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Evaluation of Mixing Wet Distillers Grains with Ground Hay in a Bunker and Covering Modified Distillers Grains to Extend Storage Life—A Demonstration Project

Daryl R. Strohbehn
Iowa State University

Daniel D. Loy
Iowa State University, dloy@iastate.edu

Joe Sellers
Iowa State University, sellers@iastate.edu

Kevin Maher
Iowa State University

Dennis R. Maxwell
Iowa State University

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Abstract
The ethanol industry is rapidly expanding. As much as 40 percent of the energy cost is associated with drying of the feed co-products. Distillers grains are excellent sources of nutrients for the diets of beef cattle, but have a short shelf life. To expand the use of wet distillers feeds to more producers, longer term, low-cost storage methods are required. Studies done in 2006–2007 showed that bagging these products was an effective management practice, but was higher in cost than acceptable to some producers. Additionally, availability of bagging equipment is limited, thus encouraging other storage methodologies to be investigated.

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Daryl Strohbehn, professor
Daniel Loy, professor
Department of Animal Science
Joe Sellers, area extension livestock specialist
Kevin Maher, ag specialist
Dennis Maxwell, ag specialist

Introduction

The ethanol industry is rapidly expanding. As much as 40 percent of the energy cost is associated with drying of the feed co-products. Distillers grains are excellent sources of nutrients for the diets of beef cattle, but have a short shelf life. To expand the use of wet distillers feeds to more producers, longer term, low-cost storage methods are required. Studies done in 2006–2007 showed that bagging these products was an effective management practice, but was higher in cost than acceptable to some producers. Additionally, availability of bagging equipment is limited, thus encouraging other storage methodologies to be investigated.

Materials and Methods

Two different storage methodologies were selected for demonstration and evaluation at the McNay Research Farm, Chariton, Iowa. The first was a large round bale bunker type of storage methodology with a farmer-friendly mixture of WDGS with solubles and ground hay. The second storage methodology was covered ground piles of MDGS with solubles. Delivery of 102.25 tons of WDGS in four walking bed semi loads (Picture 1) took place on September 26 and 27, 2007 and three walking bed semi loads of MDGS were delivered (Picture 2) on October 9, 2007.

Mixed WDGS and Hay in a Bunker. The storage procedure for this product was an 80:20 mix on an as-fed basis using 102.25 tons of WDGS and 26.8 tons of ground hay mixed via a loader tractor and packed into a large round bale bunker system. A base of packed limestone was under the bunker, which was constructed using 20, 6-ft large round bales (Picture 3). These large round bales were covered with 4 mm plastic to assist in excluding air from getting into the packed mixture, thus aiding in the prevention of spoilage.

Prior to arrival of the first load of WDGS, all of the hay was ground. To assist in getting the correct combination of 80 percent WDGS and 20 percent ground hay, the custom tub grinder was asked to create four piles of hay approximating 12,500 lb, which when incorporated with a 25 ton load of WDGS would arrive at the 80:20 ratio of WDGS to ground hay. Before the first WDGS load arrived, a layer of hay was spread in the bunker. After unloading the WDGS, additional ground hay was incorporated via the loader tractor. Mixing of the WDGS and ground hay was done by working the products back and forth with the front wheel assist loader tractor. The spinning of the wheels and the loader bucket accomplished the mixing process. Typically it took between one and one and one half hours per load of WDGS for the mixing and packing of the product into the bunker (Picture 4). The amount of time required to mix and pack a load of WDGS and hay improved with operator experience. After the four loads of WDGS were mixed and packed into the bunker, the end product was

covered with 6 mm plastic and then weighted down with ground limestone (Pictures 5 and 6).

Table 1 contains the average analysis of the WDGS and ground hay prior to mixing and then the average for the mixed WDGS/Hay product after it was stored in the bunker. An important aspect to note from the analysis is that the percent calcium was escalated from the two raw ingredients to the mixed product after storage. This was likely due to the ground limestone that served to hold down the plastic covering.

Piled Modified Distillers Grains with Solubles. The second source of distillers grains was MDGS with solubles that was stored in piles. Three loads ranging in size from 48,300 to 52,420 lb had delivery temperatures ranging from 113^{o} to 134^{o}F.

