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Feeding Corn Distiller's Co-Products to Beef Cattle

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The ethanol industry is currently in the midst of a considerable expansion period in South Dakota and surrounding states. As more ethanol plants are built and begin production, the availability of co-products for livestock feed will increase dramatically.

Co-products may offer the cattle industry a tremendous opportunity to reduce feed costs without sacrificing performance. However, there are significant challenges that must be met before feeding these products.

The majority of the new plants utilize a dry milling process to produce ethanol from corn. Dry milling (mash distillation) involves cleaning and grinding the grain into coarse flour. Then water and enzymes are added, which convert the starch into sugar. At this point the mixture, referred to as "mash," is cooked and sterilized. Once the mash has cooled, yeast is added to begin the fermentation process. Fermentation results in the production of ethanol, carbon dioxide, and residual grain particles called "spent mash." The entire mixture is then distilled to remove the ethanol and centrifuged to remove as much excess liquid as possible.

Dry Milling Co-Products

Liquid removed from the mash is called thin stillage or "sweet water." Thin stillage may be reintroduced into the cooking and distillation processes to extract residual ethanol, sold directly as livestock feed, or dehydrated to produce condensed distiller's solubles (**CDS**), or "syrup." The remaining solid fraction, called wet distiller's grains (**WDG**), may be sold directly as livestock feed or dehydrated to produce dried distiller's grains (**DDG**).

Condensed distiller's solubles are either sold directly as cattle feed or blended with the distiller's grains to produce distiller's grains + solubles. Distiller's grains + solubles are sold in wet (**WDGS**; 30% DM), modified (**MDGS**; 50% DM), or dry forms (**DDGS**; 90% DM).

One of the first challenges in using distiller's co-products is to determine the nutrient content of the co-product used. As with other co-products (soybean meal, soyhulls, sunflower meal, etc.), nutrient concentrations in distiller's co-products can be highly variable. Table 1 contains a list of commonly reported nutrient values for different distiller's co-products.

Some variation in nutrient concentrations results from differences in the nutrient content of the corn used to produce ethanol. Differences in types of yeast, fermentation and distillation efficiencies, drying processes, and amount of solubles blended back into each of the co-products may also result in nutrient variability.

Some plants may provide product specifications with guaranteed nutrient contents; however, these values are only estimates of the minimum or maximum nutrient content of a particular co-product. Testing each load is the preferred option to assess the actual nutrient concentrations of any co-product feed. When feeding co-products that have limited shelf life (CDS, WDG, WDGS), however, this is not a practical option. Therefore, at the minimum, dry matter should be determined to assess how many pounds or tons of dry matter you are purchasing and feeding to the cattle.

Feeding Distiller's Co-Products

Thin Stillage. Thin stillage contains only 5-10% dry matter and can be used to replace water in cattle feeding operations. Research suggests that replacing water with thin stillage reduces dry matter intake without negatively affecting performance.

Cattle need to adapt over time to drinking the thin stillage. Not all cattle will consume the thin stillage, so these animals must be moved to pens with traditional water sources.

Fountains and water lines should be cleaned frequently to prevent microbial growth. Diets must be adjusted to account for the additional nutrients when thin stillage is replacing water. Since the nutrient content can be highly variable, each new shipment of thin stillage should be sampled and analyzed.

Condensed Distiller's Solubles. To produce CDS, thin stillage is frequently evaporated to approximately 70% moisture. Condensed distiller's solubles provide additional protein and energy and add moisture to condition diets.

Experiments at SDSU suggest that the addition of CDS up to 10% of the diet dry matter improves average daily gain and efficiency of gain. Based on a 10% inclusion, a 700-lb steer consuming 18 lb of dry matter per day would get 1.8 lb dry matter from CDS, or 6 lb of CDS on an as-fed basis (Table 2). A 1000-lb steer would be fed 8 lb, and a 1300-lb cow would get less than 9 lb of CDS as fed.

