Matching Calving Period with Available Forage Nutrients

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Beef producers of the Northern Plains have a long established custom of calving during March. This traditional calving period has been selected, whether consciously or intuitively, to coordinate, as best as possible, the nutritional requirements of lactating livestock with the available nutrients from perennial forage plants between calving and rebreeding in order for the cows to repair any damage to the reproductive organs and to reach peak potential milk production before they are expected to rebreed during the first cycle with the bulls.

In the Northern Plains, the best coordination of nutrients demanded with nutrients available is to have the calves on the ground before the end of March. During the first month of a calves life it can not gain much more than 1.0 to 1.25 lbs/day and it takes a cow about 2 months after calving to reach peak potential lactation. There are no perennial forage plants physiologically developed enough for grazing until early May which requires a period after calving of feeding an early lactation harvested forage ration. In early May, crested wheatgrass and smooth bromegrass complementary spring pastures can be grazed. The nutritional quality is great enough for the cow to add body weight, repair internal organs, and greatly increase the quantity of milk production. After the calf is one month old, it can take advantage of the greater quantities of milk and gain weight at remarkable rates. Native rangeland grasses are physiologically developed for grazing by early June and can provide forage until mid October. The combination of domesticated grass pastures grazed during May and native rangeland pastures grazed during early June to mid October provides the best cow and calf weight gain performance with March birth dates.

Several beef producers have contemplated changing their calving date and need to know the differences in calf pasture weight gains and the net returns from perennial grass pastures when calving periods are not matched with available forage nutrients.

The range research program at the Dickinson Research Extension Center (DREC) has been conducting grazing management research since 1982 that compares the twice-over rotation system with the traditional seasonlong system. The research herd was commercial angus cross cows with average weights around 1100 to 1200 pounds. From 2004 to 2009, the average cow weights increased above 1350 lbs, then to 1450 pounds. The range research cow herd was changed to lighter weight lowline cross cows in 2010 with March born calves. The research center changed to May calving in 2012. Thus a built in calving date data set developed that compares two years (2010-2011) of lowline X cows that have March born calves, and several calves born in early April, with two years (2012-2013) of lowline X cows that have May born calves, and several calves born in early June. This situation produced eight sets of calves that were similar genetically and had four different birth periods with cows grazing two different forage management treatments; the seasonlong system and the twice-over system. This study should show differences in calf pasture weight gains and net returns caused by the different time periods that cow nutrient demand occurred in relationship to the perennial grass phenological growth stages and nutrient availability curves as affected by two different grazing management treatments.

Management Treatments

Two management treatments were evaluated (1) the spring and summer pastures of the seasonlong system, and (2) the spring and summer pastures of the twice-over system. Each system had two replications.

The seasonlong grazing system had one spring pasture of crested wheatgrass grazed during May at 1.88 acres per cow and had one summer pasture of native rangeland grazed for 137 days from early June to mid October stocked at 2.31 acres per cow-calf pair per month.

The twice-over rotation system had one spring pasture of crested wheatgrass split into two halves grazed during May at 1.15 acres per cow with each half grazed for one week then switched back to the other half for one week et cetera. The native rangeland was divided into three pastures with each pasture grazed two times per growing season. The native range was grazed for 137 days from early June to mid October stocked at 2.26 acres per cow-calf pair per month.

The quality of forage plants changes with the phenological growth stages. During vegetative growth, forage grasses vary between 16% and 12% crude protein. As the lead tillers develop towards the flower stage, crude protein levels drop to 9.6% and then decrease rapidly to 4.5% crude protein. Beef cows require 10.5% crude protein from forage plants during the early portions of lactation and require 9.6% crude protein from forage plants during the latter portions of lactation (BCRC 1999).

The forage quality on the seasonlong system changed during the growing season. Forage on the crested wheatgrass pasture had 16.8% crude protein during May. Forage on the native rangeland pasture had 12.3% crude protein from early June to mid July and the forage averaged 6.6% crude protein from mid July to mid October when lead tillers are mature and leaves are drying (Manske and Schneider 2014c, 2014d). The forage quality on the seasonlong system is greater than the requirements of a lactating beef cow during 2.5 months from early May to mid July and below the requirements during 3.0 months from mid July to mid October (figure 1).

