

Chapter 14

Use of DDGS in Beef Cattle Diets

Introduction

The U.S. beef cattle industry has been a major consumer of wet and dried corn distiller's by-products for decades. As a result, there has been considerable research conducted to evaluate the feeding value of corn distiller's by-products to cattle. Most of the research is related to feeding distiller's grains to finishing beef cattle. Several excellent research summaries and feeding recommendations have been published (Erickson et al., 2005; Tjardes and Wright, 2002; Loy et al., 2005a; Loy et al., 2005b; Schingoethe, 2004). Most recently, Klopfenstein et al. (2008) published an excellent literature review including a meta-analysis of 9 experiments where various levels of wet distiller's grains with solubles were fed to feedlot cattle.

Nutrient Composition of Distiller's By-products for Beef Cattle

For more specific information on the nutrient composition and digestibility of DDGS for beef, refer to **Chapter 4 "Nutrient Composition and Digestibility of DDGS: Variability and *In Vitro* Measurement"**.

Wet and dried distiller's grains with solubles are relatively high in protein (27 to 30%), and historically have been used as a protein supplement in feedlot cattle diets (Klopfenstein et al., 2008). Most of the protein in corn DDGS is zein, which has a high rumen escape value (Little et al., 1968), and about 40% of zein is degraded in the rumen (McDonald, 1954). Although rumen escape protein has been shown to be quite variable among distillers grains sources (Aines et al., 1987), protein in dried distiller's grains has about 2.4 times greater protein value and DDGS has 1.8 times greater protein value than soybean meal.

The primary carbohydrate fraction in DDGS is NDF (neutral detergent fiber). Much of the NDF in DDGS is obtained from the pericarp (bran) portion of the corn kernel which contains about 69% NDF, and is highly (87%) and rapidly (6.2% per hour) digested (DeHaan et al., 1983). Because of the highly digestible and rapidly fermentable fiber in DDGS, it is now being used as a high energy and protein source in diets for feedlot finishing cattle. Farlin (1981) first demonstrated that wet distiller's grains with solubles (WDGS) has more energy per kg of dry matter than corn, which was later confirmed by Firkins et al. (1985) and Trenkle (1996).

The corn oil present in DDGS is also a significant contributor to its energy content. Vander Pol et al. (2007) showed that the digestibility of corn oil was 70% and oil from WDGS was 81% digestible. It appears that some of the oil in WDGS is protected from rumen hydrolysis and hydrogenation. As the level of fatty acid intake increases, fatty acid digestion decreases (Plascencia et al., 2003), which likely explains the decline in feeding value of DDGS when fed at increasing levels of the diet (**Table 1**).

Feeding DDGS to Finishing Cattle

In the U.S., much of the distiller's grains with solubles are fed wet to finishing cattle, and as a result, it has higher energy value than DDGS. However, all of the distiller's grains with solubles exported from the U.S. for use in beef cattle rations are dried. Currently, DDGS is considered to be primarily an energy source in diets for finishing cattle. Corn DDGS is very palatable and readily consumed resulting in excellent dry matter intake. Feeding WDGS results in better growth performance compared to feeding DDGS to finishing cattle (Erickson et al., 2005). Replacement of corn grain with WDGS has consistently resulted in a 15 to 25% improvement in feed conversion when 30 to 40% of corn grain is replaced with WDGS in the diet (DeHaan et al., 1982; Farlin, 1981; Firkins et al., 1985; Fanning et al., 1999; Larson et al., 1993; Trenkle, 1997a,b; Vander Pol et al., 2005a). This improvement in feed conversion is primarily due to WDGS having 120 to 150% of the energy value of corn (Erickson et al., 2005). Drying appears to reduce the energy value to 102 to 127% of the energy value of dry rolled corn in high forage diets. It appears the high energy values of WDGS and DDGS are a result of acidosis control (Erickson et al., 2005).



