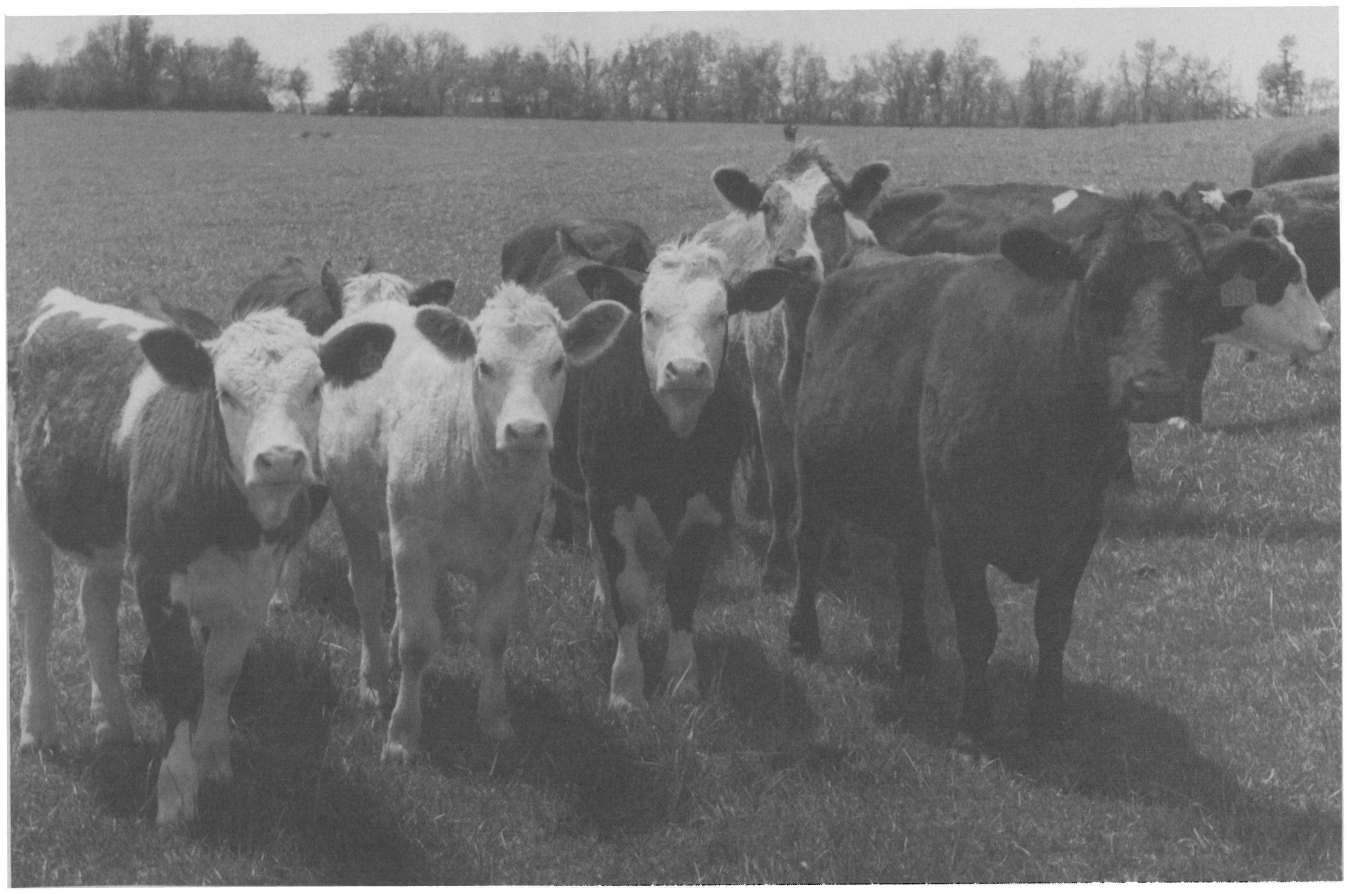
1991 BEEF CATTLE REPORT



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Animal Sciences Report 119

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This 1991 Beef Cattle Report summarizes our beef cattle research efforts during the past year. The overall goal of our beef research program continues to be to enhance Missouri's beef cattle industry through improved forage production and utilization, nutrition, physiology, genetics, management and health.

In this report we have attempted to briefly inform you of what we have done, what we found and how you may use these results in your operation. We welcome your suggestions on how to do a better job in communicating our research results.

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 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,

Gary L. Allee

Gary L. Allee
Department Chairman

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BIOLOGICAL VARIABILITY AND CHANCES OF ERROR

The variability among individual animals in an experiment often 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 results 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 1 (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 (e.g., 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 possibility of measuring the real differences resulting from treatment and thus overcoming animal variation. 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
Beef Cattle Report Editor

REPRODUCTIVE EFFICIENCY IN BOVINE FEMALES CARRYING A 1/29 CHROMOSOME TRANSLOCATION

D.W. Vogt[1] and R.R. Maurer[2]

SUMMARY

Chromosomal evaluations were conducted on 120 daughters, granddaughters or great granddaughters of a presumed 1/29 translocation carrier Simmental bull. Forty-eight (40%) of these related females were carrying the 1/29 translocation and 72 (60%) were chromosomally normal. These two groups of females were compared with regard to days to first calf, percentage of calves produced and weaned, calving interval, calving efficiency, rearing efficiency and production efficiency. Only in calving efficiency did differences between the two groups approach significance at P=.05. Calving efficiency was lower (P<0.07) in the translocation carrier (74.8%) than in the chromosomally normal (81.5%) females. Other trait comparisons showed equality or favored the chromosomally normal females but differences were not significant (P≥0.20).

INTRODUCTION

Attachment of a whole chromosome or a chromosome frequent to another chromosome in the set is called a translocation. Translocations involving chromosome pairs 1 and 29 (or other chromosome pairs) are well-documented in many cattle breeds (Long, 1985). Animals that are heterozygous (carriers) for the 1/29 translocation have 59 chromosomes instead of the normal complement of 60 chromosomes. Sexually mature 1/29 translocation carrier animals (male or female) produce a high proportion of chromosomally unbalanced gametes (sperm or ova) which, when involved in a fertilization, produces a conceptus which is generally predestined for an early prenatal death (Gustavsson, 1979; Popescu, 1980; King et. al, 1981). This, of course, is expected to reduce the reproductive efficiency of translocation carrier animals.

The purpose of this study was to compare calving and rearing efficiencies of 1/29 translocation carrier and chromosomally normal females which were daughters, granddaughters and great granddaughters of a presumed 1/29 translocation carrier Simmental bull.

MATERIALS AND METHODS

The pregnancy status of 120 cows which were daughters, granddaughters or great granddaughters of one Simmental bull was determined and chromosome analyses were completed. All animals were reared and housed at the Roman L. Hruska U.S. Meat Animal Research Center and were born between 1971 and 1982. Cows were maintained as three separate breeding groups and were generally pasture-mated by one or multiple sires for 45 to 60 days. Some cows were artificially inseminated and then exposed to bulls after the artificial insemination season. Only bulls and semen of known fertility were used. Matings occurred in the spring (May to July) and fall (November and December) breeding seasons.

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[2]USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE (Deceased).

Reproductive traits were compared between the 1/29 translocation carrier and chromosomally normal females. Days to first conception was calculated by subtracting 285 from cow age in days at first calving. Calving interval was calculated by subtracting the date born of the first and last calf and dividing by number of calves minus one. Calving efficiency of each cow was calculated as,

$$\text{Calving Efficiency} = \frac{\text{Number of calves born}}{\text{(Cow age in years at end of sampling)-(age in years at first conception)}}$$

Rearing efficiency was calculated for each female as the number of calves weaned divided by the number of calves born. Production efficiency was calculated by multiplying calving efficiency times rearing efficiency. All data, except pregnancy status, were analyzed by a one-way analysis of variance (GLM; SAS, 1985).

RESULTS AND DISCUSSION

Calving, rearing and production efficiencies of chromosomally normal and 1/29 translocation carrier females are given in Table 1. Only in calving efficiency did differences between the two groups approach significance ($P = 0.07$). Calving efficiency was lower in the carrier (74.8%) than in the noncarrier (81.5%) females. Differences between the two groups in age, number of calves produced and weaned, calving interval, rearing and production efficiencies and days to first calf were not significant ($P \geq 0.20$). However, in the latter traits, comparisons showed equality or favored the chromosomally normal females.

The reduced calving efficiency resulted from the 1/29 translocation carrier females exhibiting a delay to first successful conception of 28 days and a longer interval from their last calving until being either removed from the herd or to the end of the sampling period. This is similar to the finding of Kovacs and Csukly (1980) that 1/29 carrier females were older than chromosomally normal females by 30.5 days at their first successful conception in Hungarian Simmental cattle.

The reduced fertility and calving efficiency in the 1/29 translocation carrier females reflects their production of a high percentage of chromosomally unbalanced gametes and zygotes resulting in early embryonic death. Early embryonic death would increase the age at successful conception, reduce pregnancy rates and cause some 1/29 translocation carrier females to be culled as repeat breeders or open females. This was evident in the present study in that twice (26.2%) as many descendants of the 1/29 translocation carrier Simmental sire were culled for not being pregnant as the descendants (13.1%) of the next highest sire.

Kovacs and Csukly (1980) also reported that the average calving interval in 1/29 translocation carrier females was 21.6 days longer than in chromosomally normal females. In the present study, calving intervals were the same in the two groups of females (404.0 days for chromosomally normal females and 404.7 days for 1/29 carrier females). Culling females which did not conceive during the assigned breeding season (as was the practice in the present study) would reduce the difference found between 1/29 carrier and chromosomally normal females and likely explains the difference between the calving interval differences found in this study and that found by Kovacs and Csukly (1980).

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TABLE 1. Calving, rearing and production efficiencies of 1/29 translocation carriers and chromosomally normal cows which were descendants of one Simmental bull.

	Chromosomally normal	1/29 carriers	Probability
No. cows	72	48	
Avg. cow age (yr) at end of sampling period	4.7±0.2[a]	4.8±0.3	0.76
Days to first conception	480.0±13.8	508.0±16.9	0.20
Days to first calf	765.0±13.8	793.0±16.9	0.20
No. calves produced	2.8±0.2	2.7±0.3	0.72
No. calves weaned	2.3±0.2	2.3±0.3	0.98
Calving interval (days)	404.0±9.4(49)[b]	404.7±11.8(31)[b]	0.97
Calving efficiency (%)	81.5±2.3	74.8±2.8	0.07
Rearing efficiency (%)	80.3±3.9	77.7±4.7	0.68
Production efficiency (%)	63.5±3.3	59.3±4.1	0.43

[a]Least square means ± standard error of mean.

[b]Numbers in parentheses are the number of cows which had two or more calvings.

HERITABILITIES AND GENETIC AND PHENOTYPIC CORRELATIONS INVOLVING BIRTH WEIGHTS AND YEARLING PELVIC MEASUREMENTS IN ANGUS AND SIMMENTAL HEIFERS.

D.W. Vogt[1], J.B. Glaze[2], R.J. Lipsey[1] and M.G. Siemens[3]

SUMMARY

Genetic and phenotypic parameters were estimated for birth weight and height, width, and area measurements of pelvic size in yearling Angus and Simmental heifers. Data were from records collected at Nichols Farms in Bridgewater, Iowa over the 6-year period from 1984 through 1989. Records were available on 629 Angus heifers and 325 Simmental heifers representing 93 and 49 paternal half-sib sire groups, respectively. Heritabilities for birth weight (BW), pelvic height (PH), pelvic width (PW) and pelvic area (PA) for Angus were 0.30, 0.61, 0.29, and 0.43, respectively. Corresponding values for Simmental heifers were 0.14, 0.34, 0.44 and 0.37. Genetic correlations were consistently larger than corresponding phenotypic correlations. Genetic correlations between BW and the three measures of pelvic size were negative (range -.18 to -.36) except for the positive estimates of 0.53 for BW and PW and 0.26 for BW and PA in Simmental heifers. Phenotypic correlations between birth weights and the three measures of pelvic size were consistently low and ranged from 0.04 to 0.09.

INTRODUCTION

Numerous studies (Bellows et al., 1971; Rice and Wiltbank, 1972; Price and Wiltbank, 1978; Belcher and Frahm, 1979; Short et al., 1979; Deutscher, 1987) have shown that the incidence of dystocia increases as the ratio of calf size to dam's pelvic size increases. In these studies and others, a number of factors have been shown to influence calving difficulty but calf birth weight and dam's pelvic size apparently play major roles.

Many estimates of the heritability of calf birth weight have been published. A summary by Woldehawariat et al. (1977) of 75 such studies yielded an average weighted value of 0.45. Estimates of the heritability of pelvic size are not so numerous. Recent studies (Neville et al., 1978; Benyshek and Little, 1982; Green et al., 1984; Holzer and Schlote, 1984; Morrison et al., 1984; Nelsen et al., 1986) indicate that estimates of pelvic size heritability are generally high but ranging, for pelvic area, pelvic height, and pelvic width from 0.04 to 0.68, 0.10 to 0.57, and 0.18 to 0.83, respectively. The average size of these estimates suggest that selection for increased pelvic size would be quite effective. However, there is evidence (Benyshek and Little, 1982) that benefits from the resultant increased pelvic size might be partially offset by correlated increases in calf birth weights. Evidence to the contrary is reported by Nelsen et al., (1986).

The primary purpose of this study was to provide additional evidence regarding the genetic and phenotypic correlations between birth weight and measures of pelvic size. In addition, estimates of the heritability of these same traits were calculated.

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2 Graduate student, Department of Animal Science, Kansas State University, Manhattan.

3 Technical Representative, Dekalb Feeds, Davenport, Iowa.

MATERIALS AND METHODS

Data for this study were collected at Nichols Farms in Bridgewater, Iowa over the 6-year period from 1984 through 1989. Information collected on heifers included birth weights and yearling pelvic height, width, and area and their age and body weight at measurement. Pelvic height was determined by measuring the linear distance from the approximate midpoint of the dorsal surface to the symphis pubis to the ventral surface of the midsacrum. Pelvic width was obtained by measuring the distance between the shafts of the ilea at right angles to the height measurement. Pelvic area was calculated as the product of the height and width measurements.

A total of 629 Angus heifers representing 93 sire groups and 325 Simmental heifers representing 49 sire groups were used in the analyses. Variance and covariance components were estimated by a mixed model least squares procedure which considered the effects of sire group and progeny birth year. Pelvic measurement data were adjusted to the average age (days) at measurement (Angus = 421, Simmental = 402) using linear regression coefficients determined for each breed separately. Heritabilities and correlations were estimated using paternal half-sib procedures.

RESULTS AND DISCUSSION

Heritability estimates

Heritability estimates for the four traits are shown in table 1 for the two breeds separately.

Birth weight heritability estimates were calculated to be 0.30±0.13 and 0.14±0.17 for Angus and Simmental breeds, respectively. Many estimates of the heritability of calf birth weight have been reported. A summary by Woldehawariat et al. (1977) of 75 such studies yielded an average weighted value of 0.45 with individual estimates ranging widely from 0.00 to 0.94.

Heritabilities for the three pelvic size traits ranged from 0.29±0.13 to 0.61±0.17. Previously published (Neville et al., 1978; Benyshek and Little, 1982; Green et al., 1984; Holzer and Schlote, 1984; Morrison et al., 1984; Nelsen et al., 1986) estimates for these three traits have generally been high but range, for pelvic height, pelvic width and pelvic area from 0.10 to 0.57, 0.18 to 0.83, and 0.04 to 0.68, respectively. The average magnitude of these estimates, as well as those from the present study, suggest that selection for increased pelvic size would be quite effective in improving pelvic size.

Genetic and Phenotypic Correlations

Genetic and phenotypic correlations between birth weight and the three pelvic size traits, for the two breeds separately, are shown in table 2. Phenotypic correlations are consistently low and range only from 0.04 to 0.09. Corresponding estimates for the two breeds are nearly identical for all trait combinations. These values are nearly the same as those reported by Nelson et al. (1986) (range 0.07 to 0.10) but smaller than those reported by Benyshek and Little (1982) (range 0.21 to 0.25).

Genetic correlations between birth weight and pelvic height were very similar for the two breeds ranging from -0.30 for Simmental heifers to -0.34 for Angus heifers. However, estimates of the genetic correlations between birth weight with pelvic width and with pelvic area were quite different for the two breeds resulting in conflicting

interpretations as to consequences of effective selection programs aimed at increasing pelvic size. For the genetic correlation between birth weight and pelvic width, estimates were -0.18 in Angus and 0.53 in Simmentals. Similarly, the genetic correlation between birth weight and pelvic area was calculated to be -0.36 using Angus data and 0.26 using Simmental data. The consistently negative values for the Angus breed suggest that effective selection for increased pelvic size (height, width, and area) would not cause corresponding increases in calf birth weight. This same conclusion is reached from analyses of Simmental data only with regard to the genetic correlation between birth weight and pelvic height (r_g = -.30). In contrast, genetic correlations between birth weight with pelvic width (r_g = 0.53) and with pelvic area (r_g = 0.26) using Simmental data suggest that benefits from resultant increased pelvic size might be partially offset by correlated increases in calf birth weights.

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Table 1. Heritabilities for birth weight and yearling pelvic measurements (height, width and area) in Angus and Simmental heifers.

Breed	Trait	Heritability
Angus	Birth weight	0.30±0.13
Simmental		0.14±0.17
Angus	Pelvic height	0.61±0.17
Simmental		0.34±0.21
Angus	Pelvic width	0.29±0.13
Simmental		0.44±0.22
Angus	Pelvic area	0.43±0.15
Simmental		0.37±0.21

Table 2. Genetic and phenotypic correlations between birth weights and yearling pelvic measurements (height, width and area) in Angus and Simmental heifers.

		Correlation	
Breed	Trait	Genetic	Phenotypic
Angus	Birth weight and	-.34	.05
Simmental	Pelvic height	-.30	.04
Angus	Birth weight and	-.18	.08
Simmental	Pelvic width	.53	.08
Angus	Birth weight and	-.36	.09
Simmental	pelvic area	.26	.08

LUTEAL FUNCTION FOLLOWING INFUSION OF BOVINE RECOMBINANT INTERFERON-α_I1 INTO THE UTERUS OF POSTPARTUM BEEF COWS ANTICIPATED TO HAVE SHORT OR NORMAL LUTEAL PHASES

H.A. Garverick, M.T. Moser, D.H. Keisler, S.A. Hamilton, R.M. Roberts and M.F. Smith[1]

SUMMARY

Subnormal corpora lutea often occur in postpartum cows following the first ovulation after early weaning of calves or gonadotropin-induced ovulations. Subnormal corpora lutea regress prior to the time that the anti-luteolytic actions of the conceptuses is manifested (day 13). In the present study, intrauterine infusion of recombinant bovine interferon-α_I1 (rboIFN-α_I1) delayed regression of corpora lutea anticipated to have a short lifespan. Development of a practical treatment with rboIFN-α_I1 may lead to decreased incidence of short estrous cycles and may thereby increase the fertility of postpartum beef cows. This may result in fewer days to the subsequent pregnancy in postpartum cows and a reduction in the length of the next calving season.

INTRODUCTION

The corpus luteum is a transient endocrine gland responsible for secreting progesterone and, therefore, regulating the length of gestation and the estrous cycle. In cattle, subnormal corpora lutea form spontaneously before the first ovulatory estrus in prepuberal heifers, postpartum cows and following the early weaning of calves from cows. Similar luteal structures have been induced following early postpartum injection of gonadotropin releasing hormone (GnRH) or human chorionic gonadotropin (hCG), unless the cows have been pretreated with a progestin (norgestomet).

The first corpus luteum formed postpartum does not have an inherently short lifespan. Reduced luteal lifespan appears to be associated with a premature release of $PGF_2\alpha$ from the uterus (Copelin et al., 1987, 1989; Zollers et al., 1989; Cooper and Inskeep, 1990). Presence of an embryo prevents luteolysis in sheep and cattle unless the corpus luteum regresses prior to maternal recognition of pregnancy. Luteal regression in cows with short luteal phases occurs prior to initiation of the anti-luteolytic action by the conceptus. Recently, conceptus proteins with a anti-luteolytic function have been purified in sheep (ovine trophoblast protein 1; oTP-1) and cattle (bovine trophoblast protein-1; bTP-1). These proteins have considerable sequence similarity to interferons. Uterine infusion of bTP-1 around the time of maternal recognition of pregnancy extends luteal function in cattle (Thatcher et al., 1989). Similar results have been reported following intrauterine infusion of the more readily available recombinant bovine interferon-α_I1 (rboIFN-α_I1) into cows from days 15.5 to 21 post estrous (day 0 = estrus; Plante et al. ,1988). In cattle, bTP-1 may increase the activity of an endometrial (uterine) prostaglandin synthesis inhibitor, thereby reducing endometrial $PGF_2\alpha$

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[1]Garverick, Keisler, Roberts and Smith are Faculty members in Animal Sciences Department; Moser and Hamilton are graduate students.

synthesis (Gross et al., 1988a, 1988b). It is not known, whether administration of rboIFN-α_I1 will prevent subnormal luteal function. If so, such treatment may provide a method of reducing the incidence of short cycles and thereby increase the fertility of postpartum beef cows. The present study was conducted to determine if uterine infusions of rboIFN-α_I1 will prevent premature regression of corpora lutea expected to have a short lifespan.

