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# The Financial and Ecological Impacts of Two Stocking Levels on Chihuahuan Desert Rangeland

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# The Financial and Ecological Impacts of Two Stocking Levels on Chihuahuan Desert Rangeland

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## INTRODUCTION

Often livestock producers, agency personnel and other interested parties debate the most desirable use levels of available forage on rangelands. Conservative grazing targeting 31%–40% use of primary forage species appears to be a sound management practice for maintaining and improving ecological condition and forage production in the Chihuahuan Desert (Paulsen & Ares, 1962; Holechek et al., 1994; Holechek et al., 2003). Conservative grazing may offer other benefits to ranchers, including improved livestock productivity, lower variable costs, lower risk and similar or higher net returns per hectare compared to moderate grazing, which targets 41–50% use of primary forage species (Holechek, 1992; Winder et al., 2000). Recently, several range professionals have advocated the use of a 25% harvest coefficient in arid and semi-arid areas when stocking rates are being established with the aim of reducing risk and facilitating range improvement (Lacey et al., 1994; Johnston et al., 1996; Galt et al., 2000). We will refer to this as *light* grazing.

A review of 25 stocking rate studies in semi-arid or sub-humid rangelands in North America by Holechek et al. (1999) indicated light to conservative grazing gave only slightly lower economic returns than moderate grazing. Holechek (1992) and Winder et al. (2000) concluded conservative grazing was financially more effective than moderate grazing in studies involving the Chihuahuan Desert of New Mexico. The study conducted by Winder and coworkers (2000) was initiated with Brangus, Beefmaster and Barzona heifers. There was great variation in the animal performance portion of the Winder study, as beef females of these ages are greatly challenged to calve and re-breed as they are growing toward maturity (Hawkins et al., 2000). Thus, the first objective of this study was to evaluate the effects of conservative and moderate grazing on cow-calf production using mature Brangus cows that had been selected to perform in the Chihuahuan Desert. These cows come from a lineage bred for performance in the Chihuahuan Desert since 1966 (Winder, 1989; Winder & Beck, 1990; Winder et al., 1992). A second objective of this study was to evaluate the associations of forage use and economic return. Economic modeling has been a useful tool when evaluating financial returns in agricultural systems (Hawkes et al., 2004).

## STUDY SITE

Four study pastures located at the New Mexico State University Chihuahuan Desert Rangeland Research Center (CDRRC) were used to evaluate the effects of conservative and moderate grazing on cow-calf production and financial returns. The CDRRC is located 37 km north of Las Cruces, in south-central New Mexico. The CDRRC is on the southern portion of the Jornada del Muerto Plains between the San Andres Mountains to the east and the Rio Grande Valley to the west (32.3° north and 106° west). Elevation varies from 1,188 to 1,371 meters and topography is level to gently rolling.

Soils of the CDRRC are mainly light sandy loams underlain by calcium carbonate hardpans at depths varying from a few centimeters to greater than a meter (Valentine,

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**Table 1. Average Monthly Precipitation (cm) on the Chihuahuan Desert Rangeland Center in South-central New Mexico for the Period 1997–2002**

| Month | 71 yr. Avg. 1930-2001 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|
| January | 1.27 | 0.76 | 1.65 | 0.34 | 0.00 | 0.42 | 0.21 |
| February | 1.04 | 0.30 | 0.97 | 0.00 | 0.01 | 0.74 | 0.79 |
| March | 0.66 | 0.35 | 0.05 | 0.29 | 0.53 | 0.13 | 0.00 |
| April | 0.55 | 0.55 | 0.00 | 0.02 | 0.08 | 0.06 | 0.00 |
| May | 0.88 | 1.32 | 0.00 | 0.22 | 0.00 | 0.37 | 0.11 |
| June | 1.27 | 0.63 | 1.24 | 2.29 | 5.93 | 0.17 | 0.04 |
| July | 4.24 | 2.48 | 2.18 | 1.51 | 0.63 | 0.58 | 2.21 |
| August | 4.62 | 1.57 | 3.43 | 2.31 | 0.82 | 0.70 | 1.03 |
| September | 3.58 | 0.93 | 4.72 | 2.28 | 0.01 | 2.92 | 0.53 |
| October | 2.23 | 2.28 | 0.00 | 0.88 | 1.90 | 0.00 | 1.06 |
| November | 1.19 | 3.25 | 0.23 | 0.00 | 1.41 | 0.18 | 0.25 |
| December | 1.85 | 3.53 | 0.58 | 0.48 | 0.11 | 0.27 | 1.45 |
| Total | 23.38 | 17.95 | 15.05 | 10.61 | 11.42 | 6.525 | 7.68 |

1970; Joseph et al., 2003). They are classified as fine loamy, mixed thermic typic haplargids and are in Simona-Cruces associations (SCS, 1980).

