Pasture and Forage Costs during the Production Periods of Range Cows

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

Introduction

The pasture-forage factors that contribute to high beef production costs in the Northern Plains need to be identified before the profit margin for beef production can be improved. Identifying these factors requires that management practices be scientifically evaluated for pasture and harvested-forage costs, which constitute the greatest portion of the total annual production costs for a beef cow and calf. Pasture and forage costs for each production period need to be evaluated separately because the daily requirements for cows differ with production period.

Procedure

This study was conducted at the NDSU Dickinson Research Extension Center, located in western North Dakota. Grazingland-forage costs were evaluated from data collected on grazing management treatments involved in pasture research projects conducted between 1983 and 1998 and from forage production data collected on harvested-forage types between 1995 and 1999. Grazingland forage biomass values were based on the means of the average monthly herbage biomass data for the period grazed. Native rangeland herbage weight data used in the determination of stocking rate for the 12-month native range grazing strategy were collected monthly from ungrazed plots. The research data collected during severe water stress or drought periods were not included in this study. Range cow daily nutritional requirements, which change with cow size, level of milk production, and production period, were taken from NRC (1996). Dry matter and crude protein requirements were determined for cows with an average weight of 1200 pounds.

Forage costs for harvested-forage types used as feed for range cows were evaluated for livestock production periods. 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). Percent crude protein data for native range grasses were taken from Whitman et al. (1951) and Manske (1999 a, b). Supplemental crude protein was provided as 20% crude protein range cake, at a cost of $120.00 per ton. Supplemental forage dry matter was provided as roughage, at a cost of $35.00 per ton.

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). The pasture rent value of $8.76 per acre was used to determine costs for native rangeland and domesticated grass pastures. One treatment of crested wheatgrass was fertilized annually with 50 pounds of nitrogen per acre, at an average cost of $12.50 per acre. 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 domesticated grass 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.

Pasture and forage costs of feed to meet livestock dry matter and crude protein requirements were determined during this study. Production costs per acre were determined by adding average land rent per acre, custom farm work rates, seed costs per acre, and baling costs at per half ton rates. Costs per ton of forage dry matter (DM) were determined by dividing production costs per acre by pounds of forage dry matter yield per acre and multiplying the quotient by 2000 pounds. Costs per pound of crude protein (CP) were determined in two stages: first, pounds of forage dry matter per acre were multiplied by percentage of forage crude protein to derive pounds of crude protein per acre; then, production costs per acre were divided by pounds of crude protein per acre. Grazingland area per animal unit per month was determined in two stages: first, pounds of forage dry matter per acre were divided by pounds of forage dry matter required per animal unit per day to derive number of grazing days per acre; then, the average number of days per month was divided by the number of grazing days per acre. Harvested-forage land area per animal unit per month or per production period was determined in two stages: first, pounds of crude protein required per animal per day during a production period were divided by percentage of crude protein of forage type to derive pounds of forage dry matter to provide as feed per animal unit per day; then, pounds of forage dry matter to feed per day were divided by pounds of forage dry matter per acre, and the quotient was multiplied by 30 days per month, 30.5 days per month, or the number of days per production period. Forage-feed costs per animal per day (D), per month (Mo), or per production period (PP) were determined in three stages: first, production costs per acre were divided by pounds of forage dry matter per acre, and that quotient was divided by percentage of forage crude protein to derive cost per pound of crude protein; next, the cost per pound of crude protein was multiplied by pounds of crude protein required per animal per day during a production period; then, the forage costs per day were multiplied by 30 days per month, 30.5 days per month, or the number of days per production period.

Results

Dry Gestation Production Period

The dry gestation production period was 32 days during late fall from mid November to mid December. Forage dry matter and crude protein costs (tables 1, 2, and 3) were determined for a 1200-pound range cow during the dry gestation production period. The cow requires a daily intake of 24 lbs dry matter (DM) at 6.2% crude protein (CP) (1.49 lbs CP/day).

Native rangeland pasture during the fall dormancy period has a crude protein content of around 4.8%. Late-season native rangeland forage has pasture rent value or production costs of $8.76 per acre, forage dry matter costs of $97.33 per ton, and crude protein costs of $1.01 per pound. A cow grazing during the dry gestation production period would require 4.00 acres of native rangeland pasture per month, or 4.27 acres per period, at a cost of $37.44 per production period, or $1.17 per day. The crude protein content of mature native rangeland forage is below the requirements of a cow in the dry gestation stage, and crude protein would need to be supplemented at 0.34 lbs per cow per day, or 10.2 lbs per cow per month, at a cost of $3.26 per period. Total feed costs would be $40.70 per period, or $1.27 per day.

Cropland aftermath pasture of annual cereal stubble has very low crude protein content and does not meet the crude protein requirements of a dry gestating cow. Crop aftermath has production costs of $2.00 per

acre. A dry gestating cow would require 7.10 acres of crop aftermath per period, at a cost of $0.44 per day, or $14.20 per period.

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of around 6.4%. This low-quality perennial grass hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. Late-cut crested wheatgrass hay would be fed at 23.4 lbs DM/day to provide 1.5 lbs CP/day. An additional 0.6 lbs of roughage per day would need to be provided, at a cost of $0.34 per period. Production of late-cut crested wheatgrass hay to feed during the dry gestation production period would require 0.47 acres, and the forage would cost $0.41 per day, or $13.12 per production period. Total forage and supplement costs would be $13.46 per period, or $0.42 per day.

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of around 14.5%. This high-quality perennial grass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 10.3 lbs DM/day to provide 1.5 lbs CP/day. An additional 13.7 lbs of roughage per day would need to be provided, at a cost of $7.68 per period. Production of early cut crested wheatgrass hay to feed during the dry gestation production period would require 0.26 acres, and the forage would cost $0.21 per day, or $6.72 per production period. Total forage and supplement costs would be $14.40 per period, or $0.45 per day.

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 11.5 lbs DM/day to provide 1.5 lbs CP/day. An additional 12.5 lbs of roughage per day would need to be provided, at a cost of $7.00 per period. Production of early cut forage barley hay to feed during the dry gestation production period would require 0.07 acres, and the forage would cost $0.16 per day, or $5.12 per production period. Total forage and supplement costs would be $12.12 per period, or $0.38 per day.

Forage barley hay cut late, at the hard dough stage, has a crude protein content of 9.2%. This forage barley hay has production costs of $70.35 per acre, forage dry matter costs of $27.40 per ton, and crude protein costs of $0.15 per pound. Late-cut forage barley hay would be fed at 16.2 lbs DM/day to provide 1.5 lbs CP/day. An additional 7.8 lbs of roughage per day would need to be provided, at a cost of $4.37 per period. Production of late-cut forage barley hay to feed during the dry gestation production period would require 0.10 acres, and the forage would cost $0.22 per day, or $7.04 per production period. Total forage and supplement costs would be $11.41 per period, or $0.36 per day.

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 13.0 lbs DM/day to provide 1.5 lbs CP/day. An additional 11.0 lbs of roughage per day would need to be provided, at a cost of $6.16 per period. Production of early cut oat hay to feed during the dry gestation production period would require 0.09 acres, and the forage would cost $0.19 per day, or $6.08 per production period. Total forage and supplement costs would be $12.24 per period, or $0.38 per day.

Oat forage hay cut late, at the hard dough stage, has a crude protein content of 7.8%. This oat forage hay has production costs of $74.53 per acre, forage dry matter costs of $26.40 per ton, and crude protein costs of $0.17 per pound. Late-cut oat hay would be fed at 19.1 lbs DM/day to provide 1.5 lbs CP/day. An additional 4.9 lbs of roughage per day would need to be provided, at a cost of $2.74 per period. Production of late-cut oat hay to feed during the dry gestation production period would require 0.11 acres, and the forage would cost $0.25 per day, or $8.00 per production period. Total forage and supplement costs would be $10.74 per period, or $0.34 per day.

Pea forage hay cut at an early plant stage has a crude protein content of 18.9%. This pea forage hay has production costs of $79.96 per acre, forage dry matter costs of $55.00 per ton, and crude protein costs of $0.15 per pound. Early cut pea forage hay would be fed at 7.9 lbs DM/day to provide 1.5 lbs CP/day. An additional 16.1 lbs of roughage per day would need to be provided, at a cost of $9.02 per period. Production of early cut pea forage hay to feed during the dry gestation production period would require 0.09 acres, and the forage would cost $0.22 per day, or $7.04 per production period. Total forage and supplement costs would be $16.06 per period, or $0.50 per day.

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 10.3 lbs DM/day to provide 1.5 lbs CP/day. An additional 13.7 lbs of roughage per day would need to be provided, at a cost of $7.67 per period. Production of late-cut pea forage hay to feed during the dry gestation production period would require 0.07 acres, and the forage would cost $0.19 per day, or $6.08 per

production period. Total forage and supplement costs would be $13.75 per period, or $0.43 per day.

Forage lentil hay cut at an early plant stage has a crude protein content of 21.8%. This forage lentil hay has production costs of $59.69 per acre, forage dry matter costs of $71.60 per ton, and crude protein costs of $0.17 per pound. Early cut forage lentil hay would be fed at 6.8 lbs DM/day to provide 1.5 lbs CP/day. An additional 17.2 lbs of roughage per day would need to be provided, at a cost of $9.63 per period. Production of early cut forage lentil hay to feed during the dry gestation production period would require 0.13 acres, and the forage would cost $0.25 per day, or $8.00 per production period. Total forage and supplement costs would be $17.63 per period, or $0.55 per day.

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 10.1 lbs DM/day to provide 1.5 lbs CP/day. An additional 13.9 lbs of roughage per day would need to be provided, at a cost of $7.78 per period. Production of late-cut forage lentil hay to feed during the dry gestation production period would require 0.09 acres, and the forage would cost $0.19 per day, or $6.08 per production period. Total forage and supplement costs would be $13.86 per period, or $0.43 per day.

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.15 per pound. Oat-pea forage hay would be fed at 11.9 lbs DM/day to provide 1.5 lbs CP/day. An additional 12.1 lbs of roughage per day would need to be provided, at a cost of $6.78 per period. Production of oat-pea hay to feed during the dry gestation production period would require 0.07 acres, and the forage would cost $0.22 per day, or $7.04 per production period. Total forage and supplement costs would be $13.82 per period, or $0.43 per day.

Table 1. Pasture-forage costs of pasture to be grazed by and perennial grass hays to be fed to range cows during the 32-day dry gestation production period.

		Native Rangeland Pasture	Cropland Aftermath Pasture	Crested Wheatgrass Hay	Crested Wheatgrass Hay
Growth Stage		Dormant	Post-harvest	Mature	Boot stage
Herbage Weight	lb/ac	725	270	-	-
Forage DM Weight	lb/ac	180	135	1600	1300
Costs/Acre					
Land Rent	$	8.76	2.00	14.22	14.22
Custom Work	$	-		5.31	5.31
Seed Cost	$	-		-	-
Baling Costs	$	-		8.58	6.97
Production Costs	$/ac	8.76	2.00	28.11	26.50
Forage DM Costs	$/ton	97.33	29.63	34.80	40.80
Land Area/Month	ac	4.00	6.63	0.44	0.24
Land Area/Period	ac	4.27	7.10	0.47	0.26
Land Cost/Period	$/pp	35.04	14.20	6.68	3.64
Forage Costs/Day	$/d	1.17	0.44	0.41	0.21
Forage Costs/Period	$/pp	35.10	14.20	13.12	6.72
Crude Protein	%	4.8		6.4	14.5
Crude Protein Yield	lb/ac	8.64		102	189
Crude Protein Cost	$/lb	1.01		0.28	0.14
Supplementation					
Roughage/Day	lb/d			0.6	13.72
Crude Protein/Day	lb/d	0.34			
Sup. Cost/Period	$/pp	3.26		0.34	7.68
Total Feed Cost	$/pp	40.70	14.20	13.46	14.40
Cost/Day	$/d	1.27	0.44	0.42	0.45

Table 2. Forage costs of annual cereal hays to be fed to range cows during the 32-day dry gestation production period.

		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Land Area/Month	ac	0.07	0.09	0.08	0.10
Land Area/Period	ac	0.07	0.10	0.09	0.11
Land Cost/Period	$/pp	1.54	2.21	1.99	2.43
Forage Costs/Day	$/d	0.16	0.22	0.19	0.25
Forage Costs/Period	$/pp	5.12	7.04	6.08	8.00
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Supplementation					
Roughage/Day	lb/d	12.5	7.8	11.0	4.9
Crude Protein/Day	lb/d				
Sup. Cost/Period	$/pp	7.00	4.37	6.16	2.74
Total Feed Cost	$/pp	12.12	11.41	12.24	10.74
Cost/Day	$/d	0.38	0.36	0.38	0.34

Table 3. Forage costs of annual legume hays to be fed to range cows during the 32-day dry gestation production period.

