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# Performance and Carcass Characteristics of Finishing Beef Cattle Managed in a Bedded Hoop-Barn System

Mark S. Honeyman  
*Iowa State University*, honeyman@iastate.edu

W. D. Busby  
*Iowa State University*

Steven M. Lonergan  
*Iowa State University*, slonerga@iastate.edu

Anna K. Butters-Johnson  
*Iowa State University*, johnsona@iastate.edu

Dallas L. Maxwell  
*Iowa State University*, dallasm@iastate.edu  
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# Performance and Carcass Characteristics of Finishing Beef Cattle Managed in a Bedded Hoop-Barn System

## Abstract

The use of bedded hoop barns in finishing systems for beef cattle has not been widely researched. In this management system, beef cattle are confined to hoop barns throughout finishing, and bedding is used to absorb animal waste, which results in minimal effluent. The objective of this study was to compare the performance and carcass characteristics of finishing beef steers ( $n = 1,428$ ) managed in a bedded hoop-barn management system vs. an open-feedlot system with shelter. Six feeding trials were conducted over a 3-yr period. Three trials were conducted during summer-fall and 3 trials were conducted during winter-spring. Crossbred steers were allotted to 3 pens in the hoop-barn system and to 3 pens in the open-lot system (approximately 40 steers per pen in both facility systems). Stocking densities for the steers were  $4.65 \text{ m}^2$  per steer in the hoop-barn system and  $14.7 \text{ m}^2$  per steer in the open-lot system. The steers were begun on trial weighing 410 and 411 kg ( $SD = 21$ ), were fed for 102.3 and 103.0 d ( $SD = 3.8$ ), and were weighed off test at 595 and 602 kg ( $SD = 21$ ) for the hoop-barn and open-lot systems, respectively. Steer performance measures consisted of ADG, DMI, and G:F. Carcass characteristics were HCW, fat thickness, LM area, KPH percentage, marbling score, USDA yield grade, and USDA quality grade. No year, season, or pen (management system) main effects, or season  $\times$  management system and year  $\times$  management system interactions were observed for any of the items measured related to cattle performance or carcass characteristics ( $P > 0.05$ ). Final mud scores (a subjective evaluation of the amount of soil and manure adhering to the hair coat of the animals) were greater for the steers from the open-lot system compared with those from the hoop-barn system ( $P < 0.02$ ), suggesting steers in the hoop-barn system carried less mud than steers from the open-lot system. Average daily cornstalk bedding use in the hoop-barn system was 2.3 kg/steer during summer-fall and 2.6 kg/steer during winter-spring. The performance of finishing cattle managed in a hoop-barn system was not different from the performance of cattle managed in an open-feedlot system with shelter during summer and winter. Managing beef cattle in hoop barns required more bedding but resulted in decreased mud scores compared with cattle managed in an open-lot system with shelter. Hoop barns are a viable alternative housing management system for finishing beef cattle.

## Keywords

bedding, beef cattle facility, environment, hoop barn, season

## Disciplines

Agriculture | Animal Sciences

## Comments

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## Authors

Mark S. Honeyman, W. D. Busby, Steven M. Lonergan, Anna K. Butters-Johnson, Dallas L. Maxwell, Jay D. Harmon, and Shawn C. Shouse

## Running Head: beef cattle in hoop barns

Performance and carcass characteristics of beef cattle in bedded hoop barns<sup>1</sup>

M. S. Honeyman,<sup>\*2</sup> W. D. Busby,<sup>‡</sup> S. M. Lonergan,<sup>\*</sup> A. K. Johnson,<sup>\*</sup> D. L. Maxwell,<sup>§</sup> J. D.

Harmon,<sup>†</sup> and S. C. Shouse,<sup>‡</sup>

<sup>\*</sup>Department of Animal Science, <sup>†</sup>Department of Agricultural and Biosystems Engineering,

<sup>‡</sup>University Extension, and <sup>§</sup>Armstrong Research Farm, Iowa State University; Ames, IA 50011

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<sup>2</sup>Correspondence: 32 Curtiss Hall, phone 515-294-4621; fax 515-294-6210;

[honeyman@iastate.edu](mailto:honeyman@iastate.edu).

