Biofuels, Food & Feed Tradeoffs

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Farm Foundation

USDA's Office of Energy Policy and New Uses

Rural Development

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

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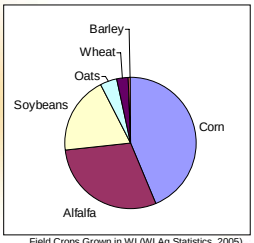
Wisconsin Field Crops

Current bioresources:

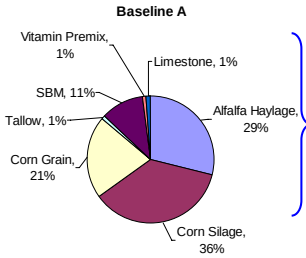
Corn → Ethanol

Soybeans → Biodiesel



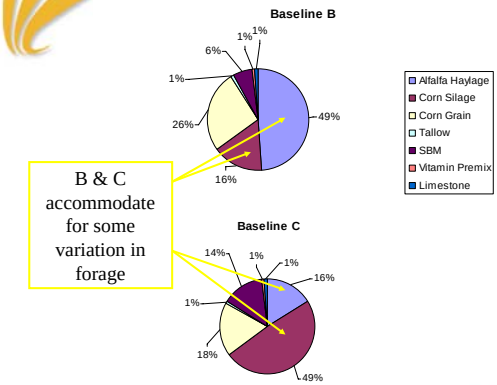
Field Crops Grown in WI (WI Ag Statistics, 2005)

Typical WI Dairy Ration

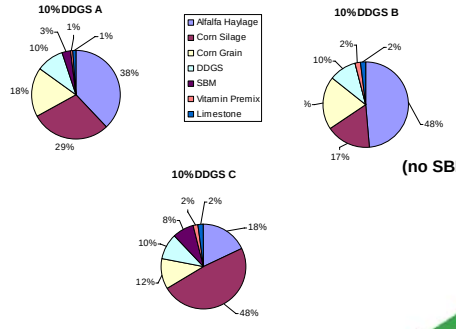


NRC Ration Program:
- 17% CP
- ~22kg/day entered milk production
- ~19kg/day DMI

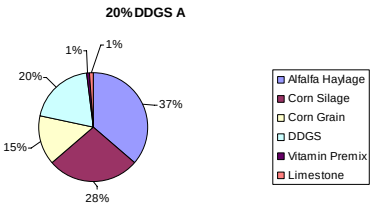
Every farm is different! Best estimate according to UW-Madison dairy nutritionists' recommendations.



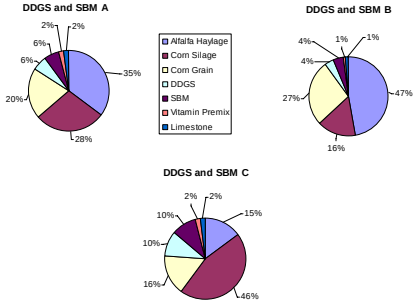
10% DDGS



20% DDGS



Maximizing Both DDGS *and* SBM



Is there enough corn grain to complete the ration?

Diet	Excess Corn Grain Available after DDGS Production to Meet Model Diet Needs (billion kg)	Annual Corn Grain portion of DMI for WI's 1.2 Million Dairy Cows (billion kg)	Difference Between Excess Corn Grain Available and Corn Grain Portion of DMI (billion kg)
10% DDGS A	6.20	1.40	4.80
10% DDGS B	6.20	1.69	4.51
10% DDGS C	6.20	0.933	5.27
20% DDGS A	3.20	1.77	1.43

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

DDGS and SBM Use (%DMI of Each DDGS & SBM)	SBM DMI per Year for WI's 1.2 Million Dairy Cows (million kg)	Annual Biodiesel Production Coproduced to Meet Annual SBM Consumption (million liters)	DDGS DMI per 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

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

Ration Name	DDGS (%DMI)	SBM (%DMI)	Annual Gasoline Displacement by Ethanol (million liters)	Annual Gasoline Displacement by Ethanol (% of gasoline used in WI in 2005)	Annual Petroleum Diesel Displacement by Biodiesel (million liters)	Annual Petroleum Diesel Displacement By Biodiesel (% 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

Energy Input to Soybean Meal (**Not** Considering Energy Input to Biodiesel)

