Cow and Calf Performance as Affected by Grazing Management

Llewellyn L. Manske PhD
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Ran ge Scientist
North Dakota State University
Dickinson Research Extension Center

Introduction

Weight gain performance of cow and calf pairs on grazinglands does not occur at the same rate during the entire grazing season and is affected, within the parameters of the animals' genetic growth potentials, by the quantity and quality of the herbage. These herbage characteristics change on a seasonal pattern of grass growth, maturity, and senescence during the grazing season, but this pattern can be modified by grazing management treatments. The timing and severity of defoliation by grazing determine whether beneficial or harmful effects occur. Grazing can change plant species composition, manipulate some plant and ecosystem processes, and alter levels and rates of plant growth. Changes different grazing treatments cause in the quantity of plant growth and the quality of herbage are important manageable factors affecting cow and calf weight performance.

The purpose of this study is to document and compare cow and calf accumulated weight gain, rate of weight gain per acre, and rate of weight gain per day on pasture-forage types of grazing management systems during the grazing season.

Procedure

This study was conducted at the NDSU Dickinson Research Extension Center, located in western North Dakota. Soils are primarily Typic Haploborolls. Average annual precipitation is 16.1 inches, with 13.6 inches (84.7%) falling as rain between April and October. Mean annual temperature is 40.8°F. January is the coldest month, with a mean temperature of 11.1°F. July and August are the warmest months, with mean temperatures of 68.6°F and 67.0°F, respectively (Manske 2003).

Grazing management systems were evaluated during the grazing season, the period from early May to mid November, when perennial forage plants are growing and biologically active. The 6.5-month (198-day) grazing season was separated into three portions. The spring portion was 31 days from early to late May, the summer portion was 137 days from early June to mid October, and the fall portion was 30 days from mid October to mid November. These three portions of the grazing season coincide with three subdivisions of the lactation production period for cows with calves born during March and early April.

Pasture-forage types were evaluated during the three portions of the grazing season. Each of the grazing treatments had two replications. The native rangeland (NR) pasture-forage type is the Wheatgrass-Needlegrass Vegetation Type (Barker and Whitman 1988) of the mixed grass prairie. The dominant native range species are western wheatgrass, needle and thread, blue grama, and threadleaved sedge. The crested wheatgrass (CW) and Altai wildrye (AW) domesticated grass pasture-forage types were seeded as monocultures, but a small assortment of forbs and other grass species developed as minor components. The cropland aftermath (CA) pasture-forage type consisted primarily of annual cereal residue of oat, barley, and/or chopped corn stubble.

Cow and calf weight performance data were collected on grazing management systems involved in pasture research projects conducted between 1983 and 1998. Commercial crossbred cattle were used on all treatments. Individual animals were weighed on and off each treatment, at 15-day intervals during the early portion of the grazing season, and at 30-day intervals during the latter portion of the grazing season. Weight performance of cows and of calves was calculated for each treatment, and differences between means were analyzed by a standard paired plot t-test (Mosteller and Rourke 1973). Portions of this data set were reported by Manske (1994a, b).

Response surface analysis (Kerlinger and Pedhazur 1973) with a repeated observation design was used to compare animal response curves among native rangeland grazing management treatments. The deferred treatment grazed one pasture from mid July to mid November. The seasonlong treatment grazed one pasture from mid June to late October. The twice-over rotation treatment grazed three pastures in rotation, with each grazed two periods between early June and mid October. Cow and calf mean weights from five years of pasture management research were adjusted to the 8th and 23rd day of each month of the grazing period. Biweekly live weight performance periods of weight gain per day and accumulated weight gain for cows and calves were used to evaluate each grazing management treatment. The response surface analysis curves were reported by Manske et al. (1988).

Grazing Management Systems

6.0-month seasonlong system

The 6.0-month seasonlong (6.0-m SL) management system started grazing in mid May. Livestock were moved to a single native rangeland pasture stocked at 4.04 acres per cow-calf pair per month. Livestock grazed on the pasture for 183 days during the three portions of the grazing season, with 16 days in spring, 137 days in summer, and 30 days in fall, and were removed from the pasture in mid November, when the calves were weaned.

4.5-month seasonlong system

The 4.5-month seasonlong (4.5-m SL) management system started grazing in early May. For the first 31 days, during the spring portion of the grazing season, livestock grazed an unfertilized crested wheatgrass pasture stocked at 1.82 acres per cow-calf pair per month. In early June, livestock were moved to one native rangeland pasture stocked at 2.86 acres per cow-calf pair per month. Livestock grazed this pasture for 137 days, during the summer portion of the grazing season. In mid October they were moved to cropland aftermath stocked at 6.63 acres per cow-calf pair per month. Livestock grazed this pasture-forage type during the fall portion of the grazing season and were removed from the pasture in mid November, when the calves were weaned.

4.0-month deferred system

The 4.0-month deferred (4.0-m Def) management system started grazing in early May. For the first 76 days, during the spring and early summer portions of the grazing season, livestock grazed an unfertilized crested wheatgrass pasture stocked at 1.67 acres per cow-calf pair per month. In mid July the livestock were moved to one native rangeland pasture stocked at 2.22 acres per cow-calf pair per month. Livestock grazed this pasture for 122 days, during late summer and fall portions of the grazing season, and were removed from the pasture in mid November, when the calves were weaned.

4.5-month twice-over rotation system

The 4.5-month twice-over rotation (4.5-m TOR) management system started grazing in early May. For the first 31 days, during the spring portion of the grazing season, livestock grazed a fertilized (50 lbs N/acre applied during the first week of April) crested wheatgrass pasture stocked at 0.75 acres per cow-calf pair per month. The livestock were then moved to one of three native rangeland pastures stocked at 2.04 acres per cow-calf pair per month. Livestock remained on native rangeland for 137 days, during the summer portion of the grazing season, grazing each pasture for two periods, one 15-day period between 1 June and 15 July (when lead tillers of grasses were between the third new leaf stage and flowering stage) and one 30-day period after 15 July (after secondary tillers of grasses reached the third new leaf stage) and prior to mid October. The first pasture grazed in the sequence was the last pasture grazed the previous year. In mid October, the livestock were moved to an Altai wildrye pasture stocked at 1.39 acres per cow-calf pair per month. Livestock grazed this pasture for 30 days, during the fall portion of the grazing season, and were removed from the pasture in mid November, when the calves were weaned.

Results

Length of grazing period for pasture-forage types (table 1) and acres per cow-calf pair (table 1, figure 1) are shown for each grazing management system. Cow performance during the three portions of the grazing season for the grazing management systems is shown in table 2 and figures 2, 3, 4, 5, 6, 7, 11, and 12. Calf performance during the three portions of the grazing season for the grazing management systems is shown in table 3 and figures 2, 3, 4, 8, 9, 10, 13, and 14.

The stocking rate during the 6.5-month grazing season on the twice-over rotation system was 17% greater than the stocking rate on the deferred system, 90% greater than the stocking rate on the 4.5-month seasonlong system, and 135% greater than the stocking rate on the 6.0-month seasonlong system.

Grazing Management Systems

6.0-month seasonlong system

The 6.0-month seasonlong management system comprised a native rangeland pasture grazed from mid May to mid November, with 16 days during spring, 137 days during summer, and 30 days during fall portions of the grazing season. Over the entire grazing season, cows gained an accumulated weight of 21.96 lbs, at a rate of 0.91 lbs per acre and 0.12 lbs per day, and calves gained an accumulated weight of 329.40 lbs, at a rate of 13.59 lbs per acre and 1.80 lbs per day. On the native rangeland pasture, cow weight performance was a gain of 2.30 lbs, at a rate of 1.09 lbs per acre and 0.14 lbs per day, during the spring portion of the grazing season; a gain of 19.66 lbs, at a rate of 1.09 lbs per acre and 0.14 lbs per day, during the summer portion of the grazing season; and a loss of 52.20 lbs, at a rate of 12.90 lbs per acre and 1.74 lbs per day, during the fall portion of the grazing season. On the native rangeland pasture, calf weight performance was a gain of 28.80 lbs, at a rate of 13.64 lbs per acre and 1.80 lbs per day, during the spring portion of the grazing season; a gain of 282.87 lbs, at a rate of 15.63 lbs per acre and 1.80 lbs per day, during the summer portion of the grazing season; and a gain of 17.73 lbs, at a rate of 4.38 lbs per acre and 0.59 lbs per day, during the fall portion of the grazing season.

4.5-month seasonlong system

The 4.5-month seasonlong management system comprised an unfertilized crested wheatgrass pasture grazed from early to late May, a native rangeland pasture grazed from early June to mid October, and a cropland aftermath pasture grazed from mid October to mid November. Over the entire grazing season, cows gained an accumulated weight of 58.86 lbs, at a rate of 2.78 lbs per acre and 0.30 lbs per day. Cow weight performance on individual pasture-forage types was a gain of 60.45 lbs, at a rate of 32.15 lbs per acre and 1.95 lbs per day, on the unfertilized crested wheatgrass pasture; a gain of 46.58 lbs, at a rate of 3.67 lbs per acre and 0.34 lbs per day, on the native rangeland pasture; and a loss of 48.17 lbs, at a rate of 7.27 lbs per acre and 1.61 lbs per day, on the cropland aftermath pasture. Over the entire grazing season, calves gained an accumulated weight of 358.11 lbs, at a rate of 16.88 lbs per acre and 1.81 lbs per day. Calf weight performance on individual pasture-forage types was a gain of 59.21 lbs, at a rate of 31.49 lbs per acre and 1.91 lbs per day, on the unfertilized crested wheatgrass pasture; a gain of 286.33 lbs, at a rate of 22.55 lbs per acre and 2.09 lbs per day, on the native rangeland pasture; and a gain of 12.57 lbs, at a rate of 1.90 lbs per acre and 0.42 lbs per day, on the cropland aftermath pasture.

4.0-month deferred system

The 4.0-month deferred management system comprised an unfertilized crested wheatgrass pasture grazed from early May to mid July and a native rangeland pasture grazed from mid July to mid November. Over the entire grazing season, cows gained an accumulated weight of 76.40 lbs, at a rate of 5.86 lbs per acre and 0.39 lbs per day. Cow weight performance on individual pasture-forage types was a gain of 69.16 lbs, at a rate of 16.63 lbs per acre and 0.91 lbs per day, on the unfertilized crested wheatgrass pasture, and a gain of 29.44 lbs, at a rate of 4.40 lbs per acre and 0.32 lbs per day, on the native rangeland pasture. Cows lost 22.20 lbs, at a rate of 9.96 lbs per acre and 0.74 lbs per day, during the fall portion of the grazing season. Over the entire grazing season, calves gained an accumulated weight of 355.64 lbs, at a rate of 27.27 lbs per acre and 1.80 lbs per day. Calf weight performance on individual pasture-forage types was a gain of 136.04 lbs, at a rate of 32.70 lbs per acre and 1.79 lbs per day, on the unfertilized crested wheatgrass pasture; and a gain of 196.50 lbs, at a rate of 24.73 lbs per acre and 1.80 lbs per day, during the summer portion of the grazing season, and a gain of 23.10 lbs, at a rate of 10.36 lbs per acre and 0.77 lbs per day, during the fall portion of the grazing season, on the native rangeland pasture.

