U.S. Grains Council:

- Building partnerships based on trust
- Bridge to world’s largest, most reliable grain supply
Motivation

- Lack of information on quality of U.S. sorghum
- Growth of U.S. sorghum exports
- Success of USGC Corn Quality Reports

Objective

- To provide information proactively on the U.S. sorghum crop to international buyers
  - Harvest
  - Early exports
Sorghum Quality Reports

2015/2016 Sorghum Early Harvest Quality Report

Early Harvest Quality Report

- Initial look at crop quality from early harvest areas
- Samples collected from southern part of growing area during August and September

Harvest and Export Cargo Quality Report

Harvest
- Evaluation of quality of crop over entire harvest season; includes early and late harvest
- Samples collected from key sorghum-producing states

Export Cargo
- Represents export quality early in the marketing year
- Samples collected during federal inspection at key sorghum-exporting ports
Sampling Methodology

- Same as Corn Harvest and Export Cargo Quality Reports

Quality Factors Tested

- Similar to corn factors with minor changes

Reporting

- Altered from corn reports due to differences in production, harvest and export patterns
USGC Quality Sampling

Harvest Sampling

- Initial levels and variability of quality characteristics across the diverse geographic regions
- Inbound, unblended commodity samples from country elevators
USGC Quality Sampling

- Initial levels and variability of early export quality at ports
- Commodity sorghum samples collected by USDA in key export areas
Quality Factors Tested

Grading Factors
- Test weight
- Broken kernel/foreign material
- Foreign material
- Total damage/Heat damage

Physical Factors
- Kernel diameter
- 1000-kernel weight
- Kernel volume
- True density
- Kernel hardness index

Moisture

Chemical Composition
- Protein
- Starch
- Oil
- Tannins

Mycotoxins
- Aflatoxins
- DON

Reported in Harvest/Export Report only
The geographic areas included in the Harvest sampling area include the highest sorghum-producing areas in the United States.
Early Harvest Quality Report

50 samples from Early Harvest area during August and September

Late Harvest

Early Harvest

U.S. GRAINS COUNCIL
Crop Condition (Rated Good or Excellent)

Source: USDA NASS
Crop Progress

Source: USDA NASS
U.S. Production

2015/2016 Sorghum Early Harvest Quality Report

<table>
<thead>
<tr>
<th>Crop Year</th>
<th>Yield (mt/ha)</th>
<th>Hectares Harvested (mil)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1.6</td>
<td>2.0</td>
</tr>
<tr>
<td>2012</td>
<td>2.0</td>
<td>2.7</td>
</tr>
<tr>
<td>2013</td>
<td>2.7</td>
<td>2.6</td>
</tr>
<tr>
<td>2014</td>
<td>2.6</td>
<td>3.1</td>
</tr>
<tr>
<td>2015p</td>
<td>3.1</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Source: USDA NASS  P=Projected
U.S. Production

2015/2016 Sorghum Early Harvest Quality Report

Source: USDA NASS  P=Projected
U.S. Production and Disappearance

2015/2016 Sorghum Early Harvest Quality Report

Source: USDA NASS  P=Projected
Where is U.S. Sorghum Going?

TOP U.S. EXPORT CUSTOMERS

1. CHINA
   Dollar amount: $1.97 BILLION
   Metric tons: 8,369,562

2. SUDAN
   Dollar amount: $51.8 MILLION
   Metric tons: 232,150

3. KENYA
   Dollar amount: $27.8 MILLION
   Metric tons: 112,624

4. JAPAN
   Dollar amount: $17.7 MILLION
   Metric tons: 71,362

5. ETHIOPIA
   Dollar amount: $12.8 MILLION
   Metric tons: 55,760

Key Global Sorghum Exporters

United States: 8.24 (74%)
Argentina: 1.60 (15%)
Australia: 0.90 (8%)
Other: 0.38 (3%)

2015/2016P (Million Metric Tons)

Source: USDA FAS  P=Projected
Grade Factors

- Average for all factors exceeded criteria for No. 1 grade

Moisture

- Drying may have been needed for part of the Early Harvest crop

Chemical Composition

- Typical starch, high oil and low protein concentrations compared to previous research
- All samples were considered tannin-free

Physical Factors

- Values were generally typical for kernels from any sorghum crop
Grade Factors and Moisture
### Grades and Grade Requirements

