U.S. Grains Council
Corn Export Cargo Quality Report
2011/2012

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 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. Lowell Hill, Marvin Paulsen, and Tom Whitaker. The Illinois Crop Improvement Association's Identity Preserved Grain Laboratory (IPGL) and Champaign-Danville Grain Inspection (CDGI) conducted analysis of the collected corn samples.

In particular, we acknowledge the irreplaceable services of the Federal Grain Inspection Service (FGIS) of the U.S. Department of Agriculture's Grain Inspection, Packers and Stockyards Administration. FGIS provided samples from export cargoes along with their grading and aflatoxin test results. The FGIS Office of International Affairs coordinated the sampling process. FGIS field staff and the Washington State Department of Agriculture collected and submitted the samples that constitute the foundation of this report. We are grateful for the time they devoted during their busy season.

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Greetings From The Council

The U.S. Grains Council is pleased to present the *Corn Export Cargo Quality Report* for the 2011/12 marketing year as a service to foreign buyers and other interested parties.

The *Corn Export Cargo Quality Report* is an objective survey, taken at the point of loading for international shipment, of the quality of U.S. yellow commodity corn destined for export. This is the second of two new Council reports concerning the quality of the 2011 crop. Earlier this year the Council's *Corn Harvest Quality Report* surveyed corn quality at the farm gate. Together, these two reports are intended to provide reliable information on U.S. corn quality for the current marketing year, based on a transparent and consistent methodology.

In addition to providing an early look at grades and standards factors and moisture (that are reported each year by the U.S. Federal Grain Inspection Service), these reports provide information on additional quality characteristics that have not been reported previously.

Quality is a vital concern for every stakeholder in the corn value chain: seed companies, corn growers, traders, corn handlers, shippers, processors and end-users. The 2011/12 *Corn Harvest Quality* and the *Corn Export Cargo Quality* reports are the first in what will become an annual series. The Council anticipates that the value of these reports to all stakeholders will increase over time as stakeholders become familiar with the information presented and with the year-to-year variations to be anticipated in the U.S.corn marketing system.

The U.S. Grains Council is committed to continuous export expansion based upon the principles of mutual benefit and increased food security through trade. We strive to be a trusted partner and a bridge between U.S. producers and international buyers. Reliable and timely information is the foundation of these efforts. We trust that our international partners will find the *Corn Harvest Quality* and *Corn Export Cargo Quality* reports informative and useful, and we invite users to contact us with comments, criticisms, or questions. When trade works, the world wins.

Sincerely,

Wendell Shauman

Wendell Shauman, Chairman
U.S. Grains Council
May 2012

U.S. GRAINS COUNCIL

Report Highlights

Export Cargo Quality Highlights

Sampled lots of the 2011/2012 corn crop were in good condition as they were being assembled for loading onto ocean vessels for export. Uniformity of the quality attributes generally increased as the corn moved through the market channel. Notable quality attributes include:

- Grade factors (test weight, BCFM and total damage) on most sublot samples were at or better than the U.S. grade limits, and compared favorably to analysis of previous years in the USDA/GIPSA annual report.
- Test weight was above the grade limit for U.S. No. 1 corn in 95% of the samples, indicating clean, sound corn.
- BCFM increased as the crop moved through the market channel but was still below the maximum limit in each contract grade.
- Total damage increased during storage and transport, but still nearly 90% of the samples in all grades was below the grade limit for U.S. No. 2 corn.

Average moisture levels in both contract grades (U.S. No. 2 or better and U.S. No. 3 or better) were at safe storage levels for transport in ocean vessels, and uniformity among sublots increased relative to Harvest Report results. More than 75% were at or below 14.5% moisture.

Sample test results for additional quality factors in this report also were indicative of a good quality 2011 corn crop.

- Protein content was unchanged from Harvest Report levels, and at 8.7% (dry basis), was better than reported in recent years. It was highest in the Southern Rail ECA (9.1%).
- Starch content was slightly higher than Harvest Report samples, with 60% of the samples equal to or above 74% (dry basis).
- Oil content was 0.1 percentage point below the Harvest Report level, but still 23% of all samples had oil content of 3.75% or higher (dry basis).
- Low levels of stress cracks (10%) and relatively high whole kernels (87.5%) in the export samples indicate good potential for reduced breakage when corn is handled, improved wet milling starch recovery, improved dry milling yields of flaking grits, and good alkaline processing ability.
- Approximately 60% of export samples had horneous endosperm less than 85% indicating corn with desirable softness for the wet millers and feeders.
- All of the sublot samples tested below the FDA action level of 20 ppb for aflatoxins and the FDA advisory levels for DON (10 ppm for chicken and cattle, and 5ppm for hogs and other animals).

Survey Overview

The *U.S. Grains Council Corn Export Cargo Quality Report 2011/12* provides accurate, unbiased information about the quality of U.S. yellow commodity corn as it is assembled for export. This report provides the results of tests on corn samples collected during the U.S. government-licensed sampling and inspection process for U.S. corn waterborne export shipments. Corn quality information is important to foreign buyers as they make decisions about purchase contracts and processing needs for corn for feed, food or industrial use. This information is important also to all of the other stakeholders in the corn value chain: seed companies, corn producers, handlers, shippers, traders and processors.

The earlier *U.S. Grains Council Corn Harvest Quality Report 2011/12* measured the quality of the corn as it entered the U.S. marketing system. However, the condition of the corn changes as it passes through the U.S. marketing system, being commingled with corn from other locations, aggregated into trucks, barges and rail cars, stored, and loaded and unloaded several times. For this reason, the *Harvest Quality Report and the Export Cargo Quality Report* should be studied together in order to understand corn quality changes that take place from harvest to export. A review of how corn quality changes from the field to the ocean vessel is provided in the "Corn Export System" section.

As with the *Harvest Quality Report,* this report is the first of what is intended to be an annual survey of the quality of the U.S. corn exports early in the marketing year. These two reports include information on grades and standards factors and moisture which may be compared to the annual U.S. Grains Exports: Quality Report published by the Federal Grain Inspection Service (FGIS). Beyond that, these reports provide information on other important quality factors that have not been surveyed systematically in the past. Without the ability to compare the 2011/12 results with previous years, these reports should be interpreted with caution. However, this year's reports will establish a benchmark for comparison of subsequent corn exports early in theshipping season. (Corn from the 2011 harvest generally is shipped during the period of November through August.). As these reports are compiled over several years, the *Export Cargo Quality Report* will gain increased value for all stakeholders in the corn value chain – from seed to consumer -by enabling them to see patterns of corn quality based on growing, drying, handling, storage, and transport conditions across the years.

The results from this year's survey of corn exports from the 2011/12 crop show relatively good quality at the ports, with high test weight and low moisture. Uniformity increased as the corn moved through the market channel. Low stress cracks and total damage are indicative of corn cargoes that will perform well in terms of retaining quality during transit. Although we do not have comparable data for previous years, we consider this to be a good quality crop based on our years of experience in observing corn quality.

This *Export Cargo Quality Report* is based on 379 yellow commodity corn samples collected in key export areas. Samples were collected from corn export cargoes as they underwent the standard federal inspection and grading process performed by the U.S. Department of Agriculture's Grain Inspection, Packers and Stockyards Administration's (GIPSA) Federal Grain Inspection Service (FGIS). The objective of this report is to survey corn quality at export and to provide information about the variability of the quality characteristics within the key export areas.

Survey Overview

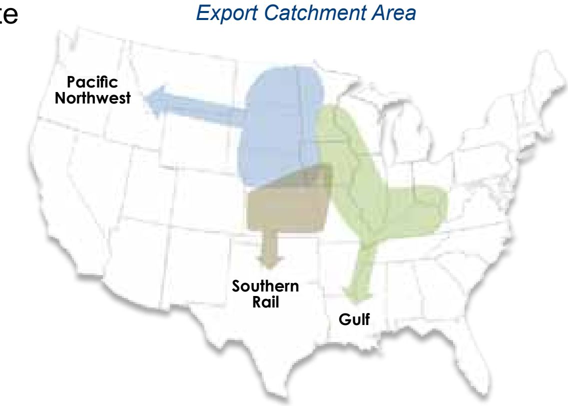
The sample test results are reported at the U.S. aggregate level (U.S. Aggregate). In addition, the key export ports are divided into three general groupings that we label Export Catchment Areas (ECAs). These three ECAs are identified by the three major pathways to export markets:

1. The Gulf ECA consisting of areas that typically export corn through U.S. Gulf ports,

2. The Pacific Northwest ECA that includes areas exporting corn through Pacific Northwest and California ports, and

3. The Southern Rail ECA consisting of areas generally exporting corn to Mexico.

Export Catchment Area



The sample test results are also summarized by "contract grade" categories. Since the limits on all official grade quality attributes (such as test weight and total damage) cannot always be met simultaneously, some factors may be better than the limit for a specified grade, but never worse. As a result, contracts are often written as "U.S. No. 2 or better," allowing some (or all) factors to be better than required by the grade specification while other factors are at or near the limit for that grade. The two contract grade categories reported in the Export Cargo Quality Report are:

- "U.S. No. 2" or "U.S. No. 2 or better" contracts specify the corn must at least meet U.S. No. 2 factor limits or be better than U.S. No. 2 factor limits. This category is designated as U.S. No. 2 o/b.

- "U.S. No. 3" or "U.S. No. 3 or better" contracts specify that the corn must at least meet U.S. No. 3 factor limits or be better than U.S. No. 3 factor limits. This category is referred to as U.S. No. 3 o/b.

For the Export Cargo Quality Report we collected 379 samples from corn shipments during January through March 2012 to generate statistically valid results for the U.S. Aggregate and by ECA. Our objective was to obtain enough samples at the ECA level to estimate quality factor averages of the corn exports with a relative margin of error (Relative ME) less than ± 10%, a reasonable target for biological data such as these factors. Details of the statistical sampling and analysis methods are presented in the "Survey and Statistical Analysis Methods" section.

Limitations of this report. This report does not predict the actual quality of any cargo or lot of corn, and it is important for all players in the value chain to understand their own contract needs and obligations. This report does not explain the reasons for changes in quality factors from the Harvest Report to the Export Cargo report. Many factors including weather, genetics, and grain handling affect changes in quality in complex ways. Sample test results can vary significantly depending on the ways in which a lot of corn was loaded onto a conveyance and the method of sampling used. The sampling method used by FGIS is explained in the section beginning on page 27. Different sampling methods can yield different testing results. The FGIS sampling method provides a truly representative sample, while other commonly used methods may yield non-representative samples of a lot due to the uneven distribution of corn in a truck or in the hold of a vessel.

U.S. Grains Council Corn Export Cargo Quality Report 2011/12 Project Team

Corn Quality Overview
(2011/12 Export Cargo)

U.S. GRAINS COUNCIL

Grade Factors and Moisture

The USDA's Federal Grain Inspection Service (FGIS) has established numerical grades, definitions and standards for measurement of many quality factors. The attributes which determine the numerical grades are test weight, broken corn and foreign material (BCFM), total damage, and heat damage. The table, "U.S. Official Corn Grades and Grade Requirements" corn grades and grade requirements areis provided summarized in the "Grade Requirements and Conversions" section of this report. U.S. law requires that these official grades and grade requirements be reviewed every four years, with inputs welcomed from all stakeholders.

Moisture content is reported on official grade certificates, but does not determine which numerical grade will be assigned to the sample.

