Pasture and Forage Costs of Grazingland and Harvested Forages for Range Cows

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Introduction

The beef production industry in the Northern Plains has low profit margins, primarily because production costs are relatively high. Reducing forage-feed costs is essential to improving profit margins because these costs constitute the greatest portion of the total production costs for a beef cow and calf. Livestock feed costs can be evaluated through comparisons of land rent values, production costs per acre (including equipment and labor), forage dry matter costs per ton, and nutrient costs per pound.

This study is intended as a comparison of pasture and forage costs of forage dry matter and crude protein for several types of grazingland forages and harvested forages. The goal of the study is to provide an understanding of the factors that affect livestock feed costs and to apply that knowledge to the development of lower-cost livestock feed management strategies. This study is not a complete economic analysis of total livestock production costs or a study in marketing schemes.

Procedure

Information on grazinglands was collected on domesticated grass and native rangeland pastures during grazing management projects conducted between 1983 and 1998 at the NDSU Dickinson Research Extension Center, located in western North Dakota. Pasture production costs were based on average land rent. Pasture-forage biomass values were based on the means of the average monthly herbage biomass data for the period grazed and on the average grazing dates and average stocking rates for the grazing treatments. Crude protein values for native range herbage were taken from Whitman et al. (1951) and Manske (1999a, b). Forage dry matter yield per acre and percent crude protein data for perennial domesticated grass hay and annual cereal and annual legume hays were taken from a previous study (Manske and Carr 2000). The annual forage data were summarized for the years 1995 to 1999 from forage production trials conducted by Dr. Pat Carr at the Dickinson Research Extension Center. Average production costs per acre for each forage type were determined by adding average custom farm work rates (Beard 1998), average land rent per acre (from western North Dakota), and average seed costs per acre (Swenson and Haugen 1999). Production costs do not include costs of fertilizer, pesticides, or transporting of feed, forages, and livestock unless specified. Pasture rent value of $8.76 per acre was used to determine costs of domesticated grass and native rangeland pastures. The value of $2.00 per acre was used for cropland aftermath grazing costs. Land rent values of $22.07 per acre for cropland and $14.22 per acre for hayland were used in the determination of forage production costs for the harvested forages.

Several grazing management treatments and grazingland-forage types and harvested-forage types were evaluated during this study. Grazingland-forage and harvested-forage types were evaluated separately during each of the range cow production periods.

The dry gestation production period was 32 days from mid November to mid December. Native rangeland was evaluated for 32 days of grazing on the 12-month repeated seasonal (12-m RS) treatment. Cropland aftermath was grazed for 32 days on the 4.0-month deferred (4.0-m Def) treatment.

The third trimester production period was 90 days from mid December to mid March. Native rangeland was evaluated for 90 days of grazing on the 12-month repeated seasonal (12-m RS) treatment.

The early lactation production period was 45 days from mid March to late April. Native rangeland was evaluated for 45 days of grazing on the 12-month repeated seasonal (12-m RS) treatment.

The lactation production period was 198 days from early May to mid November and was subdivided into three portions. The spring portion of the lactation period was 31 days from early to late May. Native rangeland was evaluated for 31 days of grazing on the 12-month repeated seasonal (12-m RS) treatment. Native rangeland was grazed for 16 days on the 6.0-month seasonlong (6.0-m SL) treatment. Unfertilized crested wheatgrass was grazed for 31 days on the 4.5-month seasonlong (4.5-m SL) and for 76 days on the 4.0-month deferred (4.0-m Def) treatments. Fertilized crested wheatgrass was grazed for 31 days on the 4.5-month twice-over rotation (4.5-m TOR) treatment.

The summer portion of the lactation period was 137 days from early June to mid October. Native rangeland was evaluated for 137 days of grazing on the 12-month repeated seasonal (12-m RS) treatment.

Native rangeland was grazed for 137 days on the 6.0-month seasonlong (6.0-m SL), for 137 days on the 4.5-month seasonlong (4.5-m SL), for 92 days on the 4.0-month deferred (4.0-m Def), and for 137 days on the 4.5-month twice-over rotation (4.5-m TOR) treatments.

