Grazingland and Harvested Forage Costs-Returns of 12-Month Management Strategies for Range Cows

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

Introduction

The beef production industry in the Northern Plains has high production costs and low profit margins. The traditional pasture-forage management practices used to provide livestock feed are based on range cow dry matter requirements determined for smaller old-style cows and sometimes slightly modified for the larger modern animals. The valuable products from grazinglands and haylands are the nutrients, not the dry matter. Traditional practices that manage forages to capture maximum dry matter are inefficient in the capture of the nutrients produced on the land and result in high livestock pasture-forage feed costs. Reduction of pasture-forage costs requires increasing the value captured from the land through efficient 12-month management strategies with improved biological effectiveness, nutrient capture efficiency, and nutrient conversion efficiency.

Efficient management strategies for the Northern Plains are based on biological and ecological sciences. Management strategies that meet the biological requirements of the plants, promote vegetative reproduction by tillering, stimulate beneficial activity of rhizosphere organisms, and facilitate the functioning of ecological processes at potential levels are biologically effective. Management strategies that coordinate grazing and haying with plant growth stages that yield the greatest nutrient weight per acre capture nutrients efficiently. Management strategies that provide nutrients to livestock at the times and in the amounts required during each production period convert nutrients efficiently into the saleable commodities of beef weight. Efficient pasture-forage management systems combine appropriate forage types in a 12-month sequence so that the dietary quantity and quality requirements of range cows coordinate with the herbage production curves and nutritional quality curves at low costs per unit of saleable commodity. These efficient management strategies result in improved livestock weight performance, reduced livestock production costs, and increased profit margins.

This study evaluated 12-month grazingland-forage and harvested-forage management strategies to determine the pasture-forage costs and returns for range cows during the cows' production periods. The 12-month grazingland-forage management strategies were identified by the type of grazing system used during the native rangeland segment: 12.0-month repeated seasonal, 6.0-month seasonlong, 4.5-month seasonlong, 4.0-month deferred, and 4.5-month twice-over rotation. The 12-month harvested-forage management strategies were identified by the forage type fed during the year: crested wheatgrass hay, forage barley hay, oat forage hay, pea forage hay, forage lentil hay, and oat-pea forage hay. The management strategy costs evaluated were pasture or land rent values per acre; production costs per acre; costs per unit of forage dry matter; costs per unit of nutrient; land area per animal unit; forage-feed costs per day, per month, or per production period; and costs per pound of calf weight gain.

Procedure

This study was conducted at the NDSU Dickinson Research Extension Center, located in western North Dakota. The native rangeland vegetation is the Wheatgrass-Needlegrass Type (Barker and Whitman 1988) of the mixed grass prairie. The dominant native range species are western wheatgrass, needle and thread, blue grama, and threadleaved sedge. Crested wheatgrass and Altai wildrye pastures were seeded as monocultures, but a small assortment of forb and other grass species developed as minor components. Pasture-forage costs and returns were evaluated from cow and calf weight performance data collected on grazing management treatments of pasture research projects conducted between 1983 and 1998. Pasture-forage biomass values were based on the means of the average monthly biomass data for the period grazed and on the average grazing dates and average stocking rates for the grazing treatments. Native rangeland herbage weight data used in the determination of stocking rate for the 12.0-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.

Commercial Hereford and Angus-Hereford cows with calves were used on the grazing management treatments. Individual animals were weighed on and

off each treatment and at biweekly or monthly intervals during the grazing season. The average livestock weight data collected on the grazing treatments were used to determine cow and calf weight performance. 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 birth date in mid March. An assumed price of $0.70 per pound was used to determine the economic value of calf accumulated weight.

Forage dry matter yield per acre and percent crude protein data for annual cereal and annual legume hays and perennial domesticated grass hay were taken from forage production data collected on harvested-forage types between 1995 and 1999 and reported in a previous study (Manske and Carr 2000a). Forage costs for harvested-forage types used as feed for range cows were evaluated as components of 12-month pasture-forage management systems. 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. 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 (Manske and Carr 2000b).

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.

Management Strategies

The descriptions of the 12-month pasture-forage management strategies begin with the dry gestation production period on the day after the previous calf was weaned and progress to the third trimester production period and the birth of a calf, then through early lactation, and through the spring, summer, and fall portions of the lactation production period, until the weaning of the calf.

Grazingland-forage management strategies

The 12.0-month repeated seasonal (12.0 M RS) management strategy was developed from herbage biomass data collected monthly from ungrazed plots. This strategy was evaluated as a sequence of separate native range pastures grazed at proper stocking rates, with each pasture grazed repeatedly during one livestock production period, at the same time (season) each consecutive year, and not grazed during any other production periods. A native range pasture was

evaluated for 32 days of grazing from mid November to mid December, during the dry gestation production period, at a stocking rate of 4.00 acres per cow per month, and supplemental range cake was provided. A native range pasture was evaluated for 90 days of grazing from mid December to mid March, during the third trimester production period, at a stocking rate of 4.97 acres per cow per month, and supplemental range cake was provided. The calves were born in mid March. A native range pasture was evaluated for 45 days of grazing from mid March to late April, during the early lactation production period, at a stocking rate of 6.48 acres per cow-calf pair per month, and supplemental range cake was provided. A native range pasture was evaluated for 31 days of grazing in May, during the spring portion of the lactation period, at a stocking rate of 4.62 acres per cow-calf pair per month. 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, at a stocking rate of 2.52 acres per cow-calf pair per month. A native range pasture was evaluated for 15 days of grazing from mid to late October, during the early segment of the fall portion of the lactation period, at a stocking rate of 4.20 acres per cow-calf pair per month, and supplemental range cake was provided. A native range pasture was evaluated for 15 days of grazing from early to mid November, during the late segment of the fall portion of the lactation period, at a stocking rate of 5.00 acres per cow-calf pair per month, and supplemental range cake was provided. The calves were weaned in mid November.

Cows on the 6.0-month seasonlong (6.0 M SL) management strategy were fed a harvested-forage ration of mature crested wheatgrass hay and roughage for 32 days from mid November to mid December, during the dry gestation production period. Cows were fed a harvested-forage ration of mature crested wheatgrass hay and range cake for 90 days from mid December to mid March, during the third trimester production period. The calves were born in mid March. Cows were fed a balanced dry lot ration of crested wheatgrass, alfalfa, and corn silage for 60 days from mid March to mid May, during the early lactation production period. The grazing portion of the 6.0-month seasonlong management strategy started in mid May. Livestock were moved to a single native range pasture stocked at 4.04 acres per cow-calf pair per month. Livestock grazed on the pasture for 183 days during the spring, summer, and fall portions of the lactation production period, until mid November, when the calves were weaned.

Cows on the 4.5-month seasonlong (4.5 M SL) management strategy were fed a harvested-forage ration of mature crested wheatgrass hay and roughage for 32 days from mid November to mid December, during the dry gestation production period. Cows were fed a harvested-forage ration of mature crested wheatgrass hay and range cake for 90 days from mid December to mid March, during the third trimester production period. The calves were born in mid March. Animals were fed a balanced dry lot ration of crested wheatgrass, alfalfa, and corn silage for 45 days from mid March to late April, during the early lactation production period. The grazing portion of the 4.5-month seasonlong management strategy started in early May. For the first 31 days, during the spring portion of the lactation production period, livestock grazed an unfertilized crested wheatgrass pasture stocked at 1.82 acres per cow-calf pair per month. In early June livestock were moved to one native range pasture stocked at 2.86 acres per cow-calf pair per month. Livestock grazed on this pasture for 137 days during the summer portion of the lactation production period, until mid October, when they were moved to cropland aftermath stocked at 6.63 acres per cow-calf pair per month. Livestock grazed cropland aftermath pastures during the fall portion of the lactation production period, until mid November, when the calves were weaned.