		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Land Area/Month	ac	0.08	0.07	0.12	0.08	0.07
Land Area/Period	$/pp	0.09	0.07	0.13	0.09	0.07
Land Cost/Period	$/pp	1.99	1.54	2.87	1.99	1.54
Forage Costs/Day	$/d	0.22	0.19	0.25	0.19	0.22
Forage Costs/Period	$/pp	7.04	6.08	8.00	6.08	7.04
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Supplementation						
Roughage/Day	lb/d	16.1	13.7	17.2	13.9	12.1
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	9.02	7.67	9.63	7.78	6.78
Total Feed Cost	$/pp	16.06	13.75	17.63	13.86	13.82
Cost/Day	$/d	0.50	0.43	0.55	0.43	0.43

Third Trimester Production Period

The third trimester production period was 90 days during winter from mid December to mid March. Forage dry matter and crude protein costs (tables 4, 5, and 6) were determined for a 1200-pound range cow during the 90-day third trimester production period. The cow requires a daily intake of 24 lbs dry matter (DM) at 7.8% crude protein (CP) (1.87 lbs CP/day).

Native rangeland pasture during the fall and winter dormancy period has a crude protein content of around 4.8%. Late-season native rangeland forage has production costs of $8.76 per acre, forage dry matter costs of $120.83 per ton, and crude protein costs of $1.26 per pound. A cow grazing during the third trimester would require 4.97 acres of native rangeland pasture per month, at a cost of $1.45 per day, $43.50 per month, or $130.50 per production period. The crude protein content of mature native rangeland forage is below the requirements of a cow in the third trimester, and crude protein would need to be supplemented at 0.72 lbs per cow per day, or 64.8 lbs per cow per period, at a cost of $19.44 period. Total feed costs would be $149.94 per period, or $1.67 per day.

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of around 6.4%. This crested wheatgrass hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. Mature crested wheatgrass hay would be fed at 24.0 lbs DM/day to provide 1.5 lbs CP/day. The nutrient content of mature crested wheatgrass hay is below the dietary requirements of a cow in the third trimester. An additional 0.33 lbs of crude protein per day would need to be provided, at a cost of $9.02 per period, when mature crested wheatgrass hay is fed at the dry matter requirement. Production of mature crested wheatgrass hay to feed during the third trimester would require 1.35 acres, and the forage would cost $0.52 per day, or $46.80 per production period. Total forage and supplement costs would be $55.82 per period, or $0.62 per day.

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of around 14.5%. This crested wheatgrass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 12.9 lbs DM/day to provide 1.9 lbs CP/day. An additional 11.1 lbs of roughage per day would need to be provided, at a cost of $17.48 per period. Production of early cut crested wheatgrass hay to feed during the third trimester would require 0.89 acres, and the forage would cost $0.26 per day, or $23.40 per production period. Total forage and supplement costs would be $40.88 per period, or $0.45 per day.

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 14.4 lbs DM/day to provide 1.9 lbs CP/day. An additional 9.6 lbs of roughage per day would need to be provided, at a cost of $14.96 per period. Production of early cut forage barley hay to feed during the third trimester would require 0.27 acres, and the forage would cost $0.21 per day, or $18.90 per production period. Total forage and supplement costs would be $33.86 per period, or $0.38 per day.

Forage barley hay cut late, at the hard dough stage, has a crude protein content of 9.2%. This forage barley hay has production costs of $70.35 per acre, forage dry matter costs of $27.40 per ton, and crude protein costs of $0.15 per pound. Late-cut forage barley hay would be fed at 20.3 lbs DM/day to provide 1.9 lbs CP/day. An additional 3.7 lbs of roughage per day would need to be provided, at a cost of $5.83 per period. Production of late-cut forage barley hay to feed during the third trimester would require 0.36 acres, and the forage would cost $0.29 per day, or $26.10 per production period. Total forage and supplement costs would be $31.93 per period, or $0.35 per day.

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 16.3 lbs DM/day to provide 1.9 lbs CP/day. An additional 7.7 lbs of roughage per day would need to be provided, at a cost of $12.13 per period. Production of early cut oat hay to feed during the third trimester would require 0.31 acres, and the forage would cost $0.24 per day, or $21.60 per production period. Total forage and supplement costs would be $33.73 per period, or $0.37 per day.

Oat forage hay cut late, at the hard dough stage, has a crude protein content of 7.8%. This oat forage hay has production costs of $74.53 per acre, forage dry matter costs of $26.40 per ton, and crude protein costs of $0.17 per pound. Late-cut oat hay would be fed at 24.0 lbs DM/day to provide 1.9 lbs CP/day. Production of late-cut oat hay to feed during the third trimester would require 0.38 acres, and the forage would cost $0.32 per day, or $28.80 per production period. Total forage and supplement costs would be $28.80 per period, or $0.32 per day.

Pea forage hay cut at an early plant stage has a crude protein content of 18.9%. This pea forage hay has production costs of $79.96 per acre, forage dry matter costs of $55.00 per ton, and crude protein costs of $0.15 per pound. Early cut pea forage hay would be fed at 9.9 lbs DM/day to provide 1.9 lbs CP/day. An additional 14.1 lbs of roughage per day would need to be provided, at a cost of $22.21 per period. Production of early-cut pea forage hay to feed during the third trimester would require 0.32 acres, and the forage would cost $0.28 per day, or $25.20 per production period. Total forage and supplement costs would be $47.41 per period, or $0.53 per day.

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 13.0 lbs DM/day to provide 1.9 lbs CP/day. An additional 11.0 lbs of roughage per day would need to be provided, at a cost of $17.33 per period. Production of late-cut pea forage hay to feed during the third trimester would require 0.25 acres, and the forage would cost $0.24 per day, or $21.60 per production period. Total forage and supplement costs would be $38.93 per period, or $0.43 per day.

Forage lentil hay cut at an early plant stage has a crude protein content of 21.8%. This forage lentil hay has production costs of $59.69 per acre, forage dry matter costs of $71.60 per ton, and crude protein costs of $0.17 per pound. Early cut forage lentil hay would be fed at 8.6 lbs DM/day to provide 1.9 lbs CP/day. An additional 15.4 lbs of roughage per day would need to be provided, at a cost of $24.26 per period. Production of early cut forage lentil hay to feed during the third trimester would require 0.46 acres, and the forage would cost $0.32 per day, or $28.80 per production period. Total forage and supplement costs would be $53.06 per period, or $0.59 per day.

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 12.7 lbs DM/day to provide 1.9 lbs CP/day. An additional 11.3 lbs of roughage per day would need to be provided, at a cost of $17.80 per period. Production of late-cut forage lentil hay to feed during the third trimester would require 0.30 acres, and the forage would cost $0.24 per day, or $21.60 per production period. Total forage and supplement costs would be $39.40 per period, or $0.44 per day.

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.15 per pound. Oat-pea forage hay would be fed at 15.0 lbs DM/day to provide 1.9 lbs CP/day. An additional 9.0 lbs of roughage per day would need to be provided, at a cost of $14.18 per period. Production of oat-pea forage hay to feed during the third trimester would require 0.26 acres, and the forage would cost $0.28 per day, or $25.20 per production period. Total forage and supplement costs would be $39.38 per period, or $0.44 per day.

Table 4. Pasture-forage costs of pasture to be grazed by and perennial grass hays to be fed to range cows during the 90-day third trimester production period.

		Native Rangeland Pasture	Crested Wheatgrass Hay	Crested Wheatgrass Hay
Growth Stage		Dormant	Mature	Boot stage
Herbage Weight	lb/ac	580	-	-
Forage DM Weight	lb/ac	145	1600	1300
Costs/Acre				
Land Rent	$	8.76	14.22	14.22
Custom Work	$	-	5.31	5.31
Seed Cost	$	-	-	-
Baling Costs	$	-	8.58	6.97
Production Costs	$/ac	8.76	28.11	26.50
Forage DM Costs	$/ton	120.83	34.80	40.80
Land Area/Month	ac	4.97	0.45	0.30
Land Area/Period	ac	14.90	1.35	0.89
Land Cost/Period	$/pp	130.52	19.20	12.66
Forage Costs/Day	$/d	1.45	0.52	0.26
Forage Costs/Period	$/pp	130.50	46.80	23.40
Crude Protein	%	4.8	6.4	14.5
Crude Protein Yield	lb/ac	6.96	102	189
Crude Protein Cost	$/lb	1.26	0.28	0.14
Supplementation				
Roughage/Day	lb/d			11.10
Crude Protein/Day	lb/d	0.72	0.33	
Sup. Cost/Period	$/pp	19.44	9.02	17.48
Total Feed Cost	$/pp	149.94	55.82	40.88
Cost/Day	$/d	1.67	0.62	0.45

Table 5. Forage costs of annual cereal hays to be fed to range cows during the 90-day third trimester production period.

		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Land Area/Month	ac	0.09	0.12	0.10	0.13
Land Area/Period	ac	0.27	0.36	0.31	0.38
Land Costs/Period	$/pp	5.96	7.95	6.84	8.39
Forage Costs/Day	$/d	0.21	0.29	0.24	0.32
Forage Costs/Period	$/pp	18.90	26.10	21.60	28.80
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Supplementation					
Roughage/Day	lb/d	9.6	3.7	7.7	
Crude Protein/Day	lb/d				0.0
Sup. Cost/pp	$/pp	14.96	5.83	12.13	0.0
Total Feed Cost	$/pp	33.86	31.93	33.73	28.80
Cost/Day	$/d	0.38	0.35	0.37	0.32

Table 6. Forage costs of annual legume hays to be fed to range cows during the 90-day third trimester production period.

		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Land Area/Month	ac	0.11	0.08	0.15	0.10	0.09
Land Area/Period	ac	0.32	0.25	0.46	0.30	0.26
Land Costs/Period	$/pp	7.09	5.52	10.15	6.62	5.74
Forage Costs/Day	$/d	0.28	0.24	0.32	0.24	0.28
Forage Costs/Period	$/pp	25.20	21.60	28.80	21.60	25.20
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Supplementation						
Roughage/Day	lb/d	14.1	11.0	15.4	11.3	9.0
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	22.21	17.33	24.26	17.80	14.18
Total Feed Cost	$/pp	47.41	38.93	53.06	39.40	39.38
Cost/Day	$/d	0.53	0.43	0.59	0.44	0.44

Early Lactation Production Period

The early lactation production period was 45 days during early spring from mid March to late April. Costs of forage dry matter and crude protein (tables 7, 8, and 9) to meet the requirements of a 1200-pound range cow during the early lactation production period were determined. The cow requires a daily intake of 27 lbs dry matter (DM) at 10.1% crude protein (CP) (2.73 lbs CP/day).

Forage on native rangeland pasture during early spring has a crude protein content of around 9.2%. Early spring native rangeland forage has production costs of $8.76 per acre, forage dry matter costs of $140.16 per ton, and crude protein costs of $0.76 per pound. A cow grazing during the early lactation period would require 6.48 acres of native rangeland pasture per month and 9.72 acres per period, at a cost of $1.89 per day, or $85.05 per production period. The crude protein content of early spring native rangeland forage is below the requirements of a cow during early lactation, and crude protein would need to be supplemented at 0.25 lbs per cow per day, or 7.5 lbs per cow per month, at a cost of $3.38 per period. Total feed costs would be $88.43 per period, or $1.97 per day.

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of around 6.4%. This crested wheatgrass hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. Mature crested wheatgrass hay would be fed at 27.0 lbs DM/day to provide 1.7 lbs CP/day. The nutrient content of mature crested wheatgrass hay is below the dietary requirements of a cow during early lactation. An additional 1.0 lb of crude protein per day would need to be provided, at a cost of $13.50 per period, when mature crested wheatgrass hay is fed at the dry matter requirement. Production of mature crested wheatgrass hay to feed during the early lactation period would require 0.76 acres, and the forage would cost $0.75 per day, or $33.75 per production period. Total forage and supplement costs would be $47.25 per period, or $1.05 per day.

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of around 14.5%. This crested wheatgrass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 18.8 lbs DM/day to provide 2.7 lbs CP/day. An additional 8.2 lbs of roughage per day would need to be provided, at a cost of $6.43 per period. Production of early cut crested wheatgrass hay to feed during the early lactation period would require 0.65 acres, and the forage would cost $0.38 per day, or $17.10 per production period. Total forage and supplement costs would be $23.53 per period, or $0.52 per day.

Crested wheatgrass, alfalfa, and corn silage were balanced in a dry lot ration to meet the requirements of a cow during the early lactation production period. This balanced ration had production costs of $37.50 per acre and forage dry matter costs of $50.00 per ton. This ration would be fed at 30.0 lbs DM/day to provide 2.7 lbs CP/day. Production of the forages in this ration would require 0.60 acres per month, and the forages would cost $0.75 per day, $22.50 per month, or $33.75 for the 45-day early lactation production period. Mineral supplementation would cost $2.25 per period. Total feed costs would be $36.00 per period, or $0.80 per day.

