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Effects of weaning age and winter development environment on heifer grazing distribution[1]

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SUMMARY

The objective of this experiment was to determine if early weaning (approximately 125 d) vs. normal weaning (approximately 250 d) and wintering replacement heifers in drylot versus rangeland affected heifer grazing distribution during the subsequent summer. Heifer calves from the 2009 and 2010 calf crop (n = 104 and 73, respectively) were allocated to the 2 weaning treatments and then stratified by age into the 2 winter development treatments. During the summer of yr 1 heifers were allocated to 2 pastures by winter treatment, and in yr 2, all 4 treatment combinations were allocated to separate pastures. A subset of heifers from each group was selected to wear global positioning system (GPS) collars (n=2 and 5 in yr 1 and 2, respectively). Readings were taken from the GPS every 15 min in yr 1 and every 65 s in yr 2. The GPS coordinates were then analyzed relative to ecological sites, water locations, fence locations, and temperature using Arc GIS (ESRI, Redlands, CA). Winter treatment affected (P<0.05) preference index (PI) for claypan and loamy sites in 2010, and distance from water in 2011. Day of sampling affected (P<0.05) claypan and loamy site PI in 2010 and thin claypan site PI in 2011. Day of sampling interacted with winter treatment (P<0.05) for distance from water in 2010, sand and thin claypan site PI in 2010 and thin claypan site PI in 2011, while day of sampling interacted with weaning treatment for distance from water in 2011. A winter by weaning treatment interaction affected (P<0.05) thin claypan site PI in 2011. Temperature had an effect on distance to fencelines in 2010 (P<0.001). There was a temperature interaction with wintered treatment effect on distance to water in 2011 (P<0.001). There was a three-way interaction (P<0.05) between weaning treatment, winter treatment and ambient temperate on the distance from water and between weaning treatment, winter treatment and day of sampling on claypan and sand site PI in 2011. In conclusion, winter development influenced patterns of range utilization. Day-of-sampling interactions indicated that range heifers did not adjust preferences and thus were already adapted to the range environment, whereas drylot heifers adjusted preferences over time suggesting they re-learned how to utilize the range environment.

INTRODUCTION

Past research has suggested that rangeland may be an effective resource to develop heifers that are destined to become range cows (Olson et al., 1992; Salverson et al., 2005). Learning and retention of grazing skills may play an important role in the development of productive range cows that are capable of harvesting adequate grazed nutrients to meet their requirements, therefore requiring minimal outside feed resources. Factors that affect grazing behavior include, but are not exclusive to, early life experiences, presence of peers, physiological or nutritional state of the animal, inherited senses, and spatial memory (Launchbaugh and Howery, 2005). Some specific factors that have been found to

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influence cattle grazing habits are vegetation biomass available in the area and water location (Gillen et al., 1984; Owens et al., 1991; Pinchak et al., 1991; Cibils et al., 2008).

The objective of this study was to determine how weaning treatment and winter development environment of beef heifers affected grazing distribution and pasture utilization throughout the following summer months. We hypothesized that range-raised heifers would have a more broad pasture distribution and better utilization. This was based on the idea that range heifers grazing throughout winter would retain grazing skills and cues learned from dams while suckling and that drylot heifers would have a re-learning period before they would be able to fully utilize the pasture. We also hypothesized that normal-weaned heifers would have better grazing habits than early-weaned heifers because they spent more time grazing with their dams learning and retaining grazing skills.

MATERIALS AND METHODS

All animal procedures were approved by the South Dakota State University Institutional Animal Care and Use Committee.

