Performance of Finishing Pigs in Hoop Structures and Confinement during Summer and Winter

M. E. Larson, graduate research assistant,
M. S. Honeyman, associate professor, and
A. D. Penner, research associate
Department of Animal Science
J. D. Harmon, associate professor, Department of Agriculture and Biosystems Engineering

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Summary and Implications

Based on these studies the performance (growth and efficiency) of hoop pigs was affected by seasonal variations. During the summer the hoop pigs grew more rapidly and were more efficient in liveweight gain than confinement pigs. However, during the winter, the trend reversed and the hoop pigs grew slower and were less efficient than confinement pigs. Apparently the hoop pigs in the cold environment used more feed for temperature maintenance. When averaged to simulate an entire year, the pigs' performance was similar. Also the pig performance was more consistent from season to season in confinement.

Overall leanness of the hoop pigs was poorer than the confinement pigs as reflected by equivalent or more backfat, smaller loin muscle areas, lower percentage of lean, less lean per pig, the same or slower rate of lean deposition, and the same or poorer efficiency of lean gain. Therefore, hoop pigs may need to be fed diets that are somewhat different than diets fed to confinement pigs. Also based on slaughter checks, control of internal parasites in hoop pigs needs to be aggressive.

Introduction

Due to the rapidly changing pork industry, all viable alternatives to swine production should be evaluated. One alternative is hoop structures or "hoops." Hoop structures come in a variety of widths (20 to 72 ft) and lengths (60 to 130 ft) to meet the needs of many producers.

The popularity and diversity of hoops seems to be expanding across the United States. Since 1996, there are over an estimated 1,500 hoops in Iowa used for pig production. Most hoops are used for finishing pigs. Hoop structures work well for gestating sows but are also being used for isolation, wean-to-finish, gilt development, and breeding.

Information about growth performance, management, economics, and environmental concerns regarding pigs raised in hoop structures has been limited. In 1997, the Hoop Research Complex (HRC) was developed at the Rhodes Research Farm to conduct year-round research, while providing current information about hoop structures. The HRC consists of three hoops and one mechanically ventilated modular confinement with slatted floors. Comparing the two production systems provides information for improved management of finishing pigs in hoops.

During the winter of 1997–1998, the first grow-finish trial was conducted at the HRC (1). Because of construction delays the pigs were not started until they weighed 100 lb. Also the purchased feeder pigs were diagnosed and treated for swine dysentry. Overall the two production systems performed similarly.

From late June 1998 to November 1999, the second trial was conducted at the HRC. From November 1998 to May 1999, the third trial was conducted. Trial 3 represented a winter feeding period and is paired with the second (summer) trial. The trials provided information about pig performance, management and environmental conditions in hoops during summer and winter feeding periods.

The objectives of this study were to document the performance of grow-finish pigs in hoops during summer and winter and to evaluate pig performance in hoops compared with pigs in a confinement housing system.

Materials and Methods

Trial 2 (summer) started June 30, 1998. Three groups of pigs (n=451) were placed in three (30 ft × 60 ft) deep-bedded hoop structures. The fourth group (n=132) was placed in a mechanically ventilated modular confinement building with slatted floors. At the start of trial 2 (summer) pigs weighed 36 lb in the hoops and 38 lb in the confinement unit. Trial 3 (winter) started on November 24, 1998. The three hoops and confinement were filled over a 3-week period. Each unit was filled with one delivery of pigs that were weaned at the same time. At the start of trial 3 (winter) the hoop pigs (n=451) weighed 32 lb and the confinement pigs (n=132) weighed 34 lb. The pigs were injected with ivermectin and vaccinated for erysipelas at the start of the trials.

The stocking densities for finishing pigs in hoop structures was 12 ft^2 per pig and 8 ft^2 per pig in confinement (2). With 12 ft^2 per pig, each (30 ft x 60 ft) hoop structure was designed to hold 150 pigs. The confinement pens (13.5 ft x 13 ft) were designed to hold 22 pigs each. In the trials, a hoop is defined as a pen. There were three pens of hoop pigs and six pens of confinement pigs. All pigs were from the ISU Lauren Christian Swine Research and Demonstration Farm, Atlantic, IA.