Storage of the MDGS was on the ground with approximately 1 to 2 in. of packed crushed limestone and then covered with 4 mm black plastic. As shown in Picture 9 each load of MDGS was piled into a pyramid with a loader tractor prior to covering with plastic. Each pyramid was covered with plastic and then ground limestone was carefully poured onto the plastic and the weight of that created a semi-tight seal with the ground, thus preventing air from entering the plastic dome (Picture 10). During the storage period no problems were incurred with rodents or other animals tearing into the plastic, however, producers have reported this as a potential problem.

Analysis of random samples at MDGS delivery showed the loads averaged 51.1 percent dry matter, 26.0 percent crude protein, and 91.8 percent TDN (Table 3).

Results and Discussion

Extreme ice/snow conditions and electrical power outages at the McNay Research Farm delayed the initiation of cattle feeding trials, thus the opening of the bunker occurred on January 3, 2008 or 98 days after mixing and packing into the bunker (Pictures 7 and 8). The last feeding day was June 3, 2008, which was 250 days after mixing and packing. On average this mixed product remained stable throughout the feeding period. Periodical analysis from late January through late April averaged 55.17 percent moisture and protein remained at 22.09 percent compared with 22.46 percent at the time of placement into the bunker.

A total of 129.05 tons of mixed product were stored in the large bale bunker (Table 2). On an as moisture basis, the product mix was 79.2 percent WDGS and 20.8 percent tub ground hay, which on a dry matter basis makes it 59.4 percent WDGS, and 40.6 percent hay. Complete feeding records were maintained and total feed taken from the bunker and offered was accumulated during the feed out. Any feed determined to be spoiled, or not fit for cattle consumption, was piled as discard and weighed. As shown in Table 2 the total shrink and unaccounted disappearance was 9.83 percent on an as-fed basis, and when calculated, 9.95 percent on a dry matter basis.

Again because of extreme ice and snow conditions at the McNay Research Farm there was a delay in the start of feeding the MDGS as a supplement in both lactating fall calving cows and pregnant spring calving cows. Throughout the winter and spring, ice, snow, and then muddy conditions influenced feeding conditions. Despite this, the first covered ground pile of MDGS was opened on January 2, 2008, 85 days after delivery and storage (Pictures 11 and 12). It was fed to lactating fall calving cows (Picture 13),

pregnant spring calving bred heifers, and mature spring calving cows. Two loads or piles of the MDGS were fed from early January through mid-February, but then extreme muddy field conditions prevented the use of the remaining third load until early May. Visual observations showed that it stored very well in the plastic covered piles—virtually no spoilage occurred and there was no discard. As Picture 14 shows, even the load uncovered on May 7 had excellent quality. In two places under the plastic there were 2 to 4 in. of surface spoilage and some small surface spots of green mold development (1 to 3 in. in diameter). No discard was experienced in the last load that had been under plastic cover for 211 days. The MDGS was mixed in an as-fed ratio of 85 percent MDGS and 15 percent ground hay and then offered as a supplement to cows either being grazed on cornstalks or being limit fed large round bales of hay. Palatability of this mix was excellent and the cows readily consumed it without hesitation.

As cattle were fed out of the MDGS piles, all feedings were weighed and recorded, thus allowing for the calculation of storage shrinkage. As Table 4 indicates, shrinkage of the MDGS in each load had a narrow range of 7.2 to 11.3 percent with an average loss of 9.28 percent for the 75.32 tons delivered to the farm.

Compilation of Storage Costs

Any time feed is stored, costs are incurred; distillers grains are no exception to this rule. Table 5 shows the accumulated costs on a cash versus non-cash cost basis. Estimated purchase cost delivered to the McNay Research Farm for the WDGS was $60/ton, while MDGS, because it is drier, was higher at $90/ton. Items included in evaluating total cost of the stored product include hay additions, tub grinding, storage site preparation, plastic coverings, labor to store the products, and tractor costs including fuel. Farm labor and tractor cost were considered to be non-cash costs. MDGS appears to be much higher from a total cost standpoint, but if one puts the two products on a 100 percent dry matter basis, MDGS costs $208.39/ton and WDGS + hay costs $203.01/ton. Keep in mind the MDGS is higher in protein and energy content, thus on a nutrient basis it is slightly lower cost.

