# RANGE RESEARCH REPORT

# Evaluation of Late Calving during Early May to Late June: Effects on Steer and Heifer Weight Gain

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The concept of changing calving dates from the long established traditional March period was initiated during the years when regional stockman attempted to develop a feedlot-slaughter plant system in the Northern Plains. The value added to finished beef animals was lost to the northern regions by shipping weaned calves and stockers to southern facilities. In order to keep a northern feedlot-slaughter plant system economically viable, regional calves would have needed to be available to enter the feedlots each month. Local cow-calf producers would have needed to adjust their calving dates. Even though the northern beef finishing system was not developed, several beef producers have ventured into, or have contemplated, changing their calving date. Unfortunately there is insufficient scientific data available that documents the positive and negative components involved when calving dates are changed from the regional traditional calving date.

**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 2014). Soils are primarily Typic Haploborolls developed on sedimentary deposits. The fine loamy soils have 5 to 6 tons of organic nitrogen per acre. 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 (tables 1 and 2).

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 2014). 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

The purpose of this research project is to describe differences in calf weight gain performance and to identify differences in forage costs and returns from pasture weight gains after forage costs that result from differences in early calf birth dates, early March to mid April, and late calf birth dates, early May to late June.

The range management grazing research projects conducted at the Dickinson Research Extension Center grazed spring and summer perennial grass pastures of the twice-over rotation system and the seasonlong system during the growing seasons from early May to mid October. Lowline X cows composed of 50% lowline and 50% angus and calves with birth dates during early March to mid April were used to graze the spring and summer perennial grass pastures during the growing seasons of 2010 and 2011. The calf birth dates for the lowline X cows were changed to late season calving during early May to late June in 2012 and 2013. These lowline X cows and calves with late birth dates were used to graze spring and summer perennial grass pastures of the twice-over rotation system and the seasonlong system during the growing seasons of 2012 and 2013.

The spring complementary crested wheatgrass pastures were grazed from early May to late May for 28 to 31 days. During the summer portion of the grazing season from early June to mid October, on the seasonlong system, one native rangeland pasture was grazed, and on the twice-over rotation system, three native rangeland pastures were grazed for two periods. During the first period of 45 days, each of the three pastures were grazed for 15 days between 1 June and 15 July (when lead tillers of grasses were between the 3.5 new leaf stage and the flower stage). During the second period of 90 days, each of the three pastures were grazed a second time for 30 days after 15 July and prior to mid October. The spring and summer perennial grass pastures were grazed during early May to mid October for 164 to 168 days. The spring and summer pastures of the seasonlong system and of the twice-over rotation grazing strategy had two replications each.

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.

Calf pasture weight gains, pasture forage costs, and net returns from pasture weight gains after forage costs were determined for the lowline X calves born in 2012 and 2013 with late birth dates during early May to late June, and for the lowline X calves born in 2010 and 2011 with early birth dates during early March to mid April.

## Results

### Calf Gains on Crested Wheatgrass

Pasture weight gains of steer and heifer lowline X calves with birth dates during the late (May) calving season were compared to that of steer and heifer lowline X calves with birth dates during the early (March) calving season with cows grazing the complementary crested wheatgrass pastures of the seasonlong grazing system and of the twice-over rotation system (tables 3 and 4).

Mean calf weight gain on crested wheatgrass pastures of the seasonlong system for steer calves with late birth dates was 0.57 lbs per day, 9.91 lbs per acre, and accumulated weight gain was 19.23 lbs. Mean calf weight gain on crested wheatgrass pastures of the seasonlong system for steer calves with early birth dates was 1.91 lbs per day, 27.65 lbs per acre, and accumulated weight gain was 53.46 lbs. The early born steer lowline X calves on the crested wheatgrass pastures of the seasonlong system had 235.1% greater gain per day, 178.1% greater gain per acre, and accumulated weight gain was 34.23 lbs (178.0%) greater than the weight gain for the late born steer calves (table 3).

