

Feeding Coproducts of the Ethanol Industry to Beef Cattle



Greg Lardy, Extension Beef Cattle Specialist
Department of Animal and Range Sciences

Ethanol industry coproducts, such as dried distillers grains plus solubles, wet distillers grains plus solubles and condensed distillers solubles (syrup) are becoming increasingly available as the ethanol industry expands. The purpose of this publication is to provide information on the feeding value of these coproducts for beef cattle and give cattle producers guidelines for their use in beef cattle rations.

The ethanol industry in the United States is expanding rapidly; consequently, the amount of coproducts available for livestock feed also is expanding at a rapid rate. In 2007, the United States will produce the equivalent of 20 million metric tons of dried distillers grains plus solubles. That production could double during the next 18 months as new ethanol production facilities are brought into operation. North Dakota produces about 445,000 tons annually. The majority of the byproducts produced in the ethanol production process is fed to ruminant animals.

Ethanol Coproducts

Corn contains approximately 61 percent starch, 3.8 percent oil, 8 percent protein, 11.2 percent fiber and 16 percent moisture. During ethanol production, starch is converted to ethanol and the other constituents of the corn kernel become coproducts. Each bushel of corn produces 2.7 to 2.8 gallons of ethanol, 18 pounds of dried distillers grains plus solubles and 18 pounds of carbon dioxide.

Wet and Dry Distillers Grains

Figure 1 diagrams the ethanol production process in a dry milling operation. Coproducts resulting from this process can include dry distillers grains (DDG), dry distillers grains with solubles (DDGS), wet distillers grains (WDG), wet distillers grains with solubles (WDGS), modified wet distillers grains plus solubles (MWDGS) and condensed distillers solubles (CDS). Whole stillage, which is the liquid fraction remaining after ethanol production, is centrifuged to remove coarse solids and then evaporated to produce thin stillage. Thin stillage is further evaporated to produce CDS (sometimes referred to as syrup). The solids portion may be sold wet as WDG; combined with CDS and sold as WDGS; dried and sold as DDG; or combined with CDS, dried and sold as DDGS. In some plants, WDGS is partially dried to produce a product called modified wet distillers grains plus solubles.

The WDG and WDGS are approximately 30 percent dry matter (DM; 70 percent moisture), while the DDG and DDGS are approximately 90 percent DM. Modified WDGS is approximately 50 percent DM. The wet coproducts (WDG, WDGS or MWDGS) have greater energy than DDG or DDGS because some of the fermentation byproducts are volatilized during the drying process. However, protein quality does not seem to be affected by proper drying. Due to the high moisture content, transportation costs must be considered when purchasing WDG, WDGS or MWDGS.

Condensed Distillers Solubles (CDS)

This syruplike product remains after thin stillage has undergone partial evaporation. Thin stillage is the liquid (5 percent DM) product that remains following removal of wet distillers grains. Thin stillage is condensed through evaporation to produce condensed distillers solubles (23 percent to 45 percent DM). Condensed distillers solubles contain approximately 20 percent to

