Kansas Agricultural Experiment Station Research Reports

Volume 7
Issue 11 *Swine Day*

Article 27

2021

Evaluation of Vegetable Protein Sources on Nursery Pig Performance in a Commercial Environment

Rafe Q. Royall
Kansas State University, rroyall@ksu.edu

Joel M. DeRouchey
Kansas State University, jderouch@ksu.edu

Mike D. Tokach
Kansas State University, mtokach@k-state.edu

See next page for additional authors

Recommended Citation

Royall, Rafe Q.; DeRouchey, Joel M.; Tokach, Mike D.; Woodworth, Jason C.; Goodband, Robert D.; Gebhardt, Jordan T.; and Haydon, Keith D. (2021) "Evaluation of Vegetable Protein Sources on Nursery Pig Performance in a Commercial Environment," *Kansas Agricultural Experiment Station Research Reports*: Vol. 7: Iss. 11. https://doi.org/10.4148/2378-5977.8191

Evaluation of Vegetable Protein Sources on Nursery Pig Performance in a Commercial Environment

Funding Source

The authors appreciate CJ America-Bio (Downers Grove, IL) for financial support.

Authors

Rafe Q. Royall, Joel M. DeRouchey, Mike D. Tokach, Jason C. Woodworth, Robert D. Goodband, Jordan T. Gebhardt, and Keith D. Haydon

Evaluation of Vegetable Protein Sources on Nursery Pig Performance in a Commercial Environment[1]

Rafe Q. Royall, Joel M. DeRouchey, Mike D. Tokach, Jason C. Woodworth, Robert D. Goodband, Jordan T. Gebhardt,[2] and Keith D. Haydon[3]

Summary

This experiment was conducted to determine the effect of vegetable protein sources on growth and economic performance of nursery pigs in a commercial research environment. A total of 2,592 pigs (L337 × 1050, PIC; initial BW of 11.8 ± 0.11 lb) were used in a 42-d study. Pens of pigs were blocked by BW and weaning date and allotted to 1 of 6 dietary treatments in a randomized complete block design with 27 pigs per pen and 16 replications per treatment across 2 rooms. Similar numbers of barrows and gilts were placed in each pen. There were six dietary treatments which included: 1) soybean meal control diet with no specialty vegetable protein source, and 5 diets containing either 2) soy protein concentrate 1; 3) soy protein concentrate 2; 4) enzyme-treated soybean meal; 5) fermented soybean meal; and 6) high protein corn DDGS. Treatment diets were formulated in two dietary phases and fed at a rate of 5 lb/pig and 18 lb/pig, respectively, with a common phase 3 diet fed for the remainder of the study. During the experimental diet feeding period (d 0 to 21) or overall (d 0 to 42), there was no evidence of difference ($P > 0.05$) for BW, ADG, ADFI, or F/G. Additionally, there was no evidence of significant difference ($P > 0.05$) for total removals, removals, or mortality. For economic analysis, there was no evidence for significant difference ($P > 0.05$) for any response criteria. In summary, no differences existed between soybean meal and the specialty vegetable protein sources used in this study.

Introduction

Soybean meal is one of the most used and important protein sources in swine diets due to its highly concentrated and digestible AA profile.[4] However, the presence of various anti-nutritional factors such as trypsin inhibitors and antigens, along with indigestible

[1] The authors appreciate CJ America-Bio (Downers Grove, IL) for financial support.

[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

[3] CJ America-Bio, Downers Grove, IL.

[4] Stein, H. H., L. L. Berger, J. K. Drackley, G. C. Fahey Jr., D. C. Hernot, and C. M. Parsons. 2008. Nutritional properties and feeding values of soybeans and their coproducts. In: L. A. Johnson, P. J. White and R. Galloway, editors, Soybeans: chemistry, production, processing, and utilization. Urbana, IL: AOCS Press; p. 613–660.

oligosaccharides, can have adverse effects on nursery pig performance and health.[5] In addition, it has been demonstrated that further processed soybean meal and other vegetable protein sources can be more tolerable in weanling pigs when compared to conventional soybean meal. The suggested improvement in gastrointestinal health should therefore lead to improvements in growth performance and feed efficiency during the early nursery period. Therefore, the objective of this study was to evaluate the effect of various specialty vegetable protein sources on nursery pig growth, feed efficiency, and economic performance.

