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Determining the Effects of Cup Waterer on Growth Performance of Growing and Finishing Pigs

Abstract

Two studies were conducted to evaluate the growth performance of growing-finishing pigs in response to different ratios of cup waterers to pigs and different locations of the cup waterers within a pen under commercial conditions. In Exp. 1, 1,134 pigs (initial pen average BW of 35.7 ± 1.17 lb) were housed in pens that provided 6.85 ft^2/pig and were used in a 113-d trial during summer months (May through September). Pens of pigs were blocked by location within the barn and allotted to treatments in a randomized complete block design. There were 14 replicate pens per treatment and 27 pigs per pen. Treatments consisted of 1, 2, or 3 cup waterers per pen, resulting in 27, 13.5, and 9 pigs per cup waterer, respectively. From d 0 to 45, increasing the number of cups per pen resulted in a quadratic increase ($P <$ 0.05) in the percentage of days that cups needed to be cleaned in order to remove fecal material. From d 80 to 113, with more waterers per pen, there was a linear increase in days the waterers were cleaned ($P <$ 0.05). For growth performance, there was no evidence of treatment effect from d 0 to 74 ($P > 0.10$); however, from d 74 to 114 and overall, increasing the number of cup waterers per pen resulted in a linear increase in average daily gain (ADG) and final BW ($P < 0.05$). Overall, there was no evidence of differences observed for average daily feed intake (ADFI) and feed efficiency (F/G) ($P > 0.10$). In Exp. 2, 1,134 pigs (initial pen average BW of 34.7 ± 0.60 lb) were housed in pens that allowed 6.85 ft^2 of space per pig and were used in a 126-d trial during winter months (October through February). Pens of pigs were randomly allotted to 1 of 3 treatments in a randomized complete block design with location within the barn being the blocking factor. There were 14 replicates per treatment and 27 pigs per pen. Treatments consisted of a 1 cup waterer installed 42 in. from the feeder; 2 cup waterers installed 24 in. and 48 in. from one side of the feeder; and 2 cup waterers installed 24 in. from each side of the feeder. Overall, there was no evidence for differences among treatments regarding the percentage of waterers that needed to be cleaned ($P >$ 0.10). For growth performance, no significant treatment effects were observed from d 0 to 70 ($P > 0.10$). From d 70 to 126 and overall, ADG was increased when pens were equipped with a 1 cup waterer located on each side of the feeder compared to pens with 2 cup waterers located on the same side of the feeder, with pens with 1 waterer intermediate ($P < 0.10$). However, there was no evidence for an overall treatment effect on ADFI, F/G, and final BW ($P > 0.10$). Results from this study indicate the optimal water cup to pig ratio changes as pigs increase in body weight. The linear improvement in growth performance as the number of drinking devices increased suggests water availability becomes more critical at heavier weight. Positioning of cup waterers within a pen is also an important factor to be taken into account, with a 1 cup waterer installed on either side of the feeder providing the highest growth rate. However, increasing the number of cups increased management associated with cleaning cups during summer months, but not during winter months. Further characterization of the interactions of cup waterer number, finishing pig weight, and cup waterer cleanliness on growth performance is needed.

Keywords

growth, drinker, water, growing-finishing pigs

Cover Page Footnote

Appreciation is expressed to Genus PIC for partial funding and expertise, to New Horizon Farms for use of the feed mill and animal facilities, and to Marty Heintz, Heath Houselog and Whitney Adler for technical assistance.

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Determining the Effects of Cup Waterer on Growth Performance of Growing and Finishing Pigs[1]