The fall portion of the lactation period was 30 days from mid October to mid November. Native rangeland was evaluated for two 15-day segments of grazing on the 12-month repeated seasonal (12-m RS) treatment. Native rangeland was grazed for 15 days on seasonlong treatments with 4.5-month periods (SL 4.5-m) and for 30 days on seasonlong treatments with 5.0-and 6.0-month periods (SL 5.0-6.0-m). Native rangeland was grazed for 30 days on the 6.0-month seasonlong (6.0-m SL) and for 30 days on the 4.0-month deferred (4.0-m Def) treatments. Altai wildrye was grazed for 30 days on the 4.5-month twice-over rotation (4.5-m TOR) treatment. Cropland aftermath was grazed for 30 days on the 4.5-month seasonlong (4.5-m SL) treatment.

The harvested forages were cut by swathing and were then rolled into large round bales. Late crested wheatgrass hay was cut at a mature plant stage. Early crested wheatgrass hay was cut at the boot stage. Forage barley hay was cut both at the milk stage and at the hard dough stage. Oat forage hay was cut both at the milk stage and at the hard dough stage. Pea forage hay was cut at both early and late plant stages. Forage lentil hay was cut at both early and late plant stages. Oat-pea forage was cut for hay.

The costs per acre for pasture and the costs per ton for harvested forages are not directly comparable. However, the cost per pound or ton of ingested forage dry matter from pastures and the cost per pound or ton of forage dry matter from harvested forages can be compared. Costs per unit of forage dry matter (DM) biomass production were determined by dividing average production costs per acre by pounds of dry matter harvested by grazing or haying per acre. Costs per unit of crude protein (CP) were determined in two stages: first, pounds of forage dry matter harvested by grazing or haying per acre were multiplied by percentage of crude protein to derive pounds of crude protein per acre; then average production costs per acre were divided by pounds of crude protein per acre.

The terms “herbage” and “forage” are not synonymous. Herbage is the total amount of aboveground biomass of herbaceous plants like grasses and forbs. Forage is the portion of the herbage that can be removed without detriment to the plants and can provide feed for grazing animals or be harvested mechanically for feeding. About 50% of the perennial plant herbage produced on grazinglands must remain with the plant to sustain healthy and productive growth. Determination of the quantitative value for 50% of the herbage produced is relatively straightforward for seasonlong and single-grazing-period grazing treatments but requires a complex set of data for grazing treatments with multiple grazing periods.

About 50% of the herbage biomass produced during the growing season can be removed from the plant without harmful effects to plant health. The amount of forage ingested by grazing livestock is actually only about 50% of this quantity, or about 25% of the aboveground herbage biomass on seasonlong and single-grazing-period treatments. This value has not been determined for grazing treatments with multiple grazing periods. The remainder of the herbage that can be removed is broken from the plant, soiled by animal waste, consumed by insects and wildlife, and lost to other natural processes.

Results

Pasture and forage costs of grazingland and harvested forages for range cows are shown in tables 1-8.

Herbage weight of perennial plants increases from early season through May, June, and July until peak herbage biomass, which occurs during the last couple weeks of July. Herbage weight then decreases as plants age and dry. The quantity of herbage biomass produced on grazinglands is dependent on plant size and plant density. These two characteristics are directly affected by the level of plant health, which is determined by the biological effectiveness of the grazing management practices used. Management practices that do not meet the biological requirements of the plants retard plant processes. The resulting deterioration in the level of plant health is manifested as decreased plant density and diminished plant size that lead to reduced herbage biomass.

Rangeland plants are not physiologically ready for grazing prior to the third-leaf stage, and grazing prior to plant readiness causes reduction in herbage biomass production (Campbell 1952, Rogler et al. 1962, Manske 2000a). Cool-season grasses on native rangeland reach the third-leaf stage in early June. Domesticated grasses like crested wheatgrass and smooth bromegrass reach the third-leaf stage in early May.

The stocking rate that a particular land area can safely support varies with grazing system. Generalized stocking rates cannot be properly determined for parcels of land or regions of the country without consideration of the type of grazing system used. Grazing systems that are based on plant requirements and that coordinate grazing periods with plant growth stages can be properly stocked at levels that would cause biological damage on a given parcel of land managed with another type of grazing system. Increasing stocking rates reduces land area and thus reduces forage costs for a cow, but higher stocking rates are not sustainable unless the grazing system is biologically effective and the plants are not damaged.