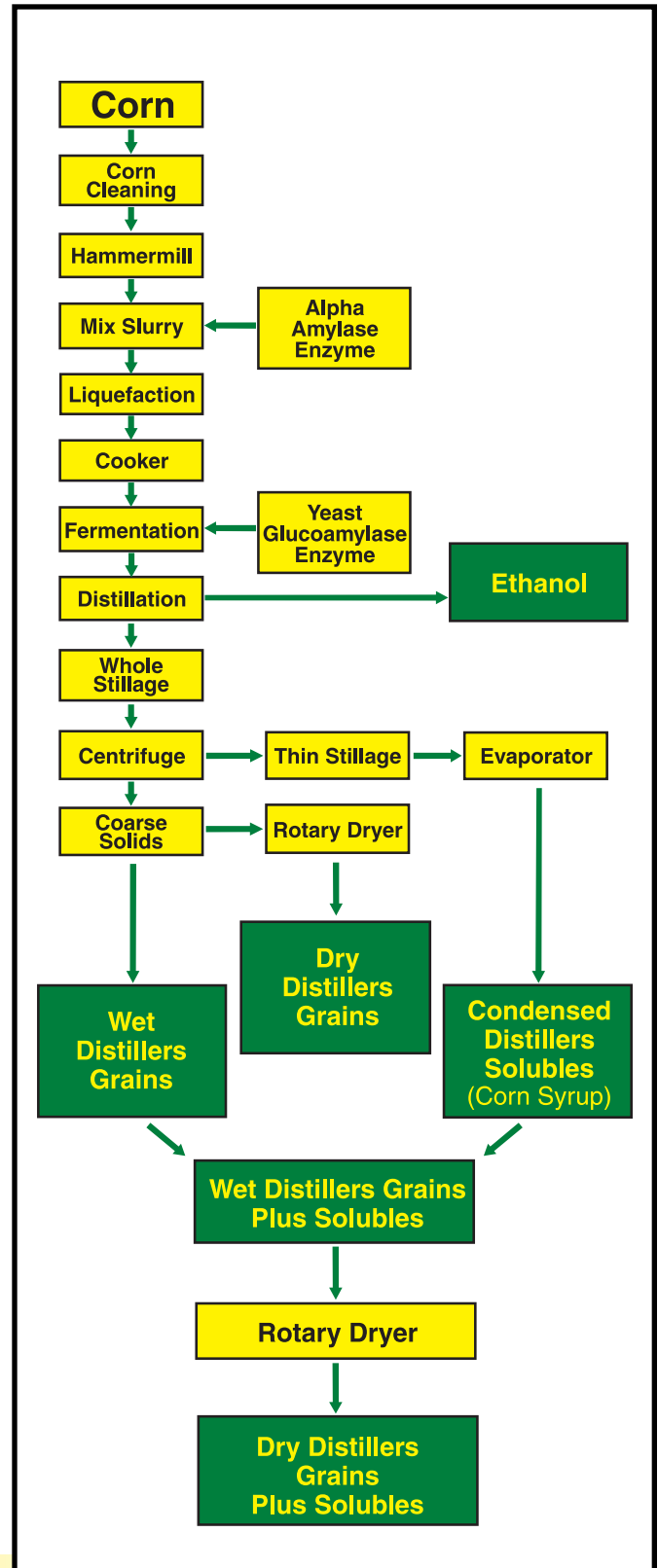


Figure 1. Ethanol and related coproducts production process diagram.

30 percent crude protein on a DM basis. Due to their liquid nature, condensed distillers solubles can be used to control dust and condition dry rations (similar to liquid molasses products). In most cases, condensed distillers solubles should be limited to 10 percent or less of the diet (DM basis; approximately 8 to 10 pounds per head on a wet basis).

Condensed distillers solubles work well as a supplement for low-quality forage diets. Producers have successfully used CDS in mixed rations with low-quality forages. The product can be highly variable, both within a plant and among plants. Laboratory analysis is recommended prior to feeding to determine nutrient content and proper levels to include in the ration. Anecdotal evidence indicates the product can be offered free choice, but it is not a recommended practice. In addition, the sulfur content of CDS can be quite high.

Nutrient Content of Ethanol Coproducts

Table 1 gives the average nutrient content for WDGS, MWDGS, DDGS and CDS. Distillers grains are relatively high in crude protein, high in fat and an excellent source of energy and protein for beef cattle. Distillers grains have a fermented aroma and are very palatable. The protein in corn distillers grains is high in escape protein (50 percent to 60 percent of the crude protein). Escape protein is not fermented in the rumen but is digested by the animal in the small intestine. Escape protein has some benefit in feeding programs where high performance is expected or where less than optimum levels of escape protein are provided in the diet.

Ethanol coproducts are high in potassium, phosphorus and other minerals. Feeders should reduce or eliminate supplemental phosphorus, potassium and sulfur when high levels of these byproducts are fed.

Table 1. Nutrient composition of ethanol coproducts.