**ABSTRACT:** Hoop barns are an alternative housing system for beef cattle feeding that have not been widely researched. The beef cattle are confined in the hoop barn and bedding is used to absorb animal waste. Runoff from bedded hoop barns is minimized and better controlled. The purpose of this study was to compare the performance and carcass characteristics of market beef steers ( $n = 1,428$ ) fed in two facility types, a bedded hoop barn (HOOP) versus an open feedlot with shelter (LOT). Six feeding trials were conducted over a 3-yr period. Three trials were conducted during summer/fall and three trials were winter/spring. Crossbred steers were allotted to three pens in the HOOP and to three pens in LOT (typically 40 steers per pen in both facility systems). Stocking densities for the steers were  $4.65 \text{ m}^2$  per steer in the HOOP and  $14.7 \text{ m}^2$  per steer in the LOT. The steers were started on trial weighing 410 and 411 kg, fed for 102 and 103 d, and weighed off-test at 595 and 602 kg for the HOOP and LOT, respectively. Steer performance measures consisted of ADG, DMI, and G:F. Carcass characteristics were HCW, fat thickness, LM area, KPH%, marbling score, USDA yield grade, and USDA quality grade. No year, season, or pen (facility type) main effects, or season  $\times$  facility type and year  $\times$  facility type interactions were observed for any of the items measured related to cattle performance or carcass characteristics ( $P > 0.05$ ). Final mud scores (a subjective evaluation of the amount of soil and manure adhered to the animal's hair coat) were greater for the steers from the LOT vs. HOOP facilities ( $P < 0.02$ ), suggesting HOOP steers carried less mud than the LOT steers. Average daily cornstalk bedding use in the HOOP was 2.3 kg per steer during summer/fall and 2.6 kg per steer during winter/spring. The bedded hoop barn was able to modify the environment by shade and shelter to allow the beef cattle to perform at an optimal level, i.e., the hoop cattle performed at a level that was not different from the performance level of cattle fed in an open feedlot with shelter during summer and winter. Feeding beef cattle in hoop barns requires more bedding but

resulted in lower mud scores than cattle fed in an open lot with shelter. Hoop barns are a viable alternative housing system for feeding beef cattle.

Key words: Beef cattle facility, hoop barns, bedding, season, environment

## INTRODUCTION

In the Midwest U.S. there are many smaller beef cattle feedlots (< 2000 head) that usually are one of three types, 1) an earthen open lot with a windbreak fence and mounds, 2) open lots with a shed or shelter, or 3) traditional confinement with slatted floors (Lawrence et al., 2006). The open lots require settling and detention basins to control runoff (Moody et al., 2006). The confinement manure is collected in pits below the slats (Lawrence et al., 2006).

If feedlot runoff is not controlled, there can be major environmental impacts (Woodbury et al., 2002). Traditional confinement systems tend to have higher facility but lower runoff control costs than open feedlots (Lawrence et al., 2006), and also have poorer cattle performance due to reduced DMI in summer (Koknaroglu et al., 2008).

Hoop barns are a versatile alternative housing for livestock, particularly for swine (Honeyman and Harmon, 2003; Lammers et al., 2007) and dairy cattle (Kammel, 2004). Hoop barns consist of steel arches covered with polyvinyl fabric. The arches are attached to posts or concrete sidewalls. For beef cattle feeding, the cattle are confined in the hoop barn and bedding is used to absorb animal waste. A bedded hoop barn was demonstrated in western Iowa for beef cattle feeding (Honeyman et al., 2008). By covering the pens with a hoop barn, runoff from feeding cattle can be minimized and better controlled (Honeyman et al., 2008).

