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Season-long grazing of seeded cool-season pastures in the Northern Great Plains

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Abstract

In the semi-arid Northern Great Plains, seeded cool-season grasses are primarily recommended for spring and fall grazing because their nutritive quality is perceived as too low to support acceptable animal weight gains during mid-summer. This perception is caused in part by traditional use of high spring stocking rates, which leave little forage remaining for mid-summer use. A study was conducted near Mandan, N.D. to determine the effect of moderate (1.6 AUM ha^{-1}) and heavy (2.4 AUM ha^{-1}) stocking rates on weight gains of yearling Hereford steers grazing crested wheatgrass (*Agropyron desertorum* [Fisch. Ex Link] Schult.), western wheatgrass (*Pascopyrum smithii* [Rydb.] Löve), smooth bromegrass (*Bromus inermis* Leyss.) and flat (class II and III) and rolling (class IV and VI) native rangelands. Studies were conducted over a 140-day grazing season during 3 summers from 1992–1994. Grazing was initiated in mid-May and terminated the last week of September or the first week of October each year. At the end of each grazing season forage samples were clipped inside and outside of cages randomly located in each pasture to estimate end of season standing crop and forage utilization. Animal activity data were collected for 9 days during August and September 1994. Steer weight gains were not different among crested wheatgrass, western wheatgrass, smooth bromegrass and flat native pastures, but weight gains of steers grazing rolling native pastures were lower (P<0.05) than gains on other pastures. Weight gains per steer were 8% higher (P<0.05) on moderately grazed pastures, but weight gains per hectare were 39% higher on heavy grazed pastures. Steers spent more (P<0.05) time grazing on smooth bromegrass than western wheatgrass, crested wheatgrass, or flat native pastures and they also spent more (P<0.05) time grazing on heavy than moderately grazed pastures. Seeded cool-season grasses produced season-long yearling steer weight gains comparable to flat native, and superior to rolling native pastures, even when grazed at a stocking rate that was 80% heavier than the rate recommended for native rangeland by the USDA-SCS (1984). These results suggest that seeded cool-season grasses can be successfully grazed season-long in the Northern Great Plains where environmental conditions and precipitation patterns are comparable to central North Dakota.

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Resumen

En la región semiárida de las Grandes Planicies del Noreste, los zacates de crecimiento invernal son recomendados principalmente para el apacentamiento de primavera y otoño porque se percibe que su calidad nutritiva es muy baja para producir ganancias de peso animal aceptables a mediados del verano. Esta percepción es causada, en parte, por el uso tradicional de altas cargas animal en primavera, lo cual deja poco forraje remanente para utilizar a mediados del verano. Se condujo un estudio cerca de Mandan, N.D. para determinar el efecto de la carga animal moderada (1.6 UAM ha^{-1}) y alta (2.4 UAM ha^{-1}) en las ganancias de peso de novillos de año raza herford apacentando "crested wheatgrass" (*Agropyron desertorum* [Fish. Ex Link] Schult), "western wheatgrass" (*Pascopyrum smithii* [Rybd]Löve), "smooth bromegrass" (*Bromus inermis* Leyss.) en pastizales nativos planos (clase II y III) y ondulados (clase IV y VI). Los estudios se realizaron durante 3 veranos, de 1992 a 1994, y la estación de apacentamiento fue de 140 días. El apacentamiento fue iniciado a mediados de mayo y terminado la última semana de septiembre o la primera de octubre. Al final de la estación de apacentamiento se cortaron muestras de forraje fuera y dentro de jaulas localizadas aleatoriamente en cada potrero, esto con el fin de determinar la biomasa en pie al final de la estación de crecimiento y la utilización del forraje. Durante 9 días, entre agosto y septiembre de 1994, se tomaron datos de actividad animal. Las ganancias de peso de los novillos no difirieron "crested wheatgrass", "western wheatgrass", "smooth bromegrass" y pastizales planos. Sin embargo, las ganancias de peso de los novillos apacentando pastizales ondulados fueron menores (P<0.05) que las ganancias obtenidas en otros potreros. Las ganancias por novillo fueron 8% mayores (P<0.05) en los potreros con carga animal moderada, pero las ganancias por hectárea fueron 39% mayores en los potreros con carga alta. Los novillos pasaron mas tiempo (P<0.05) apacentando "smooth bromegrass" que "western wheatgrass", "crested wheatgrass o pastizales planos. Los novillos de la carga alta pasaron mas tiempo apacentando que los de la carga moderada. Los zacates de crecimiento invernal produjeron ganancias de peso comparables a las obtenidas en pastizales planos y superiores a la de los ondulados, aun cuando fueron apacentados con una carga animal 80% mayor a la recomendada por el USDA-SCS (1984) para pastizales nativos. Estos resultados sugieren que en las Grandes Planicies de Noreste, donde las condiciones ambientales y patrones de precipitación son comparables a los de la región central de North Dakota, los zacates invernales pueden ser exitosamente pastoreados a lo largo de la estación.