The forage quality on the twice-over system changed during the growing season but did not decrease to the extent that it did on the seasonlong system. Forage on the crested wheatgrass pastures had 16.8% crude protein during May. Forage on the native rangeland pastures had 12.3% crude protein from early June to mid July and the forage averaged 10.1% crude protein from mid July to mid October (3.5% greater than that on the seasonlong system) because the twice-over management system stimulates 170.6% greater quantities of secondary tillers to develop from axillary buds (Manske and Schneider 2014c, 2014d). The forage quality during the entire 5.5 month spring-summer grazing period on the twice-over system was always greater than the requirements of a lactating beef cow (figure 2).

Study Area

This project was conducted at the NDSU Dickinson Research Extension Center ranch located in Dunn county in western North Dakota, USA, at 47° 14' north latitude, 102° 50' west longitude. Mean annual temperature is 42.2° F (5.7° C). January is the coldest month, with a mean temperature of 14.6° F (-9.7° C). July and August are the warmest months, with mean temperatures of 69.6° F (20.9° C) and 68.6° F (20.4° C), respectively. Long-term (1982-2013) mean annual precipitation is 17.11 inches (434.60 mm). The perennial plant growing-season precipitation (April through October) is 14.37 inches (364.87 mm) and is 84.0% of the annual precipitation. June has the greatest monthly precipitation, at 3.24 inches (82.26 mm). The precipitation received during the 3-month period of May, June, and July (8.38 inches, 212.85 mm) accounts for 48.98% of the annual precipitation (Manske 2014a). Soils are primarily Typic Haploborolls developed on sedimentary deposits. The fine loamy soils have 11.8 and 13.4 tons of organic nitrogen per acre on the seasonlong and twice-over treatments, respectively (Manske 2016). Native vegetation is the Wheatgrass-Needlegrass Type (Barker and Whitman 1988) of the mixed grass prairie.

Growing Season Precipitation

Growing season precipitation of 2010 was 16.18 inches (114.35% of LTM). April through July precipitation was 109.08% of LTM and August through October precipitation was 125.50% of LTM. Growing season precipitation of 2011 was 17.91 inches (126.57% of LTM). April through July precipitation was 134.26% of LTM and August through October precipitation was 109.62% of LTM. Growing season precipitation of 2012 was 13.63 inches (96.33% of LTM). April through July precipitation was 105.78% of LTM and August through October precipitation was 75.62% of LTM. Growing season precipitation of 2013 was 21.56 inches (152.37% of LTM). April through July precipitation was 133.88% of LTM and August through October precipitation was 192.39% of LTM. Mean growing season precipitation of 2010-2013 was 17.32 inches (122.40% of LTM). Mean April through July precipitation was 131.30% of LTM and mean August through October precipitation was 125.95% of LTM (table 1).

Water stress develops in perennial plants during water deficiency periods when the amount of rainfall is less than evapotranspiration demand. Water deficiency months were identified from historical temperature and precipitation data by the ombrothermic diagram technique (Emberger et al. 1963). The frequency of water deficiency reoccurrence during April, May, June, and July is 15.6%, 9.4%, 9.4%, and 34.4%, respectively, and during August, September, and October water deficiency reoccurs 53.1%, 56.3%, and 34.4% of the growing seasons, respectively. Long-term occurrence of water deficiency conditions is 31.3% of the growing season months, for a mean of 2.0 water deficient months per growing season (Manske 2014a). Water deficiency conditions occurred during August and October in 2010, during October in 2011, during August and September in 2012, and did not occur in 2013.

Procedures

Calf pasture weight gains, pasture forage costs, and net returns from pasture weight gains after forage costs were evaluated and compared for lowline X calves having early birth dates in March and in early April of 2010 and 2011 and for lowline X calves having late birth dates in May and in early June of 2012 and 2013 with cows grazing the spring and summer pastures of the twice-over system and with cows grazing the spring and summer pastures of the seasonlong system.