4.5-month twice-over rotation system

The twice-over rotation management system comprised a fertilized crested wheatgrass complementary pasture grazed from early to late May, three native rangeland pastures grazed in rotation from early June to mid October, and an Altai wildrye pasture grazed from mid October to mid November. Over the entire grazing season, cows gained an accumulated weight of 184.52 lbs, at a rate of 16.56 lbs per acre and 0.93 lbs per day. Cow weight performance on individual pasture-forage types was a gain of 83.08 lbs, at a rate of 110.77 lbs per acre and 2.68 lbs per day, on the fertilized crested wheatgrass pasture; a gain of 84.94 lbs, at a rate of 9.44 lbs per acre and 0.62 lbs per day, on the native rangeland pastures; and a gain of 16.50 lbs, at a rate of 11.87 lbs per acre and 0.55 lbs per day, on the Altai wildrye pasture. Over the entire grazing season, calves gained an accumulated weight of 432.12 lbs, at a rate of 37.98 lbs per acre and 2.14 lbs per day. Calf weight performance on individual pasture-forage types was a gain of 67.58 lbs, at a rate of 90.11 lbs per acre and 2.18 lbs per day, on the fertilized crested wheatgrass pasture; a gain of 302.77 lbs, at a rate of 33.64 lbs per acre and 2.21 lbs per day, on the native rangeland pastures; and a gain of 52.77 lbs, at a rate of 37.96 lbs per acre and 1.73 lbs per day, on the Altai wildrye pasture.

Cow and calf weight performance was greater on the twice-over rotation management system than on the traditional management systems. Cow accumulated weight on the twice-over system was 70.5% greater than that on the deferred system, with the rate of gain 99.5% greater per acre and 69.1% greater per day. Cow accumulated weight on the twice-over system was 213.5% greater than that on the 4.5-month seasonlong system, with the rate of gain 495.7% greater per acre and 210.0% greater per day. Cow accumulated weight on the twice-over system was 740.3% greater than that on the 6.0-month seasonlong system, with the rate of gain 1719.8% greater per acre and 675.0% greater per day. Calf accumulated weight on the twice-over system was 19.0% greater than that on the deferred system, with the rate of gain 39.3% greater per acre and 18.9% greater per day. Calf accumulated weight on the twice-over system was 18.2% greater than that on the 4.5-month seasonlong system, with the rate of gain 125.0% greater per acre and 18.2% greater per day. Calf accumulated weight on the twice-over system was 28.5% greater than that on the 6.0-month seasonlong system, with the rate of gain 179.5% greater per acre and 18.9% greater per day.

Pasture-Forage Types

Crested wheatgrass pasture forage

The stocking rate on the crested wheatgrass pasture-forage type of the twice-over rotation system was 122.7% greater than the stocking rate on the crested wheatgrass pasture of the deferred system, 142.6% greater than the stocking rate on the crested wheatgrass pasture of the 4.5-month seasonlong system, and 438.7% greater than the stocking rate on the spring native rangeland pasture-forage type of the 6.0-month seasonlong system.

Cow and calf weight performance was greater on the fertilized crested wheatgrass pasture of the twice-over rotation management system than on the pastures of the traditional management systems grazed during the same time period. Cow accumulated weight was 20.1% greater on the crested wheatgrass pasture of the twice-over system than on the crested wheatgrass pasture of the deferred system; the rate of gain was 566.1% greater per acre and 194.5% greater per day. Cow accumulated weight was 37.4% greater on the crested wheatgrass pasture of the twice-over system than on the crested wheatgrass pasture of the seasonlong system; the rate of gain was 244.5% greater per acre and 37.4% greater per day. Calf accumulated weight was 50.2% lower on the crested wheatgrass pasture of the twice-over system than on the crested wheatgrass pasture of the deferred system because of the difference in the length of the grazing period; however, the rate of gain on the crested wheatgrass pasture of the twice-over system was 175.6% greater per acre and 21.8% greater per day. Calf accumulated weight was 14.1% greater on the crested wheatgrass pasture of the twice-over system than on the crested wheatgrass pasture of the seasonlong system; the rate of gain was 186.2% greater per acre and 14.1% greater per day. Calf accumulated weight was 134.7% greater on the crested wheatgrass pasture of the twice-over system than on the 6.0-month seasonlong native rangeland grazed during May; the rate of gain was 560.6% greater per acre and 21.1% greater per day.

Cow and calf weight performance was strong on unfertilized crested wheatgrass during May but decreased considerably when grazing continued until mid July. During most years, cow-calf pairs could be expected to perform well on unfertilized domesticated cool-season grass pastures, like crested wheatgrass and smooth bromegrass, through mid June. Fertilization of crested wheatgrass pastures during the first week in April increased the amount of aboveground herbage available during May. Fertilization of crested wheatgrass pastures shortened by several weeks the period that livestock performed well but increased the stocking rate and cow and calf performance during May.

Native rangeland pasture forage

The stocking rate on the native rangeland pasture-forage type managed by the twice-over rotation treatment was 8.9% greater than the stocking rate on the native rangeland of the deferred treatment, 40% greater than the stocking rate on the native rangeland of the 4.5-month seasonlong treatment, and 99% greater than the stocking rate on the native rangeland of the 6.0-month seasonlong treatment.

Cow and calf weight performance was greater on the native rangeland pastures of the twice-over rotation management treatment than on the native rangeland pastures of the traditional management treatments. Cow accumulated weight was 117.6% greater on the twice-over rotation treatment than on the deferred treatment; the rate of gain was 114.6% greater per acre and 93.8% greater per day. Cow accumulated weight was 82.4% greater on the twice-over rotation treatment than on the 4.5-month seasonlong treatment; the rate of gain was 157.2% greater per acre and 82.4% greater per day. Cow accumulated weight was 286.8% greater on the twice-over rotation treatment than on the 6.0-month seasonlong treatment; the rate of gain was 937.4% greater per acre and 416.7% greater per day. Calf accumulated weight was 54.1% greater on the twice-over rotation treatment than on the deferred treatment; the rate of gain was 14.7% greater per acre and 3.8% greater per day. Calf accumulated weight was 5.7% greater on the twice-over rotation treatment than on the 4.5-month seasonlong treatment; the rate of gain was 49.2% greater per acre and 5.7% greater per day. Calf accumulated weight was 7.0% greater on the twice-over rotation treatment than on the 6.0-month seasonlong treatment; the rate of gain was 115.2% greater per acre and 22.8% greater per day.

Cow and calf weight gain per day and accumulated weight gain on native rangeland pasture-forage types managed with seasonlong, deferred, and twice-over rotation management treatments were evaluated with response surface analysis, and the results were reported by Manske et al. (1988). The response surface analysis curves are shown in figures 11-14.

Weight gain per day of cows grazing seasonlong and deferred treatments steadily decreased from the start of the grazing period (fig. 11) (Manske et al. 1988). There was no significant difference ($P>0.05$) in the cow weight gain per day between seasonlong and deferred treatments (fig. 11) (Manske et al. 1988, Manske 1994a, b). The weight gain per day was negative for cows during the latter portion of the grazing period on both the seasonlong and deferred treatments. The cow weight gain per day response curve for the twice-over rotation treatment was significantly different ($P<0.05$) from the response curves for the seasonlong and deferred treatments (fig. 11) (Manske et al. 1988, Manske 1994a, b). Cows on the twice-over rotation treatment initially had a reduction in gain per day, but a period with no reduction occurred during the middle portion of the grazing period before cows lost a small amount of weight during the last two weeks of the grazing period (fig. 11).

Cow accumulated weight gain was not different on seasonlong and deferred treatments, but the accumulated weight gain response curves for the seasonlong and deferred treatments were significantly different ($P<0.05$) from the start of the grazing period (fig. 12) (Manske et al. 1988, Manske 1994a, b). The upward slopes of the accumulated weight gain response curves were similar, but the downward slope of the curve for the deferred treatment was greater than the downward slope of the curve for the seasonlong treatment (fig. 12). The rate of weight loss during the latter portion of the grazing season was greater on the deferred treatment.

Cow weight gain per acre was significantly greater ($P<0.05$) on the twice-over rotation treatment than on deferred and seasonlong treatments, and the cow accumulated weight gain response curve for the twice-over rotation treatment was significantly different ($P<0.05$) from the response curves for the seasonlong and deferred treatments (fig. 12) (Manske et al. 1988, Manske 1994a, b). The upward slopes of these three curves were not different, but the downward slope of the curve for the twice-over rotation treatment was significantly less steep than the downward slope of the curves for the seasonlong and deferred treatments (fig. 12) (Manske et al. 1988). The accumulated weight loss during the latter portion of the grazing season was greater on the seasonlong and deferred treatments. Cow performance during the grazing period was greatest on the twice-over rotation treatment.

Calf weight gain per day decreased with the progression of the grazing period. The rate of decrease was different for the three grazing treatments (fig. 13) (Manske et al. 1988). The shape of the calf weight gain per day response curves for the treatments was not different, but the downward slope of the curves for the deferred treatment was significantly greater ($P<0.002$) than the downward slope of the curve for the seasonlong treatment (Manske et al. 1988). The downward slope of the curve for the twice-over rotation treatment was significantly less ($P<0.01$) than the downward slope of the curves for the seasonlong and deferred treatments (fig. 13) (Manske et al. 1988). Calf performance during the grazing period was greatest on the twice-over rotation treatment.

Calf accumulated weight gain was significantly greater ($P<0.004$) on the seasonlong treatment than on the deferred treatment (fig. 14) (Manske et al. 1988). Calf accumulated weight gain was significantly greater ($P<0.0001$) on the twice-over rotation treatment than on the seasonlong and deferred grazing treatments. The greatest differences among these three performance response curves occurred during the latter portion of the grazing period (fig. 14) (Manske et al. 1988).

The decrease in the downward slope of the calf accumulated weight gain curves (fig. 14) during the latter portion of the grazing period tended to follow the same trend as the downward slopes of the cow accumulated weight gain curves (fig. 12) for each treatment. The greatest downward slope occurred for the cows and calves on the deferred treatment. The least downward slope occurred for the cows and calves on the twice-over rotation treatment. The slopes of the curves for the seasonlong treatment were between the slopes of the curves for the other two treatments (Manske et al. 1988).

The cow and calf weight performances on the three native rangeland grazing management treatments were not very different during the early portion of the grazing period. Cow weight gain on the seasonlong and deferred treatments steadily decreased and cows lost weight during the latter portion of the grazing season. Cows on the twice-over rotation treatment gained weight during the early and middle portions of the grazing period and lost a small amount of weight at the end of the grazing period. Calf weight gain was greater on the seasonlong treatment than on the deferred treatment and was greater on the twice-over rotation treatment than on the seasonlong and deferred treatments. During the latter portion of the grazing period, cow and calf weight performance was greatest on the twice-over rotation treatment, poor on the seasonlong treatment, and poorest on the deferred treatment.

Fall pasture forage

The stocking rate on the Altai wildrye fall pasture-forage type of the twice-over rotation system was 377.1% greater than the stocking rate on the cropland aftermath pasture of the 4.5-month seasonlong system, 30.9% greater than the stocking rate on the spring unfertilized crested wheatgrass pasture of the 4.5-month seasonlong system, and 46.0% lower than the stocking rate on the spring fertilized crested wheatgrass pasture of the twice-over rotation system.

Cow and calf weight performance was greater on the Altai wildrye complementary domesticated grass pasture of the twice-over rotation system than on the cropland aftermath pasture of the 4.5-month seasonlong system. Cows gained weight on the Altai wildrye pasture and lost considerable weight on the cropland aftermath pasture. Calf accumulated weight was 319.8% greater on the Altai wildrye pasture than on the cropland aftermath pasture; the rate of gain was 1897.9% greater per acre and 311.9% greater per day.

