

PEC-M
F
O3
M5
987

IVERSITY OF MISSOURI-COLUMBIA

1987



Beef Cattle Report

DW 13

ANIMAL SCIENCES REPORT 114

Publication supported by the Frederick B. Miller Endowment Fund



UNIVERSITY OF MISSOURI-COLUMBIA

S104 Animal Sciences Center
Animal Sciences Department
University of Missouri
Columbia, MO 65211

It is a pleasure for me to write the forward for the 1987 Beef Cattle Report. This report summarizes our beef cattle research efforts during this past year. The overall goal of our beef research program continues to be to enhance Missouri's beef cattle industry through improved nutrition, physiology, genetics, management, health and forage production and utilization.

Animal agriculture is going through some challenging and changing times. Profit margins are small and consumer demands are changing. We need to continue to identify and concentrate on our strengths, decreasing our production cost by improving our efficiency, and be willing to make the necessary changes to keep our industry progressing. This is not only important to the beef industry but to all of animal agriculture and to the state because of the tremendous importance of animal agriculture to the state's economy.

The University of Missouri Animal Sciences Department is pleased to be a part of this effort by providing educational programs through research, extension and teaching.

This research publication is made possible by proceeds from the Frederick B. Miller Trust Fund. Mr. Miller operated a 1,042 acre livestock and crops farm in Sumner, Missouri. It was his desire that the farm be sold and placed in trust with the Board of Curators, University of Missouri with the understanding that the net income be utilized within the Animal Sciences Department for the purpose of research, scholarships and development of livestock.

The Animal Sciences Department, College of Agriculture and the University of Missouri are very much appreciative of the generosity of Mr. Miller. The proceeds from this endowment will not only be used in support of publications such as this, but will be of great benefit in support of our teaching, research and extension programs with the ultimate goal of improving livestock production in Missouri.

Listed within the report are those directly supporting our beef cattle program. We want to give a big "thank you" to all of our supporters. We could not have accomplished as much as we have without this support.

The overall objective of our beef cattle program is to provide information that will help cattlemen make better decisions in their cattle operations. Please stop by or contact one of us at the Animal Sciences Center in Columbia, or at one of our state research and/or extension centers at any time.

Sincerely,

A handwritten signature in cursive script that reads "Gary L. Allee".

Gary L. Allee
Department Chairman

BIOLOGICAL VARIABILITY AND CHANCES OF ERROR

The variability among individual animals in an experiment creates problems in interpreting the results. Although the cattle on treatment X may have had a larger average daily gain than those on treatment Y, variability within treatments may mean that the difference was not the result of the treatment alone. Statistical analysis lets researchers calculate the probability that such differences were from chance rather than treatment.

In some of the articles that follow you will see the notation ($P < .05$). That means the probability of the observed differences resulting from chance alone is less than five percent. When two averages are said to be "significantly different," the probability is less than five percent that the difference is from chance -- the probability exceeds 95 percent that the difference results from the treatment imposed.

Some papers will report the correlation between two treatments or traits. Correlations are a measure of the relationship between traits. The relationship may be positive (both traits tend to get bigger or smaller together) or negative (as one trait gets bigger, the other gets smaller). The perfect correlation is one (plus 1 or minus 1). If there is no relationship, the correlation is zero. Correlation does not necessarily mean cause and effect but rather gives us insight into potential relationships between traits.

In other papers, you may see a mean (statistical average) given as $2.50 \pm .10$. The 2.50 is the observed mean; .10 is the "standard error" associated with the mean. The standard error gives a range within which we can be 68 percent certain that the real population mean (i.e., the mean obtained if it were possible to sample an unlimited number of animals) would fall, in this case between 2.40 and 2.60 ($2.5 - .10 = 2.40$ and $2.50 + .10 = 2.60$).

If all animals performed exactly the same under a given environment, only one animal per environment (treatment) would be required to test research objectives. This however, is far from reality and therefore necessitates that many animals be used in research. As the ability to control the environment decreases, the number of animals required to test a research objective increases.

Many animals per treatment, replicating treatments several times with pens of animals and using uniform animals increases the probability of measuring the real differences resulting from treatment and thus overcoming animal variation. The statistical analysis allows more valid interpretation of the results with a limited number of animals. In nearly all of the research reported here, statistical analyses are included to increase the confidence you can place in the results.

Dr. Jack Whittier, Editor

ACKNOWLEDGMENTS

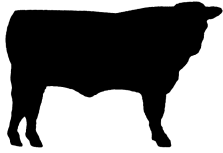
We wish to extend our appreciation to the following firms, agencies and associations who provided grant support and or products for research and developments in the beef cattle program.

ABC Labs, Columbia, MO
American Breeder's Service, DeForest, WI
American Cyanamid, Princeton, NJ
American Polled Hereford Association, Kansas City, MO
Archer-Daniels-Midland, Decatur, IL
Boehringer Ingelheim Animal Health, Inc., St. Joseph, MO
Cargill, Minneapolis, MN
Creed, Ed - Creed-Ankonny Simmental, Rhinebeck, NY
Farmland Industries, Inc., Kansas City, MO
Forsyth, Phil, Paris, MO
Hoechst-Roussel Agri-Vet Company, Somerville, NJ
Hoffmann La Roche, Nutley, NJ
Merck and Company, Inc., Rahway, NJ
International Minerals and Chemical Corp., Terre Haute, IN
Missouri Beef Cattle Improvement Association, Columbia, MO
Missouri Cattlemen's Association, Ashland, MO
Missouri Corn Merchandising Council, Jefferson City, MO
Missouri Farm Bureau, Jefferson City, MO
Missouri Department of Conservation, Jefferson City, MO
Nichols Farms, Bridgewater, IA
PBI Gordon, Inc., Kansas City, MO
R.E. John, Inc., Leawood, KS
River Bend Ranch Simmentals, Gaston, OR
Select Sires, Inc., Plain City, OH
Syntex Animal Health, Des Moines, IA
Tindle Mills, Springfield, MO
3-M Company, Minneapolis, MN
UpJohn Company, Kalamazoo, MI
Vigortone Ag Products, Inc., Cedar Rapids, IA

TABLE OF CONTENTS

	<u>Page</u>
BREEDING AND GENETICS	
Genetic and phenotypic parameter estimates for scrotal circumference and semen traits in young beef bulls -- Vogt, Gipson, Eilersieck, and Massey	1
COW-CALF PRODUCTION	
Use of a single injection of prostaglandin F2 α 96 hours after the introduction of bulls for estrous synchronization of a naturally mated herd of beef cows -- Caldwell, Anthony, Smith, Whittier, and Morrow	11
A comparison of weigh-suckle-weigh and three levels of oxytocin using a milking machine for milking beef cows -- Tucker, Morrow, Gerrish, Cundiff, Fitzgerald, Sperry and Young	16
GROWTH AND DEVELOPMENT	
Comparison of Steer-oid and Ralgro implants for suckling calves -- Sewell, Mobley, Rosenkrans, Freeman and Dunseth	20
BACKGROUNDING AND FEEDLOT NUTRITION	
Worming calves on backgrounding systems -- Ellis, Morrow, Pickle, Freeman, Booker, Chewing, Whittier	22
Intake and digestibility of tall fescue, orchardgrass and big bluestem forage by heifers in a complementary grazing system -- Turner, Paterson, J. Bowman, and Forwood	24
Influence of diet and breed on digestibility, body composition and plasma hormones of Angus and Brangus steers -- Beaver, Williams, Hannah, O'Connor, and Miller	31
Effect of cracked corn grain or corn gluten feed on digestibility and utilization of alfalfa haylage by calves -- Hannah, Paterson, Williams, and J. Bowman	36
Effects of breed and environment on diet intake, digestibility, water intake and blood parameters of Brangus and Angus steers -- Beaver, Williams, Hannah, O'Connor, and Miller	43

	<u>Page</u>
Effects of feed intake and implant on performance variables and body composition of Angus and Simmental steers -- O'Connor, Williams, Lipsey, Siemens, Beaver, Hannah, and Miller	49
 FORAGE UTILIZATION	
Comparison of systems of grazing with various cell number -- Whittier, Henning, Garner, and Morrow	53
Performance of cows on different forage management systems: Milk production -- Tucker, Morrow, Gerrish, Cundiff, Fitzgerald, Sperry, and Jacobs	58
Year-round forage grazing systems for beef cattle: Reproductive performance -- Tucker, Morrow, and Gerrish	61
Embark treatment of tall fescue: Animal performance -- Turner, Paterson, J. Bowman, D. Bowman, and Forwood	65
 ANIMAL HEALTH AND PARASITE CONTROL	
The effect of deworming cows at spring turnout and calves mid-summer with Fenbendazole on calf performance -- Whittier, Massey, Cole, Dunseth, Hartung, and Thompson	70
Nursing calf response to Ivomec treated cows grazing endophyte infected fescue pasture -- Moore, Lipsey, and Decker	79
Effect of short-term food deprivation on immune response of calves to Infectious Bovine Rhinotracheitis (IBR) virus -- Rosenquist and d'Offay	82



GENETIC AND PHENOTYPIC PARAMETER ESTIMATES FOR SCROTAL CIRCUMFERENCE AND SEMEN TRAITS IN YOUNG BEEF BULLS

D.W. Vogt¹, T.A. Gipson², M.R. Ellersieck³ and J.W. Massey¹

1987
Progress
Report

SUMMARY AND CONCLUSION

Estimated in this study were heritabilities and genetic and phenotypic correlations involving scrotal circumference (SC), percent live sperm (PLSp), sperm number (SpN), sperm concentration (SpC), sperm motility (SpM), and an overall measure of potential breeding efficiency (PBE). Potential breeding efficiency is a composite trait based on a consideration of sperm concentration, sperm motility, sperm morphology and scrotal circumference. Data were from three sources. Records on 863 Angus, 753 Polled Hereford and 302 Simmental bulls were available through the Missouri Performance-Tested Bull Sale and 1169 Polled Hereford bulls through the American Polled Hereford Association. Information from these two data sets were used to estimate heritability of scrotal circumference. The third data set was provided by Nichols Farms of Bridgewater, Iowa and included information on 465 yearling Polled Hereford and 264 yearling Simmental bulls. This latter data set was used to estimate all of the above mentioned parameters. Pooled estimates of heritability for SC, SpC, SpM, PLSp, SpN and PBE were $.51 \pm .09$, $.20 \pm .13$, $.11 \pm .12$, $.00$, $.19 \pm .14$ and $.13 \pm .12$, respectively. Phenotypic correlations involving the six traits were very consistent for the two breeds. Combined across breeds their values ranged from $.47$ for SC and PLSp to $.96$ for SpC and PBE. Genetic correlations were generally positive and high and ranged from $.65$ for SC and SpM to 1.14 for SpN and PBE.

The consistently high and desirable genetic correlations involving SC and semen quality traits, coupled with the high heritability for SC and low heritabilities for semen traits, suggests that direct selection for increased SC size would be more effective in bringing about semen trait improvement than direct selection pressure on the semen traits themselves.

¹Department of Animal Sciences, University of Missouri, Columbia

²Department of Dairy Science, University of Illinois, Urbana

³Agricultural Experiment Station, University of Missouri, Columbia

INTRODUCTION

In recent years, there has been considerable attention focused on scrotal development in the male as a means of improving bovine male fertility. Most studies (Willetts and Ohms, 1957; Ruttle et al., 1981; Fields et al., 1982 and Gipson et al., 1985) involving associations of scrotal circumference with semen traits have been phenotypic. Much less information is available regarding genetic association of these same traits (Neely et al., 1982; Brinks, 1983 and Knights et al., 1984). Additionally, only a few studies (Brinks, 1983; Knights et al., 1984 and Taylor et al., 1985) have reported heritabilities of semen traits.

Knowledge of the heritabilities of- and the genetic and phenotypic correlations between scrotal circumference and semen traits facilitates selection for increased fertility in the bull and are requisite to predictions of responses to their direct and indirect selection.

The objectives of this study were to estimate heritabilities and genetic and phenotypic correlations involving scrotal circumference with each of four semen traits and one composite trait representing an overall measure of a bull's potential breeding efficiency.

MATERIALS AND METHODS

The data for this study came from three sources. Each data set was kept separately for the purpose of statistical analysis.

Missouri tested bull sale (Data set 1). Approximately 300 bulls are sold annually through University of Missouri performance-tested bull sales. These sales are held in April and November each year. Scrotal circumference measurements are taken the day before the sale under the supervision of the faculty of the Theriogenology Department in the School of Veterinary Medicine. Scrotal circumference measurements, sale day age, sale day weight, and pedigrees were collected on 863 Angus, 753 Polled Hereford, and 302 Simmental bulls from 1978 through 1983. These data were subdivided into 16 year-season subsets (8 years and 2 seasons per year). Data set 1 was used to estimate heritability of scrotal circumference in Angus, Polled Hereford, and Simmental bulls. Scrotal circumference measurements were adjusted for age and body weight differences as described by Gipson et al. (1985). Adjusted data were analyzed within breed and year-season subsets by paternal half-sib analysis of variance. Subset data were subsequently combined by summing (separately) degrees of freedom and sums of squares obtained from appropriate subset analyses. New variance components were determined from the combined data sets and heritability was estimated as 4 times the sire component of variance divided by the sum of the sire and within sire components of variance. Standard errors of the heritability estimates were calculated using procedures outlined by Dickerson (1959).

American Polled Hereford Association (Data set 2). Measurements on scrotal circumference and body weight as well as age and pedigree information on 1169 yearling Polled Hereford bulls were made available

for this study by the American Polled Hereford Association. Data were collected in the three-year period from 1981 through 1983 with most being collected in 1982. Data were subdivided into 129 year-location subsets (3 years and 97 locations). Not all locations are represented in all years. Information in this data set, as in data set 1, was used to estimate heritability of scrotal circumference. As with data set 1, SC measurements were adjusted for differences in age and body weight using adjustment factors and procedures given by Gipson et al., (1985). The methods of statistical analysis were the same as outlined for data set 1. In data set 2, however, there was only one breed and data were subdivided into year-location subsets.

Nichols Farms (Data set 3). Data in this subset were provided by Nichols Farms of Bridgewater, Iowa and included information from the records of 465 yearling Polled Hereford bulls and 264 yearling Simmental bulls. Records were from the five-year period from 1978 through 1982. Data taken from the records included age, body weight, scrotal circumference, percent live sperm, sperm number, sperm concentration, sperm motility, and an overall measure of a bull's potential breeding efficiency. All measurements were made at the conclusion of a 140-day full-feed postweaning test period that was completed in the spring of each year.

Measurements of scrotal circumference and semen quality were made by Hawkeye Breeders Service, Inc. of Des Moines, Iowa. Scrotal circumference was measured at the largest scrotal area centered lengthwise on the testicle in accordance with recommendations of the Society for Theriogenology. Semen evaluations were made using fresh, undiluted semen collected by electroejaculation. One to three ejaculates were collected and evaluated depending on the quality of the first semen sample. Bulls with poor quality in the first or first and second samples were subsequently collected again for reevaluation. Semen quality measurements were based on the best single sample. Percent live sperm was estimated to the nearest 10% figure with values ranging from 0 to 70%. Sperm number was based on a photometer reading and recorded in millions of cells per cc. Sperm concentration ratings were based on sperm number and assigned classifications of excellent, good +, good, good -, fair and unsatisfactory. Ranges in millions of cells per cc of raw semen for these six classifications, beginning with excellent, were >1500, 1350 to 1500, 1150 to 1350, 1000 to 1150, 500 to 1000 and <500, respectively. Sperm motility was classified in the same six classifications as sperm concentration (i.e., excellent through unsatisfactory) and coded in like manner. The ranges in percentage motility values corresponding to these six classifications, beginning with excellent, were >70, 65 to 69.9, 60 to 64.9, 55 to 59.9, 25 to 54.9 and <25, respectively. Classifications of excellent through unsatisfactory for both sperm concentration and sperm motility were coded 6 through 1, respectively. Potential breeding efficiency of bulls is a composite trait based by Hawkeye Breeders Service on a consideration of sperm concentration, sperm motility, sperm morphology, and scrotal circumference. Evaluations of this composite trait are classified excellent, good +, good, good -, fair, questionable, or unsatisfactory. In the present data set there were no bulls in the questionable category. These classifications, then, were the same as

for sperm concentration and sperm motility and consequently were coded in the same manner as sperm concentration and sperm motility.

Information in this data set was used to estimate heritabilities of scrotal circumference, percent live sperm, sperm number, sperm concentration, sperm motility, and potential breeding efficiency as well as the genetic and phenotypic correlations between these traits.

Scrotal circumference measurements, as in data sets 1 and 2, were adjusted for differences due to age and body weight according to the procedures outlined by Gipson et al., (1985). Paternal half-sib analyses of variance and covariance were conducted on a within-breed and year basis. Results of these subset analyses were combined in a manner analogous to that described for data set 1. New variance and covariance components were determined from the combined data sets and subsequently, used to estimate heritabilities and genetic and phenotypic correlations.

RESULTS AND DISCUSSION

Heritability estimates. Table 1 shows estimates of heritability for scrotal circumference (SC), sperm concentration (SpC), sperm motility (SpM), percent live sperm (PLSp), sperm number (SpN) and the overall measure of a bull's potential breeding efficiency (PBE). Estimates are shown within breed and data source as well as combined across breeds and, for SC, across breeds and data source. Breed estimates of heritability for SC range from $.48 \pm .24$ to $.55 \pm .24$. Breed differences were not significant ($P > .05$). Previously reported estimates of the heritability of this trait in yearling beef bulls ranged from $.21 \pm .15$ (Blockey et al., 1978) to $.69 \pm .15$ (Coulter and Keller, 1979). Present estimates, then, are in good agreement with those previously reported.

Heritability estimates for PBE and the four semen traits were consistently low. Within breed estimates for these traits ranged from .00 for PLSp to $.28 \pm .17$ for SpC. Breed differences were not significant ($P > .05$). Previous estimates (Brinks, 1983; Knights et al., 1984, Taylor et al., 1985 and Strzezek et al., 1982) of the heritability of semen component traits generally have been low. With one exception, these estimates ranged from .00 for PLSp (Knights et al., 1984) to .28 for SpC (Brinks, 1983). The exception (Strzezek et al., 1982) was a relatively high estimate for SpC of .44.

Correlations. Phenotypic and genetic correlations involving SC, PLSp; SpN, SpC; and SpM, PBE are presented by breed and combined across breeds in table 2. Breed estimates of phenotypic correlations were very consistent and, with one exception, differed in numerical value by only .00 to .05. Breed differences were not significant ($P > .05$). Estimates combined across breeds were medium to high ranging from .47 for PLSp and SC to .96 for PBE and SpC.

A 1984 report (Knights et al.) provides estimates of phenotypic and genetic correlations for these same pairs of traits. Data upon which that report was based, and part of the data upon which the present

report is based, was provided by Nichols Farms in Bridgewater, Iowa. The report by Knights et al., (1984) used data on Angus bulls while the present study, as indicated previously, is based on data collected on Polled Hereford and Simmental bulls. Trait designation in these two studies also differs slightly. In the study by Knights et al. (1984), the trait "semen score" is a composite trait that considers sperm concentration, motility, morphology and scrotal circumference. It corresponds, then, to the trait designated potential breeding efficiency in the present study.

A number of corresponding phenotypic correlations from these two studies are of opposite algebraic sign. This difference, however, was artificially produced by coding, in the two studies, SpC, SpM and PBE in reverse orders. Recognizing this, estimates from the two studies are in very close agreement. Differences in absolute values between the 15 corresponding phenotypic correlations in these two studies ranged from .01 to .10 and averaged .03.

Additional estimates of phenotypic correlation involving some of these same trait pairs in yearling beef bulls include .63 for SC with SpN (Neely et al., 1982), .46 for SC with SpC (Brinks, 1983) and, for SC with SpM, .25 (Brinks, 1983) and $-.36$ (Chenoweth et al., 1977). The $-.36$ correlation for SC and SpM is in disagreement with other estimates and suggests an undesirable association between the two traits. Except for the .63 correlation between SC and SpN, these additional estimates are slightly lower than corresponding correlations in the present report.

Genetic correlations combined across breeds were high and positive and ranged from .65 for SC with SpM to 1.14 for SpN with PBE. Five of the 15 estimates using Simmental data only as well as data combined across breeds were inestimable because the sire component for one of the traits (PLSp) was negative. This is also shown in table 1 by the Simmental breed and combined across breeds estimates of heritability of zero for PLSp. Considering Simmental data only, three of the five inestimable genetic correlations (SpC, PLSp; SpM, PLSp; PBE, PLSp) had a negative genetic covariance and two (SC, PLSp; SpN, PLSp) had a positive genetic covariance. Combined across breeds, however, all genetic covariances were positive.

Estimated genetic correlations involving three of the four semen traits (SpC, SpM, SpN) and the composite trait (PBE) are consistently high and positive and range from 1.00 for SpC with SpM to 1.14 for SpN with PBE. All agree very well with those reported in the earlier-discussed 1984 report by Knights et al. In the 1984 report (Knights et al.) and the present report the five genetic correlations involving PLSp were inestimable because the PLSp sire component of variance was negative.

Across breed estimates of genetic correlation involving SC with SpC, SpM, SpN and PBE were also consistently high and positive and ranged from .65 for SC with SpN to .76 for SC with PBE. These values, in the sense of desirability of algebraic sign, agree with, but are consistently higher than, those reported in the previously discussed

1984 study (Knights et al).

Additional previous estimates of genetic correlation involving some of these same traits include 1.5 for SC with SpN (Neeley et al., 1982), .53 for SpC and SpM (Brinks, 1983), .26 for SpC with PLSp (Brinks, 1983) and .44 for SpM with PLSp (Brinks, 1983).

The high heritability for SC, low heritabilities for semen traits, and consistently high desirable genetic correlations between SC and the semen traits suggest that direct selection for increased SC size would be more effective in bringing about semen trait improvement than direct selection pressure on the semen traits themselves.

Table 1. Estimates of heritability

Trait	Breed			Combined Across breeds	Data Source ^c
	Angus	Polled Hereford	Simmental		
Scrotal Circumference	.55±.24	.56±.25	1.16±.53		1
Scrotal Circumference	---	.83±.18	---		2
Scrotal Circumference	---	.19±.17	.30±.27		3
Scrotal Circumference- combined across data sources	.55±.24	.51±.11	.48±.24	.51±.09 ^a	1,2,3
Sperm Concentration	---	.28±.17	.09±.20	.20±.13	3
Sperm Motility	---	.19±.16	.02±.18	.11±.12	3
Percent Live Sperm	---	.02±.14	.00 ^b	.00 ^b	3
Sperm Number	---	.16±.16	.25±.25	.19±.14	3
Potential Breeding Efficiency	---	.20±.17	.05±.18	.13±.12	3

^aCombined across breeds and data source.

^bSire component of variance was negative and heritability estimate assumed to be zero.