Forage costs were determined by the average pasture land rent per acre from western North Dakota at $8.76 per acre and the land area in acres needed to feed a cow and calf during the grazing period. Forage cost per day was determined by dividing the total forage cost by the number of days on pasture. Dollar value of calf pasture weight gain was determined from the accumulated calf weight gain which was the difference of the calf live weight at the beginning of the growth period from the calf live weight at the end of the growth period. The calf accumulated pasture weight gain was multiplied by an assumed market value of $1.25 per pound. Net return after forage costs per cow-calf pair was determined by subtracting the forage costs from the dollar value of calf pasture weight gain. Net return after forage costs per acre was determined by dividing the net return per cow-calf pair by the land area in acres needed per cow-calf pair. Net return per 640 acres was determined by multiplying the net return per acre by 640 acres. Cost per pound of calf pasture weight gain was determined by dividing the forage costs by the pounds of accumulated calf weight. Calf weaning weight as a percentage of cow weight was determined by dividing the average calf weaning weight by the average cow weight at weaning.

The best weight gain performance that occurred was by the March born calves with cows grazing the spring and summer pastures of the twice-over system. The weight gain and net returns data for these calves were the study standards used to evaluate and compare the weight gains and net returns of the calves with other birth dates and forage management treatments.

Results

The mean weight gain and net returns on spring and summer pastures of the twice-over system for early birth date lowline X calves born during March was 2.38 lbs/day, 34.10 lbs/acre, accumulated pasture weight gain of 390.06 lbs, and final pasture live weight of 560.02 lbs. The net returns per cow were $387.37, per acre were $33.86, and per 640 acres were $21,670.40 (table 2). This is the study standard treatment that has the best calf pasture weight gain and net returns because the cow nutrient requirements with calves born during March has the best match with available nutrients from perennial forage grasses. The cows were fed a high quality lactation ration from calving to early May. The cows grazed the high quality forage on the crested wheatgrass pastures during May (figure 2). During this post calving period, the cows repaired their reproductive organs, completed one reproductive cycle before exposure to the bulls, and reached milk production at peak biological potential quantities. The calves spent a full 4 weeks on the crested wheatgrass pastures at an age older than one month and were able to convert the greater quantities of milk into high rates of weight gain.

The mean weight gain and net returns on spring and summer pastures of the twice-over system for early birth date calves born during early April was 2.32 lbs/day (for a loss of 0.06 lbs/day), 33.18 lbs/ac (for a loss of 0.92 lbs/ac), accumulated pasture weight gain of 379.63 lbs (for a loss of 10.43 lbs pasture gain), and final pasture live weight of 506.33 lbs (for a loss of 53.69 lbs weaning weight). The net returns per cow were $374.33 (for a loss of $13.04/cow), per acre were $32.72 (for a loss of $1.14/ac), and per 640 acres were $20,940.80 (for a loss of $729.60/640 acres) (table 2). The calves with early April birth had 2 full weeks, a few calves had 3 weeks, on the crested wheatgrass pastures at ages older than one month compared to the calves with March births that had 4 full weeks on the crested wheatgrass pastures at ages older than one month. The small difference of 4 weeks vs. 2 weeks on crested wheatgrass pastures is easily dismissed, however, no less than 38% of the reduction in weaning weight occurred during those 2 weeks. The cows with early April calf births had only 1.5 months post calving to reach peak lactation vs. 2.0 plus months which is the cause for the remainder of the reduction in weaning weight.

The mean weight gain and net returns on spring and summer pastures of the seasonlong system for early birth date calves born during March was 2.31 lbs/day (for a loss of 0.07 lbs/day), 30.89 lbs/ac (for a loss of 3.21 lbs/ac), accumulated pasture weight gain of 378.72 lbs (for a loss of 11.34 lbs pasture gain), and final pasture live weight of 539.61 lbs (for a loss of 20.41 lbs weaning weight). The net returns per cow were $366.00 (for a loss of $21.37/cow), per acre were $29.85 (for a loss of $4.01/ac), and per 640 acres were $19,104.00 (for a loss of $2,566.40/640 acres) (table 3). The calves on the seasonlong system with March births were the same age as the calves on the twice-over system with March births. The cows on the seasonlong and twice-over systems were fed the same early lactation ration and each cow on both systems had 4 full weeks on crested wheatgrass pastures with calves that were older than one month. The difference in calf weight gains on the seasonlong system were caused by the rapid reduction in milk production of the cows grazing forage with nutritional quality far below the cows nutritional requirements after mid July (figure 1).

