1988

1988 South Dakota Beef Report

Department of Animal and Range Sciences, South Dakota State University

Agricultural Experimental Station, South Dakota State University

Cooperative Extension Service, South Dakota State University

1988

SOUTH DAKOTA BEEF REPORT

Department of Animal and Range Sciences
Agricultural Experiment Station
Cooperative Extension Service
South Dakota State University

Animal and Range Sciences Department

FACULTY

	SPECIALTY	RESPONSIBILITY
BIRKELO, Carl P.	Ruminant Nutrition	Research, Teaching
BOGGS, Donald L.	Beef Cattle Nutrition and Management	Extension
COSTELLO, William J.	Meat Science	Teaching, Research
GARTNER, F. Robert	Range Science	Research, Teaching
GEE, Dan H.	Evaluation/Marketing	Teaching
GOEHRING, Terry B.	Beef Cattle Management	Extension
HAMILTON, C. Ross	Swine Nutrition	Research, Teaching
JOHNSON, James R.	Range Science	Extension, Research
JOHNSON, Patricia S.	Range Science	Research, Teaching
JOHNSON, Roger C.	Meat Science	Research, Teaching
LIBAL, George W.	Swine Nutrition and Management	Research, Teaching
MALES, James R.	Ruminant Nutrition	Department Head
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MCFARLAND, Douglas C.	Monogastric Nutrition and Muscle Biology	Research, Teaching
MILLER, Herley L.	Reproductive Physiology	Research, Teaching
PLUMART, Phillip E.	Poultry Science	Teaching, Extension
PRITCHARD, Robbi H.	Ruminant Nutrition	Research, Teaching
PRUITT, Richard J.	Cow-Calf Management	Teaching, Research
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SLYTER, A. Lowell	Reproductive Physiology	Research, Teaching
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THOMPSON, James M.	Sheep Production and Management	Extension
WAGNER, John J.	Ruminant Nutrition	Extension, Research

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Published in accordance with an act passed in 1881 by the 14th Legislative Assembly, Dakota Territory, establishing the Dakota Agricultural College and with the act of re-organization passed in 1887 by the 17th Legislative Assembly, which established the Agricultural Experiment Station at South Dakota State University.

SDSU

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Box 2170
Brookings, SD 57007-0392

Department of Animal and
Range Sciences
College of Agriculture and
Biological Sciences
Phone: (605) 688-5165

December 1988

Dear Friends:

The Animal and Range Sciences Faculty and Staff at South Dakota State University are pleased to present the 1988 edition of our BEEF REPORT. The past year has been one of change for the Beef industry and for SDSU. The Beef Referendum passed easily, the fed cattle market has been stronger than expected and cow-calf producers have finally realized feeder calf prices high enough to pay some bills. There are also some major questions facing the industry. As I write this, we do not know the impact the drought will have on cattle numbers or on feed prices and as a result feeder calf prices. There will be continuing competition between beef, poultry and pork for the consumers dollar which will force us to maintain efficiency.

The past year has also seen some changes in the College of Agriculture and Biological Sciences and in the Animal and Range Sciences Department at SDSU. Dr. David Bryant has completed his first year as Dean. Dean Bryant has listened to your concerns and pledged the Colleges' support to the South Dakota livestock industry. Two Extension Beef Specialists have joined our staff. Dr. Don Boggs, a native of Illinois, received his Ph.D. at Michigan State University, and is stationed in Brookings. Don joined us after five years at the University of Georgia as an Assistant Professor. Dr. Terry Goehring is located at the West River Agriculture Research and Extension Center in Rapid City. Terry received his B.S. from Iowa State and graduate degrees from SDSU and Kansas State University. For the year prior to joining us, Terry worked with the American Angus Association on their Certified Angus Beef program. Don and Terry join John Wagner and Larry Insley to fill our Extension Beef Specialists slots. Dr. Carl Birkelo has also recently joined our faculty. Carl is a Ruminant Nutritionist with background in the feedlot industry and training at Colorado State University in measuring energy requirements of cattle as affected by environment. Carl rounds out our research and teaching faculty in beef and range and will especially contribute to our research efforts in maintaining and feeding cattle through the stress of South Dakota winters and summers. Finally, we also have a new department head. I have been at SDSU since July after spending ten years as a faculty member in the Department of Animal Sciences at Washington State University.

We feel that the people are in place to serve the education, research and extension needs of the beef industry in South Dakota. We have a dedicated and capable staff of animal breeders, physiologists, nutritionists, range scientists and meat scientists ready to serve the needs of South Dakota's largest industry. We want to know your concerns and work closely with you, so do not hesitate to let us know what you think. Finally, on a personal note, I want to get to know you, so be sure and take a minute to say hello.

Sincerely,

Jim Males

James R. Males
Head, Department of Animal and
Range Sciences

SDSU

COOPERATIVE EXTENSION SERVICE

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December 1988

Dear Friends:

Thank you for examining our 1988 Beef Report. This reports contains information concerning the nutrition, management, physiology, genetics and economics of producing beef cattle. Beef cattle production is South Dakota's number one industry. I hope the information presented in this report helps maintain the viability and profitability of that industry.

The information in this report is intended for several audiences and has several levels of application. Some of the articles have immediate application on the farm, ranch or agribusiness. Other articles contain more scientific information whose application is perhaps not as immediate. These articles are intended to add to our knowledge of the basic biology of beef cattle. Information such as this will ultimately lead to new discoveries and technology that may improve profitability in the future.

The Animal and Range Sciences extension, research and teaching faculty at South Dakota State University welcome any questions or comments that you may have concerning the information found in this report. We are at the university to serve the citizens of South Dakota. Please use our services and knowledge to help make your operation or business as competitive and profitable as possible.

Have a healthy, happy and prosperous 1989!

Sincerely,

John J. Wagner

John J. Wagner, Ph.D.
Editor, South Dakota Beef Report

TABLE OF CONTENTS

CATTLE Page

Section IV - Physiology

Section V - Breeding

BEEF REPORT

INTERPRETING EXPERIMENTAL RESULTS

D. M. Marshall[1]
Department of Animal and Range Sciences

CATTLE 88-1

A typical experimental format involves evaluating the response caused by application of different treatments to experimental subjects (animals, carcasses, pens, pastures, etc.). The effect of a given treatment might be evaluated by comparison to a control group or to one or more other treatment groups. However, a problem with animal research (and other types as well) is that variation not due to treatments often exists among experimental subjects.

For example, suppose that animals receiving ration A grow faster than animals receiving ration B. Was the observed difference in growth rates actually due to differences in the rations or to other factors (i.e., genetics, age, sex, etc.) or some of each? Statistical analyses evaluate the amount of variation between treatment groups relative to the amount of variation within treatment groups. In addition, variation caused by factors other than treatments can sometimes be eliminated by the statistical analysis.

The statement "the difference was statistically significant (P>.05)" indicates the probability of a difference of that magnitude occurring from chance rather than from the research treatment is less than 5%.

A correlation coefficient provides an indication of the relationship between two factors and can range from -1 to +1. A strong, positive correlation (close to 1) indicates that as one factor increases the other factor tends to increase, also. For example, several studies have shown a positive correlation between cow milk yield and calf weaning weight. A strong negative correlation (close to -1) indicates that as one factor increases the other factor tends to decrease. A correlation near zero indicates the two factors are unrelated.

Means (averages), correlations and other statistics presented in research results are sometimes followed by $\pm$ some figure known as the standard error. The standard error provides an indication of the possible error with which the statistic was measured. The size of the standard error of a treatment mean depends on the animal to animal variation within a treatment group and on the number of animals in the group.

All other factors being equal, the greater the amount of animals and(or) replications per treatment, the smaller the difference required to achieve a given value for probability of significance. Stated another way, increasing the number of animals or replications increases the likelihood of detecting differences due to treatments when such differences do indeed exist.

Several of the research reports in this publication contain statistical terminology. Although such terms might be unfamiliar to some readers, the statistical analyses allow for more appropriate interpretation of results and make the reports more useful.

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[1] Assistant Professor.

BEEF REPORT

SDSU PUREBRED BEEF HERDS

R. J. Pruitt[1] and R. H. Haigh[2]
Department of Animal and Range Sciences

CATTLE 88-2

A herd of purebred Angus and Simmental cows is maintained at the Cow-Calf Teaching and Research Unit near the SDSU campus that is used for teaching, research and extension activities. Cattle maintained at this unit are used for introductory animal science, meats, animal breeding, reproductive physiology, beef production and livestock evaluation courses. Current reproductive physiology research under the direction of Dr. Herley Miller is reported elsewhere in this publication. Besides use in the classroom, cattle are used for the annual SDSU Little International, field days and numerous 4-H, FFA and other educational events. In addition to providing research information and an opportunity for education, this herd is providing a stimulus for interactions between students and faculty and an avenue for communication between faculty and producers in the region.

In 1989 approximately 55 Angus and 40 Simmental females will calve to some of the elite bulls of the industry as indicated by National Sire Summary information. The average expected progeny differences (EPD's) for the AI sires used in 1988 and the cow herd are reported in Table 1.

TABLE 1. EXPECTED PROGENY DIFFERENCES

	AI sires used in in 1988	Cow herd	Top 10% of cows for maternal weaning weight
Angus			
Birth weight	+ 4.1	+ 4.3	+ 5.4
Weaning weight	+ 31.3	+ 19.4	+ 25.8
Milk	+ 11.8	+ 1.6	+ 7.1
Combined maternal index	+ 27.0	+ 11.7	+ 20.0
Yearling weight	+ 59.5	+ 32.6	+ 40.6
Simmental			
Calving ease	98.2	97.5	97.3
Birth weight	+ .1	+ .3	+ .8
Weaning weight	+ 13.6	+ 4.9	+ 7.5
Yearling weight	+ 30.0	+ 12.7	+ 15.5
Maternal calving ease	103.9	102.8	101.8
Maternal weaning weight	+ 9.1	+ 6.8	+ 14.5
Maternal milk	+ 2.3	+ 4.3	+ 10.8

In addition to extensive AI, embryo transfer is being used to improve our purebred herd. This has been made possible by the generosity of Dr. Bill Hines, Spearfish, South Dakota, who has donated his time and expertise in performing the transfer procedures. Various South Dakota Simmental breeders have been generous in donating embryos.

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[1]Assistant Professor.
[2]Manager, Cow-Calf Teaching and Research Unit.

The EPD's for the Angus cows remaining in the herd that were born since 1982 and the projected EPD's for 1988 AI-sired heifers are presented in Table 2. Since 1982, nearly all AI-sired females have been kept for replacements unless culled for not being pregnant in the fall. Emphasis in the recent past has been to increase growth rate by selecting sires with high EPD's for yearling weight in the Angus Sire Summary whose daughters were near breed average or above for milk production. This has resulted in not only an increase in EPD's (Table 2) but also over a 100-lb increase in weaning weights of Angus bull calves from 1983-1987. Selection of sires in the near future will emphasize increasing growth rate and milk production of the cow herd while minimizing further increases in birth weight. This is reflected in the average EPD's of the AI sires used in 1988 (Table 1).

TABLE 2. GENETIC CHANGE IN THE SDSU ANGUS HERD

		Mean expected progeny differences				
Year of birth	No. cows	Birth weight	Weaning weight	Milk	Combined maternal index	Yearling weight
1982	6	4.2	12.4	-2.8	3.4	23.0
1983	3	4.1	19.8	-1.6	8.3	34.2
1984	6	3.0	17.8	.9	9.4	31.0
1985	7	4.1	18.3	-2.5	6.6	32.7
1986	5	5.1	20.5	3.7	14.0	35.3
1987	6	5.6	25.6	.1	12.9	41.0
1988	10	5.0	24.9	4.0	16.4	45.0
Change/year		+.25	+2.0	+1.0	+2.0	+3.3

The Simmental herd has been expanded in recent years so a similar comparison of change in our Simmental herd is not possible. The EPD's of the AI Simmental sires used in 1988 (Table 1) shows an emphasis in balancing an increase in growth rate, maternal calving ease and milk production while holding birth weight near breed average.

Calves produced each year are used extensively for teaching and extension activities. In the recent past yearling bulls produced in this herd have been used in the university's other research herds with a few bulls offered for sale. Our longer range goal is to conduct a student-run bull sale to offer students valuable experience in promotion and merchandising. The yearling bulls in 1988 produced the records shown in Table 3.

TABLE 3. RECORDS OF YEARLING BULLS IN 1988

Angus		Simmental	
Birth weight	92	Birth weight	100
Weaning weight (no creep)	627	Weaning weight (no creep)	694
Yearling weight	1072	Yearling weight	1190
Scrotal circumference, cm	38.2	Scrotal circumference, cm	37.0
Frame score	6.0	Frame score	7.6
Expected progeny differences		Expected progeny differences	
Birth weight	+ 5.5	Calving ease	98.5
Weaning weight	+27.9	Birth weight	-.1
Combined maternal index	+12.8	Weaning weight	8.0
Yearling weight	+45.1	Yearling weight	17.4
		Maternal calving ease	105.1
		Maternal weaning weight	6.4
		Maternal milk	2.0

Expected progeny differences (EPD's) on young, unproven bulls that are currently calculated by many breed associations offer us the most accurate method of selecting young bulls for calving ease, growth rate and productivity of their daughters. Frame scores are provided as an objective measurement related to mature size that can be used to increase the weight at choice grade of the calves produced or limit the mature size of a bull's daughters, whichever may be desirable for a particular situation. Scrotal circumference of yearling bulls is the most useful selection tool currently available to select for improved fertility because of a strong relationship between large scrotal size and increased bull fertility and early puberty in closely related females.

If you are interested in receiving performance information on our yearling and 2-year-old bulls to be offered for sale in April, 1989, contact Dick Pruitt or Ron Haigh of the Animal and Range Sciences Department.

BEEF REPORT

HIGH-MOISTURE EAR CORN AND CORN SILAGE IN BACKGROUNDING CATTLE DIETS

M. L. Sip[1], R. H. Pritchard[2] and M. A. Robbins[3]
Department of Animal and Range Sciences

CATTLE 88-3

Summary

One hundred ninety-two Angus x Limousin steer calves (560 lb) were used in an 85-day backgrounding trial. Dietary crude protein levels of 90, 100, 110 and 120% of the NRC factorial equation recommendation were used within ad libitum-fed corn silage diets (CS) and limit-fed chopped high-moisture ear corn (HMEC) diets. The objective was to determine if optimum dietary crude protein levels differed between these two basal diets when fed at similar levels of a net energy of gain. By design of the experiment, daily dry matter intake of HMEC diets was lower than CS diets (P<.001). ADG was similar across basal diets and feed conversion was improved (P<.001) with HMEC diets. Dietary crude protein level did not affect ADG. Quadratic decreases in the protein efficiency ratio occurred as dietary crude protein level increased (P<.01). Plasma urea N (PUN) levels were higher in calves fed HMEC diets (P<.05) and increased quadratically with increasing dietary crude protein level on day 56 (P<.05). This study suggests the NRC factorial equation estimates the gram daily crude protein requirement and can be used without modification to predict dietary crude protein needs of limit-fed feeder calves.

(Key Words: Steer Calves, Crude Protein, Limit-feeding, ADG, Feed Conversion.)

Introduction

Roughage-based backgrounding programs can provide economical gains and are an important crop marketing mechanism for farmer-feeder operations in South Dakota. High variability in the energy content of roughages yielding poor prediction of average daily gain (ADG) and, frequently, a relatively expensive unit cost of net energy of gain compared to concentrates suggest alternate feeding systems may benefit feeding operations which rely on substantial amounts of purchased feedstuffs.

An alternate backgrounding management scheme may involve the use of high-concentrate diets. Use of high-concentrate diets during the backgrounding phase would allow more accurate prediction of marketing dates. Intakes of high-concentrate diets may have to be limited to small or medium framed calves to prevent excessive subcutaneous fat deposition. Excess condition may limit subsequent pasture gains or reduce slaughter weight.

Use of limit-fed high-concentrate (LFHC) diets may create management problems. Limit-feeding may cause greater ruminal proteolysis of dietary crude protein and reductions in microbial growth that may result in reduced intestinal amino acid supplies available to support gains. Ad libitum feeding is believed to be necessary for acceptable cattle performance to occur during the winter. Ad libitum feeding allows ruminal conditions to be more stable and maximizes the heat of fermentation which aids in maintaining body temperature during the winter. Interrupted consumption of highly fermentable feed occurs with limit-feeding programs. The calf's rumen buffering capabilities may be exceeded because of this situation.

The present study had two objectives: (1) to determine if optimal dietary crude protein levels differed between ad libitum-fed corn silage diets (CS) and limit-fed chopped high-moisture ear corn diets (HMEC) and (2) to determine if calves limit-fed HMEC diets would perform similarly to contemporaries fed CS diets ad libitum during cold weather conditions.

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[1]Graduate Research Assistant.
[2]Associate Professor.
[3]Manager, Nutrition Unit.

Materials and Methods

Steer calves arrived at the feedlot 4 wk prior to initiation of the 85-day backgrounding trial. They were vaccinated for IBR, BVD, PI_3, BRSV, Haemophilus somnus and treated for parasites (Ivermectin) at that time. The steers were fed a corn silage receiving diet until initiation of the trial. Steers were randomly allotted to 24 pens of 8 head each. Two steers were removed from the trial due to causes unrelated to experimental treatment. Shrunk weights were taken on day 85 after a 24-hour feed and water withdrawal.

Predictions for dry matter intake (DMI) and nutrient requirements were based on the estimated mean weights of steers for each of the three 28-day feeding periods. Individual steer weights were taken every 14 days to aid prediction of the mean steer weights within each period.

Ad libitum consumption of CS diets was allowed throughout the trial. Intakes of HMEC diets were limited to provide energy levels sufficient to support ADG's similar to CS diets based on the calculated net energy values of the diets (Table 1). For formulation purposes, ad libitum consumption of CS diets was estimated to be 100 g DMI/kg $wt^{.75}$.

TABLE 1. BASAL DIETS[abc]

Ingredient	CS	HMEC
Corn silage	78.76	
High-moisture ear corn		72.84
Rolled corn	7.50	7.50
Soybean meal	11.78	16.87
Limestone	.48	1.02
Dicalcium phosphate	1.10	.80
Potassium chloride		.47
Trace mineralized salt	.38	.50
NEm, Mcal/lb[d]	.75	.88
NEg, Mcal/lb[d]	.46	.58

[a] All diets provided >17,000 IU of vitamin A/head/day and 210 mg/head/day of monensin.
[b] Percentage dry matter basis.
[c] CS = corn silage, HMEC = chopped high-moisture ear corn.
[d] Calculated values.

Dietary crude protein levels of 90, 100, 110, and 120% of the gram daily crude protein requirement recommended by the NRC factorial equation were used within each basal diet (Table 2). Restricting DMI of HMEC diets resulted in a lower gram daily crude protein requirement for HMEC diets because of a lower estimation of daily metabolic fecal N loss. The NRC factorial equation estimates metabolic fecal N losses as being 3.34% of DMI. All other components of the NRC factorial equation were considered similar across basal diets. Monensin was included in all diets at levels of 210 mg/head/day.

TABLE 2. DIETARY CRUDE PROTEIN CONTENT OF CORN SILAGE AND HIGH-MOISTURE EAR CORN DIETS

Basal diet[b]	Dietary crude protein level[a]			
	CP-90	CP-100	CP-110	CP-120
		Period I (1-28 days)		
CS	9.38	10.02	10.60	11.52
HMEC	11.14	11.76	13.68	14.43
		Period II (29-56 days)		
CS	10.99	12.01	13.16	14.34
HMEC	13.50	14.31	15.97	17.47
		Period III (57-84 days)		
CS	10.95	11.98	13.01	13.98
HMEC	11.87	13.11	13.98	15.29

[a] Percentage of the gram daily crude protein requirement recommended by the NRC factorial equation.
[b] CS = corn silage, HMEC = chopped high-moisture ear corn.

Jugular blood samples were taken from the same four steers per pen before feeding on days 56 and 84 for determination of PUN concentrations.

Variables used to evaluate basal diet and dietary crude protein level effects were ADG, feed conversion, protein efficiency ratio (PER; lb of ADG/lb of crude protein intake, daily) and plasma urea nitrogen (PUN) concentration. Data were analyzed using procedures appropriate for a 2 x 4 factorial model. Dietary crude protein levels of 90, 100, 110, and 120% of the NRC factorial equation recommendation across basal diets are abbreviated CP-90, CP-100, CP-110, and CP-120, respectively. Significant crude protein level effects were tested for linear, quadratic, or cubic responses. Treatment means were separated by contrasts of CP-90 vs CP-100, CP-110 and CP-120; CP-100 vs CP-110 and CP-120; and CP-110 vs CP-120. No interactions existed between basal diet and crude protein level allowing independent discussion of each.

Results and Discussion

This study was conducted from December 12, 1987, to February 26, 1988. The average ambient temperature was 11 $^{\circ}$F. Temperatures of less than -20 $^{\circ}$F were recorded on nine occasions during the study.

Cumulative daily DMI were 15.52 and 13.49 lb/day for CS and HMEC diets, respectively (P<.001). These DMI corresponded to 97.9 and 84.8 g/kg wt$^{.75}$ for CS and HMEC diets, respectively (Table 3).

Gains were similar across basal diets (Table 3), indicating LFHC diets could be used as a management alternative for backgrounding cattle in South Dakota. Reduced feedlot performance would have occurred if an inability to maintain body temperature or higher incidence of digestive upset had occurred for steer calves fed HMEC diets.

Average daily gain was similar across dietary crude protein levels (Table 4), suggesting crude protein needs were satisfied by feeding 90% of the estimated crude protein requirement. Low effective ambient temperatures during the study may have increased energy requirements such that protein was not limiting growth. Canadian research has shown that cold temperatures cause increased gastrointestinal tract motility, resulting in reduced ruminal degradation of dietary crude protein and increased microbial protein production efficiency. This may have enhanced utilization of crude protein for growth.

TABLE 3. EFFECT OF BASAL DIET ON FEEDLOT PERFORMANCE

	Basal diet[a]		
	CS	HMEC	SEM
Initial wt, lb	560	560	1.70
Final wt, lb	763	758	3.77
ADG, lb	2.34	2.38	.04
Dry matter intake, lb/day[b]	15.52	13.49	.11
Feed conversion[b]	6.68	5.69	.11
PER[c]	1.23	1.27	.03
PUN (day 56), mg/dl[d]	11.61	14.20	.83
PUN (day 84), mg/dl	10.84	11.86	1.08

[a] CS = corn silage, HMEC = chopped high-moisture ear corn.
[b] Basal diet effect (P<.001).
[c] Protein efficiency ratio.
[d] Basal diet effect (P<.05).

TABLE 4. EFFECT OF DIETARY CRUDE PROTEIN LEVEL ON FEEDLOT PERFORMANCE

	Dietary crude protein level[a]				
	CP-90	CP-100	CP-110	CP-120	SEM
Initial wt, lb	562	562	558	560	2.40
Final wt, lb	761	767	752	763	5.31
ADG, lb	2.31	2.40	2.29	2.40	.07
Dry matter intake, lb/day	14.57	14.81	14.26	14.40	.13
Feed conversion	6.30	6.16	6.24	6.05	.15
PER[bce]	1.36	1.30	1.23	1.12	.04
PUN (day 56), mg/dl[cdf]	10.85	11.20	12.07	17.48	1.27
PUN (day 84), mg/dl	9.37	10.71	10.42	14.90	1.53

[a] Percentage of the gram daily crude protein requirement based on the NRC factorial equation.
[b] Protein efficiency ratio.
[c] Quadratic effect (P<.05).
[d] CP-100 differs from CP-110 and CP-120 (P<.05).
[e] CP-100 differs from CP-110 and CP-120 (P<.01).
[f] CP-110 differs from CP-120 (P<.01).

Lower DMI of HMEC diets supported ADG similar to CS diets (Table 3), resulting in better feed conversions occurring for HMEC diets (P<.001). Feed conversion was similar across dietary crude protein levels (Table 4).

Similar PER occurred across basal diets (Table 3). Higher gram daily crude protein intakes occurred with HMEC than CS diets during the feeding period (P<.001). This was the result of daily DMI of HMEC diets being a higher percentage of CS diet daily DMI than originally estimated. The NRC estimation for metabolic fecal N loss (3.34% x DMI) suggests more efficient utilization of dietary crude protein should have occurred with HMEC diets.

Steers fed HMEC diets had higher PUN levels on day 56 (Table 3; P<.05) than calves fed corn silage. Ruminal proteolysis rates with HMEC diets may have exceeded bacterial N uptake capabilities. Actual gram daily crude protein intakes were higher (P<.001) for HMEC than CS diets during period II. The average analyzed HMEC dietary crude protein percentage across the four dietary crude protein levels was 15.31%. Once daily feeding and rapid consumption of feed deliveries with HMEC diets may have contributed to elevated PUN levels.

Dietary crude protein level effects on the PER and PUN levels will be discussed simultaneously, as similar factors probably affected each variable. The PER decreased quadratically (P<.05) as dietary crude protein level increased (Table 4). Day 56 PUN concentrations increased quadratically (P<.05) in response to increasing crude protein intake. Lower PER and higher PUN occurred for steers fed CP-110 and CP-120 than CP-100 (P<.05).

Analyzed dietary crude protein percentages of the CP-100 treatment for CS and HMEC diets were 12.01 and 14.31%, respectively. As dietary crude protein percentages increased above these levels, the potential for ruminal N utilization was probably exceeded, resulting in lowered N utilization efficiency. Average daily gain did not increase when crude protein was increased beyond 90% of the estimated requirement. Plasma urea N concentrations and PER suggest crude protein requirements for steers on HMEC diets were probably met with CP-100. These data may be interpreted to indicate that, while limiting feeding may not alter daily N requirements, the mechanism of N metabolism may differ and that recycling may become relatively more important when calves are limit-fed high-concentrate diets.

