2015

2015 South Dakota Beef Report

Department of Animal Sciences, South Dakota State University

Agricultural Experiment Station, South Dakota State University

Cooperative Extension Service, South Dakota State University

SOUTH DAKOTA

BEEF REPORT

2015

South Dakota State University
College of Agriculture and Biological Sciences
Animal Science Department

Department of Animal Science

Biological Variation and Treatment Differences

Variability naturally exists among individual animals and plants. This variation can create problems when interpreting results from experiments. For example: when cattle in one treatment (X) have a numerically higher average daily gain compared to cattle in another treatment (Y), this difference in weight might be due to animal variation and not due to the treatments. Statistical analysis attempts to remove or reduce the natural variation that exists among animals and explains the difference due to the treatments.

In the following research papers, you will see notations similar to ($P < 0.05$). This means that there is less than a 5% chance that the difference between treatments is due to the natural variation that occurs. This indicates that there is greater than a 95% probability that the differences between treatments are the result of the treatments. You will also notice notations similar to ($P = 0.10$). This means that there is a 10% chance that the difference between treatments is due to the natural variation that occurs. This indicates that there is a 90% probability that the differences between treatments are the result of the treatments.

In most of the papers you will see an average, or mean, reported as 25 ± 2.3. The first number is the average value for the treatment. The second number is the standard error, or the variability that occurred, and explains how accurately the mean is estimated. There is a 68% probability that the true mean will fall within 1 standard error of the listed mean and a 94% probability that the true mean will fall within 2 standard errors. For this example we are 68% certain that the true mean is between the range of 27.3 and 22.7 and 94% certain that the true mean is between 29.6 and 20.4.

Ways we decrease variability and improve the chance of measuring differences due to treatments include: having several animals in each treatment, replicating treatments several times, and using animals that are as similar as possible. The use of statistical analysis in research allows for unbiased interpretation of results. The use of statistical analysis in the research reported her increases the confidence in the results.

Elaine Grings, Beef Report Editor

Conversion Tables

The metric system is frequently used for reporting scientific data. To aid in interpreting these data the following tables have conversions for common measurements from the metric system to the Standard English system.

Metric	English
0 C	32 F
1 milliliter (mL)	0.03 ounces (oz)
1 Liter (L)	0.26 gallons (gal)
100 grams (g)	0.22 pounds (lb)
1 kilogram (kg)	2.2 pounds (lbs)
1 meter (m)	3.28 feet (ft)

Commonly Used Abbreviations

ADG	Average daily gain
ADF	Acid detergent fiber
AI	Artificial Insemination
BCS	Body condition score
BW	Body weight
CI	Confidence interval
CIDR	Controlled internal drug releasing device
cM	Centimorgan
CP	Crude protein
d	Days
DE	Digestible energy
DM	Dry matter
DMI	Dry matter intake
DNA	Deoxyribonucleic acid
EE	Ether extract
F:G	Feed to gain
g	Gravity
GE	Gross energy
GnRH	Gonadotropin releasing hormone
GLM	General linear model
h	Hours
HCW	Hot carcass weight
IMF	Intramuscular fat
In	Inches
IVDMD	In vitro dry matter disappearance
KPH	Kidney, pelvic, and heart fat
Kcal	Kilocalories
lb	Pound
LW	Live weight
m	Meter
mm	Millimeter
Mcal	Megacalories
ME	Metabolizable energy
min	Minutes
mo	Months
MP	Metabolizable protein
NDF	Neutral detergent fiber
NEg	Net energy gain
NEm	Net energy maintenance
OM	Organic Matter
PG	Prostaglandin
ppb	Parts per billion
ppm	Parts per million
QG	Quality grade
r^2	Coefficient of determination
RDP	Rumen degradable protein
REA	Ribeye area
RNA	Ribonucleic acid
RUP	Rumen undegradable protein
s	Seconds
SAS	Statistical Analysis System
SEM	Standard error of the mean
TDN	Total digestible nutrients
USDA	United States Department of Agriculture
wk	Weeks
wt	Weight
WW	Weaning weight
YG	Yield grade
Yr	Year
YW	Yearling weight

DEPARTMENT OF ANIMAL SCIENCE

Mission
Educate, research, and disseminate the many aspects of animal agriculture and rangeland management to improve the well being of the citizens of South Dakota and the region.

Faculty
The faculty members of the Animal Science Department are always ready to answer your questions. Our Brookings phone number is (605) 688-5165. Staff members in Rapid City (RC) may be reached at (605) 394-2236. Please feel free to give any one of us a call, or check out our departmental website: www.sdstate.edu/ars/index.cfm

DEPARTMENT OF ANIMAL SCIENCES – FACULTY

NAME	SPECIALTY	RESPONSIBILITY
BLAIR, Amanda (RC)	Meat Science	Research, Extension
BOTT, Rebecca	Equine Production and Management	Teaching, Extension
BRAKE, Derek	Ruminant Nutrition	Research, Teaching
CASSADY, Joe	Genetics	Department Head
CLAPPER, Jeff	Swine Reproductive Physiology	Research, Teaching
CRIBBS, Joshua	Live Animal/Carcass Evaluation	Livestock Judging Coach
GONDA, Michael	Ruminant Animal Genetics	Research, Teaching
GRINGS, Elaine	Cow-Calf Management	Research, Extension
HELD, Jeff	Sheep Nutrition, Production/Management	Extension, Teaching
LEVESQUE, Crystal	Swine Nutrition	Research, Teaching
MASTELLAR, Sara	Equine Production and Management	Teaching
MC DANIEL, Reid	Feedlot Management	Extension, Research
NOLD, Rosie	Animal Science	Ass't Department Head, Teaching
OLSON, Ken (RC)	Beef Production	Extension, Research
PERRY, George	Beef Reproductive Management	Research, Extension
PRITCHARD, Robbi	Ruminant Nutrition	Research, Teaching
SCRAMLIN, Stacy	Meat Science	Research, Teaching
ST-PIERRE, Ben	Ruminant Microbiology	Research, Teaching
THALER, Robert	Swine Management	Extension, Research, Teaching
UNDERWOOD, Keith	Meat Science	Research, Teaching
WALKER, Julie	Beef Production	Extension, Teaching
WOYENGO, Tofuko	Swine Nutrition	Research, Teaching
WRIGHT, Cody	Cow-Calf Management	Research, Teaching

SOUTH DAKOTA STATE UNIVERSITY BEEF EXTENSION TEAM

	LOCATION	TELEPHONE
Animal Science		
GRINGS, Elaine	SDSU, Brookings, SD	605-688-5455
HARTY, Adele	Rapid City, SD	605-394-1722
MC DANIEL, Reid	SDSU, Brookings, SD	605-688-5452
OLSON, Ken	Rapid City, SD	605-394-2236
PERRY, George	SDSU, Brookings, SD	605-688-5456
RUSCHE, Warren	Watertown, SD	605-882-5140
SALVERSON, Robin	Lemmon, SD	605-374-4181
WALKER, Julie	SDSU, Brookings, SD	605-688-5458
Meat Science		
BLAIR, Amanda	Rapid City, SD	605-394-2236
UNDERWOOD, Keith	SDSU, Brookings, SD	605-688-5439
Range Management		
BAUMAN, Peter	Watertown, SD	605-882-5140
GATES, Roger	Rapid City, SD	605-394-2236
SMART, Sandy	SDSU, Brookings, SD	605-688-4017
Farm Management		
DAVIS, Jack	Mitchell, SD	605-995-7385
DIERSEN, Matthew	SDSU, Brookings, SD	605-688-4864
GESSNER, Heather	Sioux Falls, SD	605-782-3290
SAND, Shannon	Rapid City, SD	605-394-1722
Vet Science		
DALY, Russ	SDSU, Brookings, SD	605-688-6589
MISKIMINS, Dale	SDSU, Brookings, SD	605-688-5171

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Importance of estrus expression before fixed-time AI on conception rates in beef cattle[1]

B. N. Richardson[2], S. L. Hill[3], J. S. Stevenson[3], G. D. Djira[4], and G. A. Perry[2]

[2]Department of Animal Science, South Dakota State University, Brookings, SD
[3]Department of Animal Sciences and Industry, Kansas State University, Manhattan, KS
[4]Department of Mathematics and Statistics, South Dakota State University, Brookings, SD

SUMMARY

Expression of estrus prior to fixed-time AI has been reported to strongly impact overall pregnancy success. Behavioral estrus is a visual indicator that a cow or heifer's internal environment is prepared for breeding. Insemination of a cow or heifer after estrus has been expressed will yield greater pregnancy success due to adequate uterine environment, increased fertilization rates, increased accessory sperm numbers, and increased overall embryo survival. It can be difficult to analyze the effects of estrus on pregnancy success across studies due to differences in number of animals and proportion of animals exhibiting estrus per study. In order to accurately analyze such data, a meta-analysis was used to place all studies on an equal level, thus, eliminating study bias. In the present study, a meta-analysis was conducted using data available on 10,116 beef cows and heifers in 26 studies that utilized the 5 most common fixed-time AI protocols to examine the effect of expression of estrus prior to insemination on conception rates. The overall model indicated a positive effect of estrus on conception rates with cows expressing estrus before fixed-time AI having greater conception rates compared with those not exhibiting estrus. There are also numerous management factors that can influence expression of estrus. Data were available on 547 cows that were synchronized with a CIDR based fixed-time AI protocol for estrus for 2 to 4 years. Analysis of these cows indicated that days postpartum did not impact estrus expression. In contrast, Body Condition Score (BCS) influenced estrus expression with cows in a BCS of ≤ 4 having decreased expression of estrus compared to those with a BCS > 4. Initiation of estrous cycles before the breeding season also influenced estrus expression, with anestrous cows having greater expression of estrus compared with estrus-cycling cows. Fixed-time AI protocols offer producers the added benefit of reduced labor needed for heat detection, but the results of this study indicate the importance of detecting an animal in estrus prior to breeding. In conclusion, among all currently recommended fixed-time AI protocols, cows expressing estrus before fixed-time AI had improved conception rates, and BCS and estrus-cycling status had the greatest influence on expression of estrus.

INTRODUCTION

Profitability of cow-calf operations depends largely on the success of the breeding programs implemented. Development of fixed-time AI protocols that eliminate the need for heat detection greatly benefits operations where labor is limited. While these protocols are more time-efficient, detecting an animal in estrus prior to breeding will lead to better conception rates. Fixed-time AI protocols induce ovulation with an injection of GnRH regardless of whether an animal has or has not expressed estrus. Ovulation prior to estrus may lead to decreases in conception rates due to inadequate estrogen concentrations, which creates a suboptimal uterine environment needed for sperm survival (Perry and

[1] This project was funded in part by SDSU Hatch Funds

Perry, 2008). In a study conducted on heifers, those that showed estrus within 24 hr of fixed-time AI had increased follicle diameter, estrogen concentrations, and pregnancy rates than heifers that did not show estrus (Perry et al., 2007). Similar results have been reported in mature cows, with cows detected in estrus at fixed-time AI having higher pregnancy rates than cows that did not express estrus (Perry et al., 2005; Whittier et al, 2013; Thomas et al, 2014). The economic incentive of increased pregnancy rates from incorporating heat detection into fixed-time AI protocols could outweigh the disadvantage of labor costs.

To maximize estrus expression in the herd, certain management factors should be considered. Days postpartum and BCS work together to play a large role in estrus expression of cattle. Cows should be allowed an appropriate amount of time to recover after calving before beginning an AI protocol in order to maximize pregnancy rates. The first fertile estrus generally occurs about 40-60 d after calving in beef cattle, but this is largely dependent on nutritional status. Beef cows that have attained adequate body condition (approximately a BCS of 5) and that have had a longer postpartum period prior to the beginning of the breeding season will begin cycling earlier than those that have not. Therefore, the objective of this study was to examine the influence estrus expression prior to fixed-time AI on conception rates and to determine management factors affecting estrus expression in beef cattle.

MATERIALS AND METHODS

Data was available on 10,116 animals from 26 different studies (Table 1) that utilized one of the 5 most common fixed-time AI protocols with conventional semen on beef cows or heifers. These protocols included CO-Synch, CO-Synch+CIDR, 5-d CIDR, PG 6-d CIDR, and 14-d CIDR (for description and discussion of synchronization protocols see http://www.iowabeefcenter.org/estrus_synch.html). Studies used in the analysis reported conception rates of animals that did and did not show estrus prior to or at fixed-time AI. An omnibus Chi-square meta-analysis was conducted using data analysis software in order to accurately analyze these multiple studies with varying sample sizes.
For the subset of animals used to examine factors influencing estrus expression, data were available on 547 cows that were synchronized with a CIDR based fixed-time AI protocol for 2 to 4 years. Data for days postpartum, estrus-cycling status at the start of the synchronization protocol, BCS, and estrus expression prior to fixed-time AI were used in the analysis. This data was analyzed using data analysis software.

RESULTS AND DISCUSSION

The results from the meta-analysis indicate a 27% improvement in AI conception rate among animals that expressed estrus compared to animals that did not express estrus ($P < 0.01$; 95% CI = 22% to 32%; Figure 1). Days postpartum did not impact estrus expression ($P = 0.22$), but cows in a BCS of ≤ 4 (51 ± 5%) had decreased expression of estrus than those with a BCS > 4 (≥ 70 ± 4%). Anestrous cows had greater expression of estrus compared with estrus-cycling cows ($P = 0.03$; 78 ± 5% versus 70 ± 5%, respectively).

This study indicates the importance of estrus expression for pregnancy success. A 27% improvement in AI conception rates translates into an economically significant value for beef operations. Estrus expression was not affected by days postpartum in the present study. This can be attributed to the management of the herds included in the analysis, as very few animals were bred at less than 40 days postpartum. Body condition was shown to impact estrus expression, with under-conditioned animals having decreased expression of estrus. Cows that have not reached adequate condition at calving will take longer to start cycling, thus, failing to show estrus. Unexpectedly, anestrous cows (cows there were

not having normal estrous cycles prior to the start of the synchronization protocol) had greater estrus expression than estrus-cycling cows. The reason behind this could be that anestrous cows may respond to synchronization protocols better than estrus-cycling cows. Studies have found that anestrous cows express estrus earlier and with decreased time to estrus variation after injection of prostaglandin during a fixed-time AI compared to cycling cows. Although anestrous cows tend to express estrus more readily than cycling cows, it has been shown that anestrous cows still have lower conception rates than cycling cows. Because estrus-cycling cows could be at any stage of the estrous cycle at the time of synchronization, they may not respond as well as animals that are not cycling at all, therefore, having decreased estrus expression. While not every animal that is cycling will display behavioral estrus, breeding those that do after they are detected in estrus can be beneficial. Incorporation of heat detection (either by observing estrus or using an estrus detection aid to determine prior expression of estrus) into fixed-time AI breeding programs should be considered for improvements in pregnancy success, leading to greater economic gains.

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Table 1. Study details for meta-analysis. Protocol 1: Co-Synch; 2: Co-Synch + CIDR; 3: PG 6-day CIDR; 4: 5-day; 5: 14-16 day; 5.1: 14-19 day

STUDY	REFERENCE	PROTOCOL	N	MATURITY
1	*SDSU Cow Camp 2010*	1	68	Cows
2	*Lares et al., 2006*	1	214	Cows
3	*Perry et al., 2005*	1	173	Cows
4	*Perry et al., 2005*	1	108	Heifers
5	*SDSU Cow-Calf Unit, 2009*	2	119	Cows
6	*SDSU Antelope Station, 2013*	2	298	Cows
7	*SDSU Cow Camp, 2008*	2	35	Cows
8	*Hill et al., 2013*	2	1667	Cows
9	*SDSU Cow-Calf Unit, 2012*	2	41	Heifers
10	*Nash et al., 2012*	2	177	Cows
11	*Thomas et al., 2014*	2	218	Cows
12	*Swanson et al., 2012*	3	292	Heifers
13	*SDSU Cow Camp, 2008*	3	38	Heifers
14	*Bridges et al., 2014*	3	126	Heifers
15	*SDSU Cow Camp, 2011*	3	82	Cows
16	*Perry et al., 2011*	3	366	Heifers
17	*Whittier et al., 2013*	2, 4	1817	Cows
18	*Bridges et al., 2014*	4	133	Heifers
19	*SDSU Cottonwood Station, 2013*	4	124	Heifers
20	*Bridges et al., 2012*	4	2421	Cows/Heifers
21	*Kasimanickam et al., 2009*	4	830	Cows
22	*Bridges et al., 2012*	5	135	Heifers
23	*Mallory et al., 2011*	5	77	Heifers
24	*Nash et al., 2012*	5	167	Cows
25	*Martin et al., 2014*	5	194	Cows
26	*Martin et al., 2014*	5.1	196	Cows

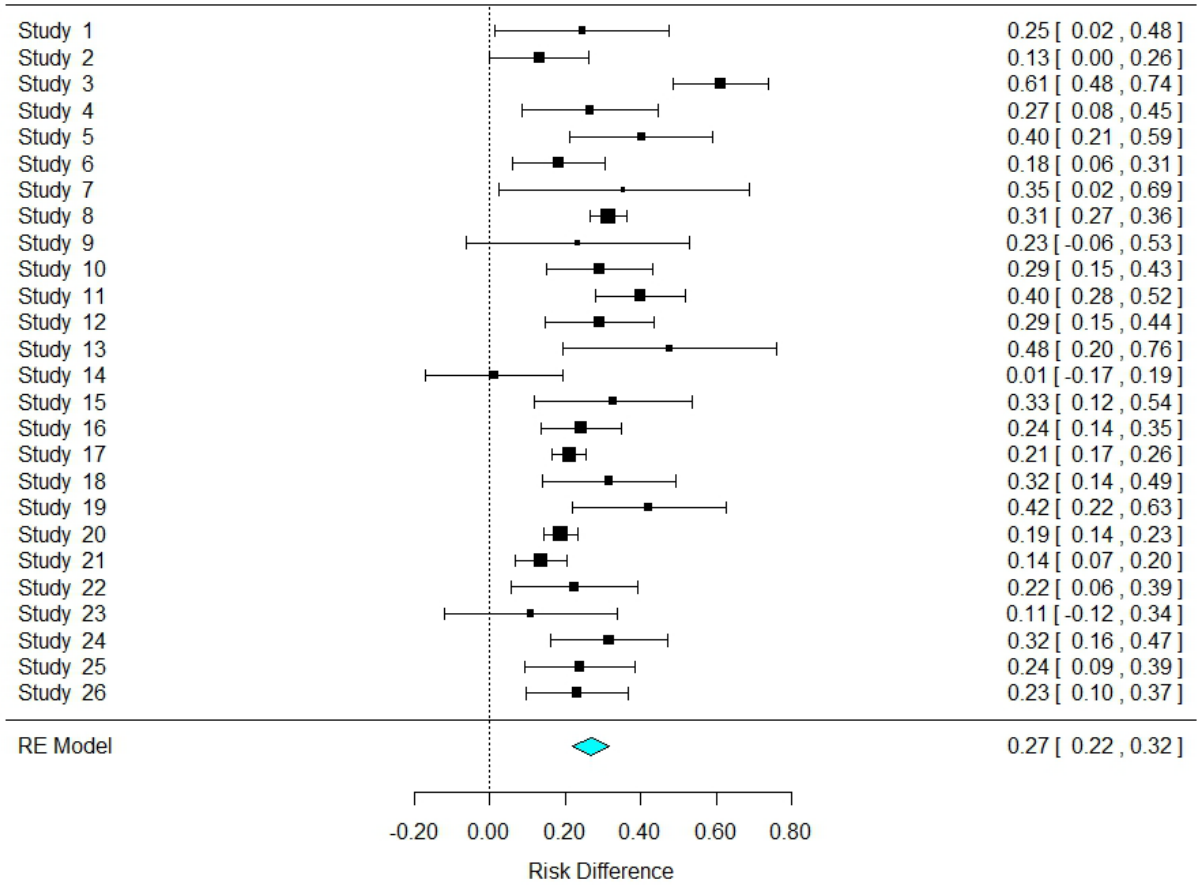

Figure 1. Means and standard errors from the 26 studies listed in Table 1 used in the Meta-analysis. The overall (RE) model indicates a 27% ± 5% increase in conception rates among animals that exhibited estrus prior to fixed-time AI.

