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Distiller's Grains for Dairy Cattle and Potential Environmental Impact

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Ethanol is produced when starch in corn grain is fermented. Most other constituents in the grain remain unchanged. The end product of the corn is distiller's grains or DDGS (distiller's grains with solubles). The DDGS retain the original fatty acids, protein, and phosphorus. In addition, variability in the grain nutrient content used in the fermentation process and the actual process itself results in a feed with variable nutrient content. Distiller's grains can be fed either in the wet (less than 25 percent dry matter) or dry (greater than 85 percent dry matter) form. Wet DDGS are difficult to store and must be fed within a few days of production. The wet DDGS can be the most cost-effective, however, if used close to where they are produced.

Research by Schingoethe (2007) with dairy cattle has indicated that DDGS can be up to 20 percent of the ration dry matter without problem, and as much as 30 percent in some situations. For lactating cows, this maximum will usually be between 6 percent to 13 pounds of 90 percent dry matter (10 percent moisture) distiller's grains. Table 1 shows the nutrient content expressed on a dry basis for corn and DDGS according to the 2001 National Research Council (NRC) and Weiss and coworkers from Ohio State.

Table 1. Nutrient composition of shelled corn and DDGS

	Corn	DDGS
Crude protein, %	9.4	29.7
Starch, % (Weiss et al)	70.0	4.0
Net energy, mcal/lb.	0.95	0.90
Fat, %	4.0	10.0
Neutral detergent fiber, %	9.5	38.8
Phosphorus, %	0.3	0.83

Because DDGS contain no or little starch and more protein, fat, and phosphorus than corn, ration reformulation is needed to adjust the amounts of forage, grain, protein supplement, and mineral additive. For dairy cattle, the main issues with feeding distiller's grains are protein concentration and quality, fat content, and phosphorus concentration.

Protein Quantity and Quality

Distiller's grains are a relatively high-protein feed with approximately 30 percent of the dry matter as protein according to the NRC (2001). Ten pounds of DDGS would supply 2.7 pounds of protein. In many rations, DDGS will substitute partially for soybean meal, which is the most common protein source for dairy cattle. The protein in DDGS is more resistant to rumen degradation than solvent-extracted soybean meal, but in some cases where there is extreme heating of DDGS during drying, there can be reduced protein digestibility. The color of the product does give an indication of heat damage, with dark brown and black being indicators of reduced digestibility. A laboratory test for heat damage should be conducted to verify potential problems before feeding.

In situations where high-protein legume hay or silage is the forage source, the protein in DDGS may be excessive, especially if the maximum is included. Processes do vary and some DDGS will have more than 30 percent protein. Therefore, if no ration adjustment is made when including DDGS, overfeeding protein is a possibility, with possible air- and water-quality impact.

The amino acid lysine is low in all corn products and consequently, rations containing DDGS with corn silage and corn grain would possibly benefit from lysine supplementation. Under these conditions the 20 percent inclusion rate may be excessive.

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Fat or Oil Content

Another possible limitation is the fat or oil content of DDGS. The NRC lists DDGS as containing 10 percent fat in the dry matter. Adding 10 pounds of DDGS results in 0.9 pound of oil. Unsaturated fats such as that found in corn grain and DDGS are especially a problem with cattle if fed in excess. Unfortunately, this fat is readily available in the rumen and if present in excess, it can interfere with rumen fermentation. Ruminants can tolerate up to 5 percent to 6 percent of the total ration dry matter as fat from typical feed ingredients. If higher fat levels are desired, it is advisable to use rumen protected fats.

If feeds such as whole cottonseeds or soybeans (20 percent fat) are fed, DDGS should be fed at less than the maximum of 20 percent inclusion rate because the maximum amount of fat would be exceeded in the formulation. If rumen protected fat supplements such as Energy Booster or Megalac are used, fat levels of 5 percent to 7 percent of the ration dry matter are tolerated reasonably well. Excessive fat in the ration can result in reduced dry matter intake, milk production, milk fat percentage, and milk protein percentage.

Phosphorus Content

According to the NRC (2001), DDGS contain 0.83 percent of the dry matter as phosphorus (P). Ten pounds of distiller's grains would contain 0.0747 pounds of P or 34 grams. Distiller's grains typically will substitute for soybean meal (0.7 percent P), corn (0.3 percent P), and silage (0.2 percent P) in varying proportions depending on the type of silage (corn vs. legume). The resulting reformulated ration balanced for energy and protein would contain at least an extra 10 grams of P when 10 pounds per cow of DDGS is included. Therefore, there can be an extra 1 gram P per 1 pound DDGS inclusion. Typical requirements for P in lactating cows are 60 to 90 grams per day (Hanigan, 2006). Research indicates that after the P requirement is reached, the excess will appear in the feces. Land application of manure adds P to the soil and any in excess of crop requirements can potentially be washed into waterways, becoming a source of pollution resulting in algal blooms and poor water quality. Also, problems with inadequate land area to spread manure can result on farms where phosphorus-based nutrient management plans are in effect.

