

# EFFECT OF GRAZING MANAGEMENT ON CATTLE DIETS AND NUTRITION IN THE COASTAL PRAIRIE

D. Lynn Drawe, James R. Frasure, and Billie E. Dahl<sup>1</sup>

## ABSTRACT

Cattle diets and nutrition were studied using fecal analysis and bite counts under (1) continuous, yearlong (CG), (2) 4-pasture, deferred-rotation (4PDR), and (3) high-intensity, low-frequency (HILF) grazing treatments at the Welder Wildlife Foundation Refuge. Of 156 plant species consumed, only 23 provided greater than 1% each of the diet. Grasses comprised 95% of the diet, forbs 4%, and browse 1%. Four warm-season grasses, silver bluestem (*Bothriochloa saccharoides*), longtom (*Paspalum lividum*), vine mesquite (*Panicum obtusum*), and meadow dropseed (*Sporobolus asper*), comprised a large percentage of the diet in all 3 treatments. Texas wintergrass (*Stipa leucotricha*) was the most highly-preferred cool-season grass. Plant community, soil type, season, and rainfall had greater effects on species consumed than did grazing treatment. On HILF the diet changed from highly-preferred to less-preferred species as the grazing period progressed. The 5 most highly-preferred grasses provided adequate crude protein and calcium to meet the minimum requirements of lactating cows except during winter. All 5 were deficient in phosphorus except during spring green-up. There were no differences in forage digestibility between treatments. Forage digestibility in HILF diets showed a significant ( $P < .05$ ) decline after the first week of a 3-week grazing period.

## INTRODUCTION

Grazing management is often an important tool in improving overgrazed rangelands in Texas. Properly handled, grazing management improves range condition and increases stocking rates (Kothmann and Mathis, 1970). A knowledge of cattle diets and nutrition is essential for successful grazing management. A comparison of plant species in cattle diets and their nutritional qualities on different grazing treatments would aid in identifying key species and measuring the effect on management practices.

In 1974, the Welder Wildlife Foundation Refuge initiated a study of (1) continuous, yearlong (CG), (2) 4-pasture, deferred-rotation (4PDR), and (3) high-intensity, low-frequency (HILF) grazing treatments. Similar research was performed at Sonora (Merrill, 1957), Throckmorton (Sanders, 1975), and Uvalde (Chamrad et al., 1982), but the more severe climatic conditions of these areas do not allow the abundance or diversity of vegetation present in the Texas Coastal Prairie. No research data were available concerning cattle diets or nutrition in these 3 grazing treatments in the Coastal Prairie.

The objectives of this study were: (1) to determine seasonal species composition of cattle diets on 3 grazing treatments; (2) to determine nutrient content of major species in the cattle diet; and (3) to determine digestibility of forage in cattle diets across the 3 grazing treatments and within grazing periods in the HILF grazing treatment.

## MATERIALS AND METHODS

### Study Area

The study was conducted on the Rob and Bessie Welder Wildlife Foundation Refuge located 8 mi. NE of Sinton, Tx. The refuge encompasses 7800 ac. The native vegetation is classified as coastal prairie grasslands interspersed with a chaparral complex. Sixteen plant communities have been identified on the refuge (Drawe et al., 1978). At the time of this study refuge pastures were in high fair range condition.

The area has a long history of livestock use dating back to the era of the Spanish missions. Following the creation of the Welder Wildlife Foundation in 1954, refuge ranges were lightly stocked with steers and a non-systematic rotational grazing program was followed. In 1974 the steer operation was replaced with a cow-calf operation.

For this study the refuge was broadly divided into clay and sandy soils as described in Drawe et al. (1978). Clay and clay loam soils occurred primarily above the Aransas River floodplain. Victoria clay (*Udic Pellustert*) is the dominant series. Texas wintergrass (*Stipa leucotricha*), meadow dropseed (*Sporobolus asper*), knotroot bristlegrass (*Setaria geniculata*), vine mesquite (*Panicum obtusum*), and silver bluestem (*Bothriochloa saccharoides*) were the dominant grasses on clay soils. Longtom (*Paspalum lividum*) was abundant during periods of above average rainfall. Honey mesquite (*Prosopis glandulosa*), huisache (*Acacia farnesiana*), and blackbrush (*Acacia rigidula*) were important woody species.

On sandy soils, restricted almost entirely to the Aransas River floodplain, seacoast bluestem (*Schizachyrium scoparium* var. *littoralis*), Pan American balsamscale (*Elyonurus tripsacoides*), and rescuegrass (*Bromus unioloides*) were dominant grasses. Woody species were primarily mesquite and huisache.

The 20-year rainfall average for the refuge was 35 in. Above average rainfall occurred 7 out of the 9 years prior to the study. Total rainfall during the study was 47 in. from August 1976 to July 1977.

### Grazing Treatments

Grazing treatments of this ranch-scale study included a 1-herd, 7-pasture HILF, a 3-herd, 4PDR, and a CG pasture. The stocking rate for all treatments was 12.5 ac/animal unit (AU). These grazing treatments were described in detail by Drawe (1987).

High-intensity, low-frequency pasture size varied from 275 to 550 ac (Figure 1). Grazing periods were from 2 to 6 weeks long followed by 5.5 months deferment. Stocking densities varied from 1.5 to 3.5 ac/AU in individual pastures.

The 4PDR treatment pastures (Figure 1) were grazed 12 months and deferred 4 months, an adaptation of the Merrill (1957) system. Stocking densities for individual pastures were approximately 9 ac/AU.

The CG pasture (Figure 1) was grazed yearlong at a stocking rate of about 12.5 ac/AU. Continuous, yearling grazing is the common ranching practice in the Coastal Prairie and was considered the standard for comparison.

<sup>1</sup>Assistant Director, former Graduate Research Fellow, Welder Wildlife Foundation, Sinton, TX 78387, and Professor, Dept. of Range and Wildlife Management, Texas Tech Univ., Lubbock, Tx 79409. This is Welder Wildlife Foundation Contribution -317.

