Costs-Returns as Affected by Grazing Management Strategies

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Introduction

The type of grazing management strategy used in cow-calf production on native rangeland and domesticated grass pastures affects the biology of plant growth and the performance of cow-calf pairs. Grazing strategy effects on plant biology are shown as differences in stocking rate and acres required per cow-calf pair during the grazing season. These values affect the costs of pasture and forage per cow-calf pair and per acre. Grazing strategy effects on animal performance are shown as differences in cow and calf gain per day and gain per acre, and total cow and calf gain per grazing season. These values affect the cost per pound of calf weight gain. Together, these grazing strategy effects determine the net returns after pasture-forage costs per cow-calf pair and per acre at a given calf market value. Implementation of grazing management strategies that have biological and economical advantages improves the profit margin for beef production in the Northern Plains.

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. 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 and a calf born in mid March.

Forage costs for harvested-forage types used as feed for range cows during the spring and fall portions of the lactation production period were evaluated from forage production data collected on harvested-forage types between 1995 and 1999. 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 (1999a, 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 the grazing season, the period from early May to mid November, when perennial forage plants are growing and biologically active. Grazingland-forage and harvested-forage types were evaluated separately during the spring, summer, and fall portions of the lactation production period.

The lactation production period was 198 days from early May to mid November and was subdivided into three portions (fig. 1). The spring portion of the lactation period was 31 days from early to late May. During this portion of the lactation period, 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. Crested wheatgrass hay cut at the mature plant stage and crested wheatgrass hay cut at the boot stage were evaluated as feed during the 31-day spring portion of the lactation period.

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 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. Cropland aftermath was grazed for 30 days on the first version of the 4.5-month seasonlong (4.5-m SL) treatment. Native rangeland was grazed for 15 days on a second version of the 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). Altai wildrye was grazed for 30 days on the 4.5-month twice-over rotation (4.5-m TOR) treatment.

Harvested forages were evaluated as alternative feed sources during the 30-day fall portion of the lactation period. The harvested forages were evaluated as hay cut by swathing and 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 at the milk stage. Oat forage hay was cut at the milk stage. Pea forage hay was cut at a late plant stage. Forage lentil hay was cut at a late plant stage. 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. Costs per pound of calf weight gain were determined in two stages: first, accumulated calf weight gain was determined by subtracting calf live weight at the beginning of a growth period from calf live weight at the end of a growth period; then, total pasture costs or forage production costs for a calf growth period were divided by the accumulated calf weight for the growth period.

The terms “herbage” and “forage” are not synonymous. Herbage is the total amount of aboveground biomass of herbaceous plants like grasses and forbs. Forage is the portion of the herbage that can be removed without detriment to the plants and can provide feed for grazing animals or be harvested mechanically for feeding. About 50% of the herbage produced by a perennial plant on grazinglands must remain with the plant to sustain healthy and productive growth. About 50% of the herbage biomass produced during the growing season can be removed from the plant without harmful effects to plant health. The amount of forage ingested by grazing livestock is

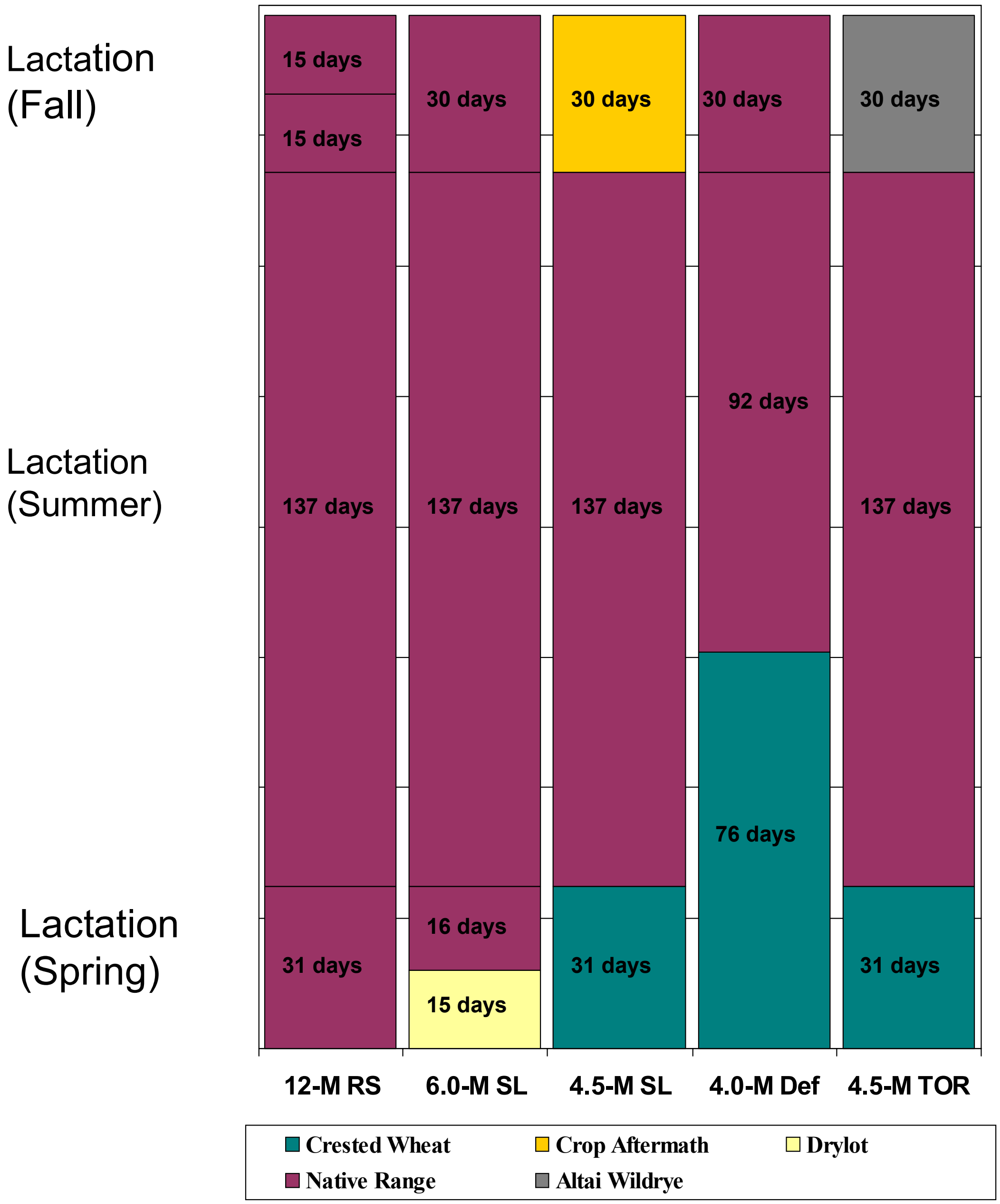

Fig. 1. Number of days per cow production period on grazing management strategies.

actually only about 50% of this quantity, or about 25% of the aboveground herbage biomass on seasonlong and single-grazing-period treatments. The remainder of the herbage that can be removed is broken from the plant, soiled by animal waste, consumed by insects and wildlife, and lost to other natural processes.

Results

Pasture-forage costs

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 1 and 2) 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 $21.70 per period, or $0.70 per day. 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 $10.85 per period, or $0.35 per day. Total forage and supplement costs would be $17.73 per period, or $0.57 per day

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 (table 3) to

Table 1. 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 2. 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

spring portion of the lactation period would require 0.41 acres, and the forage would cost $10.85 per period, or $0.35 per day. Total forage and supplement costs would be $17.73 per period, or $0.57 per day

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 (table 3) 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.