Climatic conditions on the CDRRC are typical of the Chihuahuan Desert. The study site is arid and averages 200 frost-free days per year (Joseph et al., 2003). Wells and pipelines are the only permanent sources of water available for livestock or wildlife in each pasture. Summer temperatures are high, with a mean maximum of 36°C during the month of June. Winter temperatures are cool, with a mean maximum of 13°C during January (Pieper & Herbel, 1982). There is great variation between daytime and nighttime temperatures. Winds are often strong in the spring of the year (Joseph et al., 2003). Rain gauges are well distributed throughout the CDRRC. Bimodal winter/summer precipitation occurs on the study area. During the summer months precipitation is generated from the Gulf of Mexico and is characterized by localized conventional storms of high intensity but low frequency. Winter moisture generally comes from the Pacific Ocean. Winter storms are typically gentle and broadly distributed. Mean annual precipitation is 23 cm, with 52% coming in the growing season. Average annual precipitation for the 1997–2001 period was 19.72 cm, or 84% of the 71 year average (Table 1).

The primary grasses on the CDRRC are black grama (*Bouteloua eriopoda* [Torr.]), sand dropseed (*Sporobolus* spp.), threeawn (*Aristida* spp.), bush muhly (*Muhlenbergia porteri* [Kunth] ), fluffgrass (*Erioneuron pulchellum* [Takeoka]) and tobosa (*Hilaria mutica* [Buckley]) (Winder et al., 2000). Honey mesquite (*Prosopis glandulosa* [Torr.]) is the most commonly found shrub on the CDRRC. Other important shrubs are snakeweed (*Guiterrizea sarothrae* [Pursh]), soaptree yucca (*Yucca elata* av.), creosote (*Larrea tridentata* [Purch] Nutt.) and fourwing saltbush (*Atriplex canescens* [Purch] Nutt.). Leatherweed croton (*Croton potsii* [Lam.]) is the primary forb on the CDRRC study area.

## STUDY DESCRIPTION

Four pastures with similar soils (sandy loams), topography (flat) and size were delineated and fenced in 1991 (Joseph et al., 2003; Winder et al., 2000): Pasture 1 (1,267 ha), Pasture 2 (932 ha), Pasture 3 (1,219 ha) and Pasture 4 (974 ha). The pastures are adjacent to each other and are surrounded by rangeland in mid-seral condition. The spatial ordering of the pastures from west to east is 1, 2, 3, 4. These pastures have flat terrain and similar spacing of watering points. During 1992, 1993 and 1994, these pastures were used to study the effects of range condition

and grazing intensity on cattle production (Winder et al., 2000) and wildlife populations (Nelson et al., 1997; Joseph et al., 2003).

After a period of complete destocking due to drought (August 1994 to April 1997) the four pastures were partially restocked in January 1997 and fully stocked in November 1997 for implementation of our study. Procedures of Holechek (1988) were used to set stocking rates in autumn 1997 through 2001. Pastures 1 and 3 were stocked to obtain conservative use (30%) of forage and Pastures 2 and 4 to obtain moderate use (40%) of forage.

During our study, Pastures 1, 2 and 4 were in late-seral ecological condition and Pasture 3 was in mid-seral ecological condition (Molinar, 1999), based on the quantitative climax approach of Dyksterhuis (1949). Ecological condition scores for Pastures 1, 2, 3 and 4 at the beginning of our study in 1997 were 65%, 60%, 46% and 63%, respectively (Molinar, 1999). Ecological condition scores averaged 55% for conservatively grazed pastures and 61% for moderately grazed pastures. Ecological condition involves the amount of climax or original vegetation that remains on the site.

