Cattle Diets Under Continuous and Four-pasture, One-herd Grazing Systems in Southcentral New Mexico

JAMES A. PFISTER, GARY B. DONART, REX D. PIEPER, JOE D. WALLACE, AND EUGENE E. PARKER

Abstract

Diet samples were collected from cows grazing a four-pasture, one-herd rotation system and a yearlong pasture. Differences in botanical content of the diet between the two systems was not consistent for the two years. During the first year diet of cows grazing the rotation pastures were higher in browse and lower in grass content compared to those grazing the yearlong pasture. However, during the second year, browse content of the diets was nearly identical for the two systems. Apparently higher weaning weights of calves from the yearlong system are related to greater herbage availability and digestibility compared to the rotation system.

Grazing systems have often been looked upon as a means of improving range conditions while still allowing grazing. In recent years, the interest in grazing systems has increased as additional pressures are brought to bear on our rangelands. Environmental impact statements often recommend implementation of grazing systems.

However, recent reviews of specialized grazing systems have shown diverse and often confusing results (Shiflet and Heady 1971, Herbel 1974, McDaniel and Allison 1980). Research comparing rotation and continuous grazing systems has traditionally measured vegetational cover and livestock production. Livestock responses are well-documented and have been measured in terms of cattle weight flux, average daily gain and calf weaning weights. Intensive grazing systems in which livestock are confined to relatively small pastures often decrease individual animal performance (Pieper 1980). However, underlying causes have often not been clear because of the large number of factors influencing responses (Heady 1961). Evaluating changes in selectivity of diet by cattle in specialized grazing systems may aid in quantifying and interpreting livestock and vegetational responses.

The objectives of this study were to compare botanical composition and determine digestibility of cattle diets between a four-pasture, one-herd and a year-long grazing system.

Description of Area

This study was located on the 10,520-ha Fort Stanton Experimental Ranch in southcentral New Mexico. Topography is characterized by steep canyons, arroyos, and relatively level mesas. The study area elevation varies from about 1,950 m to 2,250 m above sea level. Open grassland vegetation is found on the mesas, canyon bottoms and lower hills, while slopes and higher elevations commonly support sparse to dense stands of pinyon (*Pinus edulis* Engelm.)-juniper (*Juniperus* spp.) and wavyleaf oak (*Quercus undulata* Torr.) (Pieper et al. 1971).

The climate is mild with warm summers and cool winters. Average annual precipitation is near 40 cm with two-thirds of this moisture falling in the growing season of June, July, August and