Table 3. 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

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 4, 5, 6, and 7) 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. On grasslands that have had no grazing all growing season, the weight of the herbage on fall pastures is only about 40% to 60% of the mid summer herbage weight. 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 of the fall period, and crude protein costs of $0.34 per pound during the early segment 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 costs 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.

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 seasonlong treatments with 5.0 or 6.0 months of grazing (SL 5.0-6.0-m) that end in mid November has 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 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.

Cropland aftermath forage grazed during the fall by cattle from the first version of 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.

Early fall native rangeland forage managed by the second version of the seasonlong treatments with 4.5 months of grazing (SL 4.5-m) that end in late October has 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.

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.

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 $21.00 per period, or $0.70 per day. 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 $10.50 per period, or $0.35 per day. 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 $8.40 per period, or $0.28 per day. Total forage and supplement costs would be $14.02 per period, or $0.47 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 $9.90 per period, or $0.33 per day. Total forage and supplement costs would be $14.21 per period, or $0.47 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 $9.90 per period, or $0.33 per day. Total forage and supplement costs would be $16.52 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 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 $9.90 per period, or $0.33 per day. 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 $11.40 per period, or $0.38 per day. Total forage and supplement costs would be $16.60 per period, or $0.55 per day.

Table 4. Pasture-forage costs of native rangeland pastures to be grazed by range cows during the 30-day fall portion of

		Native		Native	Native	Native	Native
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 5. 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 6. 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 7. Forage costs of annual cereal hays and annual legume hays to be fed to range cows during the 30-day fall portion of the lactation production period.

		Forage Barley Hay	Oat Forage Hay	Pea Forage Hay	Forage Lentil Hay	Oat-Pea Hay
Growth Stage		Milk	Milk	Late	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	4733	4667	4650	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	$	4.69	6.00	23.80	12.60	29.80
Baling Costs	$	25.37	25.02	24.92	20.73	27.57
Production Costs	$/ac	68.21	69.17	86.87	71.48	95.52
Forage DM Costs	$/ton	28.80	29.60	37.40	37.00	37.20
Land Area/Month	ac	0.12	0.14	0.11	0.13	0.12
Land Area/Period	ac	0.12	0.14	0.11	0.13	0.12
Land Costs/Period	$/pp	2.65	3.09	2.43	2.87	2.65
Forage Costs/Day	$/d	0.28	0.33	0.33	0.33	0.38
Forage Costs/Period	$/pp	8.40	9.90	9.90	9.90	11.40
Crude Protein	%	13.0	11.5	14.4	14.7	12.5
Crude Protein Yield	lb/ac	606	535	685	567	611
Crude Protein Cost	$/lb	0.11	0.13	0.13	0.13	0.16
Supplementation						
Roughage/Day	lb/d	10.7	8.2	12.6	12.9	9.9
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	5.62	4.31	6.62	6.77	5.20
Total Feed Cost	$/pp	14.02	14.21	16.52	16.67	16.60
Cost/Day	$/d	0.47	0.47	0.55	0.56	0.55

Summary of pasture-forage costs

Pasture and forage costs during the spring, summer, and fall portions of the lactation production period are shown in tables 8, 9, and 10.

Total feed costs during the 31-day spring portion of the lactation production period ranged between $15.95 per period, or $0.51 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. 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. The costs of the forage from grazing unfertilized and fertilized crested wheatgrass pastures were reasonable, from $0.48 to $0.52 per day. The low cost of the forage from the unfertilized crested wheatgrass pasture of the deferred treatment cannot be maintained because the plants are grazed too heavily and too long and the amount of herbage produced each year will decrease. Fertilized crested wheatgrass pastures had the lowest costs. Total feed costs for crested wheatgrass hay cut early or cut late were considerably lower than the total feed costs for grazing native rangeland during May.

Total feed costs during the 137-day summer portion of the lactation production period ranged between $78.84 per period, or $0.58 per day, and $158.55 per period, or $1.16 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 cost of the forage from the native range pasture of the deferred treatment will increase because the plants are grazed too heavily and the amount of herbage produced each year will decrease. The costs of grazing native rangeland pastures managed by traditional practices of repeated seasonal, 6.0-month seasonlong, 4.5-month seasonlong, and deferred grazing treatments 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 $12.00 per period, or $0.40 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 harvested-forage hay costs. 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 high, from $1.18 to $1.71 per day. Total feed costs for the harvested forages, except mature crested wheatgrass hay, were lower than the total feed costs for grazing native rangeland after mid October.

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 8. 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

Table 9. 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

Table 10. 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
Oat Forage Milk	0.14	29.60	0.13	9.90	4.31	14.21	0.47
Pea Forage Late	0.11	37.40	0.13	9.90	6.62	16.52	0.55
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

Livestock Performance and Net Returns after Pasture-Forage Costs

The cow and calf weight performance and pasture-forage costs for the lactation (spring, summer, and fall portions) production period for grazingland-forage and harvested-forage management strategies were evaluated and compared. Range cow and calf performance on grazinglands is shown in tables 11-14 and figures 2-5. Pasture-forage costs and returns for management strategies are shown in tables 15-16.

12.0-month repeated seasonal management strategy

The 12.0-month repeated seasonal management strategy was developed from monthly herbage biomass data collected from ungrazed plots. The management strategy was evaluated as a system of separate native range pastures grazed at proper stocking rates, with each pasture grazed repeatedly during one livestock production period, at the same time each year. Calf weight and performance on this management strategy were estimated based on 1.80 lbs average daily gain and 95 lbs birth weight.

A native range pasture was evaluated for 31 days of grazing in May, during the spring portion of the lactation period. Spring native range forage has a crude protein content of around 16.3%. Calf weight gain was 1.80 lbs per day and 11.70 lbs per acre; accumulated weight gain was 55.80 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $39.06 per calf, and the net returns after pasture costs were a loss of $2.79 per cow-calf pair and a loss of $0.58 per acre on native range. The cost of calf weight gain was $0.75 per pound.

A native range pasture was evaluated for 137 days of grazing from early June to mid October, during the summer portion of the lactation period. Native range 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. Calf weight gain was 1.80 lbs per day and 21.78 lbs per acre; accumulated weight gain was 246.60 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $172.62 per calf, and the net returns after pasture costs were $73.98 per cow-calf pair and $6.54 per acre. The cost of calf weight gain was $0.40 per pound.

Reserved native range pastures were evaluated for two 15-day segments of grazing, one from mid to late October and another from early to mid November, during the early and late segments of the fall portion of the lactation period. The costs of grazing native rangeland during the fall were determined separately for the early and late segments of the fall period. Calf weight gain was 1.80 lbs per day and 12.86 lbs per acre during the early 15-day segment and 10.80 lbs per acre during the late 15-day segment; accumulated weight gain was 54 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $37.80 per calf, and the net returns after pasture costs were a loss of $13.40 per cow-calf pair and a loss of $2.91 per acre. The cost of calf weight gain was $0.95 per pound.

The combined grazingland pastures for the 12.0-month repeated seasonal strategy yielded an accumulated calf weight gain of 356.40 lbs on 20.69 acres in 198 days at a cost of $191.69 per cow-calf pair. When calf accumulated weight was assumed to have a value of $0.70 per pound, the net returns after pasture costs were $57.79 per cow-calf pair and $2.79 per acre for all pastures during the 6.5-month grazing season. Grazing for 6.5 months on the 12.0-month repeated seasonal strategy, a lactating cow and her calf used 3.19 acres per month, at a cost of $29.49 per month, or $0.97 per day. Each accumulated pound of calf weight cost $0.54 on the grazinglands of the 12.0-month repeated seasonal strategy.