Buckner et al. (2007) conducted a study to evaluate the effects of feeding increasing levels of DDGS to finishing steers on growth performance and carcass characteristics (**Table 1**). The results from this study showed no effect of increasing levels of DDGS on dry matter intake, 12th rib fat depth, loin muscle area, and marbling score, but there was a quadratic effect in ADG and hot carcass weight, and a quadratic trend for gain efficiency. Feeding value increases substantially compared to corn, when DDGS is added to the diet, but declines with increasing dietary inclusion rates (**Table 1**). Klopfenstein et al. (2008) used the Buckner et al. (2007) data, along with results from 4 other experiments in their meta-analysis. Their results also showed a quadratic response to ADG when increasing levels of DDGS were fed, but observed a cubic response in G:F. Results from this meta-analysis showed that maximum ADG is achieved when including 20 to 30% DDGS in the diet, and maximum G:F is achieved at a DDGS feeding level of 10 to 20% of the diet. Klopfenstein et al.

(2008) also showed that the maximum ADG and G:F responses were achieved at higher dietary inclusion rates for WDGS compared to DDGS, and the rate of decline in feeding value with increasing feeding levels was greater for DDGS compared to WDGS.

Table 1. Growth performance and carcass characteristics when finishing steers are fed increasing levels of DDGS in the diet³.

Response criteria	0% DDGS	10% DDGS	20% DDGS	30% DDGS	40% DDGS
DMI, kg/d	9.25	9.47	9.52	9.71	9.47
ADG, kg	1.50	1.61	1.68	1.62	1.59
G:F	0.162	0.171	0.177	0.168	0.168
Feeding value ¹	100	156	146	112	109
Hot carcass wt., kg	351	362	370	364	359
12 th rib fat, cm	1.42	1.37	1.50	1.40	1.47
Loin muscle area, cm ²	80.0	80.6	82.6	81.3	81.3
Marbling score ²	533	537	559	527	525

¹Value relative to corn and calculated by difference in G:F divided by DDGS dietary inclusion rate.

²Marbling score of 400 = slight⁰, 500 = small⁰

³ adapted from Buckner et al., 2007

Leupp et al. (2009) evaluated the effects of feeding increasing levels of corn DDGS on intake, digestion, and rumen fermentation in steers fed 70% concentrate diets and that dry-rolled corn can be replaced with up to 60% DDGS in a 70% concentrate diet with no adverse effects on organic matter digestibility. However, organic matter intake was reduced when 60% DDGS was added to the diet. These researchers concluded that adding 45% DDGS to growing steer diets maximized digestion and rumen fermentation.

DDGS reduces acidosis

Feeding diets containing DDGS reduces acidosis in feedlot cattle fed high grain diets. Subacute acidosis is often a problem when finishing cattle are fed high grain diets containing a significant amount of rapidly fermentable starch. Since the starch content of DDGS is low (2 to 5%), and the fiber, protein, and fat content are high, the forage content of the diet can be reduced when feeding diets containing more than 20% of dry matter intake as DDGS. Lower quality forages can be used effectively in diets that contain greater than 20% DDGS because of its high protein content (Klopfenstein et al., 2008).

High DDGS feeding levels result in excess protein and phosphorus

When DDGS is used as an energy source and added to the diet at levels greater than 15 to 20%, excess protein and phosphorus are fed. The excess protein is used for energy that occurs through deamination of amino acids and results in urea excretion. Vander Pol et al. (2005b) showed that when finishing cattle are fed diets containing 10 or 20% DDGS of diet dry matter, there is no benefit for supplementing diets with urea, suggesting that nitrogen recycling was occurring. However, Erickson et al. (2005) suggested that to be conservative, it may be best to follow NRC (1996) guidelines for degradable intake protein supplementation when formulating

diets containing less than 20% DDGS. Feeding excess phosphorus provided by DDGS in feedlot cattle diets does not appear to have any negative effects on performance or carcass traits if adequate calcium is supplemented to the diets to maintain an acceptable Ca to P ratio.

DDGS may contain high levels of sulfur

High levels of sulfur in DDGS can be a concern for beef feedlot cattle (Lonergan et al. 2001). Ethanol plants use sulfuric acid for cleaning and to control pH during ethanol and DDGS production. As a result, sulfur content of DDGS can be highly variable and range from 0.6 to as high as 1.8%. Adequate dietary sulfur is required by microorganisms in the rumen, but too much sulfur in the diet can cause polioencephalomalacia, reduce dry matter intake, ADG, and liver copper levels. Refer to **Chapter 12 “Sulfur Concerns and Benefits in DDGS”** for a detailed summary of managing sulfur intake in ruminants.

