Three-Year Summary of Performance of Finishing Pigs in Hoop Structures and Confinement during Winter and Summer

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Summary and Implications

Finishing pigs were fed for 3 years in bedded hoop structures and a confinement building with slotted floors in central Iowa. When summer and winter feeding periods for 3 years were combined, the trials showed that the finishing pigs in hoops ate 4.9% more feed, grew 1.7% faster, and required 3.4% more feed per unit of liveweight gain than confinement pigs. The mortality rate was similar and percentage of culled and light pigs was higher for hoops compared with confinement. Also, the hoop pigs had 4.9% thicker backfat with 4.8% smaller loin muscle area and 1 percentage unit less of carcass lean and carcass yield compared with confinement pigs. The efficiency of lean gain was also poorer for the hoop pigs. The hoop pigs required 6.8% more feed per unit of lean gain.

Because the hoops are unheated structures, there were seasonal effects. The hoop pigs ate more feed, particularly in the winter, grew faster in the summer, and were less efficient in the winter than the confinement pigs. The hoop pigs had thicker backfat in the summer only and were less efficient in converting feed to lean in the winter only. The hoop pigs had a greater incidence of roundworm infestations.

Therefore, hoop pigs may need to be fed diets somewhat differently than the diets fed to confinement pigs to optimize lean growth, and the control of internal parasites in hoop pigs may need to be more aggressive than in confinement. Bedding use was approximately 237 lb/pig on a year-round basis. Approximately 204 lb of bedding per pig was used in summer and approximately 270 lb of bedding per pig was used in winter.

Introduction

The Hoop Research Complex (HRC) was developed in 1997 at the ISU Rhodes Research Farm, Rhodes, IA, to conduct research and demonstrations related to feeding pigs in hoop structures. The HRC has three hoops and one mechanically ventilated modular confinement building with slatted floors. Comparing the two production systems provides information for improved management of finishing pigs in hoops in the Midwest.

During 1998 to 2001 six trials were conducted at the HRC, three summer trials (June through October/November) and three winter trials (November through April/May).

This article summarizes 3 years of data on six groups of pigs. The objectives of the study were to document the performance of finishing pigs in hoops during the summer and winter, and to evaluate pig performance in hoops compared with pigs in a confinement housing system.

Materials and Methods

The summer trials started in June and the winter trials started in November. For each trial, three groups of pigs were placed in three (30 x 60 ft) bedded hoop structures (150 pigs per hoop). A fourth group was placed in a mechanically ventilated modular confinement building with slotted floors with six pens (22 pigs per pen). The three hoops and confinement were filled over a 3-week period or less. Each unit was filled with pigs that were weaned at the same time. The pigs were injected with ivermectin and vaccinated for erysipelas at the beginning of the trials. The pigs were wormed with Safeguard in the feed at approximately 120 lb. A total of 3,517 pigs was started in the trials. The pigs weighed approximately 35 lb at the beginning of the trials (Table 1).

The stocking densities for finishing pigs in hoop structures was 12 ft^2/pig and 8 ft^2/pig in confinement. With 12 ft^2/per pig, each (30 x 60 ft) hoop structure was designed to hold 150 pigs. The confinement pens (13.5 x 13 ft) were designed to hold 22 pigs per pen. In the trials, a hoop is defined as a pen. There were three pens of hoop pigs and six pens of confinement pigs for each of the six trials. All pigs were from terminal Duroc boars crossed on predominantly white sows. The pigs were a mixture of barrows and gilts.

Pigs were fed five diets in phase *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 unheated facilities that used baled cornstalks for bedding. The north end was kept closed except for a vent at the top 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 temperature-activated 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 temperature activated cycle timer to reduce heat stress.

The pigs were weighed every 28 days. Marketing began when a pen attained 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, all the pigs were scanned for backfat and loin muscle area using real-time ultrasound by a certified technician. The pigs weighing less than 240 lb were returned to their respective pens and fed until the next marketing. When the remaining pigs in a pen averaged at least 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.

Pigs that died (natural or euthanized) were noted as mortalities. Pigs were euthanized if illness or injury was major. Pigs were culled and marketed alternatively if lameness, umbilical hernia, or other reasons made them unacceptable at the processing plant. Light pigs were marketed at the packing plant but weighted less than 220 lb liveweight.

The summer trials were marketed in October and November and the winter trials were marketed in April and May. Slaughter checks were conducted by a veterinarian on 12 confinement pigs and 30 hoop pigs for each marketing date.