The performance effects of confining feedlot cattle on a bedded pack under a high shelter (in this case a hoop barn) are not well documented. The hypothesis for this study was that the performance and carcass characteristics of cattle fed in a bedded hoop barn would be similar to cattle fed in an open lot with shelter. The objective was to compare the performance and carcass characteristics of market beef steers fed in a bedded hoop barn versus an open feedlot with shelter.

## **MATERIALS AND METHODS**

### ***Location and facility system treatments***

The study was conducted at the Iowa State University Armstrong Research and Demonstration Farm, near Lewis, IA (41° 19' N, 95° 10' W). Mean annual rainfall for the site is approximately 71 cm annually. A beef cattle hoop barn (15.24 m × 36.5 m) was erected in November 2004. The hoop barn has 3.05 m sidewalls and the height of the roof is 7.92 m. The hoop barn (HOOP) is oriented north-south with ends open and a fenceline bunk along the east side. During the winter/spring, large round bales were stacked three high across the north and south ends of the hoop barn for a partial windbreak. There was an earthen feedlot with a shelter open to the south and a fenceline bunk under roof built in 1996 (LOT). The pens were 12.2 × 48.2 m including 7.6 m sheltered by roof. The facilities are described in detail by Honeyman et al. (2008).

Stocking densities for the steers were 4.65 m<sup>2</sup> per steer in the HOOP (Shouse et al., 2004) and 14.7 m<sup>2</sup> per steer in the LOT with 2.3 m<sup>2</sup> per steer under shelter (roof) plus 12.4 m<sup>2</sup> per steer of earthen lot area (Honeyman et al., 2008). Manure and bedding management was distinct for the two facility types. The HOOP pens were bedded weekly by placing large round bales of

cornstalks in the pen. Bales were placed in the end of the pen away from the fenceline bunk and cattle were allowed to spread the bedding. As described by Honeyman et al. (2008) a 6.1-m wide concrete alley in the pens ran the length of the hoop barn along the feed bunk. The alley was scraped weekly with a tractor and loader. The scrapings were stockpiled and composted for later field application. After the cattle were marketed, the entire hoop barn bedding pack was removed.

In the LOT, the sheltered area was bedded with cornstalks as needed during the winter/spring trials only. When pens became excessively wet, the area was scraped and cornstalk bedding was added. During the summer/fall trials, the sheltered area stayed dry and did not require bedding. The unsheltered areas of the LOT were cleaned and maintained as needed. When the cattle were removed from the LOT system, the pens were scraped and manure removed.

### ***Animals***

The project was approved by the Iowa State University's Institutional Animal Care and Use Committee (log number; 3-05-5839). Six feeding trials were conducted from August 2005 to 2008. Three trials were conducted during the summer/fall (August through November) and three trials were winter/spring (December through May) periods. For each trial, crossbred steers were placed in three HOOP and three LOT pens (typically 40 steers per pen). On arrival at the farm, the steers were vaccinated with Cattle Master Gold® (Pfizer Animal Health, Lafayette, IN) and implanted with Synovex® Choice (Fort Dodge Animal Health, Overland Park, KS). A total of 1,428 steers were allocated to pens for these trials. The cattle were crossbred steers of predominantly Angus breeding and were acquired from area livestock markets. The cattle were kept in source groups and were acclimated about 2 wk prior to allotment. The steers weighed

approximately 400 to 420 kg each at the beginning of the trials. Cattle were balanced by source, hide color, and weight and then randomly allotted to facility system treatment (HOOP or LOT) and pens within treatment.

### ***Feeding and husbandry***

The cattle were fed daily in a fenceline bunk (30.5 cm/steer) in both facilities. The diet was 78% whole-shelled corn, 17% ground hay (2/3 alfalfa and 1/3 bromegrass), and 5% supplement on a dry matter basis. Water was added to the diet to improve mixing. Amount fed was adjusted daily by pen to approach ad libitum levels.

Eight steers were removed from trials due to death (5 steers), or persistent lameness or chronic bloating (3 steers). There was no pattern of removal due to facility type or season. Steers with a fever were treated and returned to the pens. In one trial, steers from one source were aggressive. These steers were evenly allocated across pens/treatments. The disposition problem caused lameness, resulting in 12 steers from the 6 pens being removed prior to the beginning of the trial resulting in one trial that had less steers available for use.

