DDGS: An Evolving Commodity

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Animals Require Nutrients on a Daily Basis

Nutrition Facts

Serving Size 1 cup (228g)
Servings per Container 2

Amount Per Serving

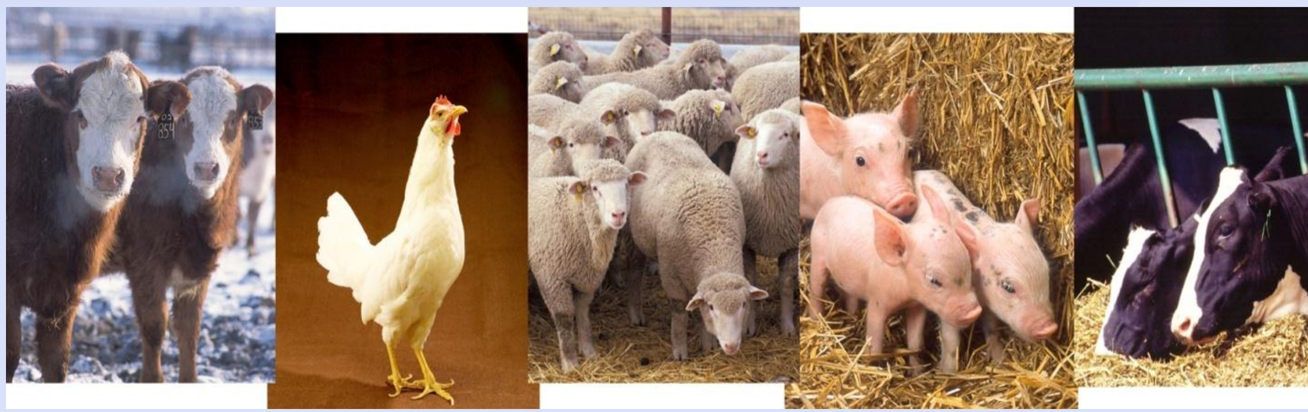
Calories 280	**Calories from Fat** 120
	% Daily Value*
Total Fat 13g	20%
Saturated Fat 5g	25%
Trans Fat 2g	
Cholesterol 2mg	10%
Sodium 660mg	28%
Total Carbohydrate 31g	10%
Dietary Fiber 3g	0%
Sugars 5g	
Protein 5g	

Vitamin A 4%	•	Vitamin C 2%
Calcium 15%	•	Iron 4%

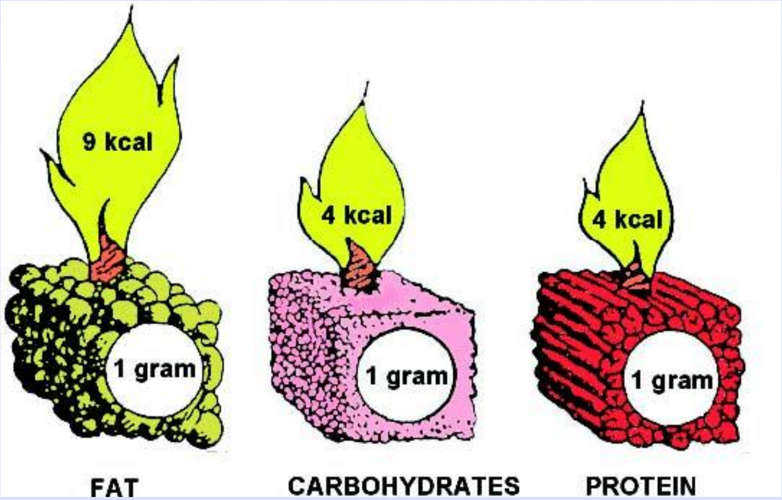
*Percent Daily Values are based on a 2,000-calorie diet. Your daily values may be higher or lower depending on your calorie needs.