Cow and calf weight performance during the fall portion of the grazing season was poor on native rangeland managed by the 6.0-month seasonlong and deferred treatments and on the cropland aftermath pasture of the 4.5-month seasonlong system. Cows on these pasture-forage types lost weight during the period between mid October and mid November, and calves with those cows gained little weight. Cow and calf weight performance on Altai wildrye pastures of the twice-over system was favorable between mid October and mid November, but not as impressive as cow and calf weight performance on the spring fertilized crested wheatgrass pastures of the twice-over system. Weight gains of cows and calves grazing Altai wildrye were considerably greater than those of livestock grazing other pasture-forage types during the same period.

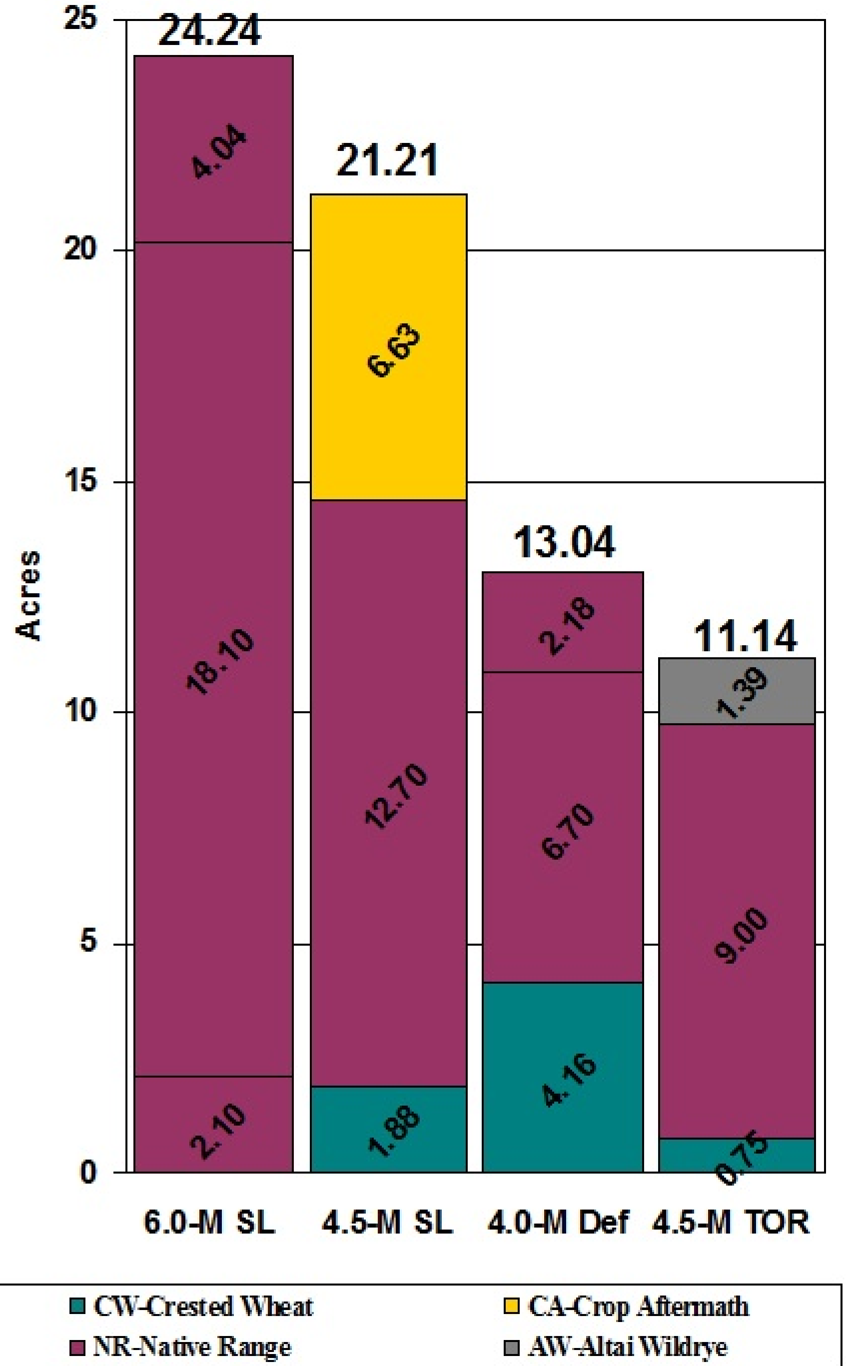

Fig. 1. Acres per cow-calf pair during spring, summer, and fall portions of the grazing season.

Table 1. Pasture-forage types, number of days per grazing period, and acres per cow-calf pair for grazing management systems.

	6.0-M Seasonlong	4.5-M Seasonlong	4.0-M Deferred	4.5-M Twice-over Rotation
Spring	Native Rangeland	Crested Wheatgrass Unfertilized	Crested Wheatgrass Unfertilized	Crested Wheatgrass Fertilized
Days	16	31	76	31
Acres	2.10	1.88	4.16	0.75
Summer	Native Rangeland	Native Rangeland	Native Rangeland	Native Rangeland
Days	137	137	92	137
Acres	18.10	12.70	6.70	9.00
Fall	Native Rangeland	Cropland Aftermath	Native Rangeland	Altai Wildrye
Days	30	30	30	30
Acres	4.04	6.63	2.18	1.39
Grazing Season				
Days	183	198	198	198
Acres	24.24	21.21	13.04	11.14

Table 2. Cow performance during the three portions of the grazing season on grazing management systems.

	6.0-M Seasonlong	4.5-M Seasonlong	4.0-M Deferred	4.5-M Twice-over Rotation
Spring	Native Rangeland	Crested Wheatgrass Unfertilized	Crested Wheatgrass Unfertilized	Crested Wheatgrass Fertilized
Accumulated Wt		60.45	69.16	83.08
Gain/Acre		32.15	16.63	110.77
Gain/Day		1.95	0.91	2.68
Summer	Native Rangeland	Native Rangeland	Native Rangeland	Native Rangeland
Accumulated Wt	21.96	46.58	29.44	84.94
Gain/Acre	0.91	3.67	4.40	9.44
Gain/Day	0.12	0.34	0.32	0.62
Fall	Native Rangeland	Cropland Aftermath	Native Rangeland	Altai Wildrye
Accumulated Wt		-48.17	-22.20	16.50
Gain/Acre		-7.27	-9.96	11.87
Gain/Day		-1.61	-0.74	0.55
Grazing Season				
Accumulated Wt	21.96	58.86	76.40	184.52
Gain/Acre	0.91	2.78	5.86	16.56
Gain/Day	0.12	0.30	0.39	0.93

Table 3. Calf performance during the three portions of the grazing season on grazing management systems.

	6.0-M Seasonlong	4.5-M Seasonlong	4.0-M Deferred	4.5-M Twice-over Rotation
Spring	Native Rangeland	Crested Wheatgrass Unfertilized	Crested Wheatgrass Unfertilized	Crested Wheatgrass Fertilized
Accumulated Wt	28.80	59.21	136.04	67.58
Gain/Acre	13.64	31.49	32.70	90.11
Gain/Day	1.80	1.91	1.79	2.18
Summer	Native Rangeland	Native Rangeland	Native Rangeland	Native Rangeland
Accumulated Wt	282.87	286.33	196.50	302.77
Gain/Acre	15.63	22.55	24.73	33.64
Gain/Day	1.80	2.09	1.80	2.21
Fall	Native Rangeland	Cropland Aftermath	Native Rangeland	Altai Wildrye
Accumulated Wt	17.73	12.57	23.10	52.77
Gain/Acre	4.38	1.90	10.36	37.96
Gain/Day	0.59	0.42	0.77	1.73
Grazing Season				
Accumulated Wt	329.40	358.11	355.64	423.12
Gain/Acre	13.59	16.88	27.27	37.98
Gain/Day	1.80	1.81	1.80	2.14

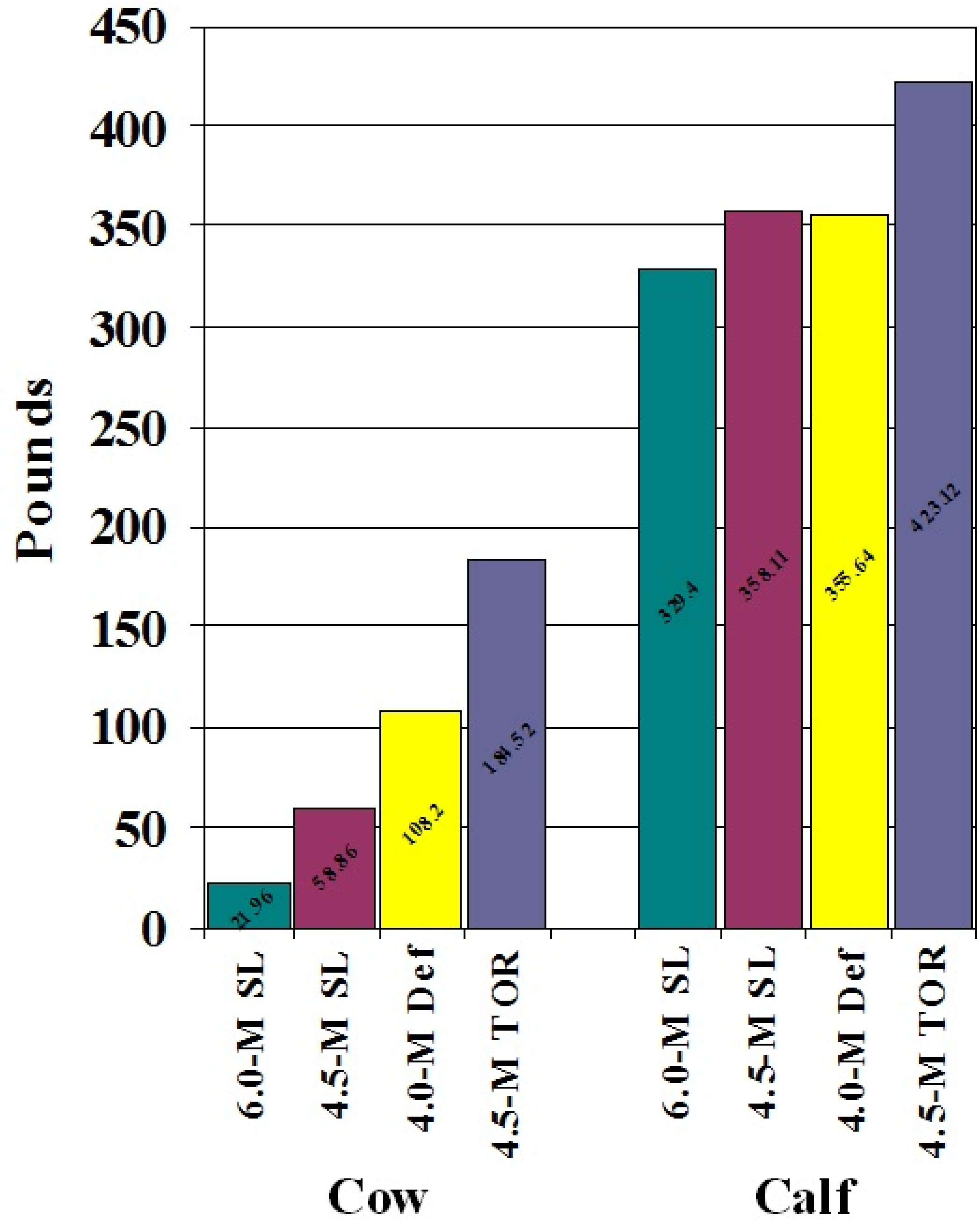

Fig. 2. Cow and calf accumulated weight gain on grazing management systems during the grazing season.