Nutrient	Dried Distillers Grains	Dried Distillers Grains plus Solubles	Modified Wet Distillers Grains plus Solubles	Wet Distillers Grains plus Solubles	Condensed Distillers Solubles
DM, %	88 to 90	88 to 90	50	25 to 35	23 to 45
DM Basis					
TDN, %	77 to 88	85 to 90	70 to 110	70 to 110	75 to 120
NEm, Mcal/cwt	89 to 100	98 to 100	90 to 110	90 to 110	100 to 115
NEg, Mcal/cwt	67 to 70	68 to 70	70 to 80	70 to 80	80 to 93
CP, %	25 to 35	25 to 32	30 to 35	30 to 35	20 to 30
DIP, % CP	40 to 50	43 to 53	45 to 53	45 to 53	80.0
UIP, % CP	50 to 60	47 to 57	47 to 57	47 to 57	20.0
Fat, %	8 to 12	8 to 12	12 to 15	10 to 18	9 to 15
Calcium, %	0.11 to 0.20	0.10 to 0.20	0.02 to 0.03	0.02 to 0.03	0.03 to 0.17
Phosphorus, %	0.40 to 1.15	0.40 to 0.80	0.50 to 1.42	0.50 to 0.80	1.30 to 1.45
Potassium, %	0.49 to 1.08	0.87 to 1.33	0.70 to 1.00	0.50 to 1.00	1.75 to 2.25
Sulfur, %	0.46 to 0.65	0.37 to 1.12	0.38 to 1.20	0.40 to 1.20	0.37 to 0.95

Table adapted from:

- 1) Stock, et al. 1995. Average Composition of Feeds Used in Nebraska. G1048. www.ianr.unl.edu/pubs/beef/G1048.pdf
- 2) Tjardes and Wright. 2002. Feeding Corn Distiller's Co-Products to Beef Cattle. South Dakota State University. ExEx. 2036.
- 3) NRC. 2001. Nutrient Requirements of Dairy Cattle.
- 4) Iowa Renewable Fuels Association. www.iowafa.org/ethanol_coproducts.php. Accessed June 19, 2007.
- 5) Internal laboratory analysis at NDSU.

The analyses given in this publication are a range of published values and regionally available laboratory analyses. Products vary and this may not represent what a particular plant is producing at any give time.



Increased levels of calcium should be used to keep the calcium-to-phosphorus ratio in the diet at 2-to-1. Elevated levels of phosphorus in these coproducts may contribute to high levels of phosphorus in the manure and increase in the amount of land required for proper nutrient management.

In areas where high-sulfate water is a problem, or when high levels of these byproducts are fed in the ration, the high sulfur levels in ethanol coproducts may create problems with polioencephalomalacia (PEM). This metabolic disease affects the neurological system. While experimental evidence for the use of increased copper and thiamine is limited, producers may want to consider elevating supplemental levels of copper and thiamine if diets high in ethanol coproducts will be fed for extended periods of time.

The type and nutrient content of coproducts produced by ethanol plants will vary. Routine sampling and laboratory analysis is recommended to effectively use these coproducts. Moisture level in the wet coproducts varies; consequently, a DM (moisture) analysis is one of the most important routine analyses to conduct. Producers also may ask the plant for a recent laboratory analysis. The analyses given in this publication are a range of published values and industry laboratory analyses and

may not accurately represent what a particular plant is producing at a given point.

Samples of each load should be kept on hand for a short period following feeding. If a problem is encountered, routine analysis may be helpful in pinpointing the source of the problem.

Results from Feeding Trials

Numerous research trials have evaluated DDG, WDG, WDGS and CDS as ration ingredients for beef cattle. Based on these research trials, WDGS appears to have a greater energy value than corn. The energy content of WDGS depends on the level fed, and the source of raw material for the ethanol facility (corn vs. other cereal grains). Based on animal performance, the energy level of WDGS is typically 100 percent to 125 percent the energy level of corn on a DM basis.

