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RESEARCH

# Early Weaning Reduces Rangeland Herbage Disappearance

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## Abstract

Early weaning of beef calves reduces nutrient and forage demand in a cow–calf enterprise, potentially contributing to reduction in forage utilization on the pasture from which calves are removed by a nonlactating cow vs. a cow–calf pair. Research was conducted to evaluate weaning beef calves 90 days early (EW) vs. normal weaning (NW) on pasture herbage disappearance in mixed-grass prairie pastures in the northern Great Plains. Spring-calving cows ($n$ = 48) were utilized in each study year (2003, 2004, and 2006) from the date of early weaning (August) until the date of normal weaning (November). Cow–calf pairs were randomly assigned each year to each NW pasture ($n$ = 8 pasture$^{-1}$); cows whose calves had been weaned early were randomly assigned to each EW pasture ($n$ = 8 pasture$^{-1}$). No calves grazed EW pastures. Cattle were weighed and body condition scored at the beginning and end of each trial period. Available herbage was determined before and after grazing in each pasture. The effect of weaning treatment on cow average daily gain and body condition score change was highly significant ($P$ < 0.001). Early-weaned cows gained weight and condition; normal-weaned cows lost weight and condition. Herbage disappearance was lower ($P$ = 0.017) in EW than NW pastures, resulting in 18.9 lb cow$^{-1}$ day$^{-1}$, or 36%, herbage savings. This is equivalent to an additional 1.1 month of grazing saved per animal unit over a 90-day period. The value of the additional animal-unit months includes extending the grazing season, increasing cow numbers, or as "banked" forage for drought management.

EARLY WEANING IS a management strategy that may reduce forage consumption during the nursing period, and therefore may increase forage available for other uses on the pasture from which calves are removed. Research has demonstrated that early weaning has improved fall cow body condition score (BCS) and cow body weight (BW) (Merrill et al., 2008; Odhiambo et al., 2009; Martins et al., 2012; Waterman et al., 2012), thereby reducing winter feeding costs while maintaining adequate BCS and BW before calving in spring (Merrill et al., 2008; Waterman et al., 2012). Drylot studies have demonstrated early-weaned cows consumed less harvested forage than normal-weaned cow–calf

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**Abbreviations:** ADG, average daily gain; AUM, animal-unit month; BCS, body condition score; BW, body weight; EW, early weaning; NW, normal weaning.

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**Table A. Useful conversions.**

| To convert Column 1 to Column 2, multiply by | Column 1 Suggested Unit | Column 2 SI Unit |
|---|---|---|
| 1.609 | mile, mi | kilometer, km ($10^{-3}$ m) |
| 2.54 | inch | centimeter, cm ($10^{-2}$ m) |
| 0.405 | acre | hectare, ha |
| 0.454 | pound, lb | kilogram, kg |
| 1.12 | pound per acre, lb/acre | kilogram per hectare, kg/ha |
| 5/9 (°F – 32) | Fahrenheit, °F | Celsius, °C |

pairs during the early-wean to normal-wean period (Peterson et al., 1987; Arthington and Minton, 2004). Pasture-based studies have shown that early-weaned cows consumed less supplemental forages (primarily hay) from the time of early weaning to normal weaning compared to normal-weaned cow–calf pairs (Story et al., 2000; Galindo-Gonzalez et al., 2007); utilization of pasture forages was not, however, evaluated in these studies. Reduced forage intake by early-weaned cows in fall should result in savings of grazed rangeland forage on the pasture from which early-weaned calves are removed; however, studies demonstrating a benefit of early weaning in measurable rangeland forage savings are lacking. While it is tempting to assume forage savings on rangelands would be similar to estimates of forage savings from drylot feeding studies, such studies do not include forage losses on rangelands associated with grazing, including wastage, trampling, and fouling. If early-weaned calves are removed from rangeland pastures and marketed after weaning, potential benefits of forage savings include opportunities to increase herd size, extend the grazing season to reduce harvested feed costs of the cow, limit herd reductions in drought years, reserve forage in case of future drought, or promote beneficial plant community change.

We initiated research in 2003 to evaluate early weaning as a management option for ranchers grazing cattle in the northern Great Plains. The objective of the component of that study described in this paper was to determine whether early weaning provides measurable savings in rangeland herbage for spring-calving cows.