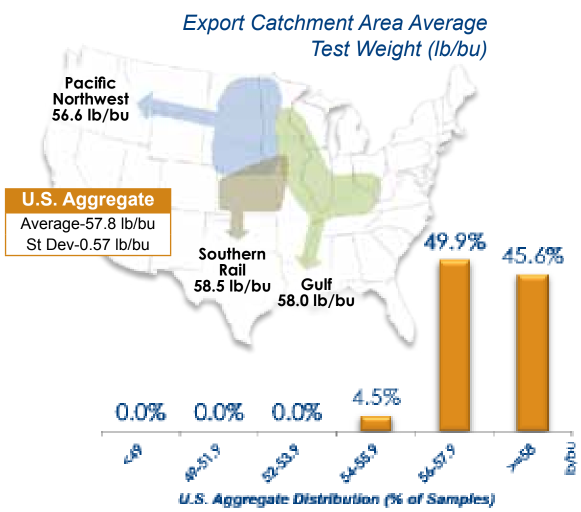
Test Weight

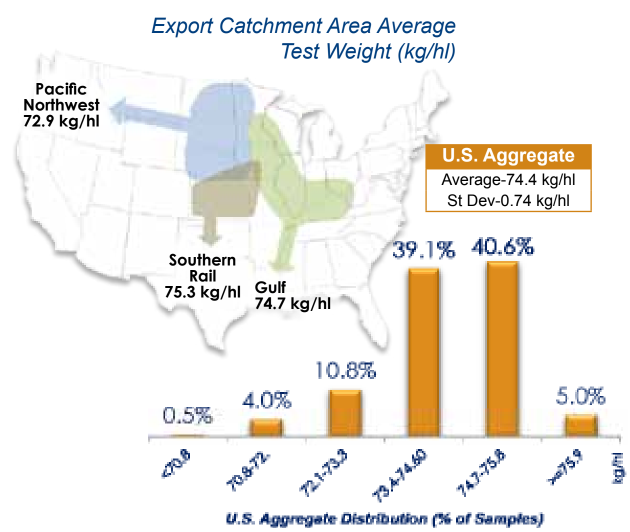
Test weight (weight per volume) is a measure of bulk density and is often used as a general indicator of overall quality and as a gauge of endosperm hardness to alkaline cookers and dry millers. It is highly correlated with true density and reflects kernel hardness and kernel maturity. Test weight is 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. High test weight at the port generally indicates high quality, high percent of horneous (or hard) endosperm and sound, clean corn. In addition, high test weight corn will allow for a greater quantity of corn for a given volume of space in the hold than the same weight of corn with a lower test weight.

Highlights

- The U.S. Aggregate average test weight of 57.8 lb/bu (74.4 kg/hl) indicates overall good quality and is nearly 2 lb/bu above the grade limit for U.S. No. 1 corn (56 lb).
- U.S. Aggregate test weight of Export Report samples was lower than test weight Harvest Report samples.
- As corn is commingled moving through the marketing channel, test weight becomes more uniform with lower standard deviation and smaller range between maximum and minimum values.
- Over 95% of all samples' test weights were at or above the minimum for U.S. No. 1 grade, and 100% were above the limit for U.S. No. 2 grade.
- The Southern Rail ECA had higher average test weight. This may be partly because all Southern Rail samples were loaded as U.S. No. 2 o/b.
- Differences in test weight among sublots loaded as U.S. No. 2 o/b and as U.S. No. 3 o/b were small since all average values were above U.S. No. 2 grade.

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





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. As corn moves through the market channel, each impact of the grain during handling, and transporting increases the amount of broken corn. As a result, the average BCFM in most shipments of corn will be higher at the port than at the country elevator level.

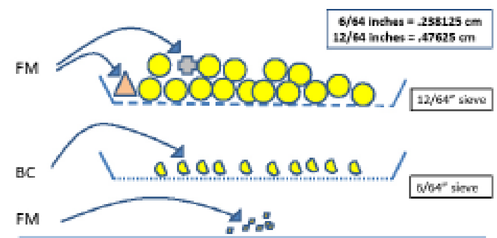
U.S. Grade BCFM Maximum Limits
No. 1: 2.0%
No. 2: 3.0%
No. 3: 4.0%

Broken corn (BC) is defined as corn and corn material 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 pieces too large to pass through a 12/64th inch sieve, as well as all fine material small enough to pass through a 6/64th inch sieve.

The diagram to the right illustrates the measurement of broken corn and foreign material for the U.S. corn grading standards.

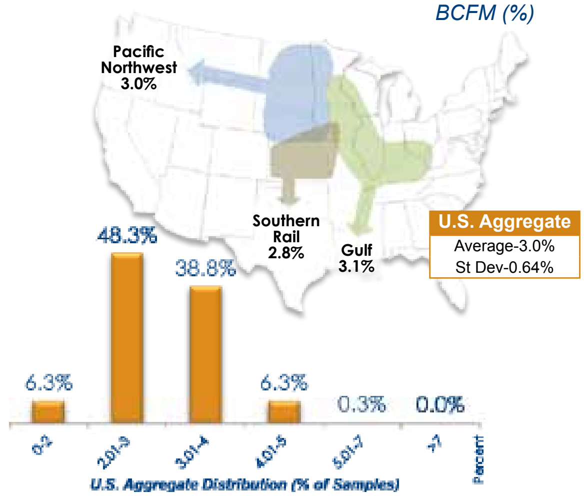
BCFM (Measured as Percent by Weight)



Highlights

- The increase in BCFM between the Harvest Report (1.0%) and Export Cargo Report (3.0%) is typically influenced by increased breakage during drying and handling.
- Corn arriving at the export point was cleaned and commingled to meet the grade limits.
- BCFM at export was significantly lower in the Southern Rail ECA possibly due to the fact that Southern Rail loaded only U.S. No. 2 o/b.
- U.S. Aggregate BCFM in each grade was below the limits for the respective contract grade (2.7% on U.S. No. 2 o/b and 3.4% on U.S. No. 3 o/b).
- The BCFM from samples in U.S. No. 2 o/b were significantly lower than for U.S. No. 3 o/b as required in the grade limits.

Export Catchment Area Average BCFM (%)



Corn Quality Overview (2011/12 Export Cargo)

Total Damage

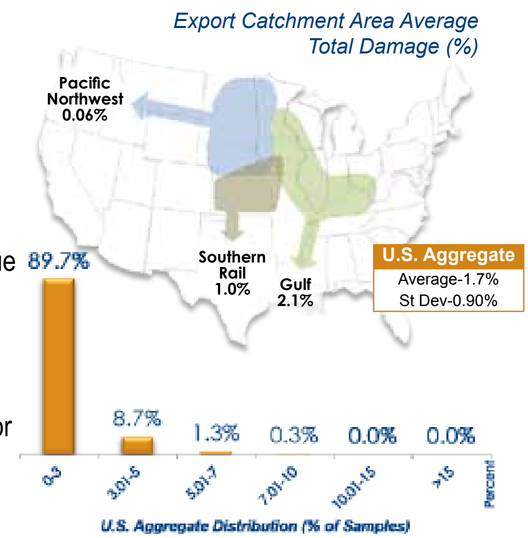
Total damage is the percentage of kernels and pieces of kernels that are visually damaged in some way, including damage from heat, frost, insect, sprout, disease, weather, ground, germ, and mold. Most of these types of damage result in some sort of discoloration or change in kernel texture. Damage does not include broken pieces of grain that are otherwise normal in appearance. Mold damage and the associated potential for mycotoxins is the damage factor of greatest concern. Mold damage is usually associated with higher moisture content and high temperature during growing and/or storage conditions.

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

Corn with low levels of total damage is more likely to arrive at destination in good condition than corn with high levels of total damage. High levels of total damage have the potential of increasing moisture and microbiological activity during transport.

Highlights

- The average levels for total damage increased slightly between the farm Harvest samples (1.1%) and eExport Cargo samples (1.7%) – a good record for over-winter storage.
- 89.7% of the export samples had 3% or less damaged kernels – well below the limit for U.S. No.3 (5%).
- Increased total damage at export was greatest in the Gulf ECA most likely due to higher moisture corn at harvest going into storage.
- U.S. Aggregate total damage was below the limits for each contract grade (1.6% for U.S. No 2 o/b and 1.9% on U.S. No. 3 o/b).
- Total damage from samples in U.S. No. 2 o/b were significantly lower than for U.S. No. 3 o/b as required in the grade limits.



Heat Damage

Heat damage is a subset of total damage in corn grades 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. Low levels of heat damage may indicate the corn has been stored at appropriate moisture and temperatures prior to delivery to the port.

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

Highlights

- There was almost no heat damage reported in any of the samples, indicating good management of the crop during storage.

Corn Quality Overview (2011/12 Export Cargo)

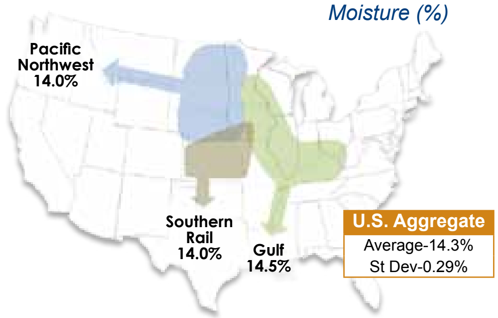
Moisture

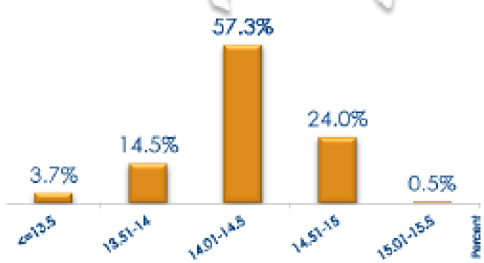
Moisture content affects the amount of dry matter being sold and purchased. In addition, the average moisture level and variability in a shipment of corn affect its quality arriving at destination. Corn is typically stored in closed, nearly airtight holds during the ocean voyage, and few bulk carriers have the ability to aerate the grain mass during transit. This lack of aeration can create an ideal environment for pockets of high moisture to initiate microbiological activity. In addition, temperature variations in the grain mass can cause moisture migration, resulting in warm moist air condensing on colder surfaces of grain, near sidewalls, or on the underside of hatch covers, which can lead to development of spoilage or hot spots. Thus, uniformity of moisture content among sublots and average moisture values below 14.5% are important for minimizing the risk of “hot spots” developing during transit. “Hot spots” are small pockets of corn where the moisture content and temperature become abnormally higher than the average for the cargo.

Highlights

- U.S. Aggregate moisture content decreased between Harvest (15.6%) and Export Cargo samples (14.3%) due mainly to drying and conditioning in the market channel following harvest deliveries.
- Moisture content variability among samples decreased as the corn moved through the market channel with a tighter range and lower variability. This was a result of drying and management to meet the export contract specifications.
- More than 75.5% of the samples had moisture at 14.5% or below, which indicates most cargoes will transport with little microbiological activity.
- Average moisture content was highest at the Gulf ports most likely as a result of higher moisture contents at harvest in that ECA.
- Moisture was slightly lower in the Pacific Northwest and Southern Rail ECAs, probably as a result of drier conditions during harvest.
- Moisture is specified in the contract by the buyer, and as a result, differences in moisture content among grades was less than 0.5 percentage points (ranging from 14.0 to 14.4%), still below safe transit levels especially during colder temperatures.

Export Catchment Area Average Moisture (%)





U.S. Aggregate Distribution (% of Samples)

Corn Quality Overview (2011/12 Export Cargo)

U.S. GRAINS COUNCIL

Grade Factors and Moisture Summary

Highlights

- Quality of the corn at export was good, with average values generally better than grade limits and contract specifications. In addition, Export Cargo Report sample quality was more uniform than the Harvest Report samples.
- Test weight was high with U.S. Aggregate samples averaging 57.8 lb/bu (74.4 kg/hl).
- Average BCFM at export was below the limits for the respective grades.
- Average total damage and heat damage were well below the limits for the grade being loaded.
- Moisture contents were lowered in the market channel to meet the contract specifications and were generally at levels for safe transit.

