

Feeding Value of DDGS for Swine, Dairy, and Beef

Dr. Jerry Shurson

Department of Animal Science

University of Minnesota

What is DDGS?

- By-product of the dry-milling ethanol industry
- Nutrient composition is **different** between dry-mill, wet-mill and beverage alcohol by-products
 - DDGS – fuel ethanol
 - DDGS - whiskey distilleries
 - Corn gluten feed – wet mill
 - Corn gluten meal – wet mill
 - Brewer’s dried grains – beer manufacturing
- Nutrient content depends on the grain source used
 - **Corn DDGS - Midwestern US**
 - Wheat DDGS - Canada
 - Sorghum (milo) DDGS - Great Plains US
 - Barley DDGS

Comparison of Nutrient Composition (100% Dry Matter Basis) of “New Generation” DDGS to Corn Gluten Feed, Corn Gluten Meal, Corn Germ Meal, and Brewer’s Dried Grains

	“New Generation” Corn DDGS (UM)	Corn Gluten Feed (NRC)	Corn Gluten Meal (NRC)	Corn Germ Meal (Feedstuffs)	Brewer’s Dried Grains (NRC)
Protein, %	30.6	23.9	66.9	22.2	28.8
Fat, %	<i>10.7</i>	3.3	3.2	1.1	7.9
NDF, %	43.6	37.0	9.7	No data	52.9
DE, kcal/kg	<i>4011</i>	3322	4694	No data	2283
ME, kcal/kg	<i>3827</i>	2894	4256	3222	2130
Lys, %	0.83	0.70	1.13	1.00	1.17
Met, %	0.55	0.39	1.59	0.67	0.49
Thr, %	1.13	0.82	2.31	1.22	1.03
Trp, %	0.24	0.08	0.34	0.22	0.28
Ca, %	0.06	0.24	0.06	0.33	0.35
Available P, %	<i>0.80</i>	0.54	0.08	0.17	0.21

By-Products from Dry-Mill Ethanol Plants

- Distiller's grains
 - Wet – 30 to 35% DM
 - Dry – 90 to 92% DM

- Condensed distiller's solubles
 - Wet – 30 to 32% DM (variable)
 - Dry – 99% DM (new spray drying process developed at U of M)