^c1 = Missouri Bull Sale; 2 = American Polled Hereford Association;
3 = Nichols Farms

Table 2. Estimates of phenotypic and genetic correlations

Trait ^a	SC	SpC	SpM	PLSp	SpN	PBE
SC						
Polled Hereford		.58	.56	.49	.57	.58
Simmental		.59	.59	.47	.68	.56
Combined		.58	.57	.47	.64	.56
SpC						
Polled Hereford	.60		.95	.81	.86	.96
Simmental	1.16		.92	.86	.84	.96
Combined	.67		.94	.82	.84	.96
SpM						
Polled Hereford	.63	.97		.82	.87	.96
Simmental	1.83	1.44		.86	.87	.93
Combined	.65	1.00		.83	.87	.95
PLSp						
Polled Hereford	.197	2.13	1.68		.80	.86
Simmental	— ^b	— ^b	— ^b		.80	.91
Combined	— ^b	— ^b	— ^b		.80	.87
SpN						
Polled Hereford	.78	1.07	1.11	2.57		.87
Simmental	.85	1.40	1.80	— ^b		.84
Combined	.69	1.06	1.02	— ^b		.85
PBE						
Polled Hereford	.68	1.02	1.03	2.08	1.18	
Simmental	1.49	1.25	1.18	— ^b	1.67	
Combined	.76	1.03	1.04	— ^b	1.14	

^aSC = Scrotal circumference

SpC = Sperm concentration

SpM = Sperm motility

PLSp = Percent live sperm

SpN = Sperm number

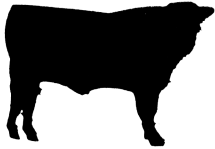
PBE = Potential breeding efficiency

^bNot estimated because sire component of variance for PLSp was negative. Of the 5 inestimable within breed (Simmental) genetic correlations, 3 (SpC, PLSp; SpM, PLSp; PBE, PLSp) had negative genetic covariances and 2 (SC, PLSp; SpN, PLSp) had positive genetic covariances. Genetic covariances combined across breeds, however, were positive.

REFERENCES

1. Blockey, MA. deB., Straw, W.M. and Jones, L.P. 1978. Heritability of serving capacity and scrotal circumference in beef bulls. *J. Anim. Sci.* 47 (Suppl. 1):253.
2. Brinks, J.S. 1983. Genetic aspects of reproduction in beef cattle. 34th Annual Beef Cattle Improvement Report and Sale Data. Colorado State Univ. Expt. Sta., Special Series 25:18.
3. Chenoweth, P.J., Abbitt, B., McInerney, M.J. and Brinks, J.S. 1977. Libido, serving capacity and breeding soundness in beef bulls. Colorado State Univ. Expt. Sta. General Series No. 966:18.
4. Coulter, G.H. and Keller, D.G. 1979. Scrotal circumference and its heritability in yearling beef bulls. *J. Anim. Sci.* 49 (Suppl. 1):288.
5. Dickerson, G.E. 1959. Techniques for research in quantitative animal genetics. In: Techniques and Procedures in Animal Production Research. Amer. Soc. Anim. Prod. pp. 56-105.
6. Fields, M.J., Hentges, J.F., Jr. and Cornelisse, K.W. 1982. Aspects of the sexual development of Brahman versus Angus bulls in Florida. *Theriogenology* 18(1):17.
7. Gipson, T.A., Vogt, D.W., Massey, J.W. and Ellersieck, M.R. 1985. Associations of scrotal circumference with semen traits in young beef bulls. *Theriogenology* 24(2):217.
8. Gipson, T.A., Vogt, D.W., Massey, J.W. and Ellersieck, M.R. 1985. Scrotal circumference adjustment factors for age and weight differences in beef bulls. *JAVMA* 186(6):580.
9. Knights, S.A., Baker, R.L., Gianola, D. and Gibb, J.B. 1984. Estimates of heritabilities and of genetic and phenotypic correlations among growth and reproductive traits in yearling Angus bulls. *J. Anim. Sci.* 58(4):887.
10. Neely, J.D., Johnson, B.H., Dillard, E.U. and Robinson, O.W. 1982. Genetic parameters for testes size and sperm number in Hereford bulls. *J. Anim. Sci.* 55(5):1033.
11. Ruttle, J.L., Bartlett, D.C., Hallford, D.M., Southward, G.M. and Bolgiano, D. 1981. Relationship of scrotal circumference and semen characteristics in New Mexico range beef bulls. *Proc. West. Sec. Amer. Soc. Anim. Sci.* 32:240.
12. Strzezek, J., Jasiorowski, J. and Czeczot, H. 1982. Genetic and biochemical indices used for an assessment of suitability of young bull semen for preservation in liquid nitrogen. 2nd Wld. Cong. Genetics Applied to Livestock Prod. 7:493.

13. Taylor, J.F., Bean, B., Marshall, C.E. and Sullivan, J.J. 1985. Genetic and environmental components of semen production traits of artificial insemination Holstein bulls. J. Dairy Sci. 68:2703.
14. Willett, E.L. and Ohms, J.I. 1957. Measurement of testicular size and its relation to production of spermatozoa by bulls. J. Dairy Sci. 40:1559.



1987
Progress
Report

USE OF A SINGLE INJECTION OF PROSTAGLANDIN $F_{2\alpha}$ 96 HOURS AFTER THE
INTRODUCTION OF BULLS FOR ESTROUS SYNCHRONIZATION OF A NATURALLY
MATED HERD OF BEEF COWS

R.W. Caldwell, R.V. Anthony, M.F. Smith,
J.C. Whittier and R.E. Morrow

SUMMARY

Our objective was to determine the effectiveness of one injection of prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) 96 hours after the introduction of intact bulls on estrous synchronization and pregnancy rate in lactating and nonlactating beef cows. One-hundred fifteen cycling beef cows were allotted by lactational status, previous calving date and breed of assigned bull to one of two treatments. Within each lactational status, one group (PG) was injected with 25 mg $PGF_{2\alpha}$ and the second group (S) received 5 ml saline. The response of lactating and nonlactating cows was similar ($P > .25$) so data from the two groups were pooled. The number of cows in estrus or the pregnancy rate from day one to four of the breeding season was not different ($P > .50$) between the treatment groups. By 96 hours following treatment the percentage of cows detected in estrus (20.7 vs 68.4%) and the pregnancy rate (17.2 vs 56.1%) was greater ($P < .005$) for PG cows. There was no difference ($P > .10$) in the total number of S and PG cows in estrus or the pregnancy rate by day 25 of the breeding season. These results indicate that one injection of $PGF_{2\alpha}$ 96 hours after the introduction of bulls is an effective means of synchronizing estrus and thereby increasing the percentage of cows which become pregnant early in the breeding season under natural service conditions.

INTRODUCTION

There are several estrous synchronization schemes available to the beef producer. The most widely used technique for estrous synchronization which has been approved for on farm usage involves giving two intramuscular injections (25 mg) of prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) eleven days apart followed by artificial insemination on subsequent detected estrus, or at a given length of time following the second injection. This as well as other estrous synchronization protocols are geared towards the usage of artificial insemination, and are fairly labor intensive. Many beef producers would like to utilize estrous synchronization to increase the percentage of their herd that is bred early in the breeding season, but do not have the experience or labor capabilities to use available estrous synchronization protocols. It was our objective to determine if treatment with a single injection of $PGF_{2\alpha}$ 96 hours after bulls had been introduced into a naturally mated herd of beef cows, could provide an effective means of estrous synchronization.

EXPERIMENTAL PROCEDURES

One-hundred fifteen crossbred fall calving beef cows at the University of Missouri-Wurdack Experimental Farm were allotted by their lactational status, previous calving date and by the breed of sire they

were to be bred to, to one of two treatment groups prior to beginning the breeding season (11/15/86 - 12/30/87). Two blood samples were collected via jugular venipuncture one week (11/7 and 11/14/86) apart immediately prior to the breeding season. The resulting plasma was analyzed for progesterone concentrations to determine the percentage of cows which had returned to estrus prior to the initiation of the breeding season. Concentrations of progesterone ($<1\text{ng/ml}$) at both samplings were used to identify noncycling animals. All 115 cows used in this experiment had returned to estrus before the initiation of the breeding season by this criteria.

Day one of the experiment (11/15/86) was the day the bulls were introduced to the herd. Seventy cows were pasture mated to four Simmental bulls and 45 cows were pasture mated to three Gelbvieh bulls. The two treatment groups consisted of either a single injection of 25mg of $\text{PGF}_{2\alpha}$ (Lutalyse, UpJohn Co., Kalamazoo, MI; $n=57$) or a single injection of 5ml of physiological saline ($n=58$) on day five (96 hours) of bull exposure. All cows were treated irregardless of whether or not they had been bred during the first 96 hours of the breeding season. The cows were observed for estrous behavior four times daily during the first 10 days of the breeding season and twice daily thereafter. All cows were palpated for pregnancy 70 days after the introduction of bulls to the breeding herds. Treatment differences in the percentage of cows exhibiting behavioral estrus and pregnancy rate were determined using chi-square statistical analysis.

RESULTS AND DISCUSSION

Table 1 presents the percentage of cows detected in estrus and the pregnancy rate prior to treatment, for 96 hours following treatment and for the first 25 days of the breeding season. The response of lactating and nonlactating cows to the treatments was similar ($P>.50$) and there were no detectable differences ($P>.25$) between the two breed of bull groups, so the data were pooled over these criteria. There was no difference ($P>.50$) in either percent detected in estrus or pregnancy rate (table 1) obtained during the 96 hours prior to treatment. However, during the first 96 hours following treatment, the percentage of cows exhibiting estrus and the pregnancy rate obtained (table 1) was greater ($P<.005$) for $\text{PGF}_{2\alpha}$ treated cows. These data are also represented in Figure 1. Since all the cows had returned to estrus before the beginning of the breeding season there was no overall treatment difference ($P>.10$) in the percentage of cows exhibiting estrus at least once or becoming pregnant during the first 25 days of the breeding season.

Lauderdale et.al. (1981) reviewed a compilation of numerous field trials conducted in the United States where $\text{PGF}_{2\alpha}$ was used for estrous synchronization. In one procedure, beef cows were observed for estrus and bred by artificial insemination during the first four days of the breeding season. Those cows which were not bred previously were administered $\text{PGF}_{2\alpha}$ on day five, and artificially inseminated on observed estrus until day nine. Within the first nine days of the breeding season 39% of $\text{PGF}_{2\alpha}$ treated cows became pregnant versus 26% of the control cows. In another comparison, they compared non-treated cows to cows which recieved one injection of $\text{PGF}_{2\alpha}$ on day one and were artificially inseminated on behavioural estrus of cows which recieved $\text{PGF}_{2\alpha}$ on day 1 and day 10 to 12 and were artificially inseminated on behavioural estrus.

The pregnancy rates obtained within the first five days after treatment were: 16% for control cows, 36% for cows receiving a single injection and 46% for cows receiving two injections of $\text{PGF}_{2\alpha}$. Our results indicated that we obtained comparable or better results by using a single injection of $\text{PGF}_{2\alpha}$ on day five of the breeding season in a naturally mated herd of beef cows.

The simplicity of our estrous synchronization procedure reduces the labor expenditure, and should be especially applicable to management systems where artificial insemination is either unfeasible or not needed, but estrous synchronization would still be beneficial. The use of estrous synchronization to get cows bred earlier in the breeding season is advantageous to producers in two ways. First, is that more calves will be born early during the calving season and will thus be older and heavier at weaning. Second, is that the earlier a cow calves, the more time she has between calving and the beginning of the breeding season to resume fertile estrous cycles. Both of these end results yields more efficient production and management practices.

LITERATURE CITED

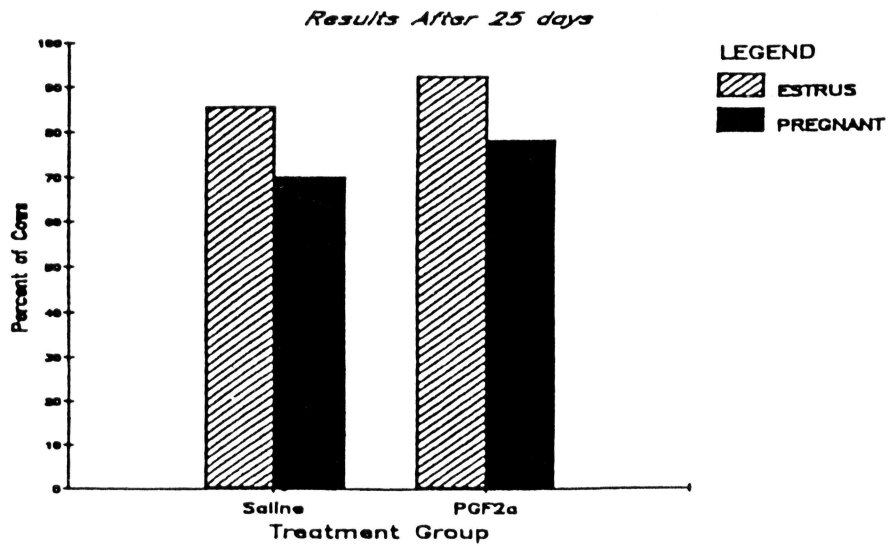
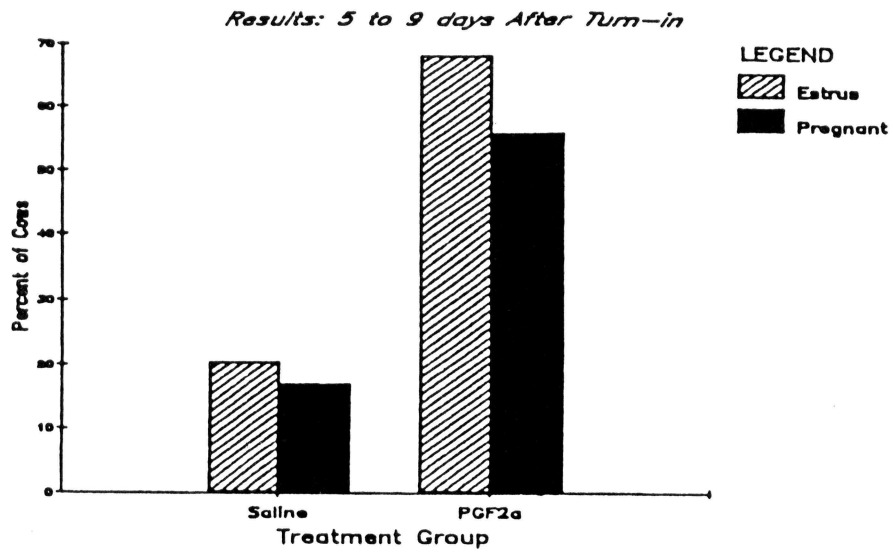
- Lauderdale, J.W., J.F. McAllister, D.D. Kratzer and E.L. Moody. 1981.
Use of prostaglandin $\text{F}_{2\alpha}$ ($\text{PGF}_{2\alpha}$) in cattle breeding. Acta Vet.
Scand. 77(Suppl.):181.

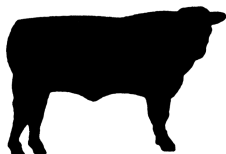
TABLE 1. EFFECT OF A SINGLE INJECTION OF SALINE OR PGF_{2α} FIVE DAYS AFTER INTRODUCTION OF BULLS ON PERCENTAGE OF COWS DETECTED IN ESTRUS AND PREGNANCY RATE

Item	Lactating		Nonlactating		Pooled	
	Saline	PGF _{2α}	Saline	PGF _{2α}	Saline	PGF _{2α}
No. Cows:	26	27	32	30	58	57
<u>d 1 to 4:</u>						
Estrus						
No	2/26	2/27	4/32	3/30	6/58	5/57
%	7.6	7.4	12.5	10.0	10.3	8.8
Pregnant						
No	2/26	2/27	4/32	2/30	6/58	4/57
%	7.6	7.4	12.5	6.7	10.3	7.0
<u>d 5 to 9:</u>						
Estrus						
No	4/26	18/27	8/32	21/30	12/58	39/57
%	15.4 ^a	66.7 ^b	25 ^a	70 ^b	20.7 ^a	68.4 ^b
Pregnant						
No	3/26	15/27	7/32	17/30	10/58	32/57
%	11.5 ^a	55.6 ^b	21.9 ^a	56.7 ^b	17.2 ^a	56.1 ^b
<u>d 1 to 25:</u>						
Estrus						
No	23/26	24/27	27/32	29/30	50/58	53/57
%	88.5	88.9	84.4	96.7	86.2	93
Pregnant						
No	18/26	21/27	23/32	24/30	41/58	45/57
%	69.2	77.8	71.9	80.0	70.7	78.9

^{ab} Percentages within the same row and same group having different superscripts are different (P < .005)

FIGURE 1
Estrus Synchronization Using
Prostaglandin and Intact Bulls





**1987
Progress
Report**

A COMPARISON OF WEIGH-SUCKLE-WEIGH AND THREE LEVELS OF OXYTOCIN USING A MILKING MACHINE FOR MILKING BEEF COWS

C. Tucker, R. Morrow, J. Gerrish, T. Cundiff,
J. Fitzgerald, T. Sperry and C. Young

SUMMARY

An experiment was undertaken to evaluate methods of obtaining milk production estimates. The methods were weigh-suckle-weigh (WSW) and the use of a milking machine (MM) with three levels of oxytocin (1cc, 2cc and 4cc). Ten IU of oxytocin equal 1cc. Milk estimates were larger when WSW was used, but there was greater variation in the estimates. All treatments using the MM were similar and there was less variation in milk estimates within each treatment. If any behavioral problems arose, WSW estimates fell drastically, whereas, MM estimates were not effected.

INTRODUCTION

The milk production of cows on different forages and/or management systems is a major concern in cow-calf operations. The two main methods of estimating milk production in beef cows are weigh-suckle-weigh (WSW) with the use of a Paul scale, and the use of a milking machine (MM). WSW requires less total cost (labor, time, equipment), than the use of milking machines, but there are concerns about the accuracy and consistency of milk estimates. The opposite is found when milking machines are used. Problems with the use of milking machines includes milk let-down and determining whether the cow is completely stripped of all her milk. Oxytocin is used to aid in milk let-down. Each method contains both advantages and disadvantages; therefore, the method used for each individual cow-calf operation must be determined by which provides sufficient estimates of milk production.

This pilot study was designed to help determine which method would be best suited for research at the Forage Systems Research Center. It was also developed to simultaneously attempt to ascertain what level of oxytocin would be necessary for proper milk let-down with the use of a milking machine.

PROCEDURE

Cows were randomly selected based on the age and sex of the calves. Cows were separated into groups of 4 with equal numbers of bull and heifer calves. The groups were randomly assigned to one of four treatments and were reassigned to a different treatment every other day. The treatments were weigh-suckle-weigh (WSW), and machine milking (MM) using 1cc, 2cc and 4cc of oxytocin. The oxytocin was administered intravenously.

The cows were separated from their calves for an 8-hour period, after which the calves were allowed to nurse and were once again separated from their dam. After 12 hours, milk production estimates were obtained based on treatment. In the course of the treatments using the milking machine, any problems, such as cows lying down and kicking

off the claw, were recorded. Problems that arose with WSW were also recorded. These included calves defecating, urinating, or nursing more than one cow. Problems were scored for the purpose of analysis as 0 (no behavior problem) or 1 (behavior problem).

The milk acquired from the use of the milking machine was weighed by milk scales. Calves were weighed with a Paul scale when WSW was used. It should be noted, also, that between milkings, all cows and calves were grouped together in the same pasture.

RESULT

Mean milk production estimates by treatment and their coefficient of variation (CV) are presented in table 1. Milk estimates from WSW were larger, however, the CV was also the largest. The means and CV's for milk estimates using a milking machine were similar, with the 2cc oxytocin treatment having the lowest CV. These results tend to single out the use of machine milking over WSW on the basis of less variation. In simpler terms, machine milking estimates are more consistent estimates than WSW.

To try and determine the cause of greater variation, the effect of behavioral problems on milk estimates by treatment was evaluated (table 2). The largest milk estimate was still obtained using WSW, but when behavioral problems arose, WSW estimates were the lowest. There was little effect on milk estimates when behavioral problems occurred using a milking machine and oxytocin. It should also be noted that when 2cc of oxytocin was used milk production estimates tended to not be effected by behavioral problems. The time it took to milk cows with a milking machine is presented in table 2. All times were similar with the exception of the 4cc treatment when cows exhibited behavioral problems. There was a tendency for time of milking to increase when behavioral problems occurred.

Milk production estimates by milk date and treatment are listed in table 3. WSW tended to vary from day to day, while milk estimates from machine milking tended to increase as milk date increased. Behavioral problems did increase from day 1 to day 3, but by day 4 they had declined. These results do show that as number of milkings increase the cow will become more comfortable which will cause milk estimates to be more accurate. Over time one may be able to stop using oxytocin as a means for milk letdown. As for now cows will be injected with 2cc of oxytocin at the Forage System Research Center based on these results and results from other studies.

TABLE 1. MILK PRODUCTION

Treatment	Milk wt. (lbs)	Coeff. Var.
Weigh-suckle-weigh	8.4	47.0
Machine Milking		
1cc oxytocin	6.1	30.1
2cc oxytocin	6.4	28.4
4cc oxytocin	6.1	33.7

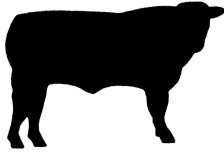
TABLE 2: MILK PRODUCTION AND LENGTH OF TIME TO MILK
BY TREATMENT AND BEHAVIOR

Treatment	Behavior	Milk wt. (lbs)	Time (min.)
Weigh-suckle-weigh			
	0	9.3	-
	1	2.5	-
Machine Milking			
1cc oxytocin	0	5.9	6.8
	1	7.9	7.5
2cc oxytocin	0	6.4	8.6
	1	6.6	7.0
4cc oxytocin	0	6.4	7.6
	1	5.4	12.0

Behavior is 0 for no problem and 1 for any behavioral problem that occurred.

TABLE 3: MILK PRODUCTION BY MILK DATA AND TREATMENT

Milk Date	WSW	Machine Milking			
		1cc	2cc	4cc	Mean
June 28	11.3	5.5	5.9	5.7	5.7
June 31	5.0	5.4	5.8	4.5	5.2
July 2	6.3	5.6	7.8	6.0	6.5
July 4	11.3	8.0	6.3	8.4	7.5



1987
Progress
Report

COMPARISON OF STEER-[®]OID[®] AND RALGRO[®] IMPLANTS FOR SUCKLING CALVES¹

Homer B. Sewell, Don Mobley, Charles Rosenkrans,
James Freeman and Dale Dunseth

SUMMARY

There were no significant differences in any of five field trials comparing the pre-weaning gain of steer calves implanted with a single dosage of STEER-oid Calf Implant vs a single dosage of Ralgro in periods ranging from 155 to 200 days. Calves implanted with STEER-oid averaged 3, 5, 11, and 14 lbs more total pre-weaning gain per head than those implanted with Ralgro in four herds, whereas calves implanted with Ralgro averaged 9 lb more gain per head than those implanted with STEER-oid in the remaining herd.

