"New Generation" Distiller's Dried Grains with Solubles in Swine and Poultry Diets

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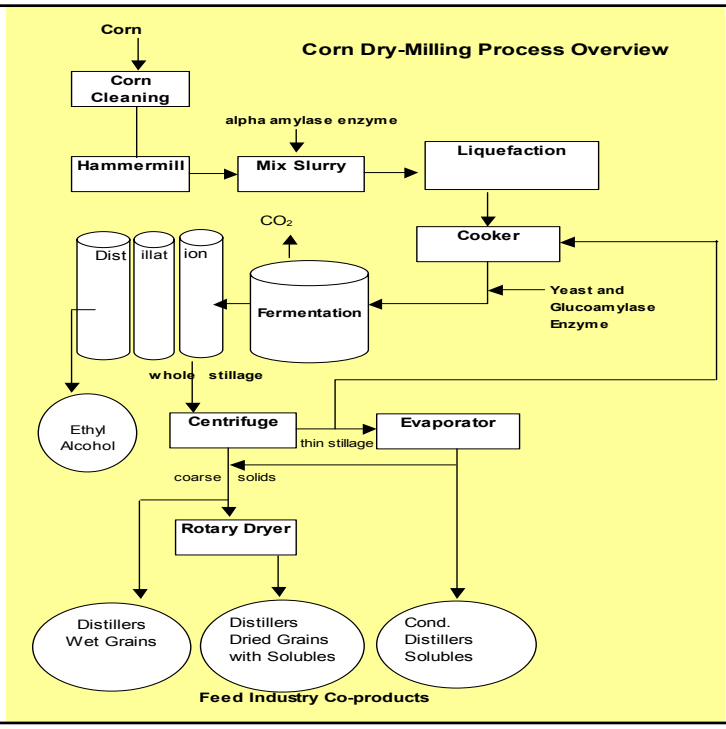
What is DDGS?

- 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" 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



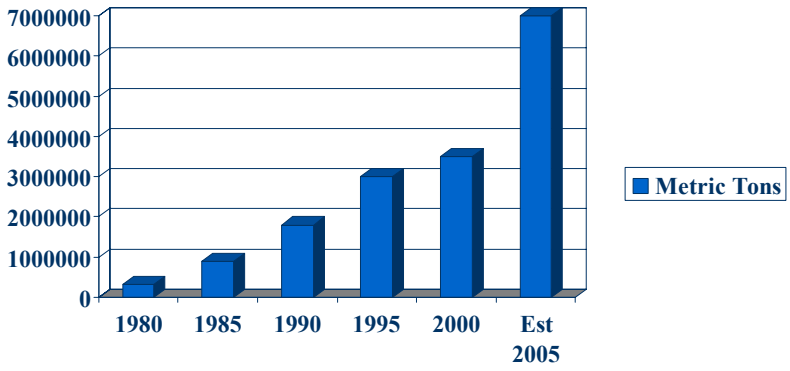
Dry-Milling Average Ethanol Yield Per Bushel (25.4 kg) of Corn

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

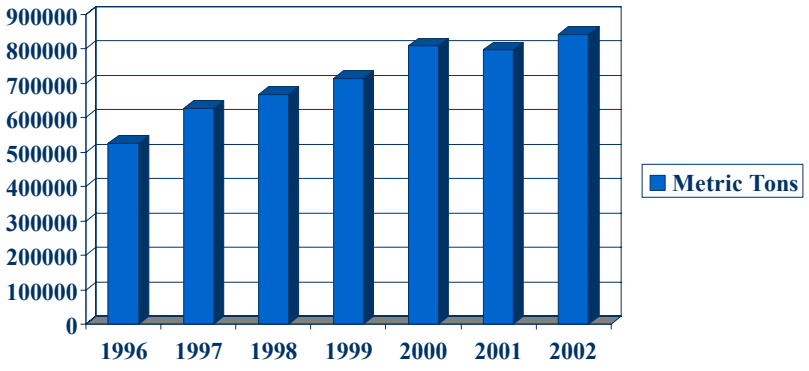
Slide courtesy of Ms. Kelly Davis, CVEC, Benson, MN

