Crop Quality and the Role of Agronomists in FSMA

Charles R. Hurburgh
And
Erin Bowers

Agricultural and Biosystems Engineering
December 2, 2015
Outline

• 2015 Crop Quality – forecast wrong again.
• 2015 Crop Volume – increasing challenge
• Food Safety Modernization Act
• The prime hazards are mycotoxins
• ….which are agronomic issues on farms
• A connected supply chain
Average Temperature (°F): Departure from Mean June 16, 2015 to September 13, 2015

State Climatologist
Iowa Dept. of Agriculture & Land Stewardship; Des Moines, IA
http://www.agriculture.state.ia.us/climatology.asp

Average Temperature (°F): Departure from Mean September 7, 2015 to September 13, 2015

Mean period is 1981-2010.

State Climatologist
Iowa Dept. of Agriculture & Land Stewardship; Des Moines, IA
http://www.agriculture.state.ia.us/climatology.asp
Accumulated Precipitation (in): Departure from Mean
June 16, 2015 to September 13, 2015

Accumulated Precipitation (in): Departure from Mean
September 7, 2015 to September 13, 2015

Mean period is 1981–2010.

State Climatologist
Iowa Dept. of Agriculture & Land Stewardship; Des Moines, IA
http://www.agriculture.state.ia.us/climatology.asp

STORAGE TEAM
So what actually happened?

September, 2015

October, 2015
## Production (2015 as of 9/01/2015)

<table>
<thead>
<tr>
<th></th>
<th>Yield (bu/a)</th>
<th>Billion bu</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2014</td>
<td>2015</td>
</tr>
<tr>
<td><strong>Corn</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>171.0</td>
<td>167.5</td>
</tr>
<tr>
<td>Iowa</td>
<td>178</td>
<td>181</td>
</tr>
<tr>
<td><strong>Soybeans</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>47.8</td>
<td>47.1</td>
</tr>
<tr>
<td>Iowa</td>
<td>51.5</td>
<td>53.0</td>
</tr>
</tbody>
</table>
## Stocks (June 1) (Billion Bushels)

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corn</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>3.85</td>
<td>4.45</td>
</tr>
<tr>
<td>Iowa</td>
<td>0.73</td>
<td>0.88 (~55% farm)</td>
</tr>
<tr>
<td><strong>Soybeans</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>0.41</td>
<td>0.63</td>
</tr>
<tr>
<td>Iowa</td>
<td>0.094</td>
<td>0.126 (~40% farm)</td>
</tr>
<tr>
<td></td>
<td>On Farm</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td>2014</td>
<td>2015</td>
</tr>
<tr>
<td>USA</td>
<td>13.0</td>
<td>13.2</td>
</tr>
<tr>
<td>Iowa</td>
<td>2.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>
## Storage vs Crop, Iowa

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production</strong></td>
<td>2.95</td>
<td>2.94 (corn and soybeans)</td>
</tr>
<tr>
<td><strong>On hand</strong></td>
<td>0.82</td>
<td>1.01 (high – June)</td>
</tr>
<tr>
<td><strong>Balance</strong></td>
<td>0.27</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Grain likely outside for a short time

Usage = 200 – 240 MM Bu/month
## Corn Quality Trends

<table>
<thead>
<tr>
<th>Year</th>
<th>Yield (bu/a)</th>
<th>Test Weight (lb/bu)</th>
<th>Moisture (15%M as-is)</th>
<th>Protein (15%M)</th>
<th>Oil (15%M)</th>
<th>Starch (15%M)</th>
<th>Density (gm/cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>194.1</td>
<td>54.0</td>
<td>25.6</td>
<td>7.6</td>
<td>3.6</td>
<td>61.1</td>
<td>1.244</td>
</tr>
<tr>
<td>2010</td>
<td>184.9</td>
<td>57.6</td>
<td>14.3</td>
<td>6.7</td>
<td>3.5</td>
<td>61.6</td>
<td>1.255</td>
</tr>
<tr>
<td>2011</td>
<td>207.6</td>
<td>58.7</td>
<td>16.8</td>
<td>7.2</td>
<td>3.6</td>
<td>61.2</td>
<td>1.271</td>
</tr>
<tr>
<td>2012</td>
<td>152.0</td>
<td>60.1</td>
<td>16.5</td>
<td>8.2</td>
<td>3.4</td>
<td>60.6</td>
<td>1.287</td>
</tr>
<tr>
<td>2013</td>
<td>201.3</td>
<td>57.0</td>
<td>19.8</td>
<td>6.9</td>
<td>3.5</td>
<td>61.3</td>
<td>1.254</td>
</tr>
<tr>
<td>2014</td>
<td>191.8</td>
<td>55.0</td>
<td>20.3</td>
<td>6.6</td>
<td>3.6</td>
<td>61.5</td>
<td>1.250</td>
</tr>
<tr>
<td>2015</td>
<td>220.8</td>
<td>57.0</td>
<td>16.6</td>
<td>6.7</td>
<td>3.4</td>
<td>61.6</td>
<td>1.240</td>
</tr>
</tbody>
</table>

