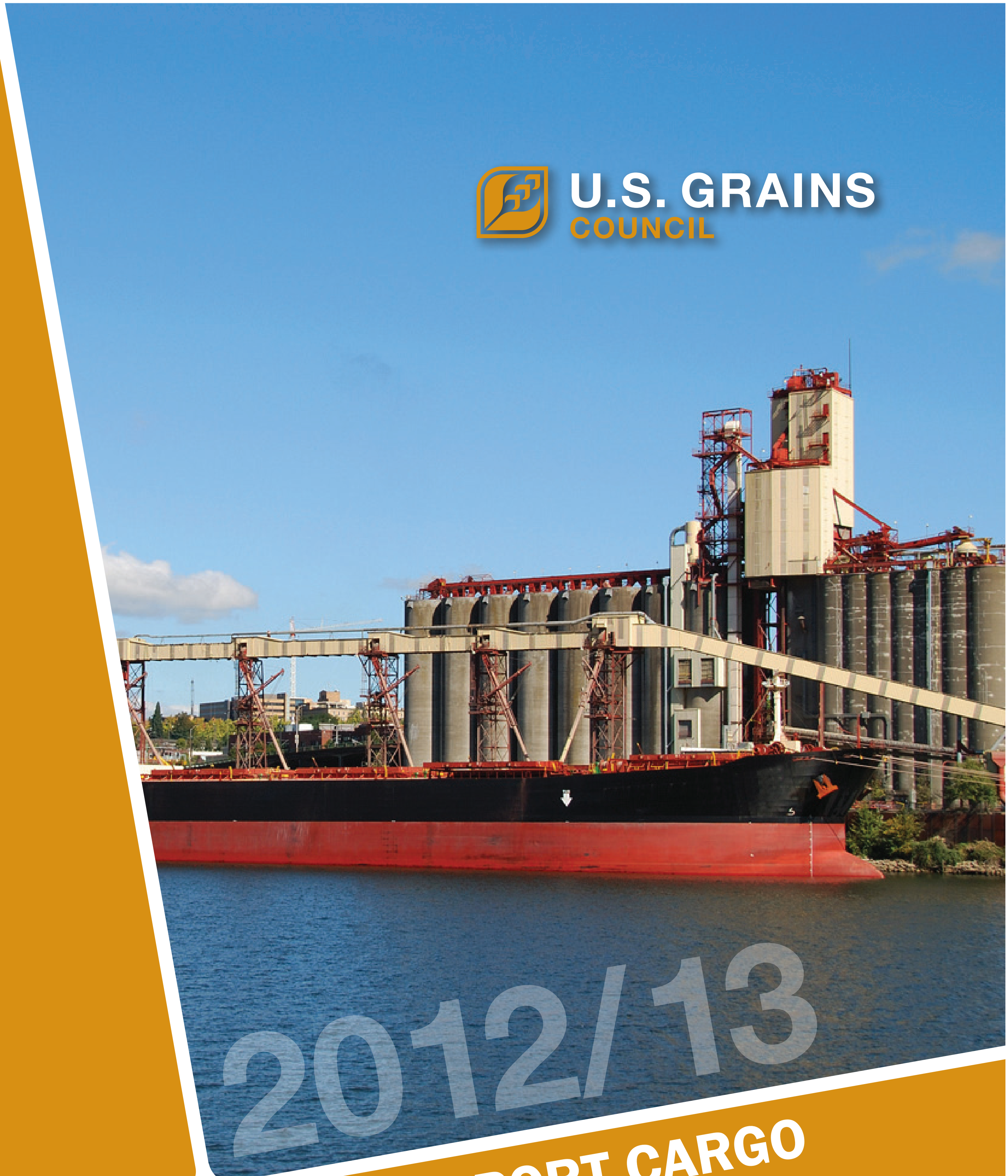


CORN EXPORT CARGO
QUALITY REPORT

ACKNOWLEDGEMENTS

Developing a report of this scope and breadth in a timely manner requires participation by a number of individuals and organizations. The U.S. Grains Council 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 (IPG Lab) 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. 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, the Washington State Department of Agriculture, and FGIS-designated domestic official service providers collected and submitted the samples that constitute the foundation of this report. We are grateful for the time they devoted during their busy season.

TABLE OF CONTENTS

GREETINGS FROM THE COUNCIL

The U.S. Grains Council is pleased to present the *U.S. Grains Council Corn Export Cargo Quality Report 2012/13* as a service to foreign buyers and other interested parties.

The *Export Cargo Report 2012/13* 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 Council reports concerning the quality of the 2012 crop. In December 2012, the *U. S. Grains Council Corn Harvest Quality Report 2012/13* examined 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.

The *Harvest Report 2012/13* and the *Export Cargo Report 2012/13* continue this series of annual reports that began in 2011. The Council anticipates the value of these reports to grow over time as stakeholders become familiar with the information presented and with the year-to-year variations expected in the U.S. corn marketing system.

Quality is a vital concern for every stakeholder in the corn value chain including seed companies, corn growers, traders, corn handlers, shippers, processors and end users. In addition to providing an early look at grade factors and moisture (that are reported each year by the U.S. Department of Agriculture's Federal Grain Inspection Service (FGIS)), these *Export Cargo Reports* provide information on additional quality characteristics that are not routinely tested and reported by FGIS.

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 at the foundation of these efforts. We trust that our international partners will find the *U.S. Grains Council Corn Harvest Quality* and *Corn Export Cargo Quality* reports informative and useful, and we invite users to contact us with comments, criticisms, or questions.

Sincerely,

Don Fast

Don Fast
Chairman
U.S. Grains Council
April 2013

I. EXPORT CARGO QUALITY HIGHLIGHTS

The quality of the corn assembled for export early in the 2012/13 marketing year, was even better than that of the previous year, despite the challenging climatic conditions of the 2012 growing season. All grade factors were at or better than 2011/12, with the exception of total damage. Moisture content was also lower. All chemical and physical attributes also showed improvement over the previous marketing year, with the exception of slightly lower starch content reflecting the higher protein and oil contents. Notable quality attributes of the 2012/13 U.S. Aggregate export samples include:

- Grade factors (test weight, BCFM, total damage, and heat damage) on most sublot samples were at or better than the U.S. grade limits.
- Average test weight (58.1 lb/bu, 74.8 kg/hl) was significantly higher in 2012/13 than in 2011/12 and was above the grade limit for U.S. No. 1 corn in 96.9% of the samples. Test weight was lower at export than at harvest (58.8 lb/bu).
- BCFM (2.7%) was below the maximum limit for U.S. No. 2. and below that of 2011/12 (3.0%). BCFM predictably increased as the crop moved through the market channel.
- Total damage (2.0%) increased during storage and transport as expected and was slightly higher at export than in 2011/12. Total damage was the only grade factor showing major differences among ECAs with the Pacific Northwest (0.6%), noticeably below the U.S. Aggregate (2.0%).
- Average moisture levels were lower, and moisture variability among sublots was greater in 2012/13 than in 2011/12. More than 80% of the 2012/13 samples were at or below 14.5% moisture. Average moisture at harvest (15.3%) was lowered to 14.2% at export due to drying and conditioning in the market channel.
- Protein content in 2012/13 (9.2% dry basis) was significantly higher than in 2011/12 (8.7%). The increased protein was likely an effect of the 2012 drought in many parts of the Corn Belt.
- Starch content (73.5% dry basis) usually varies inversely with protein and was lower in 2012/13 than in 2011/12 (74.1%).
- Oil content (3.7% dry basis) was 0.1 percentage point above the 2011/12 samples.
- Low levels of stress cracks (9%) and relatively high percent of whole kernels (89.9%) indicate potential for reduced breakage when corn is handled, improved wet milling starch recovery, improved dry milling yields of flaking grits, and good alkaline processability. These levels were an improvement over 2011/12 (10% and 87.5% respectively).
- The kernel volumes and 100-kernel weights were higher in 2012/13 than in 2011/12, indicating slightly larger kernel sizes in 2012/13.
- Like test weight, kernel true densities (1.297 g/cm^3) were significantly higher in 2012/13 than in 2011/12.
- Whole kernels for 2012/13 (89.9%) were significantly higher than for 2011/12.
- Approximately 53% of the samples had horneous (hard) endosperm equal to or greater than 85% in 2012/13 compared to 40.4% in 2011/12, indicating harder corn. This moderate increase in hardness should be desirable for dry millers, but the corn should still be well suited to the requirements of wet millers and feeders. The moderate increases found in kernel hardness, true density and test weight appear consistent with and may, in part, be explained by the higher protein contents found in 2012 corn crop.
- 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 5 ppm for hogs and other animals).

In summary, corn at export early in the 2012/13 marketing year had higher test weight, lower BCFM, lower moisture, higher protein and oil, lower stress cracks, higher density, more whole kernels, and more horneous endosperm than the export corn in 2011/12. In addition, uniformity of the quality attributes generally increased as the corn moved through the market channel. These outcomes are all indicative of corn cargoes that should perform well in terms of retaining quality during transit.

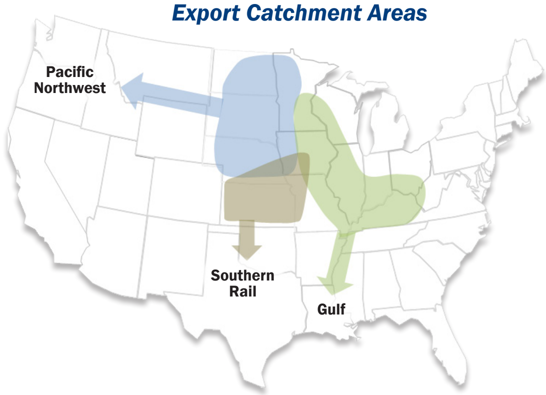
II. INTRODUCTION

Corn quality information is important to foreign buyers and other industry stakeholders as they make decisions about purchase contracts and processing needs for corn for feed, food or industrial use. The *U.S. Grains Council Corn Export Cargo Quality Report 2012/13* provides accurate, unbiased information about the quality of U.S. yellow commodity corn as it is assembled for export. This report provides test results for corn samples collected during the U.S. government-licensed sampling and inspection process for U.S. corn waterborne and rail export shipments.

This *Export Cargo Report* is based on 397 yellow commodity corn samples collected from corn export shipments as they underwent the federal inspection and grading process performed by the U.S. Department of Agriculture's (USDA) Federal Grain Inspection Service (FGIS) or licensed inspectors. The sample test results are reported at the U.S. aggregate level (U.S. Aggregate) and by export points associated with 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 consists of areas that typically export corn through U.S. Gulf ports;
2. The Pacific Northwest ECA includes areas exporting corn through Pacific Northwest and California ports; and
3. The Southern Rail ECA comprises areas generally exporting corn to Mexico.

Export Catchment Areas



The sample test results are also summarized by "contract grade" categories ("U.S. No. 2 or better" and U.S. No. 3 or better") to illustrate the practical quality differences between these two contract specifications.

A companion report, the *U.S. Grains Council Corn Harvest Quality Report 2012/13*, was released in December 2012 and reported on the quality of the corn as it entered the U.S. marketing system. The *Harvest Report 2012/13* and the *Export Cargo Report 2012/13* should be studied together so changes in corn quality that occur between harvest and export can be understood. A review of how corn quality evolves from the field to the ocean vessel or rail car is provided in the "U.S. Corn Export System" section.

This *Export Cargo Report 2012/13* is the second in a series of annual surveys of the quality of the U.S. corn exports early in the marketing year. With two years of results, the Council is drawing preliminary conclusions about corn exports early in the shipping season. In addition, the foundation for evaluating patterns of corn quality based on growing, drying, handling, storage, and transport conditions across the years has begun to develop.