Key Words: native rangelands, seasonality, crested wheatgrass, smooth bromegrass, western wheatgrass

Seeded cool-season grasses are usually recommended for spring or fall grazing in the Northern Great Plains because it is widely believed that their nutritive quality in mid-summer is too low to support adequate livestock weight gains. This pattern of use was first suggested by Sarvis (1941) and Williams and Post (1945), when they suggested that crested wheatgrass and smooth bromegrass were best used in the spring when they provided nutritious forage for grazing 2–3 weeks earlier than native grasses. They also indicated these grasses should be completely utilized by about 1 July. Rogler et al. (1962) reported that "most cool-season grasses lose quality rapidly after heading in late June". Nevertheless, both Sarvis (1941) and Williams and Post (1945) demonstrated that crested wheatgrass and smooth bromegrass could be grazed season-long and produce animal weight gains comparable to native range. Heavy stocking rates and early starting dates were used by Williams and Post (1945), thus grazing periods ranged from 79 to 180 days for crested wheatgrass and 69-160 days for smooth bromegrass depending on yearly precipitation patterns. Because producers needed a dependable summer-long forage supply, the practice of fully utilizing cool-season grasses in spring, followed by grazing native rangeland in summer was adopted. Later Frischknecht et al. (1953) suggested that crested wheatgrass could also be used for fall grazing, if regrowth was adequate. In the 1970's extensive coal mining in the Northern Great Plains (Ries et al. 1977) brought the related need to stabilize reclaimed land with perennial grasses. Before mining, about 51% of this land was in native rangelands and used for grazing. Reseeding mined land to native grass mixtures was expensive, slow, and difficult, while introduced cool-season grasses could be more readily established at lower cost and grazed more quickly after seeding. Hofmann and Ries (1989) using moderate stocking rates based on recommendations resulting from lessons learned in the 1930's drought (Dyksterhuis 1949), found that cool-season grasses could be grazed season-long (126 days) on reclaimed mined land in central North Dakota. Hofmann et al. (1993) also demonstrated that cool-season grasses seeded on non-mined land and grazed at the same season-long (133 days) stocking rate as native range produced comparable yearling steer weight gains. In that study both cool-season and native pastures were stocked at 1.5 AUM ha^{-1}, which was 15% greater than the USDA-SCS (1984) recommended stocking rate for native range in this area. However, forage utilization rates were only 30–40%, indicating that a higher stocking rate might be warranted. The objective of the study reported here was to determine the effect of moderate (1.6) and heavy (2.4 AUM ha^{-1}) season-long (140 days) stocking rates on forage utilization and the performance of yearling steers grazing crested wheatgrass, western wheatgrass, smooth bromegrass, and flat and rolling native range.

Materials and Methods

Grazing studies were conducted near Mandan, North Dakota for 140 days each summer from 1992–1994. Grazing periods were from 14 May to 30 September 1992; 20 May to 6 October 1993; and 19 May to 5 October 1994. Seeded species were 'Nordan' crested wheatgrass (*Agropyron desertorum* [Fisch. Ex Link] Schult.), 'Rodan' western wheatgrass (*Pascopyrum smithii* [Rydb.] Löve), and 'Lincoln' smooth bromegrass (*Bromus inermis* Leyss.). Native pastures were located on adjacent class II and III, 2–6% slope (flat native) and class IV and VI, 9–25% slope (rolling native) land. Seeded and native pastures included 2 replications at both moderate and heavy stocking rates. Seeded pastures were established on fine-silty, mixed Pachic Haploborolls and fine-silty mixed Typic Haploborolls soils. Flat native pastures were located on soils comparable to the seeded pastures, but rolling pastures were located on loam, silt loam, and silty clay Entic and Typic Haploborolls soils.