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 21.0 lbs DM/day to provide 2.7 lbs CP/day. An additional 6.0 lbs of roughage per day would need to be provided, at a cost of $4.73 per period. Production of early cut forage barley hay to feed during the early lactation period would require 0.20 acres, and the forage would cost $0.30 per day, or $13.50 per production period. Total forage and supplement costs would be $18.23 per period, or $0.41 per day.

Forage barley hay cut late, at the hard dough stage, has a crude protein content of 9.2%. This forage barley hay has production costs of $70.35 per acre, forage dry matter costs of $27.40 per ton, and crude protein costs of $0.15 per pound. Late-cut forage barley hay would be fed at 27.0 lbs DM/day to provide 2.48 lbs CP/day. An additional 0.25 lbs of crude protein per day would need to be provided, at a cost of $3.38 per period, when late-cut forage barley is fed at the dry matter requirement. Production of late-cut forage barley hay to feed during the early lactation period would require 0.24 acres, and the forage would cost $0.41 per day, or $18.45 per production period. Total forage and supplement costs would be $21.83 per period, or $0.49 per day.

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 23.7 lbs DM/day to provide 2.7 lbs CP/day. An additional 3.3 lbs of roughage per day would need to be provided, at a cost of $2.60 per period. Production of early cut oat hay to feed during the early lactation period would require 0.23 acres, and the forage would

cost $0.35 per day, or $15.75 per production period. Total forage and supplement costs would be $18.35 per period, or $0.41 per day.

Oat forage hay cut late, at the hard dough stage, has a crude protein content of 7.8%. This oat forage hay has production costs of $74.53 per acre, forage dry matter costs of $26.40 per ton, and crude protein costs of $0.17 per pound. Late-cut oat hay would be fed at 27.0 lbs DM/day to provide 2.1 lbs CP/day. An additional 0.62 lbs of crude protein per day would need to be provided, at a cost of $8.37 per period, when late-cut oat hay is fed at the dry matter requirement. Production of late-cut oat hay to feed during the early lactation period would require 0.21 acres, and the forage would cost $0.46 per day, or $20.70 per production period. Total forage and supplement costs would be $29.07 per period, or $0.65 per day.

Pea forage hay cut at an early plant stage has a crude protein content of 18.9%. This pea forage hay has production costs of $79.96 per acre, forage dry matter costs of $55.00 per ton, and crude protein costs of $0.15 per pound. Early cut pea forage hay would be fed at 14.4 lbs DM/day to provide 2.7 lbs CP/day. An additional 12.6 lbs of roughage per day would need to be provided, at a cost of $9.92 per period. Production of early cut pea forage hay to feed during the early lactation period would require 0.23 acres, and the forage would cost $0.41 per day, or $18.45 per production period. Total forage and supplement costs would be $28.37 per period, or $0.63 per day.

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 19.0 lbs DM/day to provide 2.7 lbs CP/day. An additional 8.0 lbs of roughage per day would need to be provided, at a cost of $6.30 per period. Production of late-cut pea forage hay to feed during the early lactation period would require 0.18 acres, and the forage would cost $0.35 per day, or $15.75 per production period. Total forage and supplement costs would be $22.05 per period, or $0.49 per day.

Forage lentil hay cut at an early plant stage has a crude protein content of 21.8%. This forage lentil hay has production costs of $59.69 per acre, forage dry matter costs of $71.60 per ton, and crude protein costs of $0.17 per pound. Early cut forage lentil hay would be fed at 12.5 lbs DM/day to provide 2.7 lbs CP/day. An additional 14.5 lbs of roughage per day would need to be provided, at a cost of $11.42 per period. Production of early cut forage lentil hay to feed during the early lactation period would require 0.34 acres, and the forage would cost $0.46 per day, or $20.70 per production period. Total forage and supplement costs would be $32.12 per period, or $0.71 per day.

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 18.6 lbs DM/day to provide 2.7 lbs CP/day. An additional 8.4 lbs of roughage per day would need to be provided, at a cost of $6.62 per period. Production of late-cut forage lentil hay to feed during the early lactation period would require 0.22 acres, and the forage would cost $0.35 per day, or $15.75 per production period. Total forage and supplement costs would be $22.34 per period, or $0.50 per day.

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.16 per pound. Oat-pea forage hay would be fed at 21.8 lbs DM/day to provide 2.7 lbs CP/day. An additional 5.2 lbs of roughage per day would need to be provided, at a cost of $4.10 per production period. Production of oat-pea forage hay to feed during the early lactation period would require 0.19 acres, and the forage would cost $0.41 per day, or $18.45 per production period. Total forage and supplement costs would be $22.55 per period, or $0.50 per day.

Table 7. Pasture-forage costs of pasture to be grazed by and perennial grass hays to be fed to range cows during the 45-day early lactation production period.

		Native Rangeland Pasture	Crested Wheatgrass Hay	Crested Wheatgrass Hay
Growth Stage		Early Spring	Mature	Boot stage
Herbage Weight	lb/ac	480	-	-
Forage DM Weight	lb/ac	125	1600	1300
Costs/Acre				
Land Rent	$	8.76	14.22	14.22
Custom Work	$	-	5.31	5.31
Seed Cost	$	-	-	-
Baling Costs	$	-	8.58	6.97
Production Costs	$/ac	8.76	28.11	26.50
Forage DM Costs	$/ton	140.16	34.80	40.80
Land Area/Month	ac	6.48	0.51	0.43
Land Area/Period	ac	9.72	0.76	0.65
Land Cost/Period	$/pp	85.15	10.81	9.24
Forage Costs/Day	$/d	1.89	0.75	0.38
Forage Costs/Period	$/pp	85.05	33.75	17.10
Crude Protein	%	9.2	6.4	14.5
Crude Protein Yield	lb/ac	11.50	102	189
Crude Protein Cost	$/lb	0.76	0.28	0.14
Supplementation				
Roughage/Day	lb/d			8.17
Crude Protein/Day	lb/d	0.25	1.00	
Sup. Cost/Period	$/pp	3.38	13.50	6.43
Total Feed Cost	$/pp	88.43	47.25	23.53
Cost/Day	$/d	1.97	1.05	0.52

Table 8. Forage costs of annual cereal hays to be fed to range cows during the 45-day early lactation production period.

		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Land Area/Month	ac	0.13	0.16	0.15	0.14
Land Area/Period	ac	0.20	0.24	0.23	0.21
Land Costs/Period	$/pp	4.41	5.30	5.08	4.63
Forage Costs/Day	$/d	0.30	0.41	0.35	0.46
Forage Costs/Period	$/pp	13.51	18.45	15.75	20.70
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Supplementation					
Roughage/Day	lb/d	6.0		3.3	
Crude Protein/Day	lb/d		0.25		0.62
Sup. Cost/Period	$/pp	4.73	3.38	2.60	8.37
Total Feed Cost	$/pp	18.23	21.83	18.35	29.07
Cost/Day	$/d	0.41	0.49	0.41	0.65

Table 9. Forage costs of annual legume hays to be fed to range cows during the 45-day early lactation production period.

		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Land Area/Month	ac	0.15	0.12	0.23	0.14	0.13
Land Area/Period	ac	0.23	0.18	0.34	0.22	0.19
Land Cost/Period	$/pp	5.08	3.97	7.50	4.86	4.19
Forage Costs/Day	$/d	0.41	0.35	0.46	0.35	0.41
Forage Costs/Period	$/pp	18.45	15.75	20.70	15.75	18.45
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Supplementation						
Roughage/Day	lb/d	12.6	8.0	14.5	8.4	5.2
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	9.92	6.30	11.42	6.62	4.10
Total Feed Cost	$/pp	28.37	22.05	32.12	22.37	22.55
Cost/Day	$/d	0.63	0.49	0.71	0.50	0.50

Lactation (spring portion) Production Period

The spring portion of the lactation production period was 31 days from early May until late May. Costs of forage dry matter and crude protein (tables 10, 11, 12, and 13) to meet the requirements of a 1200-pound range cow with a calf during the spring portion of the lactation production period were determined. A cow with a calf requires 30 lbs of dry matter per day. The cow requires a daily intake of 27 lbs dry matter (DM) at 9.3% crude protein (CP) (2.51 lbs CP/day).

Native rangeland pasture forage during the spring has a crude protein content of around 16.3%. Native rangeland plants have not reached the third-leaf stage and are not physiologically ready for grazing during the spring portion of the lactation production period in May.

Spring native rangeland forage managed by the 12-month repeated seasonal (12-m RS) strategy has pasture rent value or production costs of $8.76 per acre, forage dry matter costs of $89.85 per ton, and crude protein costs of $0.28 per pound. A cow with a calf would require 4.62 acres per month, or 4.77 acres per period, at a cost of $41.85 for the 31-day period, or $1.35 per day.

Spring native rangeland forage managed by the 6.0-month seasonlong (6.0-m SL) strategy has pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $77.52 per ton. A cow with a calf would require 4.04 acres per month, or 2.10 acres during the last 16 days of the period, at a cost of $18.40 for the 16-day period, or $1.15 per day.

Spring unfertilized crested wheatgrass complementary pasture grazed for 31 days during May by cattle on the 4.5-month seasonlong (4.5-m SL) strategy has pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $35.39 per ton. A cow with a calf would require 1.82 acres per month, or 1.88 acres per period, at a cost of $16.47 for the 31-day period, or $0.52 per day.

Spring unfertilized crested wheatgrass complementary pasture grazed for 76 days from early May until mid July by cattle on the 4.0-month deferred (4.0-m Def) strategy has pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $31.97 per ton. A cow with a calf would require 1.67 acres per month, or 4.16 acres for a period of 76 days from early May until mid July, at a cost of $36.44 for the 76-day period, or $0.48 per day.

Spring fertilized crested wheatgrass complementary pasture grazed for 31 days during May by cattle on the 4.5-month twice-over rotation (4.5-m TOR) strategy has pasture rent value of $8.76 per acre and fertilizer costs of $12.50 per acre; the resulting production costs are $21.26 per acre, and forage dry matter costs are $34.29 per ton. A cow with a calf would require 0.73 acres per month, or 0.75 acres per period, at a cost of $15.95 for the 31-day period, or $0.51 per day.

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of 6.4%. This crested wheatgrass hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. Mature crested wheatgrass hay would be fed at 27.0 lbs DM/day to provide 1.7 lbs CP/day. An additional 0.8 lbs of crude protein per day would need to be provided, at a cost of $7.27 per period. Production of mature crested wheatgrass hay to feed during the spring portion of the lactation period would require 0.58 acres, and the forage would cost $0.70 per day, or $21.70 per period. Total forage and supplement costs would be $28.97 per period, or $0.93 per day.

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of 14.5%. This crested wheatgrass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 17.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.7 lbs of roughage per day would need to be provided, at a cost of $6.88 per period. Production of early cut crested wheatgrass hay to feed during the spring portion of the lactation period would require 0.41 acres, and the forage would cost $0.35 per day, or $10.85 per period. Total forage and supplement costs would be $17.73 per period, or $0.57 per day.

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 19.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 10.7 lbs of roughage per day would need to be provided, at a cost of $5.80 per period. Production of early cut forage barley hay to feed during the spring portion of the lactation period would require 0.13 acres, and the forage would cost $0.28 per day, or $8.68 per period. Total forage and supplement costs would be $14.48 per period, or $0.47 per day.

Forage barley hay cut late, at the hard dough stage, has a crude protein content of 9.2%. This forage barley hay has production costs of $70.35 per acre, forage dry matter costs of $27.40 per ton, and crude protein costs of $0.15 per pound. Late-cut forage barley hay would be fed at 27.3 lbs DM/day to provide 2.5 lbs CP/day.

An additional 2.7 lbs of roughage per day would need to be provided, at a cost of $1.46 per period. Production of late-cut forage barley hay to feed during the spring portion of the lactation period would require 0.16 acres, and the forage would cost $0.38 per day, or $11.78 per period. Total forage and supplement costs would be $13.24 per period, or $0.43 per day.

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 21.8 lbs DM/day to provide 2.5 lbs CP/day. An additional 8.2 lbs of roughage per day would need to be provided, at a cost of $4.45 per period. Production of early cut oat hay to feed during the spring portion of the lactation period would require 0.14 acres, and the forage would cost $0.33 per day, or $10.23 per period. Total forage and supplement costs would be $14.68 per period, or $0.47 per day.