BEEF REPORT

EFFECT OF LIMIT FEEDING HIGH ENERGY GROWING DIETS ON THE EFFICIENCY OF METABOLIZABLE ENERGY UTILIZATION

J. J. Wagner[1]
Department of Animal and Range Sciences

CATTLE 88-4

Summary

One hundred twenty-eight Angus steer calves were utilized in a study to examine the effect of limit feeding on efficiency of metabolizable energy (ME) utilization during the growing phase and subsequent performance during the finishing phase. Steers limit-fed a high concentrate diet exhibited more rapid daily gains than steers full-fed the same amount of energy from a high roughage diet (2.15 vs 1.74 lb per head, respectively). Feed conversion was improved by limit feeding compared with full feeding (6.09 vs 10.19, respectively). The efficiency of ME utilization was also improved. Limit-fed steers gained .1242 lb per Mcal ME compared with .0956 lb per Mcal ME for the full-fed steers. Limit-fed cattle also required fewer days on feed (102 vs 117, respectively), gained weight more rapidly (3.43 vs 3.00 lb per head daily, respectively) and more efficiently (6.66 vs 7.53, respectively) than full-fed cattle during the finishing phase.

(Key Words: Limit Feeding, Growing Programs, Metabolizable Energy.)

Introduction

Limit-fed, high energy diets have been successfully used to grow light cattle. Gain is limited by limiting the amount of dry matter offered to cattle. As a result, feed efficiency is generally improved by limit feeding.

In order to effectively utilize limit-fed growing programs, producers must be able to predict feedlot performance with reasonable accuracy. Target sale weights and average daily gains must be met in order to allow use of the various forward pricing techniques and to allow backgrounders to consistently produce a uniform feeder steer at a predicted date.

In previous trials at the Southeast South Dakota Experiment Farm, observed performance of limit-fed cattle has been greater than that predicted by the net energy system, suggesting that the efficiency of energy utilization was improved through limit feeding. Therefore, the objectives of this research were to compare the efficiency of metabolizable (ME) utilization for limit-fed versus full-fed cattle and to determine the impact of limit feeding on subsequent performance during the finishing phase.

Materials and Methods

One hundred twenty-eight Angus steer calves that had been on a 31-day receiving trial (60% concentrate diet) were weighed following an overnight withdrawal of feed and water, blocked into two weight categories and allotted to 16 pens. Experimental diets are shown in Table 1. Cattle in four of the heavyweight pens and four of the lightweight pens were fed ad libitum amounts of a high roughage diet (1.03 Mcal ME per lb dry matter). The remaining eight pens of cattle were fed limited amounts of a high concentrate diet (1.326 Mcal ME per lb dry matter). The high concentrate diet was offered to each weight category of limit-fed cattle in an amount intended to provide similar daily ME intake as that consumed by each weight category of full-fed cattle.

Cattle were weighed on day 14, day 28 and at the completion of the 84-day trial. Final weight was obtained after an overnight withdrawal of feed and water. Interim weights were obtained after overnight withdrawal of water only. Cattle were finished as described in article CATTLE 88-5 of this report.

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[1] Assistant Professor.

TABLE 1. DIETS FED TO STEERS[a]

Ingredient	Diet Limit-fed	Diet Full-fed
Ground high moisture corn	69.190	5.193
Corn silage	8.667	45.943
Alfalfa-grass hay	8.667	45.943
Supplement		
Soybean meal	11.161	
Ground corn		2.263
Limestone	1.004	
Trace mineralized salt[b]	.800	.500
Molasses	.400	.100
Vitamin A, D, E premix[c]	.063	.040
Rumensin 60[d]	.024	.015

[a] Percentage of diet dry matter.
[b] Composition, minimum percentage, NaCl 96.0, Zn .350, Mn .209, Fe .200, Mg .150, Cu .003, I .007 and Co .005.
[c] Composition, IU per lb, vitamin A 2,000,000, vitamin D 400,000 and vitamin E 200.
[d] Composition, 60 g monensin per lb.

Data were analyzed as a randomized block design. Variables of interest for the growing phase were average daily gain, dry matter intake, feed efficiency, ME intake and the efficiency of ME utilization. Variables of interest for the finishing phase were average daily gain, feed efficiency, dry matter intake, days on feed and carcass quality and cutability traits.

Results and Discussion

Interactions between weight group and treatment were not significant. Therefore, treatment means were computed across weight categories. Performance of steers during the growing phase is displayed in Table 2. By design of the trial, full-fed cattle consumed more dry matter than limit-fed cattle (17.63 vs 13.04 lb per head daily, respectively). Full-fed cattle consumed slightly more ME than did the limit-fed cattle. Average daily gain was greater ($P<.0001$) for the limit-fed cattle than for the full-fed cattle (2.15 vs 1.74 lb per head daily, respectively).

TABLE 2. PERFORMANCE OF STEERS DURING GROWING PHASE

Item	Diet Limit-fed	Diet Full-fed	Probability
Initial weight, lb	607	606	.6417
Dry matter intake, lb	13.04	17.63	.0001
Average daily gain, lb	2.15	1.74	.0001
Feed/gain	6.09	10.19	.0001
Daily ME intake, Mcal[a]	17.30	18.16	.0068
Gain/ME, lb/Mcal	.1242	.0956	.0001

[a] ME = metabolizable energy.

Feed efficiency and the efficiency of ME utilization was improved by limit feeding. Limit-fed cattle required 6.09 lb dry matter per pound of gain compared to 10.19 lb required by the full-fed cattle. Efficiency of ME utilization was .1242 lb of gain per lb of dry matter for the limit-fed cattle and .0956 lb of gain per pound of dry matter for the full-fed cattle.

Improved efficiency of energy utilization may be due to a true improvement in the efficiency of ME utilization or it may be due to inaccurately estimating the ME content of one or more of the diet components. Average daily Rumensin intake was 188 mg/head for the limit-fed cattle and 159 mg/head for the full-fed cattle. This may have contributed to the improvement in ME use.

Performance of limit-fed cattle was generally greater than that of full-fed cattle during the finishing phase (Table 3). Cattle that had been limit-fed during the growing phase achieved 14.3% greater ($P<.05$) average daily gains, required 15 fewer ($P<.05$) days on feed and were 26 lb heavier ($P<.05$) at slaughter than cattle that had been full-fed during the growing phase. Dry matter intake was similar for both groups of cattle. Feed efficiency was markedly improved for the limit-fed cattle compared with the full-fed cattle (6.66 vs 7.53, respectively).

TABLE 3. PERFORMANCE OF STEERS DURING FINISHING PHASE[a]

Item	Growing diet		Probability
	Limit-fed	Full-fed	
Days on feed	102	117	.0386
Slaughter weight, lb	1126	1100	.0333
Dry matter intake, lb	22.43	22.30	.8319
Average daily gain, lb	3.43	3.00	.0256
Feed/gain	6.66	7.53	.0162
Hot carcass weight, lb	707	694	NS[b]
Rib eye area, in^2	12.52	12.22	NS
Marbling score, units[c]	6.02	6.03	NS
Percent choice	92.54	96.30	NS
Yield grade, units	3.15	3.16	NS

[a] Least-square means adjusted to a common fat thickness.
[b] NS = nonsignificant.
[c] Small^o - 5.00, modest^o - 6.00 and moderate^o - 7.00.

EFFECT OF PREVIOUS GROWING PROGRAM ON THE BENEFITS OF RESTRICTING FEED INTAKE DURING THE FINISHING PHASE

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CATTLE 88-5

Summary

Eight pens of cattle that had been limit-fed a high energy growing diet and eight pens that had been full-fed a high roughage growing diet were fed either ad libitum amounts of a finishing diet or 93% of ad libitum for the first 70 days of the finishing phase. From day 71 through slaughter, all cattle received ad libitum amounts of the finishing diet. Interactions between previous growing program and level of feed intake during the finishing phase were significant (P<.05). Restricting the intake of finishing cattle that had been grown using a limit-fed, high energy diet resulted in improved (P<.05) feedlot performance (3.58 vs 3.28 lb per head daily average daily gain, respectively) and efficiency (6.18 vs 7.11, respectively) over the ad libitum fed cattle. For the cattle that had been grown using a high roughage program, restricting the intake of finishing cattle resulted in poorer (P<.07) performance (2.83 vs 3.16 lb per head daily, respectively) and efficiency (7.88 vs 7.19, respectively) compared with the ad libitum fed cattle. Whether or not cattle respond to restricted intake finishing regimens may be dependent upon level of dry matter intake, dietary energy density or rate of gain during previous growing program.

(Key Words: Restricted Intake, Limit Feeding, Finishing Programs, Growing Programs.)

Introduction

Typically, cattle are full-fed high energy diets during the finishing phase. Maximum energy intake generally promotes the greatest average daily gain by cattle. Some researchers have suggested that feed conversion could be improved by restricting the intake of finishing cattle. Such an improvement may be the result of improved energy utilization and(or) less feed waste.

Previous research conducted at the Southeast South Dakota Experiment Farm showed no benefits associated with restricting the intake of finishing cattle. Average daily gains were reduced and days on feed were increased for restricted intake cattle compared with full-fed controls. Feed conversion and calculated dietary net energy values were not improved by restricting feed intake.

Cattle involved in previous South Dakota trials had been limit-fed high energy diets during the growing phase prior to placement on the restricted finishing program. Information concerning interactions between limit-fed growing programs and restricting the intake of finishing cattle is needed. The objectives of this trial were to determine the effect of restricted intake during the finishing phase on cattle performance and energy utilization and to determine the effect of previous growing program on the benefits of restricting the intake of finishing cattle.

Materials and Methods

Sixteen, 8-head pens of yearling Angus steers that had been grown as described in CATTLE 88-4 of this report were blocked according to previous growing treatment and assigned to either a full-fed finishing program or a finishing program where intake was restricted to approximately 93% of ad libitum for the first 70 days. Cattle that had been on the limit-fed regimen during the growing phase were brought up to full feed of their limit-fed diet in 1 week. Then they were offered ad libitum amounts of the finishing diet or about 93% of ad libitum as appropriate to their assigned treatment (Table 1). Cattle that had been on the full-fed regimen during the growing phase were fed ad libitum amounts of step up diet one for 1 week followed by ad libitum amounts of step up

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diet two for one week (Table 1). Following this 2-week adjustment period, these cattle were offered ad libitum amounts of the finishing diet or about 93% of ad libitum as appropriate to their assigned treatment.

TABLE 1. DIETS FED TO STEERS DURING THE FINISHING PHASE

	Diet			
Ingredient[a]	Limit-fed grower	Step up one	Step up two	Finish
Whole shelled corn		17.08	30.65	40.87
Ground high moisture corn	69.19	17.25	30.65	40.87
Alfalfa-grass hay	8.67	27.44	15.36	6.66
Corn silage	8.67	32.73	18.49	6.66
Supplement				
Soybean meal	11.16	2.97	2.97	2.97
Limestone	1.00	1.05	1.05	1.05
Dicalcium phosphate		.17	.17	.17
Trace mineralized salt[b]	.80	.50	.50	.50
Molasses	.40	.09	.09	.09
Vitamins A, D and E[c]	.063	.05	.05	.05
Potassium chloride		.10	.10	.10
Rumensin 60[d]	.024	.017	.017	.017

[a] Percentage of diet dry matter.
[b] Composition, minimum percentage, NaCl 96.0, Zn .350, Mn .209, Fe .200, Mg .150, Cu .003, I .007 and Co .005.
[c] Composition, IU per lb, vitamin A 2,000,000, vitamin D 400,000, vitamin E 200.
[d] Composition, 60 grams monensin per pound.

Initial and final slaughter weights were obtained following an overnight withdrawal of feed and water. Unshrunk weights were obtained on days 29, 42, 70 and 84 of the finishing period. Previous work at the Southeast South Dakota Experiment Farm showed no differences in dressing percentage between restricted intake and full-fed cattle. Therefore, performance data were not adjusted to a standard dressing percentage. All cattle were implanted with Ralgro at the initiation of the finishing trial. Cattle were slaughtered on a pen basis when five of eight head in each pen reached an anticipated low choice grade.

Data were analyzed as a randomized design with a 2 x 2 factorial arrangement of treatments. Factors were previous treatment during the growing phase and finish treatment. Carcass fat thickness at the 12th rib was used as a covariate in the analysis.

Results and Discussion

Interactions between growing treatment and finishing treatment were significant (P<.05). Therefore, performance of steers for each treatment combination is displayed in Table 2. Restricting the intake of finishing cattle that were grown using a limit-fed, high energy diet resulted in improved (P<.05) feedlot performance (3.58 vs 3.28 lb per head daily average daily gain, respectively) and efficiency (6.18 vs 7.11, respectively) over the ad libitum fed cattle. For the cattle that were grown using a high roughage program, restricting the intake of finishing cattle resulted in poorer (P<.07) performance (2.83 vs 3.16 lb per head daily, respectively) and efficiency (7.88 vs 7.19, respectively) compared with the ad libitum fed cattle. Carcass characteristics were similar for all treatments.

Previous growing program influenced the response of cattle to the restricted intake finishing treatment. Cattle grown using a limit-fed, high energy diet responded favorably to the restricted intake regimen. These cattle were fed less dry matter, a higher energy diet and achieved greater average daily gains than cattle grown using a full-fed high roughage diet. It is not clear which of these items may be responsible for the favorable response.

TABLE 2. PERFORMANCE OF STEERS DURING THE FINISHING PHASE[a]

	Treatment[b]				
Item[c]	LGRF	LGFF	FGRF	FGFF	Standard error
Initial wt, lb	783	786	757	752	6.28
Daily gain, lb	3.58	3.28	2.83	3.16	.09
DMI, lb	21.84	23.02	22.09	22.52	.48
F/G	6.12	7.01	7.83	7.15	.24
Days on feed	101	102	121	112	4.57
Slaughter wt, lb	1136	1117	1096	1103	8.48
HCW, lb	713	703	693	694	6.04
Fat thickness, in[d]	.67	.62	.57	.61	.03
Rib eye area, in^2	12.55	12.52	12.08	12.33	.26
Marbling score, units[e]	6.08	6.02	5.93	6.07	.15
Choice, %	86.51	96.87	94.29	100.00	3.81
Yield grade, units	3.17	3.13	3.19	3.13	.08

[a] Least square means adjusted to a common fat thickness.
[b] LGRF = limit-fed growing, restricted finishing; LGFF = limit-fed growing, full-fed finishing; FGRF = full-fed growing, restricted finishing; FGFF = full-fed growing, full-fed finishing.
[c] DMI = dry matter intake, HCW = hot carcass weight.
[d] Raw means.
[e] Small^{o} = 5.00, modest^{o} = 6.00, moderate^{o} = 7.00.

Cattle limit-fed the high energy growing diet appeared to use metabolizable energy more efficiently than cattle full-fed the high roughage growing diet (.1242 vs .0956 lb gain per Mcal ME intake, respectively). This efficiency may have continued into the finishing phase for cattle fed restricted amounts of dry matter. Cattle fed to appetite during the finishing phase may not have retained this increased efficiency during the finishing phase. However, finishing trials conducted previously at the Southeast South Dakota Experiment Farm utilized limit-fed cattle and showed no benefit to restricting intake during the finishing phase. Cattle used in the previous studies were from the same cow herd as cattle used in this year's trial but had been grown at 2.7 lb per head daily and were 60 lb heavier at the start of the finishing phase.

The basic design of this trial needs to be repeated to establish if this interaction would be observed again. Particular care needs to be taken to equalize daily gains between the limit-fed and full-fed treatments during the growing phase. In addition, the intent of this finishing trial was to restrict dry matter intake to 93% of ad libitum for the first 70 days. Dry matter intake for the first 70 days for the restricted intake treatments were 94.5 and 96.3% of ad libitum for cattle grown using the limit-fed vs full-fed diets, respectively. This discrepancy needs to be corrected in future trials as well.

BEEF REPORT

EFFECT OF DIFFERENT GROWTH PATTERNS ON FEEDLOT PERFORMANCE AND CARCASS TRAITS OF MODERATELY LARGE FRAMED FEEDER CALVES

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CATTLE 88-6

Summary

Dry matter intake of Charolais and Limousin sired crossbred steers was restricted to allow three distinctly different postweaning growth patterns. Growth patterns represented were LL--allow 2.8 lb ADG throughout the feeding period; LH--same as LL until 80% of slaughter weight, then allow ad libitum DMI; or HH--ad libitum feed intake throughout. Ad libitum fed steers consumed 23% more dry matter (P<.001) had higher ADG (3.81 vs 3.09 lb/head/day; P<.01) than steers on restricted feed intake up to 80% of slaughter weight. Feed efficiency was similar regardless of feeding rate in the early growth curve. Steers switched from restricted to ad libitum feed intake exhibited compensatory gains (P<.01), while DMI did not differ from steers previously fed ad libitum. While feeding program affected cumulative feedlot ADG and DMI (P<.05) and days on feed, feed efficiency and total dry matter consumed were not affected. LL feeding resulted in lower marbling scores and a lower percentage choice grade in carcasses of similar weights. Growth pattern had no effect on carcass composition estimated from 9-10-11 rib section when adjusted to a common carcass weight.

(Key Words: Growth Pattern, Feedlot, Steers, Gain, Efficiency, Carcass Composition.)

Introduction

Increased emphasis is being placed upon carcass specifications of fed cattle. As specifications become more defined, it is apparent that consistency within a group of cattle will become important to the beef producer. Theoretically, genetic selection is the tool of first choice for improving consistency among carcass traits for beef cattle. Unfortunately, there is only limited selection control available for feedlot operators. Management techniques that will help minimize carcass variations and help meet specifications will be valuable in the future.

The typical gain curve for feedlot cattle involves very rapid gains during the initial feeding period and very poor gains and feed efficiencies in the last weeks before slaughter. Rapid gains of growing calves are associated with excess subcutaneous fat depositions when caloric intake exceeds lean growth potential. Later in the feeding period high dry matter intakes can lead to poor feed utilization and have led some researchers to promote restricting intake of finishing cattle by 5 to 8%. Both of these observations are of concern when we try to get moderately large framed cattle ready for slaughter at 12 to 14 months of age. This study was designed to consider the effects of using controlled growth rates on the feedlot performance and carcass traits of moderately large framed crossbred steers.

Materials and Methods

Ninety Charolais x Limousin cross steer calves (613 lb) were used to evaluate the effects of growth pattern on feedlot production efficiencies and carcass traits. Calves arrived in the feedlot 4 to 6 weeks prior to initiating this study. Vaccines were administered for IBR, BVD, PI_3, H. somnus and BRSV and ivermectin was used for parasite control. A corn silage and cracked corn diet containing decoquinate was fed during the receiving period.

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Feed and water were withheld for 16 hours prior to determining initial weights. Weight and breed cross were stratified in each of 12 pens. Six pens contained 8 head and six pens contained 7 head of steers. Allotment of treatments to 7 or 8 head pens was random. Treatments included controlling dry matter intake throughout the feeding period to achieve a constant ADG of 2.8 lb (LL); controlling dry matter intake allowing 2.8 lb ADG until calves reach 80% of slaughter weight and then allowing ad libitum feed intake (LH); or allowing ad libitum feed intake throughout the feeding period (HH). One common diet was used (Table 1). For controlled growth treatments, dry matter intakes were adjusted at 28-day intervals to provide appropriate amounts of NEm and NEg for 2.8 lb ADG.

TABLE 1. COMPOSITION OF DIET USED FOR RESTRICTED AND AD LIBITUM INTAKE STEERS

Item	Percentage[a]	Formulated value
Corn silage	20.00	
Whole shelled corn	23.55	
Whole high moisture corn	47.10	
Molasses	2.00	
Soybean meal, 44%	6.05	
$CaCO_3$	1.00	
Trace mineralized salt	.30	
Crude protein		11.98
NEm, Mcal/cwt		92.3
NEg, Mcal/cwt		61.0

[a] Dry matter basis.

Slaughter weight was assigned at 1170 lb to provide 725 carcasses. Slaughter for all steers on a treatment was scheduled for the projected date that final weight would be reached. Feed and water were withheld for 24 hours prior to obtaining final weights. Steers were slaughtered 24 hours after final weights were determined. Cattle had access to feed and water between final shrunk weight and slaughter.

Carcass weights are hot carcass values. Rib fat and rib eye area were measured following a 24-hour chill. Marbling scores and percentage kidney, pelvic and heart fat were assigned at this time by the federal grader working at the slaughter plant. Rib sections were randomly selected from 16 carcasses in each treatment group for determination of 9-10-11 rib composition. Whole rib sections were uniformly separated into 9-10-11 rib portions. Bone was removed and remaining soft tissue was chopped and blended into a homogenous sample for chemical analysis. Water was considered weight loss following 48 hours drying at 50 ^{o}C in a vacuum oven. Protein was Kjeldahl N content * 6.25.

Feedlot data were analyzed as a completely random design experiment with pen representing the experiment unit. Mean per head data were used for pen analysis with no adjustment made for unequal head counts/pen. Carcass data were analyzed with carcass representing the experimental unit. All AOV and means separation tests were accomplished using GLM procedures and Duncan's option of SAS.

Results and Discussion

Ad libitum fed steers consumed 23% more dry matter ($P<.001$) during phase 1 than LL and LH steers (Table 2). Gains reflected DMI differences and were higher ($P<.01$) for HH steers. Mean F/G during phase 1 was 4.98 and was not affected by intake level. Obviously, restricted intake steers were not full. If restricted feeding had contributed to subacute digestive or metabolic disorders, poorer feed efficiency would be expected. Feed efficiency was not affected and no evidence of acute digestive upset occurred during the study. HH steers were heavier ($P<.05$) than restricted intake steers at the conclusion of phase 1. Gains of LH and LL steers were higher than projected (2.8 vs 3.08 lb/day). In part, this may be because of the long interval (28 days) used in NE calculations.

than projected (2.8 vs 3.08 lb/day). In part, this may be because of the long interval (28 days) used in NE calculations.

TABLE 2. FEEDLOT PERFORMANCE OF STEERS FED AD LIBITUM OR RESTRICTED AMOUNTS OF A FINISHING DIET

Item	Treatment			SEM
	LL	LH	HH	
Phase 1				
Initial weight	616	613	611	2.5
ADG[c]	3.07	3.10	3.81	.11
DMI[d]	15.05	15.05	19.45	.39
F/G	4.95	4.87	5.11	.20
Phase 2				
Initial weight	917	916	984	5.8
ADG[b]	3.22	3.91	3.14	.20
DMI[c]	18.65	22.23	22.53	.69
F/G[a]	5.81	5.73	7.31	.46
Cumulative				
Initial weight	1175	1170	1154	7.8
ADG[a]	3.14	3.42	3.57	.11
DMI[d]	16.67	17.91	20.54	.48
F/G	5.34	5.25	5.77	.24
Days on feed	178	163	152	

[a] Treatment effect P<.10.
[b] Treatment effect P<.05.
[c] Treatment effect P<.01.
[d] Treatment effect P<.001.

During phase 2, LH steers were switched to ad libitum intake and exhibited compensatory growth. Feed intake was similar for LH and HH steers, but LH steers had higher ADG (P<.05) and lower F/G (P<.05) than HH steers. LL steers consumed less feed than ad libitum fed steers but gained similarly to HH steers. Feed efficiency during phase 2 was similar for LL and LH steers in spite of differences in DMI.

Overall HH steers had higher ADG (P<.05) than LL steers and consumed more dry matter daily (P<.05) than LL or LH steers. Feed efficiency tended to be poorer (P<.10) when steers were fed ad libitum throughout the feeding period. It was intended that steers would be slaughtered at a similar final weight. Although final weights differ numerically, differences were not significant. Days required to reach slaughter weight were 178, 163 and 152 for LL, LH and HH groups, respectively. Total dry matter consumed while in the feedlot did not differ between groups.

Carcass weights averaged 705 lb and were similar between groups. Dressing percent was affected by feeding program being higher (P<.01) for HH than LH and LL steers (Table 3). Rib fat tended to be (P<.10) thicker for HH than LL carcasses and kidney pelvic and heart fat was higher in HH carcasses. These increases in carcass fat may explain differences in dressing percent noted. Marbling scores were higher (P<.05) in HH than LL carcasses and percentage of carcasses grading choice was lower (P<.10) for LL carcasses. The number of carcasses with Sm^- to Sm^+ marbling scores was similar between groups. Fewer carcasses from restricted growth steers had marbling scores of modest$^-$ or greater. More carcasses from the LL group had marbling scores lower than Sm^-. Analysis of soft tissue of the 9-10-11 rib section indicated no differences in water or ether extract content. Protein content was lower (P<.05) in HH than LH steers which would be consistent with indications of external fat. However, when carcass weight was included as a covariate in the analysis of variance no differences in carcass composition attributable to feeding program were noted. Bartlett's test for homogeniety of variance indicated variation was similar among treatment groups. This was interpreted to indicate that feeding programs did not alter the uniformity of carcasses produced.

TABLE 3. CARCASS TRAITS OF STEERS FED AD LIBITUM OR RESTRICTED AMOUNTS OF A FINISHING DIET

Item	Treatment group			SEM
	LL	LH	HH	
Carcass weight, lb	702	706	707	10.9
Dressing percent[f]	59.94	60.35	61.26	.25
Rib eye area, in^2	13.25	13.17	12.96	.22
Rib fat, in[d]	.32	.34	.38	.02
KPH, %[g]	2.35	2.34	2.77	.08
Marbling score[ae]	3.74	4.06	4.29	.14
Percent choice	56.7	80.0	80.0	
Carcass protein, %[bc]	14.28	14.24	13.95	.23
Carcass water, %[b]	52.92	52.79	51.91	.68
Carcass fat, %[b]	30.70	31.52	32.24	.86

[a] 3.3 = Sl^+, 3.7 = Sm^-, 4.0 = Sm^o, 4.3 = Sm^+, 4.7 = Mt^-.
[b] Least-square means corrected for carcass weight.
[c] Estimated using 9-10-11 rib section as in Hankins and Howe.
[d] Treatment effect (P<.10).
[e] Treatment effect (P<.05).
[f] Treatment effect (P<.01).
[g] Treatment effect (P<.001).

