

Use of Distillers Grains and other Alternative Feeds

Dr. Francis L. Fluharty
Department of Animal Sciences
The Ohio State University



U.S. Ethanol Legislation

- On December 19, 2007, President Bush signed The Energy Independence and Security Act of 2007, which expands the Renewable Fuels Standard (RFS) by requiring 36 billion gallons of renewable fuel be used annually by 2022, and the legislation requires 21 billion gallons of that goal must come from advanced biofuels including cellulosic ethanol

(Source: <http://www.ethanolrfa.org/>).

The Challenges:

- Two of the Major Challenges facing animal agricultural in the immediate future are:
 1. The loss of starch in animal diets, and
 2. The loss of land-based resources used for the production of feed for our animal industries.

These potentially will continue as the corn-based ethanol and cellulosic ethanol industries expand.

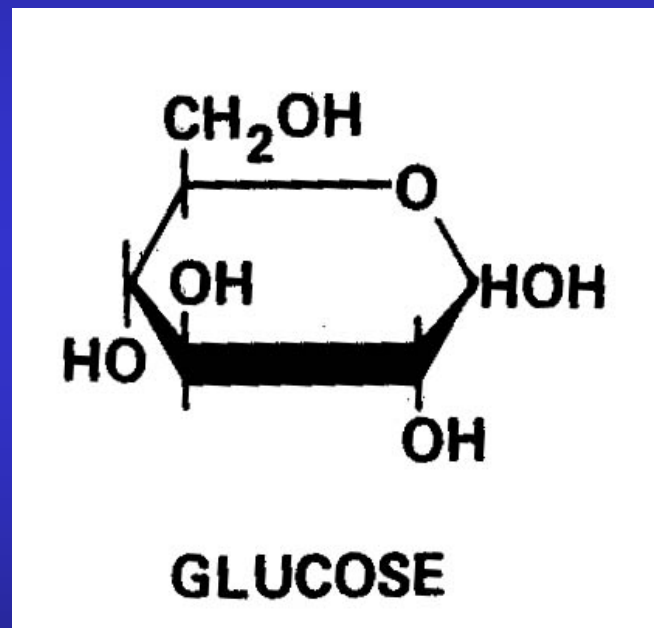
Impact of a Weak U.S. Dollar

- Iowa State University reports that “the latest USDA projections put corn exports for the 2007/08 marketing year at 2.45 billion bushels” and the primary reason for the export situation is that between January 1, 2007 and January 1, 2008, the U.S. dollar lost 15% of its value compared with the Brazilian real and 6% of its value compared with the Chinese yuan, export competitors.
- The U.S. dollar lost 6% of its value compared with the Japanese yen, making U.S. corn a very inexpensive import compared with Brazilian or Chinese corn (Source: http://www.card.iastate.edu/iowa_ag_review/winter_08/article4.aspx).

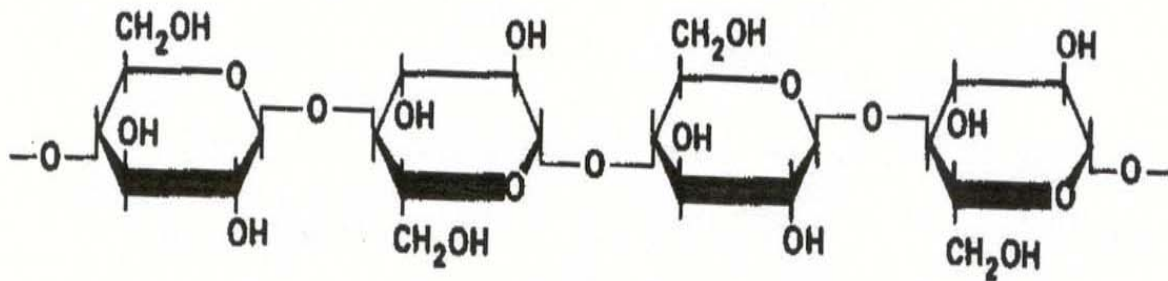
Co-Product Feeds are Replacing Corn in Beef Cattle Diets