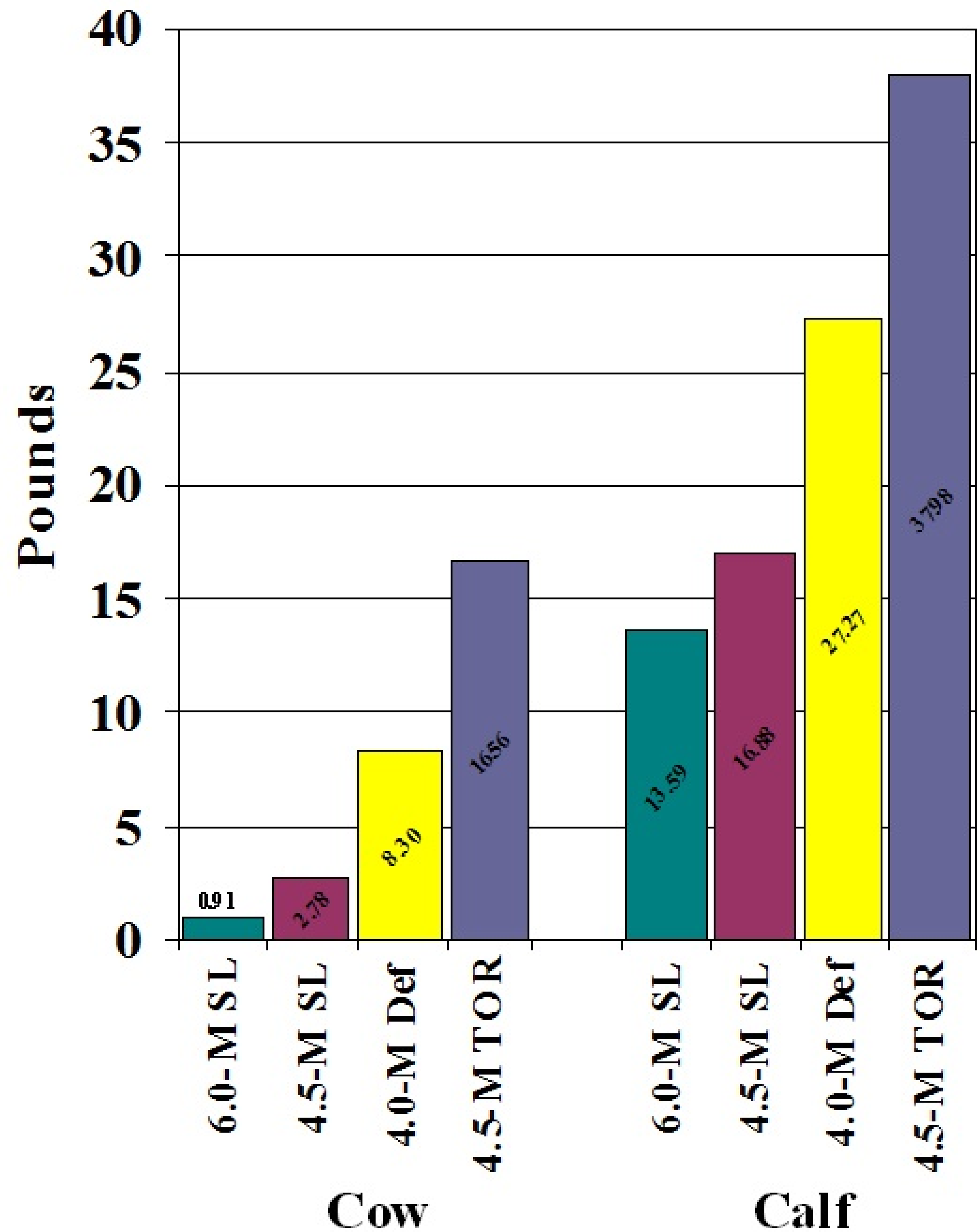

Fig. 3. Cow and calf weight gain per acre on grazing management systems during the grazing season.

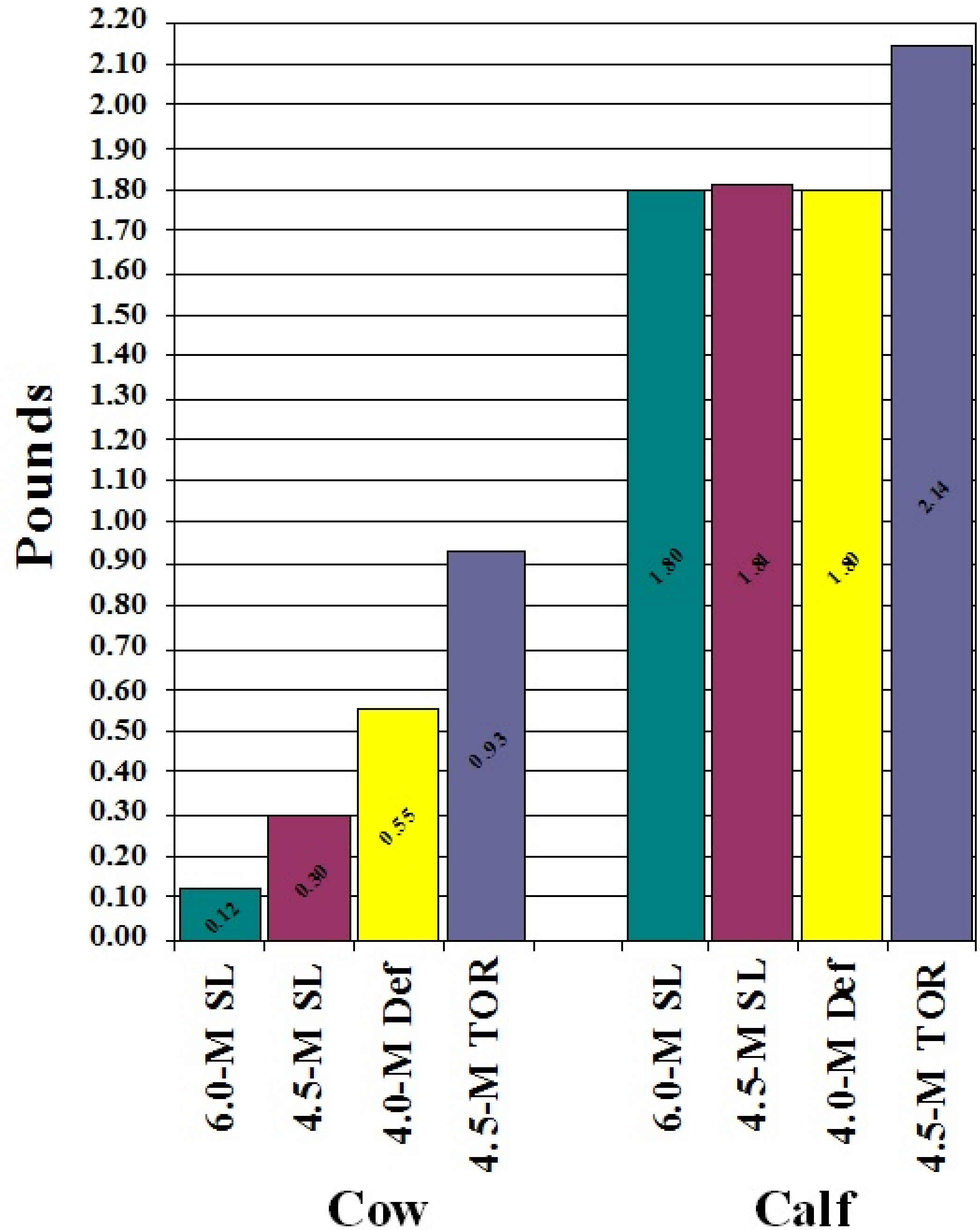

Fig. 4. Cow and calf average weight gain per day on grazing management systems during the grazing season.

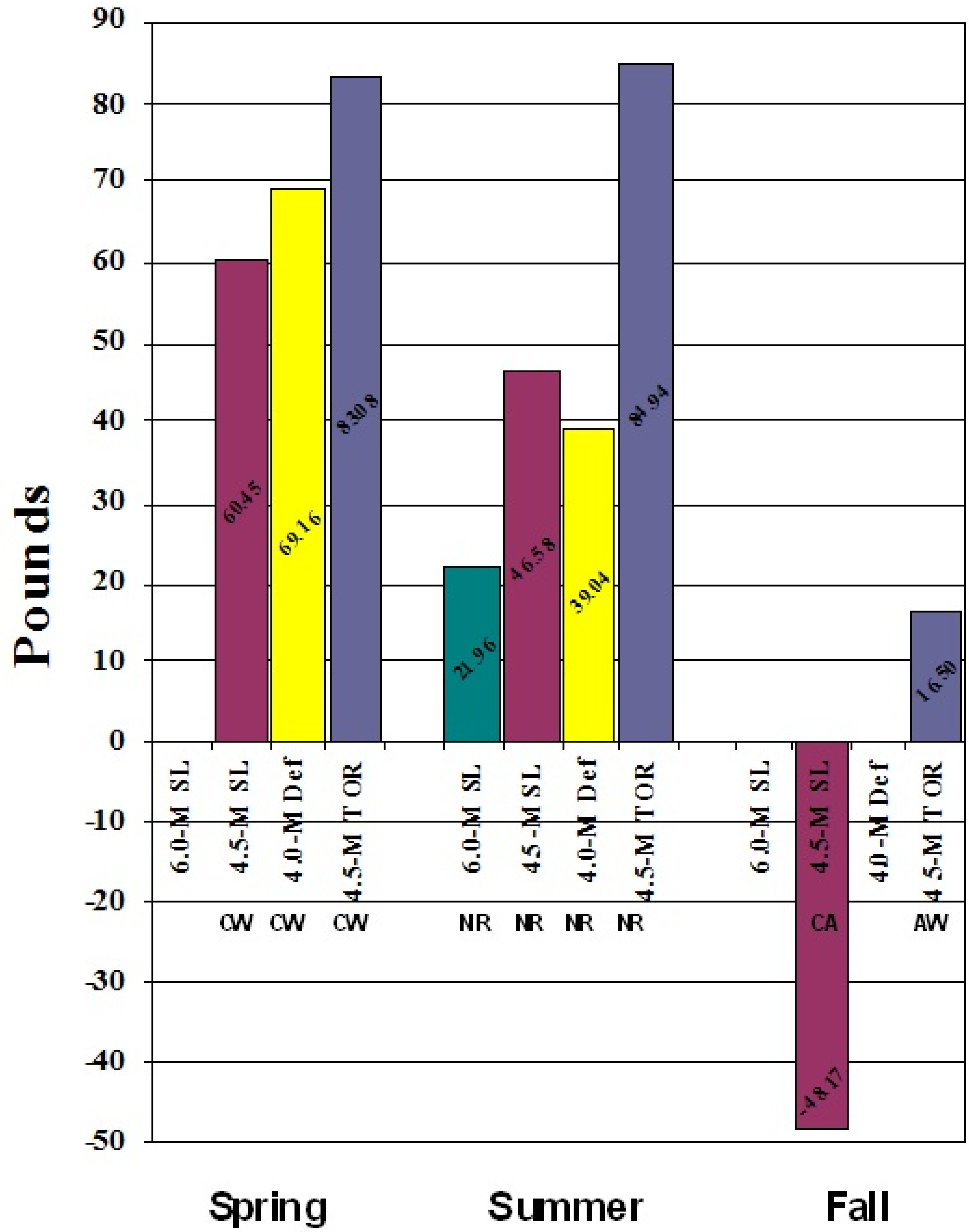

Fig. 5. Cow accumulated weight on pasture-forage types during the grazing season.

