"New Generation" Corn DDGS

Dr. Jerry Shurson
Dept. of Animal Science
University of Minnesota

Overview

- DDGS facts
- Research funding sources
- Research "road map" to evaluate DDGS as a feed ingredient for swine
- Research highlights
- Future issues and opportunities

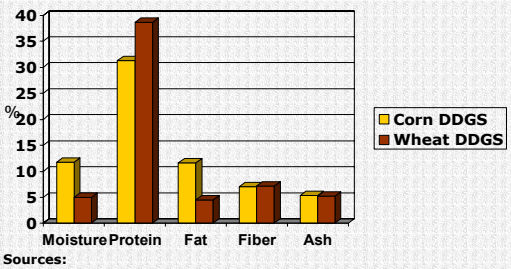
What is DDGS?

- Co-product of the dry-milling ethanol industry
  - Corn (maize) DDGS - Midwestern US
  - Wheat DDGS - Canada
  - Sorghum (milo) DDGS - Great Plains US
  - Barley DDGS
  - Rye DDGS
- DDGS is nutritionally DIFFERENT than other grain co-products

Comparison of Nutrient Composition (Dry Matter Basis) of "New Generation" DDGS to Corn Gluten Feed, Corn Gluten Meal, Corn Germ Meal, and Brewer's Dried Grains

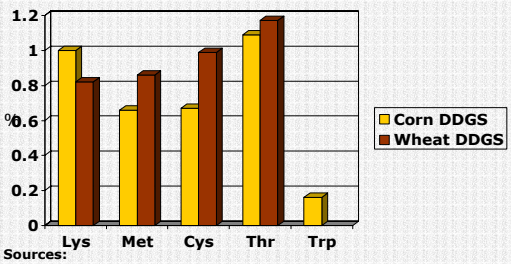
	"New" Corn DDGS (UM)	Corn Gluten Feed (NRC)	Corn Gluten Meal (NRC)	Corn Germ Meal (Feedstuffs)	Brewer's Dried Grains (NRC)
Protein, %	30.6	23.9	66.9	22.2	28.8
Fat, %	*10.7*	3.3	3.2	1.1	7.9
NDF, %	43.6	37.0	9.7	No data	52.9
DE, kcal/kg	*4011*	3322	4694	No data	2283
ME, kcal/kg	*3827*	2894	4256	3222	2130
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, %	*0.80*	0.54	0.08	0.17	0.21

Comparison of Proximate Analysis of U.S. "New Generation" Corn DDGS to Canadian Wheat DDGS (100% Dry Matter Basis)



Data Sources:
Corn DDGS: Glacial Lakes, Watertown, SD (2003)
Wheat DDGS: Mohawk Oil Co., Minnedosa, MB (1989)

Comparison of Amino Acid Analysis of U.S. "New Generation" Corn DDGS to Canadian Wheat DDGS (100% Dry Matter Basis)



Data Sources:
Corn DDGS: Glacial Lakes, Watertown, SD (2003)
Wheat DDGS: Mohawk Oil Co., Minnedosa, MB (1989)
(6 of 9 samples were wheat and corn blends)

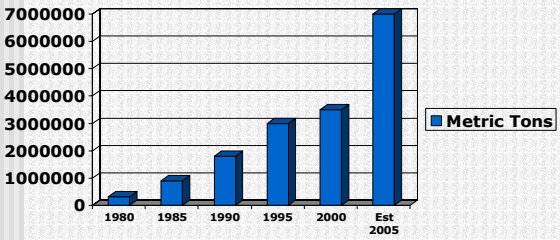
Dry-Milling Average Ethanol Yield Per Bushel (25.4 kg) of Corn

- Ethanol 10.2 liters
- DDGS 8.2 kg
- CO_2 8.2 kg

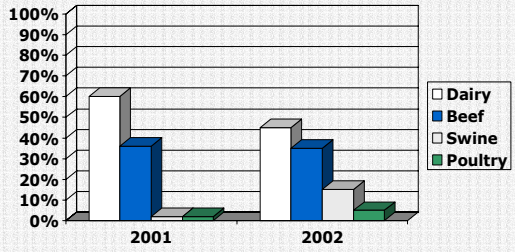
Slide courtesy of Ms. Kelly Davis, CVEC, Benson, MN