Design and Treatments

Heifer calves from the 2009 and 2010 calf crop (n = 104 and 73, respectively) were split into two different groups to either be early weaned (**EW**- about 125 d) or normal weaned (**NW**- about 250 d). These groups were based on cow assignments to weaning treatments for another study that was currently ongoing. In that study, cows were stratified into two groups and then each group was randomly assigned to either be early- or normal-weaned when they entered the study. Within the two weaning-date groups, heifers were stratified by age into two groups and each group was randomly assigned to a post-weaning development treatment. These groups were either developed through the winter from weaning to breeding in drylot (**D**) or developed from weaning to breeding on rangeland (**R**). This created the following four treatments: 1) early weaned and developed in drylot (**ED**); 2) early weaned and developed on rangeland (**ER**); 3) normal weaned and developed in drylot (**ND**); or 4) normal weaned and developed on rangeland (**NR**). Heifers developed in drylot received mixed grass and alfalfa hay (yr 1: 87.1% DM, 11.6% CP, 52.5% TDN; yr 2: 87.3% DM, 12.3% CP, 53.4% TDN) ad libitum plus 4 lb of a dried distiller's grain (**DDGS**)-based supplement/hd/d (yr 1: 93.4% DM, 22.7% CP, 75.8% TDN; yr 2: 91.8% DM, 25.4% CP, 76.7% TDN). Heifers developed on rangeland also received 4 lb/hd/d of the same supplement. During the winter when the ground was covered in snow to a depth that precluded grazing, range heifers received the same hay as the drylot heifers. Heifers in the ER treatment consumed 498 lb/hd of hay in yr 1 and 672 lb/hd of hay in yr 2. Heifers in the NR treatment consumed 483 lb/hd of hay in yr 1 and 648 lb/hd of hay in yr 2. More hay was fed to both treatment combinations in year 2 because of a greater number of days with heavy snow cover. Over the winter, each treatment combination was allocated to a separate pen or pasture. After estrus synchronization and timed AI (June 19, 2010 and June 9, 2011), all heifers were placed on rangeland to graze through the summer. During the summer of yr 1, heifers were allocated by winter treatment to 2 pastures, and all 4 treatments were allocated to separate pastures during the summer of yr 2.

Year 1 GPS Locations

Two heifers from each treatment combination were selected based BW close to the mean treatment group 365-d BW and average phenotype to represent their group's grazing habits. These heifers wore a global positioning system (GPS) – very high frequency (VHF) collar (GPS-Log-V2, Kedziora Innovation

Group Mannsville, NY) that recorded location at 15-minute intervals throughout the summer grazing season. Data were collected over a 74-d period from June 19 to August 31, 2010.

Year 2 GPS Locations

Five heifers were randomly selected from each group to wear a GPS collar using the same selection criteria as year 1. These collars contained a Garmin GPS unit (eTrex Legend H, Garmin, Olathe, Kansas) that recorded location every 65 seconds. Data were collected over a 76-d period from June 9 to August 24, 2011.

GPS Analysis

Location data points for each heifer were mapped onto a layer in ArcMap (Rock Wars, Golden CO) and intersected with a layer for 4 ecological sites (claypan, loam, sand, and thin claypan) that were common to all pastures. The number of GPS points on each ecological site per day was divided by the total GPS points that given day, resulting in the percentage of time spent each day on a given ecological site. That number was then multiplied by the percentage of the total area occupied by that ecological site to calculate the preference index (**PI**).

Fencelines and water sources were mapped using a GeoExplorer® GeoXH (Trimble® GPS Navigation; Sunnyvale, CA). With the use of Arc Map, the distance between every GPS data point for each heifer and the nearest water source and fenceline was calculated. Mean distances from the fencelines and water sources for each heifer were found for each hour of each day over the entire summer grazing period. Hourly ambient temperature readings were collected from an onsite weather station.

Statistical analysis

Preference indexes for ecological sites were analyzed by repeated measures using the MIXED procedure of SAS. The model included the independent variables of weaning treatment, wintering treatment, and day of the grazing season, along with their 2- and 3-way interactions. Day of the grazing season was considered a continuous variable and therefore treated as a covariate. Fence and water distances were also analyzed by repeated measures using the MIXED procedure of SAS using the same model.

The temperature effect on distance from water and fenceline was also analyzed as described above, with the model consisting of the independent variables of weaning treatment, wintering treatment, temperature and their 2- and 3-way interactions.

