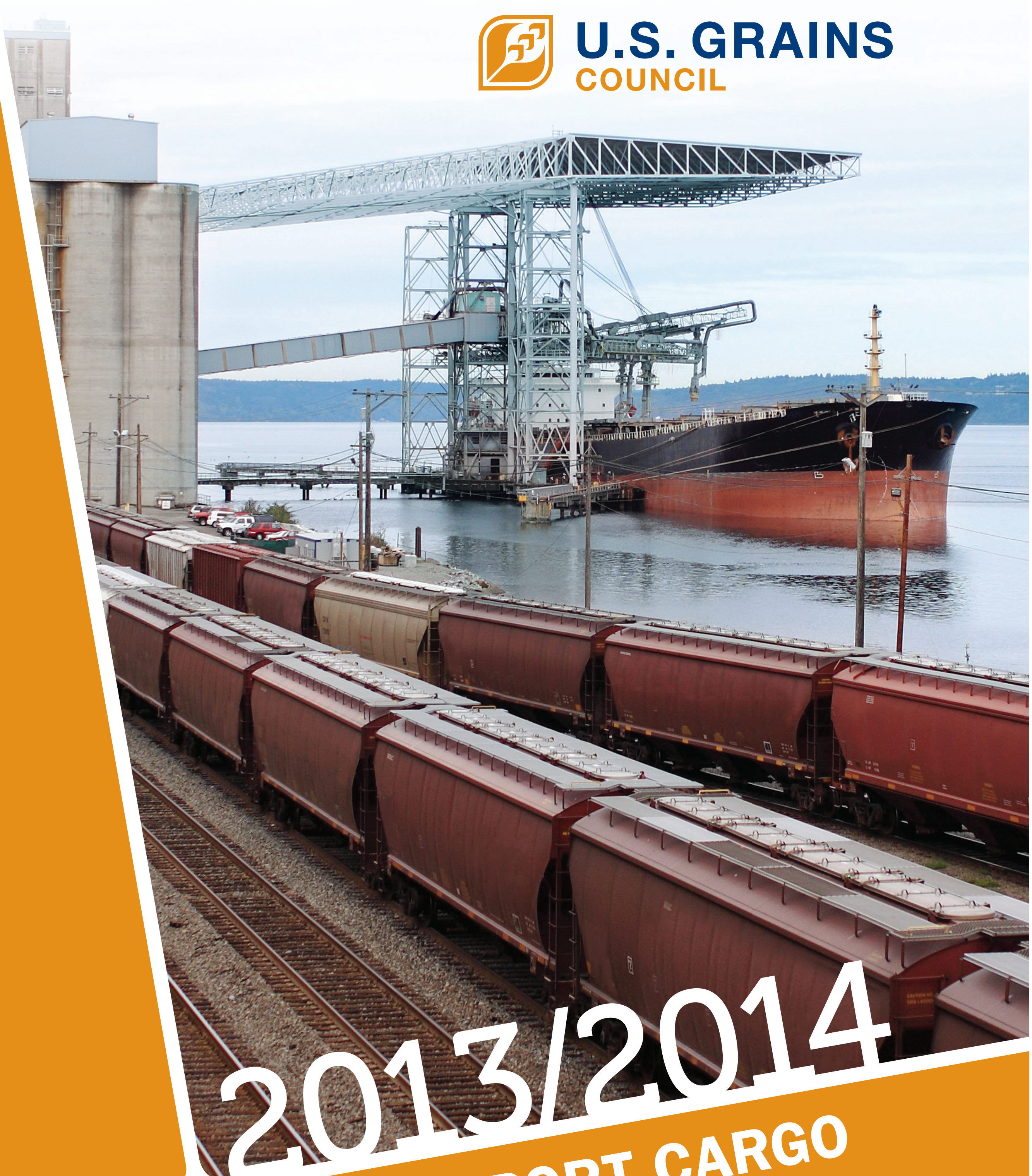


U.S. GRAINS COUNCIL

2013/2014

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 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 conducted analysis of the collected corn samples.

In particular, we acknowledge the irreplaceable services of the Federal Grain Inspection Service 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 *Corn Export Cargo Quality Report* for the 2013/14 marketing year as a service to foreign buyers and other interested parties.

Quality is a vital concern for every stakeholder in the corn value chain: seed companies, corn growers, traders, corn handlers, shippers, processors and end users. The *Corn Export Cargo Quality Report* is an objective survey, taken at the point of loading for international shipment, of the quality of U.S. yellow commodity corn destined for export.

This is the second of two reports by the Council concerning the quality of the 2013 crop. Earlier this marketing year the Council's *Corn Harvest Quality Report* surveyed corn quality at the farm gate. Together, these two reports are intended to provide reliable information on U.S. corn quality for the current marketing year, based on a transparent and consistent methodology.

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

The 2013/14 *Corn Harvest Quality* and the *Corn Export Cargo Quality* reports are the third in an annual report series. The value of these reports to all stakeholders increases each year as stakeholders become familiar with the information presented and with the year-to-year variations in the U.S. corn marketing system.

The Council is committed to continuous export expansion based upon the principles of mutual benefit and increased food security through trade. The Council serves as a trusted partner and a bridge between U.S. producers and international buyers. Reliable and timely information is the foundation of these efforts.

We trust that our international partners will find the *Corn Harvest Quality* and *Corn Export Cargo Quality* reports informative and useful, and we invite users to contact us with comments, criticisms or questions.

Sincerely,

Julius Schaaf
Chairman, U.S. Grains Council
April 2014

I. EXPORT CARGO QUALITY HIGHLIGHTS

The average aggregate quality of the corn assembled for export early in the 2013/14 marketing year was better than U.S. No. 2 on all grade factors. In addition, the incidences of positive levels of aflatoxin and deoxynivalenol (DON) test results were very low, suggesting, on average, low levels of aflatoxins and DON in export shipments. Moisture content was higher than in either of the previous years. Chemical and physical attributes were similar to 2011/12 export samples, but below that of the 2012/13 samples on some factors. Notable U.S. Aggregate quality attributes of the early 2013/14 export samples include:

GRADE FACTORS AND MOISTURE

- Average test weight of 57.3 lb/bu (73.8 kg/hl) indicates overall good quality. Although lower than in the previous two years, about 83% of all samples were above the limit for U.S. No. 1.
- BCFM (2.9%) was below the maximum limit for U.S. No. 2, but above 2012/13 (2.7%). BCFM predictably increased as the crop moved from harvest (0.9%) through the market channel to export.
- Total damage (1.7%) increased during storage and transport as expected, but was lower at export than 2012/13 (2.0%).
- Average moisture (14.5%) was higher than in the previous two years. Average harvest moisture was also higher in 2013 than in 2012 and 2011, indicating more artificial drying was needed for the 2013 crop than for the previous two crops.

CHEMICAL COMPOSITION

- Average protein content (8.6%) was lower than 2012/13 (9.2%), but appears to have returned closer to normal and was very close to 2011/12 (8.7%).
- Starch content (73.7%) followed the opposite of the protein trend, and was higher than 2012/13 (73.5%), but lower than 2011/12 (74.1%).
- Oil content (3.7%) was the same as 2012/13, but was slightly above 2011/12 (3.6%).
- Protein, starch and oil percentages all had narrower ranges and lower standard deviations at export than at the harvest level. This finding was expected, in part, because grains become more homogenous after aggregation from numerous harvest level sources.

PHYSICAL FACTORS

- Average stress cracks (16%) was higher and a higher percentage of the samples was distributed with 20% or more stress cracks than in the previous two years, likely due to more artificial drying of the 2013 crop. However, the majority of samples still had stress cracks less than 20% and should have reduced rates of breakage during handling.
- Kernel volume and 100-kernel weight were significantly lower than 2012/13 and 2011/12, indicating smaller kernel sizes in early 2013/14 corn exports than the previous two years.
- True density (1.287 g/cm^3) was significantly lower than 2012/13 (1.297 g/cm^3).
- Whole kernels (88.6%) was lower than 2012/13 (89.9%).
- Horneous endosperm (82%) was lower than 2012/13 (85%).

MYCOTOXINS

- All of the export samples tested below the FDA action level of 20 ppb for aflatoxins. A significantly higher proportion of the export samples tested below 5 ppb aflatoxin than in the 2012/13 and 2011/12 samples.
- 100% of the corn export samples tested below the FDA advisory levels for DON (5 ppm for hogs and other animals and 10 ppm for chicken and cattle). About 95% of the samples tested below 0.5 ppm DON, which was about the same as 2012/13 and higher than 2011/12.

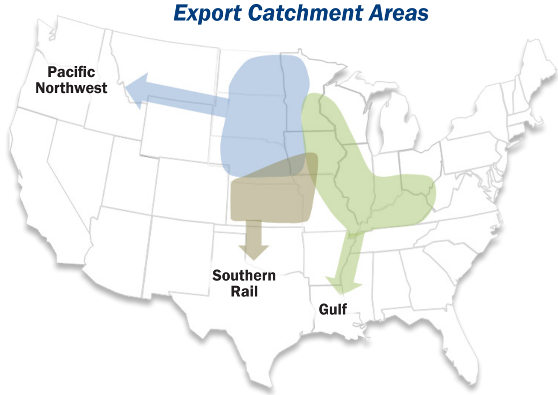
II. INTRODUCTION

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 2013/14* provides accurate, unbiased information about the quality of U.S. yellow commodity corn as it is assembled for export early in the marketing year. 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 412 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 are labeled 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 by rail from inland subterminals.

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 2013/14*, was released in December 2013 and reported on the quality of the corn as it entered the U.S. marketing system. The *Harvest Report 2013/14* and the *Export Cargo Report 2013/14* 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 2013/14* is the third in a series of annual surveys of the quality of the U.S. corn exports early in the marketing year. In addition to the Council reporting the quality of corn exports early in the current marketing year, the cumulative *Export Cargo Report* surveys will provide increasing value to stakeholders. The three years of data are beginning to enable export buyers and other stakeholders to make year-to-year comparisons and assess patterns in corn quality based on growing, drying, handling, storage and transport conditions.

This report provides detailed information on each of the quality factors tested, including average, standard deviation and distributions for the aggregate of all samples and for each of the three ECAs. 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 (continued)

For the *Export Cargo Report 2013/14,* FGIS collected samples during the early part of November 2013 through March 2014 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. Many of the quality attributes, in addition to grade, can be specified in the buyer-seller contract. 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 drying and handling affect changes in quality in complex ways. Sample test results can vary significantly depending on the ways in which a corn lot was loaded onto a conveyance and the method of sampling used.

A. Grade Factors

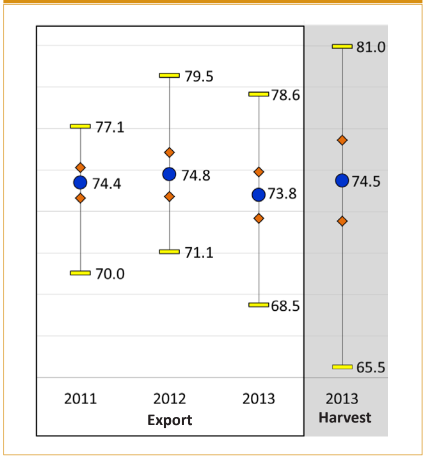
The USDA's Federal Grain Inspection Service (FGIS) has established numerical grades, definitions and standards for grains. The attributes which determine the numerical grades for corn are test weight, broken corn and foreign material (BCFM), total damage and heat damage. The table for "U.S. Corn Grades and Grade Requirements" is provided on page 47 of this report.