BEEF 2015-02

Post-weaning nutritional programming of ovarian development in beef heifers[1]

O. L. Amundson[2,3], T. G. Fountain[2,4], E. L. Larimore[3], B. N. Richardson[3], A. K. McNeel[2], E. C. Wright[2], D. H. Keisler[5], R. A. Cushman[2], G. A. Perry[3], H. C. Freetly[2]

[2]USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE
[3]Department of Animal Science, South Dakota State University, Brookings, SD
[4]Department of Animal Science and Industry, Kansas State University, Manhattan, KS
[5]Division of Animal Sciences, University of Missouri, Columbia, MO

SUMMARY

The nutritional management of replacement females from weaning to breeding is critical to lifetime productivity. Traditionally, cereal grains have been used to develop replacement heifers to attain puberty and enter the breeding system at a younger age. However, overfeeding heifers decreases number of calves weaned, while peri-pubertal caloric restriction increased primordial follicle numbers in the developing ovary. The number of primordial follicles a female has can determine her overall fertility; females with a greater amount of follicles have greater reproductive lifespans. In this study, two groups of heifers were developed to prebreeding status. One group received a control diet (228 kcal ME/BW $kg^{0.75}$) while the other received a restricted diet (157 kcal ME/BW $kg^{0.75}$) for 84 days, and were then stepped up to receive a diet containing 277 kcal ME/BW $kg^{0.75}$. Both groups were evaluated at three different time points for number of primordial follicles. Heifers on the restricted diet had more primordial follicles than control heifers at 13 mo of age. In summary, heifer input costs could be decreased without negatively effecting overall fertility and perhaps improve fertility.

INTRODUCTION

It has been well established that the main factor influencing production efficiency of a cow/calf operation is reproductive efficiency (Short et al., 1990). In a heifer production system, it is important that a replacement female weans enough calves to pay for her development costs (Mathews and Short, 2001). Therefore, the objective to developing high quality replacement females is for them to conceive early in the breeding season as well as to maximize pregnancy rates within a 45-d breeding period (Eborn et al., 2013).

Management practices implemented during heifer development impose lasting economic impacts. Traditional approaches to post-weaning development of replacement heifers have included increasing the availability of cereal grains allowing replacement heifers to attain puberty and enter the production system at a younger age. However, overfeeding heifers has been reported to decrease the number of calves weaned in the first parity and increase calving difficulty (Pinney et al., 1961). Martin et al (2008) reported that heifers developed to lighter

[1] This research was funded in part by ARS Research Project 5438-31000-093-00D (Strategies to Improve Heifer Selection and Heifer Development).

than traditional targets body weights (55%) were not detrimentally affected in profitability or future productivity. Additional data suggests that altering growth patterns, resulting in compensatory growth periods, in weaned heifers can alter the interval of time a cow is retained in the herd as well as offer producers the opportunity to decrease feed costs (Clanton et al., 1983; Lynch et al., 1997; Freetly et al., 2001). In addition, heifers developed on a stair-step nutritional management scheme have been reported to have greater productivity, along with a greater abundance of primordial follicles compared to their cohorts (Freetly et al., 2014). We hypothesized that limiting the caloric intake during the peri-pubertal period positively influences the ovarian reserve in beef heifers, contributing to increased reproductive longevity. The objective of the present study was to investigate the timing of changes in follicle populations in the ovary throughout the dietary treatments.

MATERIALS AND METHODS

All experiments were approved by the USDA Meat Animal Research Center Institutional Animal Care and Use Committee. Thirty crossbred heifers (MARC II, ¼ Angus, ¼ Hereford, ¼ Pinzgauer, ¼ Red Poll) of similar age and size born to cows $\geq$ 4 years of age were used in the study. Following weaning, heifers were moved to the USMARC feedlot in early November and trained to use Calan headgates. Heifers were fed a diet consisting of 30% alfalfa hay, 69.8% corn silage, and 0.2% salt (DM basis). At eight months of age (December), six heifers were ovariectomized under local anesthesia and ovaries were collected through flank laparotomy (Youngquist et al., 1995). This first group of heifers served as the untreated controls to determine base-line changes in the ovarian reserve prior to dietary treatments.

The remaining 24 heifers were divided into two treatment groups (n=12 heifers/diet). Heifers in the Control group were offered 228 kcal ME/BW $kg^{0.75}$ over the entire feeding period. Heifers were weighed every three weeks and feed intakes were adjusted for body weights. Orts were taken weekly such that they corresponded with weigh dates. Beginning at 256 days of age, Stair-Step heifers received adequate diet to provide 157 kcal ME/BW $kg^{0.75}$ for 84 days. Following the 84-d restriction, heifers were stepped up to receive a diet containing 277 kcal ME/BW $kg^{0.75}$ over a 15-d period and were held at this feeding level until late May. Ovaries were collected at 11 mo of age (n=6/diet), at the time when the intake for the Stair-Step heifers was increased; and at 14 mo of age (n=6/diet), after the increase in intake when the heifers would normally enter their first breeding season. Histological evaluations of primordial, primary, secondary and antral follicles were analyzed using MIXED procedure of SAS (9.2 SAS Inst. Inc., Cary, NC). At each time point, the numbers of primordial, primary, secondary, or antral follicles per section were analyzed with dietary treatment (Control or Stair-Step) as a fixed effect and animal as a random effect.

RESULTS AND DISCUSSION

There was no difference (P=0.13) in BW between treatments at 8-, 11-, or 13 mo of age. There was no effect of treatment on primordial follicles between Control and Stair-Step diets at 8 mo (P=0.41) and 11 mo (P=0.75). However, Stair-Step heifers had more primordial follicles (P=0.04) than Control heifers at 13 mo. Similar findings in the difference in follicle numbers were reported previously in heifers at 13 mo of age (Freetly et al., 2014). There was no effect of treatment on primary follicles (P=0.94) at 8 mo or 13 mo (P=0.80). However, Control heifers had a greater number of primary follicles (P=0.03) at 11 mo of age. The difference in number of

primordial and primary follicles indicates that non-caloric restricted heifers have increased activation of primordial follicles or that restricted heifers have reduced activation of follicles. There was no difference in secondary follicles between treatments at 8 mo (*P*=0.30), 11 mo (*P*=0.48) and 13 mo (*P*=0.25). There was also no effect of treatment on antral follicles between Control and Stair-Step heifers at 8 mo (*P*=0.27), 11 mo (*P*=0.75) and 13 mo (*P*=0.84). In summary, our results indicate that the ovarian reserve can be positively affected when exposing heifers to a single-phase Stair-Step program and possibly influence reproductive lifespans.

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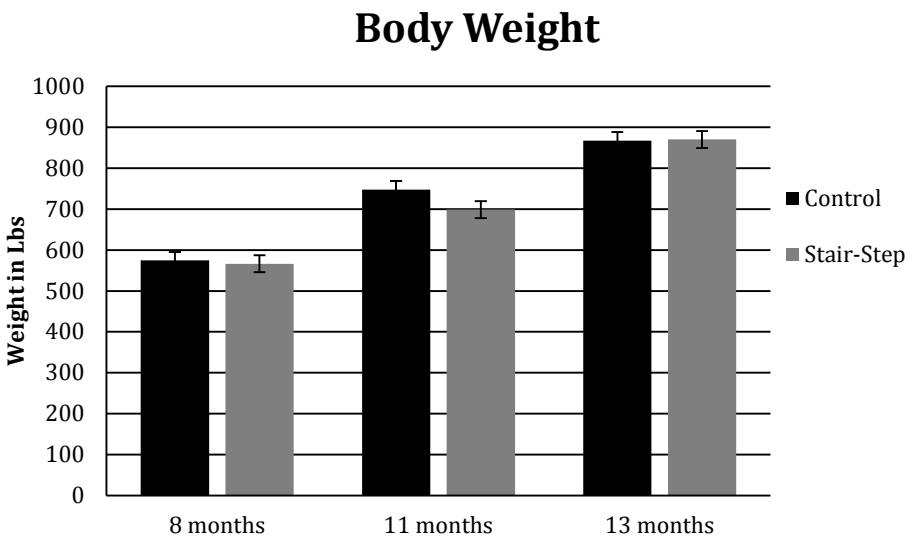

Figure 1. Body weight between Control and Stair-Step heifers at 8 mo, 11 mo, and 13 mo. There was no difference in body weight between treatment groups or time points.

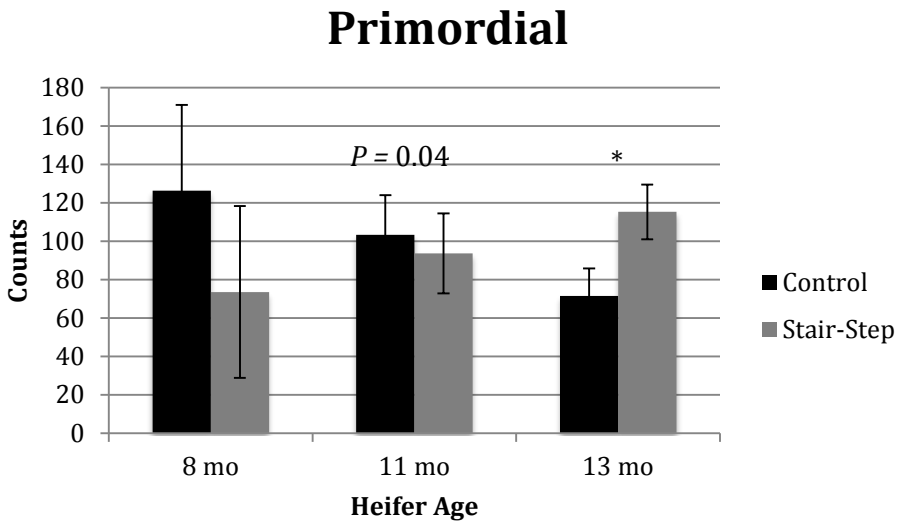

Figure 2. Primordial follicle counts between Control and Stair-Step heifers at 8 mo, 11 mo, and 13 mo ($P < 0.05$). Stair-Step heifers had a greater number of primordial follicles at 13 mo of age compared to Control heifers.

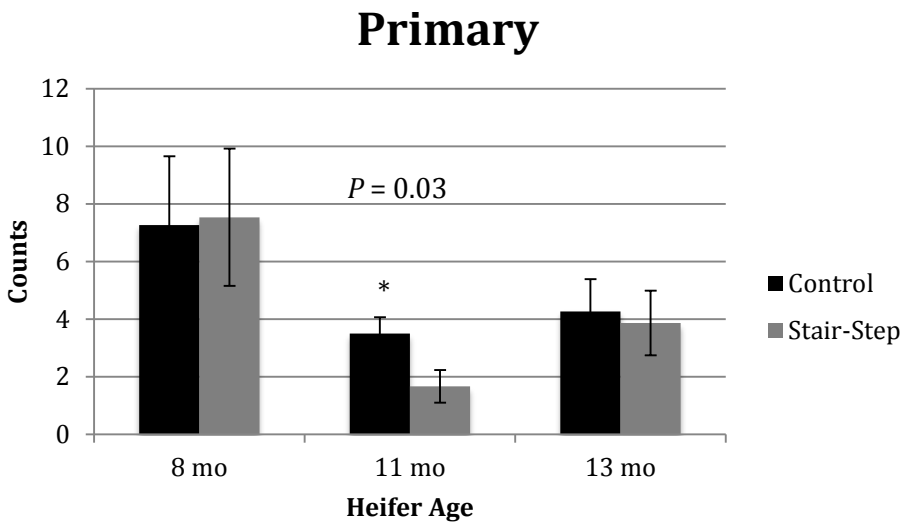

Figure 3. Primary follicle counts between Control and Stair-Step heifers at 8 mo, 11 mo, and 13 mo ($P < 0.05$). Control heifers had a greater number of primary follicles at 11 mo compared to Stair-Step heifers.

BEEF 2015-03

Uterine environment and pregnancy rate of heifers with high blood urea concentrations[1]

O.L. Amundson[2,3], E.L. Larimore[2], A.K. McNeel[3], C.C. Chase Jr.[3], R.A. Cushman[3], H.C. Freetly[3], G.A. Perry[2]

[2]Department of Animal Science, South Dakota State University, Brookings, SD
[3]USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE

SUMMARY

Reports demonstrate that excess dietary protein significantly alters the ionic composition of uterine fluid during the luteal phase ultimately decreasing fertility**.** Since the early bovine embryo cannot adapt to changes in the uterine environment, changes in the concentrations of ions (pH) in the uterus can be unfavorable to embryo development and survival therefore having negative effects on fertility. In this study, heifers fed a high protein diet had elevated systemic concentrations of plasma urea nitrogen (PUN) compared to heifers fed a control diet. However, there was no deleterious effect on uterine pH or reproductive success. In summary, excess protein in a diet did increase PUNs to a concentration that has previously been reported to be detrimental to pregnancy success; however, there was no negative effect on uterine pH or pregnancy success.

INTRODUCTION

For both beef and dairy production, one of the most important indicators of success is reproductive efficiency. Multiple studies have reported that high protein intakes at the time of breeding have negative effects on fertility (Dyck, 1991; Cassar et al., 1994; Wallace et al., 1994; Gath et al., 2012). Dietary protein is comprised of rumen degradable protein (RDP) and rumen undegradable protein (RUP). Rumen degradable protein is either used for microbial protein synthesis or nitrogen released from the protein is absorbed through the rumen and converted to urea in the liver. Rumen undegradable protein may be absorbed by the small intestine, and excessive amino acids are catabolized at the liver producing urea. Elrod et al. (1993) determined that protein fed in excess, regardless of source or its degradability impacted uterine pH. Historically, uterine pH on d 7 has been reported to be lower in heifers fed high protein diets (Elrod and Butler, 1993; Elrod et al., 1993), whereas at time of estrus uterine pH does not differ between treatments and is usually decreased (Perry and Perry, 2008a; 2008b). However, Grant et al. (2013) reported an increase in uterine pH on d 7 of the estrous cycle when beef and dairy heifers were fed urea to increase PUN concentrations. We hypothesized that feeding a high protein diet would increase urea concentrations within the uterus causing an increase in uterine pH as well as decrease pregnancy success. Therefore, the objective of this experiment was to determine the effects of feeding a high protein diet on uterine environment and pregnancy success in beef heifers.

MATERIALS AND METHODS

All experiments were approved by the USDA Meat Animal Research Center Institutional Animal Care and Use Committee. Yearling heifers (n = 150) were utilized for this study. Heifers were blocked based on

[1] Funding provided in part by SDSU Hatch Funds

breed type, age, and body weight. Within blocks, 3 contemporary groups were established (n = 50 heifers/replicate) and heifers were then randomly assigned to 1 of 2 dietary treatments (n = 25 heifers/diet): Control (30% ground alfalfa hay, 64.8% corn silage, 0.2% salt, and 5% corn; 10% CP) or High Protein (29.79% ground alfalfa hay, 64.35% corn silage, 0.2% salt, 4.97% soybean meal, and 0.07% urea; 14% CP). Replicates were staggered by 1 week. Heifers were maintained on their treatment diets from 60 d prior to uterine pH determination through the entire breeding season. Heifers were injected with $PGF_{2\propto}$ (25 mg as 5 mL of Lutalyse i.m.; Zoetis Animal Health; Florham Park, NY) and HeatWatch™ patches were applied 53 d after initiation of treatment. The HeatWatch™ data were used to determine day of the estrous cycle when uterine pH was measured. Uterine pH was determined on d 7 of the estrous cycle.

Following uterine pH determination on d 60, the heifers were injected with $PGF_{2\propto}$ and housed with four 2- or 3-year-old bulls for a 21-d natural service-breeding season (2 bulls/treatment group). The same bulls were utilized in replicate 1 and 3; 4 different bulls were used in replicate 2. Prior to mating, bulls were adapted to the experimental diets. Thirty days after the breeding season pregnancy status was determined by transrectal ultrasonography. Plasma urea nitrogen, and uterine pH, percent observed in estrus, interval from $PGF_{2\propto}$ to estrus, duration of estrus, and number of mounts recorded were analyzed using the MIXED procedure of SAS (9.2 SAS Inst. Inc., Cary, NC) with diet (Control or High Protein), replicate (1,2, or 3), and the interaction as the fixed effects.

RESULTS AND DISCUSSION

During estrus, uterine pH has been observed to decrease from 7.0 to 6.7, and following estrus uterine pH returns to ~7.0 prior to ovulation (Perry and Perry, 2008a; Perry and Perry, 2008b). Concentrations of urea nitrogen in plasma and/or milk have been monitored and associated with effects on ovarian or uterine physiology. It has been reported that concentrations above 19 mg/dL PUN decreased uterine pH and consequently decreased fertility in dairy cows (Butler, 1998, 2000; Ferguson and Chalupa, 1989). Observations from the present study indicate that high protein diets generated higher PUN concentrations compared to Control heifers (23.48 ± 0.36 mg/dL vs 13.33 ± 0.36 mg/dL; $P < 0.001$; Table 1) but had no effect on uterine pH on d 7 of the estrous cycle ($P = 0.59$; Table 1). Similarly, Elrod et al. (1993) and Elrod and Butler (1993) found that excess dietary protein intake in cows and nulliparous heifers had increased PUN concentrations (> 20 mg/dL, respectively), but, in contrast to this study uterine pH was decreased on d 7 compared with animals fed a standard diet.

There was no effect of estrus status ($P = 0.40$), or interval to estrus ($P = 0.77$; Table 2) on uterine pH, and there was no effect of diet ($P = 0.90$; Table 2), replicate ($P = 0.51$), or the diet by replicate interaction ($P = 0.40$) on pregnancy success during the 21 d breeding season. Some research has reported no decline in fertility among cows fed diets with PUN concentrations > 24 mg/dL (Carroll et al., 1988; Howard et al., 1987). Nonetheless, studies that have tried to account for reproductive management (Elrod and Butler, 1993) have reported that heifers with prebreeding PUN concentrations of $\geq$ 16 mg/dL had conception rates approximately 30% lower than heifers with PUN concentrations of < 16 mg/dL. In the present study, there was no negative effect on conception rates even when heifers were fed a diet high in protein and PUN concentration were > 23 mg/dL. This evidence would suggest that something in a high-protein diet may contribute to decreased conception rates, but it is likely not urea. Further research is necessary to determine the mechanism through which excess protein in a diet can impair reproductive function and decreased uterine pH.

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Table 1. Effect of dietary protein concentration on plasma concentrations of urea and uterine pH.

	Diet		
	Control	**High protein**	***P*-value**
Heifers, n=	60	60	
Urea, mg/dL	13.33 ± 0.36	23.48 ± 0.36	0.001
Uterine pH	6.85 ± 0.03	6.87 ± 0.03	0.68

Table 2. Effect of dietary protein concentration on estrus activity and pregnancy rate.