Materials and Methods

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. This study was conducted at a commercial nursery research site owned and operated by New Horizon Farms (Pipestone, MN). This study was conducted in two rooms with 96 pens that were completely enclosed, environmentally controlled, and mechanically ventilated. Each pen (12 × 8 ft) had plastic slatted floors and was equipped with a six-hole stainless steel dry feeder and pan waterer to provide *ad libitum* access to feed and water. Feed additions were accomplished using a robotic feeding system (FeedPro, FeedLogic Corp., Wilmar, MN) that was able to record daily feed additions for individual pens. Pens of pigs were weighed, and feed disappearance was recorded weekly during the course of the study to determine ADG, ADFI, and F/G.

Animals and diets

A total of 2,592 pigs (L337 × 1050, PIC; initial BW 11.8 ± 0.11 lb) were used in a 42-d growth study with 27 pigs per pen. The rooms were filled over the course of 7 days and all pens were balanced equally with gilts and barrows. Pens of pigs were assigned to 1 of 6 dietary treatments with 16 replications per treatment in a randomized complete block design with pens blocked by BW and weaning date. Dietary treatments included: 1) soybean meal-based control diet with no specialty vegetable protein source, along with 5 diets containing either 2) soy protein concentrate 1 (XSoy 600; CJ America-Bio Downers Grove, IL); 3) soy protein concentrate 2 (Soytide 600; CJ America-Bio Downers Grove, IL); 4) enzyme-treated soybean meal (HP 300; Hamlet Protein, Findlay, OH); 5) fermented soybean meal (Fermex 200; Purina Animal Nutrition, Shoreview, MN); and 6) high protein corn DDGS (NexPro; POET, Wichita, KS). Pigs were fed based on a budget and received 5 lb of phase 1 diet and then 18 lb of phase 2 diet. A common diet, without specialty vegetable protein sources, was fed from the end of phase 2 until d 42 (Tables 1 and 2). On d 21, 1 room of pigs (8 reps per treatment) was removed from the trial due to a PRRSV outbreak. Data from this room of pigs were included during the experimental period (d 0 to 21), but not the subsequent common period (d 21 to 42).

For experimental diets in phase 1, a control corn-soybean meal-based diet was formulated to meet or exceed NRC[6] requirement estimates. A diet with 5% soy protein concentrate 1 replacing soybean meal was formulated, then all remaining treatment

[5] Espinosa, C. D., M. S. Oliveira, L. V. Lagos, T. L. Weeden, A. J. Mercado, and H. H. Stein. 2020. Nutritional value of a new source of fermented soybean meal fed to growing pigs. J. Anim. Sci., 98:1-9. doi:10.1093/jas/skaa357.

[6] National Research Council. 2012. Nutrient Requirements of Swine: Eleventh Revised Edition. Washington, DC: The National Academies Press. https://doi.org/10.17226/13298.

diets were formulated to contain equal levels of SID Lys from the respective vegetable protein sources as that of the soy protein concentrate 1. For phase 2 diets, the level of each specialty vegetable protein source was set to half the phase 1 inclusion rate. Phase 1 diets were manufactured by Hubbard Feeds (Worthington, MN) and fed in pellet form, while phases 2 and 3 were manufactured by New Horizon Farms (Pipestone, MN) and fed in meal form.

Economic analysis

For the economic analysis, feed cost/pig, feed cost/lb of gain, revenue/pig, and income over feed costs (IOFC) were calculated for high- and low-priced diets, based on number of pigs placed and number of pigs marketed. Specialty vegetable protein source prices were set at: Xsoy 600 = $850/ton; Soytide = $800/ton; HP 300 = $1,040/ton; Fermex 200 = $545/ton; and NexPro = $510/ton. Diet costs were determined using the following ingredient costs for the high-priced diets: corn = $6.00/bu ($214/ton); soybean meal = $400/ton; L-Lys HCl = $0.80/lb; DL-Met = $2.50/lb; L-Trp = $5.00/lb; L-Val = $4.00/lb; and Threo Pro = $0.66/lb. Diet costs were determined using the following ingredient costs for the low-priced diets: corn = $3.00/bushel ($107/ton); soybean meal = $300/ton; L-Lys HCl = $0.65/lb; DL-Met = $1.70/lb; L-Thr = $0.850lb; L-Trp = $3.00/lb; L-Val = $2.50/lb; and Threo Pro = $0.66/lb. Feed cost/pig was determined by total feed intake (d 0-21) × diet cost ($/lb). Feed cost/lb of gain was calculated using feed cost/pig divided by total gain. Revenue/pig was determined for both a high price and a low price by total gain × 0.75 × $0.88/lb live gain, or total gain × 0.75 × $0.60/lb live gain, respectively. Margin over feed cost was calculated using revenue/pig – feed cost/pig.