**Grazing Systems**

- ++ High-Intensity, Low-Frequency
- o o Four-Pasture, Deferred-Rotation
- Continuous, Year-Long

**Soils**

- Clay & clay loam soils
- Sand & sandy loam soils

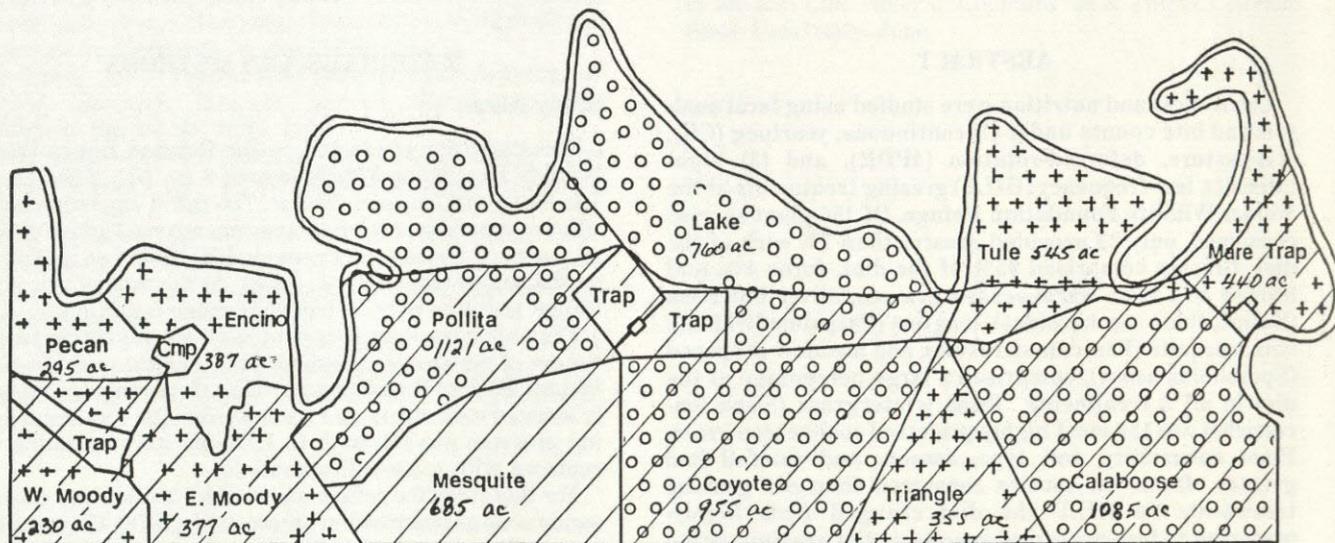


Figure 1. Pasture units and grazing treatments of the Welder Wildlife Foundation Refuge.

**Cattle Diets**

Early during the grazing treatment comparison it was observed that cattle diets and nutrition might be playing a role in causing differences in cattle performance. Therefore, during 1976 and 1977 a study was conducted to determine cattle diets on the 3 grazing treatments. Cattle diet was determined at the beginning, middle, and end of the grazing period in all 3 treatments using both direct observation of grazing animals (Bjugstad et al. 1970) and microscopic identification of fecal material (Free et al. 1970).

**Nutrient Content of Herbage**

Herbage samples of the 5 major grasses were analyzed for crude protein, calcium, and phosphorus by the Agricultural Analytical Services Laboratory at Texas A&M University. Herbage from 10 plants of each species was collected at random, composited by species monthly during 1975, 1976, and 1977, and sent to the lab for analysis. The 5 grasses included the 4 major warm-season species consumed by cattle, meadow dropseed, silver bluestem, longtom, and vine mesquite, plus the major cool season species, Texas wintergrass. Nutrient content of the herbage was compared to the nutrient requirements of beef cattle (NAS-NRC 1976) for both lactating and non-lactating cows.

**Forage Digestibility**

During 1976 and 1977 hand-plucked samples were collected from species comprising greater than 10% of cattle diets at 3 critical periods during the year: (1) late January, during winter dormancy of warm-season grasses, (2) early April, during spring green-up of warm-season grasses, and (3) early July, during maximum production of warm-season grasses. *In vitro* digestibility was determined from the hand-plucked samples (Cook, 1964) using the modified Tilley and Terry (1965) method.

Weighted digestibility values for cattle diets were calculated by multiplying percent composition of each species in the diet by its percent digestibility. Digestibility data were subjected to analysis of variance, and significant mean separations were determined by Duncan's multiple range test at the 0.05 level of significance.

Table 1. Plant species comprising more than 1% of cattle diets using the fecal analysis method in 3 grazing treatments on the Welder Wildlife Foundation Refuge. Data are averages for a full year during 1976-77.

