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A J. Myers

J R. Bergstrom

Michael D. Tokach

Robert D. Goodband

See next page for additional authors

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Abstract

A total of 1,146 growing pigs (PIC 1050 Ã— 337, initially 85.8 lb) were used in a 104-d study to evaluate the effects of diet form (meal vs. pellet) and feeder design (conventional dry vs. wet-dry) on finisher pig performance. The treatments were arranged in a 2 Ã— 2 factorial with 11 replications per treatment and 25 to 27 pigs per pen. Half of the pens were equipped with a 5-hole conventional dry feeder and the other half had a double-sided wet-dry feeder. All pigs were fed a corn-soybean meal-based diet containing 20% dried distillers grains with solubles (DDGS) during the first 4 dietary phases and 10% DDGS in phase 5. The only difference in diet among treatments was diet form (meal vs. pellet). Pen weights and feed disappearance were measured on d 0, 14, 28, 42, 56, 70, 86, and 104. Pictures of feeder pans were taken once during each phase and evaluated by a panel of 4 individuals for percentage pan coverage. From d 0 to 28, no diet form Ã— feeder design interaction was observed for ADG or F/G. Pigs fed pelleted diets had poorer ($P < 0.001$) F/G compared with those fed meal diets, which appeared to be due to poor pellet quality (39.6% fines). From d 42 to 86, pellet quality improved (4.4% fines), and a diet form Ã— feeder interaction ($P < 0.02$) was observed for ADG, whereas pigs presented meal diets in a dry feeder had decreased ADG compared with pigs presented pelleted diets in dry feeders or pigs presented feed via wet-dry feeders regardless of diet form. Pigs presented pelleted diets had improved ($P < 0.001$) F/G compared with those fed meal diets. Pigs fed via wet-dry feeders had increased ($P < 0.03$) ADFI and poorer F/G compared with pigs with dry feeders. Overall, pigs fed with wet-dry feeders had increased ($P < 0.02$) ADG and ADFI, and poorer F/G compared with those with dry feeders, whereas pigs presented pelleted diets had a tendency for improved ($P < 0.06$) F/G compared with those presented meal diets. In conclusion, regardless of diet form, pigs fed from wet-dry feeders had increased ADG and ADFI compared with pigs fed via dry feeders. Additionally, pellet quality appeared to influence responses because pigs provided higher-quality pellets via dry feeders had increased growth performance compared with pigs fed meal diets. Conversely, if pellet quality was poor, feed efficiency benefits associated with pelleting were lost.; Swine Day, Manhattan, KS, November 17, 2011

Keywords

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Authors

A J. Myers, J R. Bergstrom, Michael D. Tokach, Robert D. Goodband, Joel M. DeRouchey, Jim L. Nelssen, and Steven S. Dritz

The Effects of Diet Form and Feeder Design on the Growth Performance of Finishing Pigs[1]

A. J. Myers, J. R. Bergstrom, M. D. Tokach, S. S. Dritz[2], R. D. Goodband, J. M. DeRouchey, and J. L. Nelssen

Summary
A total of 1,146 growing pigs (PIC 1050 × 337, initially 85.8 lb) were used in a 104-d study to evaluate the effects of diet form (meal vs. pellet) and feeder design (conventional dry vs. wet-dry) on finisher pig performance. The treatments were arranged in a 2 × 2 factorial with 11 replications per treatment and 25 to 27 pigs per pen. Half of the pens were equipped with a 5-hole conventional dry feeder and the other half had a double-sided wet-dry feeder. All pigs were fed a corn-soybean meal-based diet containing 20% dried distillers grains with solubles (DDGS) during the first 4 dietary phases and 10% DDGS in phase 5. The only difference in diet among treatments was diet form (meal vs. pellet). Pen weights and feed disappearance were measured on d 0, 14, 28, 42, 56, 70, 86, and 104. Pictures of feeder pans were taken once during each phase and evaluated by a panel of 4 individuals for percentage pan coverage. From d 0 to 28, no diet form × feeder design interaction was observed for ADG or F/G. Pigs fed pelleted diets had poorer ($P < 0.001$) F/G compared with those fed meal diets, which appeared to be due to poor pellet quality (39.6% fines). From d 42 to 86, pellet quality improved (4.4% fines), and a diet form × feeder interaction ($P < 0.02$) was observed for ADG, whereas pigs presented meal diets in a dry feeder had decreased ADG compared with pigs presented pelleted diets in dry feeders or pigs presented feed via wet-dry feeders regardless of diet form. Pigs presented pelleted diets had improved ($P < 0.001$) F/G compared with those fed meal diets. Pigs fed via wet-dry feeders had increased ($P < 0.03$) ADFI and poorer F/G compared with pigs with dry feeders.