Oat forage hay cut late, at the hard dough stage, has a crude protein content of 7.8%. This oat forage hay has production costs of $74.53 per acre, forage dry matter costs of $26.40 per ton, and crude protein costs of $0.17 per pound. Late-cut oat hay would be fed at 27.0 lbs DM/day to provide 2.1 lbs CP/day. An additional 0.4 lbs of crude protein per day would need to be provided, at a cost of $3.72 per period. Production of late-cut oat hay to feed during the spring portion of the lactation period would require 0.16 acres, and the forage would cost $0.43 per day, or $13.33 per period. Total forage and supplement costs would be $17.05 per period, or $0.55 per day.

Pea forage hay cut at an early plant stage has a crude protein content of 18.9%. This pea forage hay has production costs of $79.96 per acre, forage dry matter costs of $55.00 per ton, and crude protein costs of $0.15 per pound. Early cut pea forage hay would be fed at 13.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 16.7 lbs of roughage per day would need to be provided, at a cost of $9.06 per period. Production of early cut pea forage hay to feed during the spring portion of the lactation period would require 0.15 acres, and the forage would cost $0.38 per day, or $11.78 per period. Total forage and supplement costs would be $20.84 per period, or $0.67 per day.

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 17.4 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.6 lbs of roughage per day would need to be provided, at a cost of $6.84 per period. Production of late-cut pea forage hay to feed during the spring portion of the lactation period would require 0.12 acres, and the forage would cost $0.33 per day, or $10.23 per period. Total forage and supplement costs would be $17.07 per period, or $0.55 per day.

Forage lentil hay cut at an early plant stage has a crude protein content of 21.8%. This forage lentil hay has production costs of $59.69 per acre, forage dry matter costs of $71.60 per ton, and crude protein costs of $0.17 per pound. Early cut forage lentil hay would be fed at 11.5 lbs DM/day to provide 2.5 lbs CP/day. An additional 18.5 lbs of roughage per day would need to be provided, at a cost of $10.04 per period. Production of early cut forage lentil hay to feed during the spring portion of the lactation period would require 0.34 acres, and the forage would cost $0.43 per day, or $13.33 per period. Total forage and supplement costs would be $23.37 per period, or $0.75 per day.

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 17.1 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.9 lbs of roughage per day would need to be provided, at a cost of $7.00 per period. Production of late-cut forage lentil hay to feed during the spring portion of the lactation period would require 0.14 acres, and the forage would cost $0.33 per day, or $10.23 per period. Total forage and supplement costs would be $17.23 per period, or $0.56 per day.

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.16 per pound. Oat-pea forage hay would be fed at 20.1 lbs DM/day to provide 2.5 lbs CP/day. An additional 9.9 lbs of roughage per day would need to be provided, at a cost of $5.37 per period. Production of oat-pea forage hay to feed during the spring portion of the lactation period would require 0.12 acres, and the forage would cost $0.38 per day, or $11.78 per period. Total forage and supplement costs would be $17.15 per period, or $0.55 per day.

Table 10. Pasture-forage costs of native rangeland and domesticated grass pastures to be grazed by range cows during the 31-day spring portion of the lactation production period.

		Native Rangeland (12-m RS)	Native Rangeland (6.0-m SL)	Crested Wheatgrass Unfertilized (4.5-m SL)	Crested Wheatgrass Unfertilized (4.0-m Def)	Crested Wheatgrass Fertilized (4.5-m TOR)
Days		31	16	31	76	31
Growth Stage		spring	spring	spring	spring	spring
Herbage Weight	lb/ac	780	906	1980	2192	4960
Forage DM Weight	lb/ac	195	226	495	548	1240
Costs/Acre						
Land Rent	$	8.76	8.76	8.76	8.76	8.76
Custom Work	$					12.50
Seed Cost	$					
Baling Cost	$					
Production Costs	$/ac	8.76	8.76	8.76	8.76	21.26
Forage DM Costs	$/ton	89.85	77.52	35.39	31.97	34.29
Land Area/Month	ac	4.62	4.04	1.82	1.67	0.73
Land Area/Period	ac	4.77	2.10	1.88	4.16	0.75
Land Cost/Period	$/pp	41.79	18.40	16.47	36.44	15.95
Forage Costs/Day	$/d	1.35	1.15	0.52	0.48	0.51
Forage Costs/Period	$/pp	41.85	18.40	16.47	36.44	15.95
Crude Protein	%	16.3				
Crude Protein Yield	lb/ac	31.79				
Crude Protein Cost	$/lb	0.28				
Supplementation						
Roughage/Day	lb/d					
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp					
Total Feed Cost	$/pp	41.85	18.40	16.47	36.44	15.95
Cost/Day	$/d	1.35	1.15	0.52	0.48	0.51

Table 11. Forage costs of perennial grass hays to be fed to range cows during the 31-day spring portion of the lactation production period.

		Crested Wheatgrass Hay	Crested Wheatgrass Hay
Growth Stage		Mature	Boot stage
Herbage Weight	lb/ac	-	-
Forage DM Weight	lb/ac	1600	1300
Costs/Acre			
Land Rent	$	14.22	14.22
Custom Work	$	5.31	5.31
Seed Cost	$	-	-
Baling Costs	$	8.58	6.97
Production Costs	$/ac	28.11	26.50
Forage DM Costs	$/ton	34.80	40.80
Land Area /Month	ac	0.56	0.40
Land Area/Period	ac	0.58	0.41
Land Cost/Period	$/pp	8.25	5.83
Forage Costs/Day	$/d	0.70	0.35
Forage Costs/Period	$/pp	21.70	10.85
Crude Protein	%	6.4	14.5
Crude Protein Yield	lb/ac	102	189
Crude Protein Cost	$/lb	0.28	0.14
Supplementation			
Roughage/Day	lb/d		12.69
Crude Protein/Day	lb/d	0.78	
Sup. Cost/Period	$/pp	7.27	6.88
Total Feed Cost	$/pp	28.97	17.73
Cost/Day	$/d	0.93	0.57

Table 12. Forage costs of annual cereal hays to be fed to range cows during the 31-day spring portion of the lactation production period.

		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Land Area/Month	ac	0.12	0.16	0.14	0.16
Land Area/Period	ac	0.13	0.16	0.14	0.16
Land Costs/Period	$/pp	2.87	5.53	3.09	3.53
Forage Costs/Day	$/d	0.28	0.38	0.33	0.43
Forage Costs/Period	$/pp	8.68	11.78	10.23	13.33
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Supplementation					
Roughage/Day	lb/d	10.7	2.7	8.2	
Crude Protein/Day	lb/d				0.40
Sup. Cost/Period	$/pp	5.80	1.46	4.45	3.72
Total Feed Cost	$/pp	14.48	13.24	14.68	17.05
Cost/Day	$/d	0.47	0.43	0.47	0.55

Table 13. Forage costs of annual legume hays to be fed to range cows during the 31-day spring portion of the lactation production period.

		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Land Area/Month	ac	0.14	0.11	0.21	0.13	0.12
Land Area/Period	ac	0.15	0.12	0.34	0.14	0.12
Land Costs/Period	$/pp	3.31	2.65	7.50	3.09	2.65
Forage Costs/Day	$/d	0.38	0.33	0.43	0.33	0.38
Forage Costs/Period	$/pp	11.78	10.23	13.33	10.23	11.78
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Supplementation						
Roughage/Day	lb/d	16.7	12.6	18.5	12.9	9.9
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	9.06	6.84	10.04	7.00	5.37
Total Feed Cost	$/pp	20.84	17.07	23.37	17.23	17.15
Cost/Day	$/d	0.67	0.55	0.75	0.56	0.55

Lactation (summer portion) Production Period

The summer portion of the lactation production period was 137 days from early June until mid October. Costs of forage dry matter and crude protein (tables 14, 15, 16, and 17) to meet the requirements of a 1200-pound range cow with a calf during the summer portion of the lactation production period were determined. A cow with a calf requires 30 lbs of dry matter per day. The cow requires a daily intake of 27 lbs dry matter (DM) at 9.3% crude protein (CP) (2.51 lbs CP/day).

Native rangeland pasture forage has a crude protein content of around 9.6% during mid summer. The crude protein content of native range grasses decreases after mid summer and is below the requirements of a lactating cow by early August.

Summer native rangeland forage managed by the 12-month repeated seasonal (12-m RS) strategy has pasture rent value or production costs of $8.76 per acre, forage dry matter costs of $48.26 per ton, and crude protein costs of $0.25 per pound. A cow with a calf would require 2.52 acres per month, or 11.32 acres per period, at a cost of $98.64 for the 137-day period, or $0.72 per day.

Summer native rangeland forage managed by the 6.0-month seasonlong (6.0-m SL) strategy has pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $77.50 per ton. A cow with a calf would require 4.04 acres per month, or 18.10 acres per period, at a cost of $158.55 for the 137-day period, or $1.16 per day.

Summer native rangeland forage managed by the 4.5-month seasonlong (4.5-m SL) strategy has pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $54.75 per ton. A cow with a calf would require 2.86 acres per month, or 12.70 acres per period, at a cost of $111.25 for the 137-day period, or $0.81 per day.

Summer native rangeland forage managed by the 4.0-month deferred (4.0-m Def) strategy has pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $42.52 per ton. A cow with a calf would require 2.22 acres per month, or 6.70 acres for a period of 92 days from mid July to mid October, at a cost of $58.26 for the 92-day period, or $0.63 per day.

Summer native rangeland forage managed by the 4.5-month twice-over rotation (4.5-m TOR) strategy has pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $39.02 per ton. A cow with a calf would require 2.04 acres per month, or 9.00 acres per period, at a cost of $78.84 for the 137-day period, or $0.58 per day.

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of 6.4%. This crested wheatgrass hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. Mature crested wheatgrass hay would be fed at 27.0 lbs DM/day to provide 1.7 lbs CP/day. An additional 0.8 lbs of crude protein per day would need to be provided, at a cost of $32.14 per period. Production of mature crested wheatgrass hay to feed during the summer portion of the lactation period would require 2.57 acres, and the forage would cost $0.70 per day, or $95.90 per period. Total forage and supplement costs would be $128.04 per period, or $0.93 per day.

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of 14.5%. This crested wheatgrass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 17.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.7 lbs of roughage per day would need to be provided, at a cost of $30.42 per period. Production of early cut crested wheatgrass hay to feed during the summer portion of the lactation period would require 1.82 acres, and the forage would cost $0.35 per day, or $47.95 per period. Total forage and supplement costs would be $78.37 per period, or $0.57 per day.

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 19.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 10.7 lbs of roughage per day would need to be provided, at a cost of $25.65 per period. Production of early cut forage barley hay to feed during the summer portion of the lactation period would require 0.56 acres, and the forage would cost $0.28 per day, or $38.36 per period. Total forage and supplement costs would be $64.01 per period, or $0.47 per day.

Forage barley hay cut late, at the hard dough stage, has a crude protein content of 9.2%. This forage barley hay has production costs of $70.35 per acre, forage dry matter costs of $27.40 per ton, and crude protein costs of $0.15 per pound. Late-cut forage barley hay would be fed at 27.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 2.7 lbs of roughage per day would need to be provided, at a cost of $6.47 per period. Production of late-cut forage barley hay to feed during the summer portion of the

lactation period would require 0.73 acres, and the forage would cost $0.38 per day, or $52.06 per period. Total forage and supplement costs would be $58.53 per period, or $0.43 per day.

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 21.8 lbs DM/day to provide 2.5 lbs CP/day. An additional 8.2 lbs of roughage per day would need to be provided, at a cost of $19.66 per period. Production of early cut oat hay to feed during the summer portion of the lactation period would require 0.64 acres, and the forage would cost $0.33 per day, or $45.21 per period. Total forage and supplement costs would be $64.87 per period, or $0.47 per day.

Oat forage hay cut late, at the hard dough stage, has a crude protein content of 7.8%. This oat forage hay has production costs of $74.53 per acre, forage dry matter costs of $26.40 per ton, and crude protein costs of $0.17 per pound. Late-cut oat hay would be fed at 27.0 lbs DM/day to provide 2.1 lbs CP/day. An additional 0.4 lbs of crude protein per day would need to be provided, at a cost of $16.44 per period. Production of late-cut oat hay to feed during the summer portion of the lactation period would require 0.73 acres, and the forage would cost $0.43 per day, or $58.91 per period. Total forage and supplement costs would be $75.35 per period, or $0.55 per day.

Pea forage hay cut at an early plant stage has a crude protein content of 18.9%. This pea forage hay has production costs of $79.96 per acre, forage dry matter costs of $55.00 per ton, and crude protein costs of $0.15 per pound. Early cut pea forage hay would be fed at 13.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 16.7 lbs of roughage per day would need to be provided, at a cost of $40.04 per period. Production of early cut pea forage hay to feed during the summer portion of the lactation period would require 0.65 acres, and the forage would cost $0.38 per day, or $52.06 per period. Total forage and supplement costs would be $92.10 per period, or $0.67 per day.