SUMMARY: GRADE FACTORS AND MOISTURE

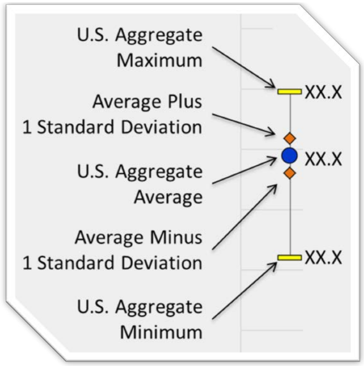
- *Average quality of the corn at export was good and more uniform than at harvest and better than grade limits for U.S. No. 2 corn on all grade factors.*
- *The grade factor average values were generally better than the grade limits for contracts loaded as U.S. No. 2 o/b and for contracts loaded as U.S. No. 3 o/b.*
- *Average quality of the 2013/14 export samples was below that of the 2012/13 samples on all factors, but equal to or better than the 2011/12 samples on BCFM and total damage.*
- *Average test weight was lower than previous years (57.3 lb/bu (73.8 kg/hl)), but still above the limit for Grade U.S. No. 1.*
- *Approximately 65% of the export samples contained BCFM levels at or below the maximum allowed for U.S. No. 2 grade.*
- *Average total damage and heat damage were well below the limits for U.S. No. 1 grade.*
- *Moisture contents were lower at export than at harvest, thus improving storability and helping meet contract specifications at export.*
- *The distribution of sample moistures shows a higher percentage above 14.5% than in the previous two years.*

III. QUALITY TEST RESULTS (continued)

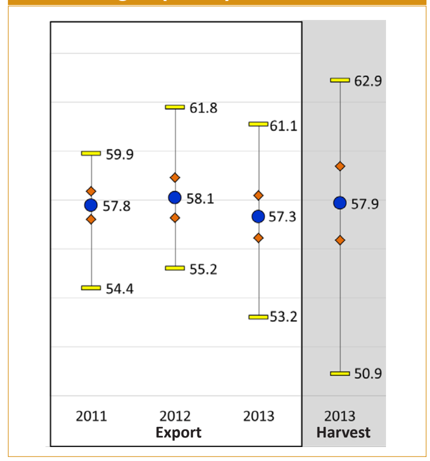
Test Weight (kg/hl)



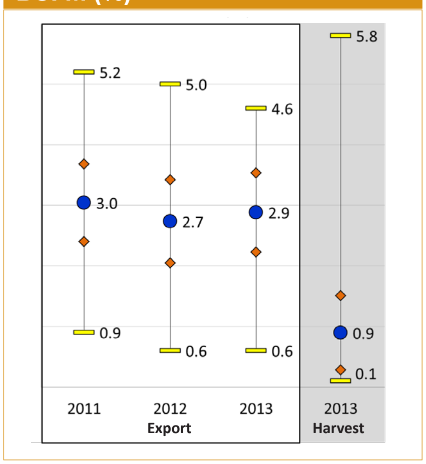
How to Read the Charts



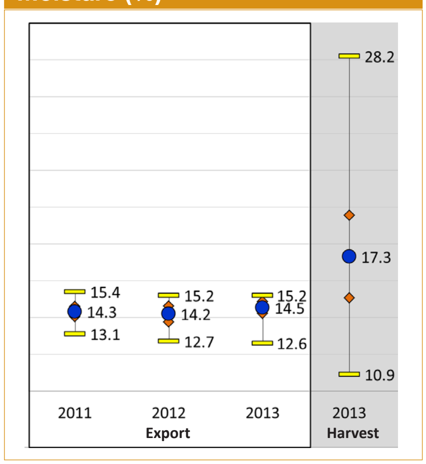
Test Weight (lb/bu)



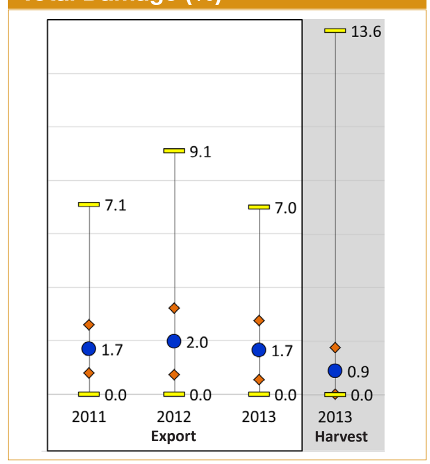
BCFM (%)



Moisture (%)



Total Damage (%)



1. Test Weight

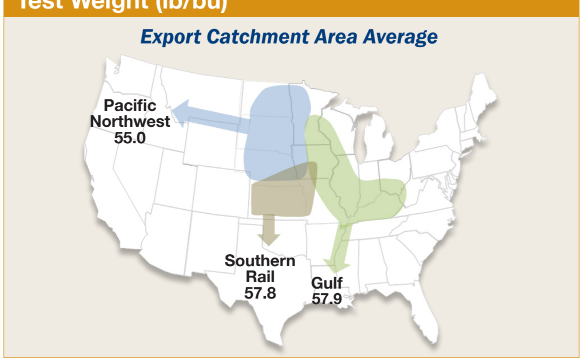
Test weight (weight per volume) is a measure of bulk density and is often used as a general indicator of overall quality and as a gauge of endosperm hardness to alkaline cookers and dry millers. It reflects kernel hardness and kernel maturity. Test weight is initially impacted by genetic differences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

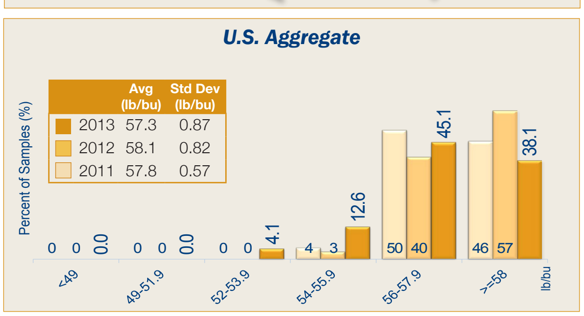
U.S. Grade Minimum Test Weight
No. 1: 56.0 lbs
No. 2: 54.0 lbs
No. 3: 52.0 lbs

RESULTS

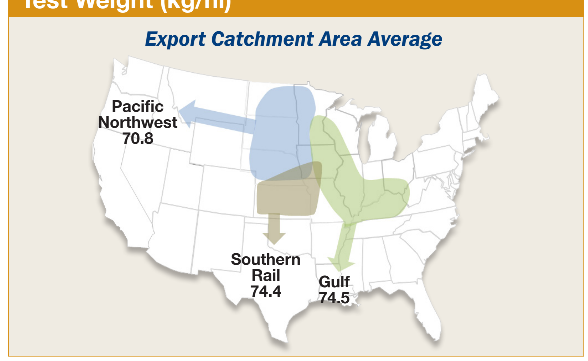
- U.S. Aggregate average test weight 57.3 lb/bu (73.8 kg/hl) was lower than the previous two years, but was above the grade limit for U.S. No. 1 corn (56.0 lb/bu).
- Over 83% of all samples' test weights were at or above the minimum for U.S. No. 1 grade (56 lb/bu) and 95.8% were above the limit for U.S. No. 2 grade (54 lb/bu). Only 4.1% of the samples fell below the U.S. No. 2 grade limit.
- Variation in the 2013/14 export samples was more than in previous years, as indicated by the higher standard deviation and wider range in values.
- The 2013/14 export samples' variability was less than the harvest samples' variability. 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.
- Test weight at export (57.3 lb/bu) was lower than test weight at harvest (57.9 lb/bu). This has been consistent for the previous two years.
- Test weight was significantly higher in samples from the Gulf ECA (57.9 lb/bu) and the Southern Rail ECA (57.8 lb/bu), with lower variability than samples from the Pacific Northwest ECA (55.0 lb/bu).

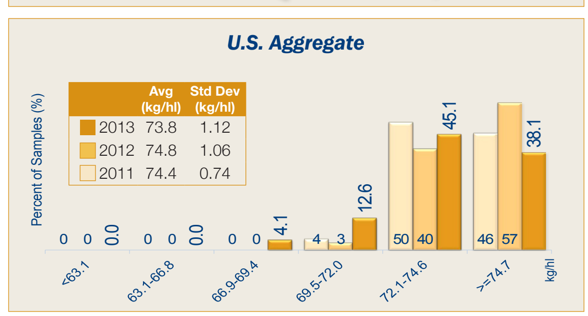
Test Weight (lb/bu)





Test Weight (kg/hl)





III. QUALITY TEST RESULTS (continued)

2. Broken Corn and Foreign Material (BCFM)

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

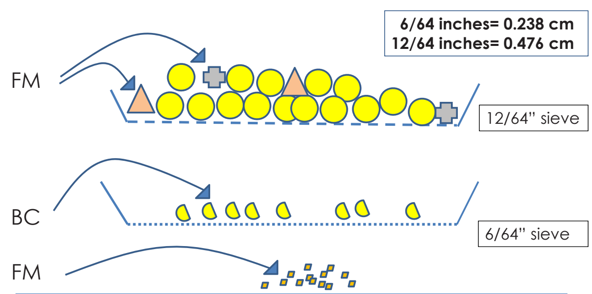
Broken corn and foreign material (BCFM) is an indicator of the amount of clean, sound corn available for feeding and processing. As corn moves from farm deliveries through the market channel, each impact on the grain during handling and transporting increases the amount of broken corn. As a result, the average BCFM in most shipments of corn will be higher at the export point than at the local elevator level.

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 grades.

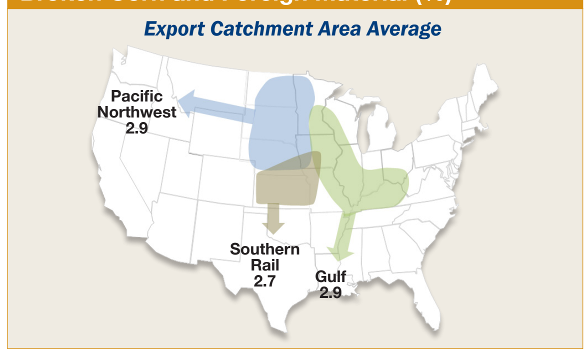
BCFM (Measured as Percent by Weight)

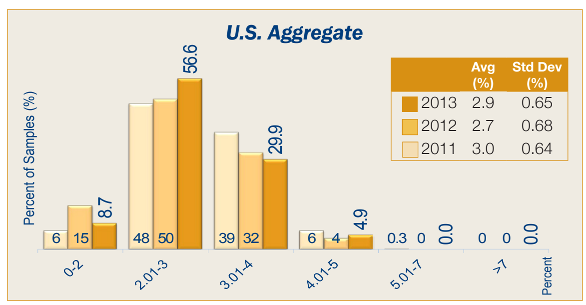


RESULTS

- Average BCFM in U.S. Aggregate export samples (2.9%) was below the maximum for U.S. No. 2 grade. It was significantly higher than in the 2012/13 samples (2.7%) but lower than in the 2011/12 samples (3.0%).
- BCFM among export samples was distributed with 65.3% of the samples at or below the grade limit for U.S. No. 2 (3%) and 95.2% at or below the grade limit for U.S. No. 3 (4%).
- The variability of the 2013/14 export samples (with a standard deviation of 0.65%) was approximately the same as that in 2012/13 (0.68%) and 2011/12 (0.64%).
- Average BCFM in contracts loaded as U.S. No. 2 o/b was 2.8% compared to the average BCFM of 3.0% in contracts loaded as U.S. No. 3 o/b. Corn arriving at the export point is often commingled from many origins to meet the limits for the contracted grade. Cleaning and loading procedures at the export point are designed to bring each factor close to but within the limits of each factor limit. Thus, BCFM would be expected to be lower in No. 2 than in No. 3 corn.
- Average BCFM at export (2.9%) was higher than at harvest (0.9%) as a result of increased breakage and stress cracks created by drying and handling impacts.
- BCFM at export was significantly lower in the Southern Rail ECA (2.7%) than in either the Gulf or Pacific Northwest ECAs (2.9%).

Broken Corn and Foreign Material (%)





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, insects, sprouting, disease, weather, ground, germ and mold. Most of these types of damage result in some sort of discoloration or change in kernel texture. Damage does not include broken pieces of grain that are otherwise normal in appearance. Mold damage 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.

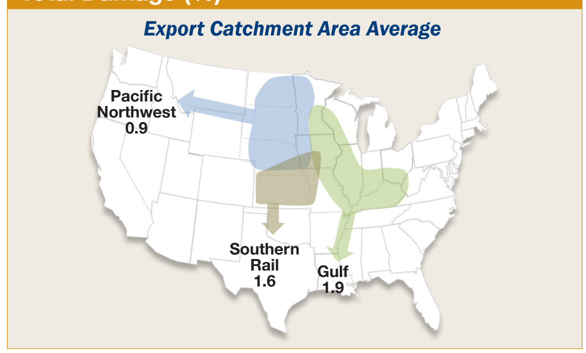
U.S. Grade Total Damage Maximum Limits
No. 1: 3.0%
No. 2: 5.0%
No. 3: 7.0%

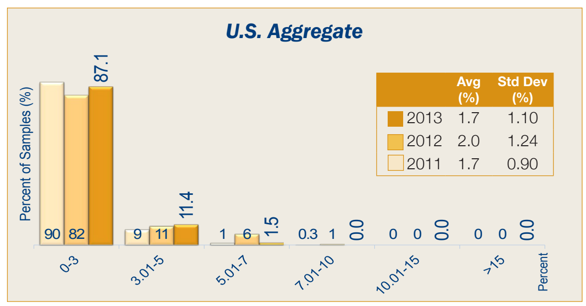
Corn with low levels of total damage is more likely to arrive at destination in good condition than corn with high levels of total damage. High levels of total damage have the potential of increasing moisture and microbiological activity during transport.

