

# Using Byproducts to Feed Dairy Cattle

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Various byproducts from feed processing industries are available for dairy farmers to incorporate into diets fed to dairy cows and replacement heifers. Using these feeds offers at least two benefits:

- may decrease the feed costs depending on prices of byproducts and grains.
- helps dispose of these byproducts in an ecologically sound manner.

## Considerations Before Purchasing a Byproduct

When determining whether to purchase and feed a particular byproduct, several factors should be considered. These include:

- Is the byproduct economical to feed? Will feeding this byproduct reduce feed costs and/or increase milk production or growth to more than pay for the additional costs?
- How palatable is the byproduct? Can it be added to a grain mix that will be fed through the parlor or individually, or does the byproduct need to be included in a total mixed ration or mixed with silage to maintain palatability?
- Does the byproduct provide an economical source of a nutrient, such as fat, fiber, or protein, needed to complement forages being fed?
- What are the additional costs associated with transportation of this byproduct to your farm? What additional costs are associated with the additional time you will need to spend locating the most economically priced commodity? These costs need to be included when calculating the cost of a particular product.
- Are special equipment or facilities needed to handle and store this byproduct? Are these available on your operation?

- How long will it take for you to feed a load of this byproduct? Can this byproduct be stored for that length of time? Wet byproducts are limited in the amount of time they can be stored and still maintain their quality.
- Is the byproduct free of contaminants which could be harmful to the cattle's health or milk supply?
- Is this byproduct available year-round, or is it available only seasonally?

## Nutrient Composition of Byproducts

The average nutrient composition (on a dry matter basis) of selected byproducts and cereal grains is listed in Table 1 (page 2). The nutrient composition of byproducts frequently is different from classical grains used to feed dairy cattle. For example, wheat middlings contain three times more phosphorus than corn grain and twice as much phosphorus as wheat grain. Thus, a different mineral mix is needed to complement the higher phosphorus content in wheat middlings. It is imperative that rations be balanced to ensure that the nutrient needs of cattle are met.

The nutrient composition of byproducts can vary between different suppliers and between loads from the same supplier. Table 2 (page 2) illustrates the amount of variation in crude protein and fat content of dried distiller's grains from three different suppliers and the variation between different batches from the same supplier. The crude protein content of dried distiller's grains ranged between 22.1 and 33.1%. Thus, the nutrient composition of byproducts needs to be analyzed when a byproduct is purchased from a different supplier and routinely even when a byproduct is purchased from the same supplier.

Moisture content affects the amount of nutrients cattle will receive from a pound of a byproduct. A higher moisture content results in fewer nutrients in a pound of the byproduct. Table 3 (page 3) illustrates how the nutrient content of distiller's grains decreases as the moisture level increases (or as dry matter content decreases).

To convert the nutrient composition from a dry matter basis to an as-fed basis, multiply the nutrient content on a dry matter basis by the percent dry matter.