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

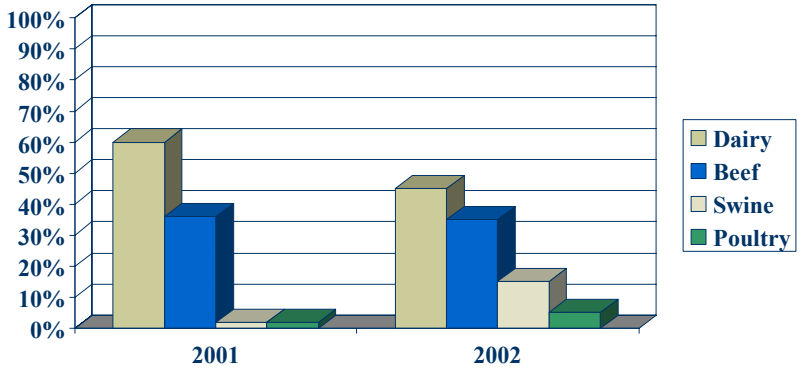
North American DDGS Production



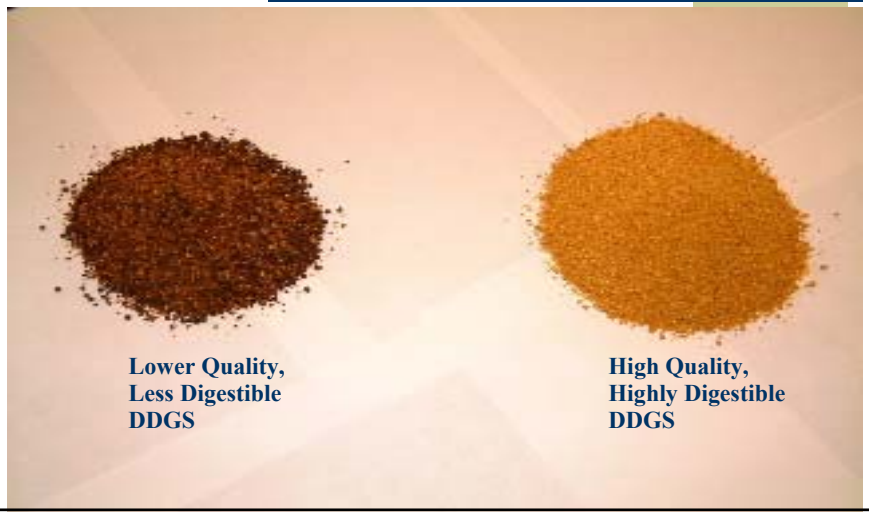
North American DDGS Exports



Estimated North American DDGS Consumption in 2001 & 2002



“New Generation” vs. “Old Generation” DDGS



Lower Quality, Less Digestible DDGS

High Quality, Highly Digestible DDGS

Use of Corn DDGS in Swine Diets

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/lb) = 3484
ME (kcal/lb) = 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 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 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?

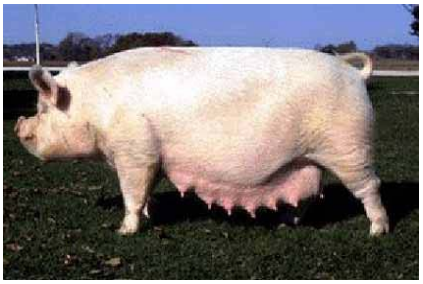
Maximum Inclusion Rates of "New Generation" DDGS in Swine Diets

(Based Upon University of Minnesota Performance Trials)

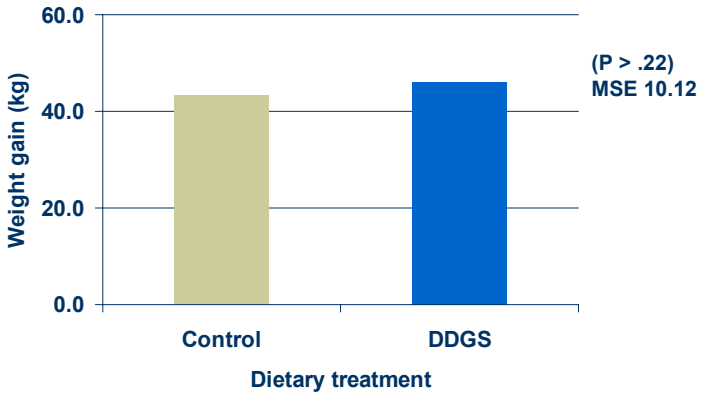
- Nursery pigs (> 7 kg)
  - Up to 25 %
- Grow-finish pigs
  - Up to 20% (higher levels may reduce pork fat quality)
- Gestating sows
  - Up to 50%
- Lactating sows
  - Up to 20%

Assumptions: no mycotoxins
formulate on a digestible amino acid and available phosphorus basis