PROCEDURES

Twenty-six beef cows in good body condition were allotted at parturition into four treatment groups in a 2 X 2 factorial design. Treatments were: saline, Group 1; rboIFN-α_I1, Group 2; norgestomet-saline, Group 3; and norgestomet-rboIFN-α_I1, Group 4. Norgestomet implants were inserted on days 21-24 postpartum and removed 9 days later (prior to hCG injection).

Following calving, cows were observed for estrus twice daily until the end of the first luteal phase. From calving until induction of ovulation with hCG, ovarian activity was monitored by determination of progesterone from serum twice weekly. Ovulation was induced 30 to 33 days postpartum with 5,000 or 10,000 IU hCG. Short-lived corpora lutea have been induced following injection of hCG early postpartum. Normal estrous cycles occur following pretreatment with norgestomet for 9 days in early postpartum cows. The purpose of groups 1 and 2 was to determine if intrauterine infusion of rboIFN-α_I1 on days 1-12 post hCG injection would prevent subnormal luteal function. Groups 3 and 4 served to verify that intrauterine infusions of rboIFN-α_I1 on days 13-24 post injection would prolong luteal function. Groups 1 (n = 7) and 3 (n = 5) were infused twice daily with saline (1 ml; containing bovine serum albumin similar to protein concentration of rboIFN-α_I1 in groups 2 and 4) on days 1 to 12 or 13 to 24 post hCG injection, respectively. Cows allotted to groups 2 (n = 8) and 4 (n = 6) were given intrauterine infusions (recto-cervical approach) of 2 mg rboIFN-α_I1 (1 ml) twice daily on days 1 to 12 or 13 to 24 post hCG injections, respectively. Sterile intrauterine infusion (stainless steel) catheters were used for infusions. In addition, blood samples were collected twice daily during intrauterine infusions and daily throughout the remainder of the first estrous cycle.

RESULTS AND DISCUSSION

The main treatment effects of norgestomet and rboIFN-α_I1 on length of the luteal phase were both significant ($P<.01$) and the interaction was nonsignificant (Figure 1). Norgestomet pretreatment increased estrous cycle length 10.2 days in saline-treated animals, while infusion of rboIFN-α_I1 increased estrous cycle length 5.7 days in cows anticipated to have short estrous cycles (Groups 1 and 2) and 2.2 days in cows anticipated to have normal estrous cycles (norgestomet pretreated; Groups 3 and 4). Pattern of secretion of progesterone in serum differed within and among treatments ($P<.01$; Figure 2). Concentration of progesterone in serum was similar among groups during the first 6 days following hCG-induced ovulation. Thereafter, mean concentration of progesterone declined and was lower ($P<.01$) in control cows (Group 1) from day 8 to 13 than in cows infused with either rboIFN-α_I1 or pretreated with norgestomet.

In the present study, intrauterine infusion of rboIFN-α_I1 delayed the luteolysis of corpora lutea anticipated to have a short lifespan. Although inhibition of endometrial PGF2α synthesis is a possible mechanism, an effect at the ovarian level cannot be eliminated. Further study is needed to examine the mechanism whereby rboIFN-α_I1 extends luteal function in corpora lutea intended to be short-lived. Regardless, development of a treatment to reduce the incidence of short cycles may result in increased fertility of postpartum beef cows.

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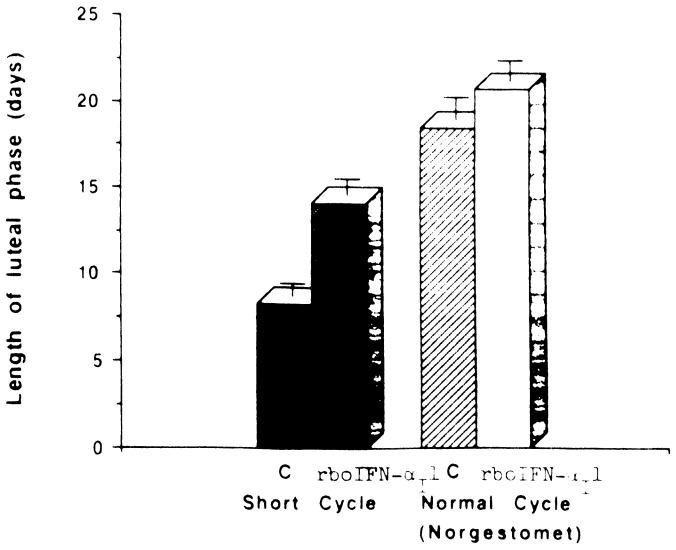

Figure 1. Length of luteal phase in anestrous beef cows following induction of ovulation with hCG on days 30-33 postpartum. Cows pretreated with norgestomet were anticipated to have normal length luteal phases, the others short luteal phases. Cows were given intrauterine infusions of either saline or recombinant bovine interferon-$\alpha_1$1 (rboIFN-$\alpha_1$1) on days 1-12 (short luteal phase) or 13-24 (normal luteal phase), respectively.

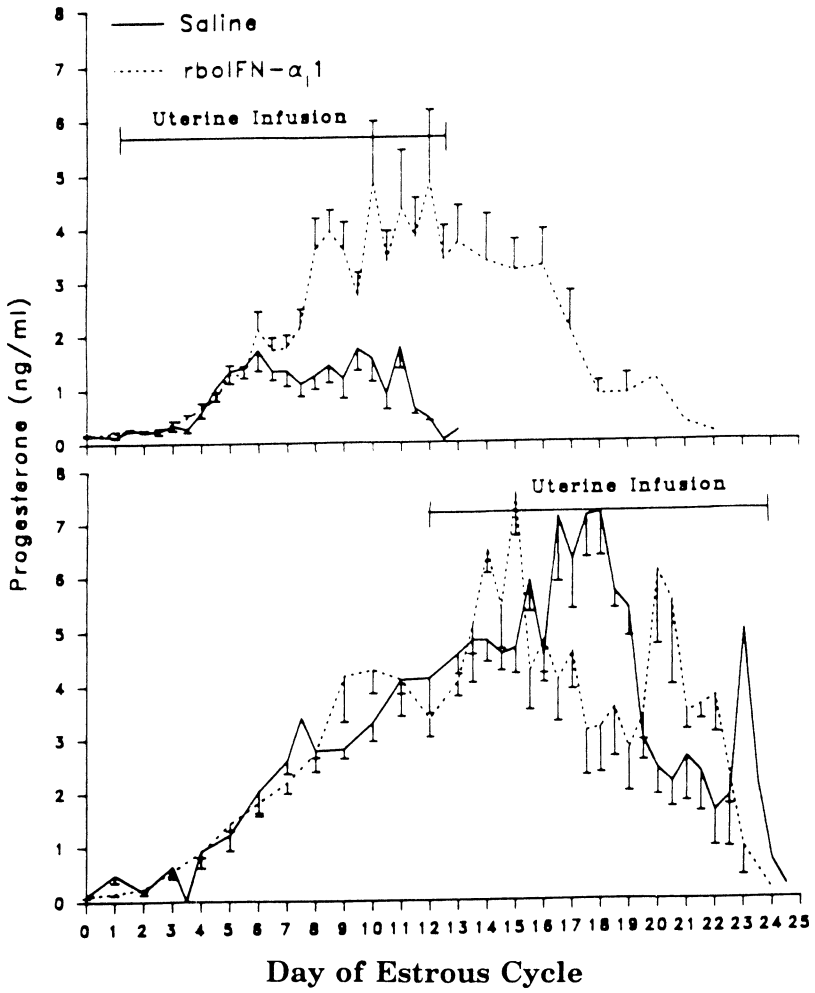

Figure 2. Concentration of progesterone in serum of anestrous beef cows following induction of ovulation with hCG on days 30-33 postpartum. Cows represented on the lower panel were pretreated with norgestomet and were anticipated to have normal length estrous cycles. Cows represented in the upper panel were anticipated to have short estrous cycles. Intrauterine infusions of saline or recombinant bovine interferon-α_I1 (rboIFN-α_I1) were performed on days 1-12 for cows in the upper panel and on days 13-24 for cows in the lower panel.

INFLUENCE OF RUMEN FERMENTATION ENDPRODUCTS ON SECRETION OF REPRODUCTIVE AND METABOLIC HORMONES IN BEEF HEIFERS

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SUMMARY

Energy affects release of pituitary and ovarian hormones. The mechanisms by which energy affects these hormones is not yet understood. Propionate, an endproduct of rumen fermentation released in large proportions during grain feeding, or acetate, another fermentation byproduct released in large proportions during forage feeding, were tested to determine their effects on release of luteinizing hormone (LH) and insulin in cyclic heifers. Heifers had been fed an energy-restricted diet for 7 days prior to ruminal infusion of these acids and an appropriate buffer or buffer alone. Another group of cyclic heifers served as a fed control. Heifers fed the energy-restricted diet lost 6% of their initial body weight, while those in the fed control gained 6% of their initial body weight. Mean concentration of LH in heifers infused with buffer alone was similar to that of heifers in the fed control; thus, effects of volatile fatty acid infusions were not detectable. Mean concentrations of insulin were increased in heifers infused with propionate. Insulin has been associated with increased LH secretion. Insulin or propionate may be the key links between energy status and reproduction.

INTRODUCTION

It is well established that nutrition plays an important role in control of reproduction in domestic animals (Short and Adams, 1988). Various effects of energy protein, mineral and vitamin deficiencies on reproductive performance have been studied. Of particular interest to cattlemen are the effects of energy on reproduction. energy contributes up to 70% of the nutrient costs in a beef production enterprise. By mechanisms not yet understood, energy affects pituitary and ovarian hormones.

Attempts to elucidate the role of energy on reproduction have provided evidence of a role for glucose or insulin. Propionate, a volatile fatty acid (VFA) endproduct of rumen fermentation released in large proportions during grain-feeding and a precursor of glucose, has been linked with improved secretion of luteinizing hormone (LH). This hormone, released in a pulsatile manner from the pituitary, contributes to maturation and ovulation of follicles. Prepuberal heifers treated with propionate (Rutter et al., 1983), and cows treated with monensin (Harrison et al., 1982), a feed additive that enhances rumen production of propionate, had improved LH secretion. However, little is known about how propionate stimulates LH secretion, and if other rumen VFA, namely acetate (produced in large proportions during forage-feeding), affect LH secretion as well. Understanding

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differences in LH secretion in response to endproducts of rumen fermentation is important to aid in devising feeding strategies to improve reproductive efficiency.

MATERIALS AND METHODS

Sixteen cyclic, rumen-cannulated Angus heifers (692 lb) were randomly assigned to one of three infusion groups; acetate (ACE), propionate (PRO) or control (CON), or a normal fed control (POS). Prior to infusion, on day 6 of a synchronized estrous cycle (estrus = day 0), heifers were switched from an 86:24 forage to grain ration fed at 2% of their body weight to an energy-restricted diet supplemented with protein, vitamins and minerals to meet requirements for these nutrients. On day 11 of the estrous cycle, heifers were given a prostaglandin injection and 24 hours later infusions began. Weights were taken after a 12-hour shrink on days 6 and 12 of the estrous cycle. Infusions lasted 6 hours during which blood samples were collected for insulin and LH analyses. Heifers in ACE or PRO treatments received intraruminally 1.7 Mcal of metabolizable energy from the respective acid plus a suitable buffer, while those in the CON group received buffer alone. Heifers in the POS group continued to receive their normal ration throughout the experiment.

RESULTS AND DISCUSSION

Heifers in all infusion treatments lost approximately 6% of their body weight during the energy restriction period prior to the infusion, while those assigned to the POS treatment gained 6% of their body weight (Table 1). Weight loss of heifers assigned to infusion treatments may not have been sufficient to affect LH secretion (Table 2). Mean LH concentrations during the 6-hour infusion period were similar for heifers in all treatment groups (Table 2). Lack of significant differences in mean LH concentration between CON and POS heifers suggest that energy restriction was not severe enough to affect LH secretion. Thus, effects of ACE or PRO infusions were undetectable.

Conversely, infusion of propionate was effective in stimulating insulin secretion (Table 2). Insulin concentrations in heifers infused with propionate increased ($P < .05$) 32%, while concentrations of insulin in heifers in the other infusion groups or the normal fed control decreased ($P < .05$) 14 to 31%.

Propionate increased secretion of LH in prepuberal heifers and cows treated with monensin (Harrison et al., 1982; Randel et al., 1983). Insulin may be associated with LH secretion in cyclic heifers (McCann and Hansel, 1986). However, increased insulin secretion in PRO heifers did not affect LH secretion in this study because LH secretion was not affected by the energy restriction, or the infusion period was not long enough, or both. Although results of this study are inconclusive with regard to effects of propionate on LH secretion, observed insulin response as a result of propionate infusion may provide an explanation to research results where propionate was demonstrated to affect LH secretion.

Further studies are being conducted to ascertain the role of propionate and insulin on LH secretion. Meanwhile, it is suggested that feeding programs be evaluated for content of propionate-producing feedstuffs. Use of monensin for improved feed efficiency and potential improvement in reproductive performance must also be considered.

TABLE 1. WEIGHTS AND WEIGHT CHANGES DURING ENERGY RESTRICTION[a]

Item	ACE	PRO	CON	POS	SE
No. of heifers	4	4	4	4	
Initial wt, lb	687	696	668	716	25
Final wt, lb	640[b]	645[b]	632[b]	762[c]	28
Wt change, lb	-47[b]	-51[b]	-36[b]	46[c]	15

[a]Seven days prior to initiation of infusions.
[b,c]Means with different superscripts differ ($P < .05$).

TABLE 2. MEAN CONCENTRATION OF LH AND INSULIN AND CHANGES IN INSULIN CONCENTRATION DURING INFUSION PERIOD[a]

Item	ACE	PRO	CON	POS	SE
LH, ng/ml	1.24	1.15	1.29	1.16	.10
Insulin, ng/ml					
Pre-infusion	.91	.82	.88	.88	.15
During infusion	.74[b]	1.08[c]	.76[b]	.61[b]	.07
Change	-.17[b]	.26[c]	-.12[b]	-.27[b]	.13

[a]Six hours on day 12 of the estrous cycle.
[b,c]Means with different superscripts differ ($P < .05$).

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USING MGA AND PROSTAGLANDIN FOR ESTROUS SYNCHRONIZATION IN BEEF HEIFERS[1].

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SUMMARY

The University of Missouri, Kansas State University and the University of Minnesota conducted a five location trial to study the use of MGA feeding and a single injection of prostaglandin (Lutalyse) to synchronize heat in yearling heifers for artificial insemination (AI). Trials were conducted at the North Missouri Center in Spickard, MO; Ft. Hays and Manhattan, KS and St. Paul and Star Buck, MN. Three hundred and sixty-two yearling heifers were used in the study and were allotted to one of two treatments. Group 1 served as a control group in which no estrous synchronization was conducted. These control heifers were bred by AI 12 hours after visual signs of heat were observed. The second group were fed .5 mg of MGA per head per day for 14 days. Sixteen days after the MGA feeding ended, the heifers in group 2 were injected with 5 ml of Lutalyse. Feeding MGA for 14 days had a positive impact on heifers that had not yet reached puberty. Puberty was induced in more heifers that were fed MGA than in the control group (78% versus 41%). The first service conception rate of heifers that attained puberty as a result of the MGA feeding was not different from the heifers in the control group that reached puberty during the same time period. The number of heifers bred by AI, either during the 21 days natural cycle for the control group, or 6 days synchronized estrus for the MGA group, was not different (70.1% for the control verses 76.4 for the MGA group). The first service conception rate was 62.5% for the heifers fed MGA and injected with Lutalyse, this compared to 55.8% in the control group, this difference was not statistically significant. The MGA system synchronized heat well and allowed for more heifers to become pregnant early in the breeding season than the un-synchronized control group.

INTRODUCTION

Development, selection, breeding, and calving of replacement heifers plays a fundamental role in the total management of beef herds. Identifying potentially productive heifers and managing them so that they become prolific cows is a critical first step toward profitability. One management practice that has been used to facilitate the breeding of heifers is to manage their reproductive cycle so that estrus, or heat, is synchronized and comes at a time when breeding can be done most easily and effectively. Synchronization of estrus also facilitates the use of genetically superior sires through artificial insemination. The economic value of estrous synchronization and artificial insemination varies greatly, depending on management and environmental conditions.

During the past few years, research has been conducted on a relatively new approach

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[1] This research project resulted from cooperative efforts of the North Central Region Committee for Cow-Calf Nutrition and Management (NCR-87).

to synchronizing estrus in heifers. Combining an orally administered synthetic progesterone, melengestrol acetate or MGA, with a prostaglandin, like Lutalyse[2], has been effective in both synchronizing estrus of pubertal heifers and in inducing puberty in heifers that have not yet reached sexual activity. This system was originally designed by researchers at Colorado State University and involves feeding MGA for 14 days; allowing the heifers to cycle once without breeding them; then injecting them with a prostaglandin (Lutalyse, Bovilene, or EstruMate) 16 or 17 days after MGA feeding ends. The purpose of the research described in this paper was to compare heifers synchronized with the MGA-$PGF_{2\alpha}$ system against a non-synchronized control group.

EXPERIMENTAL PROCEDURES

Treatments. Heifers at each location were randomly assigned to one of two treatments. The treatments were 1) non-synchronized control group (CONTROL), and 2) 14 day MGA feeding (.5 mg/head/day) followed by one prostaglandin (Lutalyse[3]) injection 16 days after last day of MGA feeding. Estrus detection and artificial insemination began following the Lutalyse injection in both treatments and continued for 24 days (any second breeding of heifers was excluded from the analysis). All inseminations were done approximately 12 hours after behavioral estrus was observed. Inseminations were done by no more than two technicians and to no more than two sires at each location.

Locations. There were five locations used in the study. Table 1 lists the locations and number of heifers used at each study site.

TABLE 1. LOCATION SITES AND NUMBER OF HEIFERS FOR MGA-$PGF^{2\alpha}$ STUDIES

Location	CONTROL	MGA-$PGF_{2\alpha}$
Ft. Hays, Kansas	84	84
Manhattan, Kansas	41	38
Spickard, Missouri	28	29
St. Paul, Minnesota	12	12
Star Buck, Minnesota	19	18
TOTAL	184	181

Supplement. A similar supplement, with the exception of the MGA addition, was fed to each treatment group. Heifers were managed as one group during the entire trial except during the 14 day MGA feeding period. An MGA-200 premix[4] was used to provide .5 mg/head/day MGA and was mixed to provide a 5 lb/head supplement as shown in Table 2.

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[2]Mention of trade name does not imply recommendation of these or other specific products by the University of Missouri.

[3] The Upjohn Company, Kalamazoo, MI provided MGA-200 premix and Lutalyse for these studies.

[4]200 mg melengestrol acetate per lb of premix.

TABLE 2. COMPOSITION OF SUPPLEMENTS FED DURING THE 14-DAY TREATMENT PERIOD

Ingredient	CONTROL		MGA-PGF$_{2\alpha}$	
	Lb	%	Lb	%
Ground Corn	3.45	69.00	3.45	69.03
Soybean Meal	1.49	29.83	1.49	29.85
Vitamin/Mineral Pack	.056	1.12	.056	1.12
MGA 200 Premix	.003	.05	-	-
TOTAL	5.00	100.00	5.00	100.00

Blood Sampling. Blood samples were drawn from all heifers at 4 prescribed times and assayed for progesterone. The sampling times were: (1) 10 days prior to the start of MGA feeding, (2) at the beginning of MGA feeding, (3) 10 days prior to the Lutalyse injection, and (4) at the time of the Lutalyse injection. This information was used to determine the number of pubertal heifers at the start of the experiment and the number of heifers in which estrus was induced by MGA feeding.

Results

Attainment of Puberty. Table 3 describes the effect of feeding MGA on heifers that were identified as non-pubertal before MGA feeding began. There was a significant location effect (P=.06) on percentage of pubertal heifers, likely due to the varied genetic and nutritional programs between locations. Thirty-seven percent more (P=.04) of the non-pubertal heifers attained puberty after the MGA feeding than occurred naturally (78% for MGA-PGF$_{2\alpha}$, 41% for CONTROL).

TABLE 3. EFFECT OF FEEDING MGA FOR 14 DAYS ON INDUCEMENT OF PUBERTY, FIRST SERVICE CONCEPTION AND PREGNANCY RATE IN NON-PUBERTAL HEIFERS

ITEM	%	%	Probability Value	
	CONTROL	MGA-PGF$_{2\alpha}$	TREATMENT	LOCATION
Pubertal, pre-MGA	62	65	.39	.06
Pubertal, post-MGA	71	81	.10	.73
Attained puberty	41	78	.04	.24
Artificially inseminated	100	94	.43	.01
First Service Conception	35	44	.29	.90
Pregnant in 21 days	35	41	.28	.89

There was no difference in first service conception rate, or 21 day pregnancy rate of the heifers that were induced to attain puberty by consuming MGA as compared to CONTROL heifers. This indicates that fertility in heifers attaining puberty after MGA was not adversely affected. There was a location effect (P=.01) for the number of heifers inseminated. This response was likely due to variation in method and intensity of estrus detection by technicians at different locations.

Synchrony of Estrus. Heifers fed MGA for 14 days and given a Lutalyse injection 16 days later expressed estrus at a higher (P<.001) level during the first 6 days of the breeding season than did the control heifers (Table 4).