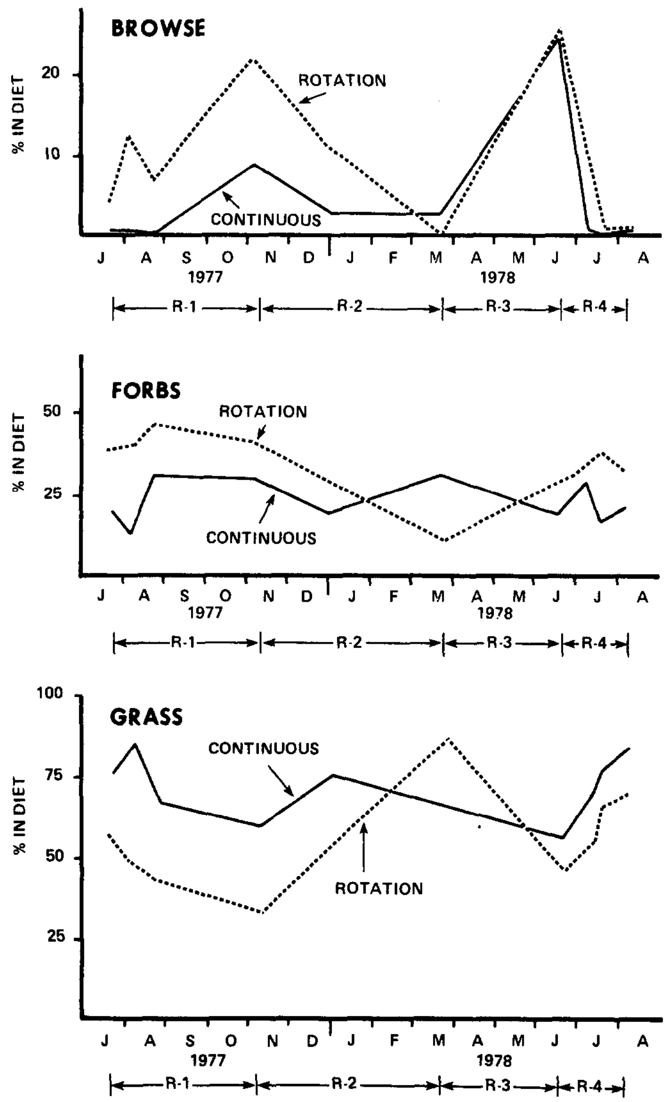

Fig. 1. *Browse, forb and grass content of cattle diets under continuous and in a one-herd, four-pasture rotational grazing system.*

Authors are former graduate assistant, professors and assistant professor in the Department of Animal and Range Sciences, New Mexico State University, Las Cruces. We thank Reldon Beck, Rod Heitschmidt, and Jerry Holechek for reviewing the manuscript and Melchor Ortiz for aid with statistical analysis. The research was done in cooperation with the Bureau of Land Management, U.S. Department of Interior.

Journal Article No. 1016, Agricultural Experiment Station, New Mexico State University, Las Cruces.

Manuscript received February 14, 1982.

September.

In 1969, a large pasture was cross fenced to create one 567-ha pasture and four smaller pastures of about 100 ha in size each. The largest pasture was grazed continuously year-long while the four smaller pastures were grazed alternately as a four-pasture, one-herd rotation system.

Stocking rates in the continuous pastures were set initially at a moderate rate approximating proper use. The rotation system was stocked at a rate 25% higher than the continuous moderate pasture. Stocking rates have varied from 8 ha per cow when the study was initiated to 40 ha per cow during the 1974 drought (Pieper et al. 1978).

Cattle movement in the rotation pastures has been based on visual estimation of herbage residue, following recommendations of Bement (1969) that optimal animal and herbage production could be achieved on blue grama range when about 300 kg/ha of residue remained ungrazed at the end of the grazing season.

Methods and Procedures

Five to 10 days before the November, January, March and June collections, the fistulated cattle were transported to Fort Stanton and allowed to graze freely their assigned pastures for adaptation purposes. Four lactating cows were used initially for collections in each treatment, but during the winter of 1977 only three animals were available for each treatment. In the spring and summer of 1978, two lactating cows and three heifers were used for each treatment.