Foliar cover and standing crop data were collected in autumn of 1993 through 2001 at ten evenly spaced key areas in each pasture (Holechek et al., 2000; Joseph et al., 2003). Autumn forage standing crop and current year growth were determined by clipping twenty 0.5-$m^2$ quadrats on each key area. Current year growth was separated from standing dead material. Grazed plants were adjusted to equivalent weight of ungrazed plants by clipping ungrazed plants of similar height and basal diameter. Herbaceous standing crop and percent relative composition of herbaceous standing crop for Pastures 1, 2, 3 and 4 in 1996 and 1997 are reported by Molinar (1999). A modification of the line-intercept procedure of Canfield (1941) was used to determine the percent cover. A meter stick was used instead of an extended line (Molinar, 1999). Measurements were made every 6.1 m along two 61-m transects at each key area. The intercept for grasses, forbs and shrubs was measured at the crown. Grazing intensity on the four pastures was evaluated from early June of 1997 through 2001 using procedures of Holechek and Galt (2000). Percent use of forage, residual vegetation and stubble heights of key species were evaluated on four key areas within each pasture. Percent use and residual vegetation were determined by clipping twenty 0.5-$m^2$ quadrats at each key area. Fifty plants were measured for stubble height along each of the two 100-m transects at each key area. In drought years black grama stubble heights were periodically checked during the summer and autumn in all four pastures. If average stubble height fell below 7.6 cm, the pasture was destocked. Both low forage production and black grama heights near or below 7.6 cm justified the decision to destock all pastures in autumn 2001.

## RESULTS AND DISCUSSION

### Precipitation Characteristics

To give insight into our findings on cattle production and financial returns under conservative and moderate grazing, we will provide a brief discussion of total precipitation and growing season (June–September) precipitation. Across the 1996 to 2001 period, neither total annual nor growing season precipitation differed ($p > 0.10$) between conservative and moderate grazing treatments or for the grazing treatment × year interaction. However, year effects were observed in both total annual and growing season precipitation. Both total annual and growing season precipitation tended to be lower ($p < 0.10$) in 1998 and 2001 than in 1997, 1999 and 2000. Based on growing season precipitation, both 1998 and 2001 were drought years, receiving 75% or less of average precipitation (Table 1). In the remainder of this paper, we will relate these precipitation conditions to outcomes in forage production and livestock production and to financial returns for grazing treatments and years.

### Vegetation Characteristics

Analysis of vegetation characteristics on these study sites by Joseph et al. (2003) showed that black grama (*Bouteloua eriopoda*) and perennial grass foliar cover tended to be lower ($p < 0.10$) on conservatively grazed pastures than on moderately grazed pastures

**Table 2. Summary of Vegetation Characteristics Associated with Lightly and Conservatively Grazed Pastures on the Chihuahuan Desert Rangeland Research Center in South-central New Mexico for the Period 1997–2002.**

| | Grazing Intensity | |
|---|---|---|
| **Vegetation Characteristic** | **Light** | **Conservative** |
| Ecological condition score | 55 | 61 |
| *Boutelouia eriopoda* cover, % | 0.7[a] | 1.1[b] |
| Perennial grass cover, % | 1.5[a] | 2.2[b] |
| Forb cover, % | 0.6 | 0.4 |
| Shrub cover, % | 4.6 | 3.3 |
| Total vegetation cover, % | 6.6 | 6 |
| Autumn perennial grass standing crop, kg/ha | 147 | 168 |
| Spring *Bouteloua eriopoda* height, cm | 11.7 | 9 |
| Spring forage utilization, % | 30 | 40 |

[a, b] Means with different superscripts within rows differ at $p < 0.05$

(Table 2). Total vegetation and shrub cover did not differ ($p > 0.10$) between treatments. Honey mesquite accounted for about 90% of the shrub cover on both treatments. Rangeland ecological condition scores based on cover did not differ ($p > 0.10$) between treatments. Across years, grazing use averaged 39% on moderately stocked pastures and 30% on conservatively stocked pastures (Table 2). Measures of stubble height of black grama were consistent with previous reports of Holechek and coworkers (2003), which suggested that conservative grazing intensity yields higher stubble height than moderate grazing intensity.

As shown in Table 3, autumn perennial grass standing crop did not differ ($p > 0.10$) between conservative and moderate grazing levels (164 versus 169 kg/ha, respectively). Year tended to be a significant ($p < 0.10$) source of variation in measures of standing crop, but there was no treatment × year interaction. Autumn perennial grass standing crop was lower ($p < 0.10$) in 1996 and 2001 than in other years (1997, 1998, 1999, 2000). This can be attributed to drought conditions in 1996 and 2001.

