Kansas State University
College of Agriculture

SWINE DAY
2026

Effect of Nursery Phase Feeding Budget on Growth Performance, Economics, and Fecal Dry Matter in Nursery Pigs Raised Under Commercial Conditions

Julian Arroyave, Mike D. Tokach, Jason C. Woodworth, Joel M. DeRouchey, Robert D. Goodband, Katelyn N. Gaffield, Jordan T. Gebhardt[1], Jorge Estrada[2], Matt Frizzo[2], and Eric Parr[2]

Summary

This experiment was conducted in a commercial research facility to validate the results of a previous study conducted at Kansas State University swine facilities that observed no difference in overall growth performance, but better economic outcomes, when the feed budgets for the more complex diets (phases 1 and 2) were reduced and the simple diet (phase 3) budget increased. A total of 1,170 pigs (initially 12.5 ± 0.70 lb) were randomly assigned to one of three nursery phase feeding budgets under a randomized complete block design. There were 26 pigs per pen and 15 pens per treatment. The feed budgets for high, medium, and low programs were 4, 2, and 0 lb/pig for phase 1 and 12, 8, and 4 lb/pig for phase 2, respectively. All pigs were then fed common phase 3 and 4 diets thereafter. Phase 1 was formulated with specialty animal protein and lactose products and was formulated to contain 18.0% lactose with 16.3% soybean meal. In phase 2, specialty protein sources and the lactose level were reduced, with diets containing 7.2% lactose and 22.5% soybean meal. Phase 3 and 4 diets were corn-soybean meal-based with no specialty protein or lactose sources. Pigs were weighed and feed disappearance was measured on d 0, 7, 14, 21, 33, 42, and 63 to calculate ADG, ADFI, and F/G. Pigs fed the high-budget program tended ($P < 0.10$) to have increased ADG and ADFI during period 2 (d 14 to 33); however, by d 63, no differences between nursery budget programs were observed for any of the response criteria, removals, or mortality. Feed cost and feed cost per lb of gain decreased ($P < 0.001$) as the budget for phases 1 and 2 was reduced. Pigs fed the high-budget program had greater ($P = 0.049$) revenue than those fed the medium-budget program, with intermediate values observed in the low-budget program, which resulted in greater income over feed cost (IOFC; $P = 0.004$) for pigs fed the low-budget program compared with those fed the medium- or high-budget programs. Pigs fed the low-budget program had numerically lower fecal dry matter (DM) compared with pigs fed the medium- or high-budget programs. In conclusion, under commercial conditions, reducing the feed budget amounts of phases 1 and

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

2 of the nursery feeding program had minimal effects on pig growth performance and lowered feed cost and feed cost per unit of gain, resulting in greater IOFC.

Introduction

The use of complex diets for newly weaned pigs has been proposed as a nutritional strategy to increase diet palatability and thereby improve feed intake. Although complex diets can improve growth performance during the early nursery period and reduce removals and mortality, their use over a longer feeding period provides no economic or performance advantage because improvements in performance are not maintained throughout the nursery phase[3].

Previous research conducted at Kansas State University demonstrated that reducing phase 1 and 2 feed budgets immediately after weaning did not affect overall growth performance but improved economic outcomes[4]. However, these responses may have been influenced by the experimental conditions in university facilities, where health challenges are minimal and the pig-to-employee ratio is less than in commercial production. Therefore, the objective of the present experiment was to evaluate the effects of reducing phase 1 and 2 feed budgets on growth performance, economics, fecal dry DM, and pig cleanliness of pigs raised under commercial conditions.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The experiment was conducted in two rooms within the same barn at a commercial weaning-to-finishing facility in Carthage, IL. One room contained 24 pens and the other 21 pens. Each pen (10 × 19 ft) was equipped with a 6-hole dry feeder and two cup drinkers to provide ad libitum access to feed and water.

Animals and diets

A total of 1,170 pigs (PIC 337 × 1050, Hendersonville, TN) initially weighing 12.5 ± 0.70 lb were used in a 63-d study with 26 pigs per pen (13 gilts and 13 barrows) and 15 pens per treatment. Pigs were assigned to pens in groups of six pens and pens of pigs were then randomly assigned to dietary treatments in a randomized complete block design.