TABLE 4. DISTRIBUTION OF BEHAVIORAL ESTRUS IN ALL HEIFERS

ITEM	% CONTROL	% MGA-$PGF_{2\alpha}$	Probability Value TREATMENT	LOCATION
Observed Behavioral Estrus by:				
6 days	25	77	<.001	.02
14 days	53	79	.24	.79
21 days	71	88	.30	.50

There was a numerically higher percent of heifers in estrus by 14 and 21 days following the $PGF_{2\alpha}$ injection. However this difference was not significant. Figure 1 shows the rate of estrus synchronization in the two treatment groups. Heifers given MGA-$PGF_{2\alpha}$ expressed estrus earlier during the AI period than the CONTROL heifers.

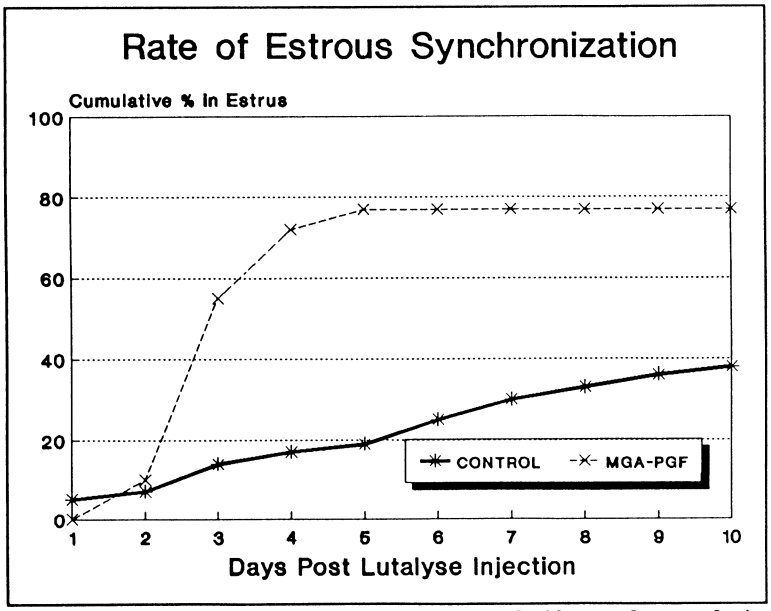

Figure 1 Cumulative percentage of heifers observed in behavioral estrus during the first 10 days of the breeding season.

Conclusions

It is concluded from this study that administering MGA for 14 days was affective in inducing puberty in pre-pubertal heifers. Fertility in puberty induced heifers was similar to heifers that attained puberty naturally. Feeding MGA for 14 days followed by a $PGF_{2\alpha}$ injection 16 days later was effective in synchronizing estrus in virgin heifers as compared to a non-synchronized control group. Low pregnancy rate in virgin

heifers is frequently the result of a large proportion of pre-pubertal heifers in the breeding herd at the start breeding. Reducing this proportion and while synchronizing estrus would be economically efficient and enhance the utilization of artificial insemination.

Application of the MGA/Prostaglandin Estrous Synchronization System

Based on this research the following procedure should be followed to implement this type of estrous synchronization system:

1. Develop the heifers to reach the desired weight and age at the start of the breeding season.

2. Determine the date that you plan to start the breeding season for the heifers.

3. Calculate backwards 32 days from the start of breeding and begin feeding .5 mg of MGA per head per day. It is critical that every heifer consume her quantity of MGA every day, therefore it is advisable to have the heifers accustomed to a similar supplement and feeding system before the MGA feeding begins. Adequate bunk space should also be provided so that all heifers can consume an equal amount of the supplement. Continue the MGA feeding for 14 days.

4. Withdraw the MGA and allow the heifers to cycle one time without breeding them. This heat cycle is sub-fertile and high conception can not be expected if they are mated at this estrus.

5. Sixteen days after the end of MGA feeding, inject all the heifers with the appropriate dosage of a prostaglandin such as Lutalyse, Bovilene, or EstruMate.

6. Observe the heifers for signs of estrus behavior and inseminate them 12 hours after they are seen in standing heat. The synchrony of estrus with this system does not allow for high success if breeding occurs at a pre-set time without regard to time of estrus.

This type of estrous synchronization system should allow a producer to get a high number of his heifers bred over a 5 to 7 day period. This would be a real advantage in getting heifers to calve early in the calving season and allow for more time to re-breed for her second calf. It may also eliminate the need of keeping a "heifer bull" to breed only the virgin heifers.

DAILY CHANGES IN ROTATIONALLY GRAZED GRASS-LEGUME PASTURES

V.G. Tate[1], R.E. Morrow[1] and J.R. Gerrish[2]

SUMMARY

Experiment 1

A 12-paddock rotation of a base bromegrass pasture with 4 paddocks brome and alfalfa, 4 of brome and birdsfoot trefoil and 4 fertilized with nitrogen was sampled each grazing day. Twelve cow-calf pairs grazed 16 acres. Paddocks were rotated every 3-4 days with 33-44 days rest. The grazing season was late April through September, 1989. Samples were taken each day to determine forage availability, forage quality and species composition. The quality estimates of the birdsfoot trefoil paddocks were fairly constant over the 3 days, with the exception that the bromegrass decreased in crude protein from 14% to 10%. The alfalfa paddocks were more variable. The crude protein of the alfalfa component decreased drastically the first two days and then leveled off. The acid detergent fiber and neutral detergent fiber increased to a greater level for alfalfa than for trefoil as grazing progressed. These data indicate a significant quality change for the alfalfa on a 3-day rotation but not for birdsfoot trefoil.

Experiment 2

Rotationally grazed alfalfa-orchardgrass pastures were sampled each grazing day to determine changes in forage availability, forage quality and species composition. The pastures were 13 acres divided into 6 paddocks and stocked with 12 cow-calf pairs. Pastures were cut for hay and then grazed from early June to late August 1989. Paddocks were rotated every 5-7 days and rested 25-35 days. The paddocks averaged 2255 lbs dry matter at the initiation of grazing, declined linearly the first 3 days and then leveled off. Protein of the alfalfa component was 25% initially and declined linearly each day grazed. Crude protein of the orchardgrass held fairly constant. The acid detergent fiber of the alfalfa was below 30% until day 4 and increased to 35%. The results indicate cattle had a high quality diet with excellent estimated consumption the first 3 days grazing the paddock. Then the quality of the diet changed and intake probably changed. To maintain a high quality diet more paddocks with a faster rotation should be used.

INTRODUCTION

Intensive rotational grazing is accomplished by subdividing a pasture into paddocks and moving the animals through these paddocks. By moving the animals the forage is provided with a period of rest which allows for uniform regrowth. Moving the animals also allows for greater utilization of the pasture and when properly managed, provides the animals with a higher level of nutrition. The critical decision is when to move the animals from one paddock to the next paddock. This decision is influenced by several factors involving both the animal and the plant. First, nutritional requirements of animals differ. A second factor is the legume must have a period of rest in order to be maintained in the stand. Carbohydrates are depleted from the root reserves in order for regrowth of the legume to occur. Continually grazing the legume plant off depletes the root reserves to a point where the plant no longer can sustain itself in the sward. By giving the plant a

period of rest, it is able to replace the carbohydrates in the roots. The remaining leaf area of the grass plant is also important because the plant must have sufficient leaf area in order for regrowth to occur. Daily changes were monitored to determine more effective ways to manage this system.

MATERIALS AND METHODS

In experiment one the bromegrass-alfalfa (br-alf) and bromegrass-birdsfoot trefoil (br-bft) pastures were part of a 12-paddock grazing system which utilized 4 br-bft paddocks, 4 br-alf paddocks, and 4 bromegrass + N paddocks and was grazed May through September. Twelve cow-calf pairs were on a total of 16 acres and were moved every 3 to 4 days, providing 33 to 44 days rest for the forage.

In experiment two hay was harvested from the alfalfa-orchardgrass pastures in mid-May and they were then grazed from June through August using a six-paddock rotation with 12 cow-calf pairs on 13 acres. Animals were moved every 5 to 7 days, depending on forage availability. This provided 25 to 35 days rest for the forage.

All pastures were sampled on a to determine daily changes in forage availability, botanical composition and quality. Forage availability was measured in pounds of dry matter per acre. Botanical composition was determined by hand separation of forage samples and quality was measured as crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF).

Forage samples were collected daily from June to August 1989. Eighteen 0.25 m^2 quadrates were hand clipped to height of 1 inch prior to the initiation of grazing a paddock, each day the animals were in a paddock and immediately following termination of grazing a paddock.

The 18 samples were weighed immediately after clipping. The samples were divided into 3 groups, samples 1-6, 7-12 and 13-18. The six samples were combined and thoroughly mixed. A subsample was taken, weighed, dried, and weighed again to determine percent dry matter (DM). A second subsample was taken and hand sorted by forage species and dead material to determine daily changes in botanical composition. The dried samples were ground through a Wiley mill with a 1 mm screen. The samples were then ground in a Udy mill through a 1 mm screen. Near infrared spectroscopy (NIRS) which uses the near infrared absorption properties of the components to separate them, was used to determine CP, ADF and NDF.

DISCUSSION

Experiment 1

The CP content of the br-bft pastures as a whole declined linearly with differences across days ranging from 13.9% CP at day 0 to 11.3% CP at day 4 (figure 1). The CP of the br component also declined linearly with differences ($P < 0.05$) across day, 14% at day 0 and 10% at day 3, but the bft did not change and averaged 21%. Over the grazing period neither ADF nor NDF changed for the composite sample which also contains dead material, or the components, with an average ADF of 33.4 for the composite sample and 21.9 and 32.4 for the bft and br, respectively (figure 2) and an average NDF of 57.8, 35.9 and 58.0 for the composite sample, the bft and the br, respectively (figure 3). Percent dry matter

increased quadratically ($P<0.05$) over the 3 day grazing cycle averaging 33% day 0-1, 39% day 2 and 47% day 3.

Forage availability in the br-bft pastures, when calculated as pounds of all material, including dead material, was a quadratic ($P<0.05$) decline ranging from 2710 lb/A at day 0 to 2148 lb/A day 1-2, to 1070 lb/A at day 3, with differences across days in the grazing cycle. When using only the green material to determine forage availability, the relationship is linear ($P<0.05$) with 2387 lb of green forage/A at day 0 and 851 lb of green forage/A at day 3.

The percentage of the individual components in the sward did not change significantly other than a quadratic increase ($P<0.05$) in percent dead material, which averaged 11% day 0-2 and 22% day 3. There was a decrease in pounds of dead material, along with a decline in all other forage components.

Daily changes ($P<0.05$) in the CP content of the br-alf pastures was quadratic for the alf component with 29% on day 0, 19.5% on day 1 and 15% on day 2-3 (figure 4). Changes were linear for both the br and composite sample, with 20% on day 0 for the br and 14% for day 1-3 and 18% for day 0-1 for the composite and 14 for day 2-3. Acid detergent fiber increased ($P<.05$) linearly for the alf component and quadratically for the composite sample, (Figure 5). The ADF of the alf was 26% at day 0, 35% at day 1-2 and 38% at day 3, the br was 31% at day 0, and 33% day 1-3, the composite sample was 31% at day 0, and 37% for day 2-3. The NDF fraction increased linearly for the alf and the composite samples with no changes in the br component. The NDF for the alf at day 0 was 39% and 47% for day 2-3, the composite sample was 51% at day 0, 57% at day 1-2 and 61% at day 3 (figure 6). Dry matter content of the br-alf pastures increased ($P<0.05$) linearly over time, from 33% at day 0-1 to 51% at day 2-3.

Dry matter forage availability in the br-bft pastures decreased quadratically ($P<0.05$) when all material, which includes dead material, was considered with an initial forage availability of 2970 lb/A, 1966 lb/A at day 1 and 1252 lb/A at day 2-3. The decline was linear when only the green material was considered, with 2776 lb/A at day 0, 1290 lb/A day 1-3.

Botanical composition of the alf component decreased linearly from day 0 at 49% to 28% at day 1-3, the br component did not change over time, and the dead material increased linearly from 5.7% at day 0, to 16% and day 1-2, to 28% at day 3. When considered as pounds of the components, the dead material changed very little over the 3-day grazing cycle.

Experiment 2

The CP content of the alf-og pastures as a whole and the individual components declined linearly from day 0 to day 6 of the grazing cycle. Differences were observed ($P<0.05$) in the individual components and the composite sample over the 6 d grazing cycle. The CP of the alf at day 0 was 25%, 22% at day 1-2, 20% at day 3 and 16% at day 4-6, and the composite had 18% CP day 0 and averaged 15% day 4-6 (figure 7). The ADF content increased linearly for alf, og and the alf-og composite sample with differences between days ($P<0.05$) only in the alf sample, with 23% ADF at day 0, 29% day 1-3 and 36% day 4-6. Differences in daily changes of NDF were observed only in the alf sample (figure 8). The NDF content of the alf and the composite sample increased linearly. The alf component had a NDF of 35% at day 0, 41% day 1-3 and 46% at day 4-6 (figure 9).

The dry matter content of the alf-og pasture increased linearly ($P<0.05$) with differences across days. At day 0-1 dry matter was 36% and a average of 44% for day 2-6.

Total forage availability when measured as pounds of dry matter per acre available included dead material. Prior to initiation of grazing a total of 2255 lb/A was available and 1648 lb/A was available after 6 days of grazing (figure 10). A quadratic decrease in forage availability is observed ($P<0.05$). When only green material was included in the dry matter available, a quadratic relationship was also observed ($P<0.05$), but forage availability day 0-1 was 1812 lb/A to an average of 1062 lb/A for day 3-6.

Botanical composition of the sorted sample indicated no differences in the percent og but a linear decline in the percent alf and a linear increase in the percent dead material. At day 0 the percent alf was 45%, by day 2-4 was 34% and 26% by day 5-6. When figured as pounds of the forage components, there was little change in the pounds of dead material ranging from 401 pounds on day 0 to 608 pounds on day 5, even though the percentage increases.

CONCLUSION

The system which uses 12 paddocks and a 3 to 4 day rotation is probably the most difficult to manage. The decision to stay on the paddock the fourth or possibly even a fifth day in a cow-calf operation results in limiting the diet of the calf because he is a very selective grazer. By remaining in a paddock the final day or two, in order maximize utilization of the available forage, the calf will limit intake of forage. Another problem is managing this system to prevent forage from becoming mature. In the spring when the forage is growing rapidly, rotation must also be rapid to prevent maturation of the forage.

When rotationally grazing the alfalfa-orchardgrass pastures using a 6 to 7 day rotation, one can graze for quality or for quantity. After the first 3 to 4 days the highest quality is exhausted but significant quantity remains. The decision must then be made whether to graze for quality or for quantity. One solution may be to graze animals with a high nutrient requirement, such as young calves and high milk producing cows the first 3 to 4 days, and then follow them with animals with a lower nutritional needs, such as dry cows or 700 to 800 pound stockers or dry cows, in order to utilize the most from the pasture.

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Figure 1. Crude Protein of Brome - BFT Pastures
12 paddock

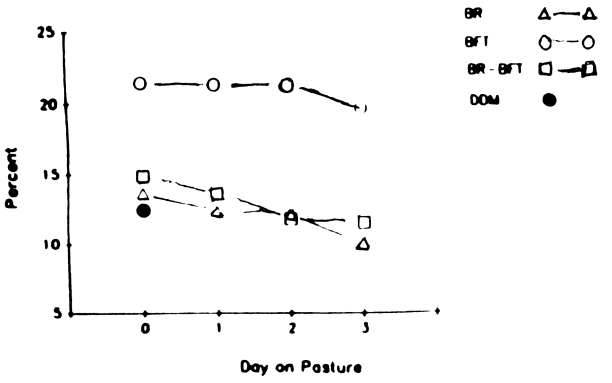


Figure 2. ADF of Brome - BFT Pastures
12 paddock

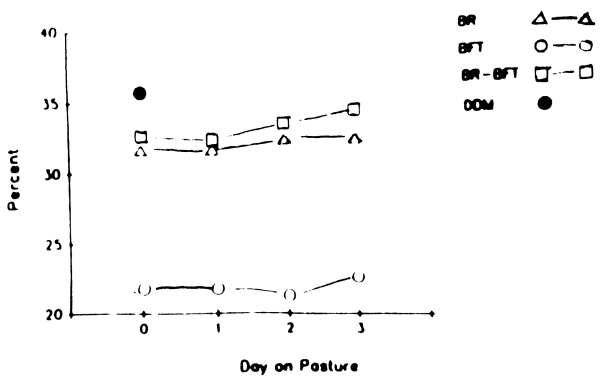


Figure 3. NDF of Brome - BFT Pastures
12 paddocks

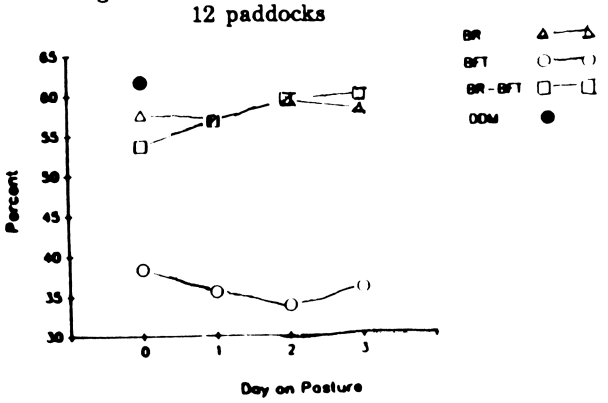


Figure 4. Crude Protein of Brome - Alfalfa Pastures
12 paddocks

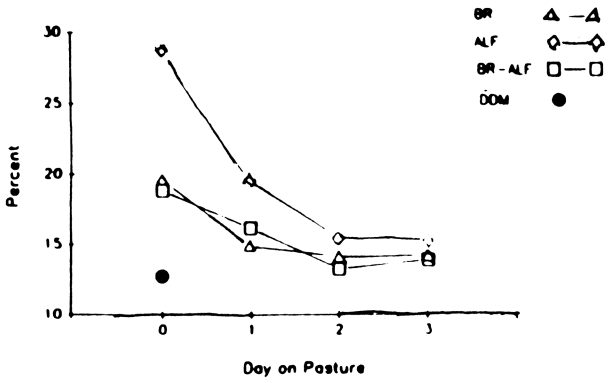


Figure 5. ADF of Brome - Alfalfa Pastures
12 paddocks

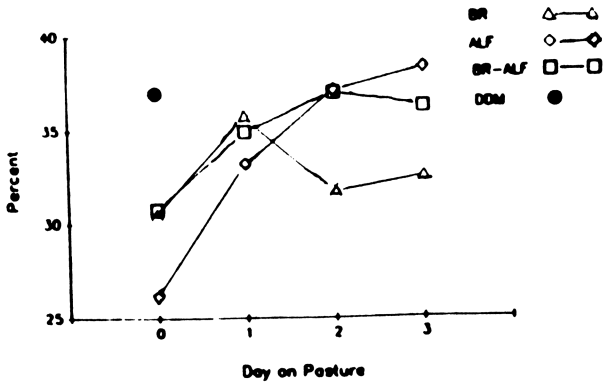


Figure 6. NDF of Brome - Alfalfa Pastures
12 paddocks

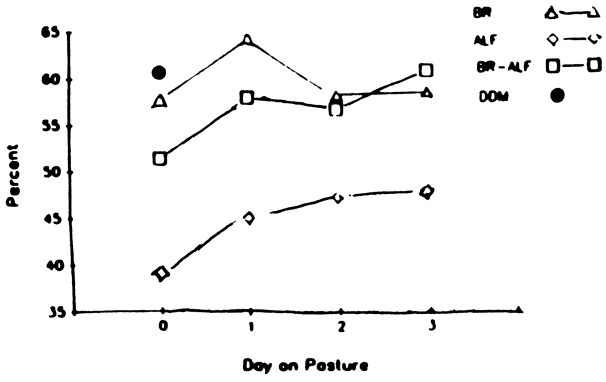


Figure 7. Crude Protein of Alfalfa - Orchardgrass Pastures 6 Paddocks

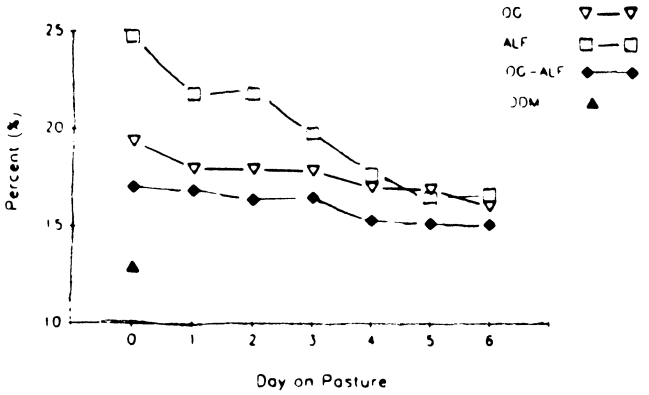


Figure 8. ADF of Alfalfa - Orchardgrass Pastures 6 Paddocks

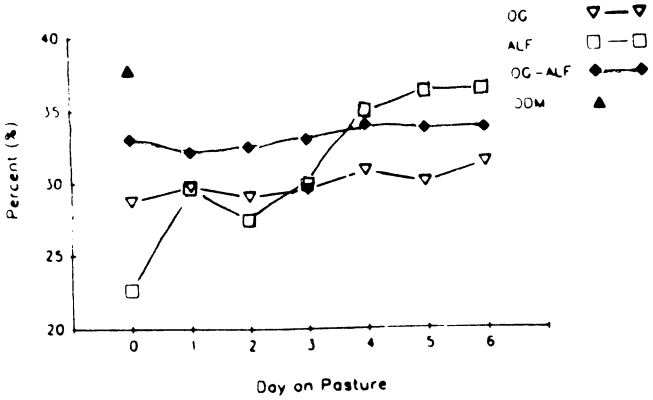


Figure 9. NDF of Alfalfa - Orchardgrass Pastures 6 Paddocks

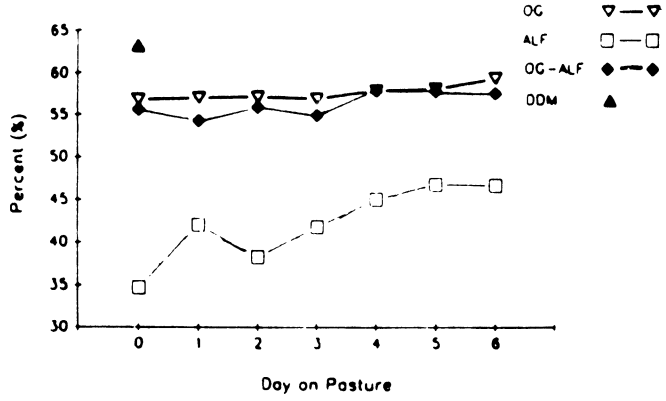
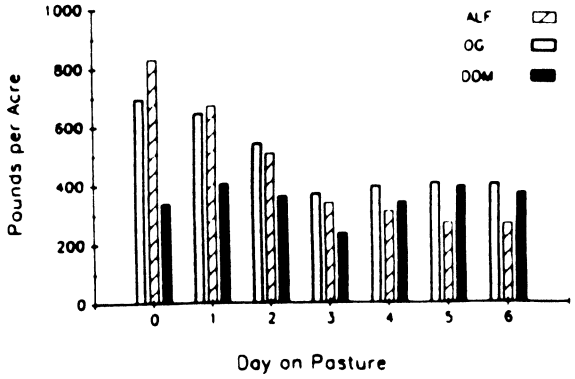


Figure 10. Daily changes of botanical composition in forage availability 6 Paddocks



STOCKPILING SYSTEMS TO EXTEND THE GRAZING SEASON

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University of Missouri

SUMMARY

Several segments of the beef industry could use stockpiled cool-season forages for winter feed (cowcalf, backgrounding). This management strategy would reduce the inputs of equipment and labor necessary to harvest hay for winter feeding. One area of present and future research at Missouri will be focused on supplementation programs designed to make optimum use of forage produced during fall regrowth. Utilizing stockpiled tall fescue for winter grazing would leave only a small window of time during late winter/early spring when forage quantity and(or) quality might be limiting. Future research will be directed toward supplementing cattle on stockpiled tall fescue in an effort to maximize the utilization of winter grazed forage.

