

Distillers Grains Use and NW Outlook

David J. Schingoethe
*Dairy Science Department
South Dakota State University*



Introduction

- Fuel ethanol production accounts for >98% of ethanol production & is rapidly increasing
- Currently >122 plants and more being built
- Distillers grains with solubles (DGS) is the major byproduct (coproduct) of ethanol production from the fermentation of corn that is fed to cattle



Introduction (cont'd)

- DGS is produced via dry grinding.
100 kg corn = 40.2 L ethanol + 32.3 kg DDGS + 32.3 kg CO₂
- Wet milling is usually used for producing corn oil, corn sweeteners or ethanol, corn gluten feed & corn gluten meal.
100 kg corn = 67.2 kg starch + 19.6 kg CGF + 5.7 kg CGM + 7.5 kg corn germ (50% oil)



Objective of this Presentation

- Review the results of feeding ethanol coproducts to dairy and beef cattle.
- Emphasis on DGS, especially for dairy cattle
- Other products mentioned will include:
 - * *Condensed Corn Distillers Solubles (CCDS)*
 - * *Corn germ*
 - * *Other new products*
- Emphasis on corn products although others will be mentioned.



Nutrient Content of Corn DGS & CCDS

Item	DGS	CCDS
	-----(% of DM)-----	
CP	30.1	18.5
RUP, % of CP	55.0	30.0
NE _L , Mcal/kg	2.26	2.03
NDF	39.0	20.0
ADF	16.1	5.0
EE	10.7	21.5
Ca	0.22	0.30
P	0.83	1.35
S	0.44	0.37



DGS for Cattle

- DGS is a good protein & energy feed to include in rations of cattle. Starch in corn is replaced by quite digestible fiber and fat in DGS
- The nutrient content of the dry matter in Distillers Grains is essentially the same for both wet & dried products
- The nutrient content is similar for DG & DGS (i.e. without & with solubles) although DGS contains more P (~ 0.9 vs ~ 0.4%).
> See Noll et al., *Poultry Sci.* 2007 for greater details



Protein in Corn Distillers Grains

- > 30% of DM; more than old “book values”
Similar for CDG & CDGS
- Good source of Ruminally Undegradable Protein (~55% RUP)
RUP is slightly less for wet vs. dried DGS
- Protein quality:
Fairly good quality; slightly better with top quality DGS
Lysine is the first limiting amino acid



Energy in Distillers Grains

- Today's Corn DGS contains 10-15 % more energy than DAIRY NRC, 2001 values¹ for dried DGS
 $NE_{Maint.} = 2.07 \text{ Mcal/kg}$
 $NE_{Gain} = 1.41 \text{ Mcal/kg}$
 $NE_L = 2.26 \text{ Mcal/kg vs. 1.96}$
- Replacing the starch in corn with the fiber & fat in CDG may decrease digestive upsets²

¹ Birkelo et al. *J. Dairy Sci.* 87: 1815-1819, 2004

² e.g. Ham et al., *J. Anim. Sci.* 72:3246-3257, 1994



Possible Challenges with DGS

- Consistent, uniform product
- High P &/or fat?
 - > *Too much solubles or separation in solubles*
- High S?
- Heat damage?
- Flowability problems?
- It may be worth paying a little more for a uniform, high quality product



DGS for Dairy Cattle



Milk Production When Fed DGS

- Usually similar or higher than when fed control diets
- With dried DGS, production tended to be highest @ up to 30% of DMI
- With wet DGS, production was highest @ up to 20% of DMI



DMI, Milk Production & Composition When Fed Various Amounts of DGS^{1,2}

Inclusion	DMI	Milk	Fat	Protein
(% of DM)	(kg/d)	(kg/d)	(%)	(%)
0	22.1 ^b	33.0 ^{ab}	3.39	2.95 ^a
4-10	23.7 ^a	33.4 ^a	3.43	2.96 ^a
10-20	23.4 ^{ab}	33.2 ^{ab}	3.41	2.94 ^a
20-30	22.8 ^{ab}	33.5 ^a	3.33	2.97 ^a
>30	20.9 ^c	32.2 ^b	3.47	2.82 ^b

¹Kalscheur, 2005. Meta analysis of 24 studies with 98 trts.