This report provides detailed information on each of the quality factors tested, including average, standard deviation, and distributions. The "Quality Test Results" section summarizes the following quality factors:

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

II. INTRODUCTION

For the *Export Cargo Report 2012/13,* FGIS collected samples during the latter part of October 2012 through February 2013 to generate statistically valid results for the U.S. Aggregate and by ECA. The objective was to obtain enough samples 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.

The *Export Cargo Report* does not predict the actual quality of any cargo or lot of corn after loading or at destination, and it is important for all players in the value chain to understand their own contract needs and obligations. In addition, 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.

A. Grade Factors

The USDA's Federal Grain Inspection Service (FGIS) has established numerical grades, definitions and standards for grains. The attributes which determine the numerical grades for corn are test weight, broken corn and foreign material (BCFM), total damage, and heat damage. The table for "Corn Grades and Grade Requirements" is provided on page 42 of this report.

SUMMARY: GRADE FACTORS AND MOISTURE

- *Quality of the corn at export was good, with average values generally better than grade limits and contract specifications. As expected, quality at export was more uniform than at harvest.*
- *Test weight was high with U.S. Aggregate samples averaging 58.1 lb/bu (74.8 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 between harvest and export, in part to meet the contract specifications at export, and were generally at levels for safe transit.*
- *Quality of the 2012/13 corn at export was better than that of 2011/12 corn at export on all grade factors except total damage (2.0% in 2012/13 compared to 1.7% in 2011/12). These were still low values, well below the maximum limits for U.S. No. 1 of 3%. With low total damage and low moisture, the 2012/13 export samples should travel in good condition.*

III. QUALITY TEST RESULTS

1. Test Weight

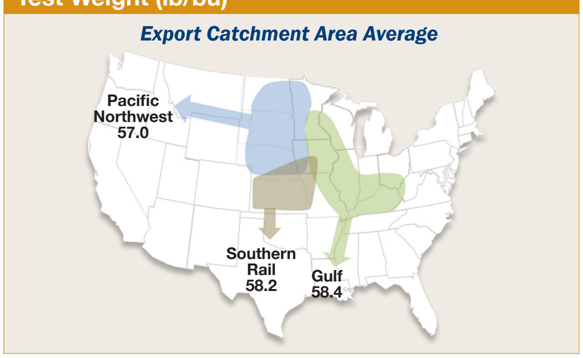
Test weight (weight per volume) is a measure of bulk density and is often used as a general indicator of overall quality and as a gauge of endosperm hardness to alkaline cookers and dry millers. It reflects kernel hardness and kernel maturity. Test weight is initially impacted by genetic differences 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.

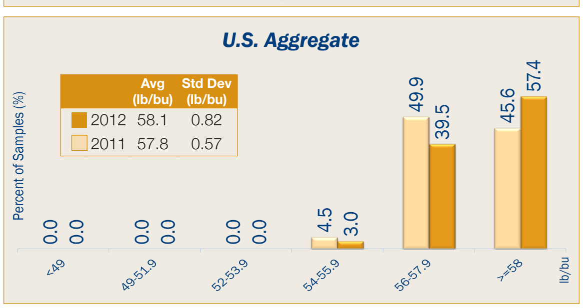
U.S. Grade Minimum Test Weight
No. 1: 56.0 lbs
No. 2: 54.0 lbs
No. 3: 52.0 lbs

HIGHLIGHTS

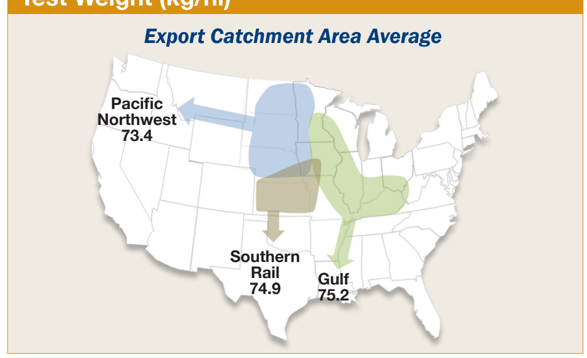
- U.S. Aggregate average test weight of 58.1 lb/bu (74.8 kg/hl) at export indicates overall good quality, is 2 lb/bu above the grade limit for U.S. No. 1 corn (56.0 lb/bu) and is higher than last year. Nearly 97% of the samples were at or above the 56.0 lb/bu minimum limit for No. 1 grade.
- Test weight at export was lower than test weight at harvest (58.8 lb/bu), resulting from higher BCFM, lower moisture, and higher damage.
- Variation in the 2012 crop was less in the export samples than in harvest samples. As corn is commingled moving through the marketing channel, test weight may change somewhat but it 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.
- Test weight was significantly higher in samples from the Gulf ECA (58.4 lb/bu) with lower variability than samples from the Pacific Northwest ECA.

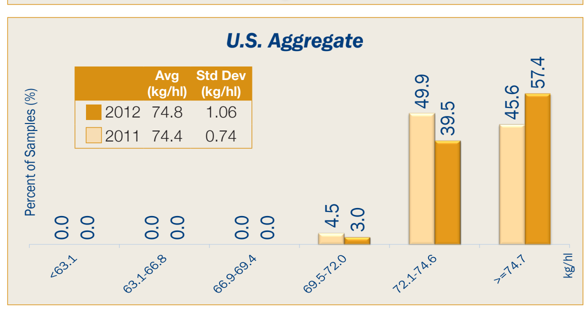
Test Weight (lb/bu)





Test Weight (kg/hl)





2. 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. 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.

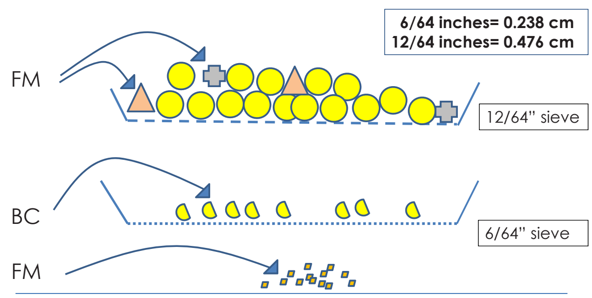
U.S. Grade BCFM Maximum Limits
No. 1: 2.0%
No. 2: 3.0%
No. 3: 4.0%

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.

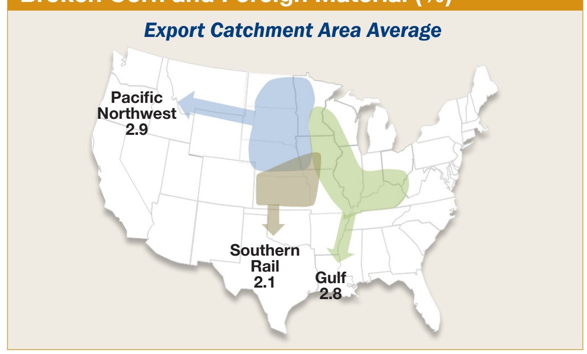
BCFM (Measured as Percent by Weight)

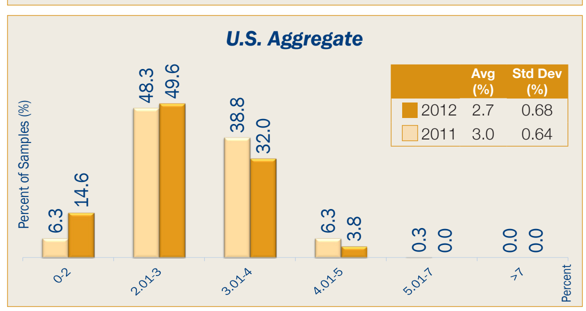


HIGHLIGHTS

- BCFM in U.S. Aggregate export samples was significantly lower in 2012/13 (2.7%) than in 2011/12 (3.0%). Average values were below the limit of 3.0% for U.S. No. 2 in the aggregate and in all ECAs.
- Export samples were very clean with 64.2% at or below the 3% maximum for Grade 2.
- The increase in BCFM between harvest (0.8%) and export (2.7%) is the result of increased breakage during drying and handling.
- Corn arriving at the export point is often commingled from many origins to meet the contracted grade limits, as indicated by the lower level of BCFM in U.S. No. 2 o/b (2.6%) than in U.S. No. 3 o/b (3.3%). U.S. Aggregate BCFM for each contract grade category was below the limits for the respective contract grade.
- BCFM at export was lower in the Southern Rail ECA than in either the Gulf or Pacific Northwest ECA.

Broken Corn and Foreign Material (%)





III. QUALITY TEST RESULTS

3. 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.

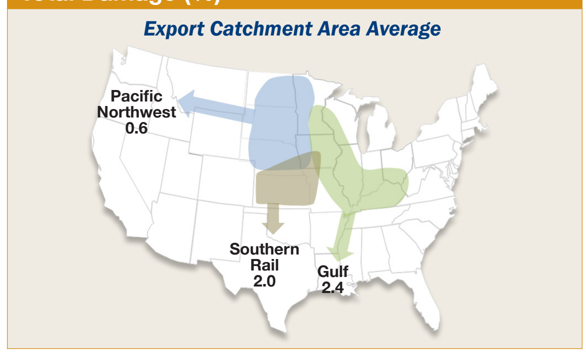
U.S. Grade Total Damage Maximum Limits
No. 1: 3.0%
No. 2: 5.0%
No. 3: 7.0%

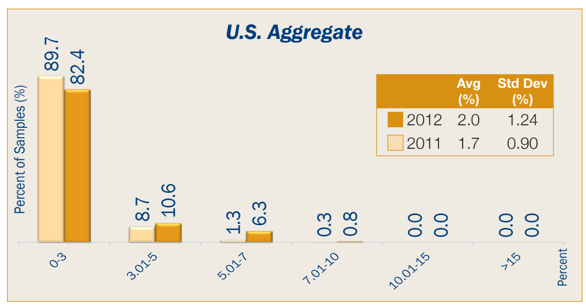
Corn with low levels of total damage is more likely to arrive at destination in good condition than corn with high levels of total damage. High levels of total damage have the potential of increasing moisture and microbiological activity during transport.

HIGHLIGHTS

- U.S. Aggregate total damage at export (2.0%) was higher in 2012/13 than in 2011/12 (1.7%), but still below the limit for U.S. No. 1 corn. Variability was also higher as indicated by the standard deviation and range.
- The average level for total damage increased significantly between the 2012 harvest (0.8%) and the 2012/13 exports (2.0%) but was still below the limit for U.S. No.1.
- 82.4% of the export samples had 3.0% or less damaged kernels – well below the limit for U.S. No. 2 of 5.0%. Only 7.1% of the samples were above the limit for grade 2.
- Total damage was highest in the Gulf ECA, and the increase in total damage between harvest and export was greatest in the Gulf ECA, most likely due to higher moisture corn at harvest.
- Total damage was well below the limits for each contract grade.

Total Damage (%)





4. 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

- Only a few samples showed any heat damage, indicating good management of drying and storage of the corn through the market channel.