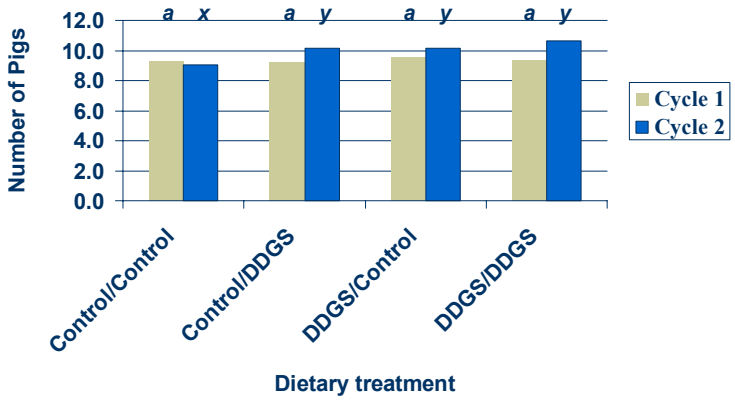
Feeding "New Generation DDGS to Sows"



Effect of Feeding a 50% DDGS Diet on Sow Weight Gain During Gestation (Reproductive Cycle 1)

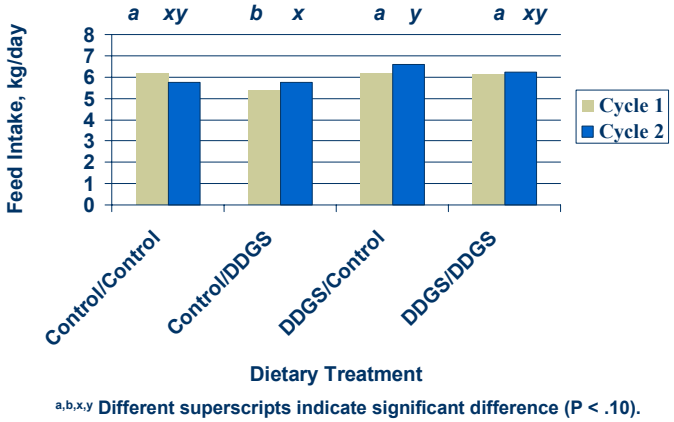


Effect of Feeding 0 or 50% DDGS Gestation Diets and 0 or 20% DDGS Lactation Diets on Pigs Weaned/Litter



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

Effect of Dietary Treatment Combination on Sow Lactation ADFI



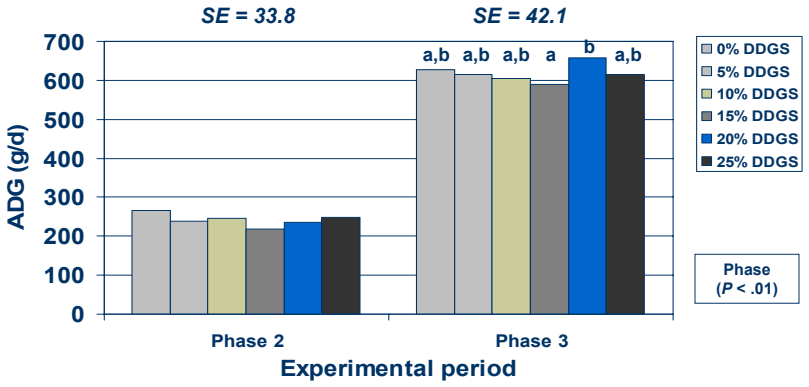
a,b,x,y Different superscripts indicate significant difference (P < .10).

Feeding "New Generation" DDGS to Weaned Pigs

Materials and Methods – Nursery Experiments

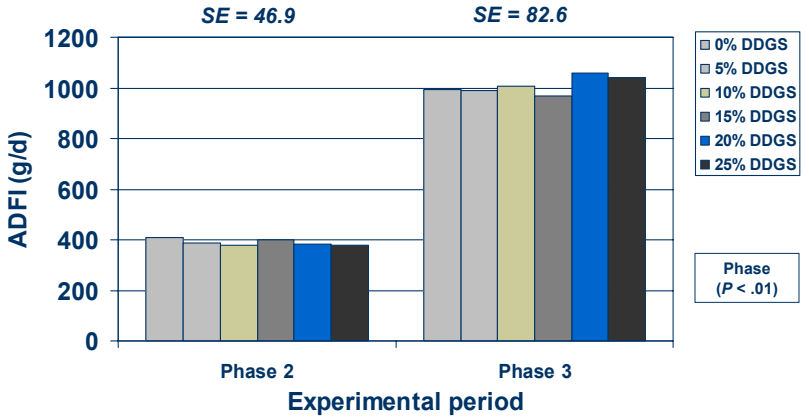
- Experiment 1
  - Pigs weaned at 19.0 ± 0.3 d of age
  - Weighed 7.10 ± 0.07 kg
- Experiment 2
  - Pigs weaned at 16.9 ± 0.4 d of age
  - Weighed 5.26 ± 0.07 kg
- Pigs were fed a commercial pelleted diet (d 0 to 3 postweaning)
- Phase II (d 4-17) and Phase III (d 18 – 35) diets were formulated on a digestible amino acid basis.
  - Diets contained 0, 5, 10, 15, 20, or 25% DDGS

