Effects of Feeder Design and Feeder Adjustment on the Growth Performance of Growing-Finishing Pigs[1]

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Summary

Two experiments were performed to evaluate the effects of feeder design (conventional dry feeder vs. wet-dry feeder) and adjustment on growing-finishing pig performance. In both experiments, all pigs (PIC 337 × 1050) were fed the same corn-soybean meal diets with 15% dried distillers grains with solubles (DDGS). In Exp. 1, 1,296 pigs (initially 43 lb) were used in a 69-d study. From d 0 to 27, 3 feeder settings were evaluated for each feeder type. Numbered settings (located in each feeder) were 6, 8, and 10 for the conventional dry feeder and 6, 10, and 14 for the wet-dry feeder. An increased setting number corresponded to a greater opening. From d 27 to 69, all feeders were adjusted to an opening of approximately 1 in. (conventional dry feeder setting 8; wet-dry feeder setting 14). From d 0 to 27, pigs using a wet-dry feeder had lower ($P < 0.02$) ADFI and better F/G than pigs using a conventional dry feeder. Increasing the feeder setting improved (linear, $P < 0.01$) ADG, ADFI, and d-27 BW of pigs using a wet-dry feeder and increased (linear, $P < 0.01$) ADFI of pigs using a conventional dry feeder. From d 27 to 69, ADG and ADFI of pigs using a wet-dry feeder were greater ($P < 0.01$) than those of pigs using a conventional dry feeder, and increasing the feeder setting from d 0 to 27 resulted in greater (linear, $P < 0.01$) ADFI and poorer F/G for pigs using a wet-dry feeder. Overall (d 0 to 69), pigs using a wet-dry feeder had greater ($P < 0.05$) ADG, ADFI, final BW, and better F/G than pigs that used a conventional dry feeder. Increasing the feeder setting of a wet-dry feeder from d 0 to 27 resulted in greater (linear, $P < 0.01$) ADG and ADFI, poorer (linear, $P < 0.03$) F/G, and heavier (linear, $P < 0.01$) final BW. Feeder setting of a conventional dry feeder from d 0 to 27 did not affect overall performance. In Exp. 2, 1,248 pigs (initially 73 lb) were used in a 93-d study. Three feeder settings were evaluated throughout the study for each feeder type (conventional dry feeder set at 6, 8, and 10; wet-dry feeder set at 10, 14, and 18). Overall, pigs using a wet-dry feeder had greater ($P < 0.05$) ADG, ADFI, final BW, HCW, backfat depth, and feed cost but reduced ($P < 0.04$) fat-free lean index (FFLI) compared with pigs using a conventional dry feeder. Increasing the feeder setting of a wet-dry feeder resulted in greater (linear, $P < 0.05$) ADG, ADFI, final BW, HCW, backfat depth, and feed cost. When HCW was used as a covariate, FFLI of pigs using a wet-dry feeder decreased (linear, $P < 0.02$) with increased feeder opening. Increasing the feeder setting of a conventional dry feeder had no effect on growth performance and carcass characteristics. In conclusion, the growth rate of pigs improved with a wet-dry feeder compared with a conventional dry feeder; however, the growth of pigs using a wet-dry feeder was more sensitive to differences in feeder adjustment.

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Key words: conventional feeder, feeder adjustment, wet-dry feeder

Introduction

Previous research at Kansas State University (Bergstrom et al., 2008[3], 2009[4]) has demonstrated that using a wet-dry feeder increases the feed intake and growth rate of finishing pigs. However, pigs using wet-dry feeders in some of our recent studies have also had poorer feed efficiency. The differences in feed efficiency responses between some experiments are of concern because the additional feed cost associated with poorer efficiency may eliminate the benefits of faster growth.

Several factors may be responsible for the different feed efficiency responses among experiments. Generally, the feed efficiency differences have been most apparent during later feeding periods, and the recent studies were initiated with lighter pigs and concluded at heavier weights than earlier studies. Therefore, differences in final BW between pigs fed using conventional dry and wet-dry feeders have been greater in the most recent studies. The carcass data from some of our recent experiments indicate that pigs that are heavier from using a wet-dry feeder may also have greater backfat depth (Bergstrom et al., 2008[3]; 2009[4]).