## Cattle Production

Grazing management and livestock development are congressionally-mandated missions of the CDRRC. This experiment station has been selecting Brangus cattle for production in the Chihuahuan Desert environment since 1966, taking advantage of heat tolerance and hybrid vigor observed in this two-breed composite of 3/8 Brahman and 5/8 Angus (Winder, 1989; Winder et al., 1992). These pedigreed cattle are useful in grazing studies, as the knowledge of their genetic background allows them to be stratified across grazing treatments to control for individual animal variation. This strategy proved successful when comparing continuous grazing systems to rotational grazing systems (Winder & Beck, 1990) and appears also to be true in the current study, as calving date, birth weight and weaning weights were similar ($p > 0.10$) between conservative and moderate grazing levels.

In an earlier study on the CDRRC, Winder et al. (2000) found no difference in calf weaning weights between conservative and moderate grazing levels in a study involving first-, second- and potentially third-calf Barzona, Brangus and Beefmaster cows. On the Fort Stanton Experimental Range in central New Mexico, Pieper et al. (1991) reported calf weaning weights were higher under moderate than under heavy grazing (198 versus 194 kg, respectively). As summarized by Pieper (1980) and Holechek et al. (2004), calf weaning weights generally decline when grazing intensities are increased from conservative to heavy levels. However, it appears that the year-to-year variation in the current study did not allow for discrimination between conservative and moderate grazing levels, or it may be that forage use at these levels is adequate to produce similar calf weaning weights.

Calf weaning weights pooled across grazing treatments for 1997, 1998, 1999, 2000 and 2001 were 264, 257, 261, 262 and 254 kg, respectively. In 2001, calf weaning weights were reduced ($p < 0.10$) relative to other years due to severe drought and poor forage growth. Previous studies on the CDRRC (Winder et al., 2000) and from other parts of New Mexico (Boykin et al., 1962; Pieper et al., 1991) have shown calf weaning

weights are reduced in drought years. Most importantly, in this study kilograms of calf weaned per hectare were greatly reduced during the drought of 1999 (Figure 1).

Body weight and body condition score (BCS) are typically indications of reproductive potential in beef cows (Houghton et al., 1990; Lalman et al., 1997). Herein, body condition scores were similar ($p > 0.10$) across grazing levels, as were winter and fall body weights (Table 4). However, there was a tendency ($p < 0.10$) for cow spring weights to be heavier (10 kg) in cows grazing conservatively stocked pastures than in cows grazing moderately stocked pastures. This was most likely a consequence of greater quality or quantity of forage in the conservatively stocked pastures and of the potential for more nutrient availability to support weight gain pre-calving and subsequent weight maintenance during early lactation. These types of interactions have been reported in other grazing studies of cow-calf units (Sims, 1993; Coleman et al., 2001) and provide opportunity for further investigation of these interactions with the grazing mission of the CDRRC. Most importantly, it must be noted that year was a significant source of variation in the analyses of animal response variables.

Pregnancy rates ($p < 0.10$) tended to be greater in moderately stocked pasture (92.6%) relative to conservatively stocked pastures (87.7%). However, either of these pregnancy rates would be desirable for most range livestock systems (Adams et al., 1994; Winder et al., 2000). During the drought of 1999, animal units, percent calf crops and kilograms of calf weaned per hectare were greater (grazing level × year; $p < 0.05$) in conservatively stocked pastures relative to moderately stocked pastures (Figure 1). Thus, conservative stocking offers an advantage over moderate stocking for sustainability of herds during short-term drought in these types of desert agricultural systems. It should also be noted that provision of protein/energy supplements and the low grazing intensities in this study probably influenced the resulting pregnancy rates.

Percent calf crop is an important variable in determining profitability of cow-calf systems in desert environments (Winder et al., 2000). Twenty-six other studies reviewed by Valentine (1990) and Holechek et al. (1999) have shown calf crop percentages are sensitive to grazing intensity. Across these studies, calf crops were 7% higher under moderate than heavy stocking rates. However, conservative stocking gave only 3% higher calf crops than moderate stocking. It is probably more important to bring attention to the fact that the economic return of most cow-calf operations will be dependent not only on pregnancy and calf crop percentages, but on female replacement cost. Female replacement cost will be greatly dependent on the cattle price cycle (Bentley & Shumway, 1981; Hughs, 2001). This makes frequent stocking and destocking, as would be required of moderate grazing systems under precipitation patterns like those observed in the current study, financially risky.