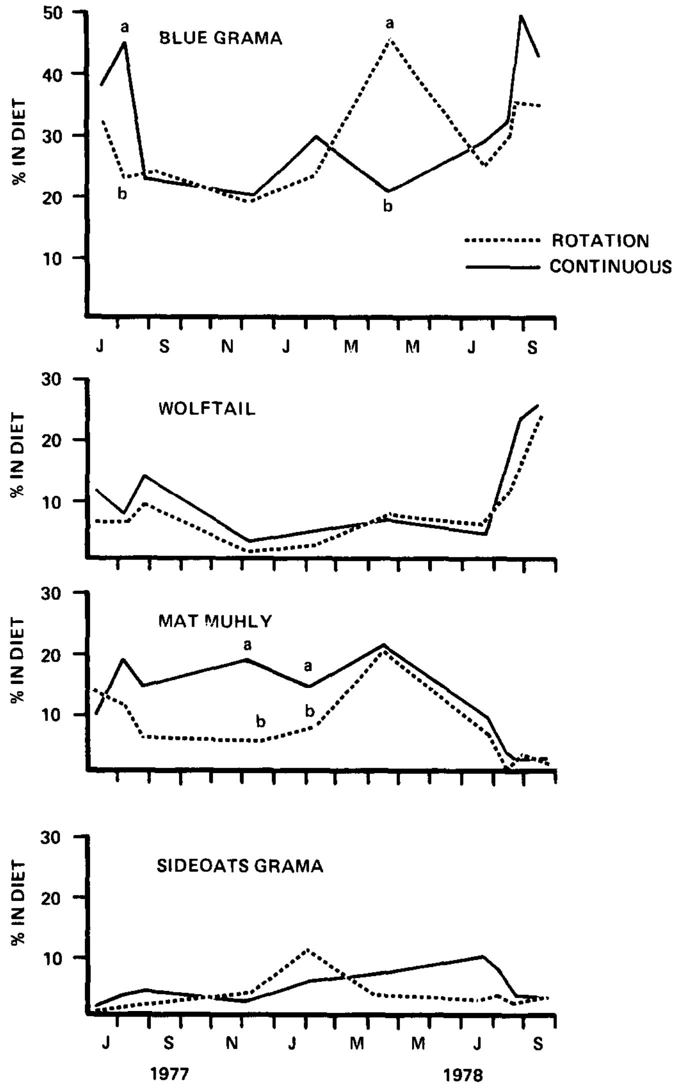

Fig. 2. *Dietary content of major grass species under a continuous and rotation system. Letters indicate significant differences (P<0.05) between systems on a particular date. Where no letters appear, there was no significant difference (P>0.05).*

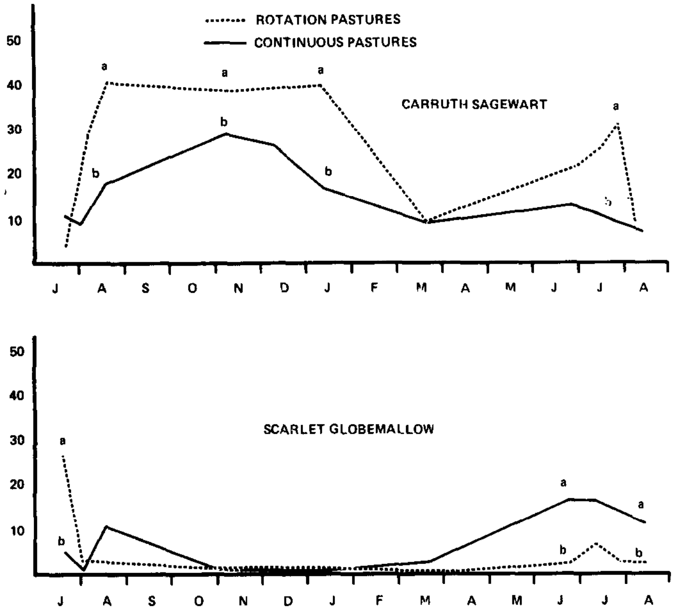

Fig. 3. *Dietary content of carruth sagewort and scarlet globemallow on a continuous and rotation grazing system. Different letters indicate significant differences between systems. Where no letters appear, there was no significant difference (P≥0.05).*

All collections in this study were made over four-day periods with esophageal fistulated animals equipped with screen-bottomed canvas collection bags. Overnight fasting was employed to insure adequate grazing and to minimize sample contamination by regurgitation. To minimize fasting effects on selective grazing, cattle were located and penned just before darkness.

Collections were made once a day at daybreak. Length of collection periods varied, but generally 20 to 30 minutes was required during the growing season to obtain an adequate sample while 40 minutes was required during the dormant season. Cattle were hazed each morning from horseback to nearby predetermined areas where previous visual observation indicated range cows were grazing. Once placed in a general area, fistulated cattle were allowed to move at will. Immediately after each sampling period, cannulas were replaced and the cattle were permitted to graze unrestrained for the remainder of the day.

Extrusa samples were taken to a mobile drying van with a forced-air oven where the samples were spread on trays and dried for 48 hr at 40°C. After drying, samples were ground in a Wiley mill through a 1-mm screen. Equal amounts of extrusa were pooled for individual animals within a collection period and stored in permanent plastic containers.

The microhistological technique (Sparks and Malechek 1968 and Hansen 1971) was used to identify plant species in diet samples.

Quantification of the diets followed Hansen (1971). Five slides were made of each sample. Twenty fields of view were systematically located on each slide at 125X magnification. Plant fragments were tabulated on a frequency basis because total fields per sample equalled 100. Percentage dry weight by species was calculated following procedures outlined by Sparks and Malechek (1968) and modified by Hansen (1971).

In vitro organic matter digestibility was determined using a modification of procedures outlined by Tilley and Terry (1963). Rumen fluid for digestibility determinations was obtained from a rumen-fistulated steer fed a diet of alfalfa hay.

Herbage standing crop was estimated by the harvest method. Herbage from 3.0 m × 0.6 m randomly distributed quadrats was clipped at ground level in four locations in the continuously grazed pasture, and one in each of the rotation pastures. Quadrats were clipped at the beginning and end of each grazing period in the rotation pastures. Herbage samples were hand separated into individual species. Sampling locations were equalized with respect to topography and distance from water.