The data were analyzed using GLM model of SAS. The experimental design was a split plot with pens nested within building type. The model used the variables-year, pen, housing type, and season. The number of pigs per pen was inherent to the housing system. Pens were not completely independent because of proximity to one another. Means presented are least squares means.

Results and Discussion

Pig performance in the hoop and confinement pens is shown in Table 1. The data are for six trials over 3 years. The pigs were started on trial at 34.7 and 35.1 lb, fed for 127.1 and 126.0 days, and marketed at 261.0 and 257.6 lb on average for the hoops and confinement, respectively. The adjusted days to 250 lb was the same (175.8 and 175.7 days) for the hoops and confinement. Bedding use was 237 lb/pig in hoops, or approximately 1 lb of bedding per pound of gain or 1.8 to 1.9 lb of bedding per day.

The hoop pigs ate more feed per day than the confinement pigs. The average daily feed intake (ADFI), which is the feed disappearance less the feed consumed by pigs that were not marketed (culls and mortalities), was 4.9% more for the hoop pigs (P<.001) (5.31 vs. 5.06 lb/d). If the feed for the pigs not marketed (culls and mortalities) was included, the average daily feed intake (AllADFI) was 5% more for the hoop pigs (P<.001) (5.45 vs. 5.19 lb/d) (Table 1).

The hoop pigs grew 1.7% faster than the confinement (P<.01) (1.80 vs. 1.77 lb/d) (Table 1). However, the hoop pigs were less efficient in converting feed to liveweight gain. The feed efficiency with feed removed for culls and mortalities (F/G) was 3.5% poorer for the hoop pigs (P<.001) (2.96 vs. 2.86 lb feed/lb gain). The feed efficiency with the feed for culls and mortalities included (AllF/G) was also 3.4% poorer for the hoop pigs (P<.01) (3.04 vs. 2.94 lb feed/lb gain) (Table 1).

The mortality rate was similar (2.8 vs. 2.5%) for hoops and confinement. The combined percentage of pigs that were culled and those that did not weigh 220 lb at marketing (lights) was 4.0% for hoops and 2.5% for confinement. This may be due to the larger number of pigs per pen in the hoops.

The carcass and scan performance of the pigs in hoops and confinement is shown in Table 2. The pigs were scanned at approximately 247 lb after 120 days on feed.

The hoop pigs were 4.9% fatter (P<.05) (.85 vs. .81 in.) and had 4.8% smaller loin muscle areas (P<.001) (6.32 vs. 6.64 sq. in.) (Table 2). When the values were adjusted to 250 lb the backfat was 4.9% more (P<.01) and the loin muscle areas were 3.9% less (P<.001) for the hoop pigs.

The carcasses from the hoop pigs had one percentage unit less lean (P<.001) (51.1 vs. 52.1%) and lower yield (P<.001) (74.9 vs. 75.8%) than the confinement pig carcasses. The rate of lean gain was slightly less (P<.05) and efficiency of lean gain was 6.8% more (P<.001) (7.56 vs. 7.08 lb lean gain/lb of feed) for the hoop pigs than the confinement pigs (Table 2).

The seasonal interactions of pig performance in hoops and confinement for summer and winter are shown in Table 3. Each season has three trials, one for each year. Bedding use was 204 lb/pig in summer and 32% more or 270 lb/pig in winter.

The pigs in hoops ate 3% more feed during the summer and 6.7% more feed in the winter than the pigs in confinement (P<.01) with the feed removed for the mortalities and culls (ADFI) (Table 3). When the feed for the mortalities and culls was included (AllADFI), there was no difference in feed intake in the summer, but during the winter the hoop pigs ate 7.9% more feed than the confinement pigs (P<.001) (Table 3). Presumably the cold environment encouraged the hoop pigs to eat more feed.

The hoop pigs grew 4% faster in the summer than the confinement pigs (P<.001), but there was no difference in the winter.

The feed efficiency of hoop pigs was 8 to 9% poorer than the confinement pigs in the winter (F/G, P<.05) (AllF/G, P<.001). This is probably because more of the feed nutrients were used for maintenance, i.e., to maintain body temperature. During the summer, the feed efficiency (F/G and AllF/G) was similar (Table 3).

Pig mortality was lower in the summer (1.8 vs. 2.7%) but higher in the winter (3.8 vs. 2.3%) in the hoops compared with confinement. This difference may be related to the colder and more variable environment in the hoops

during the winter. The total percentage of pigs that were culled and those that did not reach 220 lb at market (lights) was higher in the hoops compared with confinement during the winter and about the same in the summer (Table 3).