#### Maximum Limits of

<table>
<thead>
<tr>
<th>Grade</th>
<th>Min. Test Weight per Bushel (Pounds)</th>
<th>Heat Damaged (%)</th>
<th>Total Damage (%)</th>
<th>Foreign Material (part of total) (%)</th>
<th>Broken Kernel and Foreign Material (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. No. 1</td>
<td>57.0</td>
<td>0.2</td>
<td>2.0</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td>U.S. No. 2</td>
<td>55.0</td>
<td>0.5</td>
<td>5.0</td>
<td>2.0</td>
<td>6.0</td>
</tr>
<tr>
<td>U.S. No. 3</td>
<td>53.0</td>
<td>1.0</td>
<td>10.0</td>
<td>3.0</td>
<td>8.0</td>
</tr>
<tr>
<td>U.S. No. 4</td>
<td>51.0</td>
<td>3.0</td>
<td>15.0</td>
<td>4.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Source: USDA Federal Grain Inspection Service (FGIS)
<table>
<thead>
<tr>
<th>Grade Factors and Moisture</th>
<th>No. of Samples</th>
<th>Avg.</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Weight (lb/bu)</td>
<td>50</td>
<td>57.9</td>
<td>2.20</td>
<td>46.3</td>
<td>62.0</td>
</tr>
<tr>
<td>Test Weight (kg/hl)</td>
<td>50</td>
<td>74.5</td>
<td>2.84</td>
<td>59.6</td>
<td>79.8</td>
</tr>
<tr>
<td>BNFM (%)</td>
<td>50</td>
<td>1.4</td>
<td>0.62</td>
<td>0.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Foreign Material (%)</td>
<td>50</td>
<td>0.5</td>
<td>0.27</td>
<td>0.1</td>
<td>2.1</td>
</tr>
<tr>
<td>Total Damage (%)</td>
<td>50</td>
<td>0.2</td>
<td>0.38</td>
<td>0.0</td>
<td>5.7</td>
</tr>
<tr>
<td>Heat Damage (%)</td>
<td>50</td>
<td>0.0</td>
<td>0.00</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>50</td>
<td>14.5</td>
<td>0.88</td>
<td>11.7</td>
<td>17.3</td>
</tr>
</tbody>
</table>
Test Weight – U.S. Units

Early Harvest: 57.9 lb/bu

- Average above the minimum for No. 1 grade
- 94% of the samples at or above the limit for No. 2 grade

Test Weight (lb/bu) Harvest Area Average

<table>
<thead>
<tr>
<th>Harvest Area Average</th>
<th>Test Weight</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Harvest</td>
<td>57.9</td>
<td>2.20</td>
</tr>
<tr>
<td>Late Harvest</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Percent of Samples (%)

- 4.0 lb/bu
- 2.0 lb/bu
- 28.0 lb/bu
- 26.0 lb/bu
- 30.0 lb/bu
- 10.0 lb/bu
Early Harvest: 74.5 kg/hl

- Average above the minimum for No. 1 grade
- 94% of the samples at or above the limit for No. 2 grade
Broken Kernels & Foreign Material (BNFM) (%)

Early Harvest: 1.4%

- Average well below the maximum for No. 1 grade
- All samples were below the maximum for No. 2 grade
Foreign Material (%)

Early Harvest:
0.5%

- Average below the maximum for No. 1 grade
- 98% of the samples contained less than the maximum FM allowable for No. 2 grade
Total Damage
Early Harvest: 0.2%
- Average well below the maximum for No. 1 grade
- 98% had less than the maximum allowable for No. 2 grade

Heat Damage: Zero
- Not expected at harvest
Early Harvest: 14.5%

- Considered normal variability
- 68% exceeded 14% moisture
- Drying may have been needed for part of the Early Harvest crop
Chemical Composition
Sorghum Chemical Composition

**Protein**
- Important for poultry and livestock feeding
- Supplies essential amino acids

**Starch**
- Important source of metabolizable energy and substrates

**Oil**
- Supplies energy and fatty acids
- Important co-product of value-added processing

Influenced by genetics, crop yields, weather and available nitrogen during the growing season

Influenced by genetics, weather and crop yields
### Chemical Composition Factors

<table>
<thead>
<tr>
<th></th>
<th>No. of Samples</th>
<th>Avg.</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protein (Dry Basis %)</strong></td>
<td>50</td>
<td>10.4</td>
<td>0.75</td>
<td>7.1</td>
<td>12.7</td>
</tr>
<tr>
<td><strong>Starch (Dry Basis %)</strong></td>
<td>50</td>
<td>73.3</td>
<td>0.69</td>
<td>71.1</td>
<td>75.0</td>
</tr>
<tr>
<td><strong>Oil (Dry Basis %)</strong></td>
<td>50</td>
<td>4.3</td>
<td>0.31</td>
<td>3.0</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Tannins (mg CE/g)</strong></td>
<td>50</td>
<td>0.577</td>
<td>0.339</td>
<td>0.050</td>
<td>1.560</td>
</tr>
</tbody>
</table>
Early Harvest: 10.4%

- On the lower end of typical protein concentration values in literature for U.S. sorghum
Early Harvest: 73.3%

- Typical level for any sorghum crop
Early Harvest: 4.3%

- On the higher end of typical oil concentration values in literature for U.S. sorghum
Tannins Testing

- Quantitative test (levels to indicate presence of tannins) was used instead of qualitative test (Yes or No) for more accurate results.