Native rangeland pastures with grazing during the nongrowing season have high forage dry matter and crude protein costs. The aboveground herbage on native rangeland pastures averages less than 800 pounds per acre from November to April. The amount of forage available for ingestion by grazing animals is less than 200 pounds per acre on native rangeland pastures that have not been previously grazed during the growing season. Forage dry matter costs range between $97 and $140 per ton, and crude protein costs range between $0.76 and $1.26 per pound.

The native rangeland pasture of the 6.0-month seasonlong strategy had grazing during the summer portion of the lactation production period from early June to mid October and during periods before and after the summer period. The higher forage costs of this strategy reflect the reduced levels of herbage production caused by the decrease in plant density and plant size that results from grazing prior to the third-leaf stage in the spring and from grazing fall tillers in the late-season.

Both the 6.0-month seasonlong and 4.0-month deferred treatments extended the grazing period past mid October. The weight of the fall herbage on pastures that have not been previously grazed is only about 40% to 60% of the midsummer herbage weight on ungrazed grasslands. The weight of the fall herbage on pastures that have been previously grazed is considerably less than 50% of the potential peak herbage biomass. The stocking rates of these two treatments were not adjusted after mid October to reflect the reduction in aboveground herbage biomass. The amount of aboveground herbage that remains at the end of the grazing period is only about 200 to 300 pounds per acre. This small amount of herbage catches very little snow and provides little insulation for overwintering perennial plants. The amount of insulation affects the rate of carbohydrate respiration that occurs in the crowns of the perennial plants. When the amount of insulation is low, plants respire rapidly and the stored carbohydrate reserves can be reduced or depleted before spring. Depletion of reserves causes plant death called "winter kill", and reduction of reserves causes reduced herbage biomass production the following season.

The deferred grazing treatment withholds grazing from one or two pastures until the lead tillers of grass plants develop through the vegetative and sexually reproductive stages. Early rangeland managers believed that grass seed production was necessary for grassland health, and they developed deferred rotation grazing treatments specifically to allow grasses to flower and set seed. However, very few young grass plants mature from seed in an established grassland: almost all young grass plants are formed vegetatively. A major problem with the deferred management treatments that start grazing after grass seed development is that native-grass basal cover is reduced (Sarvis 1941, Manske et al. 1988). Another problem is that the nutritional quality of the herbage on deferred grazing treatments is below the crude protein requirements of lactating cows. Nutritional quality of native rangeland grasses decreases rapidly following the seed development stage, and the quality falls below 9.6% crude protein around mid July to early August (Manske 1999a, b).

Most livestock producers assume that beef production costs will be lower if cows graze as long as possible because it seems reasonable that allowing a cow to graze her own food is more economical than harvesting and feeding hay. When the forage costs for grazing during the fall are averaged with the costs during the summer period for such treatments as the 6.0-month seasonlong and 4.0-month deferred, the costs during the fall do not appear to be high. However, when the forage costs during the fall period are separated from those of the summer period, the greater expense of fall grazing becomes evident. The 15-day period from mid to late October has forage dry matter costs of over $80 per ton and crude protein costs around $0.34 per pound. The 15-day period from early to mid November has forage dry matter costs of over $97 per ton and crude protein costs of over $1.00 per pound. If grazing on native rangeland occurs after mid October, it should be on fall pastures separated from the summer pasture system, and the stocking rate should allot about double the number of acres per animal unit that summer seasonlong grazing treatments would require.

Grazed native rangeland pastures provide forage dry matter and crude protein at lower costs during the summer portion of the lactation production period from early June to mid October than during other times of the year. The native rangeland pastures of the 12-month repeated seasonal, 4.5-month seasonlong, and 4.5-month twice-over rotation strategies are grazed only within this portion of the growing season and have forage dry matter costs that range between $39 and $55 per ton and crude protein costs of around $0.25 per pound.