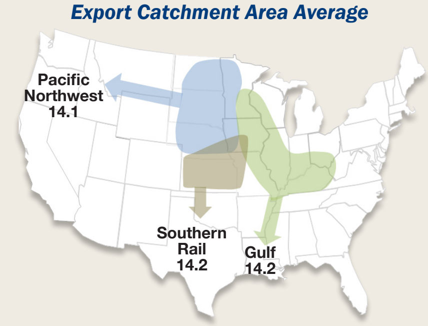
B. Moisture

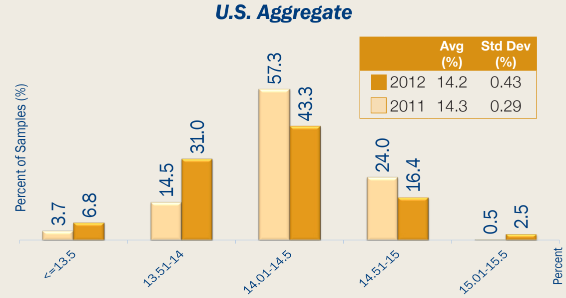
Moisture content is reported on all official grade certificates, but does not determine which numerical grade will be assigned to the sample. Moisture content is usually specified in the contract by the buyer, independent of the grade. Moisture content is important because it affects the amount of dry 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 was only one tenth of a percentage point below that of last year (2011/12), despite the effects of the drought. However, variability was greater in 2012/13 than in 2011/12 (standard deviation of 0.43% in 2012/13 compared to 0.29% in 2011/2012), probably due to the number of extremely low moisture samples this year compared to previous. (6.8% were 13.5% or lower in 2012/13 compared to 3.7% in 2011/12).
- Moisture content decreased between harvest (15.3%) and export (14.2%) as a result of drying and conditioning in the market channel following harvest deliveries.
- Moisture content variability among samples decreased as the corn moved through the market channel as a result of drying and management to meet the export contract specifications.

Moisture (%)





	Avg (%)	Std Dev (%)
2012	14.2	0.43
2011	14.3	0.29

- More than 80% (75.5% last year) of the samples had moisture contents of 14.5% or below, which indicates most cargoes will transport with little microbiological activity.
- Average moisture varied only slightly among ECAs.

III. QUALITY TEST RESULTS

SUMMARY: GRADE FACTORS AND MOISTURE

	2012 Export Cargo					2011 Export Cargo			2012 Harvest				
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	No. of Samples[1]	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate													
Test Weight (lb/bu)	397	58.1	0.82	55.2	61.8	379	57.8*	0.57	637	58.8**	1.21	49.4	62.5
Test Weight (kg/hl)	397	74.8	1.06	71.1	79.5	379	74.4*	0.74	637	75.6**	1.56	63.6	80.4
BCFM (%)	397	2.7	0.68	0.6	5.0	379	3.0*	0.64	637	0.8**	0.53	0.1	5.7
Total Damage (%)	397	2.0	1.24	0.0	9.1	379	1.7*	0.90	637	0.8**	0.72	0.0	12.7
Heat Damage (%)	397	0.0	0.02	0.0	0.4	379	0.0	0.02	637	0.0	0.00	0.0	0.0
Moisture (%)	397	14.2	0.43	12.7	15.2	379	14.3*	0.29	637	15.3**	1.72	8.9	24.7
Gulf													
Test Weight (lb/bu)	284	58.4	0.72	55.7	61.8	261	58.0*	0.51	566	58.8**	1.24	49.4	62.5
Test Weight (kg/hl)	284	75.2	0.93	71.7	79.5	261	74.7*	0.65	566	75.6**	1.59	63.6	80.4
BCFM (%)	284	2.8	0.71	0.6	4.9	261	3.1*	0.71	566	0.8**	0.52	0.1	5.7
Total Damage (%)	284	2.4	1.63	0.3	9.1	261	2.1*	1.08	566	0.9**	0.84	0.0	12.7
Heat Damage (%)	284	0.0	0.03	0.0	0.4	261	0.0	0.02	566	0.0	0.00	0.0	0.0
Moisture (%)	284	14.2	0.46	12.7	15.2	261	14.5*	0.26	566	15.8**	1.81	8.9	24.7
Pacific Northwest													
Test Weight (lb/bu)	106	57.0	0.84	55.2	60.0	83	56.6*	0.82	321	58.8**	1.15	49.4	62.3
Test Weight (kg/hl)	106	73.4	1.08	71.1	77.2	83	72.9*	1.05	321	75.7**	1.48	63.6	80.2
BCFM (%)	106	2.9	0.74	1.3	5.0	83	3.0	0.57	321	0.9**	0.58	0.1	5.6
Total Damage (%)[2]	106	0.6	0.40	0.0	2.0	83	0.6	0.54	321	0.5**	0.40	0.0	4.9
Heat Damage (%)	106	0.0	0.02	0.0	0.2	83	0.0	0.01	321	0.0	0.00	0.0	0.0
Moisture (%)	106	14.1	0.42	12.9	15.1	83	14.0	0.31	321	13.9**	1.42	8.9	21.4
Southern Rail													
Test Weight (lb/bu)	7	58.2	1.33	57.1	60.4	35	58.5	0.50	366	58.6	1.19	49.4	62.4
Test Weight (kg/hl)	7	74.9	1.71	73.5	77.7	35	75.3	0.65	366	75.5	1.53	63.6	80.3
BCFM (%)[2]	7	2.1	0.46	1.3	2.6	35	2.8*	0.30	366	0.9**	0.53	0.1	5.7
Total Damage (%)[2]	7	2.0	0.57	1.2	2.7	35	1.0*	0.50	366	0.7**	0.60	0.0	5.1
Heat Damage (%)	7	0.0	0.00	0.0	0.0	35	0.0	0.04	366	0.0	0.00	0.0	0.0
Moisture (%)	7	14.2	0.33	13.8	14.6	35	14.0	0.44	366	14.7**	1.75	8.9	22.7

** Indicates that the 2011 Export Cargo averages were significantly different from the 2012 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

*** Indicates that the 2012 Harvest averages were significantly different from 2012 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

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

[2]The Relative Margin of Error (ME) for predicting the 2012 Export Cargo population average exceeded ±10%.

III. QUALITY TEST RESULTS

SUMMARY: GRADE FACTORS AND MOISTURE

	Export Cargo Samples for Contract Loaded as U.S. No. 2 o/b					Export Cargo Samples for Contract 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)	256	58.0	0.78	55.2	60.4	119	58.2	0.74	56.4	61.8
Test Weight (kg/hl)	256	74.7	1.00	71.1	77.7	119	75.0	0.95	72.6	79.5
BCFM (%)	256	2.6	0.56	0.6	4.8	119	3.3	0.69	1.1	5.0
Total Damage (%)	256	2.1	1.27	0.0	7.8	119	1.9	1.29	0.1	9.1
Heat Damage (%)	256	0.0	0.02	0.0	0.4	119	0.0	0.01	0.0	0.2
Moisture (%)	256	14.1	0.42	12.7	15.2	119	14.2	0.44	12.9	15.1
Gulf										
Test Weight (lb/bu)	176	58.3	0.62	55.7	59.9	86	58.6	0.84	56.9	61.8
Test Weight (kg/hl)	176	75.0	0.79	71.7	77.1	86	75.4	1.08	73.2	79.5
BCFM (%)	176	2.7	0.53	0.6	4.5	86	3.3	0.69	1.1	4.9
Total Damage (%)	176	2.6	1.67	0.3	7.8	86	2.3	1.59	0.4	9.1
Heat Damage (%)	176	0.0	0.04	0.0	0.4	86	0.0	0.00	0.0	0.0
Moisture (%)	176	14.1	0.43	12.7	15.2	86	14.3	0.47	12.9	15.1
Pacific Northwest										
Test Weight (lb/bu)	73	56.9	0.96	55.2	60.0	33	57.2	0.43	56.4	58.5
Test Weight (kg/hl)	73	73.3	1.23	71.1	77.2	33	73.6	0.55	72.6	75.3
BCFM (%)	73	2.7	0.71	1.3	4.8	33	3.2	0.68	1.8	5.0
Total Damage (%)	73	0.6	0.42	0.0	2.0	33	0.5	0.34	0.1	1.9
Heat Damage (%)	73	0.0	0.00	0.0	0.0	33	0.0	0.04	0.0	0.2
Moisture (%)	73	14.0	0.44	12.9	15.1	33	14.2	0.32	13.1	14.8
Southern Rail										
Test Weight (lb/bu)	7	58.2	1.33	57.1	60.4	0	0.0	0.00	0.0	0.0
Test Weight (kg/hl)	7	74.9	1.71	73.5	77.7	0	0.0	0.00	0.0	0.0
BCFM (%)	7	2.1	0.46	1.3	2.6	0	0.0	0.00	0.0	0.0
Total Damage (%)	7	2.0	0.57	1.2	2.7	0	0.0	0.00	0.0	0.0
Heat Damage (%)	7	0.0	0.00	0.0	0.0	0	0.0	0.00	0.0	0.0
Moisture (%)	7	14.2	0.33	13.8	14.6	0	0.0	0.00	0.0	0.0

III. QUALITY TEST RESULTS

C. Chemical Composition

The components of protein, starch and oil are related to corn's nutritional value for livestock and poultry feeding, for wet milling uses, and other processing uses of corn. The relative value of these components varies for different uses of corn. In general, starch and protein have an inverse relationship in corn – more of one means less of the other. Unlike many physical attributes, chemical composition values were not expected to change significantly during storage or transport.

SUMMARY: CHEMICAL COMPOSITION

- *Protein content in 2012/13 export samples averaged 9.2% and was significantly higher than the 8.7% found for the 2011/12 export samples.*
- *Protein was significantly higher for samples from the Pacific Northwest than those at the Gulf and Southern Rail.*
- *Starch content averaged 73.5% in 2012/13 and was lower than the 74.1% found in the 2011/12 samples.*
- *Oil content (3.7%) in the 2012/13 samples was higher than the 3.6% found for the 2011/12 export samples and was the same across all ECAs.*
- *Protein, starch and oil all had narrower ranges and lower standard deviations at export than at the harvest level.*

III. QUALITY TEST RESULTS

1. Protein

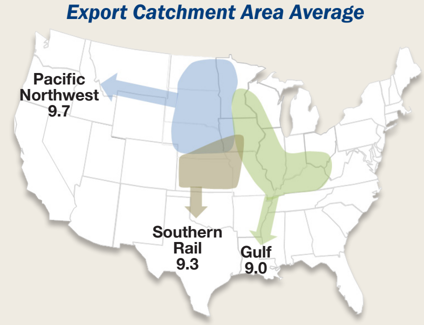
Protein is very important for poultry and livestock feeding. It helps with feeding efficiency and supplies essential sulfur-containing amino acids. Protein is usually inversely related to starch content. Results are reported on a dry basis.

HIGHLIGHTS

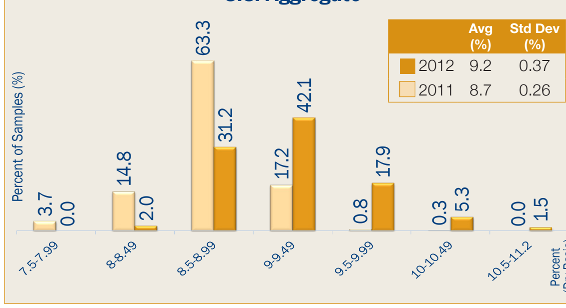
- U.S. Aggregate protein in 2012/13 was 9.2%, significantly higher than the 8.7% found in the 2011/12 samples.
- The protein content at export (9.2%) was lower than at harvest (9.4%). However, protein content at export (standard deviation of 0.37%) was more uniform than at harvest (standard deviation of 0.66%).
- Protein content in 2012/13 export samples was distributed with 67% at or above 9%, compared to 18% of the 2011/12 export samples.
- The Pacific Northwest ECA had higher average protein than that found at the Gulf and Southern Rail ECAs.
- Protein averages were slightly higher for contracts loaded as U.S. No. 2 o/b (9.2%) than those loaded as U.S. No. 3 o/b (9.1%).