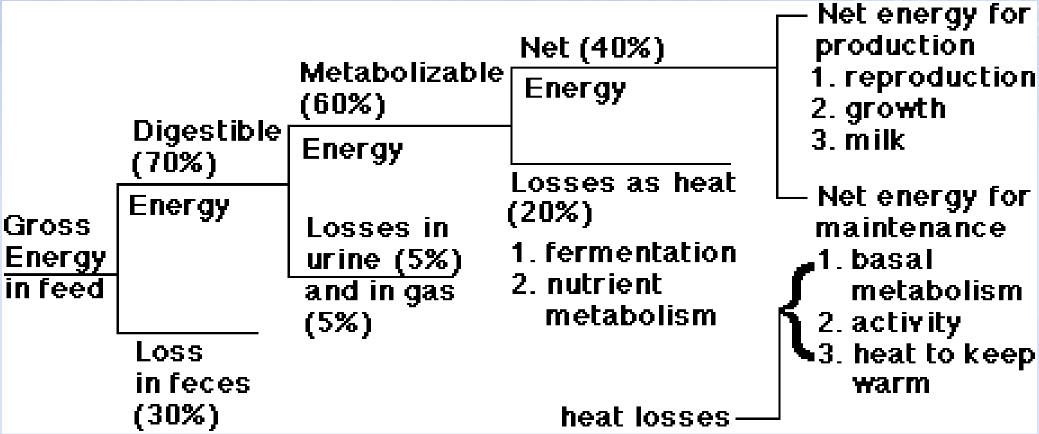
	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4



Feed Ingredients Supply Nutrients in Different Amounts and Forms





Nutritionist's Job: Develop the least expensive "recipe" of feed ingredients that will meet an animal's nutrient requirements





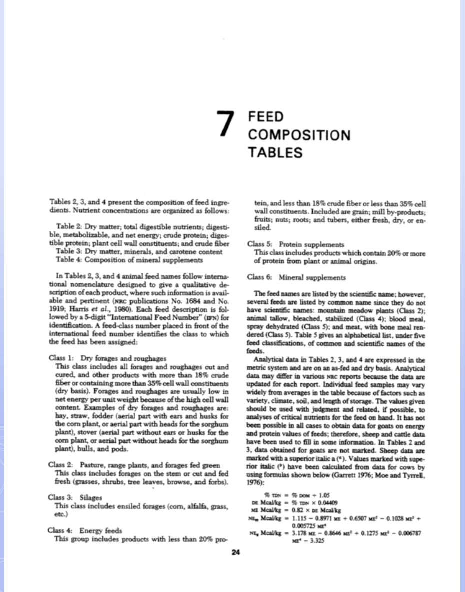

All Corn Co-Products are “Packages of Nutrients” of Varying Composition and Value

DDGS

Corn Gluten Feed

Corn Gluten Meal

Corn Germ Meal



7 FEED COMPOSITION TABLES

Tables 2, 3, and 4 present the composition of feed ingredients. Nutrient concentrations are organized as follows:

Table 2: Dry matter; total digestible nutrients; digestible, metabolizable, and net energy; crude protein; digestible protein; plant cell wall constituents; and crude fiber
Table 3: Dry matter, minerals, and carotene content
Table 4: Composition of mineral supplements

In Tables 2, 3, and 4 animal feed names follow international nomenclature designed to give a qualitative description of each product, where such information is available and pertinent (NRC publications No. 1684 and No. 1919; Harris *et al.*, 1980). Each feed description is followed by a 5-digit “International Feed Number” (IFN) for identification. A feed-class number placed in front of the international feed number identifies the class to which the feed has been assigned:

Class 1: Dry forages and roughages
This class includes all forages and roughages cut and cured, and other products with more than 18% crude fiber or containing more than 35% cell wall constituents (dry basis). Forages and roughages are usually low in net energy per unit weight because of the high cell wall content. Examples of dry forages and roughages are: hay, straw, fodder (aerial part with ears and husks for the corn plant, or aerial part with heads for the sorghum plant), stover (aerial part without ears or husks for the corn plant, or aerial part without heads for the sorghum plant), hulls, and pods.