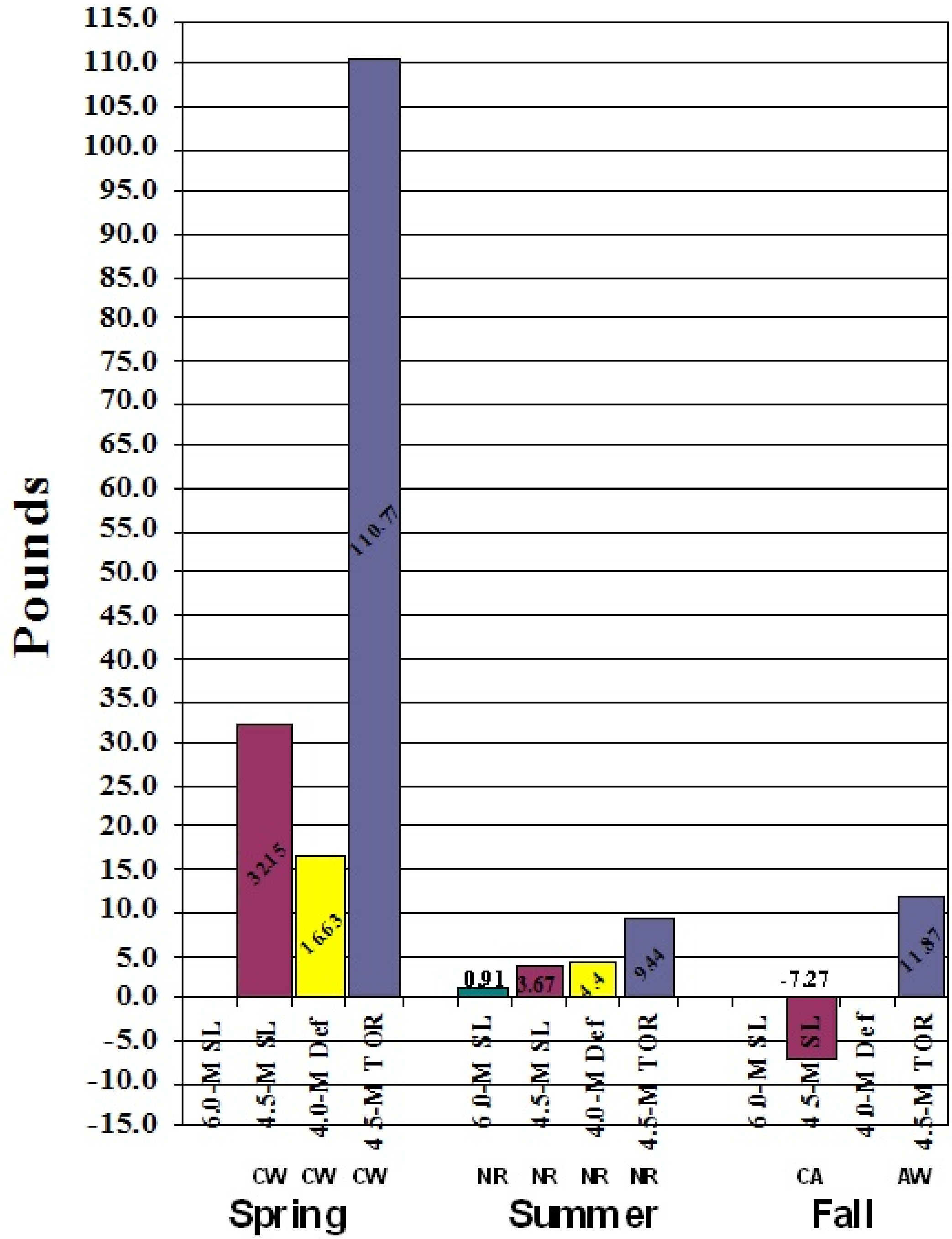

Fig. 6. Cow weight gain per acre on pasture-forage types during the grazing season.

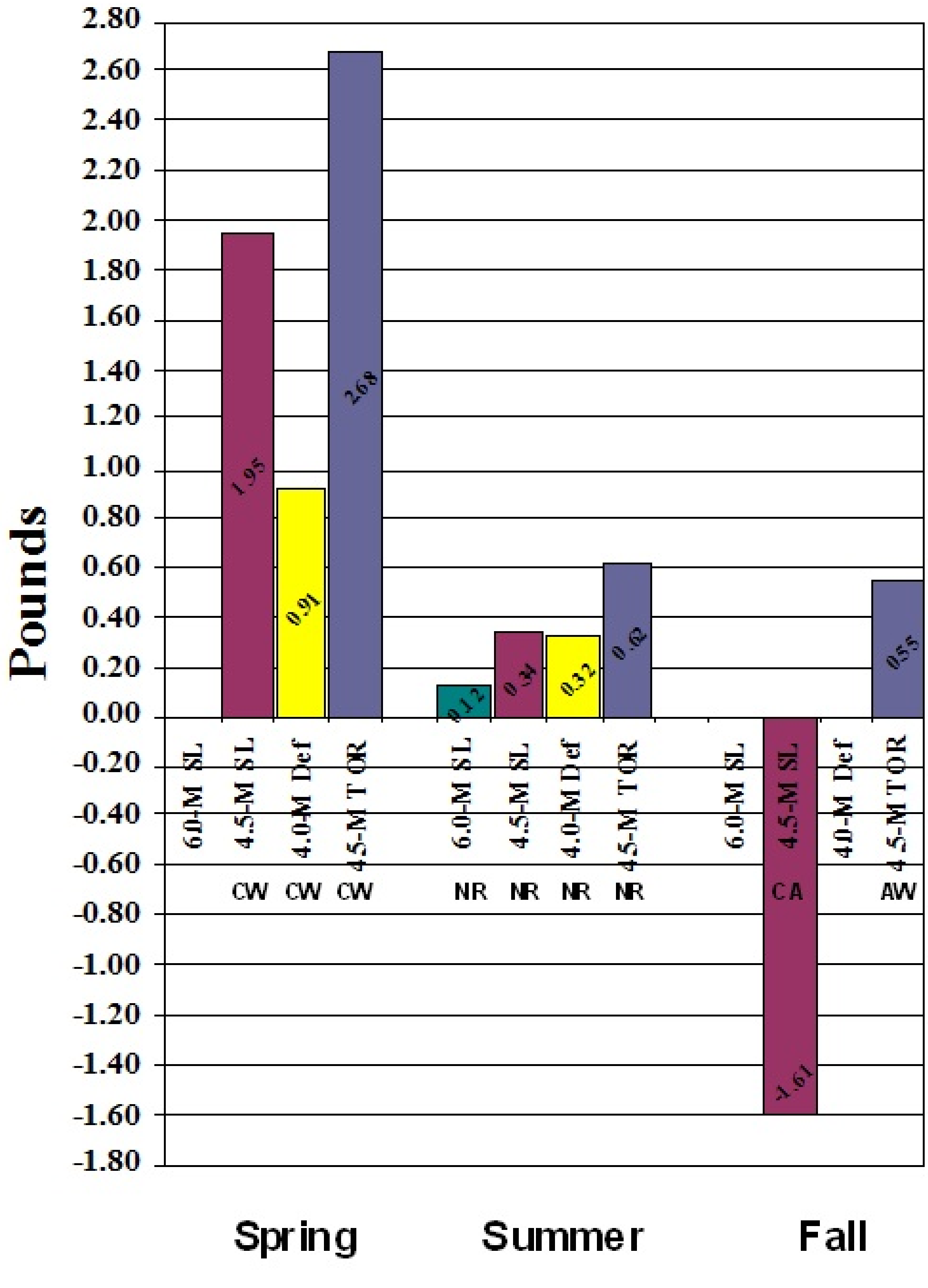

Fig. 7. Cow weight gain per day on pasture-forage types during the grazing season.

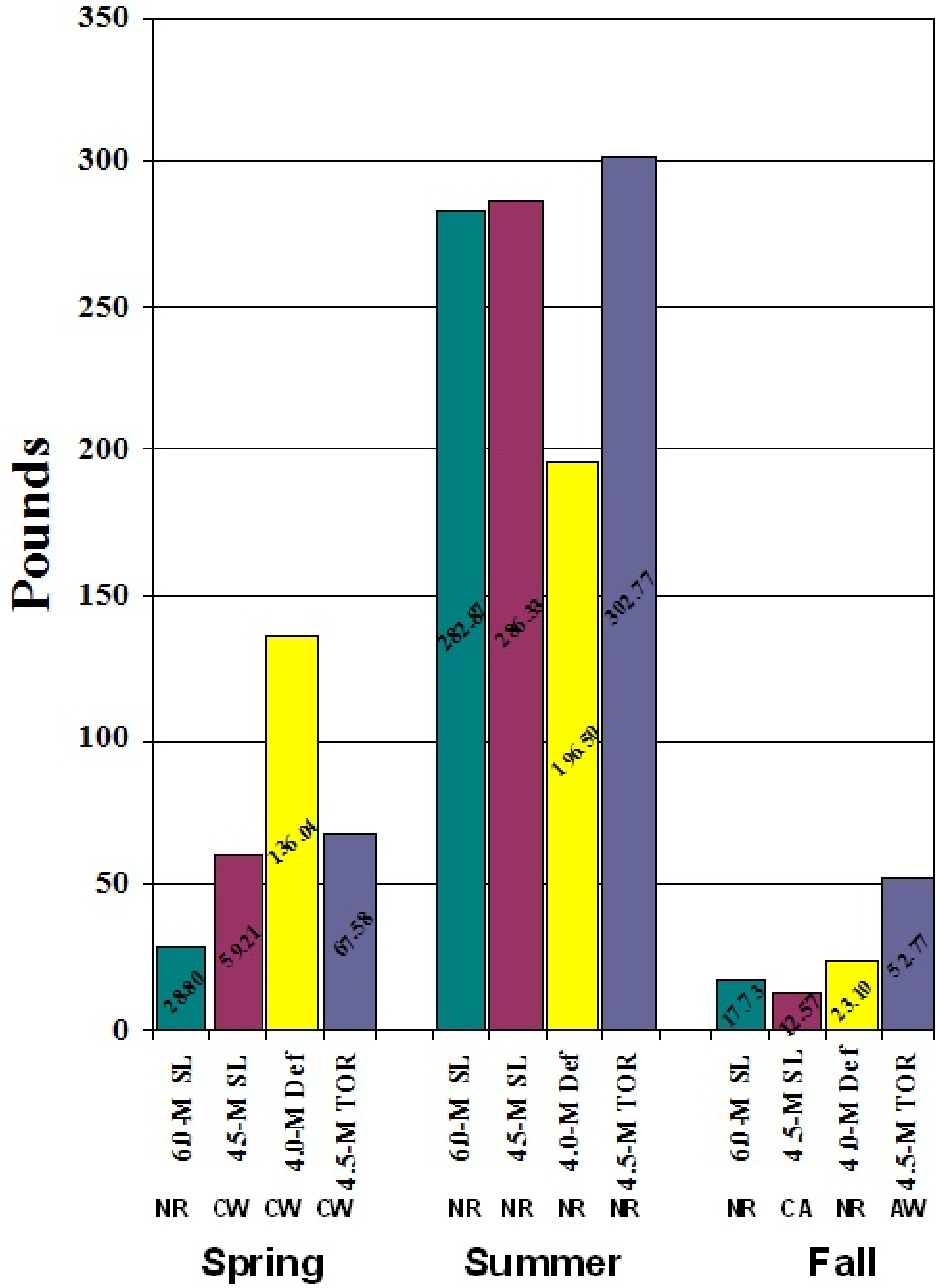

Fig. 8. Calf accumulated weight on pasture-forage types during the grazing season.