Pigs were fed five diets ad libitum during the trials. All diets were corn and soybean meal based and were fed in meal form. The diets were dispensed in each hoop by two round feeders with 12 feeding spaces each. The confinement pens contained a single round feeder with eight spaces. The hoops contained two waterers with two drinking spaces each and the confinement contained four nipple waterers per pen.

The hoop structures were operated as cold facilities that use cornstalk bales for deep bedding. The north end was kept closed during the winter and the south was left open. This allowed air to be exchanged at a sufficient rate to prevent condensation on the underside of the roof. Bedding was added to maintain a relatively dry bedding pack. During summer, both ends were left open and a sprinkler system with a cycle timer was used during hot weather.

The confinement facility used a variable-speed fan to maintain a sufficient minimum ventilation rate during winter. A propane makeup air heater was used to maintain temperature. The facility used mechanical ventilation during the summer along with a sprinkler system controlled with a cycle timer to reduce heat stress.

The animal environment was monitored in all of the facilities. In the confinement facility the temperature and relative humidity were continuously monitored with remote sensors. Ammonia was occasionally measured with dosimeter tubes. Air temperature also was measured continuously in the hoop structures. However, the effective temperature is highly influenced by heat given off by the composting bedding pack so the bedding pack temperature also was occasionally measured.

The pigs were weighed every 28 days. Marketing began when a pen achieved an average weight of 240 lb. There were two marketings for each pen. On the first marketing, all pigs weighing 240 lb or more were marketed. At this time, pigs were scanned for backfat and loin muscle area using real-time ultra sound. The pigs weighing under 240 lb were returned to their respective pens and fed until the next marketing. When the remaining pigs in a pen averaged 235 lb, the second marketing occurred. All remaining pigs were marketed at this time.

All pigs were transported to the Excel plant, Ottumwa, IA, for processing and slaughter checks. The Trial 2 hoop pigs were marketed on October 19 and November 3, 1998 and the confinement pens were marketed on November 11 and November 24, 1998. Slaughter checks were performed on approximately 10 confinement pigs and 30 hoop pigs for each marketing date. Trial 3 hoop pigs were marketed on April 12 and May 11, 1999, and confinement pigs were marketed on April 19 and May 11, 1999.

Results and Discussion

For the trial 2 (summer), the confinement pigs started the trial weighing slightly more than the hoop pigs (38 vs. 36 lb) (Table 1). At the end of the trial, the average market weight of the hoop and confinement pigs (259.6 vs. 260.0 lb) were similar.

Overall weight gain between hoop and confinement pigs was similar (224.0 vs. 222.3 lb) (Table 1). The hoop pigs grew faster and reached market weight 5 days earlier than the confinement pigs (Table 1). There was no difference in average daily feed intake (ADFI) ($P>.80$). The average daily gain (ADG) was 4 % more for the hoop pigs than the confinement pigs ($P<.001$). The hoop pigs had a lower feed to gain ratio than pigs in confinement ($P<.01$). Hoop pigs were 5% more efficient than pigs in confinement. The pigs were in good health and only 15 died during the trial. A higher mortality rate occurred in confinement (4.5%) than in hoops (2%) (Table1).

The trial 2 scan data are shown in Table 2. Lean values were calculated for the pigs with the scan data (4). Hoop pigs had 12% more backfat thickness than confinement pigs ($P<.05$). The hoop pigs had 9% smaller loin muscle area than hoop pigs ($P<.001$) (Table 2). The hoop pigs were 4% less lean than the confinement pigs ($P<.001$). However, there was no difference in the lean growth rate or efficiency of the lean gains between the two systems.

