Putting it all together: Ingredient Supply Chain Quality, Diet & Water Optimization to achieve expected efficiency

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Putting it all together

- Key challenges in ABF-Poultry production
  - Genetics, Microbiome, Gut health ("a compromise between digestion and protection"), biosecurity
- Other important factors impacting optimal performance
  - Ingredient Supply Chain Quality (Mycotoxins)
  - Diet Quality: going back to basics!
  - Water Quality
  - Overall Cost of maintaining gut health integrity (ROI)
Poultry Value Chain

Adapted from The Poultry Production Guide, Misset Intl.
Goals of this presentation:

• Share with you my views on the ingredient supply chain quality risk for poultry feeds.
• Discuss how this issue fits in the overall “gut health” challenge, for optimum ABF-nutrition strategies and regulatory compliance
Are Mycotoxins Economically Important to the grain and Livestock Industry?

- 25% world’s crops affected
- USA Mean = $932 M (CAST, 2003)
- Afla in Corn & Peanuts for Food & Feed in the US ... $484 M
- Range $418M – $1.66B
- Mitigation & Livestock losses ($472 M)
- Human health Costs??
Geographical incidence of mycotoxins in the grain supply chain

Source: Council of Agricultural Science and Technology (CAST), University of Kentucky, BA&H Analysis

A = Aflatoxin
D = Deoxynivalenol
F = Fumonisin
Z = Zearalenone
Key issue #1: Preserving grain quality throughout the supply chain
...in transport, handling....
...and storage.
Grain flow throughout the supply chain – USA System
Mold contamination

Grain delivered to the Feed Mill

(Wicklow and Donahue, 1984
USDA, 1999)
Transition from field mold species to storage mold species

Alternaria

Fusarium

Aspergillus

Penicillium
Ingredients commonly affected by molds

Corn
Corn by-products
Peanuts
Sorghum
Wheat
Wheat by-products
Rice bran
Oilseeds?
Key issue #2: opportunities for intervention

- Harvest
- Grain Elevator
- Shipping & Handling
- Feed Mill
- Storage
- End Users
Key issue #2: opportunities for intervention

No matter what you do there are some fundamentally key issues to address for technical (QA & Regulatory) and economic viability:

1. Defining appropriate **sampling protocol** (Error benchmarks & associated cost)
2. Mycotoxin analysis (field vs. Lab; standardization—kits vs. quantitative & associated cost)
3. Results evaluation (Statistics and frequency)
4. Decision making (Accept/Reject; Regulatory levels; Who, When?)
Key issue # 3: Factors affecting mold growth

- Moisture level in grain & feeds
- Relative humidity
- Temperature
- Transit & storage time
- Kernel damage
- pH
- Oxygen
Relationship among storage time, mold growth and nutrient availability

C. Reed. 2006. Managing Stored Grain to preserve quality and value.
Nutrients affected by molds

- Carbohydrates
  - Starches, sugars
- Proteins
  - Amino acids
- Lipids
  - Pigments
- Vitamins
- Minerals

C. Reed. 2006. Managing Stored Grain to preserve quality and value
Variation in ME levels in different corn samples

ME Ave. (kcal/kg): 3218 +/- 162

Danisco Animal Nutrition
AFLATOXINS

• Potent liver toxins (one of the most potent naturally occurring carcinogens known)

• Causes reduced feed intake, weight gain, milk production, reproductive performance, and immunosuppression

• Residue levels in milk cause milk to be destroyed

• Effects dairy, swine, poultry, dogs, and humans (hepatocellular carcinoma)

Photo courtesy of D. Ledoux, Univ. of MO
### Effects of low levels of AF in broilers

<table>
<thead>
<tr>
<th>AF (ppm)</th>
<th>Live Wt</th>
<th>Dressed Wt</th>
<th>Chilled Ewt</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>2024&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1914&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1490&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>0.30</td>
<td>1932&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1850&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1414&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>0.90</td>
<td>1998&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1882&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1466&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>2.70</td>
<td>1671&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1583&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1213&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>abc</sup> P < 0.05