A recent study by Neville et al. (2012) evaluated the effects of feeding an increasing concentration of DDGS (20, 40, and 60%) of the diet and corn processing method (high moisture corn vs. dry-rolled corn) on growth performance, incidence of polioencephalomalacia, and concentrations of hydrogen sulfide gas in feedlot steers. Diets ranged from 0.6 to 0.9% sulfur and were supplemented with thiamine to provide 150 mg/animal/day. Carcass-adjusted final body weight decreased linearly with increasing concentrations of DDGS in the diet but carcass adjusted gain:feed was not affected. Hot carcass weight and backfat were reduced when feeding increasing levels of DDGS resulting in decreased yield grade. Hydrogen sulfide gas increased with increasing concentration of DDGS in the diet but there were no confirmed cases of polioencephalomalacia. Corn processing method did not affect growth performance, incidence of polioencephalomalacia, or hydrogen sulfide gas concentrations in the rumen. These results, as well as those reported by Neville et al. (2010) and Schauer et al. (2008) have consistently demonstrated that S from DDGS can be fed in excess of the maximum tolerable level in both lambs and steers fed high concentrate diets. It is possible the maximum tolerable level of sulfur reported in NRC (2005) needs to be re-evaluated. These authors suggested that the source of dietary (or water soluble) sulfur may play a role in the development of clinical polioencephalomalacia and should be further investigated.

Felix et al. (2012) evaluated the effect of copper supplementation on feedlot performance, carcass characteristics, and rumen sulfur metabolism of growing cattle fed diets containing 60% DDGS. Copper supplementation did not affect rumen pH, but hydrogen sulfide gas concentration was reduced when 60% DDGS diets were supplemented with 100 mg copper/kg diet, but not for cattle fed 0 or 200 mg copper/kg of diet. Copper supplementation improved feed efficiency in cattle fed 60% DDGS diets but had minimal effects on rumen sulfur metabolism when supplemented at twice the maximum tolerable limit for beef cattle.

Feeding DDGS results in excellent beef quality and yield

Feeding diets containing DDGS does not change the quality or yield of beef carcasses, and it has no effect on the sensory and eating characteristics of beef (Erickson et al. 2005). An increasing number of studies have evaluated the quality and sensory characteristics of beef from cattle fed distiller's grains and results consistently show no negative effects on eating characteristics of beef from cattle fed high dietary levels of DDGS.

Roeber et al. (2005) evaluated color, tenderness, and sensory characteristics of beef strip loins from two experiments where wet or dry distiller's grains were fed to Holstein steers at levels up to 50% of the ration. There were no differences in tenderness, flavor, and juiciness. Similarly, Jenschke et al. (2006) showed that finishing beef cattle fed diets containing up to 50% wet distiller's grains (dry matter basis) produced steaks that were similar in tenderness, amount of connective tissue, juiciness, or off-flavor intensity. In fact, steaks from cattle fed the 0 and 10% wet distiller's grains with solubles diets were most likely to have an off-flavor compared to steaks from cattle fed the 30 and 50% wet distiller's grains with solubles diets. Gordon et al. (2002) fed diets containing 0, 15, 30, 45, 60, or 75% DDGS to finishing heifers during a 153 day finishing trial and observed that there was a small, linear improvement in tenderness of steaks from cattle fed increasing amounts of DDGS.

Koger et al. (2010) fed Angus crossbred steers diets containing 20 or 40% wet or dry distillers grains with solubles to replace all of the soybean meal and some of the cracked corn. Carcasses of steers fed distillers grains had greater fat thickness, higher yield grades than steers fed the dry-rolled corn, soybean meal, and alfalfa hay control diet. Loin muscle from steers fed DDGS had higher ultimate pH values than loins from steers fed wet distillers grains. Ground beef from steers fed distillers grains had higher α -tocopherol compared to those fed the control diet, but steers fed 40% distillers grains produced ground beef with higher TBARS (thiobarbituric acid reactive substances) as an indicator of lipid peroxidation, on day 2 of retail display than ground beef from steers fed 20% distillers grains diets. These researchers concluded that steers fed distillers grains may need to be marketed earlier than normal to avoid excess external fat, but there are no adverse or beneficial effects on the incidence of "dark cutters", retail display life of ground beef, or meat tenderness. However, beef from cattle fed distillers grains have increased polyunsaturated fatty acids which may be more susceptible to oxidative rancidity.