The seasonal interaction of carcass and scan data for summer and winter is shown in Table 4. The hoop pigs had 7.1% thicker backfat in the summer (P<.01) but did not differ in the winter compared with the confinement pigs. When adjusted to 250 lb there was no difference in backfat or loin muscle areas. The efficiency of lean gain did not differ in the summer, but was 11.8% poorer in the winter for the hoop pigs (P<.01) (Table 4).

Slaughter check data is presented in Table 5. Overall incidence of pneumonia was more in the hoop pigs (30.0 vs. 17.4%), but rhinitis incidence was similar (29.7 vs. 31.3%). Liver scar incidence, an indication of roundworm infestation was much more in the hoop pigs (25.8 vs. 0.7%). In the winter, rhinitis incidence was less in the hoops than confinement, perhaps because of improved air quality in the hoops.

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Table 1. Performance of pigs fed in hoops and confinement (6 trials, 3 years).

	Hoops		Confinement		
Measure	Mean	SEM	Mean	SEM	
Start weight, lb	34.7	.05	35.1	0.4	
End weight, lb[a]	261.0	1.2	257.6	0.8	*
Weight gain, lb	226.3	1.3	222.5	0.9	*
Days on feed	127.1	0.9	126.0	0.6	
Adjusted days to 250	175.8	0.6	175.7	0.4	
Bedding use per pig, lb[b,c]	237	---	0.0	---	
ADFI, lb/day[d]	5.31	.03	5.06	.02	***
ADG, lb/day	1.80	.01	1.77	.01	**
Feed/Gain, lb feed/lb gain[e]	2.96	.02	2.86	.01	***
AllADFI, lb/day[f]	5.45	.04	5.19	.03	***
AllF/G, lb feed/lb gain[g]	3.04	.02	2.94	.02	**
Mortalities, %[b,h]	2.8	---	2.5	---	
Culls, %[b,i]	1.7		1.0		
Lights, %[b,j]	2.3	---	1.5	---	

[a]End weight is the liveweight at the farm before shipping to the plant.

[b]No statistical analysis performed on data.

[c]Bedding use = total bedding ÷ no. of pigs at start of trial.

[d]ADFI = Feed disappearance less the feed consumed by pigs that were not marketed ÷ number of pigs marketed ÷ days on feed.

[e]F/G = ADFI ÷ ADG.

[f]AllADFI = Feed disappearance ÷ pigs marketed ÷ days on feed.

[g]AllF/G = AllADFI ÷ ADG.

[h]Mortalities are defined as pigs that died or were euthanized at the farm. The number of pigs at start of trial is the divisor in calculating percentage.

[i]Culls are defined as pigs that were marketed alternatively because of their detrimental condition, e.g., lameness, hernia, etc. The number of pigs at start of trial is the divisor in calculating percentage.

[j]Lights are defined as pigs not weighing 220 lb at marketing. The number of pigs at start of trial is the divisor in calculating percentage.

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

Table 2. Carcass and scan performance of pigs fed in hoops and confinement (6 trials, 3 years).

	Hoops		Confinement		
Measure	Mean	SEM	Mean	SEM	
Scan liveweight, lb	245.3	1.4	248.5	1.0	
Test period, days	118.8	0.9	120.8	0.7	
Backfat, in.	0.85	.01	0.81	.01	*
Loin muscle area, sq. in.	6.32	.04	6.64	.03	***
Adjusted backfat, in.[a]	.86	.01	0.82	.01	**
Adjusted LMA, sq. in.[a]	6.40	.04	6.66	.03	***
Lean, lb/pig	92.5	.5	95.6	.4	***
Lean, %[b]	51.1	.2	52.1	.1	***
Lean gain, lb/day on test[b]	.69	.01	.70	.01	*
FFLI, %[c]	47.7	.1	48.0	.1	*
Efficiency of lean gain, lb feed/lb lean gain	7.56	.06	7.08	.04	***
Yield, %	74.9	.1	75.8	.1	***

[a]Adjusted to 250 lb liveweight.

[b]Includes 0% fat, calculated with NPPC formula by using scan data.

[c]Includes 0% fat, from slaughter data sheets.

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

Table 3. Seasonal interactions of pig performance measures fed in hoops and confinement (6 trials, 3 seasons, 3 years).

