Distillers' Grains for Cows: Boon or Bust?

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The United States', and especially Iowa's, ethanol industry has increased dramatically resulting in millions of tons of the distillers grains co-products produced annually. For every one bushel of corn processed there is a yield of about 2.8 gallons of ethanol and about 17 to 18 pounds of distillers' grains (DGs) on a dry basis. Although one cannot be certain of future markets, it appears that large quantities of DGs will be available to the livestock industry for many years. Will the DGs remain the same? No, as we speak many ethanol plants are changing their manufacturing techniques, extracting corn oil and other by-products, which change the nutrient content and density of the DGs.

Corn is nearly two-thirds starch. The starch is the primary substrate for alcohol fermentation. At the dry milling plants corn is ground, then the starch is converted to sugar by enzymes before the yeast can ferment the sugar to produce ethanol and carbon dioxide. Ethanol is collected, followed by a centrifuge separation of the DGs from the solubles. The solubles can then be condensed to about 30% dry matter (condensed distillers solubles or CDS, sometimes called Syrup). The wet co-products can then be used locally or dried down to distillers dried grains (DDG) or distillers dried grains with solubles (DDGS). While the dried distillers grains can be transported longer distances, some feeding value may be lost in the drying process and drying is expensive. Many plants combine the CDS back in with DGs to produce a product called modified distillers grains with solubles (MDGS).

Is DGs a boon or bust for the Iowa cow herd? This depends on what the herd needs from a nutritional management standpoint. Certainly the beef cow operation that does not involve a grain operation stands to benefit greatly from having DGs available for supplementation routines. Additionally, DGs can assist this type of herd in growing and developing calves and replacement heifers. Now for herds with plenty of high quality hay production and corn production, the benefits are less. However, if the operation is large it can likely take advantage of market price differences between DGs, forages, feed grains which exist throughout the year.

Use of distiller's grains in some cow-calf operations can be an advantage, especially when it comes to enhancing low quality feeds like harvested corn stalks, straws or poor quality grass hay. In these situations energy level of the forages is below nutritional requirements and, in the case of cornstalks and straw, protein supplementation is a necessity. Before looking at specifics on cow and calf rations it is important to understand the basic nutrient value of ethanol co-products.

Distillers Grains Co-products

Dried distillers grains (DDG), wet distillers' grains (WDG) and distillers grains with solubles (WDGS or DDGS) contain the remaining nutrients after the corn starch is fermented to alcohol. Therefore, the original nutrients in the corn are concentrated about three times. Wet and dried distillers' grains are higher in both protein and energy than corn gluten feed because gluten and oil remain in distillers' grains. Like corn gluten feed, dried distillers grains are a good bypass protein source for cattle.

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Distillers' solubles can be added to the distillers grains, or condensed and used as a liquid cattle feed supplement. Many ethanol plants and producers call these condensed distillers solubles (CDS) "syrup". CDS appear to be slightly higher in energy and some lower in protein in comparison to wet distillers' grains when adjusted for moisture content. Because CDS are 70% in moisture, cattle producers should use heated or underground storage tanks to prevent freezing.

Nutrient Value and Considerations

DDG, DDGS, WDG and WDGS will normally analyze with 28 to 35% crude protein and 85 to 95% total digestible nutrients (dry matter basis) or more depending upon fat level. Typically CDS on a 100% dry matter basis will have from 15 to 23% crude protein and 85 to 90% total digestible nutrients or more, again depending upon fat level in the product. Feedlot research trials have shown that DGs feed with higher energy values than corn grain, but this is dependent upon the ration inclusion rate. When lower rates were fed (5 to 10% of the ration dry matter), the energy value was close to 140% the value of corn, whereas, when higher rates were fed (over 35% dry matter) the energy value was about the same as corn. Typically when we think about it for the cow herd it is assumed to be 110-125% the energy value of corn.

Like corn gluten feed, DGs are high in soluble fiber and rumen-undegradable protein, which makes it an excellent supplement for forage based situations. The soluble fiber in DGs, which is high in energy, does not interfere with the digestibility of the fiber components in forages and hays. But be aware that DGs in part get their high energy value due to the corn oil remaining in the product after ethanol production. It is normal for fat content to be 8% to 14% and total fat concentration in a beef cow ration should probably not exceed 5 to 6% fat of the total ration dry matter.