RESULTS

- U.S. Aggregate total damage (1.7%) was significantly lower than in 2012/13 (2.0%), well below the 3.0% limit for U.S. No. 1 corn.
- The average level for total damage increased significantly between the 2013 harvest (0.9%) and the 2013/14 export samples (1.7%).
- Of the export samples, 87.1% had 3.0% or less damaged kernels, meeting the requirement for No. 1. Only 1.5% of the samples were above the limit for U.S. No. 2.
- Variability in the 2013/14 export samples was lower than in 2012/13 as indicated by the standard deviations (1.10% compared with 1.24%) and the range (0.0% to 7.0% and 0.0% to 9.1%, respectively). However, the 2013/14 variability and levels were similar to those in 2011/12.
- Total damage in contracts being loaded as U.S. No. 3 (1.8%) was only slightly higher than for contracts being loaded as U.S. No. 2 o/b (1.7%).
- The Gulf ECA had the highest total damage (1.9%) compared with the Pacific Northwest (0.9%) and Southern Rail (1.6%) ECAs.
- The Gulf ECA also had the greatest increase in total damage between harvest (0.9%) and export (1.9%) of the three ECAs.

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 export point.

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

RESULTS

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

B. Moisture

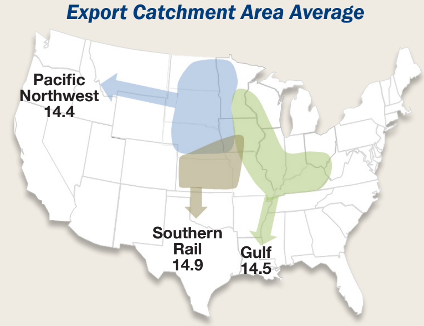
Moisture content is reported on all official grade certificates, but does not determine which numerical grade will be assigned to the sample. Moisture content is usually specified in the contract by the buyer, independent of the grade. Moisture content is important because it affects the amount of dry 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 transported in railcars or in closed, nearly airtight holds during the ocean voyage, and few bulk carriers or railcars 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. Hot spots are small pockets of corn where the moisture content and temperature become abnormally higher than the average for the cargo. 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.

RESULTS

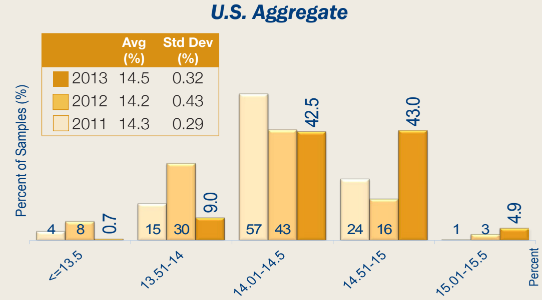
- U.S. Aggregate moisture content averaged 14.5%, significantly higher than in previous years.
- Approximately 47.9% of the export samples had moisture contents above 14.5%, compared to 19% and 25% in 2012/13 and 2011/12, respectively.
- Approximately 52.2% of the samples had moisture contents of 14.5% or below.
- Moisture standard deviation was lower in 2013/14 (0.32%) than in 2012/13 (0.43%), indicating greater uniformity, but was higher than in 2011/12 (0.29%).
- Average moisture content and moisture variability decreased between harvest and export as a result of drying and conditioning in the market channel following harvest.
- Average moisture in the Southern Rail ECA was significantly higher than in the other two ECAs in the 2013/14 export samples.

Moisture (%)

Export Catchment Area Average



U.S. Aggregate



III. QUALITY TEST RESULTS (continued)

SUMMARY: GRADE FACTORS AND MOISTURE

	2013/14 Export Cargo					2012/13 Export Cargo			2011/12 Export Cargo			2013/14 Harvest		
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	No. of Samples	Avg.	Std. Dev.	No. of Samples[1]	Avg.	Std. Dev.
U.S. Aggregate														
Test Weight (lb/bu)	412	57.3	0.87	53.2	61.1	397	58.1*	0.82	379	57.8*	0.57	610	57.9**	1.51
Test Weight (kg/hl)	412	73.8	1.12	68.5	78.6	397	74.8*	1.06	379	74.4*	0.74	610	74.5**	1.95
BCFM (%)	412	2.9	0.65	0.6	4.6	397	2.7*	0.68	379	3.0*	0.64	610	0.9**	0.61
Total Damage (%)	412	1.7	1.10	0.0	7.0	397	2.0*	1.24	379	1.7	0.90	609	0.9**	0.87
Heat Damage (%)	412	0.0	0.01	0.0	0.1	397	0.0	0.02	379	0.0*	0.02	610	0.0**	0.00
Moisture (%)	412	14.5	0.32	12.6	15.2	397	14.2*	0.43	379	14.3*	0.29	610	17.3**	2.24
Gulf														
Test Weight (lb/bu)	295	57.9	0.72	56.1	61.1	284	58.4*	0.72	261	58.0*	0.51	557	58.1**	1.49
Test Weight (kg/hl)	295	74.5	0.93	72.2	78.6	284	75.2*	0.93	261	74.7*	0.65	557	74.8**	1.91
BCFM (%)	295	2.9	0.71	0.6	4.5	284	2.8	0.71	261	3.1*	0.71	557	0.8**	0.59
Total Damage (%)	295	1.9	1.08	0.4	6.9	284	2.4*	1.63	261	2.1*	1.08	556	0.9**	0.95
Heat Damage (%)	295	0.0	0.01	0.0	0.1	284	0.0	0.03	261	0.0	0.02	557	0.0	0.00
Moisture (%)	295	14.5	0.34	12.6	15.2	284	14.2*	0.46	261	14.5	0.26	557	17.7**	2.38
Pacific Northwest														
Test Weight (lb/bu)	82	55.0	1.37	53.2	59.7	106	57.0*	0.84	83	56.6*	0.82	259	56.5**	1.60
Test Weight (kg/hl)	82	70.8	1.77	68.5	76.8	106	73.4*	1.08	83	72.9*	1.05	259	72.8**	2.06
BCFM (%)	82	2.9	0.58	1.4	4.6	106	2.9	0.74	83	3.0	0.57	259	1.1**	0.70
Total Damage (%)[2]	82	0.9	1.56	0.0	7.0	106	0.6	0.40	83	0.6	0.54	259	0.6	0.64
Heat Damage (%)	82	0.0	0.00	0.0	0.0	106	0.0	0.02	83	0.0	0.01	259	0.0	0.00
Moisture (%)	82	14.4	0.25	13.9	14.9	106	14.1*	0.42	83	14.0*	0.31	259	16.4**	2.08
Southern Rail														
Test Weight (lb/bu)	35	57.8	0.89	54.4	59.0	7	58.2	1.33	35	58.5*	0.50	313	58.3**	1.56
Test Weight (kg/hl)	35	74.4	1.14	70.0	75.9	7	74.9	1.71	35	75.3*	0.65	313	75.1**	2.00
BCFM (%)[2]	35	2.7	0.41	1.5	3.0	7	2.1*	0.46	35	2.8	0.30	313	0.9**	0.63
Total Damage (%)[2]	35	1.6	0.52	0.3	2.9	7	2.0	0.57	35	1.0*	0.50	313	1.0**	0.74
Heat Damage (%)	35	0.0	0.02	0.0	0.1	7	0.0	0.00	35	0.0	0.04	313	0.0	0.00
Moisture (%)	35	14.9	0.31	13.8	15.2	7	14.2*	0.33	35	14.0*	0.44	313	16.6**	1.74

** Indicates that the 2012/13 Export Cargo averages were significantly different from the 2013/14 Export Cargo averages, and the 2011/12 Export Cargo averages were significantly different from the 2013/14 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

*** Indicates that the 2013 Harvest averages were significantly different from the 2013/14 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

[1] Due to the Harvest 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 2013/14 Export Cargo population average exceeded ±10%.

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)	292	57.2	0.77	53.2	59.8	120	58.1	0.83	56.2	61.1
Test Weight (kg/hl)	292	73.6	1.00	68.5	77.0	120	74.8	1.07	72.3	78.6
BCFM (%)	292	2.8	0.47	1.3	4.6	120	3.0	0.97	0.6	4.3
Total Damage (%)	292	1.7	1.04	0.0	7.0	120	1.8	1.21	0.4	6.9
Heat Damage (%)	292	0.0	0.00	0.0	0.1	120	0.0	0.01	0.0	0.1
Moisture (%)	292	14.5	0.29	13.2	15.2	120	14.6	0.36	12.6	15.2
Gulf										
Test Weight (lb/bu)	175	57.7	0.59	56.1	59.8	120	58.1	0.83	56.2	61.1
Test Weight (kg/hl)	175	74.3	0.75	72.2	77.0	120	74.8	1.07	72.3	78.6
BCFM (%)	175	2.9	0.45	1.3	4.5	120	3.0	0.97	0.6	4.3
Total Damage (%)	175	1.9	0.98	0.5	5.2	120	1.8	1.21	0.4	6.9
Heat Damage (%)	175	0.0	0.00	0.0	0.0	120	0.0	0.01	0.0	0.1
Moisture (%)	175	14.4	0.30	13.2	15.1	120	14.6	0.36	12.6	15.2
Pacific Northwest										
Test Weight (lb/bu)	82	55.0	1.37	53.2	59.7	0	0.0	0.00	0.0	0.0
Test Weight (kg/hl)	82	70.8	1.77	68.5	76.8	0	0.0	0.00	0.0	0.0
BCFM (%)	82	2.9	0.58	1.4	4.6	0	0.0	0.00	0.0	0.0
Total Damage (%)	82	0.9	1.56	0.0	7.0	0	0.0	0.00	0.0	0.0
Heat Damage (%)	82	0.0	0.00	0.0	0.0	0	0.0	0.00	0.0	0.0
Moisture (%)	82	14.4	0.25	13.9	14.9	0	0.0	0.00	0.0	0.0
Southern Rail										
Test Weight (lb/bu)	35	57.8	0.89	54.4	59.0	0	0.0	0.00	0.0	0.0
Test Weight (kg/hl)	35	74.4	1.14	70.0	75.9	0	0.0	0.00	0.0	0.0
BCFM (%)	35	2.7	0.41	1.5	3.0	0	0.0	0.00	0.0	0.0
Total Damage (%)	35	1.6	0.52	0.3	2.9	0	0.0	0.00	0.0	0.0
Heat Damage (%)	35	0.0	0.02	0.0	0.1	0	0.0	0.00	0.0	0.0
Moisture (%)	35	14.9	0.31	13.8	15.2	0	0.0	0.00	0.0	0.0

III. QUALITY TEST RESULTS (continued)

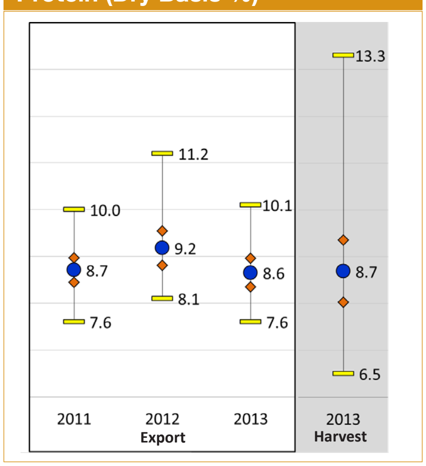
C. Chemical Composition

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

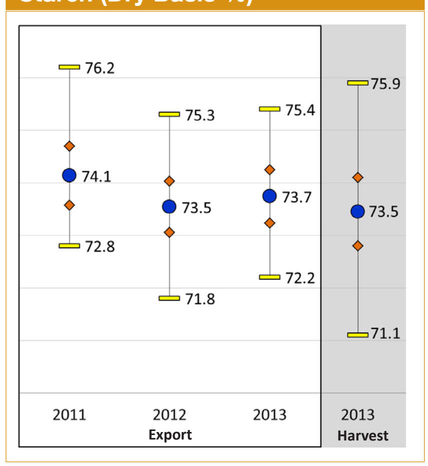
SUMMARY: CHEMICAL COMPOSITION

- *Average protein content for the 2013/14 export and 2013 harvest samples were lower than found in the 2012/13 export and 2012 harvest samples, but appear to have returned closer to normal and were very close to the 2011/12 export and 2011 harvest levels.*
- *Starch contents followed the opposite of the protein trend, and for the 2013/14 export and 2013 harvest samples, average starch content was higher than found in the 2012/13 export and 2012 harvest samples.*
- *Oil content (3.7%) in the 2013/14 export samples was the same as that found in 2012/13 and in the 2013 harvest samples.*
- *Between ECAs, average oil contents (3.5%) for 2013/14 export and 2013 harvest samples were lower for the Pacific Northwest ECA than for the other two ECAs.*
- *Protein, starch and oil all had narrower ranges and lower standard deviations at export than at harvest. This finding is, in part, due to grains becoming more homogenous after aggregation from numerous harvest level sources.*