The three experimental treatments consisted of different budgets for phase 1 and 2 diets followed by common phase 3 and 4 diets. The feed budgets for high, medium, and low programs were 4, 2, and 0 lb/pig for phase 1 and 12, 8, and 4 lb/pig for phase 2, respectively. All diets were formulated to provide a SID Lys concentration of 1.35% with similar amino acid ratios across phases, but using different ingredient compositions (Table 1). Phase 1 diets contained specialty animal protein and lactose sources, including spray-dried bovine plasma and spray-dried whey, and were formulated to contain 18.0% lactose and 16.3% soybean meal. Zinc oxide was added to provide 3,000

[3] Lee, C. H., D. Y. Jung, M. J. Park, and C. Y. Lee. 2014. Effects of varying nursery phase-feeding programs on growth performance of pigs during the nursery and subsequent grow-finish phases. J. Anim. Sci. Technol. 56:24. doi:10.1186/2055-0391-56-24.

[4] Arroyave-Jaramillo, J., J. C. Woodworth, J. T. Gebhardt, M. D. Tokach, R. D. Goodband, K. N. Gaffield, and J. M. DeRouchey. 2025. Effect of weaning body weight and nursery phase feeding budget on nursery pig growth performance, fecal dry matter, and economics. J. Anim. Sci. 103 (Suppl. 1):73. doi:10.1093/jas/skaf102.080

mg/kg of Zn to phase 1 diets. In phase 2, spray-dried bovine plasma was removed, lactose was reduced to 7.2%, Zn was reduced to 2,000 mg/kg, and soybean meal was increased to 22.5%. Phase 3 diet was fed until d 42 of the experiment and consisted of a conventional corn-soybean meal-based diet without specialty protein or lactose sources and included 250 mg/kg of Cu from $CuSO_4$. Phase 4 was fed from d 42 to 63, and it was mainly composed of a corn-soybean meal-based diet with 14% DDGS and no pharmacological minerals. All diets were manufactured by Nutrition Services Inc. (Carthage, IL), phases 1 to 3 were provided in pelleted form and phase 4 in mash form.

Daily feed additions were recorded using a computerized feeding system (DryExact Pro, Big Dutchman, Holland, MI). Pigs were weighed, and the amount of feed remaining in the feeders was estimated based on feeder volume using a regression equation on d 0, 7, 14, 21, 33, 42, and 63 to calculate ADG, ADFI, and F/G. On d 42, after the pen weights were collected, individual pig body weights (BW) were collected to estimate coefficient of variation (standard deviation / mean BW × 100) within each pen.

Pigs removed from the experimental pens due to health problems or slow growth were ear-tagged with a consecutive number and placed in independent pens within each room where they received special care. At the end of the experiment, the remaining pigs in these pens were counted to determine overall survivability.

Fecal samples were collected via rectal palpation from five pigs per pen on d 14 of the study. These samples were stored at 39.2°F until fecal DM analysis was conducted. The samples were dried in a forced-air oven for 48 h at 151°F for the determination of fecal DM.

On d 1, 5, 10, 15, and 28 after placement, pigs in each pen were visually evaluated for cleanliness (manure on body) using a binary scale, where a pig was considered dirty when more than 10% of its body surface was covered with feces; otherwise, they were considered clean.

Economic analysis

Total feed cost per pig, feed cost/lb of gain, revenue, and income over feed cost (IOFC) were calculated. Feed cost per pig placed was determined by multiplying total feed intake by diet cost. Feed cost/lb gain was calculated by dividing the total feed cost per pig by the total weight gained. The total cost for each phase, including feedmill and delivery fees, was $760.20, $465.97, $268.57, and $228.00/ton for phases 1, 2, 3, and 4, respectively. For this experiment, the revenue calculation was based on a carcass price of $0.82/lb and an assumed carcass yield of 75%.

Statistical analysis

Data were analyzed as a randomized complete block design. The lmer function was used from the lme4 package in RStudio [Version 4.0.2 (2020-06-22), R Core Team, R Foundation for Statistical Computing, Vienna, Austria] with pen serving as the experimental unit. For performance and economics variables, the model incorporated the phase feeding budget program as a fixed effect and room and BW block within room as random effects. For fecal DM, in addition to the previous components of the model, the pen ID was included as a random effect to account for the subsampling of multiple data points from the same pen.

Mortality, removals, and the proportion of dirty pigs were analyzed assuming a binomial distribution. For mortality, removals, and the proportion of dirty pigs, the response variable was calculated as the number of affected pigs divided by the initial number of pigs placed per pen. In addition, the proportion of dirty pigs was analyzed as a repeated measure across the five time points at which scores were recorded. Means separation was performed with Tukey multiple comparison adjustment. Results were considered significant with $P \leq 0.05$ and marginally significant with $P \leq 0.10$.

Results and discussion

For period 1 (d 0 to 14), no differences were observed for d 14 BW, ADG, and ADFI. However, a marginal response ($P = 0.068$) was observed for F/G, where despite no means separation observed between feed budget programs, pigs fed the low-budget program had numerically better F/G than pigs fed the other two budget programs.