One note of caution: CDS may contain up to 15% fat depending on the source, and beef cattle diets containing more than 6% fat may depress fiber intake and digestion. When CDS is added at over 20% of the diet dry matter to diets that contain feedstuffs already containing 3% fat (such as early bloom alfalfa and corn grain), the dietary fat percentage can become greater than 6% (20% @ 15% = 3%; 80 @ 3% = 2.4%; 3% + 2.4% = 5.4%< 6%).

Distiller's Grains. Distiller's grains with or without solubles are a medium protein feed and can be fed as a replacement for other protein sources (such as soybean meal, sunflower meal, urea, etc.) in beef cattle diets. The protein in distiller's grains is approximately 50% undegraded intake protein (**UIP**), commonly referred to as "bypass protein," and 50% degraded intake protein (**DIP**).

Rumen microbes require a certain level of DIP to effectively digest starch and fiber and synthesize microbial protein. Microbial protein is the primary source of protein for beef cattle; however, forage-based diets may not allow for enough microbial protein production to meet the needs of the animal. Fortunately, much of the UIP provided by different feedstuffs is available for digestion in the small intestine. Often, a combination of microbial protein and UIP is necessary to meet the metabolizable protein requirements.

Cattle consuming poor quality forages generally require DIP supplementation to improve diet digestibility and performance. For older, more mature cattle, supplementing a protein source that is high in DIP may be sufficient to meet nutrient requirements. However, heifers and young cows have greater nutrient requirements and may require UIP supplementation to meet their nutrient demands for growth, gestation, and lactation. Once the DIP requirement for forage digestion is met, supplementation of higher levels of UIP may improve growth of young cattle and reproductive performance.

Supplements can be formulated from a variety of feeds to best meet the DIP and UIP requirements; however, DDG or DDGS can serve as the sole protein source for cattle. When feeding DDG or DDGS as a sole protein source, it is important to remember that higher levels of crude protein must be fed to effectively meet the DIP requirements.

A good rule of thumb is that, to provide similar levels of DIP, it takes 2.7 lb of DDGS to replace 1 lb of 44% crude protein soybean meal.

Distiller's grains are also an effective addition to feedlot diets. Nebraska and Iowa research suggests that distiller's grains (wet or dry) at up to 40% of the diet dry matter can replace corn for growing and finishing cattle.

In many studies, feeding distiller's grains at 15-20% of the diet dry matter has improved average daily gain and efficiency of gain. Including distiller's grains up to 20% of the diet dry matter can usually be accomplished with corn-based diets that contain forages low in protein without creating excess nitrogen excretion.

Kansas and Iowa research indicates that feeding distiller's grains at or above 40% of the diet dry matter may reduce performance and efficiency of gain and/or decrease carcass quality when compared to lower levels. To feed a 700-lb steer consuming 18 lb of dry matter, a ration containing 20% distiller's grains, 4 lb DDG or 12 lb WDG, should be fed (Table 2).

Besides the nutritional benefits of distiller's grains in feedlot diets, the moisture contained in WDG helps to condition dry rations.

In addition to protein, distiller's grains contain highly digestible fiber and fat, resulting in a similar to slightly higher energy value than corn. By providing energy as highly digestible fiber, we can avoid negative associative effects (reduced forage intake and digestibility) associated with feeding starchy (high starch) feeds. Furthermore, the fiber contained in distiller's grains may help prevent digestive disturbances in feedlot cattle.

Since dried and modified distiller's grains are subjected to a drying process, there is the potential for "burning."

While the distiller's grains may not actually burn, prolonged exposure to heat or excess sugar may result in a chemical "browning reaction" that renders part of the carbohydrate and protein unavailable to the animal. This reaction is similar to that of overheated stacked alfalfa hay as a result of air infiltration.

Generally, DDG, DDGS, MDG, and MDGS should have a bright, golden to golden brown color and smell somewhat like beer. If the product has been burnt, it will be considerably darker and have a burnt molasses odor. Suppliers will often discount the price of a burnt product to account for the reduction in feed value.

The price should reflect the decrease in energy and available protein, and to accurately estimate these values the burnt product must be sampled and tested. The lab analysis should include ADIN (acid detergent insoluble nitrogen) to assess the extent of protein damage. Since the ADIN value only represents nitrogen, it must be multiplied by 6.25 to calculate the appropriate protein value. The calculated protein value represents the amount of crude protein that is unavailable.