The twice-over rotation system has the lowest native rangeland pasture-forage costs because the management strategy does not start grazing on any forage type until the grass plants have reached the third-leaf stage and avoids negative effects on plant biological processes and resulting reductions in herbage biomass production (Manske 2000b). Delaying grazing on native rangeland until grass plants have reached the third-leaf stage, in early June, requires the use of another forage type for earlier grazing. Some domesticated perennial cool-season grasses reach the third-leaf stage three to five weeks earlier than native cool-season grasses and are dependable as spring pastures from early May until early June. Crested wheatgrass is an excellent early season spring pasture forage. The start of the grazing season on domesticated grass pastures is restricted to very late April or early May because no perennial grass in the Northern Plains reaches the third-leaf stage before late April.

Unfertilized crested wheatgrass pastures provide forage at reasonable costs during May and June, but the crude protein content drops below the requirements for lactating cows in late June. Fertilized crested wheatgrass pastures provide forage at reasonable costs during May and early June. Fertilization of crested wheatgrass pastures during the first week of April increased the amount of herbage produced, and the costs per ton for forage dry matter on fertilized pastures were about the same as the costs per ton for forage dry matter on unfertilized pastures, even though the cost of the fertilizer more than doubled the production costs per acre. Fertilization shortened by several weeks the effective period of use of domesticated grass spring complementary pastures by grazing livestock.

Manipulation of secondary tiller growth of native rangeland grasses with light defoliation by grazing on each pasture for 7 to 17 days during the period between the third-leaf stage and the flowering stage (early June to mid July) can improve livestock performance for two to two and a half months at the end of the grazing season, until late September or mid October, but the biology of native grass plants does not permit extending this improved performance longer (Manske 2000b). Nutritional quality of herbage on native rangeland grazed after mid October is insufficient to meet requirements of lactating cows.

Forages that meet the nutritional requirements of lactating cows after mid October include Altai and Russian wildryes. The wildryes are the only perennial grasses that retain nutrient quality in the aboveground portions until about mid November. Altai wildrye complementary pastures with grazing during the fall portion of the lactation production period from mid October to mid November provide forage at reasonable costs. Forage dry matter costs are around $27 per ton. No perennial grass in the Northern Plains retains sufficient nutritional quality to dependably meet the nutritional requirements of lactating cows later than mid November.

Cropland aftermath is a common pasture type used just prior to weaning and then later for dry cows. The amount of forage present on most aftermath pastures is low, and even with very low production costs per acre, the forage dry matter costs are around $30 per ton. The nutrient content of stubble of annual cereals harvested for grain is extremely low. Unless the crop aftermath contains a substantial amount of sprouted grain, lactating and dry cows cannot find forage that meets their crude protein requirements. The loss of animal weight on this pasture type should be considered as a cost.

Perennial grass hay has been the major harvested-forage type used as winter feed for beef cows in the Northern Plains. Traditionally, crested wheatgrass and smooth bromegrass, domesticated perennial grass hays, are cut late, after the seed heads have developed and plants have reached maximum height. This practice yields about the year's potential amount of forage dry matter per acre, about 300 pounds per acre more dry matter than harvesting at the boot stage. However, the quantity of crude protein captured per acre in mature hay was only a little more than half the quantity of crude protein captured per acre in hay cut at the boot stage. Forage dry matter costs were $34.80 per ton for mature hay and $40.80 per ton for hay cut at the boot stage. Crude protein costs were $0.28 per pound for mature hay and $0.14 per pound for early cut hay. Mature domesticated perennial grass hay is expensive livestock feed because it has high costs per pound of crude protein.

Annual cereal hays of forage barley and oat forage cut at the milk stage or hard dough stage had high production costs that ranged from $68 to $75 per acre. However, the forage dry matter costs and crude protein costs were relatively low. Forage dry matter costs ranged between $26 and $30 per ton and crude protein costs ranged between $0.11 and $0.17 per pound. Early cut annual cereal hays captured greater pounds of crude protein per acre than the late-cut hays, and the cost per pound of crude protein was lower for the early cut annual cereal hays.

Annual legume hays of pea forage and forage lentil cut at early and late plant growth stages and oat-pea forage had high production costs that ranged from $60 to $96 per acre. The forage dry matter costs ranged from $37 to $72 per ton. The late-cut annual legume hays had lower dry matter costs than the early cut legume hays. Crude protein costs were relatively low for all annual legume hays and ranged from $0.13 to $0.17 per pound. Late-cut annual legume hays captured greater pounds of crude protein per acre than the early cut hays and had lower crude protein costs than the early cut hays.