PS 8 Species	High-intensity, low-frequency		Four-pasture, deferred-rotation		Continuous, yearlong	
	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}^{1/}$	s.d.
<b>GRASS</b>						
<i>Bothriochloa saccharoides</i>	8.9	5.8	8.5	7.0	11.4	8.6
<i>Bromus wildenowii</i>	6.3	15.7	5.0	17.0	— <sup>2/</sup>	—
<i>Buchloe dactyloides</i>	1.6	2.3	1.2	1.6	—	—
<i>Elymus canadensis</i>	1.1	2.8	—	—	—	—
<i>Elyonurus tripsacoides</i>	—	—	1.1	2.6	—	—
<i>Hilaria belangeri</i>	1.8	3.0	3.6	6.0	—	—
<i>Leersia hexandra</i>	3.0	6.8	2.0	3.4	—	—
<i>Panicum coloratum</i>	3.3	6.3	—	—	—	—
<i>Panicum obtusum</i>	4.4	4.7	6.0	5.7	8.7	5.3
<i>Paspalum lividum</i>	7.7	7.2	11.1	9.8	12.7	10.8
<i>Paspalum notatum</i>	—	—	1.3	3.9	—	—
<i>Paspalum plicatum</i>	6.0	8.7	1.4	2.7	1.4	3.6
<i>Paspalum pubiflorum</i>	—	—	1.3	3.9	—	—
<i>Schizachyrium scoparium</i>	7.0	5.9	5.9	10.22	2.6	2.8
<i>Setaria geniculata</i>	1.2	1.2	1.5	2.9	3.5	6.4
<i>Spartina spartinae</i>	1.3	2.2	—	—	—	—
<i>Sporobolus asper</i>	6.3	7.5	6.8	5.9	13.5	3.2
<i>Stipa leucotricha</i>	10.5	12.9	15.6	19.0	17.9	19.7
<b>GRASS-LIKE</b>						
<i>Carex brittoniana</i>	1.2	—	—	2.8	2.8	3.3
<b>FORBS</b>						
<i>Lesquerella argyrea</i>	—	—	1.0	3.1	1.2	3.4
<i>Malvastrum aurantiacum</i>	—	—	—	—	2.5	2.3
<i>Rhynchosia minima</i>	—	—	—	—	2.4	5.0
Totals	71.6		73.3		80.6	

1/  $\bar{x}$  = mean; s.d. = one standard deviation.

2/ — species did not occur or made up less than 1% of the diet.

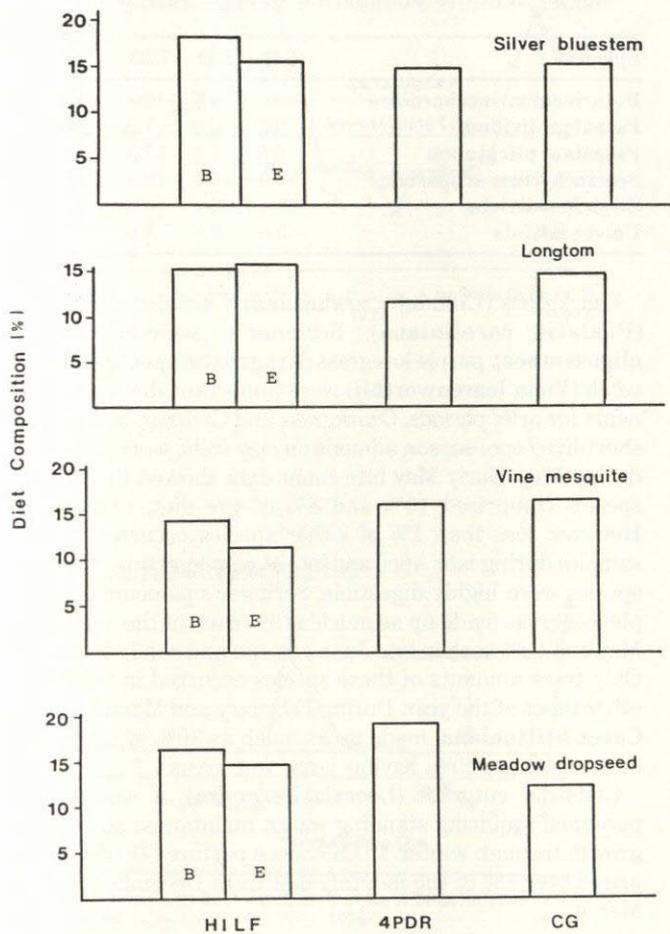


Figure 2. Diet composition of major forage species in continuous-yearlong (CG) and 4-pasture, deferred-rotation (4PDR), and the beginning (B) and end (E) of the grazing period in the high-intensity, low-frequency (HILF) systems on the Welder Wildlife Foundation Refuge. Data are averages for a 2-year period, 1975-77.

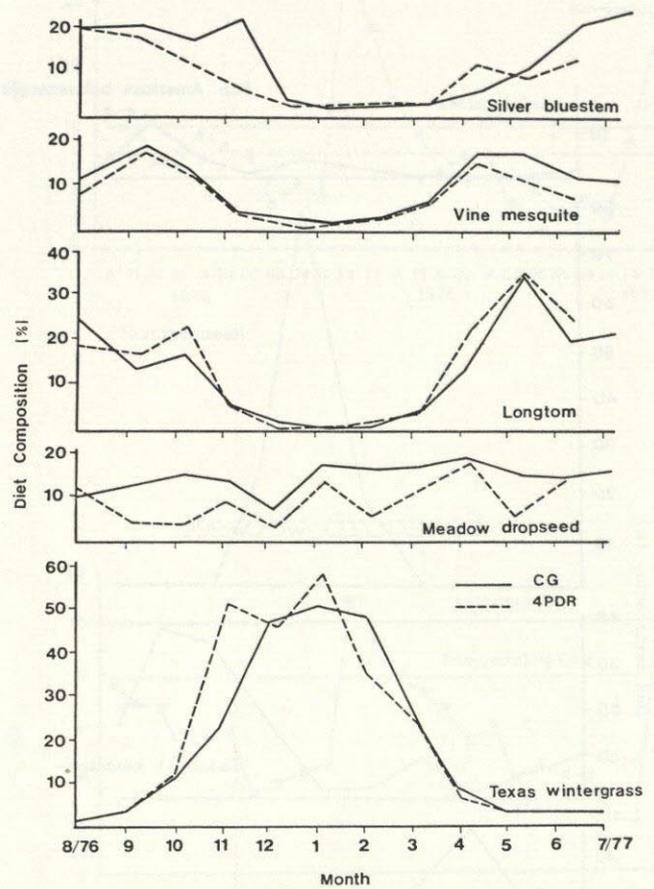


Figure 3. Seasonal trends in cattle diets for selected species on clay soil pastures in the 4-pasture, deferred rotation (4PDR) and continuous, yearlong (CG) grazing treatments on the Welder Wildlife Foundation Refuge.

