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# Comparison of steer behavior when housed in a deep-bedded hoop barn versus an open feedlot with shelter

## Abstract

The use of hoop barns as an alternative housing system for beef cattle has not been widely researched. The objectives of this study were to determine the main effects of behavior of steers 1) over winter and summer, 2) when housed in either a hoop barn or a conventional feedlot, and 3) interactions between season and housing system. A total of 960 crossbred *Bos taurus* steers were used [August 2006 to April 2008 (2 winter and 2 summer trials)]. Steers were housed in either 1 deep-bedded hoop barn (n = 12 pens; 4.65 m<sup>2</sup>/steer) or 1 open feedlot with shelter (n = 12 pens; 14.7 m<sup>2</sup>/steer). Steers were ear tagged, implanted, and weighed (414 ± 36 kg) on arrival and allotted to treatments that were balanced for source, BW, and hide color. Behavioral data (3 postures and 2 behaviors) were collected using a 10-min live scan. The experimental unit for behavior was a pen of steers. Behavioral data were arcsine transformed to achieve a normal distribution. There were no ( $P > 0.05$ ) differences for time spent at bunk or waterer for steers between housing treatments. Steers housed in an open feedlot with shelter spent less time lying and more time standing and walking ( $P < 0.05$ ) compared with steers housed in a hoop barn. There were no ( $P = 0.32$ ) differences between seasons for standing. Steers spent more time at the bunk ( $P < 0.0001$ ) and waterer ( $P < 0.0001$ ) in the summer compared with the winter. In the winter, steers engaged in more lying ( $P = 0.0002$ ) and walking ( $P < 0.0001$ ). Overall, steers stood less ( $P = 0.006$ ) and spent more time lying ( $P = 0.024$ ) when housed in a hoop barn than in the open feedlot with shelter regardless of season. Steers housed in the open feedlot with shelter walked more ( $P < 0.0001$ ) than steers housed in the hoop barn and walked more ( $P < 0.0001$ ) in winter than in summer months (6 vs. 3%). There were no ( $P > 0.05$ ) differences in time spent at bunk and waterer between housing systems within season, but time spent at the waterer and bunk decreased ( $P < 0.05$ ) for both housing systems during the winter. In conclusion, housing 40 steers per pen in a cornstalk-bedded hoop barn at 4.65m<sup>2</sup>/steer does not result in adverse behavioral alterations and can be considered as a housing alternative for finishing steers in the Midwestern United States when compared with steers fed in an open feedlot with shelter provided.

## Keywords

bedded hoop barn, behavior, open feedlot, shelter, steer

## Disciplines

Agriculture | Animal Sciences

## Comments

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## Behavior and temperament: hoops vs. feedlots

Comparison of steer behavior when housed in a deep-bedded hoop barn versus an open feedlot  
with shelter<sup>1</sup>