The 73 ha of land to be seeded was divided into 6.1 ha plots and randomly seeded to 1 of the 3 cool-season grasses by no-till seeding into spring wheat stubble (*Triticum aestivum* L.) in the fall of 1985 (Hofmann et al. 1993). Four, 6.1 ha plots were fenced on both flat and rolling native rangelands (Hofmann et al. 1993). In the current study there were 5 pasture treatments, 2 stocking rates and 2 replications of each pasture treatment by stocking rate combination for a total of twenty pastures. Stocking rates were established by adjusting pasture size to 5.7 and 3.8 ha for moderate and heavy stocking rates, respectively.

Pastures were stocked with 3 Hereford steers (*Bos taurus*) weighing approximately 294 kg at the beginning of each grazing season. Due to limited forage utilization (30–42%) in the previous study (Hofmann et al. 1993) stocking rates of 1.6 (moderate), and 2.4 AUM ha^{-1} (heavy) were established. None of the pastures were fertilized for at least 10 years before the current study was initiated in 1992, and pastures received no fertilizer during this study.

Rolling and flat native pastures differed in species composition as well as topography. Flat native pastures contained blue grama (*Bouteloua gracilis* [H.B.K.] Griffiths), green needlegrass (*S. viridula* Trin.), needleandthread (*Stipa comata* Trin. and Rupr.), western wheatgrass, sedges (Carex spp.), threeawn (*Aristida* spp.) and Kentucky bluegrass (*Poa pratensis* L.). Rolling native pastures contained the same species as flat native pastures plus little bluestem (*Schizachyrium scoparium* [Michaux]

Table 1. Precipitation (mm) and mean monthly ambient air temperatures (C) between April and October for 1992–1994 and the 80-year average.

	1992		1993		1994		80-yr avg	
Month	Precip.	Temp.	Precip.	Temp.	Precip.	Temp.	Precip.	Temp.
April	8	6	36	6	31	6	38	6
May	38	15	69	13	18	16	58	12
June	117	17	114	16	71	19	89	18
July	69	17	343	18	48	19	56	21
August	41	17	48	19	5	19	51	21
Sept	23	13	5	12	69	16	41	14
Oct	5	7	0	6	147	9	20	8
Total	301		615		389		353	

Table 2. Pasture means averaged over stocking rate and years for end of season standing crop (standing crop), forage utilization, and yearling steer weight gains for 140-day grazing seasons in 1992–1994)[1].

Pasture	Standing Crop		Utilization	Steer performance		
	Ungrazed	Grazed		Gain steer^{-1}	ADG	Gain ha^{-1}
	---------(kg ha^{-1})---------		(%)	----------(kg)----------		
Smooth bromegrass	2,898^{d}	1,946^{b}	31^{a}	143^{a}	1.02^{a}	93^{a}
Western wheatgrass	5,018^{a}	3,476^{a}	28^{a}	141^{a}	1.01^{a}	91^{a}
Crested wheatgrass	4,367^{b}	3,164^{a}	27^{a}	136^{a}	0.97^{a}	89^{a}
Flat native	3,885^{bc}	3,134^{a}	19^{a}	131^{a}	0.94^{a}	86^{a}
Rolling native	3,371^{cd}	2,470^{b}	25^{a}	115^{b}	0.82^{b}	75^{b}
SE	202	175	3	4.5	0.03	3.2

[1]Means within a column with different letters differ (P<0.05).

Nash) and patches of western snowberry (*Symphoricarpos occidentalis* Hook), and buffaloberry (*Shepherdia argentea* [Pursh] Nutt.).