RESULTS AND DISCUSSION

Cattle Diets

Cattle grazed 156 different species during this study, including 76 grasses, 4 grass-like species, 66 forbs, and 10 shrubs. Of these 156 species, only 23 provided greater than 1% each of the total diet (Table 1).

Average diet values were 92% and 95% for grasses, 7% and 4% for forbs, and 1% and < 1% for shrubs from fecal analysis and bite-count methods, respectively. Comparison of forage classes in cattle diets across treatments showed only minor differences. Grasses were the most important forage class in all treatments. Forbs were eaten in greater quantity during late winter and early spring. The only measurable use of browse and mast was on live oak (*Quercus virginiana*) in winter and honey mesquite bean pods in late summer. Although it was difficult to single out major species where a variety was consumed, 4 grasses, (1) silver bluestem, (2) longtom, (3) vine mesquite, and (4) meadow dropseed, occurred in relatively high amounts in the diet throughout most of the year across all 3 treatments (Figure 2). In fact, major differences in diet appeared to be influenced as much by differences in plant communities among pastures as by treatment.

Yearlong use made determination of seasonal trends easier for the CG pasture. Deferral in the 4PDR and HILF treatments changed species composition in cattle diets because species availability varied among pastures. One 4PDR unit was grazed for 11 months during the study, allowing a more direct comparison with the CG pasture. Silver bluestem, vine mesquite, longtom, meadow dropseed, and Texas wintergrass comprised 60% of the diets on pastures with clay soil. Despite different grazing treatments, similar seasonal trends occurred for the 5 species in both pastures (Figure 3). Texas wintergrass was a larger seasonal dietary component than other species, primarily because it was the only cool-season grass available during winter.

No valid comparison was available across treatments on sandy soils. One 4PDR unit provided seasonal data over a 10-month period during the study (Figure 4). Rescuegrass increased and declined dramatically in the diet over a 2-month period during spring green-up. The complexity of plant communities in sand and sandy loam pastures resulted in a complex diet with no single species dominating for any extended

period. Pan American balsamscale, Texas wintergrass, and seacoast bluestem were major dietary constituents for a time.

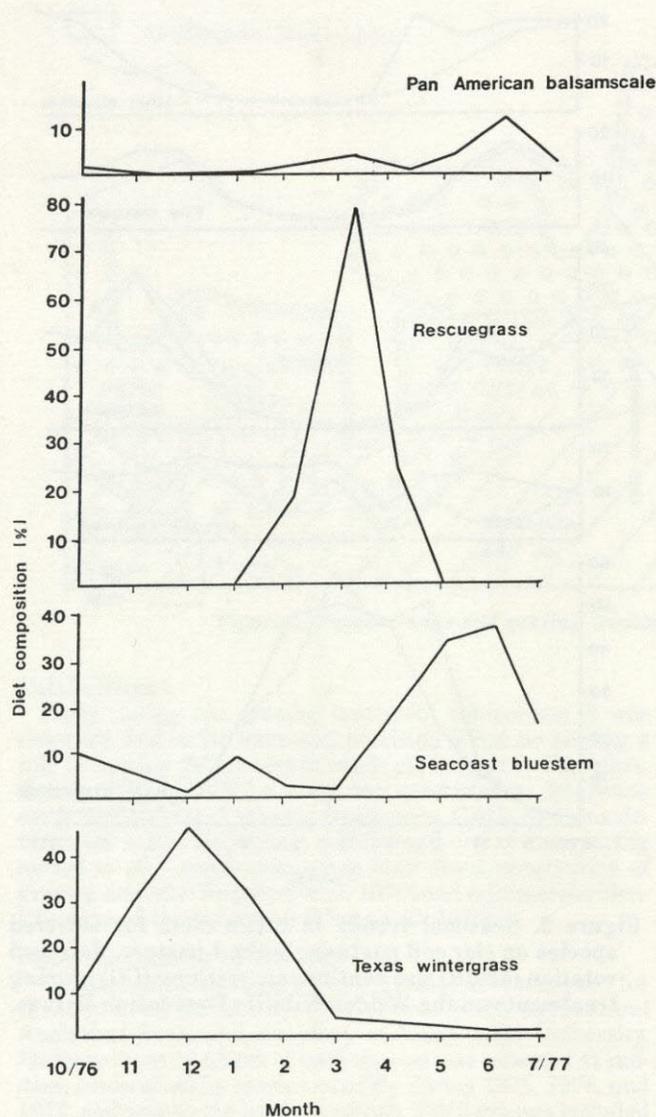


Figure 4. Seasonal trends in cattle diets for selected species on a sandy soil pasture in the 4-pasture, deferred-rotation grazing system on the Welder Wildlife Foundation Refuge.

Cattle diets in HILF pastures were determined at the beginning, middle, and end of each grazing period. Diet composition changed from highly-selected species to less-preferred species as the grazing period progressed. Relative amounts of individual species in the diet rarely varied more than 15% among sampling periods.

Seasonal trends were not as easy to follow on HILF because animals were presented with different forage species each time they moved from pasture to pasture. Seasonal changes were discernable when the same pasture was grazed at different times of the year. The high stocking density of individual HILF pastures increased competition among cattle for available forage. Warm-season grasses such as seacoast and silver bluestems, ungrazed in CG and 4PDR pastures during winter, were important components in cattle diets on HILF during winter (Table 2).

Table 2. Changes in cattle diets using the fecal analysis method at various sampling dates in Pecan Pasture of the high-intensity, low-frequency grazing system on the Welder Wildlife Foundation Refuge during 1977.