Overall, pigs fed with wet-dry feeders had increased ($P < 0.02$) ADG and ADFI, and poorer F/G compared with those with dry feeders, whereas pigs presented pelleted diets had a tendency for improved ($P < 0.06$) F/G compared with those presented meal diets. In conclusion, regardless of diet form, pigs fed from wet-dry feeders had increased ADG and ADFI compared with pigs fed via dry feeders. Additionally, pellet quality appeared to influence responses because pigs provided higher-quality pellets via dry feeders had increased growth performance compared with pigs fed meal diets. Conversely, if pellet quality was poor, feed efficiency benefits associated with pelleting were lost.

Key words: feeder, finishing pig, growth, pelleting

Introduction
Feed represents a significant portion of production costs during the finishing phase of growth, so producers are constantly evaluating ways to improve growth performance and lower feed cost. One method to accomplish both goals is pelleting diets, which has

[1] Appreciation is expressed to New Horizon Farms for use of pigs and facilities and to Richard Brobjorg, Scott Heidebrink, and Marty Heintz for technical assistance.

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

been shown to be an effective feed processing method to improve feed efficiency in pigs. Typically, a 4 to 6% improvement in F/G is observed when pigs are presented pelleted diets via conventional dry feeders.

A second method to improve growth is using different feeder designs. Bergstrom et al. (2008[3]) reported that pigs presented meal diets via wet-dry feeders have increased ADG and ADFI compared with pigs fed with conventional dry feeders. Thus, a potential interaction or additive effect may occur between feeder type and diet form. Feeding pelleted diets via a wet-dry feeder might result in a proportionately greater improvement in ADG and F/G than with conventional dry feeder; however, previous research (Myers et al., 2010[4]) evaluating the effects of diet form and feeder design observed an unexpected worsening of feed efficiency when pigs were fed pelleted diets in conventional dry feeders and no difference between meal and pelleted diets when using wet-dry feeders. The poorer feed efficiency was the result of increased feed wastage, which was attributed to poorer-quality pellets. Thus, the objective of this study was to re-evaluate the effects of diet form (meal vs. pellet) and feeder design (conventional dry vs. wet-dry) on finishing pig performance.

Procedures

All practices and procedures used in these experiments were approved by the Kansas State University Institutional Animal Care and Use Committee.

The study was conducted at a commercial swine research facility in southwestern Minnesota. The facility was a naturally ventilated double-curtain-sided barn with pit fans for minimum ventilation. Pens were located over a completely slatted concrete floor with a deep pit for manure storage. Half of the pens were equipped with a conventional 5-hole dry feeder (STACO, Shafferstown, PA), and the other half contained a double-sided wet-dry feeder that provided both feed and water (Crystal Springs, Gro Master, Omaha, NE). All pens contained cup waterers, but pens that contained wet-dry feeders had their cup waterers shut off for the duration of the trial so the only source of water was the nipple waterer located under a food shelf over the center of the feed pan inside each of the wet-dry feeders. Pigs were provided ad libitum access to feed and water for the duration of both studies. The facility utilized a computerized feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) that both recorded and delivered diets to pens as specified.

A total of 1,146 growing pigs (PIC 1050 × 337) with an initial BW of 85.8 lb were used in a 104-d growth study. Pigs were randomly allotted to 1 of 4 experimental treatments based on average initial BW and number of pigs per pen. Treatments comprised 11 pens with 26 to 27 pigs per pen. The number of barrows and gilts were equalized across all treatments.

Treatments were arranged in a 2 × 2 factorial with the main effects of diet form (meal vs. pellet) and feeder design (conventional dry vs. wet-dry). Initially, all wet-dry feeders were adjusted to provide a 1.00-in. gap width. Conventional dry feeders that contained meal diets were also adjusted to a minimum gap width of 1.00 in., but conventional dry

[3] Bergstrom et al., Swine Day 2008, Report of Progress 1001, pp. 196-203.
[4] Myers et al., Swine Day 2010, Report of Progress 1038, pp. 209-215.

feeders with pelleted diets were adjusted to a 0.70-in. minimum gap width. The feeder settings were not maintained for the duration of the trial because feeders were adjusted as required to ensure consistent feeder pan coverage of 40 to 60%.