Statistical analysis

Data were analyzed as a randomized complete block design for a one-way ANOVA using the lmer function from the lme4 package in R Studio (Version 3.5.2, R Core Team. Vienna, Austria) with pen serving as the experimental unit, weaning date and initial BW as blocking factor, and treatment as fixed effect. Differences between treatments were determined using estimated marginal means. When treatment was a significant source of variation, differences were determined by pairwise comparison using the Tukey-Kramer multiplicity adjustment to control for type I error. Results were considered significant with $P \leq 0.05$ and were considered marginally significant with $P \leq 0.10$.

Results and Discussion

From d 0 to 21, there was no evidence of difference ($P > 0.05$) for ADG, ADFI, or F/G (Table 3). However, at d 21 there was a tendency for differences ($P = 0.089$) in BW, with pigs fed diets containing the fermented soybean meal product having the greatest numeric BW and the control diet the lowest. During the common phase (d 21 to 42), there was marginally significant evidence that one treatment differed from another, but when using a Tukey multiple comparison adjustment, no pairwise differences ($P > 0.05$) for ADG and ADFI were observed. For the overall trial period (d 0 to 42), there was no evidence of difference ($P > 0.05$) for any response criteria. Additionally, there was no evidence of significant difference ($P > 0.05$) for total removals, removals, or mortality.

For economic analysis there was no evidence for significant difference ($P > 0.05$) for any response criteria. However, the fermented SBM product numerically had the greatest IOFC for each analyzed economic scenario.

In summary, feeding pigs the specialty vegetable protein sources did not significantly impact growth performance, mortality, removals, or economic return during the nursery period, compared with those pigs fed soybean meal. Thus, it appears that any of various vegetable protein sources in this study can be used to reduce the amount of soybean meal in the starter diets, although none resulted in improved performance over the control diet.

Table 1. Composition of phase 1 diets (as-fed basis)[1]

		Vegetable protein source				
Item	**Control[2]**	**Soy protein concentrate 1[3]**	**Soy protein concentrate 2[3]**	**Enzyme-treated SBM[3]**	**Fermented SBM[3]**	**High protein corn DDGS[3]**
Ingredient, %						
Corn	40.39	42.08	41.59	41.50	40.46	39.60
Soybean meal (46.5% CP)	28.94	22.17	22.18	22.18	22.19	22.19
Soy protein concentrate 1	---	5.00	---	---	---	---
Soy protein concentrate 2	---	---	5.50	---	---	---
Enzyme-treated SBM	---	---	---	5.70	---	--
Fermented SBM	---	---	---	---	6.70	---
High protein corn DDGS	---	---	---	---	---	7.50
Blood plasma	2.76	2.76	2.76	2.76	2.76	2.76
Whey powder	11.25	11.25	11.25	11.25	11.25	11.25
Whey permeate, 80% lactose	10.00	10.00	10.00	10.00	10.00	10.00
Choice white grease	3.00	3.00	3.00	3.00	3.00	3.00
Limestone	0.95	0.95	0.95	0.95	0.95	0.93
Monocalcium phosphate (21% P)	0.95	1.05	1.03	0.93	0.95	0.95
Salt	0.25	0.25	0.25	0.25	0.25	0.25
L-Lys-HCl	0.35	0.35	0.35	0.35	0.35	0.46
DL-Met	0.23	0.23	0.23	0.22	0.23	0.20
L-Thr	0.19	0.19	0.19	0.19	0.19	0.19
L-Trp	0.01	0.01	0.01	0.01	0.00	0.02
L-Val	0.10	0.09	0.09	0.09	0.08	0.08
Phytase[4]	0.02	0.02	0.02	0.02	0.02	0.02
Vitamin premix	0.05	0.05	0.05	0.05	0.05	0.05
Trace mineral premix	0.13	0.13	0.13	0.13	0.13	0.13
Selenium premix (0.06%)	0.05	0.05	0.05	0.05	0.05	0.05
Zinc oxide[5]	0.40	0.40	0.40	0.40	0.40	0.40
Total	100	100	100	100	100	100

continued

Table 1. Composition of phase 1 diets (as-fed basis)[1]