Distillers Grains Challenges

On the negative side in some situations, distillers grains when fed at moderate to high levels can provide more phosphorous and especially sulfur in the ration than required. Recent feed analysis survey work of Midwest ethanol plants found that phosphorous ranged from .4 to 1.6% and sulfur ranged from .3 to 1.4%, therefore, mineral evaluation of rations is a key factor in successful nutrition.

Phosphorous needs for British type cows as prescribed in the 2000 edition of the Nutrient Requirements of Beef Cattle (NRC) is 13 to 24 grams per day depending upon stage of production. If 5 lbs of DDGS are fed daily containing .9% phosphorous the requirement is almost met during the calf nursing period and most certainly during the dry, pregnant stage. Additional calcium may be required to maintain a 1.4:1 calcium to phosphorus ratio. Therefore, it is important to realize that mineral supplementation programs for rations using over 4-5 lbs of DGs daily can be formulated with little to no phosphorous in them.

Sulfur content was previously mentioned as a risk factor. According to NRC, the maximum tolerable concentration for beef cow rations is .40%. When beef cow rations are formulated using DGs, sulfur concentration should be evaluated. For instance, mid to late bloom alfalfa and fescue hays have between .25% to .30% and .15% to .20% sulfur, respectively. For this type of alfalfa or fescue hay, it only takes 7 or 10 lbs daily of DDGS to reach the maximum daily sulfur intake when the DGs has .8% sulfur. Keep in mind this is only intake from the feed, some water supplies can be high in sulfates and this will add to total sulfur intake. In most nutritional management situations, protein and energy requirements are met well before these excess sulfur

levels are reached, however, some producers due to low priced DGs may push to higher feeding levels of DGs. The chart contained in table 1 show acceptable versus caution and excess levels of sulfur with average Iowa hay containing 0.20% sulfur when fed in combination with varying levels of DGs that can contain sulfur levels ranging from 0.4% to 1.4%.

Table 1. Ration Sulfur Content with Distillers Grain and Hay*

	Distillers Grains as a Percent or lbs Fed in Ration, Dry Matter basis				
% Sulfur in DGs	10% 3 lbs	20% 6 lbs	30% 9 lbs	40% 12 lbs	50% 15 lbs
0.4%	0.22%	0.24%	0.26%	0.28%	0.30%
0.6%	0.24%	0.28%	0.32%	0.36%	0.40%
0.8%	0.26%	0.32%	0.38%	0.44%	0.50%
1.0%	0.28%	0.36%	0.44%	0.52%	0.60%
1.2%	0.30%	0.40%	0.50%	0.60%	0.70%
1.4%	0.32%	0.44%	0.56%	0.68%	0.80%

*Average hay analysis is .2% S, 1994-95 summary.

Total ration sulfur does not include water intake.

Cell fill code: White-acceptable S levels, Gray-caution S levels, Black-excess S levels.

Feeding Considerations in Alternative Cow and Calf Management Systems

The number and type of rations involving DGs are nearly endless; therefore, to effectively discuss them is impractical in this paper. However, it is possible to show some as examples and briefly describe them. Because producers are interested in earlier weaning of calves and maintaining cows in more confined or limited pasture situations, rations to meet these objectives are formulated and presented in table 2. These rations range from limited hay feeding situations using harvested cornstalks and DGs to corn silage combinations to strictly harvested cornstalk and DGs combinations.

Management Considerations

Beef cattle consume wet/dried DGs and CDS readily and will compete aggressively at the feed bunk for their share. Like any high energy or protein supplement fed in limited quantities, the producer needs to think about how it is offered so all animals get their required allotment. If DGs are supplemented as a single feedstuff then one needs to be sure to allow sufficient bunk or feeding space to ensure consumption by timid cattle. On the other hand, if DGs are mixed with some other feed be sure that ingredient separation does not occur causing ration “hot spots”.