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Summary

Two studies were conducted to evaluate the growth performance of growing-finishing pigs in response to different ratios of cup waterers to pigs and different locations of the cup waterers within a pen under commercial conditions. In Exp. 1, 1,134 pigs (initial pen average BW of 35.7 ± 1.17 lb) were housed in pens that provided 6.85 ft^2/pig and were used in a 113-d trial during summer months (May through September). Pens of pigs were blocked by location within the barn and allotted to treatments in a randomized complete block design. There were 14 replicate pens per treatment and 27 pigs per pen. Treatments consisted of 1, 2, or 3 cup waterers per pen, resulting in 27, 13.5, and 9 pigs per cup waterer, respectively. From d 0 to 45, increasing the number of cups per pen resulted in a quadratic increase ($P < 0.05$) in the percentage of days that cups needed to be cleaned in order to remove fecal material. From d 80 to 113, with more waterers per pen, there was a linear increase in days the waterers were cleaned ($P < 0.05$). For growth performance, there was no evidence of treatment effect from d 0 to 74 ($P > 0.10$); however, from d 74 to 114 and overall, increasing the number of cup waterers per pen resulted in a linear increase in average daily gain (ADG) and final BW ($P < 0.05$). Overall, there was no evidence of differences observed for average daily feed intake (ADFI) and feed efficiency (F/G) ($P > 0.10$). In Exp. 2, 1,134 pigs (initial pen average BW of 34.7 ± 0.60 lb) were housed in pens that allowed 6.85 ft^2 of space per pig and were used in a 126-d trial during winter months (October through February). Pens of pigs were randomly allotted to 1 of 3 treatments in a randomized complete block design with location within the barn being the blocking factor. There were 14 replicates per treatment and 27 pigs per pen. Treatments consisted of a 1 cup waterer installed 42 in. from the feeder; 2 cup waterers installed 24 in. and 48 in. from one side of the feeder; and 2 cup waterers installed 24 in. from each side of the feeder. Overall, there was no evidence for differences among treatments regarding the percentage of waterers that needed to be cleaned ($P > 0.10$). For growth performance, no significant treatment

[1]Appreciation is expressed to Genus PIC for partial funding and expertise, to New Horizon Farms for use of the feed mill and animal facilities, and to Marty Heintz, Heath Houselog and Whitney Adler for technical assistance.
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effects were observed from d 0 to 70 ($P > 0.10$). From d 70 to 126 and overall, ADG was increased when pens were equipped with a 1 cup waterer located on each side of the feeder compared to pens with 2 cup waterers located on the same side of the feeder, with pens with 1 waterer intermediate ($P < 0.10$). However, there was no evidence for an overall treatment effect on ADFI, F/G, and final BW ($P > 0.10$). Results from this study indicate the optimal water cup to pig ratio changes as pigs increase in body weight. The linear improvement in growth performance as the number of drinking devices increased suggests water availability becomes more critical at heavier weight. Positioning of cup waterers within a pen is also an important factor to be taken into account, with a 1 cup waterer installed on either side of the feeder providing the highest growth rate. However, increasing the number of cups increased management associated with cleaning cups during summer months, but not during winter months. Further characterization of the interactions of cup waterer number, finishing pig weight, and cup waterer cleanliness on growth performance is needed.

Introduction

Water is an essential nutrient that fulfills many physiological functions.[4] Water helps regulate body temperature, aids in digestion of feed, transports nutrients, and removes toxins from the body.[5] Moreover, water intake is positively correlated with feed intake and body weight.[5] The NRC[5] states that the minimum water requirement for pigs between 44.1 and 198.4 lb body weight is approximately 2 lb of water for each 1 lb of feed. Given these critical roles, water access and availability on pig farms may influence a pig's feed intake, health, and performance.

Dietary, physiological, and environmental factors can impact water requirements of swine.[5] These factors include feed ingredients, stage of production, environmental temperature and humidity, health status of the pigs, and stress. To estimate true water requirement of pigs, water wastage has to be taken into account. Due to difficulties in measuring water wastage, water usage is measured to estimate the requirement. It is reported that growing pigs allowed *ad libitum* access to feed consume approximately 2.5 lb of water per 1 lb of feed.[6] However, a more recent study reported that the relation of water:feed is dependent on waterer type, and changes as pigs grow.[7]

Water delivery equipment and placement in the pen differ between facilities and may influence overall water usage. General recommendations regarding the number of pigs per drinking device and equipment placement exist,[7,8] but limited data are available in modern production systems to support these recommendations. Therefore, the objective of this study was to evaluate the growth performance of growing and finishing pigs in response to different ratios of cup waterer to pigs and different locations of the drinking devices within a pen under commercial conditions.