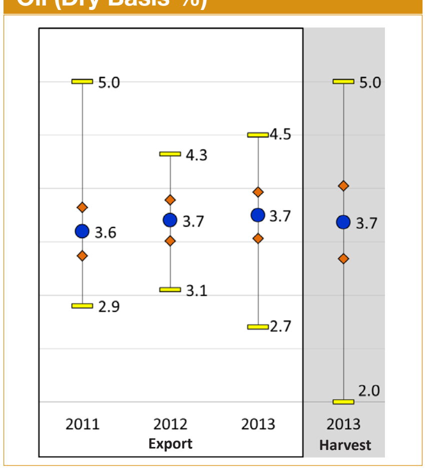
Protein (Dry Basis %)



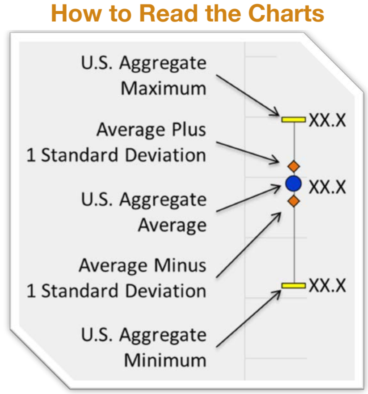
Starch (Dry Basis %)



Oil (Dry Basis %)



How to Read the Charts



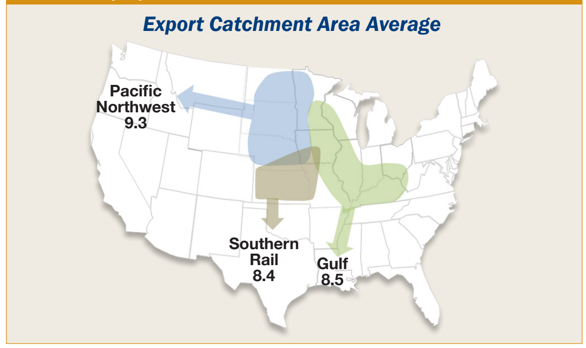
1. Protein

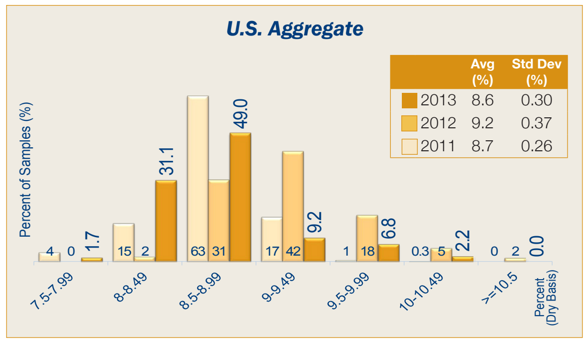
Protein is very important for poultry and livestock feeding. It supplies essential sulfur-containing amino acids and helps to improve feed conversion efficiency. Protein is usually inversely related to starch content. Results are reported on a dry basis.

RESULTS

- U.S. Aggregate protein content was 8.6%, significantly lower than in 2012/13 (9.2%), but similar to 2011/12 (8.7%).
- While average protein content at export was similar to that at harvest (8.7%), the export samples (standard deviation of 0.30%) were more uniform than the harvest samples (standard deviation of 0.66%).
- Protein contents were distributed with 18.2% at or above 9%, compared to 67% of the 2012/13 export samples. Protein distributions in the 2013/14 and 2011/12 export samples were similar, but the results skewed to lower and more normal values than levels found in the 2012/13 samples.
- The Pacific Northwest ECA had higher average protein content (9.3%) than that found in the Gulf (8.5%) and Southern Rail (8.4%) ECAs.
- Protein content averages were significantly higher for contracts loaded as U.S. No. 2 o/b (8.7%) than for those loaded as U.S. No. 3 o/b (8.4%). However, all three ECAs had contracts loaded as U.S. No. 2 o/b whereas only the Gulf ECA had contracts loaded as U.S. No. 3 o/b. The Gulf ECA contracts loaded as U.S. No. 2 o/b had higher protein content averages (8.5%) than the Gulf ECA contracts loaded as U.S. No. 3 o/b (8.4%).

Protein (%)





III. QUALITY TEST RESULTS (continued)

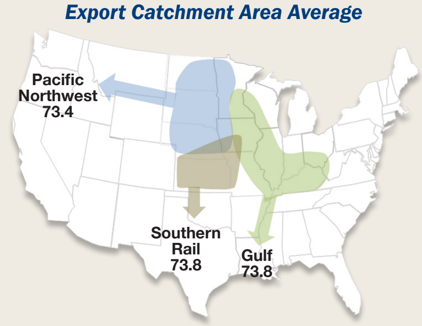
2. Starch

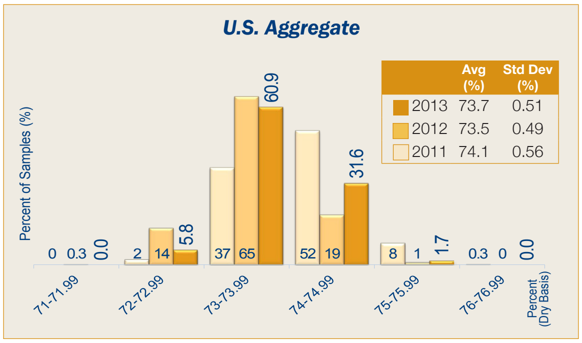
Starch is an important factor for corn used by wet millers and dry-grind ethanol manufacturers. High starch content is often indicative of good kernel maturation/filling conditions and reasonably high kernel densities. Starch is usually inversely related to protein content. Results are reported on a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

RESULTS

- U.S. Aggregate starch content was 73.7%, slightly higher than in 2012/13 (73.5%), but lower than in 2011/12 (74.1%).
- Starch contents were distributed with 33.3% at or above 74.0% compared with 2012/13 (20%) and 2011/12 (60.3%).
- The starch level at export (73.7%) was slightly higher than at harvest (73.5%). However, starch contents at export (standard deviation of 0.51%) were more uniform with a slightly lower standard deviation than in the 2013 harvest samples (standard deviation of 0.65%).
- In addition to the Pacific Northwest ECA having the highest average protein content, it also had lower average starch content (73.4%) than that found in the Gulf and Southern Rail ECAs, which both averaged 73.8%.
- Average starch content for the Gulf ECA in contracts loaded as U.S. No. 2 o/b (73.8%) was the same as for contracts loaded as U.S. No. 3 o/b (73.8%).

Starch (%)





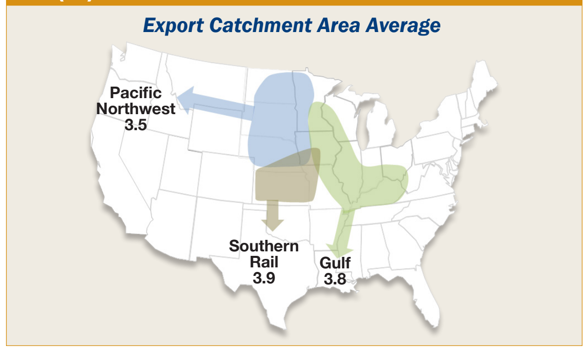
3. Oil

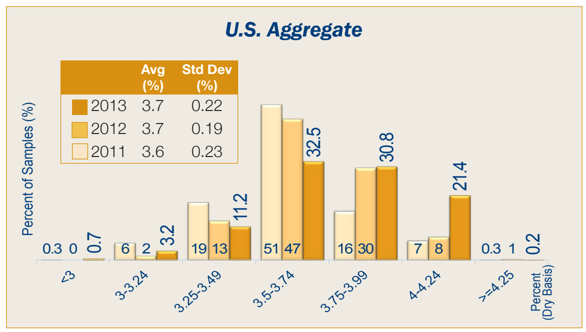
Oil is an essential component of poultry and livestock rations. It serves as an energy source, enables fat-soluble vitamins to be utilized, and provides certain essential fatty acids. Oil is also an important co-product of corn wet and dry milling. Results are reported on a dry basis.

RESULTS

- U.S. Aggregate oil content was 3.7%, the same as that found in 2012/13 but slightly higher than in 2011/12 (3.6%).
- The average oil content at export was unchanged from harvest samples for the 2013 crop. The oil content standard deviation at export (0.22%) was lower than that found at harvest (0.34%).
- Oil content averages for the Gulf, Pacific Northwest and Southern Rail ECA export samples were 3.8%, 3.5% and 3.9%, respectively. The Pacific Northwest ECA also had the lowest average oil content (3.5%) for the 2013 harvest samples.
- Approximately 52.4% contained at least 3.75% oil, in contrast to 2012/13 (39.0%) and 2011/12 (23.3%).
- U.S. Aggregate and Gulf ECA average oil contents for contracts loaded as U.S. No. 2 o/b were 3.8%, which was the same as for contracts loaded as U.S. No. 3 o/b.

Oil (%)





III. QUALITY TEST RESULTS (continued)

SUMMARY: CHEMICAL COMPOSITION

	2013/14 Export Cargo					2012/13 Export Cargo			2011/12 Export Cargo			2013/14 Harvest		
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	No. of Samples	Avg.	Std. Dev.	No. of Samples[1]	Avg.	Std. Dev.
U.S. Aggregate												**U.S. Aggregate**		
Protein (Dry Basis %)	412	8.6	0.30	7.6	10.1	397	9.2*	0.37	379	8.7*	0.26	610	8.7	0.66
Starch (Dry Basis %)	412	73.7	0.51	72.2	75.4	397	73.5*	0.49	379	74.1*	0.56	610	73.5**	0.65
Oil (Dry Basis %)	412	3.7	0.22	2.7	4.5	397	3.7*	0.19	379	3.6*	0.23	610	3.7**	0.34
Gulf												**Gulf**		
Protein (Dry Basis %)	295	8.5	0.23	7.6	9.7	284	9.0*	0.32	261	8.7*	0.21	557	8.5	0.64
Starch (Dry Basis %)	295	73.8	0.52	72.2	75.4	284	73.6*	0.51	261	74.2*	0.56	557	73.5**	0.67
Oil (Dry Basis %)	295	3.8	0.21	2.7	4.5	284	3.7*	0.21	261	3.6*	0.24	557	3.7**	0.35
Pacific Northwest												**Pacific Northwest**		
Protein (Dry Basis %)	82	9.3	0.46	8.5	10.1	106	9.7*	0.50	83	8.4*	0.42	259	9.1**	0.69
Starch (Dry Basis %)	82	73.4	0.44	72.4	74.5	106	73.3	0.62	83	74.2*	0.61	259	73.4	0.61
Oil (Dry Basis %)	82	3.5	0.24	2.9	4.2	106	3.7*	0.22	83	3.6*	0.19	259	3.5	0.33
Southern Rail												**Southern Rail**		
Protein (Dry Basis %)	35	8.4	0.44	7.8	9.6	7	9.3*	0.42	35	9.1*	0.29	313	9.1**	0.78
Starch (Dry Basis %)	35	73.8	0.55	72.4	74.9	7	73.6	0.16	35	73.6	0.45	313	73.2**	0.64
Oil (Dry Basis %)	35	3.9	0.20	3.3	4.2	7	3.7*	0.09	35	3.8	0.24	313	3.7**	0.34

** Indicates that the 2012/13 Export Cargo averages were significantly different from the 2013/14 Export Cargo averages, and the 2011/12 Export Cargo averages were significantly different from the 2013/14 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

*** Indicates that the 2013 Harvest averages were significantly different from the 2013/14 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