Table 2 rations address the various stages of production from 1st trimester pregnancy with no calf nursing to cows in mid lactation which would be in the early stages of pregnancy. This flexibility built into the table was intentional so producers could get an idea of how the rations change due to wide management variations from a calf weaning standpoint. Notice that as we ask more of the cow from a production standpoint (milk production and pregnancy) the more need there would be for the inclusion of distillers’ grains. For instance, in the limited hay ration examples the amount of WDG or WDGS ranges from 8 lbs in early pregnancy and no calf nursing to 30 lbs in the first two months of calf nursing. Table 2 also addresses how one would substitute CDS, DDGS or corn gluten feed for the WDGS in those rations.

Feeding the earlier weaned calf to normal calf market weight is another consideration in alternative cow management systems. As well, many operations need to develop breeding heifers. If one is utilizing DGs in cow feeding then it should also be considered in the calf and heifer feeding systems. Obviously depending on when the calves are weaned the size of the calf can have a considerable impact on how one would formulate a ration. Table 3 presents example rations for calf weight ranges from 300 to 600 lbs gaining from 2 to 2.5 lbs daily. This weight gain goal would coincide with how the calves would gain if they were still nursing their mothers. Along with these weight ranges are a number of feed combinations that can potentially be used. Table 4 contains example rations using various feedstuffs in combination with wet distiller's grains for developing breeding heifers from 500 to almost 900 lbs. It is imperative to realize these example rations have not been balanced for minerals and vitamins and close work with your nutritionist or feed company is likely in order.

Table 2. Rations formulated for 1350 lb British, Higher Milk Beef Cow in Maintenance Condition Score to Begin Calving March 20th.**

These rations are intended for budgeting purposes and need mineral and vitamin supplementation balancing.

	Dates				
	8/31 to 10/15	10/16 to 1/15	1/16 to 3/20	3/21 to 5/31	6/1 to 8/31
Ration Type	**1st Trimester Gestation**	**2nd Trimester Gestation**	**Pre-Calving**	**Early Lactation**	**Mid Lactation**
Limit fed Hay Corn Stalks Wet Distillers Grain	Hay 2 lbs, Stalks 20 lbs, WDG 8 lbs	Hay 3 lbs, Stalks 20 lbs, WDG 12 lbs	Hay 5 lbs, Stalks 20 lbs, WDG 20 lbs	Hay 7.5 lbs, Stalks 20 lbs, WDG 30 lbs	Hay 5.5 lbs, Stalks 20 lbs, WDG 22 lbs
Corn Silage Corn Stalks Wet Distillers Grain	Corn Silage 8.5 lbs, Stalks 20 lbs, WDG 5.5 lbs	Corn Silage 10 lbs, Stalks 20 lbs, WDG 6.5 lbs	Corn Silage 18 lbs, Stalks 20 lbs, WDG 11.5 lbs	Corn Silage 26 lbs, Stalks 20 lbs, WDG 17 lbs	Corn Silage 20 lbs, Stalks 20 lbs, WDG 13 lbs
Corn Stalks or Poor Quality Grass Hay, Wet Distillers Grain	Stalks/Hay 25 lbs, WDG 6 lbs	Stalks/Hay 25 lbs, WDG 10 lbs	Stalks/Hay 25 lbs, WDG 21 lbs	Stalks/Hay 25 lbs, WDG 34 lbs	Stalks/Hay 25 lbs, WDG 24 lbs
Corn Stalks or Poor Quality Grass Hay CDS (Corn needed in lactation)	Stalks/Hay 20 lbs, CDS 13 lbs	Stalks/Hay 24 lbs, CDS 13 lbs	Stalks/Hay 25 lbs, CDS 25 lbs	Stalks/Hay 25 lbs, CDS 33 lbs, Corn 4 lbs	Stalks/Hay 25 lbs, CDS 28 lbs
Good Quality Hay Corn	Hay 22 lbs, Corn 0 lbs	Hay 25 lbs, Corn 0 lbs	Hay 28 lbs, Corn 3 lbs	Hay 28 lbs, Corn 8 lbs	Hay 28 lbs, Corn 4 lbs

**Condensed distillers solubles will substitute for wet distillers grains at approximately 1.33 to 1. Dried distillers grains and dried corn gluten feed will substitute at approximately .4 to 1. For instance, if one is feeding 8 lbs of WDG, then 10.6 lbs of CDS would be needed or 3.2 lbs of DDG or dried CGF.

