6-1-2011

# Distillers Co-products for Beef Cows and Heifers

Cody Wright
*South Dakota State University*

Sara Winterholler
*South Dakota State University*

Megan Peterson
*South Dakota State University*

ExEx2078
June 2011
Animal & Range Sciences
6 pages

# Extension Extra

SDSU®
South Dakota State University / College of Agriculture & Biological Sciences / USDA

# Distillers Co-products for Beef Cows and Heifers

*Cody Wright, Extension beef specialist*
*Sara Winterholler, assistant professor*
*Megan Peterson, Extension livestock educator*

## INTRODUCTION

In recent years, the expansion of corn-based ethanol production has resulted in an abundance and variety of co-product feedstuffs. As research with distillers co-products has evolved, findings have indicated that the value of the protein and energy content of these feeds is suitable for use in beef cattle diets. In an era of volatile feed costs, these feeds can alleviate some of the burden of high grain prices. The biggest concerns in feeding these products to beef cattle are the potential for high sulfur and phosphorus concentrations, variation in nutrient composition as it changes relative to source and season, and the need for adequate storage facilities and handling equipment to avoid spoilage and loss.

## CO-PRODUCT FEEDS AND NUTRIENT CONTENT

Specific characteristics of co-product feeds are dependent upon processing method and extent of processing. Table 1 outlines the nutrient composition of common distillers co-product feeds as well as the range in variation of the nutrient composition of these feeds.

### Distillers grains

Distillers co-products are produced via the dry-milling process of ethanol production. In this processing technique, water and enzymes are added to ground corn to break down complex chains to a simple sugar. Yeast is then added to the sugar and enzyme slurry to be fermented to ethanol. Following the fermentation period,

**Table 1. Nutrient composition of dry milling co-products (dry-matter basis).**

| Nutrient | CDS[a] | | WDG[b] | | MDGS[c] | | DDG[d] | | DDGS[e] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| DM[f], % | 30 | 50 | 25 | 35 | 45 | 50 | 88 | 90 | 85.6 | 91.9 |
| CP[g], % | 20 | 30 | 30 | 35 | 30 | 35 | 25 | 35 | 26.3 | 34.0 |
| DIP[h], % | 20 | 50 | 45 | 53 | 45 | 53 | 40 | 50 | 40 | 50 |
| Fat, % | 9 | 15 | 8 | 12 | 8 | 12 | 8 | 10 | 9.2 | 12.6 |
| TDN[i], % | 75 | 120 | 70 | 110 | 70 | 110 | 77 | 88 | 85 | 90 |
| NEm[j], Mcal/lb | 1.00 | 1.15 | 0.90 | 1.10 | 0.90 | 1.10 | 0.89 | 1.00 | 0.98 | 1.00 |
| NEg[k], Mcal/lb | 0.80 | 0.93 | 0.70 | 0.80 | 0.70 | 0.80 | 0.67 | 0.70 | 0.68 | 0.70 |
| Ca, % | 0.03 | 0.17 | 0.02 | 0.03 | 0.02 | 0.03 | 0.11 | 0.20 | 0.0 | 0.13 |
| P, % | 1.30 | 1.45 | 0.50 | 0.80 | 0.50 | 0.80 | 0.41 | 0.80 | 0.68 | 1.09 |
| S, % | 0.37 | 0.95 | 0.50 | 0.70 | 0.38 | 0.70 | 0.48 | 0.82 | 0.12 | 0.82 |

*Adapted from Spiehs et al. (2002), Loy (2008) and Tjardes and Wright (2002).*

a – Condensed distillers solubles, b – Wet distillers grains, c – Modified distillers grains with solubles, d – Dry distillers grains, e – Dry distillers grains with solubles, f – Dry matter, g – Crude protein, h – Degradable intake protein (expressed as % of CP), i – Total digestible nutrients, j – Net energy for maintenance, k – Net energy for gain.

ethanol is extracted from the top of the mixture and the remaining co-products are divided into liquid and solid fractions by centrifugation. The liquid fraction is commonly referred to as thin stillage and is typically dried further and marketed as condensed distillers soluble (CDS), whereas wet distillers grains (WDG, 25–35% DM) are yielded as the solid fraction of this process. Many plants add CDS to WDG to yield wet distillers grains with solubles (WDGS, 25–35% DM), which can be partially dried to yield modified distillers grains (MDGS, 50% DM) or dried completely to produce dried distillers grains with solubles (DDGS, 88–90% DM).