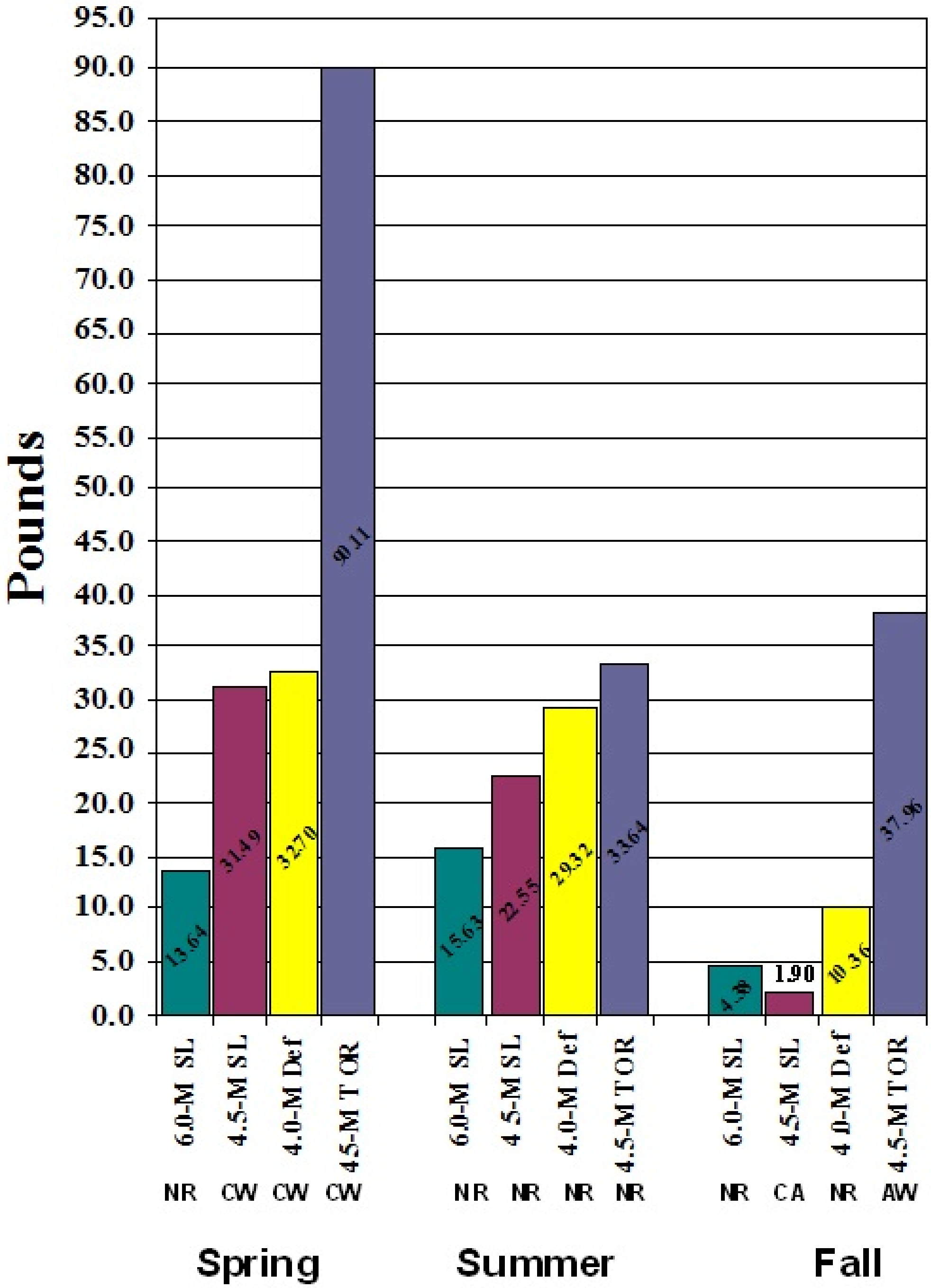

Fig. 9. Calf weight gain per acre on pasture-forage types during the grazing season.

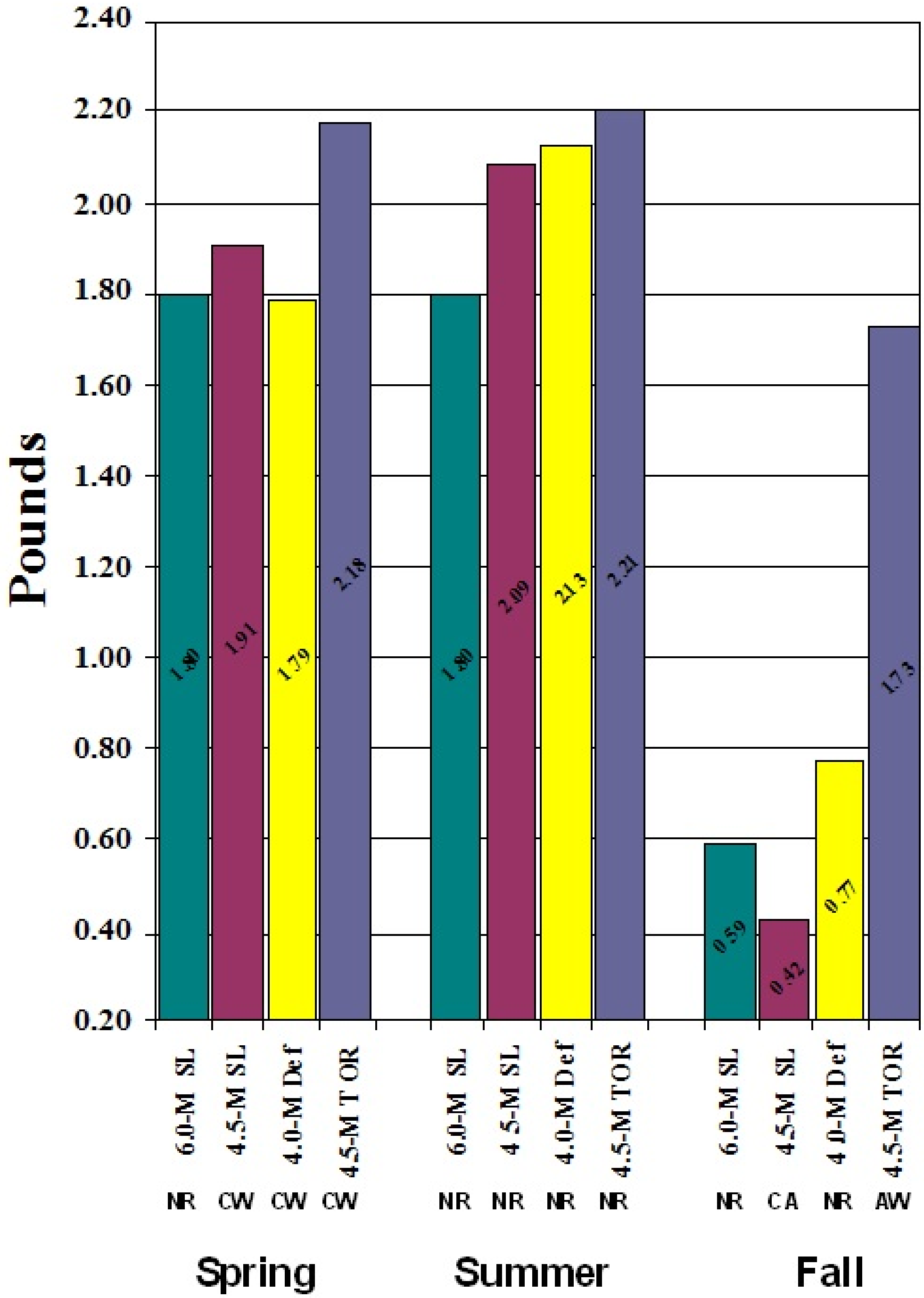

Fig. 10. Calf weight gain per day on pasture-forage types during the grazing season.

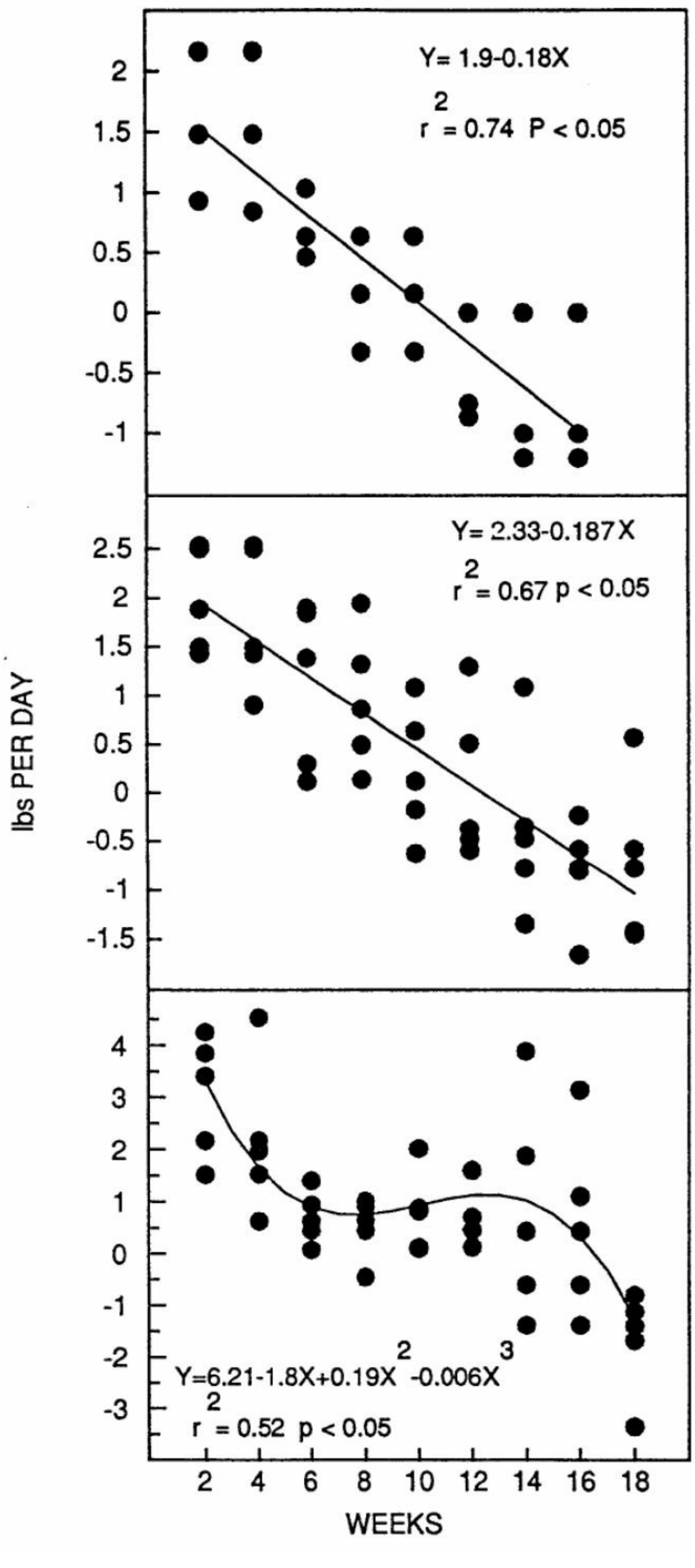

Fig. 11. Cow weight gain per day response curves for deferred (top), seasonlong (middle), and twice-over rotation (bottom) treatments (from Manske et al. 1988).