Pigs were fed a common corn-soybean meal-based diet containing 20% DDGS during the first 4 dietary phases and 10% DDGS and 5 ppm Ractopamine HCl in Phase 5 (Table 1). The only difference between diets was diet form. At different periods throughout the study, a large batch of feed was manufactured at the New Horizon Farm feed mill (Pipestone, MN), then spilt into 2 smaller batches where half of the feed was transported to a commercial feed mill to be pelleted and the other half remained at the farm feed mill and was fed the meal diet. Corn was ground to 550 microns using a roller mill. Diets were pelleted at a nearby commercial feed mill with a 125 HP California Pellet Mill (Crawfordsville, IN) equipped with a micro mini 9.53-mm (hole diameter) × 41.28-mm (effective die thickness) pellet die. Feed was steam conditioned at 150°F for 15 sec prior to pelleting. The diet was formulated to meet or exceed NRC (1998[5]) requirement estimates for 45- to 270-lb pigs.

Average daily gain, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 0, 14, 28, 42, 56, 70, 86, and 104. On d 86, 5 pigs (3 barrows and 2 gilts) from each pen were weighed and removed for marketing. At the conclusion of the trial (d 104), pigs were individually tattooed by pen and transported 1 h to a commercial packing plant (JBS Swift and Company, Worthington, MN), where carcass data were obtained for 891 pigs to determine HCW, percentage carcass yield, backfat depth, and longissimus muscle depth, which was taken by placing an optical probe between the 3rd and 4th rib from the last rib at 7 cm from the dorsal midline. Fat-free lean index (FFLI) was calculated using National Pork Producers Council (2000) procedures.

A digital photo of each feeder pan was taken once during each phase. Feeder pan pictures were then scored independently by a trained panel of 4 for percentage pan coverage. In addition, feed samples were taken from the feeders during each phase and analyzed for percentage fines and pellet durability index (PDI). Percentage fines were determined prior to testing pellets for durability. A number 6 screen was used to sift the fines from a 500-g sample of pellets. The amount of fines was then weighed and percentage fines were calculated using the following formula: weight of fines/weight of sample × 100. After fines were sifted off, PDI was determined. The sample of pellets were placed in a box and tumbled for 10 min. After 10 min, the samples were removed, sieved (number 6 screen), and the percentage of whole pellets was calculated. Pellet durability index was then calculated using the following formula: weight of pellets after tumbling/weight of pellets prior to tumbling × 100.

Treatments were arranged as a 2 × 2 factorial for both experiments and data were analyzed as a completely randomized design using the PROC MIXED procedure of SAS (SAS Institute Inc., Cary, NC). Pen was the experimental unit. When significant interactions ($P < 0.05$) were observed, least significant differences (LSDs) were used to evaluate the means. Results were considered significant at $P \le 0.05$ and considered a trend at $P \le 0.10$.

[5] NRC. 1998. Nutrient Requirements of Swine. 10th ed. Natl. Acad. Press, Washington, DC.

Results and Discussion

From d 0 to 28, no diet form × feeder design interaction was observed for ADG or F/G (Table 2). Pigs fed pelleted diets had decreased ($P < 0.01$) ADG compared with pigs fed meal diets. Pigs presented diets via wet-dry feeders had a tendency ($P < 0.06$) for improved ADG compared with pigs fed from conventional dry feeders. A trend ($P < 0.06$) for a diet form × feeder design interaction was also observed for ADFI. Pigs fed either meal or pelleted diets from a conventional dry feeder had decreased ADFI compared with those fed a pelleted diet from a wet-dry feeder, with meal-fed pigs with a wet-dry feeder intermediate. Despite the interaction, pigs fed with wet-dry feeders had increased ($P < 0.001$) ADFI compared with those with conventional dry feeders. Pigs fed meal diets had improved ($P < 0.001$) F/G compared with those fed pelleted diets, and pigs with conventional dry feeders had improved ($P < 0.02$) F/G compared with those with wet-dry feeders. Pelleted diets averaged 39.6% fines and had a PDI of 87.2. These data indicate that feeding poor-quality pellets can actually result in poorer feed efficiency compared with feeding meal diets.