²Hollmann et al., 2007 ADSA mtg. had similar results



Corn Silage or Alfalfa with DGS?¹

- Distillers grains can be used with all forages, but:
- Higher production with 15% DGS in alfalfa than in corn silage diets.
 - Increased milk yield
26.4, 28.4, & 28.9 kg/d for CS, CSAH, AH
 - Slightly decreased milk fat content
3.67, 3.55, & 3.49%
 - Tended to increase milk protein yield
0.88, 0.94, & 0.96 kg/d
 - Increased mammary gland uptake of Lys & total EAA – improved AA status with alf/DGS

¹Kleinschmit et al., 2006a

(Confirmed by Hollmann et al., 2007)



Long Term Feeding of DGS

- A trial at SDSU in which cows were fed 15% of DMI as wet DGS throughout the lactation, during the dry period, and into the next lactation^{1,2}
- After the first year¹:
 - > Similar milk production DMI, reproductive efficiency & health with wet DGS
 - > Greater milk fat (3.75 & 4.07% for control & DGS)
 - > Greater protein (3.29 & 3.41%)
 - > Greater feed efficiency (1.30 & 1.57 FCM/DMI)
- After the dry period & second year: no difference²

¹Mpapho et al., 2006; ²Mpapho et al., 2007



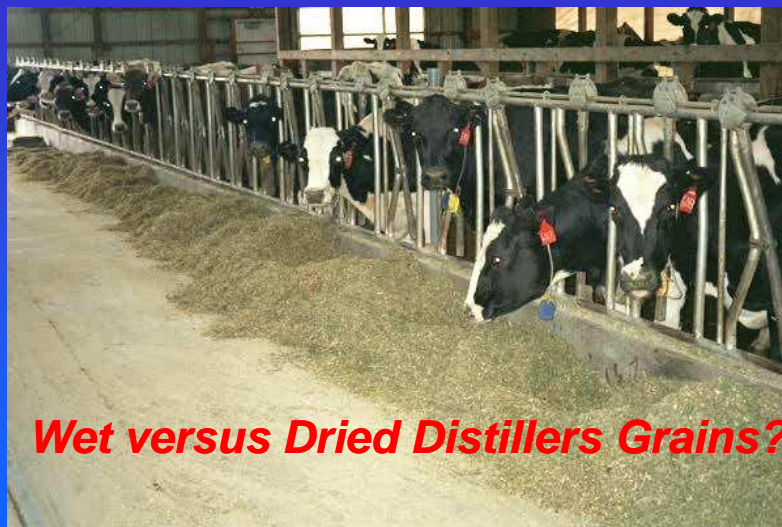
DGS from Other Grains

- **Wheat-based DGS¹ equal to barley grain for feedlot cattle**
- **Triticale DGS² supported similar milk production to corn DGS**
- **Sorghum DGS³**
 - > **Similar ADG & FE with sorghum vs. corn wet DGS**
 - > **Slightly less milk ($P < 0.13$) with sorghum vs. corn DGS**
 - > **Wet sorghum DGS was slightly less digestible than corn wet DGS**

¹Beliveau et al., 2007

²Greter et al., 2007

³Al-Suwaiegh et al., 2002



Wet versus Dried Distillers Grains?



Wet vs. Dried Distillers Grains

- Nutrient content of DM is essentially the same for both
- Animal growth & production about the same for both
- But, few studies directly compared wet vs. dried
 - > Nebraska data (*Al-Suwaiegh et al., J. Anim. Sci. 80:1105-1111, 2002*)
 - > SDSU data (*Anderson et al. J. Dairy Sci. 89:3133-3142, 2006*)



Wet vs. Dried DGS

- Nebraska data¹
 - > 15% DM as wet or dried corn or sorghum DGS
 - > Similar production for wet vs. dried DGS
 - > 6% more milk (P <0.13) with corn vs. sorghum DGS
 - > No non-DGS control diet in the experiment

¹*Al-Suwaiegh et al., J. Anim. Sci. 80:1105-1111, 2002*



Wet vs. Dried DGS

- SDSU data¹

> Diets:

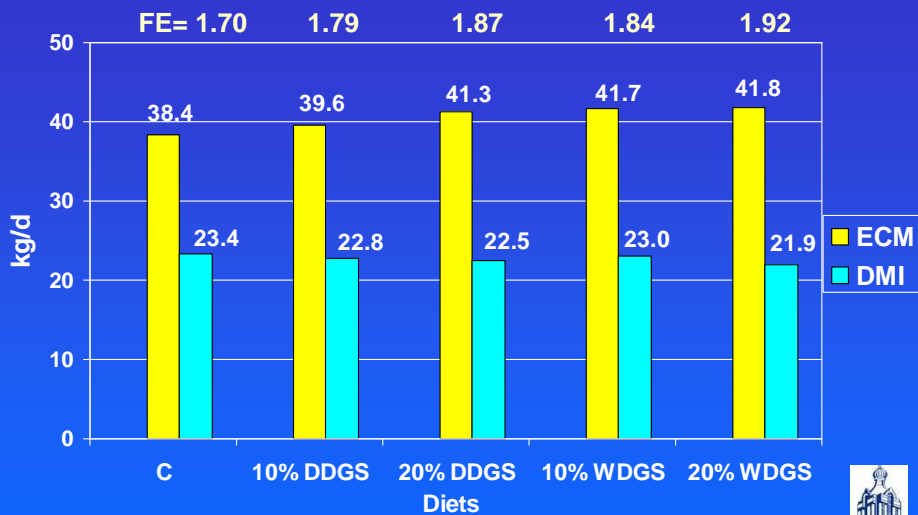
- * Control (C)
- * 10% DDGS
- * 20% DDGS
- * 10% WDGS
- * 20% WDGS