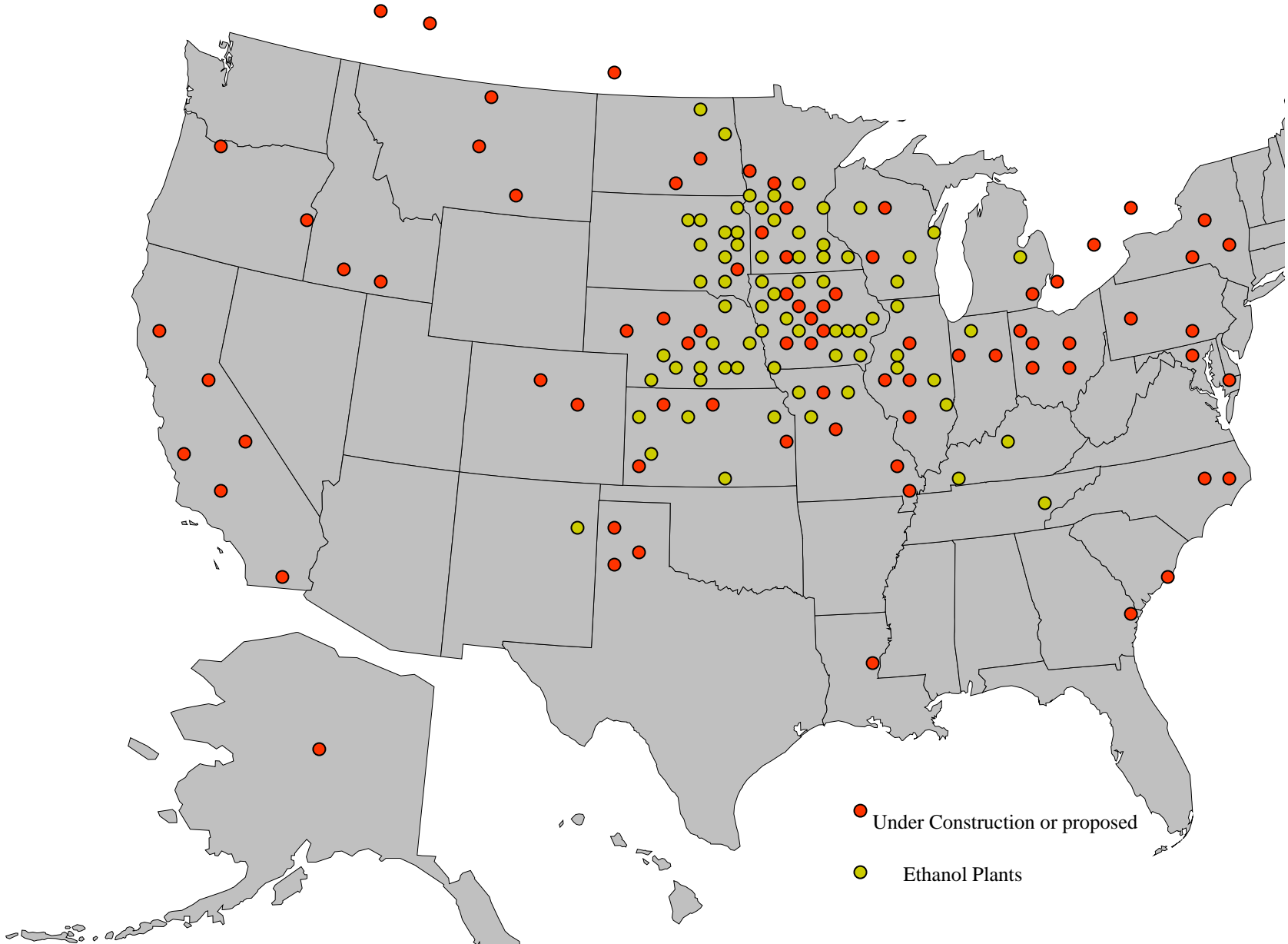
- Distiller's dried grains with solubles
 - Wet – 30 to 35% DM
 - Dried – 88 to 90% DM (most common by-product)