Effect of DDGS Level on Growth Rate (Experiment 1)

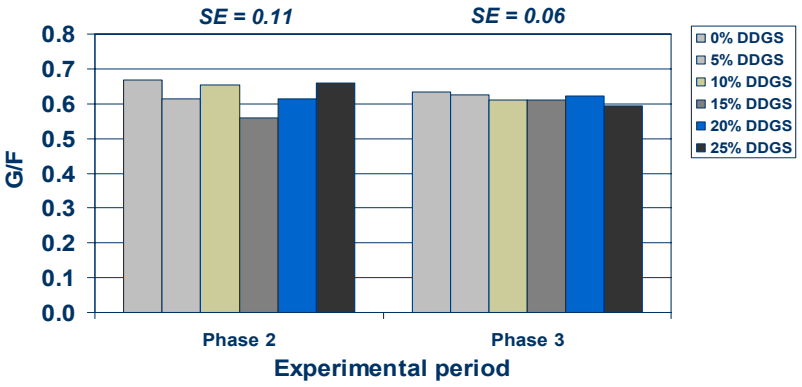


Means not sharing a common superscript letter are significantly different ($P < .05$)

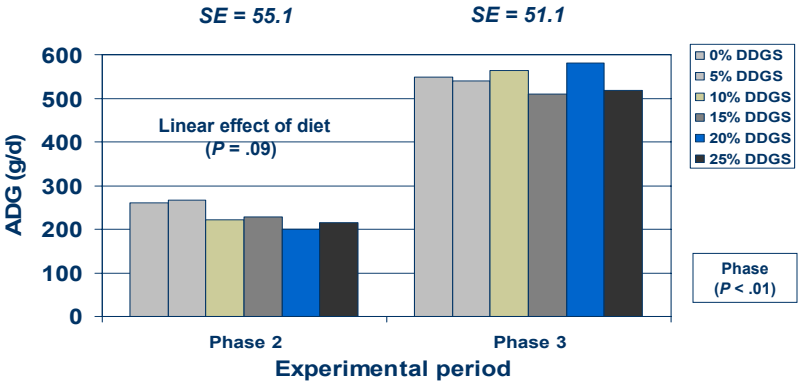
Effect of DDGS Level on ADFI (Experiment 1)



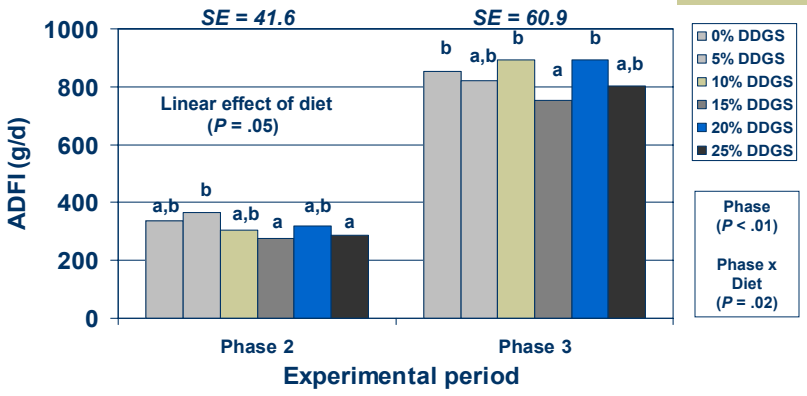
Effect of DDGS Level on Gain/Feed (Experiment 1)



Effect of DDGS Level on Growth Rate (Experiment 2)



Effect of DDGS Level on Feed Intake (Experiment 2)



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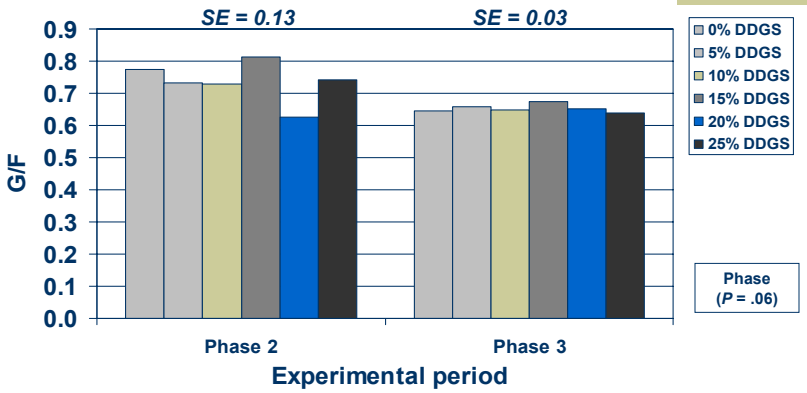
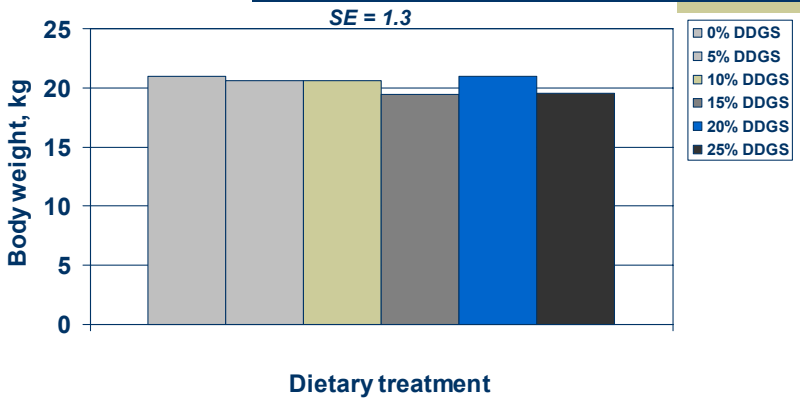
Effect of DDGS Level on Gain/Feed (Experiment 2)