Species	1/14	1/19	7/23	7/30	8/7
<i>Bothriochloa saccharoides</i>	10.1	4.7	12.3	8.6	8.2
<i>Paspalum lividum</i>	3.2	0.0	7.9	9.8	14.6
<i>Paspalum plicatum</i>	6.5	7.1	17.3	16.5	12.6
<i>Schizachyrium scoparium</i>	15.0	16.6	10.9	9.8	3.4
<i>Stipa leucotricha</i>	19.4	32.4	0.6	2.2	5.1
<i>Uniola latifolia</i>	0.0	0.0	5.8	8.3	4.8

Ozarkgrass (*Limnodia arkansana*), Carolina canarygrass (*Phalaris caroliniana*), Scribner's panicum (*Panicum oligosanthos*), purple lovegrass (*Eragrostis spectabilis*), and vetch (*Vicia leavenworthii*) were important dietary components for brief periods. Ozarkgrass and Carolina canarygrass, short-lived cool-season annuals on clay soils, were eaten only during May. Early May bite-count data showed that these 2 species comprised 16% and 8% of the diet, respectively. However, less than 1% of either species occurred in fecal samples during late April and late May, suggesting that these species were highly digestible. Scribner's panicum and purple lovegrass made up as much as 9% each of the diet in late May and 13% each in late June on sand and sandy loam soils. Only trace amounts of these species occurred in the diet at other times of the year. During February and March, a sedge, *Carex brittoniana*, made up as much as 30% of cattle diets in clay soil pastures having large wet areas.

Clubhead cutgrass (*Leersia hexandra*), a warm-season perennial requiring standing water, maintained some green growth through winter. In Calaboose pasture (4PDR) it comprised over 8% of the monthly diet from December through March.

#### Nutrient Content of Herbage

Crude protein values for Texas wintergrass and vine mesquite were mostly adequate for non-lactating cows from April through September 1975 (Figure 5). Vine mesquite provided adequate crude protein March through August 1976 and March 1977. For lactating cows, the 4 warm-season species provided adequate protein only during April and May 1975, March through June 1976, and March 1977. Texas wintergrass held up well for non-lactating cows throughout 1975, through March 1976, and during December through March 1977. It provided adequate crude protein for lactating cows during the winter of both years. Several other grasses were tested throughout the 2 years under both burned and unburned conditions, and some outstanding values can be reported. During February 1976, burned Pan American balsamscale had 17.6% crude protein. In January 1976, unburned rescuegrass had 17.9% crude protein, and March 1977 rescuegrass had 17.0% crude protein. In February and March 1977, unburned switchgrass (*Panicum virgatum*) had 15.3% and 14.7% crude protein, respectively.

Calcium content was adequate for non-lactating cows during both years in all 5 grasses except meadow dropseed during May through December 1976 (Figure 6). Calcium content for vine mesquite was above the requirement for lactating cows throughout the 2 years (Figure 4). Among other species tested, most showed adequate calcium, except one or 2 species during months in late summer and early fall.

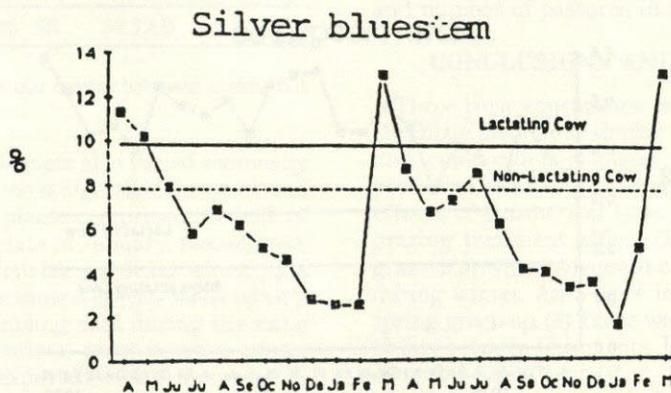
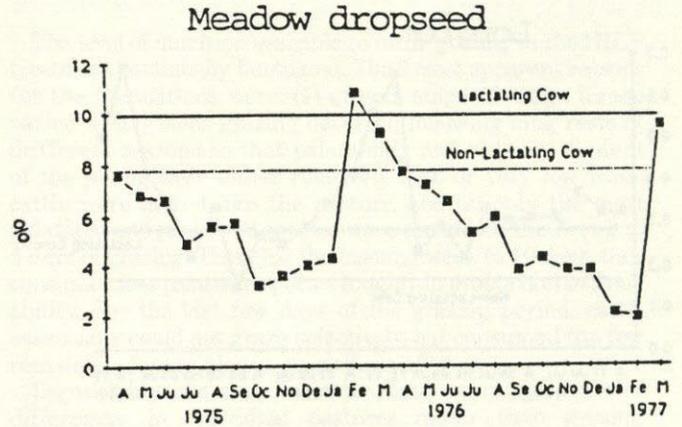
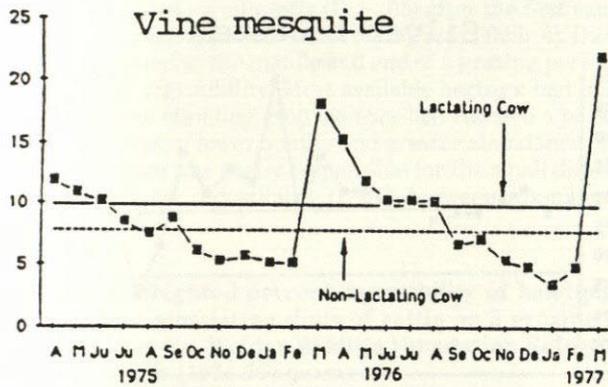
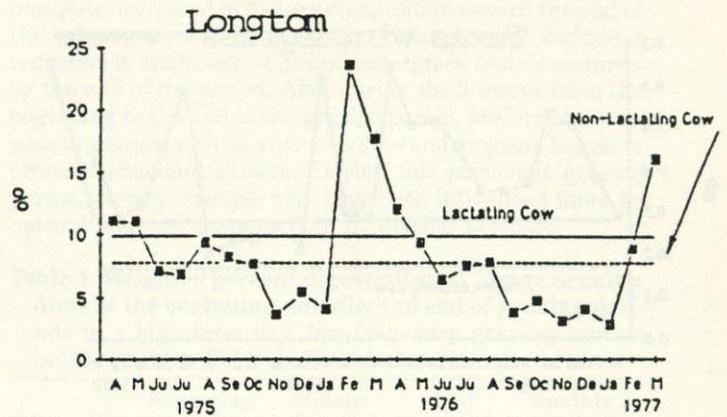
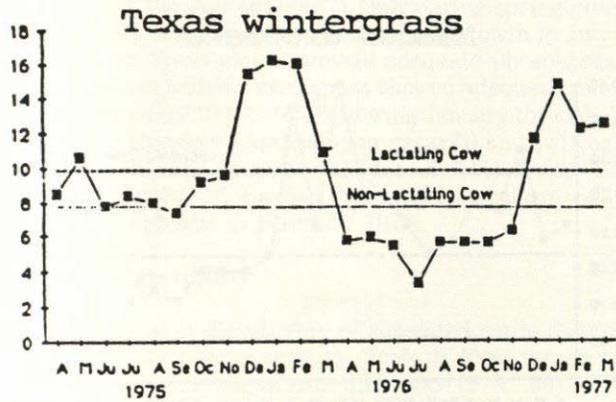