RESULTS AND DISCUSSION

Ecological site PI

In yr 1 R heifers preferred (P = 0.01) claypan ecological sites more than D heifers (PI of 6.46 ± 0.661 and 1.14 ± 0.410, respectively). There was a tendency (P = 0.10) for R heifers to increase their PI by 0.07 ± 0.028 each day of the grazing season. However, over the summer all groups had an increase of 0.04 ± 0.018 units of PI for claypan sites (P = 0.02). In yr 2, there was a three-way interaction between day, weaning treatment, and winter treatment on claypan PI. The following regression equations were generated:

$$\text{ED claypan PI} = 33.0 + (-0.500 \times \text{day})$$

$$\text{ER claypan PI} = -0.04 + (0.19 \times \text{day})$$

$$\text{ND claypan PI} = 0.09 + (0.01 \times \text{day})$$

$$\text{NR claypan PI} = 2.5 + (-0.03 \times \text{day})$$

ER and ND did not have a preference for claypan sites and NR had a slight preference. None of these preferences changed over the summer. In contrast, ED heifers had an extremely high initial PI for claypan sites, which then decreased through the grazing season ($P < 0.001$)

Drylot heifers had a greater initial preference ($P < 0.001$) for loam ecological sites than R heifers (1.76 ± 0.54 and 0.31 ± 0.080, respectively) and all groups had an increase ($P < 0.001$) of 0.01 ± 0.002 preference units each day in yr 1. There were no differences in PI for loam sites in yr 2.

In yr 1, R heifers had a greater initial preference ($P = 0.02$) for sand sites than D heifers and increased preference throughout the summer ($P = 0.001$), whereas D heifers had no change in preference as the summer progressed. The following regression equations were generated:

$$\text{D sand PI} = 0.57 + (0.004 \times \text{day})$$

$$\text{R sand PI} = 2.40 + (0.03 \times \text{day})$$

In yr 2, there was an interaction among period, weaning treatment and winter treatment ($P = 0.007$) for sand site PI. The following regression equations were generated:

$$\text{ED sand PI} = 0.3 + (0.03 \times \text{day})$$

$$\text{ER sand PI} = 0.59 + (-0.004 \times \text{day})$$

$$\text{ND sand PI} = 1.43 + (-0.01 \times \text{day})$$

$$\text{NR sand PI} = 1.96 + (0.05 \times \text{day})$$

Normal-weaned R heifers initially had a higher PI than other treatments that increased ($P < 0.001$) each day. All other groups had a smaller initial preference that did not change during the summer.

Thin clay pan site (TCP) preference in yr 1 was initially higher in D heifers than R heifers. The following regression equations were generated:

$$\text{D TCP PI} = 1.04 + (-0.006 \times \text{day})$$

$$\text{R TCP PI} = 0.84 + (0.001 \times \text{day})$$

Over the summer D heifers decreased ($P < 0.001$) preference and R heifers had no change. In yr 2, there was a weaning treatment by winter treatment interaction on thin clay pan site preference. Normal R heifers had a PI of 0.553 ± 0.087, which was similar to ED with a PI of 0.73 ± 0.082 and different from ER (0.95 ± 0.081) and ND (1.06 ± 0.087). ED was also similar to ER, but different from ND. All groups had a 0.005 ± 0.002 increase in PI over the summer ($P < 0.001$).

Distance from Fences

In yr 1, the R heifers' average distance from the fenceline was greater ($P = 0.03$) than the D heifers (459.3 ± 16.5 ft and 316.3 ± 13.4 ft, respectively). However, in yr 2 there was a tendency ($P = 0.09$) for a weaning by winter treatment interaction that indicated ED heifers mean distance was further from the fence than the NR heifers (449.5 ± 41.7 ft and 262.5 ± 49.5 ft, respectively). Heifers mean distance from the fence increased as temperature increased at 5.3 ± 1.3 ft (P < 0.001) per degree C in yr 1. However, in yr 2 there was only a tendency ($P = 0.09$) for a 4.1 ± 2.4 ft increase in distance from the fenceline per degree C as temperature increased.