Few studies have reported effects of feeder adjustment on the growth performance of growing pigs. Using the same conventional dry feeder used in our recent experiments, Duttlinger et al. (2008[5]) observed linear improvements in ADFI with increasing feeder opening and tendencies for quadratic improvements in ADG and F/G. These effects were the same for a corn-soybean meal diet and a corn-soybean meal diet with 15% DDGS and 5% bakery by-product. The effects of adjustment of wet-dry feeders on growth performance of growing pigs have not been reported.

Therefore, the objective of this research was to compare the effects of conventional dry and wet-dry feeders with various feeder settings on the growth performance and carcass characteristics of growing-finishing pigs.

Procedures

Procedures used in the experiments were approved by the Kansas State University Institutional Animal Care and Use Committee. The experiments were conducted at a commercial research finishing facility in southwestern Minnesota. The facility was double-curtain sided, with pit fans for minimum ventilation and completely slatted flooring over a deep pit for manure storage. Individual pens were 10 × 18 ft. One half of the pens were equipped with a single 60-in.-wide, 5-hole conventional dry feeder (STACO, Inc., Schaefferstown, PA) and a cup waterer in each pen. The remaining pens were each equipped with a double-sided wet-dry feeder (Crystal Springs, GroMaster, Inc., Omaha, NE) with a 15-in. feeder opening on both sides that provided access to feed and water. Each pen equipped with a wet-dry feeder also contained a cup waterer, but the cup waterers were shut off during the experiment. Therefore, the only source of water for pigs in these pens was through the wet-dry feeder.

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[3] Bergstrom et al., Swine Day 2008, Report of Progress 1001, pp. 196-203.

[4] Bergstrom et al., Swine Day 2009, Report of Progress 1020, pp. 252-261.

[5] Duttlinger et al., Swine Day 2008, Report of Progress 1001, pp 204-214.

Experiment 1

A total of 1,296 pigs (PIC 337 × 1050, initially 42.8 lb) were used in a 69-d experiment to evaluate the effects of feeder design (conventional dry vs. wet-dry feeder) and initial feeder adjustment on growing-finishing pig performance. Three feeder adjustment settings were evaluated for each of the 2 feeder types from d 0 to 27. Pigs were randomly placed into pens of 27; each pen had 14 barrows and 13 gilts. Pens of pigs were weighed and allotted to the 2 feeder types and 3 initial feeder settings within each feeder type. There were 24 pens per feeder type and 8 pens for each of the 3 feeder settings within each feeder type. All pigs were fed the same corn-soybean meal diets containing 15% DDGS during 2 dietary phases in the experiment (Table 1). The first diet phase was fed from d 0 to 39, and the second diet phase was fed from d 39 to 69.

The 3 settings used for the wet-dry feeders were the numbered adjustments of 6, 10, and 14 located on the adjustment mechanism inside each end of the feeder (Figures 1 to 3). The 3 settings used for the conventional dry feeder were the numbered adjustments of 6, 8, and 10 located on the adjustment mechanism inside each end of the feeder (Figures 4 to 6).

On d 19, measurements of the actual feeder opening were obtained for all feeders. For the wet-dry feeder, the mean gap opening was determined with two measurements (one from each side of the feeder) from the top of the feeder shelf to the bottom edge of the feed storage hopper. A digital photo of the pan/trough of each feeder was also taken on d 19. Afterward, the pictures were independently scored for percentage of pan coverage by a trained panel of 6 people. The mean pan coverage score of each feeder was used to determine the relationship between feeder opening and percentage of feed coverage in the pan.

On d 27, both feeder types were adjusted to a targeted feeder opening of approximately 1 in. (setting 8 for the conventional dry and setting 14 for the wet-dry) for the remainder of the experiment.

Data were analyzed to compare the effects of the 2 feeder types (wet-dry vs. conventional dry) and 3 initial feeder settings nested within each feeder type by using a completely randomized design and the PROC MIXED procedure of SAS (SAS Institute, Inc., Cary NC). Pen was the experimental unit.