INTRODUCTION

Grazing of stockpiled cool-season grasses may be used as an alternative to winter hay feeding. Two examples would be for maintenance of non-lactating, gestating cows and holding stocker calves for summer grazing. The aim of this paper is to review research conducted examining the value of stockpiled tall fescue for winter grazing.

STOCKPILED TALL FESCUE

Two factors must be considered when determining the value of stockpiled tall fescue for winter grazing. First, is the amount of forage available for consumption and second is the nutrient quality of the stockpiled forage. In general, with a longer accumulation period, the greater the yield of stockpiled forage but forage quality can be reduced (Fribourg and Bell, 1984). When grazing of summer and(or) fall accumulated tall fescue was delayed until winter, harvestable dry matter, digestibility and crude protein all decreased. Therefore, forage management practices should be taken into account to ensure that a sufficient level of forage is produced to ensure that acceptable animal productivity can be achieved.

Summer or fall stockpiling of tall fescue has not been shown to influence subsequent spring forage production, composition or digestibility. This is obviously one of the attributes which makes tall fescue a good grass for late summer and early fall stockpiling for subsequent winter grazing. The length of the stockpiling period has been shown to affect both forage production and quality (Table 1). The most efficient use of tall fescue would appear to be to grazing in spring and summer and not begin stockpiling for winter grazing until late-summer.

Nitrogen fertilization of tall fescue during late-summer has been shown to have beneficial results in terms of both forage production and quality. This most likely results from soil supporting fall regrowth being nitrogen deficient for forage growth. The optimum

fertilization rate depends upon climatic conditions which varies from year to year. Under good growing conditions, a response to nitrogen fertilization can be seen with up to 120 lbs of N/A. However, under average growing conditions, forage production is optimized at a nitrogen fertilization rate of 60 lbs/A.

Nitrogen fertilization also enhances forage quality. This apparently occurs because nitrogen fertilization decreases the proportion of dead leaves (Archer and Decker, 1977). The effect of date of application and level of nitrogen fertilization on tall fescue quality is shown in Table 1. Increasing nitrogen fertilization beyond 60 lbs/A had little beneficial effect on digestibility of the forage. While increasing nitrogen fertilization beyond 60 lbs/A increased nitrogen content of the grass, the fertilization rate of 60 lbs/A resulted in a forage crude protein concentration similar to the protein requirement of the animal. From a forage quality standpoint, nitrogen fertilization appears to be sufficient at levels no greater than 60 lbs/A. In addition, there does appear to be an advantage to delaying nitrogen fertilization until mid-September, which results in both an increased digestibility and crude protein concentration. From the published research reviewed it appeared that nitrogen fertilization rates above 60 lbs/A in the mid-summer or fall did not substantially increase nutrient quality of tall fescue or production of digestible dry matter.

Performance of cattle on stockpiled tall fescue has ranged from minimal gains to in excess of 1 lb/day. In a recent study conducted at the University of Missouri yearling steers grazing stockpiled fescue gained .8 lbs/day while calves fed low quality tall fescue hay gained only .2 lb/day. Management of stockpiled pastures were as follows. Tall fescue pastures were grazed by cow/calf pairs until the first week of September after which time pairs were removed and pastures were fertilized with 40 lbs of N/A. Steers were placed on pastures or in the drylot the first week of November and grazed or fed hay until the first week of April. The stocking rate was 1.7 A/calf. A trace mineral block containing rumensin was offered free choice. Based upon the gain data, we infer that stockpiled pastures were of moderate quality.

In conclusion, animal stocking rates should be adjusted to coincide with forage availability. Stockpiling would be an economically potential alternative to hay feeding during winter since only a low-cost fertilization program is required. Costs of gain for the stockpiling treatment in this experiment was only $.14/lb.

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Table 1. EFFECT OF NITROGEN FERTILIZATION AND LAST CUTTING DATE ON STOCKPILED TALL FESCUE PRODUCTION AND QUALITY

Rate of nitrogen application,	Early Sept.	Mid Sept.	Early Oct.
(lb/A)	Forage Dry Matter Production (tons/A)		
0	.1	.1	.1
53	.4	.2	.1
107	.6	.3	.2
	Crude Protein (%)		
0	9.3	9.8	10.7
53	9.3	11.4	13.5
107	11.1	13.5	16.7

Collins and Blasko (1981).

Table 2. AVERAGE DAILY GAIN OF STEERS GRAZING STOCKPILED TALL FESCUE OR FED TALL FESCUE HAY FROM DECEMBER THROUGH MARCH

	(lbs/d)
Hay	.2
Stockpiled pasture	.8

Table 3. AVERAGE DAILY GAIN OF STEERS GRAZING WHEAT (33 DAYS) OR FED A HIGH CONCENTRATE DIET (61 DAYS) WHICH HAD PREVIOUSLY EITHER GRAZED STOCKPILED TALL FESCUE OR CONSUMED LOW QUALITY TALL FESCUE HAY FOR 133 DAY

Previous Treatment	Wheat/Feedlot	Gain (lbs/A)
Hay	Wheat	.4
Hay	Feedlot	1.0
Stockpiled	Wheat	1.4
Stockpiled	Feedlot	1.8

A METHOD FOR LARGE SCALE ISOLATION OF ERGOVALINE FROM ENDOPHYTE INFESTED TALL FESCUE SEED (FESTUCA ARUNDINACEA)

Haluk Testereci[1] , George B. Garner[1], George E. Rottinghaus[2], Creighton N. Cornell[3], and Mary P. Andersen[4]

SUMMARY

Ergovaline, an ergopeptine alkaloid produced by endophyte infested tall fescue, has been considered responsible for some of the tall fescue toxicity symptoms in livestock. Testing the toxic effects of this recently identified compound requires a simple and inexpensive method for isolation of this compound, which is not commercially available. Therefore, we have developed a method using lactic acid to extract ergovaline from fescue seed. The ergovaline is then trapped on a C18 column where ergovaline is concentrated. Later, the ergovaline enriched column is eluted with a small volume of organic solvent. Lactic acid has been found to increase storage stability of dilute ergovaline solution for 8-10 days under refrigeration. This method reduced time, cost, long evaporation steps, and eliminated lipids better than conventional methods. Further purity was obtained by a second C18 chromatography column. This final enriched fraction was infused in cattle in another study to be reported later.

INTRODUCTION

Ergovaline, an ergopeptine alkaloid, has been synthesized (STADLER et al. 1964) and has been isolated from *Claviceps purpurea* (BRUNNER et al. 1979) cultures . It is the most abundant ergot alkaloid in endophyte-infested tall fescue seeds (LYONS et al. 1986). Extraction and identification of ergot alkaloids from fungal cultures (PORTER et al. 1979, PORTER and BETOWSKI 1981) and endophyte-infested tall fescue (YATES et al. 1985) were reported.

Department of Animal Sciences[1] , Veterinary Medical Diagnostic Lab[2] , College of Veterinary Medicine, Department of Biochemistry[3] , Department of Medicine[4]

Isolation of ergovaline from *Claviceps* cultures by chromatography on alumina and on paper has been described (BRUNNER et al. 1979). Good separation of ergot alkaloid extracts on octadecylsilica columns (C18) has been achieved by the use of an alkaline water:acetonitrile mobile phase (CHERVET and PLAS 1984, BETHKE et al. 1976). Industrial production of ergot alkaloids is attained by parasitic cultivation in the host plant (REHACEK 1986), saprophytic cultivation in defined media (POLI 1987), and by chemical synthesis from the ergoline ring (KOBEL and SANGLIER 1986, STADLER et al. 1964). Endophyte-infested fescue seed is a convenient, inexpensive source of ergovaline. We now report that infested tall fescue seed has been used in a large scale method for extraction, enrichment and separation of ergovaline.

METHODS

Extraction. Six kg of ground fescue seed were extracted with 30 liters of cold 4.25% aqueous lactic acid (pH~2-3) for 30 min to form a viscous paste. Paste was transferred to a large cylindrical column (16.5 X 2200 cm, designated as Column B). Column B was eluted with 4.25% lactic acid (5 liters x 3). From this column a total of 28 liters (14 liters X 2) lactic acid extract (LAE) was obtained under 20-25 psi pressure. LAE was stored at 4° C overnight. Small starch granules in LAE were removed by filtration through Whatman #42 filter paper and solka floc. Clear, bright red LAE was checked for ergovaline by HPLC (Column A) (Fig. 1).

Enrichment and Separation. Slurry packed 350 g C18 column (Column C) was preconditioned with 2 liters methanol and 2 liters 4.25% aqueous lactic acid, respectively. After LAE (14 liters) was passed through this column, column eluent did not contain ergovaline (Fig. 2). Column C was eluted with additional 4.25% Lactic acid (1 liter x 3), which removed a red pigment (Fig. 3). Later, this column was eluted with 33% acetonitrile:water, and fractions were collected. Each fraction was checked by HPLC to identify ergovaline (Fig. 4).

Liquid Chromatography. Qualitative analysis of ergovaline in extracts was performed by comparing the elution time of ergovaline standard by HPLC (Column A, 0.3 um C18 cartridge, 0.46 x 8.3 cm). Concentration and initial separation of ergovaline were

made by slurry packed 350 g C18 column, Column C. Further separation of ergovaline was made on C18 column (particle size of 60 um , 1.5 x 20 cm), Column D. Retention time of ergovaline for described conditions is the same as for standard ergovaline. Ergovaline peaks were co-eluted with external ergovaline standard. The instrument is equipped with a Hitachi Spectrofluorimeter (Model F-1200) and recorder (Model 561). Samples were loaded by a Rheodyne Model 7125 and 7010 loop injected valve, 20 μl and 1.8 ml capacity respectively. Ergovaline fractions were collected by an ISCO fraction collector Model 820. Detections were made at excitation wavelength 280 nm and emission wavelength 420 nm. The mobile phase was 33% acetonitrile buffered with ammonium carbonate (pH= 7.4). All solvents obtained from Fisher Scientific were either ACS or HPLC grade.

RESULTS AND DISCUSSION

The full chromatogram of LAE from endophyte-infested fescue seed is shown in Fig. 1. The ergovaline peak in Fig. 1 represents 24.75 ng/ml. The chromatogram shows that impurities clearly exist at this stage of extraction. Calculations from Fig. 1 indicate that a total of 6.93 mg EV seed was actually extracted. In fact, an extra 15 liters lactic acid elution of Column B yielded 0.23 ug EV/ml. This indicated that some extractable ergovaline remained on Column B. Fig. 2 is the chromatogram of the filtrate of LAE after elution from the 350 g C18 column. No ergovaline peak is present. Fig. 3 indicates that extensive rinsing of the C18 column with 4.25% lactic acid removes additional pigments, but not ergovaline. After elution of the 350 g C18 column with about 3 liters of 33 % acetonitrile:water, fluorimetrically cleaner ergovaline fractions were obtained (Fig. 4). About 40% of extracted ergovaline (1.155 mg/kg seed) was collected with acetonitrile elution from Column C (Fig. 4). Retention times of ergovaline and ergotamine by HPLC were 5.6 and 12.6 min, respectively. Elution volume of ergovaline from Column C with acetonitrile:water was about 3 liters, and later fractions had substantially less fluorescence impurity (Fig. 4). Repurification of these eluents on column D yielded only ergovaline with no other fluorescence compound. However, the purity of ergovaline needs to be proved by other methods. Extraction of endophyte-infested fescue seed with lactic acid

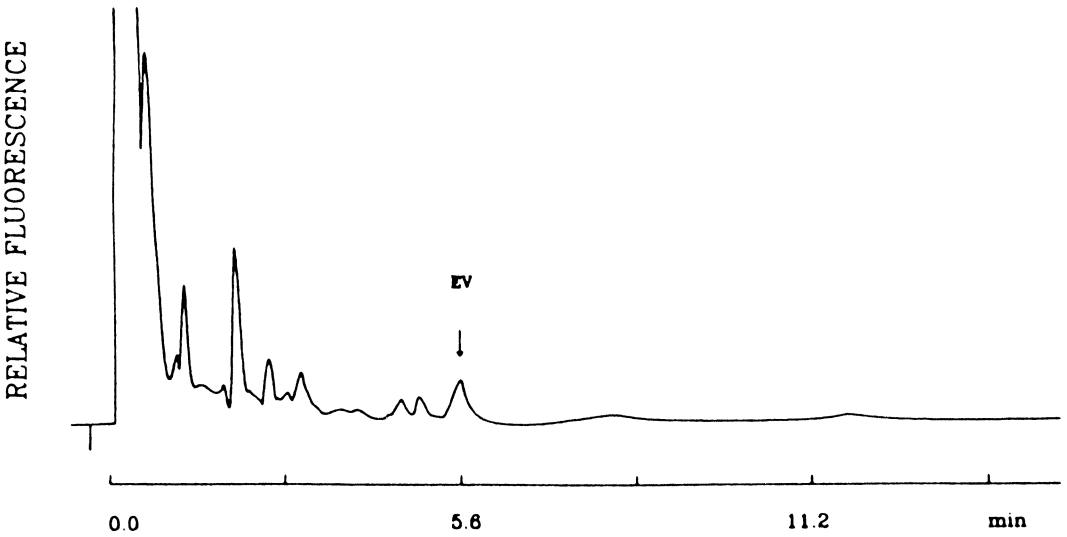

Fig. 1. Full chromatogram of lactic acid extraction of fescue seed before being filtered through Column C. Detections were made by HPLC (Column A). Recorder range was 50x1. Spectrofluorimeter sensitivity setting was 20. Flow rate was 2 ml/min.

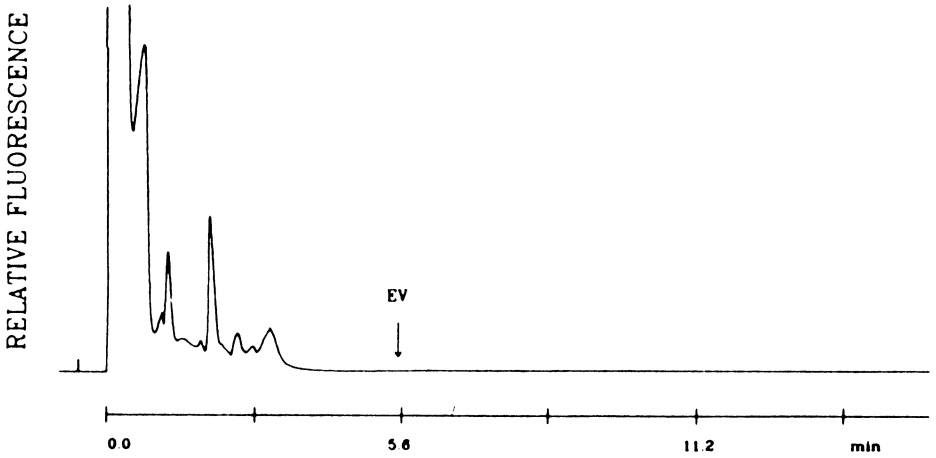

Fig. 2. Full chromatogram of lactic acid extraction of fescue seed after filtered through Column C. Detections were made by HPLC (Column A). Recorder range was 50x1. Spectrofluorimeter sensitivity setting was 20. Flow rate was 2 ml/min.

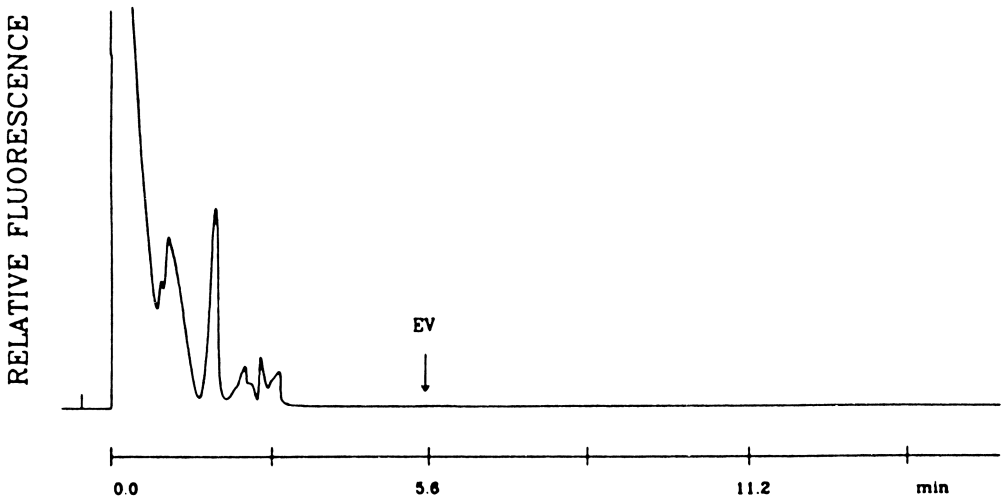

Fig. 3. Full chromatogram of 4.25% lactic acid eluent of Column C. Detections, recorder, spectrofluorimeter and flow rate settings were same as Fig. 1.

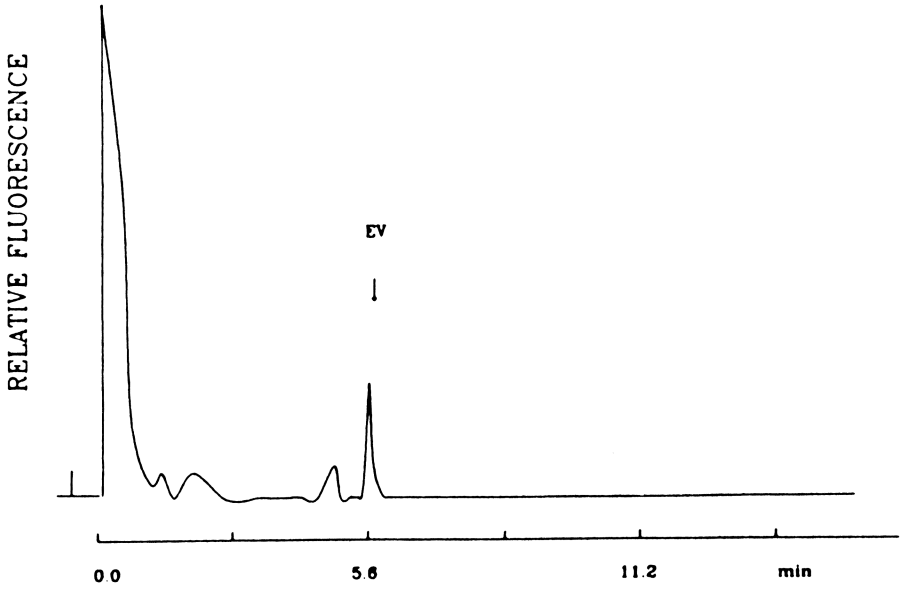

Fig. 4. Full chromatogram of 33% acetonitrile fraction of C18 Column C. Ergovaline fractions were identified by HPLC column. All settings were same as Fig. 1.

and C18 concentration eliminated conventional organic solvent extraction. This procedure reduced time and cost, since long evaporation (heat exposure), and elimination of lipids were unnecessary. Pre-conditioned C18 Column C was used repeatedly (6 times) to trap ergovaline from lactic acid extracts and reduce volume (14/0.5, v/v) without using evaporation. Rapid separation of retained ergovaline on C18 Column C is achieved with 40% yield. Lactic acid buffer for fescue extracts enhanced the stability of ergovaline to allow storage for up to 8-10 d at 4° C without significant loss in ergovaline concentration.

