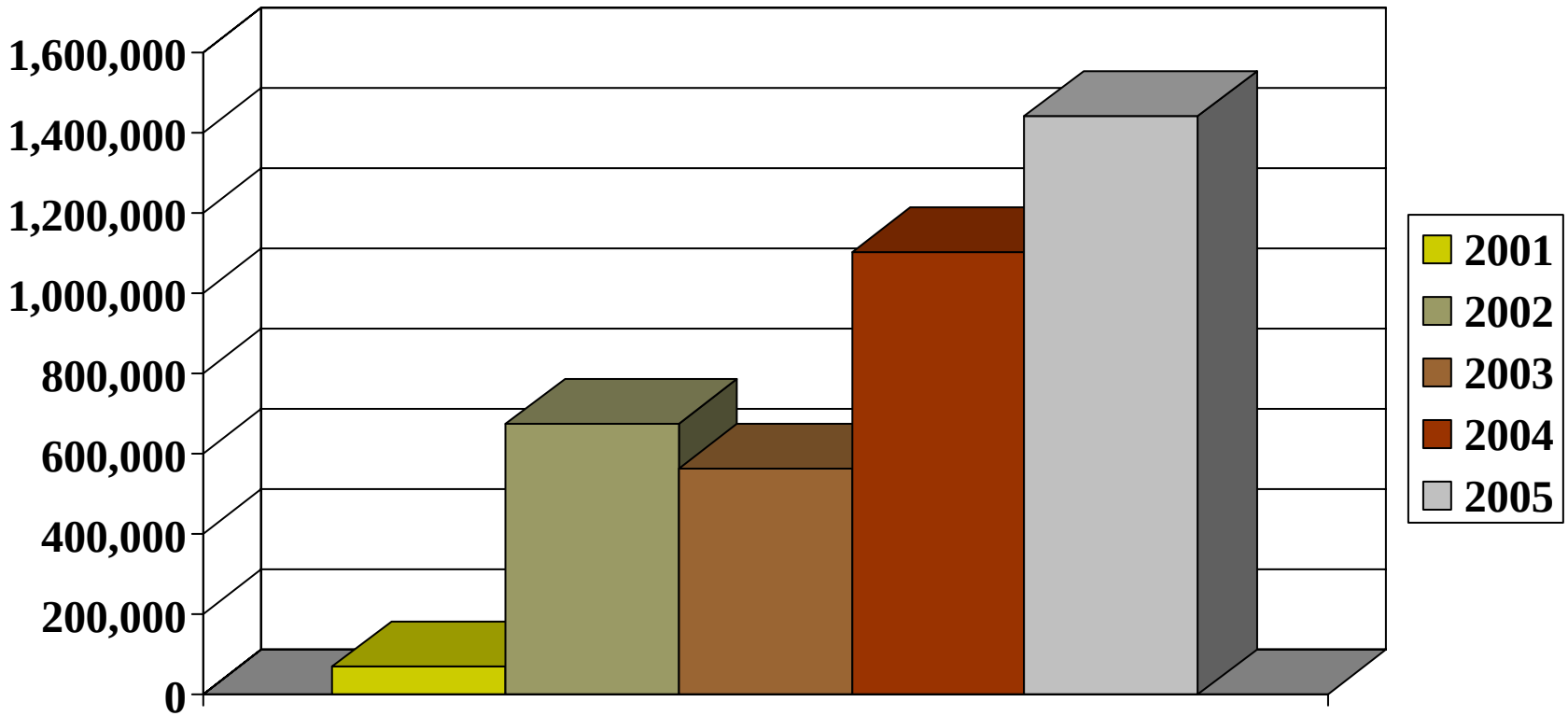
WHAT'S NEW IN FEEDING DISTILLER'S BY-PRODUCTS TO SWINE

Dr. Jerry Shurson
Department of Animal Science
University of Minnesota

Estimated DDGS Usage in U.S. Swine Feeds 2001-2005 (Metric Tonnes)



DDGS Feeding Limitations Have Been Identified

- Formulate diets on a digestible amino acid basis if > 10% is added to corn-SBM diets
- Adding DDGS to swine diets will generally:
  - reduce dry matter digestibility
  - slightly increase manure output
  - increase N excretion
  - reduce P concentration in manure if formulations based on available P
- Pork fat quality and belly firmness appear to be reduced when > 20% DDGS is added to the diet
- Feed intake and growth rate may be reduced when added to diets for pigs weighing less than 15 lbs
- Sows may require a short adaptation period when abruptly switching from a corn-soybean meal diet to a diet containing high levels of DDGS