6.0-month seasonlong management strategy

The native range period of the 6.0-month seasonlong (6.0-m SL) treatment was 183 days, with 16 days during spring, 137 days during summer, and 30 days during fall portions of the lactation production period. Cow weight gain was 0.12 lbs per day and 0.91 lbs per acre; accumulated weight gain was 21.96 lbs. Calf weight gain was 1.80 lbs per day and 13.59 lbs per acre; accumulated weight gain was 329.40 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $230.58 per calf, and the net returns after pasture costs were $18.24 per cow-calf pair and $0.75 per acre. Each accumulated pound of calf weight cost $0.64 on the native range pasture of the 6.0-month seasonlong strategy.

Performance of animals grazing native rangeland on the 6.0-month seasonlong strategy declined considerably during the 30-day fall portion of the lactation period between mid October and mid November. Cows lost 1.74 lbs per day and 12.90 lbs per acre; accumulated weight loss was 52.20 lbs per month. Calf weight gain was 0.59 lbs per day and 4.38 lbs per acre; accumulated weight gain was 17.73 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $12.41 per calf, and the net returns after pasture costs were a loss of $22.98 per cow-calf pair and a loss of $5.69 per acre. Each accumulated pound of calf weight cost $1.99 on the 6.0-month seasonlong management strategy during mid October to mid November.

4.5-month seasonlong management strategy

The spring unfertilized crested wheatgrass complementary pasture period was 31 days during the spring portion of the lactation production period. Cow weight gain was 1.95 lbs per day and 32.15 lbs per acre; accumulated weight gain was 60.45 lbs. Calf weight gain was 1.91 lbs per day and 31.49 lbs per acre; accumulated weight gain was 59.21 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $41.45 per calf, and the net returns after pasture costs were $24.98 per cow-calf pair and $13.29 per acre on crested wheatgrass pasture. The cost of calf weight gain was $0.27 per pound.

The native range period of the first version of the 4.5-month seasonlong (4.5-m SL) treatment was 137 days during the summer portion of the lactation production period from early June to mid October. Cow weight gain was 0.34 lbs per day and 3.67 lbs per acre; accumulated weight gain was 46.58 lbs. Calf weight gain was 2.09 lbs per day and 22.55 lbs per acre; accumulated weight gain was 286.33 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $200.43 per calf, and the net returns after pasture costs were $89.18 per cow-calf pair and $7.02 per acre on native range. The cost of calf weight gain was $0.39 per pound.

A second version of the 4.5-month seasonlong (SL 4.5-m) management strategy grazed native rangeland from mid June until late October. During the 15-day period from mid to late October, cows grazing native rangeland lost 0.52 lbs per day and 4.75 lbs per acre; accumulated weight loss was 7.74 lbs in 15 days. Calf weight gain during the same period was 1.35 lbs per day and 12.47 lbs per acre; accumulated weight gain was 20.33 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $14.23 per calf, and the net returns after pasture costs were a loss of $0.05 per cow-calf pair and a loss of $0.03 per acre. Each accumulated pound of calf weight cost $0.70 on the second version of the 4.5-month seasonlong management strategy during mid to late October.

Livestock on the first version of the 4.5-month seasonlong (4.5-m SL) strategy grazed a cropland aftermath pasture during the fall portion of the lactation production period from mid October to mid November. Lactating cows that grazed cropland aftermath of annual cereal residue between mid October and mid November lost 1.61 lbs per day and 7.27 lbs per acre; accumulated weight loss was 48.17 lbs. Calf weight gain was 0.42 lbs per day and 1.90 lbs per acre; accumulated weight gain was 12.57 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $8.80 per calf, and the net returns after pasture costs were a loss of $4.46 per cow-calf pair and a loss of $0.67 per acre. Each accumulated pound of calf weight cost $1.05 on cropland aftermath during mid October to mid November.

The combined crested wheatgrass, native range, and cropland aftermath grazingland types for the 4.5-month seasonlong (4.5-m SL) strategy yielded an accumulated cow weight gain of 58.86 lbs and an accumulated calf weight gain of 358.11 lbs on 21.21 acres in 198 days at a cost of $140.98 per cow-calf pair. When calf accumulated weight was assumed to have a value of $0.70 per pound, the net returns after pasture costs were $109.70 per cow-calf pair and $5.17 per acre for portions of the year that cow-calf pairs were grazing pastures. Grazing for 6.5 months on the 4.5-month seasonlong strategy, a lactating cow and her calf used 3.27 acres per month, at a cost of $0.71 per day, or $21.72 per month. Each accumulated pound of calf weight cost $0.39 on the grazinglands of the 4.5-month seasonlong strategy.

4.0-month deferred management strategy

The spring unfertilized crested wheatgrass complementary pasture period was 76 days during the spring and early summer portions of the lactation production period. Cow weight gain was 0.91 lbs per day and 16.63 lbs per acre; accumulated weight gain was 69.16 lbs. Calf weight gain was 1.79 lbs per day and 32.70 lbs per acre; accumulated weight gain was 136.04 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $95.23 per calf, and the net returns after pasture costs were $58.78 per cow-calf pair and $14.13 per acre on crested wheatgrass pasture. The cost of calf weight gain was $0.27 per pound.

The native range period of the 4.0-month deferred (4.0-m Def) treatment was 122 days, with 92 days during summer and 30 days during fall portions of the lactation production period. Cow weight gain was 0.32 lbs per day and 4.40 lbs per acre; accumulated weight gain was 39.04 lbs. Calf weight gain was 1.80 lbs per day and 24.73 lbs per acre; accumulated weight gain was 219.60 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $153.72 per calf, with $137.55 from the summer and $16.17 from the fall portions, and the net returns after pasture costs were $75.93 per cow-calf pair and $8.55 per acre on native range. The net returns during the summer portion were $79.29 per cow-calf pair and $11.83 per acre. The cost of calf weight gain on native rangeland was $0.35 per pound.

Performance of animals grazing on the 4.0-month deferred strategy declined considerably during the 30-day fall portion of the lactation production period between mid October and mid November. Cows lost 0.74 lbs per day and 9.96 lbs per acre; accumulated weight loss was 22.20 lbs. Calf weight gain was 0.77 lbs per day and 10.36 lbs per acre; accumulated weight gain was 23.10 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $16.17 per calf, and the net returns after pasture costs were a loss of $3.36 per cow-calf pair and a loss of $1.51 per acre. Each accumulated pound of calf weight cost $0.85 on the 4.0-month deferred management strategy during mid October to mid November.

The combined grazingland types for the 4.0-month deferred strategy yielded an accumulated cow weight gain of 108.20 lbs and an accumulated calf weight gain of 355.64 lbs on 13.04 acres in 198 days at a cost of $114.23 per cow-calf pair. When calf accumulated weight was assumed to have a value of $0.70 per pound, the net returns after pasture costs were $134.72 per cow-calf pair and $10.33 per acre for all portions of the grazing season. Grazing for 6.5 months on the 4.0-month deferred strategy, a lactating cow and her calf used 2.01 acres per month, at a cost of $0.58 per day, or $17.31 per month. Each accumulated pound of calf weight cost $0.32 on the grazinglands of the 4.0-month deferred strategy.