For period 2 (d 14 to 33), a tendency ($P = 0.074$) was observed for ADG, where despite no means separation was observed between feed budget programs, pigs fed the high-budget program had numerically greater ADG than pigs fed the other two budget programs. No differences were observed for d 33 BW, ADFI, and F/G.

For periods 3 (d 33 to 42), 4 (d 42 to 63), and overall (d 0 to 63), no differences were observed for any of the performance criteria. The survivability of the pigs removed from the study was lower than 5%, independent of the feed budget program (data not presented).

Feed cost and feed cost per pound of gain decreased ($P < 0.001$) as phase 1 and 2 budgets were reduced. Revenue from pigs fed the high-budget program was greater ($P > 0.05$) than those fed the medium-budget program with those fed the low-budget program intermediate. As a result, the use of the low-budget program resulted in greater ($P < 0.05$) IOFC than high- or medium-budget programs.

A treatment effect was detected ($P = 0.046$) for fecal DM at d 14, where pigs fed the low-budget program had numerically lower fecal DM compared with pigs fed the medium or high budget programs; however, no pairwise differences were observed among treatments when using a Tukey multiple comparison adjustment. No differences were observed among treatments in BW coefficient of variation at d 42.

For the proportion of pigs classified as dirty or clean in the manure-on-body score, a day × feed budget interaction was observed ($P < 0.001$). On d 1, no differences were detected among feed budget programs. On d 5, pigs fed the low-budget program were cleaner ($P < 0.05$) than those fed the high-budget program. On d 10, no differences were observed among feed budget programs. On d 15, pigs fed the high-budget program were cleaner ($P < 0.05$) than those fed the low-budget program. On d 28, no differences were observed among feed budget programs. For the main effect of day, a greater proportion of dirty pigs ($P < 0.001$) was observed on d 5 and 15 compared with d 1.

In conclusion, under commercial conditions, reducing the feed budget amount of phase 1 and 2 diets provided in the nursery feeding program had minimal effects on pig growth performance. Reducing the length of feeding phases 1 and 2 reduced feed cost and feed cost per unit of gain, resulting in greater IOFC for pigs fed the low-budget program. In addition, pigs fed the low-budget program were cleaner on d 5 but showed a numerical reduction in fecal DM on d 14 and exhibited a greater proportion of dirty pigs on d 10 and 15.

Acknowledgments

The authors appreciated Carthage Veterinary Services (Carthage, IL) for providing technical support and expertise in conducting this trial.

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Table 1. Diet composition (as-fed basis)[1]

Item	Phase 1	Phase 2	Phase 3	Phase 4
Ingredient, %				
Corn	44.19	56.48	62.35	61.72
Soybean meal, 47.7% CP	16.28	22.54	32.66	21.10
Corn DDGS, 7% oil	---	---	---	14.25
Spray-dried bovine plasma	2.50	---	---	---
Spray-dried whey	25.00	10.00	---	---
Enzymatically treated soybean meal[2]	6.00	6.00	---	---
Corn oil	3.00	1.00	1.00	---
Calcium carbonate	0.76	0.86	0.93	1.03
Monocalcium phosphate, 21% P	0.48	0.98	1.10	0.26
Salt	0.23	0.56	0.60	0.54
L-Lys-HCl	0.38	0.49	0.48	0.52
DL-Met	0.22	0.21	0.20	0.14
L-Thr	0.17	0.23	0.23	0.19
L-Trp	0.03	0.04	0.04	0.05
L-Val	0.08	0.12	0.11	0.07
Choline chloride, 60%	0.05	---	---	---
Zinc oxide	0.39	0.25	---	---
Copper sulfate	---	---	0.07	---
VTM with phytase[3]	0.25	0.25	0.25	0.15
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Standardized ileal digestible amino acids, %				
Lys	1.35	1.35	1.35	1.15
Ile:Lys	57	57	57	57
Leu:Lys	115	113	116	137
Met:Lys	36	36	36	37
Met & Cys:Lys	59	57	57	59
Thr:Lys	65	65	65	65
Trp:Lys	19.7	19.7	19.6	19.2
Val:Lys	69	69	69	71
His:Lys	34	35	37	39
NE, kcal/lb	1,204	1,134	1,116	1,115
CP, %	20.3	20.8	21.6	19.8
Lactose, %	18.0	7.2	---	---
Ca, %	0.66	0.72	0.72	0.54
P, %	0.58	0.63	0.63	0.45
STTD P, %[4]	0.51	0.51	0.48	0.34

[1] Phase 1, 2, and 3 diets were fed in pellet form, while phase 4 in mash form.