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**ABSTRACT:** Hoop barns are an alternative housing system for beef cattle that have not been widely researched. The objectives of this study were to determine the effects of housing steers in a hoop building versus a conventional feedlot during summer and winter months on behavior. A total of 960 crossbred *Bos taurus* steers were used (August 2006 to April 2008 [2 winter and 2 summer trials]). Steers were housed in either 1 deep-bedded hoop barn (n = 12 pens; 4.65 m<sup>2</sup>/steer) or 1 open feedlot with shelter (n = 12 pens; 14.7 m<sup>2</sup>/steer). Steers were ear tagged, implanted, and weighed (414 ± 36 kg) on arrival and allotted to treatments that were balanced for source, BW and hide color. Behavioral data (3 postures and 2 behaviors) were collected using a 10-min live scan and the day after behavioral collection, steers had their temperament scored (1 [calm] to 6 [wild]) determined. Experimental unit for behavior and temperament was a pen of steers. Behavioral data were arcsine transformed to achieve a normal distribution. There were no ( $P > 0.05$ ) differences for time spent at bunk or waterer for steers between housing treatments. Steers housed in an open feedlot with shelter spent less time lying and more time standing and walking ( $P < 0.05$ ) compared with steers housed in a hoop barn. There were no ( $P = 0.32$ ) differences between seasons for standing. Steers spent more time at the bunk ( $P < 0.0001$ ) and waterer ( $P < 0.0001$ ) in the summer. In the winter, steers engaged in more lying ( $P = 0.0002$ ) and walking ( $P < 0.0001$ ). Overall, steers stood less ( $P = 0.006$ ) and spent more time lying ( $P = 0.024$ ) when housed in a hoop barn than in the open feedlot with shelter regardless of season. Steers housed in the open feedlot with shelter walked more ( $P < 0.0001$ ) than steers housed in the hoop barn and walked more in winter than summer months (6 vs. 3%). There were no ( $P > 0.05$ ) differences in time spent at bunk and waterer between housing systems within season but time spent at the waterer and bunk decreased ( $P < 0.05$ ) for both housing systems during the winter. There were no ( $P > 0.05$ ) differences between housing system, season or season ×

housing system interactions for temperament. In conclusion, housing 40 steers per pen in a cornstalk bedded hoop barn at 4.65m<sup>2</sup>/steer does not result in adverse behavioral or temperament alterations and can be considered as a housing alternative for finishing steers in the Midwest U.S when compared with steers fed in an open feedlot with shelter provided.

**Keywords:** Behavior, bedded hoop barn, open feedlot, shelter, steers

### **Introduction**

In the Midwest U.S. there are many smaller beef cattle feedlots (< 2,000 head) that usually are 1 of 3 types, (1) an earthen open lot with a windbreak fence and mounds (23.2 m<sup>2</sup> per animal), (2) open lots with a shed or shelter (2.3 m<sup>2</sup> of shelter and 20.9 m<sup>2</sup> of open lot per animal) or (3) traditional confinement with slatted floors (2.3 m<sup>2</sup> per animal; Lawrence et al., 2006; Honeyman et al., 2010). However, alternative systems for housing farm animals have been investigated. One example of such a facility is the deep-bedded hoop barn (Woodbury et al., 2002; Shouse, et al., 2004; Moody et al., 2006). Hoop barns are a versatile alternative housing for livestock, particularly for swine (Honeyman et al., 2001; 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. To date there is limited information evaluating behavior and temperament of steers raised for beef production and housed in a deep-bedded hoop barn (Honeyman et al., 2008). Temperament has been defined as a set of behavioral characteristics (Core et al., 2009) and individuals may act agitated and excited when placed into a chute, while others may be calm, walk quietly and show no obvious outward signs of distress

(Grandin, 1993). Some work has begun addressing cattle temperament in extensive (Fordyce et al., 1988) and intensive (Tulloh, 1961) systems and how it can affect performance and final meat quality (Voisinet et al., 1997). Identifying alterations in cattle behavior when housed in different finishing systems could aid cattle producers when redesigning facilities to address environmental issues, economic requirements or well-being considerations (Overton, et al., 2002). Therefore, the objectives of this study were to determine the effects of housing steers in a hoop building versus a conventional feedlot during summer and winter months on behavior.

## **Materials and Methods**

### ***Farm location***

The experiment was conducted at the Iowa State University Armstrong Research and Demonstration Farm, near Lewis, IA, Pottawattamie County (41° 19' N, 95° 10' W) from August 2006 to April 2008 (2 winter trials defined as “December through May,” and 2 summer trials defined as “August through November”). In-building temperatures were recorded using data loggers (Hobo Pro series 2-Channel Temperature, Bourne, MA). A data logger was suspended 3.1 m over each pen. Temperatures (°C) were recorded every 30 min during all trials. All temperatures were averaged on a trial basis and are provided for descriptive purposes (Table 1). Long term temperature data (30-yr average) for this location was accessed from Iowa Environmental Mesonet (IEM; 2009). Rainfall for the site was approximately 71 cm annually.