Due to the potential for a large variation in the nutrient composition of these feeds and difference in dry matter content of the feeds, when feeding wet products, it is important to be cognizant of moisture levels and actual nutrient content relative to formulated values to ensure that nutrient and dry matter intake are as projected.

***Energy*** Distillers co-products provide an excellent source of supplemental energy for beef cows. Energy content in distillers is primarily from readily digestible fiber and fat, which alleviates concerns of negative associative effects when feeding with forage-based diets. It should be noted that in high-forage diets, supplemental fat (at 5% of the diet and greater) can limit forage intake and digestibility. When DDGS was fed at increasing levels, (up to 8.8 lb/day or 3.75% of total diet; 1.0 lb dietary fat from DDGS) as a supplement to low-quality forage, cow performance and reproduction were not negatively impacted. Furthermore, in a range setting, the percentage of fat from the co-products relative to total dry matter intake is typically not a large enough quantity to observe the negative effects of feeding fat to ruminants. In drylot situations, however, producers may want to utilize distillers co-products at higher inclusion rates. University of Illinois data showed that limit-feeding DDGS at 75% of the diet (15.9 lb DM), in addition to ground cornstalks, to drylotted cows had no adverse effects on cow performance or reproduction (Shike et al., 2009). Likewise, limit-feeding either WDGS + cornstalks (17 lb/hd/d) or CDS + cornstalks (17 lb/hd/d) yielded similar results for cow body condition score as compared to feeding an ad libitum forage diet (Kovarik et al., 2009).

***Protein*** Due to the nature of the protein in corn, approximately 50% of the crude protein content of distillers co-products is degradable by the rumen. The additional 50% will bypass the rumen for absorption in the small intestine. For beef cattle consuming low-quality forage diets, degradable intake protein is a key component in growth of the rumen microbial population as it relates to increasing digestibility and utilization of forage. Researchers in South Dakota demonstrated that DDGS can be fed as a replacement for sunflower meal when supplemented to beef cows grazing cornstalks (Doering-Resch et al., 2005). Similarly, a study in Oklahoma indicated that feeding equal quantities (3.4 lb/hd/d during gestation or 6 lb/hd/d during lactation) of either DDGS or a blended cottonseed meal/wheat middling supplement to cows consuming low-quality forage yielded similar results for cow body condition and reproductive performance (Winterholler et al., 2009). In the Oklahoma study, cows that were fed DDGS were marginally deficient in degradable intake protein, and when fed at the levels listed above, were apparently able to recycle an adequate amount of nitrogen back to the rumen—because performance did not suffer. However, when cows were fed a lower level of DDGS (1.7 lb/hd/d during late gestation and 3.0 lb/hd/d during early lactation) as a supplement to low-quality forage, body condition score was lowered. Because the percentage of degradable intake protein is less in distillers co-products as compared to traditional oilseed meals, researchers have tested adding urea to DDGS to raise degradable intake protein content, but additional urea was not effective at improving performance (Stalker et al., 2007). Distillers co-products can be incorporated into low-quality forage diets to meet nutritional requirements of the beef cow.

Example diets for beef cows can be found on page 3 in tables 2 and 3.