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 17.4 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.6 lbs of roughage per day would need to be provided, at a cost of $30.21 per period. Production of late-cut pea forage hay to feed during the summer portion of the lactation period would require 0.51 acres, and the forage would cost $0.33 per day, or $45.21 per period. Total forage and supplement costs would be $75.42 per period, or $0.55 per day.

Forage lentil hay cut at an early plant stage has a crude protein content of 21.8%. This forage lentil hay has production costs of $59.69 per acre, forage dry matter costs of $71.60 per ton, and crude protein costs of $0.17 per pound. Early cut forage lentil hay would be fed at 11.5 lbs DM/day to provide 2.5 lbs CP/day. An additional 18.5 lbs of roughage per day would need to be provided, at a cost of $44.35 per period. Production of early cut forage lentil hay to feed during the summer portion of the lactation period would require 0.95 acres, and the forage would cost $0.43 per day, or $58.91 per period. Total forage and supplement costs would be $103.26 per period, or $0.75 per day.

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 17.11 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.9 lbs of roughage per day would need to be provided, at a cost of $30.93 per period. Production of late-cut forage lentil hay to feed during the summer portion of the lactation period would require 0.60 acres, and the forage would cost $0.33 per day, or $45.21 per period. Total forage and supplement costs would be $76.14 per period, or $0.56 per day.

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.16 per pound. Oat-pea forage hay would be fed at 20.1 lbs DM/day to provide 2.5 lbs CP/day. An additional 9.9 lbs of roughage per day would need to be provided, at a cost of $23.74 per period. Production of oat-pea forage hay to feed during the summer portion of the lactation period would require 0.53 acres, and the forage would cost $0.38 per day, or $52.06 per period. Total forage and supplement costs would be $75.80 per period, or $0.55 per day.

Table 14. Pasture-forage costs of native rangeland pastures to be grazed by range cows during the 137-day summer portion of the lactation production period.

		Native Rangeland (12-m RS)	Native Rangeland (6.0-m SL)	Native Rangeland (4.5-m SL)	Native Rangeland (4.0-m Def)	Native Rangeland (4.5-m TOR)
Days		137	137	137	92	137
Growth Stage		summer	summer	summer	summer	summer
Herbage Weight	lb/ac	1450	906	1280	1649	1794
Forage DM Weight	lb/ac	363	226	320	412	449
Costs/Acre						
Land Rent	$	8.76	8.76	8.76	8.76	8.76
Custom Work	$					
Seed Cost	$					
Baling Costs	$					
Production Costs	$/ac	8.76	8.76	8.76	8.76	8.76
Forage DM Costs	$/ton	48.26	77.50	54.75	42.52	39.02
Land Area/Month	ac	2.52	4.04	2.86	2.22	2.04
Land Area/Period	ac	11.32	18.10	12.70	6.70	9.00
Land Costs/Period	$/pp	99.16	158.55	111.25	58.26	78.84
Forage Costs/Day	$/d	0.72	1.16	0.81	0.63	0.58
Forage Costs/Period	$/pp	98.64	158.55	111.25	58.26	78.84
Crude Protein	%	9.6				
Crude Protein Yield	lb/ac	34.85				
Crude Protein Cost	$/lb	0.25				
Supplementation						
Roughage/Day	lb/d					
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp					
Total Feed Cost	$/pp	98.64	158.55	111.25	58.26	78.84
Cost/Day	$/d	0.72	1.16	0.81	0.63	0.58

Table 15. Forage costs of perennial grass hays to be fed to range cows during the 137-day summer portion of the lactation production period.

		Crested Wheatgrass Hay	Crested Wheatgrass Hay
Growth Stage		Mature	Boot stage
Herbage Weight	lb/ac	-	-
Forage DM Weight	lb/ac	1600	1300
Costs/Acre			
Land Rent	$	14.22	14.22
Custom Work	$	5.31	5.31
Seed Cost	$	-	-
Baling Costs	$	8.58	6.97
Production Costs	$/ac	28.11	26.50
Forage DM Costs	$/ton	34.80	40.80
Land Area /Month	ac	0.56	0.40
Land Area/Period	ac	2.57	1.82
Land Cost/Period	$/pp	36.55	25.88
Forage Costs/Day	$/d	0.70	0.35
Forage Costs/Period	$/pp	95.90	47.95
Crude Protein	%	6.4	14.5
Crude Protein Yield	lb/ac	102	189
Crude Protein Cost	$/lb	0.28	0.14
Supplementation			
Roughage/Day	lb/d		12.69
Crude Protein/Day	lb/d	0.78	
Sup. Cost/Period	$/pp	32.14	30.42
Total Feed Cost	$/pp	128.04	78.37
Cost/Day	$/d	0.93	0.57

Table 16. Forage costs of annual cereal hays to be fed to range cows during the 137-day summer portion of the lactation production period.

		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Land Area/Month	ac	0.12	0.16	0.14	0.16
Land Area/Period	ac	0.56	0.73	0.64	0.73
Land Costs/Period	$/pp	12.36	16.11	14.12	16.11
Forage Costs/Day	$/d	0.28	0.38	0.33	0.43
Forage Costs/Period	$/pp	38.36	56.06	45.21	58.91
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Supplementation					
Roughage/Day	lb/d	10.7	2.7	8.2	
Crude Protein/Day	lb/d				0.40
Sup. Cost/Period	$/pp	25.65	6.47	19.66	16.44
Total Feed Cost	$/pp	64.01	58.53	64.87	75.35
Cost/Day	$/d	0.47	0.43	0.47	0.55

Table 17. Forage costs of annual legume hays to be fed to range cows during the 137-day summer portion of the lactation production period.

		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Land Area/Month	ac	0.14	0.11	0.21	0.13	0.12
Land Area/Period	ac	0.65	0.51	0.95	0.60	0.53
Land Costs/Period	$/pp	14.35	11.26	20.97	13.24	11.70
Forage Costs/Day	$/d	0.38	0.33	0.43	0.33	0.38
Forage Costs/Period	$/pp	52.06	45.21	58.91	45.21	52.06
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Supplementation						
Roughage/Day	lb/d	16.7	12.6	18.5	12.9	9.9
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	40.04	30.21	44.35	30.93	23.74
Total Feed Cost	$/pp	92.10	75.42	103.26	76.14	75.80
Cost/Day	$/d	0.67	0.55	0.75	0.56	0.55

Lactation (fall portion) Production Period

The fall portion of the lactation production period was 30 days from mid October until mid November, with an early 15-day segment from mid to late October and a late 15-day segment from early to mid November. Costs of forage dry matter and crude protein (tables 18, 19, 20, 21, and 22) to meet the requirements of a 1200-pound range cow with a calf during the fall portion of the lactation production period were determined. A cow with a calf requires 30 lbs of dry matter per day. The cow requires a daily intake of 27 lbs dry matter (DM) at 9.3% crude protein (CP) (2.51 lbs CP/day).

The costs of grazing native rangeland during the fall are considerably higher than the costs of grazing native rangeland during the summer. The weight of the herbage on fall pastures is only about 40% to 60% of the mid summer herbage weight on grasslands that have had no grazing all growing season. Native rangeland pasture forage during the fall has a crude protein content of around 4.8%, about half the content of mid summer herbage.

Fall native rangeland forage managed by the 12-month repeated seasonal (12-m RS) strategy has pasture rent value or production costs of $8.76 per acre, forage dry matter costs of $80.37 per ton during the early segment and $97.33 per ton during the late segment, and crude protein costs of $0.34 per pound during the early segment of the fall period and $1.01 per pound during the late segment. A cow with a calf would require 4.20 acres per month during the early segment and 5.00 acres per month during the late segment, or 2.10 acres during the 15-day early segment and 2.50 acres during the 15-day late segment, at a cost of $18.40 for the 15-day early segment, or $1.21 per day, and $21.90 for the 15-day late segment, or $1.46 per day. The crude protein content of mature native rangeland forage is below the requirements of a lactating cow during the fall, and crude protein would need to be supplemented at 1.21 lbs per cow per day, at a cost of $10.90 per 30-day period. Total feed cost would be $23.85, or $1.59 per day, during the early fall lactation period and $27.35, or $1.82 per day, during the late fall lactation period.

Early fall native rangeland forage managed by seasonlong treatments with 4.5 months of grazing (SL 4.5-m) that end in late October have pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $72.10 per ton. A cow with a calf would require 3.26 acres per month, or 1.63 acres during the 15-day early segment, at a cost of $14.28 for the 15-day early segment, or $0.95 per day.

Fall native rangeland forage managed by seasonlong treatments with 5.0 or 6.0 months of grazing (SL 5.0-6.0-m) that end in mid November have pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $49.21 per ton. The summer stocking rates used on these treatments are traditionally not adjusted to match the reduced fall herbage biomass, and a cow with a calf would graze 2.53 acres per month, at a cost of $22.16 for the 30-day period, or $0.74 per day.

Fall native rangeland forage managed by the 6.0-month seasonlong (6.0-m SL) strategy has pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $78.57 per ton. A cow with a calf would require 4.04 acres per month, at a cost of $35.39 for the 30-day period, or $1.18 per day.

Fall native rangeland forage managed by the 4.0-month deferred (4.0-m Def) strategy has pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $42.52 per ton. The summer stocking rate of this strategy is traditionally not adjusted to match the reduced fall herbage biomass, and a cow with a calf would graze 2.22 acres per month, at a cost of $19.53 for the 30-day period, or $0.65 per day.

Altai wildrye complementary pasture forage grazed during the fall by cattle from the 4.5-month twice-over rotation (4.5-m TOR) strategy has pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $27.04 per ton. A cow with a calf would require 1.39 acres per month, at a cost of $12.00 for the 30-day period, or $0.40 per day.

Cropland aftermath forage grazed during the fall by cattle from the 4.5-month seasonlong (4.5-m SL) strategy has production costs of $2.00 per acre and forage dry matter costs of $29.63 per ton. A cow with a calf would require 6.63 acres per month, at a cost of $13.26 for the 30-day period, or $0.44 per day.

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of 6.4%. This crested wheatgrass hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. Mature crested wheatgrass hay would be fed at 27.0 lbs DM/day to provide 1.7 lbs CP/day. An additional 0.8 lbs of crude protein per day would need to be provided, at a cost of $7.02 per period. Production of mature crested wheatgrass hay to feed during the fall portion of the lactation period would require 0.56 acres, and the forage would cost $0.70 per day, or

$21.00 per period. Total forage and supplement costs would be $28.02 per period, or $0.93 per day.

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of 14.5%. This crested wheatgrass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 17.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.7 lbs of roughage per day would need to be provided, at a cost of $6.66 per period. Production of early cut crested wheatgrass hay to feed during the fall portion of the lactation period would require 0.40 acres, and the forage would cost $0.35 per day, or $10.50 per period. Total forage and supplement costs would be $17.16 per period, or $0.57 per day.

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 19.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 10.7 lbs of roughage per day would need to be provided, at a cost of $5.62 per period. Production of early cut forage barley hay to feed during the fall portion of the lactation period would require 0.12 acres, and the forage would cost $0.28 per day, or $8.40 per period. Total forage and supplement costs would be $14.02 per period, or $0.47 per day.

Forage barley hay cut late, at the hard dough stage, has a crude protein content of 9.2%. This forage barley hay has production costs of $70.35 per acre, forage dry matter costs of $27.40 per ton, and crude protein costs of $0.15 per pound. Late-cut forage barley hay would be fed at 27.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 2.7 lbs of roughage per day would need to be provided, at a cost of $1.42 per period. Production of late-cut forage barley hay to feed during the fall portion of the lactation period would require 0.16 acres, and the forage would cost $0.38 per day, or $11.40 per period. Total forage and supplement costs would be $12.82 per period, or $0.43 per day.

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 21.8 lbs DM/day to provide 2.5 lbs CP/day. An additional 8.2 lbs of roughage per day would need to be provided, at a cost of $4.31 per period. Production of early cut oat hay to feed during the fall portion of the lactation period would require 0.14 acres, and the forage would cost $0.33 per day, or $9.90 per period. Total forage and supplement costs would be $14.21 per period, or $0.47 per day.

Oat forage hay cut late, at the hard dough stage, has a crude protein content of 7.8%. This oat forage hay has production costs of $74.53 per acre, forage dry matter costs of $26.40 per ton, and crude protein costs of $0.17 per pound. Late-cut oat hay would be fed at 27.0 lbs DM/day to provide 2.1 lbs CP/day. An additional 0.4 lbs of crude protein per day would need to be provided, at a cost of $3.60 per period. Production of late-cut oat hay to feed during the fall portion of the lactation period would require 0.16 acres, and the forage would cost $0.43 per day, or $12.90 per period. Total forage and supplement costs would be $16.50 per period, or $0.55 per day.