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[4]Roubicek, D. 1969. Water metabolism. P. 353-373 in *Animal Growth and Nutrition*, H. Hafez and I. Dyer, eds. Philadelphia: Lea and Febiger.
[5]NRC. 2012. Nutrient requirements of swine. 11th rev. ed. Natl. Acad. Press, Washington, D.C.
[6]Cumby, T. R. 1986. Design requirements of liquid feeding systems for pigs: A review. *Journal of Agricultural Engineering and Resources* 34:153-172.
[7]Brumm, M. C., Dahlquist, J. M., Heemstra, J. M. 2000. Impact of feeders and drinker devices on pig performance, water use, and manure volume. Swine Health Prod. 8(2):51-57.
[8]MWPS. Midwest Plan Service. Swine housing and equipment handbook. Publication no. MWPS-8. Iowa State University, Ames; 1983.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved all experimental procedures used in this study.

Two experiments were conducted at a commercial research-finishing site in southwestern Minnesota. The barn was naturally ventilated and double-curtain-sided. Pens had completely slatted flooring with deep pits and were equipped with a 5-hole stainless steel dry feeder. Pen dimensions consisted of 218 in. length by 122 in. width, with a 55 in. length feeder installed on the fenceline at 82 in. from the alley and 81 in. from the wall. This area provided 6.85 ft^2/pig of space allowance. Thirteen barrows and fourteen gilts (PIC; 337 × Camborough, Genus PIC, Hendersonville, TN) were housed in each pen and were allowed *ad libitum* access to feed and water throughout the study. The facility was equipped with a computerized feeding system (FeedPro; Feedlogic Corp., Willmar, MN) capable of measuring and recording daily feed additions to individual pens.

In Exp. 1, 1,134 pigs (initial pig average BW of 35.7 ± 1.17 lb) were housed in a barn with 42 pens. Upon arrival, pens of pigs were blocked by location within the barn and randomly allotted to 1 of 3 treatments in a randomized complete block design, with 14 replicates per treatment. Treatments consisted of a 1 cup waterer installed on the fenceline 42 in. from the feeder, between the feeder and the wall; 2 cup waterers installed on the fenceline 42 in. from each side of the feeder, between the feeder and the wall and the feeder and the alley; and 3 cup waterers installed on the fenceline 42 in. from the feeder, between the feeder and the alley, and 21 in. and 42 in. from the feeder, between the feeder and the wall (Figure 1). This resulted in 27, 13.5, and 9 pigs per cup waterer for treatments with 1, 2, or 3 drinkers, respectively. The typical ratio of cup waterer to pigs in this system is 1:27, and the trial was conducted during summer months from mid-May to mid-September. The average high and low temperatures observed in this location during the trial period were 79°F and 56°F, respectively.

In Exp. 2, 1,134 pigs (initial pig average BW of 34.7 ± 0.60 lb) were housed in a barn with 42 pens. At placement, pens of pigs were blocked by location within the barn and randomly allotted to 1 of 3 treatments in a randomized complete block design. There were 14 replicates per treatment and 27 pigs per pen. Treatments consisted of a 1 cup waterer installed on the fenceline 42 in. from the feeder, between the feeder and the wall; 2 cup waterers installed on the fenceline 24 in. and 48 in. from one side of the feeder, between the feeder and the wall; and 2 cup waterers installed on the fenceline 42 in. from each side of the feeder, between the feeder and the wall and the feeder and the alley (Figure 2). The trial was conducted through winter months, from early October through early February. The average high and low temperatures observed in this location during the trial period were 37°F and 16°F, respectively.

Pigs were fed common corn-DDGS-soybean meal-based diets throughout the duration of the trials, which were fed in 5 different phases (Table 1). Diets were fed in meal form and were manufactured at the New Horizon Farms Feed Mill (Pipestone, MN). Pens of pigs were weighed and feed disappearance was recorded on d 0 and every 14 d thereafter to determine ADG, ADFI, and F/G. The number of cups cleaned daily was tracked for each pen in two periods from d 0 to 45, and d 80 to the end of the trial in Exp. 1, and from d 0 to 126 in Exp. 2 to calculate the percentage of days that cups needed to have fecal material removed.