Data were analyzed by analysis of variance and *t* tests to compare systems for differences in selected species.

Results and Discussion

Dietary Composition

The percentage of browse, forbs and grass varied between the two systems for the two years (Fig. 1). In 1977, diets of the cattle grazing on the rotation system were higher in browse and lower in grass content than those on the continuous pasture. However, in 1978 there were no differences between the grazing systems as the plant groups in the diet.

Grazing systems influenced the proportion of major grass species in the diet (Fig. 2). The blue grama *(Bouteloua gracilis)* content was higher ($P<0.05$) in the diets of cows grazing the continuous pasture in August 1977, but was significantly higher on the rotation pasture in the spring of 1978. Peak blue grama amounts were recorded in the continuous pasture during the summer growing season. There was no difference in dietary content of wolftail *(Lycurus pheloides)* or sideoats grama *(Bouteloua curtipendula)* between systems on any date (Fig. 2).

The only consistent differences in grass species composition between systems was for mat muhly *(Muhlenbergia richardsonis)*. This species was consistently higher in cow diets from the continuous pasture in 1977. However, there were only small differences between the two systems in 1978 (Fig. 2).

Although there were some significant differences between systems in dietary content of scarlet globemallow *(Spharalcea coccinea)*, they were relatively small (Fig. 3). In 1977, Carruth sageworth *(Artemisia carruthii)* contributed a larger percentage of the diet of cows grazing the rotation pastures than those grazing the

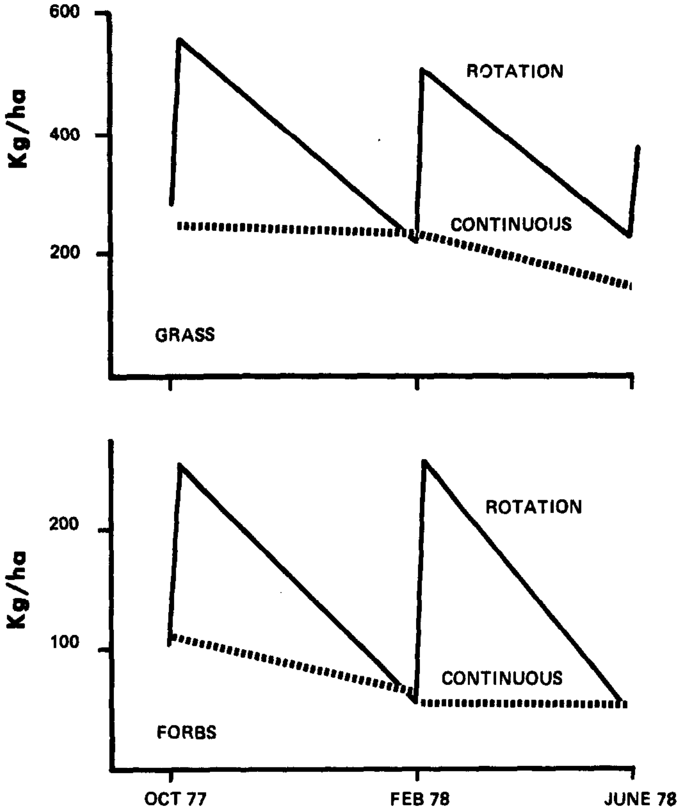

Fig. 4. *Herbage standing crop at various times during 1977 and 1978 for the two grazing systems.*