Mean calf weight gain on crested wheatgrass pastures of the seasonlong system for heifer calves with late birth dates was 0.76 lbs per day, 13.26 lbs per acre, and accumulated weight gain was 25.72 lbs. Mean calf weight gain on crested wheatgrass pastures of the seasonlong system for heifer calves with early birth dates was 2.01 lbs per day, 29.07 lbs per acre, and accumulated weight gain was 56.40 lbs. The early born heifer lowline X calves on the crested wheatgrass pastures of the seasonlong system had 164.5% greater gain per day, 119.2% greater gain per acre, and accumulated weight gain was 30.68 lbs (119.3%) greater than the weight gain for the late born heifer calves (table 3).

Mean calf weight gain on crested wheatgrass pastures of the twice-over rotation system for steer calves with late birth dates was 1.15 lbs per day, 32.12 lbs per acre, and accumulated weight gain was 39.19 lbs. Mean calf weight gain on crested wheatgrass pastures of the twice-over rotation system for steer calves with early birth dates was 2.08 lbs per day, 47.69 lbs per acre, and accumulated weight gain was 58.18 lbs. The early born steer lowline X calves on the crested wheatgrass pastures of the twice-over rotation system had 80.9% greater gain per day, 48.5% greater gain per acre, and accumulated weight gain was 19.00 lbs (48.5%) greater than the weight gain for the late born steer calves (table 4).

Mean calf weight gain on crested wheatgrass pastures of the twice-over rotation system for heifer calves with late birth dates was 1.04 lbs per day, 28.93 lbs per acre, and accumulated weight gain was 35.29 lbs. Mean calf weight gain on crested wheatgrass pastures of the twice-over rotation system for heifer calves with early birth dates was 1.79 lbs per day, 41.12 lbs per acre, and accumulated weight gain was 50.17 lbs. The early born heifer lowline X calves on the crested wheatgrass pastures of the twice-over rotation system had 72.1% greater gain per day, 42.1% greater gain per acre, and accumulated weight gain was 14.88 lbs (42.2%) greater than the weight gain for the late born heifer calves (table 4).

## Calf Gains on Native Rangeland

Pasture weight gains of steer and heifer lowline X calves with birth dates during the late (May) calving season were compared to that of steer and heifer lowline X calves with birth dates during the early (March) calving season with cows grazing the native rangeland pastures of the seasonlong grazing system and of the twice-over rotation system (tables 3 and 4).

Mean calf weight gain on native rangeland pastures of the seasonlong system for steer calves with late birth dates was 2.46 lbs per day, 31.95 lbs per acre, and accumulated weight gain was 329.77 lbs. Mean calf weight gain on native rangeland pastures of the seasonlong system for steer calves with early birth dates was 2.50 lbs per day, 32.88 lbs per acre, and accumulated weight gain was 339.34 lbs. The early born steer lowline X calves on the native rangeland pastures of the seasonlong system had 1.6% greater gain per day, 2.9% greater gain per acre, and accumulated weight gain was 9.57 lbs (0.3%) greater than the weight gain for the late born steer calves (table 3).

Mean calf weight gain on native rangeland pastures of the seasonlong system for heifer calves with late birth dates was 2.16 lbs per day, 28.08 lbs per acre, and accumulated weight gain was 289.78 lbs. Mean calf weight gain on native rangeland pastures of the seasonlong system for heifer calves with early birth dates was 2.25 lbs per day, 29.63 lbs per acre, and accumulated weight gain was 305.74 lbs. The early born heifer lowline X calves on the native rangeland pastures of the seasonlong system had 4.2% greater gain per day, 5.5% greater gain per acre, and accumulated weight gain was 15.96 lbs (5.5%) greater than the weight gain for the late born heifer calves (table 3).

Mean calf weight gain on native rangeland pastures of the twice-over rotation system for steer calves with late birth dates was 2.32 lbs per day, 30.39 lbs per acre, and accumulated weight gain was 310.56 lbs. Mean calf weight gain on native rangeland pastures of the twice-over rotation system for steer calves with early birth dates was 2.59 lbs per day, 34.42 lbs per acre, and accumulated weight gain was 351.72 lbs. The early born steer lowline X calves on the native rangeland pastures of the twice-over rotation system had 11.6% greater gain per day, 13.3% greater gain per acre, and accumulated weight gain was 41.16 lbs (13.3%) greater than the weight gain for the late born steer calves (table 4).