***Condensed distillers solubles*** Condensed distillers solubles have value as a supplement to low-quality forage, as they are moderately high in crude protein (20–30%; DM basis) and energy (70–120% TDN; DM basis). However, a large portion of energy in CDS is from fat (9–15%; DM basis), so feeding levels and nutrient composition should be monitored to avoid potential negative impacts of fat inclusion into high-forage diets. Research done by North Dakota State University indicated that intake and utilization of switchgrass hay was not negatively influenced by supplementing 3.5 lb/day of CDS, which represented 15% of total daily dry matter intake (Gilbery et al., 2006). University of Nebraska researchers reported that ensiling CDS with cornstalks is an effective management practice, but

**Table 2. Example diets for a 1,200-lb cow with average milk production.**

| Feed | Mid-gestation | | Late gestation | | | Early lactation | | |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H |
| | --------lb/d as-fed-------- | | | | | | | |
| Wheat straw | 21 | | 17.9 | | 16.6 | | 14.7 | |
| Brome hay | | 23.7 | | 22.5 | | 22.2 | | |
| Crested wheatgrass hay | | | | | | | | 22.3 |
| Corn silage | | | | | 4.5 | | 6.5 | |
| Distillers grains | 2.9 | 0.2 | 6.7 | 2.1 | 3.5 | 5.6 | 6.6 | 5.5 |
| Nutrient Content | --------% of diet DM -------- | | | | | | | |
| Crude protein, % | 7.5 | 7.0 | 11.4 | 8.8 | 8.8 | 10.7 | 10.7 | 13.1 |
| TDN, % | 49.3 | 55.9 | 56.3 | 58.5 | 56.4 | 60.1 | 60.1 | 59.9 |

**Table 3. Example diets for a 1,400-lb cow with average milk production.**

| Feed | Mid-gestation | | Late gestation | | | Early lactation | | |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H |
| | --------lb/d as-fed-------- | | | | | | | |
| Wheat straw | 21.9 | | 18.4 | | 16.8 | | 16.9 | |
| Brome hay | | 25.6 | | 23.5 | | 24.9 | | |
| Crested wheatgrass hay | | | | | | | | 25.2 |
| Corn silage | | | | | 6 | | 6.8 | |
| Distillers grains | 4.9 | 1.2 | 9.2 | 3.3 | 4.8 | 5.6 | 6.8 | 5.3 |
| Nutrient Content | --------% of diet DM -------- | | | | | | | |
| Crude protein, % | 8.3 | 7.1 | 12.2 | 8.9 | 9.0 | 10.3 | 10.3 | 12.6 |
| TDN, % | 49.6 | 54.6 | 56.7 | 57.3 | 56.6 | 59.4 | 59.1 | 59.1 |

around 10% more CDS must be fed to achieve similar performance to the combination of ensiling WDGS and cornstalks (Wilken et al., 2009).

## DISTILLERS CO-PRODUCTS FOR HEIFERS

The nutrient composition of distillers grains and CDS is particularly well suited to utilization in heifer development diets. As bred heifers reach their third trimester of gestation, their nutrient requirements increase exponentially. Unfortunately, for spring calving cowherds, this period of time often coincides with poor forage quality during winter months. As discussed previously, supplementing distillers co-products allows producers to provide energy, protein, and minerals to their cattle in a single feed ingredient. Research suggests that supplementing DDGS will result in similar weight gains and age at puberty, and potentially greater conception rates to artificial insemination relative to a supplement comprised of dried corn gluten feed, whole corn germ, and urea (Martin et al., 2007). While the exact mechanism underlying the increased conception rates is unclear, either undegradable intake protein or fat, or both, may be responsible. Since DDGS contain high concentrations of both undegradable intake protein and fat, DDGS are excellent additions to prepartum diets for beef heifers. South Dakota researchers determined that supplementing DDGS in late-gestation heifer diets resulted in greater body weight gain during the prepartum period and a greater pregnancy rates in the subsequent season when compared to soybean hull supplementation (Engel et al., 2008).

## FREQUENCY OF SUPPLEMENTATION

In an effort to reduce labor and fuel costs, some producers choose to supplement every other day or every third day, depending on weather and each individual's unique situation. In a University of Nebraska study, researchers evaluated supplementing WDGS either 3 days or 6 days per week to beef cows during late gestation and observed that frequency of supplementation had no impact on cow body weight or condition score (Musgrave et al., 2010).

## MINERAL CHALLENGES

Feeding distillers co-products to beef cattle may result in some unique challenges with respect to mineral nutrition. As discussed previously, distillers co-products commonly contain elevated concentrations of sulfur and phosphorus.