Grade Factors and Moisture Summary

	EXPORT CARGO Quality Report					HARVEST Quality Report				
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate										
Test Weight (lb/bu)	379	57.8	0.57	54.4	59.9	474	58.1	1.49	46.0	62.1
Test Weight (kg/hl)	379	74.4	0.74	70.0	77.1	474	74.8	1.92	59.2	79.9
BCFM (%)	379	3.0	0.64	0.9	5.2	474	1.0	0.65	0.0	12.1
Total Damage (%)	379	1.7	0.90	0.0	7.1	474	1.1	0.92	0.0	12.0
Heat Damage (%)	379	0.0	0.02	0.0	0.2	474	0.0	0.00	0.0	0.0
Moisture (%)	379	14.3	0.29	13.1	15.4	474	15.6	1.56	9.5	22.0
Gulf										
Test Weight (lb/bu)	261	58.0	0.51	56.6	59.9	364	58.3	1.48	46.0	62.1
Test Weight (kg/hl)	261	74.7	0.65	72.9	77.1	364	75.0	1.91	59.2	79.9
BCFM (%)	261	3.1	0.71	0.9	5.2	364	0.9	0.62	0.0	12.1
Total Damage (%)	261	2.1	1.08	0.0	7.1	364	1.3	1.09	0.0	12.0
Heat Damage (%)	261	0.0	0.02	0.0	0.2	364	0.0	0.00	0.0	0.0
Moisture (%)	261	14.5	0.26	13.7	15.4	364	16.0	1.67	9.5	22.0
Pacific Northwest										
Test Weight (lb/bu)	83	56.6	0.82	54.4	58.2	182	57.3	1.57	50.7	61.7
Test Weight (kg/hl)	83	72.9	1.05	70.0	74.9	182	73.7	2.03	65.3	79.4
BCFM (%)	83	3.0	0.57	1.2	4.2	182	1.1	0.75	0.1	4.6
Total Damage (%)[1]	83	0.6	0.54	0.0	2.9	182	0.6	0.36	0.0	5.3
Heat Damage (%)	83	0.0	0.01	0.0	0.1	182	0.0	0.00	0.0	0.0
Moisture (%)	83	14.0	0.31	13.2	14.7	182	14.7	1.28	11.7	19.6
Southern Rail										
Test Weight (lb/bu)	35	58.5	0.50	57.5	59.6	149	58.5	1.39	46.0	61.7
Test Weight (kg/hl)	35	75.3	0.65	74.0	76.7	149	75.3	1.79	59.2	79.4
BCFM (%)	35	2.8	0.30	1.8	3.3	149	1.1	0.67	0.0	12.1
Total Damage (%)[1]	35	1.0	0.50	0.5	2.9	149	1.3	0.90	0.0	5.6
Heat Damage (%)	35	0.0	0.04	0.0	0.2	149	0.0	0.00	0.0	0.0
Moisture (%)	35	14.0	0.44	13.1	14.7	149	14.9	1.42	9.5	20.2

[1] The Relative ME for predicting the Export Cargo population average exceeded ± 10%.

Corn Quality Overview (2011/12 Export Cargo)

Grade Factors and Moisture Summary

	Samples for Contracts Loaded as U.S. No. 2 o/b					Samples for Contracts Loaded as U.S. No. 3 o/b				
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate										
Test Weight (lb/bu)	188	57.8	0.51	55.5	59.6	188	57.7	0.57	54.4	59.5
Test Weight (kg/hl)	188	74.4	0.66	71.4	76.7	188	74.3	0.74	70.0	76.6
BCFM (%)	188	2.7	0.39	1.1	3.6	188	3.4	0.70	0.9	5.2
Total Damage (%)	188	1.6	0.65	0.0	4.9	188	1.9	1.11	0.1	7.1
Heat Damage (%)	188	0.0	0.00	0.0	0.2	188	0.0	0.02	0.0	0.2
Moisture (%)	188	14.3	0.23	13.1	15.0	188	14.4	0.30	13.2	15.4
Gulf										
Test Weight (lb/bu)	122	57.9	0.48	56.9	59.4	136	58.1	0.48	56.6	59.5
Test Weight (kg/hl)	122	74.5	0.62	73.2	76.5	136	74.8	0.62	72.9	76.6
BCFM (%)	122	2.7	0.41	1.1	3.6	136	3.5	0.73	0.9	5.2
Total Damage (%)	122	2.0	0.79	0.0	4.9	136	2.3	1.26	0.5	7.1
Heat Damage (%)	122	0.0	0.00	0.0	0.0	136	0.0	0.03	0.0	0.2
Moisture (%)	122	14.4	0.19	13.9	15.0	136	14.5	0.29	13.7	15.4
Pacific Northwest										
Test Weight (lb/bu)	31	56.9	0.63	55.5	58.0	52	56.4	0.87	54.4	58.2
Test Weight (kg/hl)	31	73.3	0.81	71.4	74.7	52	72.6	1.12	70.0	74.9
BCFM (%)	31	2.7	0.35	1.8	3.2	52	3.2	0.61	1.2	4.2
Total Damage (%)	31	0.5	0.30	0.0	1.3	52	0.7	0.63	0.1	2.9
Heat Damage (%)	31	0.0	0.00	0.0	0.0	52	0.0	0.01	0.0	0.1
Moisture (%)	31	14.0	0.24	13.5	14.5	52	14.0	0.34	13.2	14.7
Southern Rail										
Test Weight (lb/bu)	35	58.5	0.50	57.5	59.6	0	0.0	0.00	0.0	0.0
Test Weight (kg/hl)	35	75.3	0.65	74.0	76.7	0	0.0	0.00	0.0	0.0
BCFM (%)	35	2.8	0.30	1.8	3.3	0	0.0	0.00	0.0	0.0
Total Damage (%)	35	1.0	0.50	0.5	2.9	0	0.0	0.00	0.0	0.0
Heat Damage (%)	35	0.0	0.04	0.0	0.2	0	0.0	0.00	0.0	0.0
Moisture (%)	35	14.0	0.44	13.1	14.7	0	0.0	0.00	0.0	0.0

Corn Quality Overview
(2011/12 Export Cargo)

U.S. GRAINS COUNCIL

Chemical Composition

Chemical composition of corn is important because the components of protein, starch and oil are of significant interest to the industry. The chemical composition attributes are not grade factors. However, they 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 were not expected to change significantly during storage or transport.

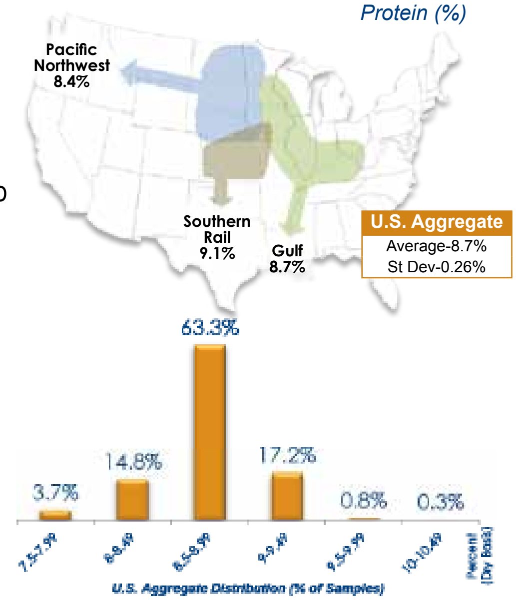
Protein

Protein is very important for poultry and livestock feeding. It helps with feeding efficiency and supplies essential sulfur-containing amino acids. Protein is usually inversely related to starch content. Results are reported on a dry basis.

Highlights

- The U.S. Aggregate protein was unchanged between Harvest and Export Cargo (8.7%) samples from the 2011 corn crop.
- U.S. Aggregate protein content at export was more uniform than at the Harvest Report level, with a tighter range from 7.6% to 10.0% and a smaller standard deviation of 0.26%.
- U. S. Aggregate protein was distributed with 63.3% between 8.5% and 8.99% and 18.3% above 9.0%.
- Protein averages were significantly different for the Gulf, Pacific Northwest, and Southern Rail ECAs – 8.7%, 8.4%, and 9.1%, respectively. The Southern Rail ECA had the highest average protein in the Harvest Report also.
- Protein percentages found for contracts loaded as U.S. No. 2 o/b or U.S. No. 3 o/b were both 8.7%.

Export Catchment Area Average Protein (%)



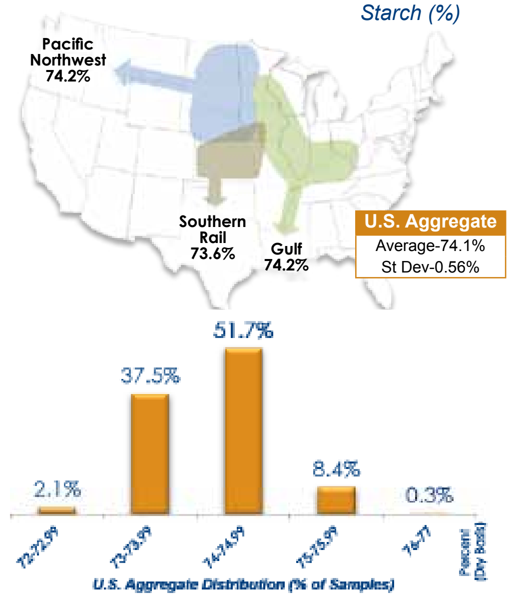
Starch

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

Highlights

- The U.S. Aggregate starch averaged 74.1% in the Export Cargo Report, slightly higher than at the Harvest Report level.
- U.S. Aggregate starch at export ranged from 72.8 to 76.2% and had a standard deviation of 0.56%. This was a slightly tighter range and smaller standard deviation than for the Harvest Report samples, indicating more uniformity.
- Of all the samples, 60.4% had a starch content equal to or above 74%.
- The starch averages for the Gulf, Pacific Northwest, and Southern Rail ECAs were 74.2%, 74.2% and 73.6%, respectively, with no significant difference in starch content between the Gulf and Pacific Northwest ECAs.
- Virtually no difference was found in starch percentages between contracts loaded as U.S. No. 2 o/b (74.1%) and contracts loaded as U.S. No. 3 o/b (74.2%).

Export Catchment Area Average Starch (%)



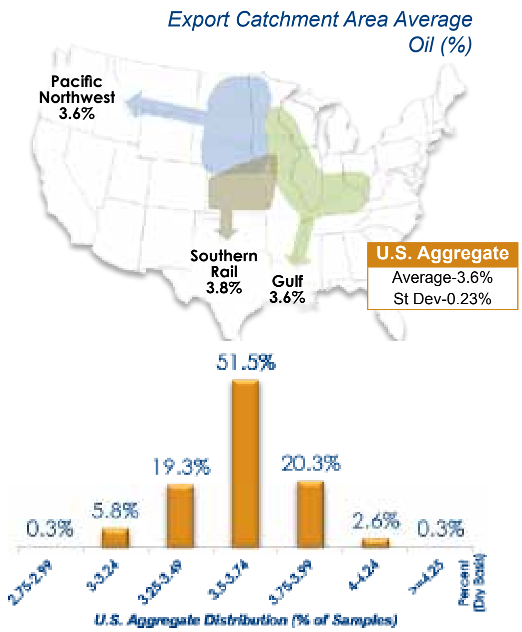
Corn Quality Overview (2011/12 Export Cargo)

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 by-product of corn wet and dry milling. Results are reported on a dry basis.

Highlights

- U.S. Aggregate oil averaged 3.6% at the export level, lower than the 3.7% found in the Harvest Report samples.
- Export samples' oil content was more uniform than in the Harvest Report with values ranging from 2.9 to 5.0% and a standard deviation of 0.23%.
- U.S. Aggregate oil was distributed with 51.5% of the sample results falling between 3.5% and 3.74%, and 23.2% of the samples at 3.75% or higher.
- Oil averages for the Gulf, Pacific Northwest, and Southern Rail ECAs were 3.6%, 3.6% and 3.8%, respectively.
- The average oil content for contracts loaded as U.S. No. 2 o/b was slightly higher than for contracts loaded as U.S. No. 3 o/b (3.62% versus 3.57% respectively, when shown to the 100th decimal place).