Considering 2600 kg produced per hectare, kcal/kg produced (Pimentel, 1980)	**903**
Energy to crush soybeans (kcal/kg) (Sheehan et. al., 1998)	4,146
Energy to crush considering 57.4% Meal in beans (kcal/kg) (Sheehan et. al., 1998)	2,380
kcal/kg Soybean Meal Produced from soybeans (Sheehan, et. al., 1998)	**2,380**
Total kcal/kg Soybean Meal (sum of soybean agriculture and soybean crushing energy inputs)	**3,283**

Energy Input to Soybean Meal (Considering Energy Input to Biodiesel)

Energy inputs to soybeans agriculture (kcal/kg soybeans) (Pimentel, 1980)	903
Energy input to crushing soybeans (kcal/kg soybeans)	4,146
Energy to convert oil to biodiesel (kcal/kg soybeans)	1,907
Total energy needed to convert 1kg soybeans to biodiesel (kcal)	6,956

Energy to convert soybeans to soybean meal considering biodiesel production inputs and meal is 57.4% of soybean (kcal/kg soybean meal)	**3,993**

Energy Input to DDGS

Energy inputs to corn agriculture (considering 56 lbs or 25 kg per bushel) (kcal/bushel corn) (Pimentel, 1980)	24,228
Energy into corn dry milling, includes ethanol production (kcal/bushel corn) (Combined thermal and electrical inputs, Shapouri, 2004)	24,679

Energy input into DDGS considering 8 kg DDGS produced per bushel (kcal/kg DDGS)	**6,113**

Primary input energy needed to produce dairy feeds.

Crop	Energy Input kcal/kg	Source
Corn in Wisconsin	954	Pimentel, 1980
Corn Silage	597	Pimentel, 1980
Alfalfa	498	Pimentel, 1980
SBM (not including conversion of oil to biodiesel)	3,283	Pimentel, 1980 & Sheehan et. al., 1998
SBM (including conversion of oil to biodiesel)	3,993	Pimentel, 1980 & Sheehan et. al., 1998
DDGS (including conversion of starch to ethanol)	6,113	Pimentel, 1980 & Shapouri et. al., 2001

Difference in Energy Input to Rations and Energy Content of Biofuels Produced

Baseline Rations	Annual Input Energy to Rations for 1.2 Million Dairy Cows (GJ)	Energy Contained in Biofuel Equivalent to DDGS and/or Soybean Meal Used in Ration (GJ)	Difference Between Energy Input to Ration and Energy Content of Fuel (GJ)
Baseline A	32.3	0	32.3
Baseline B	27.2	0	27.2
Baseline C	35.1	0	35.1

Diets Containing DDGS[a]			
20% DDGS A	62.9	52.2	10.7
10% DDGS A	40.9	25.1	15.8
10% DDGS B	39.9	25.1	14.8
10% DDGS C	47.4	25.1	22.3

[a]Energy input for SBM does not include energy input to biodiesel production.

Difference in Energy Input to Rations and Energy Content of Biofuels Produced

Diets Maximizing Soybean Meal[b]			
Soybean Meal A	35.0	8.14	26.9
Soybean Meal B	28.6	7.80	20.8
Soybean Meal C	38.6	10.3	28.3

Maximizing both DDGS and Soybean Meal[b]			
DDGS and Soybean Meal A	39.5	18.7	20.8
DDGS and Soybean Meal B	33.4	11.1	22.3
DDGS and Soybean Meal C	50.1	32.5	17.6

[b]Energy input for SBM includes energy input to biodiesel production.

Cost of Rations

Baseline Diets[a]	Cost ration/day	
Baseline A	$2.08	
Baseline B	$2.39	
Baseline C	$1.87	
		Difference Compared to Baseline
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 & 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 represents maximization of SBM in the ration.

Summary

- Based on maximum allowable DDGS and SBM, respectively:
  - 15.9% of the energy consumed as gasoline in Wisconsin could be replaced by corn grain ethanol.
  - 6% of the energy consumed as diesel could be replaced by soy biodiesel.
- Using DDGS and SBM from ethanol and biodiesel production, respectively, provides an *energy credit* to the overall energy balance of producing feeds.
- Rations which maximize the use of DDGS and/or SBM are typically *less expensive*, based on historic market prices, than diets which do not maximize these components.

Acknowledgements

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