Mean calf weight gain on native rangeland pastures of the twice-over rotation system for heifer calves with late birth dates was 2.17 lbs per day, 28.45 lbs per acre, and accumulated weight gain was 290.78 lbs. Mean calf weight gain on native rangeland pastures of the twice-over rotation system for heifer calves with early birth dates was 2.31 lbs per day, 30.73 lbs per acre, and accumulated weight gain was 314.06 lbs. The early born heifer lowline X calves on the native rangeland pastures of the twice-over rotation system had 6.5% greater gain per day, 8.0% greater gain per acre, and accumulated weight gain was 23.28 lbs (8.0%) greater than the weight gain for the late born heifer calves (table 4).

The steer and heifer lowline X calves on the crested wheatgrass and native rangeland pastures of the seasonlong system with early (March) birth dates had greater weight gain performance than the steer and heifer calves with late (May) birth dates (table 3).

The steer and heifer lowline X calves on the crested wheatgrass and native rangeland pastures of the twice-over rotation system with early (March) birth dates had greater weight gain performance than the steer and heifer calves with late (May) birth dates (table 4).

Calf Performance on the Seasonlong System

The spring and summer pastures of the seasonlong system were grazed for 168 days from early May to mid October by cows with steer lowline X calves that had late birth dates with an average on 28 May. A cow-calf pair was allotted 12.26 acres for the production period (1.94 acres of crested wheatgrass and 10.32 acres of native rangeland); at a pasture rent value of $8.76 per acre, the forage cost was $107.40 per period, or $0.64 per day. The mean steer calf weight gain was 2.08 lbs per day, 28.47 lbs per acre, and accumulated weight gain was 349.00 lbs. When calf accumulated weight was assumed to have a value of $1.25 per pound, the gross return was $436.25 per calf, and the net returns after pasture costs were $328.85 per cow-calf pair and $26.82 per acre. The net returns after pasture costs on 640 acres was $17,164.80. The cost of calf weight gain was $0.31 per pound. The mean calf final pasture live weight was 424.92 lbs and was 37.4% of the mean cow weight (table 5).

The spring and summer pastures of the seasonlong system were grazed for 164 days from early May to mid October by cows with steer lowline X calves that had early birth dates with an average on 20 March. A cow-calf pair was allotted 12.26 acres for the production period (1.94 acres of crested wheatgrass and 10.32 acres of native rangeland); at a pasture rent value of $8.76 per acre, the forage cost was $107.40 per period, or $0.65 per day. The mean steer calf weight gain was 2.40 lbs per day, 32.04 lbs per acre, and accumulated weight gain was 392.80 lbs. When calf accumulated weight was assumed to have a value of $1.25 per pound, the gross return was $491.00 per calf, and the net returns after pasture costs were $383.60 per cow-calf pair and $31.29 per acre. The net returns after pasture costs on 640 acres was $20,025.60. The cost of calf weight gain was $0.27 per pound. The mean calf final pasture live weight was 546.67 lbs and was 50.3% of the mean cow weight (table 5).

The early born steer calves on the seasonlong system had 15.4% greater gain per day, 12.5% greater gain per acre, and accumulated 43.80 lbs (12.6%) greater weight gain than that of the late born steer calves. The net returns after pasture costs for the early born steer calves were $54.75 (16.6%) greater per cow-calf pair, $4.47 (16.7%) greater per acre, and $2,860.80 (16.7%) greater per 640 acres, and the final pasture live weight was 121.75 lbs (28.7%) greater than those of the late born steer calves on the seasonlong system (table 5).

The spring and summer pastures of the seasonlong system were grazed for 168 days from early May to mid October by cows with heifer lowline X calves that had late birth dates with an average on 25 May. A cow-calf pair was allotted 12.26 acres for the production period (1.94 acres of crested wheatgrass and 10.32 acres of native rangeland); at a pasture rent value of $8.76 per acre, the forage cost was $107.40 per period, or $0.64 per day. The mean heifer calf weight gain was 1.88 lbs per day, 25.73 lbs per acre, and accumulated weight gain was 315.50 lbs. When calf accumulated weight was assumed to have a value of $1.25 per pound, the gross return was $394.38 per calf, and the net returns after pasture costs were $286.98 per cow-calf pair and $23.41 per acre. The net returns after pasture costs on 640 acres was $14,982.40. The cost of calf weight gain was $0.34 per pound. The mean calf final pasture live weight was 386.14 lbs and was 34.6% of the mean cow weight (table 5).