Dry-Milling Average Ethanol Yield Per Bushel of Corn

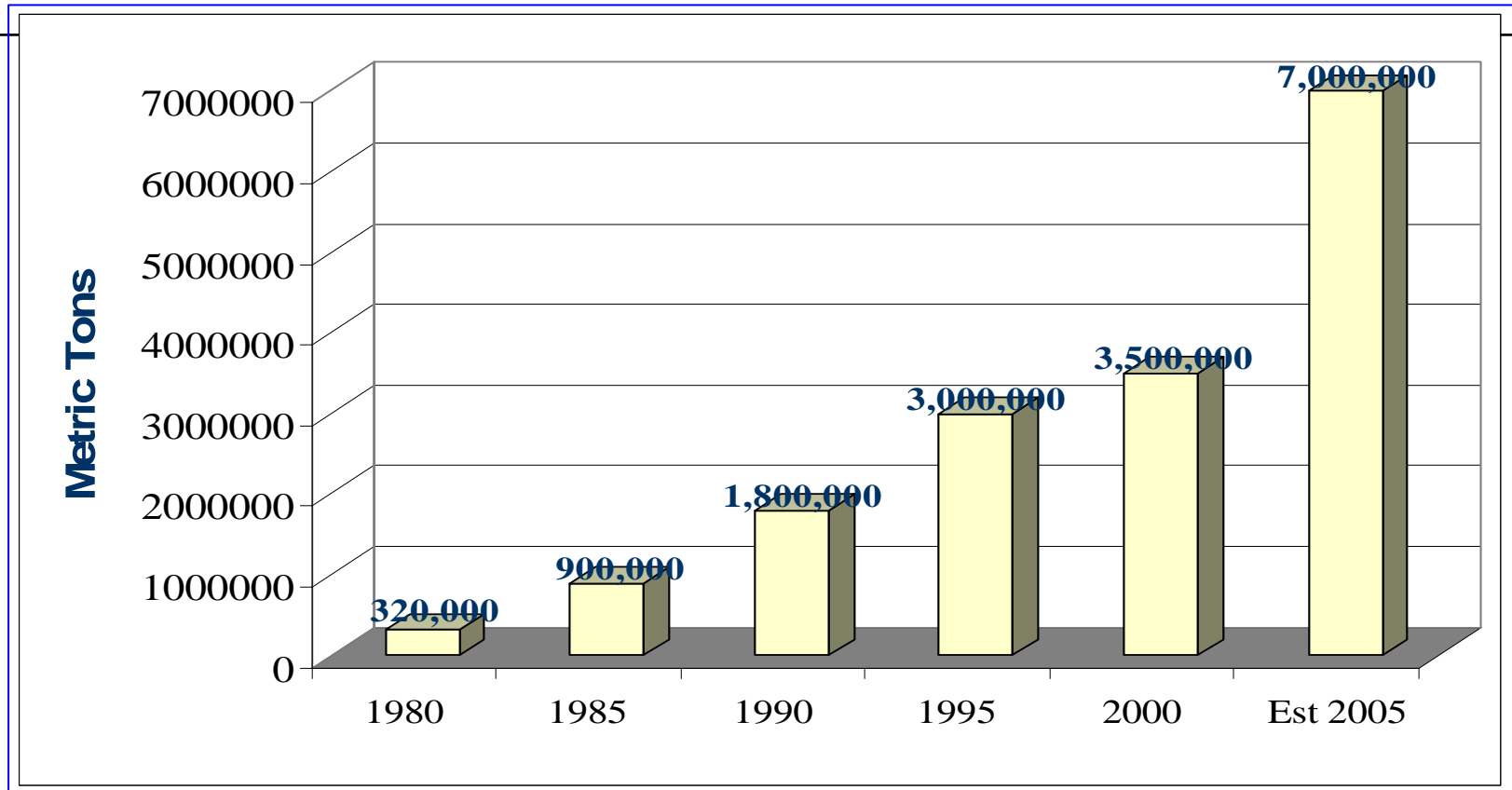


- Ethanol 2.7 gal.
- DDGS 18 lbs.
- CO₂ 18 lbs.