INTRODUCTION

STEER-oid Calf Implant is an experimental implant that has not been released for general use. It contains progesterone and estradiol benzoate at similar levels to Synovex-C, an implant that gave similar response to Ralgro implants in 5 field trials reported in the 1986 Beef Cattle Report. These trials were designed to compare STEER-oid Calf Implants with Ralgro, whose efficiency for stimulating pre- and post-weaning gain of beef calves is established.

PROCEDURE

A single implant of STEER-oid was compared with a single implant of Ralgro for suckling steer calves in five commercial herds located in mid and northern Missouri. Calves of mixed breeding were implanted at 1 to 3 months of age. Calves were either Angus-Hereford crosses or crosses of these two breeds with Continental breeds. Steer calves within a herd were allotted by a gate cut to an implant treatment. Calves were ear tagged and individually weighed once at the beginning and end of the trials. Trial lengths were 155, 177, 191, 200, and 201 days. All cow and calf pairs in a herd were grazed together on pastures that were mostly fescue or fescue-legume mixtures.

Data were statistically analyzed by analysis of variance.

RESULTS

Calves ranged from 1.30 to 1.88 lb average daily pre-weaning gain in the five herds (table). There were no significant differences in the suckling gain of steers implanted with STEER-oid vs Ralgro in any of these herds. Calves implanted with STEER-oid had 3, 5, 11, and 14 lbs

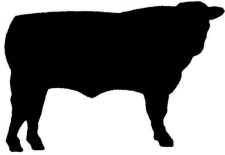
¹Support of this trial provided by Boehringer Ingelheim Animal Health, Inc., St. Joseph, Missouri

greater average total gain per head than Ralgro implanted calves in four trials (1.1, 1.6, 4.4, and 5.6%, respectively) but gained 9 lbs less per head (3.1%) in one trial. Pooling the means of the five trials gave an average daily gain of 1.52 lb and 1.54 lb for the Ralgro and STEER-oid implanted calves, respectively. STEER-oid implanted calves gained 1.8% faster for 5 lbs more total gain per head compared to Ralgro implanted calves in a summary of the five herds.

Table. STEER-oid vs Ralgro for Suckling Steer Calves

Implant	Total Head	No. Days	Avg	Avg	Avg	Avg	Diff. in	
			Initial Weight Lb	Final Weight Lb	Total Gain Lb	Daily Gain Lb	Total Gain lb	%
Ralgro	34	177	214	462	248	1.40		
STEER-oid	34		212	471	259	1.46	11	4.4
Ralgro	35	155	178	469	291	1.88		
STEER-oid	34		170	452	282	1.82	-9	-3.1
Ralgro	38	201	138	423	285	1.42		
STEER-oid	36		135	423	288	1.43	3	1.1
Ralgro	19	200	176	493	317	1.59		
STEER-oid	18		173	495	322	1.61	5	1.6
Ralgro	13	191	164	413	249	1.30		
STEER-oid	14		164	427	263	1.38	14	5.6
Summary								
Ralgro	139	185	174	452	278	1.52		
STEER-oid	136		171	454	283	1.54	5	1.8

^a None of these total gains differed statistically.



1987
Progress
Report

WORMING CALVES ON BACKGROUNDING SYSTEMS

by J. Ellis, R. Morrow, C. Pickle, J. Freeman,
B. Booker, J. Chewning, J. Whittier

INTRODUCTION

Recently the concept of controlled grazing has received a great deal of attention. The primary advantage of controlled grazing is increased utilization of the available forage and a resulting increase in total pounds of gain/acre. However, if the primary objective of a producer is increased average daily gain per animal, controlled grazing may not achieve this objective.

The use of Ivomec wormer has also been advertised as effective against both internal and external parasites. Therefore, a grazing demonstration was established at Wurdack Farm to compare controlled versus continuous grazing and also evaluate the effects of Ivomec wormer.

PROCEDURES

Fall-born calves from the cow herd at Wurdack Farm were weaned the middle of June 1986. After weaning the calves were divided into three groups with 1/2 of the calves in each group treated with Ivomec.

Pastures consisted of ten acres divided into twenty 1/2 acre paddocks in which the calves were moved to a new paddock every two days (controlled), ten acres which were grazed continuously (continuous) and seven acres of alfalfa (alfalfa). Twenty-two steers and heifers were in each of the continuous and controlled pasture groups and twelve steers on the alfalfa pasture. The controlled and continuous pastures were predominantly fescue and red clover. The calves grazed the pastures from July 9 until August 31.

RESULTS

The results are given in Figures 1 and 2. From the information in Figures 1 and 2 Ivomec would seem to increase calf gains. However, the increased gains may not pay for the improved gain. Gains were increased by 19, 6 and 6 pounds for the controlled, continuous, and alfalfa treatments, respectively. While Ivomec costs \$4.00 - \$6.00/head. However, this was only for 53 days so the economics would improve if the differences over 53 days would last the entire grazing season. The Ivomec gains on the alfalfa and continuous grazing were not greater than the calves without Ivomec possibly due to selective grazing on the continuous system and the higher quality of the alfalfa.

The alfalfa calves had the highest average daily gain (2.20 lbs/day) followed by the continuous grazing calves (0.91 lbs/day) and finally the controlled grazing calves (0.83 lbs/day). This is about what would be expected from previous work with controlled grazing. However, the gain/acre on the controlled was not higher than the continuous (96.5 lb./acre vs 105.6 lb./acre) as would be expected. This was probably related to poor quality as a result of the high weed content of the controlled and continuous pastures. Dry weather during this time was extremely detrimental to forage quality with the clover becoming non-existent. The alfalfa pastures

had the highest gain/acre (199 lbs).

The performance of the non-wormed calves on the controlled grazing showed a larger decrease in gain than the other two treatments. This effect may have been greater than expected due to two calves losing weight possibly due to causes other than no Ivomec.

Figure 1.

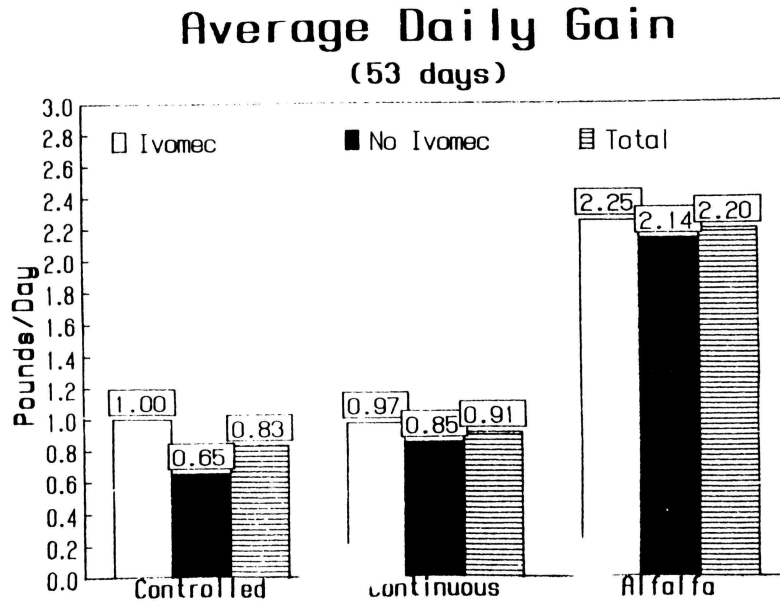
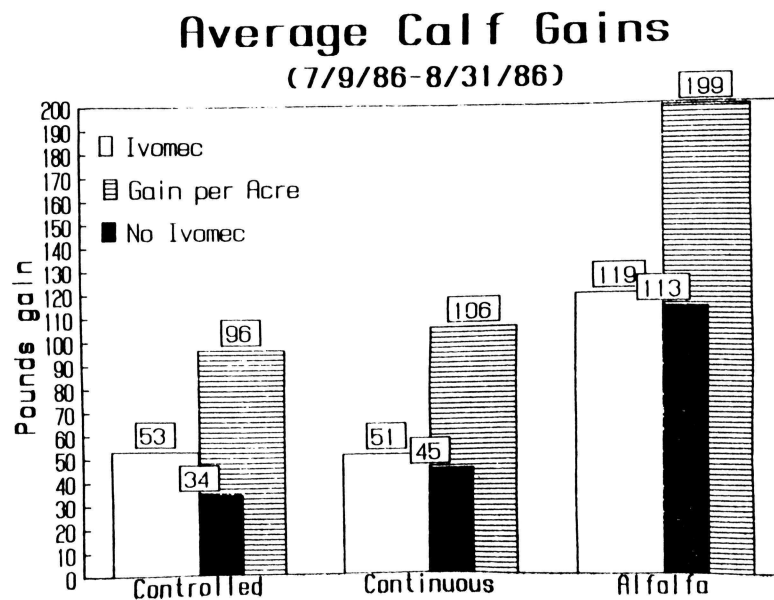
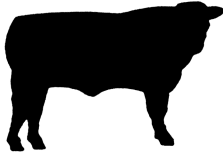


Figure 2.





1987
Progress
Report

INTAKE AND DIGESTIBILITY OF TALL FESCUE, ORCHARDGRASS AND BIG BLUESTEM FORAGE BY HEIFERS IN A COMPLEMENTARY GRAZING SYSTEM

K.E. Turner, J.A. Paterson and J.G.P.
Bowman, Animal Sciences Department

J.R. Forwood USDA-ARS, Agronomy Department

SUMMARY

Five ruminal and esophageal and six ruminal cannulated heifers were utilized in a pasture trial to estimate forage intake and digestibility when grazing either MO-96 low endophyte tall fescue-red clover, orchardgrass-red clover or big bluestem pastures from June until October. Results when averaged over the entire season indicated that organic matter (OM) intakes by heifers grazing the three pasture types were not different ($P>.10$). Organic matter digestibilities of tall fescue-red clover and big bluestem pastures were similar ($P>.10$) during the June and August grazing periods. Organic matter digestibility of tall fescue-red clover was greater ($P<.05$) than bluestem forages during October. Organic matter digestibility of clipped samples of tall fescue-red clover and big bluestem were not different ($P>.10$) during mid summer. Esophageal extrusa samples had greater ($P<.05$) OM digestibility when compared to clipped samples during the October period. Utilizing either MO-96 low endophyte-tall fescue or orchardgrass and red clover mixtures or a big bluestem pasture during the summer grazing period appears to maintain similar nutrient intakes.

INTRODUCTION

Tall fescue and orchardgrass predominate as major cultivars in cool season grass pastures. The nutritional quality and digestibility of these grasses decline rapidly during mid-summer grazing season, but improve again during the fall regrowth period of September and October. This decline in forage quality during midsummer may not meet the nutritional demands of stocker cattle grazing these dormant forages.

Big bluestem, a warm season grass cultivar, has a seasonal growth pattern different from the cool season grasses. The amount of digestible OM of big bluestem peaks during July and August. Thus, a rotational grazing system utilizing cool season grasses during the early and late grazing season, and warm season grasses during the summer, should maintain nutrient supply and improve animal performance throughout the entire grazing season.

The objective of this research was to estimate intake and digestibility of tall fescue-red clover, orchardgrass-red clover and big bluestem pastures throughout the grazing season by heifers.

PROCEDURES

Eleven heifers were utilized in the experiment. Five heifers were surgically fitted with esophageal and ruminal cannulae. The remaining six calves were fitted with rumen cannulae only.

Animals were allotted to one of three pasture types: Missouri-96 tall fescue (low endophyte), Hallmark orchardgrass or big bluestem. The tall fescue and orchardgrass pastures were interseeded with red clover. Animals were allowed to graze the pastures for approximately 10 days prior to the start of the collection period.

During each of the four collection periods (June 1, July 1, August 20, and October 1), 20 grams of chromic oxide per day was administered two times per day to each animal through the rumen cannula five days prior to and during the collection period. Random fecal grab samples were collected, composited, dried at 55 C, ground to pass a 2-mm screen and analyzed for chromium content. Fecal output was estimated by dividing the amount of chromium dosed by the percent chromium measured in the feces.

Organic matter digestibility of the forage was estimated from in vitro digestibility of esophageal extrusa. Esophageal extrusa samples were collected in the middle of each of the four collection periods. Samples were freeze-dried, ground to pass a 2-mm screen and inoculated by an in vitro (artificial rumen) digestibility procedure to determine organic matter digestibility.

Changes in forage digestion were also determined by an in situ nylon bag technique. Nylon bags (average pore size 50 microns) containing approximately 1 gram of dry, clipped forage or esophageal extrusa (period 4) were suspended in the rumen of each of the grazing heifers. In addition, bags containing 1 gram of hydrogen peroxide treated wheat straw were utilized in periods 2 to compare a rapidly degradable forage source in the three rumen environments. All bags were withdrawn after 6, 12, 24, 48, 72 and 96 hours of rumen incubation and OM disappearance determined.

Using fecal output measurements and the in vitro forage digestibility estimates, OM intakes were calculated using the following equation:

$$\text{OM Intake} = \frac{\text{Fecal output of OM}}{(1 - \text{OM digestibility of forage})}$$

Intake and digestibility data were analyzed using one way analysis of variance for a completely randomized design. Data for the period 4 in situ experiment were analyzed as a 2x2 factorial testing the main effects of forage type, harvest method (clipped or esophageal) and the interaction.

RESULTS AND DISCUSSION

Changes in OM intake and digestibility of the three pasture forages are presented in table 1. Organic matter intakes were not different ($P > .10$) among the three forage types at any of the sampling periods or when averaged over the entire grazing season. During August, heifers grazing big bluestem numerically consumed 12% more OM than heifers grazing tall fescue, and 21% more than heifers grazing orchardgrass. It should be remembered, however, that the tall fescue and orchardgrass pastures were interseeded with red clover and the tall fescue was considered to be "endophyte free". However, the question still remains unanswered as to what differences may exist in forage intake when comparing endophyte infected tall fescue to low endophyte tall fescue or big bluestem.

Organic matter digestibility was 14% greater ($P < .05$) during June for the orchardgrass (62.7%) compared with the tall fescue (54.8%). Similar differences (20%) were also seen during the July sampling period. Digestibility of the big bluestem was slightly lower during July (48%) compared with the cool season grass pastures (avg 56.7%). However, intake was greater and digestibility similar to the cool season grasses during August. Part of the reason for lack of greater differences in digestibility may be due to the amount of red clover in the tall fescue and orchardgrass pastures. When averaged over the entire grazing season, there were no differences in the digestibility of tall fescue-red clover pastures vs big bluestem pastures.

In situ OM disappearance and overall rate of in situ digestion of tall fescue-red clover, orchardgrass-red clover, big bluestem forage and peroxide treated wheat straw are presented in tables 2, 3 and 4. Digestibilities and rates of OM digestion of the peroxide treated straw in the different rumen environments were not different ($P > .05$) in July (table 2) suggesting that microbial digestion of forages is similar in the three rumen environments. During July (table 3), tall fescue-red clover samples had greater ($P < .05$) in situ OM disappearance after 48 h of rumen incubation compared with the big bluestem samples; however, both forage types were similar after 96 hours of incubation. Similar trends were again seen during the August period. The overall rate of rumen digestion of forage was numerically less for big bluestem compared with tall fescue-red clover during the July and August period. The content of red clover in the tall fescue pastures during July and August was 15.2 and 3%, respectively. Forage OM digestibility was greater ($P < .05$) for tall fescue-red clover samples when compared to big bluestem during the October period (table 4). Esophageal extrusa samples had greater ($P < .05$) OM digestion when compared to clipped samples from either tall fescue-red clover or big bluestem pastures. Overall rates of digestion were not different ($P > .05$) among the forages. These data suggest that tall fescue-red clover and big bluestem forages had similar OM digestibilities during the summer grazing period.

In conclusion, these data indicate that during the critical late summer grazing period, low endophyte tall fescue interseeded with red clover, and the warm season grass big bluestem are comparable in OM

digestibility and intake by grazing heifers. Grazing either of these pasture types during this period should help to alleviate "summer slump" problems normally encountered when cattle are grazing infected tall fescue pastures.

These data are the first of a three year research project. Based on these results, experiments will be started to determine how the inclusion of red clover is affecting total forage consumption. A second experiment will be to determine how high endophyte infected tall fescue compares with low endophyte infection. The question we are presently asking is how does big bluestem pasture compare to high endophyte tall fescue without red clover during the "summer slump" period?

This research was funded by the MO Department of Conservation and by the continuing support of the MO Farm Bureau and MO Cattlemen's Association ("Calves Go To College" Project).

Ken Turner is a PhD candidate; John Paterson, Associate Professor; Jan Bowman, Research Associate and Jim Forwood, Assistant Professor.

TABLE 1. ORGANIC MATTER INTAKES, FECAL OUTPUTS AND ORGANIC MATTER DIGESTIBILITIES WHEN HEIFER CALVES GRAZED TALL FESCUE (MO-96), ORCHARDGRASS, OR BIG BLUESTEM PASTURES

Item	MO-96		
	Tall Fescue	Orchardgrass	Big bluestem
OM intake, lb/day			
June 1	4.4	5.3	not determined
July 1	6.4	7.8	6.2
August 20	6.5	6.0	7.3
October 1	7.1	not determined	7.9
Average	6.0	6.0	7.2
Fecal output, lb/day			
June 1	2.0	2.0	
July 1	3.1	3.0	3.2
August 20	2.9	2.9	3.4
October 1	3.1		4.1
Average	2.7 ^a	2.4 ^a	3.7 ^b
OM digestibility, %			
June 1	54.8 ^a	62.7 ^b	-
July 1	51.5 ^b	61.8 ^c	48.0 ^a
August 20	55.7 ^b	51.6 ^a	53.3 ^{ab}
October 1	56.1 ^b	-	47.9 ^a
Average	54.5	56.9	50.1

a,b,cMeans in a row without a common superscript differ (P<.05).

TABLE 2. ORGANIC MATTER (OM) DISAPPEARANCE IN SITU AND RATE OF DIGESTION FOR PEROXIDE TREATED STRAW IN DIFFERENT RUMEN ENVIRONMENTS DURING JULY.

Hour of incubation	Rumen environment		
	Tall fescue-red clover	Orchardgrass-red clover	Big bluestem
	-----OM Dig., %-----		
6	8.3	8.2	8.6
12	10.3	10.4	9.9
24	18.0	17.9	17.3
48	31.6	34.5	37.7
Rate of OM dig., %/h	2.8	3.0	2.6

TABLE 3. CHANGES IN ORGANIC MATTER DIGESTIBILITY IN SITU AND RATE OF DIGESTION FOR CLIPPED FORAGE SAMPLES WHEN HEIFERS GRAZED TALL FESCUE-RED CLOVER OR BIG BLUESTEM PASTURES DURING JULY AND AUGUST.

Hour of incubation	July		August	
	Tall Fescue	Big Bluestem	Tall Fescue	Big Bluestem
	-----OM Dig., %-----		-----OM Dig., %-----	
6	26.36 ^b	20.79 ^a	16.88	15.21
12	27.56	23.49	19.14	16.93
24	32.75 ^b	25.02 ^a	24.62	23.37
48	41.69 ^b	33.52 ^a	36.41	30.52
72	46.51 ^b	39.58 ^a	44.79	38.20
96	52.51	48.23	43.73	44.33
Rate of OM dig., %/h	4.21	3.35	3.02	1.91
Red clover, % in sword	15.2	0.0	3.0	0.0

a,^bMeans in a row without a common superscript differ (P<.05).

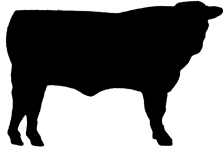
TABLE 4. CHANGES IN ORGANIC MATTER DIGESTIBILITY IN SITU AND RATE OF DIGESTION FOR CLIPPED FORAGE OR ESOPAGEAL EXTRUSA SAMPLES WHEN HEIFERS GRAZED TALL FESCUE-RED CLOVER OR BIG BLUESTEM PASTURES DURING OCTOBER.

Hour of incubation	Tall Fescue		Big Bluestem	
	Clipped	Esophageal	Clipped	Esophageal
	-----OM Digestibility, %-----			
6	10.0 ^c	18.4 ^d	9.5 ^c	11.3 ^c
12	13.6 ^{cd}	22.8 ^e	12.8 ^c	16.5 ^c
24 ^{ab}	20.9	34.5	15.3	24.2
48 ^{ab}	34.3	43.8	26.2	34.4
72 ^{ab}	40.2	48.9	32.4	42.7
96 ^{ab}	44.4	54.5	37.5	48.2
Rate, %/h	2.7	3.1	3.2	3.3

^aEffect due to forage type (tall fescue vs big bluestem; P<.05).

^bEffect due to sampling method (clipped vs esophageal; P<.05).

^{c,d,e}Harvest by forage interaction (P<.05).



1987
Progress
Report

INFLUENCE OF DIET AND BREED ON
DIGESTIBILITY, BODY COMPOSITION AND PLASMA
HORMONES OF ANGUS AND BRANGUS STEERS

E.E. Beaver, J.E. Williams, S.M. Hannah,
D.L. O'Connor and S.J. Miller, Animal
Science Department

SUMMARY

Comparisons were made in a 2 x 2 factorial growth study on the effects of diet (corn silage vs fescue) and breed (Angus vs Brangus steers) on growth, composition of growth, dry matter digestibility and plasma metabolic parameters. Steers were fed two diets: a high energy diet, consisting of 89% corn silage and 11% soybean meal for 60 days followed by a low energy diet, consisting of 88% fescue hay and 12% cracked corn-soybean meal supplement (dry matter basis) for 60 days. During the 120 day trial, no difference was found between breeds on live weight. Angus steers had greater ($P < .10$) average daily gains on corn silage and fescue diets than Brangus steers. Angus steers had lower ($P > .10$) gains when fed fescue vs corn silage diets, while Brangus steers lost weight when fed the fescue diet. For each diet, two collection trials determined no differences in diet intake and digestibility between breeds. Both breeds had lower ($P < .01$) DM intakes and digestibilities when fed fescue vs corn silage diets. Angus steers deposited more ($P < .10$) body fat than Brangus steers when fed both corn silage and fescue diets. Angus steers deposited less ($P < .10$) body fat and Brangus steers lost body fat when fed the fescue diet. Brangus steers tended ($P > .10$) to gain more body protein than Angus steers when fed corn silage diet. Both breeds had similar and lower ($P < .10$) rates of body protein deposition when fed the fescue vs corn silage diet. Brangus steers had higher ($P < .01$) insulin concentrations than Angus steers when fed corn silage diet. Insulin concentrations increased ($P < .01$) to similar levels when steers were fed fescue diets. No differences were found for glucose triiodothyronine (T_3) and thyroxine (T_4) between breeds. Glucose and T_4 decreased ($P < .01$) and T_3 increased ($P < .01$) for both breeds from corn silage to fescue diets.