### ***Performance Measures***

Cattle were weighed in the morning before feeding at 28 d intervals. A trial ended when the majority of the steers were deemed to have 10 mm of fat cover and be of Choice grade based on visual assessment. All cattle were weighed off-test and evaluated by a trained university staff member for exterior mud (soil and manure adhered to the animal's hair coat) at the end of trial. Mud scores were defined as follows: 1 = no tag, clean hide; 2 = small lumps of manure attached

to the hide in limited areas of the legs and underbelly; 3 = small and large lumps of manure attached to the hide covering larger areas of the legs, side, and underbelly; 4 = small and large lumps of manure attached to the hide in even larger areas along the hind quarter, stomach, and front shoulder; and 5 = lumps of manure attached to the hide continuously on the underbelly and side of the animal from brisket to rear quarter.

Cattle were shipped about 5-7 d after final live weights were obtained depending on the commercial abattoir schedule. On day of shipment to the abattoir (approximately 93 km from the research farm), cattle were fed  $\frac{1}{2}$  of the daily ration in the morning, shipped late in the afternoon, and processed the next day. Cattle from both facility types were shipped at the same time for each trial. Water was available at all times. Hot carcass weight was measured immediately after slaughter and carcass dressing percent determined. At the plant, carcass measurements, including 12<sup>th</sup> rib back fat, LM area, % KPH, marbling score, and USDA quality and yield grades were determined 24 hours postmortem.

Labor for delivering bedding to the pens and for cleaning manure from pens was recorded by facility type for each trial. Labor to feed the cattle and manage the cattle was not included. The weight of cornstalk large round bales for bedding was recorded by facility type for each trial.

### ***Experimental design***

The study consisted of six trials; each had two facility types with pens nested in facility type. The experimental unit was a pen of steers. Data from all trials were combined and analyzed as a mixed linear model using GLM procedure of SAS, resulting in an ANOVA with the following factors: year, season, year  $\times$  season, facility type, pen (facility type), year  $\times$  facility, season  $\times$  facility type, and error. Because there was one trial for each year  $\times$  season combination, the year

× season interaction was used for testing main effects of year and season. The model error was used to test the remaining factors. Means by facility type are presented.

## RESULTS

Means for steer performance and carcass measures are presented in tables 1 and 2, respectively. No year, season, or pen (facility type) main effects, or season × facility type and year × facility type interactions were found for any of the items measured related to cattle performance or carcass characteristics ( $P > 0.05$ ). The steers were started on trial at 410 and 411 kg, fed for 102.3 and 103 d, and weighed off-test at 595 and 602 kg for the HOOP and LOT groups, respectively. Less than 1% of the steers started on-test were removed for any reason from either facility system. There were no differences in gain, ADG, DMI, or G:F ratio ( $P > 0.05$ ). Hot carcass weight, fat thickness, LM area, KPH %, marbling score, yield grades or quality grades did not differ between facility types ( $P > 0.05$ ).

Final mud scores were greater for the steers from the LOT than for the steers from HOOP ( $P < 0.02$ , Table 1). The added mud for the LOT cattle may have numerically increased their off-test weight although the weights between facility types were not different ( $P > 0.05$ ). If the HCW of the LOT cattle is divided by a standard dressing percentage of 62% (equal to the dressing percentage of the HOOP cattle, Table 2), then the resulting mean weights are more numerically similar (see Market weight, Table 1).

Labor and bedding use by facility type is reported in Table 3. Labor use is difficult to accurately transfer to other operations, but there are some comparisons of interest. As expected, more bedding was used in the HOOP than the LOT. Average daily bedding use in the HOOP was 2.3 kg per steer during summer/fall and 2.6 kg per steer during winter/spring, about 13% more

during colder, wetter conditions. There was no bedding used in the LOT during the summer/fall, while daily use during the winter/spring was 1 kg per steer.