Ethanol Plants in North America - June 16, 2004



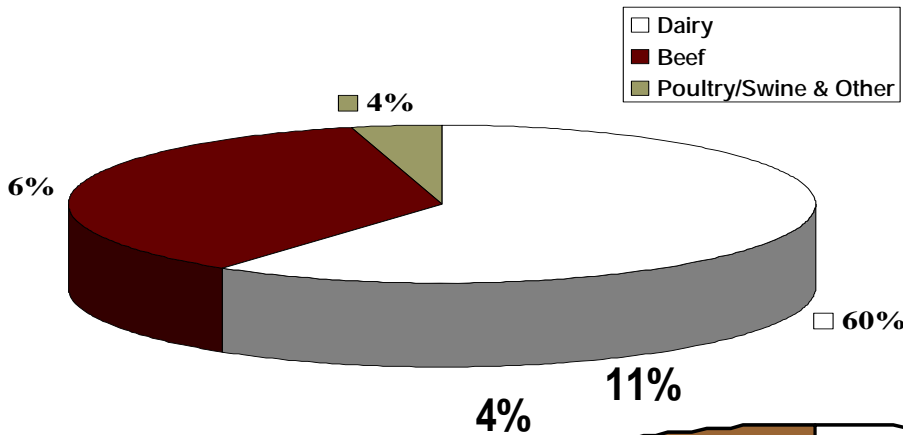
U.S. DDGS Production



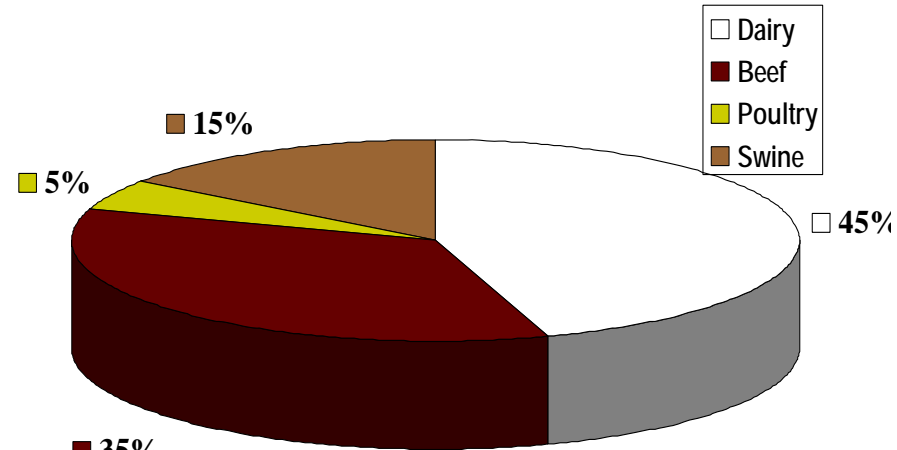
Source: Steve Markham – Commodity Specialists Company

U.S. DDGS Consumption

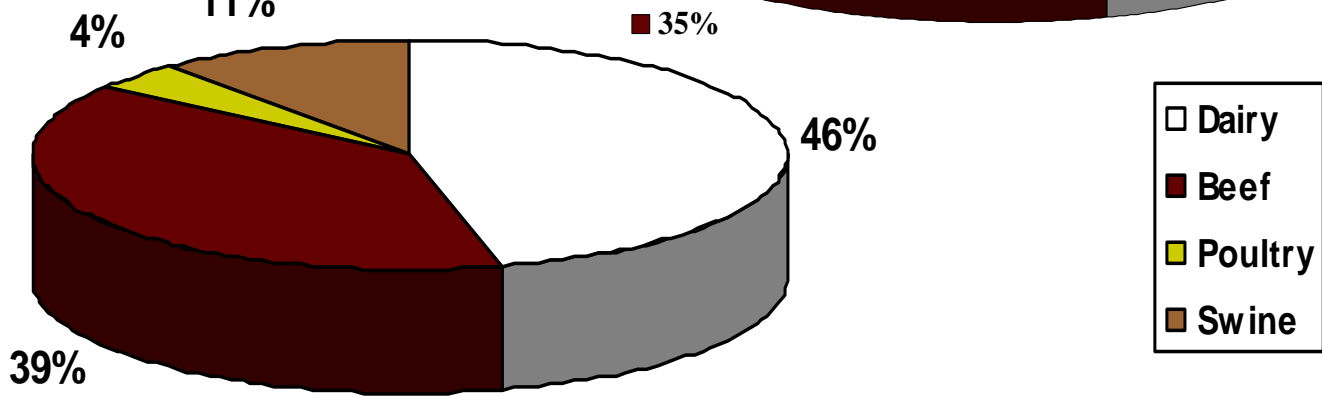
Estimate 2001



Estimate 2002



Estimate 2003



DDGS Varies Nutrient Content and Digestibility, Color, and Particle Size Among U.S. Sources



Proximate Analysis and Energy Value Averages and Ranges Among 27 U.S. DDGS Sources (100% Dry Matter Basis)

Nutrient	Average	Range
Dry matter, %	89.3	87.3 – 92.4
Crude protein, %	31.0	28.7 – 32.9
Fat, %	10.6	8.8 – 12.4
Fiber, %	7.2	5.4 – 10.4
Ash, %	6.1	3.0 – 9.8
ADF, %	13.6	8.0 – 18.1
Swine DE, kcal/kg	4053	3737 – 4319
Swine ME, kcal/kg	3790	3504 – 4048