The spring and summer pastures of the seasonlong system were grazed for 164 days from early May to mid October by cows with heifer lowline X calves that had early birth dates with an average on 13 March. A cow-calf pair was allotted 12.26 acres for the production period (1.94 acres of crested wheatgrass and 10.32 acres of native rangeland); at a pasture rent value of $8.76 per acre, the forage cost was $107.40 per period, or $0.65 per day. The mean heifer calf weight gain was 2.21 lbs per day, 29.54 lbs per acre, and accumulated weight gain was 362.14 lbs. When calf accumulated weight was assumed to have a value of $1.25 per pound, the gross return was $452.68 per calf, and the net returns after pasture costs were $345.28 per cow-calf pair and $28.16 per acre. The net returns after pasture costs on 640 acres was $18,022.40. The cost of calf weight gain was $0.30 per pound. The mean calf final pasture live weight was 517.07 lbs and was 48.1% of the mean cow weight (table 5).

The early born heifer calves on the seasonlong system had 17.6% greater gain per day, 14.8% greater gain per acre, and accumulated 46.64 lbs (14.8%) greater weight gain than that of the late born heifer calves. The net returns after pasture costs for the early born heifer calves were $58.30 (20.3%) greater per cow-calf pair, $4.75 (20.3%) greater per acre, and $3,040.00 (20.3%) greater per 640 acres, and the final pasture live weight was 130.93 lbs (33.9%) greater than those of the late born heifer calves on the seasonlong system (table 5).

Calf Performance on the Twice-over System

The spring and summer pastures of the twice-over rotation system were grazed for 168 days from early May to mid October by cows with steer lowline X calves that had late birth dates with an average on 24 May. A cow-calf pair was allotted 11.44 acres for the production period (1.22 acres of crested wheatgrass and 10.22 acres of native rangeland); at a pasture rent value of $8.76 per acre, the forage cost was $100.21 per period, or $0.60 per day. The mean steer calf weight gain was 2.08 lbs per day, 30.57 lbs per acre, and accumulated weight gain was 349.75 lbs. When calf accumulated weight was assumed to have a value of $1.25 per pound, the gross return was $437.19 per calf, and the net returns after pasture costs were $336.98 per cow-calf pair and $29.46 per acre. The net returns after pasture costs on 640 acres was $18,854.40. The cost of calf weight gain was $0.29 per pound. The mean calf final pasture live weight was 428.95 lbs and was 37.6% of the mean cow weight (table 6).

The spring and summer pastures of the twice-over rotation system were grazed for 164 days from early May to mid October by cows with steer lowline X calves that had early birth dates with an average on 19 March. A cow-calf pair was allotted 11.44 acres for the production period (1.22 acres of crested wheatgrass and 10.22 acres of native rangeland); at a pasture rent value of $8.76 per acre, the forage cost was $100.21 per period, or $0.61 per day. The mean steer calf weight gain was 2.50 lbs per day, 35.83 lbs per acre, and accumulated weight gain was 409.90 lbs. When calf accumulated weight was assumed to have a value of $1.25 per pound, the gross return was $512.38 per calf, and the net returns after pasture costs were $412.17 per cow-calf pair and $36.03 per acre. The net returns after pasture costs on 640 acres was $23,059.20. The cost of calf weight gain was $0.24 per pound. The mean calf final pasture live weight was 575.02 lbs and was 54.3% of the mean cow weight (table 6).

The early born steer calves on the twice-over rotation system had 20.2% greater gain per day, 17.2% greater gain per acre, and accumulated 60.15 lbs (17.2%) greater weight gain than that of the late born steer calves. The net returns after pasture costs for the early born steer calves were $75.19 (22.3%) greater per cow-calf pair, $6.57 (22.3%) greater per acre, and $4,204.80 (22.3%) greater per 640 acres, and the final pasture live weight was 146.07 lbs (34.1%) greater than those of the late born steer calves on the twice-over rotation system (table 6).