## STUDY AREA DESCRIPTION AND SAMPLING STRATEGY

This study was conducted in 2003, 2004, and 2006 at the North Dakota State University Dickinson Research Extension Center pastures (47°12′3″ N, 102°51′2″ W; elevation: 2410 ft), located approximately 22 mi north of Dickinson, ND. The study site was a 593-acre pasture subdivided into twelve 49.4-acre pastures in a wagon-wheel configuration with central watering. The pastures were grouped into two sets of six pastures. One group of six pastures was grazed during the period from early weaning to normal weaning in odd years, with the other group of six pastures grazed from early weaning to normal weaning in even years. The six pastures used in each year were grouped into three pairs based on similarity of topography, soils, and vegetation composition. Each pasture of a pair was assigned to either an early-weaning (EW) or a normal-weaning (NW) treatment in a randomized complete block design yielding three replicate pastures per treatment.

The study area is typical of the northern mixed-grass prairie, and ranching represents the major land use. Ecological sites are primarily Thin Claypan, Clayey, and Shallow Clayey (USDA–NRCS, 2014c). Common grass species include needleandthread [*Hesperostipa comata* (Trin. & Rupr.) Barkworth], little bluestem [*Schizachyrium scoparium* (Michx.) Nash], prairie sandreed [*Calamovilfa longifolia* (Hook.) Scribn.], western wheatgrass [*Pascopyrum smithii* (Rybd.) Á. Löve], blue grama [*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths], and buffalograss [*Bouteloua dactyloides* (Nutt.) J.T. Columbus] (USDA–NRCS, 2014a). Plant species nomenclature follows the USDA Plants Database (USDA–NRCS, 2014b).

The climate of the region is continental and semiarid with hot summers and cold winters. Maximum mean temperature at the Dickinson Station Ranch Headquarters (located within 1 mi of the study pastures) in July is 82.3°F, and minimum mean temperature in January is 3.4°F (HPRCC, 2014). Long-term annual precipitation at the Dickinson Station Ranch Headquarters is 16.07 inches (HPRCC, 2014). Annual precipitation for the 3 years of the study was similar to or greater than the long-term (1971–2000) average (Table 1). Average annual temperatures for the three study years were similar to the long-term (1971–2000) average (Table 1).

Hereford × Angus commercial cows ($n$ = 48, average BW = 1396 lbs; average calving date = 11 April) were utilized in each of the three years of the study (2003, 2004, and 2006; no data collected in 2005) from the date of early weaning until the date of normal weaning to determine any differences in herbage disappearance in relation to time of weaning. Eight cows with calves were randomly assigned each year to each of the three NW pastures, and eight cows whose calves had been weaned early were randomly assigned to each of the three EW pastures. All cattle were weighed, and cows were scored for BCS using a 9-point scale (1 = extremely emaciated, 9 = extremely obese; Wagner et al., 1988) when placed on the pastures at the time of early weaning and when removed from pastures at normal weaning. Cow BW at the beginning of the study were 1293, 1291, and 1424 lb (SE = 15.9) for 2003, 2004, and 2006, respectively.

Table 1. Long-term (1971–2000) average and monthly temperature (°F) and precipitation (inches) for 2003, 2004, and 2006 at the Dickinson Station Ranch Headquarters, near Manning, ND†.