Table 3. Rations formulated for varying weight bull or implanted steer calves early weaned to gain 2.0 to 2.5 lbs daily.**

These rations are intended for budgeting purposes and need mineral and vitamin supplementation balancing, expect heifers to gain 10% less.

Ration Type	**Weight Range 300-350**	**Weight Range 350-400**	**Weight Range 400-450**	**Weight Range 450-500**	**Weight Range 500-550**	**Weight Range 550-600**
Grass Hay, Corn, Wet Distillers Grains	Hay 4 lbs, Corn 5 lbs, WDG 5 lbs	Hay 4 lbs, Corn 6.5 lbs, WDG 5 lbs	Hay 4.5 lbs, Corn 6.5 lbs, WDG 5.5 lbs	Hay 5 lbs, Corn 7 lbs, WDG 6 lbs	Hay 5.5 lbs, Corn 7.5 lbs, WDG 6.5 lbs	Hay 6 lbs, Corn 7.5 lbs, WDG 7 lbs
Grass Hay, Corn stalks, Wet Distillers Grains	Hay 3 lbs, Stalks 3 lbs, WDG 13 lbs	Hay 3 lbs, Stalks 3 lbs, WDG 16 lbs	Hay 3.5 lbs, Stalks 3.5 lbs, WDG 17 lbs	Hay 4 lbs, Stalks 4 lbs, WDG 18 lbs	Hay 4.5 lbs, Stalks 4.5 lbs, WDG 18 lbs	Hay 5 lbs, Stalks 5 lbs, WDG 18 lbs
Grass Hay, Corn stalks, Wet Distillers Grains, Corn	Hay 2 lbs, Stalks 2 lbs, WDG 6 lbs, Corn 5 lbs	Hay 2 lbs, Stalks 2 lbs, WDG 6.5 lbs, Corn 5.5 lbs	Hay 2 lbs, Stalks 2 lbs, WDG 7 lbs, Corn 6.5 lbs	Hay 2 lbs, Stalks 2 lbs, WDG 7.5 lbs, Corn 7 lbs	Hay 2 lbs, Stalks 2 lbs, WDG 8.5 lbs, Corn 8 lbs	Hay 2 lbs, Stalks 2 lbs, WDG 9 lbs, Corn 8.5 lbs
Grass Hay, Soyhulls, Wet Distillers Grains, Corn	Hay 3 lbs, Soyhulls 3 lbs, WDG 4 lbs, Corn 3 lbs	Hay 3 lbs, Soyhulls 3 lbs, WDG 4 lbs, Corn 4 lbs	Hay 3 lbs, Soyhulls 3 lbs, WDG 4 lbs, Corn 5 lbs	Hay 3.5 lbs, Soyhulls 3.5 lbs, WDG 4 lbs, Corn 5.5 lbs	Hay 3.5 lbs, Soyhulls 3.5 lbs, WDG 4 lbs, Corn 6.5 lbs	Hay 3.5 lbs, Soyhulls 3.5 lbs, WDG 4 lbs, Corn 7.5 lbs
Good Quality Hay, Corn and 36% All Natural Supplement	Hay 3 lbs, Corn 6 lbs, Supplmt 1.5 lbs	Hay 4 lbs, Corn 6.5 lbs, Supplmt 1.5 lbs	Hay 4 lbs, Corn 7.5 lbs, Supplmt 1.5 lbs	Hay 5 lbs, Corn 8 lbs, Supplmt 1 lbs	Hay 5 lbs, Corn 9 lbs, Supplmt 1 lbs	Hay 5.5 lbs, Corn 9.5 lbs, Supplmt 1 lbs

**Condensed distillers solubles will substitute for wet distillers grains at approximately 1.33 to 1. Dried distillers grains and dried corn gluten feed will substitute at approximately .4 to 1. For instance, if one is feeding 8 lbs of WDG, then 10.6 lbs of CDS would be needed or 3.2 lbs of DDG or dried CGF.