The mean weight gain and net returns on spring and summer pastures of the seasonlong system for early birth date calves born during early April was 2.22 lbs/day (for a loss of 0.16 lbs/day), 29.67 lbs/ac (for a loss of 4.43 lbs/ac), accumulated pasture weight gain of 363.73 lbs (for a loss of 26.33 lbs pasture gain), and final pasture live weight of 500.84 lbs (for a loss of 59.18 lbs weaning weight). The net returns per cow were $347.26 (for a loss of $40.11/cow), per acre were $28.32 (for a loss of $5.54/ac), and per 640 acres were $18,124.80 (for a loss of $3,545.60/640 acres) (table 3). The calves on the seasonlong system with early April births had 2 full weeks, a few calves had 3 weeks, on the crested wheatgrass pastures at ages older than one month in which to gain weight at high rates. The cows with early April calf births had only 1.5 months post calving to reach peak lactation and then after mid July, these cows had rapid reduction in milk production, because the available forage nutritional quality (figure 1) was far below the cows nutritional requirements resulting in reduced calf weight gains.

The mean weight gain and net returns on spring and summer pastures of the twice-over system for late birth date lowline X calves born during May was 2.11 lbs/day (for a loss of 0.27 lbs/day), 30.95 lbs/acre (for a loss of 3.15 lbs/ac), accumulated pasture weight gain of 354.04 lbs (for a loss of 36.02 lbs pasture gain), and final pasture live weight of 427.82 lbs (for a loss of 132.20 lbs weaning weight). The net returns per cow were $342.34 (for a loss of $45.03/cow), per acre were $29.92 (for a loss of $3.94/ac), and per 640 acres were $19,148.80 (for a loss of $2,521.60/640 acres) (table 2). The calves on the twice-over system with May births had no time on the crested wheatgrass pastures at ages older than one month and during the days on the crested wheatgrass pastures at ages younger than one month, the weight gains were at less than 1.25 lbs/day. The cows did not have access to high quality forage during the two months post calving except for only a few days that they grazed the crested wheatgrass pasture, consequently, these cows did not reach peak lactation
rates at their biological potential causing the reduction of calf weight gains.

The mean weight gain and net returns on spring and summer pastures of the twice-over system for late birth date calves born during early June was 1.94 lbs/day (for a loss of 0.44 lbs/day), 28.54 lbs/acre (for a loss of 5.56 lbs/ac), accumulated pasture weight gain of 326.49 lbs (for a loss of 63.57 lbs pasture gain), and final pasture live weight of 367.00 lbs (for a loss of 193.00 lbs weaning weight). The net returns per cow were $307.90 (for a loss of $79.47/cow), per acre were $26.91 (for a loss of $6.95/ac), and per 640 acres were $17,222.40 (for a loss of $4,448.00/640 acres) (table 2). The calves on the twice-over system with early June births had no time on the crested wheatgrass pastures and the calves spent their first month of life, when the calves cannot gain more than 1.25 lbs/day, on native range while it was at its greatest nutritional quality when the cows were increasing in milk production but the calves were unable to convert the greater quantites of milk into weight gain. Even though the nutritional quality of the forage was always greater than the lactating cows nutritional requirements (figure 2), the nutritional quality of the native rangeland forage was not great enough for the cows to produce milk at their biological potential quantities resulting in the reduction in calf weight gains.

The mean weight gain and net returns on spring and summer pastures of the seasonlong system for late birth date calves born during May was 2.04 lbs/day (for a loss of 0.34 lbs/day), 27.99 lbs/acre (for a loss of 6.11 lbs/ac), accumulated pasture weight gain of 343.16 lbs (for a loss of 46.90 lbs pasture gain), and final pasture live weight of 416.44 lbs (for a loss of 143.58 lbs weaning weight). The net returns per cow were $321.55 (for a loss of $65.82/cow), per acre were $26.23 (for a loss of $7.63/ac), and per 640 acres were $16,787.20 (for a loss of $4,883.20/640 acres) (table 3). The calves on the seasonlong system with May births had no time on the crested wheatgrass pasture at ages older than one month and during the days on the crested wheatgrass pastures at ages younger than one month, the weight gains were at less than 1.25 lbs/day. The cows did not have access to high quality forage during the two months post calving except for only a few days that they grazed the crested wheatgrass pasture and then after mid July, these cows had rapid reduction in milk production because the available forage nutritional quality (figure 1) was far below the cows nutritional requirements resulting in the great reduction of the calf weight gains.

