Concrete vs. Dirt Feedlot Pens: The Effects in Temperature and Evening Animal Behavior on Finishing Yearlings

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Feedlot cattle that are fed in open yard lots during the summer are subject to a variety of environments which include periods of hot climatic conditions (Hahn and Mader, 1997; Mader et al., 1999b). North Dakota has a continental climate which brings average summer temperatures up to 85°F. Periods consisting of high temperature, relative humidity, and solar radiation with low wind speeds can increase heat load placed on the animal. Reduced performance, decreased comfort, and death can result due to extreme heat load (Mader et al., 1997, 1999a.; Hubbard et al., 1999).

The objective of this study was to determine if temperature differences in pen types (concrete vs. dirt) influenced cattle behavior, growth performance, and carcass characteristics. Data was collected using temperature loggers placed in pen surfaces and accelerometers fixed to ear tags. Our hypothesis was cattle fed in a concrete-surface lot would be subject to greater evening heat loads compared to those on dirt surfaces.

Materials and Methods

All procedures involving the use of animals in this experiment were approved by the North Dakota State University Institutional Animal Care and Use Committee. The experiment was conducted at the North Dakota State University Carrington Research Extension Center (CREC) located near Carrington, ND.

Experimental Design and Treatments

Three treatments were used in this completely randomized design study to evaluate animals' times of activity/inactivity, growth performance, and carcass characteristics relative to pen temperature. The treatments were dirt pens (DIRT) and concrete (CONC). All pens were fed a basal diet consisting of 49% dry-rolled corn, 24% dry-rolled barley, 14% modified distillers grains plus solubles, 6% corn silage, 4% small grain straw, and 3% dry supplement.

Animals, Initial Processing, Study Initiation

Fifty-four black angus steers (920 ± 96 lbs, initial body weight [BW]) were delivered to the CREC, weighed, randomly assigned to treatment (concrete or dirt surface lot), and assigned to one of three treatment lots (n = 6 [9 steers/pen]). Twenty-four Axivity AX-3 tri-axial accelerometers (Axivity Ltd, Newcastle, UK), fitted to Allflex ear tags, were placed on four randomly selected steers. The axes corresponded to z - front-to-back, y - side-to-side and x - vertical. The accelerometers were configured to a sample rate of 12.5 Hz.

Temperature loggers (IButton DS1925-F5; IButtonLink, LLC, Whitewater, WI) were placed within the pen surface material. Pen surface temperatures were logged every 15 minutes from June 27 to October 10, 2023. Temperatures were aggregated to 1-hour epochs and further averaged into eight 3-hour periods throughout the day. Time period 6 (6:00 p.m. - 9:00 p.m.) was analyzed using the mixed procedure of SAS 9.4 (SAS Institute Inc., NC, USA).

A training and validation dataset were created from accelerometer data and observed animal behaviors. These datasets were used in a Random Forest machine learning prediction model. The calculated metrics used to create the training and validation datasets include movement intensity (MI), signal magnitude area (SMA), energy, entropy, and movement variation (MV). Of the 59,595 recorded behavior observations, 47,676 random observations (80%) were used as the training dataset and all datapoints were utilized as the validation dataset. The Random Forest model was then applied to the total 4,147,200 1-minute epochs to create inactive/active behavior predictions for all 24 animals fitted

with accelerometers. Minutes of active behavior were averaged by pen. To coincide with any potential changes in pen temperature, minutes of activity were analyzed during time period 6.

The initial Random Forest model utilized three observed behaviors (laying, standing, and feeding) for prediction. Standing was usually predicted as laying. We merged the two inactive observed behaviors (laying and standing) into inactive to create a binary classification model of active or inactive. The training dataset predicted the active and inactive behavior 87.3% and 95.9% correctly, respectively. The Random Forest model predicted 93.7% of the overall observed dataset.

The monthly average of growth performance (weight, average daily gain (ADG), dry matter intake (DMI), and gain to feed (G:F)) were analyzed using the repeated measures procedure of PROC MIXED in SAS 9.4 (SAS Inst Inc., Cary, NC; Littell et al., 2006) with pen serving as the experimental unit.

Results

There were no detectable differences in minutes of activity due to lot surface type ($P > 0.05$; Table 1) throughout the study. There were no detectable differences in pen surface temperature at time period 6 (6:00 p.m. - 9:00 p.m.) ($P > 0.05$; Table 1) throughout the study. There were no detectable differences in animal growth performance or carcass characteristics ($P > 0.05$; Table 1).

Table 1. Main treatment effects of surface temperature and minutes of activity due to surface type treatments.

	Pen Surface Treatment			
	DIRT	CONC	SEM	*P* - value
Pen Surface Temperature, °C	16.7	16.8	0.275	0.88
Minutes of Activity, min	19.9	17.5	1.05	0.19
Weight gain, lbs	504	539	18.56	0.26
Average daily gain, lbs	4.1	4.4	0.15	0.21
Hot carcass weight, lbs	906	918	15.01	0.61
Dressing Percentage, %	63	63.7	0.1	0.37
Yield Grade	3.77	3.8	0.14	0.85
Back Fat, in	0.71	0.72	0.05	0.86
REA, in^2	13.6	13.7	0.21	0.7
Marbling Score	604	612	29.6	0.85

The use of concrete did not increase surface temperatures during the late afternoon/early evening period of the day. Having no detectable differences, both lot surfaces allow accumulated heat to be dissipated through the ground similarly, helping animals tolerate warmer and more humid afternoon temperatures.

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