Cows on the 4.0-month deferred (4.0 M Def) management strategy grazed cropland aftermath at a stocking rate of 6.63 acres per cow per month for 32 days from mid November to mid December, during the dry gestation production period. Cows were fed a harvested-forage ration of mature crested wheatgrass hay and range cake for 90 days from mid December to mid March, during the third trimester production period. The calves were born in mid March. Cows were fed a balanced dry lot ration of crested wheatgrass, alfalfa, and corn silage for 45 days from mid March to late April, during the early lactation production period. The grazing portion of the 4.0-month deferred management strategy started in early May. For the first 76 days, during the spring and early summer portions of the lactation production period, livestock grazed an unfertilized crested wheatgrass pasture stocked at 1.67 acres per cow-calf pair per month. In mid July the livestock were moved to one native range pasture stocked at 2.22 acres per cow-calf pair per month. Livestock grazed on this pasture for 122 days during the late summer and fall portions of the lactation production period, until mid November, when the calves were weaned.

Cows on the 4.5-month twice-over rotation (4.5 M TOR) management strategy were fed a harvested-forage ration of early cut forage barley hay and roughage for 32 days from mid November to mid December, during the dry gestation production period. Cows were fed a harvested-forage ration of early cut forage barley hay and roughage for 90 days

from mid December to mid March, during the third trimester production period. The calves were born in mid March. Cows were fed a harvested-forage ration of early cut forage barley hay and roughage for 45 days from mid March to late April, during the early lactation production period. The grazing portion of the 4.5-month twice-over rotation management strategy started in early May. For the first 31 days, during the spring portion of the lactation production period, livestock grazed a fertilized (50 lbs N/acre on 1 April) crested wheatgrass pasture at a stocking rate of 0.75 acres per cow-calf pair per month. The livestock were then moved to one of three native range pastures stocked at 2.04 acres per cow-calf pair per month. Livestock remained on native range for 137 days, during the summer portion of the lactation production period, grazing each pasture for two periods, one 15-day period between 1 June and 15 July (when lead tillers of grasses were between the third-leaf stage and flowering stage) and one 30-day period after 15 July (after secondary tillers of grasses reached the third-leaf stage) and prior to mid October. The first pasture grazed in the sequence was the last pasture grazed the previous year. In mid October the livestock were moved to an Altai wildrye pasture stocked at 1.39 acres per cow-calf pair per month. Livestock grazed on this pasture for 30 days, during the fall portion of the lactation production period, until mid November, when the calves were weaned.

Harvested-forage management strategies

One harvested-forage type was used for each 12-month management strategy. Each cow production period was considered separately. For individual forage types, the cow production periods were then combined as components of a complete 12-month management system. The dry gestation production period was 32 days from mid November to mid December. The third trimester production period was 90 days from mid December to mid March. The early lactation production period was 45 days from mid March to late April. The lactation production period was 31 days in spring (May), 137 days in summer (June to mid October), and 30 days in fall (mid October to mid November). 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.

Results--Grazingland-Forage Management Strategies

The total feed costs and the forage costs for the dry gestation, third trimester, early lactation, and lactation (spring, summer, and fall portions) production periods for 12-month grazingland-forage management strategies were evaluated and compared. The costs are shown in tables 1-5 and summarized in table 21. Forage and supplement costs for 12-month management strategies are shown in table 17. Range cow and calf performance on grazinglands is shown in tables 22-25. Pasture-forage costs and returns for management strategies are shown in tables 26-29. Pasture-forage feed costs for individual production periods of management strategies are shown in table 30. Costs per pound of calf weight for management strategies are shown in table 31.

12.0-month repeated seasonal

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.

Cows grazed a reserved native range pasture during the dry gestation production period. Native range pasture during the fall dormancy period has a crude protein content of around 4.8%. Late-season native range forage had 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 required 4.00 acres of native range pasture per month, or 4.27 acres per period, at a cost of $1.17 per day, $35.10 per month, or $37.44 for the 32-day production period. The crude protein content of mature native range 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 cost was $40.70, or $1.27 per day, during the dry gestation period.

Cows grazed a reserved native range pasture during the third trimester production period. Native range pasture during the fall and winter dormancy period has a crude protein content of around 4.8%. Late-season native range forage had 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 required 4.97 acres of native range pasture per month, or 14.90 acres per period, at a cost of $1.45 per day, $43.50 per month, or $130.50 for the 90-day production period. The crude protein content of mature native range 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 for the 90-day production period, at a cost of $19.44 per period. Total feed cost was $149.94, or $1.67 per day, during the third trimester period. The calves were born in mid March, at an average weight of 95 pounds. The cost per pound of calf birth weight was $1.58.

Cows grazed a reserved native range pasture during the early lactation period. During early spring, forage on native range pasture has a crude protein content of around 9.2%. Early spring native range forage had 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 required 6.48 acres of native range pasture per month, or 9.72 acres per period, at a cost of $1.89 per day, $56.70 per month, or $85.05 for the 45-day production period. The crude protein content of early spring native range 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 cost was $88.43, or $1.97 per day, during the early lactation period. The cost of calf weight gain was $1.09 per pound.

Cows grazed a native range pasture for 31 days in May, during the spring portion of the lactation period. Spring native range forage has a crude protein content of around 16.3%. Spring native range forage had 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 grazing during the spring portion of the lactation period required 4.62 acres per month, or 4.77 acres per period, at a cost of $1.35 per day, or $40.50 per month. Total feed cost was $41.85 during the spring portion of the lactation period. The cost of calf weight gain was $0.75 per pound.

Cows grazed a native range pasture for 137 days, 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 on native range grasses decreases after mid summer and is below the requirements of a lactating cow by early August. Summer native range forage had 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 grazing during the summer portion of the lactation period required 2.52 acres per month, or 11.32 acres per period, at a cost of $0.72 per day, or $21.60 per month. Total feed cost was $98.64 during the summer portion of the lactation period. The cost of calf weight gain was $0.40 per pound.

Cows grazed reserved native range pastures during 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. 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. The crude protein content of fall herbage is around 4.8%, about half the content of mid summer herbage. Fall-grazed native range pasture forage had production costs of $8.76 per acre; forage dry matter costs of $80.37 and $97.33 per ton during early and late fall, respectively; and crude protein costs of $0.34 and $1.01 per pound during early and late fall, respectively. A lactating cow grazing during the fall required 4.20 acres and 5.00 acres per month, at a cost of $36.30 and $43.80 per month, during early and late fall, respectively. The crude protein content of mature native range 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 for the 30-day period. Total feed cost was $23.85, or $1.59 per day, during the early fall portion of the lactation period and $27.35, or $1.82 per day, during the late fall portion of the lactation period. The cost of calf weight gain was $0.95 per pound.

Total feed costs for the 12.0-month repeated seasonal management strategy were $470.76 for a 12-month production period. Calf weaning weight was 532.40 pounds. When calf weaning weight was assumed to have a value of $0.70 per pound, the gross return was $372.68 per calf, and the net returns after 12-month pasture-forage costs were a loss of $98.08 per cow-calf pair and a loss of $1.98 per acre. Each pound of calf weaning weight cost $0.88 for the 12-month production period.