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ESTABLISHING ERGOVALINE LEVELS FOR FESCUE TOXICOSIS, WITH AND WITHOUT ENDOPARASITES, UNDER CONTROLLED CLIMATIC CONDITIONS

Creighton N. Cornell[1], James V. Lueker, George B. Garner, and James L. Ellis[2]

INTRODUCTION

Fescue toxicosis occurs in cattle consuming Acremonium coenophialum (endophyte) infested tall fescue under high temperature/humidity conditions. Clinical signs of toxicosis, such as reduced feed intake and weight gain, reduced milk production, elevated rectal temperature and respiration rate, profuse salivation, and reproductive problems, mimic those seen in ergotism (BACON et al. 1986). This has focused research on possible plant/fungus produced toxicants, particularly alkaloids. Following the report of significant levels of ergopeptine alkaloids in tall fescue from pastures inducing winter fescue toxicity (fescue foot, YATES et al. 1985), ergot alkaloids were demonstrated to be ubiquitous in endophyte-infested fescue but absent if fescue were endophyte-free; ergovaline accounted for 84-97% of total ergopeptine alkaloids (LYONS et al. 1986). We now know that as little as 200 ppb ergovaline in hay fed to dry-lot steers induces classical signs of fescue toxicosis (GARNER 1989). Though the literature relating parasitism and fescue toxicosis is sparse, a greater than expected beneficial effect on weight gain in cattle given anthelmintics while grazing endophyte infested pastures has been reported (ELLIS et al. 1989). This study was undertaken to establish the level of ergovaline required to induce fescue toxicosis, both with and without endoparasites, under controlled environmental conditions.

METHODS

Thirty six, Ivermectin-wormed, 180-250 kg Angus calves were haltered, acclimated to handling and fed 1.8 kg/head/day control (0) ration for 13 day before entering controlled environment chambers. Two chambers with rubber mat covered floors and metered bowl-type waterers, stanchioned six animals each. Relative humidity was 60%, photoperiod 12 hour light/dark. Control ration is shown in Table 1. Endophyte-infested seed (2, 4 or 8%) was substituted for cottonseed hulls to make rations containing 50, 100, or 200 ppb ergovaline. Fed at 14 lbs/head, daily intake was 320, 640 or 1280 µg ergovaline, respectively. Rectal temperature, respiration rate, and heart rate were measured daily at 0800 and 1600. Feed intake and water intake were recorded at 0830 daily. Animals with a rectal temperature of 105°F or greater were removed from experiment and allowed to recover in a thermoneutral environment.

To screen for uniformity of response to ambient temperature changes, calves were fed increasing amounts of control (0) ration to appetite (4.5 - 6.0 kg/head/day) and acclimated at 70-72°F for 6-7 days in climatic chambers. Chamber temperature was then raised in 2°F

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[2] University of Missouri, College of Agriculture, Department of Animal Sciences.

increments to 95°F, physiological measurements being made daily. Prior to toxicity experiments, calves were fed 10 lbs/head/day control ration during a 21 day or more recovery period.

Part A. Nine uniformly responding heifers and three steers were re-acclimated to thermoneutral chamber conditions and control ration increased to 14 lbs/head/day over 4-6 days before random allotment to test rations (0, 50, 100, or 200 ppb ergovaline), chamber temperature increases (76-90°F, 2°F increments except 2 days at 88 and 90°F) and measurement of physiological variables.

Part B. Nine remaining heifers and three steers were orally dosed with 50,000 mixed intestinal worm larvae 21 days before similar re-acclimation to thermoneutral conditions, random allotment to rations and testing at like ambient temperature (except 2 days at 86 and 88°F).

The trial was a completely randomized design, with a 2x4 factorial arrangement of treatments; individual animals were the experimental units. Analysis of variance for rectal temperature was performed by the GLM procedure of SAS INSTITUTE (1985). Means were separated by LSD at $P < .10$. In part A, two day rectal temperature values at 88 and 90°F were averaged for the analysis at each ambient temperature, respectively. In part B, the same was done for rectal temperature values at 86 and 88°F ambient temperature.

RESULTS AND DISCUSSION

Generally feed intake and water intake during screening for response to heat were adequate. Although a few animals reduced feed intake at higher ambient temperature (35°C) as might be expected, most gained weight. The best indicator of heat or fescue effects was rectal temperature, heart and respiration rate being more variable and inconsistent. Rectal temperature increased as ambient temperature increased; a large rectal temperature increase or break began at 88°F. This type of response was essentially found in 24 of 36 calves screened.

Part A. Mean µg of ergovaline consumed (as endophyte- infested fescue seed)/calf/day is shown in Table 2. Only a small reduction from calculated daily intake of 320, 640 or 1280 µg occurred. In the 100 ppb group given no parasites, the decrease was primarily due to reduced intake by one calf on the final day of experiment. A 200 ppb calf was similarly affected, however, a second calf in this group was removed from the chamber on day 9 of experiment due to a rectal temperature of 105°F.

The effect of ergovaline without endoparasites on rectal temperature is shown in Fig. 1. Rectal temperature of 200 ppb calves was higher than that in other groups over the entire range of ambient temperature increases, but differed only from the control group at 31.1 and 90°F ($P < .1$). Fifty and 100 ppb groups were intermediate in rectal temperature elevation and exceeded that of controls at 82 and 86°F, respectively. However, 50 ppb animals differed from controls only at 90°F ($P < .1$). It appears, therefore that as ambient temperature increases at 60% relative humidity, even 50-100 ppb ergovaline has measurable physiological effects on cattle. Although most overall means were not different in this separate analysis, they were numerically different and decreasing P values (Table 3) indicate ergovaline had a greater effect at higher ambient temperature.

Part B. Reduced intake was more evident in calves given endoparasites (Table 2). Although much of the decreased feed intake again resulted from a reduction on 1-3 days late in the experiment, one 50 ppb calf consistently ate less (12 lbs) on days 3-10, one 100 ppb calf reduced intake (10-11 lbs) the last 4 days of experiment and one 200 ppb calf reduced intake (8-13 lbs) over days 2-5.

Endoparasite-primed calves consuming 200 ppb ergovaline had the highest rectal temperature from 80°F on (Fig. 2). Neither 50 nor 100 ppb levels changed rectal temperature appreciably from that of controls (with endoparasites). Control values were similar to those for 50 and 100 ppb groups in part A, however, indicating that endoparsites caused a rise in rectal temperature similar to 50-100 ppb ergovaline alone. In the separate analysis (Table 4), P values exceed those of the groups without endoparasites and indicate a masking of ergovaline effects by endoparasites. The parasite effect (ergovaline with parasites vs ergovaline without parasites) accounts for all of the rectal temperature increase due to 200 ppb ergovaline in parasitized calves.

When the data are combined for analysis, results are similar to those discussed previously in regard to ergovaline effects. Rectal temperature of control, 50 and 100 ppb groups were similar. Only 200 ppb ergovaline increased rectal temperature (102, 102, 101.8, and 102.6°F for 0, 50, 100 and 200 ppb, respectively, $P < .1$). There was a significant interaction between endoparasites and ambient temperature ($P < .05$). This indicates that calves given endoparasites respond differently to an increase in ambient temperature than those without parasites.

This experiment suggests that cattle selected for environmental studies should be screened for response to heat, since all do not respond uniformly. In addition, as little as 50 ppb of ergovaline (fed as endophyte-infested fescue seed) causes measurable physiological effects in cattle. Indeed, no level of ergovaline may be without effects under some combination of high ambient temperature and humidity in an animal of given susceptibility. Further, parasitism overshadows the ergovaline effect in regard to increasing rectal temperature. Hence, rectal temperature measurements will not distinguish between an endoparasite load and fescue toxicosis.

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Table 1. CONTROL RATION (As Fed Basis)

Ingredients	Composition (%)
Fescue seed	0
Cracked corn	25
Corn gluten feed	25
Soybean meal	10
Molasses	5
Crimped oats	20
Cottonseed hulls	12
Trace mineral salts	0.5
Limestone	2
KCl	0.5

NEm (Mcal/kg) 1.81
NEg (Mcal/kg) 1.13
CP (%) 17.60

Table 2. Mean Ergovaline Intake, μg/calf/day, combined parts A and B

Calculated	No Endoparasites	Endoparasites
0	0	0
320 (50 ppb)	320	303 (290-310)[a]
640 (100 ppb)	636 (634-640)	616 (585-640)
1280 (200 ppb)	1253 (1210-1280)	1227 (1146-1274)

[a]Range in parenthesis.

Table 3. Least Squares Means for Effects of Ergovaline on Rectal Temperature (without endoparasites)

Ambient Temperature (F)	Control	50 ppb	100 ppb	200 ppb	P value
76	101.5	101.4	101.1	101.5	.52
78	101.5	101.5	101.3	101.8	.36
80	101.8	101.5	101.3	102.1	.13
82	101.9	101.8	101.6	102.5	.18
84	102.0	102.1	101.8	102.7	.24
86	102.0	102.5	102.2	103.1	.29
88	102.3	103.3	103.2	104.0	.06
90	103.3	104.3	104.1	104.6	.10

Table 4. Least Squares Means for Effects of Ergovaline on Rectal Temperature (with endoparasites)

Ambient Temperature (F)	Control	50 ppb	100 ppb	200 ppb	P value
76	101.3	101.3	101.5	101.8	.27
78	101.6	101.7	101.7	101.7	.84
80	101.7	101.8	101.9	101.7	.72
82	102.0	102.3	102.0	102.8	.41
84	102.2	102.4	101.8	102.7	.30
86	103.0	102.8	102.6	103.4	.53
88	103.9	103.9	103.5	104.4	.42
90	104.5	104.2	104.3	104.6	.77

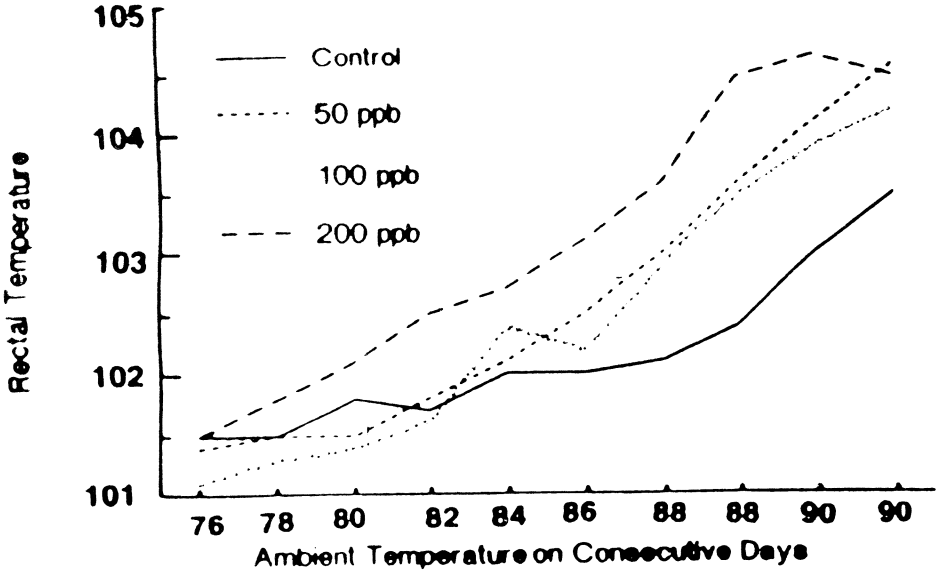

Fig. 1. Effect of ergovaline on rectal temperature, no endoparasites

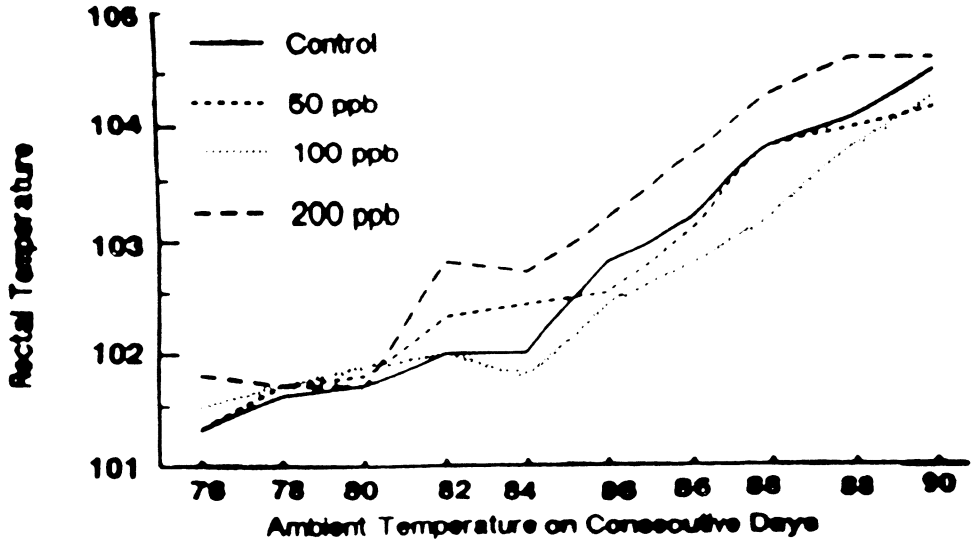

Figure 2. Effect of ergovaline on rectal temperature, with endoparasites

THE EFFECT OF SUPPLEMENTATION OF AN AMMONIATED WHEAT STRAW-ALFALFA HAY DIET

I. PERFORMANCE OF BACKGROUNDING STEERS

J.L. Ellis[1] and G.B. Garner[2]

SUMMARY

Thirty Gelbvieh sired steers (696 lb) were used in a growth trial to determine the performance of steers fed an ammoniated wheat straw-alfalfa hay ration without additional supplement, supplemented with energy from corn or corn gluten feed. Steers were randomly assigned by weight to one of three treatments (5 animals/pen). Treatments were: (1) ammoniated wheat straw ad libitum plus 4.5 lb alfalfa hay (control), (2) ad libitum ammoniated wheat straw, 4.5 lb alfalfa hay and 6.4 lb of cracked corn (corn) or (3) ad libitum ammoniated wheat straw, 4.5 lb alfalfa hay and 7.5 lb of pelleted corn gluten feed (CGF). The corn in treatment 2 contained the same amount of energy as 7.5 lb of CGF. The trial lasted 112 days, calves were weighed every 28 days and feed intake was recorded by pen. Supplementation increased ADG (lb) (0.64, 2.05 and 2.86, $P<0.01$ for control, corn and CGF treatments, respectively). Even though straw intake was not reduced by supplementation (11, 9 and 9 lb/h/d, $P>0.05$ for control, corn and CGF treatments, respectively), total daily intake was increased by supplementation (15.6, 20 and 21.3 lb, $P<0.05$ for control, corn and CGF treatments, respectively). Feed:gain ratios were improved by supplementation of an ammoniated wheat straw-alfalfa hay ration with energy (25.3, 9.8 or 7.5 feed:gain for control, corn and CGF treatments, respectively). During the finishing period, the performance of supplemented steers was reduced slightly (2.9, 3.0 and 3.5 lb/d for CGF, corn and control, respectively). However, the steers receiving the control backgrounding diet were still lighter at slaughter after 168 days on finishing diets. Corn gluten feed was an effective supplement for increasing the performance of steers backgrounded on a high roughage ration.

INTRODUCTION

Small grain production in the mid-western United States produces a large quantity of roughage residue. This residue is low quality and contains inadequate nutrients for rapid gain (greater than 1.5 lb/day) of beef steers. Research has been conducted to improve the performance of cattle fed these residues. The most viable treatment for small farm use is with anhydrous ammonia. Performance of cattle on high roughage diets have been improved by various supplements. These include alfalfa, corn, rumen degradable protein (soybean meal), rumen undegradable protein (bloodmeal) and easily digested fibrous by-product feeds (corn gluten feed).

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Since Missouri is a major producer of feeder calves and also a major grain producing state, a plentiful supply of calves for backgrounding are available along with large quantities of poor quality roughages. We were interested in determining the performance of steers backgrounded on an ammoniated wheat straw-alfalfa hay diet receiving either no supplemental energy, with supplemental energy from starch (corn) or from a high fibrous by-product feed (corn gluten feed). We were also interested in determining if backgrounding effects were eliminated during a subsequent finishing period.

MATERIALS AND METHODS

Thirty Gelbvieh sired cross-bred steers weighing 600-800 lb were randomly assigned by weight to one of three treatments. Treatments were (1) ad libitum ammoniated wheat straw plus approximately 4.5 lb DM of alfalfa hay/h/d, (2) ad libitum ammoniated wheat straw, 4.5 lb DM of alfalfa hay and 6.4 lb DM corn/h/d or (3) ad libitum ammoniated wheat straw, 4.5 lb DM alfalfa hay and 7.5 lb DM pelleted corn gluten feed/h/d. All calves were weighed on consecutive days at the beginning and end of the trial and every 28 days during the trial. Calves were on backgrounding rations for 112 days. Calves were implanted with 200 mg progesterone and 20 mg estradiol benzoate at the beginning of the backgrounding period. Straw intake was recorded by pen.

Straw was ammoniated by the addition of 3% of straw weight of anhydrous ammonia to a stack of square bales covered with plastic and sealed around the edge with soil.

After a 112 day backgrounding period, steers were gradually adapted to a high concentrate diet of corn silage, shelled corn and a pelleted urea protein supplement. Steers were implanted with 200 mg progesterone and 20 mg estradiol. Body composition of all animals ws determined by ^{40}K techniques at the beginning of the finishing period and before slaughter. Five steers (CGF treatment) were slaughtered after 112 days on feed with the remaining 25 slaughtered after 168 days on feed. Steers were weighed every 28 days, slaughtered at a commercial facility and carcass data were collected after a 24 hour chill.

The experimental design was a randomized complete block design. The trial consisted of three treatments, two blocks and five animals/pen (Snedecor and Cochran 1980). Feed intake, weight gain, feed:gain ratios, fat and protein gain and carcass traits were analyzed by the GLM procedure of SAS (SAS, 1985).

RESULTS AND DISCUSSION

Animal performance during the back-grounding period is presented in Table 1. Corn gluten feed improved performance over other treatments while corn supplemented steers had better performance than steers receiving no supplement. The rate of gain of all steers was affected by very high rates of gain during the first 28 days possibly due to recovery of shrink and fill. However, during all 28 day periods, corn gluten supplemented steers had the highest rates of gain, control steers had lowest rates of gain and corn supplemented steers intermediate.

After the first 28 days, the control steers only maintained their weight suggesting that straw and alfalfa were just meeting the maintenance requirements of these steers. The corn and corn gluten feed fed to the supplemented steers should have provided ADG of 2.9 lb/d if straw and alfalfa were meeting the maintenance requirements of these steers. The CGF steers were the only steers gaining 2.9 lb/d. The increased intake by supplemented steers was a result of the supplement fed to these steers.

Table 1 Performance and Feed Intake of Steers Consuming Ammoniated Wheat Straw-Alfalfa Hay with Corn or Corn Gluten Feed Supplements (lb Dry Matter Basis)

	CGF	Corn	Control
Backgrounding ADG (lb/d)	2.9[a]	2.0[b]	0.6[c]
Daily Straw Intake	9.2	9	11
Daily Alfalfa Intake	4.5	4.5	4.5
Daily Supplement	7.5	6.4	0.0
Total Daily Intake	21.3[d]	20.0[d]	15.6[e]

[abc] Means in the same row with different superscripts are different ($P<.01$).
[de]Means in the same row with different superscripts are different ($P<.05$).

The improvement in performance between corn and corn gluten few supplemented steers agree with those of Oliveros et al., (1989), in which daily gain was increased by the addition of 40% corn, corn bran or corn gluten feed to high roughage diets. They also reported a nonsignificant improvement in efficiency of corn by-product feeds over corn. Van der Linden (1984) reported that corn supplementation of a corn stover diet reduced cellulose and hemicellulose digestion. This may account for the reduction in performance of corn supplemented steers.

Another effect of corn gluten feed may have been due to the rumen undegradable protein of corn gluten feed. Nelson et al. (1985a, 1985b) reported that nitrogen utilization of ammoniated corn cobs was improved by a bloodmeal-corn gluten meal supplement over a corn supplement. Males (1987), reported that utilization of untreated straw can be optimized by supplementation with preformed protein. Swingle et al., (1983) , using untreated and treated straw diets with various supplements, reported that performance was not affected by source of protein or ammoniation. Nelson et al., (1985a), found no difference in performance between soybean meal, bloodmeal, or bloodmeal-urea supplementation of an ammoniated wheat straw-alfalfa haylage diet in one trial while in a second trial soybean meal supplemented steers had significantly higher average daily gain than steers on other treatments.

Feed:gain ratios are presented in Table 2. The results indicate that corn gluten feed supplemented animals were more efficient in utilization of the straw portion of the ration for gain and also utilization of the entire diet. These results support research discussed earlier when corn by-products or rumen undegradable protein improved utilization of a high fiber diet.