Figure 5. Percent crude protein content of 5 major grasses in cattle diets on the Welder Wildlife Foundation Refuge, 1975-77, compared to NRS-NRC (1976) standards for lactating and non-lactating cows.

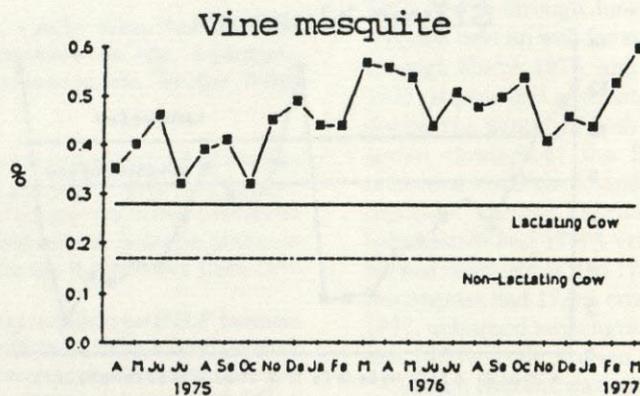
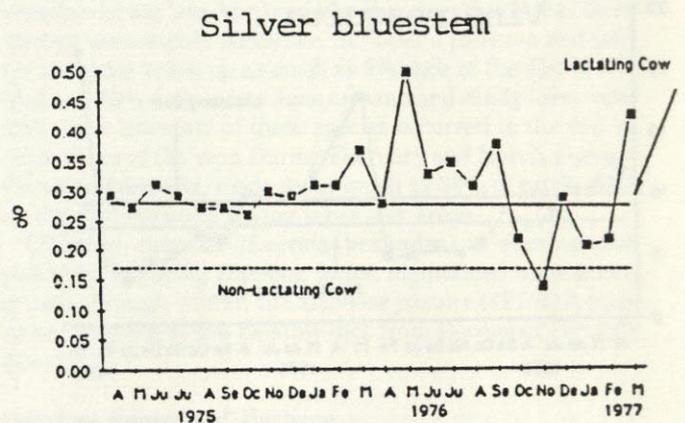
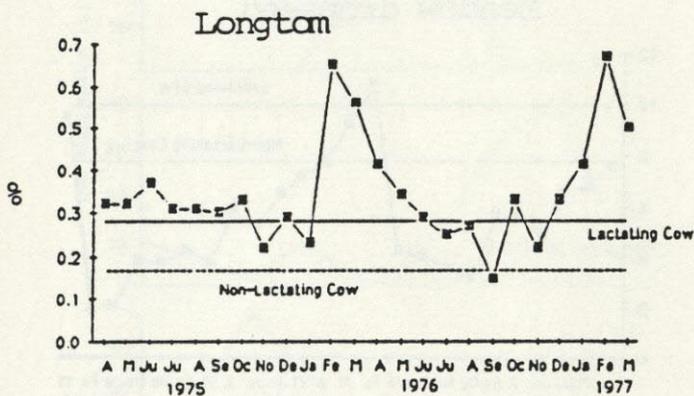
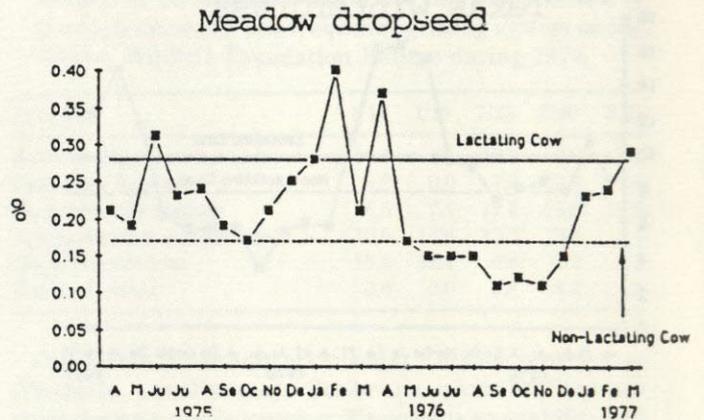
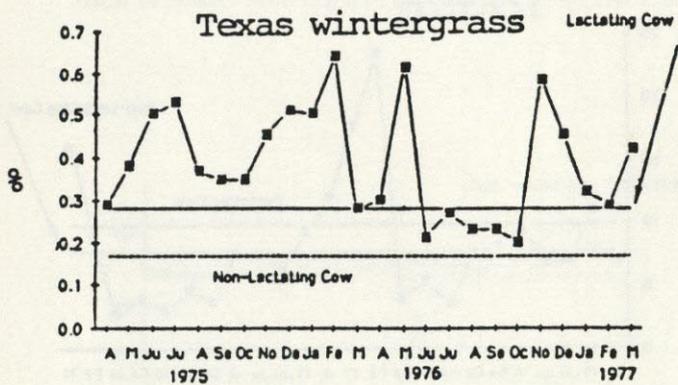


Figure 6. Percent calcium content of 5 major grasses in cattle diets on the Welder Wildlife Foundation Refuge, 1975-77, compared to NRS-NRC (1976) standards for lactating and non-lactating cows.