### ***Animals and husbandry***

The project was approved by the Iowa State University’s Institutional Animal Care and Use Committee (log number; 3-05-5839-B) and steers were housed in accordance with the *Guide*

*for the Care and Use of Agricultural Animals in Agricultural Research and Teaching* (FASS, 1999). A total of 960 steers were used for these trials. Cattle were crossbred steers of predominantly Angus breeding and were acquired from area livestock markets. Cattle were kept in source groups and were acclimated about 2 wk prior to allotment. Steers weighed approximately  $414 \pm 36$  kg at the beginning of the trials. Cattle were balanced by source, hide color, and BW and then randomly allotted to housing system treatment (Hoop barn or Open feedlot with shelter) and pens within treatment. On arrival at the farm, steers were ear tagged, vaccinated with Cattle Master Gold (Pfizer Animal Health, Lafayette, IN) and implanted with Synovex Choice (Fort Dodge Animal Health, Overland Park, KS). All steers were on a natural light cycle and farm personnel observed all steers twice daily at 0900 and 1530 h.

All steers in both treatments were fed daily (between 0700 and 0800 h) in a fenceline bunk using a mixer feeder wagon with 30.5 cm of bunk/steer in both housing systems. 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 intake levels.

Average temperatures for the trial period August 2006 through April 2008 did not differ markedly from the long-term (30-yr) average temperatures. For both summer and winter trials the overall average, average maximum and average minimum temperatures did not differ more than 1.5 ° C from the 30-yr averages for this location (Table 1).

### ***Housing system treatments***

Two housing systems were compared: a hoop barn (n = 12) with 3 pens per trial vs. an open feedlot with shelter (n = 12) with 3 pens per trial . 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 was oriented north-south with ends open and a fenceline bunk along the east side. During the winter/spring, large round bales were stacked 3 high across the north and south ends of the hoop barn for a partial windbreak (approx 10 m in length and 3 m height). There was an earthen feedlot with a shelter open to the south and a fenceline bunk under roof built in 1996. The pens were 12.2 × 48.2 m, which included 7.6 m that was 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 barn (Shouse et al., 2004) and 2.3 m<sup>2</sup> per steer under roof in the open lot with shelter plus 12.4 m<sup>2</sup> per steer earthen lot area. Manure and bedding management was distinct for the 2 housing systems. The hoop barn pens were bedded weekly by placing large round bales of cornstalks on end. 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 open feedlot with shelter system, the roofed area was bedded as needed during the winter/spring trials only. When pens became excessively wet, pens were cleaned and cornstalk bedding was added. During the summer/fall trials, the roofed areas were dry enough not to require bedding. The unroofed pen areas were maintained as needed depending on weather conditions. When the cattle in the open feedlot with shelter were sold, the pens were scraped and manure removed.

### ***Behavioral measures***

Two behaviors (***head in bunk*** defined as the steer had its head in or immediately over the bunk and ***head in waterer*** defined as head in water bowl) and three postures (***lying*** defined as the steer's main body in contact with the ground, lying laterally or sternally, ***walking*** defined as the steer on all 4 legs while changing position the pen, and ***standing*** defined as not moving, with all four legs in contact with ground and no main body contact) were recorded. All categories were mutually exclusive. Between 0700 to 1600 h at the beginning of each month 2 observers scanned all pens and recorded the behavior or posture of each steer every 10-mins. One day post-behavioral collection, steers were moved through a squeeze chute for subjective temperament scoring. Scores ranged from 1 to 6 (adapted from the Beef Improvement Federation, 2006). Score 1: exits chute calmly (walk); Score 2: restless, exits promptly (trot); Score 3: nervous, constant movement, exits at fast trot; Score 4: jumps, shakes chute, exits briskly (canter); Score 5: aggressive, jump, bellow in chute, exits at gallop; Score 6: very aggressive, charges handlers. Lanier et al. (2000) reported that the *P*-value of inter- and intra-reliability tests to be  $P < 0.05$  with experienced observers. Based on these findings one experienced researcher (40 yr of cattle experience and used the scoring system for 20 yr) assigned temperament scores to all steers over all trials.