	Vegetable protein source					
Item	Control[2]	Soy protein concentrate 1[3]	Soy protein concentrate 2[3]	Enzyme-treated SBM[3]	Fermented SBM[3]	High protein corn DDGS[3]
Calculated analysis						
SID AA, %						
Lys, %	1.40	1.40	1.40	1.40	1.40	1.40
Ile:Lys	57	57	57	58	58	56
Leu:Lys	114	115	116	115	115	124
Met:Lys	36	36	36	35	36	35
Met and Cys:Lys	59	59	59	59	59	59
Thr:Lys	65	65	65	65	65	65
Trp:Lys	19.2	19.0	19.1	19.2	19.3	19.2
Val:Lys	70	70	70	70	70	70
His:Lys	36	36	36	36	36	36
ME, kcal/lb	1,575	1,586	1,538	1,581	1,529	1,589
NE, kcal/lb	1,177	1,187	1,155	1,190	1,141	1,104
SID Lys:NE, g/Mcal	5.40	5.35	5.50	5.33	5.56	5.75
CP, %	21.7	21.6	21.6	21.7	21.5	22.2
Ca, %	0.73	0.75	0.74	0.72	0.74	0.70
Available P, %	0.54	0.55	0.54	0.54	0.53	0.54
STTD P, %	0.57	0.57	0.56	0.56	0.57	0.57

[1]Phase 1 diets were fed at a rate of 5 lb per pig and manufactured by Hubbard Feeds (Worthington, MN).
[2]The control diet did not contain any specialty vegetable protein source.
[3]1) XSoy 600; CJ America-Bio, Downers Grove, IL. 2) Soytide; CJ America-Bio, Downers Grove, IL. 3) HP 300; Hamlet Protein, Findlay, OH. 4) Fermex 200; Purina Animal Nutrition, Shoreview, MN. 5) NexPro; POET, Wichita, KS.
[4]Quantum Blue 5G (AB Vista, Plantation, FL) provided 889 FTU/lb.
[5]ZnO was fed to supply 3,000 ppm of Zn.

Table 2. Composition of phase 2 and 3 diets (as-fed basis)[1]

	Phase 2						
	Vegetable protein source						Phase 3
Item	Control[2]	Soy protein concentrate 1[3]	Soy protein concentrate 2[3]	Enzyme-treated SBM[3]	Fermented SBM[3]	High protein corn DDGS[3]	Common diet
Ingredient, %							
Corn	52.11	52.91	52.66	52.62	52.12	51.63	51.61
Soybean meal	33.3	29.95	29.95	29.95	29.95	29.95	28.16
Soy protein concentrate 1	---	2.50	---	---	---	---	---
Soy protein concentrate 2	---	---	2.75	---	---	---	---
Enzyme-treated SBM	---	---	---	2.83	---	--	---
Fermented SBM	---	---	---	---	3.35	---	---
High protein corn DDGS	---	---	---	---	---	3.75	---
DDGS	---	---	---	---	---	---	15.00
Whey permeate, 80% lactose	9.00	9.00	9.00	9.00	9.00	9.00	---
Choice white grease	1.00	1.00	1.00	1.00	1.00	1.00	2.00
Limestone	0.88	0.85	0.85	0.88	0.85	0.88	1.13
Monocalcium phosphate	1.10	1.18	1.18	1.13	1.13	1.13	0.16
Sodium chloride	0.55	0.55	0.55	0.55	0.55	0.55	0.60
L-Lys-HCl	0.45	0.45	0.45	0.45	0.45	0.51	0.52
DL-Met	0.23	0.23	0.23	0.23	0.23	0.21	0.15
THR Pro[4]	0.28	0.28	0.28	0.28	0.28	0.29	0.19
L-Trp	0.02	0.02	0.02	0.02	0.02	0.03	0.04
L-Val	0.14	0.13	0.13	0.13	0.13	0.13	---
Phytase[5]	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Vitamin trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Zinc oxide[6]	0.25	0.25	0.25	0.25	0.25	0.25	---
Aureomycin 90	0.34	0.34	0.34	0.34	0.34	0.34	0.34
Denegard 10	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Total	100	100	100	100	100	100	100

continued

Table 2. Composition of phase 2 and 3 diets (as-fed basis)[1]