INTRODUCTION

Data have shown that when grazing low quality pasture, Bos indicus breeds of cattle have greater dietary intakes and digestibilities with faster rates of ruminal fermentation than that of Bos taurus breeds. These data suggest that breeds based on the Bos indicus blood lines may utilize low quality forages more efficiently than the Bos taurus breeds. The objective of this study was to determine the effects of diet (corn silage vs fescue hay) and breed (Brangus (a Bos indicus X Bos taurus based breed) vs Angus (a Bos taurus breed)) on growth, composition of growth, dry matter intakes and digestibilities and plasma hormone parameters.

PROCEDURES

Comparisons were made in a 2 X 2 factorial trial using five Angus and five Brangus steers and two diets (corn silage and fescue hay) on average daily gain (ADG), body protein and fat deposition, dry matter intake and digestibility and plasma hormone parameters. The diets consisted of 89% corn silage and 11% soybean meal supplement (dry matter basis) with a TDN value of 70%, and 88% fescue hay with 12% cracked corn-soybean meal supplement with a TDN value of 55%. Steers consumed the corn silage based diet at approximately 2.4% of body weight and consumed the fescue diet at approximately 2.0% of body weight. Two collection trials were conducted for each diet after a 30 day adjustment period. Each collection trial consisted of a 5 day total fecal collection to determine intake and digestibility. Five days after each digestion trial, blood was collected via jugular vein at 0, 2, 4, 6, 8, 12, 18 and 24 hours after feeding, and plasma was analyzed for glucose, insulin, triiodothyronine (T₃) and thyroxine (T₄) concentrations. After the blood collection, steers were counted in the Whole Body Counter to determine ⁴⁰K content in order to predict whole body protein and whole body fat contents.

RESULTS AND DISCUSSION

No differences ($P > .10$) were found in average weights between Angus and Brangus steers fed each diet (Table 1). Therefore, differences in other parameters between breeds were not due to weight differences. Angus steers had greater ($P < .10$) ADG than Brangus steers when fed corn silage and fescue based diets. Both breeds decreased ($P < .10$) in ADG on fescue based diet as compared to their ADG's from corn silage based diet. Angus steers had greater ($P < .10$) rates of fat deposition than Brangus steers when fed either diet (Table 2). Both breeds decreased ($P < .10$) in the rate of fat deposition when fed fescue vs corn silage diets. Brangus steers tended to have greater rates of protein deposition than Angus steers when fed the corn silage diet. Both breeds decreased ($P < .01$) to similar rates of protein deposition when fed fescue diet.

Regardless of diet, no differences were found between breeds for DM intakes and diet digestibilities ($P > .10$, Table 3). Dry matter intakes and digestibilities were lower ($P < .01$) for both breeds, when steers were fed fescue vs corn silage diets.

Brangus steers had higher ($P < .01$) insulin concentrations than Angus steers when fed the corn silage diet (Table 4). Both breeds had higher ($P < .01$) and similar insulin levels on the fescue diet vs corn silage diet. No breed differences were found for glucose, T₃ and T₄ concentrations, but glucose and T₄ concentrations were lower ($P < .01$) and T₃ concentrations were higher ($P < .01$) for steers fed fescue vs corn silage diets. These data suggest that plasma hormones respond to energy intake.

The greater ADG and greater rate of fat deposition for Angus vs Brangus steers suggest that with similar DM intake and digestibilities, Angus steers utilized energy from these diets more efficiently than Brangus steers. Angus steers partitioned energy

for protein deposition. It was noted, however, that as dietary energy levels decreased from high (corn silage) to low (fescue hay) levels there was a concomitant decrease in DM intake, digestibility, ADG, fat gain, protein gain, glucose and T₄ concentrations and an increase in insulin and T₃ concentrations for both breeds. Energy level was found to have a greater influence on performance, composition of gain, diet intake and digestibility and plasma hormones than that of breed.

Table 1. Average weights and gains of Brangus and Angus steers fed a corn silage and fescue diet

Diet	Breed	Weight lbs	ADG ^{ab} lbs
Corn Silage	Brangus	669	2.0
	Angus	677	2.3
Fescue	Brangus	739	-.5
	Angus	704	.1

^aDiet effect (P<.10).

^bBreed effect (P<.10).

Table 2. Body composition of Brangus and Angus steers fed a corn silage and fescue diet

Diet	Breed	Fat gain ^{ab} lbs/day	Protein gain ^a lbs/day
Corn Silage	Brangus	.15	.42
	Angus	.94	.32
Fescue	Brangus	-.01	.01
	Angus	.06	.09

^aDiet effect (P<.10).

^bBreed effect (P<.10).

Table 3. Dry matter intake and digestibilities of Brangus and Angus steers fed a corn silage and fescue diet

Diet	Breed	DM Intake ^a lbs	DM Digestibility ^a %
Corn Silage	Brangus	15.4	70.0
	Angus	16.0	71.0
Fescue	Brangus	13.4	54.0
	Angus	13.4	54.0

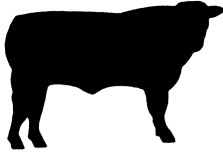
^aDiet effect (P<.01).

Table 4 Plasma hormone levels of Brangus and Angus steers fed a corn silage and fescue diet

Diet	Breed	Glucose ^a mg/dl	Insulin ^{ab} ng/ml	T3 ^a ng/ml	T4 ^a ng/ml
Corn Silage	Brangus	82.5	.96	1.34	64.9
	Angus	80.8	.56	1.19	64.8
Fescue	Brangus	65.7	1.26	1.54	43.6
	Angus	63.6	1.19	1.60	43.2

^aDiet effect (P<.01).

^bBreed effect (P<.01).



1987
Progress
Report

EFFECTS OF CRACKED CORN GRAIN OR CORN
GLUTEN FEED ON DIGESTIBILITY AND
UTILIZATION OF ALFALFA HAYLAGE BY CALVES

S.M. Hannah, J.A. Paterson, J.E. Williams
and D.K. Bowman, Animal Science Department

SUMMARY

The objectives of these experiments were to examine the effects of supplementing with different levels of cracked corn grain or corn gluten feed (a byproduct of the wet milling industry) on the digestibility and utilization of alfalfa haylage. When cracked corn was added at 0, 20, 40 or 60% of dietary dry matter, daily gains of steers increased ($P < .05$; linear) but digestibility of the alfalfa haylage decreased ($P < .05$). This reduction in digestibility was considered to be a "negative effect". Although alfalfa haylage digestion was decreased, total organic matter digestibility increased ($P < .05$; linear) with increasing corn levels. There was a 5% improvement ($P < .05$) in organic matter digestibility when corn was fed 12 times per day compared with two times per day. In a second study, adding 20, 40, 60 or 80% dry corn gluten feed to the diet did not reduce ($P > .10$) alfalfa haylage digestibility. The 40% corn gluten feed addition appeared to stimulate alfalfa fiber digestion and was considered to promote a "positive effect". A third study utilized 20 weaned bull calves in a digestion experiment to determine organic matter digestibility when 20 or 60% cracked corn or dry corn gluten feed supplements were added to the alfalfa haylage diet. Supplement addition increased total ration organic matter digestibility with a significant interaction occurring for level and type of supplement offered. Numerically, 20% dry corn gluten feed addition resulted in a lower digestibility than the other supplemented diets, while 60% dry corn gluten feed addition resulted in the highest digestibility. Both levels of corn grain resulted in similar ($P > .10$) organic matter digestibilities. A second feedlot experiment was conducted to determine rate and efficiency of gain when steers were offered alfalfa haylage alone, or supplemented with 20 or 60% cracked corn or dry corn gluten feed. All levels of supplementation increased rate of gain compared with alfalfa haylage alone. Calves given 60% supplement gained faster than calves given 20% supplement. However, no differences in feed to gain ratio were evident when comparisons of corn gluten feed to cracked corn or level of corn grain to dry corn gluten feed were made. Results of these experiments suggested that corn gluten feed did not negatively affect the digestibility of alfalfa haylage as did corn grain. The feedlot data indicated that rate and efficiencies of gain were similar ($P > .10$) between corn grain and dry corn gluten feed supplemented alfalfa haylage diets.

INTRODUCTION

Alfalfa haylage is a high quality roughage source which is high in protein and digestible cell solubles. However, because of the lignified cell wall, total organic digestibility is not as great as would be expected. One of our goals is to maximize the utilization of forages by the ruminant animal through supplementation. The animal needs to be able to maximize the dietary energy provided by the forage. However, the addition of different supplemental energy sources may have either positive or negative effect on the digestibility and utilization of the forage. The objectives of these studies were to compare the effects of different levels of corn and corn gluten feed on fiber digestion and utilization of alfalfa haylage.

PROCEDURES

Alfalfa haylage used in these experiments was from first and second cuttings. Alfalfa was cut in the early bloom stage and stored in a Harvestore. Alfalfa used in experiment 1 was harvested during May and June of 1985 and contained 67% moisture. Alfalfa used in experiment 2 was harvested during May and June of 1986 and contained 36% moisture.

Experiment 1. Experimental diets (on a 100% dry matter basis) were: (1) 100% alfalfa haylage; (2) 80% alfalfa haylage-20% cracked corn; (3) 60% alfalfa haylage-40% cracked corn and (4) 40% alfalfa haylage-60% cracked corn.

Dacron Bag Study. The objective of this trial was to determine the effect of increasing levels of corn grain addition on alfalfa haylage fiber digestion using in situ procedures. Four steers fitted with rumen cannulae were utilized in a 4x4 Latin square. Steers were fed the alfalfa haylage every four hours with corn being fed every 12 hours using automatic feeders. Animals were adapted to diets for 14 days. On day 15, dacron bags, containing approximately 1.5 g (DM) alfalfa haylage which had been washed in hot water, were placed in the rumen and removed after 12, 24, 48, 72 and 96 hours of incubation.

Organic Matter Digestibility. The objective of this trial was to determine the effect of increasing levels of cracked corn and frequency of feeding on diet organic matter digestibility. Eight steers were used in two 4x4 Latin squares. In square one, steers were fed alfalfa haylage and corn 12 times per day while in square two, steers were fed alfalfa haylage 6 times per day and corn 2 times per day. Diets were fed in both squares by automatic feeders. Steers were adapted to the diets for 19 days. On day 14, 20 g chromic oxide (used as a digesta flow marker) was fed to each steer/d and fed until the end of collection, day 24.

Feedlot Performance. The objective of this trial was to measure changes in dry matter intake, daily gain and feed to gain ratio by steers consuming the four diets. Forty-eight steers (avg initial weight of 761 lb) were allotted by weight and breed to eight pens with

each diet fed to two pens. Initial and final weights were the average of two, consecutive day full weights. The trial lasted 41 days. All animals were fed an equal amount of corn silage and corn during the final five days to minimize differences in gut fill among treatments before weighing.

Experiment 2. Experimental diets (on a 100% dry matter basis) for the dacron bag study were: (1) 100% alfalfa haylage; (2) 80% alfalfa haylage-20% corn gluten feed; (3) 60% alfalfa haylage-40% corn gluten feed; (4) 40% alfalfa haylage-60% corn gluten feed or (5) 20% alfalfa haylage-80% corn gluten feed. For the subsequent digestibility and feedlot trials, the experimental diets were: (1) 100% alfalfa haylage; (2) 80% alfalfa haylage-20% cracked corn; (3) 40% alfalfa haylage-60% cracked corn; (4) 80% alfalfa haylage-20% corn gluten feed or (5) 40% alfalfa haylage-60% corn gluten feed.

Dacron Bag Study. The objective of this trial was to determine the effect of increasing levels of corn gluten feed addition on alfalfa haylage fiber digestion using in situ procedures. Five heifers fitted with rumen cannulae were utilized in a 5x5 Latin square design. Heifers were fed alfalfa haylage and corn gluten feed twice per day. Animals were adapted to diets for 14 days. On day 15, dacron bags, containing approximately 1.5 g of alfalfa haylage which had been washed in hot water, were placed in the rumen and removed after 12, 24, 48, 72 and 96 hours of incubation.

Digestibility Study. The objective of this trial was to determine the effect of either 20% corn grain or corn gluten feed and 60% corn grain or corn gluten feed on diet organic matter digestibility. Twenty Simmental bull calves (avg wt 609 lb in individual pens) were assigned to one of the five diets (four animals per diet). Animals were adapted to diets for 21 days. Starting on day 16, chromic oxide (20 g/d) was fed to each animal as an external digestibility marker until the end of trial (day 32). Starting on day 22, fecal samples were collected from each animal twice a day for ten days.

Feedlot Study. The objective of this trial was to determine changes in dry matter intake, daily gain and feed to gain ratio of steers fed the two levels of corn grain and two levels of corn gluten feed. Seventy steers (initial wt of 780 lb) were allotted by weight to ten pens with each diet fed to two pens. Initial and final weights were the average of two consecutive full weights. The trial lasted 84 days. All animals were fed an equal amount of corn silage and corn grain during the final five days to minimize differences in gut fill among treatments before weighing.

RESULTS AND DISCUSSION

The percentage of potentially digestible alfalfa dry matter remaining in bags as affected by level of corn addition is presented in table 1. Values shown in the table are potential digestibility values based on 96 hour rumen incubation extent values. The true alfalfa haylage digestibility after 96 hours was approximately 55% for

all diets. Increasing corn level did not affect the extent of alfalfa haylage digestibility but did affect the rate of digestion. The addition of corn to the diet significantly increased the amount of potential digestion. After 12 hours of fermentation, fiber digestibility was depressed ($P < .05$) by 31 to 48% with the addition of corn to the diet. Even after 72 hours of fermentation, 60% corn addition numerically continued to depress alfalfa fiber digestion. The addition of corn to haylage diets had its greatest negative effects during the first 24 hours, after which time differences among treatments decreased.

With the addition of corn gluten feed to the diet, the amount of potentially digestible dry matter remaining was lowest ($P < .05$) for 40% corn gluten feed addition after 12 hours compared with alfalfa haylage alone or 20% corn gluten feed addition (table 2). After 24 hours, 80% corn gluten feed caused alfalfa haylage digestion to be lower ($P < .05$) than the all alfalfa haylage diet. Beyond 24 hours of incubation, all supplements caused similar alfalfa digestibilities. The addition of 40 and 60% corn gluten feed caused a faster ($P < .05$) rate of digestion compared with feeding alfalfa haylage alone.

The addition of cracked corn to alfalfa haylage caused a depression in alfalfa fiber digestion during the first 24 hours, while the addition of corn gluten feed stimulated fiber digestion during the first 12 hours. The addition of 40% corn gluten feed appeared to stimulate alfalfa fiber digestion.

As the level of cracked corn in the diet increased, organic matter digestibility was increased ($P < .05$; linear) for both 2 x/d and 12 x/d feeding of corn (table 3). When corn was fed 2 x/d, 60% corn in the diet had a 24% greater organic matter digestibility compared to 100% haylage, while 60% corn fed 12 x/d had a 30% greater organic matter digestibility compared to 100% haylage diet. There was also a 5% improvement ($P < .05$) in organic matter digestibility when corn was fed 12 x/d compared to 2 x/d.

In the bull digestibility trial (table 4), addition of corn or corn gluten feed supplementation at both 20 and 60% dietary DM, increased ($P < .01$) organic matter digestibility. However, there was a significant interaction ($P < .05$) between level of supplement and source. The diet with 20% corn gluten feed had a slightly lower digestibility than the other diets, while the diet with 60% corn gluten feed had the highest digestibility. Diets with corn addition were similar in digestibility.

Results of the first feedlot study are presented in table 5. Performance was improved in a linear ($P < .05$) manner with increasing corn addition. Steers fed the 100% alfalfa haylage diet had the slowest gain (1.28 lb/day), while steers consuming the 60% corn diet had the fastest (3.25 lb/day). Increasing the level of corn in the diet also linearly improved feed to gain ratio, with steers consuming 100% alfalfa haylage having the poorest ratio (17 lb feed/lb gain), while steers consuming the 60% corn diet had the best (7.2 lb feed/lb gain). Dry matter intakes were similar among treatments and ranges

from 21.5 to 23.4 lb/day.

Results from experiment 2 (table 6) showed that the addition of supplement again increased rate and efficiency of gain. Steers consuming diets with 20% supplement had slower gains than steers given 60% supplement (avg of 3 lb/d vs 3.8 lb/d, respectively). However, no differences in nutritional value were measured between corn grain or dry corn gluten feed.

Scott Hannah is a PhD candidate; John Paterson; Jim Williams are Associate Professors; Dave Bowman is a Research Associate.

TABLE 1. CHANGES IN THE DIGESTIBILITY OF ALFALFA HAYLAGE IN SITU WHEN INCREASING LEVELS OF CRACKED CORN WERE ADDED TO THE DIET^a

Hours of Incubation	Percent corn in diet			
	0	20	40	60
	-----% alfalfa digestibility-----			
12	48.7 ^b	33.8 ^c	32.5 ^c	25.5 ^c
24	79.5 ^b	73.5 ^b	68.7 ^b	54.3 ^c
48	92.7 ^b	90.8 ^{bc}	92.4 ^b	85.5 ^c
72	95.1 ^{bc}	98.3 ^c	98.1 ^c	93.2 ^b

^aExpressed as a percentage of potential extent of digestion.
^{b,c}Means in a row without a common superscript differ (P<.05).

TABLE 2. CHANGES IN THE DIGESTIBILITY OF ALFALFA HAYLAGE IN SITU WHEN INCREASING LEVELS OF CORN GLUTEN FEED WERE ADDED TO THE DIET^a

Hours of Incubation	Percent corn gluten feed in diet				
	0	20	40	60	80
	-----% alfalfa digestibility-----				
12	38.3 ^b	39.4 ^b	48.2 ^c	45.8 ^{bc}	42.4 ^{bc}
24	70.3 ^b	76.5 ^{bc}	77.6 ^{bc}	77.2 ^{bc}	80.6 ^c
48	90.4	91.4	91.9	89.9	90.8
72	94.4	97.4	95.7	95.3	97.4

^aExpressed as a percentage of the potential extent of digestion.
^{b,c}Means in a row without a common superscript differ (P<.05).

TABLE 3. THE EFFECT OF FREQUENCY OF CORN FEEDING AND LEVEL OF CRACKED CORN IN AN ALFALFA HAYLAGE DIET ON ORGANIC MATTER DIGESTIBILITY

Percent corn in the diet	Corn feeding frequency ^a	
	2x/d ^b	12x/d ^b
0	49.0	48.8
20	54.0	57.0
40	60.4	64.1
60	64.3	69.5
Avg ^c	56.9	59.9

^aNo interaction present.
^bLinear effect (P<.05).
^cEffect of feeding frequency (P<.05).

TABLE 4. ORGANIC MATTER DIGESTIBILITIES OF ALFALFA HAYLAGE DIETS WHICH WERE SUPPLEMENTED WITH TWO LEVELS OF CRACKED CORN GRAIN OR DRY CORN GLUTEN FEED BY BULL CALVES

Item	100% Alfalfa	Percent corn		Percent gluten feed	
		20	60	20	60
No. bulls	4	4	4	4	4
OM intake, lb/d	10.0	11.6	11.8	10.6	11.8
OM dig., %	53.6 ^a	59.9 ^{bc}	59.4 ^{bc}	57.8 ^b	62.6 ^c

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

TABLE 5. FEEDLOT PERFORMANCE OF STEERS FED ALFALFA HAYLAGE WITH INCREASING LEVELS OF CORN ADDITION

Item	Percent corn in the diet			
	0	20	40	60
No. of steers	12	12	12	12
Initial wt.,lb	760	756	760	766
Final wt.,lb	813	833	860	899
Dry matter intake, lb/day	21.5	22.2	22.2	23.4
Daily gain,lb ^a	1.28	1.86	2.41	3.20
Feed to gain ratio ^b	17.0	11.9	9.2	7.2

^aLinear effect (P<.05).

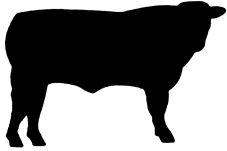
^bLinear effect (P<.10).

TABLE 6. FEEDLOT PERFORMANCE OF STEERS FED ALFALFA HAYLAGE WITH DIFFERENT LEVELS OF CORN AND CORN GLUTEN FEED

Item	Treatments				
	100% alfalfa haylage	corn		% corn gluten feed	
		20%	60%	20%	60%
No. of steers	14	14	14	14	14
Initial wt.,lb	782	781	780	778	780
Final wt.,lb	995	1028	1114	1038	1091
Dry matter intake, lb/day ^{a,b}	23.5	23.9	27.7	24.4	26.6
Daily gain, lb ^{a,b}	2.5	2.9	4.0	3.1	3.7
Feed to gain ratio ^a	9.3	8.1	7.0	7.9	7.2

^aSupplementation effect (100% alfalfa vs supplemented diets; P<.05).

^bLevel of supplement effect (20% vs 60%; P<.05).



1987
Progress
Report

EFFECTS OF BREED AND ENVIRONMENT ON DIET
INTAKE, DIGESTIBILITY, WATER INTAKE AND
BLOOD PARAMETERS OF BRANGUS AND ANGUS
STEERS

E.E. Beaver, J.E. Williams, S.M. Hannah,
D.L. O'Connor and S.J. Miller, Animal
Science Department

SUMMARY

Comparisons were made in two 2 X 2 factorial trials (growing and finishing) on the effects of temperature (18C vs 30/33C) and breed (Angus vs Brangus) on diet intake, digestibility, water intake and blood parameters. For the growing trial, steers were fed at ad libitum a diet consisting of 89% corn silage and 11% soybean meal supplement (dry) matter basis). The finishing diet consisted of 70% cracked corn, 25% corn silage and 5% soybean meal supplement offered ad libitum to steers at 18C and 33C. There was a breed X temperature interaction on DM intake and DM digestibility for the growing trial and on water intake and rectal temperature for both the growing and finishing trials. Angus steers had a greater decrease ($P < .10$) in DM intake, less of an increase ($P < .10$) in DM digestibility, and greater increase ($P < .10$) in water intake and rectal temperature than Brangus steers from 18C to 30C and 33C. There was a breed X temperature interaction on glucose concentration for both growing and finishing trials. Brangus steers had a greater decrease ($P < .01$) in glucose concentration than Angus steers from 18C to 30C in the growing trial while Angus had greater decrease in glucose concentrations from 18C to 33C in the finishing trial. Breed effected insulin concentrations as Brangus steers had greater ($P < .05$) insulin concentrations than Angus steers in the growing trial. In the finishing trial there was a breed X temperature interaction on insulin concentrations. Angus had greater increase in insulin concentraion from 18C to 33C. Breed and temperature affected triiodothyronine (T_3) concentrations with a breed X temperature interaction on thyroxine (T_4) concentrations for both the growing and finishing trials. Both breeds decreased ($P < .01$) in T_3 concentrations from 18C to 30C and 33C. Angus steers increased ($P < .01$) in T_4 and Brangus decreased in T_4 concentrations from 18C to 30C and 33C. In the finishing trial, breed affected blood pH as Angus steers had greater ($P < .01$) blood pH than Brangus steers. Temperature affected ruminal pH, blood buffering capacity, respiration rate and total blood protein. Both breeds decreased ($P < .10$) in ruminal pH and blood buffering capacity and increased ($P < .01$) in respiration rate and total blood protein as temperature increased from 18C to 33C. Breed and temperature affected pCO_2 as both breeds decreased in pCO_2 levels from 18C to 33C. Brangus steers had greater pCO_2 levels at either temperature.