[1] Due to the Harvest 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 %)	292	8.7	0.28	7.8	10.1	120	8.4*	0.27	7.6	9.7
Starch (Dry Basis %)	292	73.8	0.50	72.2	75.3	120	73.8	0.53	72.7	75.4
Oil (Dry Basis %)	292	3.8	0.21	2.9	4.5	120	3.8	0.23	2.7	4.2
Gulf										
Protein (Dry Basis %)	175	8.5	0.20	7.8	9.1	120	8.4*	0.27	7.6	9.7
Starch (Dry Basis %)	175	73.8	0.51	72.2	75.3	120	73.8	0.53	72.7	75.4
Oil (Dry Basis %)	175	3.8	0.20	3.2	4.5	120	3.8	0.23	2.7	4.2
Pacific Northwest										
Protein (Dry Basis %)	82	9.3	0.46	8.5	10.1	0	0.00	0.00	0.0	0.0
Starch (Dry Basis %)	82	73.4	0.44	72.4	74.5	0	0.00	0.00	0.0	0.0
Oil (Dry Basis %)	82	3.5	0.24	2.9	4.2	0	0.00	0.00	0.0	0.0
Southern Rail										
Protein (Dry Basis %)	35	8.4	0.44	7.8	9.6	0	0.00	0.00	0.0	0.0
Starch (Dry Basis %)	35	73.8	0.55	72.4	74.9	0	0.00	0.00	0.0	0.0
Oil (Dry Basis %)	35	3.9	0.20	3.3	4.2	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.*

D. Physical Factors

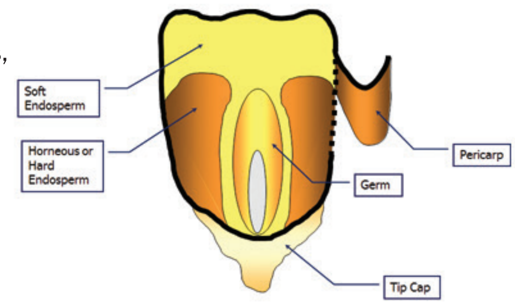


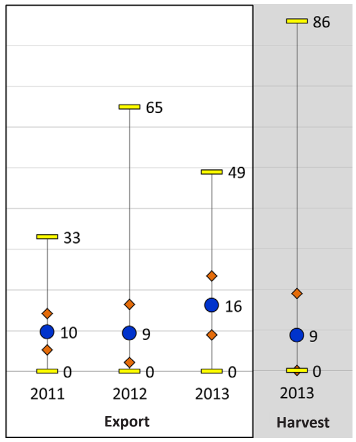
Illustration courtesy of K. D. Rausch University of Illinois

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

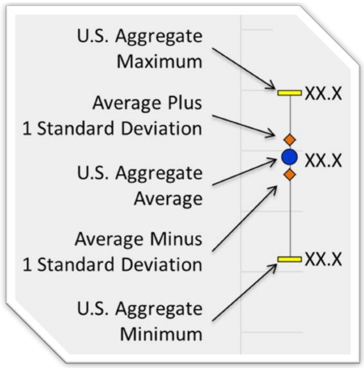
SUMMARY: PHYSICAL FACTORS

- *Average stress cracks (16%) was higher than the previous two years, which was likely due to additional drying needed with the 2013 crop; however, the majority of the export samples (70.9%) still had less than 20% stress cracks, and should have reduced rates of breakage during handling.*
- *At export, 42.5% of the 2013/14 samples had SCI of less than 40, compared to 82% in 2012/13. This would indicate that more kernels in 2013/14 have double or multiple stress cracks than in 2012/13.*
- *Whole kernels (88.6%) was lower than in 2012/13 (89.9%).*
- *Both true densities and test weights were significantly lower for 2013/14 than for 2012/13.*
- *Horneous endosperm (82%) was lower than 2012/13 (85%) and 2011/12 (84%). This indicates corn endosperm will be less hard than the previous two years.*
- *Kernel volume and 100-k weight were significantly lower than in 2012/13 and 2011/12, indicating smaller kernel sizes in early 2013/14 corn exports than in the previous two years.*
- *Average 100-k weight and true density were lower for the Pacific Northwest ECA than for the other ECAs, indicating smaller kernel sizes and lower true densities for the Pacific Northwest samples.*

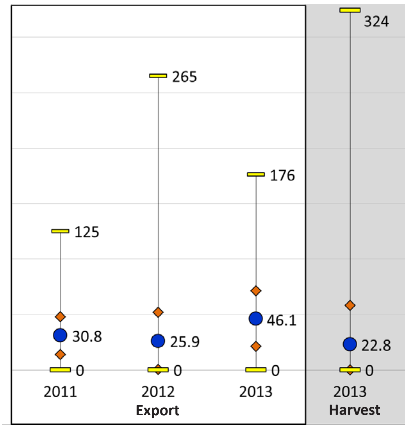
Stress Cracks (%)



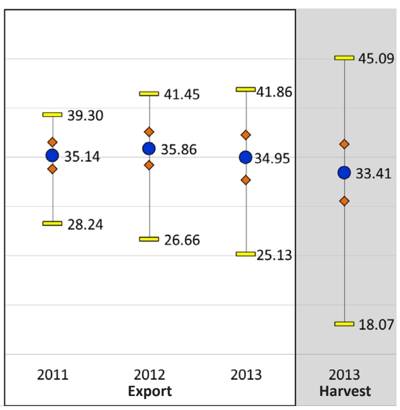
How to Read the Charts



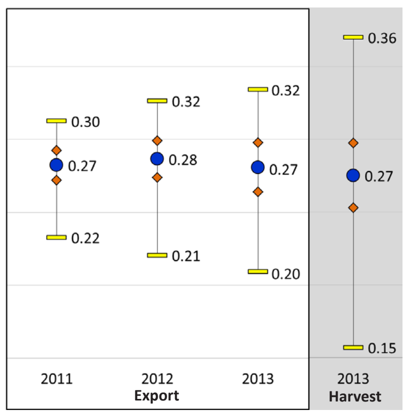
Stress Crack Index



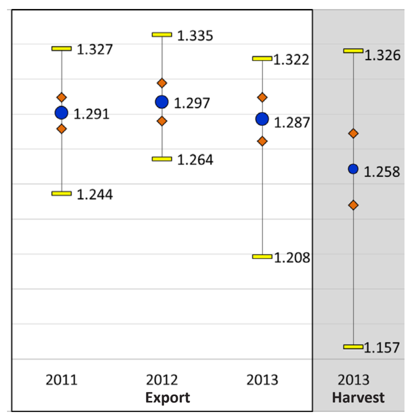
100-Kernel Weight (g)



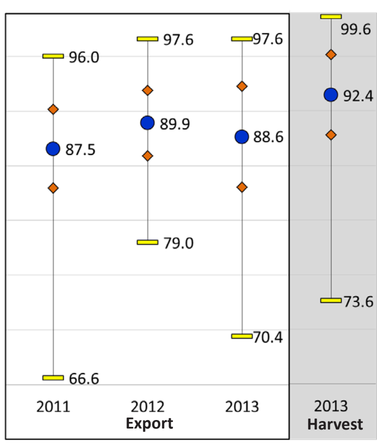
Kernel Volume (cm^3)



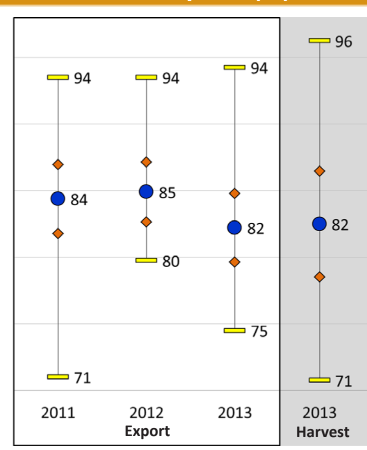
True Density (g/cm^3)



Whole Kernel (%)



Horneous Endosperm (%)



III. QUALITY TEST RESULTS (continued)

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. A kernel may have one, two or multiple stress cracks. Stress cracks affect corn in various ways:

- 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.

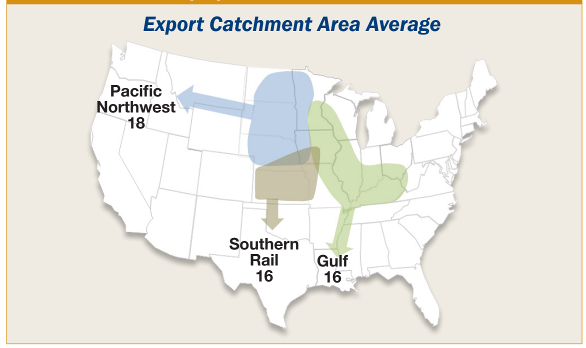
High-temperature drying is the most common cause of stress cracks. Growing conditions affect the need for artificial drying and influence the degree of stress cracking found from region to region. Then, as corn moves through the market channel, some stress-cracked kernels break, increasing the proportion of broken corn. Concurrently, impacts of kernels on other kernels or on metal surfaces 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.

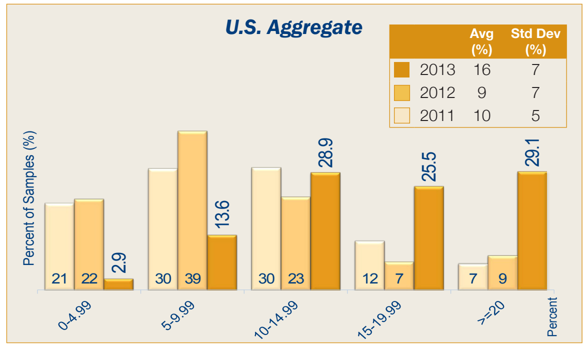
Stress crack measurements include "stress cracks" (the percent of kernels with at least one crack) and stress crack index (SCI) which is the weighted average of single, double and multiple stress cracks. "Stress cracks" measures only the number of kernels with stress cracks whereas SCI shows the severity of cracking. For example, if half the kernels have only single stress cracks, "stress cracks" 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 more desirable. In years with high levels of stress cracks, the SCI is valuable because high SCI numbers (perhaps 300 to 500) indicate the sample had a very high percent of multiple stress cracks. Multiple stress cracks are generally more detrimental to quality changes than single stress cracks.

RESULTS

- U.S. Aggregate stress cracks was 16%, significantly higher than in 2012/13 (9%).
- Stress crack percentages were higher than found at harvest for the 2013 crop corn (16% vs 9%). Increases in stress cracks also occurred with the 2012 and 2011 corn crops, and these increases may be attributed, in part, to conditioning and additional handling from the harvest elevator to the export terminal.
- Stress cracks ranged from 0 to 49% with a standard deviation of 7%.
- Almost 29.1% of the samples had greater than 20% stress cracks, compared to 9% and 7% in the previous two years. About 54.6% of the samples had greater than 15% stress cracks, compared to 2012/13 (16%) and 2011/12 (19%). This indicates a portion of the corn is experiencing higher stress cracks than in the previous two years. However, the majority of the samples (70.9%) still had less than 20% stress cracks, and should have reduced rates of breakage during handling.
- Stress cracks averaged 16%, 18% and 16% for the Gulf, Pacific Northwest and Southern Rail ECAs, respectively.
- The variability of stress cracks (standard deviation) was the same (7.0%) across all ECAs.
- Stress cracks for Gulf ECA contracts loaded as U.S. No. 2 o/b was 15%, significantly lower than the 18% in Gulf ECA contracts loaded as U.S. No. 3 o/b. The higher stress cracks found in U.S. No. 3 o/b is consistent with the higher BCFM (3.0%) compared to the lower BCFM level (2.8%) found in U.S. No. 2 o/b contracts.

Stress Cracks (%)





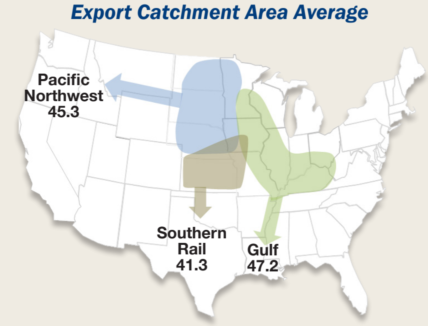
III. QUALITY TEST RESULTS (continued)

RESULTS

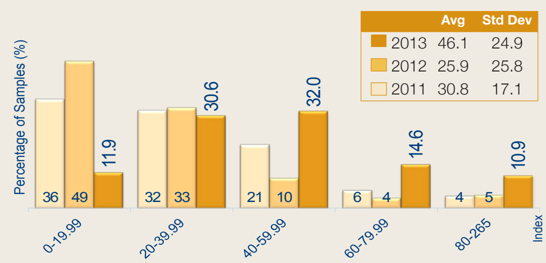
- U.S. Aggregate stress crack index (SCI) average of 46.1 was significantly higher than in 2012/13 (25.9).
- SCI ranged from 0 to 176 with a standard deviation of 24.9.
- SCI at export was higher than the SCI found at harvest (22.8).
- The SCI for the Southern Rail ECA (41.3) was lower than for the Gulf (47.2) and Pacific Northwest (45.3) ECAs.
- SCI standard deviations were nearly the same across all ECAs (26.4, 21.7 and 21.3 for Gulf, Pacific Northwest and Southern Rail, respectively).
- At export, 42.5% had SCI of less than 40, compared to 2012/13 (82%). This would indicate more kernels in 2013/14 had double or multiple stress cracks than in 2012/13.
- SCI for Gulf ECA contracts loaded as U.S. No. 2 o/b was 41.9, which was significantly lower than the 54.9 found for Gulf ECA contracts loaded as U.S. No. 3 o/b. Thus, both stress crack percentages and SCI were lower for the Gulf contracts loaded as U.S. No. 2 o/b than for Gulf contracts loaded as U.S. No. 3 o/b.