	Phase 2						
	Vegetable protein source						Phase 3
Item	Control[2]	Soy protein concentrate 1[3]	Soy protein concentrate 2[3]	Enzyme-treated SBM[3]	Fermented SBM[3]	High protein corn DDGS[3]	Common diet
Calculated analysis							
SID AA, %							
Lys, %	1.35	1.35	1.35	1.35	1.35	1.35	1.32
Ile:Lys	57	57	57	57	58	57	58
Leu:Lys	112	113	113	113	113	117	131
Met:Lys	37	37	37	37	37	37	35
Met and Cys:Lys	58	58	58	58	58	58	57
Thr:Lys	65	65	65	65	65	65	62
Trp:Lys	19.0	18.9	18.9	19.0	19.2	19.2	19.2
Val:Lys	70	71	71	70	71	71	65
His:Lys	36	36	36	36	36	36	39
ME, kcal/lb	1,511	1,516	1,492	1,513	1,488	1,517	1,541
NE, kcal/lb	1,119	1,124	1,108	1,126	1,102	1,083	1,133
SID Lys:NE, g/Mcal	5.47	5.45	5.53	5.44	5.56	5.66	5.28
CP, %	21.3	21.3	21.3	21.4	21.3	21.6	22.5
Ca, %	0.72	0.72	0.72	0.72	0.72	0.72	0.64
Available P, %	0.48	0.49	0.49	0.49	0.48	0.49	0.48
STTD P, %	0.52	0.53	0.53	0.53	0.53	0.53	0.37

[1]Phase 2 diets were fed from the completion of Phase 1 at a rate of 18 lb per pig and a phase 3 common diet was fed from the completion of Phase 2 until d 42 (approximately 39.8 lb BW). Both phase 2 and 3 diets were manufactured by New Horizon Farms (Pipestone, MN).
[2] The control diet did not contain any specialty vegetable protein source.
[3] 1) XSoy 600; CJ America-Bio, Downers Grove, IL. 2) Soytide; CJ America-Bio, Downers Grove, IL. 3) HP 300; Hamlet Protein, Findlay, OH. 4) Fermex 200; Purina Animal Nutrition, Shoreview, MN. 5) NexPro; POET, Wichita, KS.
[4] Threo Pro; CJ America-Bio, Downers Grove, IL.
[5] Optiphos Plus (Huvepharma, Peachtree City, GA) provided 790 FTU/lb.
[6] ZnO was fed to supply 2,000 ppm of Zn.

Table 3. Effects of vegetable protein sources on nursery pig performance[1,2]

	Vegetable protein source							
Item	Control[3]	Soy protein concentrate 1[4]	Soy protein concentrate 2[4]	Enzyme-treated SBM[4]	Fermented SBM[4]	High protein corn DDGS[4]	SEM	*P* =
BW, lb								
d 0	11.8	11.8	11.8	11.8	11.8	11.8	0.11	0.977
d 21	21.4	21.6	21.8	22.1	22.3	21.6	0.71	0.089
d 42	39.3	40.1	40.5	39.6	40.5	38.8	0.83	0.223
d 0 to 21 (Experimental period)								
ADG, lb	0.43	0.43	0.43	0.44	0.46	0.43	0.034	0.351
ADFI, lb	0.75	0.73	0.75	0.73	0.76	0.76	0.036	0.665
F/G	1.79	1.72	1.79	1.67	1.69	1.82	0.025	0.306
d 21 to 42 (Common period)								
ADG, lb	0.71	0.74	0.72	0.68	0.73	0.67	0.021	0.072
ADFI, lb	1.09	1.14	1.13	1.08	1.18	1.06	0.035	0.051
F/G	1.52	1.54	1.56	1.59	1.59	1.59	0.015	0.486
d 0 to 42								
ADG, lb	0.62	0.63	0.63	0.62	0.65	0.60	0.019	0.209
ADFI, lb	0.97	0.98	0.99	0.96	1.02	0.95	0.032	0.335
F/G	1.56	1.54	1.56	1.54	1.56	1.56	0.010	0.965
Total removal, %[5]	15.9	18.5	18.9	15.6	15.2	16.0	2.16	0.562
Removals, %	13.0	14.0	15.1	13.2	13.5	12.9	2.00	0.941
Mortality, %	2.8	4.4	3.7	2.3	1.6	3.0	0.99	0.221