No differences were observed for growth performance or carcass characteristics when steers were fed 0 or 30% DDGS in the growing or finishing period (Leupp et al., 2009). Marbling and tenderness were not affected by diet, but steaks from steers fed DDGS during finishing were juicier and had more flavor. These data suggest DDGS can be included at 30% dietary DM in the growing or finishing period to partially replacing dry-rolled corn with no detrimental effects on performance, carcass characteristics, or sensory attributes. However, feeding 30% DDGS may negatively affect steak color.

Similarly, Segers et al. (2011) showed that the composition and tenderness of longissimus lumborum steaks were unaffected by feeding diets containing 25% DDGS or corn gluten feed compared to soybean meal as a protein supplement from weaning to harvest. However, similar to the effects of steak color observed by Leupp et al. (2009), trained panelists in this study also

observed differences in perceived color, but overall color was similar among steaks from differing treatment groups. No differences were found in concentration of TBARS among treatment groups, but steaks from steers fed DDGS became more discolored than steaks after 9 d of retail display and contained greater polyunsaturated fatty acids, suggesting that a numerical increase in lipid oxidation may result in reduced shelf life for meat products from cattle fed DDGS. Results from this study indicate that DDGS and corn gluten feed can be substituted for soybean meal and a portion of corn in beef cattle diets from weaning to slaughter while maintaining meat quality.

Aldai et al. (2010) compared the effects of feeding wheat versus corn DDGS to feedlot cattle on meat quality and showed that wheat DDGS had no negative effects on meat quality but corn DDGS had some positive effects on meat quality such as improved tenderness and palatability compared to beef from cattle fed the barley control diet.

Impact of feeding DDGS on *E. coli* O157:H7 shedding

In 2007, there was a dramatic increase in interest in identifying and understanding the possible reasons for the increases in *E. coli* O157:H7 in ground beef contamination in the U.S. Because of the exponential increase in ethanol and distiller's grains production during this same time period, there were some suspicions that feeding distiller's grains were



contributing to this problem. As a result, researchers began conducting studies to determine if there was a relationship between feeding distiller's grains with solubles and the increased incidence of *E. coli* O157:H7 in beef. Refer to **Chapter 16 "Is There a Connection Between Feeding DDGS and *E. coli* O157:H7 Shedding in Beef Cattle"** of this Handbook for a more detailed, comprehensive summary of research results related to the potential association of DDGS with the prevalence of fecal shedding of *E. coli* O157:H7.

In summary, research results demonstrate that there is no consistent effect of feeding DDGS on *E. coli* O157:H7 shedding in beef cattle. The response to *E. coli* O157:H7 shedding may be affected by DDGS feeding level and other dietary ingredients such as type of corn processing. Currently, there is no scientific evidence suggesting that the levels of DDGS being fed is a cause for *E. coli* O157:H7 contamination in ground beef.

Other DDGS feeding applications

Less research has been conducted related to feeding corn DDGS to other ages of cattle. However, DDGS is an excellent feed ingredient that can be effectively used to supplement energy and protein in the diet when cattle are fed low quality forages. When DDGS is added to diets containing forages low in phosphorus, the phosphorus in DDGS will be of significant value. Other potential uses of DDGS include providing it as a creep feed for calves nursing cows, a supplement for grazing cattle, and a supplement for low quality forages and crop residues that might be fed to growing calves, gestating beef cows, or developing beef heifers.

Feeding DDGS to Beef Cows

Unlike for finishing beef cattle, less research has been conducted on feeding DDGS to beef cows. Loy et al. (2005a) published an excellent summary of results from including DDGS in beef cow diets. The best applications for using DDGS in beef cow diets are in situations where 1) supplemental protein is needed (especially when feeding low quality forages) to replace corn gluten feed or soybean meal, 2) a low starch, high fiber energy source is needed to replace corn gluten feed or soy hulls, and 3) when a source of supplemental fat is needed.