6.0-month seasonlong

Cows on the 6.0-month seasonlong management strategy were fed mature crested wheatgrass hay for 32 days, during the dry gestation production period. Crested wheatgrass cut late, at a mature plant stage, has a crude protein content of around 6.4%. This

low-quality perennial grass hay had 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, at a cost of $0.34 per period, would need to be provided. Production of late-cut crested wheatgrass hay to feed during this period would require 0.44 acres per month, or 0.47 acres per period, and the forage would cost $0.41 per day, $12.32 per month, or $13.12 for the 32-day production period. Total feed cost was $13.46, or $0.42 per day, during the dry gestation period.

Cows were fed mature crested wheatgrass hay during the third trimester production period. Late-cut mature crested wheatgrass hay would need to be fed at 29.7 lbs DM/day to provide 1.9 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, at a cost of $8.91 per period, would need to be provided when mature crested wheatgrass hay is fed at the dry matter requirement of 24 lbs DM/day. Production of mature crested wheatgrass hay to feed during this period would require 0.45 acres per month, or 1.35 acres per period, and the forage would cost $0.52 per day, $15.60 per month, or $46.80 for the 90-day production period. Total feed cost was $55.71, or $0.62 per day, during the third trimester period. The calves were born in mid March, at an average weight of 95 pounds. The cost per pound of calf birth weight was $0.59.

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, or 1.20 acres per period, and the forages would cost $0.75 per day, $22.50 per month, or $45.00 for the 60-day production period. Mineral supplementation would cost $3.00 per period. Total feed cost was $48.00, or $0.80 per day, during the early lactation period. The cost of calf weight gain was $0.42 per pound.

The native range period of the 6.0-month seasonlong treatment was 183 days, with 16 days during spring, 137 days during summer, and 30 days during fall portions of the lactation production period. Native rangeland forage had production costs of $8.76 per acre and forage dry matter costs of $77.69 per ton. Each cow-calf pair was allotted 24.24 acres per production period, at a rate of 4.04 acres per month and a cost of $35.39 per month. Total feed cost was $212.34, or $1.16 per day, during the spring, summer, and fall portions of the lactation 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. Each cow-calf pair was allotted 4.04 acres per month, at a cost of $1.18 per day, or $35.39 per month. Cows lost 2.65 pounds per day and lost 39.50 pounds per acre; accumulated weight loss was 79.40 pounds per month. Calf weight gain was 0.59 pounds per day and 8.82 pounds per acre; accumulated weight gain was 17.73 pounds. When calf accumulated weight was assumed to have a value of $0.70/lb, 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.

Total feed costs for the 6.0-month seasonlong management strategy were $329.51 for a 12-month production period. Calf weaning weight was 538.40 pounds. When calf weaning weight was assumed to have a value of $0.70 per pound, the gross return was $376.88 per calf, and the net returns after 12-month pasture-forage costs were $47.37 per cow-calf pair and $1.74 per acre. Each pound of calf weaning weight cost $0.61 for the 12-month production period.

4.5-month seasonlong

Cows on the 4.5-month seasonlong management strategy were fed mature crested wheatgrass hay for 32 days, during the dry gestation production period. Crested wheatgrass cut late, at a mature plant stage, has a crude protein content of around 6.4%. This low-quality perennial grass hay had 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, at a cost of $0.34 per

period, would need to be provided. Production of late-cut crested wheatgrass hay to feed during this period would require 0.44 acres per month, or 0.47 acres per period, and the forage would cost $0.41 per day, $12.32 per month, or $13.12 for the 32-day production period. Total feed cost was $13.46, or $0.42 per day, during the dry gestation period.

Cows were fed mature crested wheatgrass hay during the third trimester production period. Late-cut mature crested wheatgrass hay would need to be fed at 29.7 lbs DM/day to provide 1.9 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, at a cost of $8.91 per period, would need to be provided when mature crested wheatgrass hay is fed at the dry matter requirement of 24 lbs DM/day. Production of mature crested wheatgrass hay to feed during this period would require 0.45 acres per month, or 1.35 acres per period, and the forage would cost $0.52 per day, $15.60 per month, or $46.80 for the 90-day production period. Total feed cost was $55.71, or $0.62 per day, during the third trimester period. The calves were born in mid March, at an average weight of 95 pounds. The cost per pound of calf birth weight was $0.59.

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, or 0.90 acres per period, and the forages would cost $0.75 per day, $22.50 per month, or $33.75 for the 45-day production period. Mineral supplementation would cost $2.25 per period. Total feed cost was $36.00, or $0.80 per day, during the early lactation period. The cost of calf weight gain was $0.42 per pound.

The spring crested wheatgrass complementary pasture period was 31 days during the spring portion of the lactation production period. Unfertilized crested wheatgrass forage had production costs of $8.76 per acre and forage dry matter costs of $35.39 per ton. Each cow-calf pair was allotted 1.88 acres per period, at a rate of 1.82 acres per month. Total feed cost was $16.47, or $0.52 per day, during the spring portion of the lactation 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 4.5-month seasonlong treatment was 137 days during the summer portion of the lactation production period from early June to mid October. Summer native rangeland forage had production costs of $8.76 per acre and forage dry matter costs of $54.75 per ton. Each cow-calf pair was allotted 12.70 acres per period, at a rate of 2.86 acres per month. Total feed cost was $111.25, or $0.81 per day, during the summer portion of the lactation period. 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 management strategy grazed native rangeland from mid June until late October. Each cow-calf pair was allotted 3.26 acres per month, at a cost of $0.95 per day, or $14.28 for 15 days between mid and late October. Cows grazing native rangeland lost 0.52 pounds per day and lost 2.76 pounds per acre; accumulated weight loss was 7.74 pounds in 15 days. Calf weight gain was 1.35 pounds per day and 6.17 pounds per acre; accumulated weight gain was 20.33 pounds. When calf accumulated weight was assumed to have a value of $0.70/lb, 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 strategy grazed a cropland aftermath pasture during the fall portion of the lactation production period from mid October to mid November. Cropland aftermath forage had production costs of $2.00 per acre and forage dry matter costs of $29.63 per ton. Each cow-calf pair was allotted 6.63 acres of crop aftermath per month. Total feed cost was $13.26, or $0.44 per day, during the fall portion of the lactation period. Lactating cows that grazed cropland aftermath of annual cereal residue between mid October and mid November lost

1.61 pounds per day and lost 7.27 pounds per acre; accumulated weight loss was 48.17 pounds. Calf weight gain was 0.42 pounds per day and 1.90 pounds per acre; accumulated weight gain was 12.57 pounds. When calf accumulated weight was assumed to have a value of $0.70/lb, 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 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.

Total feed costs for the 4.5-month seasonlong management strategy were $246.15 for a 12-month production period. Calf weaning weight was 538.61 pounds. When calf weaning weight was assumed to have a value of $0.70 per pound, the gross return was $377.03 per calf, and the net returns after 12-month pasture-forage costs were $130.88 per cow-calf pair and $5.47 per acre. Each pound of calf weaning weight cost $0.46 for the 12-month production period.