Barriers for Increased DDGS Use in Swine Diets

- Variability in nutrient content and digestibility
- Low particle size and flowability problems in some sources
- Perceived risk of mycotoxins (sows)
- Ability to pellet DDGS diets
- Understanding and managing effects on pork fat quality

Barriers for Increased DDGS Use in Swine Diets

- Controversy over palatability and negative effects on feed intake at high dietary inclusion rates
- Fast, accurate, and inexpensive *in vitro* methods to estimate amino acid digestibility among sources
- Net energy values
- Need for research and education to avoid confusion over new types of Distiller's By-products

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

Averages, Coefficients of Variation, and Ranges of Selected Nutrients Among 32 U.S. DDGS Sources (100% Dry Matter Basis)

Nutrient	Average	Range
Dry matter, %	89.3	87.3 – 92.4
Crude protein, %	30.9 (4.7)	28.7 – 32.9
Crude fat, %	10.7 (16.4)	8.8 – 12.4
Crude fiber, %	7.2 (18.0)	5.4 – 10.4
Ash, %	6.0 (26.6)	3.0 – 9.8
Swine ME, kcal/kg	3810 (3.5)	3504 – 4048
Lysine, %	0.90 (11.4)	0.61 – 1.06
Phosphorus, %	0.75 (19.4)	0.42 – 0.99

Variability (CV, %) of Selected Nutrients Among U.S. DDGS Sources vs. U.S. Soybean Meal Sources

Nutrient	DDGS	Soybean Meal
Crude protein	4.5	2.3
Crude fat	17.1	30.9
Crude fiber	18.9	9.5
Ash	27.2	6.6
Lysine	12.1	3.0
Methionine	8.5	5.3
Threonine	5.8	4.2
Tryptophan	12.0	7.3
Calcium	117.5	25.8
Phosphorus	19.4	9.1

Key Points for Evaluating and Using DDGS and New Distiller's By-Products in Swine Diets

- Remember the primary components that affect nutritional and economic value
  - Metabolizable energy
  - Level and digestibility of amino acids
  - Level and availability of P
- Minimize variability in nutrient content by limiting the number of DDGS sources used
- Question generic nutrient specification values provided by the supplier when formulating diets

Key Points for Evaluating and Using DDGS and New Distiller's By-Products in Swine Diets

- Request current, complete nutrient profiles from source(s) being considered
  - www.ddgs.umn.edu
- Request evidence of mycotoxin screening procedures and quality control procedures from each source
- Although higher protein distiller's by-products may initially appear to have higher value, they are:
  - generally lower in fat and P content
  - still have inferior protein quality

Effects of Feeding DDGS to Grow-Finish Pigs on Carcass and Pork Quality

Materials and Methods

- 240 crossbred pigs (~ 63 lbs initial BW)
  - Grow-finish facilities at WCROC – Morris, MN
  - Blocked by weight, gender and litter
  - Blocks randomly assigned to 1 of 4 diet sequences
    - 5-phase feeding program
  - 0, 10, 20, or 30% DDGS diets **formulated on total lysine basis**
  - **Diets contained up to 4% soybean oil** as a supplemental fat source
  - 24 pens, 10 pigs/pen, 6 replications/trt

Effect of Dietary DDGS Level on Carcass Characteristics of Grow-Finish Pigs

	0% DDGS	10% DDGS	20% DDGS	30% DDGS
Slaughter weight, lbs	258	263	249	247
Carcass weight, lbs	189[c]	191[c]	180[d]	178[d]
Dressing %	73.4[c]	72.8[c]	72.1[d]	71.9[d]
Fat depth, in.	0.85	0.87	0.84	0.82
Loin depth, in.	2.26[ac]	2.16[b]	2.19[c]	2.06[d]
% Lean	52.6	52.0	52.6	52.5

[a, b] Means within row with unlike superscripts differ (P < .05).

[c, d] Means within row with unlike superscripts differ (P < .10).