Experiment 2

A total of 1,248 pigs (PIC 337 × 1050, initially 73.0 lb) were used in a 93-d experiment to evaluate the effects of feeder design (conventional dry vs. wet-dry feeder) and adjustment on growing-finishing pig performance and carcass characteristics. Three feeder adjustment settings were evaluated for each of the 2 feeder types throughout the experiment. Pigs were randomly placed into pens of 26; each pen had 13 barrows and 13 gilts. Pens of pigs were weighed and allotted to the 2 feeder types and 3 feeder settings within each feeder type. There were 24 pens per feeder type and 8 pens for each of the 3 feeder settings within each feeder type. All pigs were fed the same corn-soybean meal diets containing 15% DDGS during 4 dietary phases in the experiment (Table 1).

The 3 settings used for the wet-dry feeders were the numbered adjustments of 10, 14, and 18 located on the adjustment mechanism inside each end of the feeder (Figures

2, 3, and 7). The 3 settings used for the conventional dry feeder were the numbered adjustments of 6, 8, and 10 located on the adjustment mechanism inside each end of the feeder (Figures 8, 9, and 6).

On d 41 and 84, measurements of the actual feeder opening were obtained, and a photo of the pan/trough of each feeder was taken. As in Exp. 1, the pictures were scored for percentage of pan coverage, and the relationship between feeder opening and feed coverage of the pan was determined.

Data were analyzed to compare the effects of the 2 feeder types (wet-dry vs. conventional dry) and the 3 feeder settings nested within each feeder type by using a completely randomized design and the PROC MIXED procedure of SAS. Pen was the experimental unit. The carcass data were analyzed with and without using the ending HCW as a covariate.

Results

Experiment 1

The mean opening of the conventional dry feeder was greater ($P < 0.01$) than that of the wet-dry feeder on d 19 (Table 2). However, the mean percentage of pan coverage of the conventional dry feeder was less ($P < 0.01$) than that of the wet-dry feeder. The openings of both feeder types increased (linear, $P < 0.0001$) with greater feeder adjustment setting. The openings achieved were 0.59 to 0.81 in., 0.80 to 1.07 in., and 1.09 to 1.35 in. for the conventional dry feeder settings of 6, 8, and 10; and 0.50 in., 0.75 in., and 1.00 in. for the wet-dry feeder settings of 6, 10, and 14, respectively. The percentage of pan coverage of the conventional dry feeder increased (quadratic, $P < 0.01$) with greater feeder setting, as did that of the wet-dry feeder (linear, $P < 0.001$).

From d 0 to 27, pigs using the wet-dry feeder had decreased ($P < 0.02$) ADFI and better F/G than pigs using the conventional dry feeder (Table 2). Increasing the feeder setting of the wet-dry feeder increased (quadratic, $P < 0.02$) ADG, ADFI, d-27 BW, and feed cost per pig. Increasing the feeder setting of the conventional dry feeder also increased (linear, $P < 0.01$) ADFI.

After all feeders were adjusted to a common opening on d 27, ADG and ADFI of pigs using the wet-dry feeder were greater ($P < 0.0001$) than those of pigs using the conventional dry feeder from d 27 to 69. Also, increasing the feeder setting of the wet-dry feeder from d 0 to 27 resulted in increased (linear, $P < 0.0001$) ADFI and poorer F/G from d 27 to 69.

Overall (d 0 to 69), pigs using the wet-dry feeder had greater ($P < 0.05$) ADG, ADFI, final BW and feed cost per pig and poorer F/G than pigs using the conventional dry feeder. Increasing the feeder setting of the wet-dry feeder from d 0 to 27 resulted in greater (linear, $P < 0.0001$; quadratic, $P < 0.02$) ADG and ADFI, poorer (linear, $P < 0.03$) F/G, and increased (linear, $P < 0.03$) final BW and feed cost per pig. Increasing the feeder setting of the conventional dry feeder from d 0 to 27 had no effect on overall performance.

