

Animal and Forage Production on Selected Cool- and Warm-Season Grasses and Rangeland



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SUMMARY

Steers grazing warm- (bermuda and bluestem) and cool-season (fescue and wheatgrass) grasses produced adequate gains within seasons (spring, summer, fall) and year-long; however gains in the spring were generally greater than in the fall. The best seasonal rotational system was grazing Jose tall wheatgrass in the spring and fall and Hardie bermudagrass in the summer. Grasses must be maintained in an actively growing, vegetative stage for maximum animal production. Rangeland pasture produced adequate gains during spring and summer but not during fall and winter. Management systems should allow for forage utilization and rest-rotation to yield maximum forage and beef production.

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Animal and Forage Production on Selected Cool- and Warm-Season Grasses and Rangeland

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The primary use of irrigated cropland in New Mexico is producing forages for livestock grazing. Many producers use irrigated pastures in conjunction with native rangeland, but there is growing interest in developing grazing systems that will use irrigated pastures to provide high-quality year-long forage.

Pasture management can be more effective when cool- and warm-season perennial grasses are grown separately and growth habits of each species are exploited to obtain full-season grazing (Krueger and Curtis, 1979). Gross et al. (1966) reported seasonal grazing of cool- and warm-season perennial grasses has been successful for stabilizing seasonal stocking rates and increasing animal gains per ha. Krueger et al. (1974) reported pasture systems composed of separate pastures of cool- and warm-season species had the greatest carrying capacity and beef production per ha, when compared to either a cool-season native grass rangeland or an alfalfa and cool-season grass mixture.

Three experiments were conducted over three consecutive years to evaluate different animal management systems for high-quality forage on a year-round basis, using irrigated pastures consisting of cool- and warm-season perennial grasses. Animal performance and forage production were measured to characterize production traits of steers and grasses in different seasons.

EXPERIMENTAL PROCEDURES

Three experiments were conducted at the New Mexico State University Agricultural Science Center at Tucumcari, New Mexico. In Experiment 1 (1989) bluestem pastures were not available; therefore, only

bermudagrass was utilized as the warm-season pasture. Grasses used in Experiments 2 and 3 (1990, 1991) included two cool-season perennial grasses—Jose tall wheatgrass (*Agropyron elongatum*) and Johnstone tall fescue (*Festuca arundinacea*), and two warm-season perennial grasses—Hardie bermudagrass (*Cynodon dactylon*), and Ironmaster oldworld bluestem (*Bothriochloa ischaemum*). Cool-season pastures measured 1.6 ha and warm-season pastures were 1.2 ha.² Furrow irrigation was used in all pastures with row spacing of 102 cm.

Wheatgrass pastures were planted with certified seed on August 29, 1988, at a rate of 16 kg pure live seed per ha. Tall fescue pastures were planted on August 30, 1988, with certified endophyte-free seed. Seeding rate was the same as for wheatgrass pastures.

Bermudagrass pastures were sprigged June 22-24, 1988. Certified sprigs were used, and sprigging rate was approximately .21 m² per ha. The bluestem pastures were seeded on July 12, 1989. Hulled foundation seed was planted at the rate of .9 kg pure live seed per ha. In an effort to control broadleaf weeds [silverleaf nightshade (*Solanum elaeagnifolium* Cav.), curly dock (*Rumex crispas* L.), prostrate vervain (*Verbena bracteata* Lag. & Rodr.), horseweed (*Conyza canadensis* (L.) Cronq.), flixweed (*Descurainia sophia* (L.) Webb ex. Prantl), and buffalobur (*Solanum rostratum* Dun.)] pastures were treated with an annual herbicide application of Weedmaster[®] or 2,4-D at labeled rates. These herbicides were used because they possess the least restrictive grazing requirements for non-lactating beef cattle. Occasional spot treatments of Roundup[®] were used to control patches of bindweed (*Convolvulus arvensis* L.) and encroachments of bermudagrass (*Cynodon dactylon* (L) Pers.). Annual grasses, sandbur (*Cenchrus longispinus* (Hack.) Rem.), and rescuegrass (*Bromus catharticus* Bahl) were present in pastures but were not treated.

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² See Appendix A (p. 11) for conversion equivalents.

Experiment 1, 1989

Two wheatgrass and two tall fescue pastures were grazed in the spring and fall, and three bermudagrass pastures were grazed in the summer. Irrigation and fertilization schedules for all pastures are shown in table 1. Three groups of yearling crossbred steers were rotated seasonally to different pastures to make up three grazing regimes (fig. 1).

Group 1 consisted of 12 crossbred steers with an initial average body weight of 200 kg. These steers grazed wheatgrass pastures during the spring (May 3-June 28). On June 28, the steers were moved to bermudagrass pastures and remained there throughout the summer (June 28-September 20). In the fall (September 20-November 15), they were placed back on wheatgrass pastures.

Group 2 consisted of six crossbred steers with an average body weight of 205 kg. These steers grazed tall fescue pastures for a 28-d period in the spring (May 3-May 31). On May 31, the steers were moved to bermudagrass where they remained for the entire sum-

mer (May 31-September 20). For the fall period, (September 20-November 15), they were rotated back to tall fescue pastures.

Group 3 consisted of six steers similar to previous groups (avg. BW 207 kg). These steers grazed tall fescue pastures from May 3 to May 31. On May 31 these steers were moved to wheatgrass pastures where they remained until June 28. On June 28, the steers were placed on bermudagrass pastures and grazed until September 20. On September 20 they were placed back on original tall fescue pastures until November 15.

All steer weights were recorded at 28-d intervals throughout the trial following a 16-h shrink. Variables measured included animal gains for rotation groups over seasons. Forage dry matter yield (DMY) was also measured for each grass within season. Steers had free access to water, salt, and mineral blocks³ during the study period.

Forage Sampling

Herbage production data were collected during the spring, summer, and fall to assess seasonal forage dry matter yield (DMY) and pasture utilization. Three exclosures (4.5 m²) were randomly located in the upper, middle, and lower thirds of each pasture. Pastures were sampled immediately prior to grazing, at each animal weigh day, and when grazing was terminated each season. On each sampling day, grass was hand-clipped to ground level from two plots (30.5 x 102 cm) in the caged area and from two paired plots in the grazed area. The freshly clipped samples were weighed and placed in a forced-air oven (50°C) for 48 hr. Once dried, samples were reweighed and weights recorded. Dry matter yield was calculated using only samples clipped from inside the exclosures

$$\text{DMY} = \text{End dry weight} - \text{Start dry weight},$$

where end dry weight is defined as samples collected from inside exclosures at the end of the grazing period and start dry weight is defined as samples collected from inside exclosures at the start of the period.