### ***Animal handling facility and temperament scoring***

Animal handling facilities were located west of the open feedlot and had a roof providing shelter. The squeeze chute was a Silencer (Moly Mfg, Lorraine, KS) Rancher model (Interior dimensions: 0.7 m wide by 2.3 m long). Sand was placed at the exit of the squeeze chute for a distance of 3 m at a depth of 6 cm for traction. Exiting steers then proceeded to a holding pen until all steers from a pen were weighed, and then were returned to their original pen.

### ***Statistical analysis***

The experiment consisted of 4 trials comparing 2 treatments (hoop barn vs. open feedlot with shelter). The experimental unit for all measures was a pen of steers. All behavioral data were expressed as percentages and were subjected to an arcsine square root transformation process to achieve a normalized distribution, and normality was checked using the Means and Univariate procedures of SAS. Data from summer ( $n = 2$ ) and winter ( $n = 2$ ) trials were combined and the statistical data were analyzed as a mixed model with repeated measures (SAS Inst. Inc., Cary, NC) for parametric data. Season (summer and winter), treatment (hoop and feedlot), pen ( $n = 12$  per treatment), and day were used in the class statement. The statistical model main plot included the parameters of interest and the subplot included all two-way interactions. Pen nested within treatment was included as a random effect in the model. A value of  $P < .05$  was considered significant and differences between least squares means were established using the preplanned pairwise contrasts (PDIFF).

## **Results**

### ***Behavior and Posture***

There were no ( $P > 0.05$ ) differences for time spent at bunk or time spent at waterer for beef steers when housed in a hoop barn or open feedlot with shelter. There were differences ( $P < 0.05$ ) for percentage of steers standing, lying and walking, with steers housed in an open feedlot with shelter spending less time lying and more time standing and walking compared with steers housed in the hoop barn (Table 2). There were no ( $P = 0.32$ ) differences in standing between seasons (summer and winter). There were ( $P < 0.05$ ) differences for time at bunk, time at waterer, lying and walking, respectively. Steers spent more time at the bunk ( $P < 0.0001$ ) and waterer ( $P <$

0.0001) in the summer. In the winter, steers engaged in more lying ( $P = 0.0002$ ) and walking ( $P < 0.0001$ ; Table 3). Steers stood less ( $P = 0.006$ ) and laid more ( $P = 0.024$ ) when housed in a hoop barn than the open feedlot with shelter regardless of season. Steers housed in the open feedlot with shelter walked more ( $P < 0.0001$ ) than steers housed in the hoop barn and walked more in winter than summer months (6 vs. 3.5%). There were no ( $P > 0.05$ ) differences in time spent at bunk and waterer between housing systems within season but time spent at the waterer and bunk decreased over the winter compared with summer months (Table 4). Temperament scores were not affected by housing system ( $1.95 \pm 0.05$  hoop barn vs.  $1.88 \pm 0.05$  open feedlot with shelter,  $P = 0.41$ ) or season ( $1.92 \pm 0.06$  summer vs.  $1.91 \pm 0.04$  winter,  $P = 0.93$ ). In addition there were no ( $P > 0.05$ ) differences for season by housing system interactions for steer temperament summer (hoop and feedlot  $1.95 \pm 0.08$ ) and winter (hoop  $1.89$  vs. feedlot  $1.88 \pm 0.06$ ).