Experiment 2

The mean openings of the conventional dry feeder and wet-dry feeder were similar on d 41 and 84 (Table 3). The openings of both feeder types increased (linear, $P < 0.001$) with greater feeder adjustment setting. The openings achieved were 0.58 to 0.82 in., 0.83 to 1.12 in., and 1.10 to 1.36 in. for the conventional dry feeder settings of 6, 8, and 10; and 0.75 in., 1.00 in., and 1.25 in. for the wet-dry feeder settings of 10, 14, and 18, respectively. The percentage of pan coverage for both feeder types increased (linear, $P < 0.001$) with greater feeder setting on both d 41 and 84. However, the mean percentage of pan coverage of the conventional dry feeder was less ($P < 0.02$) than that of the wet-dry feeder on d 41, but they were not significantly different on d 84.

Overall (d 0 to 93), pigs using the wet-dry feeder had increased ($P < 0.05$) ADG, ADFI, final BW, HCW, backfat depth, and feed cost per pig but reduced ($P < 0.04$) fat-free lean index (FFLI) compared with pigs using the conventional dry feeder. Neither feeder type nor adjustment influenced overall feed efficiency. Increasing the feeder setting of the wet-dry feeder also resulted in increased (linear, $P < 0.05$) ADG, ADFI, final BW, HCW, backfat depth, and feed cost per pig. Additionally, when HCW was used as a covariate, the FFLI of pigs fed with a wet-dry feeder decreased (linear, $P < 0.02$) with increased feeder opening. However, increasing the feeder setting of the conventional dry feeder had no effect on growth performance and carcass characteristics.

Discussion

In Exp. 1, pigs using a wet-dry feeder had increased ADG, ADFI, final weight, and income over feed cost. These results agree with those observed in our first 69-d experiment (Bergstrom et al.[3]). However, when the wet-dry feeder was adjusted to a feeder setting of 6 for the first 27 d, ADG, ADFI, and F/G were lower than those of pigs using a wet-dry feeder with a greater initial opening and pigs using the conventional dry feeder at any of the 3 initial settings. Because the feeder opening of the wet-dry feeder with a setting of 6 was frequently found to be plugged during the first 10 d of the experiment, feed intake and growth were considerably lower for these pigs than for pigs in all of the other treatments during the first 27 d. This also resulted in lower feed intake for these pigs during the remainder of the experiment. Although these pigs' ADG and F/G improved when their feeders were changed to a setting of 14 on d 27, they were unable to fully compensate for the reduced growth that was observed in the initial 27-d period.

The lack of a negative feed efficiency response with the wet-dry feeder in the current experiment is likely associated with the tighter feeder settings tested. Our earlier experiments comparing the wet-dry and conventional dry feeders used an initial wet-dry feeder setting of 18 (recommended by the manufacturer) and a conventional dry feeder setting of 8.

Similar to the observations reported by Duttlinger et al. (2008[5]), ADFI from d 0 to 27 increased as the feeder opening of the conventional dry feeder was increased. However, the magnitude of this response was not as great as that achieved by increasing the feeder opening of the wet-dry feeder, despite the relatively equal incremental changes in the mean feeder opening. This result is likely due to the larger openings tested for the conventional dry feeder, the frequent plugging of the wet-dry feeder at the lowest feeder setting, the range of opening provided by the agitation plate within each setting of the conventional dry feeder, and the fact that the conventional dry feeders provided twice the amount of feeder space.

Regardless of the differences in ADFI, there were no differences in ADG and F/G among the different feeder openings evaluated for the conventional dry feeder. The absence of a significant ADG and F/G response to the increased feeder opening of the conventional dry feeder during the first 27 d of this experiment might also be related to the lower voluntary feed intake relative to the experiments of Duttlinger et al. (2008). The pigs in the present experiment were initially 42.8 lb, whereas Duttlinger et al. (2008) initiated their experiments with pigs weighing 77.3 lb and 129.0 lb. The F/G of pigs using the conventional dry feeder at the greatest opening was numerically poorer during the initial 27 d of our experiment, suggesting that some of the feed intake response was feed wastage.

As in previous experiments, ADG, ADFI, and final BW were improved with the wet-dry feeder in Exp. 2. As in Exp. 1, increasing the feeder opening of the wet-dry feeder resulted in linear improvements in ADG, ADFI, and final BW. However, F/G of pigs using the wet-dry feeder was only numerically worse than that of pigs using the conventional dry feeder when the wet-dry feeder was adjusted to the widest setting of 18. Increasing the feeder opening of the conventional dry feeder did not significantly affect pig performance.