Plots are usually ~ 2 lbs/bu heavier than field run, ~ 2 % pts drier

4 strip trial tests, 20-40 hybrids/location; Adair, Black Hawk, Bremer, Palo Alto counties in Iowa
## Soybean Quality Trends

<table>
<thead>
<tr>
<th>Year</th>
<th>Yield (bu/ac)</th>
<th>Moisture (as-is)</th>
<th>Protein (13%M)</th>
<th>Oil (13%M)</th>
<th>Fiber (13%M)</th>
<th>Sum (13%M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>58.7</td>
<td>13.7</td>
<td>34.7</td>
<td>18.5</td>
<td>4.9</td>
<td>53.2</td>
</tr>
<tr>
<td>2010</td>
<td>58.7</td>
<td>10.5</td>
<td>35.5</td>
<td>18.5</td>
<td>4.8</td>
<td>54.0</td>
</tr>
<tr>
<td>2011</td>
<td>65.9</td>
<td>10.5</td>
<td>34.2</td>
<td>18.4</td>
<td>4.9</td>
<td>52.6</td>
</tr>
<tr>
<td>2012</td>
<td>52.5</td>
<td>8.7</td>
<td>33.9</td>
<td>19.9</td>
<td>4.8</td>
<td>53.8</td>
</tr>
<tr>
<td>2013</td>
<td>53.6</td>
<td>11.7</td>
<td>35.3</td>
<td>19.4</td>
<td>4.7</td>
<td>54.6</td>
</tr>
<tr>
<td>2014</td>
<td>60.3</td>
<td>12.7</td>
<td>34.5</td>
<td>18.8</td>
<td>4.9</td>
<td>53.3</td>
</tr>
<tr>
<td>2015</td>
<td>62.8</td>
<td>13.2</td>
<td>34.8</td>
<td>19.1</td>
<td>4.8</td>
<td>53.9</td>
</tr>
</tbody>
</table>

4 strip trial tests, 20-40 varieties/location
Adair, Black Hawk, Bremer, Palo Alto counties in Iowa

IOWA STATE UNIVERSITY
Extension and Outreach
# Maximum storage time (months); corn and soybeans

<table>
<thead>
<tr>
<th>Temperature °F</th>
<th>13%, 11%</th>
<th>14%, 12%</th>
<th>15%, 13%</th>
<th>16%, 14%</th>
<th>17%, 15%</th>
<th>18%, 16%</th>
<th>24% N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>150</td>
<td>61</td>
<td>29.0</td>
<td>15.0</td>
<td>9.4</td>
<td>6.1</td>
<td>1.3</td>
</tr>
<tr>
<td>50</td>
<td>84</td>
<td>34</td>
<td>16.0</td>
<td>8.9</td>
<td>5.3</td>
<td>3.4</td>
<td>0.5</td>
</tr>
<tr>
<td>60</td>
<td>47</td>
<td>19</td>
<td>9.2</td>
<td>5.0</td>
<td>3.0</td>
<td>1.9</td>
<td>0.3</td>
</tr>
<tr>
<td>70</td>
<td>26</td>
<td>11</td>
<td>5.2</td>
<td>2.8</td>
<td>1.7</td>
<td>1.1</td>
<td>0.2</td>
</tr>
<tr>
<td>80</td>
<td>15</td>
<td>6</td>
<td>2.9</td>
<td>1.6</td>
<td>0.9</td>
<td>0.9</td>
<td>0.06</td>
</tr>
</tbody>
</table>

*Based on 0.5% maximum dry matter loss—calculated on the basis of USDA research at Iowa State University. Corresponds to one grade number loss; 2-3% pts of Total Damaged seeds.
And Now There is FSMA!