Most Fuel Ethanol Production is in the Western U.S. "Corn Belt"

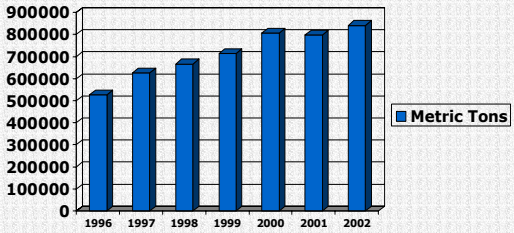
North American DDGS Production



Estimated North American DDGS Consumption in 2001 & 2002



North American DDGS Exports



"New Generation" vs. "Old Generation" DDGS

Research Funding Sources

- **Midwest DDGS Association**
  - **internal checkoff ($0.10/ton DDGS)**
- MN Corn Growers Association
- MN Pork Producers Association
- IA Corn Growers Association
- CAMAS, Inc.
- Alpharma
- IL Corn Growers Association
- SD Corn Growers Association
- Hubbard Milling

Research "Road Map" to Determine DDGS Feeding Value for Swine

- Nutrient content and variability within and among plants
- DE and ME value
- Amino acid digestibility
- Phosphorus availability
- Maximum inclusion rates in each production phase
  - Limitations for use

Research "Road Map"

- Explore "value added" properties
  - Impact on the environment
    - Odor and gas emissions
    - Manure nutrient (N and P) excretion
  - Gut health benefits
  - Improvements in litter size
  - Reduce Salmonella shedding?
  - Others?

Research "Road Map"

- DDGS Handling, Storage, and Processing Characteristics
  - Physical characteristics
    - Particle size
    - Bulk density
    - Color
  - NIR
  - Flowability
  - Shelf life
    - Rancidity
    - Molds and mycotoxins
  - Pelleting

Research Highlights

Comparison of Proximate Analysis of "New Generation" DDGS vs. NRC (1998) (100% Dry Matter Basis)

Nutrient	"New Generation" DDGS	NRC (1998)
Dry matter, %	88.9 (1.7)	93.0
Crude protein, %	30.2 (6.4)	29.8
Fat, %	10.9 (7.8)	9.0
Crude fiber, %	8.8 (8.7)	4.8
Ash, %	5.8 (14.7)	No data
NFE, %	44.5 (6.1)	No data
ADF, %	16.2 (28.4)	17.5
NDF, %	42.1 (14.3)	37.2

Values in ( ) are CV's among plants

Comparison of Energy Values of DDGS for Swine (88% DM Basis)

	"New" DDGS Calculated	"New" DDGS Trial avg.	"Old" DDGS Calculated	DDGS NRC (1998)
DE, kcal/kg	3488 Range 3418-3537	3528 Range 2975-4086	3409	3449
ME, kcal/kg	3162 Range 3087-3215	3367 Range 2820-3916	3098	2672

Corn (NRC, 1998): DE (kcal/kg) = 3484
ME (kcal/kg) = 3382

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

	"New" DDGS	"Old" 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

Comparison of Apparent Ileal Digestible Amino Acid Composition of DDGS for Swine (88% dry matter basis)

	"New" DDGS	"Old" DDGS	DDGS (NRC, 1998)
Lysine, %	0.39	0.00	0.27
Methionine, %	0.28	0.21	0.34
Threonine, %	0.55	0.32	0.49
Tryptophan, %	0.13	0.13	0.12
Valine, %	0.81	0.45	0.77
Arginine, %	0.79	0.53	0.77
Histidine, %	0.45	0.26	0.40
Leucine, %	2.26	1.62	1.85
Isoleucine, %	0.63	0.37	0.64
Phenylalanine, %	0.78	0.60	0.96

Comparison of Phosphorus Level and Relative Availability of DDGS for Swine (88% dry matter basis)

	"New" DDGS	"Old" DDGS	DDGS NRC (1998)	Corn NRC (1998)
Total P, %	0.78 Range 0.62-0.87	0.79	0.73	0.25
P Availability, %	90 Range 88-92	No data	77	14
Available P, %	0.70	No data	0.56	0.03

Comparison of Mineral Analysis of "New Generation" DDGS, "Old Generation" DDGS, and NRC (1998) (100% Dry Matter Basis)