Doerr *et al*., 1983
Associated Gut Health Issues

- Rapid Feed Passage
- Coccidiosis
- Necrotic Enteritis
- Gut mycotoxin exposure can cause:
  - oxidative damage to cell membranes
  - reductions in cellular protein synthesis
  - lesions in various parts of the gastrointestinal tract

- Impact on ABF-Poultry feeding programs?
- Organic feeding programs?
Key issue # 4:
How can we prevent mold contamination and manage the mycotoxin impact on animal performance and wellness?
Prevention and Remediation of Mycotoxin Contaminated Ingredients

- Mold inhibitors
- Fermentation
- Physical separation
- Ammoniation
- Ozone degradation
- Probiotics
- Thermal inactivation
- Irradiation
- Sequestering agents (adsorbents)
- Enzyme preparations
Opportunities for intervention in the Supply Chain

Harvest

Grain Elevator

Shipping & Handling

Feed Mill

Storage

End Users
Production of metabolic heat over time in export-condition US corn stored at 30°C

Graph showing the production of metabolic heat over time in US corn stored at 30°C. The graph compares different treatments:
- No treatment
- Cleaned
- Mold inhibitor

The x-axis represents weeks in storage, ranging from 0 to 10 weeks. The y-axis represents grain temperature in °C, ranging from 29 to 32 °C. The graph indicates that different treatments significantly affect the temperature changes over time.

C. Reed, US Grains Council, 2001
Adsorbents: Many products available. Efficacy of adsorption depends on the chemical structure

a. Mineral Clays

Chelation - Reason for Strong Binding of Aflatoxin?
(Phillips et al., 1990)

1,3 - diketone moiety is unique to aflatoxin structure

Ca++
Na+
Al+3

Possible mechanism – interaction of aflatoxin B1 with exchangable cations

b. Yeast cell wall. i.e. MOS
Impact on animal performance

- Holistic approach, integrated to gut health issues
- Gut Health is crucial for optimum nutrient utilization
- Mycotoxins play a significant role, altering the stability of the gut integrity
- Anything that can be done to avoid contact to the epithelium of the small intestine by the mycotoxins, either via the Supply Chain management, and/or utilizing adsorbents, and other additives, will ensure optimum nutrient absorption and ultimately protect animal performance
Water Quality

- Water Quality.....most underestimated nutrient?
  - We need about 2 X amount of water for every lb of feed consumed
  - Linear negative relationship with environmental temperature
  - Water intake also increases with age
## Effect of Drinker Types on Water Bacteria Contamination (Micro-Organisms/ml of Sample)

<table>
<thead>
<tr>
<th>Drinker Microorganisms</th>
<th>Nipple Entrance</th>
<th>+ End</th>
<th>Bell + Entrance</th>
<th>Bell + End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Coliforms</td>
<td>640</td>
<td>3,300</td>
<td>1,600</td>
<td>1,700,000,000</td>
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<tr>
<td>Fecal Coliforms</td>
<td>130</td>
<td>230</td>
<td>1,000</td>
<td>80,000,000</td>
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<tr>
<td>Escherichia Coli</td>
<td>110</td>
<td>900</td>
<td>900</td>
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</tr>
<tr>
<td>Fecal Streptococcus</td>
<td>55</td>
<td>1,200</td>
<td>2,000</td>
<td>36,000,000</td>
</tr>
<tr>
<td>Mesofilis MicroOrganisms+++</td>
<td>24,000</td>
<td>700,000,000</td>
<td>86,000</td>
<td>1,400,000,000</td>
</tr>
</tbody>
</table>

Adapted from Macari and Amaral, 1997.
Water Quality.....management

- A High correlation is found between Productivity Index and Water Hardness in Broilers Farms
  - Scale can reduce the volume of pipes and impact nipple drinkers. It also reduces the effectiveness of cleaners and disinfectants.
- Water pH and Chlorination effectiveness.
- What’s your water sanitation program doing to your performance?
Bottom line: How to manage the risk of such a complex issue?

Transfer it to the suppliers!
(Cost? ROI?)

Reduce the negative effects of risk!
(Using accurate info, mitigation strategies & nutrient management tools)

Accept the consequences and do nothing!
(Potential losses - $$!)
Thanks! Any Questions?

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