DDGS as a supplemental protein source

Researchers have shown that when DDGS was supplemented to provide 0.18 kg of protein/day to beef cows grazing native winter range in Colorado, it compared favorably to alfalfa hay or cull navy beans (Smith et al., 1999). Shike et al. (2004) compared performance effects of feeding corn gluten feed or DDGS as a supplement to ground alfalfa hay to lactating Simmental cows and observed that cows fed DDGS gained more weight, but produced less milk compared to cows fed corn gluten feed. However, there were no differences between cows fed DDGS and those fed corn gluten feed on calf weights and rebreeding performance. In a subsequent study, Loy et al. (2005a) reported that researchers at the University of Illinois, compared supplementing diets for lactating Angus and Simmental cows consisting of ground corn stalks with either DDGS or corn gluten feed. Cows nursing calves were limit fed total mixed rations and there were no differences in milk production and calf weight gains between cows supplemented with DDGS or corn gluten feed.

DDGS as a supplemental energy source

Dried distiller's grains with solubles is an effective energy supplement when fed with low quality forages. Summer and Trenkle (1998) showed that DDGS and corn gluten feed were superior supplements to corn in corn stover diets, but not in the higher quality alfalfa diets. Corn stover (stalks) are low in protein, energy, and minerals, but are low in cost and readily available in major corn producing states in the U.S. When low quality forages (e.g. corn stover) are fed to gestating beef cows in good condition, feeding 1.4 to 2.3 kg of DDGS per day, during the last 1/3 of gestation will meet their protein and energy requirements (Loy et al., 2002). For beef cows fed low quality forage (e.g. corn stalks) in early lactation, supplementing with 2.7 to 3.6 kg of DDGS will meet their protein and energy requirements (Loy et al., 2002).

Radunz et al. (2010) evaluated the effects of late gestation dietary energy source (grass hay, corn, and DDGS) on pre- and post-partum cow performance pre-partum dietary energy source. When these energy sources were fed at or above daily requirements, there were no detrimental effects on pre- or post-partum cow performance, and feeding DDGS as a pre-partum dietary energy source reduced daily feed costs during gestation. Dietary energy source affected the partitioning of energy and caused changes in plasma metabolites resulting in heavier birth weights of calves from cows fed DDGS or corn during late gestation compared to those fed grass hay.

DDGS as a supplemental fat source

Supplemental fat may improve reproduction in cow herds experiencing suboptimal pregnancy rates (<90%). Loy et al. (2002) indicated that feeding supplements with similar fatty acid profiles to corn oil (found in DDGS), pregnancy rates improved. They also indicated that fat supplementation works best in feeding situations where protein and/or energy supplementation is already necessary.

Engle et al. (2008) evaluated the effects of feeding DDGS compared to soybean hulls, in late gestation heifer diets, on animal and reproductive performance. Their results showed that pre-partum diets containing DDGS, as a source of fat and undegradable intake protein, improved pregnancy rates in well-maintained, primiparous beef heifers.

Shike et al. (2009) evaluated the influence of corn co-products, in limit-fed rations on cow performance, lactation, nutrient output, and subsequent reproduction. Cows fed DDGS lost 16 kg less body weight and had 0.9 kg/d less milk production, which resulted in calves tending to have lower ADG than for cows fed corn gluten feed. In a second experiment, cows were fed 2.3 kg/d of ground cornstalks and isocaloric amounts of corn gluten feed (7.7 kg/d) or DDGS (7.2 kg/d) to meet nutrient requirements. In contrast to the first experiment, cows fed DDGS tended to lose more weight than those fed corn gluten feed, but there were no differences in milk production or calf ADG. There were no differences in reproductive performance in both experiments, suggesting that DDGS and corn gluten meal can be included up to 75% of a limit-fed diet, but the higher fat content of DDGS compared with corn gluten feed did not improve reproduction.

Replacement Heifers

Very little research has been conducted on feeding DDGS to replacement heifers. However, based upon numerous studies for finishing cattle, DDGS would be an excellent source of by-pass protein and energy for developing replacement heifers. In a study by MacDonald and Klopfenstein (2004), replacement heifers grazing brome grass were supplemented with 0, 0.45, 0.90, 1.36, or 1.81 kg DDGS per day. These researchers observed that for each 0.45 kg of DDGS supplemented, forage consumption decreased by 0.78 kg per day and average daily gain increased by 27 g per day.