	Diet		
	Control	**High protein**	***P*-value**
Heifers, n=	60	60	
Interval from PG to estrus, d	2.36 ± 0.17	2.43 ± 0.17	0.77
Pregnancy rate, %	43 ± 6	44 ± 6	0.90

BEEF 2015-04

Comparison of camelina meal and distiller's dried grains with solubles in diet of beef replacement heifers[1]

E. E. Grings, A. N. Sackey, D. W. Brake, and G. A. Perry

Department of Animal Science, South Dakota State University

SUMMARY

Biofuel production from different crops yields by-product meals that are available for use as protein sources for ruminant livestock. Variation in nutrient composition among meals may result in different inclusion rates to meet nutrient needs of livestock. In this study we compared distiller's dried grains with solubles (DDGS), a by-product of ethanol production, and camelina meal, a by-product of biodiesel production, as a protein source in hay-based diets for beef heifers before breeding. Diets were formulated to be similar in energy and protein content by altering the amount of protein source and corn in the diet. Heifers fed the two protein supplements performed similarly in both weight gain and reproductive performance. Both gain and reproduction were at very acceptable levels for beef heifers, indicating that both by-product meals are satisfactory protein sources in beef heifer diets.

INTRODUCTION

Feed costs affect profitability of a beef heifer development program. Use of locally available by-product feeds should be considered when prices are favorable. Distiller's dried grains with solubles are a corn by-product of the ethanol industry and have been readily available in the Northern Plains at very competitive prices to other protein sources. Camelina (*Camelina sativa*) is a drought tolerant crop that produces oil with potential as a biofuel, leaving behind a by-product meal that has potential for use as a ruminant protein source. Researchers in Wyoming fed beef heifers camelina meal at 0.33% of BW (2.1 lbs DM/d) along with bromegrass hay for 60-d before breeding and observed similar pregnancy rates to heifers fed either soybean-corn or a soybean-corn + glycerin supplement (Moriel et al., 2011). However, in this same study, when heifers not previously observed exhibiting estrus were synchronized and bred by timed AI, heifers fed camelina meal had increased conception rates. To further evaluate diets containing biofuel by-products for replacement heifers, we compared camelina meal and DDGS in diets fed for approximately 2-3 months before breeding on growth and reproductive performance of beef heifers.

MATERIALS AND METHODS

These studies were conducted at the Cottonwood Research and Extension Center near Phillip, SD. All studies were approved by the SDSU Institutional Animal Care Committee and followed guidelines in Guide for the Care and Use of Agricultural Animals in Research and Teaching.

Before the study each year, a composite sample of corn, camelina meal and DDGS were collected and

[1] Funding for this research was provided by SDSU Agricultural Experiment Station and South Dakota Oilseed Initiative. The authors are grateful to Zoetis Animal Health for estrus synchronization supplies.

analyzed for DM, ash, CP, soluble CP, ADF, NDF, acid detergent soluble CP, neutral detergent soluble CP, lignin, starch, simple sugars, ether extract (fat), and total and individual fatty acids at a commercial laboratory (Dairy One Forage Testing Laboratory, Ithaca, NY; Table 1; ash, acid detergent soluble CP, neutral detergent soluble CP, lignin, starch, and simple sugars not reported). A representative hay sample was analyzed for DM, ash, CP, ADF, and NDF. Laboratory analysis of the initial feed sample was used to balance diets to similar energy and protein content using the Large Ruminant Nutrition System (available at http://nutrition models.tamu.edu/lrns.html).

Year 1

Beginning March 19, 2013, 110 heifers were blocked by weight (BW = 661 ± 28 lbs) into 5 pens per treatment. Heifers were fed a diet consisting of millet hay, corn and either distiller's grains with solubles or cold-pressed camelina meal (Table 2) for 78-d. Heifers were fed once daily in concrete feed bunks, with the concentrate mix fed in the morning and hay provided after the concentrate mix was consumed. Hay was fed at a level to maintain a consistent proportion of dietary ingredients. The quantity of concentrate and hay offered was adjusted to a level to allow daily cleanup of feed in the bunk. A mineral-vitamin mix was provided free-choice in each pen.

Heifers were weighed after an overnight shrink on d 1 and 72 of the study. Final weight was determined on d 72, but heifers remained on their treatment diets through d 79, the day of artificial insemination. Body condition score was determined on d 72 and at fall pregnancy check using a 1 to 9 scale (1 = emaciated to 9 = obese) by a single technician.

On d 1, 62, and 72, blood was collected by jugular venipuncture, centrifuged and serum stored for later analysis of progesterone to determine attainment of puberty. Heifers with serum progesterone concentrations of greater than 1 ng/mL at any of three bleeding dates were considered to have reached puberty.

On d 72, heifers began a 5-d CO-Synch + CIDR® fixed time AI protocol. Heifers received 100μg as 2 mL GnRH and a CIDR was inserted. Five days later, CIDRs were removed and heifers received 25 mg as 5 mL of prostaglandin F2α with a second dose 8 h later. Heifers were bred by AI 72 h after the first prostaglandin injection. One day after breeding heifers were transported to the Fort Meade grazing allotment near Sturgis, SD. Fourteen days later, three bulls were placed in the pasture with the heifers and remained for the next 46-d. Conception to AI or natural service was determined by crown-rump length using transrectal ultrasonography 96-d after AI.

During the study, feed samples were collected once per week and composited monthly for chemical analysis at the SDSU Ruminant Nutrition Laboratory. Samples were ground to pass a 1 mm screen in a Wiley mill and analyzed for DM, ash, ADF, NDF, and CP.

Year 2

Beginning April 8, 2014, 88 heifers were blocked by weight (BW = 719 ± 29 lbs) into 4 pens per treatment. Heifers were fed a diet consisting of grass hay, corn and either distiller's grains with solubles or cold-pressed camelina meal (Table 2). For 59-d, heifers were fed once daily in concrete feed bunks, with the hay fed in the morning and concentrate provided in the afternoon. Hay was fed at a level to maintain a consistent proportion of dietary ingredients. The quantity of concentrate and hay offered was adjusted to a level to allow daily cleanup of feed in the bunk.

Heifers were weighed after an overnight shrink on d 1 and 51 of the study. Final weight was determined

on d 51, but heifers remained on their treatment diets through d 59, the day of artificial insemination. Body condition score was determined on d 51 and at fall pregnancy check using a 1 to 9 scale by a single technician.

On d 1, 41 and 51, blood was collected by jugular venipuncture, centrifuged and serum stored for later analysis of progesterone to determine attainment of puberty. Heifers with serum progesterone concentrations of greater than 1 ng/mL at any of three bleeding dates were considered to have reached puberty.

On d 51, heifers began a 5-d CO-Synch + CIDR® fixed time AI protocol that was the same as year 1. One day after breeding heifers were transported to the Fort Meade grazing allotment. Thirteen days later, three bulls were placed in the pasture with the heifers and remained for the next 46-d. Conception to AI or natural service was determined by crown-rump length using transrectal ultrasonography 123-d after AI.

Feed sampling and laboratory analysis was similar to Year 1.

Statistical analysis

Due to differences in diet composition and length of feeding, data from the two years were analyzed separately. Weight data was analyzed as a completely random design with pen as the experimental unit using the mixed model procedure in SAS (SAS Inst. Inc., Cary, NC). Puberty and pregnancy data were analyzed using the GLIMMIX procedure. Treatments were considered significantly different at a value of $P < 0.05$.

RESULTS AND DISCUSSION

The cold-pressed camelina meal used in this study contained greater concentrations of CP and EE than the DDGS (Table 1). Solubility of CP was also greater in the camelina meal than DDGS. In addition to slightly greater total fatty acids, the fatty acid profile of camelina meal differed from DDGS, with a greater proportion of linolenic acid and lower proportion of oleic and linoleic acids. Difference in nutritional content of the protein sources required that camelina meal-based diets have less of the test protein source and greater amount of corn to balance for energy and protein (Tables 2 and 3).

Year 1

Dry matter intake averaged 15.9 lbs per day, which was 2.24% of BW (Table 3). Because pens were offered feed at a similar proportion of average body weight, dry matter intake was not considered a response variable. Heifer weight gains averaged 1.21 ± 0.05 lbs/d (Table 4) and final BW was 749 ± 28.1 lbs (Table 4); neither differed between dietary treatments. Additionally, no difference was detected for BCS (5.2 ± 0.06) at breeding or at fall pregnancy check between treatments.

None of the reproductive measures differed between heifers fed camelina meal or DDGS (Table 5). Ninety percent of the heifers were pubertal before breeding, 59% conceived to artificial insemination and 88% were pregnant at the fall pregnancy check.

Year 2

Heifers consumed an average of 19.3 lbs of feed per day, which was 2.54% of BW. Final BW averaged 804 ± 31.2 lbs and was not affected by dietary treatment (Table 4). Average daily gain (1.66 ± 0.09 lbs/d) did not differ with dietary treatment.

The number of heifers that had reached puberty before breeding, conception to AI, and overall pregnancy rates did not differ between treatments (Table 5). Eighty-eight percent of the heifers were pubertal at breeding, 53% conceived to AI, and 86% became pregnant during the breeding season.

Our data suggests that camelina meal has the potential to serve as a feed resource for beef replacement heifers with no adverse effect on weight gain or pregnancy rates when compared to the use of DDGS as a protein source. Heifers fed both diets had high reproductive performance and diets are acceptable for use in a heifer development program.

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Table 1. Nutrient composition of camelina meal and dried distiller's grains with solubles (DDGS) used in diets fed to beef heifers before breeding.

	Camelina meal	DDGS
YEAR 1		
CP, % of DM	40.9	30.8
Soluble CP, % of CP	74.5	20.2
NDF, % of DM	31.1	21.7
ADF, % of DM	17.8	9.2
EE, % of DM	12.1	9.0
Total fatty acids (TFA), % of DM	10.8	9.4
Oleic acid, % of TFA	16.8	27.1
Linoleic acid, % of TFA	22.6	53.1
Linolenic acid, % of TFA	28.0	1.7
YEAR 2		
CP, % of DM	41.4	33.8
Soluble CP, % of CP	60.0	15.2
NDF, % of DM	24.5	24.9
ADF, % of DM	11.9	13.2
EE, % of DM	14.9	9.3
Total fatty acids (TFA), % of DM	11.6	8.6
Oleic acid, % of TFA	18.8	25.8
Linoleic acid, % of TFA	22.7	53.2
Linolenic acid, % of TFA	22.0	2.2

Table 2. Ingredient composition of diet containing either camelina meal or dried distiller's grains with solubles (DDGS) offered during the study.

	Diet	
	Camelina meal	**DDGS**
YEAR 1	--------% of DM----------	
Millet hay	73.2	73.4
DDGS	-	14.6
Camelina meal	9.4	-
Corn	17.4	12.0
YEAR 2		
Grass hay	65.0	65.7
DDGS	-	13.0
Camelina meal	10.4	-
Corn	24.6	21.3

Table 3. Nutrient composition and DM intake of diets containing either camelina meal or dried distiller's grains with solubles (DDGS) fed to beef heifers before breeding

	Camelina meal	**DDGS**
YEAR 1	----------% DM----------	
CP	9.3	9.6
NDF	52.6	54.7
ADF	29.5	29.3
DMI, lbs/d	16.0	15.8
DMI, % of BW	2.27	2.24
YEAR 2		
CP	10.2	10.4
NDF	49.7	50.1
ADF	27.1	27.0
DMI, lbs/d	19.3	19.3
DMI, % of BW	2.54	2.54

Table 4. Performance of heifers receiving diets containing camelina meal or dried distiller's grains with solubles (DDGS) before breeding.

	Protein source			
	Camelina meal	**DDGS**	**SE**	**P-value**
YEAR 1				
Number of heifers	55	55		
BW, lbs				
Day 0	661.3	660.5	28.1	0.99
Day 72	746.1	752.3	28.1	0.88
ADG, lbs/d	1.17	1.26	0.05	0.24
BCS				
Day 72	5.2	5.2	0.06	1.00
At fall pregnancy check	5.3	5.2	0.08	0.41
YEAR 2				
Number of heifers	44	44		
BW, lbs				
Day 0	719.9	718.8	29.2	0.98
Day 51	798.3	809.7	31.2	0.80
ADG, lbs/d	1.54	1.78	0.09	0.11
BCS				
Day 51	5.0	5.1	0.13	0.73
At fall pregnancy check	5.3	5.3	0.08	0.85

Table 5. Reproductive performance of heifers fed diets containing camelina meal or dried distiller's grains with solubles (DDGS) before breeding.

	Protein source			
	Camelina meal	**DDGS**	**SE**	**P-value**
YEAR 1	----------%----------			
Pubertal before synchronization	87.3	92.7	3.9	0.33
Conception to AI	61.8	56.4	6.7	0.57
Overall pregnancy rate	90.9	85.4	4.2	0.35
YEAR 2				
Pubertal before synchronization	90.9	84.1	4.9	0.33
Conception to AI	54.6	50.7	7.4	0.71
Overall pregnancy rate	86.4	86.1	5.2	0.98

BEEF 2015-05

Effect of processing conditions on nutrient disappearance of cold-pressed and hexane-extracted camelina and carinata meals *in vitro*[1]

A. Sackey[2], E. E. Grings[2], D. W. Brake[2] and K. Muthukumarappan[3]

[2]Department of Animal Science, South Dakota State University
[3]Department of Agricultural and Biosystems Engineering, South Dakota State University

SUMMARY

Camelina and carinata are oilseed crops that have recently gained increasing attention as biofuel sources. The meals remaining after oil extraction contain relatively high concentration of protein and, because of this, there is interest in using them in livestock diets. However, the nutritional qualities of these meals are not well defined and may vary with processing conditions. In our experiment, we evaluated meals from cold-pressed and solvent-extracted camelina and carinata meals manufactured using 6 different processing conditions. Estimates of total *in vitro* OM and CP disappearance of each meal were determined according to a modified 2-phase procedure of Tilley and Terry (1963). We detected no differences in CP disappearance of camelina meal manufactured under cold-pressed extraction. In contrast, we noted differences in OM disappearance of camelina and carinata meals which had undergone different cold-press processing conditions. Differences were also observed in OM and CP disappearance of oilseed meals under varied hexane extraction conditions. Our data suggests that hexane extraction produced, on average, meals with greater OM disappearance than cold-pressing, but there were interactions by oilseed type. Hexane extraction performed under a temperature of 80°C for 90 min resulted in camelina meals with the greatest CP disappearance, whereas a temperature of 120°C for 65 min resulted in meals with the lowest CP disappearance.

INTRODUCTION

Camelina *(Camelina sativa*) and carinata (*Brassica carinata*) oilseed meals have been gradually gaining entry into the livestock feed industry as the search for alternate fuel sources has been gaining momentum. These oilseed meals are the byproducts that remain from processes that remove oil from oilseeds for biofuel. Currently, an increased attention has been given to camelina meals because they are not only economically efficient but are good source of protein and polyunsaturated fatty acids (Bonjean and Le Goffic, 1999; Hurtaud and Peyraud, 2007). Because of this, camelina meals have been used as part of livestock diets. Carinata oilseed meals have similar nutritional qualities but are not as widely used because of higher glucosinolate content compare to camelina meals. As novel feed resources, our knowledge of how the nutritional qualities of these meals vary with processing conditions is still unknown, therefore, we evaluated *in vitro* nutrient disappearance of these oilseed meals under a modified 2-phase procedure of Tilley and Terry (1963). Evaluating feeds *in vitro* is an efficient technique that allows prediction of a feed's ruminal digestibility. Our objectives were to evaluate meals manufactured from cold-pressed and solvent-extracted camelina and carinata seeds under 6 different processing conditions in order to determine the effect of processing condition on OM and CP disappearance. We hypothesize that processing condition affects nutritional quality of oilseed meals.

[1] This research was funded by the SD Oilseed Initiative and the SDSU Agricultural Experiment Station

MATERIALS AND METHODS

Meals from cold-pressed and hexane-extracted non-food oilseeds (camelina and carinata) obtained from the same source and manufactured using 6 different processing conditions were analyzed for OM and CP disappearance. Cold-pressed extraction conditions evaluated for each meal varied by die nozzle size and screw speed; 0.22 inch at 15 Hz, 0.22 inch at 20 Hz, 0.22 inch at 25 Hz, 0.25 inch at 15 Hz, 0.25 inch at 20 Hz and 0.25 inch at 25 Hz, respectively. Hexane extraction conditions evaluated varied by temperature and duration of extraction: 80 °C for 90 min, 100 °C for 65 min, 100 °C for 90 min, 120 °C for 40 min, 120 °C for 65 min and 120 °C for 90 min, respectively.

Two ruminally cannulated steers accustomed to being fed chopped hay twice daily were used in this study. Ruminal fluid was collected from each steer 4 h after feeding and after 2 h without water and transferred into separate pre-warmed thermos flasks. Evacuated ruminal contents were hand-squeezed and the associated fluid was blended for 1 min and strained through 4 layers of cheesecloth. Filtered ruminal fluid was maintained at 39°C under a constant flow of CO_2. Ruminal fluid (50 mL) from each steer was transferred to separate *in vitro* tubes in duplicate, each containing 4 g of the sample to be evaluated and 150 mL of degassed McDougall's buffer without urea. *In vitro* tubes were flushed with CO_2, capped with lids equipped with a vent to allow release of gases, and incubated for 48 h. After 48 h of incubation, *in vitro* tubes were removed from the incubator and placed in an ice bath to stop fermentation, followed by centrifugation at 2,000 x g for 15 min, after which supernatant was suctioned off. Pepsin solution (140 mL) was added to each tube and incubated for 48 h at 39 °C. *In vitro* tubes were again centrifuged for 15 min at 2,000 x g and supernatant suctioned off. Samples were lyophilized, placed into desiccator overnight and weighed to determine DM disappearance. A 0.5 g was sampled for ash determination to calculate OM disappearance. Residue of each *in vitro* tube was also analyzed for N by combustion analysis using Elementar Rapid N III for determination of CP disappearance.

All analyses were conducted at the South Dakota State University ruminant nutrition laboratory.

Statistical analysis

All data were analyzed using the PROC MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). Initially, effects of processing condition on *in vitro* OM and CP disappearance were analyzed with a model that included oilseed and processing condition and the interactions between them. A second analysis was conducted separately for each extraction method using a model that included oilseed and processing conditions. Steer was considered a random effect in all models. Differences were considered significant at $P \leq 0.05$.

RESULTS AND DISCUSSION

Hexane extraction processing conditions produced the greatest mean CP and OM disappearance in both oilseed types ($P < 0.05$). Carinata meal had greater CP and OM disappearance than camelina meal ($P < 0.05$). However, we observed an interaction ($P < 0.05$) between oilseeds and processing condition for both OM and CP disappearance.

Hexane extraction processing conditions

Differences in CP and OM disappearance in both oilseed types due to hexane extraction processing conditions were noted (Table 1). We observed difference in OM disappearance of camelina meal between hexane extraction processing condition of 120°C for 65 min and 120°C 90 min but the 120°C for 65 min processing condition was, however, not significantly different from any other processing conditions.

Hexane extraction performed under 80°C for 90 min produced camelina meal with the greatest CP disappearance, whereas a temperature of 120°C for 65 min resulted in meals with the least CP disappearance. Hexane extraction performed under temperature and time combinations of 100°C for 65 min, 100°C for 90 min, 120°C for 40 min and 120°C for 90 min, however, did not differ in CP disappearance.

