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Relationships between docility and reproduction in Angus heifers

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Abstract
Reproductive success is relevant in beef cattle operations because income generated by the sale of calves is often a large portion of an operation's income. Selecting for fertility is difficult because it is influenced by a variety of factors. Temperament could be a factor affecting fertility. Physiological responses associated with temperament can influence the probability of cows becoming pregnant because stress hormones in the bloodstream can negatively affect the release of reproductive hormones. Methods have been developed to assess temperament in cattle. Exit velocity measures the time it takes for an animal to cover a predetermined distance after vacating a chute. Chute scores range from 1 (quiet) to 6 (aggressive) and are based on the animal's behavior when confined in a chute. Positive correlations of chute score and exit velocity with cortisol indicate that both scores are reliable indicators of temperament. Handling of cattle is associated with changes in concentrations of stress hormones. Blood serum collection can provide insight into short-term stressors, and fecal sampling can be reflective of stress experienced 2'3 days before sampling. This study was conducted to investigate the relationship between animal temperament and heifer fertility as indicated by first-service artificial insemination conception rate.

Keywords
Cattlemen's Day, 2014; Kansas Agricultural Experiment Station contribution; no. 14-262-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1101; Beef Cattle Research, 2014 is known as Cattlemen's Day, 2014; Beef; Beef cattle; Fertility; Temperment; Stress

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Relationships Between Docility and Reproduction in Angus Heifers

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Introduction

Reproductive success is relevant in beef cattle operations because income generated by the sale of calves is often a large portion of an operation's income. Selecting for fertility is difficult because it is influenced by a variety of factors. Temperament could be a factor affecting fertility. Physiological responses associated with temperament can influence the probability of cows becoming pregnant because stress hormones in the bloodstream can negatively affect the release of reproductive hormones.

Methods have been developed to assess temperament in cattle. Exit velocity measures the time it takes for an animal to cover a predetermined distance after vacating a chute. Chute scores range from 1 (quiet) to 6 (aggressive) and are based on the animal's behavior when confined in a chute. Positive correlations of chute score and exit velocity with cortisol indicate that both scores are reliable indicators of temperament. Handling of cattle is associated with changes in concentrations of stress hormones. Blood serum collection can provide insight into short-term stressors, and fecal sampling can be reflective of stress experienced 2–3 days before sampling.

This study was conducted to investigate the relationship between animal temperament and heifer fertility as indicated by first-service artificial insemination conception rate.

Experimental Procedures

Data for this project were collected from three different cooperator herds. A total of 337 first-calf heifers were used in this study. Ranch 1 (n = 117) heifers were synchronized using a combined melengestrol acetate (MGA)/prostaglandin (PGF)/gonadotropin-releasing hormone (GnRH) synchronization protocol. Melengestrol acetate was fed at 0.5 mg per head per day for 14 days. On day 33, 5 ml of PGF was injected, exit velocity and chute score were recorded, and fecal samples were collected. Heifers were visually detected for standing estrous for 2 days and bred 1,014 hours after observed standing estrous. On the third day after PGF injection (day 36), all females not previously detected in heat were injected with 2 ml of GnRH and inseminated. Blood samples were collected for cortisol analysis at this time. Cleanup bulls were put in with the females on day 37. Heifers were ultrasounded at 30 days to check pregnancy status.

Ranches 2 (n = 133) and 3 (n = 87) employed CoSynch-controlled internal drug release (CIDR) protocols to synchronize their heifers. On day 0, CIDRs were inserted in addition to a 2-ml injection of GnRH. Exit velocity and chute score were recorded at this time, and fecal samples were collected for cortisol analysis. On day 7, CIDRs were then removed and a 2-ml injection of PGF was given. On day 9, the heifers were given a second 2 ml injection of GnRH and inseminated, and blood samples were collected for cortisol analysis. Heifers were ultrasounded at 30 days to check pregnancy status.

Fecal samples were taken while the animal was in the chute. Samples were stored in individual containers on ice until they could be delivered to the lab and frozen at -4°F. Blood samples were collected via venipuncture into 15-ml Vacutainer tubes with 18 G × 1.5-in. needles at breeding. Samples were immediately put on ice until they could be transported to the lab, where they were refrigerated for at least 8 hours before centrifugation.

Laboratory analysis

Refrigerated blood samples were centrifuged at 2,400 × g for 20 minutes at 39°F. Plasma was stored at -4°F until assayed. Plasma concentrations of cortisol were determined using a radioimmunoassay kit specific to bovine serum (Coat-A-Count Cortisol, Siemens Medical Solutions Diagnostics, Malvern, PA). The average intra- and inter-assay coefficients of variation were 12% and 3.5%, respectively.

Quantification of fecal corticosterone levels was modeled after protocols outlined by other researchers. Concentrations of fecal corticosterone were determined using a commercial radioimmunoassay kit (MP Biomedicals, Solon, OH) validated for use on bovine samples in July 2012. For extraction, 0.017 oz of thawed fecal matter was placed into a 0.5-oz centrifuge tube. To this, 0.15 oz of 80% methanol was added, and the tubes were placed in a lab rack vortexer for 40 minutes. Following vortexing, tubes were centrifuged at 3,000 × g for 15 minutes. The amount of corticosterone in the supernatant was determined by the I25-corticosterone radioimmunoassay. The average intra- and inter-assay coefficients of variation were 3.5% and 5.5%, respectively.