**Table 3. Autumn Perennial Grass Standing Crop (kg/ha) on Light and Conservative Grazing Treatments on the Chihuahuan Desert Rangeland Research Center for the Period 1996–2001**

| | Grazing Intensity | | |
|---|---|---|---|
| | Light | Conservative | Average |
| Year | Perennial Grass Standing Crop (Kg/ha) | | |
| 1996 | 123 | 111 | 117[c] |
| 1997 | 202 | 273 | 238[a] |
| 1998 | 181 | 112 | 147[bc] |
| 1999 | 242 | 217 | 230[a] |
| 2000 | 171 | 227 | 199[a] |
| 2001 | 65 | 72 | 69[d] |

[a, b, c, d] Means with different superscripts within rows differ at $p < 0.10$

## Financial Returns

Hypothetical net returns per hectare on conservatively and moderately stocked pastures did not differ ($p > 0.10$) when data were pooled across years ($1.10 versus $2.13 per ha, respectively; see Table 5). Grazing level × year interaction was also non-significant ($p > 0.10$). However, net returns per hectare tended to differ among years ($p < 0.10$). Net returns were $1.68, $3.56, $0.17, $1.56 and $1.23 per ha for 1997, 1998, 1999, 2000 and 2001, respectively. In 1998 and 1999, net returns per hectare differed ($p < 0.10$) from each other and from other years. However, net returns per hectare did not differ ($p >$

**Table 4. Cattle Production on Lightly and Conservatively Grazed Pastures on the Chihuahuan Desert Rangeland Research Center from 1997–2001**

| Trait | Grazing Level | | |
|---|---|---|---|
| | Conservative | Moderate | Pooled SE |
| Calving date | 83.48 | 81.45 | 1.09 |
| Adjusted birth wt., kg | 29.6 | 28.53 | 0.84 |
| Adjusted weaning wt., kg | 279.12 | 270.73 | 7.83 |
| Cow winter wt., kg | 586.08 | 591.06 | 1.88 |
| Cow winter BCS | 4.77 | 4.79 | 0.08 |
| Cow spring wt., kg | 524.52[c] | 502.42[d] | 9.67 |
| Cow spring BCS | 5.05 | 4.97 | 0.13 |
| Cow fall wt., kg | 528.61 | 541.17 | 30.47 |
| Cow fall BCS | 5.06 | 4.61 | 0.25 |
| Pregnancy rate, % | 87.73[c] | 92.64[d] | 2.03 |

[c, d] Means with different superscripts within rows tended to differ at $p < 0.10$

**Table 5. Cattle Production and Financial Characteristics for Conservative and Light Graze Treatments on the Chihuahuan Desert Rangeland Research Center for Data Pooled Across 1997–2001**

| Characteristic | Conservative Stocking | Moderate Stocking |
|---|---|---|
| Ranch Size (ha) | 16188 | 16188 |
| Number of Animal Units | 214 | 315 |
| Forage Production (kg/ha) | 172 | 180 |
| Percent Use of Forage (%) | 30 | 40 |
| Calf Crop (%) | 86 | 90 |
| Calf Weaning Weight (kg) | 270[c] | 249[d] |
| Gross Income ($/AU) | 383.45 | 314.93 |
| Supplemental Feed Cost ($/AU) | 32.38 | 32.38 |
| Variable Costs ($/AU) | 200.55 | 147.85 |
| Fixed Costs ($/AU) | 157.07 | 102.71 |
| Total Costs ($/AU) | 357.62 | 250.56 |
| Net Income ($/AU) | 56.25 | 88.91 |
| Net Income ($/ha) | 1.10 | 2.13 |

[c, d] Means within rows with different superscripts are significantly different ($p < 0.05$)

0.10) among 1997, 2000 and 2001. Above-average precipitation in 1997 resulted in a doubling of forage production across study pastures and permitted increased stocking rates until late autumn of 1998. Below-average precipitation during the growing season in 1998 reduced forage production. Therefore, sharp decreases were made in stocking levels for 1999, as demonstrated in Figure 1. Precipitation and forage production were near average in 1999 and 2000. However, severe drought in 2001 greatly depressed forage production. Pastures were destocked because of the reduction in forage production, as grazing may become unprofitable when forage production drops below 100 kg per ha (Holechek, 1996).