Table 4. Rations formulated for developing breeding heifers to gain 1.5 lbs daily.**			
	These rations are intended for budgeting purposes and need mineral and vitamin supplementation balancing.		
Ration Type	**Weight Range 525-575**	**Weight Range 675-725**	**Weight Range 825-875**
Grass Hay, Cornstalks, Wet Distillers Grains	Hay 7 lbs, Cornstalks 7 lbs, WDG 9 lbs	Hay 7.5 lbs, Cornstalks 7.5 lbs, WDG 14 lbs	Hay 8 lbs, Cornstalks 8 lbs, WDG 15 lbs
Cornstalks, Corn silage, Wet Distillers Grains	Cornstalks 9 lbs, Corn silage 10 lbs, WDG 8 lbs	Cornstalks 10 lbs, Corn silage 13 lbs, WDG 10 lbs	Cornstalks 12 lbs, Corn silage 15 lbs, WDG 10 lbs
Corn stalks, Corn, Wet Distillers Grains	Corn stalks 12 lbs, Corn 2 lbs, WDG 9 lbs	Corn stalks 15 lbs, Corn 3 lbs, WDG 10 lbs	Corn stalks 16 lbs, Corn 3.5 lbs, WDG 11 lbs
**Condensed distillers solubles will substitute for wet distillers grains at approximately 1.33 to 1. Dried distillers grains and dried corn gluten feed will substitute at approximately .4 to 1. For instance, if one is feeding 8 lbs of WDG, then 10.6 of CDS would be needed or 3.2 lbs of DDG or dried CGF.			

Feeding and Storage Management Considerations

Using wet DGs in beef cow operations can be challenging due to storage issues and managing the products in a feeding system. For instance, rations that balance off either cornstalks or poor quality hays may only require from 8 to 15 pounds of wet DGs per cow on a daily basis. For a herd of 50 cows that is only 400 to 750 lbs daily and most ethanol plants will only sell the products in 50,000 pound truck loads. A truck load can last a producer over 60 days and the dilemma is the shelf life for wet DGs without proper storage principles will be less than this, especially in warm weather. Higher storage loss results in higher feed cost per cow.

Another potential challenge is that WDGS can freeze and result in chunks ranging from softball to bowling ball in size. Experience has shown that cattle eventually consume these, but it certainly makes mixing a ration less than optimal. Using dried DGs does not present these types of problems; however, dried DGs need to be mixed with high moisture type feedstuffs to maintain mixtures and palatability. Also one does need to store the dried products in an area where losses due to wind and rain are minimized. A feed commodity shed would be preferable.

Successful storage of WDGS and MDGS is dependent upon excluding oxygen from the feedstuff. It is still unclear if there is anaerobic fermentation taking place or not. Both of these products are low in pH, therefore, if air is excluded it is unlikely that any major degree of spoilage will occur in the first six months. To date it has not been investigated whether the forages when mixed with DGs are undergoing fermentation or not. In a recent ISU demonstration where MDGS in a pyramid pile was covered with plastic, no major spoilage took place even after 211 days under cover. However, when storing MDGS in this manner it is imperative that one thinks about how much of this product can be fed in a 3 to 4 week period. Why? Because experience thus far shows that once a pile of MDGS is opened it only stays fresh for 3 to 4 weeks, so one wants it fed before it loses significant quality.

Successful storage can be a huge factor when it comes to buying these commodities. If one can purchase when prices are low, store for an extended period of time and then use when commodity prices tend to be higher; the bottom line cost of herd supplementation will be lower.

Storage experimentation and demonstration projects to date have shown that straight MDGS (50% dry matter) can be stored in silo bags and under plastic covers when in pyramid piles. But wet DGs (30-35% dry matter) can not due to high moisture content. However, Iowa and

Nebraska demonstration work has shown mixing the wet product with forages allows for successful storage in silo bags and bunker type storage structures. A summary of ISU storage demonstrations in the past three years is shown in Table 5. Typically storage loss ranges from about 8.5% to 11% with one demonstration above that due to bad silo bag management at the initiation of feeding. Cost to store has a wide range depending on methodology. Encouraging is that simple techniques like storing in pyramid piles and covering with plastic have similar storage losses to more involve storage systems involving packed silo bags.

Nebraska reported on optimum forage inclusions when storing in silo bags. On a dry basis their recommendations are as follows: grass hay – 15%, alfalfa hay – 22.5% and wheat straw – 12.5%. Ground corn stalk inclusion would likely be 12 to 15%.