**Table 1.** Nutrient composition of selected byproducts and cereal grains on a dry matter basis.

	Dry Matter Basis				
	Dry Matter (%)	Crude Protein (%)	Energy NE <sub>L</sub> (Mcal/lb)*	Calcium (%)	Phosphorus (%)
Barley	88	12.4	0.86	0.06	0.39
Blood meal, ring dried	92	95.5	1.06	0.30	0.30
Brewer's grain, dry	92	29.2	0.78	0.30	0.67
Brewer's grain, wet (21% DM)	21	28.4	0.78	0.35	0.59
Brewer's grain, wet (40% DM)	40	28.4	0.78	0.35	0.59
Corn grain, ground	89	9.4	0.91	0.04	0.30
Corn gluten meal	91	65	1.08	0.06	0.60
Corn gluten feed	87	23.8	0.79	0.07	1.00
Cottonseed, whole and linted	92	23.5	0.88	0.17	0.60
Cottonseed meal (41% crude protein)	92	44.9	0.78	0.20	1.15
Cottonseed meal (36% crude protein)	92	39	0.78	0.20	1.15
Distiller's grain with solubles, dry	92	29.7	0.89	0.22	0.83
Distiller's grain with solubles, wet	60	29.7	0.89	0.22	0.83
Fish meal, anchovy	92	71.2	1.01	4.06	2.69
Fish meal, menhaden	92	68.5	1.06	5.34	3.05
Hominy	90	12	0.81	0.03	0.65
Feather meal	93	92	0.98	0.33	0.50
Non-ruminant Meat meal	94	57.6	1.01	8.86	4.20
Non-Ruminant Meat and Bone Meal	92	54	0.74	10.60	4.73
Molasses, sugarcane, dried	94	6	0.80	1.00	0.10
Molasses, sugarcane, wet	75	6	0.80	1.00	0.10
Peanut skins	90	17.4	0.67	0.19	0.20
Soybeans, whole	92	39	1.25	0.32	0.60
Soybean meal (44%)	89	50	0.97	0.40	0.71
Soybean meal (48%)	90	54	1.01	0.35	0.70
Soyhulls	91	13.9	0.66	0.63	0.17
Thin slop	6	29.7	0.89	0.22	0.83
Tallow	99	-----	2.06	-----	-----
Urea	99	281	-----	-----	-----
Wheat	89	14.2	0.90	0.05	0.43
Wheat bran	89	17.3	0.73	0.13	1.18
Wheat middlings	89	18	0.76	0.16	1.02

\*3 times maintenance

Sources: Nutrient Requirements of Dairy Cattle, 7th revised edition. National Academy Press, 2001; Feedstuffs Reference Issue and Buyer's Guide 2006

**Table 2.** Variation in composition of dried distiller's grains plus solubles between three different sources.

	Source		
	A	B	C
<b>Crude Protein (% of Dry Matter)</b>			
Number of samples	83	19	171
Average	24.9	26.7	30.2
Range	22.1 - 28.2	23.4 - 28.7	27.2 - 33.1
<b>Fat Content (% of Dry Matter)</b>			
Number of samples	62	19	77
Average	12.8	8.8	11.6
Range	6.6 - 19.7	2 - 13	8.9 - 14.3

Taken from Chase, L. E., 1992. "Using Distiller's Grain and Hominy for Dairy Cattle Rations." Alternative Feeds for Dairy and Beef Cattle, pp. 13-19.

**Table 3.** The effect of dry matter (moisture) content on the concentration of nutrients dairy cattle receive from distiller's grain with solubles.

Type of Distiller's Grain	Dry	as-fed basis				
	Matter Content (%)	Moisture Content (%)	Crude Protein (%)	Energy NE <sub>L</sub> (Mcal/lb)	Calcium (%)	Phosphorus (%)
All water removed	100	0	25	0.93	0.15	0.71
Dried Grain	92	8	23	0.86	0.14	0.65
Wet Grain	60	40	15	0.56	0.09	0.43
Thin Slop	6	94	1.5	0.06	0.007	0.04

## Calculating the Nutritive Value

The value of a byproduct feed in providing a source of protein and energy can be compared to 44% soybean meal and shelled corn by using the protein and energy factors in Table 4. (The protein factors in Table 4 do not take into account the different types of protein, such as bypass (undegradable), soluble, or degradable protein.)

### To calculate the nutritive value of a byproduct or cereal grain:

1. Multiply the current price of shelled corn by the energy factor for the particular commodity of interest.
2. Multiply the current price for 44% soybean meal by the protein value for the particular commodity of interest.
3. Add the values in Steps 1 and 2.

**For example:** What is the nutritive value of corn gluten feed if shelled corn costs \$3.00/bushel (\$107/ton) and 44% soybean meal costs \$250/ton?

