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Edited by

Joe L. Outlaw

Agricultural and Food Policy Center
Texas A&M University
College Station, TX

James A. Duffield

Office of Energy Policy and New Uses
US Department of Agriculture
Washington, DC

David P. Ernstes

Agricultural and Food Policy Center
Texas A&M University
College Station, TX

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Biofuel Production Based on Dairy Consumption of DDGS and Soybean Meal in Wisconsin

Jennifer L. Brinker, Douglas J. Reinemann, Louis E. Armentano, T. Randall Fortenbery and Michel A. Wattiaux[1]

Introduction

Federal renewable fuel standards require 6.8 billion gallons (gal) of our nation's transportation fuels be renewable by 2010 and 7.5 billion gal of our transportation fuels be renewable by 2012. US renewable fuel production is expected to exceed this requirement. Wisconsin's Declaration of Energy Independence initiative proposes the state consume 25% of its transportation fuels as renewable by 2025. Corn and soybean production is expected to increase as demand for corn grain and soybeans increase to meet biofuel production standards.

The major dairy feed crops grown in Wisconsin are corn (for grain and for silage), soybeans and alfalfa. These feed crops allow, in part, for the production of a statewide average of about 23 kilograms (kg) /day (51 pounds (lb)/day) of milk by the state's 1.2 million dairy cows (Wisconsin Agricultural Statistics Service, 2005). Both soybean and corn crops are feedstocks for biofuel production. Dedicating all of the corn grown for grain in the state to ethanol production (which could produce 30% of the energy consumed as gasoline in Wisconsin) and all of the soybeans currently grown in the state to biodiesel production (which could replace at least 8.8% of the diesel fuel energy consumed in the state) would yield a biofuel supply equal to about 23% of the total annual energy currently consumed as petroleum diesel and gasoline in the state. The production of ethanol from corn yields a feed byproduct, dried distillers grains with solubles (DDGS). Soy oil, which is used for biodiesel production, is produced along with soybean meal (SBM). This paper presents various scenarios of rationing dairy feed in order to maximize the use of SBM and DDGS. It is assumed that all the dairy cows in the state would be fed rations which maximize DDGS and/or soybean meal. The feed scenarios considered were analyzed in terms of energy inputs and outputs and the economic costs of the rations were also considered.

Impacts of Maximizing DDGS or SBM in Wisconsin Dairy Rations on Ethanol and Biodiesel Production

The amount of DDGS that can be included in dairy rations varies according to nutritionist recommendations. This paper recommends feeding a maximum of 20% of the daily dry matter intake (DMI) per cow as distillers grains. Most dairy nutitionists have come to the concensus that of a maximum DMI of 20% DDGS can be used in feeding dairy cattle. Some dairy nutritionists recommend a more conservative maximum of 10% DDGS DMI/day due to DDGS's polyunsaturated fatty acid content (PUFA) concentration (LongView Animal Nutrition Center, 2005). Dairy nutritionists recommend feeding levels based on consideration of how individual DDGS nutrient profiles will influence the ration, especially the balance of essential amino acids and PUFA.

Maximizing the DDGS content in Wisconsin dairy rations to 20% daily DMI/cow would require the production of about 2.22 billion liters (L) (586 million gal) of ethanol annually. Utilizing DDGS as 10% daily DMI for Wisconsin's dairy herd would require the production of 1.07 billion L (282 million gal) of ethanol each year. The production of 2.22 billion L (586 million gal) or 1.07 billion L (282 million gal) of ethanol, produced to meet the annual input of 20% and 10% DDGS DMI for all Wisconsin dairy cows, has the energy equivalent of about 1.50 billion L (396 million gal) and 719 million L (190 million gal) of petroleum gasoline, respectively. This has the potential to replace from 7.61% to 15.9% of the state's gasoline consumption (Wisconsin Department of Administration, 2005). It should be noted that comparing fuel efficiency on an energy content basis and not engine performance underestimates the actual petroleum fuel replacement of ethanol and biodiesel.

Maximizing annual SBM consumption for Wisconsin's dairy herd requires 824 million kg (1.82 billion lb) of SBM.

[1] Brinker, formerly Hermans, is with GDS Associates, Inc., Madison, Wisconsin. Reinemann is a professor of biological systems engineering; Armentano is a professor of dairy science; Fortenbery is an professor of agricultural economics and the Renk Chair of Agribusiness and director of the Renk Agribusiness Institute; and Wattiaux is an assistant professor of dairy science; respectively, at the University of Wisconsin-Madison.