Pig performance of trial 3 (winter) are shown in Table 3. Beginning pig weight was similar for hoop and confinement pigs (32 vs. 34 lb). Market weight of the hoop pigs was slightly heavier than the confinement pigs (262 vs. 257 lb) ($P<.05$). The hoop pigs gained more weight than the confinement pigs (230 vs. 223 lb) ($P<.01$). However, the hoop pigs were on feed about 12 days longer than the confinement pigs (148 vs. 136 days) ($P<.01$). The hoop pigs ate about 5% more feed than the confinement pigs (5.2 vs. 4.9 lb/day) ($P<.05$), but grew about 5% slower (1.57 vs. 1.63 lb/day) ($P<.01$). Therefore, the hoop pigs were 10% less efficient (3.3 vs. 3.0) ($P<.01$). Also pig mortality and percentage of light pigs (<220 lb) at market was more for the hoops than confinement.

The trial 3 scan data is shown in Table 4. The hoop pigs' test period was 7 days longer ($P<.05$) at similar scan weights compared with the confinement pigs (233 vs. 238 lb). Average backfat thickness was the same for all pigs (.77 in.). However, the hoop pigs had smaller loin muscle area (6.0 vs. 6.6 sq in.) ($P<.01$), fewer pounds of lean per pig ($P<.05$), a lower percentage of lean ($P<.05$), a slower rate of lean deposition ($P<.01$) and a poorer efficiency of lean gain ($P<.01$) compared with the confinement pigs.

Apparently, there is a seasonal effect in the naturally ventilated hoops. In "summer" trial 2, the hoop pigs ate less feed, grew faster, and were more efficient than the confinement pigs. But in the "winter" trial 3 the hoop pigs ate more feed, grew slower and were less efficient than confinement pigs. During the winter, the hoop pigs in the cold environment consume extra feed and use a greater proportion of the feed consumed for maintenance, i.e., to maintain body temperature. All pigs were fed according to guidelines generally developed for confinement.

The scan data were not as seasonal. The summer hoop pigs were fatter than the confinement pigs, but in winter backfat was the same for both housing systems. For both seasons loin muscle area was consistently .5 $in.^2$ less in the hoop pigs than the confinement pigs. Lean percentage also was consistently about 1.2 percentage units less in the hoop pigs than confinement pigs for both seasons. However, rate of lean gain and efficiency of lean gain were similar between the groups in summer, but favored the confinement pigs during the winter.

A simple average of seasonal pig performance and scan data for the two housing systems is shown in Table 5. This represents how the systems would compare on an annual or year-round basis. The pig performance measures (ADFI, ADG, F/G) were similar between the two housing systems and did not vary more than 3%. However, the pig lean measures (BF, LMA, lean percent, lean gain, and efficiency of lean gain) were poorer for the hoop pigs by 3 to 9%. Evidently, leanness of hoop pigs needs additional research.

Slaughter check data are presented in Table 6. Overall respiratory health of the pigs was similar. The major difference was in the incidence of liver scars, which is an indicator of internal worms. During trial 2 the pigs received ivermectin at the beginning of the trial. The hoop pigs had a 23% incidence of liver scars compared with no scars on the confinement pigs. The presence of internal worms in the hoop pigs but not in confinement is probably because the hoop pigs have more access to feces than the confinement pigs on slatted floors. For trial 3, all pigs received additional dewormer (fenbendazol) at approximately 100 lb. The second deworming resulted in control of the worms in the hoop pigs and a 1% incidence of liver scars.

It should be noted that all pigs in trial 3 tested positive for PRRS virus. The pigs appeared sick briefly but did not display clinical PRRS symptoms.

Tables 7 and 8 give average monthly temperatures for trials 2 and 3. During trial 2, the average temperatures for the two building styles were similar but the standard deviations for the hoops were larger. This could indicate that the diurnal temperature swing was larger in the hoop, giving those pigs a better chance to recover from daytime heat stress conditions. Table 8 illustrates the large advantage that the confinement facility has over the hoop structures in maintaining a temperature within the thermoneutral zone during the winter.

Occasional checks of ammonia level in the structures indicated that air quality in the the confinement facility was poorer than expected. A ventilation system problem was detected and corrected. However, the the confinement facility continued to have higher ammonia levels than did the hoop structures. Dust concentration comparisons were not performed.