Carbohydrate Digestion in Ruminants

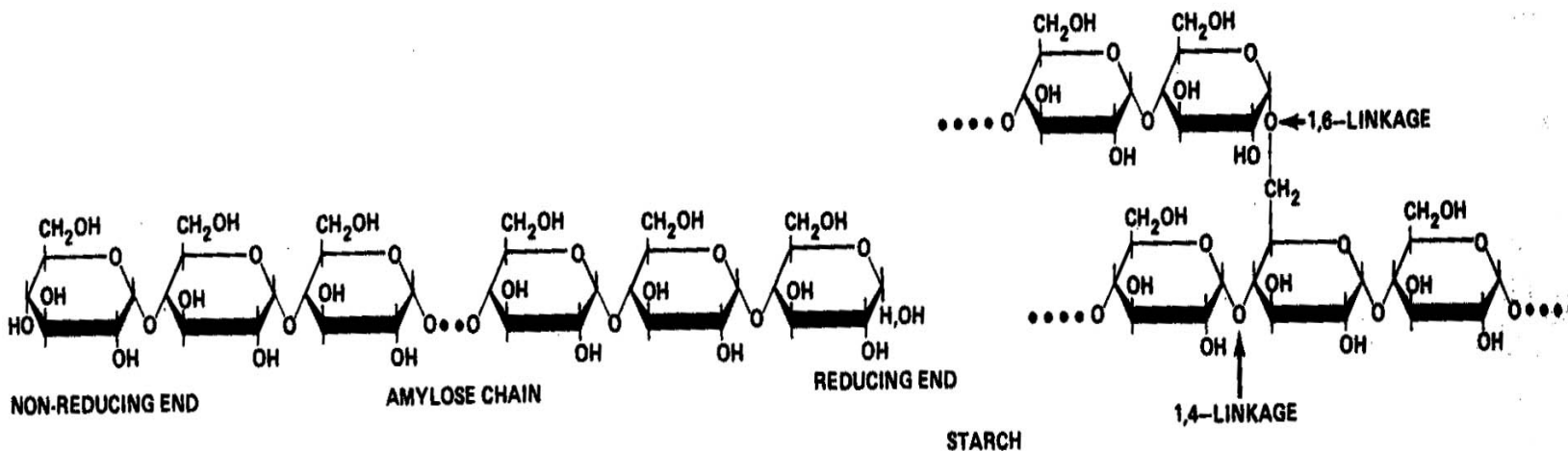
- Starch and Cellulose are both made from glucose.



- The only difference between them is that starch has an α -linkage, and cellulose has a β -linkage.



CELLULOSE



VFA Use in Ruminants

- Acetate ($\text{CH}_3 - \text{COOH}$) is primarily used in fatty acid synthesis for back fat, seam fat, and milk fat.
- Propionate ($\text{CH}_3 - \text{CH}_2 - \text{COOH}$) is converted to glucose in the liver.
- Butyrate ($\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{COOH}$) is converted to ketones during absorption through the rumen epithelial tissue, then goes to fatty acid synthesis in adipose and mammary gland.

Effect of Forage to Concentrate Ratio on Rumen Volatile Fatty Acid (VFA) Ratios in Cattle

| Forage:Concentrate Ratio | Acetate (%) | Propionate (%) | Butyrate (%) |
|-----------------------------|-------------|----------------|--------------|
| 100:0 | 71.4 | 16.0 | 7.9 |
| 75:25 | 68.2 | 18.1 | 8.0 |
| 50:50 | 65.3 | 18.4 | 10.4 |
| 40:60 | 59.8 | 25.9 | 10.2 |
| 20:80 | 53.6 | 30.6 | 10.7 |
| Annison and Armstrong, 1970 | | | |