End of the grazing season standing crop was estimated by hand clipping forage at a 5 mm stubble height from 36 by 36-cm plots, randomly located inside 0.9 by 4.3-m cages used to prevent grazing. Similar procedures were used to collect forage samples at random locations outside of each cage to estimate the amount of residual forage where grazing occurred. Samples were clipped far enough from cages to eliminate any animal-cage effects. One sample was clipped from both inside and outside of each cage and cages were relocated each year. Three cages were randomly located in each seeded pasture, 4 cages in each flat native, and 5 cages in each rolling native pasture. More cages were located in native pastures because of the diversity of vegetation. Forage samples were dried at 60°C and used to calculate end of season standing crop dry matter (DM), and grazed residue per hectare. Forage utilization was calculated as follows: Utilization (%)=[(end of season standing crop DM (within cage samples)-grazed residue DM (outside of cage samples))/end of season standing crop DM (within cage samples)] x 100.

Steers were weighed following an overnight stand without feed or water at the beginning and end of each study and at 21-day intervals during the studies. Trace mineralized salt containing 96-98.5% salt, 0.35% zinc, 0.34% iron, 0.20% manganese, 0.033% copper, 0.007% iodine, and 0.005% cobalt (Akzo Salt, Inc., Clarks Summit, Penn.) was available at all times.

In 1994 steer activities on smooth bromegrass, western wheatgrass, crested wheatgrass, and flat native pastures were observed every 20 minutes from dawn to dusk for 9 days in August and September. All treatments were observed on the same days. Time spent grazing, lying, standing, walking, playing, scratching, salting and drinking were recorded, and the percent of the total daily observation time spent in these activities was calculated. Walking, playing, scratching, salting, and drinking were minor activities which occupied little time and thus were grouped and analyzed as all other activities.

Daily precipitation and ambient minimum and maximum air temperatures were recorded at a weather station located about 3.2 km north of the study site. Monthly precipitation totals and mean monthly temperatures (minimum and maximum) were calculated and compared to historic values (Table 1).

Data were analyzed by analysis of variance according to a completely randomized design. Pasture treatment, stocking rate and pasture treatment x stocking rate were tested using replicate(pasture treatment x stocking rate) as the test term. Year, pasture treatment x year, stocking rate x year, and pasture treatment x stocking rate x year were tested using year x replication (pasture treatment x stocking rate) as the test term. Data were considered significant at P<0.05 unless otherwise indicated.

Results and Discussion

During this 3-year study, western wheatgrass had the highest average end of season standing crop dry matter per hectare and the greatest amount of grazed residue at the end of the grazing season, while smooth bromegrass had the lowest end of season standing crop dry matter and the least amount of grazed residue (Table 2). There were significant (P<0.05) interactions between pasture treatment and year for both ungrazed and grazed end of season standing crop and utilization rates, indicating that forage production and utilization differences among pasture treatments were not entirely consistent over the 3 years. In a previous study on this site (Hofmann et al. 1993), western wheatgrass was also the most productive and had the most grazed residue at the end of the season, but hilly (rolling) native pastures produced the least end of season standing crop and had the least remaining grazed residue. Despite increased stocking rates, forage utilization over both moderate and heavy treatments in the current study was lower than utilization rates for these pastures reported by Hofmann et al. (1993). Utilization in the current study ranged from 19% for flat native to 31% for smooth bromegrass pastures, but differences among pastures were not significant. Utilization rates were probably lower in the current study because precipitation levels were generally above normal (Table 1), while the earlier study included 2 drought years.

Although smooth bromegrass pastures produced the least forage, steers gained similarly on smooth bromegrass and

Table 3. Stocking rate means for end of season standing crop (standing crop), forage utilization, and yearling steer weight gains averaged over pasture treatments and years for 140-day grazing seasons in 1992–1994[1,2].

Stocking rate	Standing Crop		Utilization	Steer performance		
	Ungrazed	Grazed		Gain steer^{-1}	ADG	Gain ha^{-1}
	---------(kg ha^{-1})---------		(%)	----------(kg)----------		
Moderate	4,223^{a}	3,189^{a}	22^{b}	138^{a}	0.99^{a}	73^{b}
Heavy	3,582^{b}	2,480^{b}	30^{a}	128^{b}	0.92^{b}	101^{a}
SE	129	112	2	2.9	0.02	2

[1]Moderate and heavy stocking rates were 1.6 and 2.4 AUM ha^{-1}, respectively.
[2]Means within a column with different letters differ (P<0.05).

