1 metric ton =	1000 kg
1 bushel/acre =	0.6277 quintals/hectare	1 metric ton =	10 quintals
56 lbs/bushel =	72.08 kg/hectoliter	1 quintal =	100 kg
		1 hectare =	2.47 acres

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