Tackling storage in a bunker silo is slightly different when compared to bagging. In the ISU demonstrations, success was achieved with an 80:20 mix of WDGS:Ground Hay on an as is basis which calculated to approximately a 62:38 ratio on a dry matter basis. Nebraska reported that with larger-scale experimentation using WDGS with grass hay, 30% grass hay on a dry matter basis worked okay and required less storage space. However, they went on to indicate that 40% worked even better with larger, heavier equipment. At lower levels of hay inclusion the mixture was slick to operate implements on for packing, thus a strong suggestion that higher levels be utilized. Based on bagging results the Nebraska workers felt wheat straw would be optimal at the 25 to 32% inclusion rate in a bunker.

Table 5. Summary of ISU WDGS and MDGS storage demonstrations. Loy and Strohbehn, 2006-08.

Products stored (as is basis)	**Year**	**Storage Method**	**Storage cost/ton**	**% Total Shrink**
80% WDGS + 20% Ground Hay	2007-08	Big bale bunker, plastic sides & cover	$14.05	9.8%
80% WDGS + 20% Ground Hay	2007-08	Concrete bunker, plastic cover	Not available	10.9%
100% MDGS	2007-08	Pyramid pile, plastic covered	$4.06	9.3%
80% WDGS + 20% Ground Hay	2006-07	8 foot diameter silo bag	$20.47	9.0%
100% MDGS	2006-07	8 foot diameter silo bag	$13.28	16.7%
50% CDS + 50% Ground Hay	2006-07	Wooden side bunker, plastic cover	Not available	8.6%

Again, successful storage depends on management systems that eliminate air. Other researchers when storing wet DGs piled in a pyramid and covered with plastic have found upon opening it is

imperative to utilize the product in 3 to 4 weeks. So plan the amount stored in each pyramid pile based on how quickly you can feed it out.

Feed Cost Opportunities

When considering DGs in the operation it is dependent upon what they cost and how they compare to other feedstuffs, both home raised and those available for purchase. Several factors besides cost enter into the purchasing decision. How well does this feed fit in with the nutrition program, i.e., complementarity with other feeds? Will this feed fit into my current feeding system methodology or will there be a need for equipment changes? Is this feed easily transported? Can I purchase this feed on a consistent basis in the spot market or will I need to contract a supply? Will this feed need special storage considerations? Will this feed work with all classes of cattle in my operation?

To assist in the cost comparison process Table 6 is given. In most Iowa cases, cow herd nutrition needs energy supplementation rather than protein, but that is not always the case. Therefore, the feedstuffs are compared using cost per pound of protein and cost per pound of total digestible nutrients (TDN). Of course, an assumption of dry matter content was made so that all feeds are compared on an equal dry matter basis. But the job of price comparison is not finished with this table. One also needs to consider transportation costs, differences in storage and delivery costs to the cattle and, finally, differences in storage and feeding losses.

Often producers will ask are specific feeds priced competitively. For just over two years market prices for DGs have been tracked by the Livestock Marketing Information Center of which ISU is a member. Included in the tracking process are pricing records for plants in northeast and northwest Iowa. Because most producers look at replacing corn grain with DGs, three classes of DGs were compared to corn price on a per bushel basis. The DGs were then expressed as a percent of corn price. Figures 1-3 give the past months' price comparison for dried, wet and modified distillers' grain with solubles. As can be seen they are all on average priced less than the price of corn. For instance, DDGS averages less than 90 percent the value of corn, while WDGS averages less than 80 percent. As one might expect, there have been many occasions when the price of WDGS has been 70 percent the price of corn or lower, thus representing excellent purchase opportunities. Being prepared with storage options to handle these products is one key to lowering feed costs for cow-calf producers.

Summary

Distillers' grains are very palatable and have excellent nutritional value to the cattle industry. They can fit into many cow herd nutrition programs, however, producers need to think about how DGs complement existing on-farm feed resources, how they will be stored, is there a necessity for feeding equipment changes, can a full load be utilized in an effective manner, and will a purchase contract be necessary. Once one gets around these logistics then it is simply a matter of utilizing sound nutritional approaches when feeding DGs.