Muscle Quality Characteristics from G-F Pigs Fed Diets Containing 0, 10, 20, and 30% DDGS

Trait	0 %	10 %	20 %	30 %	RMSE
L*[a]	54.3	55.1	55.8	55.5	2.9
Color score[b]	3.2	3.2	3.1	3.1	0.8
Firmness score[c]	2.2	2.0	2.1	2.1	0.5
Marbling score[d]	1.9	1.9	1.7	1.9	0.6
Ultimate pH	5.6	5.6	5.6	5.6	0.2
11-d purge loss, %	2.1[a]	2.4	2.8[b]	2.5	1.2
24-h drip loss	0.7	0.7	0.7	0.7	0.2
Cooking loss, %	18.7	18.5	18.3	18.8	2.6
Total moisture loss[e], %	21.4	21.5	21.8	22.1	3.1
Warner-Bratzler sheer force, kg	3.4	3.4	3.3	3.3	0.5

[a] 0 = black, 100 = white
[b] 1=pale pinkish gray/white; 2=grayish pink; 3=reddish pink; 4=dark reddish pink; 5=purplish red; 6=dark purplish red
[c] 1 = soft, 2 = firm, 3 = very firm
[d] Visual scale approximates % intramuscular fat content (NPPC, 1999)
[e] Total moisture loss = 11-d purge loss + 24-h drip loss + cooking loss

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

	0 %	10%	20%	30%
Belly thickness, cm	3.15[a]	3.00[ab]	2.84[bc]	2.71[c]
Belly firmness score, degrees	27.3[a]	24.4[a]	25.1[a]	21.3[b]
Adjusted belly firmness score, degrees	25.9[d]	23.8[de]	25.4[d]	22.4[e]
Iodine number	66.8[d]	68.6[e]	70.6[f]	72.0[f]

[a, b, c] Means within rows with unlike superscripts differ (P < .10).
[d, e, f] Means within rows with unlike superscripts differ (P < .05).

U of M/Land O' Lakes Pork Fat Quality Field Study (2006)

- Facilities
  - Two commercial 1000 head finishing barns in southern MN
  - Separate sites, two independent producers
  - Each barn had 40 pens, double sided curtain
    - buildings with 8' pits
    - pit fans for ventilation
    - weighted baffle ceiling air inlets

- Genetics
  - Monsanto Genepacker sows
  - Monsanto EB terminal semen

U of M/Land O' Lakes Pork Fat Quality Field Study (2006)

- Health
  - Positive-stable for PRRS
  - Positive for Mycoplasma, but do not vaccinate
  - Negative for APP
  - Health of pigs was good

U of M/Land O' Lakes Pork Fat Quality Field Study (2006)

- **Nutrition**
  - Provided by Land O' Lakes
  - Producer A fed typical corn-soybean meal diets
  - Producer B fed corn-soybean meal diets containing 10% DDGS
  - 7-phase mixed sex feeding program
  - Last finisher diet contained 4.5g Paylean
  - Diets contained similar nutrient levels with and without 10% DDGS
  - All diets contained choice white grease as the supplemental fat source (1.25 to 3.75%).

Carcass Characteristics of Grow-Finish Pigs Fed 0 or 10% DDGS Diets (UM/LOL Field Trial)

Measurement	0% DDGS Diets	10% DDGS Diets
Carcass weight, lbs	212	210
Last rib backfat, in.	1.09	1.11
Tenth rib backfat, in.	1.01	0.99
Ham, %	11.74	11.74
Loin, %	7.93	7.91
Belly, %	10.51	10.41
Loin depth, in.	2.72	2.72
Lean %	56.36	56.47

No significant differences in carcass characteristics.

Mid-Belly Fat Quality Characteristics of Carcasses of Grow-Finish Pigs Fed 0 or 10% DDGS Diets (UM/LOL Field Trial)

Measurement	0% DDGS Diets	10% DDGS Diets
Japanese fat color score (1-4)	1.76	1.81
Mean melting point, °C	29.26	28.70
Iodine value	66.7[a]	68.3[b]
14:0, 16:0, 16:1, 17:0, 17:1, 18:0, %	No differences	No differences
18:1 oleic acid, %	47.39[c]	45.12[d]
18:2 linoleic acid, %	11.94[c]	13.98[d]
18:3, 18:4, 20:0, 20:1, 20:2, 20:4, %	No differences	No differences
Saturated fatty acids, %	33.99	34.26
Monounsaturated fatty acids, %	51.78[c]	49.47[d]
PUFA, %	14.02[c]	16.11[d]
Total Omega 3, %	0.98	0.96
Total Omega 6, %	13.02[c]	15.14[d]
Omega 6:Omega 3 ratio	13.28[c]	15.78[d]

[a, b] Means within rows with unlike superscripts differ (P < .05).
[c, d] Means within rows with unlike superscripts differ (P < .0001).

