Iowa Beef Center

ETHANOL COPRODUCTS FOR BEEF CATTLE

Fifth in a series of six ethanol coproducts publications from the Iowa Beef Center

Handling and Storage Considerations

Ethanol production in the U.S. continues to provide livestock producers with feedstuffs that are an excellent source of both protein and energy and serve as a staple in the rations of beef producers in the Cornbelt and beyond. Coproduct production has totaled more than 280 million tons of dry product-equivalent since 2000. In 2013, an estimated 40% of the total distillers grains produced were marketed in either wet or modified wet form. While potential handling and storage challenges require planning in advance and potential capital upgrades for some producers, increased animal performance and economic benefits exist for those who can effectively store and feed these higher moisture feedstuffs.

Overview

Managing ethanol coproducts in a feeding system can be challenging because of both handling and storage issues. These issues are often magnified for producers in small- to medium-sized operations that feed less total product and may have infrastructure limitations, such as storage structures and handling equipment. In addition, as distillers grains are delivered in 25-ton loads, effective handling and rate of feeding relative to shelf life can also be extremely problematic. The ability for coproducts to be easily transported and stored on the farm is important to the success of utilization by producers. However, all forms of coproducts have their own unique challenges when it comes to storage and handling.

Dried Distillers Grains

While the shelf life of dried distillers grains with solubles (DDGS) typically is not in question, the ability to handle the grain can be problematic. DDGS that contain less oil or syrup and are coarser in grain size, have greater flowability than DDGS containing greater levels of solubles/syrup or are finer in composition. DDGS that are finer in consistency, and/or contain greater concentrations of solubles are prone to bridging and become difficult to remove from storage bins, railcars, and semitrailers. This problem

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can be magnified when unloading from a hopper-bottom trailer, particularly when DDGS are loaded in transport vehicles without adequate cooling time after being removed from the dryer. Once delivered, inside storage is a necessity to protect the grain from wind and rain. While a feed commodity shed is ideal, a bin or silo with a bottom unloading sweep auger often helps in the handling process. Due to the aforementioned bridging concerns, cone-bottom bins and top-unloading silos should be avoided.

Wet and Modified-wet Distillers Grains

Extended storage of high moisture distillers grains offers beef producers the ability to take advantage of seasonal oversupplies as well as capitalize on the increased energy value of these coproducts relative to their dry counterparts. However, rations that are balanced off cornstalks or poor-quality hay may require just 8-15 lb. of wet distillers grains with solubles (WDGS) per cow on an as-fed daily basis. For a typical 50-cow herd in the Cornbelt, that is only 400-750 lb. daily, but most ethanol plants will sell the products only in 50,000-lb. truckloads. Given this math, a truckload can last a producer for more than 60 days, thus the dilemma lies in the shelf life.

Without proper storage, WDGS will spoil in warm weather conditions. It is generally accepted that spoilage of WDGS in cold weather conditions begin to occur at approximately 7 days. However, during the hot summer months, spoilage will begin in as little as 2-3 days. Conversely, another potential challenge is that WDGS can freeze, resulting in chunks that can range in size from a softball to a kitchen table (Figure 1). Experience has shown that cattle eventually consume these, but it certainly makes mixing a ration more difficult.

Figure 1. Frozen chunks of wet distillers grains

Although modified wet distillers grains (MDGS) are lower in moisture content than WDGS, spoilage remains imminent if left exposed to the elements. The amount and degree of spoilage is temperature dependent. Even though spoiled WDGS has been fed to feedlot cattle at University of Nebraska—Lincoln (UNL) without incident, studies recommend separating molded product or simply preventing spoilage in the first place before feeding. Spoilage prevention is especially critical when feeding WDGS to reproducing females. In work at Iowa State University (ISU), fungi capable of producing micotoxins (*Aspergillus* and *Fusarium* spp.) readily colonized WDGS in open storage.

Obviously, higher storage losses result in higher feed costs per cow. Thus, the most effective way to store these products and maintain the economic advantage of using these products is to eliminate oxygen from the equation. Because WDGS and MDGS typically have a pH of 4.5 or lower, by definition these products do not ensile. However, storage chambers such as silage bags and bunkers do accommodate long term preservation of these products if put in storage correctly.

WDGS and MDGS: Silo Bag Storage

A plethora of field trials, demonstration projects, and experiments have focused attention on identifying both acceptable and ideal preservation methods for these higher moisture products. It has been shown that straight MDGS (~50% dry matter) can be stored in silo bags with pressure of up to 300 psi applied by the bagger (Figure 2). This allows for adequate removal of air pockets without adding too much pressure that results in bag rupture. WDGS on the other hand are not easily stored or well preserved

Figure 2. Modified distillers grains stored in silo bag

in a silo bag due to the moisture content and/or density of the product. UNL demonstrations have shown that pure WDGS can successfully be stored in a silo bag with reduced chances of splitting if no pressure is added during the bagging process. However, this may result in higher spoilage rates than desired due to presence of air pockets. This method also requires additional bagging material and land space for storage (Figures 3 and 4).