Table 6. Cost comparison of feedstuffs for protein and energy.

Sensitivity tables below give cost / lb of crude protein

Medium Quality Hay

	% Crude Protein (DM)			82
$/ton	10	12	14	16
$40.00	$0.244	$0.203	$0.174	$0.152
$70.00	$0.427	$0.356	$0.305	$0.267
$100.00	$0.610	$0.508	$0.436	$0.381
$130.00	$0.793	$0.661	$0.566	$0.495
$160.00	$0.976	$0.813	$0.697	$0.610

Corn Silage

	% Crude Protein (DM)			40
$/ton	7	8	9	10
$20.00	$0.203	$0.152	$0.122	$0.102
$30.00	$0.305	$0.229	$0.183	$0.152
$40.00	$0.407	$0.305	$0.244	$0.203
$50.00	$0.508	$0.381	$0.305	$0.254
$60.00	$0.610	$0.457	$0.366	$0.305

Corn Grain

	% Crude Protein (DM)			87
$/bushel	8	9	10	11
$2.50	$0.641	$0.570	$0.513	$0.466
$3.00	$0.770	$0.684	$0.616	$0.560
$3.50	$0.898	$0.798	$0.718	$0.653
$4.00	$1.026	$0.912	$0.821	$0.746
$4.50	$1.155	$1.026	$0.924	$0.840

Corn Wet Distillers Grains with Solubles

	% Crude Protein (DM)			40
$/ton	27	29	31	33
$30.00	$0.139	$0.129	$0.121	$0.114
$40.00	$0.185	$0.172	$0.161	$0.152
$50.00	$0.231	$0.216	$0.202	$0.189
$60.00	$0.278	$0.259	$0.242	$0.227
$70.00	$0.324	$0.302	$0.282	$0.265

Corn Gluten Feed, Dry Pelleted

	% Crude Protein (DM)			90
$/ton	17	19	21	23
$60.00	$0.196	$0.175	$0.159	$0.145
$80.00	$0.261	$0.234	$0.212	$0.193
$100.00	$0.327	$0.292	$0.265	$0.242
$120.00	$0.392	$0.351	$0.317	$0.290

Cornstalks, Baled or Stacked

	% Crude Protein (DM)			80
$/ton	3	4	5	6
$20.00	$0.417	$0.313	$0.250	$0.208
$30.00	$0.625	$0.469	$0.375	$0.313
$40.00	$0.833	$0.625	$0.500	$0.417
$50.00	$1.042	$0.781	$0.625	$0.521
$60.00	$1.250	$0.938	$0.750	$0.625

Sensitivity tables below give cost / lb of TDN

Medium Quality Hay

	%TDN (DM)			82
$/ton	50	52	54	56
$40.00	$0.049	$0.047	$0.045	$0.044
$70.00	$0.085	$0.082	$0.079	$0.076
$100.00	$0.122	$0.117	$0.113	$0.109
$130.00	$0.159	$0.152	$0.147	$0.142
$160.00	$0.195	$0.188	$0.181	$0.174

Corn Silage

	%TDN (DM)			40
$/ton	62	66	70	74
$20.00	$0.028	$0.027	$0.025	$0.024
$30.00	$0.042	$0.040	$0.038	$0.037
$40.00	$0.055	$0.053	$0.051	$0.049
$50.00	$0.069	$0.066	$0.064	$0.061
$60.00	$0.083	$0.080	$0.076	$0.073

Corn Grain

	%TDN (DM)			87
$/bushel	87	89	91	93
$2.50	$0.059	$0.058	$0.056	$0.055
$3.00	$0.071	$0.069	$0.068	$0.066
$3.50	$0.083	$0.081	$0.079	$0.077
$4.00	$0.094	$0.092	$0.090	$0.088
$4.50	$0.106	$0.104	$0.101	$0.099

Corn Wet Distillers Grains with Solubles

	%TDN (DM)			40
$/ton	86	88	90	92
$30.00	$0.044	$0.043	$0.042	$0.041
$40.00	$0.058	$0.057	$0.056	$0.054
$50.00	$0.073	$0.071	$0.069	$0.068
$60.00	$0.087	$0.085	$0.083	$0.082
$70.00	$0.102	$0.099	$0.097	$0.095