Class 2: Pasture, range plants, and forages fed green
This class includes forages on the stem or cut and fed fresh (grasses, shrubs, tree leaves, browse, and forbs).

Class 3: Silages
This class includes ensiled forages (corn, alfalfa, grass, etc.)

Class 4: Energy feeds
This group includes products with less than 20% protein, and less than 18% crude fiber or less than 35% cell wall constituents. Included are grain; mill by-products; fruits; nuts; roots; and tubers, either fresh, dry, or ensiled.

Class 5: Protein supplements
This class includes products which contain 20% or more of protein from plant or animal origins.

Class 6: Mineral supplements

The feed names are listed by the scientific name; however, several feeds are listed by common name since they do not have scientific names: mountain meadow plants (Class 2); animal tallow, bleached, stabilized (Class 4); blood meal, spray dehydrated (Class 5); and meat, with bone meal rendered (Class 5). Table 5 gives an alphabetical list, under five feed classifications, of common and scientific names of the feeds.

Analytical data in Tables 2, 3, and 4 are expressed in the metric system and are on an as-fed and dry basis. Analytical data may differ in various NRC reports because the data are updated for each report. Individual feed samples may vary widely from averages in the table because of factors such as variety, climate, soil, and length of storage. The values given should be used with judgment and related, if possible, to analyses of critical nutrients for the feed on hand. It has not been possible in all cases to obtain data for goats on energy and protein values of feeds; therefore, sheep and cattle data have been used to fill in some information. In Tables 2 and 3, data obtained for goats are not marked. Sheep data are marked with a superior italic a (^{a}). Values marked with superior italic (^{b}) have been calculated from data for cows by using formulas shown below (Garrett 1976; Moe and Tyrrell, 1976):

$$\% \text{ TDN} = \% \text{ DOM} \div 1.05$$
$$\text{DE Mcal/kg} = \% \text{ TDN} \times 0.04409$$
$$\text{ME Mcal/kg} = 0.82 \times \text{DE Mcal/kg}$$
$$\text{NE}_m \text{ Mcal/kg} = 1.115 - 0.8971 \text{ ME} + 0.6507 \text{ ME}^2 - 0.1028 \text{ ME}^3 + 0.005725 \text{ ME}^4$$
$$\text{NE}_g \text{ Mcal/kg} = 3.178 \text{ ME} - 0.8646 \text{ ME}^2 + 0.1275 \text{ ME}^3 - 0.006787 \text{ ME}^4 - 3.325$$