Mineral Analysis Averages and Ranges Among 27 U.S. DDGS Sources (100% Dry Matter Basis)

Nutrient	Average	Range
Ca, %	0.08	0.02 – 0.12
P, %	0.75	0.42 – 0.99
K, %	0.96	0.45 – 1.27
Mg, %	0.29	0.14 – 0.38
S, %	0.62	0.34 – 1.05
Na, %	0.15	0.04 – 0.52
Zn, ppm	62	38 – 105
Mn, ppm	19	9 – 27
Cu, ppm	6	3 – 10
Fe, ppm	133	77 – 239

Amino Acid Analysis Averages and Ranges Among 27 U.S. DDGS Sources (100% Dry Matter Basis)

Nutrient	Average	Range
Arg, %	1.31	1.01 – 1.48
His, %	0.84	0.71 – 0.98
Ile, %	1.17	1.01 – 1.31
Leu, %	3.58	2.91 – 3.96
Lys, %	0.89	0.61 – 1.06
Met, %	0.65	0.54 – 0.76
Cys, %	0.68	0.61 – 0.76
Phe, %	1.51	1.36 – 1.72
Thr, %	1.15	1.01 – 1.28
Trp, %	0.25	0.18 – 0.28
Val, %	1.58	1.31 – 1.80

Comparison of Nutrient Composition of Golden DDGS to Other “DDGS Sources” (100% Dry Matter Basis)

	Golden Corn DDGS	Solulac	Badger State Ethanol	ADM - Peoria	Extruded DDGS/Soy (XDS Plus)	AGP Pelleted
Protein, %	31.82	29.32	31.62	30.12	34.44	27.0
Fat, %	11.32	3.52	15.25	8.96	13.33	9.00
Crude fiber, %	6.25	7.90	No data	7.77	7.78	15.10
ADF, %	12.37	11.80	17.91	20.95	14.44	No data
Ash, %	6.93	5.29	4.58	7.30	5.56	4.28
DE, kcal/kg*	4053	3808	No data	3796	No data	No data
ME, kcal/kg*	3781	3577	No data	3560	3749	No data
Lys, %	0.92	0.61	0.90	0.83	1.67	No data
Met, %	0.62	0.54	0.54	0.66	0.61	No data
Thr, %	1.17	1.01	1.04	1.13	2.50	No data
Trp, %	0.25	0.18	0.23	0.25	0.39	No data
Ca, %	0.07	0.12	0.06	0.51	0.22	0.17
P, %	0.77	0.78	0.89	0.68	0.72	0.62

*Calculated energy values for swine

Samples of Golden Corn DDGS from Various Midwestern U.S. Ethanol Plants



VeraSun - Aurora, SD



CVEC - Benson, MN



Al-Corn - Claremont, MN



MGP - Lakota, IA



CMEC - Little Falls, MN



Agri-Energy - Luverne, MN



LSCP - Marcus, IA



DENCO - Morris, MN

Proximate Analysis of “New Generation” DDGS (100% Dry Matter Basis)

Nutrient	“New Generation” DDGS
Dry matter, %	89.2
Crude protein, %	31.6
Fat, %	11.5
Crude fiber, %	6.2
Ash, %	7.8
NFE, %	42.8
ADF, %	11.2

Comparison of Amino Acid Composition of DDGS (88% dry matter basis)

	Golden DDGS	Traditional DDGS	DDGS (NRC, 1998)
Lysine, %	0.75 (17.3)	0.47 (26.5)	0.59
Methionine, %	0.63 (13.6)	0.44 (4.5)	0.48
Threonine, %	0.99 (6.4)	0.86 (7.3)	0.89
Tryptophan, %	0.22 (6.7)	0.17 (19.8)	0.24
Valine, %	1.32 (7.2)	1.22 (2.3)	1.23
Arginine, %	1.06 (9.1)	0.81 (18.7)	1.07
Histidine, %	0.67 (7.8)	0.54 (15.2)	0.65
Leucine, %	3.12 (6.4)	2.61 (12.4)	2.43
Isoleucine, %	0.99 (8.7)	0.88 (9.1)	0.98
Phenylalanine, %	1.29 (6.6)	1.12 (8.1)	1.27

