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Impact of Distillers Grains Moisture and Inclusion Level on Greenhouse Gas Emissions in the Corn-Ethanol-Livestock Life Cycle

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Summary

Updated meta-analysis of cattle performance equations were incorporated into the Biofuel Energy Systems Simulator (BESS) to more accurately evaluate the greenhouse gas (GHG) benefit of corn ethanol relative to gasoline. Partial drying or complete drying of wet distillers grains (DGS) reduces the feeding value of DGS for cattle and increases ethanol GHG emissions. Feeding wet DGS provides the optimum GHG benefit relative to gasoline, with associated ethanol emissions being 40% of gasoline. Ethanol production with dried DGS results in about 60% of the GHG emissions of gasoline when dry DGS is fed to feedlot cattle, dairy cows, and finishing swine.

Introduction

The Biofuel Energy Systems Simulator (BESS; *www.bess.unl.edu*) was developed to compare ethanol produced from the corn-ethanol-livestock life cycle to gasoline as a combustible motor fuel. A discussion of energy and associated GHG emissions associated with corn production, ethanol plant operation, and livestock response to DGS feeding parameters of BESS have been published (*2010 Nebraska Beef Cattle Report*, pp. 56-57).

The corn and protein replacement value of DGS is moisture level, dietary inclusion level, and livestock type dependent. Previous University of Nebraska–Lincoln research has evaluated feeding wet DGS (WDGS; 68% moisture), modified DGS (MDGS; 54% moisture), and dried DGS (DDGS; 10% moisture) to feedlot cattle. The DGS products all contained greater feeding value than corn, but feeding value decreases as moisture level decreases and as inclusion level increases for feedlot cattle. Dairy and finishing swine research does not indicate a feeding value of DGS greater than the corn and soybean meal replaced in diets. Therefore, there is a direct replacement of corn and soybean meal (lb for lb of DM) when DGS is fed to these animal classes.

Previous cattle performance equations of the BESS model were developed, with initial studies feeding wet, modified, and dry DGS to feedlot cattle. Several trials have been completed since the BESS model was developed. Meta-analysis equations developed from these larger databases will improve the accuracy of predicted BESS outcomes.

Therefore, an updated evaluation of the impact of distiller grains (DGS) moisture and inclusion level on GHG emissions from the corn-ethanol-livestock life cycle on ethanol relative to gasoline was conducted.

Procedure

The methodology for meta-analysis of pen mean observations to develop cattle performance equations when fed WDGS have been published elsewhere in this publication *(2011 Nebraska Beef Cattle Report,* pp. 40-41). This methodology was utilized to revise cattle performance equations when fed MDGS and DDGS. Modified DGS equations were developed from four UNL feedlot trials representing 85 pens and 680 steers (*2008 Nebraska Beef Cattle Report*, pp. 36-38; *2008 Nebraska Beef Cattle Report*, pp. 53-56; *2009 Nebraska Beef Cattle Report*, pp. 43-46; *2011 Nebraska Beef Cattle Report,* pp. 50-52). Dried DGS equations were developed from four UNL feedlot trials representing 66 pens and 581 steers (*1994 Nebraska Beef Cattle Report*, pp. 38-40; *2006 Nebraska Beef Cattle Report*, pp. 57-58; *2011 Nebraska Beef Cattle Report,* pp. 50-52; *2011 Nebraska Beef Cattle Report,* pp. 62-64).

These equations were incorporated into BESS to evaluate the impact of feeding WDGS, MDGS, and DDGS to feedlot cattle and dairy cattle on the GHG emissions of ethanol compared to gasoline. The feeding of DDGS to finishing swine also was evaluated.

Results

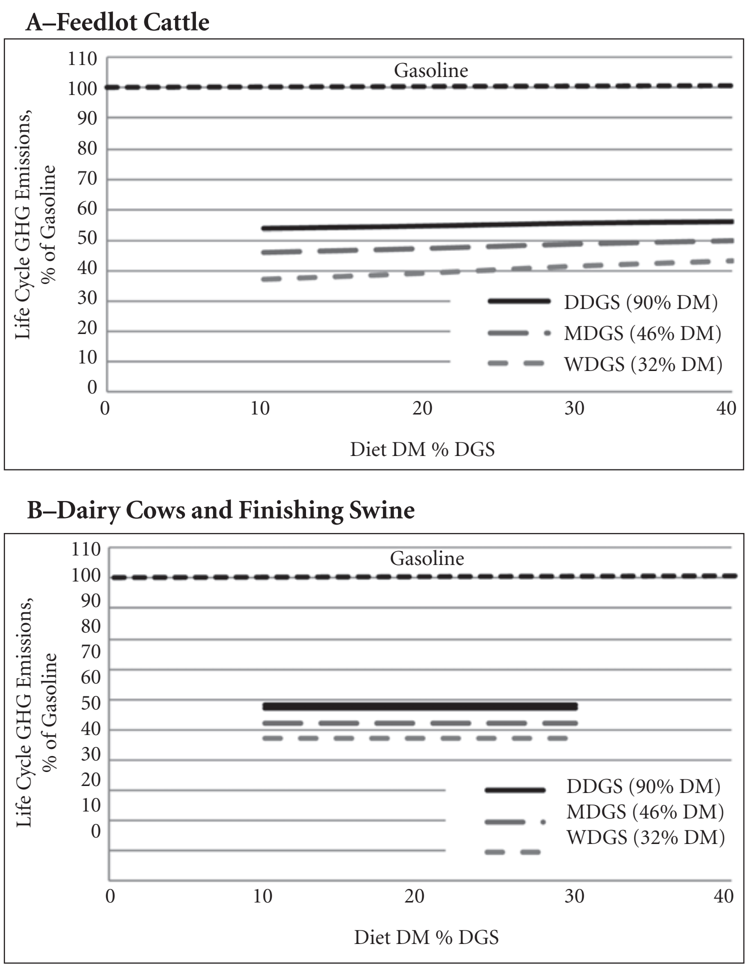
Meta-analysis of feedlot steer performance when fed DGS at different moistures and inclusion levels are presented in Table 1. The MDGS and DDGS values have been scaled to the WDGS 0% DGS intercepts so that performance of the different moisture products may be directly compared. The feeding value of WDGS was 143% to 130% of the corn replaced in the diet from 20% to 40% of diet DM. Using the same approach, the feeding value of MDGS was 124% to 117%, and 112% for DDGS. These data indicate a similar relationship of the different moisture DGS products as a study where all three DGS moistures were fed in the same trial *(2011 Nebraska Beef Cattle Report*, pp. 50-52)