Corn Gluten Feed, Dry Pelleted

	%TDN (DM)			90
$/ton	78	80	82	84
$60.00	$0.043	$0.042	$0.041	$0.040
$80.00	$0.057	$0.056	$0.054	$0.053
$100.00	$0.071	$0.069	$0.068	$0.066
$120.00	$0.085	$0.083	$0.081	$0.079

Cornstalks, Baled or Stacked

	% Total Digestible Nutrients (DM)			80
$/ton	48	50	52	54
$20.00	$0.026	$0.025	$0.024	$0.023
$30.00	$0.039	$0.038	$0.036	$0.035
$40.00	$0.052	$0.050	$0.048	$0.046
$50.00	$0.065	$0.063	$0.060	$0.058
$60.00	$0.078	$0.075	$0.072	$0.069

Figure 1. Iowa DDGS as a Percent of Corn Price, Dry Matter Basis
Source: USDA NW_GR111 Iowa Ethanol Plants - Daily Corn & Distillers Grain Prices

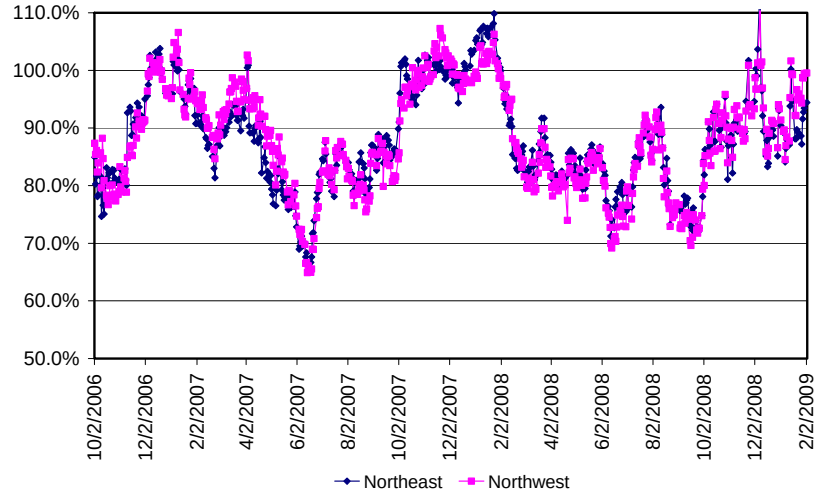

Figure 2. Iowa WDGS as a Percent of Corn Price, Dry Matter Basis
Source: USDA NW_GR111 Iowa Ethanol Plants - Daily Corn & Distillers Grain Prices

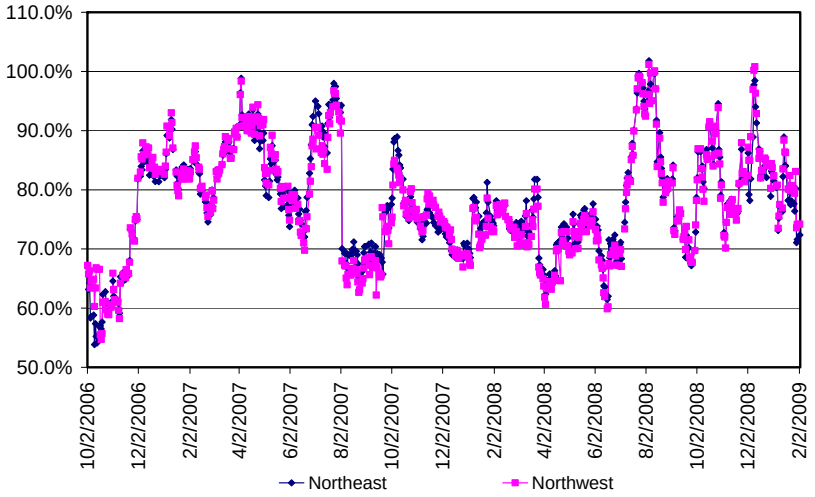

Figure 3. Iowa MDGS as a Percent of Corn Price, Dry Matter Basis
Source: USDA NW_GR111 Iowa Ethanol Plants - Daily Corn & Distillers Grain Prices