A significant observation from these studies is that income over feed cost was numerically greater with a wet-dry feeder when calculated on a live-BW basis (Exp. 1) but numerically lower when pigs were fed to a heavier BW and determined on a carcass basis using a lean premium/discount (Exp. 2). Although overall F/G was not significantly different between feeder types in Exp. 2, the greater ADG and final BW of pigs fed with a wet-dry feeder was the result of greater ADFI and total feed cost per pig. Also, pigs using a wet-dry feeder had greater backfat depth, and ADFI, total feed cost per pig, and backfat depth all increased linearly as the wet-dry feeder setting increased. The differences in backfat depth and FFLI between pigs fed with the 2 feeder types remained when HCW was used as a covariate for carcass data analysis, and FFLI decreased linearly as the wet-dry feeder setting increased.

In conclusion, compared with a conventional dry feeder with water provided separately, the wet-dry feeder improved ADG, ADFI, and final BW of growing-finishing pigs. However, a wet-dry feeder with an initial feeder setting less than 10 resulted in reduced growth performance. Feed intake and growth of pigs using a wet-dry feeder were more sensitive to differences in feeder opening and increased with greater feeder opening. The increased feed cost associated with the greater feed intake from the wet-dry feeder eliminated any net benefit from achieving a heavier final BW. Producers who want to benefit from the improved pig growth rate observed with a wet-dry feeder should determine the net benefit of achieving an optimal market weight in fewer days to market and the associated improvements in throughput and facility utilization.

Figure 1. Wet-dry feeder at setting 6 with a 0.50-in. opening and ≈35% pan coverage.

Figure 2. Wet-dry feeder at setting 10 with a 0.75-in. opening and ≈57% pan coverage.

Figure 3. Wet-dry feeder at setting 14 with a 1.00-in. opening and ≈65% pan coverage.

Figure 4. Conventional dry feeder at setting 6 with a 0.59- to 0.81-in. opening and ≈9% pan coverage.

Figure 5. Conventional dry feeder at setting 8 with a 0.80- to 1.07-in. opening and ≈21% pan coverage.

Figure 6. Conventional dry feeder at setting 10 with a 1.09- to 1.35-in. opening and ≈79% pan coverage.

Figure 7. Wet-dry feeder at setting 18 with a 1.25-in. opening and ≈87% pan coverage.

Figure 8. Conventional dry feeder at setting 6 with a 0.58- to 0.82-in. opening and ≈27% pan coverage.

Figure 9. Conventional dry feeder at setting 8 with a 0.83- to 1.12-in. opening and ≈57% pan coverage.

Table 1. Diet composition (Exp. 1 and 2)[1]

	Dietary phase			
Item	50 to 100 lb	100 to 160 lb	160 to 225 lb	225 lb to mkt.
Ingredient, %				
Corn	61.46	66.53	71.45	63.35
Soybean meal (46.5% CP)	21.43	16.64	11.85	19.80
DDGS	15.00	15.00	15.00	15.00
Monocalcium P (21% P)	0.15	---	---	---
Limestone	1.00	0.95	0.90	1.00
Salt	0.35	0.35	0.35	0.35
Liquid lysine (60% Lys)	0.45	0.40	0.35	0.35
L-Threonine	0.05	0.03	0.01	0.01
VTM + phytase[2]	0.11	0.10	0.09	0.085
Paylean, 9 g/lb	---	---	---	0.025
Total	100.00	100.00	100.00	100.00
Cost[3], $/lb	0.120	0.116	0.112	0.124
Calculated analysis				
Standardized ileal digestible (SID) amino acids				
Lysine, %	1.05	0.90	0.75	0.95
Isoleucine:lysine, %	64	66	69	68
Leucine:lysine, %	158	172	191	170
Methionine:lysine, %	28	30	33	30
Met & Cys:lysine, %	57	62	68	61
Threonine:lysine, %	62	63	64	62
Tryptophan:lysine, %	17	17	17	18
Valine:lysine, %	75	79	84	80
CP, %	19.3	17.5	15.7	18.7
Total lysine, %	1.19	1.03	0.87	1.09
ME, kcal/lb	1,523	1,527	1,529	1,526
SID lysine:ME ratio, g/Mcal	3.13	2.67	2.23	2.82
Ca, %	0.50	0.44	0.41	0.47
P, %	0.46	0.41	0.39	0.42
Available P, %	0.29	0.25	0.23	0.21