CORN QUALITY OVERVIEW
(2011/12 EXPORT CARGO)

U.S. GRAINS COUNCIL

CHEMICAL COMPOSITION SUMMARY

HIGHLIGHTS

- U.S. Aggregate protein averaged 8.7% in both the Export and Harvest samples, but protein in the Export Cargo samples was more uniform than in the Harvest Report.
- Corn protein averages for the Gulf, Pacific Northwest, and Southern Rail ECAs were significantly different at 8.7%, 8.4%, and 9.1%, respectively.
- U.S. Aggregate starch averaged 74.1% in the Export Report, compared to 73.4% in the Harvest Report. Starch was 74.2% for Gulf and Pacific Northwest ECA's but lower (73.6%) for Southern Rail ECA.
- U.S. Aggregate export oil content (3.6%) was notably lower from 3.7% found in the Harvest Report and significantly higher in the Southern Rail ECA than in the Gulf and Pacific Northwest ECAs.
- Protein, starch and oil did not vary between contracts loaded as U.S. No. 2 o/b and as U.S. No. 3 o/b.

Chemical Composition Summary

	EXPORT CARGO Quality Report					HARVEST Quality Report				
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate										
Protein (Dry Basis %)	379	8.7	0.26	7.6	10.0	474	8.7	0.60	6.7	12.5
Starch (Dry Basis %)	379	74.1	0.56	72.8	76.2	474	73.4	0.62	71.5	75.4
Oil (Dry Basis %)	379	3.6	0.23	2.9	5.0	474	3.7	0.31	2.0	5.0
Gulf										
Protein (Dry Basis %)	261	8.7	0.21	8.0	9.4	364	8.7	0.63	6.7	12.5
Starch (Dry Basis %)	261	74.2	0.56	72.8	76.2	364	73.5	0.64	71.5	75.4
Oil (Dry Basis %)	261	3.6	0.24	2.9	5.0	364	3.7	0.32	2.0	5.0
Pacific Northwest										
Protein (Dry Basis %)	83	8.4	0.42	7.6	9.5	182	8.5	0.52	6.7	11.0
Starch (Dry Basis %)	83	74.2	0.61	72.9	75.6	182	73.6	0.56	71.6	75.4
Oil (Dry Basis %)	83	3.6	0.19	3.1	4.0	182	3.6	0.26	2.8	4.7
Southern Rail										
Protein (Dry Basis %)	35	9.1	0.29	8.8	10.0	149	9.1	0.62	6.7	12.5
Starch (Dry Basis %)	35	73.6	0.45	72.8	74.8	149	73.1	0.65	71.5	74.6
Oil (Dry Basis %)	35	3.8	0.24	3.2	4.2	149	3.7	0.33	2.0	5.0

Corn Quality Overview (2011/12 Export Cargo)

U.S. GRAINS COUNCIL

Chemical Composition Summary

	Samples for Contracts Loaded as U.S. No. 2 o/b					Samples for Contracts Loaded as U.S. No. 3 o/b				
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate										
Protein (Dry Basis %)	188	8.7	0.23	7.6	10.0	188	8.7	0.27	7.7	9.5
Starch (Dry Basis %)	188	74.1	0.51	72.8	75.6	188	74.2	0.60	72.8	76.2
Oil (Dry Basis %)	188	3.6	0.23	3.1	5.0	188	3.6	0.22	2.9	4.1
Gulf										
Protein (Dry Basis %)	122	8.8	0.19	8.1	9.4	136	8.7	0.21	8.0	9.3
Starch (Dry Basis %)	122	74.1	0.53	72.8	75.4	136	74.2	0.59	72.8	76.2
Oil (Dry Basis %)	122	3.6	0.25	3.1	5.0	136	3.6	0.23	2.9	4.1
Pacific Northwest										
Protein (Dry Basis %)	31	8.2	0.31	7.6	8.8	52	8.5	0.45	7.7	9.5
Starch (Dry Basis %)	31	74.5	0.46	73.6	75.6	52	74.1	0.65	72.9	75.4
Oil (Dry Basis %)	31	3.5	0.17	3.1	3.8	52	3.6	0.20	3.1	4.0
Southern Rail										
Protein (Dry Basis %)	35	9.1	0.29	8.8	10.0	0	0.0	0.00	0.0	0.0
Starch (Dry Basis %)	35	73.6	0.45	72.8	74.8	0	0.0	0.00	0.0	0.0
Oil (Dry Basis %)	35	3.8	0.24	3.2	4.2	0	0.0	0.00	0.0	0.0

PHYSICAL FACTORS

There are tests for other quality attributes that are not grading factors, or chemical factors. These tests provide additional information about the processability of corn for various uses, as well as its storability and potential for breakage in handling. The processability, storability and ability to withstand handling of corn are influenced by corn's morphology or parts. 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, but consists of soft (also referred to as floury or opaque) endosperm and of horneous (also called hard or vitreous) endosperm as shown to the right. The endosperm contains primarily starch and protein, the germ contains oil and some proteins, and the pericarp and tip cap are mostly fiber.

Illustration courtesy of K. D. Rausch University of Illinois

The following tests reflect these intrinsic parts of the corn kernels, in addition to the growing and handling conditions that affect corn quality.

STRESS CRACKS

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

The cause of stress cracks is pressure buildup due to large moisture gradients 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 horneous endosperm; therefore, corn with higher percentages of horneous endosperm is more susceptible to stress cracking than softer grain with lower percentages of horneous endosperm. A kernel may have one, two, or multiple cracks. High-temperature drying is the most common cause of stress cracks, but handling impacts can also increase stress cracks. The impact of high levels of stress cracks on various uses includes:

General *– Increased susceptibility to breakage during handling, leading to increased broken corn needing to be removed during cleaning operations for processors, and possible reduced grade/value. It also lowers germination.*

Wet Milling *– Lower starch yield because the starch and protein are more difficult to separate. 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 greatly affect the need for artificial drying and influence the degree of stress cracking found from region to region. Then, as corn moves through the market channel, some stress-cracked kernels break, increasing the proportion of broken corn. Concurrently, impacts of kernels on other kernels or metal during handling may cause cracks in new kernels. As a result of stress-cracked corn becoming broken corn and kernels with no previous stress cracks developing stress cracks during handling, the overall percentage of kernels with stress cracks may or may not remain constant through the merchandising channel. Whether or not the stress cracks levels remain constant depends on the severity of the impacts.

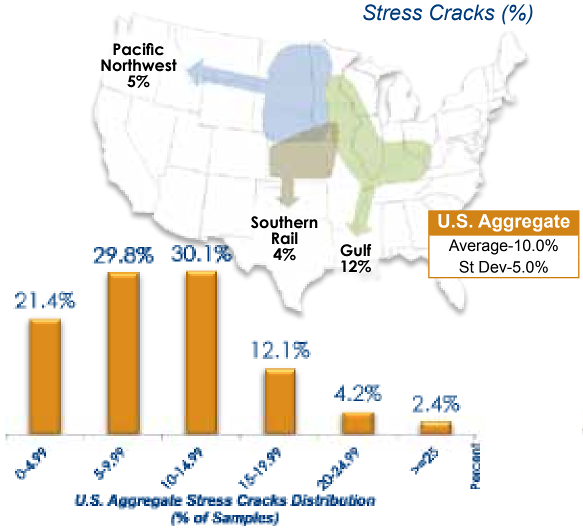
Corn Quality Overview (2011/12 Export Cargo)

Stress crack measurements include stress cracks (the percent 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 measure only the number of kernels with stress cracks whereas SCI shows the severity of cracking. For example, if half the kernels have only single stress cracks, stress cracks are 50% and the SCI is 50. However, if all the cracks are multiple stress cracks, indicating a higher potential for handling issues, stress cracks remain at 50% but the SCI becomes 250. Lower values for stress cracks and the SCI are always better. In years with high levels of stress cracks, the SCI is valuable 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.

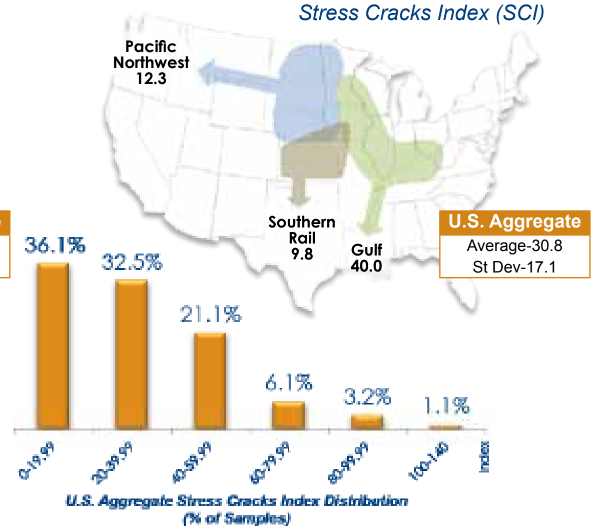
Highlights

- Stress cracks of exported U.S Aggregate corn was higher than int he Harvest samples (10% versus 3%), but still at a very low level.
- Stress cracks ranged from 0 to 33% with a standard deviation of 5.0%.
- Distribution of percentage of stress cracks showed 93.4% of the samples with less than 20% stress cracks at export. While this was lower than the 98.1% at harvest, it indicates the corn should still handle very well with relatively low amounts of breakage.
- The percent of stress cracks for the Gulf, Pacific Northwest and Southern Rail ECAs was low with 12%, 5%, and 4%, respectively. The Gulf ECA's average stress cracks were significantly higher than the other two ECAs.
- Stress crack percentages for contracts loaded as U.S. No. 2 o/b were 9.0%, slightly lower than the 11.0% found for contracts loaded as U.S. No. 3 o/b. Not surprisingly, contracts loaded as U.S. No. 2 o/b had BCFM (2.7%) which was slightly lower than the 3.4% BCFM found for contracts loaded as U.S. No. 3 o/b. Thus, contracts with higher BCFM also had slightly higher stress crack percentages.
- U.S. Aggregate SCI average of 30.8 at export was low, minimizing breakage during loading and discharge.
- In the Export Report, 68.6% of the samples had SCI of less than 40, indicating relatively few kernels had double or multiple stress cracks.
- The U.S. Aggregate SCI for contracts loaded as U.S. No. 2 o/b were 28.8, slightly lower than the 34.9 found for contracts loaded as U.S. No. 3 o/b.
- The relatively low levels of stress cracks observed for 2011 corn should indicate reduced rates of breakage when corn is loaded and discharged, improved wet milling starch recovery, improved dry milling yields of flaking grits, and good alkaline processability.

Export Catchment Area Average Stress Cracks (%)



Export Catchment Area Average Stress Cracks Index (SCI)



Corn Quality Overview (2011/12 Export Cargo)

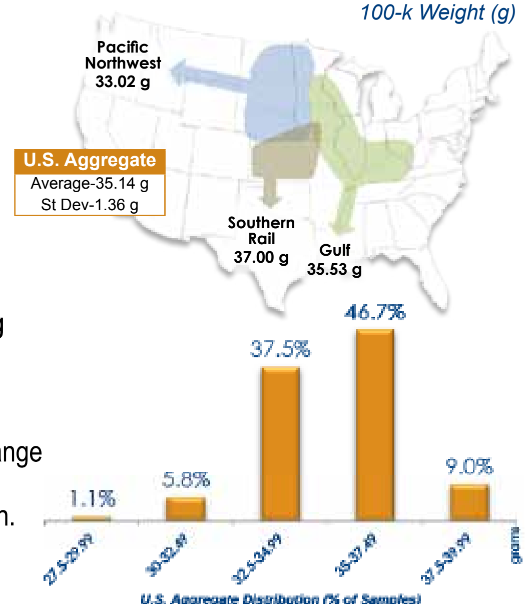
100-Kernel Weight, Kernel Volume and Kernel True Density

100-kernel (100-k) weight indicates larger kernel size as 100-k weights increase. Large kernels affect drying rates and large uniform-sized kernels often enable higher flaking grit yields in dry milling. Kernel weights tend to be higher for varieties with high amounts of horneous endosperm.

Kernel volume in 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 loss for processors and higher yields of fiber.