1. Energy value =  $(\$107/\text{ton})(0.597) = \$63.88$
2. Protein value =  $(\$250/\text{ton})(0.304) = \$76.00$
3. Total value = \$139.88

Thus, corn gluten feed has a nutritive value of \$139.88/ton. If corn gluten feed could be purchased for less than \$139.88/ton, it would be economical.

In addition, the cost per unit of protein or energy can be used to compare the nutritive value of different products. Remember that the cheapest feedstuff may not always be the most economical ingredient. The moisture content of wet byproducts should always be considered when calculating their nutritive value. Do not pay extra for high-moisture, wet byproducts compared to the dry form.

**Table 4.** Protein and energy factors for calculating the nutritive value of various commodities in relation to the prices of 44% soybean meal and shell corn

	Protein Factor	Energy Factor
Barley	0.111	0.866
Blood meal	2.025	-1.235
Brewer's grain, dry	0.433	0.357
Brewer's grain, wet (21% DM)	0.099	0.081
Brewer's grain, wet (40% DM)	0.188	0.155
Corn, shelled	0.000	1.000
Corn and cob meal (ear corn)	-0.007	0.985
Corn gluten meal, dry	1.408	-0.420
Corn gluten feed, dry	0.304	0.597
Whole cottonseed	0.323	0.850
Cottonseed meal (41% CP)	0.905	0.036
Cottonseed meal (36% CP)	0.867	0.015
Distiller's grain with solubles, dried (92% DM)	0.394	0.686
Distiller's grain with solubles, wet (60% DM)	0.257	0.447
Feather meal	1.600	-0.743
Fish meal, herring	1.875	-0.865
Fish meal, menhaden	1.651	-0.768
Hominy	0.057	0.977
Meat meal	1.227	-0.349
Meat and bone meal	1.426	-0.555
Molasses, cane, dry	0.075	0.791
Molasses, cane, wet	-0.037	0.747
Oats	0.120	0.779
Peanut skins	0.265	0.439
Whole soybeans	0.836	0.279
Soybean meal (44% CP)	1.000	0.000
Soybean meal (48% CP)	1.142	-0.142
Soyhulls	0.100	0.819
Thin stillage (slop) (6% DM)	0.026	0.045
Wheat	0.161	0.884
Wheat bran	0.235	0.585
Wheat middlings	0.274	0.523

Computer program to generate factors written by L. H. Kilmer at Iowa State University

## Selective Byproducts

Listed are several byproducts which may be available in Kentucky. Important information about each byproduct is listed, along with recommended feeding rates.

### Blood Meal

1. Byproduct of the rendering industry.
2. Made from clean, fresh animal blood exclusive of the urine, hair, stomach contents, etc.
3. Flash drying process produces a more uniform product with a higher lysine content.
4. Due to potential palatability problems, best used in total mixed rations (TMR). Needs to be added slowly over a two-week period. Palatability problems may be encountered if added to grain mixes fed in the parlor or through a computer feeder.
5. Limit intake to 0.5-1.0 lbs/cow/day in total mixed rations.

### Brewer's Grains

1. Byproduct produced by the beer or malt industry which includes spent grain and hops.
2. Dried brewer's grain is a good source of bypass (undegraded) protein.
3. Dried product is bulky and must be handled mechanically. Cows will require more time to consume this byproduct.
4. Brewer's grain is low in calcium and potassium and requires proper mineral supplementation.
5. Dried brewer's grain can be included at the rate of 25-35% of the grain mix dry matter, 15-25% of the total ration dry matter, or 6-10 lbs/cow/day.
6. Wet brewer's grains:
  - a. Feeding large amounts may reduce dry matter intake especially with corn silage diets.
  - b. Limit intake to 15-25% of the total ration dry matter or 9-10 lbs dry matter/cow/day.
  - c. Store in clean place on the farm. May be stored in a concrete or asphalt bunker silo or plastic bag.
  - d. Product deteriorates rapidly in hot weather. Should be fed within 2-5 days in the summer, but during cold weather, it will last 5-7 days.
  - e. Usually the price limits hauling no more than 100-200 miles from brewery.
  - f. Can be stored in silage bags to extend shelf life.