Since there was no effect of grazing level ($p > 0.10$) in this study, data were pooled across grazing level treatments and economic return was evaluated among years. Net returns per hectare from individual pastures and individual years were placed into categories of light, conservative, moderate and heavy grazing levels, as measured by forage use in late spring of the same year (Table 6). In an earlier study, Winder et al. (2000) also found net returns to be similar ($p > 0.10$) from conservative and moderate cattle grazing levels on the CDRRC ($1.28 versus $0.74 per ha, respectively). However, association analyses revealed that net returns per hectare were positively associated ($p < 0.10$) with previous forage year production (R = +0.67; see Figure 2) and this explanatory variable accounted for ~45% of the variation in net return. No relationship was found between net return and grazing use level. Thus, it appears that when there is ample forage to support grazing, profitability may be possible in the Chihuahuan Desert. However, it must be noted that both Holechek (1996) and this study show negative financial returns are probable when forage production drops below 100 kg/ha. Stoddart and Smith (1943) made this same general observation in their range management textbook. When stocking rates exceed 100 hectares per animal unit, rangelands are too sparsely vegetated to be used economically. Fixed costs per animal unit increase greatly under these conditions (Holechek et al., 2004). Livestock on such rangelands are likely to expend more energy seeking forage than their gains justify.

Literature reviewed by Holechek et al. (1999) show that conservative grazing promotes range improvement while moderate grazing generally gives stable range condition. Conservative compared to moderate grazing gave a more rapid recovery rate of black grama after the 1950s drought on the