Percentage apparent utilization of pastures was estimated using samples clipped from both grazed areas and clipped inside exclosures.

$$\% \text{ Apparent utilization} = \frac{P - G}{P \times 100}$$

where P is defined as dry weight from samples inside exclosure, and G equals dry weight from grazed area (Pieper, 1978).

Table 1. Irrigation and fertilization schedule for cool- and warm-season pastures in 1989.

Application date	Wheatgrass	Fescue	Bermudagrass
Irrigation (acre/feet)			
3/27	.7	.7	
4/27	.7	.7	.7
6/20			.6
7/14	.7	.7	.7
8/4			
10/3			1.3
10/20	.9	.9	.9
Total acre feet	3.1	3.1	4.3
Fertilization			
3/20 ^a	x	x	x
4/14 ^b	x	x	
4/26 ^b			x
7/15 ^c	x	x	x
Total kg N/ha	200	200	200

^aFertilizer used = 16.5-16.5-16.5 kg/ha.

^bFertilizer used = 66-66-66 kg/ha.

^cFertilizer used = 118-0-0 kg/ha.

Group	Season			n
	Spring	Summer	Fall	
1	Wheatgrass	Bermudagrass	Wheatgrass	12
2	Fescue	Bermudagrass	Fescue	6
3	Fescue and Wheatgrass	Bermudagrass	Fescue	6

Fig. 1. Seasonal animal rotation groups for 1989 grazing year.

³Purina Mineral Block 12:12 VAK, NO 3796, Purina Mills, Inc., St. Louis, MO, 63166.

Experiment 2, 1990

Animal management strategies were investigated on a seasonal, as well as year-long basis. Three seasonal animal rotations (fig. 2) were examined, as well as seasonal forage production and apparent utilization. Group 1 consisted of steers grazing annual wheat (*Triticum aestivum*) in winter (December 13 to April 11), wheatgrass in spring (April 11 to June 27), bluestem in summer (June 27 to October 3), and wheatgrass in fall (October 3 to December 12). Group 2 grazed wheat in winter, tall fescue in spring (April 11 to May 30), bermudagrass in summer (May 30 to October 3), and tall fescue in fall. Group 3 steers grazed rangeland pastures the entire year. Stocking rates were held constant on all pastures during each grazing season. All animals had free access to water, salt, and mineral blocks during the study period. Cool- and warm-season pasture irrigation and fertilization schedules are given in table 2.

Each rangeland pasture measured 6.5 ha. Dominant grasses found in these pastures included blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), and sand dropseed (*Sporobolus cryptandrus*). Sub-dominant grasses consisted of yellow bluestem (*Bothriochloa ischaemum*), threeawns (*Aristida* spp.), lovegrass (*Eragrostis* spp.), vine mesquite (*Panicum obtusum*), and silver bluestem (*Bothriochloa saccharoides*). These rangeland pastures containing some introduced grasses intermixed with native species were in good condition. Overall, these pastures were composed of good-quality warm-season grasses. (Good quality refers to species relatively low in fiber components and high in protein and digestibility.) The pastures were not subjected to any cultural practices. Two 2.8-ha pastures of winter wheat (TAM 105) were utilized in this trial. Wheat pastures were planted at a seeding rate of 78 kg/ha in early September 1989 and received a single fall irrigation. The wheat pastures were not fertilized and no cultural practices were applied during the grazing trial.

Winter. On December 13, crossbred weanling steers (avg. BW 174 kg) were weighed, randomly sorted into uniform groups, and placed on either winter wheat or rangeland pastures. Two replications of each pasture type were used. Additional steers were maintained on separate wheat pastures for use in later grazing periods, when more pastures were added to the study. Four intact and two rumen-cannulated (for another study) steers were randomly assigned to each replication of each pasture. Throughout the study, performance of cannulated steers was not consistent with intact animals; therefore, only intact animals were used in calculating animal performance data. Cannulated steers were used to sample available forage for diet quality and digestibility evaluations. Steers remained on winter pastures from December 13, 1989, through April 11, 1990. All steers were weighed periodically; however, only total-season performance was analyzed.

Steers grazing rangeland pastures were supplemented with 20% CP cubes⁴ at the rate of .45 kg·hd⁻¹·d⁻¹ from February 9 until March 18. From March 19 to April 27 steers were supplemented at the rate of .68 kg·hd⁻¹·d⁻¹. During periods of snow cover (5 days in January), all steers were fed grass hay (5 kg/hd daily) of medium to low quality. Steers on rangeland received 5 kg/hd for 2 days during that time.

Spring. On April 11, 1990, 24 steers, which were previously grazing wheat pastures, were rotated to cool-season pastures (tall fescue or wheatgrass). These pastures were the same as those used in Experiment 1. As in the winter period, six animals were randomly allotted to each cool-season pasture (4 intact, 2 cannulated). Steers that grazed rangeland pastures during the winter remained on the same pastures.

Group	Season				n
	Winter	Spring	Summer	Fall	
1	Wheat	Wheatgrass	Bluestem	Wheatgrass	12
2	Wheat	Fescue	Bermudagrass	Fescue	12
3	Rangeland	Rangeland	Rangeland	Rangeland	12

Fig. 2. Seasonal animal rotation groups for the 1990 grazing year.

Table 2. Irrigation and fertilization schedule for cool- and warm-season pastures in 1990.

Application date	Wheatgrass	Fescue	Bermuda-grass	Bluestem
Irrigation (acre/feet)				
4/25	.8	.8		
5/14			.9	.9
6/4	.7	.7		
6/16			.9	.9
8/20	.8	.8	.8	.8
Total acre feet	2.3	2.3	2.6	2.6
Fertilization				
4/9 ^a	x	x		
5/10 ^b			x	x
6/18 ^c			x	x
8/20 ^d	x	x	x	x
Total kg N/ha	187	187	306	306

^aFertilizer used = 77-77-77 kg/ha.