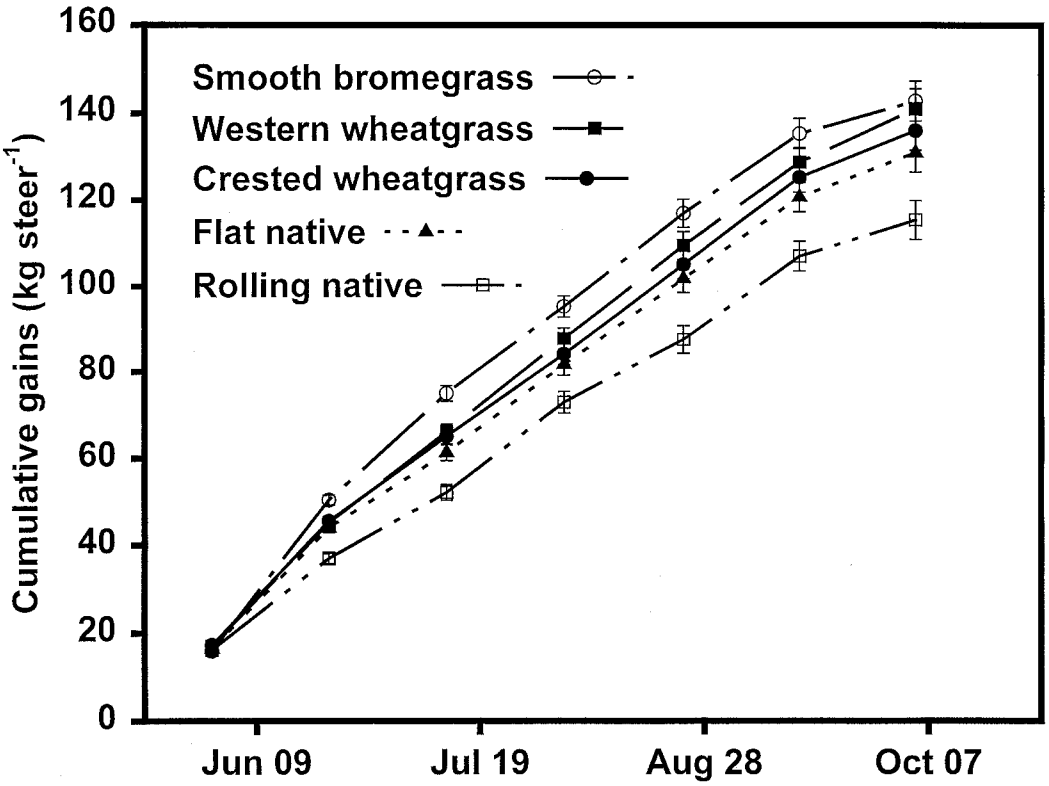

Fig. 1. Three year (1992–1994) average cumulative yearling steer weight gains by weighing period (± SE) for seeded cool-season and flat and rolling native pastures.

western wheatgrass (Table 2). There were no significant (P>0.20) interactions among pasture treatment, stocking rate, or year with regard to animal performance data. Weight gains were not different among seeded cool-season pastures and the flat native treatment, but weight gains were lower for the rolling native treatment. Hofmann et al. (1993) reported that weight gains for the level (flat) native pastures were significantly higher than gains from the seeded cool-season pastures. Differences between the 2 studies suggest that when precipitation is average or above, cool-season grasses support good animal performance, but with drought conditions weight gains from the well established native grasses may be greater.

Three-year-average cumulative weight gains show that beginning with the second weighing period in late June, steers grazing smooth bromegrass tended to have the highest weight gains while steers grazing rolling native pastures had the lowest (Fig. 1). These weight gain differences continued to increase until the end of the season, but cumulative gain differences among the other grasses changed little after mid-July. Although Sarvis (1941) reported season-long average daily gains on smooth bromegrass (0.92 kg) which were comparable to weight gains in this study (Table 2), they sometimes reported large weight losses in August and September which were not encountered in the current study (Fig. 1).