Table 1: Biofuel Production Based on the Combined Use of SBM and DDGS in Dairy Rations.

DDGS and SBM Use (%DMI of Each DDGS and SBM)	SBM DMI/Year for WI's 1.2 Million Dairy Cows (million kg)	Annual Biodiesel Production Coproduced to Meet Annual SBM Consumption (million liters)	DDGS DMI/Year for WI's 1.2 Million Dairy Cows (million kg)	Annual Ethanol Production Coproduced to Meet Annual DDGS Consumption (million liters)
4%	329	85.7	329	400
6%	525	137	526	639
10%	819	214	819	996

Table 2: Possible Petroleum Fuel Displacement in Wisconsin from Utilizing both DDGS and SBM from Ethanol and Soy Biodiesel Production.

Ration Name	DDGS Use in Ration (%DMI)	SBM Use in Ration (%DMI)	Annual Gasoline Displacement by Ethanol, Based on Fuel Energy Content (million liters)	Annual Gasoline Displacement by Ethanol, Based on Fuel Energy Content (% of gasoline used in WI in 2005)	Annual Petroleum Diesel Displacement by Biodiesel, Based on Fuel Energy Content (million liters)	Annual Petroleum Diesel Displacement by Biodiesel, Based on Fuel Energy Content (% of diesel used in WI in 2005)	Total Annual Petroleum Displacement by Ethanol and Soy Biodiesel Coproduced for Dairy Rations (% of BTU's consumed as gasoline and diesel fuel in 2005)
DDGS and SBM B	4%	4%	269	2.9	76.3	1.9	2.3
DDGS and SBM A	6%	6%	439	4.6	122	3.1	3.8
DDGS and SBM C	10%	10%	673	7.1	190	4.8	5.9

Producing this amount of SBM yields enough oil to allow for the production of about 264 million L (69.7 million gal) of biodiesel. This amount of biodiesel could replace, considering fuel efficiency and not engine performance, 235 million L (62.0 million gal), or about 6.0% of petroleum diesel used in the state in 2005 (Wisconsin Department of Administration, 2005).

Maximizing both SBM and DDGS in the same ration was also considered. The use of SBM in a dairy diet limits the use of DDGS because both feeds concentrate the crude protein content of rations. Therefore, when maximizing both SBM and DDGS in dairy diets, they are considered in the same proportion. Three proportions of DDGS and SBM use in dairy rations were modeled according to nutrient requirements when considering three different forage ratios. Three model diets were considered with the following DDGS and SBM contents: using both 4% DDGS DMI and 4% SBM DMI in one diet, a combination of 6% DDGS DMI with 6% SBM DMI in a second diet and 10% DDGS DMI with 10% SBM DMI in a third diet. Model diets, along with the respective ethanol or biodiesel coproduction needed to meet DDGS and SBM needs, are presented in Table 1. The amount of gasoline and petroleum diesel that could be replaced by corn ethanol and soy biodiesel, based on fuel energy content, is given in Table 2.

The use of DDGS and soybean meal are maximized in model dairy rations to meet typical DMI and milk production for the average Wisconsin dairy cow. Diets were formulated to keep crude protein (CP) as approximately 17% of DMI. Excess CP is both costly and leads to more nitrogen (and possibly more phosphorus (P) as CP supplements tend to have higher P than the cows diet needs to be) in manure as excess

Table 3: Ration Composition of Model Diets (% DMI).

Ration Name[a]	Alfalfa Haylage	Corn Silage	Corn Grain	Tallow	DDGS	SBM	Vitamin Premix	Limestone
Baseline A	29%	36%	21%	1%	0%	11%	1%	1%
Baseline B	49%	16%	26%	1%	0%	6%	1%	1%
Baseline C	16%	49%	18%	1%	0%	14%	1%	1%
10% DDGS A	38%	29%	18%	0%	10%	3%	1%	1%
10% DDGS B	48%	17%	20%	0%	10%	0%	2%	2%
10% DDGS C	18%	48%	12%	0%	10%	8%	2%	2%
20% DDGS A	37%	28%	15%	0%	20%	0%	1%	1%
DDGS and SBM A	35%	28%	20%	0%	6%	6%	2%	2%
DDGS and SBM B	47%	16%	27%	0%	4%	4%	1%	1%
DDGS and SBM C	15%	46%	16%	0%	10%	10%	2%	2%

[a]Diets were formulated according to NRC recommendations (National Research Council, 2001); University of WI-Madison dairy nutritionist recommendations (Wattiaux and Armentano, personal communication, 2007); and crude protein content. A, B, C represent potential variations in forage composition.