Protein (%)

Export Catchment Area Average



U.S. Aggregate



	Avg (%)	Std Dev (%)
2012	9.2	0.37
2011	8.7	0.26

III. QUALITY TEST RESULTS

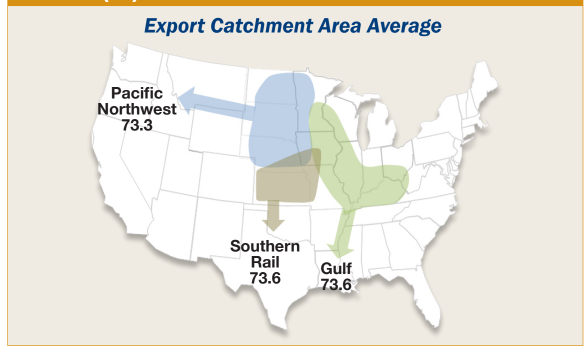
2. Starch

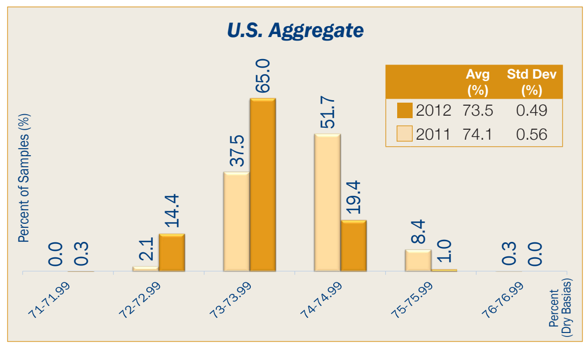
Starch is an important factor for corn used by wet millers and dry-grind ethanol manufacturers. High starch content is often indicative of good kernel maturation/filling conditions and reasonably high kernel densities. Starch is usually inversely related to protein content. Results are reported on a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

HIGHLIGHTS

- U.S. Aggregate starch in 2012/13 was 73.5%, lower than the 74.1% found in the 2011/12 samples.
- The starch level at export (73.5%) was higher than at harvest (73.0%). However, starch content at export (standard deviation of 0.49%) was more uniform with a slightly lower standard deviation, than in the harvest samples (standard deviation of 0.67%).
- Gulf samples were significantly higher in starch than the Pacific Northwest samples. Note that starch and protein contents were both inversely related and significantly different between the Gulf and Pacific Northwest.
- Starch in contracts loaded as U.S. No. 2 o/b (73.5%) was lower than in contracts loaded as U.S. No. 3 o/b (73.7%). This is the opposite for protein and consistent with the inverse relationship between starch and protein.

Starch (%)





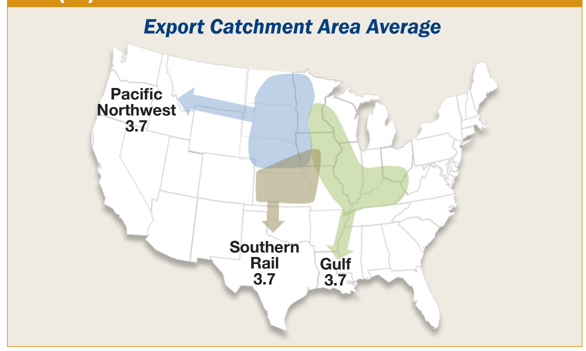
3. Oil

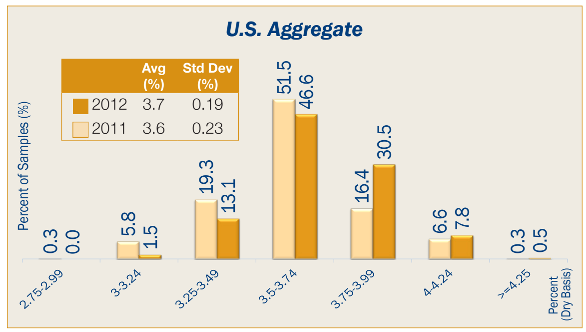
Oil is an essential component of poultry and livestock rations. It serves as an energy source, enables fat-soluble vitamins to be utilized, and provides certain essential fatty acids. Oil is also an important by-product of corn wet and dry milling. Results are reported on a dry basis.

HIGHLIGHTS

- U.S. Aggregate oil content in 2012/13 was 3.7%, higher than the 3.6% in 2011/12.
- The average oil content at export (3.7%) was unchanged from harvest for the 2012 crop. However, oil content at export (standard deviation of 0.19%) was more uniform with a slightly lower standard deviation than at harvest (standard deviation of 0.34%).
- Oil averages for the Gulf, Pacific Northwest, and Southern Rail ECAs were each 3.7%.
- About 85% of the 2012/13 export samples contained at least 3.5% oil, in contrast to 75% of the 2011/12 export samples.
- The average oil content for contracts loaded as U.S. No. 2 o/b was 3.7% which was the same as for contracts loaded as U.S. No. 3 o/b.

Oil (%)





III. QUALITY TEST RESULTS

SUMMARY: CHEMICAL COMPOSITION

	2012 Export Cargo					2011 Export Cargo			2012 Harvest				
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	No. of Samples[1]	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate													
Protein (Dry Basis %)	397	9.2	0.37	8.1	11.2	379	8.7*	0.26	637	9.4**	0.66	7.0	12.4
Starch (Dry Basis %)	397	73.5	0.49	71.8	75.3	379	74.1*	0.56	637	73.0**	0.67	70.6	75.6
Oil (Dry Basis %)	397	3.7	0.19	3.1	4.3	379	3.6*	0.23	637	3.7**	0.34	1.7	5.5
Gulf													
Protein (Dry Basis %)	284	9.0	0.32	8.1	9.8	261	8.7*	0.21	566	9.3**	0.66	7.0	11.6
Starch (Dry Basis %)	284	73.6	0.51	72.1	75.2	261	74.2*	0.56	566	73.1**	0.67	70.6	75.6
Oil (Dry Basis %)	284	3.7	0.21	3.1	4.3	261	3.6*	0.24	566	3.8**	0.35	1.7	5.5
Pacific Northwest													
Protein (Dry Basis %)	106	9.7	0.50	8.6	11.2	83	8.4*	0.42	321	9.4**	0.67	7.0	12.4
Starch (Dry Basis %)	106	73.3	0.62	71.8	75.3	83	74.2*	0.61	321	72.8**	0.66	70.6	75.1
Oil (Dry Basis %)	106	3.7	0.22	3.2	4.3	83	3.6*	0.19	321	3.7	0.31	1.7	4.9
Southern Rail													
Protein (Dry Basis %)	7	9.3	0.42	8.5	9.7	35	9.1	0.29	366	9.5	0.64	7.0	11.6
Starch (Dry Basis %)	7	73.6	0.16	73.5	74.0	35	73.6	0.45	366	72.9**	0.68	70.6	75.1
Oil (Dry Basis %)	7	3.7	0.09	3.6	3.9	35	3.8	0.24	366	3.7	0.32	1.7	4.9

** Indicates that the 2011 Export Cargo averages were significantly different from the 2012 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

*** Indicates that the 2012 Harvest averages were significantly different from 2012 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

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

SUMMARY: CHEMICAL COMPOSITION

	Export Cargo Samples for Contract Loaded as U.S. No. 2 o/b					Export Cargo Samples for Contract 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 %)	256	9.2	0.38	8.1	11.2	119	9.1*	0.33	8.3	10.4
Starch (Dry Basis %)	256	73.5	0.48	71.8	75.2	119	73.7*	0.51	72.0	75.3
Oil (Dry Basis %)	256	3.7	0.19	3.1	4.3	119	3.7	0.20	3.1	4.3
Gulf										
Protein (Dry Basis %)	176	9.0	0.32	8.1	9.8	86	9.1*	0.32	8.3	9.8
Starch (Dry Basis %)	176	73.6	0.52	72.1	75.2	86	73.7	0.46	72.5	75.2
Oil (Dry Basis %)	176	3.7	0.20	3.1	4.3	86	3.7	0.19	3.1	4.2
Pacific Northwest										
Protein (Dry Basis %)	73	9.7	0.56	8.6	11.2	33	9.1*	0.36	8.7	10.4
Starch (Dry Basis %)	73	73.3	0.58	71.8	75.2	33	73.7*	0.70	72.0	75.3
Oil (Dry Basis %)	73	3.7	0.21	3.2	4.2	33	3.7	0.23	3.3	4.3
Southern Rail										
Protein (Dry Basis %)	7	9.3	0.42	8.5	9.7	0	0.00	0.00	0.0	0.0
Starch (Dry Basis %)	7	73.6	0.16	73.5	74.0	0	0.00	0.00	0.0	0.0
Oil (Dry Basis %)	7	3.7	0.09	3.6	3.9	0	0.00	0.00	0.0	0.0

** Indicates the averages for samples with Grade "3" or "3 or Better" were significantly different from the averages for the samples with Grade "2" or "2 or Better", based on a 2-tailed t-test at the 95% level of significance.*

III. QUALITY TEST RESULTS

D. Physical Factors

Other physical attributes of corn kernels also affect corn's processability, storability and ability to withstand handling. Physical factors such as stress cracks, kernel weight, volume and density, percent whole kernels and percent horneous (hard) endosperm are influenced by genetics as well as by growing and handling conditions. Corn kernels are made up of four parts, the germ or embryo, the tip cap, the pericarp or outer covering, and the endosperm. The endosperm represents about 82% of the kernel and consists of soft (also referred to as floury or opaque) endosperm and 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.

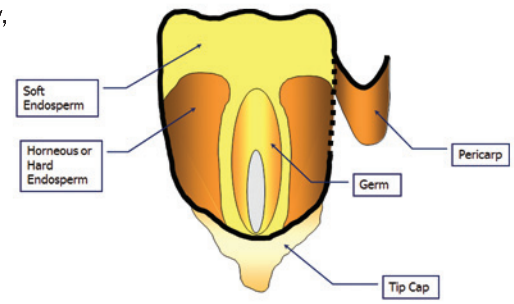


Illustration courtesy of K. D. Rausch University of Illinois

SUMMARY: PHYSICAL FACTORS

- *The low levels of stress cracks (9%) in the 2012/13 export 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 (1.297 g/cm^3) were higher for export samples than harvest samples. For the export samples, 95% had kernel true densities equal to or above 1.275 g/cm^3, which was higher than the 88% found in 2011/12. Both true densities and test weights were significantly higher for the 2012/13 export samples than for the 2011/12 export samples.*
- *The relatively high whole kernels (89.9%) in combination with the low stress cracks (9%) at export indicate the corn should have reduced breakage during loading and discharge of the cargo.*
- *Kernel volumes and 100-kernel weights were significantly higher for the 2012/13 export samples than for the 2011/12 export samples, indicating slightly larger kernel sizes in 2012/13 corn exports.*

1. Stress Cracks and Stress Cracks Index (SCI)

Stress cracks are internal fissures in the horneous (hard) endosperm of a corn kernel. The pericarp (or outer covering) of a stress-cracked kernel is typically not damaged, so the 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 moisture and temperature differences 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. Stress cracks affect corn in various ways:

- In 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.
- 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.

High-temperature drying is the most common cause of stress cracks. Growing conditions 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 on metal during handling may cause new cracks in kernels. As a result, the percentage of kernels with stress cracks may not remain constant through the merchandising channel.