Phosphorus content was deficient in all 5 species tested during most of the year (Figure 7). Only during spring greenup in February and March and during lush growth in July and August did these plants provide adequate phosphorus. Of other species tested, rescuegrass showed adequate amounts of phosphorus (0.19% to 0.37%) during January through April 1976. Big bluestem (*Andropogon gerardi*) and switchgrass showed adequate amounts (0.18% to 0.45%) during March through April 1976. Burned Pan American balsamscale had 0.51% phosphorus in February 1976.

### Forage Digestibility

Differences in digestibility of simulated cattle diets were very small between treatments (Table 3). Even though there was a statistically significant difference ( $P < .05$ ) between HILF and 4PDR on clay soils, for all practical purposes a 3.6% difference is no difference. Average diet quality was highest in April and lowest in July. This was attributed to the fact that during early growth the plants were highly digestible, than later in the growing season the plants became more lignified and digestibility decreased. Therefore, seasonal changes altered diet quality, but grazing treatment did not.

Forage digestibility in simulated diets from the HILF treatment declined significantly ( $P > .05$ ) after the first sampling date in a grazing period except during July (Table 4). Diet samples collected at the middle and end of a grazing period were similar in digestibility. Most available herbage had matured in July, and standing crop biomass had reached a peak. This combination of lower quality and greater abundance of available herbage was partly responsible for the small differences in dry matter digestibility (DMD) between sampling dates during July.

**Table 3. Weighted percent digestibility of hand-plucked samples simulating diets of cattle on 3 grazing treatments on the Welder Wildlife Foundation Refuge. Data are 2-year (1976-77) averages.**

Collection Date	High-intensity, low-frequency Clay	4-pasture, deferred-rotation Sand Clay	Continuous, Yearlong Clay	Monthly $\bar{X}$	
January	37.0	34.2	27.0	34.0	33.1 b $\bar{1}$
April	37.8	36.1	33.8	36.0	25.9 a
July	28.5	29.2	31.4	31.0	30.0 c
System $\bar{x}$	34.4A $\bar{1}$	33.2AB30	.8B	33.7AB	

$\bar{1}$  A significant difference ( $P < 0.05$ ) occurs between means not followed by the same letter.

Dry matter digestibility of cattle diets also varied seasonally (Table 4). Simulated diets were most digestible in winter and early spring when cool-season plants comprised the bulk of the diet. At the first sampling date in January, rescuegrass, Canada wildrye (*Elymus canadensis*), and Texas wintergrass made up 95% of the bites. These same 3 species made up only 44% of the diet at the last sampling date during the same period, while dormant warm-season grasses made up an additional 42% of the diet. As expected, DMD declined with this dietary change in species composition.

Dry matter digestibility also dropped in April diets with respect to time in the grazing period. Texas wintergrass, the only cool-season grass utilized in this period, made up 32%, 21%, and 6% of the diet, respectively, during early, middle, and late sampling dates. Meadow dropseed dropped from 17% of the diet early, to 8% mid, and 8% late in the grazing period.

Other warm-season grasses, primarily longtom and vine mesquite, increased in dietary composition toward the end of the grazing period. Reasons for these changes include a reduction in availability of Texas wintergrass, and its maturity by the end of the period. Also, during the 3 weeks from the beginning to the end of the grazing period, preferred warm-season grasses such as vine mesquite and longtom began to produce abundant growth. During this particular grazing period, dietary changes may have been influenced more by natural seasonal changes than by grazing pressure.

**Table 4. Weighted percent digestibility of forage in cattle diets at the beginning, middle, and end of grazing periods in a high-intensity, low-frequency grazing system on the Welder Wildlife Foundation Refuge.**

	Beginning	Middle	End	Monthly $\bar{X}$
January	42 a	37 b	38 b	39 a $\bar{1}$
April	40 a	38 b	38 b	39 a
July	30 c	29 c	29 c	29 b
X	37 A $\bar{1}$	35 B	35 B	

$\bar{1}$  A significant difference ( $P < 0.05$ ) occurs between means not followed by the same letter.

The level of nutrition available to cattle grazing in the HILF treatment continually fluctuated. The 2 most apparent reasons for the fluctuations were: (1) growth stage of range forage varied widely since grazing occurred following long rests at different seasons so that palatability and nutrient content of the plants were either relatively high or very low when cattle were moved into the pasture, and (2) only the most palatable and preferred species were consumed the first 2 to 3 days of grazing. Then, for the ensuing week to 10 days, they consumed less palatable species roughly in proportion to availability. For the last few days of the grazing period, cattle essentially could not graze selectively, but consumed the few remaining forage plants, regardless of species.

Digestibility of forage in cattle diets was a reflection of differences in individual pastures rather than grazing treatments. However, digestibility of forage in diets as HILF grazing periods progressed showed a significant ( $P < .05$ ) decline in diet quality after the first third of the grazing period. Rotating animals at weekly intervals should provide much better individual animal performance as compared to a HILF treatment with rotation at 21 days or longer. This of course, would depend upon the length of the rest period and number of pastures in the treatment.

### CONCLUSIONS AND RECOMMENDATIONS

Three basic conclusions can be drawn from these studies: (1) Cattle diets were similar on CG and 4PDR, but on HILF diet composition changed from highly-preferred to less-preferred species as the grazing period progressed. The effects of season, soil type, and rainfall were greater than grazing treatment effect. (2) The 5 most highly preferred grasses provided adequate crude protein and calcium except during winter. All 5 were low in phosphorus except during spring green-up. (3) There were no differences in forage digestibility between treatments. Forage digestibility in HILF diets showed a significant ( $P < .05$ ) decline after the first week of a 3-week grazing period.