Kernel true density is calculated as the weight of a 100-k sample divided by the volume, or displacement, of those 100 kernels. True density is a relative indicator of kernel hardness, which is useful for alkaline processors and dry millers. True density, as a relative indicator of hardness, 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 it is also more at risk for the development of stress cracks if high-temperature drying is employed. True densities above 1.30 g/cm^3 would indicate very hard corn desirable for dry milling and alkaline processing. True densities near the 1.275 g/cm^3 level and below tend to be softer, but will process well for wet milling and feed use.

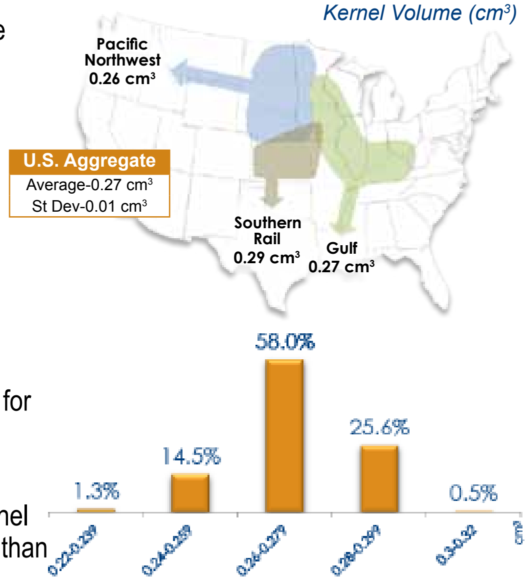
Export Catchment Area Average 100-k Weight (g)



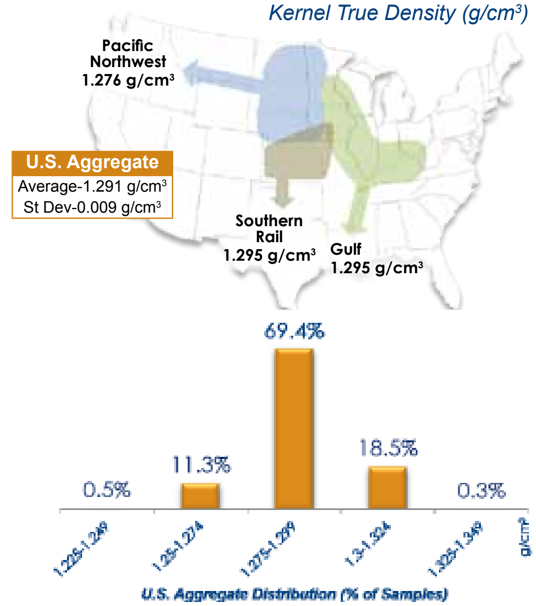
Highlights

- 100-k weight averaged 35.14 g for U.S. Aggregate Export corn sampleswith a range of 28.24 to 39.30 g. The Export Report samples had greater uniformity than the Harvest Report corn as indicated by a tighter range and lower standard deviation.
- The 100-k weights were lowest for the Pacific Northwest ECA.
- The 100-k weights were distributed such that 55.7% of the aggregate samples had 100-k weights of 35 g or greater.
- Kernel volume averaged 0.27 cm3 for U.S. Aggregate export corn samples and ranged from 0.22 to 0.30 cm3. The range and standard deviations were less in Export than with Harvest Report samples, therefore, showing more uniformity.
- The kernel volumes were smallest (0.26 cm3) for the Pacific Northwest ECA than for the other ECA's.
- About 84.1% of the U.S. Aggregate samples had kernel volumes equal to or greater than 0.26 cm3.

Export Catchment Area Average Kernel Volume (cm^3)



Export Catchment Area Average Kernel True Density (g/cm^3)



- Kernel true density averaged 1.291 g/cm3 for U.S. Aggregate Export Report corn samples and ranged from 1.244 to 1.327 g/cm3, slightly higher than for Harvest Report samples. This apparent increase in true density is likely due in part to lower moisture at export (14.3% as compared to the 15.6% aggregate average for harvest samples) and that true density tests were performed on only whole, fully intact kernels.
- For the export samples, 88.2% had kernel true density equal to or above 1.275 g/cm3.
- Among ECAs, Pacific Northwest had a lower average true density than the other two ECAs with 1.276 g/cm3 for export samples; similarly, it also had lowest average true density for the harvest samples.

Whole Kernels

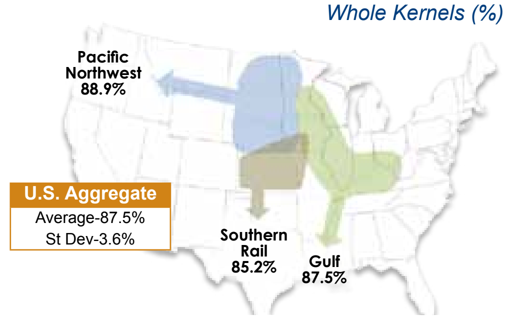
Though the name suggests some inverse relationship between whole kernels and BCFM, the whole kernels test conveys different information than the broken corn portion of the BCFM test. Broken corn is defined solely by the size of the material. Whole kernels, as the name implies, is the percent of fully intact kernels in the sample.

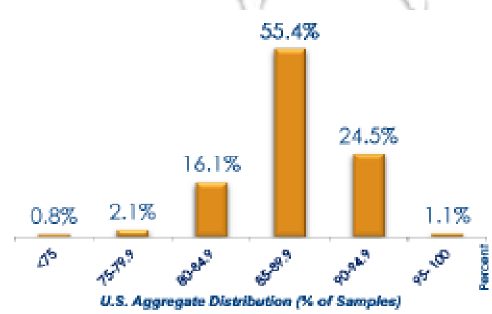
The exterior integrity of the corn kernel is very important for two key reasons. First, any breaks in the kernel pericarp affect water absorption for alkaline cooking operations. Kernel nicks or cracks allow water to enter the kernel faster than intact or whole kernels. Too much water uptake during cooking can result in expensive shutdown time and/or products that do not meet specifications. Secondly, intact whole kernels are less susceptible to mold invasion during storage and to breakage during handling. Some companies pay extra premiums for contracted corn delivered above a specified level of whole kernels.

Highlights

- Whole kernels averaged 87.5% for U.S. Aggregate corn at export level.
- Whole kernel averages for Gulf, Pacific Northwest, and Southern Rail were significantly different with 87.5%, 88.9%, and 85.2%, respectively.
- At the export level, 25.6% of the samples had whole kernels greater than 90%. Another 55.4% of the export samples were distributed in the 85 to 89.9% range.
- The whole kernel percentages for contracts loaded as U.S. No. 2 o/b were 87.6%, essentially the same as the 87.8% found for contracts loaded as U.S. No. 3 o/b.
- Whole kernels in Export Report samples were still relatively high and should help corn maintain quality during storage and enable relatively low breakage during handling.

Export Catchment Area Average Whole Kernels (%)





Corn Quality Overview (2011/12 Export Cargo)

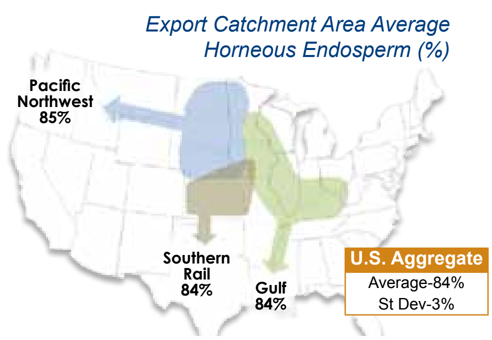
Horneous Endosperm

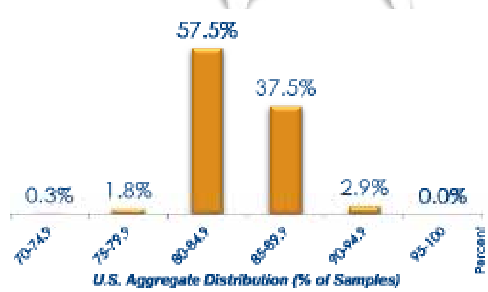
The % horneous endosperm test measures the percent of horneous or hard endosperm with a potential value from 70 to 100%. The greater the amount of horneous endosperm relative to soft endosperm, the harder the corn kernel is said to be. The degree of hardness is important depending on the type of processing.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

Highlights

- Horneous endosperm averaged 84% for U.S. Aggregate corn at both export and harvest levels. Its range of 71 to 94% was essentially unchanged from the harvest level.
- Horneous endosperm percentages varied little between the Gulf and Southern Rail ECAs but were significantly higher in the Pacific Northwest ECA.
- Horneous endosperm percentages were similar between contracts loaded as U.S. No. 2 o/b and those loaded as U.S. No. 3 o/b.
- U.S. Aggregate corn in Export Cargo Report samples had 97.9% of the samples with greater than 80% horneous endosperm, whereas in the Harvest Report, only 78.9% of the samples had greater than 80% horneous endosperm.





Corn Quality Overview (2011/12 Export Cargo)

Physical Factors Summary

Highlights

- The low levels of stress cracks (10%) in the Export Report samples indicate good potential for reduced rates of breakage when corn is handled, improved wet milling starch recovery, improved dry milling yields of flaking grits, and good alkaline processability.
- Kernel true densities (1.291 g/cm3) were higher for Export Report samples than Harvest Report samples. The slightly lower moistures at export may account for part of this increase as well as the fact that true densities were performed on completely whole, intact kernels. The lowest true densities were found in the Pacific Northwest ECA.
- The relatively high whole kernels (87.5%) in combination with the low stress cracks (10%) at export indicate the corn should have reduced breakage during loading and discharge of the cargo.
- Approximately 60% of Export Cargo Report samples had horneous endosperm less than 85%, indicating availability of corn with desirable softness for the wet millers and feeders.

Physical Factors Summary

	EXPORT CARGO Quality Report					HARVEST Quality Report				
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate										
Stress Cracks (%)	379	10	5	0	33	474	3	3	0	40
Stress Crack Index	379	30.8	17.1	0	125	474	4.6	6.0	0	129
100-Kernel Weight (g)	379	35.14	1.36	28.24	39.30	474	33.11	2.64	16.59	44.48
Kernel Volume (cm^3)	379	0.27	0.01	0.22	0.30	474	0.26	0.02	0.14	0.34
True Density (g/cm^3)	379	1.291	0.009	1.244	1.327	474	1.267	0.019	1.163	1.328
Whole Kernels (%)	379	87.5	3.6	66.6	96.0	474	93.8	3.9	57.0	99.8
Horneous Endosperm (%)	379	84	3	71	94	474	84	5	71	95
Gulf										
Stress Cracks (%)	261	12	5	1	33	364	3	3	0	40
Stress Crack Index	261	40.0	20.9	2	125	364	4.6	6.3	0	129
100-Kernel Weight (g)	261	35.53	1.32	31.99	38.37	364	33.66	2.63	16.59	44.48
Kernel Volume (cm^3)	261	0.27	0.01	0.24	0.30	364	0.26	0.02	0.14	0.34
True Density (g/cm^3)	261	1.295	0.009	1.268	1.327	364	1.271	0.019	1.168	1.328
Whole Kernels (%)	261	87.5	3.7	66.6	96.0	364	94.0	3.9	57.0	99.8
Horneous Endosperm (%)	261	84	3	71	94	364	85	5	71	95
Pacific Northwest										
Stress Cracks (%)[1]	83	5	3	0	13	182	3	3	0	35
Stress Crack Index[1]	83	12.3	8.5	0	37	182	5.2	6.6	0	129
100-Kernel Weight (g)	83	33.02	1.50	28.24	35.71	182	31.27	2.59	21.82	44.48
Kernel Volume (cm^3)	83	0.26	0.01	0.22	0.28	182	0.25	0.02	0.18	0.34
True Density (g/cm^3)	83	1.276	0.011	1.244	1.296	182	1.252	0.021	1.163	1.314
Whole Kernels (%)	83	88.9	3.0	79.2	95.4	182	93.6	3.9	74.8	99.6
Horneous Endosperm (%)	83	85	2	78	91	182	84	4	71	95
Southern Rail										
Stress Cracks (%)[1]	35	4	3	0	12	149	2	2	0	11
Stress Crack Index[1]	35	9.8	10.2	0	44	149	2.9	3.0	0	21
100-Kernel Weight (g)	35	37.00	1.29	34.36	39.30	149	33.39	2.80	16.59	44.48
Kernel Volume (cm^3)	35	0.29	0.01	0.26	0.30	149	0.26	0.02	0.14	0.34
True Density (g/cm^3)	35	1.295	0.006	1.284	1.310	149	1.273	0.017	1.163	1.314
Whole Kernels (%)	35	85.2	4.1	76.8	92.4	149	93.2	3.8	71.0	99.2
Horneous Endosperm (%)	35	84	2	80	88	149	83	4	71	95

[1] The Relative ME for predicting the Export Cargo population average exceeded ± 10%.