4.5-month twice-over rotation management strategy

The spring fertilized crested wheatgrass complementary pasture period was 31 days during the spring portion of the lactation production period. Cow weight gain was 2.68 lbs per day and 110.77 lbs per acre; accumulated weight gain was 83.08 lbs on 0.75 acres. Calf weight gain was 2.18 lbs per day and 90.11 lbs per acre; accumulated weight gain was 67.58 lbs on 0.75 acres. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $47.31 per calf, and the net returns after pasture costs were $31.36 per cow-calf pair and $41.82 per acre on fertilized crested wheatgrass pasture. The cost of calf weight gain was $0.24 per pound.

The native range period of the 4.5-month twice-over rotation (4.5-m TOR) treatment was 137 days during the summer portion of the lactation production period. Cow weight gain was 0.62 lbs per day and 9.44 lbs per acre; accumulated weight gain was 84.94 lbs. Calf weight gain was 2.21 lbs per day and 33.64 lbs per acre; accumulated weight gain was 302.77 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $211.94 per calf, and the net returns after pasture costs were $133.10 per cow-calf pair and $14.79 per acre on native rangeland. The cost of calf weight gain was $0.26 per pound.

Livestock grazed an Altai wildrye complementary pasture during the fall portion of the lactation production period. Lactating cows that grazed Altai wildrye pastures for 30 days between mid October and mid November gained 0.55 lbs per day and 11.87 lbs per acre; accumulated weight gain was 16.50 lbs. Calf weight gain was 1.73 lbs per day and 37.96 lbs per acre; accumulated weight gain was 52.77 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $36.94 per calf, and the net returns after pasture costs were $24.76 per cow-calf pair and $17.81 per acre on Altai wildrye pasture. The cost of calf weight gain was $0.23 per pound.

The combined grazingland types for the 4.5-month twice-over rotation strategy yielded an accumulated cow weight gain of 184.52 lbs and an accumulated calf weight gain of 423.12 lbs on 11.14 acres in 198 days at a cost of $106.79 per cow-calf pair. When calf accumulated weight was assumed to have a value of $0.70 per pound, the net returns after pasture costs were $189.39 per cow-calf pair and $17.00 per acre for all pastures during the grazing season. Grazing for 6.5 months on the 4.5-month twice-over rotation strategy, a lactating cow and her calf used 1.72 acres per month, at a cost of $0.54 per day, or $16.45 per month. Each accumulated pound of calf weight cost $0.25 on the grazinglands of the 4.5-month twice-over rotation strategy.

Table 11. Range cow and calf performance on native rangeland and domesticated grass pastures 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)
Length of Period	days	31	16	31	76	31
Acres/Month	ac	4.62	4.04	1.82	1.67	0.75
Acres/Period	ac	4.77	2.10	1.88	4.16	0.75
Cow Gain/Day	lbs		0.12	1.95	0.91	2.68
Cow Gain/Acre	lbs		0.91	32.15	16.63	110.77
Cow Gain/Period	lbs		1.92	60.45	69.16	83.08
Calf Gain/Day	lbs	1.80	1.80	1.91	1.79	2.18
Calf Gain/Acre	lbs	11.70	13.64	31.49	32.70	90.11
Calf Gain/Period	lbs	55.80	28.80	59.21	136.04	67.58

*Based on estimated calf weight

Table 12. Range cow and calf performance on native rangeland pastures 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)
Length of Period	days	137	183	137	122	137
Acres/Month	ac	2.52	4.04	2.86	2.22	2.04
Acres/Period	ac	11.32	24.24	12.70	8.88	9.00
Cow Gain/Day	lbs		0.12	0.34	0.32	0.62
Cow Gain/Acre	lbs		0.91	3.67	4.40	9.44
Cow Gain/Period	lbs		21.96	46.58	39.04	84.94
Calf Gain/Day	lbs	1.80	1.80	2.09	1.80	2.21
Calf Gain/Acre	lbs	21.78	13.59	22.55	24.73	33.64
Calf Gain/Period	lbs	246.60	329.40	286.33	219.60	302.77

*Based on estimated calf weight

Table 13. Range cow and calf performance on native rangeland pastures during the 30-day fall portion of the lactation production period.

		Native Rangeland (12-m RS)* Early	Late	Native Rangeland (SL 4.5-m) Early	Native Rangeland (SL 5-6-m)	Native Rangeland (6.0-m SL)	Native Rangeland (4.0-m Def)
Length of Period	days	15	15	15	30	30	30
Acres/Month	ac	4.20	5.00	3.26	2.53	4.04	2.22
Acres/Period	ac	2.10	2.50	1.63	2.53	4.04	2.18
Cow Gain/Day	lbs			-0.52	-0.82	-1.74	-0.74
Cow Gain/Acre	lbs			-4.75	-9.77	-12.90	-9.96
Cow Gain/Period	lbs			-7.74	-24.60	-52.20	-22.20
Calf Gain/Day	lbs	1.80	1.80	1.35	0.92	0.59	0.77
Calf Gain/Acre	lbs	12.86	10.80	12.47	10.90	4.38	10.36
Calf Gain/Period	lbs	27.00	27.00	20.33	27.60	17.73	23.10

*Based on estimated calf weight

Table 14. Range cow and calf performance on domesticated grass and cropland pastures during the 30-day fall portion of the lactation production period.

		Altai Wildrye (4.5-m TOR)	Crop Aftermath (4.5-m SL)
Length of Period	days	30	30
Acres/Month	ac	1.39	6.63
Acres/Period	ac	1.39	6.63
Cow Gain/Day	lbs	0.55	-1.61
Cow Gain/Acre	lbs	11.87	-7.27
Cow Gain/Period	lbs	16.50	-48.17
Calf Gain/Day	lbs	1.73	0.42
Calf Gain/Acre	lbs	37.96	1.90
Calf Gain/Period	lbs	52.77	12.57