### Corn Gluten Feed

1. A medium protein byproduct obtained when high fructose corn syrup is made.
2. Available in dry or wet form.
3. Includes the corn bran or 2/3 corn bran and 1/3 steepwater from the wet corn milling process.
4. The more steep water that is added the darker the product.
5. Byproduct is low in starch, calcium, and potassium and high in phosphorus in relation to corn grain.
6. Wet corn gluten feed should be limited to 20-35% of the total ration dry matter so that dry matter intake and ration palatability will be maintained. Can be ensiled in silage bags to extend shelf life.
7. Dry corn gluten feed: Limit to 25-30% of the total ration dry matter or 10-15 lbs/cow/day or 5-10 lbs/heifer/day.
8. Need to adapt cows slowly to product over a 2-3 day period.

### Corn Gluten Meal

1. Byproduct is produced during the wet corn milling process where corn syrup and starch are made.
2. Dried product produced from corn after the larger portion of starch, germ, and oil has been removed and separated from the bran.
3. Excellent source of bypass (undegradable) protein; however, it is low in lysine and should be blended with soybean-based products.
4. Marketed as a 40-60% protein product.
5. Limit to 15% of the grain mix or no more than 2-3 lbs/cow/day.

### Whole Cottonseed

1. This oilseed is an excellent source of energy, protein, and effective fiber.
2. It is a very bulky product, which causes mechanical difficulties when fuzzy (linted) whole cottonseed is stored in bins and auger systems.
3. Mechanically delinted whole cottonseed and pima (naturally delinted) cottonseed have similar feeding value to fuzzy whole cottonseed.
4. Acid delinted cottonseed is an inferior source of fat and fiber compared to whole fuzzy, mechanically delinted or pima cottonseed.
5. The oil is released slowly into the rumen contents when the seed is chewed, which helps reduce the harmful effects of the oil on rumen fermentation.
6. Quality of cottonseed can vary. Whole fuzzy cottonseed should be clean, free of foreign debris, and white to white-gray in color. It should rattle when shaken. Store in a dry place. If whole cottonseed becomes wet while being stored, it can heat or mold, and the seed may turn dark or black.
7. Mycotoxins, especially aflatoxins, can become a problem in the field or during storage. To reduce chances of increasing the concentration of aflatoxin during storage: (1) store seed at less than 10% moisture, (2) force air through seed, (3) shelter from rain, and (4) store on sloped concrete.
8. Gossypol is contained in whole cottonseeds, but it is not believed to cause problems when fed at the recommended amounts (provided that cottonseed meal is not in the diet at high levels).
9. Limit to 4-6 lbs/cow/day for 1200-1300 lb cow.

### **Cottonseed Meal**

1. Cottonseed meal is a byproduct produced after the oil is extracted from whole cottonseeds.
2. Two different methods are used to remove the oil from the cottonseeds, resulting in differing amounts of oil left in the meal. (Solvent extraction is the most commonly used method of processing.)
3. Cottonseed meal contains slightly less energy and available protein than soybean meal.
4. Cottonseed meal contains gossypol. Under normal feeding systems, gossypol is not provided at high enough levels to cause problems (provided whole cottonseed is NOT fed).
5. Cottonseed meal can be used to replace soybean meal.
6. DO NOT use in grain mixes for heifers less than 8 weeks of age because of potential toxic effects of gossypol. Limit amount used in grain mixes up to 24 weeks of age.