Figure 3. Bagging wet distillers grains without applying pressure with the bagger

Figure 4. Wet distillers grains bagged and sealed

Work by ISU, UNL, and Purdue University has shown that mixing wet product with forages allows successful silo bag storage. The concept is to add enough bulk fiber to the wet product to make a mixture that will withstand pressure from the bagger without a resultant splitting of the bag. While amount of forage needed to accomplish this goal will differ based on moisture of coproduct and coarseness of forage source, lower quality forages with a greater neutral detergent fiber (NDF) content such as cornstalks and straws seem to make a better mixture at lower inclusion rates. On a dry matter basis, as little as 12.5% of these forages (~5% as-fed) in the mixture has been shown to result in successful storage. For less bulky, lower fiber forages such as grass hay or more mature fresh chopped corn plants (~40%-50% dry matter), greater inclusion rates will be needed. In work completed by UNL, successful mix rates on a dry matter basis for grass hay, alfalfa hay, and wheat straw were 15%, 22.5%, and 12.5%, respectively. Resultant final mixtures ranged from 36.9%-39.5% dry matter.

WDGS and MDGS: Bunker Silo Storage

The process of storing WDGS and MDGS in a bunker silo is slightly different from using bagging. Traditional earthen and concrete bunkers, as well as temporary bunkers constructed of round bales, have proven to be effective containment and preservation devices (Figure 5). As with silo bag storage, MDGS can be stored alone in a bunker system due to their ability to remain piled; however, equipment cannot be driven across pure MDGS to pack it in the bunker. Also, MDGS has been successfully stored in pyramid shaped single load piles, covered with plastic and sealed with ground limestone for up to 8 months in ISU studies.

Figure 5. Temporary bunker made of round bales

Because of their "flowing" nature, pure WDGS storage in a bunker is challenging. Thus, mixing WDGS with forages is a necessity. UNL reported that with larger-scale experimentation using wet distillers grains with 30% grass hay on a dry matter basis was adequate and required less storage space. However, those researchers said 40% worked even better when using larger, heavier equipment. Similarly, ISU researchers successfully stored and fed mixtures of WDGS and tub-ground fescue hay at a ratio of 80:20 as-fed (60:40 dry matter basis; Figures 6 and 7). At lower levels of hay inclusion, the mixture was too slick to operate an implement for packing; thus, using higher levels is strongly suggested. Based on bagging results, the UNL researchers felt wheat straw would be optimal at the 25%-32% inclusion rate in a bunker. It is estimated that optimal cornstalk inclusion rate in a bunker would be similar to wheat straw.

Figure 6. Mixture of 20% tub ground fescue hay and 80% WDGS on as-fed basis (40:60 on dry matter basis)

Figure 7. Cows consuming WDGS and fescue hay mixture

The success of mixing and storing combinations of WDGS and forage depends on the final moisture of the product and the grind size of the forage. Based on research and demonstrations conducted to date, grinding as fine as practical and targeting at least 60% moisture (40% dry matter), will allow proper packing and oxygen exclusion for more stable long term storage. Table 1 gives approximate ratios of WDGS and forage by weight and on an as-fed basis that will result in approximately a 60% moisture end product.

Table 1. Ratio of WDGS to forage (as-fed basis) to produce a 60% moisture mixture with varying moisture contents

	Dry matter percent of WDGS		
Dry matter percent of forage	25	30	35
90	73:27	80:20	89:11
80	66:34	75:25	86:14
70	77:23	84:16	91:9

WDGS and MDGS: Alternative Mixing and Storage

Economic and mechanical constraints may limit the potential for small producers to store higher moisture ethanol coproducts using aforementioned methods. Due to these constraints, determination of a way to extend shelf life of WDGS outside of mixing with traditional mixing and/or bagging equipment is needed. When working with MDGS, researchers have successfully piled MDGS into pyramids and covered with 4mm plastic that was sealed with limestone (Figure 8).

Figure 8. Modified distillers grains stored as a pyramid under 4mm plastic and sealed with limestone

Keeping in mind that many small- to medium-sized operations may not have regular access to a mixing wagon, another option assessed at ISU involved mixing hay and WDGS in a temporary bunker system using the tires and bucket of a loader tractor (Figure 9). Samples were collected and assessed for consistency of dry matter, protein, and fiber concentrations within the final stored product. While the final mixture resulting from a mixer wagon was 2-3 times more consistent than that of the loader mixture, it was concluded that producers may find the mixture suitable for use as a supplement in wintering cow diets.

Figure 9. Mixing hay and WDGS in a temporary bunker using the bucket and tires of a loader tractor

Another option for producers who do not have mixing capabilities is the concept of layered bunker storage. With this method, higher fiber forages are layered with WDGS

at a rate that allows producers to drive over the bunker and pack the contents. While this method has been successfully demonstrated by both UNL and Purdue University, the exact amount of forage needed is not well documented, thus a "guess-and-check" technique must be utilized.