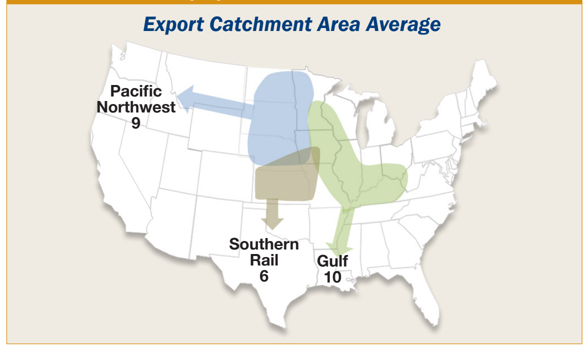
Stress crack measurements include "stress cracks" (the percent of kernels with at least one crack) and stress crack index (SCI) which is the weighted average of single, double and multiple stress cracks. "Stress cracks" measures the number of kernels with stress cracks whereas SCI shows the severity of cracking. For example, if half the kernels have only single stress cracks, "stress cracks" is 50% and the SCI is 50 (50 x 1). However, if half of the kernels have multiple stress cracks (more than 2 cracks), indicating a higher potential for handling issues, "stress cracks" remain at 50% but the SCI becomes 250 (50 x 5). Lower values for "stress cracks" and the SCI are always better. Multiple stress cracks are generally more detrimental to quality changes than single stress cracks.

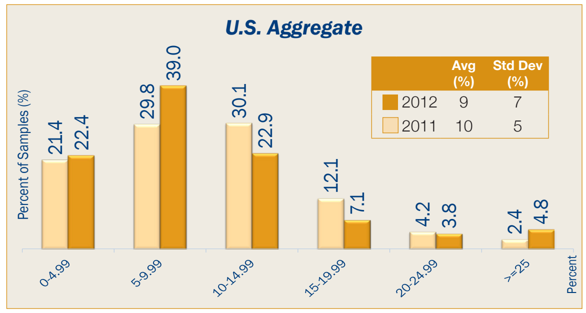
III. QUALITY TEST RESULTS

HIGHLIGHTS

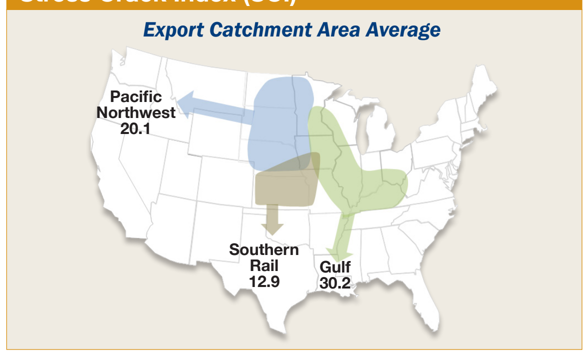
- The relatively low levels of stress cracks observed for 2012 corn should indicate reduced rates of breakage when corn is loaded and discharged, improved wet milling starch recovery, improved dry milling yields of flaking grits, and good alkaline processability.
- U.S. Aggregate stress cracks in the 2012/13 export samples was 9%, not significantly different from the 2011/12 export samples (10%).
- Stress cracks at export was higher than the stress cracks found at harvest (4%) but was still at a very low level.
- Stress cracks ranged from 0 to 65% with a standard deviation of 7%.
- About 91% of the export samples had less than 20% of their kernels with stress cracks. While this was lower than the 97% of the harvest samples with less than 20% stress cracks, it indicates the corn should still handle very well with relatively low amounts of breakage.
- Stress crack percentages for contracts loaded as U.S. No. 2 o/b were 8%, significantly lower than the 10% in contracts loaded as U.S. No. 3 o/b.
- SCI average of 25.9 in 2012/13 export samples was lower than the 30.8 found with the 2011/12 export samples. At export, 82% of the samples had SCI of less than 40, indicating relatively few kernels had double or multiple stress cracks.
- U.S. Aggregate SCI for contracts loaded as U.S. No. 2 o/b were 21.9, significantly lower than the 28.7 found for contracts loaded as U.S. No. 3 o/b.

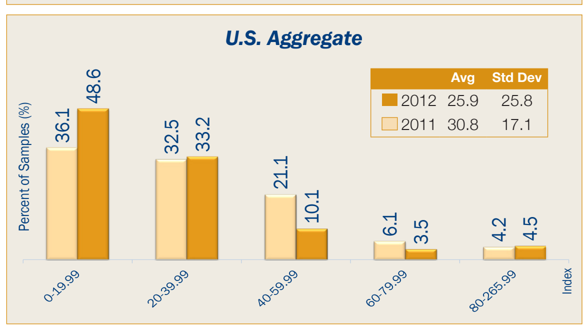
Stress Cracks (%)





Stress Crack Index (SCI)





2. 100-Kernel Weight

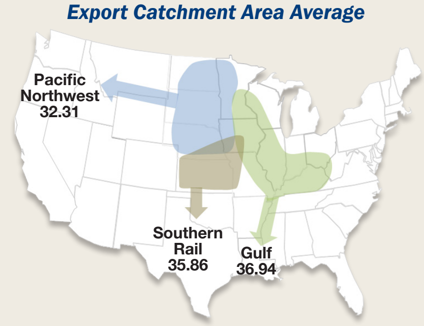
100-kernel (100-k) weight (reported in grams) indicates larger kernel size as 100-k weights increase. Large kernels may take longer to dry than smaller kernels and large uniform-sized kernels often enable higher flaking grit yields in dry milling. Kernel weights tend to be higher for varieties with high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

HIGHLIGHTS

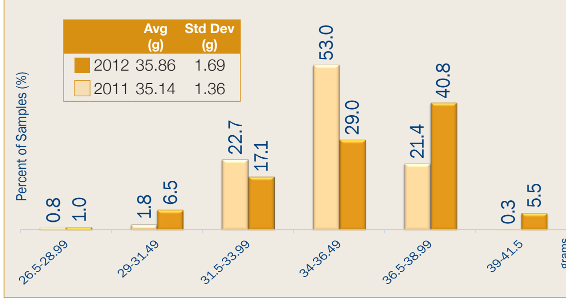
- 100-k weight averaged 35.86 g for U.S. Aggregate export corn with a range of 26.66 to 41.45 g. The export samples had greater uniformity than the harvest level corn as indicated by a tighter range and lower standard deviation.
- The 100-k weights were lower for the Pacific Northwest ECA with 32.31 g than the Gulf or Southern Rail ECAs.
- About 46% of the 2012/13 export samples had 100-k weights of 36.5 g or greater, which was much higher than the 2011/12 export samples (22%).

100-k Weight (g)

Export Catchment Area Average



U.S. Aggregate



III. QUALITY TEST RESULTS

3. Kernel Volume

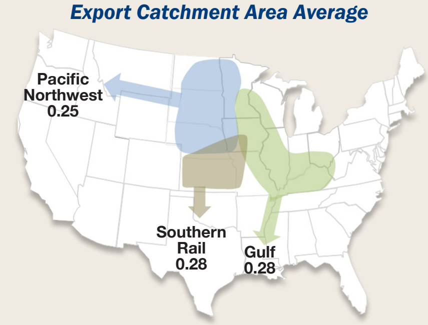
Kernel volume in cubic centimeter (cm^3) is often indicative of growing conditions. If conditions are dry, kernels may be smaller than average. If drought hits later in the season, kernels may have lower fill. Small or round kernels are more difficult to degerm. Additionally, small kernels may lead to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

HIGHLIGHTS

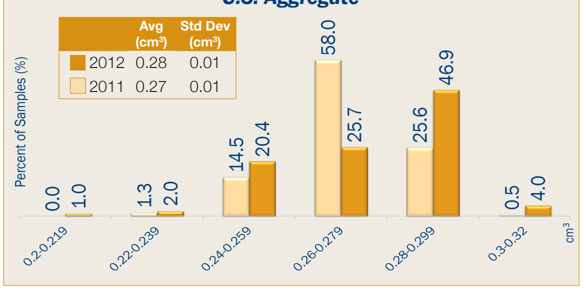
- Kernel volume averaged 0.28 cm^3 for U.S. Aggregate 2012/13 export samples, higher than the 0.27 cm^3 found in the 2011/12 export samples. Kernel volume ranged from 0.21 to 0.32 cm^3.
- The range and standard deviations were less in the 2012/13 export samples than for the 2012 harvest samples, indicating greater uniformity.
- The kernel volumes were smaller (0.25 cm^3) for the Pacific Northwest than for the Gulf and Southern Rail ECAs (0.28 cm^3).
- About 77% of the export samples had kernel volumes equal to or greater than 0.26 cm^3.

Kernel Volume (cm^3)

Export Catchment Area Average



U.S. Aggregate



4. Kernel True Density

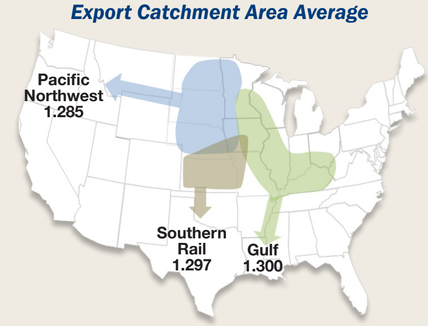
Kernel true density is calculated as the weight of a 100-k sample divided by the volume, or displacement, of those 100 kernels and is reported as g/cm^3. True density is a relative indicator of kernel hardness, which is useful for alkaline processors and dry millers. True density may be affected by the genetics of the corn hybrid and the growing environment. Corn with higher density is typically less susceptible to breakage in handling than lower density corn, but 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.

HIGHLIGHTS

- Kernel true densities averaged 1.297 g/cm^3 for U.S. Aggregate export corn, significantly higher than the 1.291 g/cm^3 found in 2011/12 exports.
- Kernel true densities at export were higher than the 1.276 g/cm^3 found for harvest corn. This apparent increase in true density is likely due in part to lower moisture at export (14.2% compared to 15.3% for harvest samples) and because true density tests were performed on only whole, fully intact kernels.
- For the export samples, 95% had kernel true densities equal to or above 1.275 g/cm^3, which was higher than the 88% found in 2011/12.
- Among ECAs, Pacific Northwest with 1.285 g/cm^3 had the lowest average true density among ECAs. The Gulf and Southern Rail ECAs had significantly higher kernel densities than the Pacific Northwest ECA.

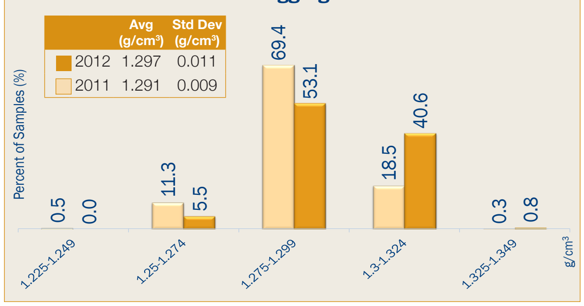
Kernel True Density (g/cm^3)

Export Catchment Area Average



U.S. Aggregate

	Avg (g/cm^3)	Std Dev (g/cm^3)
2012	1.297	0.011
2011	1.291	0.009



III. QUALITY TEST RESULTS

5. 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 weight percentage of material passing through a screen. Whole kernels, as the name implies, is the percent of fully intact kernels in the sample that have their pericarp fully intact.