### **Discussion**

Extensive research has addressed cattle behavior, performance and overall well-being in feedlots. Areas that have been addressed include strategies to reduce heat stress (Mader et al., 2003; Mader et al., 2006), seasonal effects (Ray and Roubicek, 1971), system design (Sowell et al., 1998) and management practices within the home pen (Mitlöhner et al., 2001). The hoop barn housing system differs from the open feedlot with shelter, in space allowance, bedding requirements and the amount of shade-to-shelter ratio. These differences, may in turn affect the steers' behavioral repertoire and their ability to adapt (Fisher et al., 1997; Ruis-Heutinck et al., 2000). Access and the amount of space per animal for feed bunks and waterers are of particular importance when designing a new housing system as farm animals form social hierarchies (Bouissou, 1965, Anderson and Lindgren, 1987). When steers were initially allocated to 1 of these

2 housing systems, all animals were able to access the bunk at the same time and were provided the same amount of feed bunk space (30.5 cm/steer), which facilitated cattle feeding and drinking patterns (Mitloehner et al., 2001). As steers grew, they were unable to access the feed bunk at the same time. Previous work in feedlots has reported that steers have already formed their hierarchy by this time and therefore aggression around the feed bunk does not increase and overall performance is not detrimentally affected (Stricklin, 1987). In this study, steers spent more time at the waterer (1.5%) and bunk (24%) in the summer compared with winter (0.8% vs. 19% respectively), but the housing systems within season did not differ indicating that steers were able to access key resources in both housing systems equally.

Mogensen et al. (1997) observed that wild ungulates may spend 40 to 50% of their time lying and that the event of lying is a necessary physiological function as it allows for rumination of previously ingested feedstuffs, may help to reduce lameness and also provides rest. In agreement with Mogensen et al. (1997), steers in the hoop barn spent 43% of their time lying, but this was lower for open feedlot with shelter steers (33%), conversely, open feedlot with shelter steers stood and walked more. These differences noted in lying, walking and standing between housing systems may be a function of space allowance and bedding. Previous work by Hickey et al. (2003) addressed space allowance (1.5 to 4 m<sup>2</sup>/animal) and floor type (slats vs. straw) for finishing steers and reported that time spent lying was reduced at space allowances less than 2 m<sup>2</sup>/animal, but steers lay longer on straw beds compared with steers housed on slats when the space allowance was held constant at 3 m<sup>2</sup>/animal. Hoop-barn steers in this study were housed at 4.65 m<sup>2</sup>, therefore

space allowance should be a critical consideration for producers thinking about implementing this system successfully.

Season affected the behavioral repertoire of steers, with steers lying and walking more in the winter, but time at bunk and waterer increased in the summer. Feedlot cattle can be expected to exhibit behavioral and physiological responses to increasing temperature and relative humidity (Blackshaw and Blackshaw, 1994; Mitloehner et al., 2001; Mader et al., 2003). Cattle will preferentially seek shade, engage in more drinking behaviors to disperse internal heat load and shift grazing patterns if possible. Therefore, during the summer, steers may have employed 2 heat-reducing techniques; the first was to increase their time at the bunk (provided shade in the open feedlot with shelter system) and the second was to consume more water. It would be beneficial to consider future work on steer location, shade use and length and number of drinking/eating patterns between seasons and across these housing systems. When comparing season within the housing system, steers in both systems lay more in the winter (46% hoops and 34 % open feedlot with shelter) compared with the summer (39% hoops and 31% open feedlot with shelter), although there was a remarkable difference in their lying time budget for steers in the open feedlot compared with the hoops (36% difference). Steers in the open feedlot with shelter walked more in both the summer (3.5%) and winter (6%) compared with hoop barn steers (2%) and this may be a function of thermoregulation for steers housed in open feedlot with shelter during the colder winter months of Iowa because they have the ability to move freely around their environment and, they physically have more space to move, whereas steers in hoop barn are physically confined in a smaller pen.