^bFertilizer used = 93.5-93.5-93.5 kg/ha.

^cFertilizer used = 102-0-0 kg/ha.

^dFertilizer used = 110-0-0 kg/ha.

⁴Purina Forage Balances Cube 3N, No 3422, Purina Mills, Inc., St. Louis, MO, 63166.

On May 30, steers grazing tall fescue were moved to bermudagrass pastures. Steers grazing wheatgrass were rotated to bluestem pastures on June 27. Animal weights were measured on April 11, May 2, May 30, and June 27. However, animal performance data were compared only when steers were grazing seasonal pastures simultaneously (i.e., gains made between April 11 and May 30).

Summer. Steers remained on warm-season pastures until October 3. Steer weights were monitored periodically through the summer, but as in previous seasons, only full-season weight gains were compared.

Fall. On October 3, steers on bluestem were moved back to original wheatgrass pastures. Steers grazing bermudagrass were placed on tall fescue pastures. They remained on cool-season pastures until December 12, when the year's experiment ended. Steer weights were monitored at 28-d intervals. Dry matter yield and apparent utilization were measured for warm- and cool-season grasses. Forage sampling for cool- and warm-season grasses were the same as for 1989. Winter wheat and rangeland pastures were not sampled.

Experiment 3, 1991

Two seasonal animal rotation groups (fig. 3) were examined over three seasons (spring, summer, and fall). Variables of interest included animal performance, beef production per ha, forage yield, and pasture utilization. Rotation Group 1 consisted of steers grazing wheatgrass in spring, bluestem in summer, and wheatgrass in the fall. Group 2 animals grazed tall fescue in spring, bermudagrass in summer, and tall fescue in the fall. These pastures were the same ones used in Experiment 2. Table 3 indicates irrigation and fertilization schedules for pastures.

To achieve greater beef production per ha and to improve pasture management, a "put and take" stocking system was employed for each pasture. Six animals (test) were maintained on each replication of each pasture at all times. Put and take steers were added or removed from pastures depending on available forage. Test steers were used to calculate individual animal performance because they were maintained on the same pastures at all times. Put and take animals were used

Group	Season		
	Spring	Summer	Fall
1	Wheatgrass	Bluestem	Wheatgrass
2	Fescue	Bermudagrass	Fescue

Fig. 3. Seasonal animal rotation groups for the 1991 grazing year.

Table 3. Irrigation and fertilization schedule for cool- and warm-season pastures in 1991.

Application date	Wheatgrass	Fescue	Bermuda-grass	Bluestem
Irrigation (acre/feet)				
4/22	.8	.8		
5/7			1.0	1.0
7/1			.6	.6
10/8	<u>.9</u>	<u>.9</u>	<u>.9</u>	<u>.9</u>
Total acre feet	1.7	1.7	2.5	2.5
Fertilization				
4/6 ^a	x	x	x	x
7/1 ^b			x	x
9/19 ^b	x	x		
Total N kg/ha	215	215	176	176

^aFertilizer used = 90-90-90 kg/ha.

^bFertilizer used = 86-0-0 kg/ha.

^cFertilizer used = 125-0-0 kg/ha.

along with test steers to calculate total beef production per ha. Stocking rates, therefore, changed periodically with available forage. When not in use, put and take steers were maintained separately, but on similar pastures as test animals. All animals were treated similar to animals in Experiment 2 with regard to water and supplements.

Spring. On April 10, 1991, six test animals and three put and take animals of mixed breeding were placed on both replications of wheatgrass pastures (avg. BW 252 kg). Six test animals were placed on each replication of tall fescue pastures on May 1 (avg. BW 251 kg). All steers remained on their respective pastures through the end of the spring period (May 29). Stocking rates were constant for each pasture type over the season. Wheatgrass pastures had a stocking rate of 5.6 steers per ha, and tall fescue pastures were stocked at the rate of 3.8 steers per ha. Animal weights were measured April 10, May 1, and May 29. Forage samples were collected as in previous years.

Summer. On May 29, six test animals were rotated from wheatgrass to each bluestem pasture. Six additional animals were also placed on the bluestem pastures (12 steers per replication; Group 1). For the first 28 d of the summer period, stocking rate equaled 10 steers per ha. On June 28 two put and take animals were removed from each bluestem pasture and not returned for the remainder of the year. Between June 26 and August 21, the stocking rate was 8.3 steers per ha. On August 21, another steer was removed from each bluestem pasture to give a stocking rate of 7.5 steers per ha from August 21 through October 2.

On May 29, six test animals were moved from tall fescue to each bermudagrass pasture. Additionally, three animals were placed on bermudagrass pastures, to total nine steers per bermudagrass pasture (Group 2). The stocking rate for the first 28 days was 7.5 steers per ha. On June 26, one additional steer was added to each bermudagrass pasture. These steers remained on bermudagrass for the remainder of the summer period (October 2) and stocking rate equaled 8.3 steers per ha.

All steer weights were monitored periodically through the summer, and forage samples were obtained as in the spring period. Stocking rates were adjusted based on forage available determined from clipped samples and weight gains and condition of steers.

Fall. On October 2, only the six test animals were moved from warm- to cool-season pastures. No put and take steers were used. Test steers on bluestem were rotated to wheatgrass, and test steers on bermudagrass were moved to tall fescue. These steers remained on their respective pastures through December 11, when this experiment terminated. Stocking rate for the cool-season pastures was 3.8 steers per ha. Steer weights and forage samples were measured as in previous seasons.

Statistical Analysis

Data were analyzed using methods described by Steele and Torrie (1980) with analysis of variance conducted using GLM procedures of SAS (1985). In all experiments, seasonal data were analyzed as a completely randomized design. Likewise, animal performance for the seasonal rotation groups was analyzed as a completely randomized design over seasons, as well as by month. Variables were examined by season, and when needed, by 28-d intervals within season. All treatment means were compared by Least Significant Difference when the overall treatment F was significant ($P < .10$). In all cases the experimental unit was pasture. The n values given in tables are the number of observations used for determining standard errors.