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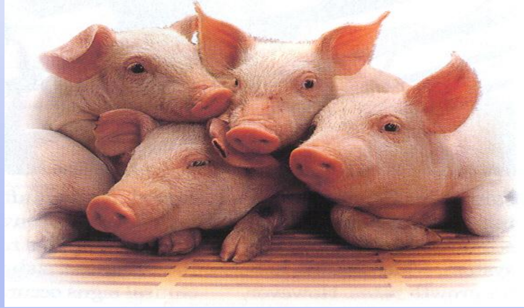
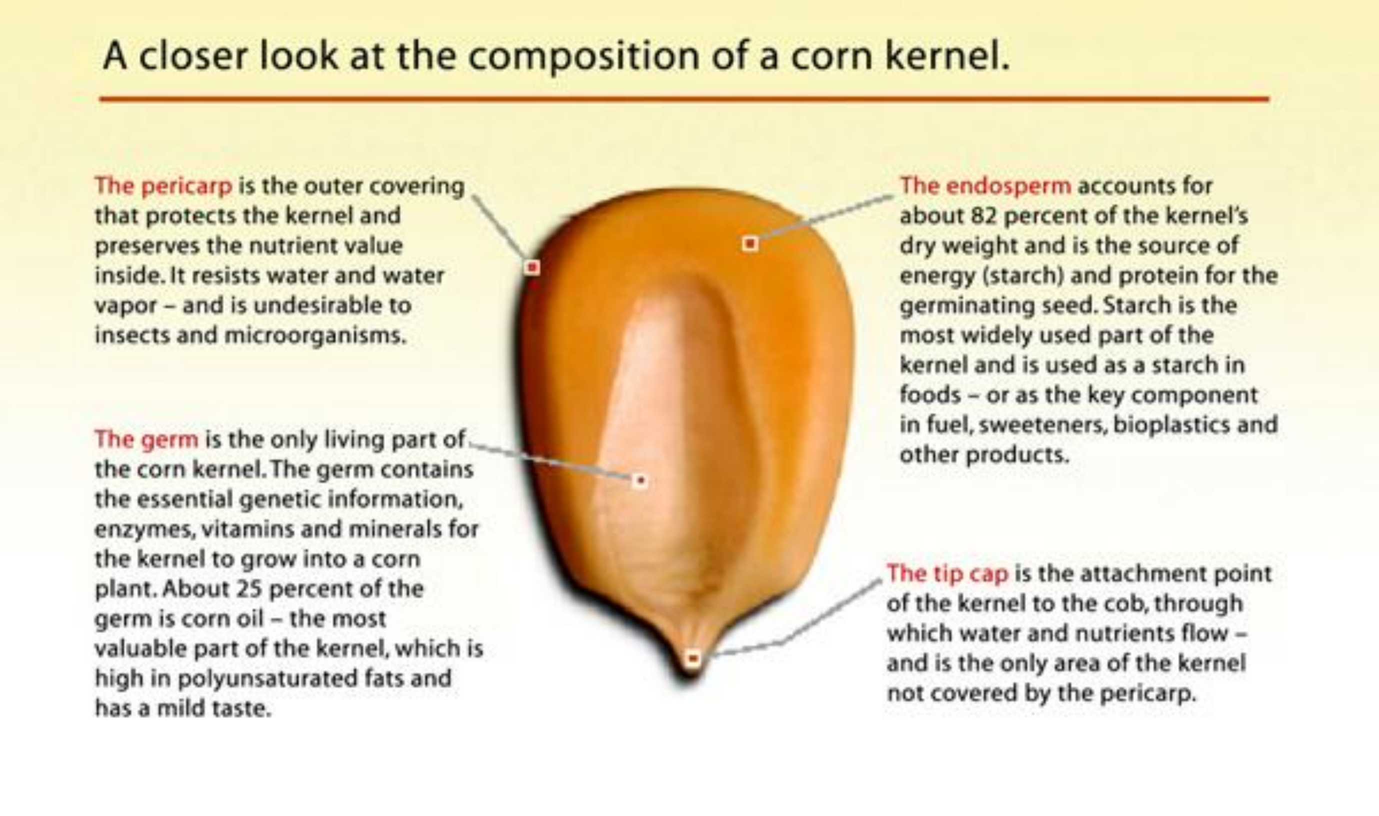
Why Are Ethanol Co-Products Changing?

- $$$
  - Narrow margins for ethanol cause implementation of technology to:
    - increase efficiency
    - reduce costs
    - increase diversity and revenues from co-products

Dry-Grind Ethanol and Co-Product Production



Front-End Fractionation



High Protein DDGS

Corn Bran

Dehydrated Corn Germ

De-hulled, De-germed Corn

De-oiled DDGS

Back-End Oil Extraction

Reduced-oil DDGS (5 to 9% crude fat)