Human-cattle interactions commonly occur during routine management procedures, handling, and at the time of marketing. Previous discussions have emphasized the importance of these human-cattle interactions, how temperament can be altered when novel stimuli is introduced

and the effects on animal well-being. Such studies include; broilers (Gross and Siegal, 1979; Jones and Hughes, 1981; Hemsworth et al., 1994), laying hens (Hemsworth and Barnett, 1989; Barnett et al., 1992), dairy cows (Boissy and Bouissou, 1988; de Passille et al., 1996; Hemsworth et al., 2000), sheep (Hargreaves and Hutson, 1990a, b), and pigs (Coleman et al., 2000; Tanida et al., 1994; Tanida et al., 1995). Cattle temperament can be scored using a variety of tools. Recently researchers have begun to try and quantify temperament of cattle by using eye white percentage (Core et al., 2009; Sandem et al., 2002), flight speed (Müller and von Keyserlink, 2006), reaction to sounds and movements (Lanier et al., 2000), and exit velocity (Curley et al., 2006; King et al., 2006). However, the traditional methodology to determine cattle temperament has been to use a subjective scale which was implemented in this study. Overall steer temperament did not differ between housing systems or between seasons. Steers tended to score on average 1.95 for summer and 1.89 in winter, and both of these scores indicate a steer that exits the chute calmly and walks. To compliment these findings, Honeyman et al., (2010) reported no differences in performance or final carcass characteristics for these steers. Therefore, these results are encouraging that even with inherently different housing system designs; steers seem to adjust and exhibit calm temperament scores over their growth phase.

## **IMPLICATIONS**

Hoop barns with bedding where the cattle are confined inside the barn are a viable alternative housing system for feeding beef cattle. Key housing designs for the hoop barn were (1) number of steers per pen, (2) stable groups, (3) access to feed bunk at placement, and (4) a space allowance of 4.65 m<sup>2</sup>/animal. With these key factors implemented, housing steers in a hoop barn did not result

in adverse behavioral alterations. Therefore, hoop barns can be considered by beef producers as a viable housing alternative for finishing steers in the Midwest U.S.

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Table 1. Temperature (mean, minimum, and maximum) for the Iowa State University Armstrong Research and Demonstration Farm, near Lewis, IA.

Temperatures <sup>f</sup>	Long-Term <sup>a</sup>			Trial period 2006 to 2008 <sup>e</sup>	
	Annual <sup>d</sup>	Winter <sup>b</sup>	Summer <sup>c</sup>	Winter	Summer
Avg. temperature, °C	9.6	0.0	13.3	-0.6	14.1
Avg. maximum temperature, °C	15.9	5.9	19.8	4.6	19.8
Avg. minimum temperature, °C	3.4	-5.9	6.9	-5.8	8.3

<sup>a</sup>Long term refers to 30-yr averages for this location Information accessed from the Iowa Environmental Mesonet (IEM) 2009.

<sup>b</sup>Winter = December through May (daily).

<sup>c</sup>Summer = August through November (daily).

<sup>d</sup>Ambient daily outdoor high and low temperatures were recorded at the Iowa Environmental Mesonet (IEM) station.

<sup>e</sup>In-building temperatures were recorded using data loggers (Hobo Pro series 2-Channel Temperature, Bourne, MA). A data logger was suspended 3.1 m over each pen. Temperatures (°C) were recorded every 30 min during the experiment.

<sup>f</sup>All temperatures were averaged on a trial duration basis and are provided for descriptive purposes.

Table 2. Steer postures and behaviors least square means ( $\pm$ SE) from live observations between 0700 and 1600 h.