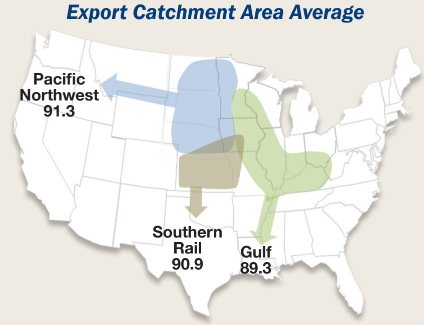
The exterior seedcoat or pericarp of the corn kernel is very important for two key reasons. First, any breaks in the kernel pericarp affect water absorption for alkaline cooking operations. Kernel nicks or cracks allow water to enter the kernel faster than for fully intact or whole kernels. Too much 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

- U.S. Aggregate whole kernels averaged 89.9%, and was higher than in the 2011/12 export samples (87.5%).
- The percent of whole kernels at export was lower than whole kernels found at harvest (94.4%).
- Whole kernel averages for Gulf, Pacific Northwest, and Southern Rail were 89.3%, 91.3%, and 90.9%, respectively.
- Over half (51%) of the 2012/13 export samples had whole kernel percentages greater than or equal to 90%, compared to 26% of the 2011/12 export samples.
- The whole kernel percentages for contracts loaded as U.S. No. 2 o/b were 90.0%, essentially the same as those found for contracts loaded as U.S. No. 3 o/b.

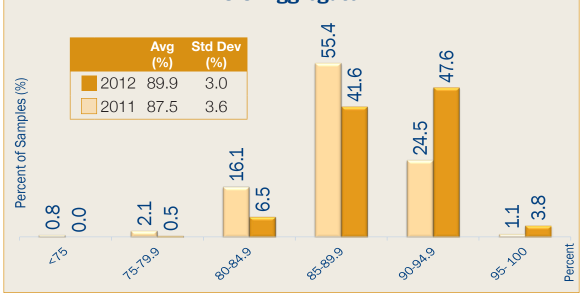
Whole Kernels (%)

Export Catchment Area Average



U.S. Aggregate

	Avg (%)	Std Dev (%)
2012	89.9	3.0
2011	87.5	3.6



6. Horneous (Hard) Endosperm

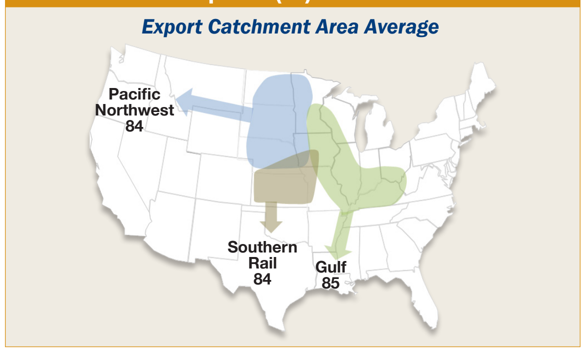
The horneous (hard) endosperm test measures the percent of horneous or hard endosperm out of the total endosperm in a kernel, with a potential value from 70 to 100%. The greater the amount of horneous endosperm relative to soft endosperm, the harder the corn kernel is said to be. The degree of hardness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

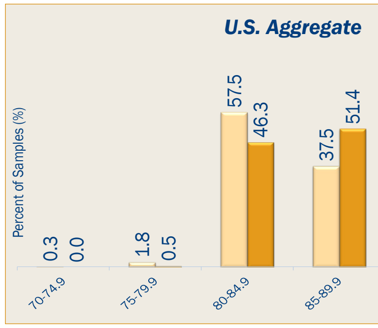
Hardness has been correlated to breakage susceptibility, feed utilization/efficiency and starch digestibility. There is no good or bad value for horneous endosperm; there is only a preference by different end users for particular ranges. Many dry millers and alkaline cookers would like greater than 90%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

HIGHLIGHTS

- U.S. Aggregate horneous endosperm averaged 85% and was higher than the 84% found for the 2011/12 export samples. The 2012/13 export samples ranged from 80 to 94% and had a smaller range and standard deviation than the 2012 harvest samples.
- Horneous endosperm averages ranged between 84% and 85% among the ECAs.
- Horneous endosperm percentages were lower (85%) for contracts loaded as U.S. No. 2 o/b than those loaded as U.S. No. 3 o/b (86%).
- At the export, 99.5% of the samples had greater than 80% horneous endosperm in contrast to harvest samples where 86.7% had greater than 80% horneous endosperm.

Horneous Endosperm (%)





	Avg (%)	Std Dev (%)
2012	85	2
2011	84	3

III. QUALITY TEST RESULTS

SUMMARY: PHYSICAL FACTORS

	2012 Export Cargo					2011 Export Cargo			2012 Harvest				
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	No. of Samples[1]	Avg.	Std. Dev.	Min.	Max.
U.S. Aggregate													
Stress Cracks (%)	397	9	7	0	65	379	10	5	637	4**	5	0	63
Stress Crack Index	397	25.9	25.8	0	265	379	30.8*	17.1	637	9.3**	14.1	0	217
100-Kernel Weight (g)	397	35.86	1.69	26.66	41.45	379	35.14*	1.36	637	34.53**	2.76	17.49	45.39
Kernel Volume (cm^3)	397	0.28	0.01	0.21	0.32	379	0.27*	0.01	637	0.27**	0.02	0.14	0.35
True Density (g/cm^3)	397	1.297	0.011	1.264	1.335	379	1.291*	0.009	637	1.276**	0.017	1.199	1.332
Whole Kernels (%)	397	89.9	3.0	79.0	97.6	379	87.5*	3.6	637	94.4**	3.4	68.0	100.0
Horneous Endosperm (%)	397	85	2	80	94	379	84*	3	637	85	4	74	97
Gulf													
Stress Cracks (%)	284	10	8	0	65	261	12*	5	566	4**	5	0	63
Stress Crack Index	284	30.2	31.5	0	265	261	40.0*	20.9	566	9.9**	15.5	0	217
100-Kernel Weight (g)	284	36.94	1.50	31.20	41.45	261	35.53*	1.32	566	34.79**	2.78	17.49	45.39
Kernel Volume (cm^3)	284	0.28	0.01	0.24	0.32	261	0.27*	0.01	566	0.27**	0.02	0.14	0.35
True Density (g/cm^3)	284	1.300	0.011	1.268	1.335	261	1.295*	0.009	566	1.276**	0.017	1.199	1.332
Whole Kernels (%)	284	89.3	3.0	79.0	96.8	261	87.5*	3.7	566	94.4**	3.5	68.0	100.0
Horneous Endosperm (%)	284	85	2	80	94	261	84*	3	566	85	4	74	97
Pacific Northwest													
Stress Cracks (%)[2]	106	9	6	0	40	83	5*	3	321	4**	4	0	55
Stress Crack Index[2]	106	20.1	18.5	0	138	83	12.3*	8.5	321	8.5**	11.5	0	130
100-Kernel Weight (g)	106	32.31	1.92	26.66	37.81	83	33.02*	1.50	321	34.07**	2.51	17.49	45.39
Kernel Volume (cm^3)	106	0.25	0.01	0.21	0.29	83	0.26*	0.01	321	0.27**	0.02	0.14	0.35
True Density (g/cm^3)	106	1.285	0.012	1.264	1.324	83	1.276*	0.011	321	1.277**	0.016	1.199	1.323
Whole Kernels (%)	106	91.3	3.1	81.8	97.6	83	88.9*	3.0	321	94.1**	3.3	68.0	99.4
Horneous Endosperm (%)	106	84	2	80	89	83	85	2	321	86**	4	74	97
Southern Rail													
Stress Cracks (%)[2]	7	6	4	2	12	35	4	3	366	3**	4	0	58
Stress Crack Index[2]	7	12.9	8.3	4	24	35	9.8	10.2	366	7.2	10.6	0	174
100-Kernel Weight (g)	7	35.86	2.31	33.14	38.77	35	37.00	1.29	366	33.89**	3.07	17.49	45.39
Kernel Volume (cm^3)	7	0.28	0.02	0.25	0.30	35	0.29	0.01	366	0.27	0.02	0.14	0.35
True Density (g/cm^3)	7	1.297	0.010	1.282	1.309	35	1.295	0.006	366	1.275**	0.016	1.199	1.328
Whole Kernels (%)	7	90.9	2.8	88.0	94.6	35	85.2*	4.1	366	94.7**	2.9	68.0	99.6
Horneous Endosperm (%)	7	84	2	81	88	35	84	2	366	85	4	74	97

** Indicates that the 2011 Export Cargo averages were significantly different from the 2012 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

*** Indicates that the 2012 Harvest averages were significantly different from 2012 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

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

[2]The Relative Margin of Error (ME) for predicting the 2012 Export Cargo population average exceeded ±10%.

SUMMARY: PHYSICAL FACTORS

	Export Cargo Samples for Contract Loaded as U.S. No. 2 o/b					Export Cargo Samples for Contract 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 (%)	256	8	6	0	50	119	10*	7	0	40
Stress Crack Index	256	21.9	20.8	0	214	119	28.7*	22.7	0	146
100-Kernel Weight (g)	256	35.93	1.71	26.66	39.85	119	35.80	1.36	30.70	40.59
Kernel Volume (cm^3)	256	0.28	0.01	0.21	0.31	119	0.28	0.01	0.24	0.31
True Density (g/cm^3)	256	1.297	0.010	1.264	1.335	119	1.297	0.011	1.266	1.335
Whole Kernels (%)	256	90.0	3.1	79.0	97.6	119	89.6	2.9	81.2	97.2
Horneous Endosperm (%)	256	85	2	80	91	119	86*	2	80	94
Gulf										
Stress Cracks (%)	176	9	6	0	50	86	10	7	0	40
Stress Crack Index	176	25.0	23.7	0	214	86	28.7	24.8	0	146
100-Kernel Weight (g)	176	37.02	1.43	31.20	39.85	86	35.80*	1.53	33.52	40.59
Kernel Volume (cm^3)	176	0.28	0.01	0.24	0.31	86	0.28*	0.01	0.26	0.31
True Density (g/cm^3)	176	1.300	0.010	1.273	1.335	86	1.297*	0.012	1.268	1.335
Whole Kernels (%)	176	89.3	3.0	79.0	96.8	86	89.6	3.0	81.2	96.0
Horneous Endosperm (%)	176	85	2	80	91	86	86	3	80	94
Pacific Northwest										
Stress Cracks (%)	73	8	6	1	40	33	10*	6	0	24
Stress Crack Index	73	17.5	19.1	1	138	33	28.7*	15.9	0	64
100-Kernel Weight (g)	73	32.42	2.25	26.66	37.81	33	35.80*	0.81	30.70	34.12
Kernel Volume (cm^3)	73	0.25	0.02	0.21	0.29	33	0.28*	0.01	0.24	0.26
True Density (g/cm^3)	73	1.285	0.012	1.264	1.324	33	1.297*	0.011	1.266	1.315
Whole Kernels (%)	73	91.4	3.3	81.8	97.6	33	89.6*	2.8	82.8	97.2
Horneous Endosperm (%)	73	84	2	80	88	33	86*	2	81	89
Southern Rail										
Stress Cracks (%)	7	6	4	2	12	0	0	0	0	0
Stress Crack Index	7	12.9	8.3	4	24	0	0.0	0.0	0	0
100-Kernel Weight (g)	7	35.86	2.31	33.14	38.77	0	0.00	0.00	0.00	0.00
Kernel Volume (cm^3)	7	0.28	0.02	0.25	0.30	0	0.00	0.00	0.00	0.00
True Density (g/cm^3)	7	1.297	0.010	1.282	1.309	0	0.000	0.000	0.000	0.000
Whole Kernels (%)	7	90.9	2.8	88.0	94.6	0	0.0	0.0	0.0	0.0
Horneous Endosperm (%)	7	84	2	81	88	0	0	0	0	0

** Indicates the averages for samples with Grade "3" or "3 or Better" were significantly different from the averages for the samples with Grade "2" or "2 or Better", based on a 2-tailed t-test at the 95% level of significance.*

III. QUALITY TEST RESULTS

E. 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 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 – are 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 USDA Federal Grain Inspection Service (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.