1. 50 g sample is ground
2. Vanillin HCl test is performed in triplicate
3. Triplicate results are averaged

- Values near or below 4.0 mg catechin equivalents (CE) per one g sample by this method generally imply absence of condensed tannins.\(^1,\(^2\)

- Type III tannin sorghums usually have values greater than 8.0 mg CE/g.

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100% of Early Harvest sorghum samples were below the threshold of 4.0 mg CE/g, thus considered tannin-free.
Physical Factors
Physical Factors – Overview

Related to processing characteristics, storability and potential for breakage

- Kernel weight, volume and density
- Kernel diameter
- Kernel hardness index
### Physical Factors

<table>
<thead>
<tr>
<th></th>
<th>No. of Samples</th>
<th>Avg.</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kernel Diameter (mm)</td>
<td>50</td>
<td>2.54</td>
<td>0.10</td>
<td>2.20</td>
<td>2.90</td>
</tr>
<tr>
<td>1000-Kernel Weight (g)</td>
<td>50</td>
<td>25.97</td>
<td>2.32</td>
<td>19.5</td>
<td>32.10</td>
</tr>
<tr>
<td>Kernel Volume (mm³)</td>
<td>50</td>
<td>19.22</td>
<td>1.61</td>
<td>14.56</td>
<td>23.46</td>
</tr>
<tr>
<td>True Density (g/cm³)</td>
<td>50</td>
<td>1.350</td>
<td>0.015</td>
<td>1.295</td>
<td>1.382</td>
</tr>
<tr>
<td>Kernel Hardness Index</td>
<td>50</td>
<td>68.5</td>
<td>6.9</td>
<td>37.1</td>
<td>84.0</td>
</tr>
</tbody>
</table>
Kernel Weight, Volume, Density

- Measure the size and composition of sorghum kernels
- Kernel volume is indicative of growing conditions and genetics

1000-Kernel Weight (mass) (g) =

\[
\frac{\text{Kernel Volume (mm}^3\text{)} \times \frac{1 \text{ cm}^3}{1000 \text{ mm}^3}}{\text{True Density (g/cm}^3\text{)}}
\]

- True density reflects kernel hardness
- Higher density – harder kernels; less susceptible to breakage
- Lower density – softer kernels; process well in size reduction; good for feed use
Early Harvest: 25.97 g

- On the lower end of typical levels in literature for U.S. sorghum
Kernel Volume (mm$^3$)

Early Harvest: 19.22 mm$^3$

- Typical values for kernels from any sorghum crop
Kernel True Density (g/cm$^3$)

Early Harvest: 1.350 g/cm$^3$

- Typical values for kernels from any sorghum crop
- Average within range of feed sorghum
Kernel Diameter

- Directly correlated with kernel volume
- Impacts size reduction behavior and material handling practices
- May indicate maturity of kernel

Kernel Hardness Index

- The higher the value, the harder the kernel
- Impacts end-use of sorghum
Kernel Diameter (mm)

Early Harvest: 2.54 mm

- Typical values for kernels from any sorghum crop
Kernel Hardness Index (KHI)

Early Harvest: 68.5

- Average is a typical value for any sorghum crop
<table>
<thead>
<tr>
<th>Sorghum Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Harvest</strong> – impacted by several factors including geography, genetics and weather</td>
</tr>
<tr>
<td><strong>Export</strong> – affected by many factors in the U.S. grain marketing system, in addition to building on the quality established at harvest</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides information for evaluating patterns in quality across geographies, how weather affects quality, and changes in quality between harvest and export</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2015/2016</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2015/2016 Sorghum Harvest and Export Cargo Quality Report</strong> in December 2015 or early January 2016 will report U.S. sorghum quality from entire harvest area and samples at export points early in the marketing year</td>
</tr>
</tbody>
</table>
Building a Tradition: Thank You!

Developing markets.  >>  Enabling trade.  >>  Improving lives.