The bedding temperature is another aspect of the thermal environment in the hoops that influences the comfort level of the animals. Earlier work during winter conditions recorded temperatures from 30^{o}F to 117^{o}F (-1.1 to 47^{o}C) at a depth of 12 in. (30 cm). This result, although beneficial in the winter, may actually be a disadvantage during summer. Bedding is generally allowed to become more saturated during the summer to minimize the composting activity, and, therefore, the bedding pack temperature would probably be lower.

Bedding use was greater during the winter trial (220 lb/pig) than during the summer trial (195 lb/pig). Large round bales of cornstalks were used for bedding.

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Table 1. Performance of pigs finished in hoops and confinement, July-November 1998, trial 2 summer.

	Hoops			Confinement		
	Mean	n	SEM	Mean	n	SEM
Start weight, lb	35.5	451	1.6	37.7	132	1.1
End weight, lb[a]	259.6	442	1.6	260.0	126	1.1
Weight gain, lb	224.0	442	1.9	222.3	126	1.3
Days on feed	117.0	442	.6	122.0	126	.4***
Bedding use per pig, lb[c]	195.0			---		
ADFI, lb/day	5.34	442	.09	5.39	126	.07
ADG, lb/day	1.91	442	.01	1.82	126	.01***
Feed/Gain, lb feed/lb gain	2.79	442	.04	2.95	126	.03**
Mortality percentage[c]	2.0			4.5		
Lights percentage[b,c]	0.0[d]			0.0		

The n value represents the number of pigs except for feed values, then the n value is equal to the number of pens of pigs.
SEM = standard error of the mean.

[a]End weight is the live weight at the farm prior to shipping to the plant.
[b]Lights were defined as pigs that did not weigh 220 lb at market.
[c]No statistical analysis was performed on data.
[d]One pig out of 442 head was under 220 lb at market.

*P<.05, **P<.01, ***P<.001.

Table 2. Performance of pigs finished in hoops and confinement using real-time ultrasound scan data, trial 2 summer.

	Hoops			Confinement		
	Mean	n	SEM	Mean	n	SEM
Scan live weight, lb	247.1	442	2.4	254.4	126	1.7
Test period, day	113.0	442	0.0	118.0	126	0.0
Backfat, in.	.97	442	.03	.85	126	.02*
Loin muscle area, sq in.	5.91	442	.09	6.42	126	.06***
Lean, lb/pig	91.8	442	.9	98.3	126	.6***
Lean, %[a]	50.2	442	.4	52.2	126	.3***
Lean gain, lb/day on test	.71	442	.01	.73	126	.01
Efficiency of lean gain, lb/feed/lb lean gain	7.24	3	.14	7.39	6	.10

The n value represents the number of pigs except for feed values, then the n value is equal to the number of pens of pigs.
SEM = standard error of the mean.

[a]Includes 5% fat.

*P<.05, **P<.01, ***P<.001.

Table 3. Performance of pigs finished in hoops and confinement, November 1998–May 1999, trial 3, winter.

	Hoops			Confinement		
	Average	n	SEM	Mean	n	SEM
Start weight, lb	31.8	451	.8	33.5	132	.6
End weight, lb/[a]	261.5	426	1.6	256.0	129	1.1*
Weight gain, lb	229.7	426	1.4	223.2	129	1.0**
Days on feed	148.0	426	1.4	136.0	129	1.0**
Bedding use/pig, lb[c]	220.0					
ADFI, lb/day	5.18	426	.070	4.93	129	.05*
ADG, lb/day	1.57	426	.01	1.64	129	.02**
Feed/Gain, lb feed/lb gain	3.31	426	.03	2.99	129	.02**
Mortality percent[c]	5.5			2.3		
Lights percent[b,c]	3.5			2.3		

The n value represents the number of pigs except for feed values, then the n value is equal to the number of pens of pigs.
SEM = standard error of the mean

[a]End weight is the live weight at the farm prior to shipping to the plant.
[b]Lights were defined as pigs that did not weigh 220 lb at marketing.
[c]No statistical analysis was performed on data.
*P<.05, **P<.01.

Table 4. Performance of pigs finished in hoops and confinement using real-time ultrasound scan data, November 1998–May 1999, trial 3.