The mean weight gain and net returns on spring and summer pastures of the seasonlong system for late birth date calves born during early June was 1.77 lbs/day (for a loss of 0.61 lbs/day), 24.31 lbs/acre (for a loss of 9.79 lbs/ac), accumulated pasture weight gain of 298.00 lbs (for a loss of 92.06 lbs pasture gain), and final pasture live weight of 377.00 lbs (for a loss of 183.02 lbs weaning weight). The net returns per cow were $265.10 (for a loss of

$122.27/cow), per acre were $21.62 (for a loss of $12.24/ac), and per 640 acres were $13,836.80 (for a loss of $7,833.60/640 acres) (table 3). The late birth date calves on the seasonlong system with early June births were severely disadvantaged. The calves had no time on the crested wheatgrass pastures even at ages younger than one month. The cows did not have access to high quality forage during the two months post calving because the cows did not graze the high quality crested wheatgrass forage at anytime after calving. During the first month after calving, these cows grazed native rangeland forage with nutritional quality that was slightly better than their nutritional requirements, when the calves cannot gain more than 1.25 lbs/day. During the second month after calving, these cows had rapid reduction in milk production because after mid July the available native rangeland forage nutritional quality (figure 1) was far below the cows nutritional requirements. These cows never had a chance to reach peak lactation levels resulting in the severe reduction in calf weight gains.

Discussion

Modern, high-performance cattle have greater nutrient demand (27%-43% greater energy and 41%-72% greater crude protein) than old-style cattle because modern cattle are larger and heavier, gain weight more rapidly, produce more milk, and deposit less fat on their bodies (Manske 2014b). The old-style cattle produced less milk but they could continue to produce milk long after the forage quality dropped below their nutrient requirements because during the periods of higher forage quality they deposited greater quantities of body fat that was used during the latter portion of the growing season to maintain milk production. Modern cattle deposit substantially less body fat and greatly decrease milk production within two weeks of the time the forage quality drops below their crude protein requirements resulting in great reductions in calf weight gains (BCRC 1999, Manske 2002, Manske and Schneider 2014c). Availability of crude protein decreases in perennial grasses much earlier in the growing season than availability of energy. Matching calving periods with the availability of crude protein from perennial forage plants has greater importance for modern cattle than it did with old-style cattle when the forefathers of the beef industry established the custom of calving during March.

Perennial grass phenological growth stages and thus the progression of the crude protein quality curves are set by the length of daylight and cannot be moved (Manske 2008a, 2008b, 2011a, 2011b). Growth stage advancement of all perennial forage grasses that grow in the Northern Plains follow only three different developmental patterns. The native grasses, both cool and warm season grass, form the middle growth pattern that provides forage crude protein from early June until mid October (Whitman et al. 1951, Sedivec 1999, Manske 2008a). The early growth pattern is formed by the domesticated cool season grasses, like crested wheatgrass and smooth bromegrass, that provides forage crude protein from early May until early June. The late growth pattern is formed by the numerous wildryes, like Russian and Altai, that provides adequate forage crude protein until mid November. There are no perennial grasses in the Northern Plains that are physiologically capable of being grazed before early May or after mid November (Manske 2011b, Manske and Schneider 2014b).

Greater calf weight gain is accumulated per acre when greater quantities of crude protein are captured per acre. Pounds of beef weight produced per acre is a relatively easy to determine important diagnostic tool to compare effectiveness of forage management practices in crude protein capture and conversion of forage nutrients into calf weight. The forage management practices that are ineffective at capturing forage crude protein, do not produce biological potential pounds of calf weight per acre, and do not produce economic returns at potential level per acre. When the quantity of economic returns captured is below the potential values, the difference is lost income that can not be recovered because there are no forage management practices that can produce economic returns greater than the biological potential level. Capturing biological potential quantities of crude protein per acre requires that the beef cow production periods and the cow nutrient requirements be matched with the available crude protein from perennial forage grasses (Manske and Schneider 2014c, 2014d), which requires calf birth dates before the end of March in the Northern Plains.