The spring and summer pastures of the twice-over rotation system were grazed for 168 days from early May to mid October by cows with heifer lowline X calves that had late birth dates with an average on 24 May. A cow-calf pair was allotted 11.44 acres for the production period (1.22 acres of crested wheatgrass and 10.22 acres of native rangeland); at a pasture rent value of $8.76 per acre, the forage cost was $100.21 per period, or $0.60 per day. The mean heifer calf weight gain was 1.94 lbs per day, 28.50 lbs per acre, and accumulated weight gain was 326.07 lbs. When calf accumulated weight was assumed to have a value of $1.25 per pound, the gross return was $407.59 per calf, and the net returns after pasture costs were $307.38 per cow-calf pair and $26.87 per acre. The net returns after pasture costs on 640 acres was $17,196.80. The cost of calf weight gain was $0.31 per pound. The mean calf final pasture live weight was 399.07 lbs and was 36.3% of the mean cow weight (table 6).

The spring and summer pastures of the twice-over rotation system were grazed for 164 days from early May to mid October by cows with heifer lowline X calves that had early birth dates with an average on 17 March. A cow-calf pair was allotted 11.44 acres for the production period (1.22 acres of crested wheatgrass and 10.22 acres of native rangeland); at a pasture rent value of $8.76 per acre, the forage cost was $100.21 per period, or $0.61 per day. The mean heifer calf weight gain was 2.22 lbs per day, 31.84 lbs per acre, and accumulated weight gain was 364.23 lbs. When calf accumulated weight was assumed to have a value of $1.25 per pound, the gross return was $455.29 per calf, and the net returns after pasture costs were $355.08 per cow-calf pair and $31.04 per acre. The net returns after pasture costs on 640 acres was $19,865.60. The cost of calf weight gain was $0.28 per pound. The mean calf final pasture live weight was 518.53 lbs and was 49.1% of the mean cow weight (table 6).

The early born heifer calves on the twice-over rotation system had 14.4% greater gain per day, 11.7% greater gain per acre, and accumulated 38.16 lbs (11.7%) greater weight gain than that of the late born heifer calves. The net returns after pasture costs for the early born heifer calves were $47.70 (15.5%) greater per cow-calf pair, $4.17 (15.5%) greater per acre, and $2,668.80 (15.5%) greater per 640 acres, and the final pasture live weight was 119.46 lbs (29.9%) greater than those of the late born heifer calves on the twice-over rotation system (table 6).

The steer and heifer lowline X calves on the twice-over rotation system had greater weight gains and greater wealth captured from the land natural resources than the steer and heifer calves on the seasonlong system. The early born steer and heifer lowline X calves had greater weight gain per day, greater weight gain per acre, and accumulated greater pasture weight than the late born steer and heifer calves. The net returns after pasture costs for the early born steer and heifer calves were greater per cow-calf pair, greater per acre, and greater per 640 acres, and the final pasture live weight was greater than those of the late born steer and heifer calves on both the twice-over rotation system and seasonlong system.

**Discussion**

Beef livestock agriculture has high production costs and low profit margins because modern high-performance cattle are still being fed with old-style traditional type forage management practices as a direct result from the common assumption that beef weight is the source of income and forage feed is an expense. Beef producers have transformed old-style, low performance cattle into high-performance, fast-growing meat animals with improved genetic potential and increased nutrient demands. Modern, high-performance cattle are larger and heavier, gain weight more rapidly, produce more milk, and deposit less fat on their bodies than old-style cattle. However, the beef production industry has not similarly improved the efficiency and production of forage feed management systems for brood cows. The asymmetrical mismatch between the quantity of forage nutrients required by modern, high-performance cows and the quantity of forage nutrients provided from traditional forage management practices perpetuates the problems with both modern cattle performance and grassland ecosystem productivity to remain at less than potential levels (Manske and Schneider 2008b).

Modern high-performance beef cattle produce at their genetic potentials when their nutrient requirements are met each day (Manske and Schneider 2007). Perennial grassland ecosystems produce at potential levels when the biological requirements of the plants and soil organisms are met (Manske 2011b). The renewable forage plant nutrients produced on the land natural resources are the original source of new wealth generated by beef livestock agriculture (Manske and Schneider 2008b).

The nutrient requirements for beef cows above maintenance levels varies with the changes in nutrient demand from milk production for the nursing calf as it grows and with the changes in nutrient demand of the physiological preparation for breeding and the development of the fetus that will be the next calf (BCRC 1999).