Data from both experiments were analyzed using the GLIMMIX procedure of SAS (Version 9.3, SAS Institute Inc., Cary, NC) with pen as the experimental unit. In Exp. 1, treatment was included in the model as a fixed effect with initial BW as a covariate, and location block was included in the model as a random effect. Polynomial contrasts were implemented to evaluate the functional form of increasing the cup waterer:pig ratio on ADG, ADFI, BW, F/G, and percentage of days that cups had to be cleaned. In Exp. 2, treatment was included as a fixed effect and location block was included in the model as a random effect. Pairwise comparisons were conducted and means were reported as least-square means. Differences in the percentage of days that had waterers cleaned per total days observed were analyzed using a binomial distribution and growth performance as normally distributed. Results were considered significant at $P \leq 0.05$ and marginally significant at $0.05 \leq P \leq 0.10$.

Results and Discussion

In Exp. 1, from d 0 to 45, there was no evidence that increasing the number of water cups improved ADG, ADFI, and F/G (Table 2, $P > 0.10$). Similarly, no evidence for differences in ADG and F/G were observed from d 45 to 74, but there was a marginal evidence of a linear increase in ADFI as the number of waterers increased ($P < 0.10$). From d 74 to 113, a significant improvement in ADG was observed as the number of cup waterers increased (linear, $P < 0.05$). There was no evidence for differences in ADFI and F/G from d 74 to 113 ($P > 0.10$). Overall, increasing the number of cup waterers resulted in a linear increase ($P < 0.05$) in ADG and final BW. No statistical differences were observed for ADFI and F/G ($P > 0.10$).

From day 0 to 45, increasing the number of cups per pen resulted in a quadratic increase ($P < 0.05$) in the percentage of days that cups needed to be cleaned in order to remove fecal material (<1, 16, and 36% of days for treatments with 1, 2, or 3 cup waterers, respectively; Table 2). From d 80 to 113 a linear increase ($P < 0.05$) in days the waterers were cleaned was observed with means of <1, 13, and 29% for treatments with 1, 2, or 3 cup waterers, respectively.

In Exp. 2, from d 0 to 70, there was no evidence of differences ($P > 0.10$) between treatments in ADG, ADFI, and F/G. However, from d 71 to 126, ADG was highest for pens containing 2 cup waterers, one in each side of the feeder, and lowest for pens containing 2 cup waterers on the same side of the feeder, with pens with a 1 cup intermediate ($P < 0.05$). This improvement in ADG was driven by a marginal significant increase ($P < 0.10$) in ADFI for pens containing 2 cup waterers, 1 on each side of the feeder. No evidence for differences ($P > 0.10$) were observed for F/G. Overall, ADG was improved when pens were equipped with 2 cup waterers located on each side of the feeder compared to pens with 2 cup waterers located on the same side of the feeder, with pens with 1 waterer intermediate. However, there was no evidence for a treatment effect ($P > 0.10$) on ADFI, F/G, and final BW. There was no evidence ($P > 0.10$) that number of waterers or water placement influenced the number of pens with cups that needed to be cleaned to remove fecal material during the entirety of the trial.

Results from this study indicate the optimal ratio of cup waterer to pigs changes as finishing pigs increase in body weight. Water availability becomes more critical at heavier weights as seen by the linear improvement in growth performance for pigs weighing more than 160 lb as the number of drinking devices increased. However, increasing the number of cups increased management associated with cleaning cups during the summer period but not during the winter period. These results also suggest installing cup waterers on each side of the feeder as opposed to both waterers next to each other on the same side of the feeder potentially make them more available for drinking purposes as the pigs grow. Further characterization of the interactions of cup waterer number, finishing pig weight, and cup waterer cleanliness on growth performance is needed.