Effects of Feeding DDGS to Grow-Finish Pigs on Feed Intake

Effect of Feeding Diets Containing DDGS on Feed Intake of Growing Pigs (Published)

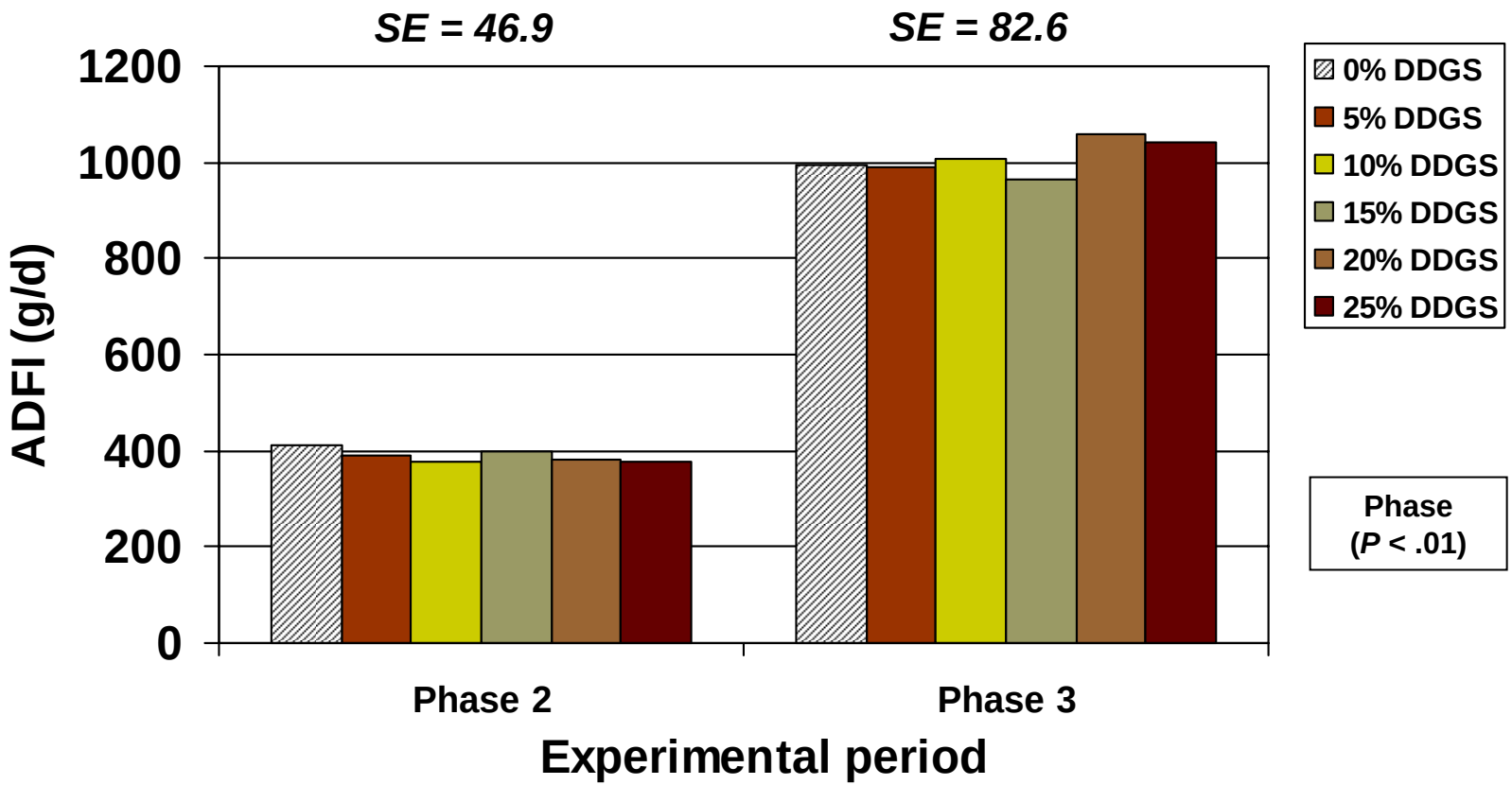
No Effect

- Hansen, E.L., G.W. Libal, D.N. Peters, and C.R. Hamilton. 1997. J. Anim. Sci. Vol. 75 (Suppl. 1) p. 194.
- Whitney, M.H., G.C. Shurson, L.J. Johnston, D. Wulf, and B. Shanks. 2001. J. Anim. Sci. 79:108 (Suppl. 1).
- Whitney, M.H. and G.C. Shurson. 2004. J. Anim. Sci. 82:122-128.
- DeDecker, J.M., M. Ellis, B.F. Wolter, J. Spencer, D.M. Webel, C.R. Bertelsen, and B.A. Peterson. 2005. J. Anim. Sci. Vol. 83 (Suppl. 2) p. 79.

Decrease