From d 28 to 42, no diet form × feeder design interactions or effects of diet form were detected for any of the growth performance criteria evaluated; however, a tendency ($P < 0.10$) was found for pigs with wet-dry feeders to have increased ADFI compared with those with dry feeders (Table 2). Pelleted diets averaged 3.9% fines and had a PDI of 89.8. No diet form × feeder design interactions were detected for feeder coverage score, but pigs fed pelleted diets had increased ($P < 0.02$) feeder pan coverage compared with those with meal diets, where pigs with wet-dry had a tendency for increased ($P < 0.06$) feeder pan coverage compared with those with dry feeders. Notably, d 28 to 42 represented a transition phase where after the poor-quality pellets were provided in the first phase, adjustments were made to provide better-quality pellets and the percentage fines and PDI represented pellet quality at the end of the phase.

From d 42 to 86, a diet form × feeder design interaction was observed ($P < 0.02$) for ADG, where pigs fed the meal diet from a conventional dry feeder had decreased ($P < 0.05$) ADG compared with pigs fed pelleted diets from the same feeder type, but no difference existed in wet-dry feeders based on diet form (Table 2). A tendency occurred for pigs fed meal diets to have increased ($P < 0.08$) ADFI compared with those fed pelleted diets. In addition, pigs with wet-dry feeders had increased ($P < 0.001$) ADFI compared with those fed with conventional dry feeders. Pigs fed pelleted diets had improved ($P < 0.001$) F/G compared with pigs fed meal diets, whereas pigs with wet-dry feeders had poorer ($P < 0.03$) F/G compared with those with conventional dry feeders. Pelleted diets averaged 4.4% fines and had a PDI of 93.5. No diet form × feeder design interactions were detected for feeder coverage score. During this phase when pellet quality was excellent, feed efficiency was improved 7.2% for pigs fed with the dry feeders and 5.1% for pigs fed with the wet-dry feeders.

From d 86 to 104, no diet form × feeder design interactions or effects of feeder design were observed for any of the growth criteria evaluated (Table 2). A tendency ($P < 0.09$) was found for pigs fed meal diets to have increased feed intake compared with those with pelleted diets. Pigs fed pelleted diets had improved ($P < 0.04$) F/G compared with pigs fed meal diets. Pelleted diets averaged 16.8% fines and had an average PDI of 93.8. A tendency occurred for a diet form × feeder design interaction ($P < 0.07$) in which pigs fed meal diets in conventional dry feeders had decreased feeder pan coverage compared with pigs fed pelleted diets from the same feeder type, and both had less coverage as the meal or pelleted feed offered via the dry or wet-dry feeders. No differences were found in feeder pan coverage observed in wet-dry feeders based on diet form. Overall (d 0 to 104), no diet form × feeder design interactions were observed for any of the growth performance criteria evaluated (Table 2). Pigs with wet-dry feeders had increased (P < 0.001) ADG and ADFI compared with those with dry feeders. Furthermore, a tendency was measured for pigs fed pelleted diets to have improved (P < 0.06) F/G compared with pigs fed meal diets. Pigs with wet-dry feeders had poorer (P < 0.02) F/G compared with those fed with dry feeders.

No diet form × feeder design interactions were detected for feeder coverage score. Pigs fed pelleted diets had increased (P < 0.01) feeder pan coverage compared with those with meal diets, and pigs with wet-dry had increased (P < 0.01) feeder pan coverage compared with those with dry feeders (Figures 1 through 4).

For carcass traits, no effect of diet form was observed for any of the criteria evaluated. Pigs fed with wet-dry feeders had heavier (P < 0.02) d-104 weights and subsequently had heavier (P < 0.004) HCW compared with those fed with conventional dry feeders, but pigs fed with dry feeders had increased (P < 0.04) carcass yield and FFLI compared with those fed with wet-dry feeders. A tendency (P = 0.06) was detected for diet form × feeder type interaction for backfat depth, in which pigs fed pelleted diets in dry feeders had greater backfat than meal-fed pigs, but the opposite was true for diet forms offered in a wet-dry feeder. Despite the interaction, pigs fed with wet-dry feeders had increased (P < 0.01) backfat depth compared with those fed with conventional dry feeders. In conclusion, regardless of diet form, pigs fed from wet-dry feeders had increased ADG and ADFI compared with pigs fed via dry feeders. Additionally, pellet quality appeared to influence responses because pigs provided higher-quality pellets via dry feeders had increased growth performance compared with pigs fed meal diets. Conversely, if pellet quality was poor, feed efficiency benefits associated with pelleting were lost.