Pea forage hay cut at an early plant stage has a crude protein content of 18.9%. This pea forage hay has production costs of $79.96 per acre, forage dry matter costs of $55.00 per ton, and crude protein costs of $0.16 per pound. Early cut pea forage hay would be fed at 13.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 16.7 lbs of roughage per day would need to be provided, at a cost of $8.79 per period. Production of early cut pea forage hay to feed during the fall portion of the lactation period would require 0.14 acres, and the forage would cost $0.38 per day, or $11.40 per period. Total forage and supplement costs would be $20.19 per period, or $0.67 per day.

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 17.4 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.6 lbs of roughage per day would need to be provided, at a cost of $6.62 per period. Production of late-cut pea forage hay to feed during the fall portion of the lactation period would require 0.11 acres, and the forage would cost $0.33 per day, or $9.90 per period. Total forage and supplement costs would be $16.52 per period, or $0.55 per day.

Forage lentil hay cut at an early plant stage has a crude protein content of 21.8%. This forage lentil hay has production costs of $59.69 per acre, forage dry matter costs of $71.60 per ton, and crude protein costs of $0.17 per pound. Early cut lentil hay would be fed at 11.5 lbs DM/day to provide 2.5 lbs CP/day. An additional 18.5 lbs of roughage per day would need to be provided, at a cost of $9.71 per period. Production of early cut forage lentil hay to feed during the fall portion of the lactation period would

require 0.21 acres, and the forage would cost $0.43 per day, or $12.90 per period. Total forage and supplement costs would be $22.61 per period, or $0.75 per day.

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 17.1 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.9 lbs of roughage per day would need to be provided, at a cost of $6.77 per period. Production of late-cut forage lentil hay to feed during the fall portion of the lactation period would require 0.13 acres, and the forage would cost $0.33 per day, or $9.90 per period. Total forage and supplement costs would be $16.67 per period, or $0.56 per day.

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.16 per pound. Oat-pea forage hay would be fed at 20.1 lbs DM/day to provide 2.5 lbs CP/day. An additional 9.9 lbs of roughage per day would need to be provided, at a cost of $5.20 per period. Production of oat-pea forage hay to feed during the fall portion of the lactation period would require 0.12 acres, and the forage would cost $0.38 per day, or $11.40 per period. Total forage and supplement costs would be $16.60 per period, or $0.55 per day.

Table 18. Pasture-forage costs of native rangeland pastures to be grazed by range cows during the 30-day fall portion of the lactation production period.

		Native Rangeland (12-m RS)		Native Rangeland (SL 4.5-m)	Native Rangeland (SL 5-6-m)	Native Rangeland (6.0-m SL)	Native Rangeland (4.0-m Def)
		Early	Late	Early			
Days		15	15	15	30	30	30
Growth Stage		fall	fall	fall	fall	fall	fall
Herbage Weight	lb/ac	870	725	973	1423	891	1649
Forage DM Weight	lb/ac	218	180	243	356	223	412
Costs/Acre							
Land Rent	$	8.76	8.76	8.76	8.76	8.76	8.76
Custom Work	$						
Seed Cost	$						
Baling Costs	$						
Production Costs	$/ac	8.76	8.76	8.76	8.76	8.76	8.76
Forage DM Costs	$/ton	80.37	97.33	72.10	49.21	78.57	42.52
Land Area/Month	ac	4.20	5.00	3.26	2.53	4.04	2.22
Land Area/Period	ac	2.10	2.50	1.63	2.53	4.04	2.18
Land Costs/Period	$/pp	18.40	21.90	14.28	22.16	35.39	19.53
Forage Costs/Day	$/d	1.21	1.46	0.95	0.74	1.18	0.65
Forage Costs/Period	$/pp	18.40	21.90	14.28	22.16	35.39	19.53
Crude Protein	%	4.8	4.8				
Crude Protein Yield	lb/ac	10.46	8.64				
Crude Protein Cost	$/lb	0.34	1.01				
Supplementation							
Roughage/Day	lb/d						
Crude Protein/Day	lb/d	1.21	1.21				
Sup. Cost/Period	$/pp	5.45	5.45				
Total Feed Cost	$/pp	23.85	27.35	14.28	22.16	35.39	19.53
Cost/Day	$/d	1.59	1.82	0.95	0.74	1.18	0.65

Table 19. Pasture-forage costs of domesticated grass and cropland pastures to be grazed by range cows during the 30-day fall portion of the lactation production period.

		Altai Wildrye (4.5-m TOR)	Cropland Aftermath (4.5-m SL)
Days		30	30
Growth Stage		fall	fall
Herbage Weight	lb/ac	2590	270
Forage DM Weight	lb/ac	648	135
Costs/Acre			
Land Rent	$	8.76	2.00
Custom Work	$		
Seed Cost	$		
Baling Costs	$		
Production Costs	$/ac	8.76	2.00
Forage DM Costs	$/ton	27.04	29.63
Land Area/Month	ac	1.39	6.63
Land Area/Period	ac	1.39	6.63
Land Costs/Period	$/pp	12.18	13.26
Forage Costs/Day	$/d	0.40	0.44
Forage Costs/Period	$/pp	12.00	13.26
Crude Protein	%		
Crude Protein Yield	lb/ac		
Crude Protein Cost	$/lb		
Supplementation			
Roughage/Day	lb/d		
Crude Protein/Day	lb/d		
Sup. Cost/Period	$/pp		
Total Feed Cost	$/pp	12.00	13.26
Cost/Day	$/d	0.40	0.44

Table 20. Forage costs of perennial grass hays to be fed to range cows during the 30-day fall portion of the lactation production period.

		Crested Wheatgrass Hay	Crested Wheatgrass Hay
Growth Stage		Mature	Boot stage
Herbage Weight	lb/ac	-	-
Forage DM Weight	lb/ac	1600	1300
Costs/Acre			
Land Rent	$	14.22	14.22
Custom Work	$	5.31	5.31
Seed Cost	$	-	-
Baling Costs	$	8.58	6.97
Production Costs	$/ac	28.11	26.50
Forage DM Costs	$/ton	34.80	40.80
Land Area /Month	ac	0.56	0.40
Land Area/Period	ac	0.56	0.40
Land Cost/Period	$/pp	7.96	5.69
Forage Costs/Day	$/d	0.70	0.35
Forage Costs/Period	$/pp	21.00	10.50
Crude Protein	%	6.4	14.5
Crude Protein Yield	lb/ac	102	189
Crude Protein Cost	$/lb	0.28	0.14
Supplementation			
Roughage/Day	lb/d		12.69
Crude Protein/Day	lb/d	0.78	
Sup. Cost/Period	$/pp	7.02	6.66
Total Feed Cost	$/pp	28.02	17.16
Cost/Day	$/d	0.93	0.57

Table 21. Forage costs of annual cereal hays to be fed to range cows during the 30-day fall portion of the lactation production period.

		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Land Area/Month	ac	0.12	0.16	0.14	0.16
Land Area/Period	ac	0.12	0.16	0.14	0.16
Land Costs/Period	$/pp	2.65	3.53	3.09	3.53
Forage Costs/Day	$/d	0.28	0.38	0.33	0.43
Forage Costs/Period	$/pp	8.40	11.40	9.90	12.90
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Supplementation					
Roughage/Day	lb/d	10.7	2.7	8.2	
Crude Protein/Day	lb/d				0.40
Sup. Cost/Period	$/pp	5.62	1.42	4.31	3.60
Total Feed Cost	$/pp	14.02	12.82	14.21	16.50
Cost/Day	$/d	0.47	0.43	0.47	0.55

Table 22. Forage costs of annual legume hays to be fed to range cows during the 30-day fall portion of the lactation production period.

		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Land Area/Month	ac	0.14	0.11	0.21	0.13	0.12
Land Area/Period	ac	0.14	0.11	0.21	0.13	0.12
Land Costs/Period	$/pp	3.09	2.43	4.63	2.87	2.65
Forage Costs/Day	$/d	0.38	0.33	0.43	0.33	0.38
Forage Costs/Period	$/pp	11.40	9.90	12.90	9.90	11.40
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Supplementation						
Roughage/Day	lb/d	16.7	12.6	18.5	12.9	9.9
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	8.79	6.62	9.71	6.77	5.20
Total Feed Cost	$/pp	20.19	16.52	22.61	16.67	16.60
Cost/Day	$/d	0.67	0.55	0.75	0.56	0.55

Production periods

Pasture and forage costs during the production periods are shown in tables 23-28.

Total feed costs during the 32-day dry gestation production period ranged between $10.74 per period, or $0.34 per day, and $40.70 per period, or $1.27 per day. All of the harvested forages provided reasonably priced feed. Forage barley hay and oat forage hay had the lowest costs. Early cut pea forage hay and early cut forage lentil hay had costs greater than $15.00 per period or $0.47 per day. The other harvested-forage types had costs lower than $14.50 per period or $0.45 per day. The costs of the forage from grazing cropland aftermath appeared to be reasonable before cow weight performance was considered. The cost of grazing native rangeland reserve pastures was high at $1.27 per day.

Total feed costs during the 90-day third trimester production period ranged between $28.80 per period, or $0.32 per day, and $149.94 per period, or $1.67 per day. Mature crested wheatgrass hay was expensive at $0.62 per day and had the highest harvested-forage hay costs. Forage barley hay and oat forage hay had the lowest costs. Early cut pea forage hay and early cut forage lentil hay had costs greater than $45.00 per period or $0.50 per day. The other harvested-forage types had costs of $0.45 or lower per day and less than $41.00 per period. The cost of grazing native rangeland reserve pastures was extremely high at $1.67 per day.

Total feed costs during the 45-day early lactation production period ranged between $18.23 per period, or $0.41 per day, and $88.43 per period, or $1.97 per day. Mature crested wheatgrass hay was expensive at $1.05 per day and had the highest harvested-forage hay costs. Early cut forage barley hay and early cut oat forage hay had the lowest costs. Late-cut oat forage hay, early cut pea forage hay, and early cut forage lentil hay were expensive forages, with costs greater than $28.00 per period or $0.62 per day. The other harvested-forage types had costs lower than $25.00 per period or $0.55 per day. The cost of grazing native rangeland reserve pastures was extremely high at $1.97 per day.

Total feed costs during the 31-day spring portion of the lactation production period ranged between $13.24 per period, or $0.43 per day, and $41.85 per period, or $1.35 per day. Mature crested wheatgrass hay was expensive at $0.93 per day and had the highest harvested-forage hay costs. Late-cut forage barley hay, early cut forage barley hay, and early cut oat forage hay had the lowest costs. Early cut pea forage hay and early cut forage lentil hay were expensive forages, with costs greater than $20.00 per period or $0.65 per day. The other harvested-forage types had costs lower than $18.00 per period or $0.58 per day. The costs of the forage from grazing unfertilized and fertilized crested wheatgrass pastures were reasonable, from $0.48 to $0.52 per day. The costs of grazing native rangeland pastures before the plants reached the third-leaf stage were high at $1.15 and $1.35 per day.

Total feed costs during the 137-day summer portion of the lactation production period ranged between $58.53 per period, or $0.43 per day, and $158.55 per period, or $1.16 per day. Mature crested wheatgrass hay was expensive at $0.93 per day and had the highest harvested-forage hay costs. Late-cut forage barley hay, early cut forage barley hay, and early cut oat forage hay had the lowest costs. Early cut pea forage hay and early cut forage lentil hay were expensive forages, with costs greater than $90.00 per period, or $0.65 per day. The other harvested-forage types had costs lower than $80.00 per period or $0.58 per day. The cost of the forage from grazing native rangeland pastures on the twice-over rotation system was reasonable at $0.58 per day. The costs of grazing native rangeland pastures managed by traditional practices were high, from $0.63 to $1.16 per day.

Total feed costs during the 30-day fall portion of the lactation production period ranged between $12.82 per period, or $0.43 per day, and $51.20 per period, or $1.71 per day. Mature crested wheatgrass hay was expensive at $0.93 per day and had the highest harvested-forage hay costs. Forage barley hay and early cut oat forage hay had the lowest costs. Early cut pea forage hay and early cut forage lentil hay were expensive forages, with costs greater than $20.00 per period or $0.65 per day. The other harvested-forage types had costs lower than $18.00 per period or $0.58 per day. The cost of the forage from grazed Altai wildrye pastures was reasonable at $0.40 per day. The cost of the forage from grazing cropland aftermath appeared to be reasonable before cow and calf weight performance was considered. The costs of grazing native rangeland pastures during the nongrowing season were expensive, from $1.18 to $1.71 per day.

Some pasture forages and some harvested forages had high livestock feed costs because the quantity of nutrients captured per acre was relatively small. Some pasture forages and some harvested forages had low livestock feed costs because the quantity of nutrients efficiently captured per acre was high in relation to the forage production costs. Mature crested wheatgrass hay had the highest harvested-forage hay costs, and forage barley hay and

early cut oat forage hay had the lowest harvested-forage hay costs.