Table 2 Feed:Gain Ratios (112 Days) When an Ammoniated Wheat Straw-Alfalfa Hay Ration was Supplemented with Corn or Corn Gluten Feed

	CGF	Corn	Control
Straw Intake/Head (112 d)	469.5	465.5	561.4
Gain/Head (112 d)	145.4	104.4	32.2
Straw:Gain Ratio	3.2	4.5	17.4
Total Intake/Head (112 d)	1086.8	1021.4	795.5
Feed:Gain Ratio	7.5	9.8	24.7

Finishing performance is presented in Table 3. Control steers had slightly higher rates of gain during the finishing period indicating some compensation. However, control steers were lighter at slaughter even after 168 days on a finishing ration. Five corn gluten feed supplemented steers were slaughtered 56 days before the other steers. If these steers had gained at the same rate for 56 more days, the slaughter weight of corn gluten feed steers would have been 1502 lb. This might have resulted in a significant difference in live slaughter weight. Table 3 also indicates that control steers had higher rates of protein growth ($P<.01$) than supplemented steers while fat gain of control animals tended to be higher than corn gluten steers.
Fox et al. (1972) and Guenther et al. (1965) determined that during early compensatory growth, gain of compensating steers was higher in protein and lower in fat while during latter periods the gain was higher in fat and lower in protein. We were not able to determine differences in composition of gain during the early and latter part of the finishing period but the overall effect was compensation of protein and fat by the control calves.

Table 3 Feedlot Performance Following 112 Days of Backgrounding on an Ammoniated Wheat Straw-Alfalfa Hay Ration with Corn or Corn Gluten Feed Supplements

	CGF	Corn	Control
ADG (lb/day)	2.9	3.0	3.5
Slaughter Weight (lb)	1415.	1426.	1356.
Adjusted weight (168 d on feed)	1502.		
Fat Gain (lb)	171.4	224.4	224.4
Protein Gain (lb)	27.1[a]	36.3[a]	52.1[b]
Average Daily Fat Gain (lb/d)	1.59	1.8	1.8
Average Daily Protein Gain (lb/d)	0.25[c]	0.29[c]	0.42[d]

[ab] Means in the same row with different superscripts are significantly different ($P<.05$).
[cd] Means in the same row with different superscripts are significantly different ($P<.01$).

Table 4 indicates that at slaughter all treatments had similar percentages of protein and fat indicating compensation. Compensation was also confirmed by the absence of treatment differences between carcass traits even though backfat thickness, KPH and yield grades of corn gluten feed steers tended to be higher. Fumagalli et al. (1989) concluded that restricted steers had less muscle, less bone and more fat than nonrestricted steers. Our restricted (control) steers had less fat and protein at slaughter (Table 4).

Table 4 Body Composition by ^{40}K Whole Body Techniques at Beginning of Feedlot Phase and Prior to Slaughter

	CGF	Corn	Control
Finishing % Fat	22.88[a]	21.98[a]	17.77[b]
% Protein	17.75[c]	17.85[c]	18.75[d]
Slaughter % Fat	30.73	32.44	29.41
% Protein	16.05	21.98	16.24

[ab] Means in the same row with different superscripts are significantly different ($P<.05$).
[cd] Means in the same row with different superscripts are different ($P<.10$).

Reduced fat in control steers is confirmed by lower yield grades, KPH and ribeye area with backfat thickness (Table 5) of control steers being intermediate between corn and corn gluten feed treatments. Corn gluten feed steers may have had different carcass traits and different body omposition if they had all been fed for 168 days.

Table 5 Carcass Traits as Influenced by Backgrounding Rations after 168 Days of a Common Feedlot Ration

	CGF	Corn	Control
Hot Carcass Weight (lb)	850.5	874.5	821.9
Quality Grade	11.1	10.7	10.9
Yield Grade	2.4[a]	1.6[b]	1.5[b]
Backfat Thickness (in)	0.39	0.23	0.28
KPH (%)	2.20	2.15	1.95
Ribeye Area (in^2)	13.5	14.4	13.2

[1] Quality Grades 10=Low Select, 11=High Select, 12=Low Choice
[ab] Means in the same row with different superscripts are different ($P<.10$).

This research indicates that a diet of ammoniated wheat straw and alfalfa hay only provides enough energy for maintenance of backgrounding steers. However, the addition of about 1% of body weight of corn significantly improves the performance of steers. In addition, the feeding of corn gluten feed also improves performance. The choice of using either corn or corn gluten feed depends on the availability of corn gluten feed. The use of corn gluten feed during backgrounding resulted in similar carcass quality while producing heavier steers at slaughter and reducing the amount of feed required during backgrounding.

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THE EFFECT OF SUPPLEMENTATION OF AN AMMONIATED WHEAT STRAW-ALFALFA DIET

II. INTAKE AND DIGESTIBILITY

J.L. Ellis[1] and G.B. Garner[2]

SUMMARY

A digestibility trial was conducted with 12 individually fed Angus heifers (400-600 lb). Dry matter intake and digestibilities were increased by supplementation (11.9, 11.9 and 8.3 lb/d intake for corn gluten feed (CGF), corn and control treatments, respectively and 57.3, 48.5 and 36.5% digestibilities for CGF, corn and control, respectively). Organic matter intake and digestibilities were also increased by supplementation (10.9, 11.2 and 7.5 lb/d for CGF, corn and control organic matter intake, respectively and 59.9, 51.4 and 40.2% for CGF, corn and control organic matter digestibilities, respectively). Neutral detergent fiber (NDF) intake and digestibilities were not increased by supplementation. This research indicates that supplementation of a high roughage ration can be inproved by the addition of either corn or corn gluten feed.

INTRODUCTION

Small grain production in the mid-western United States produces a large quantity of roughage residue. This residue is low quality and contains inadequate nutrients for satisfactory performance of beef steers. Research has been conducted to improve the performance of cattle fed these residues. The most viable treatment of these roughages is with anhydrous ammonia. Performance of cattle on high roughage diets has been improved by various supplements. These include alfalfa, starch (corn), rumen degradable protein (soybean meal), rumen undegradable protein (bloodmeal) and easily digested fibrous by-product feeds (corn gluten feed).

Since Missouri is a major producer of feeder calves and also a major grain producing state, a plentiful supply of calves for backgrounding are available along with large quantities of poor quality roughages. We were interested in determining the digestibilities of a high roughage ration and the effect of either supplemental energy from corn or corn gluten feed on digestibilities.

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MATERIALS AND METHODS

Twelve Angus heifers (400-600 lb) were used to determine dry matter, NDF and organic matter digestibilities of diets similar to those used in a growth trial. The basal diet consisted of ad libitum ammoniated wheat straw (3% anhydrous ammonia) and 0.55% body weight dry matter of alfalfa hay. Treatments were no supplement control, 0.95% body weight corn gluten feed or 0.79% body weight corn grain. Supplements were designed to provide about equal amounts of energy from the supplements (NRC, 1984).

All animals were individually fed and housed in an open front barn with paved pens (10 ftX 30 ft). Animals were fed once daily at 1100 hours and the concentrate and alfalfa hay were fed separately from the wheat straw and was readily consumed.

The experimental period consisted of a seven day adaptation period followed by a five day fecal collection period. All calves were dosed daily with 100 g of chromic oxide pellets containing 20 g/d of chromic oxide and 80 g/d of corn gluten feed. Feces were collected twice daily from the pen floor, composited and subsampled. Feces were dried at 100 C, ground through a Wiley Mill with a 1 mm screen and dry matter, organic matter and NDF concentrations were determined. Chromium concentration was determined by atomic absorption spectrometry after digestion of the feces by the procedure of Williams et al. (1962). Daily fecal dry matter, NDF and organic matter output were calculated from chromium concentration and dry matter, NDF and organic matter digestibilities were calculated.

Digestibility estimates were analyzed by the GLM procedure of SAS (SAS, 1985) as a completely randomized design (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

Intakes and digestibility estimates are presented in Table 1. Organic and dry matter digestibilities were improved by the addition of either corn or corn gluten feed to the diet. In a digestibility trial conducted by Oliveros et al. (1989), 25% corn in the diet resulted in diet digestibilities higher than those in our trial. They concluded that addition of 25% corn to a diet primarily of brome hay resulted in a negative associative effect of 4%. Since corn digestibilities were lower than those of Oliveros et al. (1989) while corn gluten feed digestibilities were similar; the additaion of corn to diets in this trial probably resulted in negative associative effects of greater than 4%.

In addition, the digestibility of dry matter and organic matter of corn gluten feed supplemented calves was numerically higher than corn supplemented steers. Since corn and corn gluten feed were supplemented at similar energy values this improvement is probably responsible for the improved performance of corn gluten feed supplemented steers observed in the growth trial. This also indicates an improvement in the utilization of the roughage portion of the ration as well.

Table 1 Intakes and Digestibilities Estimates of Calves Consuming an Ammoniated Wheat Straw-Alfalfa Diet Supplemented with Corn or Corn Gluten Feed

	CGF	Corn	Control
Dry Matter Intake (lb/d)	11.9[a]	11.9[a]	8.3[b]
Dry Matter Digestibility (%)	57.3[c]	48.5[c]	36.5[d]
Organic Matter Intake (lb/d)	10.9[a]	11.2[a]	7.5[b]
Organic Matter Digestibility (%)	59.9[c]	51.4[c]	40.2[d]
NDF Intake (lb/d)	6.7	6.8	5.9
NDF Digestibility (%)	49.1	41.9	39.3

[ab] Means in the same row with different superscripts are different ($P<.01$).
[cd] Means in the same row with different superscripts are different ($P<.05$).

This research indicates that supplementation of an ammoniated wheat straw-alfalfa hay diet with either corn or corn gluten feed increases the utilization of the entire diet. In addition, corn gluten feed seems to increase the utilization of the diet when compared to corn supplementation. The increased utilization of low quality roughages by backgrounding steers should reduce the costs of backgrounding steers.

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INTERRELATIONSHIP BETWEEN COMPOSITION OF GAIN, PLASMA INSULIN-LIKE GROWTH FACTORS AND PLASMA GROWTH HORMONE IN STEERS DURING PERIODS OF ENERGY RESTRICTION AND REFEEDING.

John M. Hayden[1,2], James E. Williams[1,3] and Robert J. Collier[4]

SUMMARY

A growth stimulatory hormone, insulin-like growth factor-1 (IGF-1), has been positively associated with nutrient intake and rate of gain during normal growth conditions in steers. This response has been associated with an increase in body tissue IGF-1 production by naturally occurring growth hormone (GH). This experiment was designed to examine the relationship between plasma hormone levels of GH, IGF-1 and insulin-like growth factor-2 (IGF-2) and body composition during energy restriction and refeeding. Eighteen yearling steers were assigned to two treatments (9 animals per treatment) consisting of an energy restricted-refed and a non-energy restricted group. During a 90 day restriction period, body weight was monitored weekly and used to adjust dry matter intake of either a low energy or an adequate energy growing diet to equal 2.0 and 2.4% of steer body weight. During refeeding, a common high energy finishing diet was fed to both treatments at 2.4% of body weight. Together with whole body protein and fat estimates, twelve steers were jugular catheterized and bled every 30 minutes for 10 hours. Blood was taken at the end of the restriction period, and on days 31 and 59 of energy refeeding. During restriction, rates of protein and fat deposition were less ($P < .05$) for restricted steers compared to non-restricted animals. Together with this response, GH concentration was 84% greater ($P < .05$); IGF-1 level was decreased ($P < .05$); and IGF-2 concentration was not different in restricted animals. During energy refeeding, GH declined in refed steers and was not different between treatments. IGF-1 levels remained lower in refed animals and gradually increased to levels similar to non-restricted steers by day 60 of refeeding. At day 60, body weight gain and protein deposition were similar between treatments. Additionally, a greater response in plasma IGF-2 was shown in refed steers during energy refeeding. In conclusion, restricted growth is associated with low plasma IGF-1 and high GH concentrations. Additionally, IGF-1 is positively related with whole body gain, and a greater response in plasma IGF-2 concentration was seen in restricted steers during energy refeeding. These results demonstrate the need to further study the response of muscle and fat tissue to changes of naturally produced hormones during restricted and compensatory growth. With this information we can better understand mechanisms that may increase growth and protein deposition in beef steers.

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INTRODUCTION

Dietary restricted cattle usually demonstrate greater rates of gain and feed conversion efficiency after refeeding them to diets adequate in nutrients. During these periods there seems to be accelerated rates of protein and fat deposition. In part, these responses have been attributed to an increase in feed intake which far exceeds those required for energy maintenance. Blood levels of insulin-like growth factor-1 (IGF-1) have been shown to be associated with nutrient availability and alteration of growth rate in steers during dietary restriction and refeeding.

We have examined the effects of standardized refeeding (intake relative to percentage of body weight) after dietary restriction on changes in body composition (Hayden et al., 1989). By use of this model we hope to decrease the variation associated with excessive and unequal individual feed consumption during refeeding, in order to better study metabolic efficiency during compensatory growth. Presently, information is lacking regarding the response of circulating IGF-1, IGF-2 and growth hormone (GH) on compositional changes during controlled refeeding. This experiment was developed to better understand hormonal effects on whole body protein and fat in steers during these conditions.

MATERIALS AND METHODS

Eighteen Chianina x British cross steers (average weight = 614 lbs) were allotted to two groups of nine animals, allowing for restricted-refed and non-restricted treatments. Steer weights were monitored weekly, and individual dry matter intakes were adjusted for the first 90 days (restriction period) to allow consumption of either an alfalfa-orchardgrass (low energy; NEg = 0.29 Mcal/lb; CP = 13%) or a corn-alfalfa (moderate energy; NEg = 0.52 Mcal/lb; CP = 13%) growing diet (Table 1) to equal 2.0 and 2.4% of body weight for restricted and non-restricted treatments. For an additional 90 days (energy refeeding period), both treatments were fed a finishing diet (dry matter intake = 2.4% of body weight) consisting of whole-shelled corn and corn silage (NEg = .65 Mcal/lb; CP = 11.5%) (Table 1).

Whole-body protein and fat were determined by measurement of naturally present potassium-40 at the University of Missouri Whole Body Counter. Body composition was determined every 30 days for 180 days.

In association with body composition estimates, 12 steers were jugular catheterized at the end of the restriction period and on days 31 and 59 of refeeding. The steers were bled every 30 minutes for 10 hours and these samples were analyzed for concentrations of GH (every 30 minutes), IGF-1 and IGF-2 (every 2 hours) by radioimmunoassay (Courtesy of Monsanto, Co., St. Louis MO).

RESULTS AND DISCUSSION

During energy restriction, restricted steers displayed less ($P < .001$) protein, fat and total body weight gain when compared to non-restricted steers (Table 2). During this response, plasma GH concentration was increased (2.0 vs 1.1 $\pm$ 0.18 ng/ml; $P < .05$; Figure 1) and IGF-1 was decreased ($P < .05$) by 75% (Figure 2). This hormonal condition has been previously shown in dietary restricted cattle (Blum et al., 1985; Ellenberger et al., 1989). In contrast, during normal feeding and growth conditions, GH actually stimulates general body production of IGF-1. Unlike IGF-1, plasma IGF-2 levels did not differ between treatments

during the restriction period and averaged 125 ng/ml (Figure 3).

Within the first 33 days of energy refeeding, the refed steers displayed lower ADG and fat deposition ($P < .05$), in addition to lower protein deposition (Table 2). This response may be associated with the time needed to adapt the rumen microorganisms of steers fed a low energy forage-based diet to a high energy finishing ration in order to maximize nutrient availability. During the next 30 days, refed steers displayed rapid growth which was 31% greater ($P < .01$) than non-restricted steers. During this compensatory growth response, protein deposition was greater ($P < .01$) and fat gains were similar in refed steers, compared to non-restricted animals (Table 3).

During energy refeeding, plasma GH levels declined rapidly to levels similar to non-restricted steers (Figure 1). Although GH levels also declined in non-restricted animals over the refeeding period, this response was not as rapid as in the refed animals (Figure 1). During energy refeeding, IGF-1 concentration increased over the energy repletion period in refed steers at a faster rate than non-restricted steers (Figure 2). Interestingly, this response does seem to follow the growth stimulatory response of the energy refed steers during this period (Table 3). Although IGF-2 values do not seem to differ between treatments, when examined over the energy refeeding period, IGF-2 levels in refed animals showed a greater and consistent increase ($> 9.0\%$; $P < .05$; Figure 3) versus those in non-restricted steers. This response may possibly suggest that IGF-2 is involved with stimulation of cellular growth during rapid compensatory gain.

Further experimentation is need to examine the actual effects of IGF on muscle and fat cell growth during conditions of restricted and compensatory growth. Presently, our laboratory is working on examining the mechanisms by which GH affects liver IGF production during these conditions.

LITERATURE CITED

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TABLE 1. COMPOSITION OF THE EXPERIMENTAL DIETS

ITEM	PERIOD --RESTRICTION-- R[a]	NR[a]	REFEEDING
	----- % of DM -----		
Alfalfa Hay	50.0	42.0	---
Orchard Grass	42.0	---	---
Whole-Shelled Corn	7.0	57.6	74.0
Corn Silage	---	---	20.0
Soybean Meal	---	---	3.7
Limestone	---	---	1.3
Potassium Chloride	---	---	.2
Sodium Phosphate	.6	---	---
Urea	---	---	.4
Trace Mineral Salt[b]	.3	.3	.3
Vit A&D Premix[c]	.1	.1	.1

[a]R=Energy restricted; NR=Non-restricted (adequate energy).

[b]NaCl 96.5%; Zn .35%; Mn .28%; Fe .17%; Cu .035%; I .007% and .0007% Co

[c]Premix contained 2,250 and 400 IU of Vit A and D.

TABLE 2. COMPOSITION OF GAIN DURING THE RESTRICTION PERIOD

ITEM	R*	NR*	SEM
ADG, lb/d	.62[a]	2.6[b]	.13
Protein Deposited, lb/d	.05[a]	.36[b]	.02
Fat Deposited, lb/d	.38[a]	1.1[b]	.08

*R=Restricted; NR=Non-Restricted

[a,b]Means within row differ (P<.001)

TABLE 3. COMPOSITION OF GAIN AFTER ENERGY RESTRICTION (ENERGY REFEEDING)

PERIOD (DAYS)	RR*	NR*	SEM
0-33			
ADG, lb/d	2.0[a]	3.1[b]	.2
Protein Deposited lb/d	.33	.41	.04
Fat Deposited lb/d	.65[a]	1.3[b]	.18
34-61			
ADG, lb/d	3.8[b]	2.9[c]	.2
Protein Deposited lb/d	.41[b]	.24[c]	.04
Fat Deposited lb/d	1.9	1.8	.11
0-61			
ADG, lb/d	2.6	2.9	.2
Protein Deposited lb/d	.36	.33	.03
Fat Deposited lb/d	1.2[a]	1.5[b]	.11

*RR=Restricted-Refed; NR=Non-Restricted

[a,b]Means within rows differ (P<.05)

[b,c]Means within rows differ (P<.01)

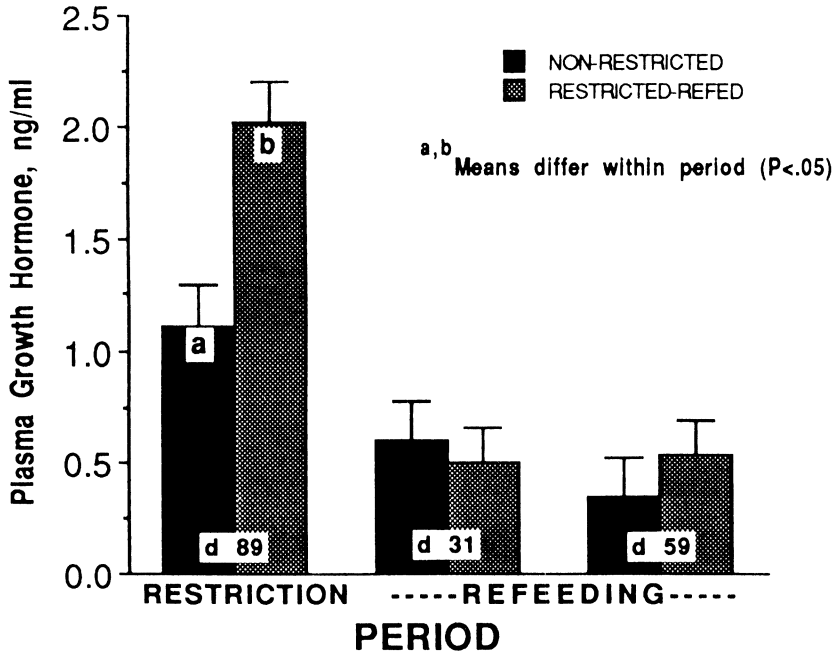

Figure 1. Plasma growth hormone concentrations during day 89 of energy restriction and on days 31 and 59 after energy refeeding.