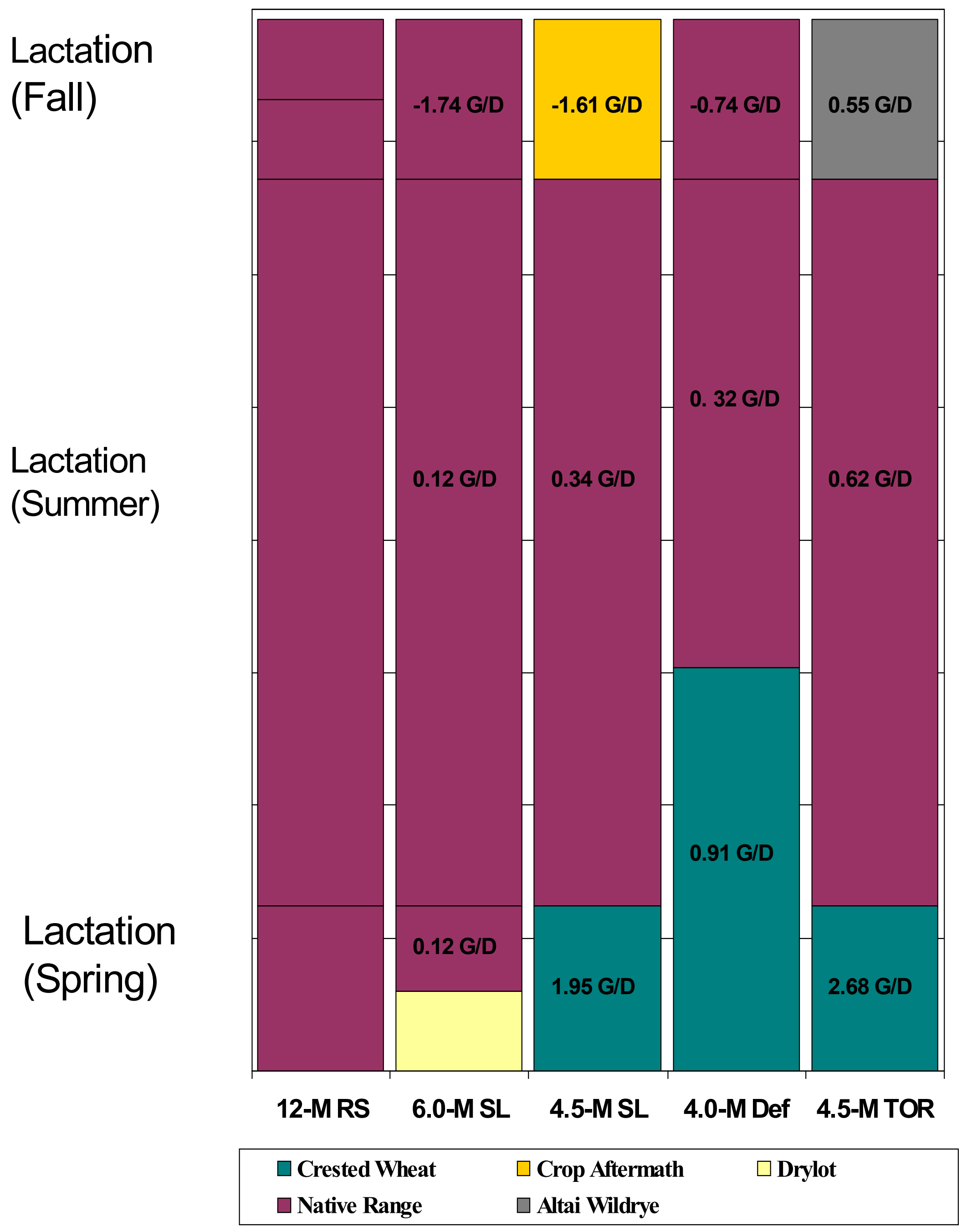

Fig. 2. Pounds of cow gain per day on grazing management strategies.

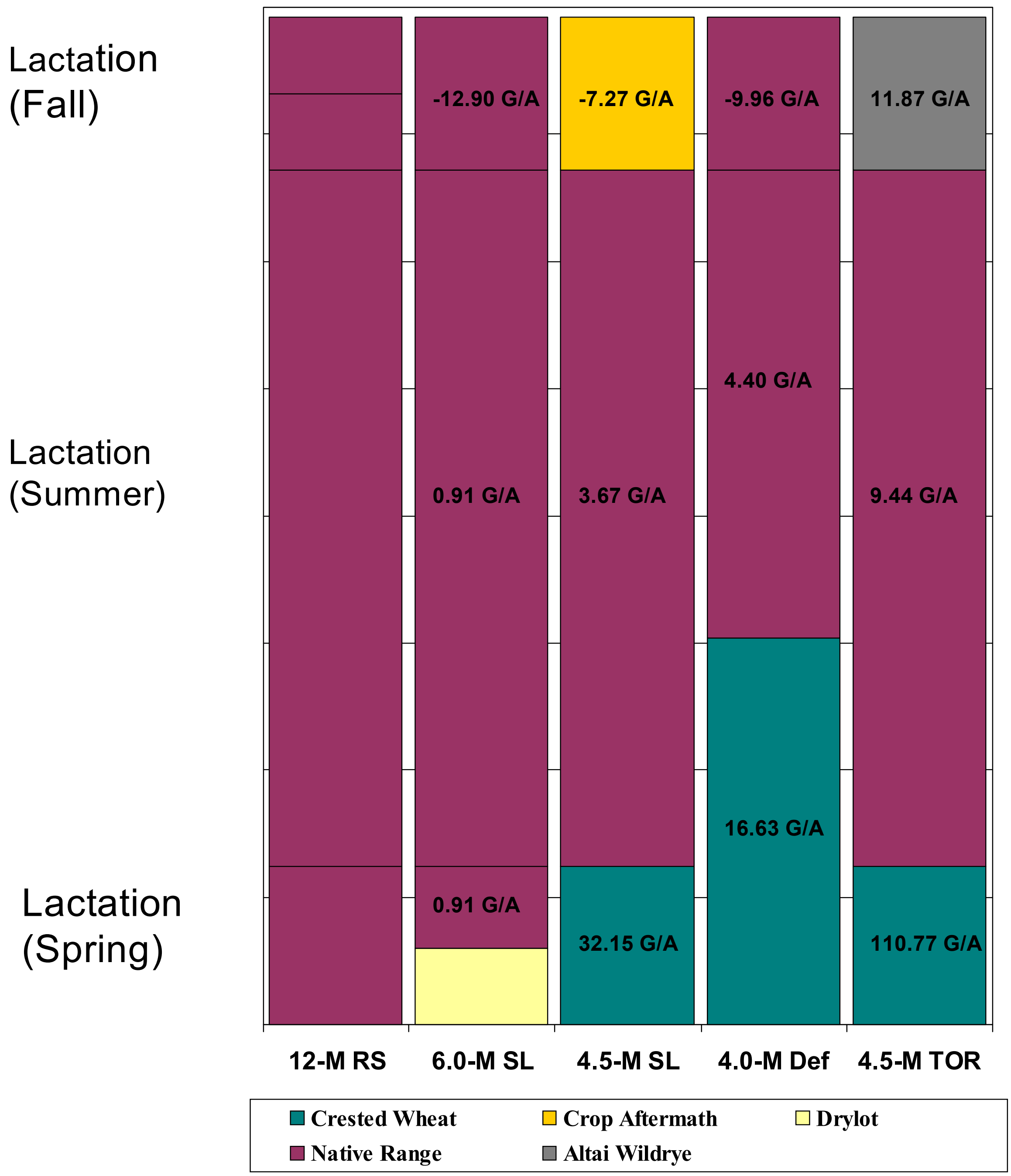

Fig. 3. Pounds of cow gain per acre on grazing management strategies.