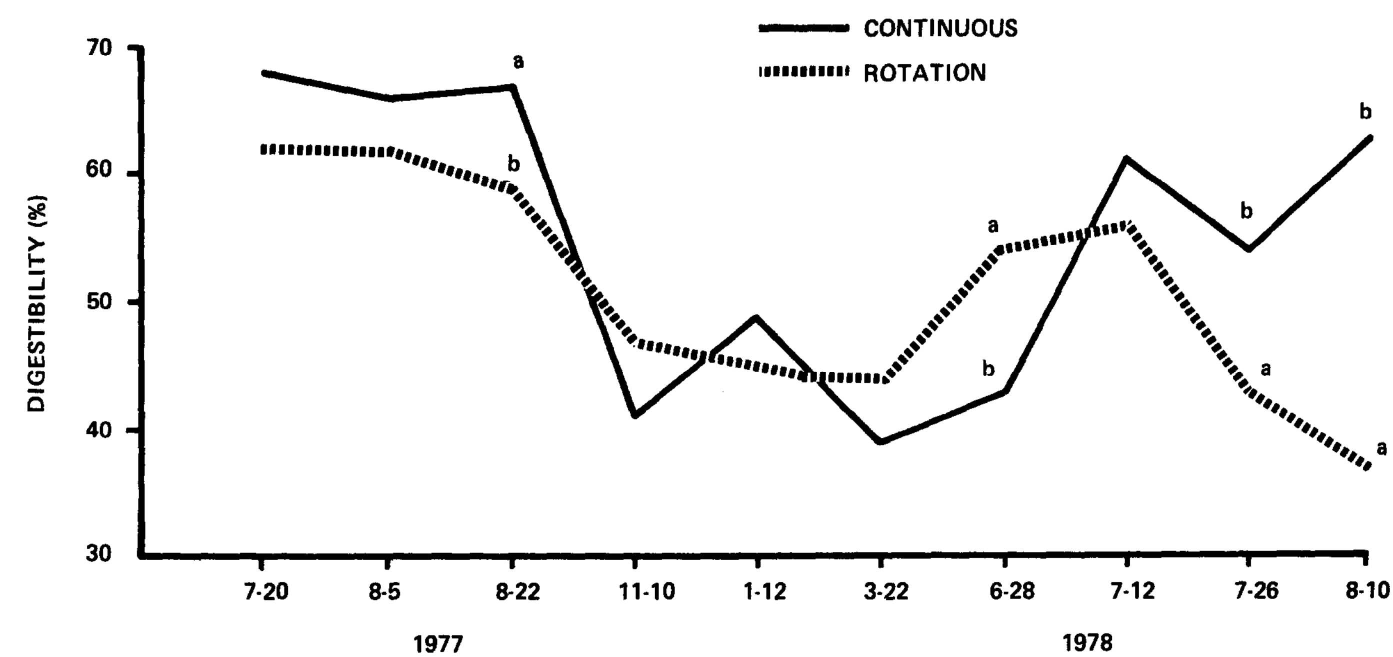

Fig. 5. *In vitro matter digestibility of cattle diets under two grazing systems. Means with different letters are significantly different (P<0.05) for that sampling period.*

continuous pasture ($P<0.05$). However, in 1978, the differences were much less pronounced (Fig. 3). Dietary levels of carruth sagewort were higher during the winter than for the other seasons for both grazing systems.

Part of the differences in dietary content of the diets might be explained by differences in availability between pastures in the two systems. The preference index for blue grama was greater than 1 on all sample dates and was generally higher under continuous grazing than under the rotation system (Pfister 1979). Wolftail also was more preferred under the continuous system than under the rotation system.

Scarlet globemallow and carruth sagewort were both highly preferred forb species at certain times of the year. However, their preference was not consistently higher for a given grazing system.

Browse species in cattle diets were primarily wavyleaf oak and fourwing saltbush. The browse content of the diet was slightly higher in winter than at other times of the year in both treatments.

There was a great deal of variability in the amount of browse in cattle diets. The dietary content of wavyleaf oak was related to the ease of prehension and the quantity of immediately-available wavyleaf oak. This species occurs in rather dense stands along canyon slopes and upper rims at Ft. Stanton. When fistulated cattle grazed through one of the dense stands of wavyleaf oak, they were observed to browse on it voraciously while continuing to roam. Upon breaking out of the wavyleaf oak stands, the cattle would resume selective grazing of grass and forbs.

In the June 27-30, 1978 sample period, the browse content of cattle diets was almost exclusively four-wing saltbush (Pfister 1979). Four-wing saltbush comprised only a small portion of the diet later.

Cattle movement within the rotation system resulted in greater dietary fluctuation than was apparent under continuous grazing (Fig. 1). Comparisons of ungrazed herbage residue indicated that there was a significant reduction is available forage within each rotation pasture during each grazing period as grazing pressure predictably reduced the available plant biomass (Fig. 4). Rested rotation pastures into which cattle were moved had significantly higher amounts of grass and forbs than the pasture vacated. Herbage standing crop declined much more rapidly on the rotation pastures than on the continuous pasture as a function of stocking pressure (Fig. 4). Apparently, when herbage standing crop reached a certain level in the continuously grazed pasture, areas more remote from water and on steep slopes were utilized, but this phenomenon was not evident from herbage samples collected on the upland sites.