- Fu, S.X., M. Johnston, R.W. Fent, D.C. Kendall, J.L. Usry, R.D. Boyd, and G.L. Allee. 2004. J. Anim. Sci. Vol. 82 (Suppl. 2) p. 50.
- Hastad, C.W., J.L. Nelssen, R.D. Goodband, M.D. Tokach, S.S. Dritz, J.M. DeRouchey, and N.Z. Frantz. 2005. J. Anim. Sci. Vol. 83 (Suppl. 2) p. 73.

Effect of DDGS Level on ADFI of Nursery Pigs (>15 lbs BW)



Whitney and Shurson (2004)

Effect of Dietary DDGS Level on Overall Growth Performance of Grow-Finish Pigs

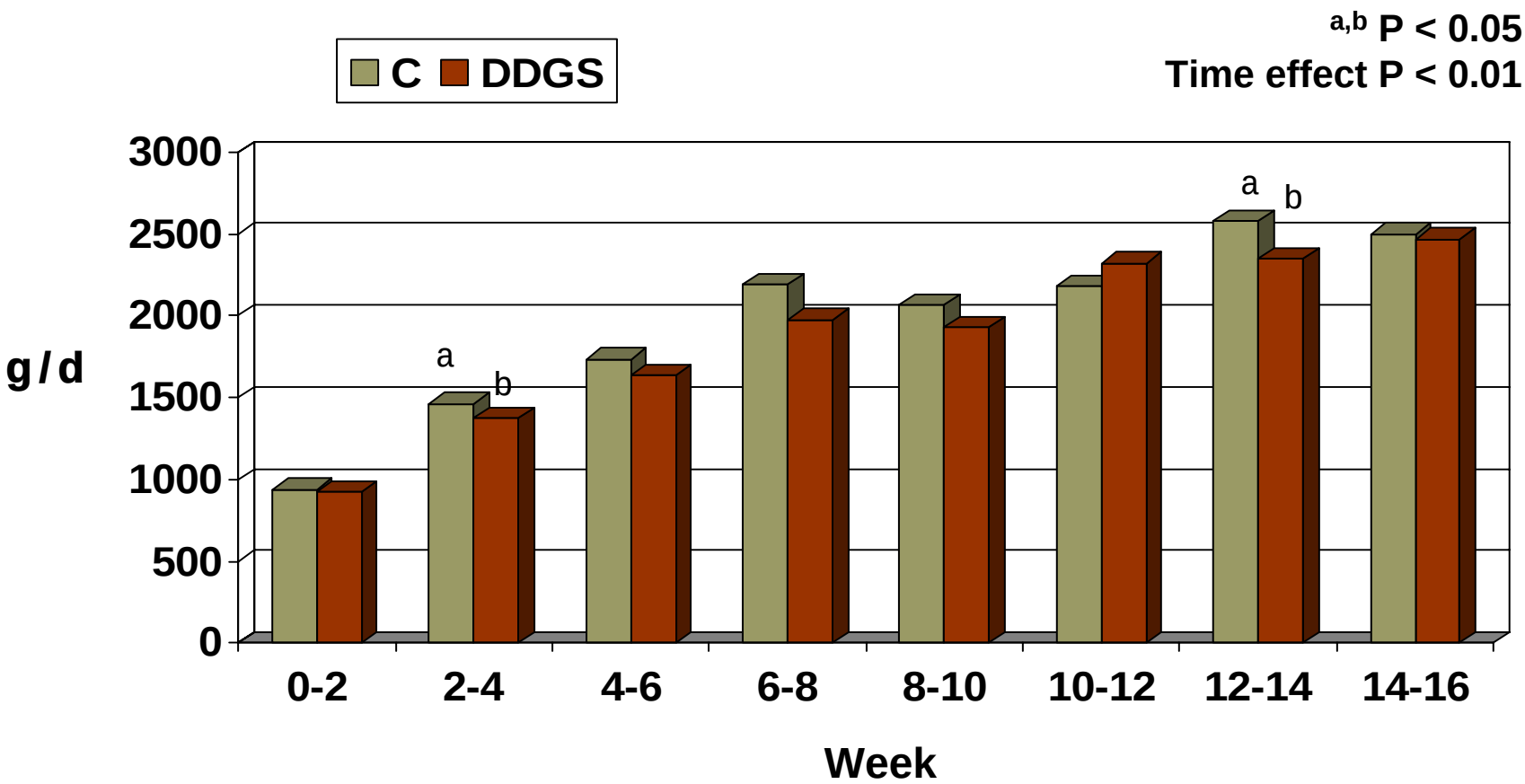
	0% DDGS	10% DDGS	20% DDGS	30% DDGS
ADG, lbs	1.90[a]	1.89[a]	1.82[bc]	1.78[bd]
ADFI, lbs	5.24	5.22	5.09	5.19
F/G	2.76[a]	2.76[a]	2.80[a]	2.92[b]
Final Wt., lbs	258[a]	259[a]	252[b]	247[b]