RESULTS AND DISCUSSION

Experiment 1, 1989

Steer performance over seasons was similar among rotation groups ($P > .10$). However, steers in Group 3 appeared to gain more than steers in Group 1 (161 vs 147 kg, respectively; table 4). Steer gains for rotation groups by 28-d periods over the spring, summer, and fall are shown in fig. 4. No differences ($P > .10$) were observed among rotation groups at any time during the year, although in the fall (Sept. 20-Nov. 15), steers in

Table 4. Gains for steer in the three seasonal rotation groups for spring, summer, and fall 1989.

Item ^c	Rotation groups ^{ab}			SE ^d	OSL ^e
	Group 1	Group 2	Group 3		
Gain (kg)	147	157	161	6.4	.26
ADG (kg)	.76	.81	.83	.03	.26

^aRotation group 1 consisted of 12 steers that grazed wheatgrass in spring, bermudagrass in summer, and wheatgrass in fall; Group 2 consisted of 6 steers that grazed fescue in spring, bermudagrass in summer, and fescue in fall; Group 3 consisted of 6 steers that grazed fescue and wheatgrass in spring, bermudagrass in summer, and fescue in fall.

^bRow values do not differ ($P > .10$).

^cRepresents total gain and ADG over spring, summer, and fall.

^dStandard error (n = 6).

^eObserved significance level.

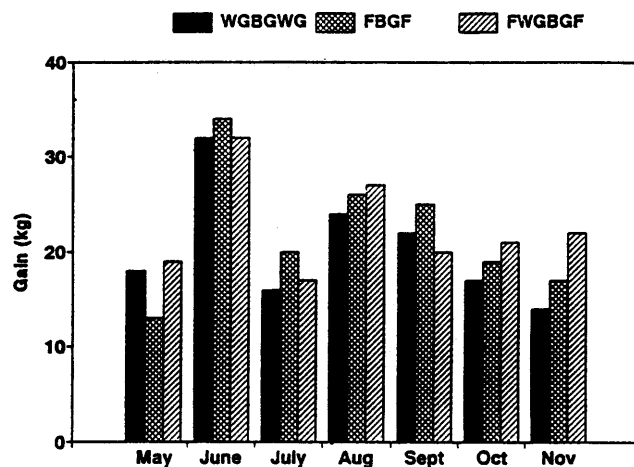


Fig. 4. Animal gains of seasonal rotation groups by 28-d intervals during 1989 (May 3-November 15).

Group 3 consistently made greater gains, while steers in Group 1 experienced the lowest gains.

Forage DMY for the cool-season pastures was examined by 28-d intervals and total in the spring and fall. In the first 28 d of the spring period (May 2-May 31), wheatgrass produced more herbage than tall fescue ($P < .05$; table 5). Although not different ($P > .10$), wheatgrass tended to produce more herbage than fescue during the second 28-d period. Forage production throughout the spring period (May 2-June 28) was greater ($P < .05$) for wheatgrass vs tall fescue pastures (4847 vs 2052 kg DM/ha; table 5). No differences in forage DMY were detected between wheatgrass and tall fescue at any time during the fall ($P > .05$; table 6). In the last 28 d of the fall period (October 19-November 14), a negative DMY occurred in the tall fescue pastures. This indicates a substantial decrease in forage production in late fall, and is most likely due to cold evening temperatures and the onset of winter dormancy. Trends in forage production similar to the spring were observed in the fall. Forage DMY tended to be greater for wheat-

Table 5. Dry matter yield of Jose tall wheatgrass and Johnstone tall fescue pastures for spring 1989.

Period	Grass ^a		SE ^f	OSL ^g
	Wheatgrass	Fescue		
5/2–5/31 ^b	2758 ^d	837 ^c	291	.04
5/31–6/28 ^b	2089	1215	245	.13
5/2–6/28 ^c	4847 ^d	2052 ^c	163	.01

^aUnits measured in kg dry matter per ha.

^bDry matter yield by 28-d periods.

^cFull season dry matter yield.

^dValues with different superscripts differ ($P < .05$).

^fStandard error ($n = 12$).

^gObserved significance level.

Table 6. Dry matter yield of Jose tall wheatgrass and Johnstone tall fescue pastures for fall 1989.

Period	Pasture ^{ab}		SE ^f	OSL ^g
	Wheatgrass	Fescue		
9/20–10/19 ^c	970	1757	292	.20
10/19–11/14 ^c	237	-1544	530	.15
9/20–11/14 ^d	1207	331	638	.46

^aUnits measured in kg dry matter per ha.

^bRow values do not differ ($P > .10$).

^cDry matter yield by 28-d periods.

^dFull season dry matter yield.

^eStandard error ($n = 12$).

^fObserved significance level.

grass vs tall fescue (1207 vs 331 kg DM/ha). Fig. 5 indicates the comparison of forage DMY during the spring and fall for wheatgrass and tall fescue. Both cool-season grasses produced substantially more forage in the spring than in the fall ($P < .05$).

Although no differences ($P > .10$) were observed in animal performance among rotation groups, steers grazing tall fescue pastures in the fall had slightly greater gains. Wheatgrass pastures produced more forage than tall fescue in the spring and fall. This suggests a greater nutritive value for tall fescue during the fall compared to wheatgrass. It was apparent that tall fescue pastures produced enough forage to sustain the imposed stocking rate. However, greater beef production per ha may be possible grazing wheatgrass pastures, because of the apparent ability of this grass to produce greater amounts of forage.

Experiment 2, 1990

Winter. Steers grazing winter wheat had greater ($P < .05$) ADG and total gain than steers grazing rangeland pastures (table 7). Because the rangeland pastures were primarily warm-season grasses, forage available to steers consisted predominantly of dormant grass species. Therefore, it is not surprising that steers grazing winter wheat

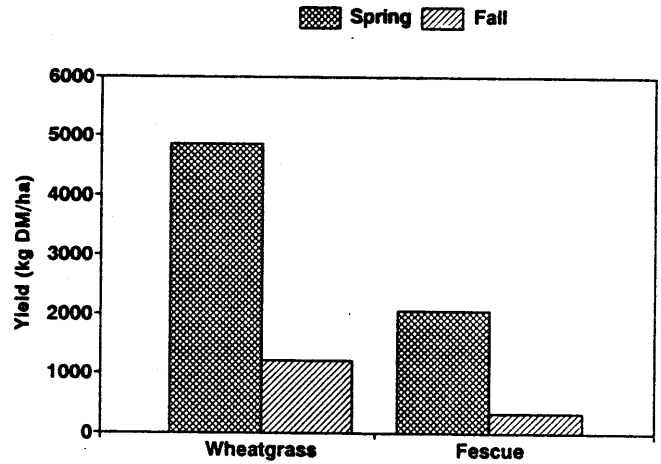


Fig. 5. Forage dry matter yield of Jose tall wheatgrass and Johnstone tall fescue for spring and fall 1989.