In this facility, restricting intake of a high grain diet was an effective means of manipulating cattle growth rates. This tool would allow accurate targeting of marketing dates. Although growth restriction did not affect carcass composition, it appears that restricted growth is a primary factor affecting marbling scores.

BEEF REPORT

CHARACTERIZATION OF FROST-DAMAGED IMMATURE SOYBEANS FOR ALFALFA AND ALFALFA-BROME HAY, CORN SILAGE OR CORN-BASED DIETS

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CATTLE 88-7

Summary

One compositional study and three single stage in vitro rumen fermentation experiments were conducted to characterize the feeding profile of frost-damaged immature soybeans (FDIS). Dawson and Dassel soybean plants were harvested at 86, 93, 100, 107 days postplanting and frozen at -5 °C to contrast with natural frozen soybeans of the same varieties that were serially planted and harvested after the first killing frost. No differences between soybean variety were detected for crude protein (CP), ether extract (EE) or dry matter content (DM). Crude protein and EE content differed ($P<.05$) between maturities of artificially frozen (AF) soybeans. Only the EE content differed ($P<.01$) with maturity of naturally frozen (NF) soybeans. Planting date had an effect ($P<.001$) on composition of mature soybeans primarily due to increasing EE component. Exp. 1. Five levels of FDIS (0, 5, 10, 15, 20%), three substrates (alfalfa hay, ALF), corn silage (CS), ground corn (WSC)) and two fermentation times (24 or 48 hours) were evaluated in single stage in vitro fermentations. FDIS supplementation had no effect on in vitro dry matter disappearance (IVDMD) of ALF or WSC, indicating that the upper limit of FDIS supplementation had not been reached. IVDMD of corn silage was depressed ($P<.01$) when FDIS exceeded 10%. Increasing levels of FDIS increased NH_3-N ($P<.01$) but had no effect on VFA concentration in fermentation liquor. Exp. 2. Alfalfa-brome hay, ALF and CS were supplemented with FDIS for 48-hour IVDMD comparisons. IVDMD was not affected by substrate, but FDIS increased IVDMD of CS ($P<.001$). Exp. 3. Four treatments, soybean meal (SBM), heated mature raw soybeans (HMB), heated FDIS (HFDIS) and FDIS, were used to differentiate oil content and trypsin inhibitor effects on roughage fermentation. Only SBM increased IVDMD ($P<.05$) of forages tested. FDIS included at 20% of the DM did not significantly decrease IVDMD of forages in most instances but may not stimulate digestion in the same manner as SBM.

(Key Words: Soybean, Frost-Damaged, Immature, Composition, In Vitro Fermentation).

Introduction

In northern regions of soybean production and southern regions where double cropping is practiced, killing frosts frequently occur before the crop has matured. Green, freeze damaged soybeans have little market value due to poor storage and processing characteristics arising from fat rancidity and presence of antinutritional factors in the damaged soybean. The inability to market frost-damaged soybeans leaves producers exposed to economic losses.

Frost-damaged soybeans have high crude protein and energy density. If livestock feeding is practical, it could provide an alternative marketing avenue for the producer. Little research has been done with frost-damaged immature soybeans (FDIS), but suspected high oil content and the presence of trypsin inhibitor cause skepticism about the use of this product for livestock feeding.

The purpose of this study was to characterize frost-damaged immature soybeans as a supplement to ruminant diets.

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Materials and Methods

Two systems were employed to obtain FDIS of varying maturity to determine effect of harvesting method and stage of maturity on chemical composition. To evaluate artificial freezing of soybeans planted on a common date, two 00 maturity varieties of soybeans (Dawson and Dassel) were planted on June 3, 1987. Soybeans were harvested at 86, 93, 100, 107 days postplanting and at full maturity to provide a wide range of maturities. Whole plants were cut, bagged and placed in a cooler to be chilled at 5 ^{o}C for 4 hours and -5 ^{o}C for 4 additional hours. Plants were then allowed to wilt 24 hours at 32 ^{o}C before soybeans were separated and frozen for subsequent analysis. Natural freezing was done using Dawson and Dassel soybean varieties planted at weekly intervals from June 29 to August 3, 1987. A killing frost occurred on October 21 providing soybeans from plants 84, 91 and 98 days postplanting and mature. Soybeans were analyzed for dry matter content, crude protein, ether extract and ash. Comparisons of procedure and maturity were made using analysis of variance and least squares means for a 4 x 2 randomized complete block design.

Three fermentation studies were conducted to determine the effects of FDIS on ruminal fermentation. In experiment 1, five levels of FDIS (0, 5, 10, 15, 20%), three substrates (alfalfa, corn silage, ground corn) and two fermentation times (24 and 48 hours) were used in a 5 x 3 x 2 factorial designed experiment. Single stage in vitro dry matter disappearance (IVDMD), pH, NH_3 and VFA concentrations were measured as dependant variables. Experiment 2. Alfalfa-bromegrass hay, alfalfa and corn silage substrate fermentations were compared using the same levels of FDIS used in Exp. 1. These 48-hour single stage fermentations were conducted to determine the effect of FDIS supplementation on high fiber substrates of differing quality. Analysis of variance was performed for a 5 x 2 factorial design. Experiment 3. Four treatments were used to separate the effects of oil content and trypsin inhibitor in unprocessed soybeans on fermentation of roughages. Treatments included soybean meal (SBM), heated mature raw soybeans (HMB), heated frost-damaged immature soybeans (HFDIS) and FDIS. Roughages from Exp. 2 were used with two levels of FDIS (10 or 20%). IVDMD means were separated by orthogonal contrast to determine the effects of the high oil and antinutritional factors of FDIS on fiber digestion.

Results and Discussion

There were no differences in composition of the soybean varieties used. Stage of development did affect ($P<.05$) crude protein and fat content of artificially frozen soybeans (Table 1). Protein decreased slightly ($P<.05$) as fat increased in artificially frozen soybeans, suggesting a simple protein dilution effect. The EE content of naturally frozen soybeans was greater for mature soybeans (Table 1). Differences ($P<.001$) occurred between mature soybeans from each harvesting method, suggesting planting date had an effect on soybean composition. No difference was detected in crude protein content between maturity groups for the naturally frozen soybeans. This can be attributed to a diminishing protein dilution effect, a result of lower overall fat content of the natural frozen soybeans due to planting date. For experimental and practical purposes, harvesting methods were considered equal and immature soybeans were pooled for IVDMD studies.

Experiment 1. Increasing level of FDIS increased ($P<.001$) in vitro NH_3 concentration for all substrates (Table 3). FDIS level did not affect total VFA concentration or acetate/propionate ratio. Substrate did affect these variables ($P<.001$) as would be expected. Substrate x level interaction for IVDMD, NH_3, VFA and A/P was significant ($P<.01$) and due to depressed fermentation of corn silage at 20% FDIS. Frost-damaged immature soybean supplementation had no effect on IVDMD for alfalfa or ground corn but decreased ($P<.001$) IVDMD for corn silage over levels of FDIS. This indicates that the maximum level for FDIS incorporation had not been reached for alfalfa or ground corn. The interaction with corn silage is not easily explained and did not occur in Exp. 2.

IVDMD was unaffected by roughage source in Exp. 2 (Table 4). Increasing proportion of FDIS improved corn silage IVDMD in this study. Composition of corn silage (Table 2) indicated a deficiency in crude protein. FDIS increased availability of NH_3-N which may have stimulated fermentation. Alfalfa and alfalfa-brome hay IVDMD were not affected by FDIS supplementation. No decrease was noted in IVDMD at the 20% level for any of the substrates, indicating again that the effective upper limit of FDIS supplementation was not reached.

No differences in IVDMD were found between mature soybeans and immature soybeans or between heated FDIS and FDIS in Exp. 3. These results indicate antinutritional factors did not have detrimental effects on fermentation of forages. IVDMD was higher ($P<.05$) for forages supplemented with SBM (Table 5). Based on comparisons of full fat and defatted soybeans, it appears that fat content may be the primary factor limiting increases in IVDMD associated with SBM supplementation. Heating FDIS did allow some improvement ($P<.05$) in IVDMD when substrate contained 20% soybeans (Table 5).

In summary, compositional and in vitro studies indicate that FDIS is a viable feedstuff for ruminants. Upper limits of feasible FDIS incorporation in high concentrate rations were not reached with 20% supplementation. FDIS increased IVDMD and improved ruminal available NH_3 in forages limited in crude protein in some instances. FDIS did not significantly decrease IVDMD at the 20% level in forages.

TABLE 1. COMPOSITION OF ARTIFICIALLY VS NATURALLY FROZEN IMMATURE SOYBEANS

	Artificial					
Days postplanting	86	93	100	107	Mature	SEM
Crude protein, %[a]	35.6	36.6	35.1	34.1	35.4	.93
Ether extract, %[a]	15.9	18.1	18.6	18.2	18.5	1.03
Ash, %	5.0	5.0	5.1	5.0	5.1	.065

	Natural[b]				
Days postplanting	84	91	98	Mature	SEM
Crude protein, %	40.2	41.4	41.2	39.7	1.28
Ether extract, %	8.0[c]	13.4[d]	14.8[e]	16.6[f]	.60
Ash, %	5.1	5.0	5.1	5.1	.045

[a] Linear effect ($P<.05$).
[b] Least-squares means.
[c,d,e,f] Means with unlike superscripts differ ($P<.05$).

TABLE 2. COMPOSITION OF IN VITRO FERMENTATION SUBSTRATES[a]

	Alfalfa hay	Corn silage	Alfalfa-brome hay	Corn	FDIS
Crude protein, %	17.9	7.3	17.1	9.1	35.6
ADF, %	34.2	24.2	32.0	3.6	15.4
NDF, %	52.4	48.2	41.6	32.5	29.4
Ash, %	8.8	5.8	13.8	1.4	5.5

[a] Percentage dry matter basis.

TABLE 3. EFFECT OF FDIS LEVEL ON 48-HOUR IVDMD OF DIFFERENT SUBSTRATES (EXP. 1)

	% FDIS					
	0	5	10	15	20	SEM
			Alfalfa Hay			
IVDMD, %[a]	54.7	53.7	52.2	51.4	55.4	2.05
NH_3, mg/dl[a]	21.2	24.6	25.0	25.7	29.3	1.45
Total VFA, m/ml[b]	33.6	34.7	33.6	25.6	19.5	3.40
A/P ratio[bc]	2.7	2.6	2.8	2.5	2.1	.075
			Corn Silage			
IVDMD, %	52.9	54.3	53.2	43.1	39.1	2.05
NH_3, mg/dl	6.4	10.8	18.8	35.7	41.8	1.45
Total VFA, m/ml	33.0	23.1	31.1	26.0	46.8	3.40
A/P ratio	1.6	1.52	1.85	1.91	2.37	.075
			Ground Corn			
IVDMD, %	78.6	75.9	79.7	79.0	78.7	2.05
NH_3, mg/dl	9.3	16.2	18.7	19.3	25.0	1.45
Total VFA, m/ml	71.8	78.8	68.4	66.7	77.7	3.40
A/P ratio	1.59	1.66	1.63	1.73	1.71	.075

[a] Substrate effect (P<.001), level effect (P<.001), substrate x level (P<.001).
[b] Substrate effect (P<.001), substrate x level (P<.01).
[c] Acetate to propionate ratio.

TABLE 4. EFFECT OF FDIS LEVEL ON IVDMD OF THREE DIFFERENT FORAGE SOURCES (EXP. 2)

	% FDIS					
Source	0	5	10	15	20	SEM
			% IVDMD			
Alfalfa hay	50.0	51.6	51.5	51.7	53.8	1.44
Corn silage[a]	41.4	52.4	54.8	56.6	56.1	1.44
Alf-brome hay	50.6	51.9	51.4	51.9	54.0	1.44

[a] Level effect (P<.001).

TABLE 5. EFFECTS OF FAT AND ANTINUTRITIONAL FACTORS OF FDIS ON IVDMD OF THREE SUBSTRATES (EXP. 3)[abcd]

Protein source	Alfalfa hay		Corn silage		Alf-brome hay		SEM
	% FDIS						
	10	20	10	20	10	20	
	% IVDMD						
SBM	56.3	60.7	61.0	66.0	54.9	59.4	1.21
HMB	55.3	57.3	59.9	61.0	57.5	57.8	.53
HFDIS	55.6	56.7	58.5	62.3	56.9	58.1	.61
FDIS	53.2	53.6	59.0	58.5	57.0	59.4	.83

[a] SBM = soybean meal, HMB = heated mature soybeans, HFDIS = heated frost damaged immature soybeans.

[b] Level effect (P<.01), substrate effect (P<.001).

[c] SBM differs from HMB, HFDIS and FDIS.

[d] HFDIS differs from FDIS (P<.05).

BEEF REPORT

EFFECT OF LATE SEASON SUPPLEMENTATION ON PERFORMANCE OF YEARLING STEERS GRAZING MIXED NATIVE RANGE OR COOL SEASON, RUSSIAN WILDRYE PASTURES

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CATTLE 88-8

Summary

Seventy-six yearling, black-baldy steers were utilized in a grazing experiment to study the effect of level of late summer, early fall protein supplement (1 versus 2 lb, 40% all natural) and type of fall pasture (mixed native range versus Russian wildrye) on average daily gain. Cattle were purchased in May as part of a larger group and gained at the rate of 1.4 lb per head daily prior to initiation of the study on September 1, 1987. Average daily gain was not affected by pasture type. Steers grazing native range and Russian wildrye gained .81 and .72 lb per head daily, respectively, during September and October. Daily gain was significantly (P<.05) greater for steers receiving 2 lb of supplement than for steers receiving 1 lb (1.01 vs .515 lb per head daily, respectively). Providing 2 lb of a 40% all natural protein supplement improved range utilization for growth.

(Key Words: Yearling Steers, Protein Supplementation, Native Range, Russian Wildrye.)

Introduction

Thousands of yearling cattle graze ranges and pastures in western South Dakota each summer. Performance by these cattle is related to several factors, including growth potential of the cattle, forage quality and availability, and type and level of supplementation.

Cattle performance is typically greatest early in the grazing season and markedly lower during late summer and early fall. This reduction in performance is due to an increase in the energy requirements of the cattle combined with a decline in forage quality and/or availability.

Rangeland vegetation in western South Dakota can be divided into two categories: native and introduced. Native pastures are typically a mix of warm and cool season grasses, with the cool season components increasing as range condition improves. Introduced pastures are commonly a monoculture of cool season grasses, primarily crested wheatgrass or Russian wildrye. Native pastures produce forage in both the cool (spring and fall) and warm (summer) seasons, although cool season production is generally the most limiting. Introduced cool season pastures are extremely productive in spring and fall, given adequate moisture, but provide no new forage in summer. Cool season production in introduced pastures is typically greater than that of native pastures even when the cool season component of the native pasture is very high.

Forage quality is largely determined by the type of grass available to the grazing animal and the season in which it is consumed. Quality is always highest during the season of active growth and declines as the grasses mature and/or become dormant. Warm season grasses produce large quantities of relatively good quality forage during summer but show a sharp decline in quality as the grasses mature in late summer and early fall. Growth of cool season grasses occurs principally in the spring. However, they may also produce good quantities of green forage in fall if moisture is adequate. Growth during a dry fall is minimal or nonexistent, leaving only the less nutritious mature forage for the grazing animal.

It has been shown that cattle grazing cool season grasses in a fall with sufficient moisture for plant growth outperform cattle grazing warm season pastures in the same season. This advantage is likely reduced during a dry

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fall. Studies in Oklahoma and Kansas have shown that limited amounts of protein supplement provided during late summer and early fall to cattle grazing warm season grasses improved both forage digestibility and intake and thus performance. It is not clear, however, whether protein supplementation of cattle grazing cool season grasses in fall would result in similar improvements in performance. Nor do we know the relative effects of providing protein supplements to cattle on warm and cool season grass pastures during relatively dry or wet seasons.

The objectives of this research were to (1) compare performance of cattle grazing either native mixed pasture (having both warm and cool season grass components) or Russian wildrye (a cool season grass) in late summer and fall, (2) determine differences in cattle performance due to different levels of protein and energy supplementation in late summer and fall for cattle grazing native mixed and cool season pastures and (3) determine differences associated with wet and dry fall growing conditions. The data presented in this paper represent only the first year of this ongoing study.

Materials and Methods

This study was conducted at the Range and Livestock Research Station (RLRS) near Philip, South Dakota. Seventy-six yearling, black-baldy steers were randomly allotted to four native and four Russian wildrye pastures in fall 1987. These steers were purchased in western South Dakota as part of a larger (125 head) group in early May at an average weight of 585 lb. The cattle had grazed experimental native range pastures during summer 1987, with an average gain of 1.4 lb/day.

The number of steers in each fall pasture varied from 6 to 12 depending on pasture size and forage production. Stocking rates were very light in order to avoid limiting forage availability during the study. Cattle in two of the native and two of the Russian wildrye pastures were fed 1 lb of a 40% all natural protein supplement per head daily. Cattle in the remaining native and Russian wildrye pastures were fed 2 lb of the same 40% supplement daily. Cattle in each pasture were fed the daily supplement allotment as a group in feed bunks. Cattle were weighed at the beginning of the study (September 1), at 30 days and again at 62 days following an overnight withdrawal of feed and water.

The experiment was a completely randomized design having a 2 x 2 factorial arrangement of treatments. Pastures were used as experimental units and the variable of interest was average daily gain.

Results and Discussion

During the summer grazing season all cattle gained an average of 1.40 lb per head daily. Late summer, early fall gains averaged .52 and 1.01 lb per head daily for the cattle receiving 1 and 2 lb of supplement, respectively (Table 1). Differences in gain between cattle grazing native and Russian wildrye pastures were not significant. Interactions between supplement level and pasture type were not significant.

Late summer and fall of 1987 were particularly dry at the Station. As a result, fall growth of Russian wildrye and native cool season grasses was limited. Most of the available forage in the Russian wildrye pastures represented growth that had occurred in the spring. This forage was dormant during the summer and of lower quality than what is typically available from Russian wildrye pastures in the fall. Forage available in native pastures was a combination of herbage produced in spring and summer and of relatively low quality during this study. It is likely, then, that supplemental protein improved digestibility and intake of Russian wildrye and the native warm and cool season grasses. During years of adequate fall rainfall, however, the level of improvement in weight gains in response to supplementation may not be observed.

Energy intake required for the observed level of performance was calculated using net energy relationships (NRC, 1984, Table 2). Cattle fed 2 lb of supplement achieved .495 lb per head greater daily gains than those fed 1 lb. This additional gain should require an additional .28 Mcal of net energy for maintenance (NEm) and an additional .98 Mcal net energy for gain (NEg). Assuming the energy content of the supplement was approximately .76 Mcal/lb NEm and .51 Mcal/lb NEg, 2.29 lb of additional supplement would be required to provide the additional energy. Feeding an additional 1 lb of supplement could not account for the observed performance increase from an energy perspective. Clearly, the additional pound of supplement must have increased forage digestibility and/or intake.

TABLE 1. LATE SEASON PERFORMANCE OF YEARLING STEERS[a]

Range type	Level of supplement 1 lb	2 lb	Average[b]
Native	.45	1.16	.81
Russian wildrye	.58	.86	.72
Average[bc]	.52	1.01	

[a] Average daily gain, lb.
[b] Standard error of the mean = .067.
[c] 1 lb vs 2 lb (P<.05).

TABLE 2. NET ENERGY REQUIRED FOR OBSERVED PERFORMANCE

Range type	Level of supplement 1 lb	2 lb	Average
Native	6.36[a]	6.70	6.53
	.71[b]	2.12	1.42
Russian wildrye	6.40	6.62	6.51
	.95	1.51	1.23
Average	6.38	6.66	
	.83	1.81	

[a] Net energy for maintenance requirement, Mcal/day.
[b] Net energy for gain requirement, Mcal/day.

The observed level of performance for cattle offered 2 lb per head daily would amount to 30 lb additional gain over the cattle fed 1 lb of supplement. If 850-lb yearling cattle were worth $70.00/cwt and the supplement cost $350/ton, an additional $10.15/head could be earned by feeding 2 lb of protein supplement per day over 1 lb (Table 3). Information in Table 3 applies only to forage conditions and relative performance differences observed in this study. Caution should be exercised when applying these results to other sets of conditions.

TABLE 3. INCREASE IN RETURNS WHEN PROTEIN SUPPLEMENT IS INCREASED FROM 1 TO 2 LB DAILY[a]

Supplement cost, $/ton	Sale price, $/cwt 60.00	65.00	70.00	75.00	80.00
250	10.25	11.75	13.25	14.75	16.25
300	8.70	10.20	11.70	13.20	14.70
350	7.15	8.65	10.15	11.65	13.15
400	5.60	7.10	8.60	10.10	11.60

[a] Per head return based on 62-day supplementation period.

It is unclear whether feeding 1 lb of supplement and maintaining ownership of the cattle for 62 additional days would be profitable, since no unsupplemented group was available. If interest costs and costs associated with feeding supplement (fuel, labor, repairs and feed bunks) are sufficiently high, the additional 62-day grazing season may not be economical. To estimate potential returns for the additional 62 days on grass, assume an interest rate of 12% and a purchase price of $90.00/cwt. Interest expense on 62 days of additional grazing would be $10.73/head [(585x$0.90x0.12)/365]x62. At a sale price of $70.00/cwt, an additional 15.3 lb/head (10.73/.70) gain or .247 lb/head daily is needed over the last 62 days to pay the additional interest expense. If it cost $1.50 per head to feed the supplement to the cattle for 62 days plus 62 lb of supplement at $.175/lb, an additional 17.6 lb/head ([1.50+(62x.175)]/.70) gain or .285 lb/head daily would cover supplementation costs. Total gain needed to cover supplementation plus interest costs would be 32.9 lb/head (15.3+17.6) or .532 lb/head daily. Cattle fed 1 lb of supplement only gained .515 lb/head daily. Based on the above assumptions, a net loss of $.73/head ([.515x62x.70]-[10.73+1.50+10.85]) would have been realized.

Feeding 2 lb of supplement per head daily would cost an additional $.175/head daily. Costs such as fuel, labor, repairs and feed bunks would probably not be any more for the 2 lb regimen than for 1 lb. Total gain needed to cover the costs associated with feeding 2 lb of supplement daily would be 48.4 lb/head (32.9+[.175x62/.70])or .781 lb/head daily. If cattle are grazing under similar conditions, it seems appropriate to increase protein supplementation to 2 lb/head daily.

BEEF REPORT

OBSERVATIONS CONCERNING THE EFFECTS OF RUMINAL EVACUATION ON INTAKE AND RUMINAL RECOVERY OF DRY MATTER

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CATTLE 88-9

Summary

The effect of repeated total ruminal evacuations on feed intake and animal behavior and rate of ruminal recovery expressed as percentage of feed bunk dry matter disappearance were observed in an observation trial with six Angus crossbred steers. Evacuation stimulated meal size and daily intake in comparison to that of a previous feeding. Feed intake decreased with consecutive evacuations. Two evacuation cycles at a 2-day interval may be the practical limit to frequency of evacuations without a 1 to 2-week recovery period. Rate of recovery of dry matter from the rumen over a 4-hour period was extremely variable and not correlated with feed intake during the same period.

(Key Words: Rumen Sampling, Rumen Evacuation.)

Introduction

Ruminally fistulated animals have been used in nutritional research for a variety of purposes. The cannulated fistula has commonly provided convenient access to the rumen for in situ (nylon bag) disappearance techniques and rate of passage studies as well as for a source of microbial inoculant for in vitro digestibility studies. Recently, there has been renewed interest in using ruminally fistulated cattle to identify and sample forages actually consumed in grazing situations. Under extensive range conditions, sampling via the rumen fistula offers several advantages over sampling via the esophageal fistula. These include the ease of maintenance of the rumen fistula and the minimal level of special handling required for the ruminally fistulated animals. Further, since salivary contamination is diluted in the rumen, there may be less bias of the chemical analyses of nitrogen and minerals in samples taken from the rumen comparison to esophageal samples.

The sampling of freshly grazed forage via the rumen involves a complete evacuation of the reticulo-rumen contents and then turning the animal on to the pasture to graze for a period of time after which the reticulo-rumen is again evacuated to obtain the sample. This technique presents several questions with regard to intake. How does the evacuation affect appetite and consequently selectivity and intake? What effects can be expected with repeated periodic evacuations? What intervals of time between evacuations minimize disruption of normal intake patterns? How does the quantity of rumen contents correlate with forage disappearance?

To anticipate the responses in several of these situations, an observation trial was conducted to study the effects of repeated rumen evacuations on dry matter intake of a forage-based diet fed to confined steers and to observe the relationship of the quantity of evacuated rumen contents to the quantity of feed missing from the feed bunk.

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Materials and Methods

Six crossbred Angus steers (656 lb) were ruminally fistulated and fitted with 4-in plastic cannulas[3]. Four weeks following surgery, four steers were selected on the basis of typical and stable feed intake for the demonstration. The diet is presented on Table 1 and was the same for all animals. The supplement, also presented on Table 1, was designed to ensure adequate protein for the recovering animal consuming a limited amount of diet and to stimulate intake of the forage.

TABLE 1. COMPOSITION OF DIET[a]

Item	%
Alfalfa-brome hay	75.00
Supplement	(25.00)
Rolled corn grain	20.56
Soybean meal	2.08
Dicalcium phosphate	.38
Calcium cabronate	.28
Vitamin A	.16
Molasses	1.29
Composition	
Crude protein	15.00
NEm[b]	.643
NEg[c]	.364
Calcium	.42
Phosphorus	.36
Vitamin A[d]	1454

[a] Dry matter basis.
[b] Net energy, maintenance, kcal/lb.
[c] Net energy, gain, kcal/lb.
[d] IU per lb.

Three consecutive total rumen evacuation cycles were performed on each steer during each of two periods. An evacuation cycle included the removal of the reticulo-rumen contents immediately prior to the morning feeding followed by a second total evacuation approximately 4 hours later. Free access to both feed and water was provided between the two evacuations.

Rumen contents from the first evacuation were placed in a double plastic sack and the air expressed before sealing each sack with a twist tie. The sack was then placed in a warm water (100 ^{o}F) bath. These contents were then replaced in the rumen following the second evacuation of each cycle.