Measure	Treatment <sup>1</sup>		<i>P</i> -value <sup>2</sup>
	Hoop	Feedlot	
No. Pens	12	12	
No. Steers	460	460	
Postures, % <sup>3</sup>			
Standing	32.3 $\pm$ 1.2	39.8 $\pm$ 1.2	0.006
Lying	42.5 $\pm$ 0.3	32.7 $\pm$ 1.3	0.003
Walking	2.0 $\pm$ 0.2	4.8 $\pm$ 0.2	0.001
Behaviors, %			
Time at bunk	22.1 $\pm$ 0.6	21.4 $\pm$ 0.6	0.66
Time at waterer	0.9 $\pm$ 0.4	1.3 $\pm$ 0.4	0.12

<sup>1</sup>Steers were housed in a deep bedded hoop barn versus an open feedlot with shelter at the Iowa State University Armstrong Research and Demonstration Farm, near Lewis, IA from August 2006 to April 2008. Two housing systems were compared—a *hoop barn* with 3 pens (n = 12) vs. an *open feedlot with shelter* with 3 pens (n = 12). Stocking densities for the steers were 4.65 m<sup>2</sup> per steer in the hoop barn (Shouse et al., 2004) and 2.3 m<sup>2</sup> per steer under roof in the open lot with shelter plus 12.4 m<sup>2</sup> per steer earthen lot area.

<sup>2</sup>Least squares means with different superscript letters differ within a row ( $P \leq 0.05$ ).

<sup>3</sup>Two behaviors and three postures were recorded and all categories were mutually exclusive. Two observers scanned all pens and recorded the behavior or posture of each steer every 10-mins. Percentages presented note the total time that all steers in all pens across each housing system were engaging in these postures and behaviors between the hours of 0700 and 1600-h.

Table 3. Steer postures and behaviors least square means ( $\pm$ SE) from live observations between 0700 and 1600 h over summer and winter.

Measure	Season <sup>1</sup>		<i>P</i> -value <sup>2</sup>
	Summer	Winter	
No. Pens	12	12	
No. Steers	460	460	
Postures, % <sup>3</sup>			
Standing	36.3 $\pm$ 1.0	35.9 $\pm$ 1.0	0.32
Lying	34.9 $\pm$ 1.2	40.2 $\pm$ 1.2	0.0002
Walking	2.8 $\pm$ 0.2	4.0 $\pm$ 0.2	<0.0001
Behaviors, %			
Time at bunk	24.6 $\pm$ 0.5	19.1 $\pm$ 0.5	< 0.0001
Time at waterer	1.4 $\pm$ 0.1	0.8 $\pm$ 0.1	<0.0001

<sup>1</sup>Trials conducted at the Iowa State University Armstrong Research and Demonstration Farm, near Lewis, IA from August 2006 to April 2008. Summer = August through November.

Winter = December through May.

<sup>2</sup>Least squares means with different superscript letters differ within a row ( $P \leq 0.05$ ).

<sup>3</sup>Two behaviors and three postures were recorded and all categories were mutually exclusive. Two observers scanned all pens and recorded the behavior or posture of each steer every 10-mins. Percentages presented note the total time that all steers in all pens across each housing system were engaging in these postures and behaviors between the hours of 0700 and 1600-h.

Table 4. Steer postures and behaviors least square means ( $\pm$ SE) from live observations between 0700 and 1600 h over summer and winter.

Summer<sup>1</sup>

Winter

<sup>1</sup>Summer = August through November. Winter = December through May.

<sup>2</sup>Steers were housed in a deep bedded hoop barn vs. an open feedlot with shelter at the Iowa State University Armstrong Research and Demonstration Farm, near Lewis, IA from August 2006 to April 2008. Two housing systems were compared; a *hoop barn* with 3 pens (n = 12) vs. an *open feedlot with shelter* with 3 pens (n = 12). Stocking densities for the steers were 4.65 m<sup>2</sup> per steer in the hoop barn (Shouse et al., 2004) and 2.3 m<sup>2</sup> per steer under roof in the open lot with shelter plus 12.4 m<sup>2</sup> per steer earthen lot area. <sup>3</sup>Least squares means with different superscript letters differ within a row ( $P \leq 0.05$ ).