For example, if a sample contains 1.2% ADIN, then the unavailable protein value is 7.5% (1.2 x 6.25). Thus, if the sample contains 30% crude protein, only 22.5% crude protein is available (30 - 22.5).

Mineral Considerations

When feeding distiller's grains, keep in mind how the mineral concentrations of the diets are affected. Distiller's grains are low in calcium (Ca) but high in phosphorus (P) and sulfur (S). Feeding distiller's grains may provide enough P to allow supplemental P sources to be removed from mineral packages for cattle consuming forage-based diets.

Feedlot diets generally contain excess P due to the high levels of corn, so, when distiller's co-products are utilized, the additional P must be considered when formulating waste management plans. Also, to facilitate proper performance and to avoid urinary calculi (water belly), Ca to P ratios should be equal to or greater than 1.2:1 but not greater than 7:1. Supplemental Ca can be provided from feedstuffs high in Ca (alfalfa), but it is more commonly supplemented as limestone.

Distiller's grains are also frequently high in sulfur. Excess dietary S can be a problem for ruminants for two reasons.

First, high levels of sulfur (above 0.4% of diet dry matter) from feed and water can lead to polioencephalomalacia (PEM), or "brainers." Second, sulfur interferes with copper absorption and metabolism. This antagonism is exacerbated in the presence of molybdenum. Producers in regions prone to high sulfate water should exercise caution if using distiller's grains in their supplements.

Storage Considerations

Storage is also a major challenge when using co-products. Since CDS and thin stillage contain a high percentage of moisture, they will gel and freeze in cold temperatures. Storage equipment to prevent these products from freezing is necessary. Storage tanks should either be buried or heated for long-term storage in the winter.

Some of the solids in these products can also separate from the liquid. Therefore, the ability to re-circulate or agitate the tank may also be advantageous for long-term storage.

Wet distiller's grains with or without solubles contain about 70% moisture, which makes them challenging to store. This product can freeze into softball size clumps during the winter, making mixing the ration more difficult and and the resulting feed less consistent.

Handling WDG in warmer weather can be even more challenging. Wet distiller's grains will mold and go out of condition in as few as 4 days, although typically, WDG have about 7 days of shelf life before going out of condition. Organic acid may extend shelf life, but the additional cost needs to be considered.

Wet distiller's grains have been successfully stored for more than 6 months in silage bags, either bagged alone or in combination with another feed to increase bulk. SDSU researchers have been very successful storing blends of WDG (70% as-fed; 50% of dry matter) and soybean hulls (30% as-fed; 50% of dry matter).

Dried distiller's grains, with or without solubles, are easier to store since they only contain 10-12% moisture. These products do have a small particle size, so storing DDG out of the wind is critical. Commodity bins or bulk storage sheds work best. Even though DDG have high levels of fat, rancidity during summer months is usually not a concern.

Economics

When determining the economic value of the co-products, comparisons should be made on an energy (Total Digestible Nutrients; **TDN**) and crude protein (**CP**) basis. Table 3 illustrates what could be paid for the various distiller's co-products to replace corn on an equivalent energy basis. The equivalent values of the various co-products compared to soybean meal on a CP basis are presented in Table 4. Keep in mind these economics do not account for any additional costs associated with freight or storage; these expenses should be carefully evaluated when deciding on the value of any feedstuff.

Summary

Distiller's co-products offer beef producers an opportunity to potentially decrease their unit cost of production while maintaining similar levels of performance.

The nutritional characteristics of distiller's co-products (high energy and medium protein levels) allow these feeds to be effectively incorporated into many feeding scenarios for many types of cattle. However, use of distiller's co-products does require consideration of nutritional properties, storage, and, most importantly, economics. Careful assessments of nutrient, shipping, and storage costs are essential when deciding if distiller's co-products are economically viable alternative feeds for your operation.