Table 1: Composition of diets, (as-fed basis), Exp. 1[1]

Item	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Ingredient, %					
Corn	59.55	62.77	65.43	68.54	66.16
Soybean meal (46.5% CP)	18.54	15.36	12.78	9.70	22.21
Dried distillers grains with solubles	20.00	20.00	20.00	20.00	10.00
Limestone	1.00	0.98	0.95	0.95	0.95
Salt	0.35	0.35	0.35	0.35	0.35
Vitamin-trace mineral premix	0.10	0.09	0.08	0.08	0.08
Liquid lysine, 60%	0.45	0.45	0.40	0.38	0.23
Phytase[2]	0.01	0.01	0.01	0.01	0.01
Ractopamine HCl[3]	---	---	---	---	0.03
Total	100	100	100	100	100
Calculated analysis					
Standardized ileal digestible amino acids,%					
Lysine	0.95	0.87	0.78	0.69	0.90
Isoleucine:lysine	69	69	72	73	74
Methionine:lysine	31	32	34	37	31
Met & Cys:lysine	64	66	71	76	64
Threonine:lysine	62	63	66	68	66
Tryptophan:lysine	17.7	17.4	17.6	17.6	19.8
Total lysine, %	1.10	1.01	0.91	0.82	1.03
CP, %	19.5	18.3	17.2	16.1	18.8
ME kcal/lb	1,527	1,528	1,529	1,530	1,526
Ca, %	0.47	0.45	0.43	0.42	0.46
P, %	0.44	0.42	0.41	0.40	0.41
Available P,%	0.28	0.28	0.26	0.24	0.21

[1] Phase 1, 2, 3, 4, and 5 diets were fed from 84 to 123, 123 to 154, 154 to 187, 187 to 254, and 254 to 284 lb BW, respectively. All dietary phases were fed in both diet forms to each feeder type.
[2] OptiPhos 2000 (Enzyvia LLC, Sheridan, IN).
[3] Ractopamine HCl (Paylean, Elanco Animal Health, Greenfield, IN) was added at 6.75 g/ton.

Table 2. Effects of diet form and feeder design on finishing pig performance[1]

	Conventional dry		Wet-dry			P <		
Item	Meal	Pellet	Meal	Pellet	SEM	Diet form × feeder	Diet form	Feeder
d 0 to 28								
ADG, lb	1.45	1.28	1.48	1.39	0.04	0.27	0.01	0.06
ADFI, lb	3.20[a]	3.17[a]	3.45[b]	3.69[c]	0.07	0.06	0.14	0.0001
F/G	2.12	2.49	2.33	2.68	0.06	0.55	0.001	0.02
Fines, %[2]	---	39.6	---	39.6	---	---	---	---
PDI[3]	---	87.2	---	87.2	---	---	---	---
d 28 to 42								
ADG, lb	2.13	2.22	2.24	2.23	0.04	0.27	0.33	0.17
ADFI, lb	4.87	5.07	5.18	5.12	0.11	0.23	0.53	0.10
F/G	2.30	2.29	2.32	2.30	0.04	0.88	0.73	0.73
Fines, %	---	3.9	---	3.9	---	---	---	---
PDI	---	89.8	---	89.8	---	---	---	---
Feeder coverage score, %[4]	52.4	67.2	63.8	78.8	6.38	0.98	0.02	0.06
d 42 to 86								
ADG, lb	2.12[a]	2.28[b]	2.31[b]	2.34[b]	0.03	0.02	0.01	0.001
ADFI, lb	6.18	6.15	6.81	6.52	0.09	0.14	0.08	0.001
F/G	2.91	2.70	2.94	2.79	0.03	0.27	0.001	0.03
Fines, %	---	4.4	---	4.4	---	---	---	---
PDI	---	93.5	---	93.5	---	---	---	---
Feeder coverage score, %	54.8	60.8	58.5	70.6	6.38	0.62	0.15	0.28
d 86 to 104								
ADG, lb	1.89	1.92	1.97	1.92	0.08	0.62	0.83	0.59
ADFI, lb	5.99	5.60	6.19	5.78	0.23	0.96	0.09	0.41
F/G	3.18	2.94	3.14	3.03	0.09	0.48	0.04	0.75
Fines, %	---	16.8	---	16.8	---	---	---	---
PDI	---	93.8	---	93.8	---	---	---	---
Feeder coverage score, %	31.3[a]	56.2[b]	70.1[b]	72.0[b]	6.38	0.07	0.03	0.001

continued

Table 2. Effects of diet form and feeder design on finishing pig performance[1]