Effect of DDGS Level on Final BW (Experiment 2)



Feeding "New Generation" DDGS to Grow-Finish Pigs

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 ($P < .05$).

Does Feeding DDGS Improve Gut Health?

What is Ileitis?

- Porcine Proliferative Enteropathy
- Caused by *Lawsonia intracellularis*
  - Present in 96% of U.S. swine herds (Bane et al., 1997)
    - 28% of pigs affected (NAHMS, 2000)
  - Can be shed in infected pigs for up to 10 weeks
- Animals are infected by oral contact with feces from animals shedding the bacteria
- 7-10 days after infection:
  - Lesions of the intestinal wall begin to form
  - Lesions maximized around 21 days post-infection

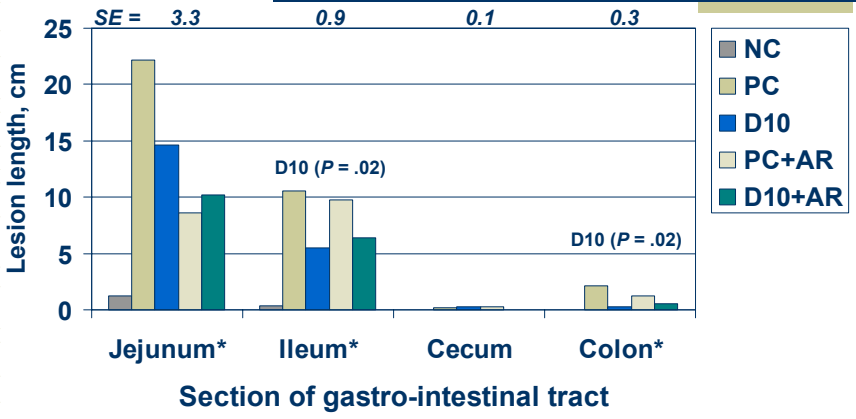
Clinical Forms of Ileitis

- Porcine Intestinal Adenomatosis (PIA)
  - Chronic form
  - Seen in growing pigs (6 - 20 weeks of age)
  - Decreased feed intake, lethargic
- Porcine Hemorrhagic Enteropathy (PHE)
  - Acute form, affects heavier pigs
    - Greatest frequency appears to be from 65 – 110 kg pigs
  - Massive intestinal hemorrhaging, bloody diarrhea, increase in mortality