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

Item	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Ingredient, %					
Corn	49.71	55.24	64.09	69.27	82.01
Soybean meal, 46.5% CP	31.89	21.13	13.30	8.38	15.99
DDGS	15.00	20.00	20.00	20.00	---
Beef tallow	---	0.80	---	---	---
Monocalcium phosphate, 21% P	0.73	0.28	0.16	0.02	0.20
Limestone	1.28	1.35	1.30	1.23	0.93
Sodium chloride	0.58	0.35	0.35	0.35	0.35
L-Lysine HCl	0.40	0.48	0.48	0.48	0.25
DL-Methionine	0.12	0.08	0.04	0.00	0.02
L-Threonine	0.10	0.11	0.10	0.09	0.09
L-Tryptophan	0.04	0.03	0.04	0.04	0.01
Phytase[2]	0.02	0.01	0.01	0.01	0.01
Vitamin and trace mineral premix	0.15	0.15	0.15	0.15	0.15
Total	100	100	100	100	100
Calculated analysis					
Standardized ileal digestible (SID) amino acids, %					
Lysine	1.320	1.130	0.940	0.820	0.770
Isoleucine:lysine	64	61	60	58	64
Leucine:lysine	139	148	160	169	155
Methionine:lysine	34	33	32	30	30
Methionine and cysteine:lysine	58	58	59	58	59
Threonine:lysine	62	63	62	62	67
Tryptophan:lysine	21.1	18.9	18.7	18.8	18.9
Valine:lysine	70	70	71	72	73
Total lysine, %	1.50	1.30	1.09	0.95	0.88
Metabolizable energy, kcal/lb	1,470	1,497	1,485	1,490	1,509
Net energy, kcal/lb	1,077	1,122	1,129	1,145	1,151
SID Lys:ME, g/Mcal	4.07	3.42	2.87	2.50	2.31
Crude protein, %	23.5	20.2	17.0	15.0	13.7
Calcium, %	0.70	0.62	0.56	0.49	0.44
Phosphorus (P), %	0.64	0.53	0.47	0.42	0.37
Standardized total tract digestible P, %	0.48	0.38	0.33	0.29	0.26
Available P,%	0.45	0.35	0.32	0.28	0.20
Calcium:phosphorus	1.09	1.17	1.18	1.17	1.18

[1]Phase 1 was fed from approximately 35 to 60 lb; phase 2 from 60 to 110 lb; phase 3 from 110 to 165 lb; phase 4 from 165 to 220 lb; and phase 5 from 220 lb to the end of each trial.
[2]Phytase (Optiphos 2000, Huvepharma Inc., Peachtree City, GA).

Table 2. Cup waterer:pig ratio on growth performance of growing-finishing pigs[1,2]

	Cup waterers					
Item[3]	1	2	3		Probability, P =	
Cup:pigs ratio	1:27	1:13.5	1:9	SEM	Linear	Quadratic
d 0 to 45						
ADG, lb	1.64	1.65	1.67	0.013	0.136	0.771
ADFI, lb	3.06	3.04	3.06	0.028	0.945	0.462
F/G	1.87	1.85	1.85	0.012	0.174	0.510
d 45 to 74						
ADG, lb	1.91	1.91	1.93	0.016	0.431	0.507
ADFI, lb	4.71	4.74	4.81	0.039	0.074	0.623
F/G	2.46	2.48	2.49	0.015	0.108	0.687
d 74 to 113						
ADG, lb	2.10	2.19	2.21	0.031	0.026	0.129
ADFI, lb	5.58	5.63	5.70	0.057	0.155	0.904
F/G	2.66	2.59	2.59	0.033	0.157	0.283
d 0 to 113						
ADG, lb	1.84	1.87	1.88	0.013	0.038	0.646
ADFI, lb	4.44	4.45	4.51	0.033	0.198	0.571
F/G	2.41	2.39	2.40	0.016	0.527	0.259
BW, lb						
d 0	35.6	35.9	35.7	1.17	0.479	0.084
d 45	110.1	110.5	111.3	0.55	0.095	0.699
d 74	165.6	165.9	167.3	0.83	0.158	0.594
d 113[4]	244.4	247.5	248.4	1.48	0.044	0.504
Days with cups cleaned, %						
d 0 to 45	0.1	16.3	36.3	---[5]	0.001	0.001
d 80 to 113	0.5	13.4	29.4	---[6]	0.001	0.581

[1]A total of 1,134 pigs (PIC 359 × 1050; initial pen average body weight 35.7 ± 1.17 lb) were used in a growth trial with 14 replicate pens per treatment and 27 pigs per pen. Treatments consisted of 1, 2, or 3 cup waterers per pen resulting in 27, 13.5, or 9 pigs per cup waterer, respectively. Treatments were randomly assigned to pens at placement based on location in the barn in a randomized complete block design.
[2]The trial was conducted through summer months, from mid-May to mid-September.
[3]Data were adjusted for initial body weight.
[4]Topping of 3 pigs per pen occurred on d 113.
[5]SEM were 0.14, 2.89, and 4.63 for treatments 1, 2, and 3, respectively.
[6]SEM were 0.46, 1.33, and 2.94 for treatments 1, 2, and 3, respectively.
ADG = average daily gain. ADFI = average daily feed intake. F/G = feed efficiency.