### **Dried Distiller's Grains with Solubles**

1. Byproduct from the fermentation of grain for the production of ethyl alcohol.
2. Dried distiller's grain with solubles. Solubles left over from the fermentation are added to the grains before they are dried (most common product).
3. Corn, milo, barley, rye, wheat, or sorghum are the grains used. Usually corn is the predominant grain used to make distiller's grain.
4. Good source of bypass (undegraded) protein if properly dried.
5. Contains 10-12% fat. Remember to include the amount of fat coming from dried distiller's grain when calculating amount of fat found in the diet.
6. Low in calcium and high in phosphorus and potassium. Proper mineral supplementation required.
7. Crude protein will vary between 23-28% on an as-fed basis
8. Generally included at the following rates: 20-35% of the grain mix, 15-25% of the total ration dry matter, or 6-10 lbs/cow/day.

### **Wet Distiller's Grains**

1. Wet distiller's grain contains approximately 65-75% moisture. It is produced by straining out the coarser particles found in the stillage and then pressing to remove some moisture.
2. Byproduct is low in calcium.
3. Feeding large amounts may reduce dry matter intake, especially on corn silage diets.
4. Limit intake to 15-25% of the total ration dry matter or 9-10 lbs dry matter/cow/day.
5. Store in a clean, dry place. It may be stored in a concrete or asphalt bunker silo or plastic bag.
6. Product deteriorates rapidly in hot weather.
  - Needs to be fed within 2-5 days in the summer.
  - During cold weather, it will last 5-7 days.
7. Can be ensiled in silage bags to extend shelf life.
8. Usually price limits hauling no more than 100-200 miles from distillery.

### **Ruminally Inert Fats (Specialty or Bypass Fats)**

1. Ruminally inert fats are fats with little effect on rumen fermentation.
2. Some examples of specialty fats\* which claim to be ruminally inert:
  - a. Megalac
  - b. Energy Booster
  - c. EnerGII
3. These products usually are the most expensive sources of supplemental fat. From an economical standpoint, they should be used after the amount of fat from natural fat sources exceeds 5% in total diet.

### **Fish Meal**

1. Made from clean, dried, ground, and undecomposed fish.
2. Rich in essential amino acids. The amino acid profile may be similar to that required for the synthesis of milk protein.
3. Due to potential palatability problems, best used in total mixed rations. Needs to be added slowly over a two-week period. Problems may be encountered if added to grain mixes fed in the parlor or through a computer feeder.

### **Hominy**

1. Byproduct from the processing of corn meal for human consumption.
2. Very palatable feedstuff which consists of a mixture of corn bran, germ, and a portion of the starchy part of the corn kernel.
3. Fat content varies between 5-12% (need to calculate the amount of fat supplied in the total ration to make sure it does not exceed 5% total fat).
4. Higher in energy, protein, fat, and fiber than corn grain.
5. Generally limited to 50% of the grain mix, 20-35% of the total ration dry matter, and 12-16 lbs/high-producing cow/day.

### **Hydrolyzed Feather Meal**

1. Byproduct from the pressure treatment of clean, undecomposed feathers from slaughtered poultry.
2. Low in lysine and methionine which are believed to control milk production. However, this product is high in cysteine which may substitute for methionine in milk production.
3. Due to potential palatability problems, best used in total mixed rations. Needs to be added slowly over a two-week period. Problems may be encountered if added to grain mixes fed in the parlor or through a computer feeder.
4. Limit intake to 0.3 lbs/cow/day in total mixed rations.

### **Liquid Whey**

1. Byproduct of cheese production.
2. Product contains mainly lactose, minerals, and water (6-7% total solids).
3. Different products available:
  - a. Liquid whey
    1. Sweet whey: From manufacture of cheddar and mozzarella cheese.
    2. Acid whey: From manufacture of cottage cheese; less palatable than sweet whey.
  - b. Liquid permeate: contains less protein and total solids and more minerals than liquid whey (on dry matter basis).
  - c. Dried whey: allows more flexibility but is usually more expensive than liquid product.
  - d. Need to know which product is available to balance nutrient needs.