Whitney et al. (2006, in press)

[a, b] Means within row with unlike superscripts differ (P < .05).

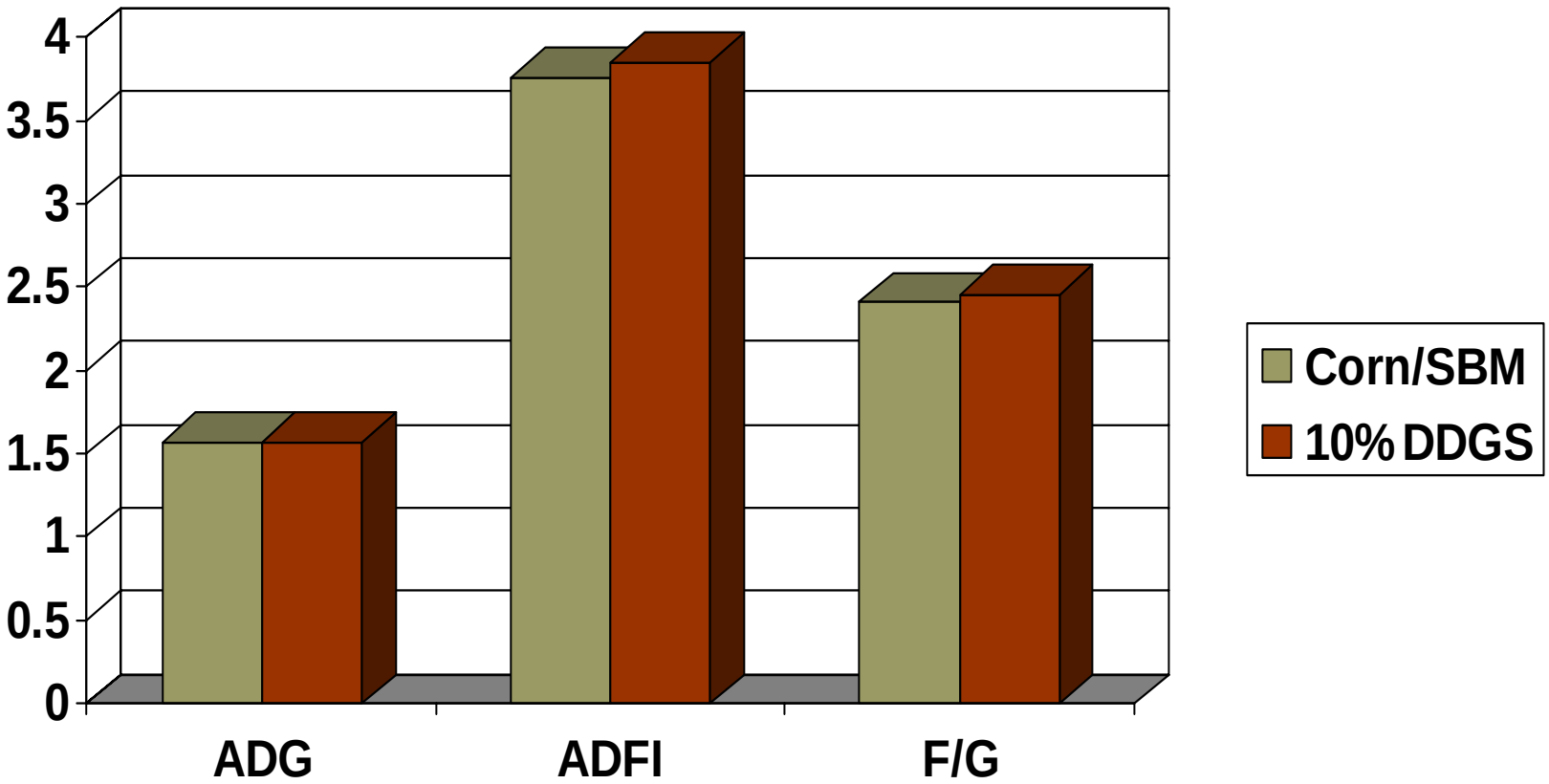
[c, d] Means within row with unlike superscripts differ (P < .10).