Loy et al. (2003) evaluated the value of supplementing the ration, daily or three times per week, with DDGS in high forage diets for growing crossbred heifers. These heifers were provided *ad libitum* access to grass hay (8.7% crude protein) and were supplemented with DDGS or dry

rolled corn. The supplements were fed at two levels and offered either daily or three times per week in equal proportions. Heifers that were supplemented daily ate more hay, gained faster, but had lower feed conversion than heifers supplemented three times per week. At both the low and high supplementation levels, heifers fed DDGS had better ADG and feed conversion than heifers fed the dry rolled corn (**Table 2**). These authors calculated that the net energy value of DDGS was 27% higher than for corn grain.

Table 2. Growth performance of growing heifers fed native grass hay and supplemented with either corn or DDGS for at two supplementation levels.

		Low ^a	High ^b
ADG, kg/d	Corn	0.37	0.71
	DDGS	0.45	0.86
DM Intake/ADG	Corn	15.9	9.8
	DDGS	12.8	8.0

^aLow = supplement fed at 0.21% of body weight

^bHigh = supplement fed at 0.81% of body weight

Source: Loy et al. (2003).

In a subsequent study, Loy et al. (2004) fed cannulated heifers either no supplement, DDGS supplemented daily, DDGS supplemented alternating days, dry rolled corn daily, or dry rolled corn supplemented on alternating days. As expected, hay intake was higher for heifers that received no supplementation compared to those that did, but there were no differences in feed intake between heifers supplemented with DDGS or corn. Heifers that were supplemented with DDGS had higher rates of rumen fiber disappearance than heifers supplemented with corn.

Loy et al. (2008) determined the effect of supplement type, concentration, and frequency of feeding on feed intake and growth performance to estimate the energy value of DDGS in a high-forage diet for growing heifers. These researchers showed that supplementing DDGS or dry-rolled corn to the ration 3 times weekly decreased forage intake and body weight gain compared with daily supplementation, but feeding DDGS improved body weight gain and gain:feed compared with dry-rolled corn. They calculated the TDN of DDGS to be 118 to 130% the value of corn when fed as a supplement to a grass-hay diet for growing heifers.

Stalker et al. (2004) conducted two experiments to evaluate the effects of supplemental degradable protein requirements when DDGS was fed as an energy source in forage based diets. Diets were formulated to be deficient (> 100 g/day) in degradable protein, but contained excess metabolizable protein. Results of this study showed that adding urea to meet the degradable protein intake requirement is not necessary when DDGS is used as an energy source in forage based diets.

Morris et al. (2005) showed that when individually fed heifers were provided high or low quality forage diets with supplementation of either 0, 0.68, 1.36, 2.04, or 2.72 kg DDGS per day, forage intake decreased and average daily gain increased. These results suggest that DDGS can be an effective forage supplement to increase growth at times when availability of forage may be limited.

Islas and Soto-Navarro (2011) evaluated the effects of supplementation of DDGS on forage intake and digestion of beef heifers grazing small-grain pasture and showed that supplementation with DDGS up to 0.6% of body with increased fat intake, as well as fat and NDF digestibility with no adverse effects on intake, digestibility, and characteristics of ruminal fermentation. Based on these results, DDGS can be successfully used as a supplement to increase lipid intake without negatively affecting forage intake or digestibility in cattle grazing small grains pasture.

Conclusions

Corn DDGS is an excellent energy and protein source for beef cattle in all phases of production. It can be effectively used as an energy source and be fed up to 40% of ration dry matter intake for finishing cattle with excellent growth performance and carcass and meat quality. However, at this high feeding rate excess protein and phosphorus will be fed.

Although controversial, there is no consistent effect of feeding DDGS on *E. coli* O157:H7 shedding in beef cattle. Dietary level of DDGS and type of corn processing (dry rolled corn, high moisture corn, steam flaked corn) may affect the response to *E. coli* O157:H7 shedding. Currently, there is no scientific evidence suggesting that the level of DDGS fed is a cause for *E. coli* O157:H7 contamination in ground beef,

The best applications for using DDGS in beef cow diets are in situations where 1) supplemental protein is needed (especially when feeding low quality forages) to replace corn gluten feed or soybean meal, 2) a low starch, high fiber energy source is needed to replace corn gluten feed or soy hulls, and 3) when a source of supplemental fat is needed.

For growing heifers, adding urea to meet the degradable protein intake requirement is not necessary when DDGS is used as an energy source in forage based diets. DDGS can be an effective forage supplement to increase growth at times when availability of forage may be limited, and DDGS has 18 to 30% higher TDN value than dry-rolled corn for developing heifers.

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