[1] Each dietary phase was formulated to meet the requirements for the BW ranges described in the table.
[2] VTM = Vitamin and trace mineral premix. Optiphos 2000 provided 0.12% available P.
[3] Ingredient prices used were: corn, $195/ton; soybean meal, $325/ton; DDGS, $160/ton; limestone, $50/ton; salt, $60/ton; liquid lysine, $1,600/ton; vitamin and trace mineral premix, $3,200/ton; phytase, $5,300/ton; Paylean, $57,000/ton; and $12/ton processing and delivery fee.

Table 2. Effects of feeder design and initial feeder adjustment on the growth performance of growing-finishing pigs (Exp. 1)[1]

	Feeder type							Probability, P <				
	Wet-dry			Conventional dry					Wet-dry		Conventional dry	
Initial feeder setting:	6	10	14	6	8	10	SEM	Feeder type	Linear	Quadratic	Linear	Quadratic
Feeder data, d 19												
Avg. max. opening[2], in.	0.50	0.75	1.00	0.81	1.07	1.35	0.023	0.0001	0.0001	---[3]	0.0001	---
Avg. min. opening[4], in.	0.50	0.75	1.00	0.59	0.80	1.09	0.027	0.01	0.0001	---	0.0001	---
Avg. opening, in.	0.50	0.75	1.00	0.70	0.94	1.22	0.024	0.0001	0.0001	---	0.0001	---
Pan coverage, %	34.9	57.3	64.5	9.0	21.1	79.0	5.70	0.01	0.001	---	0.0001	0.01
Live performance												
d 0 to 27												
ADG, lb	1.29	1.56	1.65	1.46	1.51	1.51	0.027	---	0.0001	0.01	---	---
ADFI, lb	2.36	2.83	2.95	2.70	2.79	2.86	0.034	0.02	0.0001	0.001	0.01	---
F/G	1.83	1.81	1.79	1.84	1.85	1.89	0.019	0.01	---	---	---	---
d 27 BW, lb	77.7	84.9	87.5	82.3	83.3	84.1	0.73	---	0.0001	0.02	---	---
Feed, $/pig	13.87	16.22	16.85	15.45	15.73	15.87	0.173	---	0.0001	0.001	---	---
d 27 to 69												
Feeder setting		14			8							
ADG, lb	1.99	2.05	2.04	1.89	1.89	1.90	0.022	0.0001	---	---	---	---
ADFI, lb	4.77	5.09	5.16	4.71	4.76	4.73	0.056	0.0001	0.0001	---	---	---
F/G	2.40	2.49	2.53	2.49	2.52	2.49	0.020	---	0.0001	---	---	---
d 0 to 69												
ADG, lb	1.71	1.85	1.88	1.72	1.74	1.75	0.019	0.0001	0.0001	0.02	---	---
ADFI, lb	3.81	4.20	4.29	3.92	3.98	3.98	0.042	0.001	0.0001	0.01	---	---
F/G	2.23	2.26	2.28	2.28	2.29	2.28	0.015	0.05	0.03	---	---	---
Final BW, lb	162.6	171.2	173.5	161.5	163.9	164.3	1.36	0.0001	0.0001	---	---	---
Feed, $/pig	49.50	51.97	53.13	49.50	50.03	50.45	0.597	0.003	0.001	---	---	---
IOFC[5], $	23.32	24.46	24.69	22.82	23.21	22.89	0.985	---	---	---	---	---

[1] A total of 1,296 pigs (PIC, 337 × 1050) with an initial BW of 42.8 lb were placed in 48 pens containing 27 pigs each and used in a 69-d experiment.

[2] Measured from the bottom of the feed pan (conventional dry) or shelf (wet-dry) to the bottom of the feed agitation plate (conventional dry) or feeder hopper (wet-dry) at the narrowest position.

[3] Not significant ($P > 0.05$).