Table 7. Gains of steers grazing winter wheat and rangeland pastures for winter 1990 (119 days).

Item	Pasture		SE ^c
	Wheat	Range	
ADG (kg)	.76 ^a	.07 ^b	.04
Gain (kg)	90 ^a	8 ^b	4.7

^{ab}Row values with different superscripts differ ($P < .05$).

^cStandard error ($n = 8$).

had much higher gains than steers grazing rangeland pastures. In fact, steers on rangeland pastures only maintained their initial weight, which suggests a low-quality diet, even though limited protein supplementation did occur.

Spring. Animal performance data were compared only for steers grazing cool-season pastures simultaneously (i.e., April 10–May 30), even though steers grazing wheatgrass pastures remained on these pastures for an additional 28 d. Animal performance was not different among steers grazing tall fescue, wheatgrass, or rangeland pastures during the spring grazing period ($P > .05$; table 8). Forage DMY, however, was considerably greater ($P < .05$) for wheatgrass than tall fescue (4993, 1637 kg DM/ha; table 8). Apparent utilization of cool-season pastures was similar ($P > .10$), although tall fescue pastures tended to be more highly utilized than wheatgrass pastures (55, 33 %). This would be expected because of the lower DMY on the tall fescue pastures. Steers grazing tall fescue pastures were moved to warm-season (bermudagrass) pastures 28 d earlier than steers grazing wheatgrass because tall fescue pastures were low yielding and could not support grazing with acceptable gains for the additional 28 d. At the same time, bermudagrass pastures were growing rapidly and could

Table 8. Steer gain, forage dry matter yield, and apparent utilization of Johnstone tall fescue, Jose tall wheatgrass, and rangeland pastures for spring 1990 (77 days).

Item ^a	Pasture			SE	n
	Fescue	Wheatgrass	Range		
ADG (kg)	.74	.78	.70	.05	8
Gain (kg)	36	38	34	2.6	8
Yield (kg/ha)	1637 ^c	4993 ^b	-	554	12
Utilization (%)	55	33	-	10.5	12

^aYield expressed as kg of forage dry matter per ha.

^{b,c}Row values with different superscripts differ ($P < .05$).

sustain grazing. At this time, wheatgrass pastures still had abundant available forage; therefore steers were allowed to graze these pastures for a longer period.

Summer. Steer performance was again compared when steers were only grazing warm-season pastures simultaneously. Performances of steers grazing bermudagrass, bluestem, and rangeland pastures were similar ($P > .05$), although steers grazing bluestem tended to gain less (59 kg) than steers grazing bermudagrass (72 kg) and rangeland (72 kg; table 9). Bermudagrass pastures produced almost twice as much forage as bluestem ($P < .05$; table 9). Apparent utilization of bermudagrass was also increased ($P < .10$) over that of bluestem pastures (68 vs 27 %). This was the first grazing year for the bluestem pastures, as these pastures were established one year later than the bermudagrass pastures. Grazing pressure was intentionally reduced to ensure stand establishment, therefore these data may not reflect the true yielding potential of the bluestem pastures. As mentioned earlier, rangeland pastures were primarily warm-season grasses. With a variety of warm-season grasses the steers may have had the opportunity to select a higher-quality diet, which is also reflected in the steers ADG and total gain.

Table 9. Steer gain, forage dry matter yield and apparent utilization of Hardie bermudagrass, Ironmaster oldworld bluestem, and rangeland pastures for summer 1990 (98 days).

Item ^a	Pasture			SE	n	OSL ^d
	Bermudagrass	Bluestem	Range			
ADG (kg)	.74	.61	.74	.04	8	.11
Gain (kg)	72	59	72	4.2	8	.11
Yield (kg/ha)	8451 ^b	4837 ^c	-	563	12	<.01
Utilization (kg)	68 ^b	27 ^c	-	13.6	12	.07

^aYield expressed as kg of forage dry matter per ha.

^{b,c}Row values with different superscripts differ ($P < .10$).

^dObserved significance level.

Fall. Differences in steer performance were observed among tall fescue, wheatgrass, and rangeland pastures ($P < .05$). Steers grazing tall fescue had the highest ADG, followed by those on wheatgrass and rangeland pastures (.63, .47, .31 kg, respectively; table 10). These findings agree with Wallace and Williams (1979) who reported animal performance favored tall fescue over wheatgrass. Also, because rangeland pastures primarily comprised warm-season grasses, a decline in animal performance would be expected. Forage DMY was similar ($P > .10$) between tall fescue and wheatgrass, although strong tendencies were observed for greater forage production from the wheatgrass pastures. Tall fescue pastures were more highly utilized than wheatgrass pastures ($P < .05$; table 10). These observations agree with results from Experiment 1, where wheatgrass produced more DMY than tall fescue pastures.

Over seasons. Animal gains for the three rotation groups over the year are shown in table 11. Steers in Group 2 had higher gains ($P < .10$) than steers in Groups 1 and 3. Greater gains were made by steers grazing tall fescue (Group 2) during the fall grazing period, which appears to be the season when differences among rotation groups became evident. Although steers in Group 3 (range) had poor gains in the winter and fall, they gained well in the spring and summer grazing seasons. These

Table 10. Steer gain, forage dry matter yield, and apparent utilization of Johnstone tall fescue, Jose tall wheatgrass, and rangeland pastures for fall 1990 (70 days).

Item ^a	Pasture			SE	n	OSL ^c
	Fescue	Wheatgrass	Range			
ADG (kg)	.63 ^b	.47 ^c	.31 ^d	.04	8	.09
Gain (kg)	45 ^b	33 ^c	22 ^d	3.9	8	.09
Yield (kg/ha)	651	1036	-	382	12	.49
Utilization (%)	74 ^b	55 ^c	-	4.4	12	.02

^aYield expressed as kg of forage dry matter per ha.

^{b,c,d}Row values with different superscripts differ ($P < .10$).

^cObserved significance level.