Oil Extraction in the U.S. Ethanol Industry

- Industry adoption
  - **~ 60 to 70% of ethanol plants** are extracting oil

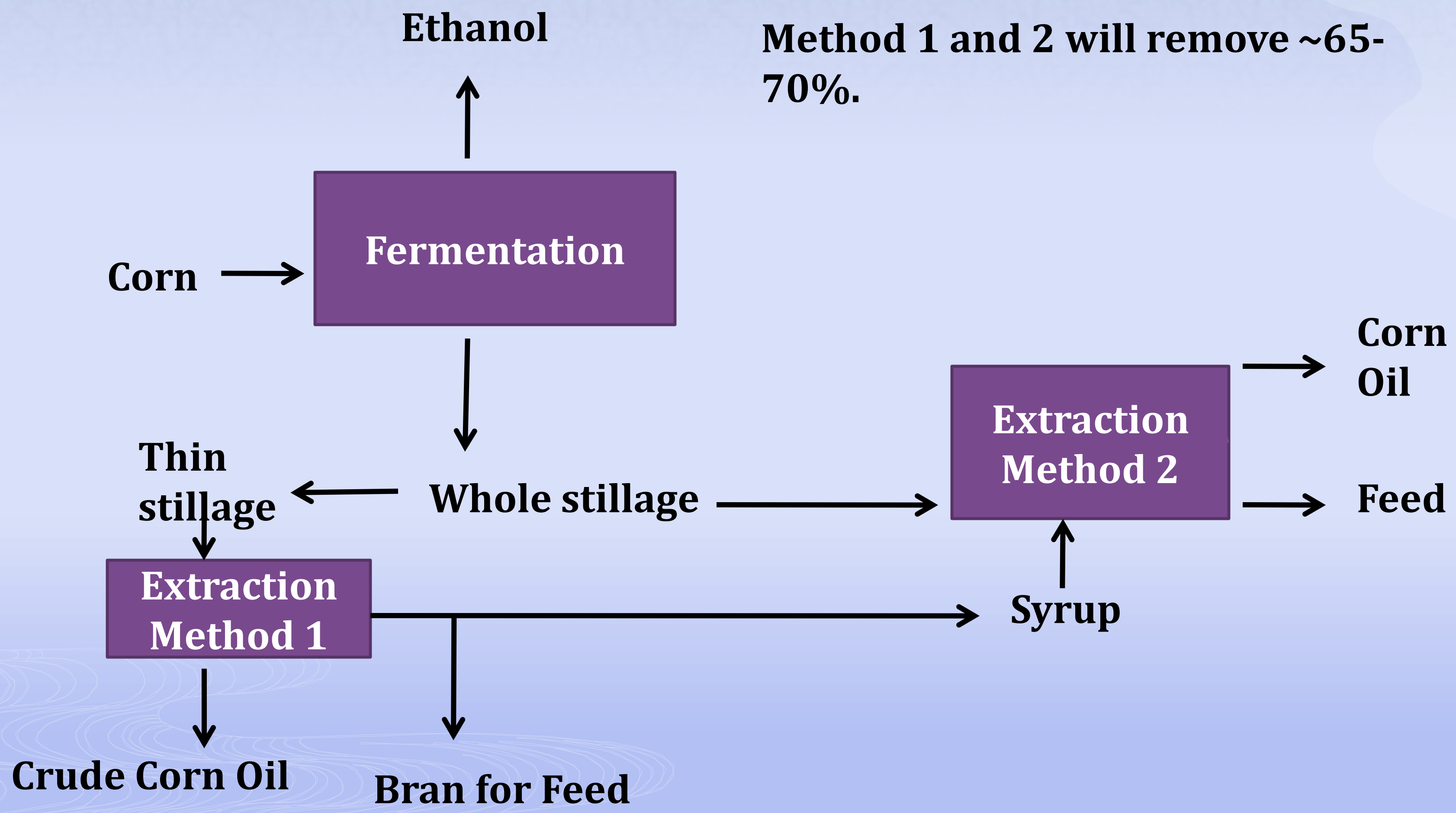
- Oil uses
  - > 50% in **biodiesel production**
  - < 50% in **blended feed-fats** (primarily by the poultry industry)

- Impact on DDGS
  - **Reduced MT of DDGS**
  - **Reduced energy content and feeding value**
    - Crude fat ranges from **5 to 13%**
    - **Most reduced-oil DDGS is 8 to 9% crude fat**
  - Research is being conducted to evaluate this impact

"Back-End" Oil Extraction Process

Approximately 30% of corn oil may be removed with Method 1.