Results of the Welder Wildlife Refuge HILF grazing treatments work have raised some of the same questions posed by Kelton (1978), i.e., that Texas grazing schemes have used 3- to 4-week grazing periods which are too long for peak animal performance. Jackson (1964) pointed out the importance of moving cattle to the next grazing unit before graz-

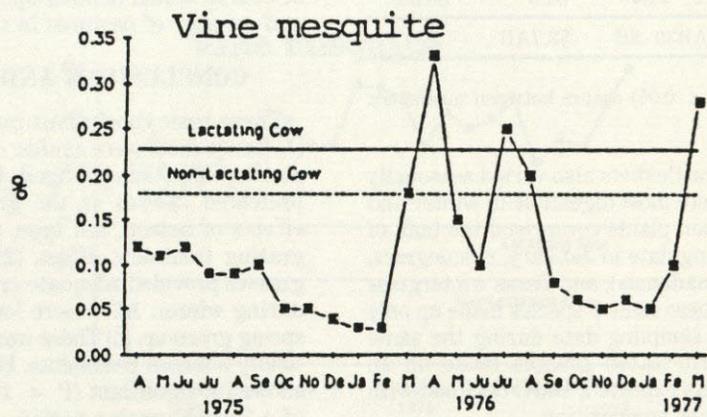
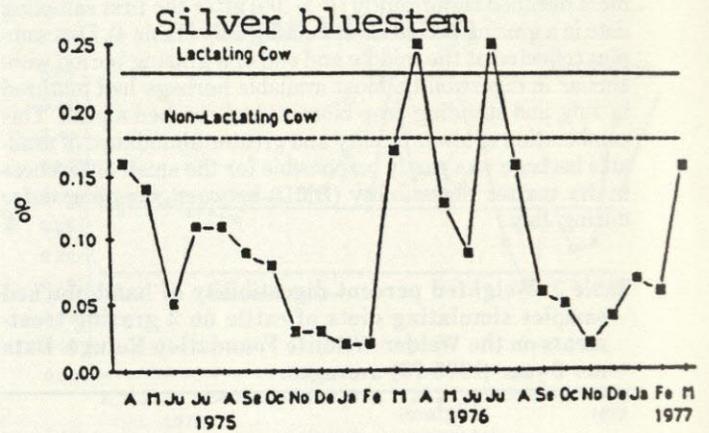
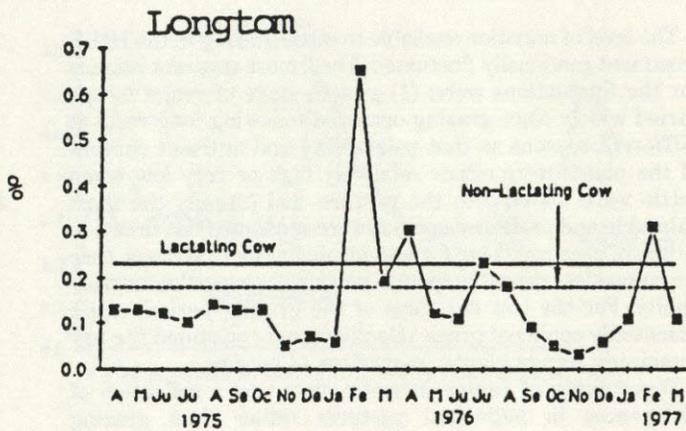
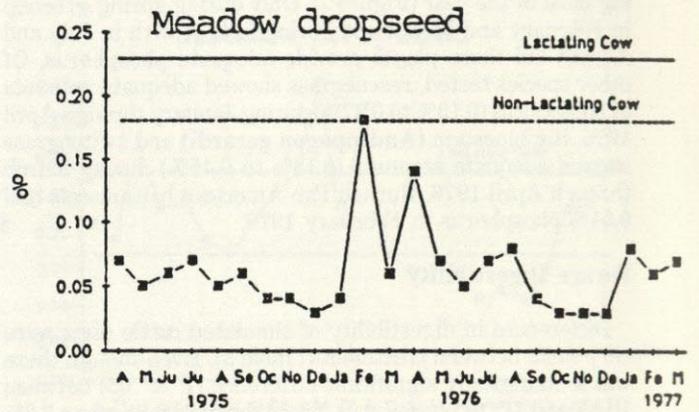
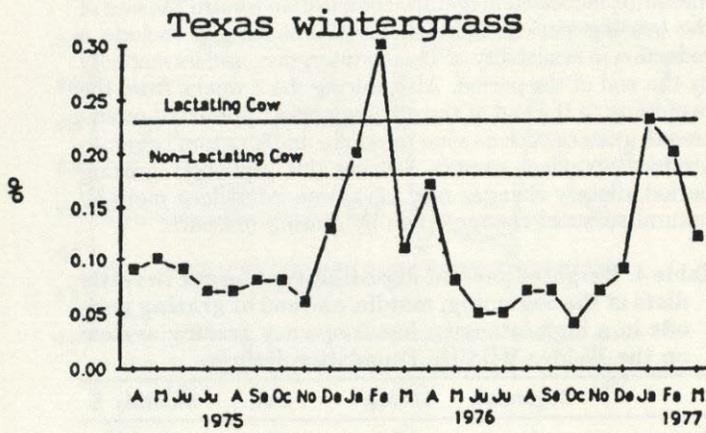


Figure 7. Percent phosphorus content of 5 major grasses in cattle diets on the Welder Wildlife Foundation Refuge, 1975-77, compared to NRS-NRC (1976) standards for standards for lactating and non-lactating cows.

ing stress causes loss of production. Reardon (personal communication) found it impossible to maintain animal production using a 21-day grazing period with a 1-herd, 6-pasture scheme in the northwestern Rio Grande Plain. Although the Welder Refuge study was conducted under higher rainfall and better growing conditions than on the Rio Grande Plain, we have continued our evaluations long enough that our data also indicate lowered animal performance with "Texas style" HILF grazing (Drawe 1987). Our studies indicate that a 1-week grazing period might be preferable.

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