The evacuation technique included the removal of the fibrous mat and large particles by hand. A shop vac was used to remove the fluid portion and the smaller particles. The rumen and reticulum walls were scraped with the side of the hand and then rinsed with clear water and again evacuated with suction. To prevent bruising of the rumen wall, suction in the vacuum was controlled by opening or closing a small split in the 2.5-in wire-reinforced vacuum hose.

[3]Appreciation is expressed to Dr. John U. Thomson, Extension Veterinarian, for doing the surgery.

The fluid fraction was strained through a 1-mm sieve and the residue weighed and sampled for dry matter determination. The particulate fraction was hand squeezed to remove excess moisture, manually mixed, weighed and sampled.

Disappearance of feed from the feed bunk between the two evacuations was measured, as was total feed intake during and following the evacuation periods.

Evacuation treatment included three total reticulo-rumen evacuation cycles. Evacuation cycle treatment intervals were (1) every 3 days, (2) every 2 days, (3) every day and (4) two evacuations on consecutive days followed by a 1-day interval before the third evacuation cycle. Two steers were used on each treatment. Each steer was used on two treatments separated by a period of time to allow feed intake to recover to normal levels.

Results and Discussion

Daily dry matter intakes over the evacuation and recovery periods are shown graphically for treatment 1 in Figure 1. One steer was removed from the trial during the second evacuation cycle for reasons unrelated to the demonstration procedures. Consequently, only one steer was evacuated at 3-day intervals. Dry matter intake the day of the first evacuation was at about the same level as the intake during the previous 2 days. Feed intake decreased abruptly over the 2 days following the evacuation with daily intake the second day about 50% of the intake the day of the first evacuation. Intake the day of the second evacuation was equal to that before the evacuations began but again dropped sharply during the 2 days following the evacuation. The steer did not eat as much the day of the third evacuation in comparison to the relatively normal intakes on the days of the first and second evacuations. Also, although feed intake was depressed over the next 2 days, the depression was not as severe as it had been following the first two evacuation cycles. Feed intake began to improve 3 days after the last evacuation and approached pre-evacuation levels by the fifth day after the last evacuation.

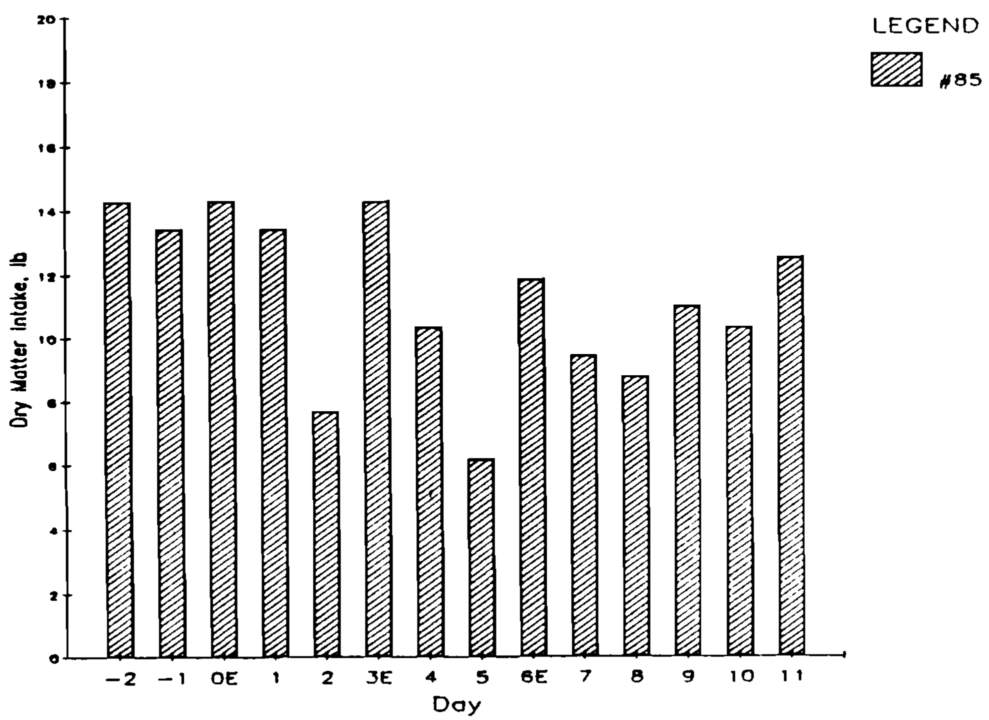

Figure 1. Daily dry matter intake, Treatment 1.
(E = Evacuation)

Feed intake data for steers with an evacuation cycle interval of every other day is shown in Figure 2. Intake was substantially stimulated on the day of the first evacuation in comparison to the intake during the previous few days. Intake dropped substantially the day after the evacuation. This pattern of a high peak intake on the day of evacuation followed by a low intake the next was repeated during the second and third evacuation cycles, although it modulated downward with each additional evacuation.

Normal intakes are determined with a relatively stable flow into and out of the rumen. When the reticulo-rumen is completely empty, intake is stimulated and greater than normal consumption ensues. Intake was markedly depressed the day following the evacuation cycle and may be partially related to the the greater than normal intake on the previous day. The average of intakes on the first day of evacuation and the next day approximate normal intake. Intakes were stimulated by consecutive evacuations and the pattern was repeated, although not to the same degree as during the first evacuation. This is more apparent with more frequent evacuations (Figure 3). Recovery of intake to pre-evacuation levels followed an irregular pattern. Intake continued to decrease for 3 or 4 days and then increased to peak over the next 4 or 5 days before descending to normal levels 12 to 13 days after the last evacuation.

Figure 3 depicts daily intakes when the evacuation cycles were on consecutive days. Intake on the day of the first evacuation is increased over the normal intake. However, when the next evacuation cycles followed on consecutive days, intakes were depressed when compared to pre-evacuation levels and continued to decline to approximately 33% of normal intake by the second day after the last evacuation. Recovery to normal intakes followed a marked "roller-coaster" pattern and was not complete within 7 days of the last evacuation.

When the reticulo-rumen was evacuated on two consecutive days and then evacuated a third time after a 1-day interval, the same trend was apparent (Figure 4). One steer was inadvertently locked out of the feeder during the night and consequently had an atypically depressed intake the day of the first evacuation.

Intake was about 40% of normal the day after the second evacuation for both steers and remained low the day of the third evacuation cycle. The day after the last evacuation intakes were slightly improved but normal intakes were not achieved within 3 days of the third evacuation.

The consistent depression of feed intake and the sporadic intakes during the recovery period for all treatments may suggest that the microbial population of the rumen contents removed at the beginning of each evacuation cycle were not surviving the 4-hour period outside of the rumen. In spite of the warm water bath and anaerobic environment, the accumulation of waste products could have been toxic within the closed environment of the airtight sack. Adding only a portion of the evacuated contents back to the rumen as an inoculant source may possibly have moderated the sporadic recovery of intakes.

Feed bunk disappearance of the diet dry matter between the first and second evacuations in a cycle (about a 4-hour period) is presented as meal size in Figure 5. In general, meal size decreased from the first to the second and from the second to the third evacuation cycle. Average meal size across animal and treatment was 3.94, 3.04 and 2.22 lb in the first, second and third evacuation cycle, respectively. This decrease in meal size with increasing number of evacuations corresponds with total feed consumed during a 24-hour period.

Some general observations concerning the behavior of the steers following each evacuation may have have some value. After the morning evacuation, as the steers were returning to the feeders they would be looking for feed and trying to enter the feeder of each pen they would pass. Upon entering the pen they would stand with their heads in the stanchions waiting to be fed. They showed no interest in water and would immediately eat when feed was presented. Although they ate voraciously when feed was first presented, they appeared satiated after a normal sized meal since they seemed to consume no more during the 4-hour period than those cattle not evacuated during the same 4-hour period.

After the second evacuation (4 hours after the first) in the cycle, the empty rumen was manually filled with the contents removed in the morning and which had been aerobically stored in a warm water bath to attempt to maintain the microbial population. Although the rumen was filled to capacity, the steers exhibited the same anxious and hungry behavior as they had in the morning when the rumen was empty.

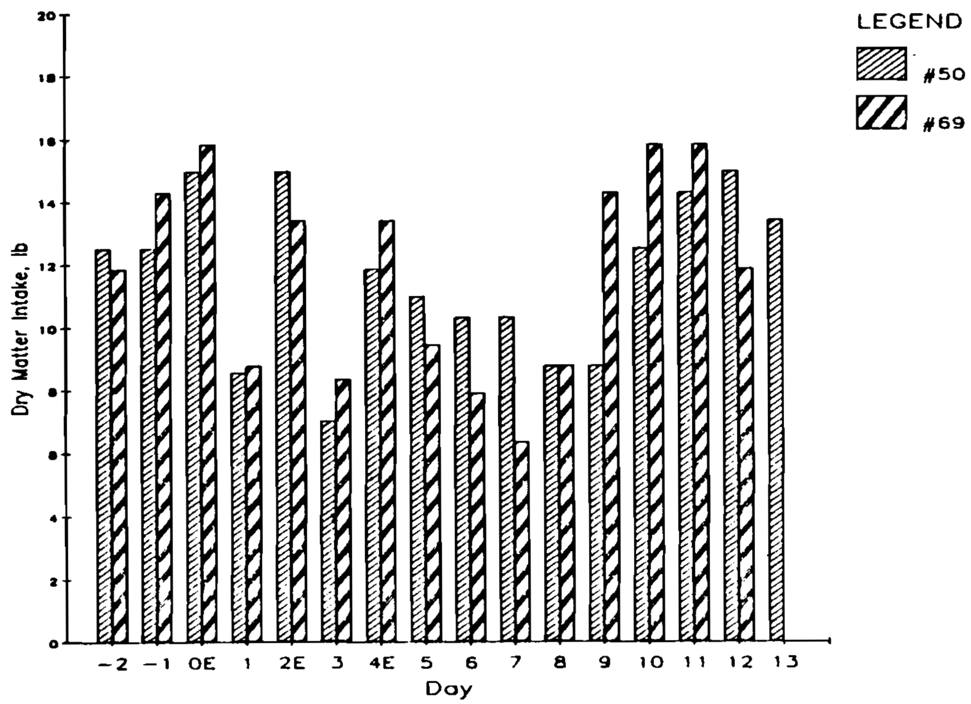

Figure 2. Daily dry matter intake, Treatment 2.
(E = Evacuation)

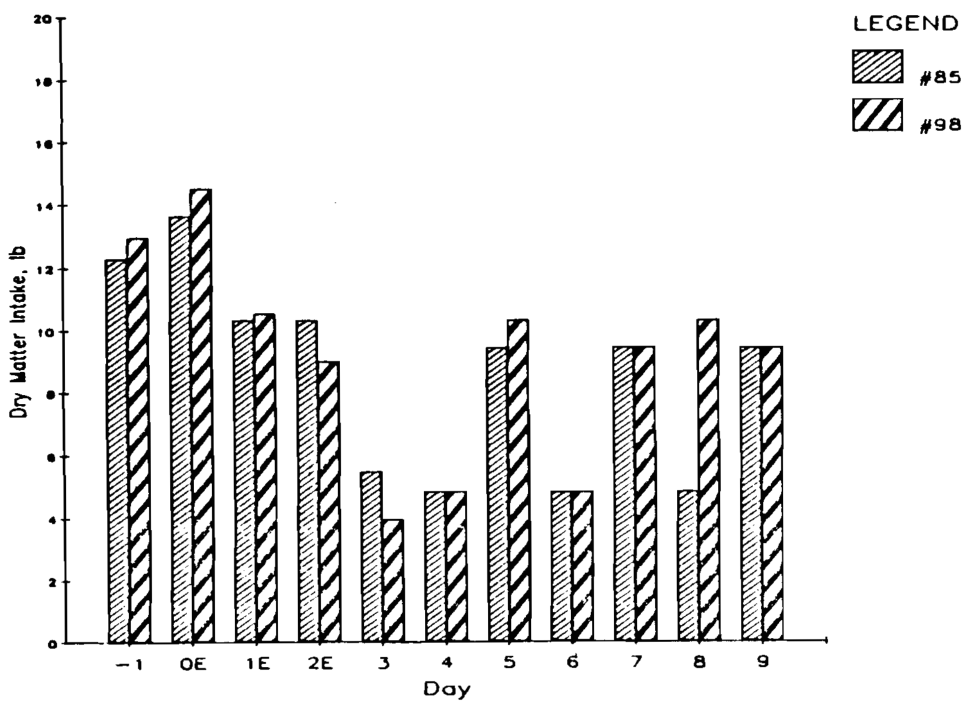

Figure 3. Daily dry matter intake, Treatment 3.
(E = Evacuation)

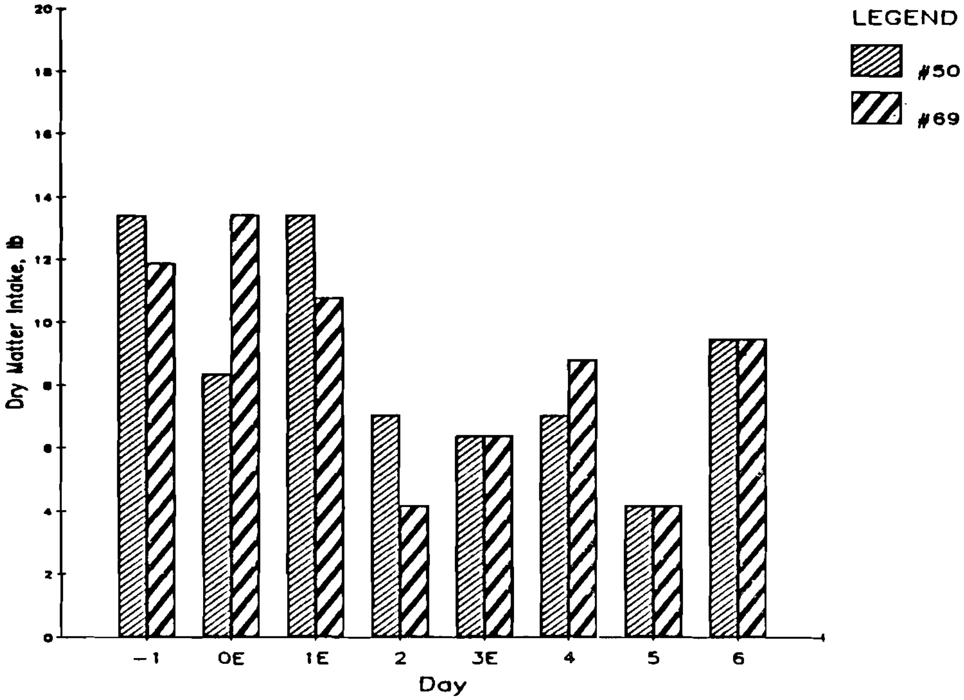

Figure 4. Daily dry matter intake, Treatment 4.
(E = Evacuation)

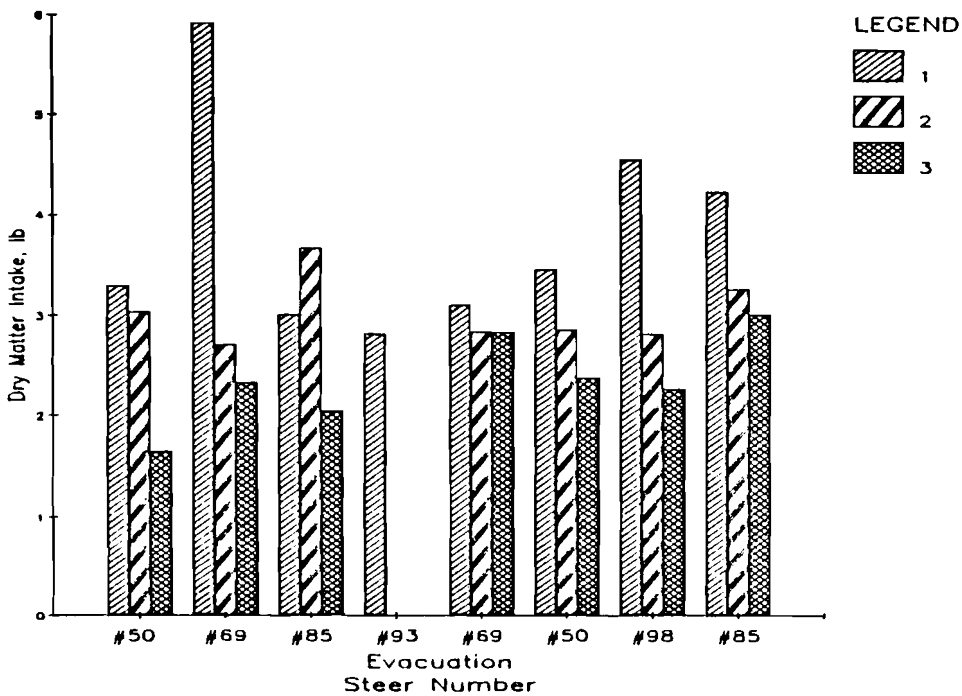

Figure 5. Meal size following rumen evacuation.

In these demonstrations, a single rumen evacuation appeared to result in anxious, hungry behavior and elevated feed intakes in yearling steers. This implies a possible loss in selectivity when this technique is applied in the sampling of mixed specie pastures. Further, there was a depression in intake following the third rumen evacuation cycle from which it may require at least 7 days to recover.

The comparison of the quantity of dry matter recovered from the rumen in relation to the dry matter missing from the feed bunk after the second evacuation of the cycle was highly variable. Ruminal dry matter recovery ranged from 55.76 to 92.75%. The overall mean of 70.50% (SE=10.01) was substantially lower than expected. The evacuation cycles were completed within 4 to 5 hours and it was anticipated that there would be virtually no flow of dry matter from the rumen during this period of time. The most obvious factor contributing to the discrepancy between amount missing from the feed bunk and that recovered in the rumen would be that which the animal spills from the feeder while eating. Two other factors may be involved as well. The hay was extremely dusty and both organic as well inorganic fines may have passed through the rumen with the liquid faction more rapidly than expected. In addition, the supplement was not pelleted and contained readily soluble and degradable constituents which may also have passed through the rumen rapidly. It seems reasonable that these three factors could account for the 25 to 30% loss in recovery rate under these circumstances. A shorter evacuation cycle and freeze-drying of the total rumen contents rather than straining the liquid faction of the rumen contents may have increased the rumen recovery rate. Recovery from the rumen was not correlated with feed bunk disappearance ($P>.88$). In a grazing situation, rate of recovery may be higher because the forage would be relatively free of fines and no supplements would be fed during the collection period. At this time, no explanations are apparent for either the extremely high or low recovery rates encountered.

Conclusions

Total rumen evacuation techniques have potential for the sampling of forage in grazing situations. Even under severe evacuation regimens, including repeated total evacuation and rinsing of the rumen, no detrimental effects were evident following a 1 to 2-week recovery period. Over the evacuation period, daily feed intake was depressed with consecutive evacuation, although any individual evacuation had a tendency to stimulate intake in comparison to previous (control) intake. The intake during the first and second evacuation cycles was normal or slightly above normal. Our observations suggest that the practical limit to frequency of evacuation is two evacuations, preferably separated by 1 day and followed by a 12-day recovery period. Animal behavior following evacuation may imply an initial loss of selectivity.

The highly variable rate of recovery from the rumen limits the value of the rumen evacuation technique in quantitative sampling, at least with the type of feedstuffs used in this trial. The potential for qualitative sampling (for example, the sampling of protein or fiber) still needs to be evaluated.

BEEF REPORT

EFFECT OF EARLY WEANING ON FEEDLOT PERFORMANCE AND CARCASS CHARACTERISTCS OF HIGH GROWTH POTENTIAL FEEDER CALVES

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CATTLE 88-10

Summary

Steer and heifer calves produced at Ft. Meade were used to evaluate early weaning and accelerated feeding as a management tool when retaining ownership of calves. Calves were weaned at 5 1/2 (EW) or 7 mo (NW) of age and started immediately on a 60% grain feeding program. Slaughter dates represented mean calf ages of 385 or 425 days and days on feed ranged from 179 to 257 days. Range conditions were good and early weaning had little effect on calf weight at any point in the feeding period. Feeding high grain diets to EW calves did not have any detrimental effects on feedlot performance when compared to NW. Early weaned calves produced carcasses that were 5 lb heavier (P<.05) than carcasses from NW cattle but had no other effects on carcass traits. Days on feed affected marbling scores independently of calf age or weaning group. EW appears to be a useful tool for reducing marketing interval for retained ownership cattle and for improving marbling scores of cattle at young ages.

(Key Words: Early Weaning, Range, Feedlot, Calves, Carcass.)

Introduction

Producers of calves with superior growth potential and(or) carcass traits can, in some instances, increase the reward for genetic selection if ownership of calves is maintained until slaughter. Postweaning management strategy is important in the success of a retained ownership program. Approaches vary widely, reflecting available resources and traditional practices. For calves with high postweaning growth rate potential, an accelerated feeding program should offer several advantages. Feeding high grain diets to high growth potential calves should allow better expression of genetic potential and allow calves to reach slaughter weight at an earlier age. Resultant feed efficiency should be improved and time necessary to receive payment for the calf crop is reduced.

There is potential for problems in an accelerated production program. Early sustained feeding of high grain diets may damage the ruminal epithelium and cause poor feed conversion. Feeding too much grain early in the growth curve may increase body fat at a given weight. To maintain trim carcasses, slaughter weight may have to be lowered. Finally, young cattle (<14 months) are noted for inconsistent production of choice carcasses.

This study was designed to evaluate the effectiveness of early weaning as a tool for accelerated beef production systems. Our objectives were to determine the effects of early weaning and days on feed on feedlot performance and carcass traits of crossbred steer and heifer calves.

Materials and Methods

Early weaning effects were studied using Charolais-sired steer and heifer calves produced by the crossbred cows maintained at Ft. Meade. Average calving date for all calves was April 2 and ranged from March 8 to May 21. Since calf age was a primary consideration in this study, allotment of calves to treatment groups and feedlot pens

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included age as well as weight stratification. Steers and heifers were balanced across treatment groups and were fed separately.

All calves were weighed September 14 at the ranch. Half of the calves were then shipped 400 miles to the research feedlot at Brookings and were considered the early weaning (EW) group. Calves were allowed access to hay and water overnight. The next morning individual weights were recorded, vaccinations for IBR, BVD, PI_3, H. somnus and 7-way clostridia and ivermectin were administered. The receiving diet (Table 1) including Deccox was fed for 28 days. Diet 2 was fed for 56 days before switching to diet 3. When diet changes were made, grain offered was held constant which actually reduced dry matter offered for the first 2 days after the switch. Beginning the third day after the switch, the new diet was offered to appetite although daily increases did not exceed 10% DMI.

TABLE 1. DIETS FED TO EARLY AND NORMALLY WEANED CALVES[a]

Item	Receiving	Grower[b]	Finisher[b]
Days fed	1-28	29-84	85-slaughter
Corn, cracked	54.1		
Corn, whole shelled		46.75	24.77
Corn, high moisture		21.55	57.80
Hay, %	40.0	25.00	10.00
Molasses, %	3.0	2.75	2.00
Soybean meal, 44%	2.5	3.29	4.07
Limestone, %		.26	1.06
Trace mineralized salt, %	.4	.40	.30

[a] Percentage dry matter basis, all diets contain 1,000 IU vitamin A/lb.
[b] Contain 26 g/T monensin.

Normally weaned (NW) calves were separated from their dams, weighed and shipped to Brookings 39 days later than EW calves (October 23). Calves in both groups were implanted with Ralgro at this time. NW calves were offered the feedlot receiving diet for 27 days (vs 28 days). In all other regards NW calves were managed in the same manner as the EW group. Interim weights were obtained on all calves to reflect weights at common ages and common days on feed. Cattle were reimplanted with Synovex-S or -H 109 days after applying the first implant.

Slaughter dates were April 21 and May 31. Half of the calves from each weaning group were slaughtered on each date. EW calves were fed for 217 or 257 days. NW calves were fed for 179 or 218 days. Cattle were denied access to feed and water for 24 hours prior to taking final weights. On the initial slaughter date, 4 head were removed from each pen. Selection was based upon final live weights. Selected cattle represented the distribution of weights within the pen. Pen was the experimental unit for evaluating feedlot performance. Disturbing pen makeup at the initial kill date limits comparisons of feedlot performance to the time of initial slaughter.

Hot carcass weights were noted at slaughter. After a 24-hour chill, rib fat and rib eye area were measured. Marbling score and percentage kidney, pelvic and heart fat were determined by a federal grader. The same grader was utilized on each slaughter date.

Feedlot data were analyzed as a 2 x 2 factorial where weaning group and gender represented main effects. Pen was considered the experimental unit for evaluating feedlot performance. Six 8 head pens of steers and six 8 head pens of heifers were represented in the dataset. Carcass data were analyzed using weaning group and gender as main effects in a 2 x 2 factorial design. Individual carcasses represented experimental units in those analyses.

Results and Discussion

Calves weaned at normal age started on feed nearly 100 lb heavier than early weaned counterparts (Table 2), because pasture gains were good, exceeding 2.5 lb/day during this period. Steers and heifers had similar feedlot arrival weights. During the initial 28 days in the feedlot, NW calves consumed more dry matter and were less efficient than EW calves. Those differences may reflect the difference in feedlot arrival weights. When NW calves arrived at the feedlot, they were 16 lb lighter (P<.05) than EW calves on that same date.

TABLE 2. FEEDLOT PERFORMANCE OF EARLY AND NORMALLY WEANED FEEDER CALVES

	Group		Grower		
Item	EW[a]	NW[b]	Steer	Heifer	SEM
Feedlot arrival weight, lb	476[e]	573	524	524	4.5
Receiving ADG, lb/head	4.01	4.06	4.25[d]	3.81	.12
DMI, lb/head	13.09[c]	14.38	13.68	13.79	.09
F/G	3.29[c]	3.55	3.22[d]	3.62	.09
Cumulative ADG, lb/head	3.11	3.19	3.31[e]	2.99	.05
DMI, lb/head	18.85[d]	19.72	19.32	19.25	.02
F/G, lb/head	6.07	6.20	5.83[d]	6.45	.12
Apr 21 slaughter weight, lb	1151	1137	1176[e]	1113	7.9
May 31 slaughter weight, lb	1254	1264	1296[e]	1222	12.6

[a] Early weaned.
[b] Normally weaned.
[c] Main effect (P<.05).
[d] Main effect (P<.01).
[e] Main effect (P<.001).