Research comparing the feeding value of dry distillers grains and wet distillers grains indicates that wet distillers grains are higher in energy than dry distillers grains. Reasons for the lower energy values for dried distillers grains could include 1) inclusion of some residual ethanol and other fermentation byproducts in the wet product, 2) moisture content of the wet distillers grains, 3) a reduction in subacute acidosis when wet

distillers grains are fed or 4) heat damage during drying. Most available research indicates the energy content of dried distillers grains is equal to or slightly lower than corn.

Research with CDS and thin stillage indicates that these liquid coproducts have greater energy content than corn. Research conducted at the University of Nebraska indicates that inclusion of CDS in the diet improves ruminal fermentation by increasing the numbers of starch and lactic acid-utilizing bacteria. This suggests CDS improve animal performance by altering ruminal fermentation and enhancing starch digestion while reducing acidosis. NDSU research indicates CDS improves fiber digestion and forage intake in some situations but not in others. More research with this product is needed to determine when responses may be expected.

Feeding Recommendations

Backgrounding and Finishing Diets

Distillers grains (wet or dry; with or without solubles) can be fed at 10 percent to 15 percent of the diet (DM basis) as a source of supplemental protein in backgrounding and finishing diets. When fed at levels greater than 15 percent of the diet, distillers grains are also an energy source, replacing corn or other grains in the diet. Dried distillers grains can be fed at levels up to 40 percent the diet DM. However, in most cases, the optimum level is generally less than 30 percent. Wet distillers grains can be included in backgrounding and finishing diets at levels up to 40 percent the diet dry matter. However, at these levels, diets will contain excess protein and phosphorous, which may have manure nutrient management implications for many cattle feeders. In addition, at these levels, sulfur becomes a concern. Most research data indicates the optimum level of wet distillers grains is 25 percent to 30 percent of the diet dry matter when used in dry-rolled corn based diets.

Condensed distillers solubles can be used as a conditioning agent, source of energy or source of protein. As a conditioning agent in the ration, CDS can be included at 5 percent to 10 percent of the diet dry matter. This level will help control dust and improve palatability of dry rations and increase energy and protein content of the diet. Although generally not

included at levels above 10 percent of the diet dry matter, CDS are a good source of supplemental protein and energy in the diet.

Forage-Based Diets for Beef Cows

In forage-based diets for beef cows, distillers grains (wet or dry; with or without solubles) can be used as a source of supplemental protein and energy. The amount depends on the desired performance and nutrient content of the basal forage. In most cases, this would mean feeding up to 4 pounds of distillers grains per head per day on a DM basis.

Condensed distillers solubles can be used as a source of supplemental protein for beef cows fed low-quality hay. Mixing CDS with chopped hay is the most effective way to deliver it to the cow herd. Producers also may consider pouring it on top of hay in the feeder or other delivery mechanisms. Condensed distillers solubles also may be mixed with other dietary ingredients or supplements and delivered to the cow herd in that manner.

High variability in intake can be expected if CDS is fed separately and cattle allowed to consume it free choice. Anecdotal evidence indicates cows will consume as much as 60 pounds (as is) of CDS daily if allowed to consume it free choice.

Creep Feeds

Dried distillers grains and DDGS can be used as an ingredient in creep feeds. The flavor, aroma and nutrient characteristics of DDGS make it an excellent addition to creep feeds. Best results are obtained when DDGS are included at no more than 50 percent of the creep feed.

Other Considerations

- Ethanol coproducts contain high levels of phosphorus (P), potassium and sulfur. In some cases, the phosphorus and potassium may be needed in the diet. However, in most backgrounding and finishing diets, supplemental calcium (Ca) will be needed to maintain the optimum Ca-to-P ratio.
- High sulfur (S) levels in ethanol coproducts have been implicated in increased incidence of polioencephalomalacia (PEM or polio). Dietary levels above 0.4 percent S can be problematic. Remember that sulfur in water sources (sulfates) also contributes to the sulfur level the animal consumes. Testing of water sources to determine sulfur level is

recommended prior to feeding high levels of these byproducts.

- Be sure to work with a reputable trucking firm. Feed can become contaminated due to improper cleanout between load or handling of hazardous materials as backhauls.
- Some liquid byproducts can separate during longer term storage. Be sure to watch for signs of settling or separation. Cases of digestive upset can occur when these materials settle out or separate.