The annual nutritional quality curves of available perennial forage plants change with the development of the phenological growth stages. Plant growth is triggered by changes in day length (photoperiod). Domesticated grasses are physiologically ready for grazing in early May and they have the highest levels of crude protein during May. Native cool-season grasses are physiologically ready for grazing in early June and they have adequate levels of crude protein from early June to the middle of July. Native warm-season grasses are physiologically ready for grazing in mid June and they have adequate levels of crude protein from June to late July (Whitman et al. 1951, Manske 2008a, 2011a). Adequate crude protein levels from native cool-season and warm-season grasses can be extended to late September or mid October by stimulation of vegetative tillers during the period of early June to mid July (Manske 2011b).

The nutritional quality curves of available perennial grasses cannot be changed. The time of year during which the cow production periods with different nutritional requirements occur can be changed and synchronized with the nutritional quality curves of the perennial grasses by rationally setting the calving date which is determined by the breeding date. The nutritional quality curves of the common domesticated grasses and the native rangeland grasses in the Northern Plains match the nutritional requirement curves of the spring and summer lactation production periods of cows with calving dates during January through March (Manske 2002, 2008a).

The nutrients are the valuable products produced by forage plants on the land. The cow processes the forage nutrients and produces milk resulting in calf weight accumulation. The calf weight is the commodity sold at the market, nevertheless, the original source of the income from the sale of beef weight is the forage nutrients. The renewable forage nutrients are the primary unit of production in a beef operation, and they are the source of new wealth from agricultural use of grazingland and hayland resources (Manske and Schneider 2007).

The quantity of new wealth generated from agricultural use of land resources is limited by the biological capacity of the forage plants to produce herbage and nutrients from soil, sunlight, water, and carbon dioxide and by the effectiveness of management treatments in capturing value from plant production. Increasing value captured from the land requires using biologically effective forage management strategies that place priority on plant health and stimulate ecological biogeochemical processes, enhance vegetative plant growth, capture a high proportion of the produced nutrients, and efficiently convert these nutrients into saleable commodities such as calf weight (Manske and Schneider 2007).

The quantity of crude protein captured per acre as livestock feed is the factor that has the greatest influence on the costs of pasture forage and harvested forage and on the amount of new wealth generated from the land resources. The weight of crude protein captured per acre is related to the percent crude protein content and the weight of the forage dry matter at the time of grazing or haying. The cost per pound of crude protein is determined by the weight of the crude protein captured per acre prorated against the forage production costs which include the land costs, equipments costs, and labor costs per acre. Reductions in livestock feed costs result from capturing greater quantities of crude protein per acre. Capturing greater quantities of the produced crude protein from a land base causes reduction in the amount of land area required to feed a cow-calf pair and results in lowering the forage feed costs because the forage production costs per acre are spread over a greater number of pounds of crude protein (Manske and Schneider 2007).

The nutritional quality curves of the domesticated perennial grasses and the native rangeland perennial grasses in the Northern Plains are not synchronized with the nutritional requirement curves of the production periods of cows with calving dates during the perennial grass growing season, April through October (Manske 2002). When the nutrient quality curves of the available perennial forage grasses and nutrient requirement curves of beef cows are not synchronized, modern high-performance beef cattle do not produce at genetic potentials, perennial grassland ecosystems do not produce at biogeochemical potentials, and new wealth captured from forage plant nutrients through beef weight gain is not generated at potential levels. Forage nutrients from sources other than perennial grasses is required to provide low-cost feed for beef cows with calving dates during April through October (Manske 2002).

Lower forage feed costs and greater net returns after forage costs are largely determined by the biological effectiveness of meeting the plant and soil organism requirements, the efficiency of crude protein capture per acre, and the efficiency at conversion of forage crude protein into a saleable product like calf weight resulting from biologically effective forage management strategies that have the nutrient requirement curves of cow production periods synchronized with the nutrient quality curves of the available perennial forage grasses (Manske and Schneider 2007).