Mineral	"New Generation" DDGS	"Old Generation" DDGS	NRC (1998)
Ca, %	0.06 (57.2)	0.44	0.22
P, %	0.89 (11.7)	0.90	0.83
K, %	0.94 (14.0)	0.99	0.90
Mg, %	0.33 (12.1)	0.40	0.20
S, %	0.47 (37.1)	0.51	0.32
Na, %	0.24 (70.5)	0.28	0.27
Zn, ppm	98 (80)	80	86
Mn, ppm	16 (33)	50	26
Cu, ppm	6 (20)	14	61
Fe, ppm	120 (41)	219	276

Values in ( ) are CV's among plants

Why is there so much interest in feeding DDGS to swine?

- "New Generation" DDGS is high in digestible nutrients
- Economical partial replacement for:
  - corn
  - soybean meal
  - dicalcium phosphate
- Increasing production and supply
- Unique properties
  - reduce P excretion in manure
  - increase litter size weaned/sow
  - gut health benefits?

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 P basis

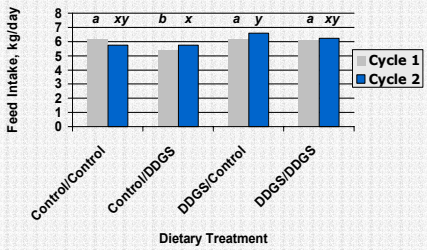
Feeding Limitations

Fat Quality Characteristics of Market Pigs Fed Corn-Soy Diets Containing 0 to 30% DDGS

	0 %	10%	20%	30%
Belly thickness, cm	3.15^{a}	3.00^{a,b}	2.84^{a,b}	2.71^{b}
Belly firmness score, degrees	27.3^{a}	24.4^{a,b}	25.1^{a,b}	21.3^{b}
Adjusted belly firmness score, degrees	25.9^{a}	23.8^{a,b}	25.4^{a,b}	22.4^{b}
Iodine number	66.8^{a}	68.6^{b}	70.6^{c}	72.0^{c}

Means within a row lacking common superscripts differ (P < .05).

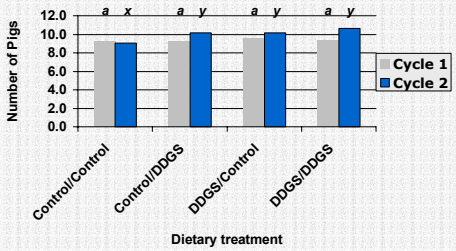
Effect of Dietary Treatment Combination on Sow Lactation ADFI



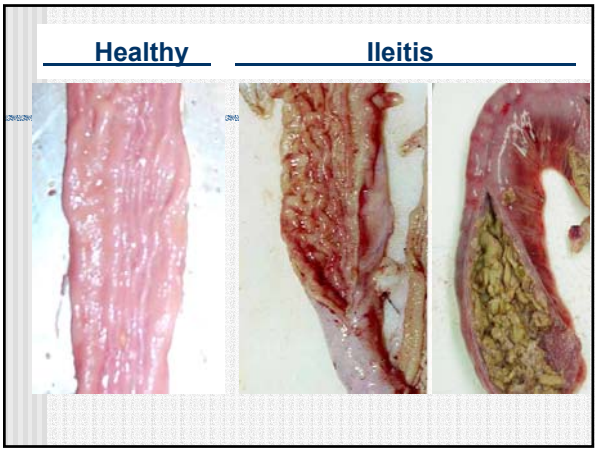
^{a,b,x,y} Different superscripts indicate significant difference (P < .10).

"Value Added" Properties of DDGS

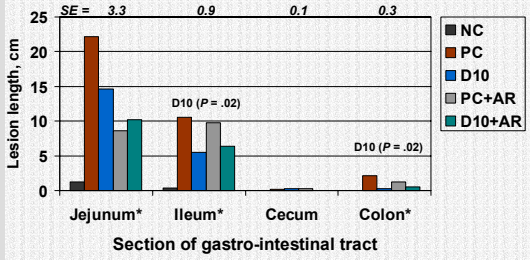
Effect of Feeding 0 or 50% DDGS Gestation Diets and 0 or 20% DDGS Lactation Diets on Pigs Weaned/Litter



^{a,b,x,y} Different superscripts indicate significant difference (P < .10).