INTRODUCTION

With summers in Southern Missouri ranging in temperature from 25C to 35C or higher, this region requires an animal that can minimize the effects of heat stress on overall performance. Bos indicus are

considered to be more heat tolerant than *Bos taurus* species and should produce more efficiently under elevated temperatures. The objective of this study was to determine the effect of temperature and breed on Brangus (a *Bos indicus* X *Bos taurus* based breed) vs Angus (a *Bos taurus* breed) steers on DM intake, DM digestibility, water intake and blood parameters when fed a corn silage growing diet and a high concentrate finishing diet.

PROCEDURES

Three, 2 X 2 factorial trials were conducted to determine the effects of breed (Brangus vs Angus) and temperature (18C vs 30/33C) on intake, digestibility, water intake and blood parameters. In trial 1, eight Angus and eight Brangus steers were housed at 18C or 30C (4 steers of each breed per temperature). In trial 2, two Angus and two Brangus steers were housed at 18C then at 30C. In both trials, steers were individually offered a diet of 89% corn silage and 11% soybean meal supplement (dry matter basis). Total fecal collection, to determine DM digestibility, were taken for five days at each temperature with DM intake and water consumption measured each morning for the five days. Data were found to be similar for both trials and therefore pooled. In trial 3, two Angus and two Brangus steers were housed at 18C and at 33C and offered ad libitum access to a diet consisting of 70% cracked corn, 25% corn silage and a 5% soybean meal supplement (dry matter basis). For trials 2 and 3, water consumption and rectal temperature were measured for five days at each temperature. For trials 2 and 3, blood was collected via jugular vein at 0, 2, 4, 6, 8, 12, 18 and 24 hours after feeding and repeated the following day. Plasma was analyzed for glucose, insulin, triiodo-thyronine (T₃) and thyroxine (T₄) concentrations. In trial 3, blood was also analyzed for pH, pCO₂, buffering capacity and protein level; animal respiration rate was also measured.

RESULTS AND DISCUSSION

As noted in Table 1, there was a breed X temperature interaction (P<.10) for DM intake, DM digestibility, water consumption and rectal temperature. Angus steers had a greater increase (P<.10) in water consumption and rectal temperature with less of an increase (P<.10) in diet digestibility and a greater decrease (P<.10) in DM intake than Brangus steers as temperature increased from 18C to 30C. This suggests that Brangus steers were able to compensate for decreases in DM intake at 30C by increasing DM digestibility to a greater extent than Angus steers. The greater decrease (P<.01) in plasma glucose concentrations for Brangus vs Angus steers as temperature was increased from 18C to 30C resulted in a breed X temperature interaction (Table 2). Plasma insulin concentrations were greater (P<.05) for Brangus vs Angus steers at 18C or 30C. Decreases in glucose may be due to increases in insulin concentrations with the greater change in plasma glucose in Brangus steers due to higher insulin concentrations. Plasma T₃ concentrations were greater (P<.05) in Brangus vs Angus steers and greater (P<.05) at 18C vs 30C. The breed X temperature interaction (P<.01) for plasma T₄ concentrations was attributed to Angus steers increasing in T₄

concentrations with increasing temperature while that for Brangus steers did not change. These changes in T_4 concentration suggest differences in thyroid activity between these breeds at 30C. Brangus steers decreased in thyroid activity as observed by decreases in both T_3 and T_4 levels while Angus steers had decreased the conversion of T_4 to T_3 , the more biologically active thyroid hormone.

Previous research has reported that animals on high concentrate diets show little or no influence of heat stress as measured by animal performance. In this study, there was a breed X temperature interaction on water intake and rectal temperature (Table 3) with Angus steers having a greater ($P < .10$) increase in water consumption and rectal temperature. There was a temperature effect on ruminal pH with Angus steers tending to have a greater ($P < .05$) decrease in ruminal pH than Brangus steers as temperature increased. There was a breed effect on blood pH (Table 4) with Angus steers having higher ($P < .05$) blood pH than Brangus steers. To maintain blood pH, there was a temperature effect on blood buffering capacity. Both breeds decreased ($P < .05$) in buffering capacity as temperature increased. Angus steers had a greater numerical decrease in buffering capacity than Brangus steers. Respiration rate increased ($P < .05$) for both breeds as temperature increased. The breed and temperature effects ($P < .05$) on blood pCO_2 (partial pressure of blood CO_2) occurred due to a decrease in blood pCO_2 values as temperature increased. This suggested that with greater respiration rates at higher temperatures, there is an increased exchange of O_2 and CO_2 thus causing a decreased blood pCO_2 . As shown in Table 5, the breed X temperature interaction ($P < .10$) regarding glucose and insulin concentrations was due to Angus steers having lower glucose concentrations and lower insulin concentration as temperature increased from 18C vs 33C compared to Brangus steers which did not change due to temperature. The temperature effect ($P < .10$) on T_3 concentration was attributed to both breeds decreasing in T_3 concentrations to decrease heat production as temperature increased. The breed X temperature interaction ($P < .10$) for T_4 concentrations was attributed to decreases in T_4 concentration by Brangus steers while Angus steers increased in T_4 concentration as temperature increased, suggesting differences in thyroid activity between breeds. Brangus steers decreased in T_3 and T_4 concentrations while Angus steers decreased in T_3 concentration and increased in T_4 concentration with an increase in environmental temperature. The temperature effect ($P < .05$) on blood protein (table 4) with both breeds increasing in blood protein as temperature increased suggested with decreased T_3 levels that protein degradation increased over protein synthesis, increasing protein metabolites in blood.

These data suggest that tremendous changes occur in the physiological characteristics of heat stressed cattle as they adapt to increased environmental temperatures. As compared to Brangus steers, Angus steers had greater increases in water intake, greater decreases in DM intake and greater changes in plasma hormone and blood gas parameters when exposed to increased environmental temperature. Brangus steers demonstrated greater heat tolerance and less heat stress than Angus steers under similar environmental conditions.

Table 1. Effects of breed and temperature on DM intake, digestibility, water intake and rectal temperature of steers on a growing diet

Temp. C	Breed	DM Intake ^a lbs.	DM Dig. ^a %	Water Intake ^a l/d	Rectal Temp. ^a C
18	Brangus	15.6	63.4	7.6	39.1
	Angus	18.3	71.1	12.6	38.6
30	Brangus	12.7	79.3	28.2	39.8
	Angus	12.8	73.6	44.0	40.9

^aBreed X Temperature Interaction (P<.10).

Table 2. Effects of breed and temperature on plasma hormone parameters of steers on a growing diet.

Temp. C	Breed	Glucose ^c mg/dl	Insulin ^b ng/ml	T3 ^{ab} ng/ml	T4 ^c ng/ml
18	Brangus	61.9	2.66	1.76	38.1
	Angus	53.3	2.10	1.44	31.8
30	Brangus	55.7	3.09	.78	35.3
	Angus	51.9	2.46	.63	46.1

^aTemperature Effect (P<.05).

^bBreed Effect (P<.05).

^cBreed X Temperature Interaction (P<.01).

Table 3. Effects of breed and temperature on water intake, rectal temperature and rumen pH of steers fed a finishing diet

Temp. C	Breed	Water Intake ^b l/d	Rectal Temp. ^b C	Rumen pH ^a
18	Brangus	7.5	39.3	6.5
	Angus	17.2	39.3	6.6
33	Brangus	19.8	39.9	6.3
	Angus	51.2	40.7	6.2

^aTemperature Effect (P<.05).

^bBreed X Temperature Interaction (P<.10).

Table 4. Effects of breed and temperature on respiration rate and blood gas parameters of steers fed a finishing diet

Temp. C	Breed	Resp. ^a rate per min.	Blood pH ^b	Blood ^{ab} CO2 mmHg	Buffering ^a Capacity Meq/l	Blood ^a Protein %
18	Brangus	15	7.37	50.1	7.37	6.5
	Angus	14	7.39	49.3	8.44	6.5
33	Brangus	113	7.37	44.4	.33	6.9
	Angus	106	7.39	41.8	.22	7.0

^aTemperature Effect (P<.05).

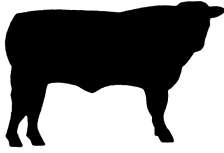
^bBreed Effect (P<.05).

Table 5. Effect of breed and temperature on plasma hormone parameters of steers fed a finishing diet.

Temp. C	Breed	Glucose ^b mg/dl	Insulin ^b ng/ml	T3 ^{ab} ng/ml	T4 ^b ng/ml
18	Brangus	53.8	4.69	2.26	55.5
	Angus	58.1	3.15	2.21	43.7
33	Brangus	54.3	4.89	1.79	42.8
	Angus	50.7	4.92	1.75	50.2

^aTemperature Effect (P<.10).

^bBreed X Temperature Interaction (P<.10).



1987
Progress
Report

EFFECTS OF FEED INTAKE AND IMPLANT ON PERFORMANCE VARIABLES AND BODY COMPOSITION OF ANGUS AND SIMMENTAL STEERS

D.L. O'Connor, J.E. Williams, R.J. Lipsey,
M.G. Siemens, E.E. Beaver, S.M. Hannah and
S.J. Miller, Animal Science Department

SUMMARY

A performance trial using 12 Angus and 12 Simmental steers was conducted to examine the effects of breed and implant at 3 levels of dry matter (DM) intake on average daily gain (ADG), feed efficiency (FE) and body composition. Steers were individually fed a diet consisting of 78% corn-corn cob based ration and 22% alfalfa-smooth brome hay (DM basis) at a H (9.57 kg/d), M (7.12 kg/d) or L (6.6 kg/d) level of DM intake for the 87 day trial. Two steers from each breed within each intake level were implanted with zeranol at the initiation of the trial. Implant had no effect on any of the variables examined ($P > .10$). Angus steers had higher ($P < .05$) weight gains and FE than Simmental steers. Angus steers also had greater ($P < .05$) daily protein deposition per weight^{.75} than Simmental steers, as determined by measuring K^{40} content in the Whole Body Counter. Steers on the H level of DM intake had greater ($P < .01$) weight gain, fat gain per weight^{.75} and protein gain per weight^{.75} than those on the M or L levels. The M and L levels of DM intake were similar. The FE was greater ($P < .05$) for steers on the H level of intake than the M level, which, in turn, was similar ($P > .05$) to that of steers on the L level of intake. In conclusion, Angus steers were more efficient at feed utilization and had greater rates of protein deposition per weight^{.75} than Simmental steers.

INTRODUCTION

The possibility of altering the proportion of lean to fat in growing animals has been the focus of much interest in the field of ruminant nutrition. It has been demonstrated that the composition of gain can be modified by increasing the plane of nutrition and with anabolic agents like zeranol, but little research has been conducted to determine the effects of restricted intakes on body composition and performance parameters of different breeds with varying propensities of fat and lean deposition. The objective of this trial was to determine the effects of breed and implant on the maintenance requirements of cattle. However, in this report, the performance and compositional gain as influenced by breed, implant and level of feed intake will be presented.

PROCEDURES

A study was conducted to ascertain the influence of breed and implant on the efficiency of energy utilization. The main effects were breed, implant and level of dry matter (DM) intake. Twelve Angus and 12 Simmental steers (avg. wt. 692 and 724 lbs., respectively) were fed a 78% corn-cob based diet with 22% alfalfa-smooth brome hay at a H

(9.57 kg/d), M (7.12 kg/d) or L (6.6 kg/d) level of DM intake for 87 days. Two steers from each breed within each intake level were implanted with zeranol at the initiation of the trial. Average daily gain, feed efficiency (FE, kg of gain/kg of feed) and dry matter (DM) intake were determined. Whole body fat and protein deposition were also determined from K^{40} measurements using the Whole Body Counter. The whole body fat and protein gains were expressed as grams of gain per weight^{.75} per day. An analysis of variance was performed using GLM procedures (SAS, 1979) for daily gain, DM intake, FE, rates of protein and fat gain per weight^{.75}. The statistical model for the experiment was a 2 x 2 x 3 factorial arrangement of treatments with main effects of breed, implant and level of feed intake and the interactions between main effects.

RESULTS AND DISCUSSION

Implantation with zeranol had no effect ($P > .10$) on daily gain, DM intake, FE and body composition (table 2), thus effects of breed and level of DM intake will be discussed. For the 87 day trial, Angus steers had higher ($P < .05$) weight gains and FE than that of Simmental steers (table 3). When expressed per weight^{.75}, daily protein gain was higher ($P < .05$) for Angus steers as compared to that of Simmental steers, while daily rate of fat deposition was not different between breeds. These data suggest that differences in ADG, FE and rate of protein deposition between breeds may be attributed to lower maintenance requirements of Angus vs Simmental steers.

Since there were no breed x feed level interaction, data were pooled to examine main effects. Steers on the H level of DM intake had greater ($P < .05$) weight gain, FE, whole body fat gain and whole body protein gain than those on the M and L levels of DM intake. Steers on the M level of DM intake had higher ($P < .05$) weight gain and protein gain per weight^{.75} than those fed the L level of DM intake; FE and fat gain per weight^{.75} for M steers fed M and L of DM intake were similar.

In conclusion, the higher ADG and FE for Angus vs Simmental steers was attributed to a greater rate of protein deposition per weight^{.75}. The differences in protein gain per weight^{.75} between breeds suggests that Angus steers are more efficient in utilizing energy at these levels of feed intake as compared to Simmental steers. These data also demonstrate that between the H and M level of intake, changes in fat and protein gain accounted for differences in daily gain. At the M and L level of intake, only protein gain accounted for differences in daily gain.

Table 1. Diet Composition

Feed Ingredient	Angus %			Simmental %		
	H	M	L	H	M	L
Corn	44.45	21.65	14.20	35.35	18.10	10.10
Molasses	5.00	5.00	5.00	5.00	5.00	5.00
Soybean meal	2.50	3.50	2.50	3.50	3.75	2.50
Alfalfa meal	5.00	5.00	5.00	5.00	5.00	5.00
Corn cobs	20.00	41.75	50.00	28.00	45.00	54.25
Limestone				.20		
Dical	.20	.25	.45	.10	.30	.30
Salt	.35	.35	.35	.35	.35	.35
Alfalfa-Bromegrass	22.50	22.50	22.50	22.50	22.50	22.50

Table 2. Daily Gain, DM Intake, FE, Whole Body Protein and Fat Gain Per Weight^{.75} as Influenced by Implant^a

Implant	ADG lb/d	DM intake lb	FE lb/lb	Protein gain lb/lb ^{.75} /d	Fat gain lb/lb ^{.75} /d
No	1.18	17.38	.066	.0013	.0047
Yes	1.18	16.94	.067	.0013	.0051

^aMeans were not different (P>.10).

Table 3. Daily Gain, DM Intake, FE, Whole Body Protein and Fat Gain Per Weight^{.75} as Influenced by Breed

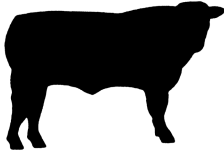
Breed	ADG lb/d	DM intake lb/d	FE lb/lb	Protein gain lb/lb ^{.75} /d	Fat gain lb/lb ^{.75} /d
Angus	1.32 ^a	17.16	.074 ^a	.0016 ^a	.0056 ^a
Simmental	1.06 ^b	16.94	.059 ^b	.00097 ^b	.0043 ^a

^{a,b}Means with different superscripts differ at P<.05.

Table 4. Daily Gain, DM Intake, FE, Whole Body Protein and Fat Gain Per Weight^{.75} as Influenced by Level of Intake

Level	ADG lb/d	Intake lb/d	FE lb/lb	Fat gain lb/lb ^{.75} /d	Protein gain lb/lb ^{.75} /d
H	1.94 ^a	21.05 ^a	.092 ^a	.0072 ^a	.0019 ^a
M	.97 ^b	15.66 ^b	.061 ^b	.0041 ^b	.0013 ^b
L	.66 ^c	14.52 ^b	.046 ^b	.0033 ^b	.00061 ^c

a,b,cMeans with different superscripts differ at P<.05.



1987
Progress
Report

COMPARISON OF SYSTEMS OF GRAZING WITH VARIOUS GRAZING CELL NUMBER

Drs. Jack Whittier, George Garner, Ron Morrow
and Jimmy Henning

Departments of Animal Science and Agronomy, University of Missouri-Columbia

SUMMARY

This report contains the first year's results of a three-year study designed to compare the productive efficiency of 4 grazing systems. This research was conducted during the 1986 grazing season at the North Missouri Center near Spickard, Missouri. Eight, 10-acre pastures containing a mixture of tall fescue, Kentucky bluegrass and variable volunteer legumes were stocked with yearling steers. The fescue was 68% infected with endophyte fungus. The four grazing systems were:

- A. Two paddock rotation with $\frac{1}{2}$ of the pasture harvested for hay.
- B. Three paddock rotation with $\frac{1}{3}$ harvested for hay.
- C. Six paddock rotation stocked 20% higher than system A and B.
- D. Twelve paddock rotation stocked 33% higher for 63 days then stocked at the same rate as system A and B for the remainder of the grazing season.

Each treatment had 2 replications. Pastures were sampled periodically for forage availability and plant specie composition. Composition data will be used to monitor shifts in the plant community over the 3-year study. Pounds of beef produced per acre for system A, B, C, and D were 254, 237, 256, and 253, respectively, this production was not statistically different ($P > .10$). In addition systems A and B produced 13.7 and 4.7 tons of hay respectively. Based on the results of the first year's data, the additional cost associated with more grazing cells was not profitable.

INTRODUCTION

Efficiency of production must be considered more and more as economic circumstances continue to tighten in today's agriculture. Missouri offers a good environment for beef cattle production. Almost 45% of the land in the state is used for pasture or hay production, another 27% of the state is used for crop production which provides crop residue as an additional source of forage from crop residue. With this valuable natural resource, Missouri cattlemen have many options available.

Much attention has been given to so-called "new" ways of grazing livestock. Intensive grazing systems, based on method used in South Africa and New Zealand have found their way to Missouri. In an effort to gain more understanding about how these systems apply to Missouri, and what we can expect from these systems, the following study is currently underway.

PROCEDURES

One-hundred and fourteen yearling steer of mixed breeding were grazed during the 1986 grazing season on 10 acre pastures at the North Missouri Research Center. The 8 pastures used in the study were further subdivided into smaller paddocks as described below. The grazing systems were replicated twice.

Four grazing management systems were studied. These systems were designed as follows:

- A. A two paddock system with the pasture divided in half from May 1 until July 3. Half of pasture (5 acres) was harvested for hay on June 12, the other half was grazed with 12 steers. On July 3 the dividing fence was removed and the steers grazed the entire pasture until October 10.
- B. A three paddock rotation system with the pasture divided in thirds. One of the paddocks (3.3 acres) was harvested for hay on June 12 and the other 2 paddocks were grazed in a 2 week rotation by 12 steers. On July 3 a 7-day rotation was begun through all 3 paddocks, this continued until October 10.
- C. A six paddock rotation stocked with 15 steers. The steers were rotated every 4 days from May 1 to October 10.
- D. A 12 paddock rotation system with a 2-day rotation. Eighteen steers were grazed from May 1 to July 3, then 6 steers were marketed and the remaining 12 steers continued on the 2-day rotation through the 12 paddocks until October 10.

During the first week of April, 40 lbs nitrogen, 40 lbs phosphorus, and 40 lbs potassium fertilizer per acre were applied to the research area.

Plant species composition was determined at the start, middle and end of the grazing period. Clipped samples were taken randomly throughout the pastures and separated according to grasses or legume. Forage samples were dried and saved for laboratory analysis.

Forage availability was measured using a rising plane forage meter. These measurements were taken each time the animals were rotated, both from the paddock they were entering and from the paddock they were leaving.

At mid-summer, samples of fescue were collected and analyzed for infection of endophyte fungus. The results indicated a 68% infection level.

Steers were supplemented with 3 lbs of grain from July 3 to September 25. A 75:25 corn/soybean meal mixture was fed as supplement.

RESULTS

Table 1 shows the animal performance for the 1986 grazing season.

Table 1. Average Daily Gain, Gain Per Head, and Gain Per Acre of Grazing Steers on Four Management Systems.

<u>System</u>	<u>Head</u>	<u>ADG (#/d)</u>	<u>Gain/Hd (#)</u>	<u>Gain/A (#)</u>
May 1 to July 3				
A ¹	24	1.89 ^a	121 ^a	145
B ³	24	1.61 ^a	103 ^a	118
C ⁴	30	1.65 ^a	106 ^a	158
D ⁴	36	1.12 ^b	72 ^b	130
July 3 to October 10				
A	24	.91 ^a	90 ^a	108 ^{ab}
B	24	.94 ^a	94 ^a	107 ^{ab}
C	30	.65 ^b	65 ^b	97 ^a
D	24	1.04 ^a	103 ^a	124 ^b
May 1 to October 10				
A	24	1.29	211	245
B	24	1.21	196	237
C	30	1.04 ⁵	170	256
D	24/36	1.09 ⁵	178	253

¹ Graze ½, hay ½, then graze whole pasture.

² Graze 2/3, hay 1/3, then 7 day rotation on 3 paddocks.

³ Stocked 20% higher than A or B, 4 day rotation on 6 paddocks.

⁴ Stocked 30% higher until July 3, 2 day rotation on 12 paddocks.

⁵ Weighed average to account for decrease in stocking rate mid-summer

^{a, b} Values within a column and time period with different superscripts differ (P < .10).

There was no significant advantage to increasing the number of paddocks based on the results of this first year's data. Individual animal performance (ADG) was higher (P .10) for the steers stocked at a lower rate during the first 63 days. During the second 100 days, steers in system C gained slower (P < .10) than other systems.

Hay was harvested from systems A and B on June 12. This date coincided with mid to full bloom stage of the fescue and bluegrass. Table 2 shows the amount of hay harvested from each system.

Table 2. Quantity of Hay Harvested From Pasture Management Systems 1 and 2

System	Replication	No. of Big Round Bales	Avg Bale Wt (lbs)	Tons of Hay	Acres	Tons/Acre Rep.	Syst.
1	1	26	614	7.98	5	1.60	1.37
	2	18½	614	5.68	5	1.14	
2	1	7-2/3	614	2.35	3.3	.71	.71
	2	7-2/3	614	2.35	3.3	.71	

The amount of hay harvested is in addition to the gain produced by the cattle. When a value for the hay and cattle are calculated, the extra labor, fencing materials, and interest on the additional cattle for the more intensive systems was not offset by higher production. Table 3 shows these calculations.