Stress Crack Index (SCI)

Export Catchment Area Average



U.S. Aggregate



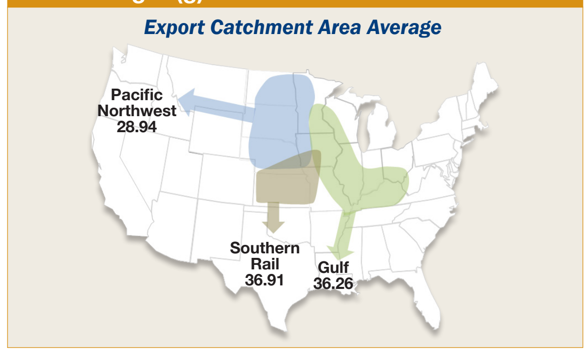
2. 100-Kernel Weight

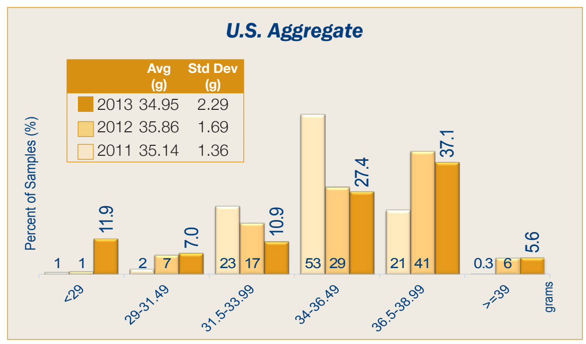
100-kernel (100-k) weight (reported in grams) indicates larger kernel size as 100-k weights increase. Kernel size affects drying rates. As kernel size increases, the volume-to-surface area ratio becomes higher, and as the ratio gets higher, drying becomes slower. In addition, large uniform-sized kernels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

RESULTS

- 100-k weight averaged 34.95 g with a range of 25.13 to 41.86 g. This 100-k weight was significantly lower than in 2012/13 (35.86 g).
- 100-k weight was significantly higher than for the 2013 harvest corn (33.41 g). Higher average 100-k weight at export than at harvest has been seen in each of the past three years. Since the 100-k weights are based on 100 fully intact kernels, any breakage occurring in transit could have self-selected out smaller kernels that might have been soft or more prone to breakage.
- The 2013/14 export samples had greater uniformity than the 2013 harvest samples as indicated by a tighter range and lower standard deviation.
- The average 100-k weight was significantly lower for the Pacific Northwest ECA (28.94 g) than for the Gulf (36.26 g) or Southern Rail (36.91) ECAs. The same pattern was observed in the previous two years.
- About 70% of the 2013/14 export samples (76% in 2012/13) had 100-k weight of 34.0 g or greater.

100-k Weight (g)





III. QUALITY TEST RESULTS (continued)

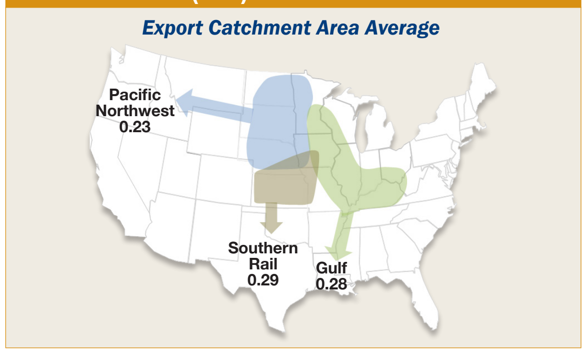
3. Kernel Volume

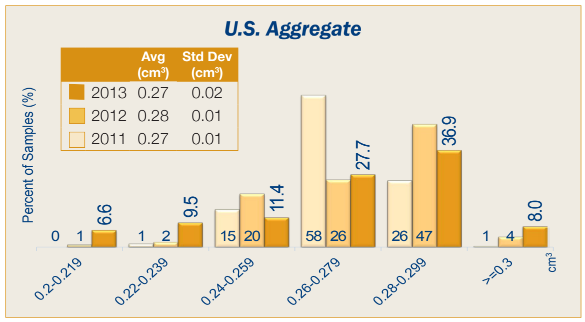
Kernel volume in cubic centimeter (cm^3) is often indicative of growing conditions. Small or round kernels are more difficult to degerm. Additionally, small kernels may lead to increased cleanout losses for processors and higher yields of fiber.

RESULTS

- Average kernel volume (0.27 cm^3), lower than found in 2012/13 (0.28 cm^3), was the same as for the 2013 harvest samples.
- Kernel volume ranged from 0.20 to 0.32 cm^3.
- The standard deviation of 0.02 cm^3 was the same but the range was less in the 2013/14 export samples than in the 2013 harvest samples.
- As in the previous two years, the average export kernel volume was significantly smaller (0.23 cm^3) for the Pacific Northwest than for the Gulf (0.28 cm^3) and Southern Rail (0.29 cm^3) ECAs. Average kernel volume was also smaller for the harvest samples in the Pacific Northwest ECA than in the other two ECAs in 2013 and 2011.
- Approximately 72.6% of the 2013/14 export samples had kernel volumes equal to or greater than 0.26 cm^3, compared with 77% in 2012/13.

Kernel Volume (cm^3)





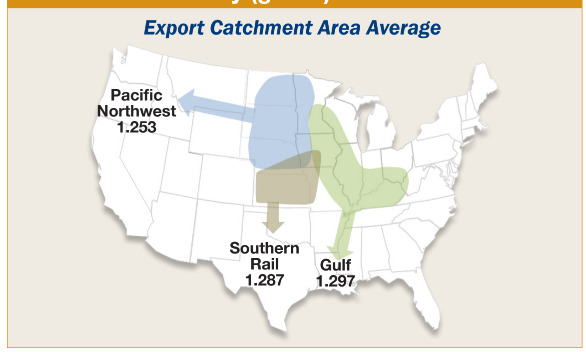
4. Kernel True Density

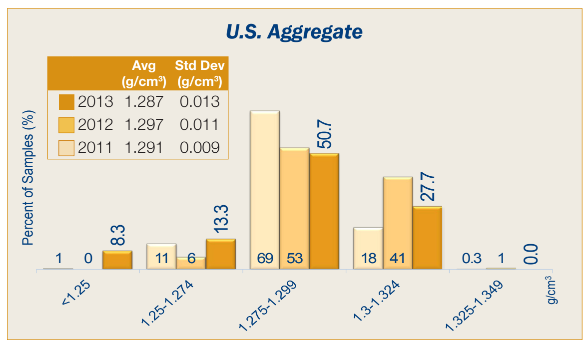
Kernel true density is calculated as the weight of a 100-k sample divided by the volume, or displacement, of those 100 kernels and is reported as g/cm^3. True density is a relative indicator of kernel hardness, which is useful for alkaline processors and dry millers. True density may be affected by the 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.

RESULTS

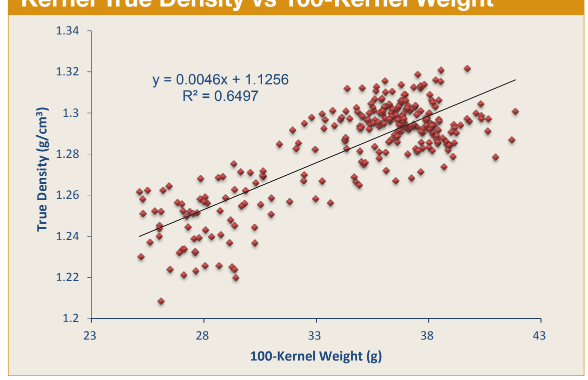
- Kernel true density averaged 1.287 g/cm^3 and was significantly lower than found in 2012/13 (1.297 g/cm^3).
- Average kernel true density for the 2013/14 export samples was significantly higher than for the 2013 harvest samples (1.258 g/cm^3). Average true density was also higher at export than at harvest in the previous two years. This higher true density at export is likely due, in part, to the higher 100-k weights that also occurred each year at export.
- For the export samples, 78.4% had kernel true densities equal to or above 1.275 g/cm^3, compared with 95% found in 2012/13.
- There is a weak but positive relationship for the 2013/14 export corn between 100-k weight and true density as shown in the graphic show at the lower right. (The correlation coefficient is 0.76.)
- The Pacific Northwest had the lowest average true density and 100-k weight among ECAs for each of the past three years.

Kernel True Density (g/cm^3)





Kernel True Density vs 100-Kernel Weight



5. Whole Kernels

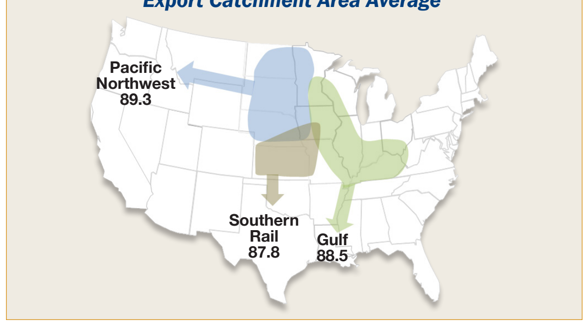
Though the name suggests some inverse relationship between whole kernels and BCFM, the whole kernels test conveys different information than the broken corn portion of the BCFM test. Broken corn is defined solely by weight percentage of material passing through a screen. Whole kernels, as the name implies,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

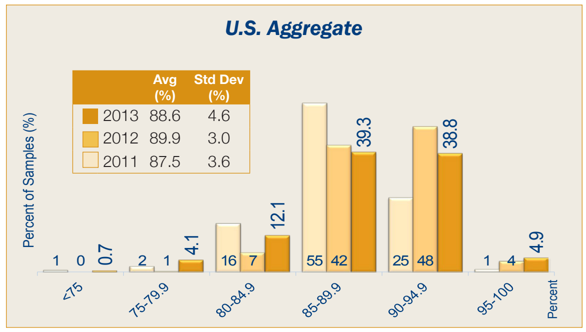
The exterior integrity of the corn kernel is very important for two key reasons. First, it affects water absorption for alkaline cooking operations. Kernel nicks or cracks allow water to enter the kernel faster than for fully intact or whole kernels. Too much water uptake during cooking can result in 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.

RESULTS

- U.S. Aggregate whole kernels averaged 88.6% and was significantly lower than in 2012/13 (89.9%).
- The average percent of whole kernels at export was significantly lower than found at harvest (92.4%).
- The 2013/14 export samples had more variability (range of 70.4 to 97.6% with a standard deviation of 4.6%) than the 2013 harvest samples (range of 73.6 to 99.6% and standard deviation of 3.7%).
- Whole kernel averages for the Gulf (88.5%), Pacific Northwest (89.3%) and Southern Rail (87.8%) ECAs were not significantly different from one another.
- The percent of samples that had whole kernel percentages greater than or equal to 90% was 43.7%, compared to 52% of the 2012/13 export samples.
- The whole kernel percentages for contracts loaded as U.S. No. 2 o/b were 88.0%, somewhat lower than the 89.6% found for contracts loaded as U.S. No. 3 o/b.

Whole Kernels (%)





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.