4.0-month deferred

Cows on the 4.0-month deferred management strategy grazed cropland aftermath for 32 days, during the dry gestation production period. Crop aftermath of annual cereal stubble has very low crude protein content. A dry gestating cow grazed 7.10 acres of crop aftermath per period, at a cost of $13.26 per month when crop aftermath production cost was valued at $2.00 per acre. Total feed cost was $14.20, or $0.44 per day, during the dry gestation period. This forage source was below the crude protein requirements of a dry gestating cow. Dry cows grazing crop aftermath lost an average of 1.14 lbs per day and lost an average of 4.82 lbs per acre; accumulated weight loss was 36.48 lbs per period.

Cows were fed mature crested wheatgrass hay during the third trimester production period. Crested wheatgrass cut late, at a mature plant stage, has a crude protein content of around 6.4%. This low-quality hay had 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. This late-cut hay would need to be fed at 29.7 lbs DM/day to provide 1.9 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, at a cost of $8.91 per period, would need to be provided when mature crested wheatgrass hay is fed at the dry matter requirement of 24 lbs DM/day. Production of mature crested wheatgrass hay to feed during this period would require 0.45 acres per month, or 1.35 acres per period, and the forage would cost $0.52 per day, $15.60 per month, or $46.80 for the 90-day production period. Total feed cost was $55.71, or $0.62 per day, during the third trimester period. The calves were born in mid March, at an average weight of 95 pounds. The cost per pound of calf birth weight was $0.59.

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, or 0.90 acres per period, and the forages would cost $0.75 per day, $22.50 per month, or $33.75 for the 45-day production period. Mineral supplementation would cost $2.25 per period. Total feed cost was $36.00, or $0.80 per day, during the early lactation period. The cost of calf weight gain was $0.42 per pound.

The spring crested wheatgrass complementary pasture period was 76 days during the spring and early summer portions of the lactation production period. Unfertilized crested wheatgrass forage had production costs of $8.76 per acre and forage dry matter costs of $31.97 per ton. Each cow-calf pair was allotted 4.16 acres per period, at a rate of 1.67 acres per month. Total feed cost was $36.44, or $0.48 per day, during the spring and early summer portions of the lactation 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 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 treatment was 122 days, with 92 days during summer and 30 days during fall portions of the lactation production period. Native rangeland forage had production costs of $8.76 per acre and forage dry matter costs of $42.52 per ton. Each cow-calf pair was allotted 8.88 acres per period, at a rate of 2.22 acres per month. Total feed cost was $77.79, or $0.64 per day, during the late summer and fall portions of the lactation 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 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. Native rangeland forage had production costs of $8.76 per acre and forage dry matter costs of $42.52 per ton. Each cow-calf pair was allotted 2.18 acres per period, at a rate of 2.22 acres per month. Total feed cost was $19.53 per period, or $0.65 per day, during the fall portion of the lactation period. Cows lost 0.74 pounds per day and lost 9.96 pounds per acre; accumulated weight loss was 22.20 pounds. Calf weight gain was 0.77 pounds per day and 10.36 pounds per acre; accumulated weight gain was 23.10 pounds. When calf accumulated weight was assumed to have a value of $0.70/lb, 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.

Total feed costs for the 4.0-month deferred management strategy were $220.14 for a 12-month production period. Calf weaning weight was 536.14 pounds. When calf weaning weight was assumed to have a value of $0.70 per pound, the gross return was $375.30 per calf, and the net returns after 12-month pasture-forage costs were $155.16 per cow-calf pair and $6.93 per acre. Each pound of calf weaning weight cost $0.41 for the 12-month production period.

4.5-month twice-over rotation

Cows on the 4.5-month twice-over rotation management strategy were fed early cut forage barley hay for 32 days, during the dry gestation production period. Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay had 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, at a cost of $7.00 per period, would need to be provided. Production of early cut forage barley hay to feed during this period would require 0.07 acres per month, and the forage would cost $0.16 per day, $4.80 per month, or $5.12 for the 32-day production period. Total feed cost was $12.12, or $0.38 per day, during the dry gestation period.

Cows were fed early cut forage barley hay during the third trimester production period. Forage barley hay cut at the milk stage 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, at a cost of $14.96 per period, would need to be provided. Production of early cut forage barley hay to feed during this period would require 0.09 acres per month, or 0.27 acres per period, and the forage would cost $0.21 per day, $6.30 per month, or $18.90 for the 90-day production period. Total feed cost was $33.86, or $0.38 per day, during the third trimester period. The calves were born in mid March, at an average weight of 95 pounds. The cost per pound of calf birth weight was $0.36.

Cows were fed a dry lot ration of early cut forage barley hay during the early lactation production period. Forage barley hay cut at the milk stage 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, at a cost of $4.73 per period, would need to be provided. Production of early cut forage barley hay to feed during this period would require 0.13 acres per month, or 0.20 acres per period, and the forage would cost $0.30 per day, $9.00 per month, or $13.50 for the 45-day production period. Total feed cost was $18.23, or $0.41 per day, during the early lactation period. The cost of calf weight gain was $0.21 per pound.

The spring crested wheatgrass complementary pasture period was 31 days during the spring portion of the lactation production period. Fertilized crested wheatgrass forage had production costs of $21.26 per acre and forage dry matter costs of $34.29 per ton. Each cow-calf pair was allotted 0.75 acres per period. Total feed cost was $15.95, or $0.51 per day, during the spring portion of the lactation 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 treatment was 137 days during the summer portion of the lactation production period. Native rangeland forage had production costs of $8.76 per acre and forage dry matter costs of $39.02 per ton. Each cow-calf pair was allotted 9.00 acres per period, at a rate of 2.04 acres per month. Total feed cost was $78.84, or $0.58 per day, during the summer portion of the lactation 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. Altai wildrye forage had production costs of $8.76 per acre and forage dry matter costs of $27.04 per ton. Each cow-calf pair was allotted 1.39 acres per period. Total feed cost was $12.00, or $0.40 per day, during the fall portion of the lactation 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.

Total feed costs for the 4.5-month twice-over rotation management strategy were $171.00 for a 12-month production period. Calf weaning weight was 603.62 pounds. When calf weaning weight was assumed to have a value of $0.70 per pound, the gross return was $422.53 per calf, and the net returns after 12-month pasture-forage costs were $251.53 per cow-calf pair and $21.54 per acre. Each pound of calf weaning weight cost $0.28 for the 12-month production period.

Cow and calf performance was strong on unfertilized crested wheatgrass during May and June but decreased considerably when grazing continued until mid July. Fertilization on crested wheatgrass pastures during the first week of April increased the amount of herbage produced but shortened by several weeks 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.

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

later portion of the grazing period, after early August, animal weight performance was greater on the twice-over rotation treatment than on the seasonlong and deferred treatments.

Cow average daily gain on the seasonlong and deferred treatments steadily decreased as the grazing period progressed. Cows gained weight during the early portion of the grazing period but lost weight during the later portion. Weight loss during the later 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 daily gain, 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 average daily gain on the seasonlong and deferred treatments decreased as the grazing season progressed. The decrease in calf average daily gain 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 daily gain during the later 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.

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.

Results--Harvested-Forage Management Strategies

The total feed costs and the harvested-forage costs for the dry gestation, third trimester, early lactation, and lactation (spring, summer, and fall portions) production periods for 12-month harvested-forage management strategies were evaluated and compared. The costs are shown in tables 6-16. Forage and supplement costs for 12-month management strategies are shown in tables 18-20.
Crested wheatgrass hay cut late

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of 6.4%. This crested wheatgrass hay had 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.