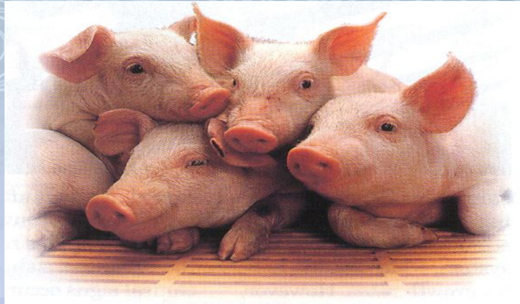
Method 1 and 2 will remove ~65-70%.



How Does Oil Extraction Affect Energy and Feeding Value of Reduced-Oil DDGS?

Impact of Reduced-Oil DDGS on ME Content for Swine

What Have We Learned?



- **Crude fat content DOES NOT accurately estimate ME** in reduced oil-DDGS
- **Fiber is a significant determinant of ME** but its measurement is highly variable
- **ME prediction equations have been developed** for reduced-oil DDGS:
  - ME kcal/kg DM = (0.90 × GE, kcal/kg) − (29.95 × % TDF)
  - ME kcal/kg DM = (0.94 × GE, kcal/kg) − (23.45 × % NDF) − (70.23 × % Ash)
  - ME kcal/kg DM = 4,548 – (49.7 x % TDF) + (52.1 x % EE)
  - ME kcal/kg DM = 3,711 – (21.9 x % NDF) + (48.7 x % EE)
  - ME kcal/kg DM = 4,132 – (57.0 x % ADF)

Impact of Reduced-Oil DDGS on AME Content and Performance for Poultry

Reduced-Oil DDGS Nutrient Profiles

Nutrient	Normal DDGS	Medium Oil DDGS	Low Oil DDGS
Crude protein, %	28.9	28.3	27.5
Crude fat, %	**11.2**	**7.3**	**5.6**
Crude fiber, %	7.4	6.9	6.8
Lysine, %	1.00	0.86	0.83
Methionine, %	0.55	0.58	0.55
Cysteine, %	0.74	0.70	0.57
TSAA, %	1.19	1.28	1.12
Phosphorus, %	0.98	0.84	0.91

Source: Purdum and Kreifels (2012)

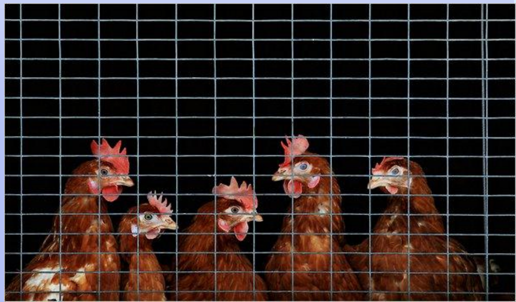
What Have We Learned?

- **NO EFFECT on layer performance** when feeding reduced-oil DDGS vs. "typical" DDGS.
  - % Egg production
  - Egg weight
  - Feed conversion

- **Feed intake slightly increases** (2 to 2.4 g/d) when fed reduced-oil DDGS diets.

- **Layers will be less affected than broilers** when fed reduced-oil DDGS because of lower diet ME requirements.

- **AME_n can be estimated** by using the following equation:
  - AME_n (kcal/kg DM) = 3,517 – (33.27 x % hemicellulose) + (46.02 x % crude fat) – (82.47 x % ash) Rochelle et al. (2011)