The changes in amounts of forage available influenced selectivity as cattle were abruptly moved from a grazed rotation pasture to a rested pasture with a new basis for selection. When fistulated cattle were removed from rotation pasture 1 to rested rotation pasture 2 in the winter of 1977, dietary composition shifted to a higher level of browse than was recorded at the last collection period in rotation pasture 1 (Fig. 1). There was a corresponding decrease in the grass component of the diets. As cattle were moved from rotation pasture 2 to pasture 3, there was a significant increase in total grasses consumed. The dietary shift to grass was influenced by several factors including the season of the year, increasing plant palatability and an increase in the grass portion of the available forage. The perennial grasses were beginning to green up and abundant green shoots 6 cm tall were observed. The move from rotation pasture 3 to pasture 4 revealed an upward shift in forb content. Amounts of browse also increased; grasses declined from 88% to 46% in the same period.

Digestibility

In vitro organic matter digestibility (IVOMD) of the diets was not significantly different ($P>0.05$) between the two grazing treatments during the dormant season (Fig. 5). However, during the growing season, cows grazing the continuous pasture appeared to select a diet more highly digestible than those grazing the rotation pastures. In 1978, differences in digestibility were especially pronounced. For example, digestibility of diets collected between August 8 and 11, 1978, was 63% for cows on the continuous pasture and only 37% for those on the rotation pasture (Fig. 5).

Jeffries and Rice (1969) reported movement to a new rotation unit resulted in increased digestibility. However, in our study, cattle movement within the rotation pastures during the dormant season did not result in increased digestibility. But in the early summer of 1978, as cattle were shifted from rotation pasture 3 to pasture 4, a substantial increase in IVOMD was recorded. Plant maturity apparently had a greater influence over digestibility than increased selectivity resulting from the rotational rest.

Rotation pasture diets decreased in digestibility as grazing periods progressed ($P<.05$). An expected decrease occurred when a grazing period corresponded with a period of increasing plant maturity and eventual dormancy. Another factor in declining IVOMD was decreased selectivity under progressive defoliation. As defoliation progressed, available leafy material decreased as did digestibility. In rotation pasture 4 available forage remained nearly constant over the measure portion of the grazing period, yet digestibility fell ($P<.01$).

Reduced diet selectivity was the major factor in decreasing digestibility over time in rotation 4. In the continuously grazed pasture, the trend of increasing intake during the summer was similar to previously noted increases in digestibility. The trends were just the opposite in rotation pasture 4. If the pattern of declining digestibility and intake (Pfister 1979) in pasture 4 over time was truly indicative of the nutritional stress endured by the cattle at the end of each grazing period, this stress may have been manifested in a longer interval from calving to first estrus, lower conception rates and reduced calf weaning weights. Low energy levels pre-partum tend to delay first estrus, and low energy levels post-partum reduce conception rates (Dunn et al. 1969). Overlap of the last portion of a rotation pasture grazing period with a critical reproductive period may have resulted in impaired reproductive function. Reduced figures for percent calf crop weaned and calf weaning weight reflect previous stress, whether nutritional, reproductive or both.

In the spring of 1978, about one-half of the rotationally grazed range cows had yet to calve when the continuously grazed cattle completed calving. The percent of calf crop weaned over a seven-year period was higher in the continuously grazed pasture (Pieper et al. 1978). Since death loss has been negligible on both grazing treatments, data for percent calf crop weaned represent comparative conception rate. Average calf weaning weights over the same seven-year period were 14 kg higher in the continuous pasture. These animal production data indicate that rotation grazing did limit livestock response (Pieper et al. 1978). In a ranch operation, such differences in livestock production would mean sizable differences in revenue.

Summary and Discussion

There were more differences in dietary content between grazing systems in 1977 than 1978, more browse and less grass in the diets of cows grazing rotation pastures than those grazing the continuous pastures and more mat muhly and less carruth sagewort in diets of cows grazing the continuous pasture when compared to those grazing the rotation pastures. Differences were not pronounced in 1978. It seems unlikely that differences in dietary composition could explain the greater weaning weights of calves from the continuous pasture as reported by Pieper et al. (1978). With fairly large pastures it is difficult to obtain representative samples of what cattle are eating when esophageal samples were collected once a day for only a short period of time. Nevertheless, our data indicated that diets vary considerably seasonally and between years. No consistent patterns emerged.