Labor for cleaning and bedding generally followed the trends for bedding use, except for the LOT after the winter/spring trials (Table 3). When comparing the two facilities, the total labor for bedding and cleaning was similar across seasons. The greatest difference was labor distribution (data not shown). The HOOP alley was scraped weekly except when manure was frozen, and the bedded area was cleaned after the cattle were removed. The LOT was scraped as needed to maintain cattle comfort in response to weather (1 to 5 times per summer/fall and 10 to 14 times per winter/spring). Thus the labor for bedding and cleaning was more evenly distributed throughout the feeding period for the HOOP.

## DISCUSSION

Overall, cattle performed similarly with similar carcass characteristics for both facility types. Our earlier work (Honeyman et al., 2008) showed that the thermal environment in these two facility systems differed. The hoop barn had fewer hours in the “alert” category during the summer, but provided less shelter for cattle during the winter. “Alert” is defined as a temperature humidity index (THI) of greater than 74 and less than or equal to 79 (LCI, 1970; Hubbard et al., 1999). However, the cattle were able to compensate for the differences in thermal environment of the facility systems and performed similarly in both systems.

The thermal environment that cattle experience impacts performance. Providing housing is one way to minimize environmental stress on cattle (Mitlöhner et al., 2002). Environment influences the maintenance energy requirement and DMI of cattle (Delfino and Mathison, 1991). Extensive work in Iowa feeding beef cattle in various facility systems has shown improved

performance and feed efficiency by providing shelter versus cattle fed in open lots (Leu et al., 1977; Muhamad et al., 1983; Koknaroglu et al., 2005). However, this research also showed that cattle in traditional confinement buildings had poorer performance and lower DMI than cattle in open lots or open lots with shelters, particularly during the summer.

An analysis of Iowa feedlot performance records found that beef cattle fed in lots with shelter had greater ADG than cattle fed in confinement or open lots during warm seasons, and that cattle fed in confinement had lower DMI and ADG than cattle fed in open lots or open lots with shelter in any season (Koknaroglu et al., 2008). Also, beef cattle performance in Iowa was most negatively affected for lighter cattle during winter and heavier cattle during summer compared to other groups. Shelter was most beneficial during summer (Koknaroglu et al., 2008).

In the current study, cattle assigned to the LOT treatment were in a facility type similar to the open lot with shelter system of the earlier Iowa research. This facility system has been shown to produce superior cattle performance compared to traditional confinement or open lots without shelter (Leu et al., 1977; Muhamed et al., 1983; Koknaroglu et al., 2005). Cattle fed in the bedded hoop barn matched the performance of this optimal open lot with shelter system, even though the cattle were confined in the hoop barn.

Aside from the benefits of bedding enhancing animal comfort in winter months, during the summer days the hoop barn acts as a shade. It is well documented that shade is beneficial to cattle during periods of hot weather by decreasing solar radiation, heat load, and cattle body temperatures (Blackshaw and Blackshaw, 1994; Mader et al., 1997; and Hahn et al., 2001). Cattle in the two facility systems had comparable DMI indicating that the HOOP cattle were able to dissipate heat load in the high hoop barn structure during the summer nights (Brosh et al., 1998; Brown-Brandl et al., 2005). High temperatures depress cattle DMI, particularly in

traditional confinement (Koknaroglu et al., 2008). The traditional confinement does not cool overnight. If cattle do not cool during the night, their core body temperatures do not return to normal and the following day a higher core temperature occurs, thus depressing DMI (Brown-Brandl et al., 2005).

Based on our results, the bedded hoop barn was able to modify the environment by shade and shelter to allow the beef cattle to perform at an optimal level, i.e., the HOOP cattle performed at a level that was not different from the performance level of cattle fed in the open feedlot with shelter during summer and winter. Therefore, the hypothesis was confirmed.