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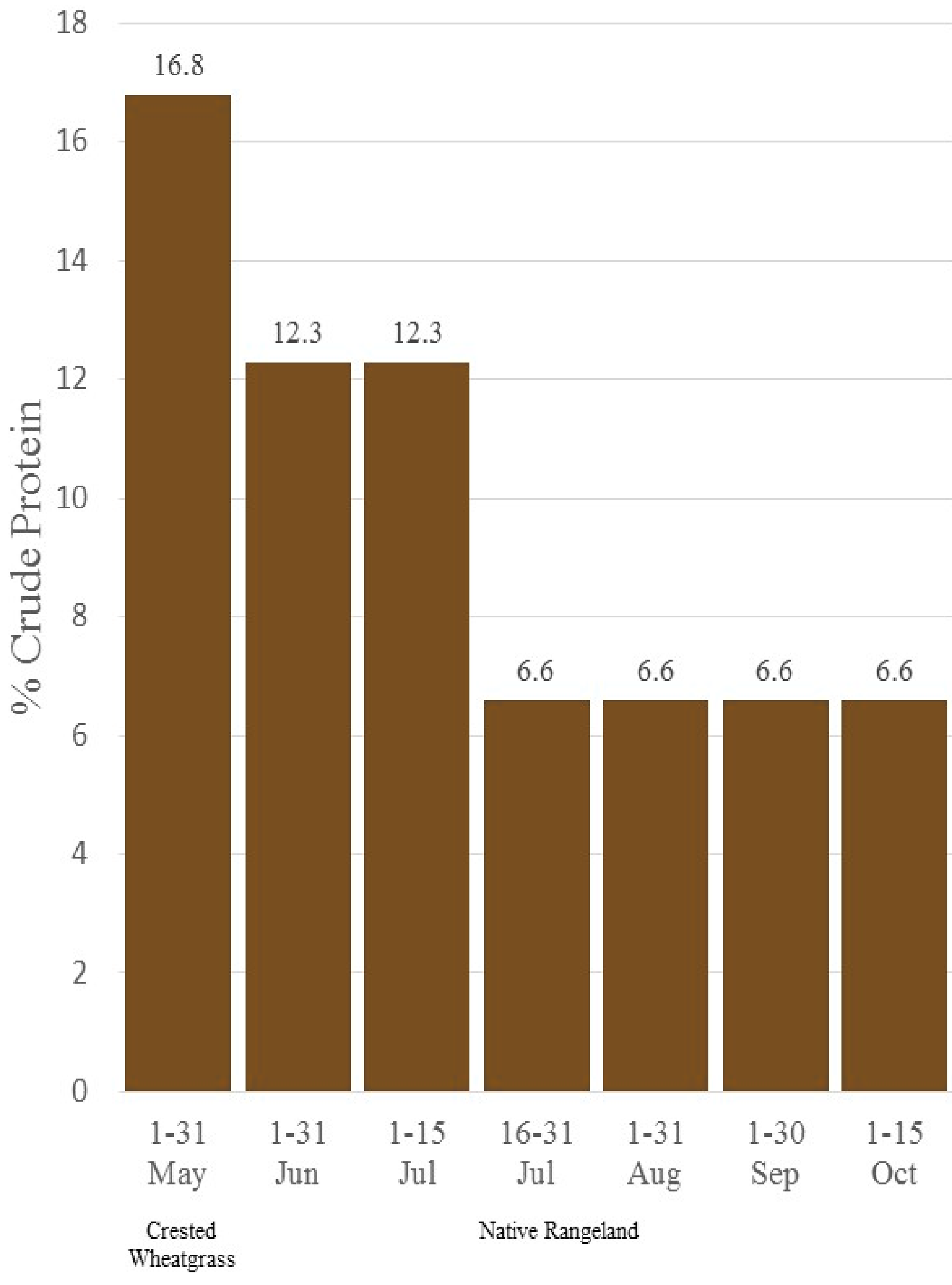

Figure 1. Available Percent Crude Protein on Seasonlong Management.