Digestibility data suggested, however, that cattle grazing the continuous pasture could select a more digestible diet than those on the rotation pastures during the growing period. This is the time when nutrition would have the greatest impact on fall calf weaning weights. The depressed digestibility of cow diets on the rotation system apparently was a result of lack of selectivity of plant parts, and not of individual species. Digestibility differences were greatest in 1978 when dietary composition was similar. These data do not agree with data presented by Walton et al. (1981) for a brome-alfalfa-creeping red fescue pasture in Alberta, Canada, or for short grass vegetation in Wyoming (Jefferies and Rice 1969). However, other studies have shown a reduction in digestibility under intensive grazing systems compared to continuous or extensive systems (Heithold et al. 1980, Taylor et al. 1980). The relationship shown in this study between diet digestibility and calf performance should be considered a working hypothesis until further data are obtained.

Literature Cited

Bement, R.E. 1969. A stocking rate guide for beef production in blue grama range. J. Range Manage. 22:83-86.

Dunn, T.G., J.E. Ingalls, D.R. Zimmerman, and J.N. Wiltbank. 1969. Reproductive performance of two-year-old Hereford and Angus heifers as influenced by pre- and post-calving energy intake. J. Anim. Sci. 29:719-726.

Hansen, R.M. 1971. Drawings of tissue of plants found in herbivore diets and in the litter of grasslands. U.S.I.B.P. Grassland Biome Tech. Rep. No. 70. Colo. State Univ., Fort Collins.

Jefferies, Ned W., and Richard W. Rice. 1969. Nutritive value of clipped and grazed range forage samples. J. Range Manage. 22:192-195.

Herbel, C.H. 1974. A review of research related to development of grazing systems on native ranges of the western United States. Keritlow, K.W. and R.H. Art. (Coord.). *In:* Plant morphogenesis for scientific management of range resources. USDA Misc. Pub. 1271.

Heithold, D.W., H.E. Kiesling, and R.F. Beck. 1980. Nutritive value of forage on continuous and seasonally-grazed semiard range. Abstr. 72nd Ann. Meet. Amer. Soc. Animal Sci.

McDaniel, Kirk C., and Chris Allison (Eds.). 1980. Grazing management systems for southwest rangelands symposium. Range Improve. Task Force. New Mex. State Univ., Las Cruces.

Pfister, J.A. 1979. Comparison of cattle diets under continuous and four-pasture, one-herd grazing systems. M.S. Thesis. New Mexico State Univ., Las Cruces.

Pieper, Rex D. 1980. Impacts of grazing systems on livestock. McDaniel, K.C. and C. Allison (Eds.) *In:* Proc. Grazing Management Systems for Southwest Rangelands Symposium. Range Improve. Task Force. New Mex. State Univ., Las Cruces.

Pieper, Rex D., James R. Montoya, and V. Lynn Groce. 1971. Site characteristics on pinyon-juniper and blue grama ranges in southcentral New Mexico. New Mex. State Univ. Agr. Exp. Sta. Bull. 573.

Pieper, Rex D., G.B. Donart, E.E. Parker, and J.D. Wallace. 1978. Livestock and vegetational response to continuous and a four-pasture one herd grazing system in New Mexico. Proc. First Int. Rangeland Congr. 1:560-562.

Shiflet, T.N., and H.F. Heady. 1971. Specialized grazing systems: their place in range management. USDA Soil Con. Serv. SCS-TP-52.

Sparks, D., and J.C. Malechek. 1968. Estimating percentage dry weight in diets using a microscope technique. J. Range Manage. 21:264-265.

Taylor, Charles A., M.M. Kothmann, L.B. Merrill, and Doak Ellidge. 1980. Diet selection by cattle under high-intensity low frequency, short duration, and Merrill grazing systems. J. Range Manage. 33:428-434.

Tilley, J.M.A. and R.A. Terry. 1963. A two-stage technique for the in vitro digestion of forage crops. J. Brit. Grassl. Soc. 18:104-111.

Walton, P.D., R. Martinez, and A.W. Bailey. 1981. A comparison of continuous and rotational grazing. J. Range Manage. 34:19-21.