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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 | 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. Running total precipitation in inches for growing season months of 2010-2013, DREC Ranch, North Dakota.

| | Apr | May | Jun | Jul | Aug | Sep | Oct |
|---|---|---|---|---|---|---|---|
| Long-term mean 1982-2011 | 1.41 | 4.01 | 7.25 | 9.69 | 11.42 | 12.88 | 14.15 |
| 2010 | 1.43 | 5.13 | 8.63 | 10.57 | 11.96 | 16.05 | 16.18 |
| % of LTM | 101.42 | 127.93 | 119.03 | 109.08 | 104.73 | 124.61 | 114.35 |
| 2011 | 1.66 | 8.53 | 10.68 | 13.01 | 15.71 | 17.47 | 17.91 |
| % of LTM | 117.73 | 212.72 | 147.31 | 134.26 | 137.57 | 135.64 | 126.57 |
| 2012 | 2.38 | 3.96 | 8.27 | 10.25 | 11.07 | 11.28 | 13.63 |
| % of LTM | 168.79 | 98.75 | 114.07 | 105.78 | 96.94 | 87.58 | 96.33 |
| 2013 | 1.05 | 8.60 | 10.83 | 12.96 | 15.77 | 18.21 | 21.56 |
| % of LTM | 74.47 | 214.46 | 149.38 | 133.75 | 138.09 | 141.38 | 152.37 |
| Mean | 1.63 | 6.56 | 9.60 | 11.70 | 13.63 | 15.75 | 17.32 |
| % of LTM | 115.60 | 163.47 | 132.45 | 120.72 | 119.33 | 122.30 | 122.40 |

Table 3. Weight gain for steer and heifer lowline X calves with early and late birth dates, grazing spring and summer seasonlong system pastures, from early May to mid October.

| Seasonlong | | Crested Wheatgrass | Native Rangeland 1st Period | Native Rangeland 2nd Period | Total Native | Total Season | Final Pasture Weight |
|---|---|---|---|---|---|---|---|
| 2010-2011 | | Early Birth Date | | | | | |
| Steer | | | | | | | |
| Weight Gain | lbs | 53.46 | 108.80 | 230.54 | 339.34 | 392.80 | 546.67 |
| Gain/Day | lbs | 1.91 | 2.44 | 2.52 | 2.50 | 2.40 | |
| Gain/Acre | lbs | 27.56 | 10.54 | 22.34 | 32.88 | 32.04 | |
| Heifer | | | | | | | |
| Weight Gain | lbs | 56.40 | 102.00 | 203.74 | 305.74 | 362.14 | 517.07 |
| Gain/Day | lbs | 2.01 | 2.29 | 2.23 | 2.25 | 2.21 | |
| Gain/Acre | lbs | 29.07 | 9.88 | 19.74 | 29.63 | 29.54 | |
| 2012-2013 | | Late Birth Date | | | | | |
| Steer | | | | | | | |
| Weight Gain | lbs | 19.23 | 109.77 | 220.00 | 329.77 | 349.00 | 424.92 |
| Gain/Day | lbs | 0.57 | 2.55 | 2.42 | 2.46 | 2.08 | |
| Gain/Acre | lbs | 9.91 | 10.64 | 21.32 | 31.95 | 28.47 | |
| Heifer | | | | | | | |
| Weight Gain | lbs | 25.72 | 98.21 | 191.57 | 289.78 | 315.50 | 386.14 |
| Gain/Day | lbs | 0.76 | 2.28 | 2.11 | 2.16 | 1.88 | |
| Gain/Acre | lbs | 13.26 | 9.52 | 18.56 | 28.08 | 25.73 | |

Table 4. Weight gain for steer and heifer lowline X calves with early and late birth dates, grazing spring and summer twice-over rotation system pastures, from early May to mid October.