The dry gestation production period was 32 days. Mature 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 mature crested wheatgrass hay to feed during this period would require 0.44 acres per month, or 0.47 acres per period, and the forage would cost $13.12 per production period. Total forage and supplement costs during the dry gestation period would be $13.46, or $0.42 per day.

The third trimester production period was 90 days. Mature crested wheatgrass hay would be fed at 24.0 lbs DM/day to provide 1.5 lbs CP/day. An additional 0.3 lbs of crude protein per day would need to be provided, at a cost of $9.02 per period. Production of mature crested wheatgrass hay to feed during this period would require 0.45 acres per month, or 1.35 acres per period, and the forage would cost $46.80 per production period. Total forage and supplement costs during the third trimester period would be $55.82, or $0.62 per day.

The early lactation production period was 45 days. Mature crested wheatgrass hay would be fed at 27.0 lbs DM/day to provide 1.7 lbs CP/day. An additional 1.0 lbs of crude protein per day would need to be provided, at a cost of $13.50 per period. Production of mature crested wheatgrass hay to feed during this period would require 0.51 acres per month, or 0.76 acres per period, and the forage would cost $33.75 per production period. Total forage and supplement costs during the early lactation period would be $47.25, or $1.05 per day.

The spring portion of the lactation production period was 31 days. 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 this period would require 0.56 acres per month, or 0.58 acres per period, and the forage would cost $21.70 per period. Total forage and supplement costs during the spring portion of the lactation period would be $28.97, or $0.93 per day.

The summer portion of the lactation production period was 137 days. 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 this period would require 0.56 acres per month, or 2.57 acres per period, and the forage would cost $95.90 per period. Total forage and supplement costs during the summer portion of the lactation period would be $128.04, or $0.93 per day.

The fall portion of the lactation production period was 30 days. 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 this period would require 0.56 acres per month, or per period, and the forage would cost $21.00 per period. Total forage and supplement costs during the fall portion of the lactation period would be $28.02, or $0.93 per day.

The mature crested wheatgrass hay treatment would require 6.29 acres to produce forage to feed during all of the production periods. Harvested forage would cost $232.27 and supplementation would cost $69.29 per year. Total feed costs for this 12-month management strategy would be $301.56 per year, or $0.83 per day.

Crested wheatgrass hay cut early

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of 14.5%. This crested wheatgrass hay had 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.

The dry gestation production period was 32 days. 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 this period would require 0.24 acres per month, or 0.26 acres per period, and the forage would cost $6.72 per production period. Total forage and supplement costs during the dry gestation period would be $14.40, or $0.45 per day.

The third trimester production period was 90 days. 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 this period would require 0.30 acres per month, or 0.89 acres per period, and the forage would cost $23.40 per production period. Total forage and supplement costs during the third trimester period would be $40.88, or $0.45 per day.

The early lactation production period was 45 days. 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 this period would require 0.43 acres per month, or 0.65 acres per period, and the forage would cost $17.10 per production period. Total forage and supplement costs during the early lactation period would be $23.53, or $0.52 per day.

The spring portion of the lactation production period was 31 days. 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 this period would require 0.40 acres per month, or 0.41 acres per period, and the forage would cost $10.85 per period. Total forage and supplement costs during the spring portion of the lactation period would be $17.73, or $0.57 per day.

The summer portion of the lactation production period was 137 days. 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 this period would require 0.40 acres per month, or 1.82 acres per period, and the forage would cost $47.95 per period. Total forage and supplement costs during the summer portion of the lactation period would be $78.37, or $0.57 per day.

The fall portion of the lactation production period was 30 days. 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 this period would require 0.40 acres per month, or per period, and the forage would cost $10.50 per period. Total forage and supplement costs during the fall portion of the lactation period would be $17.16, or $0.57 per day.

The early cut crested wheatgrass hay treatment would require 4.43 acres to produce forage to feed during all of the production periods. Harvested forage would cost $116.52 and supplementation would cost $75.55 per year. Total feed costs for this 12-month management strategy would be $192.07 per year, or $0.53 per day.

Forage barley hay cut early

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay had 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.

The dry gestation production period was 32 days. 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 this period would require 0.07 acres per month, or per period, and the forage would cost $5.12 per production period. Total forage and supplement costs during the dry gestation period would be $12.12, or $0.38 per day.

The third trimester production period was 90 days. 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 this period would require 0.09 acres per month, or 0.27 acres per period, and the forage would cost $18.90 per production period. Total forage and supplement costs during the third trimester period would be $33.86, or $0.38 per day.

The early lactation production period was 45 days. 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 this period would require 0.13 acres per month, or 0.20 acres per period, and the forage would cost $13.50 per production period. Total forage and supplement costs during the early lactation period would be $18.23, or $0.41 per day.

The spring portion of the lactation production period was 31 days. 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 this period would require 0.12 acres per month, or 0.13 acres per period, and the forage would cost $8.68 per period. Total forage and supplement costs during the spring portion of the lactation period would be $14.48, or $0.47 per day.

The summer portion of the lactation production period was 137 days. 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 this period would require 0.12 acres per month, or 0.56 acres per period, and the forage would cost $38.36 per period. Total forage and supplement costs during the summer portion of the lactation period would be $64.01, or $0.47 per day.

The fall portion of the lactation production period was 30 days. 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 this period would require 0.12 acres per month, or per period, and the forage would cost $8.40 per period. Total forage and supplement costs during the fall portion of the lactation period would be $14.02, or $0.47 per day.

The early cut forage barley hay treatment would require 1.35 acres to produce forage to feed during all of the production periods. Harvested forage would cost $92.96 and supplementation would cost $63.76 per year. Total feed costs for this 12-month management strategy would be $156.72 per year, or $0.43 per day.

Forage barley hay cut late

Forage barley hay cut late, at the hard dough stage, has a crude protein content of 9.2%. This forage barley hay had 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.

The dry gestation production period was 32 days. 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 this period would

require 0.09 acres per month, or 0.10 acres per period, and the forage would cost $7.04 per production period. Total forage and supplement costs during the dry gestation period would be $11.41, or $0.36 per day.

The third trimester production period was 90 days. 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 this period would require 0.12 acres per month, or 0.36 acres per period, and the forage would cost $26.10 per production period. Total forage and supplement costs during the third trimester period would be $31.93, or $0.35 per day.

The early lactation production period was 45 days. 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. Production of late-cut forage barley hay to feed during this period would require 0.16 acres per month, or 0.24 acres per period, and the forage would cost $18.45 per production period. Total forage and supplement costs during the early lactation period would be $21.83, or $0.49 per day.

The spring portion of the lactation production period was 31 days. 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 this period would require 0.16 acres per month, or per period, and the forage would cost $11.78 per period. Total forage and supplement costs during the spring portion of the lactation period would be $13.24, or $0.43 per day.

The summer portion of the lactation production period was 137 days. 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 this period would require 0.16 acres per month, or 0.73 acres per period, and the forage would cost $52.06 per period. Total forage and supplement costs during the summer portion of the lactation period would be $58.53, or $0.43 per day.

The fall portion of the lactation production period was 30 days. 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 this period would require 0.16 acres per month, or per period, and the forage would cost $11.40 per period. Total forage and supplement costs during the fall portion of the lactation period would be $12.82, or $0.43 per day.