Item	Conventional dry		Wet-dry		SEM	P <		
	Meal	Pellet	Meal	Pellet		Diet form × feeder	Diet form	Feeder
d 0 to 104								
ADG, lb	1.90	1.94	2.02	1.99	0.02	0.18	0.73	0.001
ADFI, lb	5.13	5.07	5.54	5.42	0.08	0.68	0.25	0.001
F/G	2.71	2.62	2.75	2.72	0.03	0.36	0.06	0.02
Feeder coverage score, %	46.2	61.4	64.1	73.8		0.56	0.01	0.01
Carcass measurements[7]								
Live weight, lb	277.9	281.5	291.3	286.8		0.28	0.90	0.02
HCW, lb	207.3	208.7	216.8	214.7		0.49	0.88	0.004
Carcass yield, %	75.6	76.3	74.7	74.6		0.52	0.63	0.03
FFLI, %[8]	51.3	51.1	50.4	50.7		0.26	0.69	0.04
Back fat depth, in.	0.63[a]	0.64[a]	0.70[b]	0.67[b]		0.06	0.52	0.001
Loin depth, in.	2.43	2.43	2.43	2.44		0.90	0.72	0.88

[a,b,c] Means lacking a common superscript within a row differ ($P < 0.05$).
[1] A total of 1,146 growing pigs (PIC 1050 × 337, initially 84.2lb) were used with 26 to 27 pigs per pen and 11 pens per treatment.
[2] Percentage fines were determined using a number 6 screen.
[3] Pellet durability index was determined by tumbling 500 g samples of feed for 10 minutes, then using a number 6 screen to sift off the fines.
[4] Pictures of feeder pan coverage were taken on d 54, 78, and 104. A panel of 4 then scored feeder pan pictures for percentage of feeder pan coverage.
[5] STACO, Shafferstown, PA.
[6] Crystal Springs, Gro Master, Omaha, NE.
[7] Carcass data were obtained for 891 pigs from 44 pens. Backfat depth, and loin depth were adjusted to a common HCW.
[8] Fat-free lean index (National Pork Producers Council, 2000).

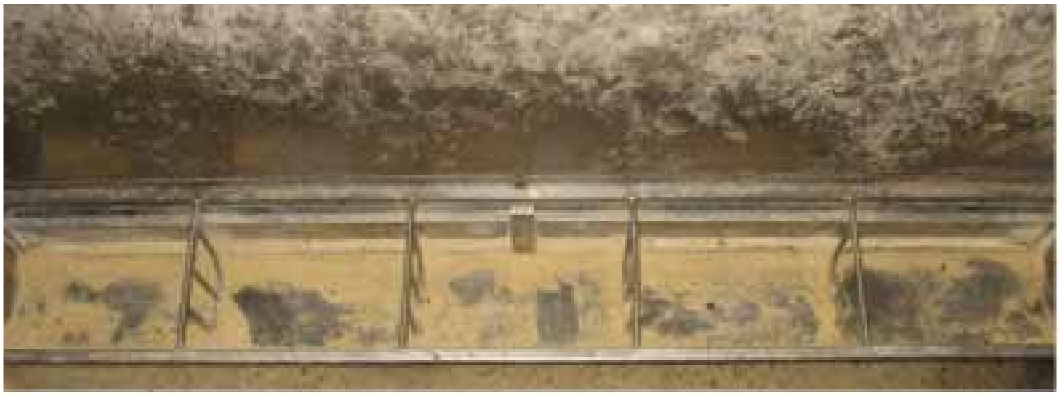

Figure 1. Conventional dry feeder with meal diets averaging 46% feeder pan coverage, Exp. 2.

Figure 2. Conventional dry feeder with pelleted diets averaging 61% feeder pan coverage, Exp. 2.

Figure 3. Wet-dry feeder with meal diets averaging 64% feeder pan coverage, Exp. 2.

Figure 4. Wet-dry feeder with pelleted diets averaging 74% feeder pan coverage, Exp. 2.