Excess dietary sulfur, regardless of source, can be problematic for ruminants. In the rumen, sulfur not utilized for microbial protein synthesis is reduced to sulfide. Production of sulfide results in increased concentrations of hydrogen sulfide, a neurotoxic gas that accumulates in the ruminal gas cap. Although the specific mechanism(s) of inhalation or ingestion are uncertain, hydrogen sulfide enters the blood stream. At high-enough concentrations, hydrogen sulfide can lead to a commonly fatal condition known as sulfur-induced polioencephalomalacia. High sulfur concentrations in distillers co-products can be particularly problematic for cattle consuming high-sulfur water commonly found throughout the Upper Great Plains. To prevent development of neurological disorders associated with sulfur, the National Research Council suggests a maximum dietary sulfur concentration of 0.5% for cattle consuming at least 40% roughage in their diet (NRC, 2005).

A second issue associated with elevated dietary sulfur is the antagonistic effect of sulfur on copper status. Sulfur is known to reduce copper absorption either alone or in combination with molybdenum. Consequently, as the concentration of sulfur in the diet, either from feed or water, increases, so should the copper concentration. As the sulfur concentration increases from 0.2% to 0.5%, the total dietary copper concentration should be increased from the requirement of 10 ppm to perhaps as high as 30 ppm (NRC, 1996). It may also be beneficial to provide ¼ to ½ of the supplemental copper from an organic source.

Elevated dietary phosphorus concentrations resulting from feeding distillers co-products is far easier to address than sulfur, and may actually represent an opportunity to reduce or eliminate the need for supplemental phosphorus. The primary risk associated with elevated phosphorus is urinary calculi, or "water belly." Urinary calculi can be generally be prevented by supplementing calcium to achieve a calcium:phosphorus ratio of at least 1.5:1. However, supplementing calcium to achieve ratios above 2:1 will not further reduce the risk. Phosphorus contained in distillers co-products is available to the animal, and as such, should be included as part of the total dietary phosphorus supply. In many cases, the additional phosphorus supplied by distillers co-products will offset much, if not all, of a dietary deficiency. In this case, the phosphorus concentration of the mineral supplement can be reduced dramatically, generally resulting in substantial cost savings.

## FEED DELIVERY

Regardless of the form of distillers co-product being fed, it is generally best to deliver the product in a bunk. University of Nebraska researcher's documented a feed loss of 13–20% when WDGS was fed on the ground versus a bunk, and ground feeding WDGS resulted in lower body condition scores (Musgrave et al., 2010). However, it may not always be possible to feed co-products in a bunk, particularly under range conditions. When use of a bunk is not practical, feed should be delivered on a relatively clean and dry location.

## STORAGE

### Dry distillers grains

Due to the high fat content of DDGS, pelleting is difficult. As such, most DDGS is stored in a loose form. Anecdotal evidence suggests that storage of DDGS in bins can be problematic. The DDGS tends to bridge substantially when stored in bins, making removal particularly difficult. Generally, it is best to store DDGS on the ground in commodity bays that provide protection from wind and precipitation.

### Storage of corn distillers solubles using a tank

Corn distillers solubles has a longer storage life compared to other co-products but requires storage and unloading facilities for liquid feed. When stored in a tank, a pump may be used to prevent settling by re-circulating or agitating the liquid. Storage tanks have been heated or buried underground to help prevent freezing in colder climates.

### Storage of co-products in silo bags

Excluding oxygen exposure is the key to reducing spoilage losses when storing co-products. Using silo bags results in air exclusion and lower spoilage and dry matter losses. Storage of WDGS in a silo bag under pressure (300 psi or greater) can result in the bag splitting. However, storage of WDGS without pressure results in bags that have low height and may allow air pockets to form. Using pressure and adding ground forages such as corn stalks, wheat straw, and grass hay mixed with WDGS improves bag shape. The amount of forage needed is determined by the fiber content of the forage. Grass hay is less fibrous than corn stalks and wheat straw; as a result, more is needed to mix with the co-product. Additionally, the moisture content of the mixture should be at least 50% to prevent air pockets and spoilage. Storage of CDS is similar to WDGS except more forage may need to be added. Modified distillers grains can be bagged by using pressure without adding forage (as required for WDGS), due to the lower moisture content of MDGS. Also, soy hulls and beet pulp are good feeds to use in combination with distillers co-products, because they are low in protein, fat, and phosphorus.