If distiller's grains substitutes for other high-P feeds such as cottonseeds (0.6 percent P), brewer's grains (0.67 percent P), wheat bran (1.18 percent P), wheat middlings (1.02 percent P), or corn gluten feed (1.0 percent P), there may be little net change and in some cases an actual reduction in P in the ration. However, the P requirement for lactating cows would normally be exceeded with these type rations and manure P levels increased. The P requirement for lactating cows is less than 0.4 percent of ration dry matter. Although forages are usually considered low P sources, notice in Table 2 that rye silage and intensively managed pasture can have more P than other forages.

The question arises as to what can be done when the phosphorus content of the ration is excessive and no inorganic sources are included in the ration. Some feeds are identified in Table 2 that are low in phosphorus (0.20 percent P or less). Some of these are readily available such as citrus pulp, cottonseed hulls, and soybean hulls. Others may have application under certain circumstances and limitations. In conclusion, to manage phosphorus content of rations, it is necessary to analyze phosphorus levels and look for alternative feeds in some cases.

Recommendations to Minimize Environmental Impact

1. Laboratory analysis of DDGS is recommended before feeding because of potential variation.

2. To prevent overfeeding of protein, do not add the maximum inclusion rate of DDGS to rations that contain significant amounts of high-protein legume hays, silages, or other feeds without ration reformulation and adjustment. Generally, the lactating cow ration of crude protein content should be below 19 percent of the dry matter and below 18 percent if balanced for rumen degradability and dry matter intakes are monitored. Nonlactating animals over 6 months of age would need less than 14 percent protein.

3. Limit total ration fat level to 7 percent of ration dry matter from all sources, including forages, grains, supplements, and by-product feeds. Feeding distiller's grains above 20 percent of ration dry matter can result in excess fat and unsaturated fatty acids when other high-fat feeds are used. Excessive fat can result in reduced dry matter intake, milk yield, and milk components.

4. If corn and corn silage are removed from the ration with DDGS inclusion, the level of starch should be monitored. Rations typically should contain 24 percent to 26 percent starch in the ration dry matter.

Table 2. Crude protein (CP), fat, and phosphorus content of selected feeds (NRC 2001)

	% DM		
	CP	**Fat**	**P**
Forages			
Alfalfa hay, immature	22.8	2.1	0.31
Alfalfa hay, mature	17.8	1.6	0.28
Grass hay, immature	18.0	3.3	0.34
Grass hay, mature	10.8	2.0	0.26
Barley silage	12.0	3.5	0.30
Corn silage	8.8	3.2	0.26
Rye silage	16.1	3.8	0.42
Pasture, intensively managed	26.5	2.7	0.44
Grains			
Barley	12.4	2.2	0.39
Corn	9.4	4.2	0.30
Protein meals			
Cottonseed meal, solvent	44.9	1.9	1.15
Peanut meal, solvent	51.8	1.4	0.64
Soybean meal, solvent	49.9	1.6	0.70
Fish meal, menhaden	68.5	10.4	3.05
Whole seeds			
Cottonseeds	23.5	19.3	0.60
Soybeans, roasted	43.0	19.0	0.60
By-products			
Brewers grains, dry	29.2	5.2	0.67
Brewers grains, wet	21.8	5.2	0.59
Corn gluten feed	23.8	3.5	1.00
Distiller's grains	29.7	10.0	0.83
Hominy	11.9	4.2	0.65
Wheat bran	17.3	4.3	1.18
Wheat middlings	18.5	4.5	1.02
Low P feeds			
Citrus pulp	6.9	4.9	0.12
Cottonseed hulls	6.2	2.5	0.12
Molasses, sugarcane	5.8	0.2	0.10
Soybean hulls	13.9	2.7	0.17
Sugar beet pulp	10.0	1.1	0.09

5. When using DDGS, supplemental inorganic phosphorus sources are normally not needed. Substituting DDGS for a combination of corn, soybean meal, and silage can result in an extra gram of P for each pound of distiller's grains fed. Other high-P feeds may need to be reduced in rations with distiller's grains to prevent P levels from being excessive. Ration P should be below 0.4 percent of ration dry matter for lactating cattle. Nonlactating cattle and growing replacement heifers need less than 0.3 percent, but many times this is difficult to achieve with P levels found in most feedstuffs.

6. To prevent environmental issues related to feeding protein and P, amounts of DDGS included should be based on other available feeds and amounts in rations.

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