*\*Mention or display of a trademark, proprietary product, or firm in text or figures does not constitute an endorsement and does not imply approval to the exclusion of other suitable products or firms.*

4. Precautions when feeding:
  - a. Need steady supply of the product.
  - b. Cattle will take approximately four weeks to become accustomed to the product. During this time, they may have diarrhea.
  - c. Bloat can become a problem when large amounts are consumed in a short period of time. Need to limit access.
  - d. Whey is very corrosive and, therefore, should be stored in plastic, stainless steel, or glass.

#### **Non-Ruminant Meat Meal**

1. A rendered product from the carcasses of swine or poultry excluding blood, hair, hoof, hide trimmings, feces, and stomach. Similar to meat and bone meal except no minimum phosphorus concentration required.
2. Due to potential palatability problems, best used in total mixed rations. Needs to be added slowly over a two-week period. Problems may be encountered if added to grain mixes fed in the parlor or through a computer feeder.
3. Limit intake to 1.5-2.5 lbs/cow/day in total mixed rations.
4. Do not feed ruminant derived meat and bone meal back to ruminants.

#### **Non-Ruminant Meat and Bone Meal**

1. A rendered product from the carcass of swine or poultry excluding blood, hair, hoof, hide trimmings, feces, and stomach. It contains a minimum of 4% phosphorus with a calcium content that does not exceed 2.2 times the phosphorus concentration.
2. Due to potential palatability problems, best used in total mixed rations. Needs to be added slowly over a two-week period. Palatability problems may be encountered if added to grain mixes fed in the parlor or through a computer feeder.
3. Limit intake to 1.5-2.5 lbs/cow/day in total mixed rations.
4. Do not feed ruminant derived meat and bone meal back to ruminants.

#### **Molasses**

1. Byproduct of sugar production from cane, sugar beets, or other sources (cane molasses is the most common.).
2. Used to control dust in concentrate mixes (4-7% of the grain mix) and increase palatability of feeds (example: calf starters).
3. When large amounts are fed for an extended period of time, adjustments must be made in vitamin supplementation. Molasses is deficient in Vitamins A and D, thiamin, and riboflavin; it is a good source of niacin and pantothenic acid.
4. Beet molasses is similar in feeding value to cane molasses.
5. Expensive when fed at concentrations greater than 7% of concentrate mix. (To be cost effective, 6 1/2 gal of molasses needs to cost less than a bushel of #2 yellow corn.)
6. Limit amount fed to 2-3 lbs/cow/day.

#### **Peanut Skins**

1. Includes skins from the processing of peanuts, broken nuts, and nuts rejected during preparation for human consumption.
2. They are high in fat and may contain additional salt and oil added in the processing.
3. They are fairly high in tannins which act in the gut to bind proteins and make some of the protein unavailable for digestion and absorption.
4. Limit to 5-8% of the total ration dry matter.

#### **Whole Soybeans—Raw or Roasted**

1. Very palatable feed that is easily incorporated into many different feeding systems as a topdress, part of a total mixed ration, or in a grain mix.
2. Can be fed either raw or roasted.
  - a. Raw whole soybeans
    1. DO NOT FEED in diets containing urea!!!
    2. When beans are ground or added to ensiled forages or wet byproducts, chances of rancidity are increased.
    3. Works well in corn silage based rations.
  - b. Roasted whole soybeans
    1. Properly roasted soybeans contain more bypass (undegraded) protein and the urease and trypsin inhibitors are denatured.

2. Large variation exists in the nutritive value of beans that have been roasted. These differences are explained by differences in temperature, time of heating, moisture of the seed at the start of roasting, and how beans are handled after they are roasted.
3. Beans should NOT be charred but cooked throughout and not raw in the center.
4. Color is not a good indicator of the quality of the roasting process.
5. Drum-roasted soybeans should exit the roaster at approximately 295°F and be held without cooling for an additional 30 min (steeping).
3. To limit the amount of fat from natural fat sources to 3% fat, limit to 3-5 lbs of beans/1200-1300 lb cow/day (with no other high fat sources added).