### Storage in bunkers

Co-products may be stored in bunkers made from concrete or round bales. Wet distillers grains with solubles and MDGS may be placed in the bunker with or without adding forage. Using straight WDGS can be challenging, as it tends to spread out once it is placed in the bunker. Modified distillers grains with solubles that is 42–50% DM can be stored without added forage, but cannot be compacted by driving equipment into the bunker. Corn distillers solubles should be mixed with ground forage, then packed and covered to reduce spoilage. A minimum of 50% corn stalks or wheat straw should be mixed with CDS. Also, covering a bunker with plastic or layering with salt helps to reduce spoilage and shrink loss.

### Storage in piles

Wet distillers grains with solubles can be piled on the ground in windrows and covered with CDS or plastic. If CDS is used, expect loss due to drying during storage. One option for storage of MDGS is to pile in a pyramid, cover it with plastic, and pour ground limestone onto the pile to make a semi-tight seal. An additional option for storing MDGS is to store it between large round bales, cover it with plastic, and place tires on top to hold it down.

### Cattle performance from stored co-products

Storage of WDGS with forages has shown mixed results for improving cattle performance after feeding from storage compared to fresh feed (Nuttelman et al., 2008; Peterson et al., 2009, Wilken et al., 2009; Nuttelman et al., 2010). The pH of WDGS after processing from the ethanol plant is around 4 to 4.5. Therefore, fermentation of WDGS mixed with wheat straw is minimal due to acidic conditions. However, in a couple of trials, there has been an improvement in palatability shown by an increase in dry matter intake for stored WDGS and wheat straw compared to fresh mixtures (Buckner et al., 2010; Nuttelman, et al., 2010). Also, studies have shown by storing WDGS and straw that digestibility of the straw has improved which leads to increased ADG and decreased F:G (Buckner et al., 2010, Wilken et al., 2009). However, other studies have shown similar cattle performance by feeding stored versus fresh feed and do not indicate that feeding quality changed during storage (Nuttelman et al., 2008; Peterson et al., 2009).

## PRICING CO-PRODUCT FEEDS

Co-product feeds are generally among the most economical sources of protein and energy available to cow-calf operations. However, because of the variability in the forms of co-products and their nutrient content, it is essential to compare them on an equivalent basis. It is also essential to consider the prices on a delivered basis.

Accurate comparisons between co-products and other feeds can be done easily using the following equations. The first step is to correct for moisture. Use equation 1 for this step.

Equation 1.

| | | | | |
|---|---|---|---|---|
| $/unit (delivered) | ÷ | % dry matter (as a decimel) | = | $/unit (dry matter basis) |

Equation 1. Example.

| | | | | |
|---|---|---|---|---|
| $100/ton (delivered) | ÷ | 0.50 (50% dry matter) | = | $200/ton (dry matter basis) |

Once the $/unit on a dry matter basis has been determined, it can be corrected for either protein (% crude protein) or energy (% TDN). This can be done by using equation 2.

Equation 2.

| | | | | |
|---|---|---|---|---|
| $/unit (dry matter basis) | ÷ | % CP or TDN (as a decimel) | = | $/unit of CP or TDN (dry matter basis) |

Equation 2. Example

| | | | | |
|---|---|---|---|---|
| $200/ton (dry matter basis) | ÷ | .30 (30% CP) | = | $/667 ton CP (dry matter basis) |

Producers simply looking for protein supplements should calculate cost per unit of crude protein. Those looking for feeds to provide primarily energy should calculate the cost per unit of TDN. The cost per unit of crude protein or TDN can be calculated for any feed, including commercial products. Once the cost per unit of crude protein or TDN is determined for each of the feed, the results can be compared to determine the most economical source of the desired nutrient. It is important to remember that these equations are only effective in determining the most economical feed ingredient. Recommended feeding levels still should be considered when formulating diets.