| Twice-over Rotation | | Crested Wheatgrass | Native Rangeland 1st Rotation | Native Rangeland 2nd Rotation | Total Native | Total Season | Final Pasture Weight |
|---|---|---|---|---|---|---|---|
| 2010-2011 | | Early Birth Date | | | | | |
| Steer | | | | | | | |
| Weight Gain | lbs | 58.18 | 113.58 | 238.14 | 351.72 | 409.90 | 575.02 |
| Gain/Day | lbs | 2.08 | 2.55 | 2.60 | 2.59 | 2.50 | |
| Gain/Acre | lbs | 47.69 | 11.11 | 23.30 | 34.42 | 35.83 | |
| Heifer | | | | | | | |
| Weight Gain | lbs | 50.17 | 104.00 | 210.06 | 314.06 | 364.23 | 518.53 |
| Gain/Day | lbs | 1.79 | 2.34 | 2.30 | 2.31 | 2.22 | |
| Gain/Acre | lbs | 41.12 | 10.18 | 20.55 | 30.73 | 31.84 | |
| 2012-2013 | | Late Birth Date | | | | | |
| Steer | | | | | | | |
| Weight Gain | lbs | 39.19 | 102.37 | 208.19 | 310.56 | 349.75 | 428.95 |
| Gain/Day | lbs | 1.15 | 2.38 | 2.29 | 2.32 | 2.08 | |
| Gain/Acre | lbs | 32.12 | 10.02 | 20.37 | 30.39 | 30.57 | |
| Heifer | | | | | | | |
| Weight Gain | lbs | 35.29 | 99.58 | 191.20 | 290.78 | 326.07 | 399.07 |
| Gain/Day | lbs | 1.04 | 2.32 | 2.10 | 2.17 | 1.94 | |
| Gain/Acre | lbs | 28.93 | 9.74 | 18.71 | 28.45 | 28.50 | |

Table 5. Weight gain, costs, and net returns for steer and heifer lowline X calves with early and late birth date categories grazing spring and summer seasonlong system pastures, from early May to mid October.

| | | Early Birth Date | | Late Birth Date | |
|---|---|---|---|---|---|
| Calf Birth Dates | | Steer | Heifer | Steer | Heifer |
| Birth Date | | 20 Mar | 13 Mar | 28 May | 25 May |
| Birth Weight | lbs | 71.9 | 67.1 | 75.9 | 70.6 |
| 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 | 392.80 | 362.14 | 349.00 | 315.50 |
| Gain/Day | lbs | 2.40 | 2.21 | 2.08 | 1.88 |
| Gain/Acre | lbs | 32.04 | 29.54 | 28.47 | 25.73 |
| Wt Value@$1.25/lb | | 491.00 | 452.68 | 436.25 | 394.38 |
| Net Return/Cow | $ | 383.60 | 345.28 | 328.85 | 286.98 |
| Net Return/Acre | $ | 31.29 | 28.16 | 26.82 | 23.41 |
| Cost/lb Gain | $ | 0.27 | 0.30 | 0.31 | 0.34 |
| Weaning Wt | lbs | 546.67 | 517.07 | 424.92 | 386.14 |
| % Cow Wt | | 50.3 | 48.1 | 37.4 | 34.6 |
| C-Cprs/640 ac | | 52 | 52 | 52 | 52 |
| Net Return/640 ac | $ | 20,025.60 | 18,022.40 | 17,164.80 | 14,982.40 |

Table 6. Weight gain, costs, and net returns for steer and heifer lowline X calves with early and late birth date categories grazing spring and summer twice-over rotation system pastures, from early May to mid October.

| | | Early Birth Date | | Late Birth Date | |
|---|---|---|---|---|---|
| Calf Birth Dates | | Steer | Heifer | Steer | Heifer |
| Birth Date | | 19 Mar | 17 Mar | 24 May | 24 May |
| Birth Weight | lbs | 74.5 | 70.1 | 79.2 | 73.0 |
| 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 | 409.90 | 364.23 | 349.75 | 326.07 |
| Gain/Day | lbs | 2.50 | 2.22 | 2.08 | 1.94 |
| Gain/Acre | lbs | 35.83 | 31.84 | 30.57 | 28.50 |
| Wt Value@$1.25/lb | | 512.38 | 455.29 | 437.19 | 407.59 |
| Net Return/Cow | $ | 412.17 | 355.08 | 336.98 | 307.38 |
| Net Return/Acre | $ | 36.03 | 31.04 | 29.46 | 26.87 |
| Cost/lb Gain | $ | 0.24 | 0.28 | 0.29 | 0.31 |
| Weaning Wt | lbs | 575.02 | 518.53 | 428.95 | 399.07 |
| % Cow Wt | | 54.3 | 49.1 | 37.6 | 36.3 |
| C-Cprs/640 ac | | 56 | 56 | 56 | 56 |
| Net Return/640 ac | $ | 23,059.20 | 19,865.60 | 18,854.40 | 17,196.80 |

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