Healthy

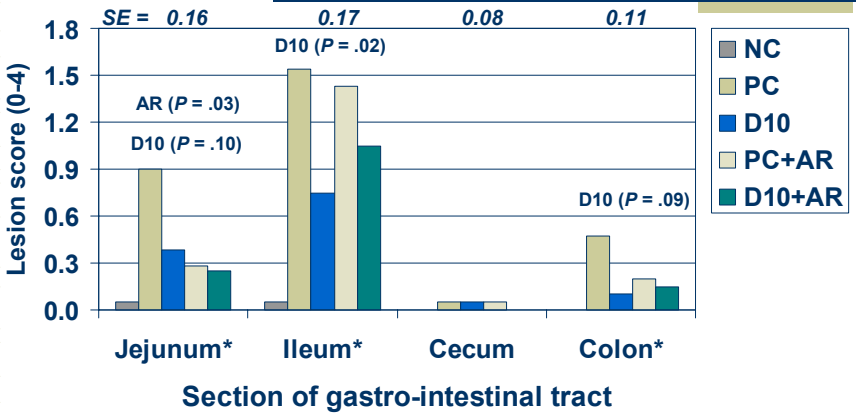
Ileitis

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



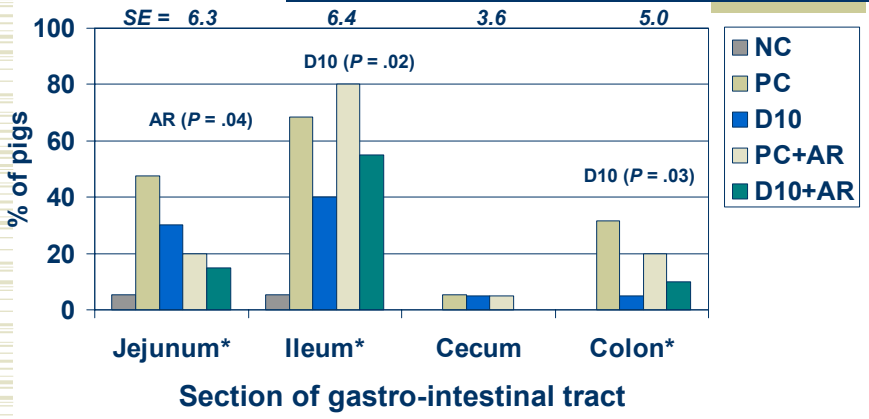
* Effect of disease challenge ($P < .01$).

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



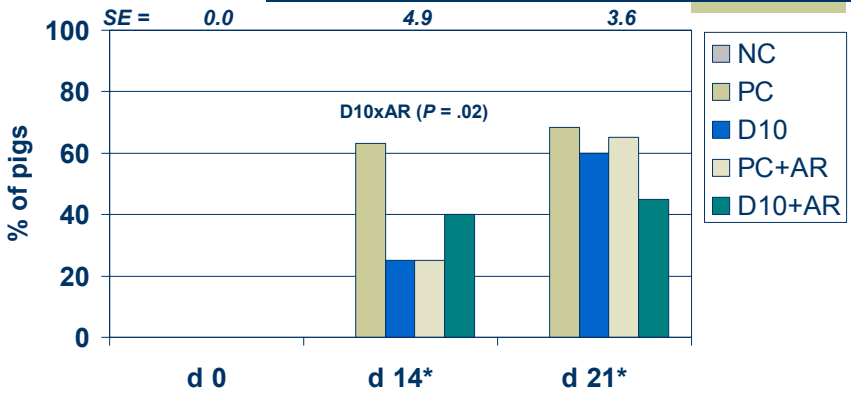
* Effect of disease challenge ($P < .01$).

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



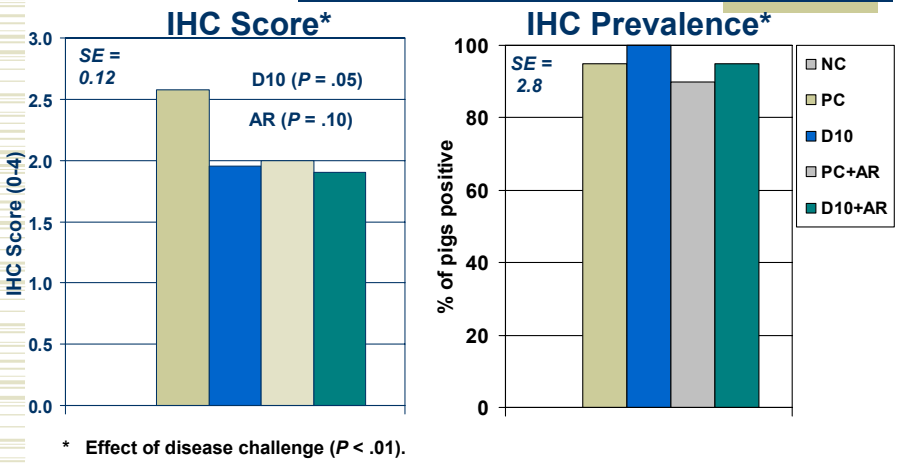
* Effect of disease challenge ($P < .01$).

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



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

Effect of Treatment on *L. intracellularis* Infection (IHC Analysis) Experiment 2



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

Summary of Results, Experiment 2

- Inoculation level was close to goal
- DDGS inclusion (10%) or antimicrobial regimen had a positive effect on the pig's ability to resist an ileitis challenge
- No beneficial additive effects of combining DDGS and BMD®/Aureomycin® regimen

DDGS and Phytase are a Key Part of Manure Phosphorus Management

- Adding 20% DDGS to a corn-soy diet and formulating on an available P basis
  - can reduce manure P by > 12%
- Adding phytase to a corn-soy diet
  - increases P bioavailability from 15% to > 45%
- Lowering dietary P, adding 20% DDGS & phytase
  - can reduce manure P excretion by 40 to 50%