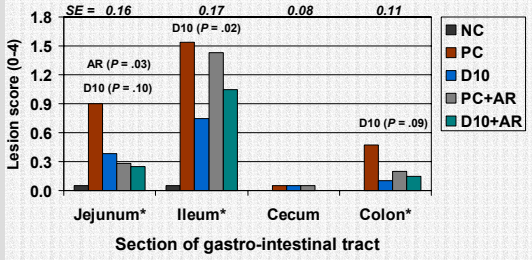


Effect of Dietary Treatment on Lesion Length (21 d Post-Challenge) Experiment 2



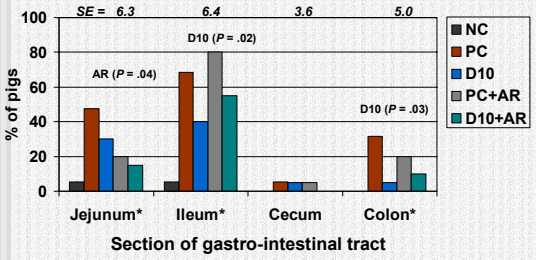
* Effect of disease challenge ($P < .01$).

Effect of Dietary Treatment on Lesion Severity (21 d Post-Challenge) Experiment 2



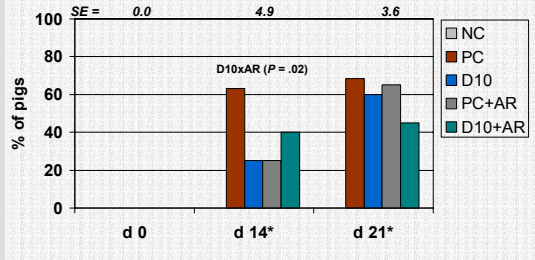
* Effect of disease challenge ($P < .01$).

Effect of Dietary Treatment on Lesion Prevalence (21 d Post-Challenge) Experiment 2



* Effect of disease challenge ($P < .01$).

Effect of Dietary Treatment on Fecal Shedding (PCR Analysis) Experiment 2



* Effect of disease challenge ($P < .01$).

Quality, Handling, Storage, and Processing Characteristics

Bulk Density of "New Generation" DDGS

- DDGS samples from 16 "New Generation" plants
  - Avg. bulk density = 35.7 lbs/cubic ft.
  - Std. deviation among plants = 2.79 lbs/cubic ft.
  - Coefficient of variation among plants = 7.8%
  - Range in bulk density among plants:
    - 30.8 to 39.3 lbs/cubic ft.

DDGS Particle Size

- DDGS samples obtained from 16 "new generation" plants
  - Average particle size = 1282 microns
  - Standard deviation = 305 microns
  - Coefficient of variation among plants = 24%
  - Range in average particle size among plants - 612 to 2125 microns

NIR Calibrations for DDGS

Nutrient	R	Rmsep,%	R^2	CV,%
Lysine	0.89	0.064	.79	16.2
Methionine	0.81	0.044	.66	14.2
Threonine	0.73	0.046	.53	6.2
Energy	0.87	37	.76	1.9

R = correlation between actual and predicted values
Rmsep = prediction error
R^2 = proportion of the total variation explained by calibrations
CV, % = coefficient of variation among DDGS samples

Correlation Between DDGS Color and Amino Acid Digestibility (r^2)

Amino acid	L*	a*	b*
Lys	.67	NS	.77
Cys	.67	NS	.74
Thr	.51	NS	.58

Current and Future DDGS Research

- Impact of feeding DDGS on pre-harvest food safety (Salmonella)
  - **Mindy Spiehs, PhD candidate**
- Spray-dried distiller's solubles fractions in baby pig diets
  - **Jeff Knott, PhD candidate**
- Impact of adding DDGS and phytase on manure P content and chemical forms of P
  - **Mark Whitney, PhD candidate**
- Correlation between DDGS color, ADICP, and true amino acid digestibility in poultry
- Methods to improve flowability and pelleting of DDGS
  - **collaboration with AURI**
- Stability and preservation of DDGS in various climates


Spray Dried Distiller's Solubles (SDDS)
Spray Dried Yeast Cream (SDYC)
Spray Dried Residual Solubles (SDRS)