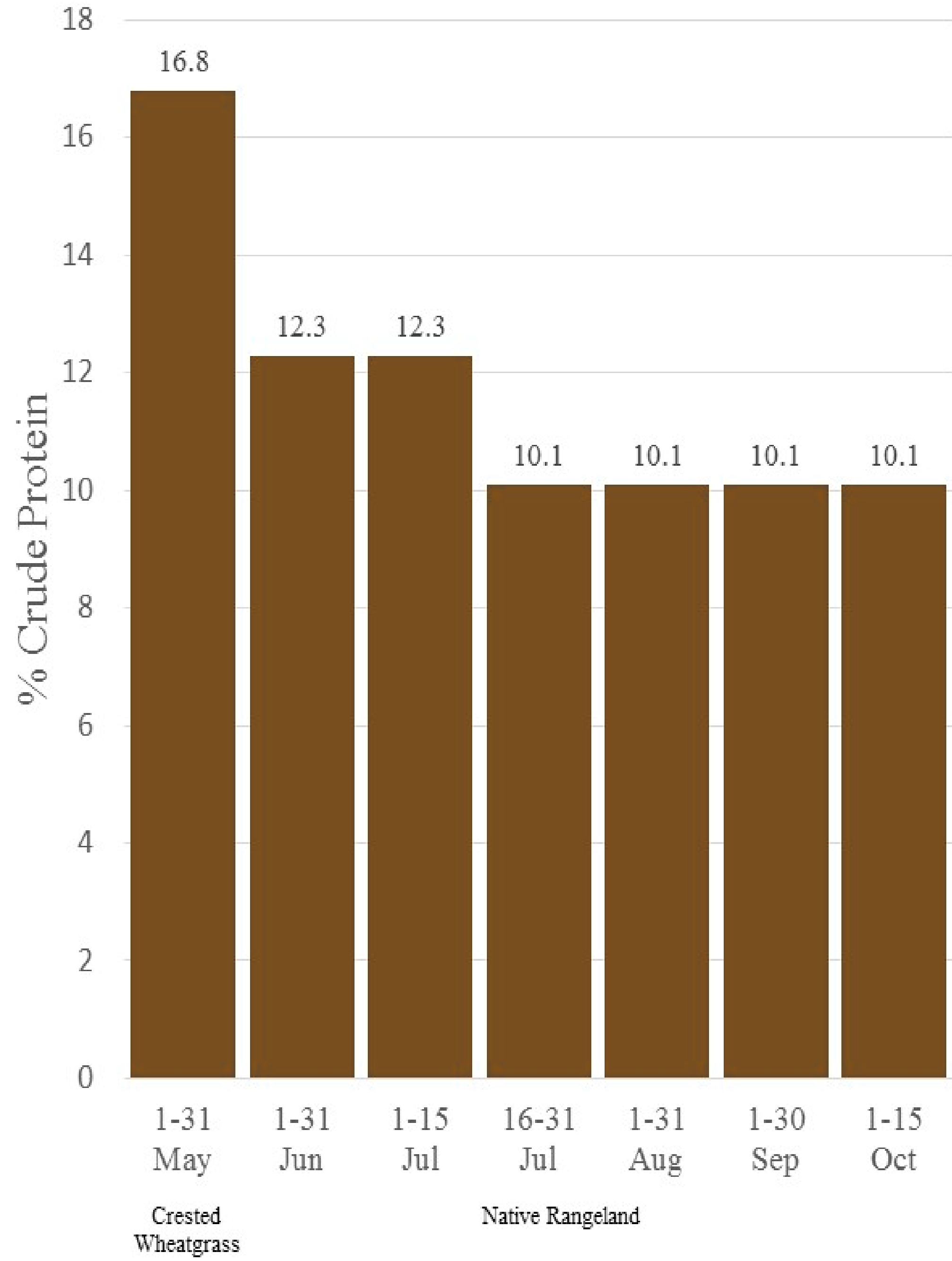

Figure 2. Available Percent Crude Protein on Twice-over Management.