> 15 cows in 5 x 5 Latin sq., 4-wk periods

¹Anderson et al. *J. Dairy Sci.* 89:3133-3142, 2006



Prodn., DMI, & FE When Fed Wet or Dried DGS



Anderson et al., 2006

Feed Efficiency = ECM/DMI



Storage & Handling Considerations with DGS

- Dried DGS can be easily stored & shipped
- Wet DGS: avoids the cost of drying, but
 - > Higher cost of shipping per ton of DM
 - > Cannot store more than 5-7 d without spoilage, although preservatives may help
 - > But there are methods to increase storage life of wet DGS to more than 6 mo.



Methods to Increase Storage Time of Wet Distillers Grains

- Add preservatives: *may add a few days*
- Store in silo bags: *can store > 6 mo.*
- Blend with other feeds: *e.g. corn silage, soy hulls, beet pulp*



Milk Composition When Fed Distillers Grains



Milk Fat % When Fed DGS

- Milk fat is not usually affected by feeding DGS **unless** routinely recommended ration formulation guidelines, such as feeding sufficient amounts of effective forage fiber are not followed



Milk Fat % When Fed DGS

- Milk fat is not usually affected by feeding DGS unless routinely recommended ration formulation guidelines, such as feeding sufficient amounts of effective forage fiber are not followed
- Sufficient forage usually means 50% of DM from forage; 24% NDF from forage



Milk Fat % When Fed DGS

- Milk fat is not usually affected by feeding DGS unless routinely recommended ration formulation guidelines, such as feeding sufficient amounts of effective forage fiber are not followed
- Sufficient forage usually means 50% of DM from forage; 24% NDF from forage
- **DGS** contains abundant fiber (~39% of DM), **but** it is **not** “effective fiber”



Fat %

(Meta analysis, Kalscheur 2005)

Inclusion level (All diets)	LS Mean (%)	Response (%)	P <
0%	3.39	-	
0 - 10%	3.43	0.037	NS
10 - 20%	3.41	0.017	NS
20 - 30%	3.33	0.060	0.15
> 30%	3.47	0.084	0.16



Fat % Decreased Only When Not Fed Sufficient Effective Fiber

(Meta analysis, Kalscheur 2005)

% forage in diet	LS Mean (%)	Response (%)	P <
< 50%	3.21 ^b	-	
50%	3.50 ^a	0.287	0.01
> 50%	3.45 ^a	0.239	0.01



Replacing Forage Fiber with DGS Fiber Can Decrease Milk Fat %¹

<u>Diets</u>	<u>Fat, %</u>
Control (55% forage) ²	3.34
7% DGS ² (48% forage)	3.25
14% DGS ² (41% forage)	3.04
<u>21% DGS² (35% forage)</u>	<u>2.85</u>

¹Cyriac et al., *J. Dairy Sci.* 88(Suppl.1):252 (Abstr.), 2005

²Control: 40% corn silage & 15% alfalfa hay;
Other diets: DGS in place of some CS;
all diets = 30.7% NDF



Milk Fat % When Fed DGS

- The key to maintaining milk fat tests is to maintain sufficient amounts of effective forage fiber (e.g. >50% forage). Then, feeding DGS will not affect milk fat %
- Adding yeast culture¹ or non-effective fiber sources won't cover for insufficient forage fiber

¹Hippen et al., 2007



Fatty Acid Composition of Milk Fat When Fed DGS?

- Not extensively studied
- Modest increases in unsat'd fatty acids including the healthful *cis-9,trans-11* CLA & vaccenic acid^{1,2}
- Few changes in fatty acids that may decrease milk fat % (e.g. *trans-10,cis-12* CLA)^{1,2}

¹Leonardi et al., 2005

²Anderson et al., 2006



Milk Protein % When Fed DGS

- Seldom affected by feeding DGS
- The lysine limitation in DGS may cause a slight decrease in milk protein % with lower protein diets
- Any decrease may be more noticeable in diets with > 30% DGS, possibly because of the Lys limitation & high RUP



How Much Distillers Grains Can be Fed to Dairy Cattle?