The cost of grazingland forage and harvested forage is affected by the efficiency of the harvest strategy and by the quantity of nutrients captured relative to the potential quantity of nutrients produced. Forage management treatments and forage types can be evaluated accurately by comparisons based on the costs per unit of nutrient.

Table 1. Forage dry matter biomass and crude protein yield and costs for pastures grazed during the dry gestation production period.

	Costs/acre								
	Land Rent	Custom Work	Baling Costs	Production Costs $/ac	Forage Biomass Yield lb/ac	Forage Biomass Costs $/ton	Crude Protein %	Crude Protein Yield lb/ac	Crude Protein Costs $/lb
mid Nov-mid Dec									
Native Rangeland (12-m RS)	8.76			8.76	180	97.33	4.8	8.64	1.01
Cropland Aftermath	2.00			2.00	135	29.63			

Table 2. Forage dry matter biomass and crude protein yield and costs for pastures grazed during the third trimester production period.

	Costs/acre								
	Land Rent	Custom Work	Baling Costs	Production Costs $/ac	Forage Biomass Yield lb/ac	Forage Biomass Costs $/ton	Crude Protein %	Crude Protein Yield lb/ac	Crude Protein Costs $/lb
mid Dec-mid Mar									
Native Rangeland (12-m RS)	8.76			8.76	145	120.83	4.8	6.96	1.26

Table 3. Forage dry matter biomass and crude protein yield and costs for pastures grazed during the early lactation production period.

	Costs/acre								
	Land Rent	Custom Work	Baling Costs	Production Costs $/ac	Forage Biomass Yield lb/ac	Forage Biomass Costs $/ton	Crude Protein %	Crude Protein Yield lb/ac	Crude Protein Costs $/lb
mid Mar-late Apr									
Native Rangeland (12-m RS)	8.76			8.76	125	140.16	9.2	11.50	0.76

Table 4. Forage dry matter biomass and crude protein yield and costs for pastures grazed during the spring portion of the lactation production period.

	Costs/acre								
	Land Rent	Custom Work	Baling Costs	Production Costs $/ac	Forage Biomass Yield lb/ac	Forage Biomass Costs $/ton	Crude Protein %	Crude Protein Yield lb/ac	Crude Protein Costs $/lb
early May-late May									
Native Rangeland (12-m RS)	8.76			8.76	195	89.85	16.3	31.79	0.28
Native Rangeland (6.0-m SL)	8.76			8.76	226	77.52			
Crested Wheatgrass Unfertilized (4.5-m SL)	8.76			8.76	495	35.39			
Crested Wheatgrass Unfertilized (4.0-m Def)	8.76			8.76	548	31.97			
Crested Wheatgrass Fertilized (4.5-m TOR)	8.76	12.50		21.26	1240	34.29			

Table 5. Forage dry matter biomass and crude protein yield and costs for pastures grazed during the summer portion of the lactation production period.

	Costs/acre								
	Land Rent	Custom Work	Baling Costs	Production Costs $/ac	Forage Biomass Yield lb/ac	Forage Biomass Costs $/ton	Crude Protein %	Crude Protein Yield lb/ac	Crude Protein Costs $/lb
early Jun-mid Oct									
Native Rangeland (12-m RS)	8.76			8.76	363	48.26	9.6	34.85	0.25
Native Rangeland (6.0-m SL)	8.76			8.76	226	77.50			
Native Rangeland (4.5-m SL)	8.76			8.76	320	54.75			
Native Rangeland (4.0-m Def)	8.76			8.76	412	42.52			
Native Rangeland (4.5-m TOR)	8.76			8.76	449	39.02			

Table 6. Forage dry matter biomass and crude protein yield and costs for pastures grazed during the fall portion of the lactation production period.