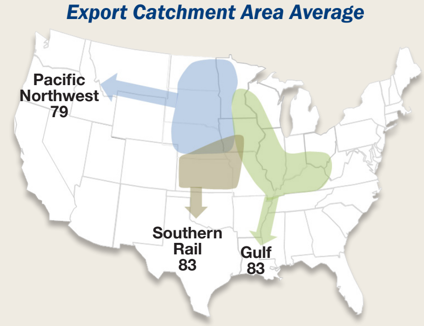
Hardness has been correlated to breakage susceptibility, feed utilization/efficiency and starch digestibility. There is no good or bad value for horneous endosperm; there is only a preference by different end users for particular ranges. Many dry millers and alkaline cookers would like greater than 90%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

RESULTS

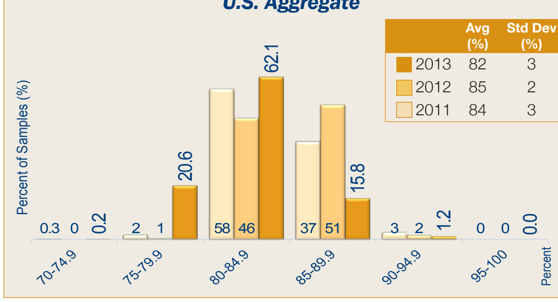
- U.S. Aggregate horneous endosperm averaged 82%, significantly lower than in 2012/13 (85%).
- The 2013/14 export samples ranged from 75 to 94% and had a smaller range and standard deviation than the 2013 harvest samples.
- The horneous endosperm for the Pacific Northwest ECA was significantly lower (79%) than that for the other two ECAs (both 83%).
- Average horneous endosperm was lower (82%) for contracts loaded as U.S. No. 2 o/b than for contracts loaded as U.S. No. 3 o/b (84%).
- At export, 79.1% of the samples had greater than 80% horneous endosperm in contrast to 2012/13 (99%).

Horneous Endosperm (%)

Export Catchment Area Average



U.S. Aggregate



III. QUALITY TEST RESULTS (continued)

SUMMARY: PHYSICAL FACTORS

	2013/14 Export Cargo					2012/13 Export Cargo			2011/12 Export Cargo			2013/14 Harvest		
	No. of Samples	Avg.	Std. Dev.	Min.	Max.	No. of Samples	Avg.	Std. Dev.	No. of Samples	Avg.	Std. Dev.	No. of Samples[1]	Avg.	Std. Dev.
U.S. Aggregate												**U.S. Aggregate**		
Stress Cracks (%)	412	16	7	0	49	397	9*	7	379	10*	5	610	9**	10
Stress Crack Index	412	46.1	24.9	0	176	397	25.9*	25.8	379	30.8*	17.1	610	22.8**	35.1
100-Kernel Weight (g)	412	34.95	2.29	25.13	41.86	397	35.86*	1.69	379	35.14	1.36	610	33.41**	2.88
Kernel Volume (cm^3)	412	0.27	0.02	0.20	0.32	397	0.28*	0.01	379	0.27	0.01	610	0.27**	0.02
True Density (g/cm^3)	412	1.287	0.013	1.208	1.322	397	1.297*	0.011	379	1.291*	0.009	610	1.258**	0.021
Whole Kernels (%)	412	88.6	4.6	70.4	97.6	397	89.9*	3.0	379	87.5*	3.6	610	92.4**	3.7
Horneous Endosperm (%)	412	82	3	75	94	397	85*	2	379	84*	3	610	82	4
Gulf												**Gulf**		
Stress Cracks (%)	295	16	7	0	49	284	10*	8	261	12*	5	556	9**	11
Stress Crack Index	295	47.2	26.4	0	176	284	30.2*	31.5	261	40.0*	20.9	556	23.5**	39.5
100-Kernel Weight (g)	295	36.26	2.12	29.86	41.86	284	36.94*	1.50	261	35.53*	1.32	556	34.10**	2.94
Kernel Volume (cm^3)	294	0.28	0.02	0.23	0.32	284	0.28*	0.01	261	0.27*	0.01	556	0.27**	0.02
True Density (g/cm^3)	295	1.297	0.010	1.254	1.322	284	1.300*	0.011	261	1.295*	0.009	556	1.261**	0.020
Whole Kernels (%)	295	88.5	4.6	70.6	97.6	284	89.3*	3.0	261	87.5*	3.7	556	92.4**	3.8
Horneous Endosperm (%)	295	83	3	76	94	284	85*	2	261	84*	3	556	83	4
Pacific Northwest												**Pacific Northwest**		
Stress Cracks (%)[2]	82	18	7	6	38	106	9*	6	83	5*	3	259	10**	10
Stress Crack Index[2]	82	45.3	21.7	12	105	106	20.1*	18.5	83	12.3*	8.5	259	27.4**	31.1
100-Kernel Weight (g)	82	28.94	2.81	25.13	37.64	106	32.31*	1.92	83	33.02*	1.50	259	30.33**	2.70
Kernel Volume (cm^3)	82	0.23	0.02	0.20	0.29	106	0.25*	0.01	83	0.26*	0.01	259	0.24**	0.02
True Density (g/cm^3)	82	1.253	0.020	1.208	1.312	106	1.285*	0.012	83	1.276*	0.011	259	1.241**	0.022
Whole Kernels (%)	82	89.3	4.1	74.4	95.4	106	91.3*	3.1	83	88.9	3.0	259	92.5**	3.3
Horneous Endosperm (%)	82	79	3	75	87	106	84*	2	83	85*	2	259	80**	3
Southern Rail												**Southern Rail**		
Stress Cracks (%)[2]	35	16	7	3	29	7	6*	4	35	4*	3	312	5**	6
Stress Crack Index[2]	35	41.3	21.3	3	82	7	12.9*	8.3	35	9.8*	10.2	312	11.7**	16.5
100-Kernel Weight (g)	35	36.91	2.45	27.13	41.03	7	35.86	2.31	35	37.00	1.29	312	34.23**	2.87
Kernel Volume (cm^3)	35	0.29	0.02	0.22	0.32	7	0.28	0.02	35	0.29	0.01	312	0.27**	0.02
True Density (g/cm^3)	35	1.287	0.013	1.234	1.305	7	1.297*	0.010	35	1.295*	0.006	312	1.267**	0.020
Whole Kernels (%)	35	87.8	5.2	70.4	95.8	7	90.9*	2.8	35	85.2*	4.1	312	92.5**	3.5
Horneous Endosperm (%)	35	83	2	77	88	7	84	2	35	84	2	312	83	4

** Indicates that the 2012/13 Export Cargo averages were significantly different from the 2013/14 Export Cargo averages, and the 2011/12 Export Cargo averages were significantly different from the 2013/14 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

*** Indicates that the 2013 Harvest averages were significantly different from the 2013/14 Export Cargo averages, based on a 2-tailed t-test at the 95% level of significance.*

[1] Due to the Harvest 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 2013/14 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 (%)	292	15	6	0	38	120	18*	9	0	49
Stress Crack Index	292	42.5	21.0	0	111	120	54.9*	31.5	0	176
100-Kernel Weight (g)	292	35.26	2.01	25.13	41.86	120	35.58	2.46	29.86	40.97
Kernel Volume (cm^3)	292	0.27	0.02	0.20	0.32	120	0.27	0.02	0.23	0.32
True Density (g/cm^3)	292	1.288	0.012	1.208	1.321	120	1.294*	0.011	1.265	1.322
Whole Kernels (%)	292	88.0	4.6	70.4	95.8	120	89.6*	4.3	70.6	97.6
Horneous Endosperm (%)	292	82	2	75	90	120	84*	3	76	94
Gulf										
Stress Cracks (%)	175	15	6	0	33	120	18*	9	0	49
Stress Crack Index	175	41.9	20.8	0	111	120	54.9*	31.5	0	176
100-Kernel Weight (g)	175	36.72	1.71	30.92	41.86	120	35.58*	2.46	29.86	40.97
Kernel Volume (cm^3)	175	0.28	0.01	0.25	0.32	120	0.27*	0.02	0.23	0.32
True Density (g/cm^3)	175	1.298	0.010	1.254	1.321	120	1.294*	0.011	1.265	1.322
Whole Kernels (%)	175	87.7	4.6	76.0	95.6	120	89.6*	4.3	70.6	97.6
Horneous Endosperm (%)	175	82	2	78	90	120	84*	3	76	94
Pacific Northwest										
Stress Cracks (%)	82	18	7	6	38	0	0	0	0	0
Stress Crack Index	82	45.3	21.7	12	105	0	0.0	0.0	0	0
100-Kernel Weight (g)	82	28.94	2.81	25.13	37.64	0	0.00	0.00	0.00	0.00
Kernel Volume (cm^3)	82	0.23	0.02	0.20	0.29	0	0.00	0.00	0.00	0.00
True Density (g/cm^3)	82	1.253	0.020	1.208	1.312	0	0.000	0.000	0.000	0.000
Whole Kernels (%)	82	89.3	4.1	74.4	95.4	0	0.0	0.0	0.0	0.0
Horneous Endosperm (%)	82	79	3	75	87	0	0	0	0	0
Southern Rail										
Stress Cracks (%)	35	16	7	3	29	0	0	0	0	0
Stress Crack Index	35	41.3	21.3	3	82	0	0.0	0.0	0	0
100-Kernel Weight (g)	35	36.91	2.45	27.13	41.03	0	0.00	0.00	0.00	0.00
Kernel Volume (cm^3)	35	0.29	0.02	0.22	0.32	0	0.00	0.00	0.00	0.00
True Density (g/cm^3)	35	1.287	0.013	1.234	1.305	0	0.000	0.000	0.000	0.000
Whole Kernels (%)	35	87.8	5.2	70.4	95.8	0	0.0	0.0	0.0	0.0
Horneous Endosperm (%)	35	83	2	77	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.*

E. Mycotoxins

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

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 effect 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 412 export samples for aflatoxins for the *Export Cargo Report 2013/14*. Results of the 2013/14 survey are as follows:

- 381 samples or 92.5% of the 412 samples tested had no detectable levels of aflatoxins (defined as less than 5.0 ppb or the FGIS lower reporting level). This 92.5% is greater than the 77.8% of the 2012/13 export samples and 85.6% of the 2011/12 export samples.
- 25 samples or 6.1% of the 412 samples tested had aflatoxin levels greater than or equal to 5.0 ppb, but less than 10 ppb. This 6.1% is less than the 10.1% of the 2012/13 export samples and 8.1% of the 2011/12 export samples.
- 6 samples or 1.5% of the 412 samples tested had aflatoxin levels greater than or equal to 10.0 ppb, but less than the FDA action level of 20 ppb. This 1.5% is less than the 12.1% of the 2012/13 export samples and 6.3% of the 2011/12 export samples.
- 100% of the samples tested were below or equal to the FDA action level of 20 ppb, which are the same as the 2012/13 and 2011/12 export reports.

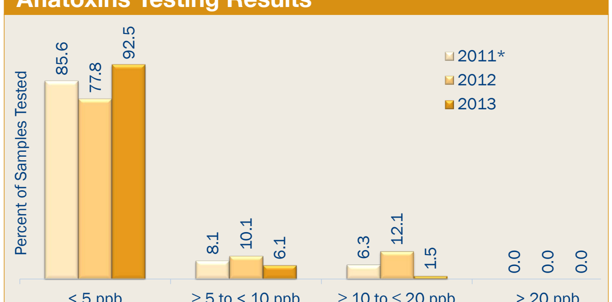
Note: Results for 46 of the 379 samples tested in 2011/2012 are excluded from the 2011/2012 distribution because the analytical method for aflatoxins used for the 2011/2012 survey did not allow the samples to be placed into ppb categories chosen for the 2013/2014 report. However, the test results for all 46 samples were below or equal to the FDA action level of 20 ppb.

Comparing the 2013/14 aflatoxin export survey results to the 2012/13 and 2011/12 export survey results suggests that there were fewer incidents of aflatoxins in 2013 than in either the 2012 and 2011 crop seasons. The higher proportion of samples with no detectable levels of aflatoxins in 2013 than in 2012 and 2011 may be due, in part, to more favorable weather conditions during the 2013 growing season when compared to similar environmental conditions during the 2012 and 2011 growing seasons. These results are consistent with the aflatoxin results from the *Harvest Reports 2013/14, 2012/13 and 2011/12.*

Aflatoxins

	Percent of Total Samples				
	< 5 ppb	≥ 5 to < 10 ppb	≥ 10 to ≤ 20 ppb	> 20 ppb	Total
U.S. Aggregate	92.5%	6.1%	1.5%	0.0%	100.0%
By ECA					
Gulf	89.8%	8.1%	2.0%	0.0%	100.0%
Pacific Northwest	98.8%	1.2%	0.0%	0.0%	100.0%
Southern Rail	100.0%	0.0%	0.0%	0.0%	100.0%

Aflatoxins Testing Results



* Results for 46 of the 379 samples are excluded because the analytical methods used for the 2011/12 samples do not allow the samples to be placed into the categories chosen for this year's report. However, the test results for all 46 samples were below or equal to the FDA action level of 20 ppb.