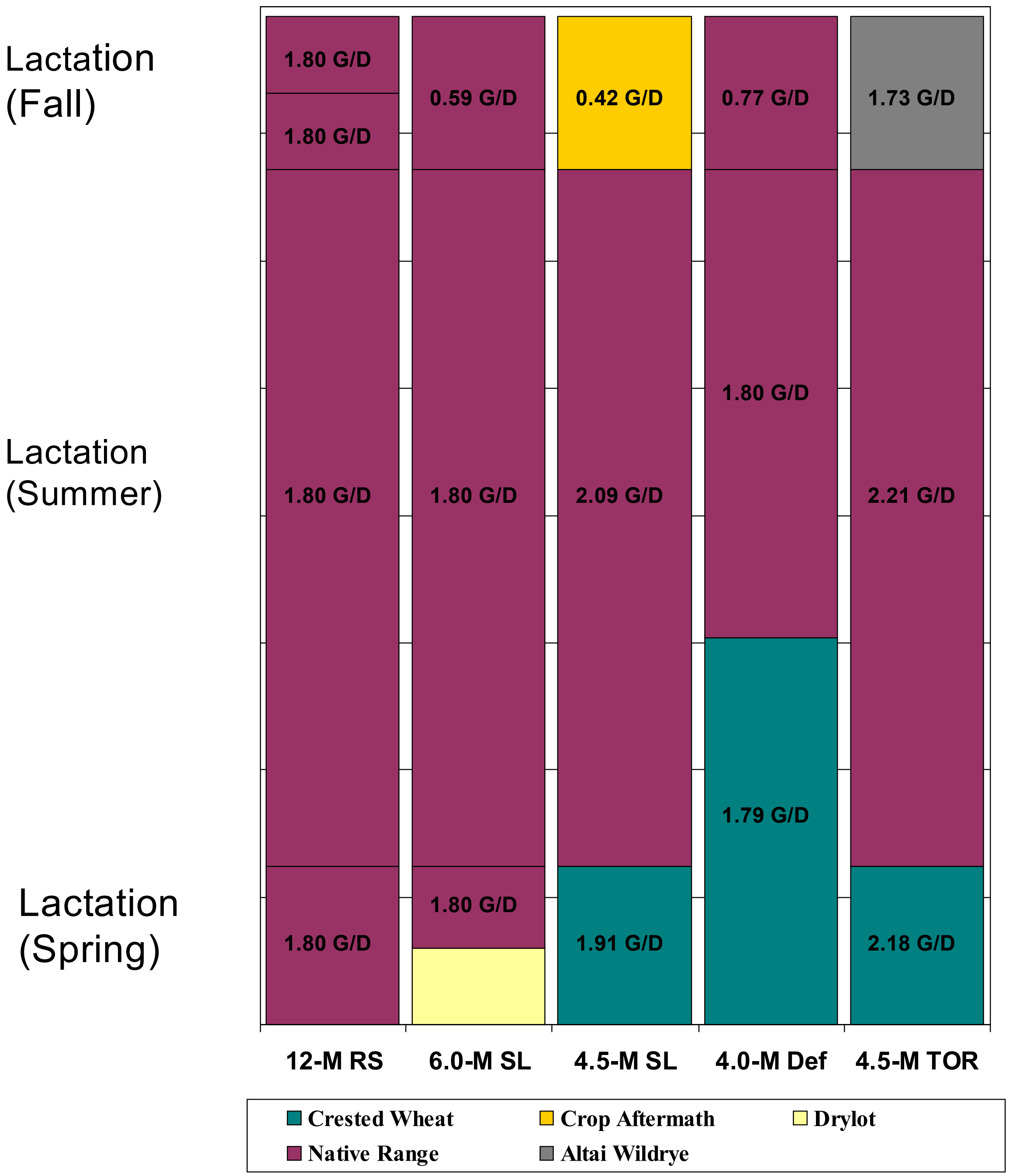

Fig. 4. Pounds of calf gain per day on grazing management strategies.

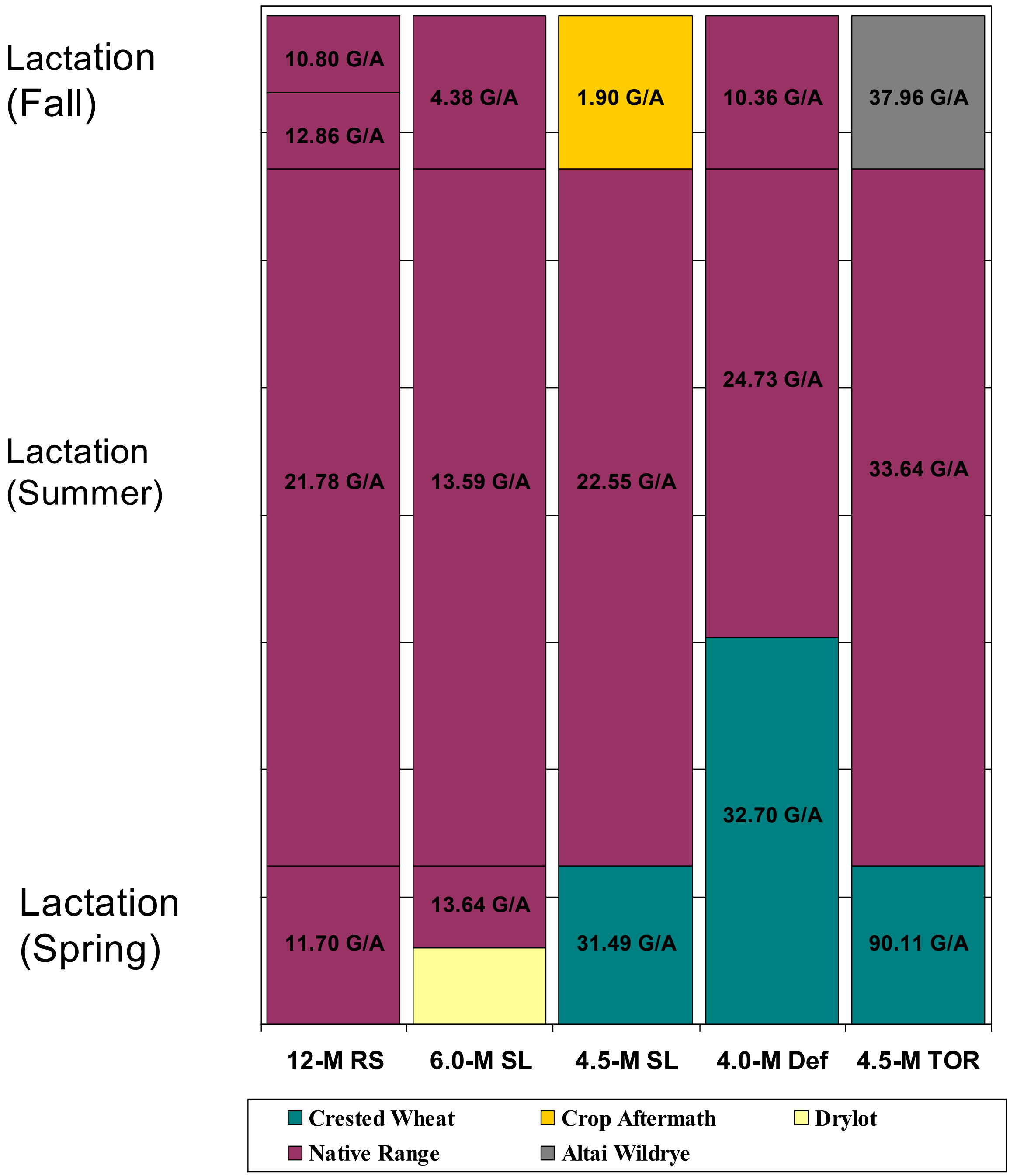

Fig. 5. Pounds of calf gain per acre on grazing management strategies.

Table 15. Costs and returns during the spring, summer, and fall portions of the lactation production period for grazing management strategies.

		12-M Repeated Seasonal*	6.0-M Seasonlong	4.5-M Seasonlong	4.0-M Deferred	4.5-M Twice-over Rotation
Spring Lactation Period		Native Rangeland	Native Rangeland	Crested Wheatgrass Unfertilized	Crested Wheatgrass Unfertilized	Crested Wheatgrass Fertilized
Accumulated Calf Wt.	lbs	55.80	28.80	59.21	136.04	67.58
Weight Value @ $0.70/lb	$	39.06	20.16	41.45	95.23	47.31
Pasture and Forage Costs	$	41.85	18.40	16.47	36.44	15.95
Net Return/c-c pr	$	-2.79	1.76	24.98	58.78	31.36
Net Return/acre	$	-0.58	0.83	13.29	14.13	41.82
Cost/lb of Calf Gain	$	0.75	0.64	0.27	0.27	0.24
Summer Lactation Period		Native Rangeland	Native Rangeland	Native Rangeland	Native Rangeland	Native Rangeland
Accumulated Calf Wt.	lbs	246.60	282.87	286.33	196.50	302.77
Weight Value @ $0.70/lb	$	172.62	198.01	200.43	137.55	211.94
Pasture and Forage Costs	$	98.64	158.55	111.25	58.26	78.84
Net Return/c-c pr	$	73.98	38.75	89.18	79.29	133.10
Net Return/acre	$	6.54	2.13	7.02	11.83	14.79
Cost/lb of Calf Gain	$	0.40	0.56	0.39	0.30	0.26
Fall Lactation Period		Native Rangeland	Native Rangeland	Cropland Aftermath	Native Rangeland	Altai Wildrye
Accumulated Calf Wt.	lbs	54.00	17.73	12.57	23.10	52.77
Weight Value @ $0.70/lb	$	37.80	12.41	8.80	16.17	36.94
Pasture and Forage Costs	$	51.20	35.39	13.26	19.53	12.00
Net Return/c-c pr	$	-13.40	-22.98	-4.46	-3.36	24.76
Net Return/acre	$	-2.91	-5.69	-0.67	-1.51	17.81
Cost/lb of Calf Gain	$	0.95	1.99	1.05	0.85	0.23

*Based on estimated calf weight

Table 16. Range cow and calf performance and costs and returns during the lactation production period for grazing management strategies.