We noted no difference in OM disappearance of hexane extracted carinata meal between 80°C for 90 min and 100°C for 65 min. Similarly, processing condition at 100°C for 90 min resulted in OM disappearance of hexane extracted carinata meal that only compares with processing at 120°C for 65 min. Similar OM disappearance of hexane extracted carinata meal was observed between processing at 120°C for 90 min and 120°C for 40 min.

Crude protein disappearance of carinata meal manufactured under a hexane extraction processing temperature of 100°C for 90 min was significantly greater than all other hexane processing conditions except processing at 120°C for 65 min. Disappearance of CP of carinata meals manufactured at a temperature of 120°C for 65 min also did not differ from that produced at 100°C for 65 min and 120°C for 40 min, as well. No difference in the CP disappearance of hexane extracted carinata meals was observed among meals manufactured under 80°C for 90 min, 100°C for 65 min, 120°C for 40 min and 120°C for 90 min.

Cold-press processing conditions

Organic matter disappearance of cold pressed camelina meal observed under a die nozzle of 0.22 inch and screw speed of 20 Hz was significantly greater than that of 0.25 inch die nozzle and either a 20 or 25 Hz screw speed (Table 2). No significant differences in the OM disappearance of cold-pressed camelina meal were, however, detected when processing conditions of die nozzle and screw size of 0.22 inch at 15 Hz, 0.22 inch at 20 Hz, 0.22 inch at 25Hz and 0.25 inch at 15 Hz, respectively were used. A die nozzle of 0.25 inch with a screw speed of 25 Hz resulted in the lowest OM disappearance of cold pressed camelina meal. No significant differences in CP disappearance among cold-pressed camelina meals were noted.

Cold-pressed extraction performed under a die nozzle and screw size of 0.22 inch at 15 Hz resulted in the greatest OM disappearance of carinata meal, whereas a die nozzle and screw speed of 0.22 inch at 20Hz or 0.25 inch at either or 25 Hz and resulted in meals with the lowest OM disappearance. No significant differences in OM disappearance of carinata meals manufactured under cold-pressed processing conditions of 0.22 inch at 25 Hz and 0.25 inch at 15Hz were noted.

Crude protein disappearance was not different when cold-pressed carinata meals were manufactured under a die nozzle and screw speed of 0.22 inch at 20 Hz or 0.25 inch at 25 Hz. Observed CP disappearance among these 2 processing conditions, however, differed from 0.22 inch at 15 Hz. Crude protein disappearance of carinata meals manufactured under cold-pressed processing conditions of 0.22 inch at 15 Hz, and 0.22 inch at 25 Hz and 0.25 inch at 15 Hz were similar. Observed CP disappearance of carinata meal processed under a processing condition of 0.22 inch at 15 Hz was, however, significantly greater than carinata meal manufactured under a processing condition of 0.25 inch at 20 Hz.

Implications

Our data suggest that hexane extraction performed under a temperature of 80°C for 90 min will result in camelina meals with the greatest CP disappearance, whereas a temperature of 120°C for 65 min will results in camelina meal with the lowest CP disappearance. Cold-press processing pressure had no effect on CP disappearance of camelina meal but differences were observed for carinata meals. A die nozzle and a screw speed of 0.22 inch at 15Hz will lead to the greatest OM disappearance and one of the greatest CP disappearances for carinata meal. Given that there were limited differences in OM disappearance and no difference in CP of cold-pressed camelina, cost involved as well as other factors such as oil quality and quantity extracted should be considered when choosing between processing camelina oilseeds under a die nozzle and screw sizes of 0.22 inch at 15 Hz, 0.22 inch at 20 Hz, 0.22 inch at 25 Hz, or 0.25 inch at 15 Hz. The same consideration should be applied in choosing between processing carinata oilseed meals at 100°C for 90 min or 120°C for 65 min.

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Table 1. Effect of temperature and time during hexane extraction of camelina and carinata seeds on organic matter (OM) and crude protein (CP) disappearance of their meals *in vitro*.

Oilseed	Processing Temperatures						SE
	80°C 90 min	**100°C 65min**	**100°C 90 min**	**120°C 40 min**	**120°C 65 min**	**120°C 90 min**	
	----------Disappearance, %----------						
Camelina							
OM	65.7^{ab}	65.8^{ab}	65.8^{ab}	65.5^{ab}	64.0^{b}	67.5^{a}	1.19
CP	82.4^{a}	79.6^{b}	78.8^{b}	79.7^{b}	76.4^{c}	79.0^{b}	0.78
Carinata							
OM	78.4^{d}	78.6^{d}	86.8^{a}	84.0^{bc}	85.5^{ab}	82.5^{c}	1.19
CP	87.5^{c}	87.9^{bc}	91.5^{a}	88.6^{bc}	89.7^{ab}	86.7^{c}	0.78

Means with differing superscript are significantly different from each other (P < 0.05).

Table 2. Effect of pressure during cold-press extraction of camelina and carinata seeds on organic matter (OM) and crude protein (CP) disappearance of their meals *in vitro*.

Oilseed	Processing Pressure						SE
	0.22inch 15Hz	**0.22inch 20Hz**	**0.22inch 25Hz**	**0.25inch 15Hz**	**0.25inch 20Hz**	**0.25inch 25Hz**	
	----------Disappearance, %----------						
Camelina							
OM	66.1^{ab}	67.5^{a}	66.0^{ab}	65.9^{ab}	65.1^{b}	63.2^{c}	0.97
CP	81.2	82.7	81.6	82.5	81.2	81.7	0.75
Carinata							
OM	79.1^{a}	72.4^{c}	75.3^{b}	75.7^{b}	72.2^{c}	73.2^{c}	0.97
CP	89.9^{a}	85.2^{c}	87.8^{ab}	88.1^{ab}	87.7^{b}	87.0^{bc}	0.75

Means with differing superscript are significantly different from each other (P < 0.05).
SE is the largest SE observed for that treatment.

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Postruminal flow of glutamate linearly increases small intestinal starch digestion in cattle[1]

E. J. Blom[2], D. W. Brake[2], and D. E. Anderson[3]
[2]Department of Animal Science, South Dakota State University
[3]Department of Large Animal Clinical Sciences, University of Tennessee

SUMMARY

Improving performance and efficiency among cattle fed corn-based diets could have large benefit to cattle production in the United States. Starch escaping ruminal fermentation is not efficiently digested in the small intestine; however, postruminal flows of casein (i.e., milk protein) or glutamate (an amino acid or building block of protein) increase small intestinal starch digestion in cattle. The objective of this study was to determine responses of small intestinal starch digestion in cattle to increasing amounts of postruminal glutamate. Increasing amounts of duodenal glutamate linearly increased small intestinal and postruminal starch digestion. These data indicate that postruminal glutamate can provide benefit to cattle fed corn-based diets.

INTRODUCTION

Cattle performance is often first limited by energy (Lofgreen and Garrett, 1968; NRC, 2000). Thus, cattle are often fed diets with appreciable amounts of cereal grains that provide energy as starch (Vasconcelos and Galyean, 2007). Small intestinal starch digestion (SISD) can provide up to 42% more energy than ruminal fermentation of starch (Owens et al., 1986); however, extent of SISD is less compared to ruminal fermentation. Consequently, cattle are typically fed diets with large amounts of ruminally fermentable starch. Unfortunately, increases in ruminally fermentable energy are associated with reductions in dry matter intake and increases in metabolic disorders (Owens et al., 1998). Increases in SISD may provide large benefits to cattle.

Greater postruminal flows of high quality protein (i.e., casein) or glutamate increase SISD in cattle (Richards et al., 2002; Brake et al., 2014b). Our objective was to quantify effects of increasing amounts of postruminal glutamate flow on SISD. We hypothesized that small increases in postruminal glutamate flow would increase SISD.

MATERIALS AND METHODS

Five ruminally, duodenally, and ileally cannulated Jersey × Limousin steers (BW = 773 ± 24 lb) were placed in a 5 × 5 Latin square with 12-d periods. Steers were housed in individual pens in a temperature-controlled room under 16 h of light and 8 h of darkness. Cattle were moved to metabolism stalls 1 d before sample collection. Every 12 h, steers were fed a low-starch diet (Table 1; 11.3 ± 0.13 lbs DM/d, about 1.5 × NE_m; NRC, 2000). The diet was formulated to provide adequate ruminally available N and only moderate amounts of ruminally undegradable protein.

[1] This project is a contribution from the South Dakota Agricultural Experiment Station, Brookings.

Treatments were continuous duodenal infusions of raw cornstarch (1507 ± 18 g[2] DM/d) and either 0 (control), 30.9 ± 0.59, 62.4 ± 1.16, or 120.4 ± 3.39 g glutamate/d, or casein (a positive control; 387.9 ± 18.34 g DM/d). Glutamate infusions delivered 39.9, 80.6, and 155.5% of glutamate provided by casein. Additionally, glutamate infusions provided 3.35 ± 0.06, 6.77 ± 0.13, and 13.06 ± 0.37 g of N/d, compared to casein which provided 56.36 ± 2.73 g of N/d.

Periods consisted of 8 d of adaptation and 4 d of sample collection. Diet and ort samples were collected on d 8 to 11 to correspond to the ileal and fecal samples collected on d 9 to 12. Ileal and fecal spot samples were collected every 4 h between 12-h feeding intervals on d 9 to 12 and composited. Sampling time was delayed 1 h each subsequent d so that composites were representative of each h in a 12-h period.

Ileal, fecal, and feed samples were analyzed for DM, OM, and starch. Additionally, ileal and fecal samples were analyzed for ethanol-soluble starch (i.e., short chain starch).

Data were analyzed using the Mixed procedure of SAS (SAS Inst. Inc., Cary, NC). Fixed effects were treatment and period; steer was a random effect. Linear, quadratic, and cubic contrasts were used to determine responses to greater flows of glutamate. The positive control (casein) was compared to the negative control by a *t*-test. Differences were declared when $P \leq 0.05$, and tendencies were considered at $0.05 < P \leq 0.15$.

RESULTS AND DISCUSSION

Results are summarized in Table 2. By design, amount of starch infused was not affected by glutamate (*Linear* = 0.46) or casein (*P* = 0.45). Casein increased SISD (*P* = 0.05) compared to control. Furthermore, casein tended (*P* = 0.07) to decrease ileal starch flow and decreased (*P* = 0.01) fecal starch flow compared to control. Brake et al. (2014b) infused similar amounts of postruminal starch and casein and reported increased SISD. Similarly, these authors (Brake et al., 2014a, 2014b) observed decreased ileal and fecal starch flow.

Greater flows of glutamate increased SISD (*Linear* = 0.02) and postruminal starch digestion (*Linear* = 0.05; *Cubic* = 0.03). Ileal DM flow (*Quadratic* = 0.14) and ethanol-soluble starch flow (*Linear* = 0.16) tended to decrease with greater infusion of glutamate. Ileal (*Linear* = 0.04) and fecal (*Linear* = 0.04; *Cubic* = 0.04) starch flow decreased with greater infusion of glutamate. When Brake et al. (2014a) duodenally infused casein (400 g/d) they observed increased ($P < 0.01$) SISD and decreased ($P < 0.01$) ileal starch flow, but found increased flows of ethanol-soluble starch at the ileum (*P* = 0.05).

Increased SISD with greater postruminal flows of glutamate could provide large benefit to cattle. When cattle were postruminally infused with 120.4 g/d glutamate, SISD was 49.6% compared to 37.2% when cattle received no postruminal glutamate or casein. Previous data indicate that starch digested in the small intestine provides 42% more NE than ruminally-fermented starch (Owens et al., 1986). McLeod et al. (2001) reported that retained energy from postruminally digested starch was 1.75 kcal/g of starch digested. A 33% increase in SISD can contribute to appreciable increases in retained energy. For example, a feedlot steer fed a dry rolled corn-based diet will typically consume about 5,000 g (11 lb) of starch/d (Theurer, 1986), and nearly 1,500 g (3.3 lb) will flow to the small intestine (Owens et al., 1986; Theurer, 1986). These data indicate increased postruminal flow of glutamate could increase retained

[2] 100 g = 0.22 lb

energy from diet to 0.32 Mcal/d because of increased SISD. In a 900 lb steer expected to finish at 1350 lb with a small marbling score, this additional retained energy would result in an approximate increase 0.22 lb of ADG.

In order to fully optimize SISD in cattle, it is necessary to understand response of SISD to postruminal glutamate. Clearly, postruminal glutamate increases SISD; it is possible that greater amounts of glutamate would further improve SISD.

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Table 1. Composition of soybean hull-based diet

Ingredient	**% DM**
Soybean hulls	72.4
Brome hay	20.0
Corn steep liquor	6.0
Limestone	1.0
Salt	0.5
Mineral and vitamin premix[1]	0.1
Nutrient concentration	
NE_m, Mcal/cwt[2]	78.5
CP, % DM[3]	13.1
Undegradable intake protein, % CP[2]	40.8
Starch, % DM[3]	0.8

[1]Designed to provide to diet (DM basis) 100 ppm Fe, 40 ppm Mn, 60 ppm Zn, 20 ppm Cu, 1 ppm I, 0.2 ppm Se, 0.2 ppm Co, 1,000 IU of vitamin A/lb, 125 IU of vitamin D/lb, and 23 IU of vitamin E/lb.

[2]Predicted from tabular values (NRC, 2000).

[3]Analyzed value.

Table 2: Effect of duodenal infusion of glutamate on ileal and fecal nutrient flows and small and large intestinal starch disappearance in steers receiving 3.3 lb duodenally-infused raw cornstarch

		Glutamate, g/d					*P*-value for contrasts			
Item	**Control**	**30.9**	**62.4**	**120.4**	**Casein**	**SEM**	**Linear**	**Quadratic**	**Cubic**	**Control vs. casein**
No. of observations	4	5	5	4	5					
Duodenal starch infused, g/d[1]	1531	1516	1534	1479	1483	49	0.46	0.68	0.66	0.45
Nutrient flow to ileum, g/d										
DM	2716	2596	2367	2538	2681	201	0.33	0.14	0.43	0.84
Starch	965	844	801	752	801	68	0.04	0.33	0.74	0.07
Ethanol soluble starch	154	132	119	119	171	27	0.16	0.30	0.99	0.42
Glucose	3	20	14	7	1	6	1.00	0.08	0.21	0.81
Small intestinal starch digestion[2]	37.2	44.4	47.9	49.6	46.1	3.3	0.02	0.16	0.83	0.05
Nutrient flow to feces, g/d										
DM	3965	4170	3709	3434	3642	453	0.27	0.76	0.49	0.56
Starch	490	570	383	355	278	74	0.04	0.82	0.04	0.01
EtOH soluble starch	71	70	66	73	48	10	0.90	0.68	0.78	0.10
Glucose	47	56	46	43	46	11	0.64	0.73	0.49	0.97
Postruminal starch digestion[2]	68.0	62.2	75.1	76.3	80.9	4.9	0.05	0.85	0.03	0.02

[1]100 g = 0.22 lb

[2]% of infusion

BEEF 2015-07

Effectiveness of high inclusion liquid feed for finishing steers[1,2]

R. H. Pritchard[3], A. R. Taylor[4], H. Blalock[5]

[3]Department of Animal Science, South Dakota State University
[4]North Dakota State University, Carrington Research Center, ND
[5]Quality Liquid Feeds, Dodgeville,WI

SUMMARY

A finishing phase study was conducted to measure the effectiveness of replacing dry rolled corn with a high inclusion liquid feed for finishing steers. Treatments were based upon 3 supplements: 1) Control 3.3% inclusion meal-type supplement (CO); 2) Typical Liquid Supplement 4.5% inclusion liquid supplement (TLS); and 3) High Liquid Supplement 9.0% inclusion liquid supplement (HLS). Supplements displaced dry rolled corn in finishing diets. Five 5 pens of 7 or 8 yearling steers with an initial BW of 930 lb assigned to each treatment for the 119 d experiment. The assayed supplement inclusion averaged 3.35%, 4.48% and 8.97% for the CO, TLS and HLS treatments, respectively. In general, interim performance periods resulted in similar DMI across diets and the HLS diet generally improved ADG and F:G when compared to the CO diet. On a shrunk live BW basis cumulative F:G was lower for HLS than CO and tended to be lower than when TLS diet was fed. The HLS also tended (P = 0.08) to increase ADG compared to the TLS. These responses suggest the caloric value of the HLS exceeded the caloric value of the DRC that it replaced. The liquid supplements had no adverse effects on Quality Grade and tended to improve Yield Grade compared to CO. The high inclusion liquid supplement used in this study was an effective substitute for dry rolled corn in a finishing diet.

INTRODUCTION

Supplemental liquid feeds (SLF) are commonly used in feedlot diets. They may be included as a commodity or as a manufactured supplement containing additional CP, micro-nutrients and additives. Prevalent commodity sources of SLF include molasses, condensed corn distiller's grains, stillage, and glycerin. These ingredients differ in composition and handling characteristics, but all can at times provide cost effective sources of energy and/or CP. They can also serve to improve the physical characteristics, and in some instances, the mix integrity of the diet.

Traditionally the use of SLF as a true supplement has targeted inclusion levels <5% of the diet. When SLF are cost competitive sources of energy and/or CP, lower cost diet formulations could be achieved by increasing the volume of SLF in a manufactured liquid supplement. This approach would also have logistical advantages in that additional SLF could be included in the diet without having to deal with delivery, storage, and batching of an additional ingredient. The objective of this experiment was to determine the feasibility of using a higher inclusion level liquid supplement in high concentrate diets for finishing cattle

[1] IACUC approval 13-039E.
[2] This study was sponsored by Quality Liquid Feeds, Dodgeville, WI.

MATERIALS AND METHODS

This experiment was conducted at the Ruminant Nutrition Center (RNC) during June through October 2013. Supplements were formulated to be the carrier for required vitamins, minerals, and other micro-ingredients (Table 1) and were included at different levels in the diet: CO) 3.3% inclusion meal-type supplement; TLS) 4.5% inclusion liquid supplement; HLS) 9.0% inclusion liquid supplement. The TLS and HLS supplements were commercial products provided by Quality Liquid Feeds and provided similar contributions of micro-ingredients to the complete diet. The CO dry supplement was manufactured by South Dakota State University. Diets were formulated to utilize commodities common to the area (Table 2). Three transition diets (Table 2) were used for adapting steers to the final diets. Final test diets were first delivered on d 19 of the study. All final diets were formulated to contain 28 g/ton monensin. Diet ingredients were sampled weekly for nutrient analysis. Actual diet formulations and compositions (Table 3) were back calculated based upon weekly assay data and feed batching records. While on the finishing diet it was necessary to replace corn silage with sorghum silage at d 43 and to replace the sorghum silage with ground grass hay at d 92 as these commodity inventories were depleted. Diets were mixed and delivered two times daily (50/50).

Steers for this study (n=117, BW=930 ± 53 lb) were from a single origin and purchased at a SD sale barn. Standard RNC receiving protocols were followed. Body weight was recorded during processing for allotment purposes. For allotment, steers were stratified by BW across 3 treatments and then into 5 replicate pens within each treatment. Individual steer BW was measured again the day after processing as steers were sorted to assigned pens. Initial BW for performance calculations was the average of these 2 consecutive day BW determinations.

Individual BW was also measured on days 28, 56, 84, 105 and 119. Steers were implanted with Revalor® 200 at the time d 28 BW were measured. Weighing of steers occurred prior to the morning feed delivery. Feed records were summarized at intervals corresponding to weigh days. All interim steer performance data were calculated without applying shrink. Once the entire population was estimated to have approximately 0.50" in ribfat thickness (visual appraisal) steers were co-mingled and shipped to a commercial abattoir as a single lot. Individual steer identity was maintained through the abattoir and matched to camera grading data acquired from the packing plant.