Cumulative feedlot ADG was not affected by weaning age. Daily DMI was higher for NW calves. Since the average weight in the feedlot of NW calves is greater than the average weight of EW calves, greater daily DMI would be expected. Cumulative feed efficiency was not affected by early weaning. Early and normal weaned calves had similar finished weights on both slaughter dates. Steers gained 10% faster (P<.01) than heifers and were more efficient (P<.01; Table 2). On both slaughter dates steers were heavier (P<.001) than heifers. No efforts were made to suppress heat in the heifers. Several heifers suffered vaginal prolapses that required attentiond during the feeding period. Both factors would contribute to poorer ADG and feed efficiency.

There was no difference in final live weight of EW or LW groups. EW carcasses were heavier (750 vs 745 lb; P<.01), but this response may be of limited marketing importance. Rib fat thickness, rib eye area and yield grade were not affected by weaning date.

Carcass data could be evaluated on the basis of feeding groups. The four groups and days on feed were early weaned-early kill date (217 days); early weaned-late kill date (257 days); normal wean-early kill date (179 days) and normal wean-late kill date (218 days; Table 3). Cattle on feed for 179 days produced lighter carcasses, with less rib fat and lower marbling scores (P<.05). When cattle were fed for 217 days as EW or 218 days as NW groups, the older cattle produced heavier carcasses (P<.05). Other carcass traits were similar among the two groups fed for 217 days.

Birth date was known for all calves in this study and calf age was similar in each feeding group. Using calf age as a covariate and gender and feeding group as independent variables, only feeding group was found to affect marbling score. In other words, days on feed was important in affecting marbling score independent of age. Mean age at each kill date was 385 and 425 days. These data indicate that difficulties in getting cattle <14 months of age to consistently produce carcasses with small amounts of marbling are more a function of the feeding program than physiological maturity.

TABLE 3. CARCASS TRAITS OF EARLY AND NORMALLY WEANED CALVES FED FOR DIFFERING PERIODS OF TIME

Weaning group	Early		Normal		
Kill group	Early (217 days)	Late (257 days)	Early (179 days)	Late (218 days)	SEM
Carcass weight, lb[c]	722[e]	778[d]	713[e]	779[d]	12.5
Rib fat, in	.48[de]	.50[d]	.40[e]	.44[e]	.027
Rib eye area, in^2	13.53	13.93	13.69	13.83	.287
Yield grade	2.66[de]	2.75[d]	2.36[e]	2.55[de]	.122
Marbling score[ab]	5.21[ef]	5.58[d]	4.96[f]	5.50[de]	.120

[a] Slight = 4.0; Small = 5.0; Modest = 6.0.
[b] Weaning group effect P<.10.
[c] Weaning group effect P<.01.
[def] Means within a row with unlike superscripts differ (P<.05).

Early weaning did not accelerate the growth curve of the calves in this study, since EW and NW calves had similar weights at any point in time. Pasture conditions were good and gains by normally weaned calves exceeded 2.5 lb/day during the last 39 days prior to weaning. Under less favorable conditions we have measured poorer gains during this time of year that may make early weaning more appealing.

These data do indicate that, by earlier weaning, calves fed high energy diets will achieve choice grade at a younger age than normally weaned calves. Since similar days on feed were required for either weaning group to produce choice carcasses, early weaning would principally benefit individuals retaining ownership of their calf crop until slaughter.

BEEF REPORT

EFFECTS OF BODY CONDITION ON REPRODUCTIVE PERFORMANCE OF RANGE BEEF COWS

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CATTLE 88-11

Summary

Mature Simmental x Angus crossbred cows were fed differing levels of nutrition from December to May in each of 3 years to create a wide range in cow body condition or fleshiness at the beginning of the calving season (beginning mid-March) and when turned to summer pasture (early May) 1 month prior to the beginning of a 60-day breeding season (early June). Cows that were fleshier in March, May or June cycled earlier and conceived earlier. Being thin in May or June had a more detrimental effect on pregnancy rate for cows that calved late in the calving season. A condition score of 4 for early calving cows and 5 for late calving cows at calving and breeding were the minimum body condition for high reproductive performance.

(Key Words: Beef Cow, Body Condition, Reproduction, Nutrition.)

Introduction

Many researchers have shown that body condition of beef cows affects reproductive performance. Previous studies have linked higher cow body conditions with shorter intervals from calving to first estrus and increased percentage of cows pregnant. It is not clear as to the minimum degree of body condition at various stages of production that will lead to adequate reproductive performance under different conditions.

The objectives of this study are to (1) establish the minimum cow body condition before calving and breeding necessary for adequate reproductive performance and (2) evaluate subjective and objective measurements to describe body condition of beef cows. The results reported in this paper relate to objective 1.

Materials and Methods

Mature Simmental x Angus crossbred cows wintered at the SDSU Range and Livestock Research Station near Philip and summer grazed near Sturgis, South Dakota, were allotted each December by age and previous calving date to one of two levels of early winter nutrition. Within 1 week following calving, cows were reallotted by calving date, calf sex, cow age and early winter treatment to one of two late winter treatments fed until early May. Early and late winter treatments were designed to create a wide range in cow body condition prior to calving and in early May.

All cows grazed native range as a group from early May to early December each year. The 60 to 70-day breeding season began on June 6 each year. For the first 2 years, cows were exposed to Charolais bulls. During the third year, cows were observed for estrus for the first 25 days of the breeding season and artificially inseminated to Simmental or Angus bulls. Cows were then exposed to Simmental or Angus bulls for the remainder of the breeding season.

Cow body condition scores (Table 1), cow weights (after overnight withdrawal from feed and water), backfat needle probes (Cook's probe taken between 12th and 13th ribs) and weight/height ratios (weight/height at top of the hook bones) were monitored monthly from December through July. Blood from each cow was collected twice monthly (7-10 days apart) in early May, June and July for detection of cyclic activity via serum progesterone as

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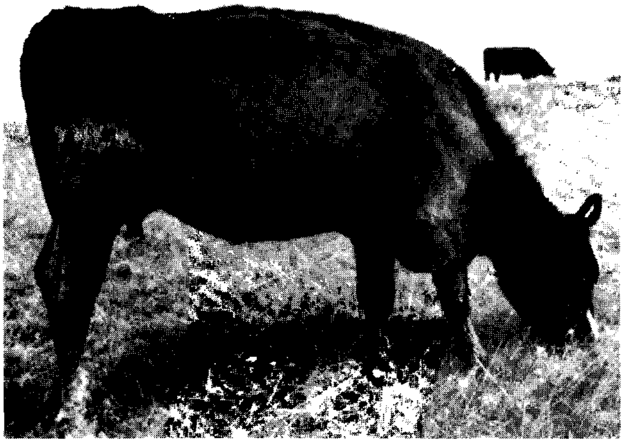
TABLE 1. KEY POINTS FOR CONDITION SCORING BEEF COWS

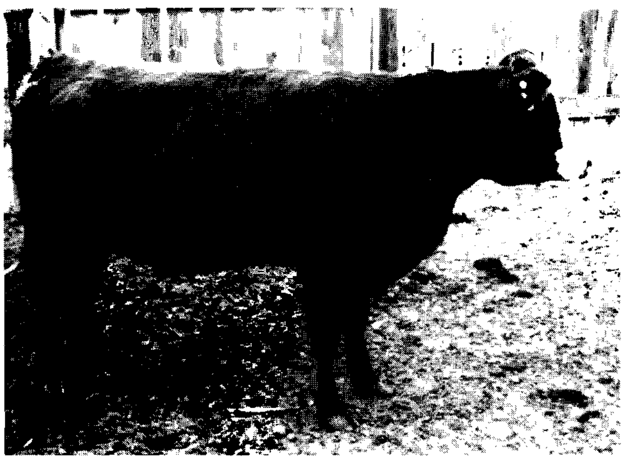
Reference point	Condition score 1	2	3	4	5	6	7	8	9
Physically weak	yes	no	no	no	no	no	no	no	no
Muscle atrophy[a]	yes	yes	slight	no	no	no	no	no	no
Outline of spine visible	yes	yes	yes	slight	no	no	no	no	no
Outline of ribs visible	all	all	all	3-5	1-2	0	0	0	0
Fat in brisket and flanks	no	no	no	no	no	some	full	full	extreme
Outline of hip and pin bones visible	yes	yes	yes	yes	yes	yes	slight	no	no
Fat udder and patchy fat around tail head	no	no	no	no	no	no	no	slight	yes

[a] Muscles of loin, rump and rearquarter are concave, indicating loss of muscle tissue.

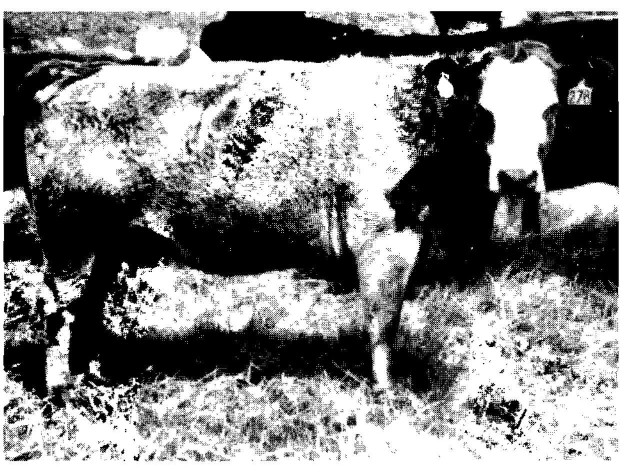
CONDITION SCORE 1



CONDITION SCORE 3



CONDITION SCORE 5



Left: Condition Score 7; Right: Condition Score 2

CONDITION SCORE 7

determined by radioimmunoassay. Pregnancy was determined by rectal palpation in October. Conception date was estimated by subtracting an assumed 285-day gestation length from calving dates the following spring. Only records from cows nursing calves were included in statistical analyses.

Treatment effects were analyzed as a 2 x 2 factorial using the General Linear Model procedure (GLM) of the Statistical Analysis System (SAS). Means were separated by the Predicted Difference option. Conception to artificial insemination was analyzed by Chi-square Analysis. Prediction equations to analyze the effects of condition score and days from calving to the beginning of the breeding season were developed using the Logist Procedure of SAS (cycling, conception during the first 21 days of breeding season, pregnancy) and GLM (conception date).

Results and Discussion

The nutritional treatments imposed produced differences in weight change and body condition (Tables 2-4). Those treatments that produced greater winter weight loss and lower body condition scores resulted in fewer cows cycling prior to and during the breeding season and later conception dates.

TABLE 2. EFFECTS OF EARLY AND LATE WINTER TREATMENTS (1984-85)

Early winter treatment	High		Low	
Late winter treatment	High	Low	High	Low
No. cows	18	19	21	19
Cow wt, lb, 12/13/84	1030	983	1021	1045
Cow condition score				
12/13/84	5.4	5.2	5.4	5.4
3/12/85	5.8	5.6	5.4	5.0
5/7/85	5.4^{a}	4.6^{b}	4.5^{b}	4.2^{b}
6/5/85	5.1	4.7	4.5	4.9
Cow wt change, lb				
12/13/84-2/15/85	46^{a}	51^{a}	-11^{b}	-42^{c}
2/15/85-3/12/85	22^{a}	15^{a}	42^{b}	53^{b}
3/12/85-5/7/85	-176	-191	-172	-174
12/13/84-5/7/85	-114^{a}	-134^{ab}	-145^{bc}	-167^{c}
5/7/85-6/5/85	46^{ab}	57^{ab}	31^{a}	64^{b}
Cow cycling, %				
5/7/85	33	37	10	26
6/5/85	75^{a}	56^{ab}	33^{b}	35^{b}
7/2/85	100	100	90	100
Cows pregnant, fall 1985, %	100	100	90	100
Conception date, 1985	June 15^{a}	June 22^{ab}	June 26^{b}	June 27^{b}

^{a,b,c} Means in a row without common superscripts differ ($P<.05$).

TABLE 3. EFFECTS OF EARLY AND LATE WINTER TREATMENTS (1985-86)

Early winter treatment	High		Low	
Late winter treatment	High	Low	High	Low
No. cows	25	23	22	24
Cow wt, lb, 12/9/85	1030	1047	1012	1012
Cow condition score				
12/9/85	5.7	5.3	5.6	5.4
3/7/86	5.5^{a}	5.1^{ab}	4.9^{bc}	4.6^{c}
5/9/86	4.5^{a}	3.6^{b}	4.1^{a}	2.9^{c}
6/5/86	5.3^{a}	4.6^{b}	5.1^{a}	4.1^{c}
Cow wt change, lb				
12/9/85-2/7/86	29^{a}	33^{a}	-40^{b}	-40^{b}
2/7/86-3/7/86	-22^{a}	-18^{a}	4^{b}	7^{b}
3/7/86-5/9/86	-130^{a}	-180^{c}	-106^{b}	-158^{c}
12/9/85-5/9/86	-121^{a}	-165^{b}	-143^{ab}	-191^{c}
5/9/86-6/5/86	119	125	121	112
Cows cycling, %				
5/9/86	20	13	9	4
6/5/86	56^{a}	48^{ab}	50^{a}	25^{b}
7/2/86	80^{a}	61^{ab}	77^{ab}	54^{b}
Cows pregnant, fall 1986, %	92	96	95	100
Conception date, 1986	June 21^{ab}	June 23^{ab}	June 17^{a}	June 24^{b}

^{a,b,c} Means in a row without common superscripts differ (P<.05).

TABLE 4. EFFECTS OF EARLY AND LATE WINTER TREATMENTS (1986-87)

Early winter treatment	High		Low	
Late winter treatment	High	Low	High	Low
No. cows	25	24	21	24
Cow wt, lb, 12/13/86	1133	1135	1133	1115
Cow condition score				
12/5/86	6.2	6.4	6.2	6.3
3/6/87	6.2^{a}	6.0^{a}	5.3^{b}	5.2^{b}
5/8/87	4.8^{a}	3.6^{b}	4.5^{a}	2.5^{c}
6/5/87	5.0^{a}	4.3^{b}	4.4^{ab}	3.4^{c}
Cow wt change, lb				
12/5/86-2/13/87	53^{a}	48^{a}	-8^{b}	-40^{c}
2/13/87-3/6/87	21^{a}	15^{a}	42^{b}	51^{b}
3/6/87-5/8/87	-233^{a}	-310^{b}	-198^{c}	-264^{d}
12/5/86-5/8/87	-174^{a}	-253^{b}	-218^{c}	-295^{d}
5/8/87-6/5/87	62^{a}	86^{b}	75^{ab}	84^{b}
Cows cycling, %				
5/7/85	32^{a}	17^{ab}	24^{a}	4^{b}
6/5/85	72^{a}	42^{b}	62^{a}	13^{c}
7/2/85	96^{a}	96^{a}	95^{a}	63^{b}
Cows pregnant, fall 1987, %	100	96	91	83
Conception date, 1987	June 29^{ab}	June 26^{a}	July 1^{ab}	July 7^{b}

^{a,b,c} Means in a row without common superscripts differ (P<.06).

The probability of a cow cycling prior to the breeding season and conceiving in the first 21 days of the breeding season and pregnancy was greater for cows that were fleshier in March, May and June (Table 5). Cows that calved earlier, allowing more time from calving to the beginning of the breeding season, were more likely to cycle early and conceive in the first 21 days of the breeding season (Table 6). To help evaluate the importance of body condition under different situations, data were analyzed separately for those cows that calved early in the calving season (greater than 60 days from calving to the beginning of the breeding season) and late calving cows (less than or equal to 60 days from calving to the breeding season).

TABLE 5. EFFECT OF CONDITION SCORE ON REPRODUCTIVE PERFORMANCE BASED ON PREDICTION EQUATIONS

March condition score	Proba-bility	May condition score	Proba-ability	June condition score	Proba-ability
Probability of cycling at the beginning of the breeding season					
1		1	.08[a]	1	
2		2	.15	2	.05[a]
3	.09[a]	3	.26	3	.12
4	.19	4	.42	4	.28
5	.35	5	.59	5	.52
6	.55	6	.75	6	.74
7	.74	7	.86	7	.89
8	.86	8		8	
Probability of conceiving in the first 21 days of the breeding season					
1		1	.33[a]	1	
2		2	.44	2	.27[a]
3	.44[a]	3	.56	3	.41
4	.53	4	.66	4	.57
5	.62	5	.76	5	.72
6	.71	6	.83	6	.83
7	.78	7	.89	7	.90
8	.84	8		8	
Probability of pregnancy during 60-day breeding season					
1		1	.76[a]	1	
2		2	.87	2	.74[a]
3	.86[b]	3	.93	3	.87
4	.92	4	.97	4	.94
5	.95	5	.98	5	.98
6	.97	6	.99	6	.99
7	.98	7	1.00	7	1.00
8	.99	8		8	

[a] Probability that slope equals zero is <.01.
[b] Probability that slope equals zero is =.10.

TABLE 6. EFFECT OF DAYS FROM CALVING TO THE BEGINNING OF THE BREEDING SEASON ON REPRODUCTIVE PERFORMANCE BASED ON PREDICTION EQUATIONS

Days after calving	May condition score 3	May condition score 6	June condition score 3	June condition score 6
	Probability of cycling prior to the breeding season			
30[a]	.05	.32	.02	.30
50	.14	.56	.06	.55
70	.31	.78	.15	.78
90	.55	.91	.34	.91
	Probability of conceiving in the first 21 days of the breeding season			
30[a]	.37	.70	.25	.70
50	.47	.78	.33	.78
70	.58	.84	.43	.84
90	.67	.89	.54	.89

[a] Probability that slope for days after calving equals zero is <.0001.

Pregnancy rates were surprisingly high despite average winter weight loss of as much as 26% of cow weight for one combination of treatments during the third year.

Based on the information in Table 7, pregnancy rates were greater than 90% if early calving cows were a condition score 3 or greater in June. Condition in March and May was less closely related to pregnancy rate. However, if cows calved late in the calving season, they needed to be one condition score higher in June to have the same probability of being pregnant. Condition in May, 30 days prior to the breeding season, was more closely related to pregnancy rate for later calvers. Having cows in condition score 3 or less in May and June was much more detrimental to pregnancy rate for cows calving late in the calving season.

Although early calving cows have a higher probability of becoming pregnant even if thin (CS 3 or less), a more detrimental effect is the reduced probability of cycling prior to the beginning of the breeding season (Table 5) and conceiving in the first 21 days of the breeding season (Table 7). There was no interaction between condition score prior to calving with condition score in May or June for day of conception. This indicates that we would expect the same effect of condition score in May or June regardless of how fleshy the cows were at calving time.

It has been suggested that thinner cows may have higher conception rates to a single service than fleshy cows. Results in Table 8 indicate that conception rates of those artificially inseminated was actually lower for thin cows. When calculated as a percentage of cows conceiving during the 25-day artificial insemination of all cows in the herd, conception rates were much lower for thin cows. It should be noted that very few cows could be considered fat (condition score 7 or greater) in May or June. This would indicate that for cows to be too fleshy to allow high conception rates they would need to be a condition score 7 or greater.

In summary, cows that are fleshier at calving and prior to the breeding season cycle sooner after calving and are more likely to conceive early in the breeding season. For cows that calve later in the calving season, a condition score of less than 4 at the beginning of the breeding season and less than 3 at 30 days prior to the breeding season resulted in pregnancy rates less than 90% during a 60-day breeding season.

TABLE 7. EFFECT OF CONDITION SCORE AND CALVING DATE ON SUBSEQUENT REPRODUCTIVE PERFORMANCE BASED ON PREDICTION EQUATIONS

March condition score	Early calvers	Late calvers	May condition score	Early calvers	Late calvers	June condition score	Early calvers	Late calvers
Probability of pregnancy during 60-day breeding season								
1			1	.89	.53[a]	1		
2			2	.93	.75	2	.81[b]	.60[a]
3	.88		3	.95	.89	3	.91	.80
4	.93	.88	4	.97	.96	4	.96	.91
5	.96	.93	5	.98	.98	5	.98	.97
6	.98	.96	6	.99	.99	6	.99	.99
7	.99	.97	7	.99	1.00	7	1.00	.99
8	.99	.99	8			8		
Probability of conceiving in the first 21 days of the breeding season								
1			1	.46[a]	.13[a]	1		
2			2	.54	.24	2	.29[a]	.23[a]
3	.51[b]		3	.61	.40	3	.44	.36
4	.58	.41[a]	4	.69	.59	4	.60	.50
5	.65	.56	5	.75	.75	5	.75	.65
6	.72	.70	6	.81	.87	6	.85	.77
7	.77	.81	7	.85	.93	7	.92	.86
8	.82	.89	8			8		
Day of conception (Julian date)								
1			1	184.7[a]	198.5[a]	1		
2			2	181.8	192.8	2	187.6[a]	195.7[a]
3	187.1[b]		3	178.9	187.1	3	183.1	190.2
4	182.6	188.5[a]	4	176.0	181.4	4	178.6	184.6
5	178.1	182.5	5	173.0	175.7	5	174.1	179.0
6	173.6	176.6	6	170.1	170.0	6	169.6	173.4
7	169.2	170.7	7	167.2	164.3	7	165.1	167.8
8	164.7	164.7	8			8		

[a] Probability that slope is equal to zero <.05.
[b] Probability that slope is equal to zero <.10.

TABLE 8. COWS CONCEIVING TO ARTIFICIAL INSEMINATION, 1987

	May condition score			June condition score	
	1,2,3	4	5,6,7	2,3,4	5,6,7
No. cows	46	31	28	71	34
No. cows inseminated	25	24	22	41	30
Conception to AI of cows inseminated, %	68.0	70.8	77.3	63.4[c]	83.3[d]
Cows conceiving to AI of all cows, %	37.0[c]	54.8[d]	60.7[d]	36.6[a]	73.5[b]

[a,b] Within month means in a row without common superscripts differ ($P<.05$).
[c,d] Within month means in a row without common superscripts differ ($P<.10$).

Cows that calved early in the calving season could be thinner than late calvers for the same level of reproductive performance. This points out the importance of managing yearling heifers to have a high percentage calving earlier in the calving season as 2-year-olds to insure a high likelihood of pregnancy in subsequent years. For cows that calve early in the calving season, the detrimental effect of delayed conception would result in lower pregnancy rates if thin for two or more years in a row.

The minimum body condition recommended from this study would depend on the level of performance expected. To achieve a goal of approximately 95% pregnancy rate and 60% conceiving in the first 21 days of the breeding season would require a minimum condition score of 4 at the beginning of the breeding season for cows calving early in the calving season and 5 for late calvers. To ensure that the thinnest cows are a condition score 4, it would be appropriate to have a goal of 5 for a herd average. In this study where abundant forage was available for 30 days prior to and during the breeding season, cows could be 1 condition score less 30 days prior to the breeding season, making a herd average of condition score 4 an appropriate goal at that time. In situations where such weight gain is not possible, a goal of 5 at 30 days prior to the breeding season would be advisable.

The higher pregnancy rate of early calving cows at any body condition points out the importance of managing to have a high percentage of young cows calve early. In years when cows are thinner than planned due to drought or extreme winter weather, relatively high pregnancy rate can still be obtained without lengthening the breeding season if a high percentage of cows are calving early in the calving season.

BEEF REPORT

EFFECTS OF COW BODY CONDITION AND CALVING DATE ON CALF PERFORMANCE

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CATTLE 88-12

Summary

Records from 285 Charolais-sired calves out of 133 Simmental x Angus crossbred cows taken over 3 years were used to evaluate the influence of cow body condition at calving, condition score change following calving and calf birth date on calf performance. Calves nursing cows with higher condition scores in March had increased daily gains from birth until May. However, at weaning time average daily gain and weaning weights were similar regardless of cow condition at calving. Cows which maintained body condition or lost less than two condition scores from March to May weaned heavier calves than cows which lost two or more condition scores after calving. Calf growth rate from birth until 6 months of age was similar between calves born early and those born late in the calving season.

(Key Words: Beef Cow, Calf Performance, Condition Score, Calving Date.)

Introduction

Researchers have found that lower cow nutrition and body condition at calving decreases average daily gain of the young calf. With the arrival of spring grass, lighter calves appear to compensate for earlier depressed gains and their weaning weights are similar to calves from fleshier cows.

Preliminary results from the Gundmonson Sandhills Laboratory, Nebraska, compared calf performance of March- and April-born calves. No differences in weaning weights taken at a common age were observed between the two groups. Although older calves were heavier at weaning time, their average daily gain from birth to weaning was not affected by month of birth.

Data from this study were recorded in conjunction with a 3-year project designed to determine the minimum cow body condition before calving and breeding necessary for adequate reproductive performance. The objectives of this analysis were (1) to determine the effects of cow body condition at calving and condition score change from calving until May on calf performance and (2) to determine the influence of calving date on calf performance under range conditions.

Materials and Methods

Simmental x Angus crossbred cows and their Charolais-sired calves were wintered at the SDSU Range and Livestock Research Station near Philip and grazed summer pastures near Sturgis, South Dakota. Calving occurred from mid-March until mid-May. Cows and calves grazed native pastures as one group from May until weaning. High and low early and late winter nutritional treatments established wide ranges in cow body condition in March prior to the start of the calving season and in early May upon "turnout" onto summer pastures. Visual condition scores (CS 1-9, 1 = severely emaciated) were assigned cows using the average score of two assessors in March and May of each year. A more complete description of condition scores are outlined in paper 88-11 of this publication. Calf weights (after feed and water removal overnight) were recorded at the end of late winter treatment and monthly thereafter until weaning.