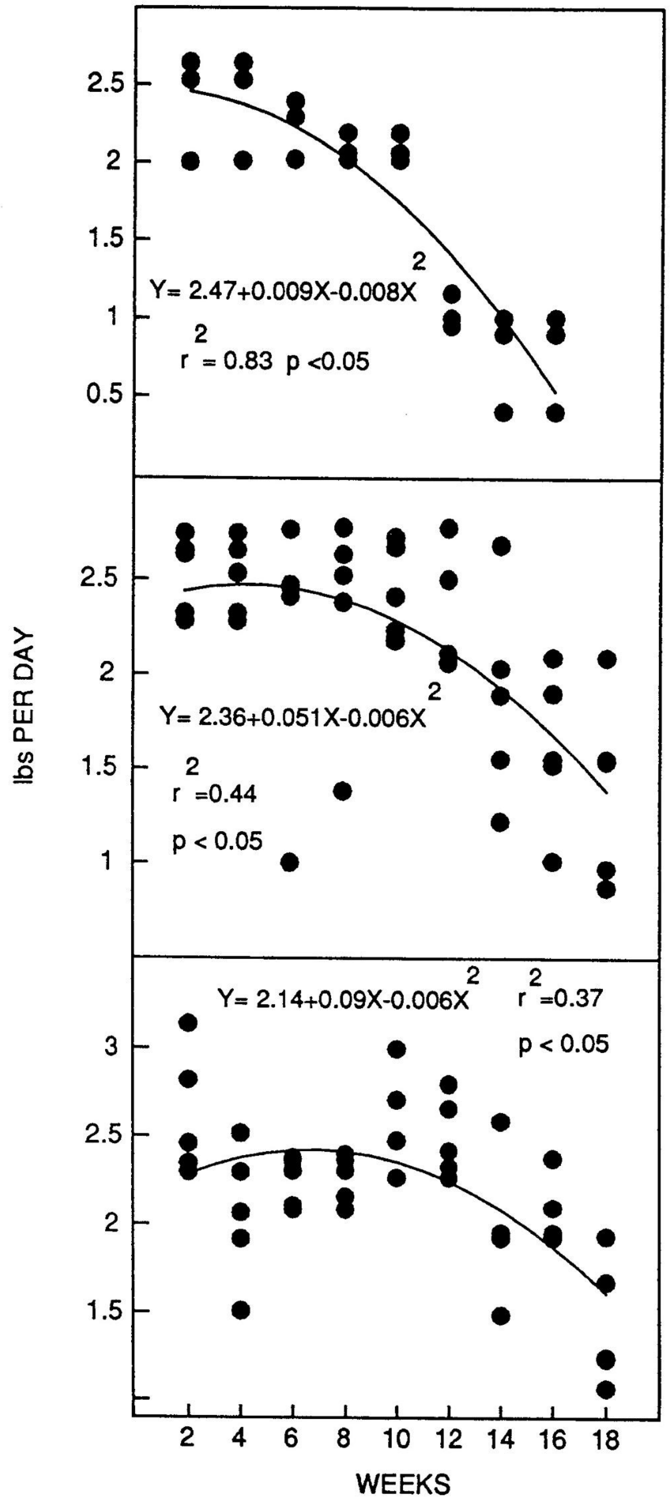

Fig. 12. Cow accumulated weight gain response curves for deferred (top), seasonlong (middle), and twice-over rotation (bottom) treatments (from Manske et al. 1988).

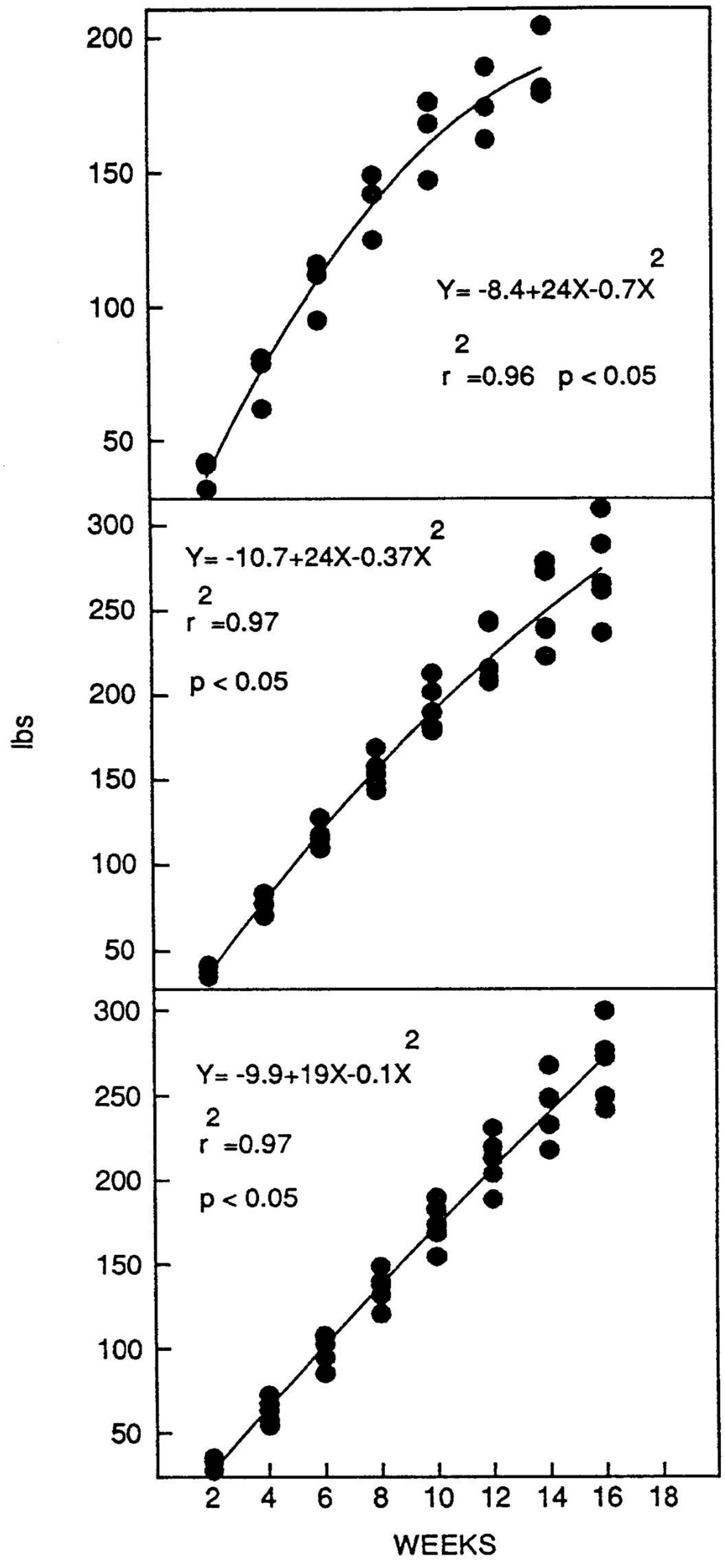

Fig. 13. Calf weight gain per day response curves for deferred (top), seasonlong (middle), and twice-over rotation (bottom) treatments (from Manske et al. 1988).

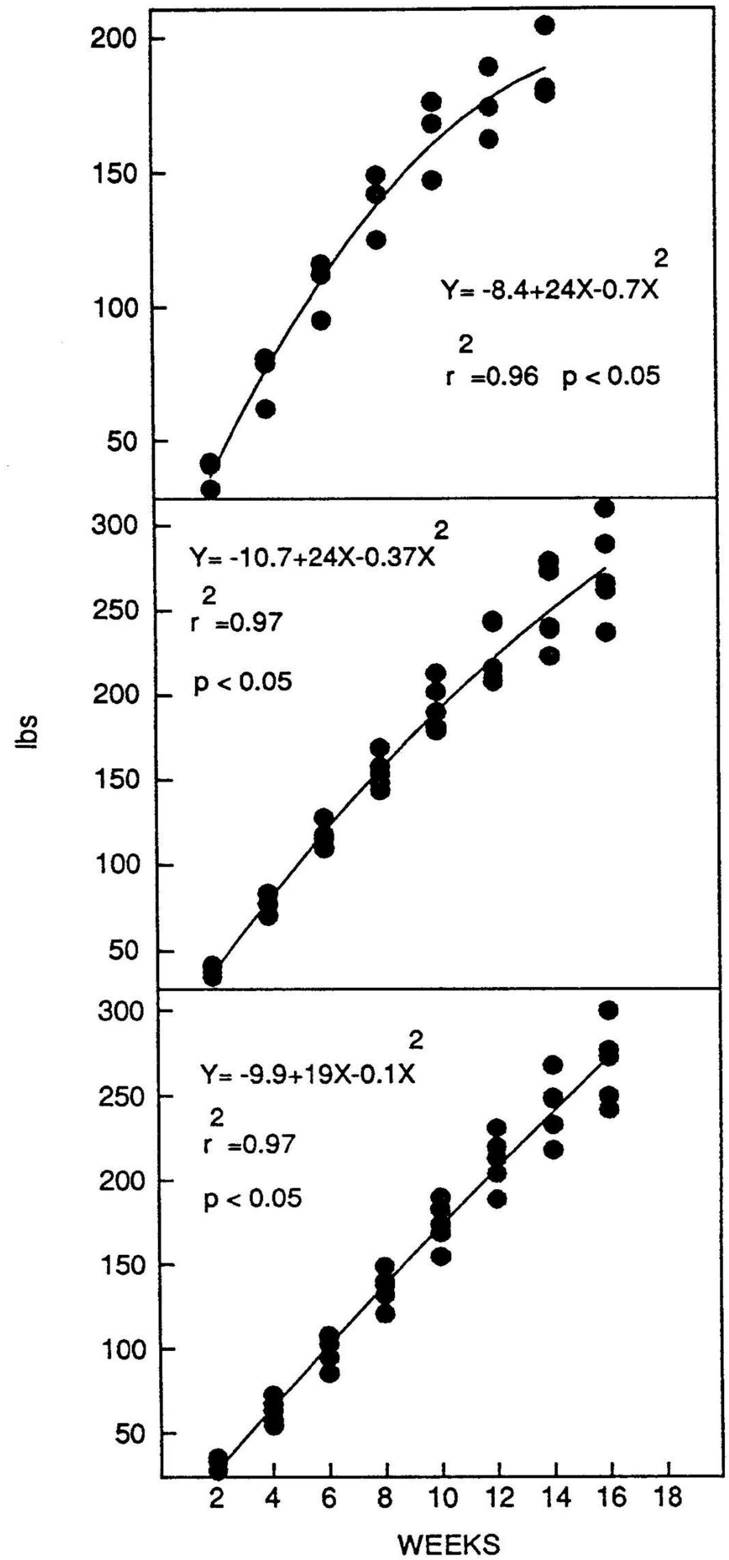

Fig. 14. Calf accumulated weight gain response curves for deferred (top), seasonlong (middle), and twice-over rotation (bottom) treatments (from Manske et al. 1988).

Discussion

Cows and calves do not gain weight at the same rate during the entire grazing season. The differences in cow and calf weight performance are caused by differences in pasture-forage types, changes in the growth stage of plants, and differing effects grazing management practices have on plant growth.

Twice-over and traditional grazing management systems

Individual cow and calf weight performance and cow and calf weight production per acre were greater on the twice-over rotation system than on traditional management systems. Individual cow weight performance was about three times greater on the twice-over rotation system than average individual cow weight gain on traditional management systems, and cow weight gain per acre was more than four times greater on the twice-over rotation system than on traditional management systems. Individual calf weight performance was about 20% greater on the twice-over rotation system than average individual calf weight gain on traditional management systems, and calf weight gain per acre was about two times greater on the twice-over rotation system than on traditional management systems.