Corn Quality Overview (2011/12 Export Cargo)

U.S. GRAINS COUNCIL

Physical Factors Summary

	Samples for Contracts Loaded as U.S. No. 2 o/b					Samples for Contracts Loaded as U.S. No. 3 o/b				
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate										
Stress Cracks (%)	188	9	4	0	26	188	11	5	0	33
Stress Crack Index	188	28.8	15.0	0	97	188	34.9	19.3	0	125
100-Kernel Weight (g)	188	34.98	1.20	31.10	39.30	188	35.11	1.35	28.24	38.37
Kernel Volume (cm^3)	188	0.27	0.01	0.24	0.30	188	0.27	0.01	0.22	0.30
True Density (g/cm^3)	188	1.292	0.007	1.265	1.313	188	1.289	0.010	1.244	1.322
Whole Kernels (%)	188	87.6	3.2	72.6	96.0	188	87.8	3.9	66.6	95.6
Horneous Endosperm (%)	188	84	3	71	93	188	85	2	78	93
Gulf										
Stress Cracks (%)	122	11	5	2	26	136	12	6	1	33
Stress Crack Index	122	37.4	18.5	2	97	136	41.8	22.4	2	125
100-Kernel Weight (g)	122	35.18	1.29	32.13	38.18	136	35.84	1.23	32.19	38.37
Kernel Volume (cm^3)	122	0.27	0.01	0.25	0.29	136	0.28	0.01	0.25	0.30
True Density (g/cm^3)	122	1.295	0.007	1.275	1.313	136	1.294	0.009	1.268	1.322
Whole Kernels (%)	122	87.5	3.2	72.6	96.0	136	87.5	4.2	66.6	95.6
Horneous Endosperm (%)	122	84	3	71	93	136	85	2	80	93
Pacific Northwest										
Stress Cracks (%)	31	5	2	1	9	52	5	3	0	13
Stress Crack Index	31	11.0	6.4	1	28	52	13.0	9.5	0	37
100-Kernel Weight (g)	31	33.38	0.88	31.10	34.95	52	32.81	1.74	28.24	35.71
Kernel Volume (cm^3)	31	0.26	0.01	0.24	0.27	52	0.26	0.01	0.22	0.28
True Density (g/cm^3)	31	1.281	0.008	1.265	1.296	52	1.273	0.012	1.244	1.296
Whole Kernels (%)	31	89.0	2.9	83.4	93.8	52	88.8	3.0	79.2	95.4
Horneous Endosperm (%)	31	85	2	81	90	52	85	2	78	91
Southern Rail										
Stress Cracks (%)	35	4	3	0	12	0	0	0	0	0
Stress Crack Index	35	9.8	10.2	0	44	0	0.0	0.0	0	0
100-Kernel Weight (g)	35	37.00	1.29	34.36	39.30	0	0.00	0.00	0.00	0.00
Kernel Volume (cm^3)	35	0.29	0.01	0.26	0.30	0	0.00	0.00	0.00	0.00
True Density (g/cm^3)	35	1.295	0.006	1.284	1.310	0	0.000	0.000	0.000	0.000
Whole Kernels (%)	35	85.2	4.1	76.8	92.4	0	0.0	0.0	0.0	0.0
Horneous Endosperm (%)	35	84	2	80	88	0	0	0	0	0

Corn Quality Overview (2011/12 Export Cargo)

Mycotoxins

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

The *Harvest Quality Report* previously presented a summary of the instances when aflatoxins or DON was detected in some of the samples at harvest. This *Export Cargo Quality Report* again reports on instances when aflatoxins or DON was detected in the export corn samples. No specific levels of either aflatoxins or DON are reported. As additional *Export Cargo Quality Reports* are conducted, they will convey the year-to-year pattern of mycotoxin presence in corn as the crop is exported.

Assessing the Presence of Aflatoxins and DON

The U.S. grain merchandising industry implements strict safeguards for handling and marketing any elevated levels of mycotoxins. All stakeholders in the corn value chain – seed companies, corn growers, grain marketers and handlers as well as U.S. corn export customers – interested in understanding how mycotoxin infection is influenced by growing conditions and the subsequent storage, drying, handling and transport of the grain as it moves through the U.S. corn export system. To assess the impact of these conditions on aflatoxins and DON development, this report summarizes the results from official FGIS aflatoxin tests and from independent DON tests for all the export samples collected as part of this survey. Details on the testing methodology employed in this study for the mycotoxins are in the "Testing Analysis Methods" section.

Testing results

All 379 Export Cargo Quality Study samples were analyzed for aflatoxins and DON with FGIS-approved test kits. Of the 379 samples, 332 were tested for quantitative aflatoxin results. The remaining 47 samples were tested for qualitative results as required by the export contract. At the U.S. Aggregate level, the aflatoxin results for 68.6% of the samples were equal to or below 2 ppb. Results for the remaining 31.4% of the samples at the U.S. Aggregate level were between 2 and 20 ppb. All samples were below the FDA action level of 20 ppb.

Aflatoxin

	Percent of Total Samples			
	≤ 2 ppb	> 2 to ≤ 20 ppb*	> 20 ppb	Total
U.S. Aggregate	68.6%	31.4%	0.0%	100.0%
By ECA				
Gulf	71.6%	28.4%	0.0%	100.0%
Pacific Northwest	45.8%	54.2%	0.0%	100.0%
Southern Rail	100.0%	0.0%	0.0%	100.0%

* This category includes the results for 47 samples from the Gulf and Pacific Northwest ECAs tested with qualitative kits (12.2% of the 379 samples). The qualitative tests report results as either ≤ 20 ppb or > 20 ppb; therefore, some of the results reported in this category could have actually been ≤ 2 ppb.

DON

	Percent of Total Samples			
	≤ 0.5 ppm	> 0.5 to ≤ 5.0 ppm	> 5.0 ppm	Total
U.S. Aggregate	84.2%	15.8%	0.0%	100.0%
By ECA				
Gulf	87.4%	12.6%	0.0%	100.0%
Pacific Northwest	98.8%	1.2%	0.0%	100.0%
Southern Rail	25.7%	74.3%	0.0%	100.0%

The DON quantitative testing results for the 379 samples indicated that 84.2% were below 0.5 ppm at the U.S. Aggregate level. The balance of the samples' results fell between 0.5 and 5.0 ppm. All samples were below the FDA advisory level of 5.0 ppm (10 ppm for chickens and cattle).

U.S. GRAINS COUNCIL

Mycotoxin Background: General

The levels at which the fungi produce the mycotoxins are impacted by the fungus type and the 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 production regions might not produce elevated levels of any mycotoxins, while in other years, the 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 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 import 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 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 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 Regulatory Guidance for Toxins and Contaminants" found at http://www.ngfa.org/files/misc/Guidance_for_Toxins.pdf.

Mycotoxin 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 the *Aspergillus* fungus 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" and the sum of the four aflatoxins is called "total aflatoxins". Aflatoxin B1 is the most commonly found aflatoxin in food and 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 are toxic in humans and animals by primarily 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 in poultry and ducks, the most sensitive of the animal species. Livestock may experience reduced feed efficiency or reproduction, and both humans' and animals' 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 for total aflatoxins in human food, grain and livestock feed products if the levels exceed:

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

FDA has established additional policies and legal provisions concerning the blending of corn with levels of aflatoxins exceeding these threshold levels. In general, FDA currently does not permit the blending of corn containing aflatoxins 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 U.S. 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. These requirements result in relatively low levels of aflatoxins in exported grain.

Mycotoxin Background: DON (Deoxynivalenol) or Vomitoxin

DON is another mycotoxin of concern to some importers of corn grain. It is produced by certain species of the *Fusarium* fungus, the most important of which is *F. graminearum* (*Gibberella zeae*) which also causes Gibberella ear rot (or red ear rot). The fungus can be spotted easily in corn because of the conspicuous red discoloration of kernels on the ear. The presence of *Gibberella zeae* is mostly a problem when warm, wet weather occurs at flowering. The fungus grows down the silks into the ear, and in addition to producing DON, it results in damage to kernels that are evident during the grain inspection process. DON and Gibberella ear rot is most common in the northern Corn Belt states. This may be due to the susceptibility to the fungus of very early maturing corn hybrids commonly grown in these areas.

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 by-products for swine, not to exceed 20% of their diet,
- 10 ppm in grains and grain by-products for chickens and cattle, not to exceed 50% of their diet, and
- 5 ppm in grains and grain by-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.

U.S. Corn Export System

U.S. GRAINS COUNCIL

Corn Export System

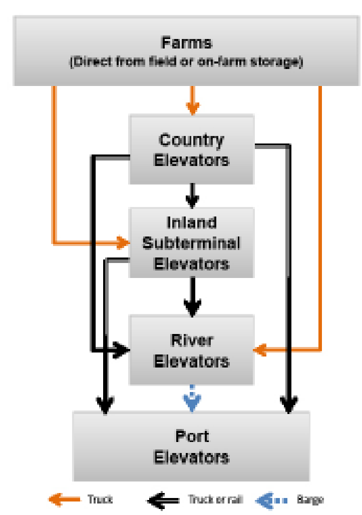
This *U.S. Grains Council Corn Export Cargo Quality Report 2011/12* provides advance information about corn value by surveying quality when the corn is ready to be loaded onto the vessel for export. Corn quality includes a range of properties that can be categorized as:

- Intrinsic quality characteristics – Protein, oil and starch content, hardness, and density are all intrinsic quality characteristics and are of critical importance to the end user. Since they are nonvisual, they can only be determined by analytical tests.
- Physical quality characteristics – These attributes are associated with outward visible appearance of the kernel or measurement of the kernel characteristics. Characteristics include kernel size, shape and color, moisture, test weight, total damaged and heat-damaged kernels, broken kernels, stress cracking and potential for breakage. Many of these characteristics are measured when corn receives an official USDA grade.
- Sanitary quality characteristics – These characteristics indicate the cleanliness of the grain. Attributes include presence of foreign material, odor, dust, rodent excreta, insects, residues, fungal infection and non-millable materials.

The intrinsic quality characteristics are impacted significantly by genetics and growing season conditions and typically do not change at the aggregate level as corn moves through the marketing system. On the other hand, the physical and sanitary characteristics can change as corn moves through the market channel. The parties involved in corn marketing and distribution use technologies (such as drying and conditioning) at each step in the channel to prevent or minimize the loss of physical and sanitary quality. The *Harvest Quality Report* assessed the quality of the 2011 corn crop as it entered the marketing system and reported the crop as favorable. This *Export Cargo Quality Report* provides information on the impact of the subsequent practices including drying, handling, blending, storing, and transporting on the crop up to the point where it is being loaded for export. To provide the backdrop for this assessment, the following sections describe the export corn flow, the practices applied to corn as it moves through the market channel, and the implication of these practices on corn quality. Lastly, the inspection and grading services provided by the U.S. government are reviewed.