The late-cut forage barley hay treatment would require 1.75 acres to produce forage to feed during all of the production periods. Harvested forage would cost $126.83 and supplementation would cost $22.93 per year. Total feed costs for this 12-month management strategy would be $149.76 per year, or $0.41 per day.

Oat forage hay cut early

Oat hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat hay had 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.

The dry gestation production period was 32 days. 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 this period would require 0.08 acres per month, or 0.09 acres per period, and the forage would cost $6.08 per production period. Total forage and supplement costs during the dry gestation period would be $12.24, or $0.38 per day.

The third trimester production period was 90 days. 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 this period would require 0.10 acres per month, or 0.31 acres per period, and the forage would cost $21.60 per production period. Total forage and supplement costs during the third trimester period would be $33.73, or $0.37 per day.

The early lactation production period was 45 days. 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 this period would require 0.15 acres per month, or 0.23 acres per period, and the forage would cost $15.75 per production period. Total forage and supplement costs during the early lactation period would be $18.35, or $0.41 per day.

The spring portion of the lactation production period was 31 days. 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 this period would require 0.14 acres per month, or per period, and the forage would cost $10.23 per period. Total forage and supplement costs during the spring portion of the lactation period would be $14.68, or $0.47 per day.

The summer portion of the lactation production period was 137 days. 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 this period would require 0.14 acres per month, or 0.64 acres per period, and the forage would cost $45.21 per period. Total forage and supplement costs during the summer portion of the lactation period would be $64.87, or $0.47 per day.

The fall portion of the lactation production period was 30 days. 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 this period would require 0.14 acres per month, or per period, and the forage would cost $9.90 per period. Total forage and supplement costs during the fall portion of the lactation period would be $14.21, or $0.47 per day.

The early cut oat forage hay treatment would require 1.55 acres to produce forage to feed during all of the production periods. Harvested forage would cost $108.77 and supplementation would cost $49.31 per year. Total feed costs for this 12-month management strategy would be $158.08 per year, or $0.43 per day.

Oat forage hay cut late

Oat hay cut late, at the hard dough stage, has a crude protein content of 7.8%. This oat forage hay had 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.

The dry gestation production period was 32 days. 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 this period would require 0.10 acres per month, or 0.11 acres per period, and the forage would cost $8.00 per production period. Total forage and supplement costs during the dry gestation period would be $10.74, or $0.34 per day.

The third trimester production period was 90 days. 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 this period would require 0.13 acres per month, or 0.38 acres per period, and the forage would cost $28.80 per production period. Total forage and supplement costs during the third trimester period would be $28.80, or $0.32 per day.

The early lactation production period was 45 days. Late-cut oat hay would be fed at 27.0 lbs DM/day to provide 2.1 lbs CP/day. An additional 0.6 lbs of crude protein per day would need to be provided, at a cost of $8.37 per period. Production of late-cut oat hay to feed during this period would require 0.14 acres per month, or 0.21 acres per period, and the forage would cost $20.70 per production period. Total forage and supplement costs during the early lactation period would be $29.07, or $0.65 per day.

The spring portion of the lactation production period was 31 days. 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 this period would require 0.16 acres per month, or per period, and the forage would cost $13.33 per period. Total forage and supplement costs during the spring portion of the lactation period would be $17.05, or $0.55 per day.

The summer portion of the lactation production period was 137 days. 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 this period would require 0.16 acres per month, or 0.73 acres per period, and the forage would cost $58.91 per period. Total forage and supplement costs during the summer portion of the lactation period would be $75.35, or $0.55 per day.

The fall portion of the lactation production period was 30 days. 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 this period would require 0.16 acres per month, or per period, and the forage would cost $12.90 per period. Total forage and supplement costs during the fall portion of the lactation period would be $16.50, or $0.55 per day.

The late-cut oat forage hay treatment would require 1.75 acres to produce forage to feed during all of the production periods. Harvested forage would cost $142.64 and supplementation would cost $34.87 per year. Total feed costs for this 12-month management strategy would be $177.51 per year, or $0.49 per day.

Pea forage hay cut early

Pea forage hay cut at an early plant stage has a crude protein content of 18.9%. This pea forage hay had 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.

The dry gestation production period was 32 days. 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 this period would require 0.08 acres per month, or 0.09 acres per period, and the forage would cost $7.04 per production period. Total forage and supplement costs during the dry gestation period would be $16.06, or $0.50 per day.

The third trimester production period was 90 days. 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 this period would require 0.11 acres per month, or 0.32 acres per period, and the forage would cost $25.20 per production period. Total forage and supplement costs during the third trimester period would be $47.41, or $0.53 per day.

The early lactation production period was 45 days. 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 this period would require 0.15 acres per month, or 0.23 acres per period, and the forage would cost $18.45 per production period. Total forage and supplement costs during the early lactation period would be $28.37, or $0.63 per day.

The spring portion of the lactation production period was 31 days. 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 this period would require 0.14 acres per month, or 0.15 acres per period, and the forage would cost $11.78 per period. Total forage and supplement costs during the spring portion of the lactation period would be $20.84, or $0.67 per day.

The summer portion of the lactation production period was 137 days. 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 this period would require 0.14 acres per month, or 0.65 acres per period, and the forage would cost $52.06 per period. Total forage and supplement costs during the summer portion of the lactation period would be $92.10, or $0.67 per day.

The fall portion of the lactation production period was 30 days. 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 this period would require 0.14 acres per month, or per period, and the forage would cost $11.40 per period. Total forage and supplement costs during the fall portion of the lactation period would be $20.19, or $0.67 per day.

The early cut pea forage hay treatment would require 1.58 acres to produce forage to feed during all of the production periods. Harvested forage would cost $125.93 and supplementation would cost $99.04 per year. Total feed costs for this 12-month management strategy would be $224.97 per year, or $0.62 per day.

Pea forage hay cut late

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay had 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.

The dry gestation production period was 32 days. 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 this period would require 0.07 acres per month, or per period, and the forage would cost $6.08 per period. Total forage and supplement costs during the dry gestation period would be $13.75, or $0.43 per day.

The third trimester production period was 90 days. 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 this period would require 0.08 acres per month, or 0.25 acres per period, and the forage would cost $21.60 per production period. Total forage and supplement costs during the third trimester period would be $38.93, or $0.43 per day.

The early lactation production period was 45 days. 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 this period would require 0.12 acres per month, or 0.18 acres per period, and the forage would cost $15.75 per production period. Total forage and supplement costs during the early lactation period would be $22.05, or $0.49 per day.

The spring portion of the lactation production period was 31 days. 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 this period would require 0.11 acres per month, or 0.12 acres per period, and the forage would cost $10.23 per period. Total forage and supplement costs during the spring portion of the lactation period would be $17.07, or $0.55 per day.

The summer portion of the lactation production period was 137 days. 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 this period would require 0.11 acres per month, or 0.51 acres per period, and the forage would cost $45.21 per period. Total forage and supplement costs during the summer portion of the lactation period would be $75.42, or $0.55 per day.

The fall portion of the lactation production period was 30 days. 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 this period would require 0.11 acres per month, or per period, and the forage would cost $9.90 per period. Total forage and supplement costs during the fall portion of the lactation period would be $16.52, or $0.55 per day.

The late-cut pea forage hay treatment would require 1.24 acres to produce forage to feed during all of the production periods. Harvested forage would cost $108.77 and supplementation would cost $74.97 per year. Total feed costs for this 12-month management strategy would be $183.74 per year, or $0.50 per day.