- **Recommend max. of ~ 20% of ration DM**
 - > e.g. ~4.5-5.5 kg/d of Dried; ~15-17 kg/d of Wet
 - > *Can usually formulate nutritionally balanced diets while replacing large amounts of grains & protein supplements*



How Much Distillers Grains Can be Fed to Dairy Cattle?

- **Recommend max. of ~ 20% of ration DM**
 - > e.g. ~4.5-5.5 kg/d of Dried; ~15-17 kg/d of Wet
 - > *Can usually formulate nutritionally balanced diets while replacing large amounts of grains & protein supplements*
- **No advantage to feeding >20% of DM as DGS**
 - > *May have decreased DMI, especially with wet, definitely @ >30% of DMI because diet becomes too wet*
 - > *Likely excess protein & P in diets*



Dry Matter Intake, kg/d of Wet vs. Dried DGS

Inclusion of DGS	All	Wet	Dried
0%	22.2 ^b	21.3 ^b	23.5 ^c
0 - 10%	23.7 ^a	23.7 ^a	23.6 ^{bc}
10 - 20%	23.4 ^{ab}	22.9 ^{ab}	23.9 ^{ab}
20 - 30%	23.2 ^{ab}	21.3 ^{ab}	24.2 ^a
> 30%	20.9 ^c	18.6 ^c	23.3 ^{bc}

(Meta analysis, Kalscheur 2005)



DGS for Beef Cattle

- Can successfully feed as much as 40% of DM as wet or dried DGS^{1,2}

- * As energy source at that level
- * At high levels, more protein & P than needed



- NE_G more than for dry-rolled corn²
 - * Wet CDG: 29-40% more than corn
 - * Dried CDG: 21% more than corn
- Fewer cases of subacute acidosis²

¹ Al-Suwaiegh et al., 2002

² Ham et al., 1994



DGS for Calves & Heifers

- Calves

Successfully replaced grain and protein supplement at 28 & 56% of the diet.

- Growing dairy heifers

DGS can be included at 20 to 30% of the diet.

Increase forage in diet to balance the nutrient requirements or restrict intake in order to meet but not exceed energy requirements.

If animals are overfed energy, over-conditioning can result.



DGS for Dry Cows



- > DGS can be included at a low inclusion rate (10%) if diet is balanced with low nutrient feeds (such as roughages).

- > Do not allow cows to over-condition during the dry period.



Other Distillers Products

More than just DGS



Distillers Solubles



Feeding Distillers Solubles

- Med. Protein (18% CP); Good Energy (21% EE, NE_L 2.03 Mcal/kg)
- Often blended with DG as DGS
- May be blended with other feeds
- Increased production when fed as 5% or 10% Condensed CDS (28% DM) to lactating cows¹
 - > Milk production increased 4% with CDS
 - > Slight decrease in milk fat %
 - > Fed 10 or 20% of DMI as CDS with no problems, but high P in 20% CDS diets²
 - > 10% CDS + 0.5% fish oil: increased milk CLA³

¹DaCruz et al., 2005 ²Sasikala-Appukuttan et al., 2006

³Bharathan et al., 2007



Modified Distillers Products

- Some ethanol plants are offering products with different proportional blends of components & drying. e.g.
 - > Partially dried (e.g. 50% DM)
 - > Higher or lower proportions of solubles blended with DG
- It is important to obtain accurate analyses of these products & Check on consistency



Other Distillers Products for the Future

- More than just DGS will be available. e.g.
 - > Distillers solubles are available now
 - > Distillers bran + solubles
 - > Higher protein (45+% CP) lower fat DG
Products are becoming available
 - > Corn germ (20+% fat from dry grind;
40+% fat from wet milling)
Good source of energy for lactating cows¹

¹Abdelqader et al. (2006)



The Future?

- Expect to see new & improved “value added” products.
- e.g. Today’s DGS is already better & more uniform than products from 20 years ago.
- Fractionation will allow new products that are
 - > e.g. *higher in protein; other products that are higher in fat, fiber, & high or low in P.*
 - > *Will the fat in DGS go to biodiesel?*
 - > *Will the fiber in DGS go to cellulosic ethanol?*
- Feeding value of cellulosic coproducts?
- Loop system with ethanol plant & feedlots/dairies?



Summary

- DGS, fed wet or dried, is a good protein and energy feed to include in diets of cattle.
- Distillers solubles can be fed separately or blended with DG.
- Future research may focus on new value-added products



Questions?