U.S. Export Corn Flow

As corn is harvested, farmers transport grain to on-farm storage, end users, or commercial grain facilities. While many producers feed their corn production to their own livestock, the majority of the corn moves to other end users (feed mills or processors) or commercial grain handling facilities such as country elevators, inland subterminal or river elevators, and port elevators. Country elevators typically receive most of their grain directly from farmers. Subterminal elevators (either inland or river) collect grains in quantities suitable for loading on unit trains and barge tows for onward transport. These elevators receive more than half their corn from other elevators (usually country elevators) and are often located where the transport of bulk grain can be easily accommodated by unit trains or barges. Country, inland subterminal and river elevators can provide functions such as drying, cleaning, blending, storing and merchandising corn. The larger inland subterminal and river elevators supply most of the corn to port elevators intended for export markets. The following figure conveys the flow of U.S. corn destined for export markets.



U.S. GRAINS COUNCIL

U.S. Corn Export System

Impact of the Corn Market Channel on Quality

While the U.S. corn industry strives to minimize the change in the physical and sanitary quality attributes as corn moves from the farm to export ports, there are stages of the system where these quality characteristics change. These changes are inevitable due to the biological nature of the grain and the physical handling and conditioning required to move corn from production areas to export ports. The following sections introduce these various activities within the U.S. corn marketing system to provide some insight on why corn quality may change as it moves from the field to the ocean vessel.

Drying and Conditioning

Farmers often harvest their corn at moisture contents ranging from 18 to 30%. This range of moisture content generally exceeds safe storage levels which usually vary from 14 to 17%. Thus, wet corn at harvest must be dried to a lower moisture content to be considered safe for storage and transport. Conditioning is the use of aeration fans to control temperatures and moisture contents which are both important to monitor for storage stability. Drying and conditioning may occur either on a farm or at a commercial facility. When corn is dried, it can be dried by systems using natural air, low-temperature, or high-temperature drying systems. The high-temperature drying methods will often create more stress cracks in the corn and ultimately lead to more breakage during handling than natural air or low-temperature drying methods. However, high temperature is the only option in some cases due to logistics.

Storage and Handling

In the U.S., the storage types in which corn is stored can be broadly categorized as upright metal bins, concrete silos, flat storage (buildings), or on-ground piles. Upright bins and concrete silos with fully perforated floors are the most easily managed storage types because they allow in-floor aeration ducts or on-floor air ducts to help maintain uniform airflow through the grain. Flat storage or on-ground piles can be used for short-term storage when harvest production is higher than normal and surplus storage is needed. However, it is more difficult to install aeration ducts in these types of storage, and they often do not provide uniform aeration. In addition, on-ground piles are sometimes not covered and may be subjected to weather elements that can result in mold damage.

Handling equipment can involve both vertical elevations by bucket elevator or horizontal conveying usually by belt or en-masse conveyors. Regardless of how the corn is handled, some corn breakage will occur. The rate of breakage will vary by types of equipment used, severity of the grain impacts, grain temperature and moisture content, and by corn quality factors such as stress cracks or hard endosperm. As breakage levels increase, more fines (broken pieces of corn) are created which lead to less uniformity in aeration and ultimately to higher risk for fungi and insect infestation.

Cleaning

Cleaning corn involves scalping or removing large non-corn material and sieving to remove small shriveled kernels, broken pieces of kernels, and fine materials. This process reduces the amount of broken kernels and foreign material found in the corn. The potential for breakage and initial percentages of broken kernels, along with the desired grade factor, dictate the amount of cleaning needed to meet contract specifications. Cleaning can occur at any stage of the market channel where cleaning equipment is available.

Transporting Corn

The U.S. grain transportation and distribution system is probably the most efficient one in the world. It begins with farmers typically transporting their corn from the field by either farm tractor wagons or trucks to on-farm storage or country elevators. Corn is then transported by truck and/or rail from country and inland subterminal elevators and by barge from river elevators to its next destination. Once at export ports, corn is loaded onto ocean-going vessels. As a result of this complex yet flexible marketing system, corn can be loaded and unloaded several times, increasing the amount of broken kernels, stress cracks and breakage.

U.S. Corn Export System

U.S. GRAINS COUNCIL

Corn quality changes during shipment in much the same manner as it changes during storage. Causes of these changes include moisture variability (non-uniformity) and moisture migration due to temperature differences, high humidities and air temperatures, mold development, and insect invasion. However, there are some factors prevalent for grain transportation that make quality control during transport more difficult than in fixed storage facilities. First, there are few modes of transport equipped with aeration, and as a result, corrective actions for heating and moisture migration cannot be taken during transport. Another factor is the accumulation of fine material (spoutlines) near the center when loading barges and ocean vessels. This results in the whole kernels tending to roll to the sides, while fine material segregates in the center. A similar segregation occurs during the unloading process at each step along the way to final destination.

Implications on quality

The intrinsic quality attributes such as protein cannot be altered within a corn kernel. However, as corn moves through the U.S. corn market channel, corn from multiple sources is mixed together. As a result, the average for the intrinsic quality is affected by the quality levels of the corn from the multiple sources. However, the above-described marketing and distribution activities inevitably alter the physical and sanitary quality characteristics. The attributes that can be affected include test weight, damaged kernels, broken kernels, kernel size, stress crack levels, moisture contents and variability, foreign material, and mycotoxin levels.

U.S. Government Inspection and Grading

Purpose

Global corn supply chains need verifiable, predictable and consistent oversight measures that fit the diverse needs of all end users. Oversight measures, implemented through standardized inspection procedures and grading standards, are established to provide:

1. Information for buyers about grain quality prior to arrival at destination, and
2. Food and feed safety protection for the end users.

The U.S. is recognized globally as having a combination of official and industry standards that are typically used for exporting grains and referenced in export contracts. U.S. corn sold by grade and shipped by vessel in foreign commerce must be officially inspected and weighed by the USDA's Federal Grain Inspection Service (FGIS) with a few exceptions. Qualified state and private inspection agencies are permitted to be designated by FGIS as official agents to inspect and weigh corn at specified interior locations. In addition, certain state inspection agencies can be delegated by FGIS to inspect and weigh grain officially at certain export facilities. Supervision of these agencies' operations and methodologies is performed by FGIS's field office personnel.

Inspection and Sampling

The loading export elevator provides FGIS or the delegated state inspection agency a load order specifying the contract quality of the corn to be loaded as designated in the export contract. The load order specifies the contract U.S. grade requirements of corn which have been agreed upon by the foreign buyer and the U.S. supplier, plus any special requirements requested by the buyer such as minimum protein content, maximum moisture content, or other special requirements. The official inspection personnel determine and certify that the corn loaded in the vessel actually meets the requirements of the load order. Independent laboratories can be or are used to test for quality factors not mandated to be performed by FGIS or for which FGIS does not have the local ability to test.

U.S. Corn Export System

Shipments or "lots" of corn are divided into "sublots." Representative samples for grading are obtained from these sublots using a diverter sampling device approved by FGIS. This device takes an incremental portion every 500 bushels (about 12.7 MT) from the moving grain stream during assembly for final shipment. The incremental portions are combined by sublot and evaluated by licensed inspectors. The results are entered into a log and, using statistical techniques, a determination is made as to acceptance or rejection on each factor according to specifications in the contract. Any sublot that does not meet requirements on any factor must be returned to the elevator or given a separate certification. The average of all sublots meeting the contract requirements for each factor tested is reported on the final certificate.

Grading

Yellow corn is divided into five U.S. numerical grades and U.S. Sample Grade. Each grade has limits for test weight, broken corn and foreign material (BCFM), total damaged kernels, and heat-damaged kernels as a subset of total damage. The limits for each grade are summarized in the table shown in the "Grade Requirements and Conversions" section on page 36. In addition, FGIS provides certification of moisture and other attributes, if requested, such as stress cracks, protein, oil and mycotoxins. In some cases, independent labs are used to conduct the non-official FGIS tests, depending on the contract.

Export contracts for corn specify many conditions related to the cargo, including the contract grade. Since the limits on all grade factors cannot always be met exactly simultaneously, some grade factors may be better than a particular grade, but they cannot be worse. For example, test weight may be higher than U.S. No. 1 on nearly all sublots. To allow for this flexibility, contracts are often written as "U.S. No. 2 or better" or "U.S. No. 3 or better". This permits some factors to be near the limit for that grade while other factors may be better than called for in the grade specifications.

Survey and Statistical Analysis Methods

Survey Design and Sampling

Overview

The key points for the statistical sample design and sampling process for this *Export Cargo Quality Report* are as follows

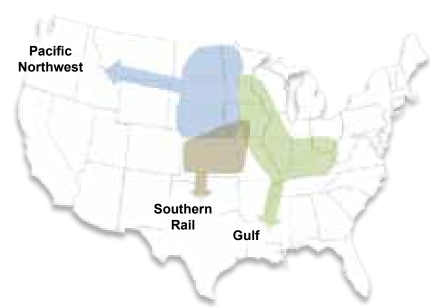
- Following the process developed for the earlier *Harvest Quality Report*, we stratified the samples according to Export Catchment Areas (ECAs) – the Gulf, Pacific Northwest, and Southern Rail.
- To achieve a maximum 10% relative margin of error (Relative ME) at the 95% confidence level and to ensure proportional sampling from each ECA, we specified the targeted number of total samples to be 394 samples collected from the ECAs as follows: 261 from the Gulf, 83 from Pacific Northwest, and 50 from Southern Rail.
- Samples from the port of Galveston, Texas, were collected for the Southern Rail ECA. This is because the inspection samples from interior rail shipments are not collected and inspected by USDA's Federal Grain Inspection Service (FGIS), but by any of several official agencies designated by FGIS, and the inspection data are not stored on the FGIS computer system, therefore, making the logistics for using interior shipments infeasible. FGIS and industry experts believe corn being exported by vessel from Texas is fairly representative of corn from the Southern Rail ECA.
- Although we calculated, based on the five-year average pace of exports that the samples could be collected over a four-week period, the unexpectedly slow pace of export shipments this season necessitated that we modify the sampling process, doubling the frequency of sampling.
- Export inspections from Texas were so slow that we were not able to collect the targeted number of samples in time for this report. As a result, 35 samples were collected for the Southern Rail. The U.S. Aggregate averages for the quality factors were weighted according to the targeted proportion by ECA.
- To evaluate the statistical validity of the samples, the relative margin of error (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 were less than ±10% except for three attributes from the Pacific Northwest and Southern Rail ECAs – total damage, stress cracks percent and stress crack index.

Survey Design

For this *Export Cargo Quality Report*, the target population was yellow commodity corn from the twelve key U.S. corn producing states representing about 98% of U.S. exports in 2010. A ***proportionate stratified sampling*** technique was used to ensure a sound statistical sampling of U.S. yellow corn exports. Two key characteristics define the sampling technique for this report: the ***stratification*** of the population to be sampled and the sampling ***proportion*** per subpopulation or strata.

Stratified sampling involves dividing the survey population of interest into distinct, non-overlapping subpopulations called strata. For the *Harvest* and *Export Cargo* Corn Quality Reports, the twelve corn-exporting states are divided into three general groupings which we refer to as Export Catchment Areas (ECAs). These three ECAs are identified by the three major pathways to export markets:

1. The Gulf ECA consisting of areas that typically export through U.S. Gulf ports,
2. The Pacific Northwest ECA that includes areas exporting corn through Pacific Northwest and California ports, and
3. The Southern Rail ECA consisting of areas generally exporting corn by rail to Mexico.



Survey and Statistical Analysis Methods

Using data from the FGIS Export Grain Information System (EGIS), each ECA's proportion of the total annual yellow corn exports for 2008 through 2010 was calculated and averaged over the three years. This average share of exports was used to determine the ***sampling proportion*** (the percent of total samples per ECA) and ultimately, the number of yellow corn samples to be collected from each ECA. The specified sampling proportions for the three ECAs are as follows:

Percent of Samples per ECA

Gulf	Pacific Northwest	Southern Rail	Total
67.9%	21.6%	10.5%	100.0%

The ***number of samples*** collected within each ECA was established so we could estimate the true averages of the various quality factors with a certain level of precision. The level of precision chosen for the *Export Cargo Quality Report* was a relative margin of error (Relative ME) no greater than ± 10%, estimated with 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., variability of the quality factor in the corn exports) 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.