Table 1. Nutrient concentrations of corn co-products expressed on a dry matter basis[a]

	CDS	*WDG*	*MDGS*	*DDG*	*DDGS*
Dry matter (DM), %	30-50	25-35	50	88-90	88-90
Crude protein (CP), %	20-30	30-35	30-35	25-35	25-32
Degradable intake protein (DIP), % of CP	50	45-53	45-53	40-50	43-53
Fat, %	9-15	8-12	8-12	8-10	8-10
Neutral detergent fiber (NDF), %	10-23	30-50	30-50	40-44	39-45
Total digestible nutrients (TDN), %	75-120	70-110	70-110	77-88	85-90
Net energy for maintenance (NEm), Mcal/lb	1.00-1.15	0.90-1.10	0.90-1.10	0.89-1.00	0.98-1.00
Net energy for gain (NEg), Mcal/lb	0.80-0.93	0.70-0.80	0.70-0.80	0.67-0.70	0.68-0.70
Calcium, %	0.03-0.17	0.02-0.03	0.02-0.03	0.11-0.20	0.17-0.26
Phosphorus, %	1.3-1.45	0.5-0.8	0.5-0.8	0.41-0.80	0.78-1.08

[a]Adapted from the National Research Council and industry publications.

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Table 2. Maximum inclusion rate of rates of co-products for different cattle types

		Co-product maximum inclusion rate (lb)			
Cattle Type	*Weight range (lb)*	*WDG*[a]	*MDGS*[a]	*DDG*[a]	*CDS*[b]
Growing calf	500 – 700	10 – 12	5.5 – 7	3 – 3.5	4 – 6
Finishing steer	900 – 1200	15 – 20	9 – 12	4.5 – 6	7.5 – 10
Cow	1200 – 1500	16 – 20	9.5 – 12	5 – 7	8 – 10

[a] Assuming maximum inclusion rate is 20% of dry matter intake; WDG, 30% DM; MDGS, 50% DM; DDG, 90% DM.
[b] Assuming maximum inclusion rate is 10% of dry matter intake; CDS, 30% DM.

Table 3. Equivalent value of co-products compared to corn on an energy (TDN) basis[a]

	Co-products ($/ton)				
Corn ($/bu)	*CDS*	*WDG*	*MDGS*	*DDG*	*DDGS*
1.50	20.09	18.26	30.44	54.79	60.27
1.60	21.43	19.48	32.47	58.44	64.29
1.70	22.77	20.70	34.50	62.09	68.30
1.80	24.11	21.92	36.53	65.75	72.32
1.90	25.45	23.13	38.56	69.40	76.34
2.00	26.79	24.35	40.58	73.05	80.36
2.10	28.13	25.57	42.61	76.70	84.38
2.20	29.46	26.79	44.64	80.36	88.39
2.30	30.80	28.00	46.67	84.01	92.41
2.40	32.14	29.22	48.70	87.66	96.43
2.50	33.48	30.44	50.73	91.31	100.45

[a] Assumptions: corn, 88% DM and 88% TDN; CDS, 30% DM and 97% TDN; WDG, 30% DM and 88% TDN; MDGS, 50% DM and 88% TDN; DDG, 90% DM and 88% TDN; and DDGS, 90% DM and 97% TDN.

Table 4. Equivalent value of co-products compared to soybean meal (SBM) on a crude protein basis[a]

Co-products ($/ton)					
SBM ($/ton)	*CDS*	*WDG*	*MDGS*	*DDG*	*DDGS*
150	26.33	33.71	56.18	101.12	94.80
160	28.09	35.96	59.93	107.87	101.12
170	29.85	38.20	63.67	114.61	107.44
180	31.60	40.45	67.42	121.35	113.76
190	33.36	42.70	71.16	128.09	120.08
200	35.11	44.94	74.91	134.83	126.40
210	36.87	47.19	78.65	141.57	132.72
220	38.62	49.44	82.40	148.31	139.04
230	40.38	51.69	86.14	155.06	145.37
240	42.13	53.93	89.89	161.80	151.69
250	43.89	56.18	93.63	168.54	158.01

[a] Assumptions: soybean meal,89% DM and 48% CP; CDS, 30% DM and 25% CP; WDG, 30% DM and 32% CP; MDGS, 50% DM and 32% CP; DDG, 90% DM and 32% CP; and DDGS, 90% DM and 30% CP.