| Month | Temperature | | | | Precipitation‡ | | | |
|---|---|---|---|---|---|---|---|---|
| | 1971–2000 | 2003 | 2004 | 2006 | 1971–2000 | 2003 | 2004 | 2006 |
| | °F | | | | inches | | | |
| January | 13.8 | 14.7 | 7.9 | 29.0 | 0.4 | 0.9 | 0.8 | 0.5 |
| February | 20.7 | 14.4 | 18.9 | 18.6 | 0.4 | 0.4 | 0.9a | 0.6 |
| March | 30.0 | 24.7 | 34.2 | 27.8 | 0.8 | 3.5 | 1.9 | 1.1 |
| April | 41.9 | 45.2 | 43.5 | 46.7 | 1.4 | 1.3 | 0.9 | 2.7 |
| May | 54.0 | 53.2 | 50.9 | 54.0 | 2.1 | 4.3 | 1.3 | 2.8 |
| June | 63.0 | 61.6 | 58.2 | 64.1 | 3.0 | 1.4b | 1.7 | 2.1 |
| July | 68.6 | 71.1 | 68.9 | 74.8 | 2.5 | 2.0 | 2.0 | 1.0 |
| August | 68.1 | 72.6 | 63.8 | 69.9 | 1.8 | 0.8 | 0.9 | 2.9 |
| September | 56.8 | 57.3 | 59.1 | 55.7 | 1.4 | 2.4 | 2.3 | 1.4 |
| October | 43.9 | 48.7 | 43.1 | 38.8 | 1.2 | 0.7 | 3.1 | 2.0 |
| November | 27.7 | 20.2 | 35.0 | 30.5 | 0.7 | 0.6 | 0.2 | 0.3 |
| December | 16.6 | 24.1 | 23.5 | 22.4 | 0.4 | 0.7a | 0.4 | 0.7 |
| Annual | 42.2 | 42.3 | 42.2 | 44.3 | 16.1 | 19.1 | 16.3 | 17.6 |
| % of long-term avg. | | | | | 100 | 119.0 | 101.4 | 109.5 |

† From HPRCC (2014).

‡ Precipitation values followed by a letter indicate missing data for 1 day (a) or 3 days (b).

Weaning dates for EW calves were 11 Aug. 2003, 10 Aug. 2004, and 8 Aug. 2006; weaning dates for NW calves were 6 Nov. 2003, 23 Nov. 2004, and 7 Nov. 2006.

Fifty vegetation sample sites were randomly located in each pasture. Before grazing the pastures each year, paired plots (0.25 sq m; 2.69 sq ft) with similar species composition and biomass were marked at each sample site. Plots sampled in previous years were avoided. Locations of plots were recorded using GPS (Global Positioning System) units, and plots were marked with wooden stakes to facilitate relocation. One plot of each pair was randomly assigned to either the pre- or postgrazing sampling period. Pregrazing biomass was collected on each of the 50 pregrazing plots in each pasture just before initiation of grazing (late July or early August), and postgrazing biomass was collected on each of the 50 postgrazing plots in each pasture after cattle were removed from the pastures (November). At each sampling period, all vegetation in each plot for that period was clipped to ground level and bagged. Samples were oven-dried at 140°F, and herbage disappearance was calculated as the difference between pre- and postgrazing sample weights for each pair of plots. Disappearance was converted from g 0.25 m$^{-2}$ to lb cow$^{-1}$ day$^{-1}$. Quality of forage in the pastures during the study was expected to be fairly low because grazing occurred at the end of the growing season. Some regrowth due to favorable fall temperatures and precipitation (Table 1) likely improved forage quality to some degree. Forage quality was not, however, determined for vegetation in the study pastures. Plant communities between study pastures were similar, providing very similar forage quality for cattle in both weaning treatments.

## STATISTICAL ANALYSIS

The experiment was a randomized complete block design with pasture pairs as blocks ($n$ = 3); treatments were randomly assigned to pastures within each block. Two levels of treatment (early- and normal-weaned cows), were applied to the pastures over 3 years, creating a two-weaning treatment by three-year factorial treatment structure. Herbage disappearance, cattle BW, BCS, average daily gain (ADG), and change in BCS from early weaning to normal weaning were analyzed using PROC MIXED of SAS (SAS Institute, 2008) to determine treatment and year effects and their interaction. Replicated pastures were the experimental units to which the fixed factors of EW or NW were randomly applied, and therefore pasture replicate was specified as the random effect. The Kenward–Roger option was used to estimate denominator degrees of freedom. Year was specified as a repeated measure. The variance–covariance matrix was chosen in an iterative process wherein best fit was based on the Schwarz's Bayesian Criterion (Compound Symmetry provided the best fit). Initial BW or BCS were included as a covariate for cattle final BW, final BCS, ADG, and BCS change as appropriate. Significance was interpreted at $P <$ 0.05 for all tests unless otherwise indicated.