## LITERATURE CITED


Buckner, C. D., T. J. Klopfenstein, G. E. Erickson, W. A. Griffen, J. A, Benton. 2010. Comparing ensiled or fresh mixed wet distillers grains with solubles with straw at two inclusions in growing calf diets. MP 93. Nebraska Beef Report. Pp 42-43.

Doering-Resch, H. L., C. Wright, K. Tjardes, G. Perry, K. Bruns and B. Rops. 2005. Effectiveness of dried distiller's grain with soluble as a replacement for oilseed meal in supplements for cattle consuming poor quality forage. South Dakota Agric. Exp. Sta. Research Report. 14:68-72.

Engel, C. L., H. H. Patterson, and G. A. Perry. 2008. Effect of dried corn distillers grains plus solubles compared with soybean hulls, in late gestation heifer diets, on animal and reproductive performance. J. Anim. Sci. 86:1697-1708.

Gilbery, T. C., G. P. Lardy, S. A. Soto-Navarro, M. L. Bauer, and J. S. Caton. 2006. Effects of corn condensed distillers solubles supplementation on ruminal fermentation, digestion, and in situ disappearance in steers consuming low-quality hay. J. Anim. Sci. 84:1468-1480.

Kovarik, L. M., M. K. Luebbe, R. J. Rasby, and G. E. Erickson. 2009. Limit feeding beef cows with bunkered wet distillers grains plus soluble or distillers soluble. MP 92. Pages 11-12 in Nebraska Beef Rep. Lincoln, NE.

Martin, J. L., A. S. Cupp, R. J. Rasby, Z. C. Hall, and R. N. Funston. 2007. Utilization of dried distillers grains for developing beef heifers. J. Anim. Sci. 85:2298-2303.

Musgrave, J. A., L. A. Stalker, M. C. Stockton, and T. J. Klopfenstein. 2010. Comparison of feeding wet distillers grains in a bunk or on the ground to cattle grazing native Sandhills winter range. MP 93. Pages 17-18 in Nebraska Beef Rep. Lincoln, NE.

Nuttelman, B. L., T. J. Klopenstein, G. E. Erickson., W. A. Griffen, and M. K. Luebbe. 2008. The effects of supplementing wet distillers grains mixed with wheat straw to growing steers. MP 91. Nebraska Beef Report. Pp 29-30.

Nuttelman, B. L. W. A. Griffen, T. J. Klopfenstein, W. H. Schacht, L. A. Stalker, J. A. Musgrave, J. D. Volesky. 2010. Supplementing wet distillers grains mixed with low quality forage to grazing cow/calf pairs. MP 93. Nebraska Beef Report. Pp 19-21.

Peterson, M. M., M. K. Luebbe, R. J. Rasby, T. J. Klopfenstein, G. E. Erickson and L. M. Kovarik. 2009. Level of wet distillers grains plus solubles and solubles ensiled with wheat straw for growing steers. MP 92. Nebraska Beef Report. Pp 35-36.

Shike, D. W., D. B. Faulkner, D. F. Parrett, and W. J. Sexten. 2009. Influences of corn co-products in limit-fed rations on cow performance, lactation, nutrient output, and subsequent reproduction. Prof. Anim. Sci. 25:132-138.

Stalker, L. A., D. C. Adams, and T. J. Klopfenstein. 2007. Urea inclusion in distillers dried grains supplements. Prof. Anim. Sci. 23:390-394.

Wilken, M. F., M. K. Luebbe, G. E. Erickson, T. J. Klopfenstein and J. R. Benton. 2009. Feeding corn distillers soluble or wet distillers grains plus soluble and cornstalks to growing calves. MP 92. Nebraska Beef Report. Pp 30-32.

Winterholler, S. J., C. P. McMurphy, G. L. Mourer, and D. L. Lalman. 2009. Supplementation of dried distiller's grains with solubles to beef cows consuming low-quality forage during late gestation and early lactation. J. Anim. Sci. 87 (E-Suppl. 3):12.



South Dakota
Cooperative Extension Service
SDSU®





**EXEX2078 Access at http://pubstorage.sdstate.edu/AgBio_Publications/articles/ExEx2078.pdf**