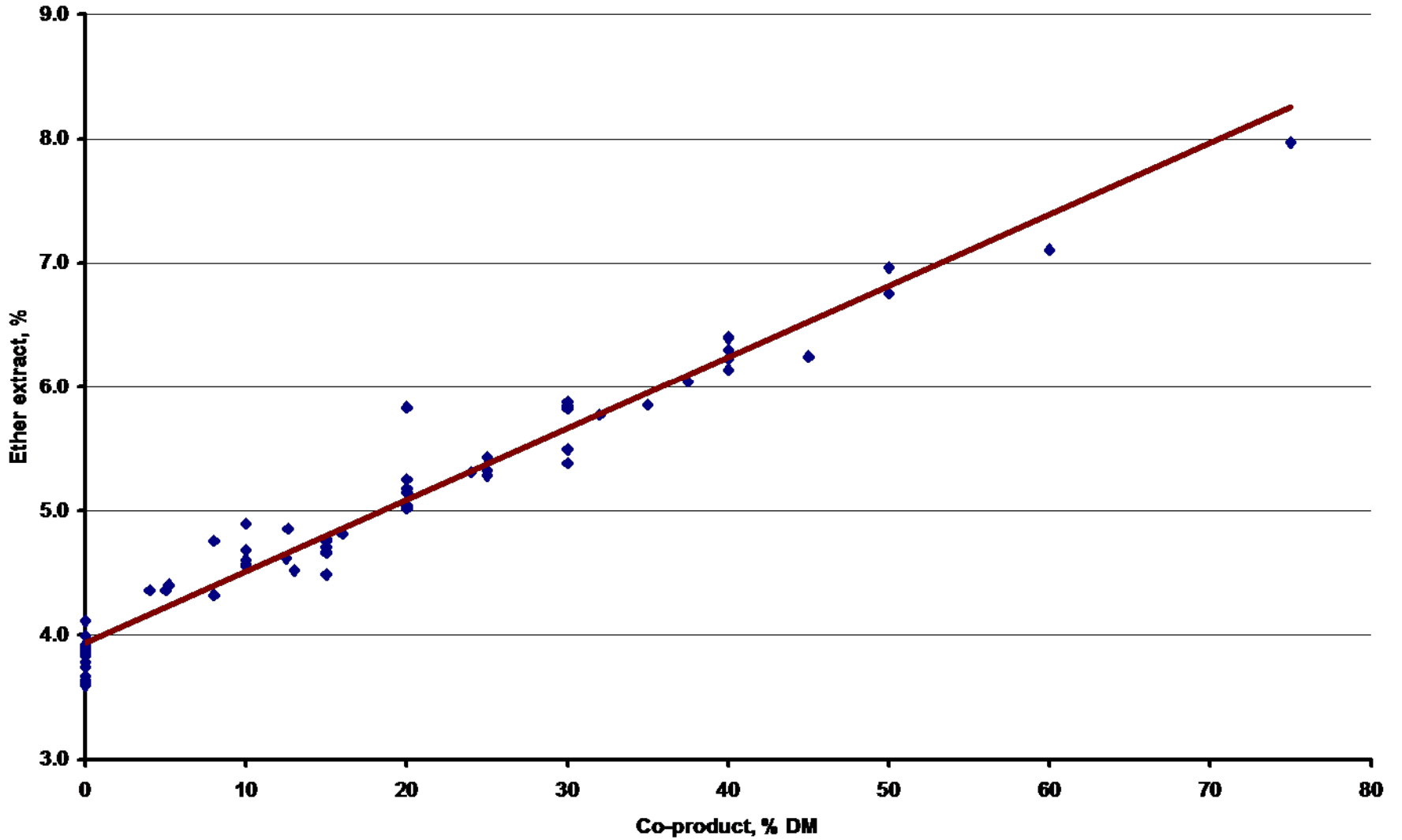
Diet Affects Growth Rate and End Products of Rumen Fermentation

- High-concentrate (starch-based) diets result in increased propionate production relative to acetate, and propionate is the only VFA converted to glucose in the liver.
- Higher levels of glucose production in the liver result in a greater average daily gain, more lean tissue growth per day, and more intramuscular fat (marbling) deposited.
- Higher forage diets result in higher levels of acetate result in more back fat and more milk fat.