Storing Wet and Dry Distillers Grains

Wet distillers grains and WDGS will mold rapidly (approximately seven days) during the summer. Cattle feeders should plan on feeding enough to use a truckload on a weekly basis during the summer to minimize spoilage problems. During the colder winter months, spoilage develops at a much slower rate, extending the storage time. However, storage should not exceed three to four weeks unless plastic silage bags or other oxygen-limiting structures are used to limit spoilage.

Wet distillers grains and WDGS can be stored in an oxygen-limiting environment, such as plastic silage bags, as a means of prolonging storage by limiting oxygen penetration. However, filling the bags can be difficult. If bags are packed too tightly, the bags can split as the WDG or WDGS settle. Take care to not pack the bags too tightly. Holes should be patched or covered promptly to prevent spoilage. Wet distillers grains can be stored in bunker-type silos and covered with plastic; however, some spoilage should be expected with this storage method. Research conducted at the University of Illinois indicates bunker storage with a salt covering (1 pound per square foot) will result in a very acceptable storage method for MWDGS.

Dried distillers grains and DDGS can be stored in conventional grain storage structures or in flat storage, such as a Quonset. However, in some cases, bridging has occurred in conventional grain storage structures. Producers are encouraged to check with the plant for specific storage recommendations. Be sure to check the moisture content prior to storage to reduce spoilage or

bridging problems. For long-term storage, the moisture level should be below 15 percent. In addition, DDG and DDGS should be allowed to cool to ambient temperatures before it is placed in a storage structure to reduce bridging problems.

Material Handling Considerations for Liquid Coproducts

The use of liquid ingredients such as CDS will require purchase of liquid feed handling equipment if such equipment is not already in place. Most liquid handling systems can be installed with a modest equipment investment. The tanks should be housed either indoors or buried underground to prevent freezing of the liquid materials. Because some settling and separation occurs with these liquids, a recirculating or agitation pump may be necessary to reduce settling if the CDS will be stored for longer periods of time. Condensed distillers solubles should be agitated prior to adding it to the feed ration or mixer. Mix and agitate CDS thoroughly if it appears to have separated during storage.

Summary

Coproducts from the ethanol industry are useful feed ingredients for beef cattle producers. Corn distillers grains are high in energy and protein and can be used in many different types of rations. Condensed distillers solubles can be used as a source of supplemental protein, a ration conditioner and a source of energy in beef cattle diets. However, because condensed distillers solubles are a liquid, they do require the purchase of liquid handling equipment. These coproducts also can vary in nutrient content and moisture level. Routine sampling and laboratory analysis are recommended and rations should be adjusted accordingly.

Sources of Ethanol Coproducts in North Dakota

Other plants may be found in Minnesota and South Dakota, but transportation costs should be factored in before purchasing coproducts and shipping them great distances.

Sources of dried distillers grains suppliers and contact information.	
Supplier	Marketing Contact
North Dakota	
Alchem Ltd. Grafton, N.D.	Commodity Specialist Company (800) 769-1066
ADM Corn Processing Walhalla, N.D.	(701) 549-3931
Blue Flint Ethanol Underwood, N.D.	Tom Streifel (701) 442-7505 tstreifel@blueflintethanol.com
Red Trail Energy Richardton, N.D.	(701) 974-3880
US Bio - Hankinson Hankinson, N.D. (Available 2nd Quarter, 2008)	UBE Ingredients (316) 616-3500
South Dakota	
North Country Ethanol Rosholt, S.D.	(605) 537-4585
Glacial Lakes Energy Watertown, S.D.	(605) 882-8480
Heartland Grain Fuels Aberdeen, S.D.	(800) 774-6537, ext. 112
Northern Lights Ethanol Big Stone City, S.D.	Dakota Commodities (888) 327-8799
Poet Nutrition Sioux Falls, S.D.	(888) 327-8726, ext. 270
Minnesota	
DENCO, LLC Morris, Minn.	(320) 589-2931

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