Statistical analysis

Logistic regression was used to determine the factors that influenced pregnancy rate. Contemporary group was fit as a fixed effect, whereas fecal cortisol, blood cortisol, exit velocity, chute score, weight, and age were included as covariates. Contemporary group was based on ranch. Correlation coefficients were also calculated between fetal cortisol, blood cortisol, exit velocity, chute score, weight, and age.

Results and Discussion

Summary statistics for the study are presented in Table 1. The power of our test could not detect any significant predictors of 30-day pregnancy for ranches 2, 3, and the combined data; however, chute score ($P < 0.0348$) and weight ($P < 0.0082$) were found to have odds ratio estimates different from 1 as significant predictors of 30-day pregnancy. The odds ratio estimate for chute score (Table 2) has a significant interpretation, meaning that a 1-unit increase in average chute score will reduce the probability of pregnancy at ranch 1 by 48.1%. Therefore, poor temperament indicated by increasing chute score was associated with a decreased probability of becoming pregnant. This is consistent with the findings of Cooke et al. (2009), who reported that physiological responses associated with temperament can influence the probability of cows becoming pregnant during the breeding season. The odds ratio estimate for weight is more difficult to interpret, because a 1-lb increase in weight will decrease the probability of pregnancy by 1%.

In contrast to expectations, an increase in heifer weight at breeding was associated with a decrease in the probability of becoming pregnant.

A positive correlation between fetal cortisol and age ($P < 0.0003$) was found for ranch 1, meaning that as age increased, so did fecal corticosterone concentration. Fecal cortisol positively correlated with blood cortisol at ranch 3 ($P < 0.0109$), meaning that as fetal cortisol concentrations increased, so did blood cortisol concentrations.

Blood cortisol positively correlated with exit velocity for the combined data ($P < 0.0001$) and for ranch 2 ($P < 0.0062$). This means that as blood cortisol increased, EV also increased, which is consistent with findings of other researchers. Blood cortisol negatively correlated with age for the combined data ($P < 0.0369$) and for ranch 2 ($P < 0.0327$); in other words, as blood cortisol increased, age seemed to decrease, meaning younger animals tended to have higher blood cortisol concentrations.

Exit velocity positively correlated with chute score for the combined data ($P < 0.0001$), ranch 1 ($P < 0.0302$), and ranch 2 ($P < 0.0001$). This correlation is logical, meaning that as exit velocity increased for an animal, average chute score increased as well. This is consistent with another study which found that exit velocity and chute score were positively correlated. Exit velocity was negatively correlated with both weight and age for both the combined data ($P < 0.0084$ and $P < 0.0321$, respectively) and for ranch 2 ($P < 0.0001$ and $P<0.0061$, respectively). This relationship suggests that as exit velocity increased, both weight and age decreased.

Average chute score was found to negatively correlate with age for the combined data ($P < 0.0127$). According to this result, older animals would have lower average chute score than younger animals. Weight positively correlated with age for the combined data ($P < 0.0001$), ranch 1 ($P < 0.0001$), ranch 2 ($P < 0.0001$), and ranch 3 ($P < 0.0002$). This result is obvious, meaning that weight increased steadily with age.

Implications

Although the results from our combined data were not conclusive for predictors of 30-day pregnancy, results from ranch 1 and the amount of variation in measures of temperament and reproductive status at all locations showed that these traits can be improved.

Table 1. Summary statistics for combined data of all ranches

Variable	N	Mean	SD[1]	Minimum	Maximum
Fecal cortisol, ng/0.5g	333	119.53	34.54	15.80	315.00
Blood cortisol, ng/ml	336	40.96	21.85	4.45	113.50
Exit velocity, ft/second	329	1.89	0.77	0.23	7.32
Chute score[2]	337	1.87	0.74	1.00	4.00
Weight, lb	336	763.64	77.84	510.00	964.00
Age, day	336	413.25	17.19	359.00	464.00

[1]SD = standard deviation.

[2]1 = quiet, 6 = aggressive.

Table 2. Odds ratio estimates (ORE), confidence limits, and *P*-value for the logistic regression of 30-day pregnancy on fecal cortisol, blood cortisol, exit velocity, average chute score, weight, and age for all data

Variable	ORE	Confidence limits		*P*-value
Fecal cortisol, ng/0.5g	1.006	0.998	1.015	0.1451
Blood cortisol, ng/ml	1.007	0.995	1.018	0.2379
Exit velocity, ft/second	0.949	0.677	1.332	0.7639
Chute score[1]	0.706	0.494	1.009	0.0560
Weight, lb	0.993	0.986	1.001	0.0724
Age, day	1.001	0.984	1.017	0.9316

[1] 1 = quiet, 6 = aggressive.