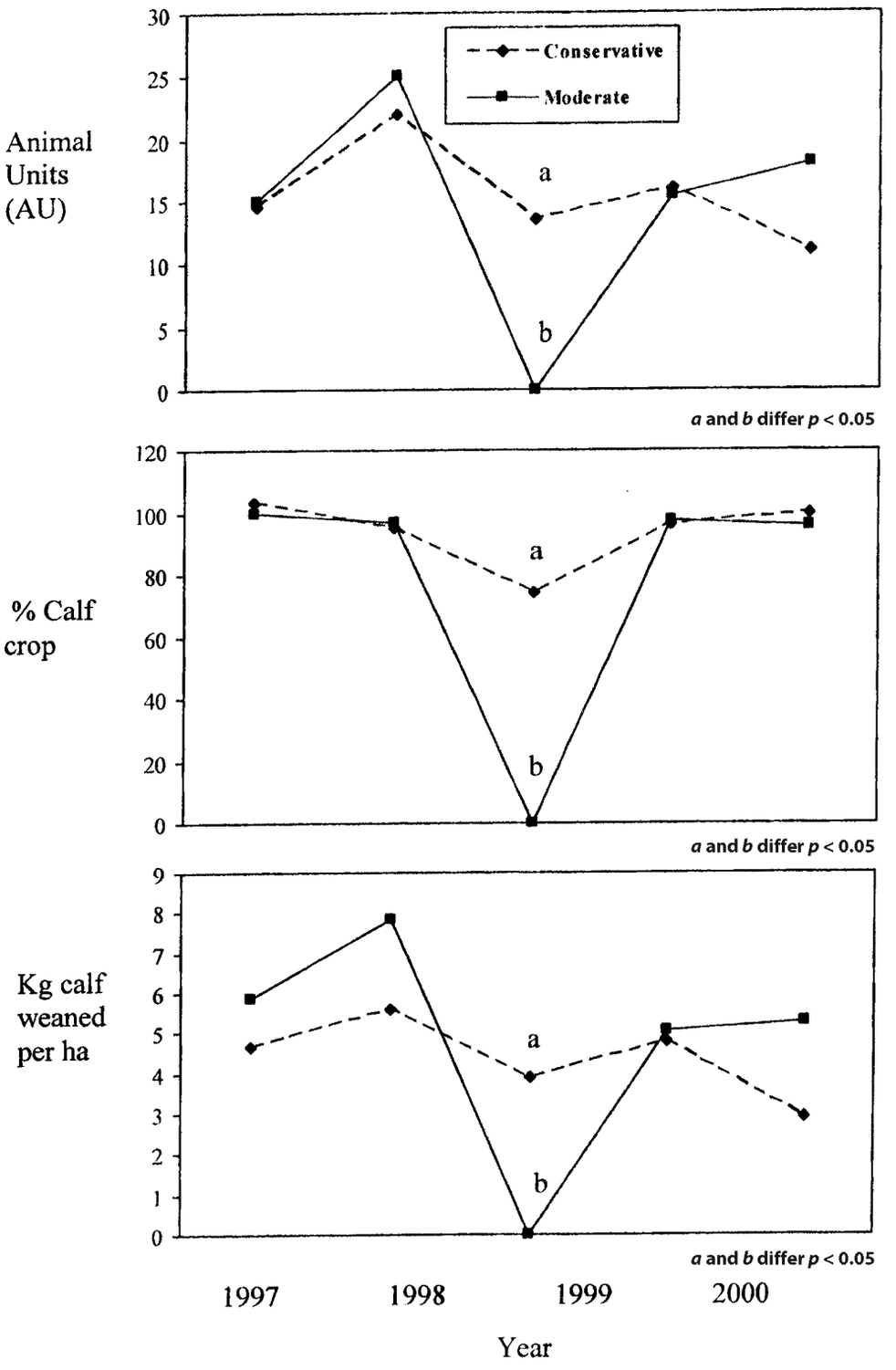


***Figure 1.*** Animal units (top panel), percent calf crop (middle panel), and kilograms of calf weaned per hectare (bottom panel) in lightly and conservatively stocked pastures on the Chihuahuan Desert Rangeland Research Center 1997 to 2000.

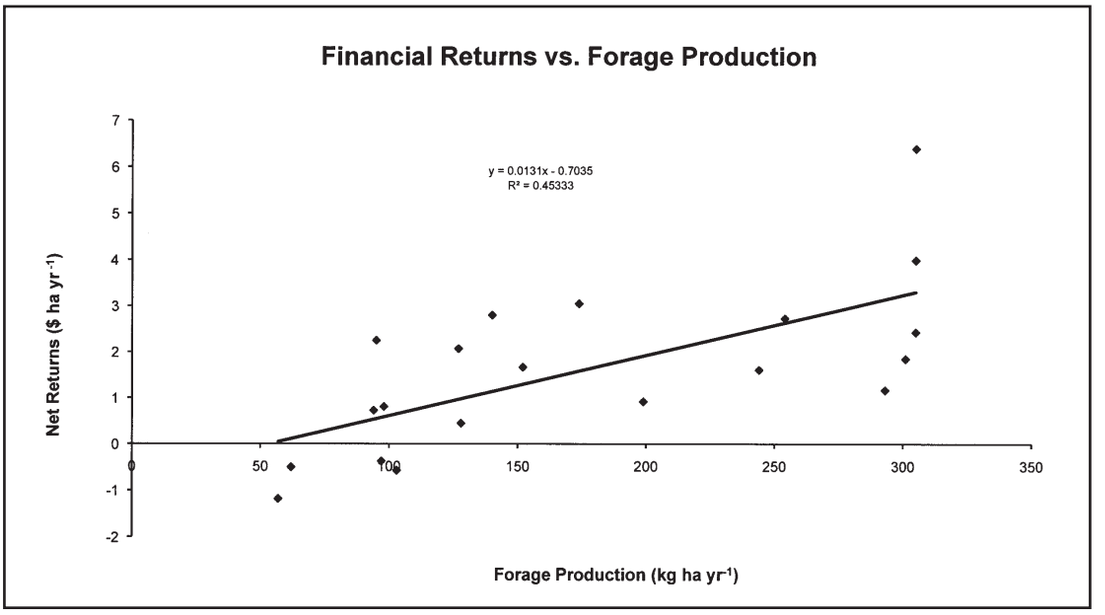


***Figure 2.*** Linear relationship between financial returns ($/ha/yr) and forage production (kg/ha) for individual pastures and years in the 1997–2001 period on the Chihuahuan Desert Rangeland Research Center.