• Preventive Control rules now final; Food and Feed.
• Feed mills, ethanol plants, etc. must have:
  – CGMP
  – Hazard Analysis/PC Qualified Person
  – Verified Preventive Control Plan
• Handling and Storage: Exempt from above only
• Supplier verification – sellers are a risk for users.
• Lots of materials will be available.
Creating a food safety/quality management system plan for a grain elevator.
GEAPS Three hour Workshop
Iowa State University Extension and Outreach

Workshop Outline

Brief Introduction: Dr. Charles Hurburgh

The impact of the Food Safety Modernization Act on grain handling.
Instructor: Dr. Angela Shaw

Creating Food Safety Plans
- QMS Principles/structure related to FSMA
- Writing objectives and procedures that can be documented, and validated
Instructor(s):

Class exercise; designing a food safety hazard control procedure
Instructor: Connie Hardy

--Break—

Cross Compliance: Other procedures-driven market or regulatory needs that can be met simultaneously.
- Occupational Safety plans
- Biosecurity/bioterror plans
- Environmental compliance plans.
- Pest control plans/sanitation
Instructor: Dr. Gretchen Mosher

Economics: How to figure costs and benefits of quality management systems.
Instructor:
GEAPS 530
Quality Management Systems for Bulk Materials Handling Systems

Created and Taught By:
The Iowa Grain Quality Initiative
Iowa State University Extension

Charles R. Hurburgh, Jr., Professor
Gretchen A. Mosher, Assistant Professor
Howard E. Shepherd, Program Coordinator
4.1 General requirements

The organization shall establish, document, implement and maintain an effective food safety management system and update it when necessary in accordance with the requirements of this International Standard.

The organization shall define the scope of the food safety management system. The scope shall specify the products or product categories, processes and production sites that are addressed by the food safety management system.

The organization shall:

a) ensure that food safety hazards that may be reasonably expected to occur in relation to products within the scope of the system are identified, evaluated and controlled in such a manner that the products of the organization do not, directly or indirectly, harm the consumer;

b) communicate appropriate information throughout the food chain regarding safety issues related to its products,
Special callout sections...

Information: Many processes are not documented in scientific journals; in these cases, the team leader should be able to make inferences and judgements from related material that is published.

Interpretation: Suitability means that the system completely covers the hazards you will face in real operations. What constraints will the organization be working under? The food safety leader should work to ensure that the constraints are understood and that mitigation is completed. Conduct “what ifs.” The food safety leader should know the industry, be comfortable with public relations, have credibility with management, and be organized.

Collaboration/Best Practice Sharing: Share characteristics required for the food safety team leader position. The requirements and how the present food safety team leader meets those criteria should be in writing to the extent that human resources policies will allow.
### Food Safety Checklist Example

#### Part 1: Food Safety Program

<table>
<thead>
<tr>
<th>Questions</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
<th>Documents, filenames</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food Safety Program</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1  A documented food safety program that incorporates Quality Management Program has been implemented</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2  The operation has designated someone to implement and oversee the food safety program</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3  All food safety documentation is located in one central location.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4  Records are kept for two years in an orderly manner.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5  A map of the facility and grounds is available.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Chapter 1

INTRODUCTION TO FOOD SAFETY PREVENTIVE CONTROLS COURSE

File: FSPCA Ch01 Intro 2014 11 06
Consider having someone take this training when it is offered (next 1-2 yrs.)

ISU and others will have certified lead instructors.