Table 23. Pasture and forage costs during the dry gestation production period.

	Land Area ac/pp	Forage Dry Matter $/ton	Crude Protein $/lb	Forage Cost $/pp	Supplement Cost $/pp	Total Feed Cost $/pp	Cost per Day $/d
12-m RS							
Native Rangeland	4.27	97.33	1.01	35.10	3.26	40.70	1.27
6.0-m SL							
4.5-m SL							
4.0-m Def							
Cropland Aftermath	7.10	29.63		14.20		14.20	0.44
4.5-m TOR							
Crested Wheatgrass							
Mature	0.47	34.80	0.28	13.12	0.34	13.46	0.42
Crested Wheatgrass							
Boot Stage	0.26	40.80	0.14	6.72	7.68	14.40	0.45
Forage Barley							
Milk	0.07	28.80	0.11	5.12	7.00	12.12	0.38
Forage Barley							
Hard Do.	0.10	27.40	0.15	7.04	4.37	11.41	0.36
Oat Forage							
Milk	0.09	29.60	0.13	6.08	6.16	12.24	0.38
Oat Forage							
Hard Do.	0.11	26.40	0.17	8.00	2.74	10.74	0.34
Pea Forage							
Early	0.09	55.00	0.15	7.04	9.02	16.06	0.50
Pea Forage							
Late	0.07	37.40	0.13	6.08	7.67	13.75	0.43
Forage Lentil							
Early	0.13	71.60	0.17	8.00	9.63	17.63	0.55
Forage Lentil							
Late	0.09	37.00	0.13	6.08	7.78	13.86	0.43
Oat-Pea Forage							
Hay	0.07	37.20	0.16	7.04	6.78	13.82	0.43

Table 24. Pasture and forage costs during the third trimester production period.

	Land Area ac/pp	Forage Dry Matter $/ton	Crude Protein $/lb	Forage Cost $/pp	Supplement Cost $/pp	Total Feed Cost $/pp	Cost per Day $/d
12-m RS							
Native Rangeland	14.90	120.83	1.26	130.50	19.44	149.94	1.67
6.0-m SL							
4.5-m SL							
4.0-m Def							
4.5-m TOR							
Crested Wheatgrass							
Mature	1.35	34.80	0.28	46.80	9.02	55.82	0.62
Crested Wheatgrass							
Boot Stage	0.89	40.80	0.14	23.40	17.48	40.88	0.45
Forage Barley							
Milk	0.27	28.80	0.11	18.90	14.96	33.86	0.38
Forage Barley							
Hard Do.	0.36	27.40	0.15	26.10	5.83	31.93	0.35
Oat Forage							
Milk	0.31	29.60	0.13	21.60	12.13	33.73	0.37
Oat Forage							
Hard Do.	0.38	26.40	0.17	28.80	0.0	28.80	0.32
Pea Forage							
Early	0.32	55.00	0.15	25.20	22.21	47.41	0.53
Pea Forage							
Late	0.25	37.40	0.13	21.60	17.33	38.93	0.43
Forage Lentil							
Early	0.46	71.60	0.17	28.80	24.26	53.06	0.59
Forage Lentil							
Late	0.30	37.00	0.13	21.60	17.80	39.40	0.44
Oat-Pea Forage							
Hay	0.26	37.20	0.16	25.20	14.18	39.38	0.44

Table 25. Pasture and forage costs during the early lactation production period.

	Land Area ac/pp	Forage Dry Matter $/ton	Crude Protein $/lb	Forage Cost $/pp	Supplement Cost $/pp	Total Feed Cost $/pp	Cost per Day $/d
12-m RS							
Native Rangeland	9.72	140.16	0.76	85.05	3.38	88.43	1.97
6.0-m SL							
4.5-m SL							
4.0-m Def							
4.5-m TOR							
Crested Wheatgrass							
Mature	0.76	34.80	0.28	33.75	13.50	47.25	1.05
Crested Wheatgrass							
Boot Stage	0.65	40.80	0.14	17.10	6.43	23.53	0.52
Forage Barley							
Milk	0.20	28.80	0.11	13.51	4.73	18.23	0.41
Forage Barley							
Hard Do.	0.24	27.40	0.15	18.45	3.38	21.83	0.49
Oat Forage							
Milk	0.23	29.60	0.13	15.75	2.60	18.35	0.41
Oat Forage							
Hard Do.	0.21	26.40	0.17	20.70	8.37	29.07	0.65
Pea Forage							
Early	0.23	55.00	0.15	18.45	9.92	28.37	0.63
Pea Forage							
Late	0.18	37.40	0.13	15.75	6.30	22.05	0.49
Forage Lentil							
Early	0.34	71.60	0.17	20.70	11.42	32.12	0.71
Forage Lentil							
Late	0.22	37.00	0.13	15.75	6.62	22.37	0.50
Oat-Pea Forage							
Hay	0.19	37.20	0.16	18.45	4.10	22.55	0.50

Table 26. Pasture and forage costs during the spring portion of the lactation production period.

	Land Area ac/pp	Forage Dry Matter $/ton	Crude Protein $/lb	Forage Cost $/pp	Supplement Cost $/pp	Total Feed Cost $/pp	Cost per Day $/d
12-m RS Native Rangeland	4.77	89.85	0.28	41.85		41.85	1.35
6.0-m SL Native Rangeland	4.04	77.52		35.65		35.65	1.15
4.5-m SL Crested Wheatgrass	1.88	35.39		16.47		16.47	0.52
4.0-m Def Crested Wheatgrass	1.73	31.97		14.88		14.88	0.48
4.5-m TOR Crested Wheatgrass	0.75	34.29		15.95		15.95	0.51
Crested Wheatgrass Mature	0.58	34.80	0.28	21.70	7.27	28.97	0.93
Crested Wheatgrass Boot Stage	0.41	40.80	0.14	10.85	6.88	17.73	0.57
Forage Barley Milk	0.13	28.80	0.11	8.68	5.80	14.48	0.47
Forage Barley Hard Do.	0.16	27.40	0.15	11.78	1.46	13.24	0.43
Oat Forage Milk	0.14	29.60	0.13	10.23	4.45	14.68	0.47
Oat Forage Hard Do.	0.16	26.40	0.17	13.33	3.72	17.05	0.55
Pea Forage Early	0.15	55.00	0.15	11.78	9.06	20.84	0.67
Pea Forage Late	0.12	37.40	0.13	10.23	6.84	17.07	0.55
Forage Lentil Early	0.34	71.60	0.17	13.33	10.04	23.37	0.75
Forage Lentil Late	0.14	37.00	0.13	10.23	7.00	17.23	0.56
Oat-Pea Forage Hay	0.12	37.20	0.16	11.78	5.37	17.15	0.55

Table 27. Pasture and forage costs during the summer portion of the lactation production period.

	Land Area ac/pp	Forage Dry Matter $/ton	Crude Protein $/lb	Forage Cost $/pp	Supplement Cost $/pp	Total Feed Cost $/pp	Cost per Day $/d
12-m RS Native Rangeland	11.32	48.26	0.25	98.64		98.64	0.72
6.0-m SL Native Rangeland	18.10	77.50		158.55		158.55	1.16
4.5-m SL Native Rangeland	12.70	54.75		111.25		111.25	0.81
4.0-m Def Native Rangeland	9.99	42.52		86.31		86.31	0.63
4.5-m TOR Native Rangeland	9.00	39.02		78.84		78.84	0.58
Crested Wheatgrass Mature	2.57	34.80	0.28	95.90	32.14	128.04	0.93
Crested Wheatgrass Boot Stage	1.82	40.80	0.14	47.95	30.42	78.37	0.57
Forage Barley Milk	0.56	28.80	0.11	38.36	25.65	64.01	0.47
Forage Barley Hard Do.	0.73	27.40	0.15	56.06	6.47	58.53	0.43
Oat Forage Milk	0.64	29.60	0.13	45.21	19.66	64.87	0.47
Oat Forage Hard Do.	0.73	26.40	0.17	58.91	16.44	75.35	0.55
Pea Forage Early	0.65	55.00	0.15	52.06	40.04	92.10	0.67
Pea Forage Late	0.51	37.40	0.13	45.21	30.21	75.42	0.55
Forage Lentil Early	0.95	71.60	0.17	58.91	44.35	103.26	0.75
Forage Lentil Late	0.60	37.00	0.13	45.21	30.93	76.14	0.56
Oat-Pea Forage Hay	0.53	37.20	0.16	52.06	23.74	75.80	0.55

Table 28. Pasture and forage costs during the fall portion of the lactation production period.

	Land Area ac/pp	Forage Dry Matter $/ton	Crude Protein $/lb	Forage Cost $/pp	Supplement Cost $/pp	Total Feed Cost $/pp	Cost per Day $/d
12-m RS Native Rangeland	4.60	88.85	0.68	40.30	10.90	51.20	1.71
6.0-m SL Native Rangeland	4.04	78.57		35.39		35.39	1.18
4.5-m SL Cropland Aftermath	6.63	29.63		13.26		13.26	0.44
4.0-m Def Native Rangeland	2.18	42.52		19.53		19.53	0.65
4.5-m TOR Altai Wildrye	1.39	27.04		12.00		12.00	0.40
Crested Wheatgrass Mature	0.56	34.80	0.28	21.00	7.02	28.02	0.93
Crested Wheatgrass Boot Stage	0.40	40.80	0.14	10.50	6.66	17.16	0.57
Forage Barley Milk	0.12	28.80	0.11	8.40	5.62	14.02	0.47
Forage Barley Hard Do.	0.16	27.40	0.15	11.40	1.42	12.82	0.43
Oat Forage Milk	0.14	29.60	0.13	9.90	4.31	14.21	0.47
Oat Forage Hard Do.	0.16	26.40	0.17	12.90	3.60	16.50	0.55
Pea Forage Early	0.14	55.00	0.15	11.40	8.79	20.19	0.67
Pea Forage Late	0.11	37.40	0.13	9.90	6.62	16.52	0.55
Forage Lentil Early	0.21	71.60	0.17	12.90	9.71	22.61	0.75
Forage Lentil Late	0.13	37.00	0.13	9.90	6.77	16.67	0.56
Oat-Pea Forage Hay	0.12	37.20	0.16	11.40	5.20	16.60	0.55

Discussion

Production costs per acre for harvested forages were greater than pasture rent per acre. Production costs per acre for annual cereal and annual legume hays were considerably greater than those for perennial grass hay. Production costs per acre for harvested forages cut late were greater than production costs per acre for the same forage type cut early because the greater dry matter yield of the late-cut forages resulted in increased baling costs. The relationships among forage production costs of pastures, perennial hays, and annual hays are often interpreted to indicate that feeding livestock annual cereal and annual legume hays is more expensive than feeding livestock perennial grass hay, which in turn is more expensive than grazing livestock on perennial grass pasture. This interpretation of pasture-forage production costs per acre has been the basis for numerous extended grazing management treatments for range cows. However, neither production costs per acre nor pasture rent per acre accurately reflects livestock production costs because forage dry matter weight per acre and nutrient weight per acre captured through grazing or haying vary with forage type and plant growth stage, and the variations are not proportional to these per acre costs.

The costs per unit of forage dry matter reflect the relationships between the pasture rent per acre or production costs per acre and the amount of dry matter consumed by grazing livestock or harvested for hay. Cost of harvested forage per unit of weight is commonly used to compare different forage types, but cost of grazingland-forage dry matter consumed by livestock during grazing is generally not considered by livestock producers when they compare costs of management strategies. The forage dry matter costs per ton for ingested forage from native range pasture during the nongrowing season were very high and were greater than the forage dry matter costs for perennial grass hays and annual cereal and annual legume hays. During the growing season, ingested forage dry matter costs per ton from native rangeland, crested wheatgrass, and Altai wildrye pastures were generally comparable to the dry matter costs for harvested forages. Forage dry matter costs per ton were greater for harvested forages cut early than for the same forage type cut late because the production costs per acre were shared by fewer pounds of forage dry matter yield for the early cut forages. Forage dry matter costs per unit of weight do not accurately reflect livestock production costs because of the variable quantity of nutrients contained within the dry matter and the resulting differences in the amount of dry matter needed to provide adequate quantities of nutrients for livestock.

Cost per unit of nutrient is an important indicator of livestock pasture-forage costs. Nutrient cost per unit of weight is related to the forage dry matter cost and the quantity of nutrients per unit of forage weight. Crude protein costs during the nongrowing season on native range pastures were very high and were considerably greater than crude protein costs per pound for harvested forages. Crude protein costs during the growing season on perennial grass pastures were reasonable and just slightly higher than crude protein costs for harvested forages. Crude protein costs for early cut perennial grass hay and annual cereal hays were lower than crude protein costs for the same forage types cut late. Crude protein costs for late-cut annual legume hays were lower than crude protein costs for the same forage types cut early. High-quality forages have lower costs per unit of nutrient than low-quality forages at the same cost per unit of dry matter. Even high-quality forages with a higher cost per unit of dry matter may actually be less costly feed because less of the high quality forage is needed to meet the nutritional requirements of the livestock. Crude protein content of herbage on late-season native range and cropland aftermath pastures was below the requirements of range cows.