## HERBAGE DISAPPEARANCE

The availability of forage throughout the grazing period on all pastures was not limiting in any year (Table 2). Average herbage standing crop for EW and NW pastures across the three study years before grazing was 1889 and 1764 lb acre$^{-1}$, respectively; postgrazing herbage standing crop averaged 1348 and 1054 lb acre$^{-1}$ for EW and NW pastures, respectively. Herbage disappearance was greater ($P$ = 0.017) in NW pastures compared to EW pastures

**Table 2. Least squares means (SEM) for cattle weight and body condition score (BCS), and herbage biomass at early-weaning (EW; early August) and normal-weaning (NW; early November) dates in 2003, 2004, and 2006 for a grazing study at North Dakota State University Dickinson Station Ranch pastures. Three EW pastures were grazed by eight recently weaned, nonlactating cows without calves (calves weaned one day earlier) and three NW pastures were grazed by eight cow–calf pairs.**

| | Year and weaning date | | | | | |
|---|---|---|---|---|---|---|
| | 2003 | | 2004 | | 2006 | |
| Variable measured | August | November | August | November | August | November |
| Cow weight (lb) | | | | | | |
| EW cows | 1261 (22.4) | 1292 (18.1) | 1275 (22.4) | 1331 (16.5) | 1450 (22.4) | 1499 (23.2) |
| NW cows | 1325 (22.4) | 1086 (13.1) | 1307 (22.4) | 1236 (13.9) | 1398 (22.4) | 1331 (16.6) |
| Cow BCS | | | | | | |
| EW cows | 5.83 (0.235) | 5.64 (0.159) | 4.71 (0.235) | 6.43 (0.165) | 5.83 (0.235) | 6.04 (0.139) |
| NW cows | 5.83 (0.235) | 3.59 (0.159) | 4.75 (0.235) | 5.16 (0.161) | 5.13 (0.235) | 4.81 (0.136) |
| Calf weight (lb) | | | | | | |
| EW calves | 389 (17.3) | – | 411 (17.3) | – | 443 (17.3) | – |
| NW calves | 411 (17.3) | 529 (16.2) | 412 (17.3) | 619 (16.2) | 432 (17.3) | 632 (16.2) |
| Herbage biomass (lb/acre) | | | | | | |
| EW pastures | 1984 (694) | 1268 (113) | 1778 (345) | 1253 (128) | 1905 (169) | 1523 (221) |
| NW pastures | 2126 (505) | 1148 (83) | 1403 (393) | 999 (94) | 1763 (235) | 1014 (68) |

(52.5 vs. 33.6 ± 15.0 lb cow$^{-1}$ day$^{-1}$, respectively). Disappearance did not differ among years ($P = 0.77$) or respond to the weaning treatment × year interaction ($P = 0.99$).

An average herbage savings of 18.9 lb cow$^{-1}$ day$^{-1}$, or 36%, resulted when early weaning was used as a management tool. Using a 90-day grazing period (from early to normal weaning), the amount of additional herbage available per cow was 1701 lb (18.9 lb cow$^{-1}$ day$^{-1}$ × 90 day). Assuming 50% grazing efficiency, 1.1 additional animal-unit months (AUMs; 1 AUM = 780 lb forage) would be available (1701 lb × 50% × 1 AUM/780 lb herbage) per cow. The value from a livestock producer standpoint of this amount of saved herbage accrued as additional AUMs is that it could be used in variety of ways, such as extending the grazing season later into the fall and winter, increasing the number of cows, or as "banked" forage to contribute to a drought management plan. During drought, herbage savings due to early weaning can reduce damaging grazing pressure on rangeland pastures and/or reduce the need to cull the cow herd to balance limited forage resources.