An important consideration to keep in mind is the added cost to store these products is quite different. Piling the MDGS on the packed limestone and covering with plastic only cost $4.06/ton, while putting the WDGS + hay mix into the bunker cost $16.53/ton. Additionally, the amount of labor necessary to accomplish these two different practices is considerable. However, it needs to be remembered there is no way one can store WDGS in this cover pile manner, therefore, it is necessary to make dry forage additions, thus allowing it to be stored for extended periods of time. The other advantage of the mixed WDGS with forages is that it enhances the nutritional value of poor quality forages and makes a palatable extender for this wet byproduct. But this added cost reinforces the idea that WDGS needs to be purchased at a discount due to the added cost of transporting the extra moisture plus the added costs of storing in this correct manner.

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Table 1. Analysis of wet distillers grains and ground hay used at ISU McNay Research Farm prior to and at placement into bunker (100% dry matter basis).

Item	Wet distillers grain*	Ground hay	Mixed product into bunker
Dry matter, %	33.49	87.33	45.21
Moisture, %	66.51	12.67	54.79
Crude protein, %	28.49	9.27	22.46
ADF, %	13.49	42.78	30.40
NDF, %	21.02	64.10	40.20
Fat, %	11.31	---------	7.56
Ash, %	6.19	---------	
Calcium, %	.04	.49	1.94
Phosphorus, %	.88	.22	.57
Magnesium, %	.33	.21	.27
Potassium, %	1.10	1.57	1.40
Sulfur, %	.71	.20	.50
TDN, %	87.67**	55.57***	na
NEm, Mcal/cwt	98.57**	52.74***	na
NEg, Mcal/cwt	67.75**	27.29***	na
NEl, Mcal/cwt	92.17**	56.50***	na

*Average of four samples going into storage.
**Determined by OARDC.
***Determined by ADF.
na = not available.

Table 2. Summary of mixing and bunker storage of WDGS with tub ground hay.

	As is basis, lb	% of total	Dry matter basis, lb
Purchased wet DG	204,500	79.2	68,487
Custom tub ground hay	53,592	20.8	46,802
Total	**258,092**		**115,289**
		Bunker stored mixed product fed	
148 day heifer trial	175,326	67.93	79,265
Spring calving cows	57,400	22.24	25,951
Total fed	**232,726**	**90.17**	**105,216**
		% WDGS/Hay mix shrink	
Discarded spoiled mix	10,400	4.03	4,702
Unaccounted for shrink	14,966	5.80	6,766
Total shrink	**25,366**	**9.83**	**11,468**

Table 3. Analysis of modified distillers grains used at the ISU McNay Farm (100% dry matter basis).

Item	Modified distillers grain*
Dry matter, %	51.13
Moisture, %	48.87
Crude protein, %	26.04
ADF, %	8.60
NDF, %	21.68
Fat, %	14.87
Ash, %	6.18
Calcium, %	.04
Phosphorus, %	1.08
Magnesium, %	.40
Potassium, %	1.40
Sulfur, %	.85
Manganese, ppm	21
Zinc, ppm	76
Copper, ppm	6
Iron, ppm	115
Sodium, %	.34
Chloride, %	.20
TDN, %	91.82**
NEm, Mcal/cwt	104.06**
NEg, Mcal/cwt	72.35**
NEl, Mcal/cwt	96.80**

*Average of three samples going into storage.
**Determined by OARDC.

Table 4. Summary of storing and feeding modified distillers grains with solubles.

	Lb
MDGS into plastic covered piles, total purchased	150,640
Load 1 purchase	48,300
Load 2 purchase	49,920
Load 3 purchase	52,420
Amount fed from plastic covered piles, total fed	136,658
Fed from load 1	43,717
Fed from load 2	44,295
Fed from load 3	48,646
Total % shrink	9.28
% shrink: load 1	9.49
% shrink: load 2	11.27
% shrink: load 3	7.20

Table 5. Analysis of cost for bunker and plastic covered piles of distillers grains with and without shrink accounting.