		12-M Repeated Seasonal*	6.0-M Seasonlong	4.5-M Seasonlong	4.0-M Deferred	4.5-M Twice-over Rotation
Length of Season	days	198	183	198	198	198
Acres/Month	ac	3.19	4.04	3.27	2.01	1.72
Acres/Season	ac	20.69	24.24	21.21	13.04	11.14
Cow Gain/Day	lbs		0.12	0.30	0.55	0.93
Cow Gain/Acre	lbs		0.91	2.78	8.30	16.56
Cow Gain/Season	lbs		21.96	58.86	108.20	184.52
Calf Gain/Day	lbs	1.80	1.80	1.81	1.80	2.14
Calf Gain/Acre	lbs	17.23	13.59	16.88	27.27	37.98
Calf Gain/Season	lbs	356.40	329.40	358.11	355.64	423.12
Weight Value @ $0.70/lb	$	249.48	230.58	250.68	248.95	296.18
Pasture and Forage Costs	$	191.69	212.34	140.98	114.23	106.79
Net Return/c-c pr	$	57.79	18.24	109.70	134.72	189.39
Net Return/Acre	$	2.79	0.75	5.17	10.33	17.00
Cost/lb of Calf Gain	$	0.54	0.64	0.39	0.32	0.25

*Based on estimated calf weight

Projected pasture-forage costs and net returns

The individual cow-calf pair data for the grazing management strategies were projected to a beef herd of 100 cows and a herd of 300 cows (table 17). The differences in the land area required for forage nutrient production, in total feed costs, and in net returns after pasture-forage costs result from the differences in the biological effectiveness and the nutrient capture and conversion efficiency of the various grazing management strategies.

The land area required to produce the forage nutrients for 100 cows during the grazing season was 1114 acres for the 4.5-month twice-over rotation, 1304 acres for the 4.0-month deferred, 2121 acres for the 4.5-month seasonlong, 2069 acres for the 12-month repeated seasonal, and 2424 acres for the 6.0-month seasonlong treatments.

Total feed costs (pasture and harvested forages) for 100 cows during the grazing season were $10,679 for the 4.5-month twice-over rotation, $11,423 for the 4.0-month deferred, $14,098 for the 4.5-month seasonlong, $19,169 for the 12-month repeated seasonal, and $21,234 for the 6.0-month seasonlong treatments.

Net returns after pasture-forage feed costs for 100 cows during the grazing season were $18,939 from the 4.5-month twice-over rotation, $13,472 from the 4.0-month deferred, $10,970 from the 4.5-month seasonlong, $5,779 from the 12-month repeated seasonal, and $1,824 from the 6.0-month seasonlong treatments.

The land area required to produce the forage nutrients for 300 cows during the grazing season was 3342 acres for the 4.5-month twice-over rotation, 3912 acres for the 4.0-month deferred, 6363 acres for the 4.5-month seasonlong, 6207 acres for the 12-month repeated seasonal, and 7272 acres for the 6.0-month seasonlong treatments.

Total feed costs (pasture and harvested forages) for 300 cows during the grazing season were $32,037 for the 4.5-month twice-over rotation, $34,269 for the 4.0-month deferred, $42,294 for the 4.5-month seasonlong, $57,507 for the 12-month repeated seasonal, and $63,702 for the 6.0-month seasonlong treatments.

Net returns after pasture-forage feed costs for 300 cows during the grazing season were $56,817 from the 4.5-month twice-over rotation, $40,416 from the 4.0-month deferred, $32,910 from the 4.5-month seasonlong, $17,337 from the 12-month repeated seasonal, and $5,472 from the 6.0-month seasonlong treatments.

The net returns after pasture-forage costs were greatest on the biologically effective 4.5-month twice-over rotation grazing management system. The management strategies with moderate net returns were the 4.0-month deferred and 4.5-month seasonlong traditional systems. The management strategies with low net returns were the 12-month repeated seasonal and 6.0-month seasonlong traditional systems.

Table 17. Projection of net returns from 100-cow and 300-cow herds on grazing management strategies during the 6.5-month grazing season.

	100 Cows				**300 Cows**			
Grazing Management Strategies	Land Area	Total Feed Cost	Calf Weight Value @$0.70/lb	Net Return	Land Area	Total Feed Cost	Calf Weight Value @$0.70/lb	Net Return
	Acres	$	$	$	Acres	$	$	$
12-M Repeated Seasonal	2069	19,169	24,948	5779	6207	57,507	74,844	17,337
6.0-M Seasonlong	2424	21,234	23,058	1824	7272	63,702	69,174	5472
4.5-M Seasonlong	2121	14,098	25,068	10,970	6363	42,294	75,204	32,910
4.0-M Deferred	1304	11,423	24,895	13,472	3912	34,269	74,685	40,416
4.5-M Twice-over Rotation	1114	10,679	29,618	18,939	3342	32,037	88,854	56,817

Discussion

Today's fast-growing, high-performance cattle are genetically different from the old-style cattle and have higher rates of weight gain, produce greater quantities of milk, are larger, weigh more, and deposit less fat on their bodies. Because of the higher rates of production and larger size, modern animals require greater quantities of nutrients throughout the production year. A high-performance cow that has medium milk production and is 20% greater in size than an old-style animal requires 24% more energy and 34% more crude protein per year. During the 6.5-month grazing season from early May to mid November, this high-performance cow with a calf born in mid March requires 27% more energy and 41% more crude protein than an old-style cow-calf pair for production performances at their respective genetic potentials.

Old-style, traditional feed management systems are designed to provide forage to meet the dry matter requirements of old-style cattle and are usually evaluated by the cost per ton for harvested forages and by the cost per acre for pastures. Most pastures under traditional management practices cannot provide the 19% increase in dry matter needed to support high-performance cows at the stocking rate appropriate for old-style animals, and the forage produced fails to provide the greater quantities of nutrients. When high-performance livestock are fed forage from low-performance, old-style pasture-forage management systems, the forage crude protein levels are below livestock requirements during 40% to 60% of the days in a production year and the deficiency results in animal performance below potential, in high forage-feed costs, and in low profit margins.

Adjustments of old-style management practices to provide greater amounts of dry matter per cow and appropriate additions of crude protein supplement will improve animal performance. Profit margins will not improve, however, as long as the value of the increases in pasture and forage provided per cow is greater than the value of increases in production per cow.

Modern high-performance cow-calf pairs have greater pasture-forage costs and lower net returns after pasture-forage costs on old-style traditional management systems like the 12-month repeated seasonal, 6.0-month seasonlong, 4.5-month seasonlong, and 4.0-month deferred grazing practices than on biologically effective management systems like the 4.5-month twice-over rotation grazing practice.