Cumulative live performance was calculated in two ways: by applying a 3% shrink to the BW determined on d 119 and also by using a carcass adjusted final BW. The carcass adjusted final BW was calculated as HCW/0.625 (62.5% dress) to account for potential differences in fill.

Data were analyzed on a pen mean basis using PROC GLM procedure of SAS (SAS Inst. Inc., Cary NC) as appropriate for a randomized complete block design experiment with pen as the experimental unit. Means separations were achieved using Fisher's T Test.

RESULTS AND DISCUSSION

The purchased lot of steers included a subpopulation of highly excitable steers. Nine steers had to be removed from the study early in the feeding period because of disposition related problems. Target goals for feed formulations, specific supplement inclusions, and fatness endpoint were achieved. While on the finishing diets supplement levels averaged 3.35%, 4.48% and 8.97% for the CO, TLS and HLS treatments, respectively (Table 3). The only other ingredient inclusion that varied was the dry rolled corn (DRC), which was displaced by liquid supplements relative to inclusion rate. Treatments did differ

slightly (P < 0.01) in CP content (13.5, 14.0 and 14.2%, respectively; Table 3) in response to increased liquid supplement inclusion in the diet. Average ribfat of the carcasses was 0.53 in.

There were no noticeable dietary differences in how the steers started on feed as reflected by similar DMI during the initial 28 d period (Table 4). In general, during the subsequent interim performance periods DMI remained similar across diets and the HLS generally improved ADG and F/G compared to the CO treatment (Table 4). There were no digestive disorders associated with these diets.

On a shrunk live BW basis cumulative F:G was lower (P<0.05) for the HLS than the CO diet. The HLS diet tended (P<0.10) to increase ADG and decrease F:G compared to the TLS diet (Table 5). This suggests that the caloric value of the HLS diet exceeded the caloric value of the DRC that it replaced. It could be argued that this difference in F:G among dietary treatments was due to the lower (13.5 vs 14.0%) CP of the CO treatment. However, there were no differences in cumulative intake among the three treatments and all diets met or exceeded NRC CP requirements (11.3 %).

It was unusual that the carcass adjusted performance data were more variable than live performance data. This may be a consequence of the excitable steers that were pulled from the study. The frequency of problematic steers was similar across treatments, but these steers varied in BW which by their dismissal impacted the initial BW distributions. This probably led to the HCW variation among pens within a treatment when data were analyzed on a pen mean basis.

Carcass data confirm that these were quality cattle fed to a typical industry endpoint. Overall the carcasses graded 86% Choice or better and 46% Premium Choice and Prime. The liquid supplements had no adverse effects on Quality Grade. There was no basis to expect carcass traits to be affected by diet unless diet caused differences in ADG which could impact HCW and carcass fatness. There were trends toward larger REA, lower ribfat thickness, and ultimately a trend towards lower yield grades with TLS and HLS diets.

SUMMARY

There were no adverse events such as metabolic disorders or reduced Quality Grade or Yield Grade associated with feeding typical or high levels of liquid supplements. Liquid supplements improved growth efficiency, which has been observed previously and attributed to improved mix quality and subsequent uniformity of nutrient intake. The high inclusion supplement tended to lead to more efficient production than the typical inclusion supplement. This is probably not due to further improvements in mix quality. The more likely explanation is that the components of the high inclusion supplement contained more useful energy than the DRC that was replaced in the diet. Higher inclusion level of a diluted liquid supplement was an effective and convenient method for including additional liquid byproducts in beef cattle finishing diets.

Table 1. Control treatment meal supplement formula for 1 ton batches[1]

Ingredient	Pounds
Canola meal	310
Potassium chloride	298
Trace mineralized salt	179
Limestone	1040
Urea	149
Premix[2]	25

[1]As is basis

[2]Premix contained ground corn, monensin, vitamins A & E, $ZnSO_4$, and $CuSO_4$

Table 2. Step-up diets for Control (CO), Typical (TLS), and High (HLS) inclusion liquid supplements fed to yearling steers.[1]

	CO	TLS	HLS
Step 1 - Fed days 1-5		%	
Corn Silage	30.0	30.0	30.0
Grass hay	25.0	25.0	25.0
DRC	23.0	22.0	18.0
HMC	10.0	10.0	10.0
mDGS[2]	9.0	9.0	9.0
Supplement[3]	3.0	4.0	8.0
Step 2 – Fed days 6-11			
Corn Silage	25.0	25.0	25.0
Grass Hay	10.0	10.0	10.0
DRC	29.7	28.5	24.0
HMC	20.0	20.0	20.0
mDGS[2]	12.0	12.0	12.0
Supplement[3]	3.3	4.5	9.0
Step 3 – Fed days 12-18			
Corn Silage	20.0	20.0	20.0
DRC	34.7	33.5	29.0
HMC	27.0	27.0	27.0
mDGS[2]	15.0	15.0	15.0
Supplement[3]	3.3	4.5	9.0

[1]DM basis

[2] modified distiller's grains (50% DM)

[3]Supplements contained monensin and provided minerals and vitamins to meet or exceed NRC requirements.

Table 3. Finishing diet formulations and composition for Control (CO), Typical (TLS), and High (HLS) inclusion liquid supplements for yearling steers.[1, 2]

	Treatment					
	CO[3]		TLS		HLS	
19-42 d						
Corn Silage, %	8.45	(0.36)	8.45	(0.36)	8.45	(0.36)
DRC, %	35.34	(0.30)	34.15	(0.29)	29.70	(0.25)
HMC, %	34.22	(0.78)	34.22	(0.78)	34.22	(0.78)
mDGS, %	18.72	(0.25)	18.72	(0.25)	18.72	(0.25)
Supplement[4], %	3.28	(0.03)	4.46	(0.04)	8.93	(0.07)
DM, %	65.2	(0.53)	64.3	(0.52)	63.6	(0.52)
CP,%	13.3	(0.40)	13.8	(0.40)	13.9	(0.40)
NDF, %	15.9	(1.01)	15.7	(0.97)	15.3	(0.97)
NE_G, Mcal/cwt	64.4	(0.10)	64.7	(0.10)	64.9	(0.10)
43-91 d						
Sorghum Silage, %	7.70	(0.32)	7.71	(0.32)	7.71	(0.32)
DRC, %	35.70	(0.43)	34.53	(0.40)	30.04	(0.37)
HMC, %	35.24	(0.42)	35.27	(0.42)	35.28	(0.43)
mDGS, %	18.01	(0.73)	18.03	(0.73)	18.04	(0.73)
Supplement[4], %	3.34	(0.05)	4.46	(0.06)	8.93	(0.11)
DM, %	65.4	(0.86)	64.5	(0.85)	63.8	(0.83)
CP, %	13.5	(0.35)	14.0	(0.37)	14.2	(0.35)
NDF, %	15.7	(0.35)	15.5	(0.35)	15.1	(0.36)
NE_G, Mcal/cwt	63.2	(0.11)	63.6	(0.11)	63.9	(0.12)
92-119 d						
Grass hay, %	7.93	(0.41)	7.94	(0.41)	7.94	(0.41)
DRC, %	36.18	(0.48)	35.00	(0.47)	30.45	(0.38)
HMC, %	33.99	(0.64)	34.02	(0.65)	34.04	(0.67)
mDGS, %	18.49	(0.70)	18.51	(0.69)	18.52	(0.69)
Supplement[4], %	3.42	(0.12)	4.53	(0.13)	9.07	(0.25)
DM, %	73.6	(2.08)	72.5	(2.03)	71.5	(1.98)
CP, %	13.7	(0.30)	14.3	(.19)	14.5	(0.20)
NDF, %	16.3	(0.40)	16.1	(.39)	15.7	(0.39)
NE_G, Mcal/cwt	63.1	(0.16)	63.5	(.15)	63.7	(0.16)

[1]All values except DM on DM basis.

[2]Based on weekly ingredient analyses.

[3]Mean (Std Dev).

[4]Supplements contained monensin and provided minerals and vitamins to meet or exceed NRC requirements.

Table 4. Interim periods steer performance responses to Control (CO), Typical (TLS), and High (HLS) inclusion liquid supplement treatments.[1]

	Treatment			
	CO	**TLS**	**HLS**	**SEM**
Initial BW, lb	915	918	913	2.2
1 to 28d				
d 28 BW, lb	1007	1009	1006	2.3
ADG, lb	3.28	3.24	3.31	0.077
DMI, lb	19.95	19.93	19.91	0.107
F:G	6.13	6.19	6.03	0.137
29 to 56 d				
d 56 BW, lb	1129	1141	1145	6.1
ADG, lb	4.37[a]	4.74[a]	4.95[b]	0.142
DMI, lb	23.15	23.17	23.23	0.386
F:G	5.31[a]	4.89[b]	4.71[b]	0.116
57 to 84 d				
d 84 BW, lb	1235	1235	1239	7.0
ADG, lb	3.76	3.36	3.36	0.142
DMI, lb	24.17[a]	22.98[b]	23.00[b]	0.356
F:G	6.43	6.97	6.86	0.280
85 to 105 d				
d 105 BW, lb	1345	1347	1358	7.4
ADG, lb	5.24[a]	5.33[ab]	5.68[b]	0.126
DMI, lb	28.28	27.14	27.95	0.446
F:G	5.42[a]	5.10[ab]	4.93[b]	0.149
106 to 119 d				
d 119 BW, lb	1381	1387	1404	7.8
ADG, lb	2.59[a]	2.81[a]	3.24[b]	0.131
DMI, lb	27.60	26.22	27.15	0.487
F:G	10.89[a]	9.36[b]	8.40[b]	0.426

[1]Non-shrunk BW basis.

[a,b]Means within a row without a common superscripts differ (P<0.05).

Table 5. Cumulative steer performance responses to Control (CO), Typical (TLS), and High (HLS) inclusion liquid supplement treatments.

	Treatment			
	CO	**TLS**	**HLS**	**SEM**
Shrunk Basis[1]				
Final BW, lb	1339[y]	1345[yz]	1361[z]	7.6
ADG[1], lb	3.56[y]	3.59[y]	3.77[z]	0.062
DMI, lb	24.07	23.42	23.69	0.279
F:G	6.75[a]	6.53[ab‡]	6.29[b‡]	0.084
Carcass Adjusted Basis[2]				
Final BW, lb	1343	1352	1360	10.0
ADG, lb	3.60	3.65	3.76	0.085
F:G	6.70	6.44	6.32	0.154

[1]3% shrink applied to d119 BW.

[2]Calculated Final BW = HCW/0.625.

[a,b]Means within a row without a common superscript differ (P<0.05).

[y,z]Means within a row without a common superscript differ (P<0.10).

[‡] TLS and HLS means differ (*P*=0.09)

Table 6. Carcass traits, quality grade, and yield grade distributions when Control (CO), Typical (TLS), and High (HLS) inclusion liquid supplement treatments were fed.[1]

	Treatment			
	CO	TLS	HLS	SEM
Dress, %[3]	62.66	62.80	62.46	0.327
HCW, lb	839	845	851	6.2
REA, in[2]	12.62[y]	12.77[yz]	13.13[z]	0.162
Ribfat, in	0.56[ay]	0.53[abz]	0.49[b]	0.013
KPH, %	1.99	1.95	1.97	0.022
Marbling[4]	594	602	587	16.3
Yield Grade	3.49[a]	3.38[ab]	3.25[b]	0.068

[1]Pen mean basis

[3]HCW as % shrunk BW

[4]400 = slight°; 500 = Small°

[a,b]Means within a row without a common superscript differ (P<0.05).

[x,y,z]Means within a row without a common superscript differ (P<0.10).

BEEF 2015-08

Time of suckling implant influences on weaning weight, post-weaning performance, and carcass traits in steer calves[1]

R.H. Pritchard[2], A.R. Taylor[3], S.M. Holt[4], K.W. Bruns[5], and H.M. Blalock[6]

[2]Department of Animal Science, South Dakota State University, Brookings, SD
[3]North Dakota State University, Carrington, ND
[4]Nutrition Service Association, Australia
[5]University of Nebraska, North Platte, NE
[6]Quality Liquid Feeds, WI.

SUMMARY

The effect of time of suckling calf implant (SCI) use on weaning weight (WW), post-weaning performance and subsequent carcass traits was compared in steer calves produced on one ranch in western SD. Calves were born in March and April of each year and were reared on native range prior to weaning. The SCI strategies used included: non implanted controls (NI) or implanted with Synovex C either in May (MAY), or August (AUG). Age groups of dams (<4 years or ≥4 years) were managed separately through the breeding seasons. At weaning (late October) all calves were weaned and relocated to the SDSU Ruminant Nutrition Center feedlot. Steers were individually weighed, vaccinated, and treated for parasites and the processing body weight recorded was considered the WW. Steers were sorted into feedlot pens by SCI treatment (8 or 9 steers/pen; 8 pens/treatment; 24 pens/yr). Steers were backgrounded and finished using diets and management typical for this region and included the use of implants uniformly across SCI treatments. Both the MAY and AUG implant treatments increased WW over non-implanted calves. The magnitude of this was response interacted with the age of the dams. Steers nursing mature cows and implanted in May had the greatest increase in WW over NI (40 lb). The WW advantage for steers nursing mature cows and implanted in August was reduced to 17 lb. Timing of implant administration had the opposite effect in young cows and was more beneficial when steers were implanted in August. The weight advantage due to suckling implants persisted through to carcass weight. The SCI treatments did not affect the post-weaning ADG or feed efficiency of the steers and had no adverse effects on Quality Grade of the carcasses produced. There was a substantial benefit to the cow calf producer to match the time of implant administration with the age of the dam with no adverse impact on overall beef production.

INTRODUCTION

It is prudent to occasionally take time to confirm continued efficacy of technologies we have in use as commercial cattle production models evolve. Typically suckling phase implants are administered between the end of calving and onset of the breeding season. With the dramatic improvements in calf growth that have occurred since implants were introduced, this may no longer be the optimal time to administer the implant. Pre-weaning vaccinations administered in late summer create a convenient opportunity to implant calves at an older age. In a preliminary study we saw a significant increase in WW

[1] Project funding by the SD Ag Experiment Station and the Beef Nutrition Program

when implants were administered during the vaccination process 30 d pre-weaning. The magnitude of the response was sufficient to merit an investigation into the preferred time to administer suckling calf implants. Another consideration regarding the practice of implanting suckling calves is the concern that this practice could diminish post-weaning steer performance. This experiment was designed to evaluate the efficacy of use and timing of suckling calf implants under conditions typical of a western SD cow-calf production system, and to account for potential impacts on post-weaning cattle performance.

MATERIALS AND METHODS

The study was repeated over 2 consecutive years using Angus and Angus x Limousin steer calves from a ranch located in western SD. All experiments were approved by the SDSU Institutional Animal Care and Use Committee.

Calving season on the cooperating ranch was March and April. In May every 3rd bull calf that was restrained for castration, vaccination, and branding was implanted. In August, every 2nd calf restrained during a revaccination process that was not implanted in May, was implanted. This resulted in steer calves (yr 1=194; yr 2=196) allotted into 1 of 3 treatments: 1) no implant (NI); 2) Synovex C (Zoetis, Florham Park, NJ) implant administered in May (MAY); or 3) Synovex C implant administered in August (AUG). Specific dates for implanting suckling steer calves were: Yr 1) May 18 and Aug 29-30; and Yr 2) May 21-22 and Aug. 17 & 18. Dam age was classified as immature dams < 4 years of age (IMM); or mature dams ≥ 4 years of age (MAT). Dam age groups were managed separately on the ranch through the breeding season each year. Cows and calves were managed on native range (without creep feed).

In late October steers were weaned and immediately shipped 360 mi to the SDSU Ruminant Nutrition Center research feedlot. Upon arrival at the feedlot, steers had overnight (10 h) access to water and long-stem grass hay prior to processing. At initial processing individual body weights were recorded and steers were vaccinated against viral antigens related to respiratory disease using Resvac 4/ Somubac (Zoetis, Florham Park, NJ) and clostridial organisms using Ultrabac 7 (Zoetis, Florham Park, NJ). Steers were treated for internal and external parasites using Dectomax (Zoetis, Florham Park, NJ). The BW collected at this time was considered calf WW. Steers were sorted by implant treatment, then stratified by WW and randomly assigned to a pen resulting in 8 pens per implant treatment, (8 or 9 steers per pen), for 24 pens total each year. Steers were implanted with Synovex S (Zoetis, Florham Park, NJ) a few days (Yr 1=6 d; Yr 2=5 d) following arrival to the feedlot. Steers were then re-implanted at the beginning of the finishing phase (Yr 1=70 d; Yr 2=77 d from initial implant) with either a Revalor S (Merck, Summit, NJ) or a Ralgro (Merck, Summit, NJ) implant. Steers that received a Ralgro implant at the beginning of the finishing phase were re-implanted (Yr 1 = 127 d; Yr 2 = 139 d from initial implant) with Revalor S.

The backgrounding diet consisted mainly of corn silage and dry rolled corn (10.9 %CP; 53 Mcal NE_g/cwt). Finishing diets were primarily corn based ingredients (13.1 % CP; 61 Mcal NE_g/cwt). Feed deliveries were managed according to a clean bunk management system. Calves were fed once daily (beginning at 0800) during the backgrounding and finishing phases. Individual feed ingredients were sampled weekly throughout the study and analyzed for DM, CP, ash, NDF, and ADF to assure they met published nutrient requirements for this class of cattle (NRC). Dry matter intakes were calculated using weekly feed analyses and daily feed batching and delivery information for the feeding period. All BW were collected in the morning prior to feed delivery. Cattle health was monitored daily with treatment practices following approved health protocols.

Cattle were marketed when the majority of the cattle were estimated to average 0.4 in of 12th rib backfat thickness (Yr 1 = 221 d and Yr 2 = 208 d in the feedlot). Unshrunk BW were used to calculate ADG and feed efficiency during the backgrounding phase. Final BW is reported as a carcass adjusted final BW (hot carcass weight/0.625) to correct for potential year effects on fill and mud. This carcass adjusted final BW was used to calculate ADG during the finishing phases of the study.

The overall statistical model (GLM, SAS; SAS Inst. Inc., Cary NC) used to test WW included Year, Age of Dam, SCI, and the interaction of Age of Dam x SCI. The model for evaluating carcass traits included these same independent variables with the post-weaning treatment and the interaction of SCI x post-weaning treatment added to the model. There were no interactions between pre- and post-weaning treatments. This allowed us to consider an individual steer as an experimental unit for the carcass data since SCI and age of dam were specific to each individual. Because the population included more mature cows than young cows the individual steer data are reported as least squares means and separation tests were accomplished using the PDIFF option (SAS). Steer performance in the feedlot was evaluated on a pen mean basis using the same independent variables as were used for evaluating carcass traits.

RESULTS

This study was repeated over 2 yr, on the same ranch, and with similar timelines. The differences in WW between years (Table 1) are probably a consequence of growing season forage availability. It is noteworthy that there was no SCI x Year interaction for WW. The lack of interaction suggests that implants were equally effective in years with more and less favorable grass conditions.

Young cows represented 36% of the total cow population. Steers produced by MAT cows were heavier at weaning ($P<0.05$; Table 1) and yielded heavier carcasses (767 v 811 lb; $P < 0.001$). The impact of age of dam on post-weaning growth efficiency could not be measured because steers from MAT and IMM dams were co-mingled in each pen.