Characteristics of Distillers Grains

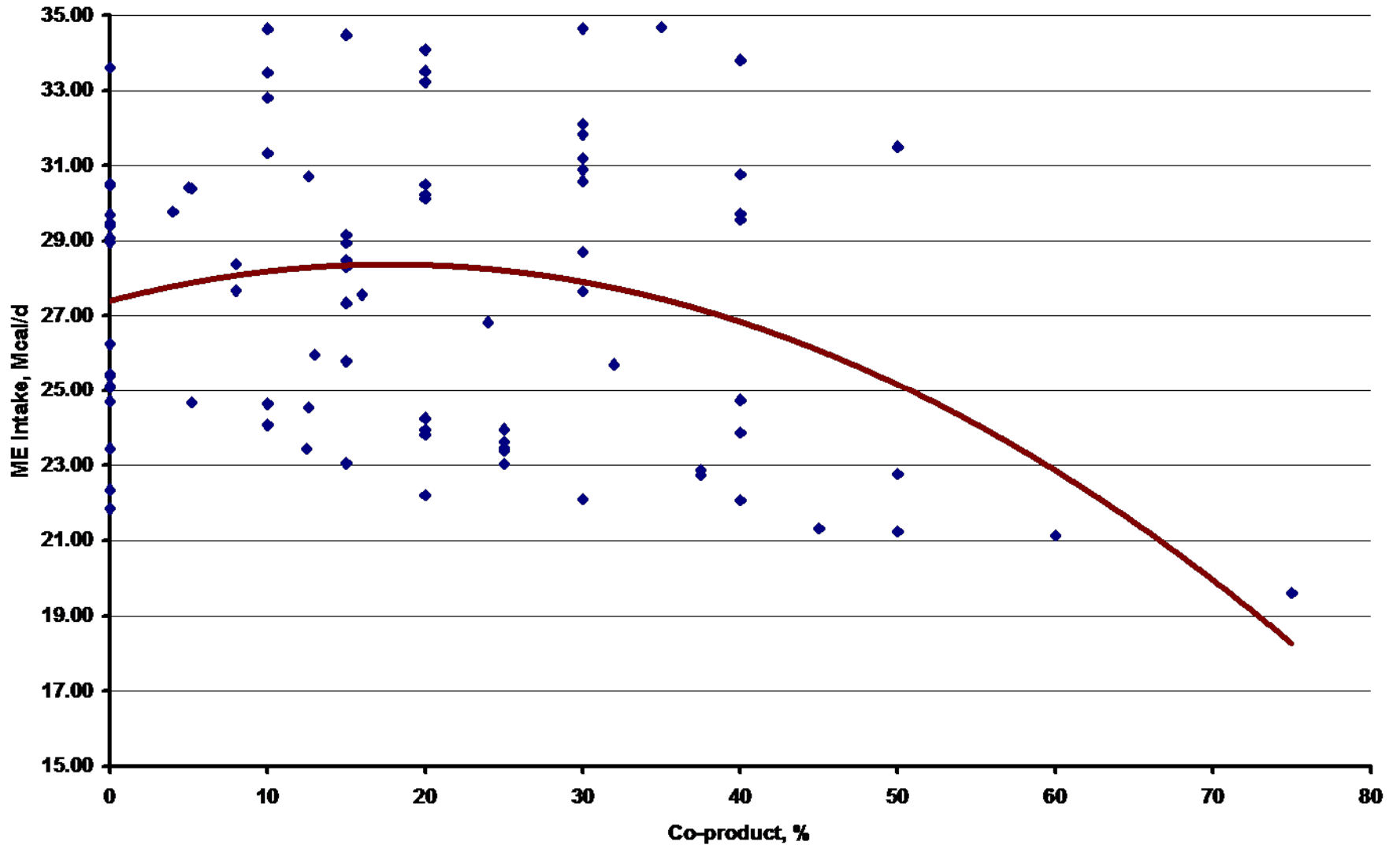
- High Fiber (rapidly digested)
- High Energy (100%+ the energy value of corn, due to average of 10.5% oil)
- High Protein (30%)
- Low Starch
- Minerals (High: P, S) (Low: Ca)

Ether Extract and Co-Product



Dicostanzo, 2006

ME Intake and Co-Product Content



Dicostanzo, 2006

Safety/Composition of Distillers Grains

- Attributes under some situations
 - Low Starch: Reduced incidence of acidosis
 - Low NPN: Reduced incidence of ammonia toxicity at higher levels of intake with pastured cattle
- Problems
 - Sulfur (.4% = upper limit for beef cattle, sulfate toxicity)
 - Thiamine (2.5 mg/lb DM, or 150 mg/hd/d above 40% DGS in Diet)
 - Check S in drinking water
 - Ca:P Ratio
 - Variation Plant-to-Plant, Load-to-Load

Sulfur Concentrations

- Maximum Tolerable Limit is .4% of diet DM
- WDGS and DDGS commonly contain .7% to 1.3% S
PRODUCT VARIABILITY
- Maximum concentration of sulfate in water when animals are fed high-concentrate diets should not be over 600 mg sulfate/L (200 mg Sulfur/L) or 2,500 mg sulfate/L (834 mg Sulfur/L) when diets contain at least 40% forage or more.

Sulfate Toxicity

- Can Induce thiamin deficiency
- Reduces Copper and Selenium absorption
- Reduces feed intake and production
- Animals may have excessive saliva production
- Animals look emaciated
- Abnormal behavior and neurological changes
- Can cause death



Current Impacts of Ethanol

- The cost of other co-product feeds is increasing as nutritionists try to reduce feed costs with feeds lower in oil and sulfur than distillers grains, while maintaining an energy value close to corn.
- The problems associated with the removal of corn starch from animal diets, and its replacement with feeds having more concentrated minerals, protein, and aflatoxins must be dealt with, including the excretion in feces and urine of greater concentrations of unabsorbed nutrients.