Corn ethanol GHG emissions were less than 60% of gasoline (97.7 $gC0_2e/MJ$) for all scenarios analyzed (Figures 1A and 1B). Feeding WDGS to feedlot cattle provided optimum ethanol GHG emissions relative to gasoline, with 38% to 43% of gasoline GHG emissions for 10% to 40% of diet DM as WDGS, respectively. Ethanol GHG emissions, when MDGS was fed to feedlot cattle, were intermediate of WDGS and DDGS and were 46%

Table 1. Finishing steer performance when fed different dietary inclusions of corn wet distillers grains plus solubles (WDGS), modified distillers grains plus solubles (MDGS), or dried distillers grains plus solubles (DDGS) replacing dry-rolled and high-moisture corn.

DGS Inclusion[1]:	0DGS	10DGS	20DGS	30DGS	40DGS	Lin[2]	Quad[2]
WDGS							
DMI, lb/day	23.0	23.3	23.3	23.0	22.4	0.01	< 0.01
ADG, lb	3.53	3.77	3.90	3.93	3.87	< 0.01	< 0.01
F:G	6.47	6.16	5.96	5.83	5.78	< 0.01	< 0.01
Feeding value, %[3]		150	143	136	130		
MDGS							
DMI, lb/day	23.0	23.8	24.1	24.0	23.4	0.95	< 0.01
ADG, lb	3.53	3.77	3.90	3.92	3.83	< 0.01	< 0.01
F:G	6.47	6.29	6.17	6.10	6.07	< 0.01	0.05
Feeding value, %[3]		128	124	120	117		
DDGS							
DMI, lb/day	23.0	24.0	24.6	24.9	24.9	< 0.01	0.03
ADG, lb	3.53	3.66	3.78	3.91	4.03	< 0.01	0.50
F:G	6.47	6.39	6.32	6.25	6.18	< 0.01	0.45
Feeding value, %[3]		112	112	112	112		

[1]Dietary treatment levels (DM basis) of distillers grains plus solubles (DGS), 0DGS = 0% DGS, 10DGS = 10% DGS, 20DGS = 20% DGS, 30DGS = 30% DGS, 40DGS = 40% DGS.
[2]Estimation equation linear and quadratic term t-statistic for variable of interest response to DGS level.
[3]Percent of corn feeding value, calculated from predicted F:G relative to 0WDGS F:G, divided by DGS inclusion.



Figures 1A and 1B. Comparison of greenhouse gas (GHG) emissions from ethanol to gasoline when accounting for distillers grains moisture, level of dietary inclusion, and livestock class fed.

to 50% and 54% to 56% of gasoline, respectively, for MDGS and DDGS. Ethanol GHG emissions were less beneficial when DDGS was fed instead of MDGS, and both DDGS and MDGS were less beneficial than WDGS for both beef and dairy. Greenhouse gas emissions of ethanol were similar when DDGS was fed to beef, dairy, and swine.

Ethanol plant energy use and associated GHG emissions are related to the moisture level of DGS produced. All ethanol plants produce WDGS. Some plants choose to remove moisture from WDGS to form DDGS. Ethanol plants producing DDGS require 1.7 times as much energy as ethanol plants producing WDGS. The amount of energy required to haul DGS to feedlots and within feedlots also is dependent on DGS moisture content.

The expanded cattle performance calculations included in this analysis further validate that feeding WDGS to feedlot cattle is the optimum feed use of DGS based on feeding performance and GHG emissions. Partial drying (MDGS) or complete drying (DDGS) of DGS reduces the environmental GHG benefit of corn ethanol relative to gasoline. These benefits are due to ethanol plants not having to use as much energy to run DGS dryers in the plants, and improved feedlot cattle performance when DGS is fed in the wet form instead of drier forms.

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