**Current Plan:**

First ISU Offering  
May 9 -13, 2016  
Human and Animal Food Courses.  
At ISU, Ames.
All FSMA-covered facilities that produce food or feed or their ingredients will need a food safety preventive controls plan

In this plan, the facility will:

1. Identify animal food safety hazards

2. Determine *significant* food safety hazards
   – those that are reasonable + likely to occur + likely to kill or injure an animal

3. Define preventive control measures for those hazards deemed significant
Potential Grains Hazards

• Physical Hazards
  – Non-grain material (glass, metal, wood, petroleum residue)
  – Animal excreta or carcasses

• Chemical Hazards
  – Treated seed
  – Antibiotic residue in by-products
  – Allergen (other grains)

• Microbial Hazards
  – Mycotoxins from fungi
  – Flooded grain
## Primary mycotoxins of concern in Midwest grains

<table>
<thead>
<tr>
<th>Mycotoxin</th>
<th>Fungus</th>
<th>Primary cereal crops affected</th>
<th>Favorable conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aflatoxin</td>
<td>Aspergillus flavus, Aspergillus parasiticus</td>
<td>Corn Rice</td>
<td>Hot, drought</td>
</tr>
<tr>
<td>Deoxynivalenol</td>
<td>Fusarium graminearum, Fusarium culmorum</td>
<td>Corn Wheat Barley</td>
<td>Cool, wet</td>
</tr>
<tr>
<td>Fumonisin</td>
<td>Fusarium verticillioides, Fusarium proliferatum</td>
<td>Corn</td>
<td>Warm-hot, drought during grain maturity</td>
</tr>
<tr>
<td>Zearalenone</td>
<td>Fusarium graminearum, Fusarium culmorum</td>
<td>Corn Wheat</td>
<td>Cool, wet</td>
</tr>
</tbody>
</table>
Cooler and wetter-than-average conditions during grain fill meant we were on the lookout for Gibberella ear rot in 2015 corn.

**Pathogen**
*Fusarium graminearum, F. culmorum*

**Mycotoxin**
deoxynivalenol (vomitoxin), zearalenone

Actual: we have seen DON and ZEAR, some fumonisin
**all well below levels of concern**
At least one type of mycotoxin at every FSMA-regulated facility is likely to be deemed a significant hazard and need preventive controls

• Mycotoxins are:
  – Chemical compounds produced by some fungi
  – Naturally occurring; not completely avoidable
  – With good management practices mycotoxin levels typically do not increase in storage
FSMA and grain handling-who in the grain industry is subject to the rules?

**Covered**
- Processors, mills, or other facilities (e.g., ethanol → DDGS) that produce human or animal food or ingredients are covered

**Exempt**
- Vertically integrated facilities (farm + processor)
- Farms
- Elevators that only handle and store grain
  - exempt from some portions

http://www.agri4africa.com/imgs/newsarticles/id000000116b.jpg
What does that mean for exempt entities like farmers and elevators?

• They are a risk point in someone else’s hazard analysis/production chain

• FSMA regulated facilities that are supplied by unregulated facilities (i.e., farmers and elevators) will be more stringent on mycotoxin controls

• Expect purchase contracts to become more detailed

• Increased testing at receiving; increased traceability

• Exempt from the rules ≠ exempt from liability
What does that mean for regulated facilities attempting to manage mycotoxins?

• They should have:
  – A monitoring program (incoming grain)
    Including sampling and testing
  – A validation program for outgoing co-products
    Required validation step for food safety plan
    Response plan for co-products not meeting specs.
  – A training program

All of the strategies, protocols, and test results should be documented and readily available
What does this mean for crop advisors and agronomists?

• FSMA regulated entities will be seeking more information on mycotoxin risks
• Scouting and disease incidence reporting will become more valuable as a predictive tool
• These individuals can serve as the link between the exempt and regulated entities
The control point for mycotoxins is at grain receiving

• No particular mycotoxin management strategy is being mandated by FDA under FSMA

• It is important to have a strategy for incoming grain
  – Anticipate your risk (weather/climate) and how it may impact your major markets
  – Test new crop grain more frequently to assess actual risk (more information on mycotoxins is available at iowagrain.org)
  – Keep a running average
  – Document everything you do

• Regulated or not, the moral of the story is awareness
Where To Find Us…

Iowa Grain Quality Initiative

www.iowagrain.org

Supporting Services and Technologies for BioProcess Industries

Analytical Programs
Quality Management Systems

Iowa State University
Extension and Outreach