[4] Measured from the bottom of the feed pan (conventional dry) or shelf (wet-dry) to the bottom of the feed agitation plate (conventional dry) or feeder hopper (wet-dry) at the widest position.

[5] IOFC = income over feed cost; calculated by subtracting the total feed cost per pig from the estimated revenue per pig using a live price of $44.73/cwt.

Table 3. Effects of feeder design and feeder adjustment on the growth performance of growing-finishing pigs (Exp. 2)[1]

	Feeder type							Probability, P <				
	Wet-dry			Conventional dry					Wet-dry		Conventional dry	
Initial feeder setting	10	14	18	6	8	10	SEM	Feeder type	Linear	Quadratic	Linear	Quadratic
Feeder data												
Avg. max. opening[2], in.	0.75	1.00	1.25	0.82	1.12	1.36	0.058	0.001	0.001	---[3]	0.001	---
Avg. min. opening[4], in.	0.75	1.00	1.25	0.58	0.83	1.10	0.068	0.001	0.001	---	0.001	---
Avg. opening, in.	0.75	1.00	1.25	0.70	0.97	1.23	0.059	---	0.001	---	0.001	---
d 41 pan coverage, %	52.5	63.1	84.9	23.6	58.4	83.0	5.85	0.02	0.001	---	0.001	---
d 84 pan coverage, %	52.9	72.0	82.3	40.4	66.3	83.0	5.87	---	0.001	---	0.001	---
Live performance, d 0 to 93												
ADG, lb	2.08	2.15	2.22	1.95	2.03	2.02	0.038	0.0001	0.01	---	---	---
ADFI, lb	5.53	5.81	6.10	5.24	5.41	5.34	0.149	0.0001	0.01	---	---	---
F/G	2.67	2.71	2.75	2.68	2.67	2.64	0.054	---	---	---	---	---
final live BW, lb	263.1	268.5	278.0	252.4	259.4	259.6	5.54	0.01	0.05	---	---	---
Carcass and economics[5]											---	---
HCW, lb	192.1	197.9	204.5	188.6	192.4	193.5	3.97	0.05	0.04	---	---	---
Backfat depth, in.	0.67	0.67	0.73	0.65	0.64	0.64	0.016	0.001	0.01	---	---	---
with HCW as covariate	0.67	0.67	0.72	0.65	0.64	0.64	0.016	0.001	0.02	---	---	---
Loin depth, in.	2.42	2.44	2.46	2.38	2.39	2.37	0.055	---	---	---	---	---
with HCW as covariate	2.43	2.42	2.40	2.42	2.41	2.37	0.053	---	---	---	---	---
FFLI[6]	50.1	50.2	49.8	50.2	50.4	50.5	0.21	0.04	---	---	---	---
with HCW as covariate	50.2	50.1	49.5	50.4	50.5	50.5	0.19	0.001	0.02	---	---	---
Total revenue/pig, $	110.97	113.53	117.58	108.99	111.24	111.90	2.882	---	---	---	---	---
Feed, $/pig	71.92	76.34	80.58	68.50	70.98	70.12	2.135	0.001	0.01	---	---	---
Feed, $/lb gain	0.38	0.39	0.39	0.38	0.38	0.38	0.008	---	---	---	---	---
IOFC[7], $	39.05	38.93	36.99	40.49	40.26	41.78	2.327	---	---	---	---	---

[1] A total of 1,248 pigs (PIC, 337 × 1050) with an initial BW of 73.0 lb were placed in 48 pens containing 26 pigs each.
[2] Measured from the bottom of the feed pan (conventional dry) or shelf (wet-dry) to the bottom of the feed agitation plate (conventional dry) or feeder hopper (wet-dry) at the narrowest position.
[3] Not significant ($P > 0.05$).
[4] Measured from the bottom of the feed pan (conventional dry) or shelf (wet-dry) to the bottom of the feed agitation plate (conventional dry) or feeder hopper (wet-dry) at the widest position.
[5] A total of 1,021 pigs were used to determine the carcass characteristics of the feeder treatments.
[6] FFLI = fat-free lean index.
[7] IOFC = income over feed cost; calculated by subtracting the feed cost per pig from the revenue per pig using a carcass base price of $56.03/cwt and premiums/discounts.