1. Aflatoxins Testing Results

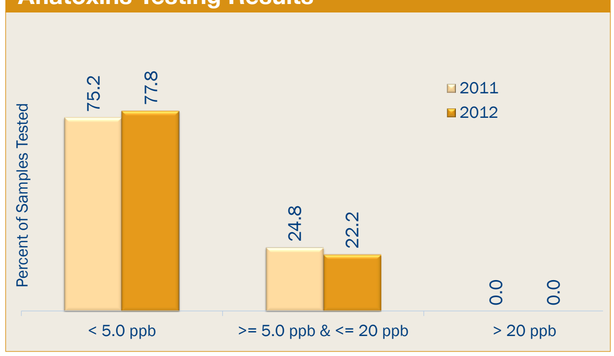
FGIS tested all 397 samples for the *Export Cargo Report 2012/13* for aflatoxins. Results of the 2012/13 survey are as follows:

- 309 or 77.8%, of the samples had no detectable levels of aflatoxins (less than 5.0 ppb, the FGIS lower reporting level). For the 2011/12 report, 75.2% of the samples tested had no detectable levels of aflatoxins.
- 88 samples or 22.2%, of the samples showed aflatoxins in levels greater than or equal to 5.0 ppb but less than the FDA action level of 20 ppb, compared to 24.8% of the samples tested for the 2011/12 exports.
- 100% of the export samples tested were below or equal to the FDA action level of 20 ppb, the same percentage as for the 2011/12 export samples tested.

Aflatoxins

	Percent of Total Samples			
	< 5 ppb	≥ 5 to ≤ 20 ppb	> 20 ppb	Total
U.S. Aggregate	77.8%	22.2%	0.0%	100.0%
By ECA				
Gulf	70.8%	29.2%	0.0%	100.0%
Pacific Northwest	100.0%	0.0%	0.0%	100.0%
Southern Rail	28.6%	71.4%	0.0%	100.0%

Aflatoxins Testing Results

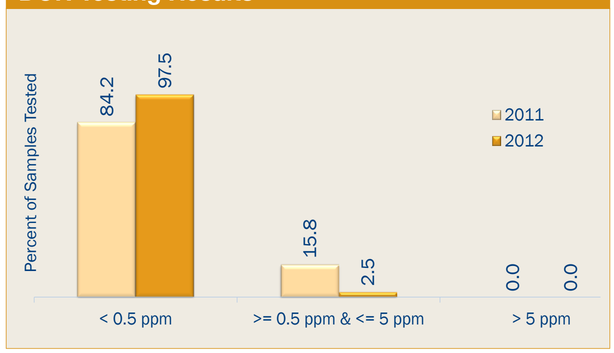


2. DON (Deoxynivalenol or Vomitoxin) Testing Results

All 397 samples for the *Export Cargo Report 2012/13* were tested for DON. Results of the testing are shown below:

- 387 samples (97.5%) had less than 0.5 ppm of DON compared to 84.2% of the 2011/12 export samples.
- 10 samples, or 2.5% of the samples, tested greater than or equal to 0.5 ppm, but less than or equal to the FDA advisory level of 5 ppm. For the 2011/12 export samples, 15.8% of the samples had detectable DON levels in the same range.
- 100% of the samples tested below or equal to the FDA advisory level of 5 ppm, the same percentage as for the 2011/12 export samples.

DON				
	Percent of Total Samples			
	< 0.5 ppm	≥ 0.5 to ≤ 5.0 ppm	> 5.0 ppm	Total
U.S. Aggregate	97.5%	2.5%	0.0%	100.0%
By ECA				
Gulf	96.8%	3.2%	0.0%	100.0%
Pacific Northwest	100.0%	0.0%	0.0%	100.0%
Southern Rail	85.7%	14.3%	0.0%	100.0%



3. Mycotoxin Background: General

The levels at which the fungi produce mycotoxins are influenced by the fungus type and the environmental conditions under which the corn is produced and stored.

Because of these differences, mycotoxin production varies across the U.S. corn-producing areas and across years.

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.

4. 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.

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

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.

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

5. 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 *Fusarium*, 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 are 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.

IV. U.S. CORN EXPORT SYSTEM

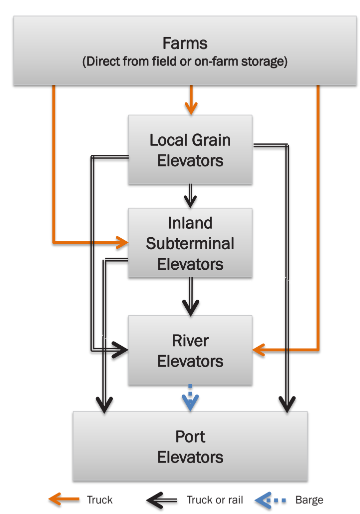
This *U.S. Grains Council Corn Export Cargo Quality Report 2012/13* provides advance information about corn quality by evaluating and reporting quality attributes when the corn is ready to be loaded onto the vessel or rail car for export. Corn quality includes a range of attributes that can be categorized 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. Some 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 cleaning, drying and conditioning) at each step in the channel to increase uniformity and to prevent or minimize the loss of physical and sanitary quality. The *Harvest Report 2012/13* assessed the quality of the 2012 corn crop as it entered the marketing system and reported the crop as favorable in terms of high test weight, high protein, relatively high kernel densities and uniformly low moistures. This *Export Cargo Report* provides information on the impact of the subsequent practices including cleaning, drying, handling, blending, storing, and transporting on the crop at the point where it is being loaded for export. To provide the backdrop for this assessment, the following sections describe the market channel from farm to export, 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.

A. U.S. Export Corn Flow

As corn is harvested, farmers transport grain to on-farm storage, end users, or commercial grain facilities. While some producers feed their corn 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 local grain elevators, inland subterminal or river elevators, and port elevators. Local grain elevators typically receive most of their grain directly from farmers. Inland subterminal or river elevators collect grains in quantities suitable for loading on unit trains and barge tows for further transport. These elevators receive more than half of their corn from other elevators (usually local grain elevators) and are often located where the transport of bulk grain can be easily accommodated by unit trains or barges. Local grain, inland subterminal and river elevators provide functions such as drying, cleaning, blending, storing and merchandising grain. River elevators and the larger inland subterminals supply most of the corn destined for export markets. The figure to the right conveys the flow of U.S. corn destined for export markets.



B. Impact of the Corn Market Channel on Quality

While the U.S. corn industry strives to minimize changes in the physical and sanitary quality attributes as corn moves from the farm to export, there are points in the system where quality changes inevitably occur due to the biological nature of the grain. The following sections provide some insight on why corn quality may change as corn moves from the field to the ocean vessel or rail car.

1. Drying and Conditioning

Farmers often harvest corn at moistures ranging from about 18 to 30%. This range of moisture contents exceeds safe storage levels which are usually about 14 to 15%. Thus, wet corn at harvest must be dried to a lower moisture to become 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 methods. 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 drying is often needed to facilitate timely harvesting of grain.

2. Storage and Handling

In the U.S., corn storage structures can be broadly categorized as upright metal bins, concrete silos, flat storage inside buildings, or flat storage in on-ground piles. Upright bins and concrete silos with fully perforated floors or in-floor ducts are the most easily managed storage types because they allow aeration with uniform airflow through the grain. Flat storage can be used for short-term storage. This occurs most often when harvest production is higher than normal and surplus storage is needed. However, it is more difficult to install adequate aeration ducts in flat 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 vertical conveying by bucket elevators and/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 hardness of 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 fungal invasion and insect infestation.

3. 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.

4. Transporting Corn

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

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, fungal invasion, and insect infestation. However, there are some factors affecting 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 (spout lines) near the center when loading rail cars, barges and ocean vessels. This results in whole kernels tending to roll to the outer 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.

5. 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 a given intrinsic quality characteristic is affected by the quality levels of the corn from the multiple sources. The above-described marketing and transportation activities inevitably alter the various physical and sanitary quality characteristics. The quality characteristics that can be directly affected include test weight, damaged kernels, broken kernels, kernel size, stress crack levels, moisture contents and variability, foreign material, and mycotoxin levels.

C. U.S. Government Inspection and Grading

1. 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 grades and standards that are typically used for exporting grains and referenced in export contracts. U.S. corn sold by grade and shipped in foreign commerce must be officially inspected and weighed by the USDA's Federal Grain Inspection Service (FGIS) or an official service provider delegated or designated by FGIS to do so (with a few exceptions). In addition, all corn exports must be tested for aflatoxins, unless the contract specifically waives this requirement. 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.

2. Inspection and Sampling

The loading export elevator provides FGIS or the delegated state inspection agency a load order specifying the quality of the corn to be loaded as designated in the export contract. The load order specifies the U.S. grade and all other requirements which have been agreed upon in the contract between 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 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.

IV. 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 metric tons) from the moving grain stream just after the final elevation before loading into the ship or rail car. The incremental portions are combined by sublot and inspected by licensed inspectors. The results are entered into a log and, typically, a statistical loading plan is applied to assure not only that the average result for each factor meets the contract specifications, but also to assure the lot is reasonably uniform in quality. Any sublot that does not meet uniformity criteria on any factor must be returned to the elevator or certified separately. The average of all sublot results for each factor is reported on the final official certificate. 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, rail car, or in the hold of a vessel.

3. 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 "U.S. Corn Grades and Conversions" section on page 42. In addition, FGIS provides certification of moisture and other attributes, if requested, such as stress cracks, protein, oil and mycotoxins. Export contracts for corn specify many conditions related to the cargo, in addition to the contract grade. In some cases, independent labs are used to conduct tests not required by FGIS.

Since the limits on all grade factors cannot always be met simultaneously, some grade factors may be better than a particular grade, but they cannot be worse. For example, a lot may meet the requirements for U.S. No. 2 except for one factor which would cause it to grade U.S. No. 3. For that reason, most contracts are written as "U.S. No. 2 or better" or "U.S. No. 3 or better". This permits some grade factor results to be at or near the limit for that grade, while other factor results are "better than" that grade.

V. SURVEY AND STATISTICAL ANALYSIS METHODS

A. Overview

The key points for the survey design and sampling, and statistical analysis for this *Export Cargo Report 2012/13* are as follows:

- Following the process developed for the *Export Cargo Report 2011/12*, samples were stratified according to Export Catchment Areas (ECAs) – the Gulf, Pacific Northwest, and Southern Rail.
- To achieve a maximum ± 10% relative margin of error (Relative ME) for the U.S. Aggregate level and to ensure proportional sampling from each ECA, the targeted number of total samples was 426 samples to be collected from the ECAs as follows: 284 from the Gulf, 87 from the Pacific Northwest, and 55 from the Southern Rail.
- Southern Rail ECA samples were provided by any of several official agencies designated by USDA's Federal Grain Inspection Service (FGIS) that inspect and grade rail shipments of corn destined for export to Mexico. Gulf and Pacific Northwest samples were collected by FGIS field offices at ports in the respective ECAs.
- Export inspections of shipments from the Southern Rail ECA (interior) did not generate the targeted number of samples for this report because there were very few interior shipments meeting the sampling criteria. As a result, only 7 samples were collected for the Southern Rail ECA. Nonetheless, 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 number of samples surveyed, 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 ECA – total damage, stress cracks, and stress crack index - and four attributes from the Southern Rail ECA – BCFM, total damage, stress cracks, and stress crack index.