Table 3. Determining the effects of cup waterer placement on growth performance of growing-finishing pigs[1,2]

	Cup waterers				
Item	1	2 (both sides)	2 (one side)	SEM	Probability, $P =$
d 0 to 70					
ADG, lb	1.82	1.84	1.83	0.020	0.789
ADFI, lb	3.84	3.86	3.81	0.057	0.729
F/G	2.11	2.10	2.08	0.016	0.317
d 71 to 126[3]					
ADG, lb	1.91[a,b]	1.96[a]	1.87[b]	0.021	0.026
ADFI, lb	5.86[b]	6.02[a]	5.86[b]	0.059	0.054
F/G	3.08	3.08	3.13	0.034	0.281
d 0 to 126					
ADG, lb	1.84[a,b]	1.87[a]	1.83[b]	0.013	0.071
ADFI, lb	4.60	4.67	4.58	0.051	0.259
F/G	2.51	2.50	2.51	0.018	0.833
BW, lb					
d 0	34.7	34.8	34.7	0.60	0.995
d 70	160.9	162.1	161.5	1.80	0.755
d 126	265.7	270.3	266.2	2.15	0.170
Days with cups cleaned					
d 0 to 126, %	<1	<1	<1	0.013	0.999

[1]A total of 1,134 pigs (PIC 359 × 1050; initial pen average body weight 34.7 lb) were used in a growth trial with 14 replicate pens per treatment and 27 pigs per pen. Treatments consisted of a 1 cup waterer, 2 cup waterers installed on one side of the feeder (between the feeder and the wall), or a 1 cup waterer installed on both sides of the feeder (between the feeder and the wall and the feeder and the alley) per pen. Treatments were randomly assigned to pens at placement based on body weight and location in the barn in a randomized complete block design.
[2]The trial was conducted through winter months, from early October through early February.
[3]Topping of 2 pigs per pen occurred on d 112.
ADG = average daily gain. ADFI = average daily feed intake. F/G = feed efficiency.