Overall, the use of implants during the suckling phase increased WW by 22 lb ($P<0.05$). There was a significant interaction between age of dam and the timing of the suckling implant (Table 1). In MAT cows the MAY implant increased WW by 40 lb over that of NI steers on MAT cows ($P<0.05$). The WW response to the AUG implant was less (17 lb) in the MAT group. In contrast, steers on IMM cows benefited most from the AUG implant with WW 25 lb heavier than NI steers in the IMM group ($P<0.05$). In the IMM group the MAY implant only increased WW by 9 lb and was not different from IMM group NI steers ($P>0.10$).

We can use this data to reconstruct an idealized suckling calf implant strategy where steer calves on IMM cows are implanted exclusively in August and steer calves on MAT cows are implanted exclusively in May. In the IMM group (36% of the herd) the AUG implant benefit was 25 lb. In the MAT group (64% of the herd) the MAY implant benefit was 40 lb. Using the following equation the increase in WW would be 35 lb.

Change in WW = (36% x 25 lb) + (64% x 40 lb)

Applying this logic and WW responses shown in Table 1 to other dates, implanting all steers in May would increase WW by 29 lb; and implanting all steers only in August would increase WW by 26 lb.

In the feedlot steers were segregated only by SCI. Additional post-weaning treatments were balanced across SCI. These additional post-weaning treatments did not impact steer performance and there were

no interactions evident ($P > 0.20$) between pre- and post-weaning treatments. This allowed us to focus on the impact of SCI on subsequent performance.

The SCI had no effect on ADG or feed efficiency in the receiving, backgrounding, or finishing phases of production (Table 2). Treatment means were quite similar and the study was sufficiently sensitive to have detected responses of <5% for ADG or F/G. The added WW caused by SCI was still evident as heavier BW at the end of backgrounding ($P <0 .05$).

The numerical rankings of HCW reflected the rankings for WW, but were not significantly different. A contrast of Non-implanted vs Implanted did show a tendency for suckling implants to increase HCW (783 v 791 lb; $P=0.10$). Collectively at weaning, implanted calves weighed 22 lb more than non-implanted calves. At this stage of growth the dressing percentage of steer calves is about 55%. This would equate to 12 lb additional carcass weight in the implanted calves. Final HCW were 8 lb heavier for these groups, suggesting the added growth due to suckling implants was likely retained throughout 200+ days post-weaning phase of growth.

All other aspects of carcass traits including marbling and YG were quite similar whether or not the suckling calves received an implant (Table 3).

CONCLUSIONS

Administering implants causes a significant increase in the WW of steer calves. This response can be maximized by using an implant strategy that considers the age of the dam. There was no evidence that the use of implants in suckling steer calves has any adverse effects on post-weaning performance or subsequent carcass traits.

Table 1. Impact of time of suckling calf implant administration and cow age on weaning weight of spring born steer calves. [1, 2]

		Main Effects	
Year	**1**	**2**	
n	194	196	
WW, lb	538[a] (3.9)	571[b] (3.9)	
Cow Age	**Immature**	**Mature**	
n	143	247	
WW, lb	530[a] (4.4)	580[b] (3.4)	
Implant	**None**	**May**	**August**
n	130	128	132
WW, lb	540[a] (4.8)	564[b] (4.8)	561[b] (4.8)

	Cow Age x Implant Time[3]					
Implant	**None**		**May**		**August**	
Cow Age	**Immature**	**Mature**	**Immature**	**Mature**	**Immature**	**Mature**
n	45	85	50	78	48	84
WW	518[a] (7.9)	561[c] (5.7)	527[a,b] (7.5)	601[e] (6.0)	543[b] (7.6)	578[d] (5.8)

[1] Weaning weight measured as feedlot arrival BW

[2] Least squares mean (standard error)

[3] Cow age x implant treatment ($P < 0.01$)

[a,b,c,d,e] Means lacking a common superscript differ ($P < 0.05$)

Table 2. Impact of suckling phase implant treatments on post-weaning steer performance[1]

	Suckling Implant Treatment			
	None	**May**	**August**	**SEM**
Receiving Grower				
End grower BW, lb	759[a]	779[b]	772[b]	3.41
ADG, lb	3.46	3.49	3.45	0.053
DMI, lb	15.27	15.76	15.48	0.167
F/G	4.44	4.54	4.50	0.044
Finishing Phase				
Final BW, lb[2]	1265	1280	1276	6.1
ADG, lb	3.77	3.73	3.75	0.042
DMI, lb	21.70	21.66	21.98	0.174
F/G	5.77	5.83	5.88	0.056

[1] Pooled two year data represented by 16 pens of 8 steers per treatment

[2] Calculated as HCW/0.625 to correct for fill and mud

Table 3. Impact of suckling implant treatment on subsequent carcass traits[1]

	Suckling Implant Treatment			
	None	**May**	**August**	**SEM**
HCW, lb	783	789	794	5.5
REA, in^2	12.65	12.78	12.88	0.103
Ribfat, in	0.48	0.44	0.47	0.011
KPH, %	1.98	1.93	1.87	0.041
Marbling[2]	581	565	571	83
Yield Grade	3.02	2.90	2.94	0.050

[1] Individual carcass basis

[2] 400 = slight°; 500 = small°

BEEF 2015-09

Effects of zilpaterol hydrochloride supplementation on growth performance, carcass characteristics and production economics of steers differing in breed composition[1]

J.O. Fulton[1], K.C. Olson[2], J.J. Kincheloe[2], A.A. Harty[2], M.K. Luebbe[3], K.R. Underwood[1]
S.M. Scramlin[1], A.D. Blair[2]

[1]South Dakota State University, Brookings, SD
[2]South Dakota State University, Rapid City, SD
[3]University of Nebraska, Panhandle Research Station, Scottsbluff, NE

SUMMARY

The β–adrenergic agonist zilpaterol hydrochloride (ZH) affects skeletal muscle growth, but little is known if this response is influenced by differences in genetic background of cattle. The objective of this study was to determine the effects of ZH on growth, carcass characteristics and production economic responses of Angus-sired (ANG) and SimAngus-sired (SIMANG) steers. Pens within each block × breed composition were randomly assigned to either ZH (8.3 ppm of DM; fed for the final 20 d before slaughter) or control (CON; 0 ppm ZH). Steers were ultrasounded before ZH inclusion and following withdrawal to determine the influence of ZH on change in ribeye area (REA), fat thickness and percent intramuscular fat (IMF). Carcass and feedlot performance data were collected and used to determine breed composition and ZH effects on economic responses. The interaction of breed composition × ZH had no influence on measured responses. Breed composition did not influence change in ultrasound measurements during the ZH feeding period or feedlot performance. Carcasses from SIMANG steers had larger REA and improved YG, while ANG steers had increased marbling scores. SimAngus-sired steers produced a greater percentage of YG 2 and a lower percentage of YG 3 carcasses than ANG steers. A greater proportion of ANG carcasses were classified as upper 2/3 Choice while a greater proportion of SIMANG carcasses were included in the lower 1/3 Choice designation. Carcass value per cwt was greater for ANG compared to SIMANG carcasses while other economic responses were similar. Feeding ZH improved ADG, YG, and REA and resulted in increased YG 2 carcasses. Total carcass value was greater for ZH compared to CON. While CON had increased IMF during ZH feeding, this did not manifest into differences in QG. Breed composition influenced carcass grid premiums, but not overall carcass value. Feeding ZH improved carcass value by increasing HCW. Responses among breed composition were as expected for ANG vs SIMANG cattle types. The resultant economic effect was that grid premiums for higher-grading ANG cattle were offset by larger HCW for SIMANG, leading to similar overall carcass values. Finally, the influence of ZH on growth and carcass traits was as expected with increased carcass value being realized through heavier HCW.

INTRODUCTION

Inclusion of the β–adrenergic agonist zilpaterol hydrochloride (ZH, Zilmax®, Merck Animal Health, Summit, NJ) in beef finishing diets has been shown to have dramatic effects on skeletal muscle growth. This shifts the composition of gain and results in improvements in ADG and F:G in the feedlot, as well as increases in dressing percentage, HCW and cutability of the carcass (Delmore et al., 2010). Much work

[1] Funded by the South Dakota Agriculture Experiment Station and the SDSU Research/Scholarship Fund.

has focused on the effects of feeding ZH to a single 'type' of cattle but our understanding of feeding ZH to cattle with differing breed compositions commonly used in the Northern Plains (Angus (ANG) and SimAngus (SIMANG) is limited.

Angus and SIMANG cattle have inherent differences in muscle and adipose composition that could result in differential responses to ZH. Therefore, the objective of this study was to determine the effect of ZH on growth performance, carcass characteristics and production economics of feedlot cattle with varied breed composition.

MATERIALS AND METHODS

Animals and Basal Diet

The South Dakota State University (SDSU) Institutional Animal Care and Use Committee approved all procedures involving animals. Cows at the SDSU Cottonwood and Antelope Research stations, of primarily Angus genetics, were artificially inseminated to 1 of 2 bulls. Bulls were either 100% Angus or 50% Angus × 50% Simmental from a common Angus sire (GAR Predestined, American Angus Association Registration Number 13395344). Purebred Angus clean-up bulls from the same sire were used to complete a 60-d breeding season. Steer progeny (n = 133) were transported post-weaning to the University of Nebraska Panhandle Research Center feedlot. Steers were fed a common 60% roughage:40% concentrate (DM basis) backgrounding diet for 45 d prior to the start of the project. At the start of the experiment, steers were fed a 45% roughage:55% concentrate diet and were adapted using 3 diets over a 63-d period to reach the final diet of 16% roughage:84% concentrate. Steers remained on this diet until marketed (97 d or 126 d). Diet ingredients were alfalfa hay, corn silage, wet distillers grains plus solubles (WDGS), dry rolled corn (DRC), and a supplement (supplement was formulated to include 0.3% urea and to provide a dietary DM inclusion of 0.3% salt, 60 ppm of Fe, 40 ppm of Mg, 25 ppm of Mn, 10 ppm of Cu, 1 ppm of I, 0.15 ppm of Se, 1.5 IU/g of vitamin A, 0.15 IU of vitamin D, 8.81 IU/kg of vitamin E. Monensin (Rumensin®, Elanco Animal Health, Indianapolis, IN) and tylosin (Tylan®, Elanco Animal Health) were fed at 360 and 90 $mg \cdot hd^{-1} \cdot d^{-1}$, respectively. Varying combinations of these ingredients were used to formulate least cost diets throughout the feeding period. All steers were implanted with 36 mg zeranol (Ralgro®, Merck Animal Health, Summit, NJ) at d -2 of trial initiation. Steers were re-implanted at 70 d with 200 mg trenbolone acetate and 40 mg estradiol (Revalor®-XS, Merck Animal Health, Summit, NJ).

Experimental Design and Treatments

Angus-sired (n=76) and SIMANG-sired (n=57) steers were allocated to a randomized incomplete block design with 4 blocks of ANG and 3 blocks of SIMANG. Treatments were arranged as a 2 × 2 factorial of sire breed and finishing diets fed with (ZH) or without (CON) ZH (8.3 ppm of DM) for 20 d prior to slaughter. Initial BW of 598.8 ± 41.6 lb and 610.1 ± 41.6 lb (least squares means ± SEM) for ANG and SIMANG, respectively, tended to differ (P = 0.082). Using initial BW as the blocking factor, steers were stratified by initial BW into blocks of four pens (9 or 10 steers per pen) with ZH treatment randomly assigned within each breed composition x block combination. The experimental design resulted in 4 BW blocks (3 complete and 1 incomplete with only 2 pens of ANG represented), 7 pen replicates per ZH treatment, 8 pen replicates of ANG, 6 pen replicates of SIMANG, 4 pen replicates of each ZH x ANG treatment combination, and 3 pen replicates of each ZH x SIMANG combination. Following a 3 d withdrawal from ZH, steers were marketed in 2 groups (153 d and 182 d on feed) when they were visually estimated to average 0.4 inch of 12^{th} rib backfat thickness. The first group was the heaviest 2 blocks and the second group was the lightest 2 blocks, so all treatments were equally represented at each harvest date.

Ultrasound measurements

Real-time ultrasound measurements were collected and analyzed to determine 12th rib subcutaneous fat thickness, percent intramuscular fat (IMF) and ribeye area (REA) of each steer using an Aloka 500V instrument (Aloka, Wallingford, CT). Initial ultrasound measurements were collected 4 d prior to ZH inclusion and final measurements on the morning of harvest. Body weights were also collected at these time points. Differences (final – initial) in fat thickness, IMF, and REA were calculated to evaluate change in carcass composition during the ZH feeding period.

Slaughter and Carcass Data Collection

Final BW was measured when steers were ultrasounded on the morning of slaughter (final BW was adjusted by 4% to represent a standard shrink). Steers were transported approximately 123 miles to a commercial packing plant (Cargill, Fort Morgan, CO) where they were slaughtered under standard, humane harvest procedures. Carcasses were tracked through the harvest floor to maintain animal identification. Individual HCW were recorded at slaughter. Ribeye area, 12th rib backfat, and percentage KPH were recorded by university-trained personnel. Marbling score and QG were assigned by a USDA grader. Hot carcass weight, REA, 12th rib backfat, and KPH were then used to calculate USDA YG for each individual carcass.

Economic Analysis

Economic data were collected and analyzed to determine treatment differences in $/cwt carcass value, total carcass value per steer ($/steer), feed cost of gain (FCOG, $/lb), and return on feed ($/steer). Individual carcasses were priced on the Fort Morgan Angus America Marketing Agreement grid in place during the period these cattle were harvested. Carcass values ($/cwt and $/steer) were taken directly from closeout sheets for individual animals based on HCW, carcass quality and YG. Actual daily feed costs were determined and used to calculate FCOG, which was calculated as the pen mean of actual pen feed cost·head^{-1}·day^{-1}· divided by ADG. Feed costs make up the largest cost for finishing cattle; therefore the return on feed was used as a baseline net return comparison. Return on feed per head was calculated by subtracting total feed cost from total carcass value.

Statistical Analysis

One animal died during the treatment period and was excluded from the dataset. Continuous response variables, including growth, measured carcass traits, and economic responses were analyzed as a 2 × 2 factorial treatment structure in a randomized incomplete block design using the MIXED procedure of SAS (SAS Inst.Inc., Cary, NC). Pen served as the experimental unit and was included as a random effect. Breed composition, ZH treatment, and their interaction were included as fixed effects. The Kenward-Roger option was used to calculate denominator degrees of freedom. Least squares means were calculated, and because the ZH × breed composition interaction was never significant ($P > 0.05$), were separated by the F-tests of fixed effects. Because the QG and YG classifications of each carcass conform to binomial distributions, the proportion (number graded in the class divided by number in the pen) of carcasses in each grade classification were analyzed as binomial distributions in the GLIMMIX procedure of SAS using the same model as above.

RESULTS AND DISCUSSION

Zilpaterol hydrochloride is a potent beta-adrenergic agonist that elicits a compositional change by increasing muscle synthesis and decreasing adiposity of growing animals (Mersmann, 1998). Previous research has investigated the impact of ZH on performance and carcass characteristics within cattle of

similar breed composition such as calf-fed Holsteins (Beckett et al., 2009); however, it is unknown whether cattle of different genetic backgrounds will respond differently to ZH. Therefore, the objective of this study was to determine whether cattle of different breed compositions common to the Northern Great Plains would have a differential response to ZH supplementation.

The ZH × breed composition interaction did not influence ($P > 0.05$) any of the feedlot performance, carcass, or economic traits evaluated in this study, therefore only the main effects of ZH treatment and breed composition are presented. Gruber et al. (2007) investigated the effects of ractopamine hydrochloride on feedlot steers of varying genetic backgrounds and reported no interaction between treatment and breed composition. Ractopamine hydrochloride functions to increase protein synthesis while ZH has been shown to both increase protein synthesis and decrease degradation resulting in increased REA, decreased fat thickness and higher yielding carcasses (Scramlin et al., 2010). The lack of interaction in the present study indicated that even though the steers differed in genetic background, they responded similarly to ZH.

Breed composition did not affect ($P > 0.05$) cumulative ADG, final BW, DMI, or F:G of steers (Table 1). Changes in ultrasound fat thickness, REA, percent IMF, and ADG during the ZH feeding period were not different ($P > 0.05$) between the breed compositions of cattle investigated in this study. These results indicate ANG and SIMANG cattle responded similarly in regard to deposition of the muscle and fat tissues evaluated over the ZH treatment period. Carcass evaluation revealed no difference ($P > 0.05$) in HCW between breed compositions; however, SIMANG had a larger ($P < 0.05$) REA and improved ($P < 0.05$) YG compared with ANG carcasses. Carcasses produced by SIMANG steers also tended to have reduced ($P < 0.10$) fat thickness. Marbling score was greater ($P < 0.01$) in ANG carcasses compared with SIMANG. SimAngus-sired steers produced a greater proportion ($P < 0.05$) of YG 2 and lower proportion of YG 3 ($P < 0.05$) carcasses than ANG steers (Table 2). A greater proportion ($P < 0.05$) of ANG carcasses were classified as upper 2/3 Choice and there was a trend for a greater proportion ($P < 0.15$) of ANG carcasses grading Prime. There was no difference ($P > 0.05$) in the number of carcasses grading Select. However, there was an increase ($P < 0.05$) in the proportion of SIMANG carcasses classified in the lower 1/3 of the Choice grade compared with ANG. Carcass value per cwt was greater for ANG than SIMANG ($P < 0.01$) because of premiums on the grid for higher quality-grading carcasses. However, overall carcass value per head was similar ($P = 0.61$) as a result of greater value per cwt for ANG carcasses multiplied by numerically lower HCW for ANG than SIMANG carcasses. Feed cost of gain and return on feed were not ($P > 0.44$) influenced by breed composition.

Supplementation with ZH for 20 d prior to slaughter improved ($P < 0.05$) ADG during the ZH feeding period, did not affect ($P > 0.05$) overall ADG or DMI over the entire feeding period, but tended to improve ($P = 0.07$) overall F:G (Table 1). Supplementation with ZH had no effect ($P > 0.05$) on final BW. The difference between ultrasound measurements taken 4 d prior to ZH supplementation and on the day of slaughter revealed ZH treated cattle tended ($P < 0.10$) to gain more REA during the treatment period compared with CON while CON cattle accumulated more ($P < 0.01$) intramuscular fat than ZH. Fat thickness between the initial and final ultrasound was not different ($P > 0.05$) between treatments. Carcasses from ZH treated steers tended to have heavier ($P < 0.10$) HCW than CON steers as well as increased ($P < 0.001$) REA and improved ($P < 0.05$) YG. Despite greater accretion of IMF during the ZH feeding period, CON carcasses had similar ($P > 0.10$) marbling scores to ZH carcasses. In agreement with similar change between treatments in ultrasound fat thickness during the ZH feeding period, carcass backfat thickness was similar ($P > 0.10$) between ANG and SIMANG. Additionally steers supplemented with ZH produced a greater ($P < 0.05$) percentage of YG 2 carcasses and tended to produce fewer ($P < 0.10$) YG 3 than CON fed steers (Table 2). Supplementation with ZH did not affect ($P = 0.58$) distribution

of QG compared to CON carcasses. Steers supplemented with ZH produced carcasses with increased total value ($P < 0.05$) compared to CON; however, there were no differences ($P > 0.10$) between treatments for price per cwt, FCOG, or return on feed.