Our results are proportionate to herbage savings calculated based on forage consumption by a nonlactating (EW) cow compared to a suckling calf plus lactating cow (NW) using NRC (2000) predictions of forage intake. Predicted forage intake based on NRC (2000) for a 1350-lb cow in early gestation is 27.2 and 28.9 lb day$^{-1}$ when nonlactating and lactating, respectively. Predicted forage intake for a 500-lb calf is 11.9 lb day$^{-1}$. Daily forage intake of suckling calves calculated using data from Ansotegui et al. (1991) ranges from 1.4 to 2.8% of calf BW, which is supportive of this calculation (11.9 lb equals 2.4% of BW). Predicted daily forage intake by an EW, nonlactating cow of 27.2 lb is about 81% of measured EW herbage disappearance, while the sum of predicted daily forage intake by a NW calf and lactating cow is 40.8 lb, which is about 78% of measured NW disappearance. The fact that predicted forage intake is a percentage of total disappearance should be expected because disappearance due to nonconsumptive processes, such as trampling and waste, also occurs. Favorable precipitation and temperatures from August to November (Table 1) in each year of the study likely resulted in vegetation growth during that period, increasing the mass of herbage available for grazing from the beginning of the grazing period to the end of the grazing period in all pastures similarly. Thus, our estimates of herbage disappearance in both treatments are likely conservative. However, differences in disappearance were the main emphasis of this study, and should have remained proportional as long as neither treatment limited forage growth potential.

This study is unique in that it evaluates differences in pasture forage disappearance by EW cows and NW cow–calf pairs from rangeland pastures rather than disappearance of harvested forages in drylot or supplemental harvested forages on pasture. Results of this study, however, support results of other studies that reported substantial harvested feed savings associated with early weaning (Peterson et al., 1987; Purvis II and Lusby, 1996; Story et al., 2000). Peterson et al. (1987) reported 45.3% less forage consumption of harvested feed by early-weaned cows than normal-weaned cow–calf pairs, which is similar to the 36% pasture forage savings determined in this study.

## CATTLE RESPONSES

The effect of weaning treatment on cow ADG and BCS change was highly significant ($P < 0.001$). Early-weaned cows gained BW and BCS during the early-wean to normal-wean period, whereas NW cows lost both BW and BCS (Table 2). These results are similar to those reported for other weaning studies conducted on pasture (Merrill et al., 2008; Odhiambo et al., 2009; Martins et al., 2012; Waterman et al., 2012) and in drylot (Peterson et al., 1987).

Forage quantity was not limiting for either the EW or NW herds (Table 2); forage quality would have been relatively poor, but similar for both EW and NW cows. Thus, the reduction in cow BW and BCS of NW cows compared to the EW cows is most likely explained by the continued demand for milk by NW calves. It is likely, however, that NW calf gains of 1.86 lb day$^{-1}$ (SEM = 0.02) during the early-wean to normal-wean period were limited due to the quality of the forage available to the cows and calves.

When removing early-weaned calves from rangeland, it is important to recognize that savings in grazed herbage and harvested feed costs associated with cow maintenance must also be weighed against the possible loss in calf value due to lighter weaning weight at early weaning (Table 2) (Story et al., 2000) or with additional harvested feed costs accumulated with feeding early-weaned calves harvested feeds. Strategic feeding and marketing plans for early-weaned calves must be incorporated into an EW program (Lusby et al., 1981; Peterson et al., 1987; Story et al., 2000; Weder et al., 2004; Arthington et al., 2005). Opportunity cost for individual operations should be calculated, and the program should be evaluated for ranch profitability as a whole, from cow–calf through the level of retained ownership needed to obtain comparable or superior profits to an NW program (Story et al., 2000).

## IMPLICATIONS

Substantial economic value may be associated with the level of pasture herbage savings demonstrated in this study. Additional available herbage from removing early-weaned calves from rangeland could be used to extend the grazing season and reduce reliance on purchased and harvested feed for cows during winter. Alternatively, additional cattle could be added to the herd to utilize the additional AUMs of available grazing. During drought, herbage savings due to early weaning can reduce damaging grazing pressure on rangeland pastures and/or reduce the need to cull the cow herd to balance forage resources. The additional benefit of early weaning demonstrated in this study and others where cattle grazed pastures or rangeland (Short et al., 1996; Schultz et al., 2005; Merrill et al., 2008; Waterman et al., 2012) is increased BW and BCS for early-weaned cows compared with conventionally weaned cows. This benefit in BW and BCS for early weaning has also been demonstrated for cattle grazing pastures with supplemental feed provided (Story et al., 2000; Odhiambo et al., 2009; Martins et al., 2012). Cows entering the winter months at a heavier weight and in superior body condition require less feed to maintain them in good condition through calving and rebreeding, reducing expensive winter feed costs and improving profitability.


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