	Costs/acre								
	Land Rent	Custom Work	Baling Costs	Production Costs $/ac	Forage Biomass Yield lb/ac	Forage Biomass Costs $/ton	Crude Protein %	Crude Protein Yield lb/ac	Crude Protein Costs $/lb
mid Oct-late Oct									
Native Rangeland (12-m RS)	8.76			8.76	218	80.37	4.8	10.46	0.34
Native Rangeland (SL 4.5-m)	8.76			8.76	243	72.10			
early Nov-mid Nov									
Native Rangeland (12-m RS)	8.76			8.76	180	97.33	4.8	8.64	1.01
mid Oct-mid Nov									
Native Rangeland (SL 5-6-m)	8.76			8.76	356	49.21			
Native Rangeland (6.0-m SL)	8.76			8.76	223	78.57			
Native Rangeland (4.0-m Def)	8.76			8.76	412	42.52			
Altai Wildrye (4.5-m TOR)	8.76			8.76	648	27.04			
Cropland Aftermath (4.5-m SL)	2.00			2.00	135	29.63			

Table 7. Forage dry matter biomass and crude protein yield and costs for crested wheatgrass hay cut at two growth stages.

	Costs/acre								
	Land Rent	Custom Work	Baling Costs	Production Costs $/ac	Forage Biomass Yield lb/ac	Forage Biomass Costs $/ton	Crude Protein %	Crude Protein Yield lb/ac	Crude Protein Costs $/lb
Crested Wheatgrass									
Mature	14.22	5.31	8.58	28.11	1600	34.80	6.4	102	0.28
Boot stage	14.22	5.31	6.97	26.50	1300	40.80	14.5	189	0.14

Table 8. Forage dry matter biomass and crude protein yield and costs for annual cereal and annual legume hays.

	Costs/acre									
	Land Rent	Custom Work	Seed Costs	Baling Costs	Production Costs $/ac	Forage Biomass Yield lb/ac	Forage Biomass Costs $/ton	Crude Protein %	Crude Protein Yield lb/ac	Crude Protein Costs $/lb
Forage Barley Milk	22.07	16.08	4.69	25.37	68.21	4733	28.80	13.0	606	0.11
Forage Barley Hard Do.	22.07	16.08	4.69	27.51	70.35	5133	27.40	9.2	468	0.15
Oat Forage Milk	22.07	16.08	6.00	25.02	69.17	4667	29.60	11.5	535	0.13
Oat Forage Hard Do.	22.07	16.08	6.00	30.38	74.53	5667	26.40	7.8	435	0.17
Pea Forage Early	22.07	16.08	23.80	15.01	79.96	2800	55.00	18.9	526	0.15
Pea Forage Late	22.07	16.08	23.80	24.92	86.87	4650	37.40	14.4	685	0.13
Forage Lentil Early	22.07	16.08	12.60	8.94	59.69	1667	71.60	21.8	361	0.17
Forage Lentil Late	22.07	16.08	12.60	20.73	71.48	3867	37.00	14.7	567	0.13
Oat-pea Forage Hay	22.07	16.08	29.80	27.57	95.52	5143	37.20	12.5	611	0.16

Discussion

Increasing the value captured from grassland pastures and harvested forages is the key to improving profit margins for the beef production industry. The improved efficiency of biologically effective pasture-forage management strategies results in increased value captured from resources on a land base.

Some production costs for the beef industry in the Northern Plains are unnecessarily high because livestock producers tend to rely on traditional pasture-forage management practices that inefficiently capture the nutrients produced on a land base. These practices result in higher costs for the nutrients ingested by the animals, increased annual production costs per animal, and low profit margins. Just as the value added to a commodity at each stage of production provides economic benefit, increasing the value captured from the land base reduces costs and strengthens profit margins.

Pasture-forage management strategies that increase value captured place the biological requirements of the plants and the ecosystem processes as the highest priority. Those systems coordinate grazing and harvest periods with plant growth stages to remove greater amounts of nutrients rather than greater amounts of dry matter and to provide adequate nutrients throughout the cows' 12-month production cycle. Implementing biologically effective pasture-forage management strategies increases the quantity of forage nutrients produced and improves the efficiency of forage nutrient capture and conversion of forage nutrients into saleable commodities. An increased quantity of forage nutrients produced and captured as a commodity reduces livestock production costs and improves profit margins.

Acknowledgment

I am grateful to Sheri Schneider for assistance in production of this manuscript and for development of the tables. I am grateful to Amy M. Kraus for assistance in preparation of this manuscript.

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