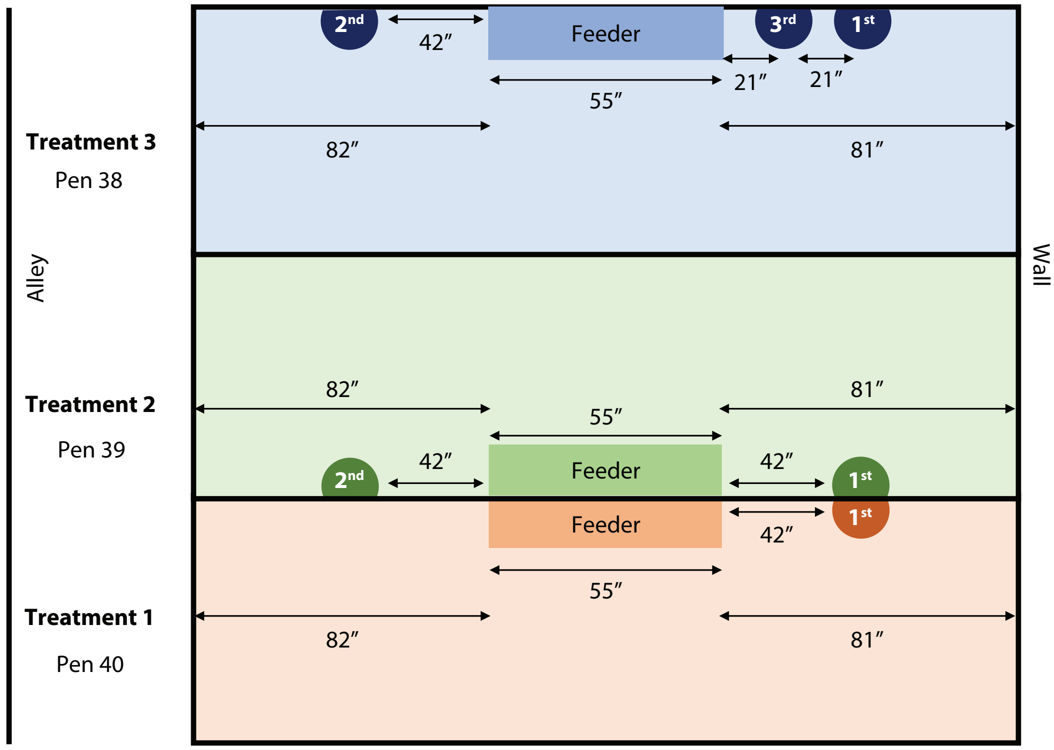

Figure 1. Pen layout for Exp. 1. Treatments consisted of 1, 2, or 3 cup waterers per pen resulting in 27, 13.5, or 9 pigs per cup waterer. Treatment 1 had one cup waterer installed 42 in. from the feeder, between the feeder and the wall. Treatment 2 had a 1 cup waterer installed 42 in. from the feeder, between the feeder and the wall, and one installed 42 in. from the feeder, between the feeder and the alley. Treatment 3 had one cup waterer installed 42 in. from the feeder, between the feeder and the alley, and 2 cup waterers installed 21 in. and 42 in. from the feeder, between the feeder and the wall.

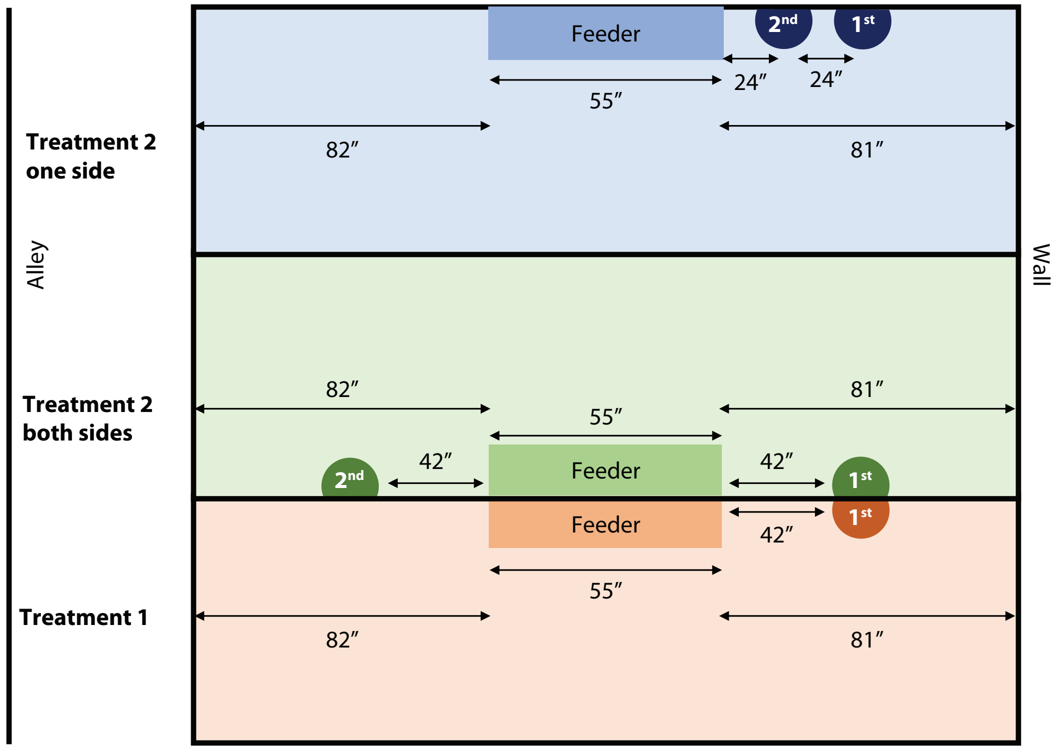

Figure 2. Pen layout for Exp. 2. Treatments consisted of: a 1 cup waterer installed 42 in. from the feeder, between the feeder and the wall; 2 cup waterers, with one cup waterer installed 42 in. from the feeder, between the feeder and the wall, and one installed 42 in. from the feeder, between the feeder and the alley; and 2 cup waterers installed 24 in. and 48 in. from the feeder, between the feeder and the wall.