Land area per animal unit has not been traditionally recognized as an important factor in beef production costs. Land area per month required for a range cow on reserved native range pastures during the nongrowing season was considerable and was more than twice the land area required per month during the growing season. Land area required to produce one month of forage from harvested forages was relatively small. Crested wheatgrass hay cut at a mature plant stage required the larger land area, and forage barley cut at the milk stage, pea forage cut late, and oat-pea hay required the smaller land areas. Costs of the land area required to provide adequate quantities of forage for a cow contribute substantially to total pasture-forage production costs. The greater the amount of the produced nutrients captured from a land base, the smaller the land area required by an animal unit and the lower the pasture-forage production costs.

Livestock forage-feed costs during the nongrowing season on native range pastures were extremely high because the captured forage quantity and quality were low. Forage costs during the growing season on native rangeland pastures managed by traditional practices were high because captured forage quantity and quality were lower than potential. Forage costs on native rangeland pastures managed by the twice-over rotation system were reasonable because forage quality and quantity were near the land's potential production. Forage costs on cropland aftermath were relatively low because the

rent value of cropland aftermath was low. However, the considerable weight loss in cows and low weight gain in calves grazing cropland aftermath should be regarded as a substantial cost. Forage costs per day and per month for early cut crested wheatgrass hay were about half the forage costs for mature-cut crested wheatgrass hay. The forage costs for early cut annual cereal hays were lower than the forage costs for late-cut annual cereal hays. The forage costs for late-cut annual legume hays were lower than the forage costs for early cut annual legume hays. The forage costs for oat-pea hay were similar to the forage costs for late-cut annual cereal hays and early cut legume hays.

Perennial grass hays yield greater pounds of crude protein per acre when harvested during early developmental stages, around the boot stage to flowering stage. Annual cereal hays yield greater pounds of crude protein per acre when harvested during early developmental stages, around the flowering stage to late milk stage. Annual legume hays generally yield greater pounds of crude protein per acre when harvested during the middle and late stages of development. Cereal-legume mixed hays have generally not produced greater quantities of forage dry matter or pounds of crude protein per acre than have annual cereals or annual legumes seeded separately, because of the differences in the optimum times to harvest annual cereals and annual legumes. Cutting forage hays at their optimum harvest times reduces livestock forage costs per day and per production period because the cost per pound of crude protein is lower when greater pounds of crude protein per acre are captured during harvest. Grazingland forages grazed during the period when greater pounds of crude protein per acre can be captured have lower livestock forage costs. Crested wheatgrass has lower forage costs when grazed during May. Native rangeland has lower forage costs when grazed between early June and mid October. Altai wildrye has low forage costs when grazed between mid October and mid November.

Extending the grazing season has traditionally been regarded as less expensive than feeding harvested forages, but having cows graze their own feed is not necessarily the lowest-cost strategy. Grazing native rangeland during the fall is commonly accepted as a low-cost, innocuous practice; however, costs of forage dry matter and crude protein on native rangeland during the fall are extremely high, and fall grazing has the potential to degrade grassland ecosystems. The cost of grazing native rangeland during the fall is high because the weight of the herbage on fall pasture is only about half of the mid summer herbage weight and grazing livestock therefore require about twice as many acres per month during the fall as they do during the summer. The nutritional quality of mature herbage during fall is about half of the herbage nutrient content during summer. The crude protein content of mature native range forage is below the requirements of dry cows, and supplementation is needed.

Grazing mature rangeland during the fall can have negative economic consequences beyond the fall because the practice can remove or damage fall growth and other leaf material that the grass plant depends on to survive the winter and resume growth the next spring. Perennial grasses are perpetuated primarily through vegetative reproduction by tillering rather than through sexual reproduction. Very few perennial grasses grow from seed in established grasslands. Perennial grasses start growth of next year's plants in late summer or early fall, during winter hardening, the process of physiological preparation for the winter season. Warm-season grasses produce a relatively large bud but suspend additional growth until the next spring. Cool-season grasses produce tillers with one and a half to four leaves.

Fall tillers grow from axillary buds on the crowns of perennial grass species between mid August and the end of the active growing season and remain viable over the winter. These fall tillers continue growth as lead tillers the following spring, producing a high proportion of that season's herbage. After the lead tillers have flowered, secondary tillers can grow from axillary buds.

During the later portion of the growing season, the grass plant population consists of mature lead tillers, secondary tillers, and fall tillers. Mature lead tillers that are near the completion of their life cycle and secondary tillers that have developed seed heads will not overwinter but will progress through a natural aging process called senescence. During this aging process, the cell components of the aboveground structures are translocated to belowground structures. The translocation of cell contents reduces the nutritional quality and the weight of the herbage. The nutritional quality of mature herbage during fall decreases to about 4.8% crude protein. The weight of the herbage is about 40% to 60% of the herbage weight during mid summer. Secondary tillers that have not entered the sexually reproductive stage and fall tillers will overwinter. These tillers retain active leaf material until the end of the growing season, when the chlorophyll fades and the leaves lose their green color, appearing brown like the leaves of lead tillers that have completed their growth cycle.

Perennial grasses remain alive and maintain physiological processes throughout the year, even during the winter. Winter dormancy for perennial grasses is not a period of total inactivity but a period of reduced biological activity. The crown, some portions of the root system, and some leaf tissue remain active by using stored carbohydrates. Winter survival and spring regrowth of secondary tillers and fall tillers depend on the plant's having adequate carbohydrate reserves.

The quantity of carbohydrates stored during the winter hardening process is closely related to the amount of active leaf material on each tiller. Tillers with abundant leaf area during late summer and early fall can store adequate quantities of carbohydrates to survive the winter and produce robust leaves the following spring. Generally, the greater the number of active leaves on tillers during the fall, the more robust the plants will be the following spring. Heavy grazing of grasslands during August to mid October removes sufficient leaf material from secondary and fall tillers that quantities of carbohydrates stored will be low. Tillers with low carbohydrate reserves may not survive until spring. It is suspected that fall tillers with fewer than one and a half leaves may be unable to store adequate carbohydrate reserves to survive the winter. Plants that have low carbohydrate reserves and survive the dormancy period produce tillers with reduced height and weight.

The rate at which plants respire, or use stored carbohydrates, during the winter is affected by the amount of insulation that standing plant material and snow provide from the cold winter air temperatures. The greater the amount of insulation, the more slowly the plant draws on its carbohydrate reserves. When the standing herbage on a grassland is grazed short and most of the snow is blown off, very rapid respiration can occur and deplete carbohydrate reserves before spring, causing plant death called "winter kill".

On tillers that have overwintered, the leaf portions with intact cell walls can regreen early in the spring. The leaf portions with ruptured cell walls remain brown. The surviving leaves, with their brown tops and green bases, are most obvious soon after the snow melts. When the current year's early leaf growth has been exposed for several hours to air temperatures below 28° F, it may have large dry portions and appear similar to overwintering leaves. The green portion of the overwintered leaves provides photosynthetic products that, in combination with remaining stored carbohydrates, support the development and growth of new leaves and roots. The robustness of spring growth in plants that overwinter depends on the amount of surviving leaf area.

Removal of the leaf area of the overwintering tillers by grazing during fall or winter deprives developing tillers of a major source of nutrients, increases the demand on low levels of carbohydrate reserves, and results in reduced leaf production. Reductions in leaf height (Manske 2000) for the major graminoids during the succeeding growing season range from 17% to 43%, and the contribution of herbage weight to the ecosystem biomass is greatly reduced.

The common assumption that perennial grasses will not be harmed by grazing after they turn brown following a hard frost guides numerous fall grazing practices. This popular belief is not consistent with the biology of grass growth and should not be used as a foundation for grazing management decisions because of the resulting reductions in grass production and increases in grazingland-forage costs the following year. Management strategies coordinated with the biological requirements of grass plants promote vigorous growth of the plants and the efficient capture of forage dry matter and nutrients produced. These characteristics result in considerable reductions in grazingland-forage costs for cows and calves.

Feeding low-cost harvested forages is an economically and ecologically sound alternative to grazing livestock on fall native range pasture. Harvested forages are usually viewed as expensive feeds because the production costs per acre are greater than pasture rent per acre and a high percentage of the harvested-forage production costs consist of labor and equipment costs. Some harvested forages are expensive, but not all harvested forages are high-cost feeds. Harvested forages cut at plant stages that yield great amounts of dry matter and low amounts of crude protein per acre have high costs per unit of nutrient and are generally expensive forages that increase livestock production costs. However, harvested forages cut at plant stages that yield great amounts of crude protein per acre have lower costs per unit of nutrient and are relatively low-cost forages that help reduce livestock production costs. Early crested wheatgrass, early forage barley, early oat forage, late pea forage, late forage lentil, and oat-pea forage have crude protein costs below $0.25/lb and total feed costs below $0.62/day. Use of these forages should help reduce livestock production costs so that profit margins are positive even when calves are sold at $0.70/lb.

Traditionally, beef producers have based evaluations of animal production costs on the rent

value per acre for pasture and the production costs per acre or the market value per ton for harvested forages. Traditional comparisons of pasture or land rent values, forage production costs per acre, and forage dry matter bulk weight costs do not accurately reflect livestock production costs and the effectiveness of pasture-forage management strategies. Calculations using these traditional market values can result in misleading assessments of forage costs. 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. Therefore, determination of the profit or loss from forages is more accurately made from calculations based on the costs and returns per unit of nutrients. Total profits from forages and beef animals can be determined from the quantities of nutrients required by the livestock. Substantial reduction in beef production costs can be achieved by producers who change to forage management strategies that efficiently capture low-cost nutrients produced on a land base.

Conclusion

Pasture-forage management systems for beef production in the Northern Plains need improved efficiency to increase the value captured from the land. During the past several decades the type of livestock in the region has shifted from a low-performance to a fast-growing, high-performance animal that produces most efficiently when its diet meets nutrient requirements during each production period. Traditional pasture-forage management practices do not provide diets that meet livestock immediate nutrient demand, and attempts to produce high-performance livestock by using slightly modified traditional low-performance management strategies have led to high production costs and low profit margins.

Efficient pasture-forage management strategies for high-performance livestock provide pasture and forage types so that herbage production curves and nutritional quality curves coordinate with the dietary quantity and quality requirement curves of cow production periods. Such management strategies meet the nutritional requirements of high-performance livestock during each production period at low costs per unit of saleable product. Evaluation of the effectiveness of management strategies in reducing livestock pasture-forage production costs can be accomplished through comparisons of costs per unit of nutrient, land area per animal unit, forage feed costs per day or per production period, and costs per pound of calf weight gain. Implementation of efficient pasture-forage management strategies will result in improved livestock weight performance, reduced livestock production costs, and increased profit margins.

Acknowledgment

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

Literature Cited

Barker, W.T., and W.C. Whitman. 1988. Vegetation of the Northern Great Plains. Rangelands 10:266-272.

Beard, L.W. 1998. 1998 North Dakota custom rates. North Dakota Agricultural Statistics Service. http://www.nass.usda.gov/nd/cus

Manske, L.L. 1999a. Annual nutritional quality curves for native range cool season grasses. NDSU Dickinson Research Extension Center. Range Management Report DREC 99-1026. Dickinson, ND. 16p.

Manske, L.L. 1999b. Annual nutritional quality curves for native range warm season grasses. NDSU Dickinson Research Extension Center. Range Management Report DREC 99-1027. Dickinson, ND. 13p.

Manske, L.L. 2000. Fall grazing affects grass leaf height. NDSU Dickinson Research Extension Center. Range Management Report DREC 00-1031. Dickinson, ND. 9p.

Manske, L.L., and P.M. Carr. 2000. Determination of costs of harvested forage types to help reduce beef production costs. NDSU Dickinson Research Extension Center. Range Research Report DREC 00-1029. Dickinson, ND. 18p.

National Research Council. 1996. Nutrient requirements of beef cattle. 7th rev.ed. National Academy Press, Washington, DC.

Swenson, A., and R. Haugen. 1999. Projected 2000 crop budgets for southwest North Dakota. NDSU Extension Service. http://www.ext.nodak.edu/extpubs/agecon/

Whitman, W.C., D.W. Bolin, E.W. Klosterman, H.J. Klostermann, K.D. Ford, L. Moomaw, D.G. Hoag, and M.L. Buchanan. 1951. Carotene, protein, and phosphorus in range and tame grasses of western North Dakota. North Dakota Agricultural Experiment Station. Bulletin 370. Fargo, ND. 55p.