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Table 1. Least squares means and SEM for performance trait responses to main effects of cattle breed composition and zilpaterol hydrochloride (ZH)[1] supplementation[2]

	Breed Composition		ZH, ppm of DM				
Item	**Angus**	**SimAng**	**0**	**8.3**	**SEM**	***P* > F[3]**	***P* > F[4]**
ADG, initial-final, lb	3.83 ± 0.165[5]	3.87 ± 0.180	3.76	3.94	0.172	0.790	0.198
Final BW, lb[6]	1224.7 ± 28.8	1241.9 ± 31.0	1221.4	1245.0	29.7	0.451	0.281
DMI, lb·steer^{-1}·d^{-1}	21.91 ± 1.274	22.13 ± 1.285	22.15	21.89	1.278	0.574	0.423
F:G, lb·lb^{-1}	5.81 ± 0.520	5.72 ± 0.532	5.98	5.55	0.524	0.705	0.071
Fat change[7], in	0.04 ± 0.015	0.03 ± 0.017	0.04	0.03	0.016	0.677	0.490
REA change[7], cm^2	1.1 ± 0.46	0.7 ± 0.49	0.6	1.2	0.47	0.298	0.092
IMF change[7], %	0.29 ± 0.188	0.39 ± 0.207	0.61	0.07	0.195	0.583	0.010
ADG, ZH feeding period, lb	2.31 ± 0.191	2.44 ± 0.233	1.96	2.79	0.209	0.674	0.017
HCW, lb	787.2 ± 17.8	796.6± 18.9	778.4	805.4	18.3	0.475	0.052
REA, cm^2	13.7 ± 0.28	14.3 ± 0.30	13.4	14.6	0.29	0.028	0.001
Yield grade	2.95 ± 0.079	2.62 ± 0.091	2.96	2.60	0.086	0.020	0.014
Fat thickness, in	0.58 ± 0.025	0.51 ± 0.02	0.57	0.53	0.027	0.093	0.369
Marbling score[8]	592.5 ± 22.4	486.2 ± 24.4	544.4	534.4	23.1	0.001	0.581
$/cwt[9]	210.43 ± 2.47	207.69 ± 2.50	209.03	209.09	2.48	0.009	0.938
Carcass Value, $/steer	1672.81 ± 50.50	1658.65 ± 52.30	1633.32	1698.13	51.19	0.617	0.038
Feed COG[10], $/lb	0.199 ± 0.017	0.194 ± 0.017	0.197	0.196	0.017	0.443	0.922
Return on feed, $/steer	1043.32 ± 43.22	1047.73 ± 46.37	1029.44	1061.61	44.39	0.896	0.322

[1] Zilpaterol hydrochloride was administered during the final 20 d of the finishing period.

[2] The breed composition × ZH interaction did not affect ($P > 0.05$) any performance traits.

[3] Probability of a greater F value for the main effect of breed composition.

[4] Probability of a greater F value for the main effect of ZH treatment.

[5] LS mean ± SEM

[6] Final BW were adjusted by 4% as per standard industry shrink.

[7] Change in ultrasound backfat thickness (FT), ribeye area (REA), and intramuscular fat (IMF) during the 20-d ZH feeding period.

[8] 400 = Slight^0; 500 = Small^0; 600 = Modest^0

[9] Weighted mean grid price per cwt of HCW.

[10] Feed cost of gain

Table 2. Least squares means and SEM for proportion of carcasses in each USDA YG and QG in response to main effects of breed composition and zilpaterol hydrochloride (ZH)[1] supplementation[2]

	Breed Composition		ZH, ppm of DM			
Item	**Angus**	**SimAngus**	**0**	**8.3**	***P* > F[3]**	***P* > F[4]**
Calculated USDA YG[5]						
2	0.2785 ± 0.060	0.5726 ± 0.074	0.3015 ± 0.066	0.5450 ± 0.070	0.016	0.034
3	0.6872 ± 0.074	0.4020 ± 0.062	0.6501 ± 0.081	0.4429 ± 0.085	0.019	0.059
USDA QG[6]						
Prime	0.1224 ± 0.039	0.0351 ± 0.024	0.0837 ± 0.042	0.0526 ± 0.029	0.140	0.558
Upper ⅔ Choice	0.6843 ± 0.053	0.3308 ± 0.063	0.5151 ± 0.064	0.5023 ± 0.069	0.006	0.895
Lower ⅓ Choice	0.1292 ± 0.039	0.5297 ± 0.068	0.2527 ± 0.062	0.3308 ± 0.066	0.002	0.413
Select	0.0496 ± 0.029	0.1232 ± 0.061	0.0789 ± 0.042	0.0788 ± 0.042	0.208	0.998

[1] ZH was administered during the final 20 d of the finishing period.

[2] The breed composition × ZH interaction did not affect ($P > 0.05$) USDA yield and quality grades.

[3] Probability of a greater F value for the main effect of breed composition.

[4] Probability of a greater F value for the main effect of ZH treatment.

[5] Only YG 2 and 3 are reported herein because none of the carcasses graded YG 1 or 5, and only 2 Angus carcasses that did not receive ZH graded YG 4.

[6] None of the carcasses graded Standard or lower.

BEEF 2015-10

A six year summary of feedlot health records from the Opportunities Farm[1,2]

H. Carroll[3], R. McDaniel[3], and M. Loewe[4]

[3]Department of Animal Science, South Dakota State University
[4]Opportunities Farm, Lennox SD

SUMMARY

Livestock housing at the Opportunities Farm is comprised of three different cattle feeding pen designs. The three pen designs are a monoslope barn (MON), open pens (OPN), and open pens with shelter over the feeding area (OS). Analyses of 6 years of data ranging from 2008 through 2013 were conducted. Morbidity and mortality rates for each year were compared for all cattle fed during the six year interval, regardless of feeding facility design. Cattle fed at the Opportunities Farm during this period had morbidity and mortality rates equivalent to what would be expected by feedlots throughout North America. Morbidity significantly differed by year. Specifically, year influenced incidences of respiratory disease, foot rot, and lameness but had no effect on mortality. A comparative analysis of the effect of feeding pen design on cattle health was conducted. The OPN design had higher total morbidity and incidence of respiratory disease than the OS design. No differences relative to facility design were found for any other animal health measure.

INTRODUCTION

Opportunities to feed cattle in the Northern Plains states continue to expand. With this expansion, different feeding facility designs are a common discussion among producers. Little information about cattle feeding pen designs and its impact on animal health is available to feedlot managers common to this geographic area. Cattle morbidity and mortality rates impact the success of a feedlot from both an economic and animal welfare perspective. Some studies have found overall morbidity rates to be 15-45% and mortality rates to be 1-5% for feedlot cattle (Irsik et al., 2006; Kelly and Janzen, 1986; Loneragan et al., 2001), but none have specifically compared feeding facility designs. Investigations of the impacts of feeding facility design on cattle health and welfare will assist feedlot managers and allied industry experts in making management decisions. The objectives of these analyses were 1) summarize the overall health performance of cattle fed at the Opportunities Farm during the period from 2008 to 2013, regardless of feeding facility design and 2) determine if feeding facility design has an impact on cattle health.

MATERIALS AND METHODS

The Opportunities Farm is a production-scale teaching classroom and outreach laboratory that consists of three unique cattle feeding facilities. The three cattle feeding facilities consist of 1) a monoslope barn

[1] Salaries provided by the Opportunities Farm or state and federal funds appropriated to South Dakota State University.
[2]Authors extend appreciation to R. Pritchard, D. Brake, and R. Daly for their contributions to data analysis and review of this article.

(MON), 2) dirt-mound open pens (OPN), and 3) partially-covered pens (OS). An expanded description of the three facilities can be found in the 2006 South Dakota Beef Report (Loe et al., 2006).

Data were obtained from 2008 to 2013 for the three facility designs at the Opportunities Farm near Lennox, SD. The cattle fed were typical of those in the region including predominantly Angus or Angus influenced cattle. Calves received during the fall typically arrived newly weaned and calves received at other times of the year were typically backgrounded. Occasional groups of long yearlings were received in July through September. The start and end dates for the record review were determined by the date that lots of cattle were shipped. Any unclear records were removed from the data set prior to analysis. A total of 10,609 head of cattle were placed into the Opportunities Farm feeding facilities during the review period.

Health records for treated animals typically included cattle ID, date, approximate weight, rectal temperature, number of times treated, treatment administered, dosage, illness diagnosis, and any additional comments. Death loss records typically included date, cattle ID, and suspected cause of death (some causes confirmed by necropsies).

Cattle morbidity was classified into six categories: respiratory, foot rot, lameness, pinkeye, digestive, or other based on individual treatment records. Respiratory included any diagnosis indicated as respiratory or diphtheria. Foot rot included diagnoses solely indicated as foot rot. Lameness included lameness/limps, leg wounds, or arthritis/sore joints, and edema. Pinkeye included only diagnoses of pinkeye. Digestive included any diagnosis indicated as digestive, enterotoxemia, coccidiosis, or bloat. The Other category included diagnoses indicated as hardware disease, nervous/uncoordinated, prolapse, haemophilus, droopy, or non-specific. Morbidity rates for each pen were calculated by dividing the number of animals treated by the number of cattle placed in the pen times 100. Total morbidity is the cumulative incidence of all health records.

Cattle mortality was classified into three categories: respiratory, digestive, and other. Respiratory cases included any diseases of the respiratory tract or mycoplasma. Digestive cases include any diseases of the digestive tract and abdominal abscesses. Other cases included any other diseases that do not fit into the respiratory or digestive categories (e.g. hardware disease, suicides, heat stress). Mortality rates for each pen were calculated using the same method as morbidity rates.

A summary of all of the cattle fed at the Opportunities Farm, regardless of feeding facility design, was conducted. All morbidity and mortality variables were assessed with a completely random design using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) with shipping date as the fixed effect.

Feeding facility was analyzed with a completely random design using the MIXED procedure of SAS with feeding facility as the fixed effect and lot of cattle as the random effect. This analysis was conducted using only common lots that were randomly allocated across the three feeding facilities to reduce the potential for the results to be confounded by origin and previous animal history. This analysis utilized a subset of the entire database including 54 observations.

RESULTS AND DISCUSSION

Total morbidity differed across year ($P < 0.01$; Table 1). Incidences of respiratory disease, foot rot, and lameness were impacted by year ($P \leq 0.05$). Cattle mortality did not differ by year ($P \geq 0.10$). The effect of year on cattle health is most likely influenced by variations in cattle source, cattle type, previous calf

history, weather, exposure to disease vectors, and pathogen load. During 2011 to 2013, several lots were administered metaphylaxis (mass medication) treatments (oxytetracycline dehydrate/flunixin meglumine[a], ceftiofur crystalline free acid[b], or tilmicosin phosphate[c]). The lots administered these treatments were high-risk weaned calves (BW typically around 500 lb) that experienced either drought or storm stress or were newly weaned calves purchased from a sale barn. These particular incidences exemplify the impact that cattle source, cattle type, and previous calf history can have on post-arrival health.

The results of the feeding facility comparison should be evaluated with caution given the small number of pens per facility (Table 2). The OPN design had higher incidence rates for total morbidity ($P = 0.02$) and respiratory cases ($P = 0.03$) than the OS design. No differences ($P > 0.20$) in designs were found for any other animal health measure.

ENDNOTES

[a] Hexasol Injection, Norbrook Laboratories Ltd., Newry, County Down, Northern Ireland.
[b]Excede Sterile Suspension for Cattle, Zoetis Animal Health, New York, NY.
[c]Micotil 300, Elanco Animal Health, Indianapolis, IN.

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Table 1. Morbidity and mortality rates by year at the Opportunities Farm from 2008 to 2013[1]

	2008	2009	2010	2011	2012	2013	SEM	P-value
Pens of cattle	21	27	15	20	22	25	-	-
Cattle fed, head	1,684	2,112	1,236	1,623	1,852	2,102	-	-
Total morbidity, %	2.6[a]	3.6[a]	8.5[b]	9.5[bc]	15.5[d]	11.1[cd]	2.5	< 0.01
Respiratory	0.44[a]	2.2[ab]	2.5[b]	5.8[c]	12.1[d]	7.7[c]	2.0	< 0.01
Foot Rot	0.77[a]	1.3[ab]	5.5[c]	2.3[b]	1.4[ab]	1.3[ab]	1.2	0.05
Lameness	0[a]	0[a]	0.17[b]	0.48[cd]	0.39[c]	0.58[d]	0.16	< 0.01
Pinkeye	1.4	0	0.08	0.19	0.73	0.78	0.47	0.09
Digestive	0	0.05	0.16	0.38	0.45	0.24	0.16	0.11
Other	0.17	0.05	0.42	0.58	0.92	0.77	0.29	0.06
Total mortality, %	0.47	0.71	0.99	0.62	0.66	0.92	0.26	0.61
Respiratory	0.12	0.10	0.07	0.12	0	0.14	0.08	0.74
Digestive	0.18	0.29	0.17	0.13	0.40	0.29	0.16	0.73
Other	0.17	0.3	0.75	0.3	0.26	0.49	0.17	0.14

[1]Year was determined by date that cattle were shipped.

[a,b,c,d]LSmeans within a row with different superscripts differ (*P*-value ≤ 0.05).

Table 2. Comparison of three feeding facility designs at the Opportunities Farm[1]

	OS	MON	OPN	SEM	*P*-value
n (pens)	18	18	18	-	-
Cattle fed, head	1452	1452	1449	-	-
Total morbidity, %	3.5[a]	5.1[ab]	7.4[b]	0.94	0.02
Respiratory	1.9[a]	2.9[ab]	4.9[b]	0.75	0.03
Foot Rot	1.0	1.1	1.4	0.40	0.75
Lameness	0.1	0.1	0.1	0.04	0.38
Pinkeye	0.5	0.7	0.7	0.21	0.79
Digestive	0.1	0.1	0.2	0.12	0.84
Other	0.2	0.3	0.2	0.16	0.93
Total mortality, %	0.6	0.6	0.8	0.21	0.82
Respiratory	0.1	0.1	0.1	0.08	0.81
Digestive	0.1	0.2	0.4	0.15	0.43
Other	0.4	0.3	0.3	0.12	0.74

[1]Analysis completed on common lots that were randomly allocated across the three feeding facilities from 2008 to 2013.

[a,b]LSMeans within a row with different superscripts differ (*P* < 0.05).

BEEF 2015-11

SDSU Calf Value Discovery 2013/2014 Summary Report[1]

J. A. Walker and W. C. Rusche

Department of Animal Science, South Dakota State University

SUMMARY

The Calf Value Discovery Program (CVD) allows cow-calf producers to gain knowledge of the finishing segment of the beef cattle industry and the marketing of fed cattle. Specifically, CVD provides an opportunity for cow-calf producers to learn how their calves perform in a feedlot and their carcass value when sold in a value-based marketing system. Each producer taking part in the program could consign 5 or more steers weighing between 500 and 800 pounds to the CVD program. Animals were finished at VanderWal Yards (Bruce, SD) in a calf-fed program using typical diets and management protocols. Carcass and feedlot performance information from calves were returned to producers for use in making future management decisions to improve profitability.

MATERIALS AND METHODS

Seven cow-calf operations in South Dakota and Minnesota consigned calves to the 2013-2014 CVD program. The number of animals consigned by producers ranged from 7 to 74. Calves were received on November 6 and 7, 2013. Upon receipt, calves were vaccinated against viral and bacterial respiratory (Bovi-Shield Gold BVD, Inforce 3, One-Shot, Zoetis, Florham Park, NJ) and clostridial pathogens.

For each animal, individual BW was recorded at arrival at the feedyard, on d 37, d 106, and on the day of shipment to harvest. A pencil shrink factor of 4% was applied to all weights. Since cattle were fed in a single pen, individual feed intake was calculated based on animal performance and diet energy content using NRC (2000) equations. At harvest, individual identification was tracked through the plant and individual carcass camera data, including hot carcass weight (HCW), 12th-rib fat thickness, ribeye area, percent kidney, pelvic, and heart fat (KPH), marbling score, and USDA Quality and Yield Grades, were reported by the plant.

Feeding expenses included feed costs, which were based on calculated individual intake as a fraction of actual feed delivery, yardage ($0.38 per animal per day), and veterinary expenses.

To estimate initial feeder calf values, weighted average feeder steer prices were obtained from the South Dakota Auction Market Summary report (USDA Agricultural Market Service report SF_LS795) for the two week surrounding November 6 and 7, 2013. These prices were regressed on selling weights. Using that equation and the actual weight at arrival, the estimated initial value of each calf was determined.

[1] Project supported by registration fees paid by participants. Mention of a proprietary product does not constitute a guarantee or warranty of the product by South Dakota State University of the authors and does not imply its approval to the exclusion of other products that may also be suitable.

Actual prices received were used to calculate carcass value and feeding period profitability for the grid based marketing method. To estimate what factors were associated with feeding performance or profit and quality grade for calves that finished the 2013-2014 CVD program, calves were divided into thirds based on net profit from the feeding period. Profit or loss for this analysis was determined by subtracting feeding expenses and the estimated initial calf value from the actual carcass value received. A general linear model was used to separate means between groups (PROC GLM, SAS Inst. Inc., Cary, NC). The association of USDA Quality Grade among profit groups was determined by χ_2 (PROC FREQ, SAS). Means were considered different when $P \leq 0.05$.

RESULTS AND DISCUSSION

Two calves died and one calf (1.86%) was removed from the program due to chronic health issues and their data were excluded from the analysis. Overall cattle performance data is presented in Table 1. Calves were placed with an average weight of 583 ± 109.8 lbs. Some calves were accepted into the program whose initial weights were outside the recommended range of 500 to 800 pounds. Average final BW for steers (average DOF = 212) was 1,271 ± 103.0 lb, and ADG was 3.24 lb/d. Averages for daily dry matter intake (DMI) and F:G ratio were 19.3 lb and 5.97, respectively. On average, steers were harvested at slightly less than the target fat thickness (0.4 in).

Expenses and returns are summarized in Table 2. On average, feeding costs were $528.39 per animal. When carcasses were sold on a grid basis, carcass value ranged from $1,171.22 to $2,414.23. Had the carcasses been sold on a dressed basis this range would have been smaller ($1,302.57 to $2,364.96). When including the initial value of the feeder calf, individual returns ranged from a loss of $250.63 to a profit of $600.34. Average return was $283.17 per steer.

In Table 3, the top 1/3 most profitable steers (High profit) had heavier placement and final weights compared to the Middle and Low profit groups ($P < 0.0001$). Steers in the High and Middle profit groups had a greater ADG compared to the Low profit group ($P = 0.04$). Higher profit group steers consumed more feed (DMI) and had poorer F:G compared to the Middle and Low profit groups ($P < 0.0001$). Based on NRC (2000) models, the High profit group would be expected to have decreased DMI and improved F:G compared to the Middle and Low profit groups. However, these estimates of individual feed intake and feed efficiency should be interpreted with caution as actual individual feed intake was not measured. Using these estimates of DMI, High and Middle profit steers had higher total costs than either the Low profit groups due to greater DMI (Table 5, $P < 0.001$).

Steers in the High profit group had heavier HCW and increased dressing percentage (Table 3, $P < 0.001$) than Low profit steers, with Middle profit steers being intermediate. The high profit group had increased marbling scores compared to Middle and Low groups (Table 3, $P < 0.003$). Ribeye area was larger for the High and Middle profit steers compared to the Low group ($P = 0.0005$). High and Middle profit steers had similar USDA Yield Grades, however, High and Low profit groups were different ($P = 0.05$). It should be noted that all profit groups' average USDA Yield Grade were within the same Yield Grade of 2. Twelfth-rib fat thickness was decreased in the Low profit group compared to the High and Middle profit groups ($P = 0.003$).