	Modified DGS		Wet DGS + Hay	
	Per ton	Total	Per ton	Total
Purchased distillers grains		150,640		204,500
Hay additions				53,592
Total		150,640		258,092
Cash costs				
Delivered cost distillers grains	$90.00	$6,778.80	$60.00	$6,135.00
Hay – poor quality @ $30/bale			$6.23	$803.88
Tub grind poor quality hay			$2.48	$320.00
Labor for storage site preparation MDGS-2 hrs WDGS-4 hrs	.027 hrs	2 hrs	.031 hrs	4 hrs
Labor for tub grinding hay			.031 hrs	4 hrs
Labor to cover storage site	.020 hrs	1.5 hrs	.039 hrs	5 hrs
Labor to pack bunker			.054 hrs	7 hours
Large hay bales for bunker sides-20 bales poor quality			$4.65	$600
Ground limestone WDGS-18 tons MDGS-7 tons	$.93	$70.00	$1.39	$180.00
Amount and cost of plastic MDGS-1 roll of 50 ft × 100 ft WDGS-1 roll of 50 ft × 100 ft and 2 rolls of 10 ft × 50 ft	$1.86	$140.00	$1.30	$168.00
Cost of fuel: 1 or 2 – 85 hp tractors (.044 gal/hp/hr** and $3.20/gal	$0.48	$35.90	$1.95	$251.33
Total cash cost	$92.76	$7,024.50	$78.00	$8,458.21
Total cash cost accounting for shrink	$102.25	$7,743.06	$86.50	$9,380.29
Non-cash costs				
Cost farm crew labor ($15/hr)	$.70	$52.50	$2.32	$300.00
Cost of 2-85 hp tractors	$.60	$45.00	$2.44	$315.00
Total non-cash cost	$1.30	$97.50	$4.76	$615.00
Total non-cash cost accounting for shrink	$4.30	$107.47	$5.28	$682.05
Total all costs	$94.06	$7,122.00	$82.76	$9,073.21
Total all costs accounting for shrink	$106.55	$7,850.53	$91.78	$10,162.34

**ISU Ag and Biosystems Engineering fuel estimate.

Picture 1. Delivery of wet distillers grains.

Picture 2. Delivery of modified distillers grains.

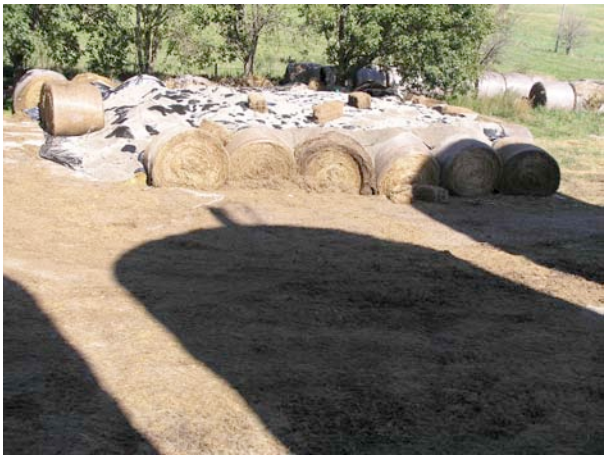
Picture 3. Large round bale bunker with plastic lining on limestone.

Picture 4. Mixing WDGS and ground hay in bunker.

Picture 7. Wet DG-Hay mix 1/11/08.

Picture 5. WDGS + Hay packed in bunker prior to covering.

Picture 8. Wet DG-Hay mix closeup.



Picture 6. Plastic covered WDGS + Hay bunker.

Picture 9. Piling MDGS prior to covering.

Picture 10. Sealing down plastic with ground limestone.

Picture 13. Lactating cows fed MDGS-hay mix ration.

Picture 11. Opening MDGS pile 1/2/08.

Picture 14. Last MDGS load opened May 7, 2008.

Picture 12. MDGS pile 1/11/08 after 9 days feeding.