Table 11. Gains for steers in the three seasonal rotation groups for spring, summer, and fall, 1990.

Item	Rotation groups ^a			SE ^d
	Group 1	Group 2	Group 3	
Total Gain (kg)	156 ^c	180 ^b	142 ^c	6

^aGroup 1 grazed Jose wheatgrass (spring), Ironmaster oldworld bluestem (summer), and Jose wheatgrass in fall; Group 2 grazed Johnstone tall fescue (spring), Hardie bermudagrass (summer), and Johnstone tall fescue in fall; Group 3 grazed rangeland pastures during each season.

^{b,c}Row values with different superscripts differ ($P < .10$).

^dStandard error (n = 4).

steers may have experienced some compensatory gain during the warm season grazing periods, when their diet quality was considerably higher. Fig. 6 illustrates the difference in DMY of wheatgrass and tall fescue between the spring and fall. Large differences were observed, with both grasses producing greater quantities of forage during the spring season ($P < .05$).

Experiment 3, 1991

Spring. Average daily gains for steers grazing either wheatgrass or tall fescue were not different ($P > .05$). Total gain for the spring period tended to be higher for steers grazing wheatgrass pastures (table 12) because steers grazed wheatgrass for a longer period (56 d) than tall fescue (28 d). Beef production per ha was markedly

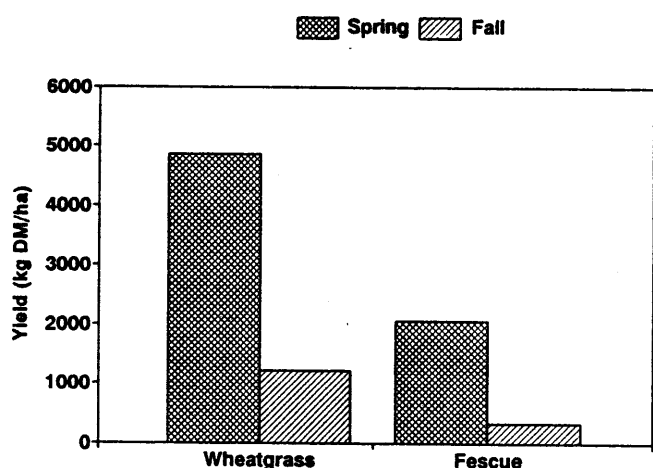


Fig. 6. Forage dry matter yield of Jose tall wheatgrass and Johnstone tall fescue for spring and fall 1990.

Table 12. Steer gain, beef production, forage dry matter yield and apparent utilization of Jose tall wheatgrass and Johnstone tall fescue pastures for spring 1991.^{ab}

Item	Pasture		SE ^c	OSL ^f
	Wheat-grass	Fescue		
Animal gain (kg)	42	23	5.4	.11
ADG (kg)	.85	.81	.2	.85
Beef production (kg/ha)	234 ^c	84 ^d	20.0	.03
Forage yield (kg DM/ha)	2296 ^c	767 ^d	78.3	.02
Utilization (%)	59 ^c	38 ^d	3.7	.06

^aSpring grazing period for wheatgrass pastures = April 10-May 29, while spring grazing period for fescue pastures = May 1-May 29.

^bStocking rates for wheatgrass and fescue pastures were 5.6 and 3.8 steers per ha, respectively.

^{cd}Row values with different superscripts differ ($P < .10$).

^cStandard error (n = 12).

^fObserved significance level.

greater ($P < .05$) for wheatgrass vs tall fescue (234 vs 84 kg/ha). Likewise, forage DMY was substantially higher ($P < .05$) for wheatgrass vs tall fescue pastures (2296 vs 767 kg DM/ha; table 12). Differences in apparent utilization of the wheatgrass and tall fescue pastures were also present. Wheatgrass pastures were utilized more fully ($P < .10$) than tall fescue pastures (59, 38%; table 12), in agreement with Experiments 1 and 2. In all years, wheatgrass produced more DMY than tall fescue. Because forage production on wheatgrass pastures was greater, these pastures were able to accommodate more animals per ha, with greater beef production while maintaining individual ADG at levels similar to previous years when pastures were stocked at a lower rate.

Summer. Steers grazing bermudagrass had greater gains than steers grazing bluestem pastures ($P < .10$). Beef production per ha, however, was similar between bermudagrass and bluestem pastures ($P > .10$; table 13). This can be explained by a higher average stocking rate on the bluestem pastures (8.6 vs 8.0 hd/ha). Individual animal gains in this experiment were similar to steers grazing the same pastures in Experiment 2. However, by using better management strategies, beef production was increased in this experiment by increasing the stocking rate of both pastures. Burns et al. (1984) reported bermudagrass pastures require a heavy stocking rate in order to maintain vegetative growth. Therefore, by increasing the stocking rate it was possible to increase the nutritive quality of these pastures. Forage DMY for the summer period was greater ($P < .05$) for bermudagrass vs bluestem pastures (11477 vs 10019 kg/DM/ha; table 13). These results, coupled with those of Experiment 2, indicate bermudagrass has a greater capacity for forage production.

Table 13. Steer gain, beef production, forage dry matter yield, and apparent utilization of Hardie bermudagrass and Ironmaster oldworld bluestem pastures for summer 1991.^{ab}

Item	Pasture		SE ^c
	Bermuda-grass	Blue-Bluestem	
Animal gain (kg)	91 ^c	80 ^d	2.7
ADG (kg)	.73 ^c	.64 ^d	.02
Beef production (kg/ha)	673	662	26.1
Forage yield (kg DM/ha)	11477 ^c	10019 ^d	169.3
Utilization (%)	79	89	5.8

^aSummer grazing period for bermudagrass and bluestem = May 29-October 2.

^bAverage stocking rate for bermudagrass and bluestem pastures over the summer period = 8.0 and 8.6 steers per ha, respectively.

^{cd}Row values with different superscripts differ ($P < .10$).

^cStandard error (n = 12).

Fig. 7 illustrates DMY of the warm-season pastures by 28-d periods. Bermudagrass tended ($P > .10$) to produce more DMY than bluestem in the first 28 d of the summer. In the second month of summer, no differences ($P > .10$) were observed in DMY. In the third month, bermudagrass produced more forage than bluestem ($P < .10$), and no differences were observed ($P > .10$) in the final 28 d of summer.