#### **Soyhulls (Soybean Mill Run, Soybean Flakes, Soybran Flakes)**

1. Byproduct of soybean processing for oil and meal.
2. Soybean hulls NOT HEAT PROCESSED contain urease activity and should not be used in rations containing urea. Most soyhulls are heat processed to inactivate the ureases (known as soybean mill run).
3. Byproduct should be used to replace grain portion of diet, NOT forages.
4. Very palatable feedstuff which is high in digestible fiber but very low in effective fiber (fiber to stimulate cud chewing).
5. Used to add bulk to finely textured rations.
6. Flows well and easily handled with augers and storage bins.
7. Added at the maximum rate of 20-25% of the total ration dry matter or 8-12 lbs/cow/day.

### **Stillage (Thin Slop)**

1. Byproduct from the distillery industry.
2. Material remaining after straining, pressing, or centrifuging out larger particles.
3. Very low in dry matter content (may average 2-6% dry matter).
4. On a dry matter basis, nutrient content similar to dried distiller's grains with solubles, except bypass protein (very low amounts of bypass protein).
5. Limit intake so that dry matter or nutrient intake does not limit milk production.
  - a. Limit intake to 50-100 lbs/cow/day or 3.5-7 lbs dry matter/cow/day.
6. Mineral supplementation should complement the low calcium and high phosphorus content of this byproduct.

### **Tallow**

1. Derived primarily from rendered beef fat but may include other animal fats.
2. Requires special handling equipment because at room temperature it is a solid or semi-solid. To be mixed within feed, it must be heated so that it can be melted.
3. Nine different grades of tallow are sold. Good quality (fancy bleachable) tallow should be used for the most consistent animal response.
4. Limit to 1 lb/1200 lb cow/day.

### **Urea (Nonprotein nitrogen source)**

1. Contains 45% Nitrogen = approx 282% protein equivalent.
2. Urea is broken down to ammonia in the rumen. With an energy source, the ammonia is used by the microbes in the rumen to produce microbial protein.
3. Urea is equal to soybean meal as protein supplement when crude protein content of total ration is below 12% and no highly degradable protein sources are fed. However, value as a protein source decreases when crude protein content of the total diet is above 12% and if no bypass (undegradable) protein sources are added. (Normally milk cow diets contain greater than 14% crude protein.)
4. Do not feed urea to calves under 6 months of age or to early lactation cows fed a corn/soybean meal grain mix. (Can use NPN source if bypass protein sources are used in grain mix for early lactation cows.)
5. Do not exceed 1% of the grain mix.
6. Treating corn silage with anhydrous ammonia:
  - a. Advantages
    1. Decreases feed costs
    2. Increases crude protein content of silage by 50%. Increases both NPN and true protein fractions in corn silage.
    3. Results in better silage fermentation.
    4. Extends bunk life of silage.
  - b. Use caution when applying because this is a hazardous material.

### **Vegetable Oils**

1. Free vegetable oils should not be fed to dairy cattle.
2. The free oil may coat the rumen bacteria or feed particles and reduce fiber digestion and milk fat test.

### **Wheat Bran**

1. Byproduct produced during the milling of wheat for flour.
2. Slightly higher in fiber than wheat middlings (ADF% = 10 vs. 15% DM basis).
3. Limit to 25% of the grain mix or 6 lbs/cow/day.

### **Wheat Middlings**

1. Byproducts from the milling of wheat for flour.
2. Highly palatable feedstuff which is low in calcium and high in phosphorus. Requires proper mineral supplementation.
3. Contains 92% of the energy value of corn and is higher in protein than corn grain.
4. Limit to 25-50% of the grain mix, 15-25% of the total ration dry matter, or 6-12 lbs/cow/day to prevent palatability problems.

### **Yellow Grease**

1. Byproduct derived from grease used in the restaurant industry.
2. Best used in feedlot rations rather than rations for lactating dairy cows.

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