Table 3. Gross Value of Steer and Hay Production per Acre for the Four Grazing Systems

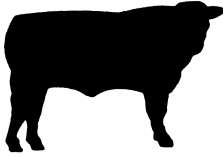
System	Lbs of steer Gain/Acre	Avg Price per Lb	Gross Value	Tons of Hay/Ac	Price/Ton	Gross Value	Total
1	254	.60	151.98	1.37	\$25	34.25	186.23
2	237	.60	142.44	.71	\$25	17.75	160.19
3	256	.60	153.36	0	-	-	152.36
4	253	.60	151.80	0	-	-	151.80

Increased paddock number did not give volunteer legumes an advantage over the companion tall fescue. In late May, pastures were almost totally grass, either tall fescue-bluegrass or tall fescue alone. In August, legumes were clearly present on the shorter pastures, but were so short that they did not contribute to the yield of the hand-clipped samples. Pastures were generally very low in available forage during latter July, August, and early September. Even after cooler temperatures and rainfall in September, fescue growth was less than expected. No shift to grass species from fescue to bluegrass or any other species was observed.

DISCUSSION

Animal gains from May 1 to July 3 averaged .68 lb per day greater than after July 3. This late summer decline is not unusual for tall fescue, particularly with 68% endophyte infection. However, in an intensive system of grazing using multi-paddocks, the forage resource must be matched to the expected level of production. Intensive short duration grazing systems are essentially grass feedlots. No feedlot operator would set out to finish a group of cattle with ample feed for only the first 1/3 of the feeding period. An April to October intensive system based solely on tall fescue is feed-limited during summer. For intensive grazing systems to be profitable, a more steady supply of high quality forage is needed for entire grazing system. Combining tall fescue with annual or native warm season grasses or alfalfa may make intensive grazing systems more profitable compared to fescue alone.

It must be recognized that this is only one year's data and the 1986 grazing season was above average for rainfall and temperatures were cooler than normal. Due to this fact the production per acre in all systems may have been great enough that differences were not measured. However, these data raise a caution for those considering an intensive grazing system. These results indicate that simply dividing the pasture in half until one cutting of hay is harvested then allowing the animals to graze the whole pasture may be the best system when pastures are primarily tall fescue.



1987
Progress
Report

PERFORMANCE OF COWS ON DIFFERENT FORAGE MANAGEMENT SYSTEMS: MILK PRODUCTION

C. Tucker, R. Morrow, J. Gerrish, T. Cundiff,
J. Fitzgerald, T. Sperry and D. Jacobs

SUMMARY

Hereford cows on three different forage management systems at the Forage Systems Research Center in North Central Missouri were milked for 4 consecutive months. This was to determine if milk production was affected by different forage management intensities. Cows on the high and low management systems produced more milk, while calves on the medium and low systems had greater gains. As milk production declined, the calf gains tended to increase probably due to forage availability and consumption. Three-year-old cows produced the least milk and their milk production dropped off faster than 4, 5, and 6-year-olds.

INTRODUCTION

Milk production of the cow is a major factor determining the performance of suckling calves in a cow-calf operation. In order to evaluate the performance of cows on different management systems, milk production must be determined. It is important to determine how much of the calf gain is due to milk production and how much is due to forage utilization. Due to calves being selective grazers, this can be determined by the forage availability and quality in each system. The objective of this project is to evaluate the milk production of cows on systems of different forage management intensities and to compare these estimates to calf performance.

PROCEDURE

Spring-calving Hereford cows mated to Gelbvieh bulls were milked to determine their milk production in different forage management systems. The systems were of different intensities consisting of high, low and medium management systems. Low intensity management was a 3-paddock rotation, consisting of orchardgrass-red clover pastures (2.67 acres/cow-calf unit). Medium was a 6-paddock rotation with 4-paddocks of orchardgrass-red clover and ladino clover and 2-paddocks of orchardgrass and nitrogen (2 acres/cow-calf unit). The high management system was a 12-paddock rotation with 4-paddocks of brome grass and nitrogen, 4-paddocks of brome grass-birdsfoot trefoil and 4-paddocks of brome grass-alfalfa (1.33 acres/cow-calf unit).

All cows in replicates 1 and 2 of the low (N= 12) and medium (N= 16) management system were milked, while only 12 from the high management system were milked. The lactational performance of these cows was determined by 12-hour milk production estimates through machine milking. The cows were milked once each month from May through September. The May milking data was not used since it was the first time for these cows to be milked. Every month the cows were separated from their calves for an 8-hour period, after which the calves were then

allowed to nurse and then separated from their dams. After a 12-hour period the cows were milked by milking machine preceded by a 2cc injection of oxytocin. The milk was weighed and samples were obtained to determine the percent protein fat and somatic cell count. The 12-hour milk production estimate were converted to 24 hour milk production for analysis.

RESULTS

Milk production by system is presented in table 1. Cows on the low and high management systems averaged more milk produced than those on the medium. Milk production declined each month until September in which all systems had similar milk production estimates. The average milk production should decline after June since that is near the period of time that those cows would reach their peak of lactation and forage quality has decreased. With this decline, the calves are assumed to be utilizing more forage.

No differences were detected in percent protein or fat between systems. The average percent protein and fat across systems was 3.20 and 3.16, respectively. Similar results were found with somatic cell counts with the average across all systems being 635. This indicates that the use of a milking machine did not cause any increase in bacteria in the teats.

Calf gains by system are shown in table 2. Calves on the low management gained more weight per month than those on the high or medium management systems. Calves from the high management system had greater gains in July and August than those from the medium system, while calves from the medium system gained more in June and September. Overall gain per calf and gain per animal by system are shown in figure 1. Calves in the low and medium systems gained more weight than those on the high system. When calf gain is broken down into gain per acre the results are opposite. This is attributed to greater forage utilization resulting from a higher stocking density. The main factors in determining the system of choice would be dependent on the availability of resources and the cost associated with their use.

When calf gain is compared to the milk production estimates, calf gain tended to increase while milk production decreased. This can be accounted for by the calves utilizing greater amounts of forages as the season progressed and milk production declined. Total milk production for the four month period was larger for the low and high system, while the overall gain for the calves was greater for the low and medium. The greater gains from these two systems are due to the calves being in systems with lower stocking rates, resulting in greater forage availability.

Milk production by cow age is presented in table 3. The three-year-old cows milk production was lower than the other age groups for all months. Also their milk production dropped faster as the season progressed. Milk production, as a whole, during June and July increased with age.

TABLE 1: MILK PRODUCTION BY SYSTEM

System	<u>24 Hour Milk Production (lb)</u>				Four Month Milk Production(lb)
	June	July	Aug	Sept	
High	11.9	11.0	9.9	7.7	1,272
Low	12.0	9.7	9.9	6.8	1,244
Medium	9.5	8.5	9.1	7.6	1,135

TABLE 2: CALF GAIN BY SYSTEM (1 LBS. PER MONTH)

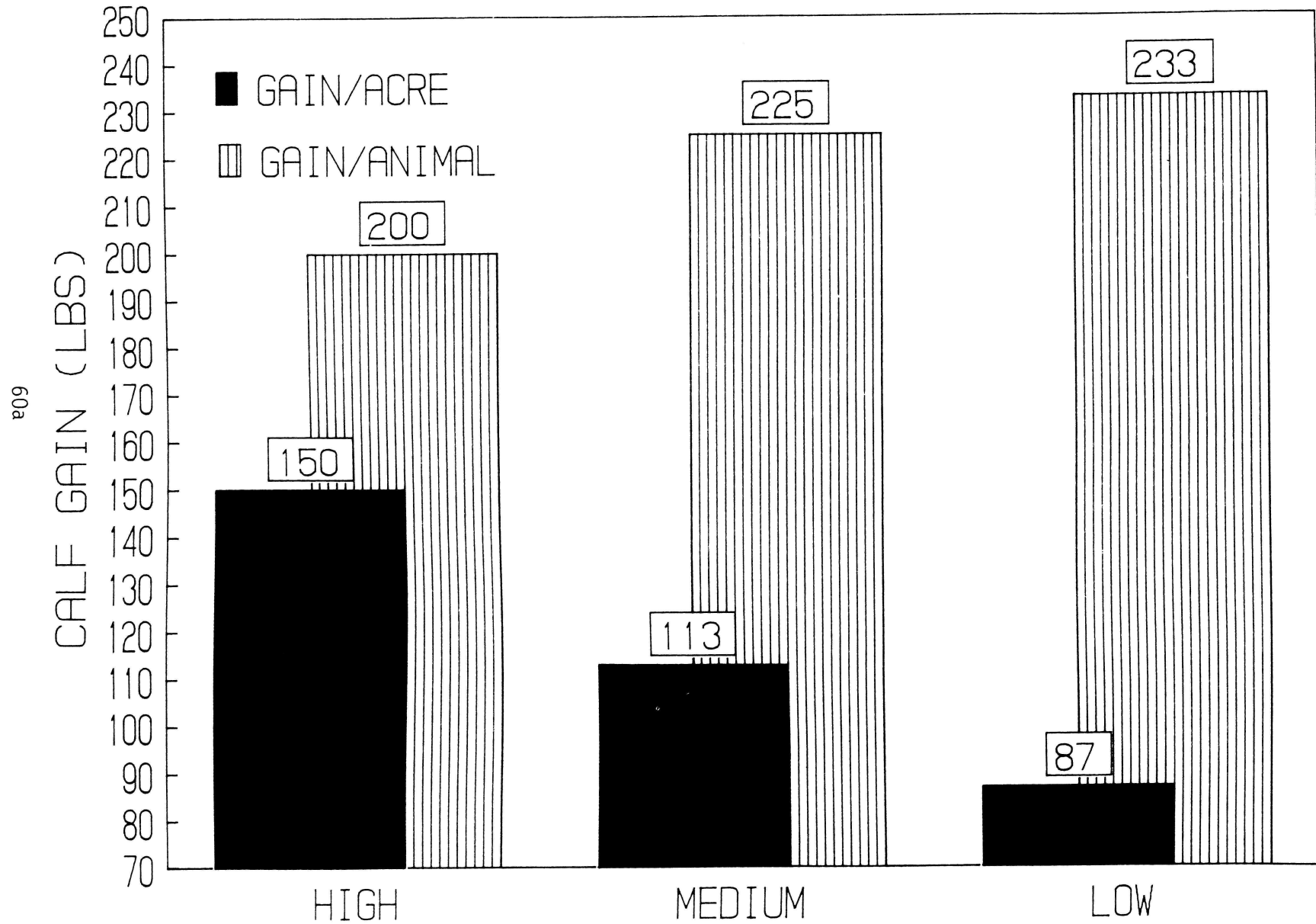
System	June	July	Aug	Sept
High	41.8	40.7	63.1	49.4
Low	54.2	52.1	59.3	65.1
Medium	45.2	39.8	57.5	59.7

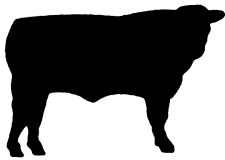
TABLE 3: MILK PRODUCTION BY COW AGE

Cowage	<u>24 Hour Milk Production (lb)</u>				Four Month Milk Production (lb)
	June	July	Aug	Sept	
3	8.5	7.0	6.0	5.3	997
4	10.7	9.1	9.7	8.0	1160
5	11.5	10.0	10.8	8.1	1339
6	13.4	11.7	10.4	8.0	1370

CALF GAIN BY SYSTEM

Fig. 1.





**1987
Progress
Report**

YEAR-ROUND FORAGE SYSTEMS FOR BEEF CATTLE: REPRODUCTIVE PERFORMANCE

C. Tucker, R. Morrow and J. Gerrish

SUMMARY

Reproductive performance of cows on three different forage systems and two different winter nutritional schemes were analyzed. Winter nutrition affected pregnancy rates of cows grazing fescue pasture. This effect was greater for cows on high endophyte pastures. Cows that were open at the end of breeding season lost more weight in the winter and gained less in the summer. These cattle also tended to have lower condition scores. Calves nursing open cows gained less than calves nursing bred cows. Three-year-old cows had the lowest condition scores and lowest pregnancy rate and calves nursing these cows had the lowest average daily gain. Winter nutrition and fescue affected reproductive performance of 3-year-old cows. Winter supplementation of 3-year-old cows on all forages and mature cows on endophyte infected pastures is necessary to insure good reproductive performance.

INTRODUCTION

Research at the Forage Systems Research Center has been aimed at forage systems analysis. During the last four years, this research concerned the utilization of three forage systems for beef production systems. The most significant factor involved in cow performance is reproduction. When looking at the utilization of forage by cow-calf pairs, the reproductive performance of the animal must be considered. The objective of this article is to report on the reproductive performance of cows on year-round forage system.

PROCEDURES

Reproductive performance of spring-calving Hereford cows (120 cows/year) bred to Polled Hereford bulls was analyzed. The data were from a four year project (1981-85) at the Forage Systems Research Center in North Central Missouri. The project was separated into summer and winter phases. The cows were allocated each year at the beginning of the winter phase, which ran from November to April. In the summer phase (April-September), the cows were placed into three different forage systems (bromegrass-red clover, orchardgrass-red clover and tall fescue + N). Percent endophyte infection of tall fescue was 77, 18 and 23%, respectively for replications (reps) 1, 2 and 3. Since endophyte levels were similar in reps 2 and 3, they were combined and classified as low endophyte pasture for analysis purposes. Further explanations of the summer and winter phase of this project are reported in the Forage Day and Forage Reports (1986) and Beef Reports (1985-86).

The variables analyzed were pregnancy rate, condition score and weight change of cows, cow age and calf average daily gain. Condition score was determined by weight-height ratios for different months.

RESULTS

The pregnancy rates of cows on bromegrass, orchardgrass and tall fescue were 96, 92 and 85 percent, respectively. The cows on fescue had lower conception rates due to endophyte in the pastures (78 and 87% respectively, for high and low endophyte). The pregnancy rate for cows on high nutrition (grain and hay) and low nutrition (hay) during the winter phase were 95% and 85%, respectively. Pregnancy rates by forage and winter nutrition are listed in table 1. Winter nutrition did not affect pregnancy rates of cows on bromegrass or orchardgrass pastures. When cows were on fescue pastures, winter nutrition did affect pregnancy rates (91 and 76 percent, respectively, for high and low nutrition). This effect was further enhanced by level of endophyte in the pasture (table 2). As endophyte increased, pregnancy rates decreased. These results indicate there is a need for winter supplementation for cows on tall fescue to conceive, and as endophyte levels increase, this need becomes more important.

A comparison of condition scores and weight change by pregnancy status are presented in table 3. Cows entering the summer phase with low condition tended to not become bred and they maintained that lower condition throughout the summer. Those cows entering the summer phase in better condition tended to conceive and maintain their condition over the summer. Cows which conceived were those that lost less weight in the winter and gained more in the summer. This would lead to the question in the case of the open cows not gaining in the summer, if they may be giving more milk, i.e. better mothers. Several articles have reported that cows gaining less weight or losing some condition are better providers for their calves.

The average daily gains of calves by month are presented in table 2. Calves by cows that didn't conceive gained less than those that did (1.58 lb/day and 1.76 lb/day, respectively). This tends to negate the thought that cows with lower condition scores or those that gained less in the summer gave more milk. This is in agreement with other research indicating average condition cows give more milk.

The data were analyzed by cow age to try and determine which age group had the lower condition scores and to determine the concurrent performance of their calves (table 3). The 3-year-old cows entered the breeding season with lower condition scores and exhibited this effect throughout the summer. The average daily gains of their calves were lower than all other age groups with the exception of the 11-year-olds calves. The largest group of open cows across years was 3-year-olds. It should also be noted that 3-year-olds on fescue pastures that had been on low winter nutrition had the lowest pregnancy rate (67.8 vs 87.7% for high nutrition). From these results one can conclude that winter supplementation is a necessity for 3-year-old cows to insure good reproductive performance.

TABLE 1: PREGNANCY RATE BY FORAGE AND WINTER NUTRITION¹

<u>Forage</u>	<u>Winter Nutrition</u>	<u>Pregnancy Rate</u>
Bromegrass	high	98
	low	96
Orchardgrass	high	96
	low	89
Fescue	high	91
	low	76

¹Low nutrition group did not receive supplementation.

TABLE 2: PREGNANCY RATE BY ENDOPHYTE AND NUTRITION

<u>Endophyte Level</u>	<u>Winter Nutr.</u>	<u>Preg.</u>
High	High	86
High	Low	69
Low	High	94
Low	Low	79

Endophyte: High = 77% and Low = 21%

TABLE 3: COMPARISON OF CONDITION SCORES AND WEIGHT CHANGE OF NON-PREGNANT AND PREGNANT COWS

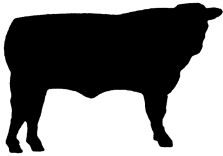
	<u>Weight Change</u>		<u>Condition Score</u>
	<u>Winter (lbs)</u>	<u>Summer (lbs)</u>	
Bred	-103	31	21.7
Open	-124	8	20.8

TABLE 4: AVERAGE DAILY GAIN OF CALVES ON PREGNANT OR NON-PREGNANT COW

	<u>May</u> <u>lb/day</u>	<u>June</u> <u>lb/day</u>	<u>July</u> <u>lb/day</u>	<u>Aug</u> <u>lb/day</u>	<u>Sept</u> <u>lb/day</u>	<u>Overall</u> <u>lb/day</u>
Bred	2.11	1.74	.97	1.70	1.39	1.76
Open	1.92	1.62	.64	1.59	1.19	1.58

TABLE 5: CONDITION SCORE OF COWS, PERCENT PREGNANCY AND THEIR CALVES AVERAGE DAILY GAIN (ADG)

<u>Cowage</u>	<u>May</u>	<u>Pregnancy %</u>	<u>Calf ADG</u>
3	19.6	86(N=125)	1.61
4	21.3	94(N= 95)	1.74
5	21.7	93(N= 63)	1.82
6	22.3	94(N= 52)	1.77
7	22.8	98(N= 45)	1.88
8	23.5	94(N= 49)	1.80
9	22.7	90(N= 44)	1.74
10	21.9	80(N= 24)	1.85
11	21.5	83(N= 6)	1.55



1987
Progress
Report

EMBARK TREATMENT OF TALL FESCUE- ANIMAL PERFORMANCE

Ken Turner, John Paterson, Jan Bowman
and Dave Bowman, Animal Science Department

Jim Forwood, USDA-ARS, Agronomy Department

SUMMARY

Three experiments were conducted to determine the effects of treating tall fescue pastures with the plant growth regulator Embark, on forage intake and calf gains. All pastures contained in excess of 85% endophytic fungus (Acremonium coenophalium). Experiment 1 was conducted during July to determine forage intake, amount of available forage and digestibility of forage organic matter. The second experiment was conducted to compare calf gains when steers grazed untreated or Embark treated tall fescue from May until October. The third experiment was conducted to determine gains and forage intake by yearling heifers consuming untreated or Embark treated tall fescue which was harvested for hay and fed during a winter drylot feeding experiment.

Embark treatment reduced the amount of available forage/acre compared to control pastures throughout the grazing season. Heifers grazing Embark treated tall fescue consumed 40% more organic matter (17.6 vs 12.5 lb/d) than calves grazing untreated pastures. Organic matter digestibility was improved 21% due to Embark treatment (67.3% vs 55.6%).

In experiment two forty-eight steer calves (avg initial weight of 491 lb) grazed (1.6 steers/acre) untreated or Embark treated tall fescue pastures from May 5th until October 26th (168 days). Steers grazing Embark treated tall fescue gained weight 28% faster than steers grazing untreated tall fescue (1.14 lb/day vs .88 lb/day). For the entire trial, Embark treatment resulted in 42 more pounds of calf gain.

In experiment three forty-eight yearling heifers (avg initial weight of 697 lb) were offered tall fescue hay in round bales which were harvested from untreated or Embark treated pastures. In addition to the hay, approximately six pounds of energy supplement was given each day. Heifers consuming Embark treated hay consumed 14% more hay and gained 29% faster than heifers consuming untreated hay (18.3 vs 16 lb for hay consumption and 1.74 vs 1.34 lb/day for gain, respectively).

Although Embark treatment of tall fescue reduced the amount of available forage/acre, the Embark-treated tall fescue during July and August was of higher nutritional value than untreated tall fescue.

INTRODUCTION

Methods to maintain a high level of forage quality during the mid-summer grazing period have been investigated. Inclusion of clover, grazing of warm season grasses and increased levels of energy supplementation have been shown to improve animal gains. Spraying the cool season grass with a plant growth regulator in an attempt to prevent seed head formation and maintain the forage in a more vegetative state of growth has also been investigated. Results from several universities have shown that forage quality is indeed higher when treated with a plant growth regulator. Embark is one type of regulator which may hold promise as part of an overall grazing program. The objectives of this research were to determine what effect treating tall fescue with Embark had on forage intake and gains by grazing calves. A second objective was to determine the feeding value of Embark-treated tall fescue hay.

PROCEDURES

Experiment 1: Four Hereford calves and two yearling heifers fitted with esophageal cannulae were assigned to either untreated or Embark-treated tall fescue pastures. This experiment was part of a larger cow-calf experiment described by Dr. Garner in the 1986 Forage Day Report (Animal Sciences Report 110). The amount of available forage per acre and amount of digestible organic matter per acre were determined each month by random sampling of the pastures. The amount of forage in a 12" x 12" square was handclipped (3 samples/pasture) and brought to the laboratory for nutrient analysis. Esophageal extrusa samples were collected biweekly, freeze-dried and analyzed for in vitro digestible organic matter, fiber and minerals. Forage intake by the calves was indirectly estimated using an indigestible external marker (Yb) to determine fecal output (pulse-dose technique).

Experiment 2: Forty-eight Hereford x Angus steer calves with an initial weight of 491 lb were weighed on consecutive days and allotted to either untreated or Embark-treated (.25 lb/acre) tall fescue pastures. Each pasture was 5 acres in size and had a fixed-stocking rate of 1.6 steers/acre. Steers were allowed to graze pastures 14 days after treating with Embark. The study lasted from May 5th until October 26th; 168 days. Control pastures were not clipped during the study.

Experiment 3: Forty-eight yearling Hereford x Angus heifers with an average initial weight of 697 lb were utilized in an experiment to determine gains and hay intake. Large round bales of tall fescue hay which were previously untreated or were treated with Embark were offered in a winter (January-April) drylot experiment. Forage was harvested for hay the previous July and stored outside, uncovered in a bale yard. In addition to the hay, six pounds of an energy (corn-soybean meal-corn gluten feed) supplement were fed each day.

RESULTS

Experiment 1: Embark treatment significantly reduced the amount of available forage/acre during the entire grazing season (figure 1). The amount of digestible organic matter was also less (figure 2). Even though Embark reduced the total amount of digestible forage, it was estimated that forage availability was not limiting animal performance at the selected stocking rates for this experiment (1.15 cow-calf pairs/acre). Forage organic matter intake and digestibility were greater ($P < .05$) by heifers consuming Embark treated tall fescue compared with untreated tall fescue (table 1). Forage intake was increased by 5 lb/day (17.6 vs 12.5 lb) while digestibility was improved by 11.7 percentage units (67.3 vs 55.6%). Allowing calves to select Embark-treated forage which was of higher nutrient quality and did not have poorly digestible stems is probably responsible for much of the improvement.