Steer weight gains by 28-d periods are shown in fig. 8. Steers on bermudagrass and bluestem made their highest gains during the first 28-d of summer. During the second 28-d period in summer, animal gains decreased on both bermudagrass and bluestem, probably a result of increased ambient temperatures. Steer gains remained relatively constant throughout the remainder of the summer. No differences ($P > .10$) were noted between steers grazing bermudagrass or bluestem for any 28-d interval; however, in the first and third month steers grazing bermudagrass tended to have greater gain. These data correspond to the amount of available forage. In the first and third month of summer, bermudagrass had the highest available forage.

Fall. Total animal gain, ADG, and beef production per ha were similar among steers grazing wheatgrass and tall fescue ($P > .10$; table 14). Wheatgrass pastures had a strong tendency ($P > .10$) to produce more DMY than tall fescue (1150 vs 27 kg DM/ha), although no differences were observed in apparent utilization between wheatgrass and tall fescue (table 14). This agrees with previous results indicating wheatgrass has an inherent ability to produce greater amounts of forage than tall fescue.

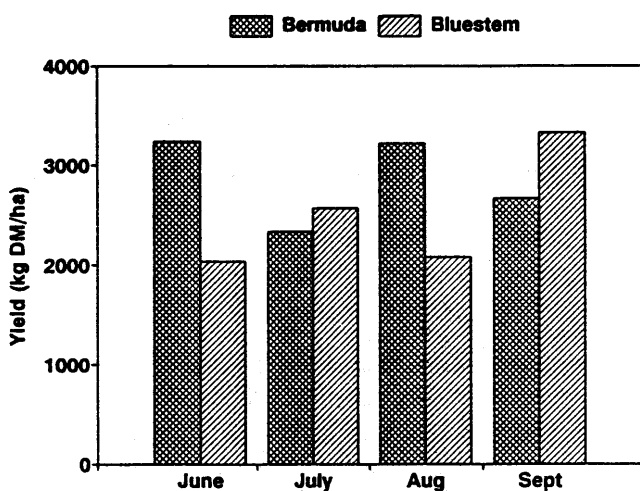


Fig. 7. Forage dry matter yield by month of Hardie bermudagrass and Ironmaster oldworld bluestem for summer 1991.

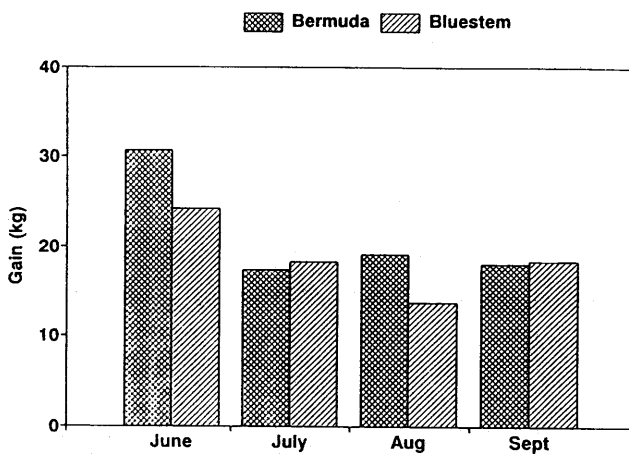


Fig. 8. Gains by month of steers grazing Hardie bermudagrass and Ironmaster oldworld bluestem for summer 1991.

Table 14. Steer gain, beef production, forage dry matter yield and apparent utilization of Jose tall wheatgrass and Johnstone tall fescue pastures for fall 1991.^{ab}

Item	Pasture ^c		SE ^e	OSL ^f
	Wheatgrass	Fescue		
Animal gain (kg)	27	26	4.5	.87
ADG (kg)	.38	.36	.1	.87
Beef production (kg/ha)	99	95	16.6	.87
Forage yield (kg DM/ha)	1150	27	390	.18
Utilization (%)	61	68	5.3	.44

^aFall grazing period = October 2-December 11.

^bStocking rate for both pasture types = 3.8 steers per ha.

^cRow values do not differ ($P > .10$).

^dStandard error (n = 12).

^eObserved significance level.

Fig. 9 illustrates forage DMY for wheatgrass and tall fescue at 28-d intervals for the fall grazing period. Although not different ($P > .10$), wheatgrass produced more forage than tall fescue at each 28-d interval. Forage production also declined dramatically during the last 28 d of the fall period, indicating the beginning of winter dormancy.

In the first 14 d of the fall period, steers grazing wheatgrass gained more ($P < .10$) than steers on tall fescue. In the following 28-d periods no differences in animal gain occurred ($P > .10$) between steers grazing wheatgrass and tall fescue, even though steers grazing tall fescue did gain slightly more than steers on wheatgrass (fig. 10).

Over seasons. Examination of DMY during the spring vs fall of wheatgrass and tall fescue revealed differences

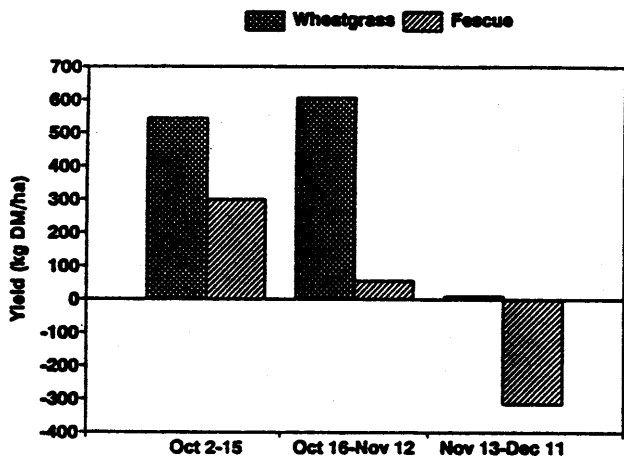


Fig. 9. Forage dry matter yield by month of Jose tall wheatgrass and Johnstone tall fescue for fall 1991.