Values in () are CV's among plants

Composition of Distiller's Grains for Cattle

Nutrient	% of DM
Crude Protein	30-36
RUP, % of CP	47-57
NE _L , Mcal/lb	1.00
Fat, %	9.8
ADF, %	19.0
NDF, %	38.0
Ca, %	0.15
P, %	0.83

Energy Value of DDGS for Ruminants

Good Quality DDGS contains:

7-11% more energy than “book values”

10-20% more energy than corn

$$NE_L = 1.00 \text{ Mcal/lb}$$

$$NE_M = 1.06 \text{ Mcal/lb}$$

$$NE_G = 0.73 \text{ Mcal/lb}$$

$$TDN = 94\%$$

$$DE = 1.84 \text{ Mcal/lb}$$

$$ME = 1.64 \text{ Mcal/lb}$$



Protein in Distiller's Grains

> 30% of DM and more than old “book values”

- Similar for DDG & DDGS

Good source of Ruminally Undegradable Protein (~55% RUP)

- RUP is slightly less for wet vs. dried DDG

Protein quality

- Fairly good quality
- Lysine is the first limiting amino acid

The Use of DDGS in Swine Diets



Benefits of Using DDGS in Swine Diets

- Often an economical partial replacement for:
 - corn
 - soybean meal
 - dicalcium phosphate

- Large supply available where hogs are produced

- Unique properties
 - reduce P excretion in manure
 - increase litter size weaned/sow
 - gut health benefits

Nutritional Advantages of DDGS

- **Higher total and available P than corn**
 - Partially replace inorganic P supplementation
 - Contributes ~ 50% of diet cost savings when economical
 - Reduces manure P content if diets are formulated on available P basis

- **Higher total amino acid levels than corn**
 - If golden, supply more digestible amino acids than corn
 - Replace a portion of soybean meal in the diet

- **Fiber composition (high insoluble fiber) may be partially responsible for:**
 - Improved litter size when fed at high levels to sows
 - Improved gut health in grow-finish pigs

- **Convenient way to add fat (oil) to the diet**

- **Energy is 97-100% of the energy in corn**

Nutritional Limitations of DDGS for Swine

- **Poor protein quality (like corn)**
 - Low lysine as % of crude protein
 - Increases manure N content
 - Tryptophan is second limiting amino acid

- **Must be golden in color**
 - Dark, overheated DDGS is low in amino acid digestibility (especially lysine)

- **Energy value = 97-100% the value of corn**
 - May be slightly limiting at high dietary inclusion rates (> 30%)

- **Corn oil is unsaturated**
 - Soft, oily pork fat at high dietary inclusion rates

- **Temporary reduction in feed intake**
 - When abrupt switch from a corn-soy diet to a high DDGS diet

Maximum Inclusion Rates of “New Generation” DDGS in Swine Diets

(Based Upon University of Minnesota Performance Trials)

- Nursery pigs (> 7 kg)
 - Up to 25 %
- Grow-finish pigs
 - Up to 20% (higher levels may reduce pork fat quality)
- Gestating sows
 - Up to 50%
- Lactating sows
 - Up to 20%

Assumptions: no mycotoxins

formulate on a digestible amino acid and available phosphorus basis

Current DDGS Feeding Practices

- Used almost exclusively in grow-finish diets
 - 10% inclusion most common
 - Gut health benefits frequently observed
 - Up to 15 to 20% inclusion
 - When competitively priced
 - Need to supplement with synthetic amino acids
- Limited use in sow feeds
 - Perceived risk of mycotoxins
 - 10% inclusion when used
- Limited use in nursery feeds
 - Lower amino acid content/nutrient density vs other ingredients
 - Limited formulation space in high nutrient dense diets
 - 5% inclusion when used