Crested wheatgrass pasture forage

Crested wheatgrass develops three new leaves on lead tillers four to five weeks earlier in the spring than cool-season native grass species, and both unfertilized and fertilized crested wheatgrass provide excellent complementary spring pastures during May. Crude protein content of unfertilized pastures decreases as the season progresses, dropping below the requirements for lactating cows in late June. Fertilization of crested wheatgrass pastures with 40 to 60 pounds of nitrogen per acre during the first week of April nearly doubled the amount of herbage biomass on the pastures during May. The readily available mineral nitrogen improved the water use efficiency of plants and was responsible for some true increase in herbage production. However, much of the observed increase of aboveground herbage in May came from the increased rate of growth of less developed tillers that were already in the plant population and would have grown later in the season. This rapid earlier growth of the less developed tillers reduced the amount of aboveground herbage biomass later in the spring on fertilized pastures and shortened by several weeks the period in which the herbage quantity and quality met lactating cow requirements.

Cow and calf weight gain per acre on crested wheatgrass pastures has phenomenal potential during May. High rates of weight gain can be achieved if the cows are approaching their peak lactation levels at the start of the grazing period and the calves are old enough to consume the milk produced and gain great amounts of weight per day. Cows that are at early lactation and have newborn or young calves gain weight on crested wheatgrass pastures in May, but these cow-calf pairs cannot gain weight at rates near potential because they cannot capture a high proportion of the available nutrients efficiently and convert the nutrients into milk production and calf weight.

Crested wheatgrass can tolerate short-term heavy defoliation only if the plants are permitted adequate time to recover following the grazing period. Crested wheatgrass pastures grazed so heavily in May that only 2.5 to 3 inches of live plant residue remain at the end of the month require the rest of the growing season to recover. The photosynthetic activity of the leaf area produced by the secondary tillers that develop later in June restores plant health and replenishes the carbohydrate reserves preparing plants for next season's grazing period. Consumption of the dry herbage from the previous growing season's secondary tillers reduces the rate of passage of the current season's lush green vegetation and helps to prevent grass tetany and milk fever in grazing cows. Crested wheatgrass fields that are grazed as complementary spring pastures in a management system should be neither cut for hay during the summer nor grazed during the fall or winter.

Native rangeland pasture forage

Cow and calf weight performance generally did not differ among native rangeland treatments during the early grazing period of June and July, but during the latter portion of the grazing period, after early August, animal weight performance was greater on the twice-over rotation treatment than on the seasonlong and deferred treatments.

Cow weight gain per day on the seasonlong and deferred treatments steadily decreased as the grazing period progressed. Cows on the seasonlong and deferred treatments gained weight during the early portion of the grazing period but lost weight during the latter portion. Weight loss occurred at a greater rate on the deferred treatment. Cows on the twice-over rotation treatment gained weight at a greater rate than did cows on the seasonlong and deferred treatments. Cows on the twice-over rotation treatment gained weight during the early and middle portions of the grazing period and lost a small amount of weight at the end of the grazing period. Cow accumulated weight gain, gain per acre, and gain per day were greater on the twice-over rotation treatment than on the seasonlong and deferred treatments.

Calf weight performance during the early portion of the grazing period was about the same on all native rangeland treatments. The greatest differences occurred during the latter portions of the grazing period. Calf weight gain per day on the seasonlong and deferred treatments decreased as the grazing season progressed. The decrease in calf gain per day was greater on the deferred treatment. The decrease in calf gain per day during the latter portion of the grazing period was smaller on the twice-over rotation treatment than on the seasonlong and deferred treatments. Calf accumulated weight gain was greater on the seasonlong treatment than on the deferred treatment. Calf accumulated weight gain was greater on the twice-over rotation treatment than on the seasonlong and deferred treatments.

The 6.0-month seasonlong grazing treatment started grazing native rangeland early, before the plants developed three new leaves. Starting grazing before the third new leaf stage deprives grass plants of needed leaf area and results in reductions in grass growth and herbage production (Campbell 1952, Rogler et al. 1962, Manske 2000). The nutritional quality of the herbage on native rangeland was at or above the cows' requirements 42.1% and below the cows' requirements 57.9% of the 183-day grazing period. Early in the grazing period, cows were able to select forage that provided adequate nutrition and they could gain weight, but after early August, cows were unable to select adequate forage to maintain body weight and milk production. The loss of herbage production caused by grazing early resulted in reduced stocking rates and reduced animal performance. During the latter portion of the grazing period, cows lost all but a small amount of their accumulated weight. Calf accumulated weight gain, rate of weight gain per acre, and rate of weight gain per day were greatly reduced soon after the cows started to lose weight.

The 4.5-month seasonlong grazing treatment delayed grazing on native rangeland until the cool-season native grasses had reached the third new leaf stage. At this time of year, herbage was still actively growing and early leaves on several grass species were fully expanded and at or near full weight. The nutritional quality of the herbage on native rangeland was at or above the cows' requirements 44.5% and below the cows' requirements 55.5% of the 137-day grazing period. Early in the grazing period, cows were able to select forage that provided adequate nutrition and they could gain weight, but they had a steady decline in weight gain per day from the start of the grazing period. After early August, most of the growth of grasses had been completed and the nutrient content of the available vegetation had dropped below cow requirements. Cows were unable to select adequate forage to maintain body weight and milk production during the latter portion of the grazing period. Calf accumulated weight gain, rate of weight gain per acre, and rate of weight gain per day were greatly reduced soon after the cows started to lose weight.

The deferred grazing treatment deferred grazing on native rangeland until most grass species had reached the seed development stage and nearly all of the plant growth in weight had been completed. Grasses decrease in nutritional quality following the flowering stage, and their nutrient content soon drops below the minimum requirements of livestock. Most of the grass leaves of the available forage were fully expanded and at later stages of senescence. The nutritional quality of the herbage on native rangeland was at or above the cows' requirements 13.1% and below the cows' requirements 86.9% of the 122-day grazing period. Early in the grazing period, cows were able to select forage that provided adequate nutrition and they could gain weight, but after early August, cows were unable to select adequate forage to maintain body weight and milk production. Calf accumulated weight gain, rate of weight gain per acre, and rate of weight gain per day were greatly reduced soon after the cows started to lose weight.

Loss of weight by cows during the latter portion of the grazing period on the traditional management treatments--6.0-month seasonlong, 4.5-month seasonlong, and deferred management treatments--is not apparent because cow weight gain during the early portion of the grazing season was greater than weight loss during the latter portion of the grazing season. The loss of weight is not harmful to the health of the animals but does indicate that cows were unable to maintain body weight and lactation on the forage available. Calf weight performance decreased greatly during the period that the cows lost weight. Cow and calf weight performance on native rangeland managed by traditional treatments is below the genetic potentials of modern livestock.

The twice-over rotation grazing treatment delayed grazing on native rangeland until the cool-season native grasses had developed three new leaves. After the three-and-a-half-leaf stage, grass plants can physiologically tolerate moderate defoliation, and grazing at appropriate stocking rates will not cause a reduction in herbage production. From early June to mid July, when lead tillers are actively growing, grazing that removes about 10% to 33% of the young leaf material on 60% to 80% of the plants manipulates grass plant biological processes that activate and enhance vegetative reproduction processes resulting in stimulation of secondary tiller growth. During the early portion of the grazing period, prior to mid July, livestock were moved through each of the three pastures one time. Cow gain per day decreased during the first pasture rotation because the fully expanded leaves of lead tillers were decreasing in nutritional quality; however, the nutritional quality of the herbage remained above the cows' minimum dietary requirements so that the animals continued to gain weight. Cow weight gain per day remained fairly steady during the middle portion of the grazing period, when cows were rotated a second time through each pasture. The nutritional quality of the herbage on native rangeland was at or above the cows' requirements 89.8% and below the cows' requirements 10.2% of the 137-day grazing period. Cows prolonged their weight gain late into the grazing period, and the twice-over rotation strategy delayed by two to two and a half months the weight loss typical on traditional grazing treatments.

The improved cow weight performance on the twice-over rotation treatment is a result of two management-related changes in plant growth. First, a high proportion of the grass leaves consumed by the cows during the early portion of the grazing period were near full weight and of high quality so that animals could fulfill their daily dietary needs by grazing fewer plants. This allowed a high number of immature leaves to escape grazing during the first pasture rotation and to be available fully expanded, near maximum weight, and at high nutrient quality during the second pasture rotation. Second, light grazing during the early portion of the grazing period stimulated grass plant vegetative tillering and increased plant density and the number of leaves available for grazing during the second pasture rotation. During the middle and late portions of the grazing period, the leaves on the secondary tillers were phenologically younger, less developed, and of higher nutritional quality than leaves on the lead tillers of the same species (Sedivec 1999). Together, grazing primarily fully expanded leaves, which reduces the number of plants per animal per day, and the increase in grass density from secondary tillers result in the increase in herbage biomass and permit an increase in stocking rate. Calf accumulated weight gain, rate of weight gain per acre, and rate of weight gain per day were lower during the latter portion of the grazing season than during the early portion. The rate of decline in calf performance during the latter portion of the grazing period on the twice-over rotation treatment was considerably less than the decline on traditional grazing treatments.

Fall pasture forage

Manipulating vegetative reproduction of native grasses and increasing secondary tillers improve herbage quality and extend the period of improved livestock performance two to two and a half months during the latter portion of the grazing period, until late September or mid October. The biology of native grass plants does not permit extending these conditions beyond mid October, when native rangeland herbage quality is insufficient to meet the requirements of lactating cows.

Wildryes such as Altai and Russian are the only perennial grasses that retain nutrient quality in the aboveground portions of the plant until about mid November. Weight gains of cows and calves grazing Altai wildrye complementary pastures during mid October to mid November were considerably greater than those of livestock grazing native rangeland managed by 6.0-month seasonlong and deferred treatments and those of livestock grazing cropland aftermath pastures during the same period; cows on the native rangeland and cropland aftermath lost weight and the calves with these cows gained little weight. No perennial grass in the Northern Plains retains sufficient nutritional quality to dependably meet the nutritional requirements of grazing lactating cows later than mid November.

Conclusion

The twice-over rotation system has greater individual cow and calf weight performance and greater cow and calf weight production per acre than traditional management systems. The improved animal performance on the twice-over rotation system results from increased efficiency of capturing value from the land resources. Sustaining increased value capture requires improvement of the biological effectiveness, nutrient capture efficiency, and nutrient conversion efficiency of grazing management.

The biological performance level of the plant component of grassland ecosystems determines the weight performance of the livestock component. Improved biological effectiveness of grazing management increases herbage and nutrient production by meeting the biological requirements of plants and ecosystem processes. Livestock grazing coordinated with specific plant growth stages and seasons of the year beneficially manipulates plant biological processes, stimulates soil organism activity, and enhances the biogeochemical cycles responsible for the flow of nitrogen, carbon, and water through ecosystems.

Nutrients are necessary to support the life and production of a beef cow and calf. The nutrients, not the dry matter, are the valuable products from forage plants. When the focus is shifted to harvesting greater nutrient weight per acre rather than greater forage dry matter weight per acre and to improving nutrient capture efficiency, the weight of nutrients grazing captures from the land resource increases. Produced nutrients are efficiently captured by livestock grazing pasture-forage types during their optimum plant growth stages, when the percent nutrient content and the weight of forage dry matter yield the greatest nutrient weight per acre.

Cows and calves grazing herbage that is at or above their nutritional requirements have greater weight production levels than cows and calves grazing herbage that is below their nutritional requirements. Improved nutrient conversion efficiency increases cow and calf weight production levels by providing nutrients at the times and in the amounts required during each production period. Livestock produce at greater efficiencies when not limited by periods with nutrient deficiency. Increased livestock weight performance from improved efficiency of nutrient conversion can be maintained when appropriate pasture-forage types are combined in sequence so that the herbage production curves and nutritional quality curves meet the cow and calf dietary quantity and quality requirements during the entire grazing season.

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