	Hoops			Confinement		
	Mean	n	SEM	Mean	n	SEM
Scan liveweight, lb	233.4	426	2.9	237.7	129	2.0
Test period, day	132.0	426	2.2	125.0	129	1.5*
Backfat, in.	.77	426	.02	.77	129	.01
Loin muscle area, sq in.	6.00	426	.09	6.56	129	.07**
Lean, lb/pig	91.4	426	1.1	95.2	129	.1*
Lean, %[a]	53.1	426	.4	54.3	129	.3*
Lean gain, lb/day on test	.62	426	.01	.68	129	.01**
Efficiency of lean gain, lb/feed/lb lean gain	7.44	3	.14	6.11	6	.10**

The n value represents the number of pigs except for feed values, then the n value is equal to the number of pens of pigs.
SEM = standard error of the mean
[a]Includes 5% fat.
*P<.05, **P<.01.

Table 5. Performance of finishing pigs in hoop and confinement on an annual basis (summer and winter trials averaged).

	Annual			
Item	Hoop	Confinement	Difference	Ratio[a]
Start weight, lb	34	36	-2.0	95
End weight, lb	261	258	+2.0	101
Weight gain, lb	227	223	+4.0	103
Days on feed	133	129	+4.0	103
ADFI, lb/day	5.26	5.16	+.10	102
ADG, lb/day	1.75	1.73	-.02	101
F/G, feed/gain	3.05	2.97	-.07	103
Backfat, in.	.87	.81	+.06	107
LMA, sq in.	5.96	6.49	-.55	92
Lean, %	51.7	53.3	-1.60	97
Lean gain, lb/day	.67	.71	-.04	94
Efficiency lean gain, feed/lean gain	7.34	6.75	+.59	109

[a]Ratio = (hoop value/confinement value) *100.

Table 6. Slaughter check data for pigs in hoops and confinement.

	No. of pigs	Pneumonia		Rhinitis		
		Score	Incidence, %	Score	Incidence, %	Liver scar incidence
All hoops	180	1.4	23	0.6	31	12
Trial 2 (summer)	60	1.5	32	1.0	48	23
Trial 3 (winter)	120	1.2	14	0.2	10	1
All Confinement	64	1.3	24	0.7	35	0
Trial 2 (summer)	24	1.2	17	1.1	46	0
Trial 3 (winter)	40	1.4	30	0.3	25	0

Table 7. Monthly average air temperatures for trial 2.

	Totally Enclosed Confinement		Average Hoop	
	Ave °F (°C)	Std Dev	Ave °F (°C)	Std Dev
July 1998	76.0 (24.4)	6.3 (3.5)	76.7 (24.8)	7.8 (4.3)
August 1998	76.4 (24.7)	5.1 (2.8)	75.4 (24.1)	6.8 (3.8)
September 1998	73.7 (23.2)	7.0 (3.9)	71.2 (21.8)	9.4 (5.2)
October 1998	64.7 (18.2)	4.8 (2.7)	54.7 (12.6)	8.2 (4.6)
November 1998	58.9 (14.9)	2.9 (1.6)	38.2 (3.4)	7.9 (4.4)

Table 8. Monthly average air temperatures for trial 3.

	Totally Enclosed Confinement		Average Hoop	
	Ave °F (°C)	Std Dev	Ave °F (°C)	Std Dev
December 1998	73.9 (23.3)	1.2 (0.7)	21.2 (-6.0)	13.0 (7.2)
January 1999	63.4 (17.4)	3.5 (1.9)	31.3 (-0.4)	5.6 (3.1)
February 1999	60.3 (15.7)	2.4 (1.3)	36.5 (2.5)	8.8 (4.9)
March 1999	61.6 (16.4)	3.1 (1.7)	41.7 (5.4)	10.7 (5.9)
April 1999	63.1 (17.2)	3.7 (2.1)	53.4 (11.9)	9.3 (5.2)
May 1999	65.0 (18.3)	5.6 (3.1)	60.0 (15.6)	9.0 (5.0)