Diet Composition When 18.8% DDGS and Phytase are Added to the Diet

Ingredient	Corn-SBM-1.5 kg Lysine	18.8% DDGS + Phytase
Corn, kg	798.3	636.3
Soybean meal 44%, kg	176.9	159.4
DDGS, kg	0.0	188
Dicalcium phosphate, kg	11.6	0.0
Limestone, kg	7.2	9.8
Salt, kg	3.0	3.0
L-lysine HCl, kg	1.5	1.5
VTM premix, kg	1.5	1.5
Phytase, 500 FTU/kg	0.0	0.5
TOTAL, kg	1000.0	1000.0

Use of Corn DDGS in Poultry Diets

Unidentified Growth or Hatchability Factors

- Growth response (Couch et al., 1957)
  - 5% DDGS in turkey diets
  - 17-32% improvement in gain
- Feed preference (Alenier & Combs, 1981)
  - 10% DDGS in chicken layer diets
- Reproduction improvement (Manley, 1978)
  - 3% DDGS in turkey breeder hen diets
  - improvement in egg numbers and hatch (late lay)

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

	"New Generation" DDGS	NRC (1994)
AME, kcal/kg	2260 Range 2090-2418	2480
TME, kcal/kg	2850 Range 2650 - 3082	3097

Source: Noll and Parsons. 2003. Unpublished data.

Amino Acid Content of Corn DDGS (5 Sources)

Amino acid	Range	Average	NRC, 1994
Methionine, %	0.44 – 0.56	0.49	0.60
Cystine, %	0.45 – 0.60	0.52	0.40
Lysine, %	0.64 – 0.83	0.74	0.75
Arginine, %	1.02 – 1.23	1.08	0.98
Tryptophan, %	0.19 – 0.23	0.22	0.19
Threonine, %	0.94 – 1.05	0.98	0.92

Source: Noll and Parsons. 2003. Unpublished data.

True Digestible Amino Acid Levels of Corn DDGS for Poultry (5 Sources)

Amino acid	True Dig. Amino Acid, %	Average	Digestibility Coefficient, %	Average
Methionine	0.35 – 0.53	0.43	86 - 90	88
Cystine	0.28 – 0.57	0.40	66 - 85	76
Lysine	0.37 – 0.74	0.53	59 - 83	71
Arginine	0.73 – 1.18	0.93	80 - 90	86
Tryptophan	0.14 – 0.21	0.18	76 - 87	82
Threonine	0.61 – 0.92	0.74	67 - 81	75

Source: Noll and Parsons. 2003. Unpublished data.

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

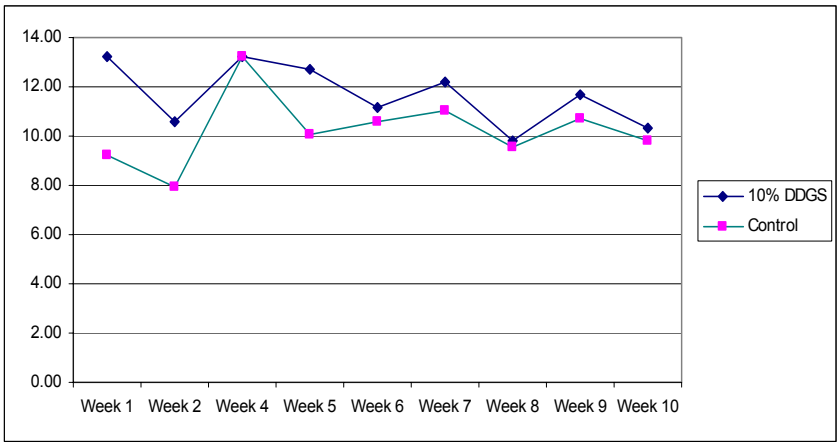
Amino acid	L*	a*	b*
Lys	.67	NS	.77
Cys	.67	NS	.74
Thr	.51	NS	.58

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

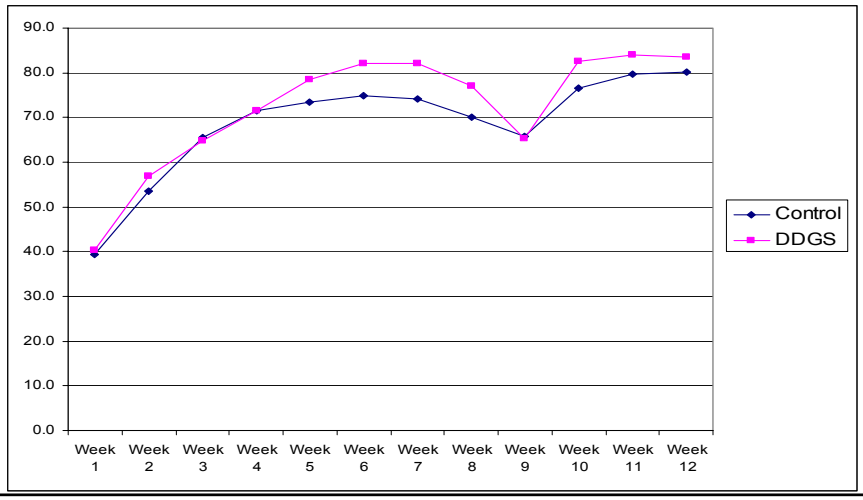
	"New Generation" DDGS	NRC (1994)
Total P, %	0.74	0.72
P Availability, %	61 Range 54 - 68	54
Available P, %	0.45	0.39