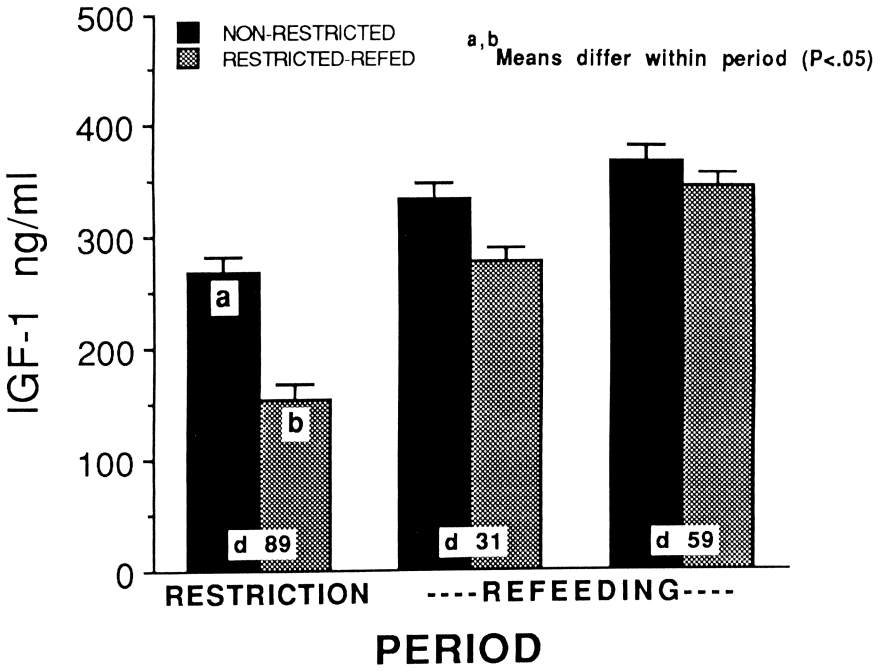

Figure 2. Plasma insulin-like growth factor-1 concentrations during day 89 of energy restriction and on days 31 and 59 after energy refeeding.

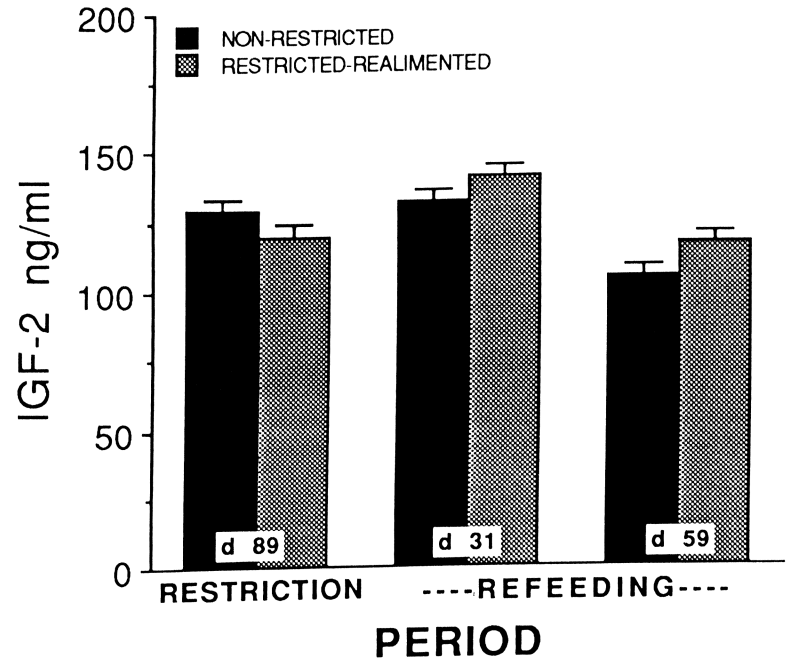

Figure 3. Plasma insulin-like growth factor-2 concentrations during day 89 of energy restriction and on days 31 and 59 after energy refeeding.

ESTIMATING COW BODY COMPOSITION

B.D. Belew[1], R.J. Lipsey[1], H.B. Hedrick[2], A. DiCostanzo[1], and J.A. Paterson[1]

SUMMARY

- MU Animal Scientists need accurate estimates of live cow body composition.
- This experiment compared shrunk body weight, weight to height ratio, condition score and MU Whole Body Counter evaluations as non-destructive prediction methods.
- The MU Whole Body Counter accounted for more variation in percentage lipid and protein than the other methods.
- New instrument standards for predicting live cow composition were developed for the MU Whole Body Counter.

INTRODUCTION AND OBJECTIVES

Scientists concerned with nutrition and reproduction management experiments with beef cows need reliable methods to predict body composition of growing and breeding animals. Since the slaughter of breeding animals is impractical, we compared the effectiveness of body weights, condition scores and the MU Whole Body Counter evaluations (^{40}K) as predictors of cow empty body composition.

MATERIALS & METHODS

Live weight (LW), condition score. weight to height ratio and whole body potassium content (predicted from ^{40}K) of 22 non-lactating beef cows (792 to 1639 lb) were used to predict empty body composition (entire body minus ingesta). Condition scores (see 1986 UMC Beef Report, p. 130 for guidelines) were assigned by four independent observers and averaged for each cow. A 9-point scoring system was used with: 1=very thin, 5=moderate and 9=very fat. Cows were fasted 15 h and LW was obtained prior to counting. Whole body ^{40}K was determined on each cow on a Friday and the following Monday. Each time, cows were subjected to two 2-min counts; an additional determination was made if the second count varied more than 2%. Immediately after the second ^{40}K determination, cows were conventionally slaughtered and carcasses chilled for 24 h. Components collected and weighed at slaughter included hide, ingesta, hot carcass and residue (blood, organs in thoracic cavity, cheek and head meat, tongue, udder and empty viscera). The skull and shanks were weighed, discarded and equated as bone in the analyses. The right side of each carcass was separated into kidney, pelvic and heart fat (KPH), bone (including heavy connective tissue), and soft tissue (muscle and fat). The soft tissue was processed as ground beef and sampled. The KPH was weighed, ground and sampled. Bones were sawed every inch on a band saw and samples taken from the residual saw dust. All samples were analyzed for moisture, lipid and protein.

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[1]Animal Sciences

[2]Food Science and Nutrition

RESULTS AND DISCUSSION

The 15-h shrink before ^{40}K determinations minimized gut fill weight variation between the counting dates. The correlation coefficient between successive animal weights was 0.99. The correlation between the successive ^{40}K determinations was 0.92. These observations indicate that a single ^{40}K determination following a 15-h shrink is adequate for assessing cow composition.

Means, standard deviations and ranges of cow measurements and composition are in Table 1. Although the weight range was large, none of the 22 cows were extremely thin (condition scores 1 or 2). The leanest cow was 14.2% lipid. On the other hand, condition score 8 cows are very fat. Typically, steers that grade choice are about 25 % lipid, so the fattest cow at 34.8% was visually obese.

Simple correlation coefficients between cow measurements and percentage empty body components indicate that weight, weight to height ratio and condition score accounted for similar amounts of variation in composition (Table 2). From a data collection standpoint, weighing or condition scoring cows are simple, useful methods for evaluating compositional differences. Because there was no improvement in prediction of composition using weight to height ratio over live weight or condition score, we compared only live weight, condition score and the Whole Body Counter in prediction equations.

Separate prediction equations using either shrunk body weight, condition score or shrunk body weight and ^{40}K were developed from the data (Table 3). The amount of variation in empty body composition accounted for by shrunk weight and ^{40}K was consistently superior to either body weight or condition score alone. Although these equations require verification, i.e., testing on an independent sample of cows, it appears that the University of Missouri Whole Body Counter is more sensitive to compositional differences than simply weighing or scoring cows.

TABLE 1. MEANS, STANDARD DEVIATIONS AND RANGES OF COW[a] MEASUREMENTS AND COMPOSITION[b]

ITEM	MEAN	SD	MINIMUM	MAXIMUM
Weight, lb	1064	205	792	1639
Weight/Height	21.6	3.3	17.0	30.6
Condition Score	5.1	1.2	3.2	8.3
Predicted K, grams	933.4	158.8	693.0	1273.0
Moisture, %	52.9	4.8	41.8	59.0
Lipid, %	21.9	6.0	14.2	34.8
Protein, %	17.6	1.2	15.1	19.5

[a] 22 cows
[b] Live body minus gut fill

TABLE 2. SIMPLE CORRELATION COEFFICIENTS (r) BETWEEN MEASUREMENTS AND EMPTY BODY COMPONENTS

ITEM	% MOISTURE	% LIPID	% PROTEIN
Weight	-.78	.78	-.67
Weight/Height	-.77	.78	-.71
Condition Score	-.73	.73	-.75

TABLE 3. COMPARISON OF PREDICTION EQUATIONS FOR EMPTY BODY COMPOSITION OF COWS USING WEIGHT, CONDITION SCORE AND POTASSIUM[a]

COMPONENT	EQUATION	R^2
Moisture, % =	72.19-.018 (wt,lb[b])	.61
Moisture, % =	67.73-2.91 (CS[c])	.54
Moisture, % =	67.40+.016 (K,gm[a])-.028 (wt,lb[b])	.73
Lipid, % =	-2.47+.023 (wt,lb[b])	.62
Lipid, % =	3.38+3.65 (CS[c])	.53
Lipid, % =	3.37-.02 (K,gm[a])+.035 (wt,lb[b])	.73
Protein, % =	21.93+.004 (wt,lb[b])	.45
Protein, % =	21.56+.77 (CS[c])	.56
Protein, % =	20.10+006 (K,gm[a])-.008 (wt,lb[b])	.71

[a] Grams of potassium from Whole Body Counter detected ^{40}K
[b] Cow weight, 15-h shrink
[c] Condition score

COMPARISON OF STEER-OID AND RALGRO IMPLANTS FOR YEARLING STEERS ON SUMMER PASTURES

Homer B. Sewell[1] and Don Mobley[2]

SUMMARY

Three groups of steers on two northwest Missouri farms with average initial weights of 778, 550 and 540 lb were used to compare the growth promoting effectiveness of a single Ralgro implant, a reimplant of Ralgro and a single STEER-oid implant for summer grazing periods of 162, 160 and 159 d.

Ralgro was reimplanted at mid-trial. A severe drouth reduced the quantity and quality of forage on all farms. A reimplant of Ralgro increased total gain by 18 lb (1.14 ADG) and a STEER-oid implant gave 7 lb (1.07 ADG) more average total gain per head than a single Ralgro implant (1.02 ADG) for the 162-d grazing period on Vogler's farm.

Steers implanted in herd one on Kinman's farm with a second Ralgro and a single STEER-oid had 9 and 12 lbs, respectively, greater total gain than those given a single Ralgro. Average daily gains for the 160-d trial were 1.54, 1.59 and 1.61 lbs for the respective implants. These steers consumed 11 lbs/hd/d of a salt-limited corn-soybean meal supplement.

Steers in herd two on the Kinman farm were not fed concentrates on pasture and gained less than 0.1 lb/hd/d for the last 86 d of the trial. Average daily gains for the 159-d period were 0.87, 0.89 and 0.89, respectively for a single Ralgro, 2nd Ralgro and a single STEER-oid implant, respectively.

INTRODUCTION

The summer grazing period for cattle backgrounded in Missouri often lasts from 150 to 180 d. Ralgro is the growth promoting implant used in many of these herds. Previous studies have indicated that Ralgro implants are effective for around 100 d. A reimplant of Ralgro at 80 to 100 d has increased total gain compared to one initial implant in grazing periods of 150 to 180 d in trials at the University of Missouri and other experiment stations.

STEER-oid is a growth promoting implant for steers. Each dose contains 200 mg of progesterone and 20 mg of estradiol benzoate. There is a need to determine how STEER-oid implants compare with other growth promoting implants in periods exceeding 150 days. These trials were designed to compare Ralgro and STEER-oid implants for yearling steers grazed approximately 160 d.

PROCEDURE

Ninety-nine yearling steers (Angus x Hereford) on the Curt Vogler farm near Rockport, Missouri were used to compare the effects of a single Ralgro implant, a reimplant of Ralgro or a STEER-oid implant for steers grazing spring and summer pastures. The steers were purchased in Nebraska in mid-November averaging 446 lbs. They averaged 1.83 lbs average daily gain on a winter ration of corn silage, legume hay and 3 lbs

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concentrate /hd/d. The steers averaged 778 lbs on May 11, 1989 when allotted by gate-cut to Ralgro and Synovex implant treatments. Two-thirds were implanted with Ralgro and one-half of these were reimplanted with Ralgro after 76 d giving treatments of one initial implant of Ralgro, a reimplant of Ralgro and one initial implant of STEER-oid. Steers were dewormed and given a fly tag in each ear when placed on test. Cattle were individually weighed once at the start, at the time of the second Ralgro implant and at the close of the trial. Steers were weighed off test October 20, 1989 after grazing fescue-brome pastures for 162 d.

Yearling steers of mixed English and Continental breeding were divided into herds one and two of 177 head and 172 head, respectively, on the Bill Kinman farm, Maryville, Missouri. Cattle in herd one and two had average initial weights of 550 and 540 lbs. They were purchased from South Dakota in October and wintered for approximately 200 days on drouth corn silage, alfalfa hay and 2.3 lbs of concentrate /hd/d. They gained 0.85 lb daily. Cattle were allotted, weighed and given the same implant treatments as described for animals in the Vogler herd.

The two herds were grazed separately. There was a severe drought and pastures were extremely short of forage after mid-July. Cattle in herd one grazed a mixture of fescue and bluegrass for 160 days. They consumed 11 lbs /hd/d of a self-fed corn-grain supplement mixture containing 11% plain salt from July 11 to end of trial (100 d). Cattle in herd two grazed 100 acres of a mixed fescue and bluegrass pasture for 159 d with 70 acres of alfalfa pasture added August 1st. No grain was fed and forage quantity and quality became extremely deficient after mid-July.

Each herd was analyzed individually testing treatment means difference using Fisher's Least Significant Difference (LSD).

RESULTS

The cattle averaged 1.07 lb daily gain for the 162-d grazing period on the Vogler Farm (Table 1). The large winter average daily gain (1.83 lb) and droughty pastures were likely responsible for their low gain on pasture. The herd averaged 1.48 lb daily gain for 76 d prior to giving the 2nd Ralgro implant and 0.68 lb daily for 86 d after the second implant.

The average daily gains for the single Ralgro, 2nd Ralgro and STEER-oid groups were .57, .77 and .73 lb daily, respectively, for the 86 d after reimplanting Ralgro (Table 1). Thus, a reimplant of Ralgro increased daily gain by .2 lb ($P<.05$) indicating the effectiveness of the initial Ralgro implant had diminished. Steers implanted with STEER-oid averaged .16 lb faster daily gains than those implanted with one Ralgro for the last 86 d of the 162-d period, indicating a single STEER-oid implant may have a longer period of effectiveness than a single Ralgro implant.

There were small differences in total gain for the three implant treatments. The 2nd Ralgro increased total gain by 18 lbs (1.14 ADG) and the STEER-oid implant gave 7 lb. (1.07 ADG) more total gain per head than a single Ralgro implant (1.02 ADG) for the 162-d period (Table 1). None of these differences were statistically significant ($P>.05$). Research results indicate implant responses are reduced when cattle gain approximately 1 lb daily or less.

Steers in herd one on the Kinman farm were self-fed 11 lbs of grain /hd/d on pasture for the last 100 d of the trial and averaged 1.56 lb daily for 160-d (Table 2). The herd averaged 2.10 lb daily gain for the 73 d before the 2nd Ralgro implant was given

and 1.14 lb daily for 87 d after the 2nd implant. All groups had the same average daily gain prior to the 2nd Ralgro implant.

The average daily gains of the single Ralgro, 2nd Ralgro and STEER-oid treatment groups were 1.07, 1.17 and 1.21 lbs ($P<.05$), respectively, for the 87 days after administering the 2nd Ralgro implant (Table 2). A second implant of Ralgro increased average daily gain by .1 lb (9.3%) for these last 87 days compared to the one initial Ralgro resulting in 9 lbs additional average gain per head. Cattle implanted with STEER-oid had similar average daily gain to those implanted with the 2nd Ralgro (1.21 vs 1.17) but .14 lb ($P<.05$) faster daily gain than the single Ralgro group (1.21 vs 1.07) for the last 87 d of the 160-d trial. Evidently, the STEER-oid implant had a longer period of effectiveness than the single Ralgro implant. Since the only difference in performance among the groups was in the last period, the additional gains per head for the 2nd Ralgro and STEER-oid treatments vs a single Ralgro implant for the total period were the same as for the period after the 2nd Ralgro implant (9 and 12 lb). Average daily gains for the 160 d were 1.54, 1.59 and 1.61 lbs, respectively, for single Ralgro, 2nd Ralgro and single STEER-oid implants.

Performance was poor in Kinman's herd two after the 2nd Ralgro implant on July 25 (Table 2). Pastures were extremely poor. Average daily gain for the herd dropped from 1.84 lb daily in the first 73 days to .05 lb daily for the 86 days after the 2nd Ralgro implant. Many of the cattle lost weight in the latter period. There were little differences in performance among groups for either period. The average daily gains for the total trial (159 d) were 0.87, 0.89 and 0.89, respectively, for one Ralgro, two Ralgro and STEER-oid treatments. Evidently, poor nutrition after the 2nd implant nullified any potential growth stimulation from the implants.

TABLE 1. STEER-OID VS ONE OR TWO RALGRO IMPLANTS FOR YEARLING STEERS ON SUMMER PASTURES - VOGLER[a]

Implant	1-Ralgro	2-Ralgro	STEER-oid
No. of Head	33	33	33
Initial wt, lb	776	777	781
Before 2nd Ralgro - 76 d			
Wt., lb	893	895	891
Gain, lb	117	118	110
ADG, lb	1.54[b]	1.55[b]	1.45b[b]
Final wt., lb	942	961	954
After 2nd Ralgro - 86 d			
Gain, lb	49	66	63
ADG, lb	.57[b]	.77[c]	.73[bc]
Total Period - 162 d			
Gain, lb	166	184	173
ADG, lb	1.02[b]	1.14[b]	1.07[b]
Difference vs 1 Ralgro			
Gain, lb	-----	18	7
ADG, lb	———	.12	.05
%	———	11.8	4.9

[a] Initial Implants - May 11; 2nd Ralgro July 11 (76 d); Final Weight Oct. 20 (162 d)

[bc] Means in the same row with different superscripts are significantly different ($P<.05$).

TABLE 2. STEER-OID VS ONE OR TWO RALGRO IMPLANTS FOR YEARLING STEERS ON SUMMER PASTURES - KINMAN[ab]

	1 - Ralgro	2 - Ralgro	STEER-oid
Herd One			
No. Head	60	59	58
Initial wt, lb	558	539	554
Before 2nd Ralgro - 73 d			
wt, lb	711	692	707
Gain, lb	153	153	153
ADG, lb	2.10[c]	2.10[c]	2.10[c]
Final wt, lb	804	794	812
After 2nd Ralgro - 87 d			
gain, lb	93	102	105
ADG, lb	1.07[c]	1.17[cd]	1.21[d]
% Difference		9.3	13.1
Total Period 160 d			
Gain, lb	246	255	258
ADG, lb	1.54[c]	1.59[c]	1.61[c]
Difference vs 1 - Ralgro			
Gain, lb	———	9	12
ADG, lb	———	.04	.07
% Difference	———	3.7	4.9
Herd Two			
No. Head	58	57	57
Initial wt, lb	532	541	546
Before 2nd Ralgro - 73d			
wt., lb	669	673	683
Gain, lb	137	133	137
ADG, lb	1.88[c]	1.82[c]	1.88[c]
Final wt, lb	670	682	687
After 2nd Ralgro - 86d			
Gain, lb	1.0	9	4
ADG, lb	0.01[c]	0.1[c]	.04[c]
Total Period 159 D			
Gain, lb	138	141	141
ADG, lb	0.87[c]	0.89[c]	0.89[c]
Difference vs 1 Ralgro			
Gain, lb	-----	3	3
ADG, lb	-----	.02	.02
% Difference	-----	2.0	2.0

[a] Herd One: Initial Implants - May 12; 2nd Ralgro - July 24 (73d); Final Wt - Oct. 19 (160d)
[b] Herd Two: Initial Implants - May 13; 2nd Ralgro - July 25 (73d); Final Wt - Oct. 19 (159d)
[c d] Means in the same row with different superscripts are significantly different ($P<.05$).

EVALUATION OF FEEDLOT STEER TRAITS TO DETERMINE PROFITABILITY[1]

K. L. Shern[2], A. DiCostanzo[3], E. Cole[4], C. W. Peters[5], R. J. Lipsey[6]

SUMMARY

- Cattle that graded Choice were more apt to be profitable than those grading less than Choice.
- Heavy arrival weights were negatively associated with profitability.
- Performance traits (ADG and dressing percentage) influenced profitability more than cutability traits.
- In all test years except 1981-82, high profit and low profit pens had similar feeder calf frame and value, but the high profit pens had higher ADG and percent Choice.

INTRODUCTION

Cow-calf producers often do not have the opportunity to assess the profit potential of their calves beyond weaning or backgrounding. Therefore, it is difficult for some cattle producers to prioritize genetic and management decisions that might affect feedlot and consumer demands for their products. University of Missouri Extension Service designed the Southwest Missouri Steer Feedout to allow Missouri cow-calf producers to evaluate their calves for profitability through identifying finishing costs and carcass values. Each year, Extension personnel have made this information public for producers to evaluate the performance of their calves. This paper, summarizes information from five years on factors that affect profit from finishing steers in the feedlot.

MATERIALS AND METHODS

Profitabilities of finishing steers in the feedlot were evaluated from data collected in the Missouri Steer Feedout Program over a 5-year period. Spring-born steer calves were delivered to a custom feedlot in early November. They were weighed, measured for frame size, treated for parasites, vaccinated, and assigned feeder calf market values by professional order buyers. After a 20-day break-in period, the steers were gradually moved up to the finishing ration. Records kept on the calves while on feed included: owner, sire breed, dam breed, birth date, initial frame score, starting weight, feeder value, days on feed, off test weight, ADG, carcass weight, dressing percentage, backfat, ribeye area, percent kidney, pelvic and heart fat, yield grade, quality grade, carcass price adjusted for discounts, feed intake per pen, feed costs per pen, lot costs per pen, and net profit per pen. Since calves were fed in large groups, individual feed intakes were calculated using metabolic body weight, ADG and values for net energy for maintenance, NEm Req = 0.077(avg wt in kg)$^{.75}$, and net energy for gain NEg Req = NRC Coefficient x (avg wt in kg)$^{.75}$ x ADG$^{1.07}$

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[1] This project was supported by the University of Missouri College of Agriculture Office of Resident Instruction under guidelines for the Undergraduate On-Campus Internship Program.