Experiment 2: Gains by steers grazing Embark treated tall fescue pastures were increased ($P < .05$) by approximately 28% (table 2). At the end of the 168 day experiment, steers grazing the treated pastures weighed 42 lb more than steers grazing the untreated pastures.

Experiment 3: Total gains by heifers consuming Embark-treated hay were 30% greater than by heifers consuming untreated hay (109 vs 84 lb). Part of the increase in performance was due to increased hay consumption (18.3 vs 16 lb/day) and also to increased digestibility of the hay. Laboratory analysis showed the in vitro digestibility of the Embark hay was 65% compared with 61% for the untreated hay.

The use of a plant growth regulator such as Embark to maintain forage quality during midsummer grazing appears to be one approach for increasing animal performance. It may prove useful as part of an overall grazing strategy in which animals first graze untreated forage during spring and early summer, treated forage during mid- and late-summer and untreated forage again in early fall.

This research was funded by the 3M Corporation, the Missouri Research Assistance Act and by the continuing support of the Missouri Farm Bureau and Missouri Cattlemen's Association ("Calves go to College Project").

Ken Turner is a PhD candidate; John Paterson, Associate Professor; Jan and Dave Bowman, Research Associates and Jim Forwood, Assistant Professor.

Figure 1. EFFECT OF EMBARK TREATMENT OF TALL FESCUE ON POUNDS OF AVAILABLE FORAGE PER ACRE

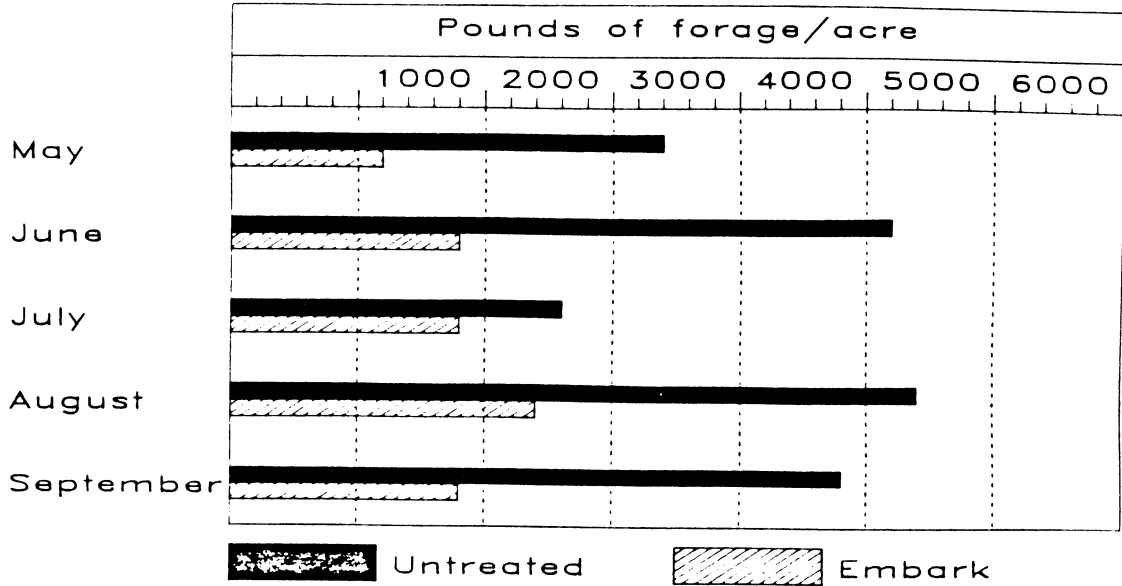


Figure 2. EFFECT OF EMBARK TREATMENT OF TALL FESCUE ON POUNDS OF DIGESTIBLE ORGANIC MATTER PER ACRE

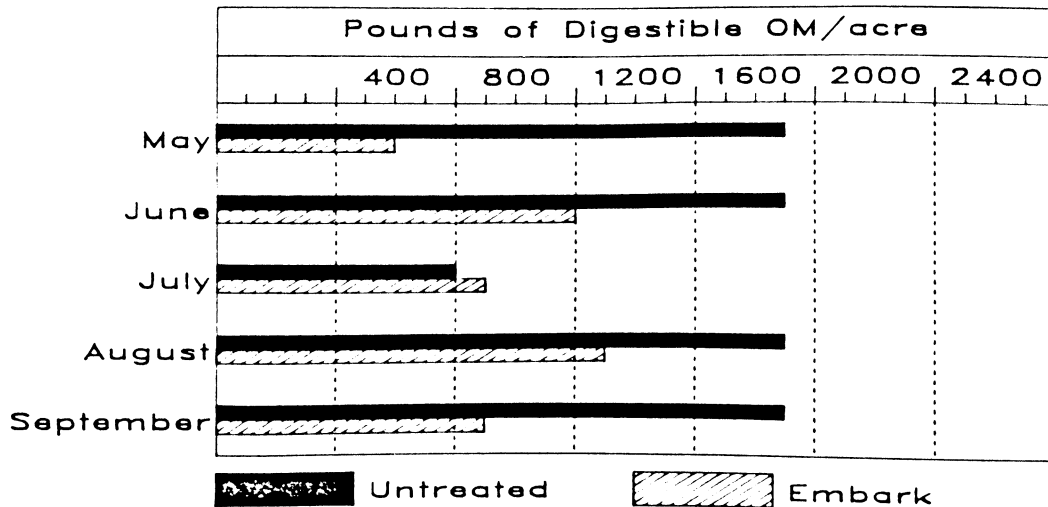


TABLE 1. ORGANIC MATTER INTAKE AND DIGESTIBILITY OF EMBARK TREATED TALL FESCUE BY GRAZING CALVES DURING JULY

Item	Untreated	Embark treated
Forage OM intake, lb	12.5	17.6
Intake as a % of animal body weight	1.6 ^a	2.1 ^b
Forage OM digestibility, %	55.6 ^a	67.3 ^b
Available forage dry matter, lb/acre	2665	1836
Digestibility forage organic matter, lb/acre	787	901

a,^bMeans with unlike superscripts differ (P<.05).

TABLE 2. GAINS BY STEERS GRAZING EMBARK TREATED TALL FESCUE PASTURES (168 DAY EXPERIMENT)

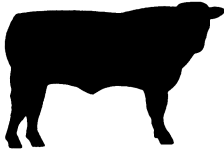
Item	Untreated	Embark treated
No. steers	42	24
Initial weight, lb	492	490
Daily gains, lb	.88 ^a	1.14 ^b
Total gain, lb	147 ^a	191 ^b
% improvement		28

a,^bMeans with unlike superscripts are different (P<.05).

TABLE 3. GAINS BY YEARLING HEIFERS CONSUMING LARGE ROUND BALES OF TALL FESCUE HAY WHICH HAD BEEN PREVIOUSLY TREATED WITH EMBARK

Item	Untreated hay	Embark-treated hay
No. heifers	24	24
Initial weight, lb	697	697
Hay intake, lb/day	16 ^a	18.3 ^b
Daily gain, lb	1.34 ^a	1.74 ^b
Total gain, lb	84 ^a	108 ^b
% improvement		29
DM digestibility of hay, %	61 ^a	65 ^b

a,^bMeans with unlike superscripts are different (P<.05).



1987
Progress
Report

THE EFFECT OF DEWORMING COWS AT SPRING TURNOUT
AND CALVES MID-SUMMER WITH FENBENDAZOLE ON
CALF PERFORMANCE

Jack Whittier, John Massey, Eldon Cole, Dale
Dunseth, Karl Hartung, and Jerry Thompson

Department of Animal Science
In Cooperation with American Hoechst Agri-Vet, Somerville, NJ

SUMMARY

Four field trials were conducted during the summer of 1986 to evaluate a treatment schedule designed to achieve seasonal control of internal parasites in spring-calving cowherds in Missouri. Three-hundred and twenty-two cow-calf pairs at four locations were used. Fenbendazole (Safeguard[®]) was administered orally to half the cows and calves at each location prior to turnout on summer pasture, approximately May 1. The same calves were retreated 60 days later. The other pairs received no treatment and grazed on separate, comparable pastures. Fecal samples were collected from approximately 10% of animals three times during the study and analyzed for 6 parasite egg types. Fecal egg counts at weaning were higher ($P < .05$) for roundworm (Trichostrongyles) (5.95 vs 2.46 eggs/g) and hookworm (Bunostomum) (.14 vs 0 eggs/g) parasites in cows not treated with Fenbendazole. Non-treated calves had higher ($P < .05$) egg counts for roundworms (86.59 vs 52.03 eggs/g) and thread worms (Strongyloides) (.93 vs .12 eggs/g) 60 days after initial treatment and round worms (130.18 vs 38.88 eggs/g) and whipworms (capillaria) (1.78 vs .10 eggs/g) at weaning compared to treated calves. There was a treatment by location interaction ($P < .01$) for parasite infestation, indicating that Fenbendazole was effective in reducing parasite population when parasites were present, but could not be measured when parasite infestation was low. Calf average daily gain was not different when all 4 herds were pooled. Two herds showed similar gains in both groups while one herd showed higher ($P < .05$) gains and one herd showed lower ($P < .01$) gains in calves treated with Fenbendazole. Based on the results of these trials Fenbendazole was effective in reducing fecal egg counts yet animal performance did not always coincide with estimated parasite infestation.

INTRODUCTION

Internal parasites can cause decreased animal performance if infestation is high and unchecked. In 1983, Bumgarner et al. (1983) reported results from a North Central Missouri cowherd in which half the cows in the herd were drenched with Fenbendazole shortly after calving and their calves were drenched with Fenbendazole in mid-July. They reported a .24 pound increase in ADG and 49.6 pound increase in 205-day adjusted weight for calves treated with Fenbendazole when compared to untreated calves.

We wish to express our thanks to Mrs. Helen Spellman, Crane, MO; Kenneth and Gene McLain, Meadville, MO; Mr. Dwinell Graff, Savannah, MO; and Dr. Curtis Long, Butler, MO for their cooperation and use of their cowherds. Also, our thanks goes to Dr. Gil Myers, Ib Hagsten, Pat Hogan and Ernest Keith from American Hoechst for supplying the Fenbendazole and their technical assistance.

Based on this research we decided to test this treatment schedule in four spring calving cowherds throughout the state. The objective of this study was to determine if calf performance was improved by treating cows at pasture turnout and calves at mid-season with Fenbendazole.

PROCEDURES

Cowherds were selected in cooperation with Area Livestock Extension Specialists (Fig. 1) to represent different parts of the state. The treatment schedule to control worm parasites was as follows: At pasture turnout (approximately May 1) one-half of the cows and calves at each location were orally administered the recommended dosage of Fenbendazole suspension (Safeguard[®]) the other one-half were not treated for worm parasites. At mid-season (approximately July 1) the same calves previously treated were retreated with Fenbendazole. Fecal samples were collected from the cows at pasture turnout and weaning and from the calves at mid-season and weaning. These samples were analyzed for concentration of worm parasite eggs by the Parasitology Laboratory at the University of Missouri School of Veterinary Medicine. The technician counting the eggs did not know the treatment identification. Cows were weighed at turnout to establish proper dosage level. Calves were weighed at turnout, mid-season, and weaning to establish weight change.

Animals were grazed on separate, yet similar pastures throughout the summer. We recognize it is difficult, if not impossible to have identical pastures in such field trials, and since the treatments were not replicated at each location, the results may be confounded by pasture differences.

RESULTS AND DISCUSSION

Worm parasites effecting cattle can be classified into three broad categories (Williams, 1983). Table 1 lists the classification and common names of parasites identified in fecal samples from this study.

The results of the fecal egg count analysis are shown in Table 2. To diminish the pasture differences, data were pooled across locations. Figures 2 and 3 show the breakdown by location for the most economically important worm parasite group measured, trichostrongyles. This parasite group includes the Ostertagia genus which generally represent up to 90% of the parasites in the trichostrongyles group.

The fecal egg count results indicate that Fenbendazole was effective in controlling the parasite level in herds with a relatively high level of infestation. The herd represented as DD showed numerically higher fecal eggs in the treated calves than the untreated calves for trichostrongyles type parasites. This difference is not significant and therefore cannot be used to draw any conclusion.

The performance of the calves was unaffected ($P > .10$) by parasite control when the data were pooled (Fig. 4). One herd (DD) showed an average daily gain advantage ($P < .01$) for the untreated calves, while a second herd (JT) showed a advantage ($P < .05$) for the treated calves.

Based on the results of this trial, it is concluded that Fenbendazole was effective in controlling worm parasites. However, calf performance was unaffected by deworming treatment when data were pooled. We recommend that producers critically review the level of parasite infestation prior to treatment for internal parasites. If levels are high, a deworming program should be utilized. However, if parasite level is low, there may be no economic advantage to deworming.

Literature Cited

- Bumgarner, S.C., R.M. Corwin, T. Fairbrother. 1983. Epidemiology of Beef Cattle Parasitism in Missouri: A Strategic Deworming Program for Spring Calving Cow-herds. 1983. Beef Cattle Research Report, University of Missouri. 1983:132.
- Williams, J.C. 1983. Internal Parasites of Cattle. American Hoechst Corporation, Somerville, NJ.

Table 1. Classification of Cattle Parasites of Consequence Identified in Fecal Samples

Group	Group Members	Common Name
Strongyles (hookworms)	<u>Bunostomum phlebotomum</u>	Hookworm
	<u>Oesophagostomum radiatum</u>	Nodular worm
Trichostrongyles (roundworms)	<u>Ostertagia ostertagi</u>	Brown or medium stomach worm
	<u>Trichostrongylus axei</u>	Small stomach worm
	<u>Haemonchus placei</u>	Barberpole worm
	<u>Cooperia</u> spp.	Cooper's worms
	<u>Trichostrongylus colubriformis</u>	Bankrupt worm
	<u>Nematodirus helvetianus</u>	Threadnecked worm
Others	<u>Dictyocaulus viviparus</u>	Lung worm
	<u>Trichuris discolor</u>	Whipworm
	<u>Strongyloides papillosus</u>	Intestinal threadworm
	<u>Capillaria</u> spp.	Whipworm

From: Internal Parasites of Cattle. J.C. Williams, 1983.

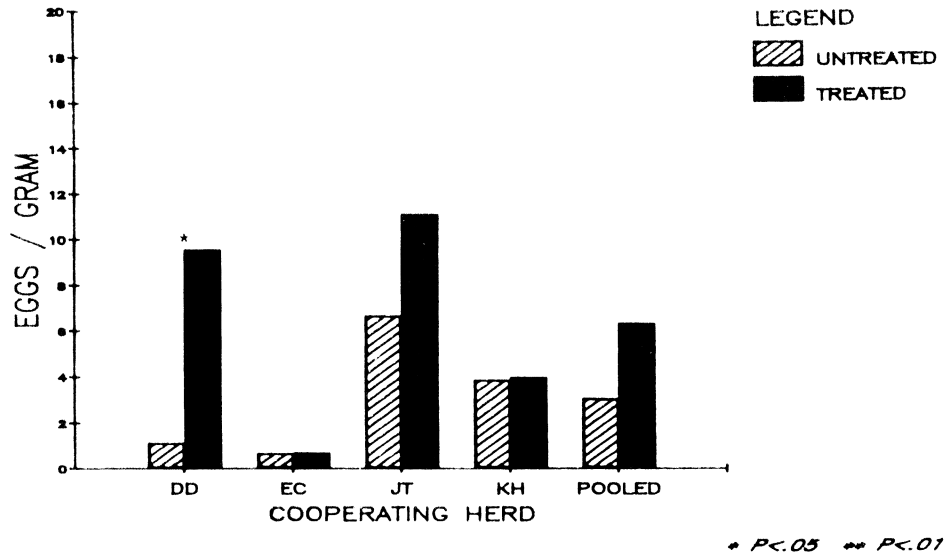
Table 2. Least Squares Means for Fecal Egg Counts by Parasite Species for Pooled Data from Four Locations

Parasite Type	Parasite eggs/ gram of Feces		Standard Error	Probability Level
	Treated	Untreated		
Cows at Pasture Turnout:				
Trichostrongyles	6.37	3.12	1.29	.08
Capillaria	.10	.09	.05	.89
Strongyloidis	.10	.12	.05	.78
Bunostromum	.07	.11	.03	.48
Cows at Weaning Time:				
Trichostrongyles	2.64	5.94	.75	.01
Capillaria	.00	.10	.04	.09
Strongyloidis	.02	.00	.02	.41
Bunostromum	.00	.14	.05	.04
Calves at Mid-season:				
Trichostrongyles	52.03	86.59	8.15	.01
Capillaria	.00	.02	.01	.39
Strongyloidis	.12	.93	.13	.01
Bunostromum	31.78	25.34	8.77	.61
Nematodirus	2.59	3.28	.54	.37
Calves at Weaning Time:				
Trichostrongyles	38.88	130.18	7.00	.01
Capillaria	.10	1.78	.11	.01
Strongyloidis	1.88	.63	.49	.08
Bunostromum	3.30	5.63	3.45	.58
Nematodirus	7.08	11.70	3.15	.30



Figure 1. Location and number of cow-calf pairs used to measure the effect of Fenbendazole treatment for parasite control.

PARASITE EGG COUNTS
 Cow Fecal Samples
 At Pasture Turnout
TRICHOSTRONGYLUS



Cow Fecal Samples
 At Weaning Time
TRICHOSTRONGYLUS

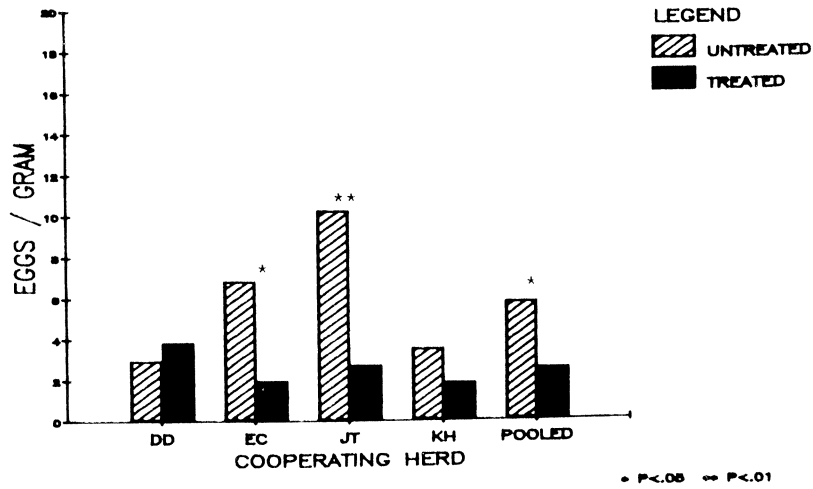


Figure 2. Parasite egg counts (trichostrongyles) from fecal samples collected from cows at four locations at pasture turnout and weaning time.

PARASITE EGG COUNTS
Calf Fecal Samples
At Mid-Season
TRICHOSTRONGYLUS

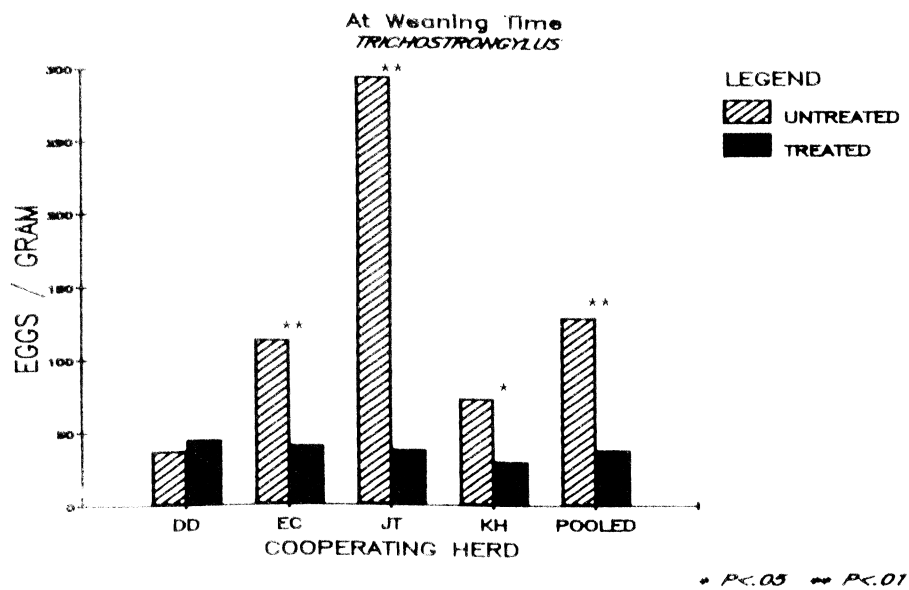
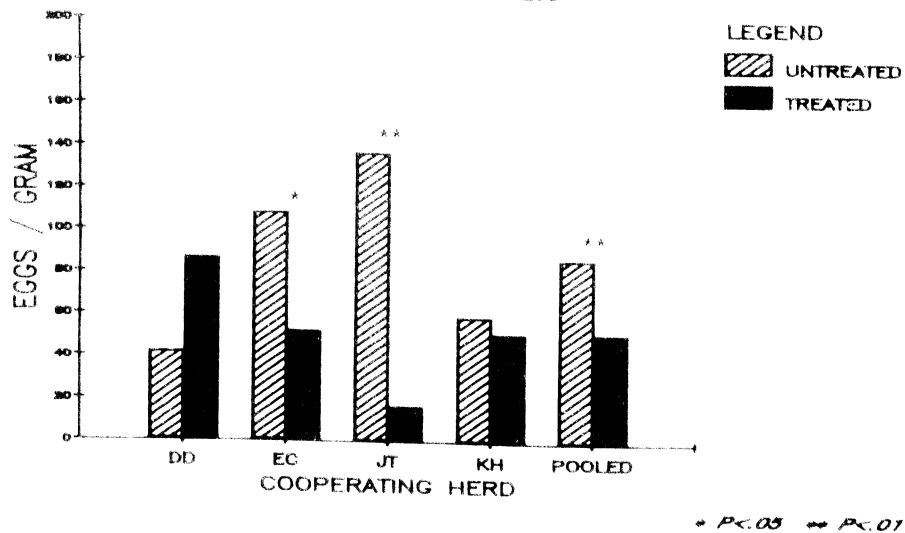


Figure 3. Parasite egg counts (trichostrongyles) from fecal samples collected from calves at four locations mid-season and weaning time.