Source: 2003 Lumpkins, Dale, and Batal, University of Georgia. Abstract.

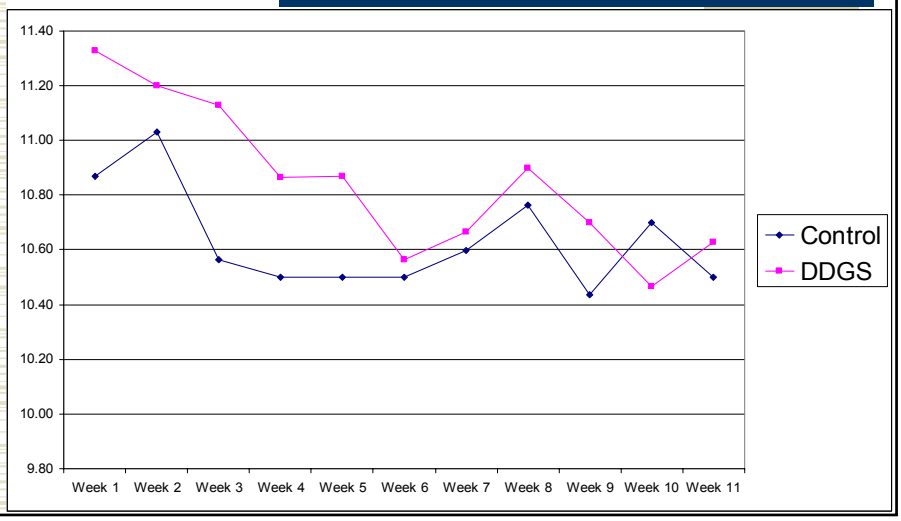
Xanthophyll Content of Control and DDGS Diets During a 12-Wk Layer Trial in Jalisco Mexico



Average Percentage of Production by Week for Layers Fed Control and DDGS Diets – Jalisco Mexico



Differences in Yolk Color (Roche Units) in Eggs Produced by Layers Fed Control and DDGS Diets – Jalisco Mexico



Results from Recent Broiler DDGS Trials

- Broiler chicks (0 to 18 days) fed diets containing:
  - 0% DDGS - 3000 kcal ME/kg
  - 15% DDGS – 3000 kcal ME/kg
  - 0% DDGS – 3200 kcal ME/kg
  - 15% DDGS – 3200 kcal ME/kg
- ADG and G/F higher for 3200 kcal ME diets
- No difference in performance between 0% or 15% DDGS within dietary energy level

Source: Lumpkins, Batal, and Dale. 2003.

Results from Recent Broiler DDGS Trials

- Broiler chicks (0 to 42 days) fed isocaloric and isonitrogenous diets containing:
  - 0% DDGS
  - 6% DDGS
  - 12% DDGS
  - 18% DDGS
- No difference in ADG and G/F when 0, 6, or 12% DDGS diets were fed
- ADG was reduced for chicks fed 18% DDGS
- No difference in carcass yields

Source: Lumpkins, Batal, and Dale. 2003.

Results from Recent Layer DDGS Trials

- Laying hens (21 to 43 weeks of age) fed diets containing:
  - 0% DDGS – 2800 kcal ME/kg
  - 15% DDGS – 2800 kcal ME/kg
  - 0% DDGS – 2870 kcal ME/kg
  - 15% DDGS – 2870 kcal ME/kg
- No differences in egg production except when low energy, 15% DDGS diet was fed (reduction)
- No differences in egg weight, specific gravity, Haugh units, yolk color, or shell breaking strength

Source: Lumpkins, Batal, and Dale. 2003.

Recommended Inclusion Rates of DDGS for Poultry

- Broilers
  - 10% inclusion rates (Starter/Finisher)
    - Without energy adjustments
  - > 10%
    - With adjustments for lys, met, thr, trp, and energy
- Chicken Egg Layers
  - 10% inclusion rate

U of M DDGS Web Site
www.ddgs.umn.edu

We have developed a DDGS web site featuring:

* research summaries
    - swine, poultry, dairy, & beef
    - DDGS quality
* presentations given
* links to other DDGS related web sites
* international audiences