## **IMPLICATIONS**

Hoop barns with bedding where the cattle are confined inside the barn are a viable alternative housing system for feeding beef cattle. As a facility type, bedded hoop barns offer no cattle performance or carcass advantages or disadvantages compared to cattle fed in open feedlots with shelter. Hoop barns require more bedding but result in lower subjective mud scores. Although not measured in this study, intuitively by keeping feedlot cattle in a hoop barn, runoff would be minimized compared to an open feedlot setting. This characteristic is a key factor in high rainfall areas like the U.S. Midwest, South, or East.

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Table 1. Performance of steers fed in six trials over 3 yr in bedded hoop pens (HOOP) and open lots with shelter (LOT)<sup>1</sup>

	HOOP	LOT	SEM	P-value
No. of pens	18	18	--	--
Head (on-test)	712	716	--	--
Head (off-test)	707	713	--	--
Initial weight, kg	410	411	5	0.94
Final weight, kg	595	602	5	0.32
Weight gain, kg	185	191	3	0.16
On-test period, d <sup>2</sup>	102.3	103.0	0.9	0.62
Market weight, kg <sup>3</sup>	595	598	5	0.58
ADG, kg/d	1.82	1.87	0.03	0.19
DMI, kg/(steer.d)	12.46	12.46	0.12	0.98
G:F, g/kg	145.7	150.2	2.3	0.18
Mud score <sup>4</sup>	1.86	2.22	0.10	0.02

<sup>1</sup>No season × facility type interaction for the items listed were observed ( $P > 0.05$ ). LS means presented.

<sup>2</sup>On-test period was the number of days from the trial start weight to the trial off-test weight.

<sup>3</sup>Calculated using hot carcass weight ÷ 62% standard yield or dressing percentage.

<sup>4</sup>Mud score scale: 1 = no visible mud and 5 = heavy mud on animal. Evaluated at end of trial.

Table 2. Carcass characteristics of steers fed in six trials total over 3 yr in bedded hoop pens (HOOP) and open lots with shelter (LOT)<sup>1</sup>

	HOOP	LOT	SEM	P-value
HCW, kg	368.7	370.9	2.9	0.59
Fat thickness, cm	1.08	1.08	0.19	0.92
LM area, cm <sup>2</sup>	85.0	84.5	0.3	0.38
KPH, %	2.43	2.43	0.07	0.99
Marbling score <sup>2</sup>	1031	1027	5	0.61
USDA yield grade No. 1 and 2, %	63.2	62.9	2.7	0.94
USDA choice, %	75.4	74.3	2.7	0.78

<sup>1</sup>No season × facility type interaction for the items listed were observed ( $P > 0.05$ ). LS means presented.

<sup>2</sup>Marbling score scale: slight = 900; small = 1000; modest = 1100.

Table 3. Seasonal labor and bedding use in a bedded hoop barn (HOOP) and open lots with shelter (LOT)

Item	Summer/fall <sup>1</sup>		Winter/spring <sup>2</sup>		Total <sup>3</sup>	
	HOOP	LOT	HOOP	LOT	HOOP	LOT
Bedding, kg	2.3	0.0	2.6	1.0	4.9	1.0
(steer/d)	(2.0-2.7)		(2.4-2.7)	(0.6-1.3)		
Labor, <sup>4</sup> hr/group	21.1	13.6	22.5	28.7	43.6	42.3
	(18.5-24.3)	(12.0-15.3)	(19.8-26.0)	(23.5-35.8)		
Labor, <sup>5</sup> min/steer	10.9	6.8	11.3	14.4	22.1	21.2
	(9.3-12.2)	(6.0-7.6)	(9.9-13.1)	(12.0-17.9)		

<sup>1</sup>Summer/fall groups started on test in August and were marketed in November. Means shown.

Values in parentheses are the range.

<sup>2</sup>Winter/spring groups started on test in December were marketed in April/May. Means shown.

Values in parentheses are the range.

<sup>3</sup>Total = sum of means for summer/fall and winter/spring.

<sup>4</sup>Labor is for bedding and cleaning manure only.

<sup>5</sup>Labor per group × 60 min ÷ mean no. of steers per group.