2. DON (Deoxynivalenol or Vomitoxin) Testing Results

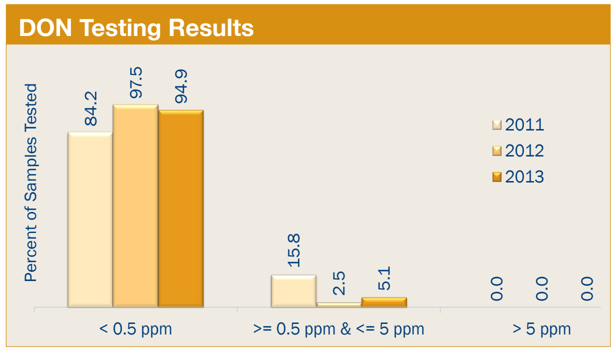
A total of 412 export samples were tested for DON for the *Export Cargo Report 2013/14*. Results of the testing are shown below:

- 391 samples or 94.9% of the 412 samples tested had levels less than 0.5 ppm of DON. This 94.9% is less than the 97.5% of the 2012/13 export samples but greater than the 84.2% of the 2011/12 export samples.

- 21 samples or 5.1% of the 412 samples tested had DON levels greater than or equal to 0.5 ppm, but less than or equal to the FDA advisory level of 5 ppm. This 5.1% is greater than the 2.5% of the 2012/13 export samples but less than the 15.8% of the 2011/12 export samples.

- 100% of the samples tested were below or equal to the FDA advisory level of 5 ppm, which are the same as the 2012/13 and 2011/12 export reports.

DON				
	Percent of Total Samples			
	< 0.5 ppm	≥ 0.5 to ≤ 5.0 ppm	> 5.0 ppm	Total
U.S. Aggregate	94.9%	5.1%	0.0%	100.0%
By ECA				
Gulf	93.9%	6.1%	0.0%	100.0%
Pacific Northwest	98.8%	1.2%	0.0%	100.0%
Southern Rail	94.3%	5.7%	0.0%	100.0%



Comparing the 2013/14 DON export survey results to the 2012/13 and 2011/12 DON export survey results indicates that there were less DON contaminations in the 2013 crop season than in the 2011 crop season and about the same as in the 2012 crop season. These results are consistent with the DON results for the *Harvest Reports 2013/14, 2012/13 and 2011/12.*

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 Mycotoxin Regulatory Guidance” found at *http://www.ngfa.org/wp-content/uploads/NGFAComplianceGuide-FDARegulatoryGuidanceforMycotoxins8-2011.pdf*.

4. Mycotoxin Background: Aflatoxins

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

There are four types of aflatoxins naturally found in foods – aflatoxins B1, B2, G1 and G2.These four aflatoxins are commonly referred to as “aflatoxins” or “total aflatoxins.” Aflatoxin B1 is the most commonly found aflatoxins in food and feed and is also the most toxic. Additionally, dairy cattle will metabolize aflatoxins to a different form of aflatoxins called aflatoxin M1, which may accumulate in milk.

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

The FDA has established action levels for aflatoxins 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 United States must be tested for aflatoxins according to Federal law. Unless the contract exempts this requirement, testing must be conducted by FGIS. Corn above the FDA action level of 20 ppb cannot be exported unless other strict conditions are met. 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). Gibberella zeae can develop when warm or moderate and wet weather occurs at flowering. The fungus grows down the silks into the ear, and in addition to producing DON, it produces conspicuous red discoloration of kernels on the ear. The fungus can also continue to grow and rot ears when corn is left standing in the field. Mycotoxin contamination of corn caused by Gibberella zeae is associated with excessively postponing harvest and/or storing high-moisture corn.

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

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

- 5 ppm in grains and grain 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

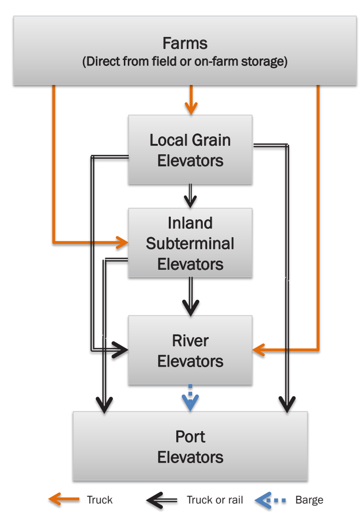
This *U.S. Grains Council Corn Export Cargo Quality Report 2013/14* provides advance information about corn quality by evaluating and reporting quality attributes when the corn is ready to be loaded onto the vessel or rail car for export. Corn quality includes a range of attributes that can be categorized 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 2013/14* assessed the quality of the 2013 corn crop as it entered the marketing system and reported the crop as good with low incidences of aflatoxins and DON. This *Export Cargo Report* provides information on the impact of the subsequent practices including cleaning, drying, handling, blending, storing and transporting of 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, both of which are 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 United States, 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 corn 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 leads 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 arguably 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 take place during transport. Another factor is the accumulation of fine material (spout lines) beneath the loading spout 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 United States 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 or rail car 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.

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 47. 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 official grade factors (such as test weight and total damage) cannot always be met simultaneously, some grade factors may be better than the limit for a specified 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 2013/14* are as follows:

- Following the process developed for the *Export Cargo Report 2011/12* and *2012/13*, 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 430 samples to be collected from the ECAs as follows: 294 from the Gulf, 82 from the Pacific Northwest and 54 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, 35 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 one attribute from the Pacific Northwest ECA – total damage - and three attributes from the Southern Rail ECA – total damage, stress cracks and stress crack index.

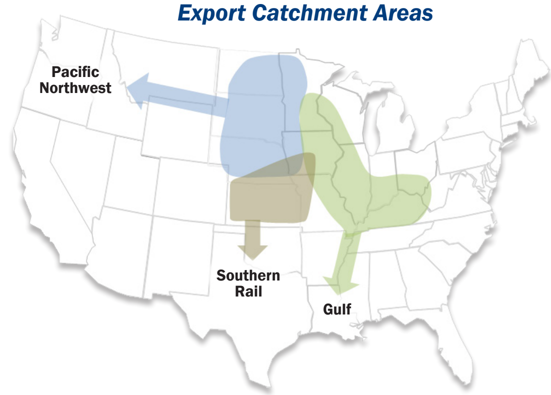
B. Survey Design and Sampling

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 United States 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.

Using data from the FGIS Export Grain Information System (EGIS), each ECA's proportion of the total annual yellow corn exports for the 2007/08 through the 2012/13 corn marketing years was calculated and averaged over the six 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
68.2%	19.2%	12.6%	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 2012/13 results of 397 samples. Heat damage, 100-k weight, and kernel volume were not examined. Based on these data, a total sample size of 430 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 430 samples resulted in the following number of targeted samples from each ECA:

Number of Samples per ECA			
Gulf	Pacific Northwest	Southern Rail	Total
294	82	54	430

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 2013 corn was reaching export points by late October 2013, it was decided to start the sampling period early November 2013. Therefore, FGIS sent instruction letters to the Gulf and Pacific Northwest field offices on October 29, 2013 and to the domestic inspections office on November 4, 2013. The sampling period began November 4, 2013, for the Gulf and Pacific Northwest ECAs and November 11, 2013, 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.

V. SURVEY AND STATISTICAL ANALYSIS METHODS (continued)

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 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 November 17, 2013 for the Pacific Northwest ECA and January 13, 2014 for the Gulf ECA when the targeted number of samples per ECA was reached. As of March 21, 2014, 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 on March 21, 2014.

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. Contract grades are described in the "Corn Export System" section on page 39. 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 a surplus sample in the Gulf ECA (which provided a slightly 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.

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)		
	Total Damage	Stress Cracks	Stress Crack Index
Pacific Northwest ECA	37%	--	--
Southern Rail ECA	11%	14%	17%

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 2013/14* and *Export Cargo Report 2013/14*,
- Between factors in the *Export Cargo Report 2013/14* and *Export Cargo Report 2012/13*, and the *Export Cargo Report 2013/14* and *Export Cargo Report 2011/12*,
- Among factors in the *Export Cargo Report 2013/14* ECAs (Gulf, Pacific Northwest, Southern Rail), and
- Between chemical and physical factors in the *Export Cargo Report 2013/14* 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 composition, physical factors and DON testing. Upon arrival at IPG Lab, the samples were split into two subsamples using a Boerner divider while keeping the attributes of the grain sample evenly distributed between the two subsamples. 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 12/64th inch round-hole sieve and all matter other than corn that remains on the top of the sieve. BCFM measurement can be separated into broken corn and foreign material. Broken corn is defined as all material passing through a 12/64th inch round-hole sieve and retained on a 6/64th inch sieve. Foreign material is defined as all material passing through a 6/64th inch round-hole sieve and the coarse non-corn material retained on the 12/64th inch sieve. While FGIS can report broken corn and foreign material separately if requested, BCFM is the default measurement and thus was provided for the *Export Cargo 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.

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 to 450 gram (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) one crack; (3) two cracks; and (4) more than two cracks. Stress cracks, expressed as a percent, are all kernels containing one, two or more than two cracks divided by 100 kernels. Lower levels of stress cracks are always better since higher levels of stress cracks lead to more breakage in handling. If stress cracks are present, singles are better than doubles or multiples. Some corn end users will specify by contract the acceptable level of cracks based on the intended use.

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

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

Where

SSC is the percentage of kernels with only one crack;

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

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

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

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 to 100%, though most individual kernels fall in the 70 to 95% range.

E. Mycotoxin Testing

Official aflatoxin results are provided by FGIS for the *Export Cargo Report 2013/14*. 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 or FluoroQuant Afla IAC, Envirologix QuickTox™ for QuickScan Aflatoxin (AQ 109 BG and AQ 209 BG), Neogen Reveal Q+ for Aflatoxin, Reveal Q+ for Aflatoxin Green, or Veratox® Aflatoxin Quantitative Test, Charm Sciences ROSA® FAST, WET™, WET™ XR Aflatoxin Quantitative Test, or R-Biopharm RIDASCREEN® FAST Aflatoxin SC test or RIDA QUICK Aflatoxin RQS.

For the DON testing, the FGIS-approved Envirologix QuickTox™/QuickScan 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 distilled water (5:1), and the extract was tested using the Envirologix AQ 254 BG test kits. The DON was quantified by the QuickScan system.

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

A letter of performance has been issued by FGIS for the quantification of DON using the Envirologix AQ 254 BG kit.

VII. U.S. CORN GRADES AND CONVERSIONS

U.S. CORN GRADES AND GRADE REQUIREMENTS

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

U.S. Sample Grade is corn that: (a) Does not meet the requirements for the grades U.S. Nos. 1, 2, 3, 4 or 5; or (b) Contains stones with an aggregate weight in excess of 0.1 percent of the sample weight, two or more pieces of glass, three or more crotalaria seeds (Crotalaria spp.), two or more castor beans (Ricinus communis L.), four or more particles of an unknown foreign substance(s) or a commonly recognized harmful or toxic substance(s), eight 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

U.S. GRAINS COUNCIL

20 F Street, NW Suite 600
Washington, DC 20001

Phone: (202) 789-0789
Fax: (202) 898-0522

Email: grains@grains.org
Website: grains.org

Western Hemisphere

Panama City
Tel: 011.507.315.1008
Fax: 011.507.315.0503
LTA@grains.org

Mexico

Mexico City
Tel: 011.52.55.5282.0244
Fax: 011.52.55.5282.0969
mexico@grains.org

Middle East and Africa

Tunis
Tel: 011.216.71.908.622
Fax: 011.216.71.906.165
tunis@usgrains.net

Egypt

Washington, D.C.
Tel: 202.789.0789
Fax: 202.898.0522
grains@grains.org

People's Republic of China

Beijing
Tel: 011.86.10.6505.1314
Fax: 011.86.10.6505.0236
grainsbj@grains.org.cn

Korea

Seoul
Tel: 011.82.2.720.1891
Fax: 011.82.2.720.9008
seoul@grains.org

Japan

Tokyo
Tel: 011.81.3.6206.1041
Fax: 011.81.3.6205.4960
tokyo@grains.org

Taiwan

Taipei
Tel1: 011.886.2.2508.0176
Tel2: 011.886.2.2507.5401
Fax: 011.886.2.2502.4851
taipei@grains.org

Southeast Asia

Kuala Lumpur
Tel: 011.60.3.2093.6826
Fax: 011.60.3.2093.2052
grains@grainsea.org

Developing Markets ■ Enabling Trade ■ Improving Lives