The Use of DDGS in Dairy Rations



Wet vs. Dried Distiller's Grains for Dairy Cows

Nutrient content of DM is the same for both

Considerations for Wet Distiller's Grains:

- Can usually store only 5-7 days
- May need preservatives (e.g. propionic acid or other organic acids, etc.)
- Limited economical hauling distances
- Rations may be too wet
 - limit total DM intake, especially if ensiled forages are also fed



Production Response of Dairy Cows When Fed Distiller's Grains

The same as, or greater than when fed SBM

Increased or no change when supplemented with protected lysine & methionine

Similar to when fed a blend of protein supplements (SBM, FM, DG)

How Much Distiller's Grains Can be Fed to Dairy Cows?

Recommend max. of ~ 20% of ration DM

- 10-13 lb/d of dried
- 30-40 lb/d of wet

Usually no palatability problems

At 30% of DM:

- May decrease DMI, especially if Wet CDG
- May feed excess protein

Example Ration Considerations for Dairy Cattle

Diets containing 50:50 forage:concentrate

- If equal proportions of alfalfa & corn silage

 - * **DG can replace most or all protein supplement**

- If mostly corn silage

 - * **More DG can be fed but may need some other protein supplement (check Lysine and P levels)**

- If mostly alfalfa

 - * **Less DG likely needed to supply diet CP**

The Use of DDGS in Beef Rations

A photograph of a feedlot with several black steers. The steers are standing in a row, eating from a large pile of yellow hay. The feedlot is enclosed by a metal fence, and the background shows a large, dark structure, likely a barn or feed storage building. The text "The Use of DDGS in Beef Rations" is overlaid in white, bold, serif font across the upper portion of the image.

Nutritional Value of DDGS for Beef Cattle

- ❑ Excellent protein source (28% crude protein)
- ❑ High by-pass protein
- ❑ Excellent source of essential minerals (P and K)
- ❑ Improves rumen health
- ❑ Very palatable
- ❑ 1.8 times more value compared to soybean meal

Distiller's Grains for Beef Cattle

- As protein source
 - 6-15% of ration DM

- As an energy source
 - when fed at >15% of DM
 - may reduce acidosis because highly digestible fiber in place of starch

- ADG and F/G usually better than with corn

Value of Nutrients in DDGS for Finishing Cattle

- Energy
 - Wet distiller's grains – 110 to 125% energy of corn (DM basis)
 - DDGS – 100% of corn (DM basis)
- Protein
 - By-pass > soybean meal
 - Wet = Dry is properly dried
- Fiber
 - High fiber and low starch reduces fermentation rate
 - Safe ingredient to start cattle on finishing diets
 - Reduces subacute acidosis
- Fat
 - Oil content limits the quantity fed (<40%)
- Phosphorus
 - No value in corn-based finishing diets
 - Value as a supplement to low P forages

How Much Distiller's By-Products Can Be Fed to Beef Cattle?

- DDGS (90% DM)
 - Feed to supply protein to meet requirement
 - < 20 % ration dry matter

- Wet DGS (30% DM)
 - Feed to supply protein and energy
 - Commonly fed at < 25% of ration dry matter
 - Greatest value at 15 to 20% of ration dry matter
 - Can feed up to 40% of ration dry matter
 - Overfeed protein and phosphorus

- Wet Condensed Distiller's Solubles (30% DM)
 - Feed to supply protein and energy
 - Limit to < 10% of ration dry matter

U of M DDGS Web Site

www.ddgs.umn.edu

We have developed a DDGS web site featuring:

- * nutrient profiles and sample photos from various DDGS sources
- * research summaries
 - swine, poultry, dairy, & beef
 - DDGS quality
- * presentations given
- * links to other DDGS related web sites
- * international audiences