Distance from Water

Past research has found that the location of water influences pasture distribution (Gillen et al., 1984; Owens et al., 1991; Pinchak et al., 1991; Cibils et al., 2008) and our finding support this. In yr 1, there was an interaction between day and winter treatment ($P = 0.02$). The R heifers started the grazing season at a closer mean distance to water than the D heifers (387.2 ± 123.0 ft and 1650.3 ± 112.2 ft, respectively), and the average distance for R heifers did not change ($P > 0.05$) over the summer but the D heifers moved closer to water at a rate of 9.74 ± 3.12 ft/day ($P = 0.002$). This suggests that once the D heifers became more familiar with where the water source was in relation to other resources, they did not venture as far away. In yr 2, there was no change over time in relation to the winter treatment, but the average distance to water was greater ($P < 0.001$) for the R than the D heifers (1446.9 ± 60.0 ft and 564.3 ± 57.7 ft, respectively). There was also a day by weaning treatment interaction ($P = 0.002$). The following regression equations were generated:

$$\text{EW distance to water} = 1036 \text{ ft} + (2.46 \text{ ft} \times \text{day})$$

$$\text{NW distance to water} = 1377 \text{ ft} - (8.46 \text{ ft} \times \text{day})$$

The EW heifers started the grazing season closer to water than NW, and the EW mean distance to water did not change ($P > 0.05$) over the season while the NW heifers reduced distance over time ($P < 0.001$). Early-weaned D heifers had a tendency ($P = 0.07$) to be closer to water than ER heifers in yr 2 (324.2 ± 69.0 ft and 1775.0 ± 88.3 ft, respectively). There was also a tendency ($P = 0.09$) in yr 2 for the mean distance from water to decrease by 3.0 ± 1.8 ft/day. This suggested that the ER heifers had improved grazing distribution relative to the other treatments combinations because they had spent the greatest amount of post-weaning time in the grazing setting on rangeland.

There was an interaction between temperature and winter treatment for influence of temperature on distance from water in yr 1 ($P < 0.001$). The following regression equations were generated:

$$\text{D distance to water} = 1352 \text{ ft} + (-35.5 \text{ ft} \times {}^{\circ}\text{C})$$

$$\text{R distance to water} = 202 \text{ ft} + (-4.9 \text{ ft} \times {}^{\circ}\text{C})$$

Drylot-developed heifers traveled further from water than range-developed heifers at cooler temperatures, but ventured closer to water as temperature increased. In yr 2 there was a three-way interaction between temperature, weaning, and winter treatments (P = 0.007). The following regression equations were generated:

$$\text{ED distance to water} = 127\ \text{ft} + (-1.8\ \text{ft} \times {}^{\circ}\text{C})$$

$$\text{ER distance to water} = 412\ \text{ft} + (7.2\ \text{ft} \times {}^{\circ}\text{C})$$

$$\text{ND distance to water} = 270\ \text{ft} + (-2.82\ \text{ft} \times {}^{\circ}\text{C})$$

$$\text{NR distance to water} = 497\ \text{ft} + (-7.56\ \text{ft} \times {}^{\circ}\text{C})$$

Both ED and ND heifers started closer to the water than ER and NR heifers and did not change distance with temperature. However, ER heifers increased distance and NR heifers reduced distance as temperature increased. This suggested that other factors besides water location affected grazing distribution.

Heifer grazing distribution is based on learned experiences, social cues and pasture environment. In this study, heifers that were wintered on rangeland initially utilized the pasture more evenly because the drylot heifers apparently needed to have a learning period. Past research has shown that water and vegetation location influence cattle pasture distribution and our results support that. By wintering heifers on rangeland, a producer will have heifers that do not require a learning period during the summer and will be able to better utilize their pastures.

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