Forage lentil hay cut early

Forage lentil hay cut at an early plant stage has a crude protein content of 21.8%. This forage lentil hay had 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.

The dry gestation production period was 32 days. 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 this period would require 0.12 acres per month, or 0.13 acres per period, and the forage would cost $8.00 per production period. Total forage and supplement costs during the dry gestation period would be $17.63, or $0.55 per day.

The third trimester production period was 90 days. 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 this period would require 0.15 acres per month, or 0.46 acres per period, and the forage would cost $28.80 per production period. Total forage and supplement costs during the third trimester period would be $53.06, or $0.59 per day.

The early lactation production period was 45 days. 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 this period would require 0.23 acres per month, or 0.34 acres per period, and the forage would cost $20.70 per production period. Total forage and supplement costs during the early lactation period would be $32.12, or $0.71 per day. The spring portion of the lactation production period was 31 days. 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 this period would require 0.21 acres per month, or per period, and the forage would cost $13.33 per period. Total forage and supplement costs during the spring portion of the lactation period would be $23.37, or $0.75 per day.

The summer portion of the lactation production period was 137 days. 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 this period would require 0.21 acres per month, or 0.95 acres per period, and the forage would cost $58.91 per period. Total forage and supplement costs during the summer portion of the lactation period would be $103.26, or $0.75 per day.

The fall portion of the lactation production period was 30 days. 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 $9.71 per period. Production of early cut forage lentil hay to feed during this period would require 0.21 acres per month, or per period, and the forage would cost $12.90 per period. Total forage and supplement costs during the fall portion of the lactation period would be $22.61, or $0.75 per day.

The early cut forage lentil hay treatment would require 2.30 acres to produce forage to feed during all of the production periods. Harvested forage would cost $142.64 and supplementation would cost $109.41 per year. Total feed costs for this 12-month management strategy would be $252.05 per year, or $0.69 per day.

Forage lentil hay cut late

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay had 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.

The dry gestation production period was 32 days. 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 this period would require 0.08 acres per month, or 0.09 acres per period, and the forage would cost $6.08 per production period. Total forage and supplement costs during the dry gestation period would be $13.86, or $0.43 per day.

The third trimester production period was 90 days. 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 this period would require 0.10 acres per month, or 0.30 acres per period, and the forage would cost $21.60 per production period. Total forage and supplement costs during the third trimester period would be $39.40, or $0.44 per day.

The early lactation production period was 45 days. 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 this period would require 0.14 acres per month, or 0.22 acres per period, and the forage would cost $15.75 per production period. Total forage and supplement costs during the early lactation period would be $22.37, or $0.50 per day.

The spring portion of the lactation production period was 31 days. 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 this period would require 0.13 acres per month, or 0.14 acres per period, and the forage would cost $10.23 per period. Total forage and supplement costs during the spring portion of the lactation period would be $17.23, or $0.56 per day.

The summer portion of the lactation production period was 137 days. 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 $30.93 per period. Production of late-cut forage lentil hay to feed during this period would require 0.13 acres per month, or 0.60 acres per period, and the forage would cost $45.21 per period. Total forage and supplement costs during the summer portion of the lactation period would be $76.14, or $0.56 per day.

The fall portion of the lactation production period was 30 days. 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 this period would require 0.13 acres per month, or per period, and the forage would cost $9.90 per period. Total forage and supplement costs during the fall portion of the lactation period would be $16.67, or $0.56 per day.

The late-cut forage lentil hay treatment would require 1.48 acres to produce forage to feed during all of the production periods. Harvested forage would cost $108.77 and supplementation would cost $76.90 per year. Total feed costs for this 12-month management strategy would be $185.67 per year, or $0.51 per day.

Oat-pea forage hay

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay had 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.

The dry gestation production period was 32 days. 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 forage hay to feed during this period would require 0.07 acres per month, or per period, and the forage would cost $7.04 per production period. Total forage and supplement costs during the dry gestation period would be $13.82, or $0.43 per day.

The third trimester production period was 90 days. 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 this period would require 0.09 acres per month, or 0.26 acres per period, and the forage would cost $25.20 per production period. Total forage and supplement costs during the third trimester period would be $39.38, or $0.44 per day.

The early lactation production period was 45 days. 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 period. Production of oat-pea forage hay to feed during this period would require 0.13 acres per month, or 0.19 acres per period, and the forage would cost $18.45 per production period. Total forage and supplement costs during the early lactation period would be $22.55, or $0.50 per day.

The spring portion of the lactation production period was 31 days. 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 this period would require 0.12 acres per month, or per period, and the forage would cost $11.78 per period. Total forage and supplement costs during the spring portion of the lactation period would be $17.15, or $0.55 per day.

The summer portion of the lactation production period was 137 days. 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 this period would require 0.12 acres per month, or 0.53 acres per period, and the forage would cost $52.06 per period. Total forage and supplement costs during the summer portion of the lactation period would be $75.80, or $0.55 per day.

The fall portion of the lactation production period was 30 days. 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 this period would require 0.12 acres per month, or per period, and the forage would cost $11.40 per period. Total forage and supplement costs during the fall portion of the lactation period would be $16.60, or $0.55 per day.

The oat-pea forage hay treatment would require 1.29 acres to produce forage to feed during all of the production periods. Harvested forage would cost $125.93 and supplementation would cost $59.37 per year. Total feed costs for this 12-month management strategy would be $185.30 per year, or $0.51 per day.

Supplementation

Most of the harvested-forage types evaluated had levels of crude protein greater than the amount required by range cows, and additional dry matter was needed. Roughage supplementation was required during all of the production periods for early cut crested wheatgrass, early cut forage barley, early cut oat forage, early cut pea forage, late-cut pea forage, early cut forage lentil, late-cut forage lentil, and oat-pea forage hays. A few of the harvested-forage types had levels of crude protein lower than the amount required by range cows. Crude protein supplementation was required with late-cut crested wheatgrass hay during the third trimester, early lactation, and lactation (spring, summer, and fall portions) periods; late-cut forage barley hay during the early lactation period; and late-cut oat forage hay during the early lactation and lactation (spring, summer, and fall portions) periods. Standard items for roughage and crude protein supplementation were used in this study in order to evaluate the differences among the harvested-forage types. Not all types of supplements have these same costs, and selective substitution could reduce the supplementation expenses.

Results--Comparisons of 12-Month Management Strategies

Pasture-forage management treatments and grazingland-forage and harvested-forage types during the dry gestation, third trimester, early lactation, and lactation (spring, summer, and fall portions) production periods were evaluated and compared, as were the total 12-month grazingland-forage and harvested-forage costs for 12-month management strategies for range cows in the Northern Plains. One management strategy was developed from native range herbage biomass data as a 12-month grazing system on native range pastures, with none of the feed provided as harvested forage. Three of the management strategies followed traditional practices, with typical variations of mature crested wheatgrass hay, crested wheatgrass pasture, native range pasture, and cropland aftermath pasture. One management strategy was the twice-over rotation system with complementary spring and fall pastures; developed specifically for the Northern Plains, this management strategy was designed to meet the biological requirements of the plants, facilitate the functioning of ecological processes, and counterbalance problematic biological conditions inherent in the grassland ecosystems so that grass plant performance and cow and calf weight performance are improved over those on traditional management practices.