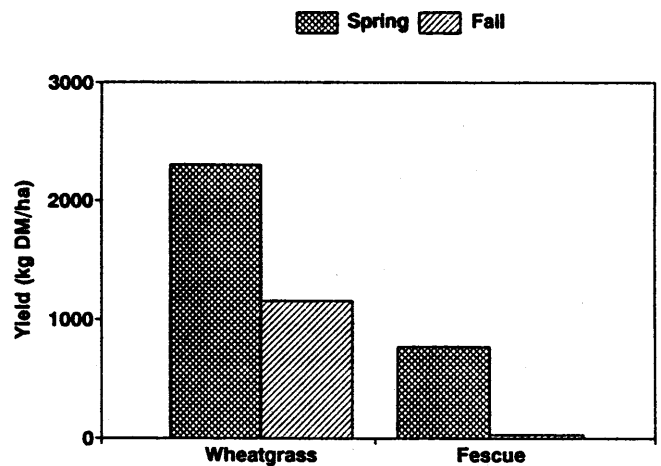


Fig. 11. Dry matter yield of Jose tall wheatgrass and Johnstone tall fescue for spring and fall 1991.

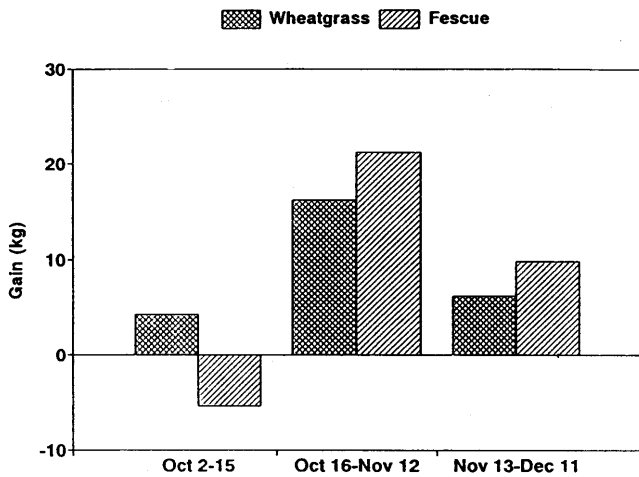


Fig. 10. Gain by month for steers grazing Jose tall wheatgrass and Johnstone tall fescue for fall 1991.

Table 15. Gains for steers in the two seasonal rotation groups for spring, summer, and fall 1991.

Item ^c	Rotation Groups ^{ab}		SE ^d
	Group 1	Group 2	
Total gain (kg)	129	137	3.1
ADG (kg)	.59	.63	.01

^aGroup 1 grazed Jose tall wheatgrass (spring), Ironmaster oldworld bluestem (summer), and Jose tall wheatgrass in the fall; Group 2 grazed Johnstone tall fescue (spring), Hardie bermudagrass (summer), and Johnstone tall fescue in the fall.

^bRow values do not differ ($P > .10$).

^cAnimal performance based on 217 d on trial.

^dStandard error ($n = 12$).

in seasonal production of each pasture type. Wheatgrass and tall fescue produced more forage ($P < .10$) in the spring than in the fall (fig. 11).

Animal performance for the two rotation groups over the spring, summer, and fall did not differ ($P > .10$; table 15). Steers in Groups 1 and 2 had their highest rates of gain in the spring season (fig. 12). In the summer, steer gains in both groups declined, and rate of gain fluctuated for the rest of the trial. Differences in rate of gain were observed during the fourth 28-d period, with steers in Group 2 gaining more ($P < .10$) than steers in Group 1 (fig. 12).

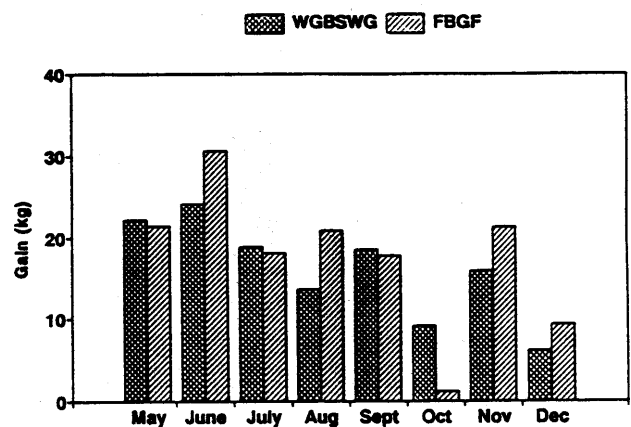


Fig. 12. Gains by month for steers in the seasonal rotation groups for spring, summer, and fall 1991.

CONCLUSIONS

Year-long animal management strategies utilizing cool- and warm-season grasses can result in greater animal gains and beef production per ha over continuous year-long grazing of rangeland pastures. Wheatgrass has an inherent ability to produce greater amounts of forage than fescue in the spring, as well as fall. This greater forage production allows for increased beef production per ha, while maintaining individual animal gains at an acceptable level. Jose tall wheatgrass pastures must be stocked at levels great enough to prevent growth from becoming stemmy and rank. Johnstone tall fescue did not yield an acceptable level of forage and therefore would not be recommended for grazing purposes. Hardie bermudagrass was superior to Ironmaster oldworld bluestem in terms of forage yield. Both warm-season grasses have the potential to produce an acceptable amount of forage. Imposed management practices should provide enough animals to maintain grasses in an actively growing, vegetative stage to maintain maximum animal production.

These experiments indicate the best seasonal rotation system would be grazing Jose tall wheatgrass in the spring and fall, and Hardie bermudagrass in the summer. These two grasses demonstrated greater production potential and have the ability to produce more beef per ha without sacrificing individual animal performance.

The rangeland pastures proved to be of good quality, and acceptable animal gains were made in the spring and summer. This implies that rangeland pastures can be used in conjunction with introduced species to provide quality grazing, i.e., introduced pasture grasses can be used to reduce pressure on native range. Management systems that can utilize existing rangeland pastures when quality is high, and use introduced pasture when rangeland quality is low (winter, fall), could prove to be an economical alternative, especially with regard to cow/calf performance.

Future research on these and other introduced grasses should define stocking limits and forage quality of different grasses more fully under different management strategies. Further research needs to be done to determine the economic feasibility of different animal/pasture management systems.

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APPENDIX A CONVERSION EQUIVALENTS

$$\text{kg/ha} \times .9 = \text{lb/ac}$$

$$\text{kg} \times 2.2 = \text{lb}$$

$$\text{ha} \times 2.5 = \text{ac}$$

$$\text{cm} \times 2.5 = \text{in.}$$

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July 1995

Las Cruces, NM
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