[1] A total of 2,592 pigs (L337 × 1050, PIC; initial BW of 11.8 ± 0.11 lb) were used in a 42-d study with 27 pigs per pen and 16 replicates per treatment. On d 21, 1 room of pigs (8 reps per treatment) was removed from the trial because of a PRRSV outbreak.
[2] Pens of pigs were fed diets in 2 phases, with phase 1 diets being budgeted for 5 lb/pig, and phase 2 diets being budgeted for 18 lb/pig. Following phase 2 all pigs were fed a common diet.
[3] The control diet did not contain any specialty vegetable protein source.
[4] 1) XSoy 600; CJ America-Bio, Downers Grove, IL 2) Soytide; CJ America-Bio, Downers Grove, IL. 3) HP 300; Hamlet Protein, Findlay, OH. 4) Fermex 200; Purina Animal Nutrition, Shoreview, MN. 5) NexPro; POET, Wichita, KS.
[5] Removals and mortality data were measured from d 0 to 21.

Table 4. Effects of vegetable protein sources on nursery pig economics from d 0 to 21 (experimental period)[1,2]

	Vegetable protein source							
Item	Control[3]	Soy protein concentrate 1[4]	Soy protein concentrate 2[4]	Enzyme-treated SBM[4]	Fermented SBM[4]	High protein corn DDGS[4]	SEM	*P* =
$/pig placed at high ingredient and pig prices[5,6]								
Feed cost	3.69	3.70	3.74	3.82	3.78	3.78	0.162	0.867
Feed cost/lb gain[7]	0.472	0.464	0.476	0.460	0.444	0.479	0.0254	0.628
Revenue[8]	5.49	5.53	5.54	5.84	5.96	5.53	0.463	0.318
IOFC[9]	1.81	1.83	1.80	2.02	2.18	1.75	0.328	0.258
$/pig placed at low ingredient and pig prices[10]								
Feed cost	3.33	3.39	3.43	3.51	3.46	3.46	0.145	0.662
Feed cost/lb gain	0.427	0.426	0.436	0.423	0.406	0.438	0.0235	0.660
Revenue	3.75	3.77	3.78	3.98	4.07	3.77	0.316	0.318
IOFC	0.41	0.38	0.35	0.48	0.61	0.32	0.255	0.715

[1] A total of 2,592 pigs (L337 × 1050, PIC; initial BW of 11.8 ± 0.11 lb) were used in a 42-d study with 27 pigs per pen and 16 replicates per treatment. On d 21, 1 room of pigs (8 reps per treatment) were removed from the trial because of a PRRSV outbreak.

[2] Pens of pigs were fed diets in 2 phases, with phase 1 diets being budgeted for 5 lb/pig, and phase 2 diets being budgeted for 18 lb/pig. Following phase 2 all pigs were fed a common diet.

[3] The control diet did not contain any specialty vegetable protein source.

[4] 1) XSoy 600; CJ America-Bio, Downers Grove, IL. 2) Soytide; CJ America-Bio, Downers Grove, IL. 3) HP 300; Hamlet Protein, Findlay, OH. 4) Fermex 200; Purina Animal Nutrition, Shoreview, MN. 5) NexPro; POET, Wichita, KS.

[5] Specialty vegetable protein source prices were set at: Xsoy 600 = $850/ton; Soytide = $800/ton; HP 300 = $1,040/ton; Fermex 200 = $545/ton; NexPro = $510/ton.

[6] For high priced diets corn was valued at $6.00/bu ($214/ton), soybean meal at $400/ton, L-Lys HCl at $0.80/lb, DL-Met at $2.50/lb, L-Trp at $5.00/lb, L-Val at $4.00/lb, and Threo Pro at $0.66/lb.

[7] Feed cost/lb gain = (total feed cost/pig) / (total gain/pig).

[8] Revenue = (d 21 BW – d 0 BW) × 0.75 × gain value ($0.88/lb at high prices: $0.60/lb at low prices).

[9] IOFC = revenue – feed cost.

[10] For low-priced diets, corn was valued at $3.00/bu ($107.14/ton), soybean meal at $300/ton, L-Lys at $0.65/lb, DL-Met at $1.70/lb, L-Trp at $3.00/lb, and L-Val at $2.50/lb.