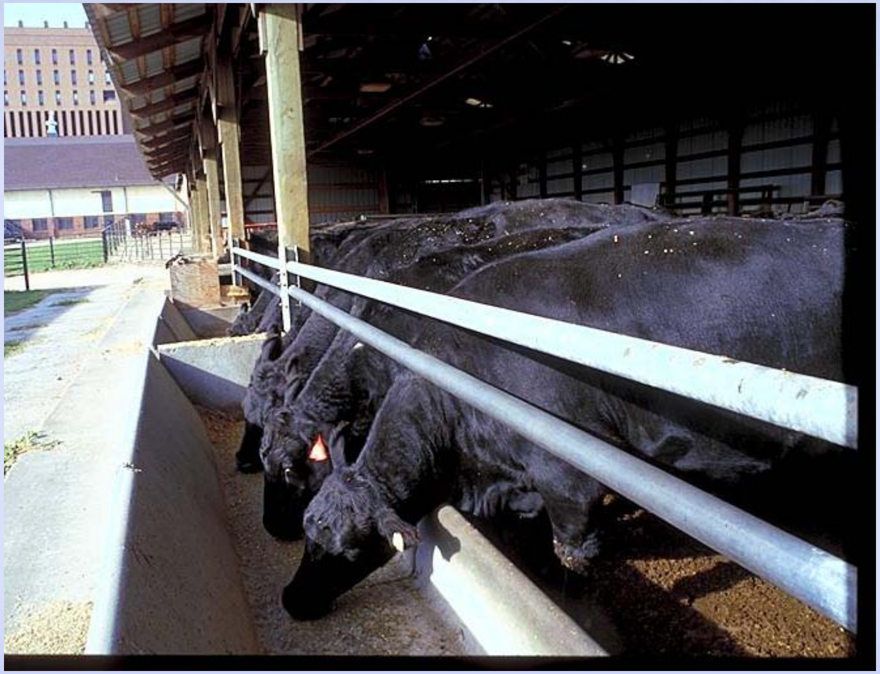


Impact of Reduced-Oil DDGS on Milk Production of Lactating Dairy Cows

What Have We Learned?

- Feeding diets containing up to 30% de-oiled DDGS (3.5% fat):
  - **Had no effect on**:
    - Dry matter intake
    - Crude protein intake
    - Nitrogen efficiency
    - Milk yield
    - Milk protein yield
  - **Increased**:
    - Milk production efficiency
    - Milk fat % and milk fat yield
    - Milk protein % (quadratically)
    - Milk total solids %

Impact of Reduced-Oil DDGS on Performance and Carcass Composition of Beef Cattle



What Have We Learned?

- Feeding reduced-oil DDGS (6.7% crude fat):
  - **Growth performance and carcass quality**
    - **Reduced-oil DDGS = corn**
    - **Reduced-oil DDGS < "typical" DDGS** (12.9% crude fat)
  - **1 percentage point ↓ in oil content = 1.3% ↓ in NE_g**

What Are the Future Co-Product Possibilities?

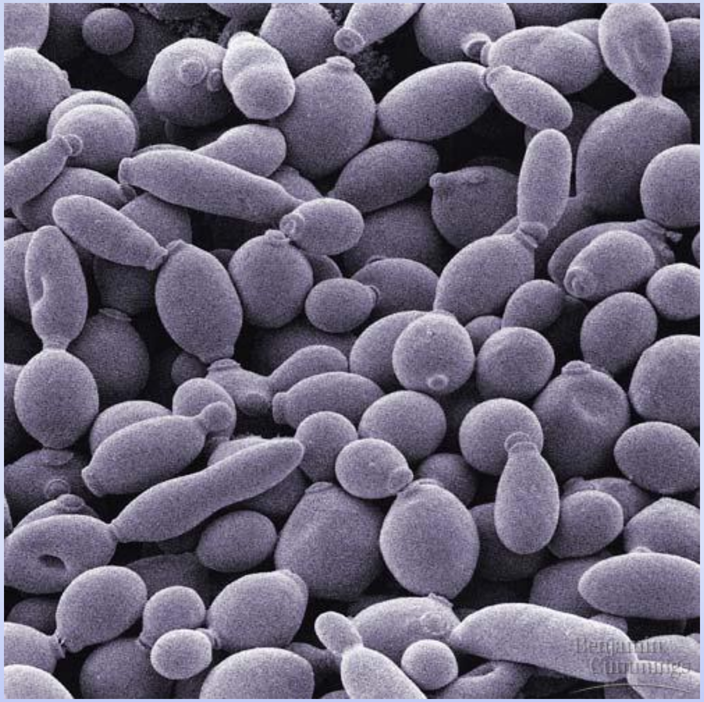
Co-Product Blends, Brands and "Value Enhancers"

Blends of various non-traditional corn co-products produced in small amounts (i.e. hominy feed, corn gluten, dried liquids) will be combined with DDGS to add value.