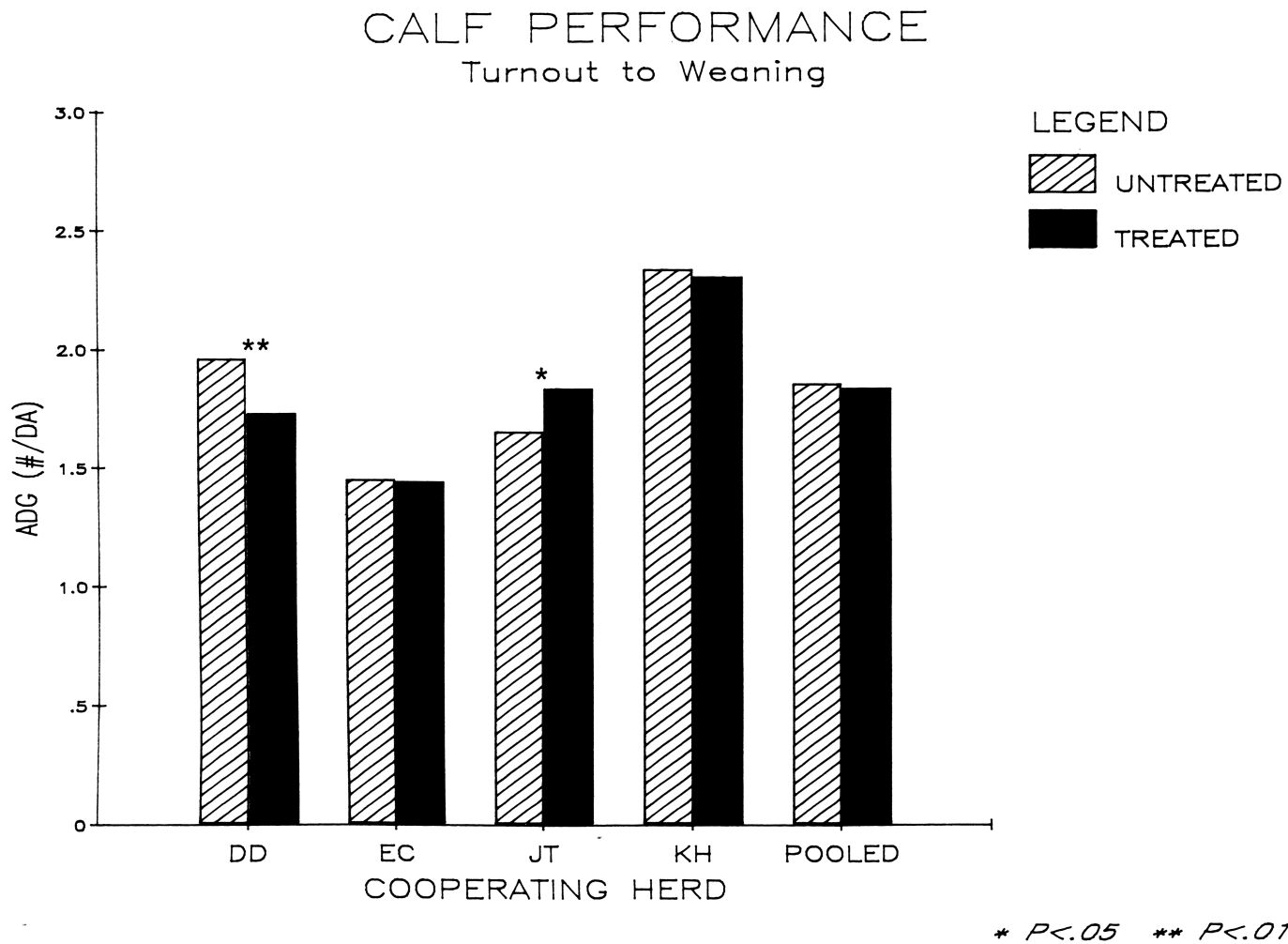
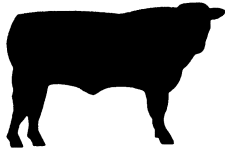


Figure 4. Average daily gain (ADG) of calves from pasture turnout to weaning time in calves treated with Fenbendazole or left untreated.



1987
Progress
Report

NURSING CALF RESPONSE TO IVOMEC^a TREATED COWS GRAZING ENDOPHYTE INFECTED FESCUE PASTURES

K.A. Moore, R.J. Lipsey, and A.L. Decker

SUMMARY

Twenty-four Angus cow-calf pairs were assigned to two treatments to evaluate how Ivomec injections effect performance on endophyte infected fescue pastures. Treatments were Ivomec and no Ivomec for the cows. All calves received Ivomec. No difference ($P>.05$) existed between treatments for traits evaluated. However, calf average daily gains, when standardized (ADG) approached significance ($P=.082$) and were 2.24 pounds per day for calves on cows receiving Ivomec and 2.01 pounds per day for calves on cows that did not receive Ivomec. Cow gain, body condition, hair coat, muddiness and respiration (clinical endophyte toxicosis) were not different between treatments.

OBJECTIVE

The objective of this study was to determine the effect Ivomec injection had on the performance of cow-calf pairs grazing pastures of endophyte infected tall fescue.

MATERIALS AND METHODS

Twenty-four Angus cow-calf pairs were utilized for this study (cows ranged in age from 2-8 years). The cows have been maintained on endophyte infected fescue pastures the majority of their productive lives. The cows and calves were weighed every 28 days from July 22 to September 16. At first weighing, fecal samples were taken from every cow and every other cow was injected with Ivomec. All of the calves were given Ivomec at the second weighing. Cows were subjectively scored for body condition, hair coat, muddiness and respiration on a monthly schedule on afternoons when ambient temperature was 90 degrees F or above.

Body Condition

Body condition is scored on a scale of 1 to 9. A one is emaciated with no detectable fat over extremities, and nine is extremely fat. Scores of 5 to 7 are given to cows in their optimum condition, and 8 and 9 refers to fat cows.

Hair Coat

Hair coat is scored on a five point scale. One is long shaggy hair over the majority of the body. Five describes a completely slick, shiney haircoat.

^aIvomec and laboratory analyses donated by Merck & Company, Rahway, New Jersey.

Muddiness

Muddiness is scored on a five point scale. One describes mud/manure over the majority of the body. Five describes no signs of organic matter originating from wet areas sought out by heat stressed cattle.

Respiration

Respiration utilizes a five point scale. One describes an open mouth, obvious salivation and nasal mucus and very rapid breathing. A score of five represents total comfort, normally grazing or ruminating.

RESULTS AND DISCUSSION

Fecal samples taken from cows on day 1 of the experiment revealed extremely low parasite egg concentration. No differences were found for weight gain, condition score, muddiness, hair coat, respiration or calf weight gain by treatment. Repeated endophyte sensitivity scores appeared consistent. Endophyte sensitivity scores suggested cows that were initially less stressed remained so (table 1). These results suggest some effect of Ivomec in alleviating the reduced ADG in suckling calves on high endophyte pastures. The results do not clearly show if the effect is caused by reduced parasitism or somehow related to the toxins of the endophyte.

TABLE 1. AVERAGE ENDOPHYTE TOXICOSIS SCORES AND GAINS FOR COW-CALF PAIRS FOLLOWING IVOMEC INJECTIONS OF HALF THE COWS AND ALL CALVES

	Treated		Untreated	
	Initial	Ending	Initial	Ending
Cows				
Body condition ^a	4.63	4.81	4.14	4.64
Hair coat ^b	3.85	3.75	3.89	3.75
Muddiness ^c	3.83	3.69	3.57	3.73
Respiration ^d	3.52	4.36	3.43	4.52
Weight ^e	1041.1	1132.7	1023.3	1096.4
Gain (lbs)	--	91.25	--	73.17
Calves				
Weight	322.5	442.3	281.3	379.9
ADG ^f g	--	2.24	--	2.01

^ascored on a scale of 1 to 9 with 1 being emaciated, 9 being fat and 5-7 being optimum.

^bscored on a scale of 1 to 5 with 1 being long and shaggy and 5 describes a completely slick shiney haircoat.

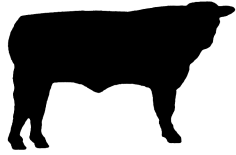
^cscored on a scale of 1 to 5 with 1 having mud/manure over the majority of the body and a score of 5 describes a cow free of mud/manure.

^dscored on a scale of 1 to 5 with 1 describing a cow that is obviously under respiratory stress and a score of 5 describes a cow that is comfortable.

^eweights were not different between treatments.

^fADG was standardized by using initial weight as a covariant.

gP=0.081.



1987
Progress
Report

EFFECT OF SHORT-TERM FOOD DEPRIVATION ON IMMUNE RESPONSES OF CALVES TO INFECTIOUS BOVINE RHINOTRACHEITIS VIRUS.

B.D. Rosenquist and J.M. d'Offay

SUMMARY

Three groups of calves were inoculated intranasally with infectious bovine rhinotracheitis (IBR, red nose) virus to determine how a 3-day fast affected neutralizing antibodies in sera and nasal secretions and systemic cell-mediated immune (CMI) responses to IBR virus. The effects of fasting on leukocyte numbers, hematocrit values and serum cortisol concentrations were also determined. One group was inoculated 1 day after onset of and another at the end of the fast, immediately before refeeding. Control calves were inoculated but not fasted.

Hematocrit values increased as a result of fasting, signifying a mild degree of dehydration. Total leukocyte counts were not affected by fasting. Serum cortisol concentrations in fasted calves at time of inoculation were increased over prefast values. Levels declined in all groups after infection.

Local and systemic antibody responses were not different between fasted and nonfasted calves. Significant CMI responses of peripheral lymphocytes to IBR antigen were for the most part absent in all groups of calves. In all groups, the average leukocyte counts remained within normal ranges. We conclude that these indicators of host resistance were not adversely affected by short-term fasting.

INTRODUCTION

Cattle ill with viral respiratory disease have frequently been subjected to various stresses. A stressor often associated with translocation of calves from place of origin to a feedlot is short-term food deprivation or fasting. It may result from both lack of feed and from inappetence due to fatigue, anxiety and fright during lengthy hauls. Depression of food intake can also occur after introduction of calves to new diets on arrival at feedlots, and after weaning.

Nutrition is considered important in the pathogenesis of bovine respiratory tract disease. Although malnutrition decreases the resistance of animals to most bacterial and parasitic infections, undernutrition may increase resistance to certain viral infections. We previously reported that fasting appeared to enhance interferon production after IBR infection.¹ Interferon is a protein(s) produced by animals during viral infections and is an important factor in recovery from viral infections. Since both humoral and cell mediated immunity are also considered important in recovery from IBR virus infections, and might be adversely affected by short-term food deprivation, we here describe the effect of a 3-day fast on the immune response of these calves to infection with IBR virus. The effects of fasting on clinical signs, serum cortisol levels, hematocrit, and leukocyte counts are also described.

MATERIALS AND METHODS

Virus

The IBR virus was propagated in bovine fetal kidney cells from a strain of virus developed for intranasal vaccination.

Experimental design

Two groups of calves (Angus, Hereford, and Angus-Hereford crosses) were purchased locally, and weighed between 265 and 440 lb. The first group (8 calves) was divided into 3 treatment groups. The second group (9 calves) was used to replicate the previous study. Calves were pastured (fescue grass) upon arrival for about 3 weeks and supplemented as a group with approximately 3.3 lb of a grain concentrate per head daily. Three calves with low antibody titers to IBR virus were included in the study; other calves were seronegative. Virus was not isolated from nasal swabs taken at time of arrival and just before inoculation.

Treatment groups were selected at random and housed in separate buildings 3 days before inoculation. The 12 calves in groups 1 and 2 were fasted for 3 days, while the 5 calves in the third group (controls) were fed throughout the experimental period. All were inoculated intranasally on experimental day 0 with 2 ml of IBR virus (10^6 TCID₅₀/ml), 1 ml per nostril, with a gas powered atomizer. At this time, group 1 calves (fasted from day -1 to day 2) had been fasted for 1 day and group 2 calves (fasted from day -3 to day 0) for 3 days.

Except for the fast period, confined calves were fed the grain concentrate (average 3.3 lb/head daily) in addition to grass hay provided ad libitum. Feed and bedding were removed during the fast. Water was available at all times. The calves were observed on a daily basis and rectal temperatures recorded whenever samples were taken. Samples were collected each morning.

Neutralization tests

Neutralizing antibody titers against IBR in sera and nasal secretions (NS) were determined in bovine fetal kidney cell cultures by a microtitration technique. Serums were obtained upon arrival, and on days 0, 14 and 28. Nasal secretions were collected on days 0, 5, 7 and 14. Titers were recorded as the reciprocal of the highest final dilution of sample which completely protected at least 3 of 4 wells against a challenge virus dose of 100 TCID₅₀.

Lymphocyte transformation tests

The cell mediated immune response (CMI) of calves to IBR virus was determined by measuring the incorporation of tritiated thymidine by peripheral lymphocytes using whole blood cultures. Blood samples were collected in preservative-free heparin on days -3, 0, 3, 5, 7, 11 and 14 and diluted 1:5 in RPMI 1640 medium. After dilution, 100 μ l of each sample was added to triplicate microtiter plate wells containing control medium and three dilutions (1:10, 1:50 and 1:100) of heat-inactivated IBR virus. After incubation for 4 days at 37 C, the cultures were pulsed with 25 μ Ci of (methyl-³H) thymidine, incubated for an additional 24 h and terminated by freezing at -80 C. Leukocytes were collected and the uptake of tritiated thymidine was determined in a liquid scintillation counter. The measure of lymphocyte transformation was expressed as a stimulation index (SI). The SI was determined by dividing the mean dpm of sample wells by the mean dpm of non-stimulated control wells.

Leukocyte count, hematocrit, and serum cortisol

Blood samples were collected on days -3, 0, 1, 2, 3, 4, 5 and 7. Total blood leukocytes were counted with a hemacytometer and packed cell volumes were determined by the microhematocrit method. Cortisol was determined in serum samples collected on days -3, 0, 1, 2, 3 and 4, and was quantitated by solid phase radioimmunoassay.

Statistical analysis

All variables with repeated daily observations were analyzed as a 2-factor experiment (day, treatment) using a split-plot in time analysis of variance. The least significant difference (LSD) was used to effect separation of means when day by treatment interaction was significant.

RESULTS

Clinical observations

A 3-day fast in calves receiving water ad libitum did not, by itself, result in any clinically apparent ill effects. After inoculation with IBR virus, all calves showed an increase in serous nasal discharge which tended to become mucoid and in some cases purulent after a few days; no difference was noticed between fasted and nonfasted control calves. Transient cough and diarrhea were observed in a few calves early during infection. The diarrhea usually lasted 2 days and was present in a few animals only, mainly in fasted calves upon refeeding. Dullness and lethargy were particularly noticeable in control calves on day 4. Ten of 17 (58%) calves developed fever of 40 C or greater, usually of 1 or 2 days duration, by the 4th or 5th postinoculation day. These calves were distributed approximately equally amongst groups.

Immune response to IBR virus

All 14 seronegative calves seroconverted by day 14. Two of the 3 calves with preexisting antibody titers developed a significant increase in serum neutralizing antibodies. Neutralizing antibodies against IBR virus were not detected in the NS of calves on days 5 and 7, but were present in 7 out of 17 on day 14. Responses were thus similar between groups (Table 1).

A significant CMI response, occurring on day 7, was noted in only 1 of 8 calves tested. This calf was seropositive at time of inoculation, presumably due to an earlier active immune response. Two other calves responded with low stimulation indexes, with responses in each noted only once (Table 2). Since differences in response between treatment groups were not evident, and since 8 of 9 calves used in the replicate study were seronegative, these tests were not repeated.

Hematology

Mean leukocyte counts in all groups were within normal ranges on all days and neither fasting nor infection had any obvious deleterious effects (Table 3). Mean hematocrit values during fasting increased significantly ($P < 0.01$) above baseline values before fasting (Table 4). In both fasted groups, mean values recorded 72 h after onset of the fast were also higher ($P < 0.01$) than corresponding values for nonfasted calves. A mild degree of dehydration was thus associated with fasting.

Cortisol

A significant ($P < 0.01$) increase in serum cortisol levels over prefast values was only recorded in group 2 calves (Table 5). A marked drop in mean values was noted within the first 24 h after refeeding. Mean levels tended to decrease after infection. In group 1, where the cortisol levels were expected to increase with fasting, a significant ($P < 0.01$) drop occurred between day 0 and 2.

DISCUSSION

In this study, we measured total leukocyte numbers, blastogenic transformation of lymphocytes and neutralizing antibodies in the serum and NS to find out if fasting influenced these parameters of host resistance. A 3-day fast was chosen since during this time a high percentage of newly received feeder or stocker beef calves do not eat.

Seroconversion after vaccination with IBR virus is the criterion measured to determine that vaccines meet licensing requirements and a satisfactory host response has occurred. The neutralizing antibody response after virus inoculation was not different between groups. Sixteen of 17 calves developed significant increases (seroconversion or at least 4-fold increases in titer) in IBR serum antibodies. In NS, antibodies were first detected on day 14, which is in agreement with findings by some investigators although others have reported low levels of NS antibodies in some calves earlier (day 7) after intranasal vaccination with IBR virus, or none at all.

Because antibody production tends to be detected only after recovery from IBR virus infection is well under way, it has been suggested that the CMI response which occurs earlier after infection, might play a more important role than neutralizing antibodies in recovery from IBR. Except for one seropositive calf (sensitized animal) that responded with high SI, all others did not respond or responded with low SI. In the present study, lymphocytes collected from fasted and nonfasted calves had similar (essentially negative) blastogenic responses.

Since lack of food is a form of stress, any changes observed or masked in our calves might have been mediated purely through stress, as evidenced by increased cortisol levels. Serum cortisol levels in initial fasted serum samples were significantly increased over baseline values, however, only in calves inoculated at the end of fasting, however, and were not different than prefast values 24 h later. So any changes or lack thereof did not appear to be related to differences in serum cortisol. Although water was provided ad libitum during the fast, some dehydration was observed in fasted calves. This was not unexpected, since cattle deprived of food also limit their water intake, and similar degrees of hemoconcentration are observed whether or not water is provided.

Other mediators of nonspecific and specific (immunological) host resistance (i.e., alveolar macrophages, complement, neutrophils, natural killer cells, interleukins) may be important in the pathogenesis of bovine respiratory tract disease. The effect of fasting on these mediators was not measured in this study and is unknown. Short-term fasting, however, did not adversely affect development of neutralizing antibodies or leukocyte numbers in this study, and, as previously reported, did enhance nasal interferon levels without any increase or an actual decrease in amount of virus excreted. Dietary manipulation may offer ways to enhance mediators such as interferon and increase resistance of calves to viral pathogens to which they may become exposed.

REFERENCE

d'Offay, J.M. and B.D. Rosenquist. 1986. Interferon production and replication of infectious bovine rhinotracheitis virus in fasted calves. *J. Interferon Research* 6:79.

TABLE 1. Neutralizing antibody titers in sera and NS of calves inoculated with IBR virus on day 0

Group	Calf No.	Experimental days		
		0	14	28
1 (inoculated 24 hours into fast)				
	3	8	16 (4)	8
	5	0	8 (0)	4
	8	0	8 (0)	8
	14	0	8 (0)	4
	15	0	8 (0)	4
	16	0	16 (4)	4
2 (inoculated at end of fast)				
	6	0	4 (0)	4
	11	0	32 (8)	32
	13	0	4 (0)	16
	17	0	4 (0)	4
	18	4	16 (4)	8
	19	0	4 (0)	4
3 (nonfasted control)				
	1	0	4 (0)	4
	7	4	32 (4)	16
	20	0	4 (8)	4
	21	0	8 (4)	4
	22	0	8 (0)	4

Values in parentheses denote neutralizing antibody titers in NS

Antibodies not detected in any NS on experimental days 0, 5 and 7

Titers are the reciprocals of dilutions which protected at least 3 of 4 wells;
 ≥ 4

TABLE 2. Blastogenic response of whole blood cultures to inactivated IBR virus antigen.

Group	Calf No.	Experimental days						
		0*	3	5	7	11	14	21
1 (inoculated 24 hours into fast)								
	3	160 (0)	0 (0)	310 (0)	13980 (23)	530 (0)	1410 (5)	2602 (6)
	5	0 (0)	0 (0)	0 (0)	200 (0)	210 (0)	0 (0)	0 (0)
	8	1410 (0)	0 (0)	120 (0)	0 (0)	0 (0)	0 (0)	0 (0)
2 (inoculated at end of fast)								
	6	0 (0)	0 (0)	0 (0)	770 (2)	0 (0)	0 (0)	0 (0)
	11	440 (0)	350 (0)	460 (0)	240 (0)	340 (0)	380 (0)	0 (0)
	13	0 (0)	0 (0)	570 (0)	140 (0)	0 (0)	0 (0)	0 (0)
3 (nonfasted control)								
	1	0 (0)	0 (0)	1100 (3)	0 (0)	0 (0)	0 (0)	0 (0)
	7	290 (0)	0 (0)	0 (0)	480 (0)	0 (0)	300 (0)	0 (0)

* = all calves inoculated with IBR virus

Data expressed as disintegrations per minute (dpm); 0 = < 100

Values for stimulation index (SI) shown in parentheses: 0 = ≤ 2

TABLE 3. Mean total leukocyte counts per ml of whole blood.

Group	Experimental days							
	-3	0*	1	2	3	4	5	7
1 (inoculated 24 hours into fast)								
	15600	11500	12000	12600	14600	13800	13500	11200
2 (inoculated at end of fast)								
	10600	10200	12800	10600	11100	12000	11900	9700
3 (nonfasted control)								
	11000	11800	11100	10900	11000	12500	12800	11300

* = time of inoculation with IBR virus

TABLE 4. Mean hematocrit values (Hct%).

Group	Experimental days							
	-3	0*	1	2	3	4	5	7
1 (inoculated 24 hours into fast)	32.0 ^c	<u>36.0</u> ^a	<u>36.0</u> ^a	<u>35.5</u> ^{ab}	33.8 ^{abc}	33.3 ^{bc}	31.5 ^c	31.3 ^c
2 (inoculated at end of fast)	31.8 ^c	<u>36.7</u> ^a	34.5 ^{ab}	32.5 ^{bc}	30.5 ^c	31.3 ^c	30.3 ^c	30.8 ^c
3 (nonfasted control)	32.6	33.8	33.9	32.5	32.0	32.8	32.5	32.3

Means within the same group with different superscripts differ (P < 0.01)

* = time of inoculation with IBR virus

Means obtained during fasting are underlined

TABLE 5. Mean serum cortisol concentration ($\mu\text{g}/\text{dl}$).

Group	Experimental days					
	-3	0*	1	2	3	4
1 (inoculated 24 hours into fast)	3.23 ^{abc}	<u>4.26</u> ^a	<u>3.53</u> ^{ab}	<u>2.43</u> ^{bcd}	1.50 ^d	1.90 ^{cd}
2 (inoculated at end of fast)	1.56 ^b	<u>4.25</u> ^a	2.40 ^b	1.87 ^b	1.45 ^b	1.30 ^b
3 (nonfasted control)	2.66	2.72	1.63	1.63	1.61	1.31

Means within the same group with different superscripts differ ($P < 0.01$)

* = time of inoculation with IBR virus

Means obtained during fasting are underlined



The University of Missouri is an equal opportunity institution

7/87/1M