CDRCC (Valentine, 1970). Several more years of study on the described pastures will be needed to determine the effects of conservative and moderate grazing on long-term plant survival and productivity. However, based on our review of the literature, it seems probable that rangelands in an early- or mid-seral stage would benefit from conservative compared to moderate grazing. As a final point, surplus carryover forage does have value as a reserve or stockpile against drought. This value is difficult to quantify. Various studies reviewed by Molinar et al. (2001) show residual forage can increase forage production in dry years and is therefore not wasted.

In summary, it appears that Brangus calf performance and financial returns are similar between conservative and moderate grazing levels in the Chihuahuan Desert, but that a positive relationship exists between financial returns and forage production. There appears to be a herd sustainability advantage during short-term drought when grazing is conducted at a conservative versus a moderate level.

## Study Limitations

The primary experimental limitation in this study was that one of the experimental pastures (Pasture 3, conservatively grazed) had a lower black grama component than the other three pastures. Perennial grass production in Pasture 3 averaged 90 kg/ha/yr compared to 261, 209 and 145 kg/ha/yr for Pastures 1 (conservative), 2 (moderate) and 4 (moderate), respectively. Net returns per hectare per year averaged a loss of $0.12 for Pasture 3 compared to a gain of $2.31, $2.20 and $2.07 for Pastures 1, 2 and 4, respectively. The low black grama component and hence low forage production of Pasture 3 disproportionately increased the variation in financial returns among the pastures. Holechek (1996) found financial returns per hectare in the Chihuahuan Desert were closely linked with forage production and rangeland ecological condition. The prevalence of black grama in the vegetative composition largely determines both forage production and rangeland ecological condition. Pasture 1, which has a 33-year history of conservative grazing, had the highest production of black grama, the highest perennial grass production and the highest net returns per hectare. In contrast, Pasture 3, which had been moderately grazed in most of the last 35 years, had the lowest black grama production, lowest perennial grass production and negative net returns per hectare. Generally, Pastures 2 and 4 have a history of conservative to moderate grazing.

This assessment is based on both quantitative and qualitative observations made by Dr. Jerry Holechek and Dr. Reldon Beck, longtime range researchers on the CDRRC.

## Management Implications

Black grama is the primary decreaser perennial grass in the Chihuahuan Desert (Paulsen & Ares, 1962). It is superior to other Chihuahuan Desert grasses in productivity, nutritional value and drought resistance (Paulsen & Ares, 1962). However, it is quite sensitive to grazing intensity (Paulsen & Ares, 1962; Valentine, 1970; Holechek et al., 2003). Conservative grazing may have benefits over moderate grazing in terms of enhancing or maintaining black grama productivity (Valentine, 1970).

From the standpoint of the livestock producer, the primary concern with light to conservative grazing is reduced net income ($/ha/year). This study showed no differences in financial returns from conservative versus moderate Brangus cow-calf grazing on Chihuahuan Desert rangelands. Winter cow weights, autumn cow weights, body condition scores and calf birth and weaning weights did not differ between conservative and moderate grazing treatments. Spring cow weight and pregnancy rates did differ between the treatments.

Light to conservative grazing appears to be well suited to ranchers who prefer a passive, low-risk, low-input approach to running their operations. These grazing levels are suggested for Chihuahuan Desert pastures and ranches in an early- or mid-seral stage where rapid successional advance is a goal and there is concern that a threshold will be crossed beyond which rangeland recovery may not occur.

Moderate grazing is best suited for ranchers who actively manage their rangelands, are willing to do intensive monitoring, and have a high proportion of land in late-seral or climax condition. Ranchers using moderate grazing must be willing and prepared to quickly reduce livestock numbers in drought years. They must also understand the cattle price cycle and when their forage supply allows for restocking of a ranch. To those ranchers who can maintain this level of management, there may be a financial advantage in moderate grazing compared to conservative grazing.

**Table 6. Financial Returns ($/ha) from Individual Pastures and Years When Associated Grazing Use Levels Were Categorized Into Heavy, Moderate, Conservative and Light**

| Grazing Use Level | Average Grazing Use | Average Net Return ($/ha) | Pooled SEM[a] Observations |
|---|---|---|---|
| Heavy | 58 | -0.37 | 0.82 |
| Moderate | 45 | 2.05 | 1.06 |
| Conservative | 36 | 2.13 | 0.77 |
| Light | 22 | 1.34 | 0.33 |

[a] Standard error of the mean

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**Notes**

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