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Results and Discussion

Calves from fleshier cows at calving had higher average daily gains from birth to May (Table 1). Higher cow body condition in March did not improve calf rate of gain after May. Calf weight after May and 205-day adjusted weights were similar regardless of cow body condition at calving.

TABLE 1. EFFECTS OF COW CONDITION SCORE IN MARCH ON CALF PERFORMANCE

	March cow condition score			
	3,4	5	6	7,8
No. of calves	60	128	66	31
Calf average daily gain, lb/day				
Birth to May	1.64[a]	1.84[ab]	1.89[ab]	2.14[b]
May to July	2.53	2.53	2.42	2.47
July to September	2.80	2.75	2.75	2.78
Calf weight, lb				
May	149[a]	158[b]	161[b]	166[b]
June	214	228	226	229
July	288	297	293	301
September	536	538	536	547
205 day adjusted weight, lb	596	598	595	609

[a,b] $(P<.05)$.

Average daily gain and actual weights of calves from cows that maintained or lost less than two condition scores from March to May were similar (Table 2). Once cows and calves grazed summer pastures calf gains were similar until weaning for all groups. If cows lost at least two or more condition scores during the late winter treatment period, calf rate of gain was depressed enough to lower 205-day adjusted weaning weights approximately 20 pounds.

No interactions were found between condition score in March and condition score change from March to May for calf performance. The effect of condition score change on calf performance was not influenced by cow body condition at calving.

Differences in calf gains occurred from birth to May and from May to July for early and late born calves (Table 3). However, calf gains from birth to approximately 6 months of age were not different. Monthly weights were higher for early born calves while 205-day adjusted weights were similar.

As suggested by previous studies, early calf performance improved as cow body condition at calving increased. Summer weight gains and calf weaning weights were not affected by cow body condition at calving. If cow nutrition after calving was severely restricted to the point that cows lost two or more condition scores before May, then calf gains during that period were decreased and not compensated for by weaning time. No differences were found in weaning weights for early versus late calves when compared at a common age. Under these range conditions, differences in weaning weights were due to an age advantage for older calves and not differences in average daily gain.

TABLE 2. EFFECTS OF COW CONDITION SCORE CHANGE FROM MARCH UNTIL MAY ON CALF PERFORMANCE

	Condition score change, March to May		
	Maintained	Lost one	Lost two or more
No. of calves	42	127	116
Calf average daily gain, lb/day			
Birth to May	2.09[a]	2.01[a]	1.54[b]
May to July	2.53	2.46	2.49
July to September	2.76	2.78	2.77
Calf weight, lb			
May	164[a]	164[a]	147[b]
June	232[a]	228[a]	212[b]
July	303[a]	298[a]	283[b]
September	545[a]	545[a]	528[b]
205-day adjusted weight, lb	607[a]	606[a]	586[b]

[a,b] (P<.05).

TABLE 3. EFFECTS OF CALVING DATE ON CALF PERFORMANCE

	Early calves	Late calves
No. of calves	194	57
Average calving date	March 24	April 15
Calf average daily gain, lb/day		
Birth to May	2.04[a]	1.73[b]
May to July	2.36[a]	2.49[b]
July to September	2.71	2.78
Birth to September (early calves)		
Birth to October (late calves)	2.46	2.44
Calf weight, lb		
May	167[a]	138[b]
June	235[a]	199[b]
July	306[a]	267[b]
September	551[a]	506[b]
September (early calves)		
October (late calves)	551	548
205-day adjusted weight, lb	600	593

[a,b] (P<.05).

BEEF REPORT

RELATIONSHIPS BETWEEN BODY CONDITION SCORES AND LIVE ANIMAL MEASUREMENTS OF BEEF COWS

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CATTLE 88-13

Summary

Records from 133 mature Simmental x Angus cows collected over a 3-year period were used to determine the relationships between body condition scores and other measurements of cow body condition. Positive correlations were found between condition scores and backfat, weight/height ratios and cow weight. Correcting weight/height ratios of pregnant cows for weight of the conceptus did not improve the correlations with condition score. Backfat measurements had limited use in describing body condition, since backfat was near zero for cows less than condition score 5. Equations using condition scores accurately predicted weight/height ratios.

(Key Words: Beef Cow, Condition Score, Weight/Height Ratio, Backfat.)

Introduction

Reproductive performance of beef cows has been shown to be affected by cow body condition at calving and breeding. Condition scores are subjective evaluations of cow body condition that are highly correlated with body composition or degree of carcass fat and muscle. Weight/height ratios and backfat are objective measurements of cow body condition that can be obtained without having to sacrifice the animal.

This report is derived from a 3-year study conducted to determine the minimum cow body condition before calving and breeding necessary for adequate reproductive performance. The objective related to this paper was to determine the relationships between condition scores and other live animal measurements of cow body condition.

Materials and Methods

Simmental x Angus crossbred cows were wintered at the SDSU Range and Livestock Research Station near Philip, South Dakota, and grazed summer pastures near Sturgis, South Dakota. Calving occurred from mid-March until mid-May. Wide ranges in cow body condition were established prior to calving and in early May by assigning cows to high or low early and late winter nutritional treatments. In March, May and June of each year, condition scores (CS 1-9, 1 = severely emaciated) were assigned cows using the average score of two assessors. A more complete description of condition scores are outlined in paper 88-11 of this publication. Backfat measurements using a Cooks probe[3] were taken over the loin between the 12th and 13th ribs for the first 2 years of the study. Each year hip height was averaged using three monthly measurements. Weight/height ratios were computed by dividing live weight (after feed and water were removed overnight) by hip height. Cow weights in early March were adjusted for conceptus weight using the following equation:

$$\text{Adjusted weight} = \text{Actual weight} - \frac{\text{Calf birth weight}}{.6} + (1.25 \times \text{No. of days to calving})$$

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Results and Discussion

Nutritional treatments produced a wide range of cow condition scores in March, May and June (Tables 1, 2 and 3). Average hip heights were similar across a wide range of condition scores, indicating that frame size did not influence an assessor's ability to evaluate cow body condition. Cows in condition score less than 5 had little or no measurable backfat ($\leq$.02 in).

TABLE 1. MEAN LIVE ANIMAL MEASUREMENTS TAKEN IN MARCH BY CONDITION SCORE

Live animal measurement	Condition score					
	3	4	5	6	7	8
No. of cows	10	46	146	70	27	5
Live weight, lb	939	965	1044	1171	1237	1315
Adjusted live weight, lb[a]	834	850	928	1047	1117	1186
Weight/height, lb/in	18.5	19.3	20.8	23.2	24.3	25.9
Adjusted weight/height, lb/in	16.5	17.0	18.5	20.8	21.9	23.3
Hip height, in	50.6	50.0	50.1	50.4	50.8	50.8
No. of cows	10	37	91	33	14	4
Backfat, in	.02	.02	.04	.07	.11	.25

[a] Adjusted for weight of conceptus.

TABLE 2. MEAN LIVE ANIMAL MEASUREMENTS TAKEN IN MAY BY CONDITION SCORE

Live animal measurement	Condition score						
	1	2	3	4	5	6	7
No. of cows	7	31	70	98	82	14	8
Live weight, lb	744	804	845	883	960	983	1035
Weight/height, lb/in	14.9	16.1	16.7	17.6	19.0	19.6	20.4
Hip height, in	50.5	49.9	50.4	50.1	50.4	50.1	50.7
No. of cows	2	11	51	66	52	10	7
Backfat, in	.00	.00	.01	.02	.05	.07	.12

TABLE 3. MEAN LIVE ANIMAL MEASUREMENTS TAKEN IN JUNE BY CONDITION SCORE

Live animal measurement	Condition score					
	2	3	4	5	6	7
No. of cows	6	32	106	130	30	9
Live weight, lb	855	902	946	996	1132	1138
Weight/height, lb/in	16.9	17.9	18.8	19.8	22.3	22.5
Hip height, in	50.5	50.4	50.2	50.1	50.5	50.5
No. of cows	0	15	55	98	22	7
Backfat, in		.01	.02	.03	.05	.10

Positive correlations ($P<.001$) were found between condition scores, backfat probes and weight/height ratios in March and May (Tables 4 and 5). Adjusting weight/height ratios for weight of the conceptus did not increase the correlation with condition score or backfat.

TABLE 4. PARTIAL CORRELATION COEFFICIENTS BETWEEN CONDITION SCORE AND LIVE ANIMAL MEASUREMENTS IN MARCH[a]

	Condition score	Backfat	Weight/height ratio
Backfat	.59*		
Weight/height ratio	.74*	.46*	
Adjusted weight/height ratio	.73*	.44*	.96*
Live weight	.62*	.42*	.97*

[a] Model included year as an independent variable.
* P<.001.

TABLE 5. PARTIAL CORRELATION COEFFICIENTS BETWEEN CONDITION SCORE AND LIVE ANIMAL MEASUREMENTS IN MAY[a]

	Condition score	Backfat	Weight/height ratio
Backfat	.62*		
Weight/height ratio	.67*	.37*	
Live weight	.58*	.35*	.97*

[a] Model included year as an independent variable.
* P<.001.

The relationships between condition score and backfat and weight/height ratio in March, May and June were linear (Table 6). Backfat measurements increased quadratically as weight/height ratios increased. Equations used to estimate weight/height ratios by condition score had the highest predictive value or R^2. Correcting weight/height ratios for conceptus weight did not improve the prediction equation. This could be due to the narrow range of calving dates causing only a small variation in cow weight due to day of gestation. Equations using weight/height ratio to determine cow backfat had lower R^2 values and had especially low predictive values in May and June when a high percentage of cows had little or no fat cover.

TABLE 6. EQUATIONS USED TO DETERMINE THE RELATIONSHIP BETWEEN CONDITION SCORE, BACKFAT AND WEIGHT/HEIGHT RATIO[a]

Month	Prediction equation	R^2
March	W/H = 3.7 + 3.3 (CS)	.56
	Adjusted W/H = .9 + 3.4 (CS)	.53
	BF = -.42 + .09 (CS)	.36
	BF = .53 - .058 (W/H) + .0017 $(W/H)^2$	.29
May	W/H = 7.3 + 2.55 (CS)	.43
	BF = -.17 + .048 (CS)	.44
	BF = -.04 + .0035 (W/H) + .00002 $(W/H)^2$	.06
June	W/H = 3.77 + 3.36 (CS)	.41
	BF = -.31 + .07 (CS)	.23
	BF = .19 - .0185 (W/H) + .00053 $(W/H)^2$	.05

[a] CS = condition score; BF = backfat in inches, W/H = weight/height in lb/inch.

When using weight/height ratios, conceptus weights and gut fill differences between animals must be considered. In this study a high percentage of thin cows in May and June had nearly immeasurable amounts of fat cover as detected by backfat probes which limited its use as an indicator of cow body condition. Condition scores and weight/height ratios were closely related. Prediction equations reported could be used to convert condition scores to weight/height ratios.

BEEF REPORT

ECONOMIC ANALYSIS OF USING MIXING EQUIPMENT FOR GROWING HEIFERS

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CATTLE 88-14

Summary

Seventy-two Simmental cross and Charolais cross heifers (475 lb) were utilized in a growing study to estimate the economic value of using a mixer wagon and feed scale to feed light cattle a high roughage diet. Cattle fed the mixed diet gained an additional 22.6 lb on 61.2 lb less dry matter over the 133-day trial than did cattle fed the unmixed diet. Annual ownership and repair costs were assumed to equal $2356. If yearling feeder cattle sold for $80/cwt and if corn, hay and corn silage were worth $90, $80 and $25 per ton, respectively, it would take a minimum of 114 head on feed for 133 days each year to pay annual costs for the wagon. The economic analysis of the data from this trial suggests that even relatively small cattle feeding operations should strongly consider investing in a mixer wagon with a scale.

(Key Words: Feedlot, Mixing Equipment, Economic Analysis.)

Introduction

Many farmer feeders do not have feed scales or mixer wagons to feed cattle. They feel that they cannot afford the expense of this feeding equipment. They feed by what is often referred to as the "front end loader and scoop shovel method". Roughage is often measured by volume using a front end loader or large round bale. Likewise, grain and supplement are measured by volume using bushels, buckets, bags or a scoop shovel.

There are two potential problems associated with feeding by this method. First, feeding by volume can result in tremendous variation in the amount of dry matter offered to cattle, particularly if high silage diets are used. Second, producers are unable to adequately mix diet components under this system. Cattle are given the opportunity to select their own diet. Some cattle may eat predominately roughage. Other cattle may eat predominately concentrate. Other cattle may eat some combination in between.

Weighing of feed commodities and feeding them as a completely mixed ration allows cattle feeders more control over the diet. Intake may be stabilized and every mouthful of feed that the cattle eat may contain a proper balance of carbohydrate, protein, vitamins and minerals. Performance by cattle fed known amounts of a completely mixed diet will likely be greater than that by cattle fed diet components separately. Differences in performance relative to feed costs and other operating expenses will determine if purchasing, operating and maintaining a mixer wagon and scale is economical for farmer feeders.

The objective of this research was to determine performance differences between cattle fed completely mixed diets with feed deliveries weighed out at each feeding versus cattle fed by volume unmixed diets. A second objective was to evaluate the economics of using a mixer wagon with scales for farmer feeder operations.

Materials and Methods

Beginning in mid-October, a total of 72 Simmental cross and Charolais cross heifers (475 lb) were purchased from four South Dakota locations and transported to the Southeast South Dakota Experiment Farm near Beresford. Upon arrival, cattle were allowed access to long stem grass hay and water overnight. During a two week receiving

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period, heifers were fed a standard 60% concentrate starter diet. Once all cattle were assembled, they were shrunk overnight, weighed, ear tagged, vaccinated (IBR, BVD, PI_3, 7-way clostridial bacterin), dewormed, stratified by weight and breed and allotted to eight 9-head pens. The trial started November 4, 1987, and lasted 133 days.

Four pens of heifers were fed ad libitum amounts of a completely mixed grower diet (Table 1). The appropriate amounts of corn silage, ground hay, high moisture corn and supplement for all four pens were weighed into the mixer wagon (Schwartz three auger mixer, 2 ton capacity) and thoroughly mixed prior to feeding. Precise amounts of this total mixed ration were weighed out to each of the four pens of heifers. The four remaining pens of heifers were fed the same diet. Total amount of feed offered to these cattle was approximately the same as the total amount of feed offered to the cattle fed the completely mixed diet. Feed commodities were not mixed prior to feeding and individual feed deliveries to each pen were estimated by volume. The total amount of corn silage, ground hay, high moisture corn and supplement needed for all four pens was weighed out and placed in a separate pile for each commodity. One fourth of each pile, as estimated by volume, was placed into the feed bunk for each pen using a front end loader and scoop shovel. All feed for a particular pen was placed in the same bunk. Corn silage, hay, corn and supplement were layered in the bunk in that respective order.

TABLE 1. DIET FED TO HEIFERS DURING GROWING STUDY

Ingredient	Percentage[a]
Corn silage (35% dry matter)	39.27
Alfalfa-grass hay (16% crude protein)	39.27
Ground high moisture corn (72% dry matter)	15.10
Supplement	
Corn grain	5.58
Trace mineralized salt[b]	.50
Cane molasses	.25
Rumensin 60[c]	.02
Vitamin A-30[d]	.01

[a] Dry matter basis.
[b] Composition, minimum percentage, NaCl 96.0, Zn .350, Mn .209, Fe .200, Mg .150, Cu .003, I .007 and Co .005.
[c] Contains 60 grams monensin per lb.
[d] Contains 30,000 IU vitamin A per gram.

Results and Discussion

Table 2 displays the performance of heifers. Average daily gain was approximately 10.3% greater ($P<.05$) for the heifers fed the completely mixed diet. Statistical analyses were not possible on feed intake and feed conversion data. Feed deliveries to each of the four unmixed pens were estimated by volume and assumed to be the same for each pen. Average daily dry matter intake of the cattle fed the mixed diet was about 2.7% less than the intake of the cattle fed the unmixed diet. Feed conversion was improved by 11.8% for the cattle fed the completely mixed diet. Over the entire trial these differences in performance amounted to 22.6 lb additional gain per head on 61.2 lb less dry matter for the heifers fed the completely mixed diet.

Economic Analysis. Although the use of a scale-mixer wagon improves the productivity of the cattle being fed, it is a matter of economics as to whether one should invest in such equipment. The following discussion is to help in determining the minimum size of operation which can profitability adopt this technology.

TABLE 2. PERFORMANCE OF HEIFERS FED EITHER MIXED OR UNMIXED DIETS

Item	Treatment Mixed	Treatment Unmixed	SEM[a]
Initial weight, lb	476	474	6.37
Average daily gain, lb[b]	1.82	1.65	.06
Daily dry matter intake, lb	16.59	17.05	NE[c]
Feed/gain	9.12	10.38	NE

[a] Standard error of the mean.
[b] $P<.05$.
[c] Nonestimable.

The first step in the analysis is to determine the cost of owning and operating a scale-mixer wagon. The information presented in Table 3 represents an Arts-Way[5] mixer wagon equipped with an electronic scale and other most frequently needed options. The prices and technical data were obtained from an Arts-Way vendor, literature and from the Agricultural Engineers Yearbooks.

TABLE 3. ESTIMATED OWNERSHIP AND REPAIR COSTS OF A MIXER WAGON

List price	$12,779			
Cash price (20% discount)		$10,223.20		
State sales tax (3%)		306.70		
Total cash cost			$10,529.90	
Less salvage value (15%)			1,579.48	
Depreciable value			8,950.42	
Annual depreciation (10 year life)				$ 895.04
Annual repair (5% of list price)				638.95
Housing				73.92
Interest on average investment at 12% ($10,529.90 + $1,579.48) x (.12/2)				726.56
Insurance ($2.00 per thousand)				21.06
Total annual ownership and repair cost				$2,355.54

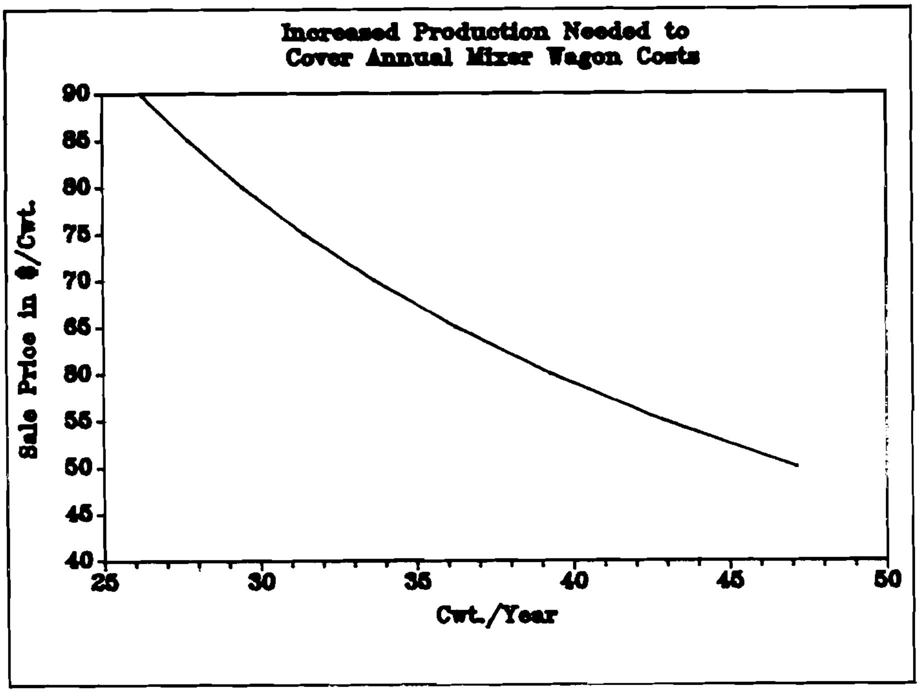
The cost of the tractor used with the mixer wagon is not included in this analysis. For the size of wagon being evaluated here, a 30 to 40 horsepower tractor is sufficient. Mixing time is short, usually about 10 minutes, and may be done as the wagon is towed to the feed bunk. For the analysis at hand, it was assumed the cost of the tractor needed for the wagon was about the same as the cost saved by not using the present equipment to deliver the feed to the bunk.

The feeding trial shows that during the 133-day feeding period cattle fed the mixed diet gained 22.6 more lb on less feed than did the control group. If these extra pounds are sold as feeder cattle at $.80 per pound, an extra $18.08 is generated per head. Ignoring for the time being that less feed was used, it will take a minimum

[5] Arts-Way is a registered trademark for Arts-Way Manufacturing Company, Inc., Armstrong, IA. No endorsement of this product is intended or implied.

of 130.3 head on feed for 133 days per year to pay the ownership and operating cost of the wagon ($2356/$18.08 = 130.3). Stated in terms of additional beef produced, it will take 2,944.4 additional lb of beef produced per year to pay the annual costs of the wagon.

If the price of the animals being fed declines, it will take more head or pounds to cover the costs of the wagon. For example, if the price of feeders sold is only $.60 per lb, it will take 3,926 more lb to pay wagon costs. This translates into 173.7 head when each animal gains an additional 22.6 lb by market time, up from the 130.3 head when the price is $.80. The figure may be used to estimate the increased production in pounds, at various sale prices, needed to cover the annual costs of owning and using a scale-mixer wagon.



When including the feed saved, the number of head needed to pay for the wagon is reduced slightly. The more costly the feed, the fewer head it takes to justify the use of a scale-mixer wagon. With the ration used and feeds priced at $2.50 per bushel for corn, $80 per ton for hay and $25 per ton for corn silage, the 61.2 lb of feed (dry matter basis) saved per head has a value of $2.59. When adding this to the $18.08 additional sales per head, it will take 114 head on feed for 133 days per year to pay for the wagon. If the prices of these feeds are decreased to $2.00 for corn, $20 per ton for silage and $50 per ton for hay, feed savings amount to $1.89 per head. If the 22.6 additional lb of gain are sold at $.60 per lb and the feed savings are included, then at least 152.5 head need to be fed annually to pay the annual cost of a wagon.

With performance data available only for growing heifers, it would be very risky to estimate by extrapolation the benefits of a scale-mixer wagon for finishing cattle. The rations are different and we lack the data to determine the increased productivity, if any, when feeding high concentrate rations as are used in finishing. Feeding less bulky finishing rations may likely result in less increase in productivity from mixing, meaning less value from the wagon. Likewise, the price of slaughter cattle is usually less than for feeder cattle, resulting in the increased production being sold at a lower price. On the other side, with the higher cost per cwt of finishing rations, each pound of feed saved means greater benefit from a wagon. Using mixing equipment may allow feeders to use higher concentrate diets, thus improving average daily gain. Any increase in the rate of gain means less days on feed and lower operating costs on the animal being finished, a plus for this piece of equipment. So at this time we cannot make a determination as to the net economic benefit of such a wagon in the finishing lot.

Other Considerations When Investing in a Mixer Wagon. The life of the wagon was estimated at 10 years or 10,000 loads. This would be 1,000 loads per year or 2.74 loads per day. Repair costs will likely increase and life decrease as use is increased above 1,000 loads per year. However, less use will not necessarily mean less repair per year. Deterioration from weather and acid from feeds will not decrease with less use and, in fact, may increase. Obsolescence is a function of time only, so it is not affected by level of use. From this we can conclude that costs will remain about constant with decreased use, while each load in excess of 1,000 loads per year will increase depreciation and repair costs by $1.53.

In this experiment, approximately 2.30 bushels of feed were required per head per day. Therefore, it took about 306 bushels of feed per head over the 133 days. With a 175-bushel wagon, this is about 1.75 loads per head to bring them from starting weight to sale weight. Using the $80 per cwt sale price and the high prices for feeds, the break-even level of production to cover annual costs of the wagon is about 114 head per year. Thus, at the break-even level of production the wagon would be used for only 199.5 loads per year. Therefore, use could be increased five times and not have an appreciable increase in annual costs of the wagon. Even with cattle selling at $60 per cwt and low priced feeds, there is plenty of reserve capacity. At the lower prices, the break-even level is 152.5 head per year, which would require only 267 loads per year. This would allow for a 375% increase in use without increasing annual costs. A 175-bushel wagon should feed 570 head for 133 days of this ration with a thousand loads. A producer who is is putting more pounds of gain on each animal will obviously be feeding fewer cattle from starting weight to sale weight per thousand loads.

The time and labor required using a scale-mixer wagon is another aspect which should be evaluated. While it may take more time to load a mixer wagon with a scale due to the weighing process, the time traveling between the feed bunks and feed storage area with the loader may be reduced. Whether there is a net gain or loss in time depends on the current feed handling techniques vis-a-vis the new. Because most farmers have an older, small tractor which can easily handle the mixer wagon, no additional investment is likely to be needed above the cost of the wagon.

In conclusion, the evidence of this experiment indicates that a mixer wagon equipped with a scale can be a profitable investment for feedlot operators feeding high roughage rations to light cattle. With feeder cattle selling in the $.70 to $.80 range, the break-even level of production is 110 to 160 head on feed for 133 days per year but will depend on how much improvement a particular operation can gain due to more accurate feeding and the value of feed saved.

BEEF REPORT

EFFECTS OF BULL EXPOSURE AND GONADOTROPIN RELEASING HORMONE ON POSTPARTUM INTERVAL AND FERTILITY IN BEEF COWS

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CATTLE 88-15

Summary

Spring calving beef cows were utilized in a study to determine the effects of bull exposure (BE) and Gonadotropin Releasing Hormone (GnRH) administration on return to estrus and reproductive efficiency. Cows were either exposed to an epididectomized bull soon after calving until the breeding season or not exposed to bulls (NE). All cows were synchronized with Synchro-Mate B (SMB). One-half of the BE and NE cows were implanted with GnRH at SMB implant removal in 1987 or given an injection of GnRH at breeding in 1988. Each year, 20 cows were bled hourly for 80 consecutive hours after SMB removal. There was no difference (P>.05) in days from calving to first estrus, calving date, number of cows cycling before breeding or conception rate to the synchronized estrus between BE or NE cow groups. In 1987 GnRH implants reduced (P<.05) the time from SMB removal to the pre-ovulatory LH peak by 23.5 hours. However, there was no difference (P>.05) in LH peak levels, duration of Luteinizing Hormone (LH) peak or conception rate. Bull exposure and GnRH implants had little effect on the interval from calving to first estrus or reproductive performance.