Effect of Feeding a Diet Containing 50% DDGS on ADFI (g/d) of Growing-Finishing Pigs



Spiehs et al. (2004)

Effect of Adding 10% DDGS to Grow-Finish Diets on ADG, ADFI, and F/G for a 64 d Grow-Finish Period



Lawrence (2003) – Hubbard Milling Commercial Feeding Trial

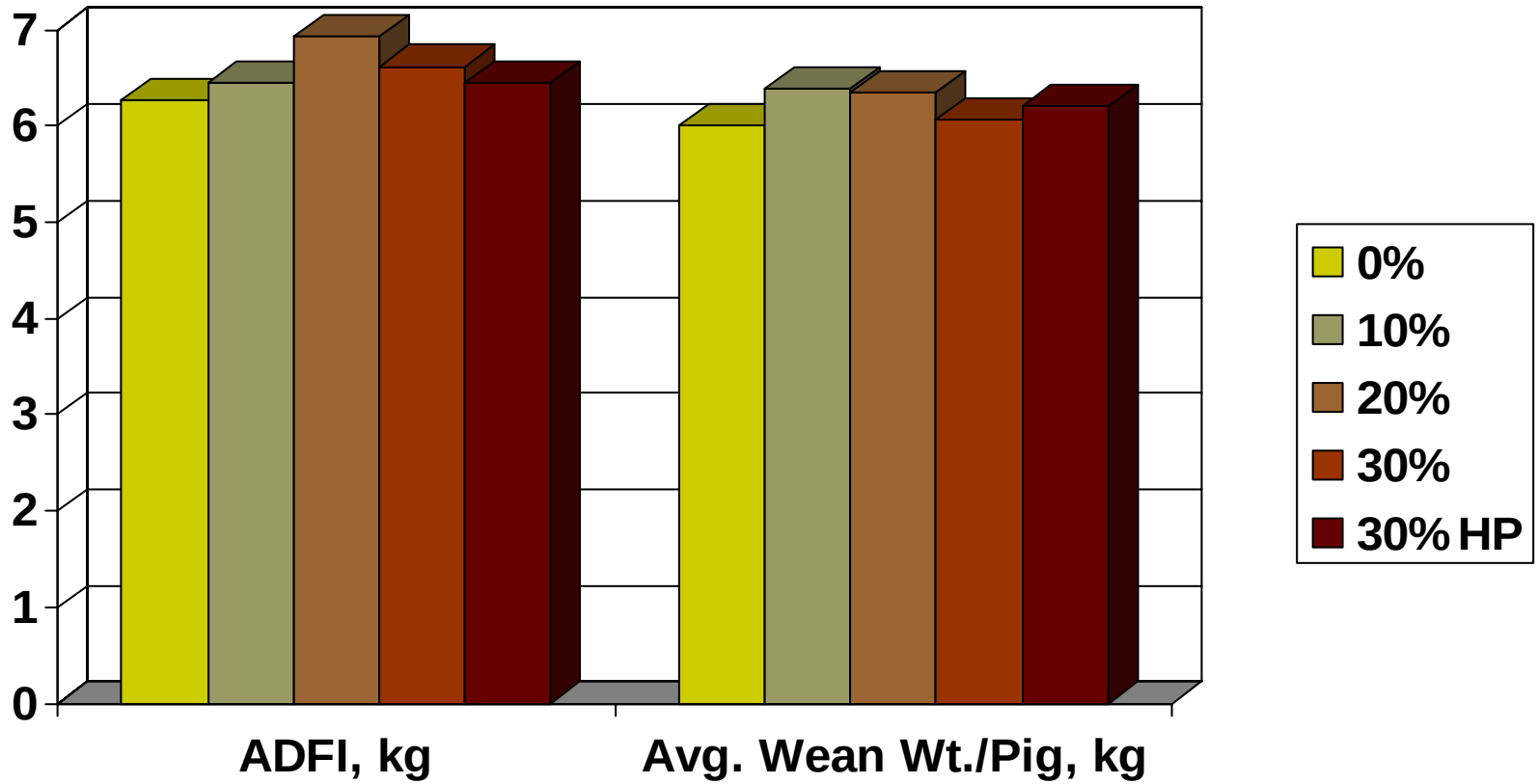
Typical Grow-Finish Pig Performance When 10% DDGS is Added to the Diet in a 1000 Head Commercial Finishing Barn