Condensed Distillers Solubles (CDS)

Not surprisingly, condensed distillers solubles (CDS; 25%-35% dry matter) may prove to be the most challenging coproduct for producers to use due to capital expenditures needed to store and handle the liquid product. In addition to storage tanks, circulation pumps may be needed to keep the solid fraction of the liquid suspended. Although it is strongly recommended that CDS be circulated for 30-45 minutes before feeding, it may be possible to handle CDS without a pump. However, this type of handling will result in increased nutritional variability of the product being fed. It should be noted that cold temperatures cause CDS to thicken, thus lead to increased management concerns during the winter months. In colder climates, including much of Iowa, buried or heated/insulated storage is advised to avoid freezing of CDS. Much like WDGS, CDS have successfully been mixed with forages and stored in bunker and silo bag systems. Optimal storage requires a rate closer to 50:50 on a dry matter basis, as a successful final mixture will likely need to approach 50% dry matter.

Another approach taken by researchers as well as producers is adding CDS to round bales of low-quality forage either before or after baling. UNL researchers have successfully added CDS to windrows of native grass hay one day prior to baling at concentrations of 16%, 20%, and 35% of final bale dry matter using a modified liquid fertilizer trailer and spray boom set-up (Warner et al., 2012). It is important to note that if using this approach, the fertilizer tank should never be used for actual fertilizer, because insufficient cleaning of fertilizer products could lead to various toxicities. Other demonstrations have explored adding CDS to round bales by setting them on end and adding CDS at the rate of 10%-20% of bale dry matter. However, this has been accomplished at various success rates, as dispersion of CDS is dependent on bale density. While this practice may improve feeding value of low quality forages, storage of bales on end will increase dry matter losses and potentially increase wastage at the feeder if inside storage is not available.

Storage Losses

For proper ration budgeting, additional considerations should be made to predict potential storage losses. ISU demonstrations have shown total storage losses of MDGS stored from 80-200 days in silo bags may total more than 16%, with 3% loss from purchase to bagging, 5% to spoilage, and 8.6% lost to unaccounted storage and/or feeding losses. When piled in a pyramid, storage losses ranged from 7%-11% with an average just above 9%. For WDGS, losses resulting from temporary bunker storage of an 80:20 WDGS:fescue hay mixture (as-fed; 60:40 dry matter basis) ranged from 9%-11%. ISU results are consistent with UNL reports of 8%-12% storage losses of WDGS mixtures in a silage bag. Rules of thumb would suggest that storage losses would be less in a silo bag system when compared to bunker storage, and that 6-10 inches of the face of the storage vessel should be fed per day to avoid spoilage. If storage and feeding loss measurements have not previously been assessed on an individual operation, cautiously assuming 10%-12% loss at onset of storage should prevent long-term feed budgets from coming up short. More information on storage and storage losses of coproducts can be found in Iowa State University Animal Industry Reports R2003 (2005), R2288-2290 (2006), and R2409-2412, 2414, and 2416-2417 (2009).

Additional Considerations

Storage demonstrations outlined above were conducted in an attempt to determine the maximum amount of high moisture coproduct that can be stored in a finite space. The resultant chemical composition of these blends is energy dense and often best used as a supplement to cow diets. Questions have arisen as to proper storage of high moisture coproducts blended with forages at a rate that allows for producers to use the final mix as a complete feed. Ideally, sampling of both feedstuffs would be done prior to mixing. However, this likely is not feasible in order to store WDGS prior to initiation of spoilage. Using book values for chemical composition of WDGS, and mixing with cornstalks in this example, a ratio around 80%-85% stalks and 15%-20% WDGS on an dry matter basis (40% WDGS and 60% stalks, as-fed) would be needed to meet wintering cow requirements for a spring calving herd (Geppert and Gunn, 2014: IBCR 200D). This mixture will be significantly bulkier than those previously discussed and significantly more challenging to pack or bag in a manner that eliminates or minimizes air pockets. Producers should consider

chopping cornstalks so the particle size is similar to silage. This enables better packing and bagging capabilities without added risk of silo bag puncture.

As with any high moisture product placed in a bag or silo, shelf life (stability) of the product once it's been re-opened should be considered. It is commonly accepted that the face of a bunker containing pure corn silage starts to spoil after 24-30 hours of exposure to air. Purdue University researchers analyzed lab scale mini-silos containing various mixtures of WDGS with corn silage, cornstalks, and wheat straw (Gunn et al., 2013). Silos were opened at 98 days, and in all instances, as the concentration of WDGS increased, so did the stability of the resultant mixture. When WDGS were mixed 50:50 (as-fed) with corn silage, shelf life was improved to approximately 100 hours. Cornstalks or wheat straw with WDGS had a shelf life of 60 and 100 hours for mixtures containing 50% and 75% WDGS (as-fed), respectively. Based on this report, even small- to-medium sized beef operations should be capable of feeding the face of the bunker or bag within the time period that precedes spoilage of the mixture.

Conclusion

The type and amount of distillers coproducts implemented into feeding scenarios will be unique to individual operations based on the class of livestock being fed and number of head on feed. Nevertheless, there are multiple storage options that may allow for small- to medium-sized producers to incorporate these coproducts when it is economically advantageous.

References

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