(Key Words: Cows, Bull Exposure, GnRH, Postpartum Interval, Fertility.)

Introduction

The postpartum interval is the period of time from calving until the first estrus that is accompanied by ovulation. Management practices to decrease the time from calving to first fertile estrus would be economically beneficial to the cow-calf producer. Decreasing postpartum interval should allow more time from first fertile estrus until the breeding season. This would increase the probability of cows conceiving early in the breeding season, resulting in older and heavier calves at weaning and assuring cows maintain a 365-day calving interval.

Recent research at SDSU and other research stations have indicated the presence of bulls immediately after calving may reduce the time to first estrus in beef cows.

Gonadotropin Releasing Hormone (GnRH) administered before breeding has resulted in various results concerning conception rate. Since GnRH controls the release of Luteinizing Hormone (LH) which causes ovulation, administration of GnRH may result in increased fertility.

The purpose of this study is to evaluate the effects of bull exposure postpartum on resumption of estrus and subsequent fertility and the effects of GnRH administration on fertility in the beef cow.

Materials and Methods

Forty-six beef cows in 1987 and 59 in 1988 were allotted to one of two treatment groups. Each year after calving (1 to 7 days) every other cow was exposed to a sterile bull (BE). The remainder were not subjected to bull exposure (NE). Cow groups were maintained in separate pastures with no fence-line contact. Supplementary feeding consisted of corn silage and haylage or hay to meet nutrient requirements and trace mineral salt. Cows were in excellent body condition throughout the experimental period.

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Cows in both groups were bled weekly via jugular venipuncture from 30 days after calving until synchronization to determine when cycling occurred. Serum progesterone values were determined by radioimmunoassay to confirm cycling status.

All cows were synchronized with Synchro-Mate B (SMB). Following SMB implant removal, calves were separated from the cows for 48 hours. Cows were artificially inseminated 48 hours after implant removal. In 1987 one-half of the cows were given a GnRH implant at the time of SMB removal. In 1988 GnRH implants were not available, so a GnRH injection was given to one-half the cows at the time of AI. During the next 30 days a sterile bull was utilized for estrus detection and cows returning to estrus were inseminated. Cows were then exposed to an intact bull for an additional 30 days.

Each year 20 cows (10 from BE and 10 from NE; one-half receiving GnRH and one-half not receiving GnRH) were cannulated and bled hourly after implant removal for 80 hours. Blood samples were assayed in 1987 for LH and are presently being assayed for 1987 estradiol and 1988 LH and estradiol levels.

Results and Discussion

There was a trend for cows exposed to bulls to return to estrus sooner than those not exposed (Table 1) but this was not a significant advantage (P>.05). Cows in the BE group had a 5-day advantage in 1987 and 4 days in 1988. There was no difference (P>.05) in calving date either of the 2 years.

No difference (P>.05) was detected in the number of cows in estrus before synchronization between the BE and NE groups. However, there was a difference (P<.05) between the 2 years in the percentage of cows in estrus before synchronization. In 1987 the number of cows in estrus before synchronization was less than expected (39.1 and 30.4% for BE and NE, respectively). No apparent reason for the significant year difference is suggested with average calving date similar both years. Synchronized estrus conception rate was lower in 1987 than 1988 but not significantly. This may be associated with the GnRH implant used in 1987 compared to the injection in 1988. Conception rate for BE and NE cows was similar (P>.05) during the AI period and breeding period in 1987. Conception rate for the AI and breeding season for 1988 will be determined using calving dates in 1989.

TABLE 1. AVERAGE CALVING DATE, DAYS FROM CALVING TO FIRST ESTRUS, COWS IN ESTRUS AND CONCEPTION RATES FOR BE AND NE COWS

	1987		1988	
	Bull exposed	Nonexposed	Bull exposed	Nonexposed
No. cows	23	23	30	29
Avg calving date	3-20	3-19	3-21	3-23
Days from calving to 1st estrus	50.7±4.8	55.9±4.1	46.8±3.2	50.8±3.6
No. cows in estrus prior to synchronization	9[a]	7[a]	20[b]	19[b]
Conception[c] to:				
synchronized estrus, %	30.4	47.8	46.7	48.3
AI period, %	73.9	87.0		
breeding season, %	91.3	95.6		

[a,b] Values in rows with unlike superscripts differ (P<.05).
[c] 1987 based on calving, 1988 based on breeding records.

There was a difference (P<.05) in the timing of the pre-ovulatory LH peak in cows implanted with GnRH (Table 2). The peak in implanted cows occurred 23.4 hours earlier than in nonimplanted cows. There was no difference in LH peak levels, length of the LH surge or LH levels during the sampling period between GnRH implanted and nonimplanted cows. The synchronized estrus conception rate was not different (P>.05) between the two groups or between years. Implanted cows in 1987 had lower conception rate (though not significant) than nonimplanted cows. This is probably due to the earlier occurrence of the pre-ovulatory surge, resulting in the implanted cows ovulating sooner. Since all cows were inseminated at the same time, the earlier ovulating GnRH implanted cows may have had aged ova resulting in lower conception rates. There was an advantage in conception rate to synchronized AI in 1988 for cows injected with GnRH compared to noninjected cows (60.7 vs 39.3%, respectively).

TABLE 2. PEAK LH LEVELS, DURATION OF LH PEAK, TIME OF PEAK LH OCCURRENCE AND CONCEPTION RATE TO COWS IMPLANTED OR INJECTED WITH GNRH

	1987		1988	
	GnRH	Control	GnRH	Control
No. cows	24	22	28	28
Hours from SMB removal to LH peak	19.4[a]	42.9[b]		
LH peak levels, mg/ml	23.5	22.4		
LH peak duration, hours	12.3	10.2		
Conception rate to synchronized estrus[c], %	33.3	45.5	60.7	39.3

[a,b] Values in rows with unlike superscripts differ(P<.05).
[c] Cows implanted with GnRH in 1987 and injected in 1988.

This study will continue for an additional year injecting cows with GnRH at breeding. Hormone data will be determined to provide information on circulating levels in cows administered GnRH at breeding to increase conception rate.

BEEF REPORT

EFFECTS OF ADMINISTERING PROGESTERONE OR PROGESTERONE AND GnRH BEFORE PUBERTY ON AGE AT PUBERTY AND REPRODUCTIVE RESPONSE IN CROSSBRED BEEF HEIFERS

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CATTLE 88-16

Summary

One hundred six crossbred heifers were utilized to determine prepubertal treatment of progesterone or progesterone plus Gonadotropin Releasing Hormone (GnRH) on age at puberty, conception to a synchronized estrus and conception during the breeding season. Days to puberty were 369.5 ± 6.2, 363.1 ± 9.9 and 360.4 ± 7.8 for control, progesterone primed and progesterone plus Gonadotropin Releasing Hormone (GnRH), respectively. There was no difference ($P>.05$) in age of puberty, number cycling before synchronization or conception rate during a 35-day breeding season. The percentage of heifers conceiving to synchronized estrus was lower ($P<.10$) for control compared to progesterone or progesterone plus GnRH treated heifers. Injecting GnRH at breeding had little ($P>.05$) effect on increasing conception rates to the synchronized estrus or during the breeding season.

(Key Words: Beef Heifers, Puberty, GnRH, Progesterone, Fertility.)

Introduction

Decreasing the time to puberty in beef heifers should result in increased conception rate early in the breeding season, since the heifer would be cycling for a longer period of time prior to breeding. Also, older and larger calves would result at weaning, and a longer period of time would be available for the heifer to begin cycling before the second breeding season. Some research has been conducted administering reproductive hormones to heifers before puberty, resulting in varying results on decreasing time to puberty. A management procedure to decrease time to puberty resulting in increased reproductive efficiency in first calf beef heifers would be economically important to the cow-calf producer. The purpose of this study was to evaluate several hormones administered before puberty and their effects on age at puberty and subsequent reproductive performance in crossbred beef heifers.

Materials and Methods

One hundred six crossbred beef heifers were randomly allotted to one of three groups. One group was the control and did not receive hormone therapy. A second group was progesterone primed before puberty (9 days Synchro-Mate B). The third group was progesterone primed and injected with Gonadotropin Releasing Hormone (GnRH) at SMB removal. Each of the treatment groups were divided and one-half of each group given GnRH injections at trial initiation. Blood was collected via jugular venipuncture weekly from October until all heifers were synchronized for breeding in May. Blood samples were centrifuged and the serum harvested and analyzed by radioimmunoassay for progesterone levels to determine when cycling was initiated. On May 9 all heifers were synchronized with Synchro-Mate B and inseminated 48 hours after implant removal. At breeding each of the three prepubertal groups were divided and one-half of each group injected with GnRH and the other one-half control. One week after AI, the heifers were exposed to bulls for 28 days. Eighty-one days after AI the heifers were rectally palpated and conception date estimated.

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[2]Assistant Professor.
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Results and Discussion

There was no difference (P>.05) in age to puberty between the three prepubertal treatment groups (Table 1). Also, no difference (P>.05) existed between the three prepubertal groups in the number of heifers cycling before estrous synchronization. Collectively, 54 of the 106 heifers were cycling before synchronization. After synchronization and breeding, all heifers but one that did not conceive started cycling. This may be due to the progesterone implant and estradiol injection associated with SMB synchronization.

TABLE 1. EFFECTS OF PROGESTERONE PRIMING AND PROGESTERONE PRIMING + GNRH ON REPRODUCTIVE DEVELOPMENT IN CROSSBRED BEEF HEIFERS

	Control	Progesterone	Progesterone + GnRH
Number of heifers	34	36	36
Days to puberty	369.5 ± 6.2	363.1 ± 9.9	360.4 ± 7.8
Cycling before synchronization[a]	17 (50.0)	17 (47.2)	20 (55.6)

[a] Values in parenthesis are percentages.

Conception rates to the synchronized estrus and for the breeding season are presented in Table 2. The lowest conception rate to synchronized estrus was in the control heifers (P<.10). Both control treatment groups prepubertal had lower conception rates than progesterone primed or progesterone primed plus GnRH groups. There was no difference (P>.05) in conception rate for the breeding season for the prepubertal treatments or the GnRH injection at breeding. Average conception rates from the prepubertal treatments to synchronized estrus were 47.1, 61.1 and 69.4% for control, progesterone primed and progesterone primed plus GnRH, respectively, and for the breeding season 82.4, 91.7 and 80.6% for control, progesterone primed and progesterone primed plus GnRH, respectively.

Progesterone priming or progesterone priming plus GnRH had little effect on age to puberty or reproductive performance in beef heifers. Also, little advantage existed by injecting heifers with GnRH at the time of insemination.

TABLE 2. CONCEPTION RATE TO SYNCHRONIZED AI AND BREEDING PERIOD FOR BEEF HEIFERS TREATED WITH PROGESTERONE AND GNRH BEFORE PUBERTY AND GNRH AT BREEDING

Prepuberty	Breeding	No. of heifers	Conception rate to synchronized estrus[a]	Conception rate for breeding season[a]
Control	Control	18	8 (44.4)[b]	14 (77.8)
Progesterone	Control	17	10 (58.8)[c]	15 (88.2)
Progesterone + GnRH	Control	19	14 (73.7)[c]	15 (79.0)
Control	GnRH	16	8 (50.0)[b]	14 (87.5)
Progesterone	GnRH	17	11 (64.7)[c]	14 (82.4)
Progesterone + GnRH	GnRH	19	12 (63.2)[c]	18 (94.7)

[a] Values in parenthesis are percentages.
[b,c] Values in columns with unlike superscripts differ (P<.10).

BEEF REPORT

SERUM d-β-HYDROXYBUTYRATE AND UREA NITROGEN AS INDICATORS OF BEEF COW NUTRITIONAL STATUS

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CATTLE 88-17

Summary

Mature Simmental x Angus crossbred cows were fed differing levels of nutrition before and after calving (mid-March to early May) to determine if blood serum levels of d-β-hydroxybutyrate (BHB) and urea nitrogen (SUN) could be used as indicators of nutritional status. Visual condition scores and condition score change were used as subjective appraisals of cow nutritional status. BHB levels prior to calving were elevated for cows close to calving and those carrying male fetuses. SUN levels prior to calving were higher for thin cows that were losing body condition. If on a low plane of nutrition after calving, BHB values were higher for fleshier cows in May. No differences for either blood metabolite in May were observed for cows fed higher levels of nutrition after calving. A combination of the two metabolites indicated general changes in nutritional status of beef cows. Large variation among cows of similar condition made these metabolites inconsistent in evaluating small differences in nutritional status.

(Key Words: Beef Cow, Nutrition, Condition Score, Blood Metabolites.)

Introduction

Past studies have suggested that the ketone body d-β-hydroxybutyrate (BHB), which is derived from fatty acids and used as an energy source, may be a useful indicator of cow nutritional status. Cows fed diets lower in energy content than required to maintain body weight would start to utilize fat reserves for energy which may be monitored by BHB. Thin animals with little or no stored fat deposits start to utilize their own muscle tissues for energy which possibly could be monitored by serum urea nitrogen (SUN). The objective of this study was to evaluate BHB and SUN as a research tool for indicating beef cow nutritional status.

Materials and Methods

Data were collected over 2 years from 129 mature, Simmental x Angus cows wintered at the SDSU Range and Livestock Research Station near Philip that calved from mid-March to mid-May. In early December of each year, cows were allotted by age and previous calving date to a high or low early winter nutritional treatment. All cows were fed and managed as one group from mid-February until calving. Within 1 week after calving, cows were reallotted by calving date, calf sex, cow age and early winter treatment to a high or low late winter treatment which lasted until "turnout" onto summer pastures in early May. Nutritional treatments were designed to create a wide range of cow condition scores in mid-March and early May (Tables 1 and 2). Visual cow body condition scores (CS 1-9, 1 = extremely emaciated) were assigned in February, March and May using the average score of two individuals.

In mid-March and early May blood samples were collected from cows after feed and water were withheld for 18 hours. Clotted blood was centrifuged and separated serum was frozen for later colorimetric determinations of serum urea nitrogen (SUN) and d-β-hydroxybutyrate (BHB).

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Results and Discussion

Early winter nutritional treatments did not affect cow BHB levels prior to calving in March (Tables 1 and 2). SUN concentrations in March were elevated in cows on low early winter treatment during the second year when cows averaged one condition score less than cows on high treatment.

Since diet may affect blood metabolite levels, the only valid treatment comparisons in May were the effects of early winter treatment on cows on the same late winter treatment. Early winter nutrition did not affect blood metabolites if cows received the high nutritional treatment after calving. If cows were fed the low nutritional treatment after calving (which produced more severe weight loss), BHB and SUN in combination indicated greater muscle breakdown for cows that were thinner at calving due to low early winter nutrition and greater fat breakdown for fleshier cows due to higher early winter nutrition.

TABLE 1. EFFECT OF 1986 EARLY AND LATE WINTER TREATMENTS ON COW PERFORMANCE AND BLOOD METABOLITE LEVELS

Early winter treatment (12/9/85-2/7/86)	High		Low	
Late winter treatment (calving-5/9/86)	High	Low	High	Low
No. cows	25	23	22	24
Initial wt, lb, 12/9/85	1032	1049	1014	1014
Total winter weight change 12/9/85-5/9/86, lb	-121[a]	-165[bc]	-143[ab]	-194[c]
Condition score:				
2/7/86	5.6[a]	5.5[a]	4.8[b]	4.3[c]
3/7/86	5.5[a]	5.1[ab]	4.9[bc]	4.6[c]
5/9/86	4.5[a]	3.6[b]	4.1[a]	2.9[c]
d-β-hydroxybutyrate, mg/dl				
3/7/86	4.5	4.0	4.7	4.4
5/9/86	2.8[a]	2.2[b]	2.8[a]	1.6[c]
Serum urea nitrogen, mg/dl				
3/7/86	11.9	12.0	12.1	12.8
5/9/86	16.9[a]	13.1[b]	16.2[a]	14.2[b]

[a,b,c] $P<.05$.

TABLE 2. EFFECT OF 1987 EARLY AND LATE WINTER TREATMENTS ON COW PERFORMANCE AND BLOOD METABOLITE LEVELS

Early winter treatment (12/5/86-2/13/86)	High		Low	
Late winter treatment (calving-5/8/86)	High	Low	High	Low
No. cows	25	24	21	24
Initial wt, lb, 12/5/85	1135	1138	1135	1118
Total winter weight change 12/5/85-5/8/86, lb	-174[a]	-254[b]	-218[c]	-295[d]
Condition score:				
2/13/87	6.3[a]	6.4[a]	5.2[b]	5.1[b]
3/6/87	6.2[a]	6.0[a]	5.3[b]	5.2[b]
5/8/87	4.8[a]	3.6[b]	4.5[a]	2.5[c]
d-β-hydroxybutyrate, mg/dl				
3/6/87	3.8	4.9	5.2	5.7
5/8/87	3.1[a]	4.9[b]	2.6[a]	3.6[a]
Serum urea nitrogen, mg/dl				
3/6/86	9.3[a]	9.2[a]	10.6[ab]	11.5[b]
5/8/87	16.6[ab]	15.4[a]	17.8[b]	17.7[b]

[a,b,c] P<.05.

Sex and day of gestation influenced cow BHB levels in March (Table 3). Cows with male fetuses (average birth weight = 93 lb) had higher BHB concentrations than cows with female fetuses (average birth weight = 87 lb). In addition, cows closer to their calving date had higher BHB levels in March. BHB levels decreased .04 mg/dl for each day further away a cow was from calving (P<.01). SUN levels were not affected by calf sex or day of gestation.

TABLE 3. EFFECT OF SEX OF FETUS ON BHB AND SUN LEVELS IN MARCH

Sex of fetus	Male	Female
No. cows	105	108
BHB, mg/dl	4.8[a]	4.1[b]
SUN, mg/dl	11.7	11.3

[a] P<.05.

When cow condition score in March and condition score change from February until March were used as an indication of cow nutritional status, BHB levels in March were similar for all condition scores (Table 4). SUN in March was higher for cows in condition score $\leq$ 4 than cows in condition score $\geq$ 6. Thin cows in condition score 4 or less that were losing body condition had the highest SUN levels, possibly indicating that thin cows no longer had adequate fat stores and were using muscle tissue as an energy source.

TABLE 4. EFFECT OF COW CONDITION SCORE IN MARCH AND CONDITION SCORE CHANGE ON BHB AND SUN LEVELS IN MARCH

	March condition score								
	3,4			5			6,7,8		
	Condition score change (February-March)								
	-1	0	1	-1	0	1	-1	0	1
No. cows	8	31	6	12	78	11	8	53	6
BHB, mg/dl	3.9	4.4	4.3	4.4	4.8	5.3	5.8	3.9	3.0
SUN, mg/dl	14.3[a]	11.0[bc]	12.7[ab]	11.3[bc]	11.1[bc]	12.8[ab]	8.9[c]	11.1[bc]	9.7[bc]

[a,b,c] P<.05.

Blood metabolite levels by condition score in May were analyzed separately for each late winter treatment as dietary nitrogen intake has been shown to influence SUN. Nearly all cows were losing body condition after calving until blood samples were collected in May. Cows on low postcalving nutrition with lower condition scores in May were metabolizing less fat as indicated by lower BHB levels (Table 5). No differences in May BHB or SUN values were observed among condition score groups for cows fed the high level of late winter nutrition (Table 6).

TABLE 5. EFFECT OF COW CONDITION SCORE IN MAY ON BHB AND SUN LEVELS FOR COWS ON LOW LATE WINTER TREATMENT

	May condition score		
	2	3	4,5
No. cows	32	33	24
d-β-hydroxybutyrate, mg/dl	2.6[a]	3.2[ab]	4.0[b]
Serum urea nitrogen. mg/dl	17.2	15.9	15.1

TABLE 6. EFFECT OF COW CONDITION SCORE IN MAY ON BHB AND SUN LEVELS FOR COWS ON HIGH LATE WINTER TREATMENT

	May condition score		
	2,3	4	5
No. cows	14	38	39
d-β-hydroxybutyrate, mg/dl	2.5	2.9	2.8
Serum urea nitrogen, mg/dl	17.6	16.2	17.2

In conclusion, a combination of BHB and SUN more accurately indicate cow nutritional status than either one individually. While these blood metabolites are useful in determining wide differences in nutritional status, they have limited value in consistently determining small differences due to large variation among cows of similar condition.

BEEF REPORT

BREED EVALUATION FOR EFFICIENCY OF FEED UTILIZATION FOR FIRST CALF PRODUCTION

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CATTLE 88-18

Summary

Individual feed intake was measured in drylot on first-calf females for a 1-year period through weaning of their first calf. Dam breeds included crossbred Simmental-Hereford, Angus-Hereford, Salers-Hereford and Tarentaise-Hereford produced in two-breed rotations and straightbred Hereford. Cow weights were heaviest for Simmental-Hereford and lowest for Tarentaise-Hereford and straightbred Hereford. Calf weaning weights were heaviest for Simmental-Hereford and lightest for straightbred Hereford and Angus-Hereford. Intake of cow feed TDN was highest for Simmental-Hereford cows and lowest for Tarentaise-Hereford and straightbred Hereford. Breed group rankings for total cow feed and calf creep feed TDN intake were the same as rankings for cow TDN intake. Efficiency of feed utilization was calculated as total TDN consumed by the cow and calf during the year divided by calf weaning weight. Breed group averages for efficiency ranged from 12.8 lb TDN/lb calf weaning weight for Tarentaise-Hereford to 13.8 lb TDN/lb calf weaning weight for Angus-Hereford. A large amount of variation among individual cows for the efficiency ratio was noted. These results indicate some differences among breed types for efficiency of feed utilization for first calf production, although variation among individuals was also important.

(Key Words: Beef Cows, Breed Evaluation, Efficiency.)

Introduction

Because of the low reproductive rate of the cow compared to competing meat species, maintenance of the breeding herd comprises a major portion the total feed energy required to produce edible beef. Approximately 65 to 75% of the total feed energy utilized for beef production is used by the cow herd. Because cow feed represents such a large overhead to cost of production, it is important to identify and evaluate factors potentially affecting efficiency of feed utilization by the cow herd. Data used in the present study were obtained from a project designed to evaluate genetic aspects of efficiency of feed utilization by beef cattle. The objective of the present study was to characterize dam breed types for efficiency of feed utilization for first calf production.

Materials and Methods

First-calf females and their calves were maintained in a drylot management system where individual feed intake could be measured. Pregnant heifers were placed in the drylot in October at an average age of 1.6 years. Each heifer remained in the drylot 1 year, through weaning of her first calf the following October. A different group of females were evaluated each year over a 7-year period. Breed types evaluated included crossbred Angus-Hereford, Simmental-Hereford, Tarentaise-Hereford and Salers-Hereford produced in rotational crossbreeding systems and straightbred Hereford.

Under the drylot management system, cows were placed in individual feeding stalls twice daily and provided limited amounts of pelleted hay, chopped hay and grain. Feeding levels were adjusted for each individual at 28-day intervals to provide gains assumed to be desirable for typical replacement female development and to provide acceptable rebreeding performance. Calves were allowed overnight access to individual creep feeders with intent to replace forage which calves would have consumed under pasture conditions. Feed energy intake was

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expressed as pounds of total digestible nutrients (TDN). To prevent cross-nursing, calves were kept separate from their dams, except when cows were in their individual feeding stalls.

Results and Discussion

Straightbred Hereford and crossbred Salers-Hereford were included in only 3 years of the study, so numbers of cow-calf pairs for these breed groups were considerably fewer than for other breed groups. Tarentaise-Hereford were included in 5 years of the study, while Simmental-Hereford and Angus-Hereford crosses were included in all seven years. For most traits evaluated, breed group means were adjusted for differences in calf sex, age of calf, year to year variation and sire of the calf. Only 2-year-old cows were evaluated in this particular study, so weaning weights were not adjusted for age of dam.

Cow weights are presented by dam breed group in Table 1. Cow weights at calving and at weaning were heaviest for Simmental-Hereford, intermediate for Angus-Hereford and Salers-Hereford and lowest for Tarentaise-Hereford and straightbred Hereford.

TABLE 1. RAW MEANS FOR COW AGE AT CALVING AND LEAST-SQUARES MEANS FOR COW WEIGHT AT CALVING AND COW WEIGHT AT WEANING

Dam breed group	No. of cow-calf pairs	Cow age at calving, days	Cow weight at calving, lb	Cow weight at weaning lb
Hereford	23	758	897 ± 32.4^{c}	994 ± 29.8^{c}
Simmental-Hereford	119	732	1010 ± 23.8^{a}	1087 ± 23.9^{a}
Angus-Hereford	138	736	958 ± 23.7^{b}	1044 ± 23.8^{b}
Salers-Hereford	25	716	954 ± 32.1^{bc}	1038 ± 29.2^{bc}
Tarentaise-Hereford	62	728	922 ± 27.2^{c}	1002 ± 25.9^{c}

^{a,b,c} Means in the same column not sharing a common superscript differ (P<.05).

Calf weaning weight, TDN intake of cow and calf and efficiency of TDN utilization are presented by dam breed group in Table 2. Calves from Simmental-Hereford cows were heaviest at weaning, although the difference between this group and the Tarentaise-Hereford group was not statistically significant. Calves from straightbred Hereford and Angus-Hereford cows had the lightest average weaning weights, although not significantly lighter than calves from Salers-Hereford cows.

Intake of calf creep feed TDN by calves from Salers-Hereford cows averaged 241 lb per calf. Intake of creep feed TDN did not vary significantly among the other breed groups, averaging 284 lb. Intake of cow feed TDN was significantly higher for Simmental-Hereford cows (averaged 5754 lb per cow for the year) than for all other breed groups, reflecting the higher weights and milk production of Simmental-Hereford. Intake of cow feed TDN was intermediate for Salers-Hereford and Angus-Hereford cows and lowest for Tarentaise-Hereford and straightbred Hereford. Breed group rankings for total cow and calf TDN intake were the same as rankings for cow TDN intake.