	Summer		Winter		SEM	
Measure	Hoop	Conf	Hoop	Conf	Hoop	Conf
Start wt., lb	34.0	35.8	35.4	34.4	.7	.5
End wt., lb[1]	259.3	254.8	262.7	260.4	1.7	1.2
Weight gain, lb	225.3	219.1	227.3	226.0	1.9	1.3
Days on feed	122.9	124.3	131.3	128.5	1.2	.9
Adjusted days to 250	174.9	178.5	176.7	172.9	.9	.6 **
Bedding use, lb/pig[2,3]	203.7	---	269.8	---	---	---
ADFI, lb/day[4]	5.18[g]	5.03[f]	5.44[h]	5.10[f,g]	.05	.03 **
ADG, lb/day	1.84[i]	1.77[j]	1.75[j]	1.77[j]	.01	.01 ***
Feed/gain, lb feed/lb gain[5]	2.81[a]	2.84[a]	3.11[c]	2.89[b]	.02	.02 *
AllADFI, lb/day[6]	5.29[i]	5.19[i]	5.60[j]	5.19[i]	.06	.04 ***
ALLF/G, lb feed/lb gain[7]	2.88[i]	2.93[i]	3.21[j]	2.94[i]	.03	.02 ***
Mortalities, %[2,8]	1.8	2.7	3.8	2.3	---	---
Culls, %[2,9]	1.7	1.0	1.8	1.0	---	---
Lights, %[2,10]	.8	1.7	3.8	1.3	---	---

Means in the same row with the same superscript do not differ. Superscripts a, b, and c, are used for .05 significance, f, g, and h for .01, and i and j for .001.

[1]End weight is the liveweight at the farm before shipping to the plant.

[2]No statistical analysis performed on data.

[3]Bedding use = total bedding ÷ no. of pigs at start of trial.

[4]ADFI = feed disappearance less the feed consumed by pigs that were not marketed ÷ number of pigs marketed ÷ days on feed.

[5]F/G = ADFI ÷ ADG.

[6]AllADFI = feed disappearance ÷ pigs marketed ÷ days on feed.

[7]AllF/G = AllADFI ÷ ADG.

[8]Mortalities are defined as pigs that died or were euthanized at the farm. The number of pigs at start of trial is the divisor in calculating percentage.

[9]Culls are defined as pigs that were marketed alternatively because of their detrimental condition, e.g., lameness, hernia, etc. The number of pigs at start of trial is the divisor in calculating percentage.

[10]Lights are defined as pigs not weighing 220 lb at marketing. The number of pigs at start of trial is the divisor in calculating percentage.

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

Table 4. Seasonal interactions of carcass and scan performance measures of pigs fed in hoops and confinement (6 trials, 3 seasons, 3 years).

	Summer		Winter		SEM	
Measure	Hoop	Conf	Hoop	Conf	Hoop	Conf
Scan wt, lb	247.2	246.9	243.4	250.1	2.0	1.4
Test period, days	117.3	119.7	120.2	122.0	1.3	.9
Backfat, in.	.91[h]	.84[g]	.78[f]	.78[f]	.02	.01 **
Loin muscle area, sq. in.	6.29	6.50	6.36	6.78	.06	.04
Adj. backfat, in.[1]	.92	.85	.80	.78	.01	.01
Adjusted LMA, sq. in.[1]	6.34	6.55	6.46	6.78	.06	.04
Lean, lb/pig	91.7	93.8	93.2	97.3	.7	.5
Lean, %[2]	50.3	51.4	51.9	52.7	.2	.2
Lean gain, lb/day on test[2]	.69[g]	.69[g]	.69[g]	.71[f]	.01	.01 **
FFLI, %[3]	46.8	47.3	48.5	48.8	.2	.1
Eff. of lean gain, lb feed/lb gain[2]	7.36[g]	7.22[g]	7.75[h]	6.93[f]	.09	.06 **
Yield, %	73.9	75.0	76.0	76.6	.2	.1

Means in the same row with the same superscript do not differ. Superscripts a, b, and c are used for .05 significance and f, g, and h for .01.

[1]Adjusted to 250 lb liveweight.

[2]Includes 0% fat, calculated with NPPC formula using scan data.

[3]Includes 0% fat, from slaughter data sheets.

**P<.01

Table 5. Slaughter check summary of pigs fed in hoops and confinement.

	All		Summer		Winter	
	Hoop	Conf	Hoop	Conf	Hoop	Conf
Pigs checked	360	144	180	72	180	72
Pneumonia incidence, %	30.0	17.4	30.0	13.9	30.0	20.3
Rhinitis incidence, %	29.7	31.3	44.4	36.1	15.0	26.4
Livers scarred, %	25.8	0.7	35.6	1.4	16.1	0.0