Alternatives to Corn or Forage

| | Corn Grain | Corn Silage | Corn Stover | Wheat Straw | Soybean Straw | DDGS | CGF | Pelleted Soyhulls |
|--------------|------------|-------------|-------------|-------------|---------------|--------|------|-------------------|
| CP, % | 8.5 | 8.1 | 5 | 3.6 | 5.2 | 29 | 22 | 12.1 |
| RDP,% | 5.8 | 5.7 | - | - | - | 21 | 19 | - |
| TDN, % | 90 | 70 | 49 | 41 | 42 | 88 | 83 | 64 |
| NEm, Mcal/kg | 2.24 | 1.63 | 1.14 | .64 | .68 | 2.18 | 2.03 | 1.44 |
| NEg, Mcal/kg | 1.55 | 1.03 | .58 | .11 | .15 | 1.5 | 1.37 | .86 |
| NDF, % | 9.5 | 45 | 65 | 73 | 70 | 42 | 38 | 62 |
| Lignin, % | .9 | 4 | 7 | 14 | 16 | 4 | 3 | 2 |
| EE Fat, % | 4.2 | 3.1 | 2.1 | 1.8 | 1.5 | 10.5 | 3.2 | 2.1 |
| Sulfur, % | .14 | .15 | .11 | .19 | .26 | .5-1.3 | .23 | .09 |

Midwest Feed Grains Prices Are High: Compare Them on an Equal Weight Basis

| Feedstuff | Price | Price / Pound |
|--------------|------------|---------------|
| Corn | \$5.32/bu | .095 |
| Soybeans | \$12.64/bu | .21 |
| Wheat | \$8.70/bu | .145 |
| Oats | \$3.52/bu | .11 |
| Soybean meal | \$350/ton | .175 |
| CGF, 21% | \$160/ton | .08 |
| DDGS | \$170/ton | .085 |

Phosphorus in Feedlots

- Phosphorus in Corn and Co-Product Feeds: Corn Grain .35%P; Corn Gluten Feed (dry or wet) 1.10%; Dry Distillers Grains .83%; Soybean Meal .71%.
- Erickson et al. (2002) fed steers with grain-based diets containing .16% P (non-supplemented), .22, .28, .34, or .40% P, and concluded that supplementation of P in finishing diets is unnecessary from both economic and environmental standpoints and should be discontinued.
- The Federation of Animal Science Societies concluded that P excretion can be reduced 20 to 30% by not adding supplemental P to the diet of cattle being fed grain-based diets (FASS, 2001).

FDA Concerns With Aflatoxins

- Aflatoxins are not destroyed during ethanol production, **but are concentrated** in the distillers grains by-products where they may be present at **levels as high as three times that found in the corn** or grain-sorghum starting materials.
- Chronic poisoning, or aflatoxicosis, can result when low levels of toxin are eaten over a period of time.
- In general, affected livestock exhibit decreased growth rate, lowered productivity (milk), and **immunosuppression**, but **reduced growth rate** is considered the most common effect, and in young animals, this may be the only detectable abnormality.

<http://www.fda.gov/cvm/AflatoxinAssign.htm>

U.S. Food and Drug Administration Guidelines for Acceptable

Levels of Aflatoxins in Food and Feed

- **Action Level (ppb) Commodity Species**
- 0.5 (Aflatoxin M1)^a Milk Humans
- 20.0 Any food except milk Humans, Feed All species

Exceptions

- 300.0 Cottonseed meal used in feed All species
- 300.0 Corn for Finishing beef cattle,
- 200.0 Corn for Swine (>100 lbs.)
- 100.0 Corn for Breeding cattle, breeding swine, and mature poultry

^aSpecifically for aflatoxin M1, a toxic metabolite of aflatoxin B1, that occurs in milk.

Source: *Cast 1989* from <http://www.oznet.ksu.edu/library/grsci2/MF2061.pdf>

Summary

- Two Limiting Factors With Distillers Grains:
 - Total dietary fat should be 5% of diet or lower.
 - Total dietary S should be lower than .3% with a maximum tolerable limit of .4%, as sulfur compounds in the water must be taken into consideration.
- Additionally, when co-product feeds are used, the mineral program must be adjusted for high levels of phosphorus, and nutrient management plans will be even more important due to absorption limitations.

Final Thoughts

The Seven Sages of Greece (620 BC to 550 BC) included the following sayings in their teachings:

‘Nothing in Excess’ by Solon of Athens
and

‘Forethought in All Things’ by Periander of
Corinth