Grazing native rangeland pastures during May is expensive, costing even more than feeding mature crested wheatgrass hay during the same period. Rangeland plants are not physiologically ready for grazing prior to the third-leaf stage, and grazing prior to plant readiness causes a reduction in herbage biomass production (Campbell 1952, Rogler et al. 1962, Manske 2000a). Delaying grazing on native rangeland until grass plants have reached the third-leaf stage, in early June, requires the use of another forage type for earlier grazing. Some domesticated perennial cool-season grasses like crested wheatgrass and smooth bromegrass reach the third-leaf stage three to five weeks earlier than native cool-season grasses and are dependable as spring pastures from early May until early June. Crested wheatgrass is an excellent early season spring pasture forage. The start of the grazing season on domesticated grass pastures is restricted to very late April or early May because no perennial grass in the Northern Plains reaches the third-leaf stage before late April.

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

Cow and calf performance was strong on unfertilized crested wheatgrass during May and early and mid June but decreased considerably when grazing continued until mid July. Fertilization on crested wheatgrass pastures shortened the period during which livestock performed well. Weight performance for cows and calves during May and early June was greater on fertilized crested wheatgrass pastures than on unfertilized pastures, but livestock performance on fertilized crested wheatgrass pastures decreased earlier, in mid June.

Grazed native rangeland pastures provide forage dry matter and crude protein at lower costs during the summer portion of the lactation production period from early June to mid October than during other times of the year. The native rangeland pastures of the 4.5-month seasonlong and 4.5-month twice-over rotation strategies were grazed only within this portion of the growing season and had forage dry matter costs that ranged between $39 and $55 per ton and crude protein costs of around $0.25 per pound. The twice-over rotation system had the lowest native rangeland pasture-forage costs because the management strategy does not start grazing on any forage type until the grass plants have reached the third-leaf stage, so the system avoids negative effects on plant biological processes and resulting reductions in herbage biomass production (Manske 2000c).

Cow and calf weight performance generally did not differ among native range treatments during the early grazing period of June and July, but during the latter portion of the grazing period, after early August, animal weight performance was greater on the twice-over rotation treatment than on the traditional seasonlong and deferred treatments.

Cow gain per day on the seasonlong and deferred treatments decreased successively as the grazing period progressed. Cows gained weight during the early portion of the grazing period but lost weight during the latter portion. Weight loss during the latter portion of the grazing season occurred at a greater rate on the deferred treatment. Cows on the twice-over rotation treatment gained weight at a greater rate than did cows on the seasonlong and deferred treatments. Cows on the twice-over rotation treatment gained weight during the early and middle portions of the grazing period and lost a small amount of weight at the end of the grazing period. Cow gain per day, accumulated weight, and gain per acre were greater on the twice-over rotation treatment than on the seasonlong and deferred treatments.

The greatest differences in calf performance on the native range treatments occurred during the later portions of the grazing period. Calf gain per day on the seasonlong and deferred treatments decreased as the grazing season progressed. The decrease in calf gain per day was greater on the 6.0-month seasonlong than on the deferred treatment and greater on the deferred treatment than on the 4.5-month seasonlong treatment. Calf accumulated weight was greater on the 4.5-month seasonlong treatment than on the deferred treatment and greater on the deferred treatment than on the 6.0-month seasonlong treatment. The decrease in calf gain per day during the latter portion of the grazing period was smaller on the twice-over rotation treatment than on the seasonlong and deferred treatments. Calf accumulated weight gain was greater on the twice-over rotation treatment than on the 4.5-month seasonlong, the 4.0-month deferred, and the 6.0-month seasonlong treatments.

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

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

Nutritional quality of forage on native rangeland after mid August is below the requirements of lactating cows, and the weight performance of cows and calves diminishes greatly unless vegetative reproduction of secondary tillers is stimulated, as it is on the twice-over rotation system. Manipulation of secondary tiller growth of native rangeland grasses with light defoliation by grazing on each pasture for 7 to 17 days during the period between the third-leaf stage and the flowering stage (early June to mid July) can improve livestock performance for two to two and a half months at the end of the grazing season, until late September or mid October, but the biology of native grass plants does not permit extending this improved performance longer (Manske 2000c). Nutritional quality of herbage on native rangeland grazed after mid October is insufficient to meet requirements of lactating cows.

Forages that meet the nutritional requirements of lactating cows after mid October include Altai and

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

Cow and calf weight performance on Altai wildrye pastures between mid October and mid November was favorable, but not as impressive as livestock weight performance on fertilized crested wheatgrass during May. Weight gains of cows and calves grazing Altai wildrye were considerably greater than those of livestock grazing native range or crop aftermath during the same period. Lactating cows on 6.0-month seasonlong and deferred native range grazing treatments and on crop aftermath of annual cereal stubble treatments lost weight during the period between mid October and mid November, and calves with those cows gained little weight.

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

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

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

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

The costs per acre for pasture and the costs per ton for harvested forages are not directly comparable. However, the cost per pound or ton of ingested forage crude protein and dry matter from pastures and the cost per pound or ton of forage crude protein and dry matter from harvested forages can be compared. Perennial grass hay has been the major harvested-forage type used as winter feed for beef cows in the Northern Plains. Traditionally, crested wheatgrass and smooth bromegrass--domesticated perennial grass hays--are cut late, after the seed heads have developed and plants have reached maximum height. This practice yields about the year's potential amount of forage dry matter per acre, about 300 pounds per acre more dry matter than harvesting at the boot stage. However, the quantity of crude protein captured per acre in mature hay is only a little more than half the quantity of crude protein captured per acre in hay cut at the boot stage. Forage dry matter costs were $34.80 per ton for mature hay and $40.80 per ton for hay cut at the boot stage. Crude protein costs were $0.28 per pound for mature hay and $0.14 per pound for early cut hay. Mature domesticated perennial grass hay is expensive livestock feed because it has high costs per pound of crude protein.

Annual cereal hays of forage barley and oat forage cut at the milk stage had high production costs that ranged from $68 to $70 per acre. However, the forage dry matter costs and crude protein costs were relatively low. Forage dry matter costs ranged between $28 and $30 per ton and crude protein costs ranged between $0.11 and $0.13 per pound. Early cut annual cereal hays capture greater pounds of crude protein per acre than the late-cut hays, and the cost per pound of crude protein is lower for the early cut annual cereal hays.

Annual legume hays of pea forage and forage lentil cut at late plant growth stages and oat-pea forage had high production costs that ranged from $71 to $96 per acre. The forage dry matter costs ranged from $37 to $38 per ton. The late-cut annual legume hays had lower dry matter costs than the early cut legume hays. Crude protein costs were relatively low for all annual legume hays and ranged from $0.13 to $0.16 per pound. Late-cut annual legume hays capture greater pounds of crude protein per acre and have lower crude protein costs than the early cut hays.

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

Increasing the value captured from grassland pastures and haylands is the key to improving profit margins for the beef production industry. The improved efficiency of biologically effective pasture-forage management strategies results in increased value captured from resources on a land base. Just as adding value to a commodity at each stage of production provides economic benefit, increasing the value captured from the land base reduces costs and strengthens profit margins.

Some production costs for the beef industry in the Northern Plains are unnecessarily high because livestock producers tend to rely on traditional pasture-forage management practices that inefficiently capture the nutrients produced on a land base. These practices result in higher costs for the nutrients ingested by the animals, increased annual production costs per animal, and low profit margins.

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.

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

Efficient pasture-forage management strategies for high-performance livestock provide pasture and forage types to 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.

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