We did not know the population variances for any of the fifteen quality factors evaluated for this year's corn exports. When population variances are not known, variance estimates from similar data sets or studies are used. For a proxy for this year's study, we calculated the variances and ultimately the estimated number of samples needed for the Relative ME of ± 10% for four quality factors – test weight, moisture, broken corn and foreign material (BCFM), and total damage – using the 2010 EGIS corn export data. Total damage had the largest Relative ME of the four factors. Based on these data, a minimum sample size of 50 would be needed to estimate the true average of total damage with our desired level of precision.

Number of Samples per ECA

	Gulf	Pacific Northwest	Southern Rail	Total
Targeted	261	83	40	384
Additional			10	10
Total	261	83	50	394

We did not have data for the remaining eleven quality factors to estimate their variances or sample sizes needed for our targeted Relative ME. Consequently, it is our intent to use this year's results to estimate the variances and Relative ME for all fifteen quality attributes for future *Harvest* and *Export Cargo Quality Reports*. In future years, we will adjust our sampling protocol accordingly to increase our sampling accuracy and to obtain a Relative ME of ± 10% or less for all fifteen quality factors.

The sampling proportions of 67.9%, 21.6% and 10.5% for the Gulf, Pacific Northwest and Southern Rail ECAs, respectively, and a total sample size of 384 would allow us to estimate the true averages of the four quality characteristics with our desired level of precision for the U.S. Aggregate and for the three ECAs with one exception. The one exception was total damage in the Southern Rail ECA because the ECA's sample size would be only 40. Therefore, it was decided to collect an additional 10 samples in the Southern Rail ECA to have sufficient samples for estimating total damage with a Relative ME of less than ± 10%. Despite the additional 10 samples collected from the Southern Rail ECA, the U.S. Aggregate averages would be weighted by the original sampling proportions.

Survey and Statistical Analysis Methods

Sampling

Since corn samples for interior rail shipments are not collected and inspected by FGIS, but by any of several officially designated agencies, FGIS does not have direct access to their samples or inspection data. These issues created logistical challenges that made it infeasible to collect samples from the interior rail shipments for the *Export Cargo Quality Report*. Upon consultation with FGIS personnel and industry participants familiar with the flow of grain exiting the south-central part of the U.S., it was determined that a reasonable proxy for Southern Rail samples would be seabound shipments collected through the FGIS League City Field Office. In theory, the corn exiting by rail and by ship through Texas has similar, if not the same, origination. Therefore, samples collected through the GIPSA League City Field Office (and specifically, the port of Galveston), were collected to represent the Southern Rail ECA.

The sampling was administered by FGIS as part of their inspection services. Instruction letters were sent to field offices by FGIS on January 30, 2012, and the sampling period began February 6, 2012. The FGIS field offices in the respective ECAs responsible for overseeing the sample collection within their region were as follows: Gulf – New Orleans, Louisiana; Pacific Northwest – Olympia, Washington (Washington State Department of Agriculture); and Southern Rail – League City, Texas.

Representative sublot samples from the ports were collected as ships were loaded, and only lots for which quantitative aflatoxin testing was being performed were to be sampled. (However, some samples were provided on which qualitative aflatoxin tests were performed as required by the export contract.) Samples for grading are obtained by a diverter sampling device approved by FGIS. The diverter sampler “cuts” (or diverts) a representative portion at periodic intervals from a running stream of corn. A cut occurs every few seconds, or about every 500 bushels (about 12.7 MT) as the grain is being assembled for export. The frequency is regulated by an electric timer controlled by official inspection personnel, who periodically determine that the mechanical sampler is functioning properly.

While the sampling process is continuous throughout loading, a shipment or “lot” of corn is divided into “sublots” for the purpose of determining uniformity of quality. Sublot size is based on the hourly loading rate of the elevator and the capacity of the vessel being loaded. Sublot sizes range from 60,000 to 100,000 bushels. All samples are inspected to ensure the entire shipment is uniform in quality.

The frequency of the sampling of the sublots was determined by the desired length of the sampling period. The original goal was to have a four-week sampling period. Based on a five-year average of exports from these ECAs, it was concluded that the targeted number of samples could be collected from each ECA within four weeks by collecting samples from sublots ending in the numbers 3 and 7. However, it became evident after two weeks into the sampling period that exports from all three ECAs were less frequent than projected. As a result, sampling frequency was doubled for all three ECAs, effective March 1, 2012. Sublots ending in 0, 3, 5 and 7 were sampled from that point forward.

A minimum of 2,700 grams was collected by the FGIS field staff and the Washington State Department of Agriculture, congregated at the field offices, and mailed to Illinois Crop Improvement Association Identity Preserved Grain Laboratory (IPGL). Upon arrival at IPGL, the samples were divided for use at IPGL and Champaign-Danville Grain Inspection (CDGI), a FGIS-designated official inspection agency.

The sampling period ended March 6, 2012, for the Pacific Northwest ECA and March 17, 2012, for the Gulf ECA when the targeted number of samples per ECA was reached. As of March 28, 2012, no additional shipments from which samples could be collected were expected from the League City region in the near future. Therefore, in order to publish the *Export Cargo Quality Report* in a timely manner, the sampling period for the Southern Rail ECA concluded March 28, 2012.

Survey and Statistical Analysis Methods

U.S. GRAINS COUNCIL

Statistical Considerations

Only 35 of the targeted 50 samples for the Southern Rail ECA were collected due to low export volume during the sampling period. This reduced number of samples had implications on calculating the U.S. Aggregate statistics and on the ability to estimate the true average for total damage for the Southern Rail ECA. The U.S. Aggregate averages and standard deviations were weighted by ECA using the original sampling proportions.

The Relative ME was calculated for each of the quality factors tested for this study at the U.S. Aggregate level and for each of the ECAs. The Relative ME was less than ± 10% for all the quality attributes at the U.S. Aggregate level and for the ECAs except for total damage, stress crack percent, and stress crack index for the Pacific Northwest and Southern Rail ECAs. The Relative ME for total damage, stress cracks percent and stress crack index were as follows:

	Relative ME		
ECA	Total Damage	Stress Cracks %	SCI
Pacfic Northwest	19%	11%	15%
Southern Rail	14%	23%	36%

While the lower level of precision for these quality factors in these two ECAs is less than desired, these levels of Relative ME do not invalidate the estimates. Footnotes in the summary tables for "Grade Factors and Moisture" and "Physical Factors" indicate the attributes for which the Relative ME exceeds ± 10%. With the 2011 samples as a basis, we will be able in future reports to use the variances from this year's results to calculate sample sizes for these factors and adjust our sampling protocol to obtain a Relative ME of 10% or less.

Any references in the "Corn Quality Overview (2011/12 Export Cargo)" section to statistical differences are validated by two-tailed t-tests at the 95% confidence level that we calculated for results:

- Between factors in the *Harvest Quality Report* and *Export Cargo Quality Report*,
- Among factors in the *Export Cargo Quality Report* ECAs (Gulf, Pacific Northwest, Southern Rail), and
- Between factors in the *Export Cargo Quality Report* contract grades (U.S. No. 2 o/b, U.S. No. 3 o/b).

Testing Analysis Methods

USDA's Federal Grain Inspection Service (FGIS) provided official grading and aflatoxin results from its normal inspection and testing procedures for each sublot corn sample collected. The corn samples were sent directly from the FGIS field offices to the Illinois Crop Improvement Association Identity Preserved Grain Laboratory (IPGL) in Champaign, Illinois, for the chemical, physical factors, and DON testing. Upon arrival at IPGL, the samples were split into two subsamples using a Boerner divider. One subsample was delivered to the Champaign-Danville Grain Inspection (CDGI) agency for the DON testing. CDGI is the official grain inspection service provider for east-central Illinois as designated by FGIS. The other subsample was dried to approximately 15% moisture and analyzed at IPGL for the chemical composition and other physical factors following either industry norms or well-established procedures in practice for many years. IPGL has received accreditation under the ISO/IEC 17025:2005 International Standard.

Corn Grading Factors

Test Weight

Test weight is the weight 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 United States Standards for Grain 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 United States Standards for Grain 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 sieve. Foreign material is defined as all material passing through a 6/64th inch round-hole sieve and the coarse non-corn material retained on the 12/64th inch sieve. While FGIS can report broken corn and foreign material separately if requested, BCFM is the default measurement and thus was provided for the *Export Cargo Quality Report*. BCFM is reported as a percentage of the initial sample by weight.

Total Damage/Heat Damage

Total damage is part of the FGIS Official United States 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), surface mold, 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 is 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.

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Testing Analysis Methods

Moisture

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

Chemical Composition

NIR Proximate Analysis – Corn

Proximates are the major components of the grain. For corn, the NIR Proximate Analysis includes oil content, protein content, and starch content (or total starch). This procedure is nondestructive to the corn.

Chemical composition tests for protein, oil, and starch were conducted using a 400–450 g sample in a whole-kernel Foss Infratec 1229 Near-Infrared Transmittance (NIRT) instrument. The NIRT was calibrated to chemical tests, and the standard error of predictions for protein, oil, and starch were about 0.2%, 0.3%, and 0.5%, respectively. Results are reported on a dry basis percentage (percent of non-water material).

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 with a minimum of four decimal places. The averaged 100-kernel weight is reported in grams.

The kernel volume is calculated using a helium pycnometer to determine the volume (displacement) of the two replicates and is expressed in $cm^3/100$. Kernel volumes usually range from 0.18-0.30 cm^3 per kernel for small and large kernels, respectively.

True density is calculated as the mass (or weight) of the two replicates of 100 externally sound kernels by the volume (displacement) of the same 100-kernels. The replicate results are averaged. True density is reported in grams per cubic centimeter (g/cm^3). True densities typically range from 1.20 to 1.35 g/cm^3 at “as is” moistures 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) 1 crack; (3) 2 cracks; and (4) more than 2 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 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.

Testing Analysis Methods

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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 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 Endosperm

The % horneous (or hard) endosperm test is performed by visually rating 20 externally sound kernels, placed germ facing up, on a light table. 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 70-100%, though most individual kernels fall in the 70-95% range.

Mycotoxin Testing

The *Export Cargo Quality Report* official aflatoxin results are provided by FGIS. For the aflatoxin testing, a sample of at least 10 pounds of shelled corn was used according to FGIS official procedures. The 10-pound sample is ground using a FGIS-approved grinder. Following the grinding stage, two 500-gram ground portions are removed from the 10-pound comminuted sample using a riffle divider. From the 500-gram ground portion, a 50-gram test portion is randomly selected for testing. After adding the proper chemicals to the 50-gram test portion, aflatoxin is quantified or qualified. For the quantitative tests, one of the following FGIS-approved test kits may have been used: Aflatest, Fluoroquant, Veratox-AST, Myco, RIDASCREEN Fast Aflatoxin Total, or RIDASCREEN Fast Aflatoxin SC test. The FGIS-approved qualitative test kits that may have been used were: Rosa Aflatoxin P/N 20 ppb, ROSA Aflatoxin P/N 10 ppb, ROSA BEST Aflatoxin P/N, Reveal for Aflatoxin (MeOH or EtOH), and Romer AgraStrip.

For the DON testing, the FGIS-approved Romer AgraQuant test method was used. An approximately 1350-gram portion was ground by a Romer Mill to a particle size which would pass through a number 20 wire mesh sieve and divided down to a 50-gram sample using a riffle divider. The sample was then processed as the FGIS *DON (Vomitoxin) Handbook* requires. The DON was extracted with 250 ml of distilled water, and the extracts were tested using the Romer AgraQuant micro well test kits. The DON results were read using the StatFax Reader.

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Grade Requirements and Conversions

Corn Grades and Grade Requirements

Grade	Minimum Test Weight per Bushel (Pounds)	Maximum Limits of Damaged Kernels: Heat Damaged (Percent)	Maximum Limits of Damaged Kernels: Total (Percent)	Maximum Limits of 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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