Table 4: Prices Considered When Calculated Costs of Model Rations.

Feed	Price as Fed ($/ton)	Price as Dry Matter ($/ton)	Source of Price
Alfalfa Haylage	$129.92	$129.92	Average price prime grade large bale (Barnett, 2007)
Corn Silage	$22.80	$22.80	Price of corn/bushel (Economic Research Service, 2002-2007) x 10 (Lauer and Undersander, 2004)
Corn Grain	$81.43	$84.82	Economic Research Service, 2002-2007
Tallow	$460.00	$460.00	Agricultural Marketing Service, 2007 based on $20.00/cwt
Vitamin Premix	$540.00	$540.00	Howard and Shaver, 1997 based on $27.00/cwt
Limestone	$140.00	$140.00	Howard and Shaver, 1997 based on $7.00/cwt
SBM	$192.75	$215.36	Average price from 1999-2007 in Decatur, Illinois (Economic Research Service, August 2005)
DDGS	$89.07	$99.84	Average price from 1999-2007 in Lawrenceburg, Indiana (Economic Research Service, August 2005)

Note: cwt = hundredweight or 100 pounds.

protein is simply excreted. Various protein supplements may be available to a producer depending on location. SBM is currently the protein supplement most often used in Wisconsin dairy rations and this paper considers how producers may wish to retain SBM while adding DDGS as DDGS becomes more readily available. Ration components of model diets are given in Table 3.

Using Feed Prices to Compare Cost of Dairy Rations

The Economic Research Service (ERS) provides historical reports of feed commodity prices. Data from these reports were used to find the average prices and the fluctuation in these commodity prices, for SBM, distillers dried grain and corn grain using available data from the ERS (Economic Research Service, 2005). The prices of feeds are presented in Table 3. These prices were used along with the intake consumed of each feed for the rations evaluated in this study. The cost per day of each ration are given in Table 4.

Considering the data presented in Table 4, it appears that maximizing use of DDGS or SBM in dairy diets is usually a cheaper alternative to the baseline diets. One should also consider if the production of ethanol continues to increase, the quantity of DDGS will rise and its price may likely decrease.

Summary and Conclusion

Opportunities exist for integration of corn ethanol production and soy biodiesel production and the dairy industry.

Table 5: Approximate Cost of Rations Modeled in this Study.

Baseline Diets[a]	Cost ration/day	Difference Compared to Baseline
Baseline A	$2.08	
Baseline B	$2.39	
Baseline C	$1.87	
Diets Containg DDGS		
20% DDGS A	$2.08	$0.00
10% DDGS A	$2.34	$0.26
10% DDGS B	$2.23	-$0.16
10% DDGS C	$1.76	-$0.11
Diets Maximizing SBM and DDGS		
DDGS and SBM A	$2.13	$0.05
DDGS and SBM B	$2.20	-$0.19
DDGS and SBM C	$1.81	-$0.06

[a]Costs also represent maximization of SBM in the ration.

Soybean crushing yields SBM, which is used to supplement crude protein intake of dairy cows, as well as soy oil which can be processed into biodiesel. DDGS, a byproduct of ethanol production may also contribute to dairy feed rations as a protein supplement. Considering the nutritional needs of the Wisconsin dairy herd, biofuel production based on the maximum amounts of DDGS and SBM allowable in dairy rations was calculated. It was found that about 15.9% of the energy consumed as gasoline in Wisconsin could be replaced by ethanol based on maximum allowable DDGS consumption by the state's 1.2 million dairy cows. Biodiesel production, based on maximum allowable SBM consumption by the state's dairy herd, could replace approximately 6.0% of the petroleum diesel used in Wisconsin. Maximizing both SBM and DDGS, each at 10% DMI in the state's dairy rations would allow for 5.9% of the on-road petroleum gasoline and diesel to be replaced by biofuels. Considering the SBM and DDGS allowable in the state's dairy herd rations, the amount of biofuel that can be co-produced is less than Wisconsin's Declaration of Energy Independence goal of 25% by 2025. The state may need to optimize SBM and DDGS use within the state for other livestock rations, such as beef, swine and poultry, to retain the feed byproducts of biofuel production needed to meet this goal. Rations that maximize the use of DDGS and/or SBM are typically less expensive, based on historic market prices, than diets that do not maximize these components.

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