Branded corn co-products that have unique feeding applications, value, and are distinctly different than "commodity" co-products may become available.

Co-product **"value enhancers"** which may consist of enzymes, probiotics, or other additives may be added to DDGS to increase nutritional value for specific feeding applications.

New Yeast Strains Used in Ethanol Production May Alter Co-Product Composition



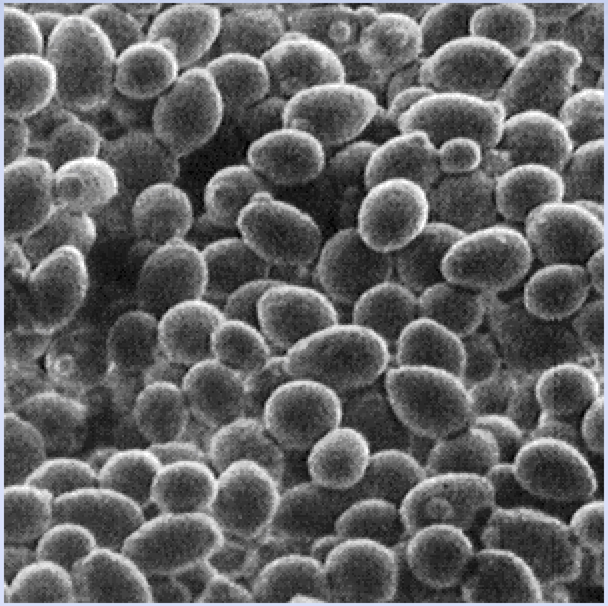
More complete carbohydrate conversion to ethanol will reduce starch and fiber content (energy value).

Isobutanol Co-products – Will They Be Different Than DDGS?

Moving Toward Advanced Cellulosic Ethanol Production

- Fuel Biorefinery
  - Daily processing of 2,200 dry tons of **corn stover** ($65/MT) produces:
    - 131 million L of **ethanol**
      - 51% of revenue
    - 129,000 tons of **dried feed yeast**
      - 42% of revenue with a price of $0.70 to $1.20/kg
      - current market for feed yeast is $0.80 to $3.00/kg
    - 168,000 tons of **lignin-rich "green coal"**
      - 7% of revenue

Dried Yeast Co-Product



High protein (46%) and high digestible amino acid source

New Co-Products from Advanced RIN

Barley

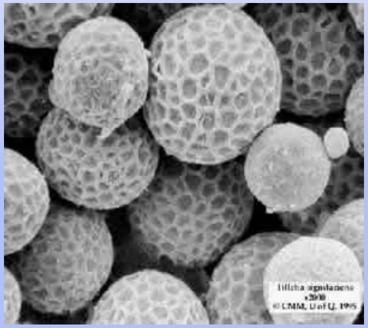
Sweet Sorghum

Sorghum Grain

Several non-traditional feedstocks may be used to produce ethanol and co-products under the Advanced RIN (Renewable Identification Number) designation

MycoMeal - Fungi for Feed

- **Produced from thin stillage** (van Leeuwen, 2012)
  - 0.1 to 0.15 lbs DM per gallon of thin stillage
  - Reduces ethanol production energy cost by reducing cost of evaporation
- Contain **2x energy content of corn and DDGS**
- **High amino acid content**
  - allows replacement of soybean meal and fish meal in diets
- Soon to be available for sale through MycoInnovations



Other Potentially Evolving Co-Products

- Dried condensed solubles
- Dried liquid extractives
- Low fiber DDGS
- Reduced phosphorus DDGS
- Algae co-products

Final Thoughts

- The more things change…
  - As the co-product composition changes, **research is needed** to determine:
    - Benefits and limitations
    - Optimal dietary inclusion rates
    - Which animal species obtains the highest value

- The more they stay the same…
  - **Ethanol co-products have always had value in animal feeds**
    - Value depends on energy, protein (amino acid), and phosphorus content
    - Value varies by animal species