Grow-Finish Pigs Fed Diets Containing DDGS

	No DDGS	10% DDGS
Pigs in	993	988
Pigs Out	979	971
Daily Gain, lb	1.63	1.62
Feed:Gain	2.75	2.74
Feed cost, $/hd	$32.69	$32.53

Source: Land O'Lakes/Purina Feed

Effects of Feeding Increasing Levels of DDGS to Lactating Sows on Average Daily Feed Intake and Average Pig Weight at Weaning Song et al. (2006)



Utilized 323 lactating sows (65 sows/dietary treatment)
Song et al. (2006), unpublished

Effects of Feeding Increasing Levels of DDGS to Grower-Finisher Pigs on Growth Performance Over a 92-Day Feeding Period

	0% DDGS	10% DDGS	20% DDGS	30% DDGS
ADG, lbs	2.27	2.23	2.18	2.16
ADFI, lbs	5.64	5.58	5.38	5.31
G/F	0.405	0.400	0.407	0.405
Final body wt., lbs	273	268	267	262

Fu et al. (2004)
Significant linear decrease in ADG, ADFI, and Final Body Wt. as DDGS Level Increased
Significant linear increase in G/F as DDGS Level Increased

Effect of DDGS Level on ADFI[a] of Growing-Finishing Pigs

DDGS	0%	10%	20%	30%
Phase 1, lb[b]	3.34	3.29	3.20	3.03
Phase 2, lb[c]	5.04	5.02	4.84	4.65
Phase 3, lb[c]	5.84	5.83	5.60	5.57
Phase 4, lb	6.53	6.77	6.51	6.43
Phase 5, lb	7.35	7.29	7.27	7.08
Overall[b]	5.93	5.96	5.81	5.67

[a]Data are means of 48 individually penned pigs
[b]Linear effect of increasing DDGS in the diet ($P < 0.01$)
[c]Linear effect of increasing DDGS in the diet ($P < 0.05$)

Source: de Rodas (2005) LOL-Purina Feeds

Take Home Message

- The increase in demand for corn by the ethanol industry will
  - reduce amount of corn available for feed
  - increase the price of corn
- DDGS will continue to be used to a greater extent in pork production
  - increased supply of DDGS
  - cost effectiveness of partially replacing some corn, soybean meal and inorganic P
- Challenges
  - identifying high quality, consistent sources
  - evaluating the feeding value of new fractionated by-products

Take Home Message

- Feeding diets containing 10% DDGS to growing-finishing pigs result in
  - Acceptable growth performance
  - Acceptable carcass quality
- Linoleic acid and unsaturated fatty acids increase as increasing levels of DDGS are added to the diet.
- Using a carcass fat iodine value of 70 as a standard
  - DDGS can likely be added to grower-finisher diets at levels up to 20% before the amount of unsaturated fatty acids in pork fat become a concern
- It is unclear why increasing levels of DDGS in swine diets decrease feed intake in a few studies
  - DDGS quality?
  - Presence of anti-palatability compounds?
  - Pig performance level?

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

We have developed a DDGS web site featuring:

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