End of season standing crop averaged over all cool-season and native pastures was greater (P<0.05) at the moderate compared to the heavy stocking rate, which suggests the heavier stocking rate may have adversely affected forage production (Table 3). Grazed residue was also greater (P<0.05) on moderately grazed pastures, therefore forage disappearance per hectare through grazing, trampling and deterioration was comparable between moderate and heavy stocking rates at 1,034 and 1,102 kg ha^{-1}, respectively.

Average daily gains were significantly higher (8%) at the moderate compared to the heavy stocking rate, but weight gains per hectare were 39% higher for the heavy stocking rate (Table 3). Cumulative weight gains for moderate and heavy stocking rate treatments averaged over all 3 years did not vary significantly (P<0.11) until mid-July (Fig. 2). From early August until October, steers grazing at the moderate stocking rate had

Table 4. Mean end of year standing crop (standing crop), forage utilization, and yearling steer weight gains averaged over pasture treatment and stocking rates for 140-day grazing seasons in 1992, 1993, and 1994[1].

	Standing Crop		Utilization	Steer performance		
Year	Ungrazed	Grazed		Gain steer^{-1}	ADG	Gain ha^{-1}
	---------(kg ha^{-1})---------		(%)	----------(kg)----------		
1992	3,483^{c}	2,544^{c}	27^{a}	135^{a}	0.96^{a}	88^{a}
1993	3,928^{b}	3,136^{a}	20^{b}	139^{a}	0.99^{a}	91^{a}
1994	4,296^{a}	2,818^{b}	32^{a}	125^{b}	0.89^{b}	82^{b}
SE	120	81	2	2	0.01	1.2

[1]Means within a column with different letters differ (P<0.05).

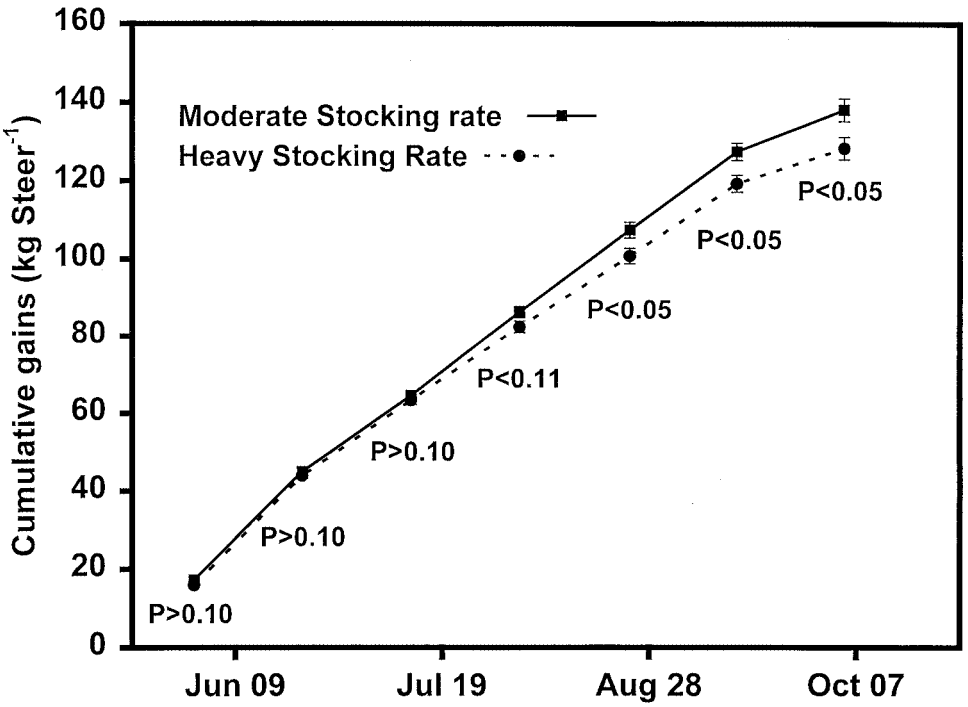

Fig. 2. Three year (1992–1994) average cumulative yearling steer weight gains by weighing period (± SE) for moderate and heavy stocking rates.

progressively higher weight gains than steers grazing at the heavy stocking rate.