A increased proportion of the steers in the High profit group graded Choice or higher compared to the Middle and Low profit groups (Table 4, $P < 0.0001$). The premiums captured due to higher quality grades combined with an advantage in HCW resulted in significant differences in carcass values, $2,090.36, $1,910.16 and $1,704.28 for High, Middle, and Low profit group steers, respectively (Table 5, $P <$

0.0001). At the University of Illinois, researchers reported that 96% of the variation among carcass value can be explained by HCW, marbling and yield group (Retallick, et al., 2013). Even though the steers in the High profit group were heavier and thus more valuable at the start of the feeding period and had increased feeding cost than Low profit group, the greater carcass value resulted in a net return of $364.71 for the High profit steers compared to $281.60 and $203.21 for the Middle and Low groups, respectively. The feeding cost were increased for High and Middle profit groups compared to Low profit group; however, there was only $20.45 different between High and Low profit groups.

These results for calf-fed steers agree with similar data sets showing that the most profitable cattle were those that were the fastest gaining with the heaviest HCW and a greater percentage grading Choice or higher (Walter and Hale, 2011). Conversely those steers with the greatest losses were those with the poorest feedlot performance that had carcasses that were lighter and less likely to grade Choice.

For cow/calf producers, the Calf-Value Discovery Program provides feedback on feeding performance and carcass characteristics of calves and an opportunity to benchmark their calf crop to a larger group of cattle when placed in a calf fed system. Ultimately, market conditions and input prices can greatly impact feeding profitability from year to year, but these data provide useful guidelines for making selection and marketing decisions in the future.

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Table 1. Overall performance and carcass characteristics of cattle enrolled in the 2013-2014 South Dakota Calf-Value Discovery Program.

Item	Mean	SEM	Minimum	Maximum
Days on feed	212	18.0	186	230
SBW[a], lb				
D 0	583	109.8	305	854
D 37	678	117.7	357	952
D 106	929	127.0	591	1,248
Final	1,271	103.0	937	1,505
ADG, lb/d	3.24	0.32	2.22	3.90
DMI, lb/d	19.3	1.58	13.87	23.25
F:G	5.97	0.44	4.80	6.99
HCW, lb	803	69.9	547.3	985.4
Dress., %	63.14	2.21	54.67	68.91
12-th rib fat thickness, in.	0.35	0.13	0.08	0.72
Rib eye area, in^2	12.88	1.44	9.14	17.19
KPH, %	1.84	0.22	1.36	2.43
Marbling score[b]	424	89.6	270	720
USDA Yield Grade	2.27	0.76	1.00	4.00

USDA Quality Grade distribution	n	Percent
Prime	3	1.9
Choice	106	65.8
Premium Choice	25	15.5
Select	50	31.1
Dark Cutter	1	0.6
No roll	1	0.6

[a]SBW = Shrunk Body Weight (4% pencil shrink applied to BW)

[b]Marbling score: 300-399 = Slight, 400–499 = Small, 500-599 = Modest.

Table 2. Feeding expenses and carcass values of cattle enrolled in the 2013-2014 South Dakota Calf-Value Discovery Program.

Item	Mean	SEM	Minimum	Maximum
Feeder calf cost, $/steer	1,089.97	123.92	731.12	1,381.69
Feeding costs, $/steer				
Feed cost	398.47	27.76	305.34	463.94
Treatment cost	3.57	12.69	0.00	110.08
Total feeding cost	528.39	33.60	439.82	641.05
Grid marketing returns				
Carcass value, $/steer	1,901.54	187.00	1,171.22	2,414.23
Feeding profit[a], $/steer	1,353.82	173.09	710.95	1,840.42
Grid net profit, $/steer	283.17	117.02	(250.63)	600.34

[a]Feeding profit is carcass value minus feeding cost.

Table 3. Feedlot performance and carcass characteristics of steers enrolled in the 2013-2014 South Dakota Calf-Value Discovery Program according to profit group.

	Profit Group				
Item	**High**	**Middle**	**Low**	**SEM**	**P-Value**
Number of head	54	53	54		
Days on feed	204[a]	214[b]	218[b]	2.36	< 0.0001
SBW[d], lb					
D 0	674[a]	586[b]	491[c]	11.03	< 0.0001
D 37	775[a]	683[b]	577[c]	11.74	< 0.0001
D 106	1,038[a]	934[b]	815[c]	12.18	< 0.0001
Final	1,353[a]	1,277[b]	1,183[c]	10.42	< 0.0001
ADG, lb/d	3.33[a]	3.23[a]	3.17[b]	0.04	0.04
DMI[e], lb/d	20.5[a]	19.3[b]	18.0[c]	0.17	< 0.0001
F:G	6.19[a]	5.99[b]	5.72[c]	0.05	< 0.0001
HCW, lb	869[a]	806[b]	733[c]	5.83	< 0.0001
Dress., %	64.2[a]	63.2[b]	62.0[c]	0.28	< 0.0001
12-th rib fat thickness, in.	0.38[a]	0.37[a]	0.30[b]	0.02	0.003
Rib eye area, in^2	13.4[a]	13.0[a]	12.3[b]	0.19	0.0005
KPH, %	1.83	1.86	1.85	0.03	0.75
Marbling score[f]	456[a]	416[b]	400[b]	11.95	0.003
USDA Yield Grade	2.44[a]	2.26[a,b]	2.09[b]	0.10	0.05

[a,b,c] Means within a row differ; P-values noted in table.

[d] SBW = Shrunk Body Weight (4% pencil shrink applied to BW)

[e] Calculated from BW and ADG

[f] Marbling score: 300-399 = Slight, 400-499 = Small, 500-599 = Modest.

Table 4. USDA Quality and Yield Grade distributions of steers enrolled in the 2013-2014 South Dakota Calf-Value Discovery Program according to profit group.

	Profit Group						
	High		Middle		Low		
Quality Grade	**n**	**Percent**	**n**	**Percent**	**n**	**Percent**	**P-Value**
Prime	3	5.6	0		0		< 0.0001
Choice	43	79.6	38	71.7	25	46.3	
Premium Choice	15	27.8	5	9.4	5	9.3	
Select	8	14.8	15	28.3	27	50.0	
No Roll	0		0		1	1.9	
Dark Cutter	0		0		1	1.9	
Yield Grade							
1	6	3.7	8	5.0	11	6.8	0.05
2	21	13.0	24	14.9	28	17.4	
3	24	14.9	20	12.4	14	8.7	
4	3	1.9	1	0.6	1	0.6	
5	0		0		0		

Table 5. Feedlot performance and carcass characteristics of steers enrolled in the 2013-2014 South Dakota Calf-Value Discovery Program according to profit group.

	Profit Group				
Item	**High**	**Middle**	**Low**	**SEM**	**P-Value**
Feeder calf cost, $/steer	1,188.48	1,097.23	984.34		
Feed cost	412.90[a]	401.06[b]	381.49[c]	3.39	< 0.0001
Treatment cost	1.53	3.13	6.05	1.74	0.173
Total feeding cost	537.17[a]	531.33[a]	516.72[b]	4.49	0.0045
Grid marketing returns					
Carcass value, $/steer	2,090.36[a]	1,910.16[b]	1,704.28[c]	13.67	< 0.0001
Feeding profit[a], $/steer	1,533.95[a]	1,359.42[b]	1,168.20[c]	11.87	< 0.0001
Grid net profit, $/steer	364.71[a]	281.60[b]	203.21[c]	13.32	< 0.0001

[a,b,c] Means within a row differ; P-values noted in table.

[d] Feeding profit is carcass value minus feeding cost.

BEEF 2015-12

SDSU Cow/Calf Teaching and Research Unit[1]

Cody Wright, Kevin Vander Wal, and George Perry

Department of Animal Science, South Dakota State University

SUMMARY

The SDSU Cow/Calf Unit (CCU) is a multi-purpose facility that provides resources for Animal Science courses and research projects. Cattle produced at the facility are also utilized by Little International, Block and Bridle, and livestock judging teams. The facility is managed by Kevin Vander Wal and generally employs 4 to 5 undergraduate students.

BREEDING PROGRAM

Although the CCU has a multi-purpose mission, the breeding program is primarily centered on the production of bulls and females that can be used for teaching purposes and sold to the general public. Artificial insemination is used extensively. The program primarily utilizes proven sires; however, each year a percentage of the females are bred to younger sires with lower accuracy expected progeny differences (EPDs). The objective of the breeding program is to produce docile cattle with excellent calving ease, growth, and carcass characteristics. Average expected progeny differences of the cows, heifers, and AI sires used in 2014 are included in Tables 1 and 2.

Table 1. Average expected progeny differences of Angus cows, heifers, and AI sires used in 2014.

	Expected progeny differences[a]									Value Indexes[b]	
	CED	BW	WW	YW	SC	Milk	Marb	REA	Doc	$W	$B
Cows	7.2	1.6	51.6	92.4	0.90	27.7	0.48	0.58	12.6	37.19	79.52
Heifers	6.8	1.8	56.9	99.9	0.93	28.5	0.50	0.71	12.9	36.36	86.92
AI sires	11.0	0.5	63.6	114.8	1.27	34.8	0.99	1.09	25.6	51.40	108.20

[a]CED = calving ease direct; BW = birth weight; WW = weaning weight; YW = yearling weight; SC = scrotal circumference; Milk = maternal milk; Marb = marbling score; REA = ribeye area; Doc = docility

[b]$W = wean value; $B = beef value

[1] The authors would like to acknowledge Zoetis Animal Health for product donations (Eazi-Breed CIDRs, Lutalyse, and Factrel) toward the synchronization research projects, and Western Point, Inc., Apple Valley, MN for the donation of EstroTect patches. Salaries and research support were also provided by state and federal funds appropriated to South Dakota State University.

Table 2. Average expected progeny differences of SimAngus™ cows, heifers, and AI sires used in 2014.

	Expected progeny differences[a]								Indexes[b]	
	CE	**BW**	**WW**	**YW**	**MLK**	**Marb**	**REA**	**Doc**	**API**	**TI**
Cows	15.3	-1.6	56.4	90.0	26.4	0.50	0.73	11.3	146.5	72.4
Heifers	15.6	-1.6	60.9	97.3	28.7	0.47	0.90	11.8	150.7	76.9
AI Sires	13.2	-0.5	71.6	113.4	29.0	0.54	0.95	14.7	151.9	83.7

[a]CE = calving ease; BW = birth weight; WW = weaning weight; YW = yearling weight; MLK = milk; Marb = marbling score; REA = ribeye area

[b]API = all-purpose index; TI = terminal index

REPRODUCTIVE PERFORMANCE

In 2014, the cowherd was utilized in a reproductive experiment. The standard 7-d CO-synch + CIDR program was applied to all cows. Estrotect patches were applied at time of CIDR removal. At 60 hours after CIDR removal, patches were read and animals were placed into four groups (Table 3).

Table 3. Experimental design beginning 60 h after CIDR insert removal and prostaglandin F_{2a} delivery.

		Time since CIDR removal, h	
Patch score[1] (estrus classification)	**Treatments**	**60**	**75**
Nearly or 100% activated - estrus	Estrus control (CON)	AI + GnRH	…
Anything less - nonestrus	Early GnRH and early AI (E-E)	AI + GnRH	…
Anything less - nonestrus	Early GnRH but delayed AI (E-D)	GnRH	AI
Anything less - nonestrus	Delayed GnRH and delayed AI (D-D)	…	AI + GnRH

[1]Patch scores (2 = fully, 1 = partly, or 0 = not activated per photos).

There were 102 cows on the study. Sixty cows had activated patches at 60 hours (CON) and an AI conception rate of 78% (47/60). Of the remaining 42 females, 14 were allotted to the each of the remaining treatments (E-E, E-D, and D-D). Conception rates for the E-E, E-D, and D-D groups were 71% (10/14), 50% (7/14), and 50% (7/14), respectively. Caution should be exercised when evaluating these data. Because of the small number of cows, the data have not been analyzed statistically and have been included in a larger, multi-state study that includes herds from KS, ND, CO, MS, MN, FL, and IL.

SALES

Each April, the SDSU Seedstock Merchandising class coordinates an annual bull sale at the CCU. The sale is designed to be a learning experience for the students and they are responsible for advertising, promotional videos, developing the sale catalog, and customer service. In 2014, the bull sale attracted customers from SD, IA, and MN. The sale included 16 Angus and 15 SimAngus™ yearling bulls. Results of the sale are presented in Table 4.

Table 4. Results from 2014 annual bull sale

	Lots	Average	Range
Angus bulls	16	$5087.50	$2800-$8600
SimAngus™ bulls	15	$4053.33	$3000-$5700
Overall bull average	31	$4587.10	
Angus sire groups			
Connealy Consensus 7229	1	$4166.67	
Connealy Final Solution	3	$6033.33	
Connealy Imprint 8317	1	$5500.00	
Hoover Dam	3	$3766.67	
KM Broken Bow 002	2	$7300.00	
S Chisum 6175	1	$5600.00	
SAV Pioneer 7301	1	$4500.00	
VAR Rocky 80029	2	$4650.00	
Simmental and SimAngus sire groups			
Gibbs 0689X Crimson Tide	3	$3433.33	
Hooks Shear Force 38K	2	$4400.00	
MR NLC Upgrade U8676	5	$4660.00	
S D S Graduate 006X	1	$3500.00	
TJ Sharper Image 809U	3	$3966.67	
TNT Finale W241	1	$3000.00	

NEW FACILITY

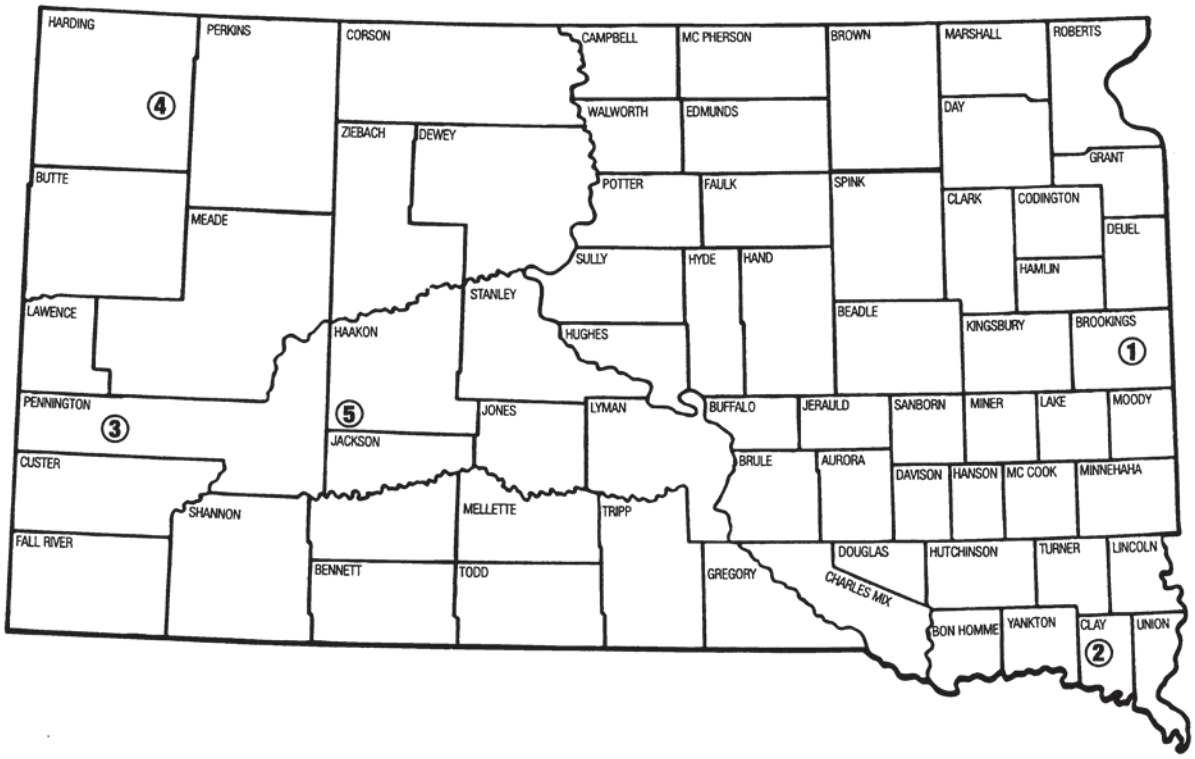
The current CCU was built in 1950 and, while it is a functional facility for managing a cowherd, it has significant limitations as a teaching and research facility. One of the components of the Land-Grant mission is teaching. Our objective is to provide our students with the best education possible and a large component of educational process is experiential learning (i.e., learning by doing). The current facility is not well equipped to provide a positive learning experience to students. A second component of the Land-Grant mission is research. Conducting research that answers production related questions and provides new technology to producers is essential to the long-term viability of the beef industry in South Dakota. Other than a small group of replicated pastures, the current CCU is not equipped to support research. The final component of the Land-Grant mission is Extension and outreach. Effective transfer of new knowledge and technology from the university to end users allows for the most current research findings to be adopted by the industry. The new facility will greatly enhance the ability of our faculty and staff to conduct informational meetings, trainings, and seminars to producers and industry professionals.

Final plans are in place for a new facility near campus to support the teaching, research, and Extension efforts in beef cattle production. The new facility will be equipped with Insentec individual feeding units that will allow for collection of individual feed intake and application of individual treatments to cattle within the same pen. The new facility will also have Insentec water units that will allow us to quantify water intake during different times of the year, during different stages of production, and with different types of diets. The water units will also be individually plumbed and equipped with dose meters that will allow for application of treatments via the water supply. This equipment will greatly enhance the ability of the facility to support numerous types of research in nutrition, genetics, reproduction, health, and other disciplines without having to expand the current cowherd. The facility will also be constructed to

facilitate biosecurity of the cattle fed there. We will be able to house both feedlot cattle and our own cattle in the facility at the same time. The facility will also enhance our ability to teach and conduct Extension and outreach activities. It will be equipped with a classroom and an indoor working facility to allow students and producers to be exposed to hands-on learning experiences throughout the year.

We continue to raise funds from both individuals and allied industry partners. Numerous families and corporate partners have made incredibly generous commitments to the project, but we still need more financial commitments before we can break ground on this facility. If you would like to receive more information on the new facility or if you are interested in contributing to the project, please contact Dr. Cody Wright (cody.wright@sdstate.edu; 605-688-5448) or Mike Barber at the SDSU foundation (mike.barber@sdsufoundation.org; 605-697-7475).

Animal Science Research and Extension Units



1 Brookings: SDSU campus, Agricultural Experiment Station, Cooperative Extension Service

2 Beresford: Southeast South Dakota Research Farm
Beef cattle nutrition
Swine nutrition and management

3 Rapid City: West River Ag Center
Professional research and Extension staff in Animal Science, Range Science, Agronomy, Horticulture, Community Development, Economics, 4-H, and Extension administration

4 Buffalo: Antelope Range Livestock Station
Beef cattle breeding and range beef herd management
Sheep nutrition, management, and breeding

5 Phillip: Range and Livestock Research Station
Range beef nutrition and herd management
Range management

These research and Extension units are geographically located in South Dakota to help solve problems, bring the results of livestock and range research to users, enhance the statewide teaching effectiveness of the Animal Science Department staff, and maintain a close and productive relationship with South Dakota producers and the agribusiness community.

The state of South Dakota is · our campus · our research lab · our classroom