Table 1. Precipitation in inches for growing season months of 2010-2013, DREC Ranch, North Dakota.

	Apr	May	Jun	Jul	Aug	Sep	Oct	Growing Season
Long-term mean 1982-2011	1.41	2.60	3.24	2.44	1.73	1.46	1.28	14.15
2010	1.43	3.70	3.50	1.94	1.39	4.09	0.13	16.18
% of LTM	101.42	142.31	108.02	79.51	80.35	280.14	10.16	114.35
2011	1.66	6.87	2.15	2.33	2.70	1.76	0.44	17.91
% of LTM	117.73	264.23	66.36	95.49	156.07	120.55	34.38	126.57
2012	2.38	1.58	4.31	1.98	0.82	0.21	2.35	13.63
% of LTM	168.79	60.77	133.02	81.15	47.40	14.38	183.59	96.33
2013	1.05	7.55	2.23	2.13	2.81	2.44	3.35	21.56
% of LTM	74.47	290.38	68.83	87.30	162.43	167.12	261.72	152.37
Mean	1.63	4.93	3.05	2.10	1.93	2.13	1.57	17.32
% of LTM	115.60	189.42	94.06	85.86	111.56	145.55	122.46	122.40

Table 2. Weight gain, costs, and net returns for early and late birth calves with lowline cows grazing crested wheatgrass and native rangeland pastures of twice-over rotation from early May to mid October, 2010-2011 and 2012-2013.

		Twice-over Rotation			
		Early Birth Date		Late Birth Date	
		March Born	Early April Born	May Born	Early June Born
Land Rent	$	8.76	8.76	8.76	8.76
Land Area	ac	11.44	11.44	11.44	11.44
Forage Costs	$	100.21	100.21	100.21	100.21
Days on Pasture		164.00	164.00	168.00	168.00
Cost/Day	$	0.61	0.61	0.60	0.60
Calf Wt					
Pasture Gain	lbs	390.06	379.63	354.04	326.49
Gain/Day	lbs	2.38	2.32	2.11	1.94
Gain/Acre	lbs	34.10	33.18	30.95	28.54
Wt Value@$1.25/lb		487.58	474.54	442.55	408.11
Net Return/Cow	$	387.37	374.33	342.34	307.90
Net Return/Acre	$	33.86	32.72	29.92	26.91
Cost/lb Gain	$	0.26	0.26	0.28	0.31
Weaning Wt	lbs	560.02	506.33	427.82	367.00
Cow Wt	lbs	1057.52	1057.52	1120.10	1120.10
% Cow Wt		53.0	47.9	38.2	32.8
C-Cprs/640 ac		56	56	56	56
Net Return/640 ac	$	21,670.40	20,940.80	19,148.80	17,222.40

Table 3. Weight gain, costs, and net returns for early and late birth calves with lowline cows grazing crested wheatgrass and native rangeland pastures of seasonlong from early May to mid October, 2010-2011 and 2012-2013.

		Seasonlong			
		Early Birth Date		Late Birth Date	
		March Born	Early April Born	May Born	Early June Born
Land Rent	$	8.76	8.76	8.76	8.76
Land Area	ac	12.26	12.26	12.26	12.26
Forage Costs	$	107.40	107.40	107.40	107.40
Days on Pasture		164.00	164.00	168.00	168.00
Cost/Day	$	0.65	0.65	0.64	0.64
Calf Wt					
Pasture Gain	lbs	378.72	363.73	343.16	298.00
Gain/Day	lbs	2.31	2.22	2.04	1.77
Gain/Acre	lbs	30.89	29.67	27.99	24.31
Wt Value@$1.25/lb		473.40	454.66	428.95	372.50
Net Return/Cow	$	366.00	347.26	321.55	265.10
Net Return/Acre	$	29.85	28.32	26.23	21.62
Cost/lb Gain	$	0.28	0.30	0.31	0.36
Weaning Wt	lbs	539.61	500.84	416.44	377.00
Cow Wt	lbs	1080.91	1080.91	1126.08	1126.08
% Cow Wt		49.9	46.3	37.0	33.4
C-Cprs/640 ac		52	52	52	52
Net Return/640 ac	$	19,104.00	18,124.80	16,787.20	13,836.80

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