Ungrazed end of season standing crop increased significantly from 1992–1994, but the grazed end of season standing crop was lower in 1994 than 1993 (Table 4). Higher ungrazed end of season standing crop each year may have reflected a gradual recovery from the drought of 1988 and 1989 and carry over water from 1993. Lauenroth and Sala (1992) also reported a lag time between increased precipitation and a response in forage production. Forage utilization was highest in 1994, and lowest in the extremely wet year of 1993. End of season grazed and ungrazed standing crop differences between 1993 and 1994 could have been due to less growing season precipitation in 1994, which would have resulted in less forage regrowth and lower grazed end of season standing crop. The high ungrazed end of season standing crop in 1994 probably occurred early in the summer as a result of stored moisture from 1993. It is unlikely that ungrazed end of season standing crop levels were substantially affected by a build up of the previous year's forage growth, because cages were relocated each year.

Steers on smooth bromegrass pastures spent significantly more time grazing than steers on western wheatgrass, crested wheatgrass, or flat native pastures (Table 5). Time utilized in other activities was similar among pastures, but steers grazing smooth bromegrass tended to spend less time lying, standing, and in all other activities compared to steers on the other pastures. Smooth bromegrass pastures produced the lowest dry matter yield, yet steer weight gains were comparable to the other pastures, therefore grazing time may have been greater because steers were exercising a high degree of diet selectivity or because less available forage necessitated increased grazing time. Hardison et al. (1954), Kirby and Stuth (1982), and many others have reported that cattle graze selectively and that they prefer leaves to stems.

Steers spent significantly less time grazing and more time standing on moderately stocked than on heavily stocked pastures (Table 6). Steers on heavily stocked pastures may have spent more time grazing because lower forage production (Table 3) necessitated increased grazing time for them to reach satiety.

Conclusions

Results of this study show that cool-season seeded grasses can be grazed continuously over a 140-day season in the Northern Great Plains, where precipitation and environmental conditions are similar to central North Dakota, and support yearling steer weight gains comparable to good quality native

Table 5. Percentage of observation time steers were engaged in various activities during dawn to dusk observation for 9 days in August and September 1994[1].

Pasture	ACTIVITY			
	Grazing	Lying	Standing	All Other
	(%)			
Smooth bromegrass	64[a]	26[a]	7[a]	3[a]
Western wheatgrass	57[b]	31[a]	9[a]	4[a]
Crested wheatgrass	59[b]	30[a]	7[a]	4[a]
Flat native	58[b]	28[a]	10[a]	4[a]
SE	1.1	1.1	0.7	0.3

[1]Means within a column with different letters differ (P<0.05).

Table 6. Effect of stocking rate on the percentage of time steers were engaged in various activities during dawn to dusk observations over 9 days in August and September 1994[1,2].

Stocking rate	ACTIVITY			
	Grazing	Lying	Standing	All Other
	(%)			
Moderate	58[b]	30[a]	9[a]	4[a]
Heavy	61[a]	28[a]	7[b]	4[a]
SE	0.8	0.8	0.5	0.2

[1]Moderate and heavy stocking rates were 1.6 and 2.4 AUM ha^{-1}, respectively.
[2]Means within a column with different letters differ ($P<0.05$).

rangelands and better than more typical rolling rangelands. These data agree with results reported by Hofmann et al. (1993), but do not support the popular management philosophy that cool-season grasses should only be used for spring and fall grazing. Data from this study further indicate that it may be possible to graze cool-season grasses season-long at stocking rates as much as 80% higher than USDA-SCS (1984) recommendations for native range. Acceptable stocking rates will vary according to soil type and precipitation amounts. Good quality native rangelands should not be plowed and reseeded to cool-season grasses, but disturbed lands or marginal croplands can be seeded to cool-season grasses for season-long grazing. Introduced cool-season grass seed is less expensive, the grasses are easier to establish, and they can be grazed sooner after seeding compared to native grass mixtures. Planting introduced cool-season grasses also gives producers the additional flexibility of alternating between small grain and perennial grass production.

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