[2] HP 300; Hamlet Protein; Findlay, OH.

[3] Vitamin and trace mineral premix, including 340 FTU/lb of phytase (Quantum Blue, ABVista, Plantation, FL) with an assumed release of 0.11% STTD P.

[4] Standardized total tract digestible phosphorus.

Table 2. Effect of nursery pig phase feeding budget program on growth performance, economics, and fecal dry matter[1]

	Phase feeding budget, lb/pig[2]				
	High	Medium	Low		
Phase 1	4	2	0		
Phase 2	12	8	4	SEM	*P* =
BW, lb					
d 0	12.5	12.5	12.5	0.695	0.488
d 14	19.9	19.7	20.0	1.735	0.710
d 33	41.8	41.1	41.4	2.150	0.396
d 42	54.5	53.5	54.0	2.458	0.326
d 63	88.5	87.3	88.4	1.037	0.346
Period 1 (d 0 to 14)					
ADG, lb	0.52	0.52	0.54	0.076	0.755
ADFI, lb	0.63	0.61	0.61	0.076	0.449
F/G	1.21	1.18	1.15	0.033	0.068
Period 2 (d 14 to 33)					
ADG, lb	1.15	1.11	1.11	0.026	0.074
ADFI, lb	1.46	1.43	1.43	0.046	0.242
F/G	1.42	1.44	1.43	0.013	0.496
Period 3 (d 33 to 42)					
ADG, lb	1.40	1.37	1.38	0.034	0.444
ADFI, lb	2.20	2.15	2.16	0.063	0.243
F/G	1.57	1.57	1.57	0.014	0.898
Period 4 (d 42 to 63)					
ADG, lb	1.62	1.61	1.64	0.067	0.435
ADFI, lb	2.95	2.90	2.94	0.106	0.579
F/G	1.82	1.80	1.79	0.017	0.317
Overall (d 0 to 63)					
ADG, lb	1.20	1.17	1.19	0.052	0.156
ADFI, lb	1.87	1.82	1.84	0.075	0.167
F/G	1.56	1.56	1.54	0.009	0.340
Removals, %	1.00	1.82	1.41	0.516	0.592
Mortality, %	1.02	2.55	2.04	0.876	0.293
Total, %	2.18	4.61	3.63	0.763	0.170
Economics, $/pig placed[3]					
Feed cost	17.94[a]	15.86[b]	15.16[c]	1.030	< 0.001
Feed cost/lb of gain[4]	0.23[a]	0.22[b]	0.21[c]	0.004	< 0.001
Revenue[5]	45.87[a]	44.15[b]	45.23[ab]	2.159	0.049
IOFC[6]	28.68[a]	28.29[a]	30.07[b]	1.141	0.004
Fecal dry matter, %[7]					
d 14	22.62	23.09	20.49	0.756	0.046

Coefficient of variation, %[8]					
d 42	17.41	17.91	17.61	1.168	0.904
Proportion of dirty pigs, %[9]					
d 1	4.06	2.67	3.87	1.150	> 0.100
d 5	10.68[b]	6.09[ab]	4.15[a]	2.180	< 0.050
d 10	2.01	4.30	5.49	1.410	> 0.100
d 15	4.97[a]	8.11[ab]	13.18[b]	2.510	< 0.050
d 28	0.80	0.00	0.21	0.042	> 0.100

[1] A total of 1,170 pigs (PIC 337 × 1050, Hendersonville, TN) were used in a 63-d study with 26 pigs per pen and 15 pens per treatment. Pigs were placed in two independent rooms within the same barn, in a wean-to-finish commercial facility located in Carthage, IL.

[2] The phase-feeding budget consisted of varying quantities of phases 1 and 2, followed by a common phase 3 diet until d 42 and a common phase 4 diet until d 63 of the experiment.

[3] Total feed cost per ton were calculated: Phase 1 = $760.20; Phase 2 = $465.97; Phase 3 = $268.57; and Phase 4 = $228.00.

[4] Feed cost/lb of gain = total feed cost ÷ total gain per pen.

[5] Revenue = (total gain / pig placed × 0.75) × $0.82.

[6] Income over feed cost = revenue – feed cost.

[7] Fecal samples were collected from 5 pigs per pen.

[8] At d 42, all pigs were individually weighed to estimate the coefficient of variation for pig weight within each pen.

[9] A pig was considered dirty when more than 10% of the body surface was covered with feces. A day × feed budget interaction was observed ($P < 0.001$). In addition, a day effect ($P < 0.001$) was detected, with a greater proportion of dirty pigs on d 5 and 15 compared with d 1.