Neither calf weight nor calf weight/cow weight are necessarily good indicators of efficiency. Efficiency of feed utilization was calculated as total TDN consumed by the cow and calf during the year divided by calf weaning weight. Tarentaise-Hereford cows and their calves consumed an average of 12.8 lb TDN per lb of calf weaning weight. This average was significantly less than averages of all other groups except straightbred Hereford. Differences among breed group averages for straightbred Hereford, Salers-Hereford and Angus-Hereford were not statistically significant. When large numbers of animals are included, a relatively smaller difference is required for statistical significance. The Simmental-Hereford group average (13.4) was significantly different from the Angus-Hereford group average (13.8), even though a similar difference between straightbred Hereford and Angus-Hereford was not statistically significant.

TABLE 2. LEAST-SQUARES MEANS FOR CALF WEANING WEIGHT, COW AND CALF TDN INTAKE AND EFFICIENCY

Dam breed group	Calf weaning weight, lb	Calf creep feed TDN, lb	Cow feed TDN, lb	Total cow and calf TDN, lb	Efficiency lb/lb[a]
Hereford	424 ± 13.8^{cd}	285 ± 14.5^{b}	5348 ± 86^{d}	5628 ± 89^{de}	$13.3 \pm .42^{bcd}$
Simmental-Hereford	458 ± 8.1^{b}	287 ± 7.9^{b}	5754 ± 41^{b}	6038 ± 43^{b}	$13.4 \pm .28^{c}$
Angus-Hereford	424 ± 8.0^{d}	284 ± 7.9^{b}	5479 ± 40^{c}	5763 ± 42^{ce}	$13.8 \pm .28^{d}$
Salers-Hereford	433 ± 13.2^{cd}	241 ± 13.6^{c}	5599 ± 83^{c}	5840 ± 85^{c}	$13.5 \pm .40^{cd}$
Tarentaise-Hereford	443 ± 10.2^{bc}	278 ± 10.3^{b}	5356 ± 60^{d}	5635 ± 61^{d}	$12.8 \pm .33^{b}$

[a] Efficiency = (total cow and calf TDN)/calf weaning weight.
[b,c,d] Means in the same column not sharing a common superscript differ ($P<.05$).

While comparison of breeds is of interest, it is also important to recognize the wide variation among individual cows for efficiency of feed utilization. Cow efficiency ratio ranged from 10.4 to 19.3 lb TDN per lb calf weight weaned in this analysis. Of the 367 cow-calf pairs evaluated, 36 pairs had efficiency ratios of 11.5 or less, while 34 pairs had efficiency ratios of 16 or greater. A cow with an efficiency ratio of 16 would require the energy equivalent of over 2 tons of typical quality hay more than a cow with an efficiency ratio of 11.5 to supply the energy required to produce 500 lb of calf weaning weight . These figures indicate the potential usefulness of developing methods of predicting, at a young age, relative differences among heifers for future efficiency. Prediction formulas based on cow and calf weights at weaning have been developed, but use of these formulas requires that the cow has already weaned a calf.

These results indicate some differences among breed types for efficiency of feed utilization for first calf production, although variation among individuals is even more important. While efficiency in this paper refers to conversion of feed energy to calf weaning weight, it should be noted that evaluation of dam breed types for overall value should be based on additional factors including reproductive performance and calf price.

BEEF REPORT

RELATIONSHIP OF SIRE EXPECTED PROGENY DIFFERENCES TO MATERNAL PERFORMANCE OF FIRST-CALF DAUGHTERS IN A COMMERCIAL HERD

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CATTLE 88-19

Summary

Maternal performance for first calf production was evaluated in retrospect for daughters whose sires had expected progeny differences (EPDs) available from 1988 beef breed association national genetic evaluation summaries. When grouped into high EPD and low EPD groups, sire EPD group averages for actual daughter milk production and weaning weights of daughters' offspring consistently ranked the same as sire group average EPDs for milk and maternal weaning weight, although differences between groups were not statistically significant.

(Key Words: Beef Cattle, Commercial, Expected Progeny Difference, Maternal.)

Widespread use of artificial insemination makes it possible to compare performance of sires and their relatives across herds within the same breed. For some beef breeds, relative genetic values expressed as expected progeny differences (EPDs) are available for essentially every registered animal in the breed with appropriate, recorded performance data. Thus, both seedstock and commercial breeders are likely to encounter EPD specifications on bulls available for sale or on bulls whose semen is available for sale.

The extent to which breeders utilize EPD information to assist in selection will depend on their level of confidence in the effectiveness of utilizing such information. Research at the University of Georgia (Hough et al., 1985) indicated that selection for increased yearling weight in Hereford cattle based on EPDs was effective. Information concerning the relationship of sire EPDs to actual performance of descendants in commercial herds is lacking. Semen from sires available through commercial semen companies has been used at the SDSU Antelope Range Livestock Station for a number of years, and daughters of many of these sires have been retained as replacement heifers. The objective of this analysis was to examine the relationship of sire EPDs for milk and maternal weaning weight, as published in 1988 national genetic evaluation programs, to actual performance of sires' daughters and daughters' offspring.

Materials and Methods

The data used in this analysis were collected on 2-year-old beef females and their calves managed in a drylot environment. Dam breed types included crossbred Angus-Hereford and Tarentaise-Hereford produced in two-breed rotational crossbreeding systems, and also straightbred Hereford. Sires of the dams were Angus, Tarentaise or Polled Hereford. Some of the sires were used in natural matings, while others were used in artificial insemination. Many of the artificial insemination sires have current EPD information available through their respective breed associations. Several of the sires have EPDs computed in current summaries even though EPDs were not available at the time semen of the sires was obtained. Current (1988) EPDs were obtained for as many of the sires as possible, either from the breed association's published 1988 sire summary or directly from the breed association. Data used to analyze actual offspring performance had not been reported to breed associations and so represent an independent set of data compared to data used to compute EPDs.

Daughters were born at the Antelope Range Livestock Station in northwestern South Dakota but produced their first calf in a drylot at Brookings as part of another experiment. These females entered the drylot at an average

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age of 1.6 years and remained there for 1 year through weaning of their first calf. A different set of first-calf females was evaluated each year from 1981 through 1987. Milk production was measured by weighing the calf before and after nursing after an overnight separation of calf and dam. Milk production was measured at four different dates in the first 5 years, five dates in 1986 and six dates in 1987. The milk production measurements for a cow were totaled and divided by the number of measurements. Weaning weights of drylot calves were obtained in October. Variables of interest in this analysis are daughters' milk production and weaning weights of daughters' offspring.

Since comparisons of EPDs are valid only within a breed, separate analyses were completed for each sire breed of daughters. Angus and Tarentaise sires were mated only to cows within their respective rotation, whereas Polled Hereford sires were used in each rotation and on straightbred cows. Contemporary groups were formed based on year of daughter production and sex of daughters' calves and, in the case of Hereford sires, also on dam breed type. Data for contemporary groups that included daughters of only one sire were deleted. Means were computed by sire for daughters' milk production and for weaning weight of daughters' offspring (i.e., grand-offspring of sire). Relative values of sire EPDs were examined within each sire breed, and sires were assigned to a high EPD group, low EPD group or non-EPD group. The non-EPD group included primarily cleanup bulls. Averages were computed for each sire EPD group by weighting each sire mean by the number of records associated with each sire mean. EPD sires were assigned to groups in a manner which maximized the difference between weighted average EPD's of high EPD vs low EPD groups.

Results and Discussion

Grouping of data into high EPD, low EPD and non-EPD groups within each sire breed resulted in rather uneven numbers of daughters per group. This was not unexpected since matings were not planned with the present analysis in mind. For this same reason, differences between high EPD and low EPD groups for sire EPDs were smaller than desired in some cases, particularly for milk EPD groups for Angus and Tarentaise sires. Grouping of sires into high and low EPD categories does not necessarily reflect how these sires rank within their respective breeds but how they rank relative to other sires in this analysis (on a within breed basis).

Performance of first-calf daughters and their offspring grouped by sire milk EPD's is presented in Table 1. A difference in sire milk EPDs should be interpreted as the expected difference in weaning weights of offspring of sires' daughters due to differences in daughters' milk production. Weaning weights were adjusted for age of calf but not for age of dam, since all dams were the same age (2-year-old). For all three sire breeds, daughters of high milk EPD sires ranked higher for calf weaning weight and milk production than daughters of low milk EPD sires, although differences between groups were not statistically significant. Differences between weaning weights of offspring of daughters of high vs low milk EPD sires exceeded sire milk EPD differences. Daughters of high milk EPD sires ranked higher for calf weaning weights than daughters of non-EPD sires. Daughters of low milk EPD sires produced heavier calf weaning weights than daughters of non-EPD sires for Tarentaise and similar calf weaning weights compared to daughters of non-EPD sires for Polled Hereford and Angus.

TABLE 1. FIRST-CALF PERFORMANCE OF DAUGHTERS GROUPED BY SIRE MILK EPDs

	No. sires	No. daughters	Sire milk EPD[a] EPD	Acc.	Daughter 1st calf weaning wt, lb	Daughter milk yield[b]
			Polled Hereford Sires			
High EPD sire	1	8	+32.7	.88	442.6	6.41
Low EPD sires	2	35	+19.4	.60	422.8	6.24
Non-EPD sires	7	37			421.0	6.51
			Angus Sires			
High EPD sire	1	21	- 2.4	.88	454.8	8.24
Low EPD sire	1	4	- 4.7	.58	450.9	7.59
Non-EPD sires	3	21			445.8	7.19
			Tarentaise Sires			
High EPD sires	1	5	+ 2.9	.97	470.4	10.67
Low EPD sires	3	16	- 1.9	.89	447.8	9.07
Non-EPD sire	1	26			421.5	8.53

[a] Group average EPD and Accuracy values were computed by weighting individual sire values by numbers of daughters.

[b] Milk production expressed as pounds of milk after an overnight separation of calf and dam.

First-calf performance of daughters grouped by sire maternal weaning weight EPDs is presented in Table 2. A difference between two sires' maternal weaning weight EPDs should be interpreted as the expected difference in weaning weights of offspring of sires' daughters due to differences in milk production and genetic growth potential. For Polled Hereford sires, the difference between actual weaning weights of offspring of daughters of high vs low maternal weaning weight EPD sires closely reflected the difference between sire EPDs of the two groups. For Tarentaise sires and Angus sires, differences in daughter first-calf weaning weights reflected differences in sire EPDs less closely than for Hereford sires, but actual differences in performance were in the same direction as sire EPD differences. Differences in actual performance between high EPD vs low EPD group averages were not statistically significant with the limited numbers of records. For all three sire breeds, daughters of high EPD sires ranked higher for first-calf weaning weights than daughters of non-EPD sires. Daughter first-calf weaning weights were similar for low EPD vs non-EPD sire groups.

TABLE 2. FIRST-CALF PERFORMANCE OF DAUGHTERS GROUPED BY SIRE MATERNAL WEANING WEIGHT EPDs

	No. sires	No. daughters	maternal weaning wt[a] EPD	Daughter 1st calf weaning wt, lb	Daughter milk yield[b]
		Polled Hereford Sires			
High EPD sire	1	8	+36.7	442.6	6.41
Low EPD sires	2	35	+17.7	422.8	6.24
Non-EPD sires	7	37		421.0	6.51
		Angus Sires			
High EPD sire	1	21	+14.6	454.8	8.24
Low EPD sire	1	4	+ 5.0	450.9	7.59
Non-EPD sires	3	21		445.8	7.19
		Tarentaise Sires			
High EPD sires	2	17	+ 2.6	459.1	9.50
Low EPD sires	2	4	-10.5	428.2	9.23
Non-EPD sire	1	26		421.5	8.53

[a] Group average EPD and Accuracy values were computed by weighting individual sire values by numbers of daughters.
[b] Milk production expressed as pounds of milk after an overnight separation of calf and dam.

In conclusion, maternal performance of sires' daughters for first-calf production were consistent with sires' rankings for milk EPDs and maternal weaning weight EPDs, although differences between high EPD vs low EPD groups were not statistically significant. Magnitudes of differences in actual performance between high EPD and low EPD groups were reasonably reflective of EPD differences, especially considering the limited numbers of sires and daughters evaluated. Data will continue to be collected and re-summarized at a future date.

Literature Cited

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BEEF REPORT

COMPARISON OF SIRE EXPECTED PROGENY DIFFERENCES TO ACTUAL PERFORMANCE OF CROSSBRED OFFSPRING

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CATTLE 88-20

Summary

Actual performance of crossbred calves produced at the Antelope Range Livestock Station was evaluated and compared to the sire's expected progeny differences (EPDs) as reported in 1988 beef breed association sire summaries. Comparisons were made between high EPD and low EPD sire groups in retrospect for actual birth weight and weaning weight performance of crossbred progeny. Separate analyses were completed for Polled Hereford, Simmental, Tarentaise and Angus sires. Progeny of high EPD sires ranked higher for average birth weight than progeny of low EPD sires for all sire breeds. Rankings for calf weaning weight were less consistent than for birth weight in reflecting rankings of sire EPDs.

(Key Words: Beef Cattle, Expected Progeny Difference, Crossbred Offspring.)

Introduction

Expected progeny differences (EPDs) have become increasingly available to seedstock and commercial beef cattle breeders to evaluate the relative genetic value of a sire within a breed. Comparisons among sires in national genetic evaluation programs have been made possible by widespread use of sires in artificial insemination programs and development of sophisticated computing and statistical techniques. For some breeds, comparisons can be made among all registered animals in the breed with appropriate performance data. It should be stressed that although EPDs can evaluate animals across herds they should not be used to compare animals in different breeds. For EPDs to be commonly used as a selection tool by commercial beef breeders, evidence that actual performance of crossbred offspring reflects relative differences in sires' EPD values would be useful. The objective of this analysis was to evaluate in retrospect the relationship of actual performance of sire crossbred offspring to 1988 sire EPDs for birth weight and weaning weight.

Materials and Methods

This analysis included data from crossbreeding systems implemented at the Antelope Range Livestock Station in northwestern South Dakota. Sires of the offspring were either Tarentaise, Angus, Simmental or Polled Hereford. Cow breed types included Angus-Hereford, Simmental-Hereford and Tarentaise-Hereford cross cows produced in two-breed rotational crossbreeding systems. The initial F1 cross cows generally were mated to Hereford sires as were the crossbred cows within each rotation that were of low percentage Hereford. Cows containing high percentage Hereford were mated to the other sire breed within the rotation.

EPD information was acquired where possible on the artificial insemination sires used, from either national sire summaries published by the breed associations or directly from the breed association. The EPDs assigned to the sires were from recent (1988) summaries rather than from summaries published at the time at which the sires were actually used. EPDs were not available at the the time of use of some of the sires for which current EPDs are available. Calf birth weights and 205-day weaning weights were adjusted using the Beef Improvement Federation standard adjustments for age of dam. Performance comparisons were made between high EPD sires and low EPD sires on a within breed basis.

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Analyses were completed separately for each sire breed. Sires with 1988 EPDs were assigned within a breed to a high EPD group or low EPD group. All non-EPD sires (primarily cleanup bulls) were assigned to a non-EPD group. A weighted average EPD was computed for both of the EPD groups based on the number of offspring for each sire within the group. Since bulls might rank differently for different traits, group average EPDs were computed once based on birth weight EPD rankings (Table 1) and again based on weaning weight EPD rankings (Table 2).

Contemporary groups were formed based on the year the offspring was born and sex of calf. Contemporary groups which contained only one sire's offspring were deleted. Inspection of contemporary groups revealed that one Polled Hereford sire with EPDs produced offspring only in contemporary groups in which the only other calves were sired by non-EPD bulls. Since the offspring of this sire never competed directly with offspring of other EPD sires, a second analysis was conducted for Polled Hereford in which data involving offspring of this sire were deleted.

Least-squares means were computed by individual sire for adjusted birth weight and adjusted weaning weight of offspring. Offspring performance values were used to compute a weighted average for each sire EPD group based on the number of offspring. Sires were grouped into respective high and low groups such that differences between the weighted EPD values for the high and low groups were maximized. Since original matings were not made with the present analysis in mind, numbers of EPD sires are limited and numbers of offspring per sire are much less balanced than desired. Data used to analyze actual offspring performance had not been reported to breed associations and represent an independent dataset compared to data used to compute EPDs.

Results and Discussion

Of primary interest was the extent to which differences in 1988 EPDs between high EPD and low EPD groups reflected differences in performance of crossbred offspring. The grouping of sires into high and low EPD categories does not necessarily reflect how these sires rank within their respective breeds but simply how they rank relative to other sires in this analysis (on a within breed basis). Also, one should not try to evaluate sire breeds from these analyses since different sire breeds were mated to different dam breeds.

Data in Table 1 summarize performance of the offspring of high versus low EPD groups when arranged according to birth weight EPDs. Birth weights of offspring for the high birth weight EPD group ranked higher than for the low EPD group for all sire breeds. Among Simmental and Tarentaise sires, offspring birth weights for non-EPD sires averaged lower than for offspring of high EPD sires but were similar to birth weights of offspring sired by low EPD sires. For Polled Hereford sires, offspring birth weights were similar among all three groups. Analysis I for Polled Hereford sire groups included all EPD sires, whereas Analysis II did not include offspring data for the one EPD sire whose calves' only contemporaries were offspring of non-EPD sires.

Data presented in Table 2 are of similar content to that in Table 1, except the high and low EPD sire groups were assigned based on sire weaning weight EPDs. In the case of the Tarentaise sires, the high and low groups for weaning weight contained the same sires as did the high and low groups for birth weight. In the case of the Simmental and Polled Hereford breeds, sires ranked differently for weaning weight EPD than they did for birth weight so some of the individual sires fell into different groups for each trait. For Simmental and Tarentaise, offspring weaning weights averaged higher for the high weaning weight EPD group than for the low or non-EPD groups, and offspring weaning weights were similar for low EPD and non-EPD groups. For Polled Hereford sires, offspring weaning weights were similar for high and low EPD groups, but averaged higher for non-EPD sires than for EPD sires.

Data were available from offspring of Angus sires but were not included in the tables since only two of the Angus sires had EPDs. These two sires ranked the same for offspring birth weight as for birth weight EPD. However, their ranking for offspring weaning weight was switched from their weaning weight EPD ranking, despite a difference in weaning weight EPDs of 17 lb. Accuracy values for weaning weight EPD were .93 for one bull and .83 for the other bull.

TABLE 1. OFFSPRING PERFORMANCE OF SIRES GROUPED BY BIRTH WEIGHT EPDs

	No. sires	No. offspring	Birth wt[a] EPD	Birth wt[a] Acc.	Birth wt[b], lb	Weaning wt[c], lb
			Simmental Sires			
High EPD sire	1	21	+2.6	.65	103.7	589.9
Low EPD sires	3	89	-2.2	.90	96.7	551.3
Non-EPD sire	1	80			96.9	549.1
			Tarentaise Sires			
High EPD sires	2	36	+1.1	.95	93.0	527.7
Low EPD sires	2	16	-3.6	.89	85.4	502.8
Non-EPD sire	1	64			86.4	504.0
			Polled Hereford Sires			
Analysis I						
High EPD sire	1	86	+2.3	.84	90.3	532.2
Low EPD sires	3	75	+0.1	.90	89.5	541.7
Non-EPD sires	8	110			90.7	546.1
Analysis II						
High EPD sire	1	86	+2.3	.84	90.2	532.0
Low EPD sires	2	57	+0.4	.93	89.7	533.3
Non-EPD sires	8	110			90.7	546.1

[a] Group average EPDs and Accuracy values were computed by weighting the individual sire values within the group by the number of offspring.
[b] Birth weights were adjusted using the Beef Improvement Federation standard adjustments for age of dam.
[c] 205-day weaning weights were adjusted using the Beef Improvement Federation standard adjustments for age of dam.

TABLE 2. OFFSPRING PERFORMANCE OF SIRES GROUPED BY WEANING WEIGHT EPDs

	No. sires	No. offspring	Wean wt[a] EPD	Wean wt[a] Acc.	Birth wt, lb[b]	Weaning wt, lb[c]
Simmental Sires						
High EPD sires	2	68	+15.2	.81	99.5	567.2
Low EPD sires	2	40	+4.5	.90	95.6	544.6
Non-EPD sire	1	76			96.9	549.1
Tarentaise Sires						
High EPD sires	2	37	+8.4	.95	93.0	527.7
Low EPD sires	2	16	-16.3	.89	85.4	502.8
Non-EPD sire	1	65			86.4	504.0
Polled Hereford Sires						
Analysis I						
High EPD sires	2	57	+9.3	.92	89.7	533.1
Low EPD sires	2	99	-3.2	.82	90.1	538.8
Non-EPD sires	8	103			90.7	546.1
Analysis II						
High EPD sires	2	57	+9.3	.92	89.7	533.3
Low EPD sire	1	82	-3.1	.83	90.2	532.0
Non-EPD sires	8	103			90.7	546.1

[a] Group average EPDs and Accuracy values were computed by weighting the individual sire values within the group by the number of offspring.

[b] Birth weights were adjusted using the Beef Improvement Federation standard adjustments for age of dam.

[c] 205-day weaning weights were adjusted using the Beef Improvement Federation standard adjustments for age of dam.

In conclusion, progeny of high birth weight EPD sires consistently had heavier average birth weights than progeny of low EPD sires. Rankings based on calf weaning weight were frequently consistent with sire EPD group rankings, with a notable exception in comparing two Angus sires. Original matings were not planned with the present analysis in mind, and "ties" between sires were often largely indirect. Offspring data for some sires could not be included in the analysis. It would be desirable to collect additional data with more sires and better balance in the number of offspring per sire.

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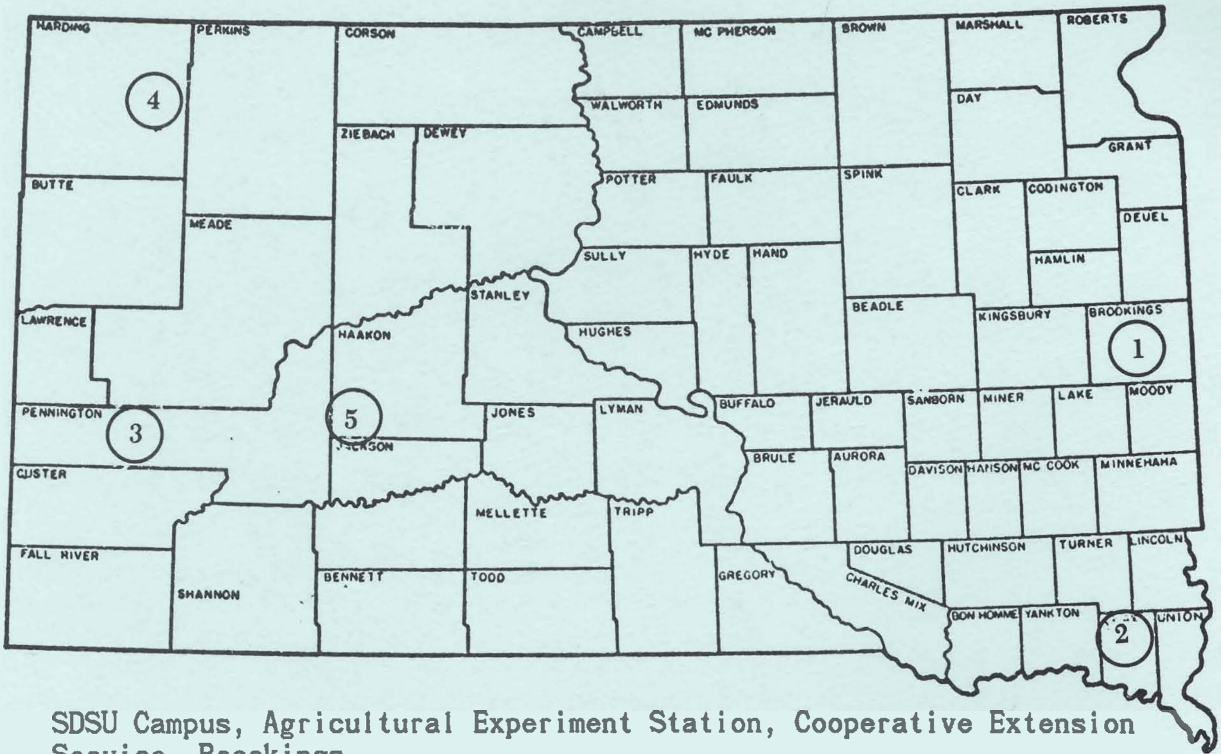
Hoffman-LaRoche, Inc.
Hugleman Ranch, Winner, SD
Iowa Beef Processors, Luverne, MN
IMC, Pitman-Moore
John Morrell Packing Company, Sioux Falls, SD
Leafstedt, James, Alcester, SD
Merck and Company, MSD-AGVET
National Live Stock and Meat Board
Pfizer, Inc.
Purina Mills, Inc.
Select Sires, Inc., Plain City, OH
Southeast SD Experiment Farm Corporation
SD Beef Cattle Improvement Association
SD Beef Industry Council, Pierre
SD Cattlemen's Association
SD Livestock Foundation
SD Stockgrowers Association
SD Veterinary Medical Association

ANIMAL AND RANGE SCIENCES
RESEARCH AND EXTENSION UNITS



1. SDSU Campus, Agricultural Experiment Station, Cooperative Extension Service, Brookings.

2. Southeast South Dakota Research Farm, Beresford
   Beef cattle nutrition * Swine nutrition and management.

3. West River Agricultural Research and Extension Center, Rapid City
   Professional research and extension staff in Animal and Range Sciences, Plant Science, Economics, 4-H and Extension Administration.

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

5. Range and Livestock Research Station, Philip
   Range beef nutrition * 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 the user, enhance the statewide teaching effectiveness of the Animal and Range Sciences Department staff and maintain a close and productive relationship with South Dakota producers and our agri-business community.

THE STATE OF SOUTH DAKOTA
IS
OUR CAMPUS * OUR RESEARCH LAB * OUR CLASSROOM