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The difference between final carcass value and feeder calf value and feed, veterinary, marketing (hauling, Beef Checkoff etc,), fixed and interest costs, constituted profit per head. Simple correlations of variables within years with profit were calculated. Variables having the greatest influence on profit were selected by regression models. These models identified optimum subsets of variables. Partial correlations were performed on resulting models to identify contributions of each variable to profit. Upper 15% and lower 15% profit pens were identified within year and their performance, carcass and economic traits characterized to further substantiate the role of selected variables for determination of profit.

RESULTS AND DISCUSSION

Data collected over 5 years were pooled and summarized describing the population (Table 1). The feeder cattle starting weights ranged from 440 to 1058 lbs. Although beginning frame scores ranged from 2.0 to 8.0, 95% of the cattle delivered were between frame score 3.0 and 7.0. Sire breeds of feeder cattle included Angus, Beefmaster, Braford, Brahman, Brangus, Charolais, Chianina, Gelbvieh, Hereford (polled and horned), Limousin, Murray Grey, Red Brahman, Red Brangus, Saler, Santa Gertrudis, Simbrah, Simmental and South Devon.

When three of the five steers in a consignor pen were visually estimated to grade Choice, they were slaughtered. However, in 1987-88 steers were slaughtered at either 139 days on feed or 160 days on feed. Carcass value was determined by current prices adjusted for weight, quality and cutability discounts. Discounts over five years ranged from $2.50/cwt to $12.50/cwt for Select, $2.00/cwt to $10.00/cwt for carcasses under 600 lbs., $4.00/cwt to $12.50/cwt for yield grade 4's and 5's, and $24.00/cwt for dark cutters.

Regression procedures were used to identify traits that influenced profit. Carcass price, adjusted for weight, quality and cutability discounts accounted for 23 to 74% of the variation in profitability. Obviously, cattle without discount priced carcasses were more profitable. Starting weight was an important factor 4 of 5 years. Heavy feeder cattle were less profitable. During years in which carcass weight was not important in the model, dressing percentage was a factor. Contributions of feeder frame, feeder value and ADG were inconsistent and year-dependent.

Identification of the 15% highest and the 15% lowest profit consignor pens substantiated that performance and quality grade affected profit more than cutability traits (Table 3). In fact, the high profit pens were slightly fatter and averaged 0.5 lb/day greater ADG than the low profit groups.

TABLE 1. POOLED MEANS, STANDARD DEVIATIONS AND RANGES OF INDEPENDENT VARIABLES FROM FIVE TRIALS

Item	Mean	SD	Minimum	Maximum
Starting wt, lbs	679.	90.	440.	1058.
Starting frame	5.0	1.0	2.0	8.0
Feeder value, $/cwt	69.86	8.48	59.00	85.00
Days on feed	150.	16.	120.	181.
ADG, lbs/da	2.8	0.4	1.2	3.9
Feed intake, lbs DM	3453.	607.	1987.	5980.
Off test wt, lbs	1097.	98.	825.	1478.
Dressing percentage	60.3	2.4	53.9	68.5
Backfat, in	0.29	0.13	0.05	1.0
Ribeye area, in^2	12.0	1.6	7.9	19.2
KPH, %[a]	2.0	0.5	1.0	4.0
Yield grade	2.3	0.62	1.0	5.0
Quality grade[b]	9.5	0.9	8.	13.
Carcass wt, lbs	662.	70.	483.	908.
Carcass price, $/cwt	108.82	6.03	91.50	118.00
Profit, $/hd	3.93	62.57	-223.39	177.07

[a]Kidney, pelvic and heart fat.
[b]9 = high Select, 10 = low Choice, etc.

TABLE 2. PARTIAL CORRELATIONS OF INDEPENDENT VARIABLES TO PROFIT BY YEAR

Year	Starting wt	In frame	Feeder value	ADG	DP[a]	Carcass wt	Carcass price
1981-82	.	-.30	-.26	.	.53	.	.67
1982-83	-.50	.	.	.58	.66	.	.52
1986-87	-.77	.	.	.	.	.83	.54
1987-88	-.69	.	-.67	.	.	.87	.48
1988-89	-.76	.	.	.	.	.83	.86

[a]Dressing percent i.e. hot carcass weight/live weight

TABLE 3. COMPARISON OF LOW AND HIGH PROFIT PENS CONSIGNED BY YEAR[a]

Item	1981-82		1982-83		1986-87		1987-88		1988-89	
	Low	High	Low	High	Low	High	Low	High	Low	High
Starting frame	4.4	2.9	4.1	4.0	5.6	5.7	4.9	5.3	6.0	6.3
Starting wt, lbs	666.	617.	636.	525.	592.	619.	628.	712.	822.	776.
Feeder value, $/cwt	63.00	62.00	64.00	62.50	62.00	64.00	74.00	71.00	79.00	79.00
ADG, lbs/da	2.6	2.9	2.3	2.9	2.1	2.8	3.0	3.3	2.4	3.2
Off test wt, lbs	1080.	1009.	991.	1040.	932.	1055.	1071.	1173.	1140.	1289.
Backfat, in	0.26	0.36	0.25	0.32	0.17	0.23	0.21	0.50	0.32	0.35
KPH, %[b]	2.8	2.2	2.1	2.4	1.5	1.6	1.7	2.2	1.6	1.7
Quality grade[c]	8.8	9.7	9.1	10.8	8.2	8.8	9.5	10.3	8.8	9.7
Carcass price, $/cwt	112.00	114.80	103.37	106.00	95.50	103.00	110.00	114.00	106.78	114.00
Profit, $/hd	2.69	135.62	-35.64	61.12	-46.07	109.75	-132.43	28.86	-100.50	85.40

[a]Lowest 15% and highest 15%.
[b]Kidney, pelvic and heart fat.
[c]9 = high Select, 10 = low Choice, etc.

SUMMARY OF THE RED BOOK DATA FROM THE INTEGRATED RESOURCE MANAGEMENT PROGRAM IN MISSOURI - 1987-89

J. C. Whittier

INTRODUCTION

Early in 1987 a program entitled Integrated Resource Management (IRM) was initiated in Missouri. The purpose of the program was and is to develop an integrated approach to identification and solution of problems related to livestock production in Missouri. One of the tools used to identify problem areas in cow-calf production was the use of a pocket-sized data collection book. These books are red in color and have become known simply as "RED BOOKS". There were 600 Red Books distributed to selected cattle producers in 1987, 1200 in 1988, 750 in both 1989 and 1990. These books contain pages for recording reproduction and growth performance, health care, death losses, inventories and other management practices related to the cowherd. The Red Books also contain a daily planning calendar and are designed to be a simple, yet comprehensive record of the yearly cow-calf production cycle.

In cooperation with the Red Book holders and the Area Extension Livestock Specialists, the data recorded in these books throughout the years were accumulated at the University of Missouri. The following is a brief summary of some of the key indicators of production gathered from the Red Books during 1987-1989. The key indicators used were: **G**rowth, **O**pen cows, **L**ength of the calving season, and **D**eath loss. We have adopted the acronym "**GOLD**".

GROWTH

Figure 1 shows the average growth rate for heifers, steers and bulls from birth to weaning for calves reported during the three years. Average daily gain was quite good for these calves. When expressed as pounds of calf weaned per cow in the breeding herd, an average of 328 pounds per cow was reported for the 3 years. It is important to recognize that even though heavy calves are produced at weaning, if an excessive number of calves are lost due to open cows or death losses prior to weaning, total profitability is negatively affected.

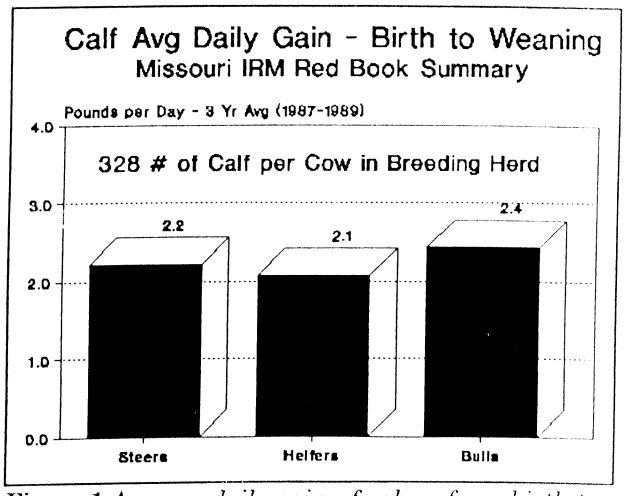


***Figure 1** Average daily gain of calves from birth to weaning and pounds of calf weaned per cow in the breeding herd.*

OPEN COWS

On the average, 38.6% of the producers reported that they used pregnancy diagnosis as a management practice. This is somewhat lower than expected. Identifying open cows soon after the breeding season enables decisions of culling or feeding non-pregnant cows to be made in a timely manner. The costs of maintaining a non-productive female have a direct impact on net return. Nearly 11% of the cows were diagnosed as open by the pregnancy

exam. Even if the decision was made not to market the open cows a pregnancy testing time, knowing which cows are open would facilitate more strategic feeding and marketing programs. This appears to be an area of management that could be improved.

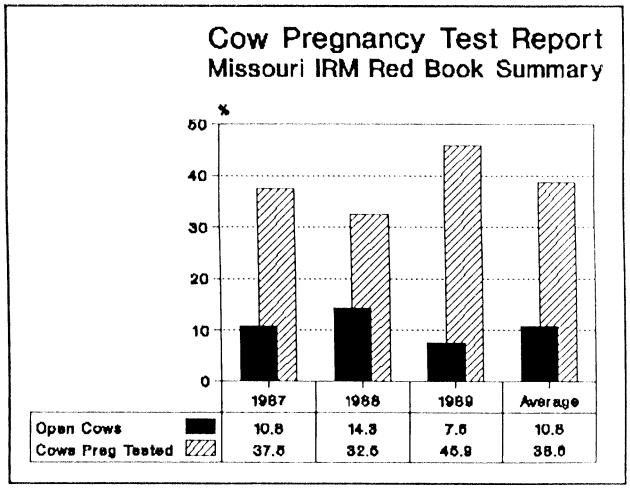


Figure 2 Indicators of reproductive performance.

LENGTH AND DISTRIBUTION OF CALVING SEASON

Figures 3 and 4 depict the length of the calving season and the percentage of calves born in each 21 day period. Twenty-one days represents the length of a heat cycle during the breeding season and therefore the opportunity to conceive at various intervals from when the bull is turned in. The line indicated at the top represents the possible percentage of calves that could be born in each period if 100% of the cows were cycling when the breeding season begins and with a conception rate of 65% for each mating. Research suggests 65% conception as the biological average conception rate for cattle. The data from the Red Books shows that 1989 was a year where the pattern of calving most closely approached this possible distribution. The average length of the calving season of 189 days is too long to exercise the type of management and control necessary. Shorter calving seasons allow several advantages that will not be discussed in this paper.

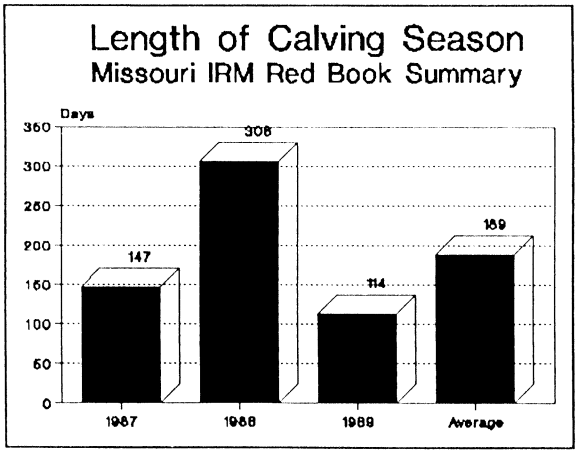


Figure 3 Length of the calving season reported for 1987, 1988 and 1989.

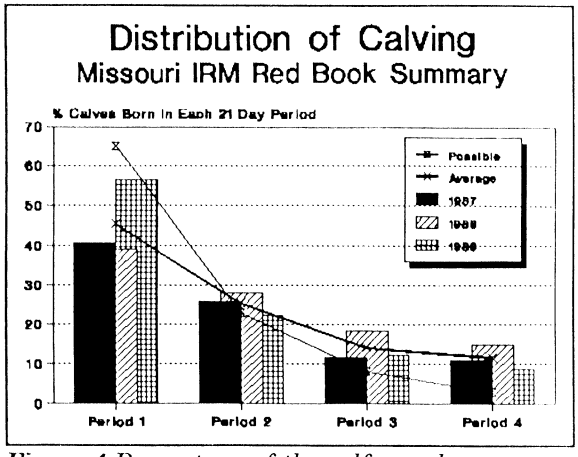


Figure 4 Percentage of the calf crop born during each 21 day period of the calving season.

DEATH LOSSES AND CAUSES

An average of 6.8% of the calves born during the 3 years reported, died between birth and weaning (Figure 5). This percentage, coupled with the number of open cows reduced the percent calf crop weaned to approximately 82%. Figures 6 and 7 show the ages of the calves when they died and the reported causes of death. Due to errors in reporting, there were a number of calves that were not accounted for in the Red Book reports. This fact likely

explains the reason for the high percentage (41.8) of missing calves. Calf death losses at or near calving were likely related to calving difficulty (dystocia) since calving difficulty was reported as a major cause of death. Emphasis on reducing calving difficulty appears warranted based on these data. Management practices such as proper development of replacement heifers, selection of calving ease sires, and evaluation of pelvic area of heifers and bulls, may be areas in which progress could be made.

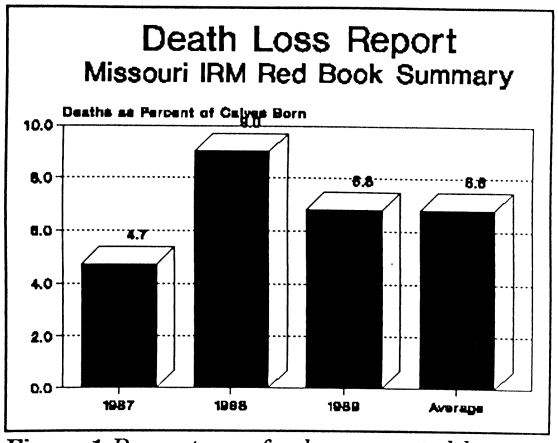


Figure 1 Percentage of calves reported lost between birth and weaning over 3 years.

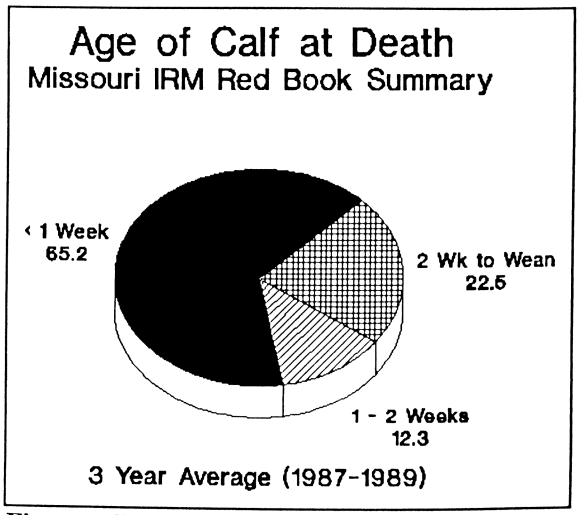


Figure 2 Distribution of age of calves at death.

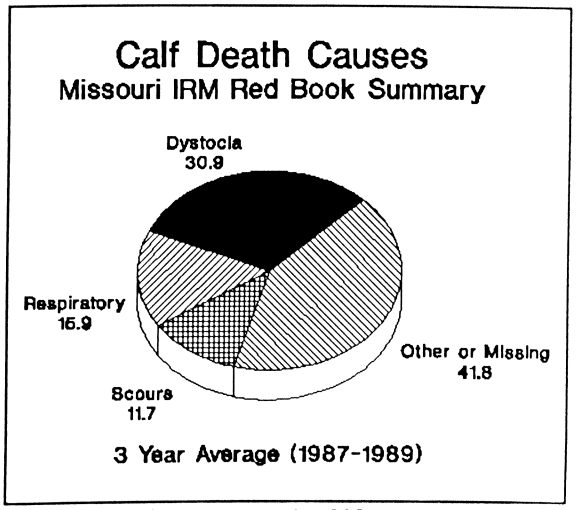


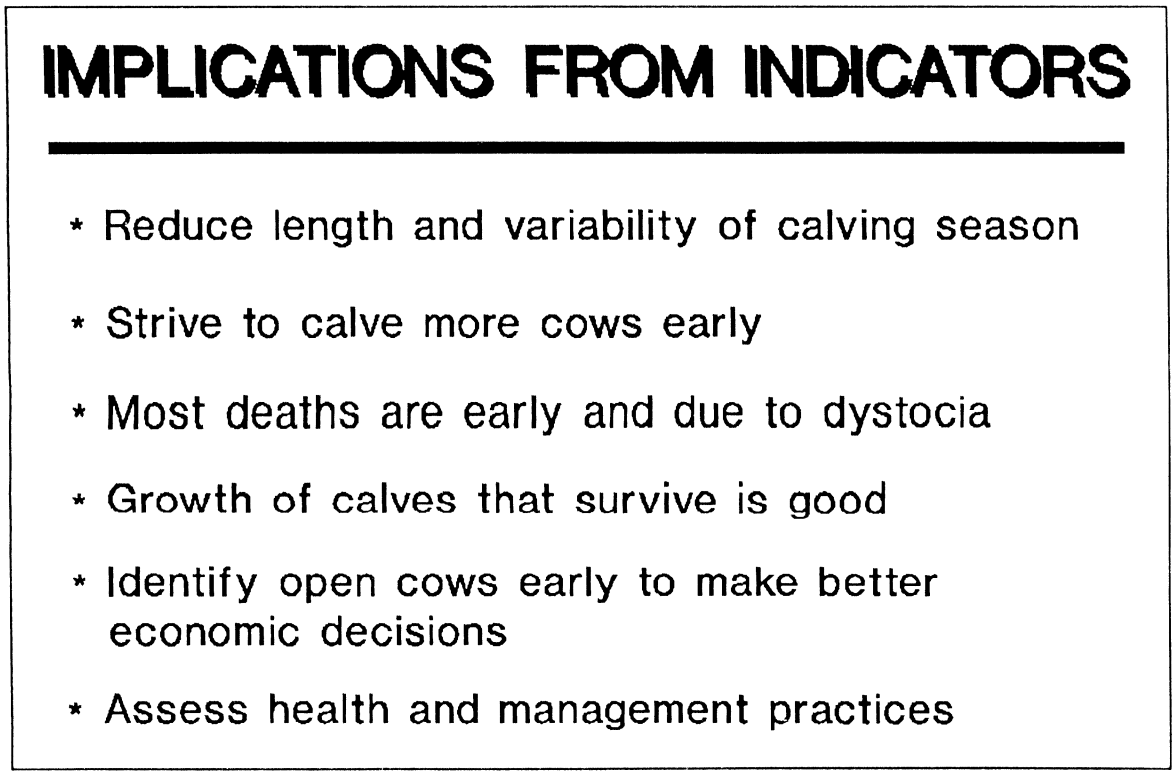
Figure 3 Major causes of calf losses reported.

OTHER MANAGEMENT PRACTICES USED

The results of the Red Book summary indicated that a high percentage of cow-calf producers make use of growth-promoting implants in their operations, both as suckling calves and at weaning. Of the respondents, a high percentage stated that they vaccinate both their cows, calves and bulls with the generally recommended vaccinations. Most cows were vaccinated for vibriosis and leptospirosis, while cow vaccines for clostridium, E. Coli, hemophilus, and pasteurella were less common. Over 50% of the herds reported treatment of the mature cows for both internal and external parasites. Additional data related to bull breeding soundness examinations, culling criteria, primary forage grazed, and marketing systems used were also collected and are not reported here due to space. Future reports will contain additional supplementary information.

IMPLICATIONS FROM THE INDICATORS

Figure 8 lists and summarizes some of the implications this authors draws from the data summary. Much can be learned by analyzing where an operation is in relation to the state average and to its own production goals. It has been stated that "knowledge gives power over nature". By better understanding the factors that relate to production efficiency, more appropriate and educated decisions can be made.



THANKS

Appreciation is expressed to the Missouri producers who assisted in the collection of this data, without actual data, this endeavor would not have been possible. Thanks is also expressed to Area Extension Specialist who helped distribute the Red Books and collect the summaries of the information. Last but certainly not least, gratitude goes to the sponsors who have assisted financially in making the Red Books available at no cost to Missouri cattle producers, they are:

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Through Mr. Frederick B. Miller's Trust, the Department of Animal Sciences in the College of Agriculture is able to enrich the programs of research, scholarships and development of livestock.

Participants from off-campus and from other faculties assemble with resident staff from the University of Missouri Animal Science faculty to review, discuss and update technology related to the industry opportunities and problem evaluations. This new knowledge base complements existing technology. It also provides Missouri producers the opportunity to improve resource utilization for maximum production efficiency and profitability.

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