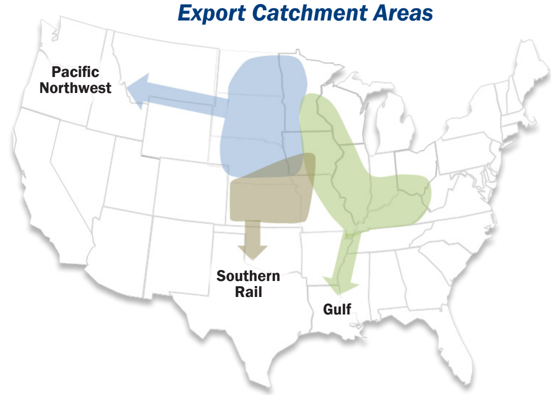
B. Survey Design and Sampling

1. Survey Design

For this *Export Cargo Report*, the target population was yellow commodity corn from the twelve key U.S. corn-producing states representing about 99% of U.S. corn exports. 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 stratum.

Stratification involves dividing the survey population of interest into subpopulations called strata. For the *Export Cargo Reports*, the key corn-exporting areas in the U.S. are divided into three geographical groupings which we refer to as Export Catchment Areas (ECAs). These three ECAs are identified by the three major pathways to export markets:

Export Catchment Areas



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

V. 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 the 2010/11 and 2011/12 corn marketing years was calculated and averaged over the two marketing 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
66.7%	20.5%	12.8%	100.0%

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

Since the population variances for the 15 quality factors evaluated for this year's corn exports were not known, the variance estimates from last year's *Export Cargo Report* were used as estimates of the population variance. The variances and ultimately the estimated number of samples needed for the Relative ME of ± 10% for 12 quality factors were calculated using the 2011/12 results of 379 samples. Heat damage, 100-k weight, and kernel volume were not examined. Based on these data, a total sample size of 426 would allow the Council to estimate the true averages of the quality characteristics with the desired level of precision for the U.S. Aggregate. Applying the sampling proportions previously defined to the total of 426 samples resulted in the following number of targeted samples from each ECA:

Number of Samples per ECA			
Gulf	Pacific Northwest	Southern Rail	Total
284	87	55	426

2. Sampling

The sampling was administered by FGIS and participating official service providers as part of their inspection services. Based on feedback from the FGIS field offices indicating that 2012 corn was reaching export points by mid-October 2012, it was decided to start the sampling period the latter part of October 2012. Therefore, instruction letters were sent to field offices and the domestic inspections office by FGIS on October 22, 2012, and the sampling period began October 22, 2012, for the Gulf and Pacific Northwest ECAs and October 29, 2012, for the Southern Rail ECA. 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 – FGIS Domestic Inspection Operations Office in Kansas City, Missouri.

Representative sublot samples from the ports in the Gulf and Pacific Northwest ECAs were collected as ships were loaded, and only lots for which quantitative aflatoxin testing was being performed were to be sampled. 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 moving stream of corn. A cut occurs every few seconds, or about every 500 bushels (about 12.7 metric tons) 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 sublot samples are inspected to ensure the entire shipment is uniform in quality.

The same sampling frequency for the Pacific Northwest and Gulf ECAs as last year's export cargo survey was used for this year's survey. Therefore, sublots ending in 0, 3, 5 and 7 from each lot during the survey period were sampled.

For the Southern Rail samples, a representative sample was taken at domestic interior elevators using a diverter sampler to ensure uniform sampling. A cut is taken about every 500 bushels. After collecting samples from five consecutive rail cars, a five-car composite sample was made from unit trains consisting of 100 rail cars of yellow corn inspected for export to Mexico and for which quantitative aflatoxin testing was being performed.

For each sample, a minimum of 2700 grams was collected by the FGIS field staff, the Southern Rail ECA official service providers, and the Washington State Department of Agriculture, congregated at the field offices, and mailed to Illinois Crop Improvement Association's Identity Preserved Grain Laboratory (IPG Lab). Refer to the "Testing Analysis Methods" section for the description of the testing methods employed for the study.

The sampling period ended February 4, 2013, for the Pacific Northwest ECA and February 14, 2013, for the Gulf ECA when the targeted number of samples per ECA was reached. In the Southern Rail ECA, the sampling criteria were based on the number of rail cars in and the pattern of historical rail shipments from the interior. However, interior rail shipments during the sampling period were different than in recent marketing years, resulting in very few unit trains containing corn being exported. Adjustments to the sampling criteria were made in February 2013 to account for the different sizes of rail shipments and to expand the options for collecting Southern Rail samples. Unfortunately, the adjustments did not generate additional samples, and as of March 18, 2013, no additional shipments from which samples could be collected were expected for the Southern Rail in the near future. Therefore, in order to publish the *Export Cargo Report* in a timely manner, the sampling period for the Southern Rail ECA concluded in February 2013.

C. Statistical Analysis

The sample test results for the grade factors, moisture, chemical composition, and physical factors were summarized as the U.S. Aggregate and also by the three ECAs (Gulf, Pacific Northwest, and Southern Rail) and two "contract grade" categories. Since the limits on all official grade quality attributes (such as test weight and total damage) will not usually 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 in the *Export Cargo Report* are:

- "U.S. No. 2" or "U.S. No. 2 or better" contracts specify that 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 designated as U.S. No. 3 o/b.

The sampling process resulted in surplus samples in the Pacific Northwest (which provided greater sampling density in that ECA) and less than the targeted number of samples in the Southern Rail ECA. However, the U.S. Aggregate averages and standard deviations were weighted by ECA using the original sampling proportions.

V. SURVEY AND STATISTICAL ANALYSIS METHODS

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 Gulf ECA. The Relative ME exceeded ± 10% for some quality factors (see table below) in the Pacific Northwest and Southern Rail ECAs:

	Relative Margin of Error (ME)			
	BCFM	Total Damage	Stress Cracks	Stress Crack Index
Pacific Northwest ECA	--	13%	22%	29%
Southern Rail ECA	12%	45%	69%	62%

While the lower level of precision for these quality factors in the two ECAs is less than desired, the levels of Relative ME do not invalidate the estimates. The averages for the quality factors are the best possible unbiased estimates of the true population means. However, they are estimated with greater uncertainty than the quality factors with a Relative ME less than ± 10%. Footnotes in the summary tables for "Grade Factors and Moisture" and "Physical Factors" indicate the attributes for which the Relative ME exceeds ± 10%. This allows the reader to keep in mind the greater degree of uncertainty of the sample average representing the true population mean.

References in the "Quality Test Results" section to statistical differences were validated by 2-tailed t-tests at the 95% confidence level. The t-tests were calculated:

- Between factors in the *Harvest Report 2012/13* and *Export Cargo Report 2012/13*,
- Between factors in the *Export Cargo Report 2012/13* and *Export Cargo Report 2011/12*,
- Among factors in the *Export Cargo Report 2012/13* ECAs (Gulf, Pacific Northwest, Southern Rail), and
- Between chemical and physical factors in the *Export Cargo Report 2012/13* contract grades (U.S. No. 2 o/b, U.S. No. 3 o/b).

VI. 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 (approximately 6 pounds/2700 grams) were sent directly from the FGIS field offices to the Illinois Crop Improvement Association's Identity Preserved Grain Laboratory (IPG Lab) in Champaign, Illinois, for the chemical, physical factors, and DON testing. Upon arrival at IPG Lab, the samples were split into two subsamples using a Boerner divider. One subsample was analyzed for DON. The other subsample was analyzed for the chemical composition and other physical factors following either industry norms or well-established procedures in practice for many years. IPG Lab has received accreditation under the ISO/IEC 17025:2005 International Standard for many of the tests. The full scope of accreditation is available at http://www.pjview.com/clients/pjl/viewcert.cfm?certnumber=1752.

A. Corn Grading Factors

1. 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).

2. 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 $12/64^{th}$ 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 $12/64^{th}$ inch round-hole sieve and retained on a $6/64^{th}$ inch sieve. Foreign material is defined as all material passing through a $6/64^{th}$ inch round-hole sieve and the coarse non-corn material retained on the $12/64^{th}$ 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 Report*. BCFM is reported as a percentage of the initial sample by weight.

3. 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.

B. Moisture

The moisture determined using an approved moisture meter at the time of inspection is reported. These meters are 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.

VI. TESTING ANALYSIS METHODS

C. Chemical Composition

1. NIR Proximate Analysis – Corn

Proximates are the major components of the grain. For corn, the Near-infrared (NIR) Proximate Analysis includes oil content, protein content, and starch content (or total starch). NIR Proximate Analysis or spectroscopy uses the unique interactions of specific wavelengths of light with the sample, calibrated to traditional chemistry methods, to evaluate the levels of oil, protein and starch in the sample. This procedure is nondestructive to the corn.

Chemical composition tests for protein, oil, and starch were conducted using a 400–450 g sample in a whole-kernel Foss Infratec 1229 Near-Infrared Transmittance (NIRT) instrument. The NIRT was calibrated using reference wet chemistry methods, 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).

D. Physical Factors

1. 100-Kernel Weight, Kernel Volume and Kernel True Density

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

The kernel volume for each 100-kernel replicate is calculated using a helium pycnometer and is expressed in cubic centimeter (cm^3) per kernel. Kernel volumes usually range from 0.18-0.30 cm^3 per kernel for small and large kernels, respectively.

True density of each 100 kernel sample is calculated by dividing the mass (or weight) of the 100 externally sound kernels by the volume (displacement) of the same 100 kernels. The two replicate results are averaged. True density is reported in grams per cubic centimeter (g/cm^3). True densities typically range from 1.16 to 1.35 g/cm^3 at "as is" moistures of about 12 to 15%.

2. 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 by contract the acceptable level of cracks based on the intended use.

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

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

Where

SSC is the percentage of kernels with only one crack,

DSC is the percentage of kernels with exactly two cracks, and

MSC is the percentage of kernels with more than two cracks.

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

3. 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%.

4. Horneous (Hard) 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.

E. Mycotoxin Testing

Official aflatoxin results are provided by FGIS for the *Export Cargo Report 2012/13*. 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 was 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 one of the 500-gram ground portions, a 50-gram test portion is randomly selected for testing. After adding the proper extraction solvent to the 50-gram test portion, aflatoxin is quantified. The following FGIS-approved quantitative test kits may have been used: VICAM AflaTest™, Beacon Analytical Plate Kit, Romer Labs FluoroQuant Afla IAC, Envirologix QuickTox™ for QuickScan Aflatoxin, Neogen Reveal Q+ for Aflatoxin or Veratox® Aflatoxin Quantitative Test, Charm Sciences ROSA® FAST or WET™ Aflatoxin Quantitative Test, or R-Biopharm RIDASCREEN® FAST Aflatoxin SC test.

For the DON testing, the FGIS-approved Envirologix QuickTox™/QuickScantest method was used. A 1350-gram sample of shelled corn (obtained by dividing the original sample) was ground to a particle size which would pass through a number 20 wire mesh sieve and divided down to a 50-gram test portion using a Romer Model 2A sampling mill. The 50-gram test portion was then processed as the FGIS *DON (Vomitoxin) Handbook* requires. DON was extracted with 250 ml of distilled water, and the extract was tested using the Envirologix AQ 204 BG test kits. The DON was quantified using the QuickScanReader.

VII. U.S. CORN GRADES AND CONVERSIONS

CORN GRADES AND GRADE REQUIREMENTS

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

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

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

U.S. AND METRIC CONVERSIONS

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

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