The harvested-forage management strategies were developed from one perennial domesticated grass harvested as hay at two growth stages, two annual cereals both harvested as hay at two growth stages, two annual legumes both harvested as hay at two growth stages, and a mixed annual cereal-annual legume forage harvested as hay.

Twelve-month total forage-feed costs per 1200-pound cow nursing a calf for eight months were less than $200 for the 4.5-month twice-over rotation, the crested wheatgrass hay cut early, the forage barley hay cut early and late, the oat forage hay cut early and late, the pea forage hay cut late, the forage lentil hay cut late, and the oat-pea forage hay management strategies. Twelve-month total forage-feed costs were greater than $300 for the 12-month repeated seasonal, the 6.0-month seasonlong, and the crested wheatgrass hay cut at the mature plant stage management strategies.

The management strategy consisting of 12 months of grazing on native range pastures with no harvested-forage feed was the least efficient management strategy during all production periods and had the highest costs in all cost categories except production costs per acre. These high costs resulted in negative net returns after pasture costs when calves were sold at $0.70 per pound.

The three management strategies with traditional practices had similar calf performance and calf weaning weights. All three traditional management strategies had positive net returns after pasture and forage costs, per cow-calf pair ($47.37 to $155.16) and per acre ($1.74 to $6.93), when calves were sold at $0.70 per pound. These three management strategies, however, did not have very high profit margins.

The twice-over rotation management strategy with three-pasture native range rotation system, spring and fall domesticated grass complementary pastures, and early cut annual cereal hay as the harvested-forage feed was the most efficient of the grazingland-forage management strategies. It had the lowest land area per month; the lowest land area per 12-month period; the lowest forage feed cost during dry gestation, third trimester, early lactation, spring lactation, summer lactation, and fall lactation production periods; the lowest total 12-month feed cost; and the lowest crude protein supplementation costs. The twice-over rotation management strategy also had the lowest cost per pound of calf birth weight ($0.36), the lowest cost per pound of calf accumulated weight ($0.25), and the lowest cost per pound of calf weaning weight ($0.28). The twice-over rotation management strategy had the highest net returns after pasture and forage costs, per cow-calf pair ($251.53) and per acre ($21.54), when calves were sold at $0.70 per pound.

The harvested-forage management strategies required lower land area per animal than the grazingland-forage management strategies. Forage barley hay cut early and late and oat forage hay cut early had lower total 12-month feed costs than the twice-over rotation management strategy.

Despite the potential economic advantages of providing harvested forages to beef cows for 12 months, the management strategy is not common in the Northern Plains. Most beef producers have not seriously considered 12-month harvested-forage management strategies as a viable option. The 12-month livestock feed costs for eight of the evaluated harvested-forage types were lower than the 12-month livestock feed costs for the 6.0-month seasonlong, 4.5-month seasonlong, and deferred management strategies, which are common grazing management practices in the region. Beef producers using these traditional management practices could reduce their 12-month livestock feed costs by implementing 12-month harvested-forage management strategies.

An obvious practical application of 12-month

harvested-forage management strategies would be for the beef production operation that desires to expand the size of the cow herd but, for some reason, can not expand the size of the land base. The 12-month harvested-forage management strategies provide a mechanism by which stockmen can produce relatively low-cost forage and feed for a greater number of cows on a smaller land base per cow.

Another practical application of 12-month harvested-forage management strategies would be to provide low-cost forage for beef cow herds with calf birth dates at unconventional times. Cow herds with conventional calf birth dates (January through April) can efficiently capture low-cost forage from domesticated and native range perennial grasses when grazing and cutting are properly coordinated with plant growth stages. However, with grazing, the herbage growth curves and nutritional quality curves of perennial grasses can not be effectively matched biologically with the nutrient requirements for cows with unconventional calf birth dates. The resulting inefficiency of nutrient capture would increase the costs of livestock feed and the costs of calf accumulated weight. Feed costs for cow herds with unconventional calf birth dates could be reduced with the use of low-cost annual cereal and annual legume hays harvested at their optimum plant growth stages.

Domesticated perennial grass hay harvested by the traditional practice of cutting grass late, at a mature plant stage, is expensive livestock feed. The cost of forage weight does not reflect the cost of livestock feed from harvested forages. Land costs, production costs, equipment costs, and labor costs per acre are important, but these costs do not regulate the costs of livestock feed. The nutrient content of the forage at the growth stage when plants are cut affects the costs of the harvested forage as livestock feed. Cutting forage at the optimum growth stage reduces nutrient cost per unit of weight and the cost of livestock feed. Not all harvested forages are expensive livestock feed.

Results--Projected Beef Cow Herd Costs and Returns

The individual cow data presented for 12-month grazingland-forage management strategies were projected to a herd of 300 cows (table 32) and to a production land base of 5,000 acres (table 33). Net returns after pasture and forage costs ranged from -$29,424 to $75,459 per year from the management strategies with 300 cows. The net returns after pasture and forage costs ranged from -$9,808 to $107,655 per year from the management strategies with 5,000 production acres. The cow genetics and the land production capabilities were assumed to be the same across all treatments. The differences in the net returns result from the differences in the biological effectiveness and the nutrient capture and conversion efficiency of the various grazing management strategies.

The individual cow data for 12-month harvested-forage management strategies were projected to a herd of 300 cows (table 34). The differences in the land area required for forage production and in the total 12-month feed costs result from the differences in the biological effectiveness and the nutrient capture and conversion efficiency of the various harvested-forage management strategies.

The land area required to produce the forage for 300 cows for 12 months was 372 to 444 acres for late-cut legume hays, 387 acres for oat-pea forage hay, 405 to 465 acres for early cut cereal hays, 525 acres for late-cut cereal hays, 474 to 690 acres for early cut legume hays, 1329 acres for early cut crested wheatgrass hay, and 1887 acres for mature crested wheatgrass hay. Mature crested wheatgrass hay required 42% more land area than early cut crested wheatgrass hay and more than four times the land area that early cut cereal hays and late-cut legume hays required to produce adequate forage.

Total feed costs (forage and supplement) for 300 cows for 12 months ranged between $44,000 and $56,000 per year for early cut cereal hays, late-cut cereal hays, late-cut legume hays, and oat-pea forage hay; these costs were comparable to the total feed costs for the twice-over rotation ($51,000) management strategy. Total feed costs for early cut crested wheatgrass hay were less than $58,000 per year. Total feed costs for early cut legume hays were between $67,000 and $76,000 per year and were comparable to the total feed costs for the deferred ($66,000) and the 4.5-month seasonlong ($74,000) management strategies. Total feed costs for mature crested wheatgrass hay were around $97,000 per year and were comparable to the total feed costs for the 6.0-month seasonlong ($99,000) management strategy. Feed costs for the forage barley hays, the early cut oat forage hay, and the twice-over rotation management strategies were less than half the feed costs for the mature crested wheatgrass hay management strategy. Feed costs for the late-cut legume hay, the late-cut oat forage hay, and the oat-pea forage hay management strategies were less than 60% of the feed costs for the mature crested wheatgrass hay management strategy. Feed costs for the early cut legume hay, the deferred, and the 4.5-month seasonlong management strategies were less than 80% of the feed costs for the mature crested wheatgrass hay management strategy. Feed costs for the mature crested wheatgrass hay and the 6.0-month

seasonlong management strategies were similar; both were expensive methods of producing forage for beef cows for twelve months.

Results--Efficiencies of 12-Month Pasture-Forage Management Strategies

The levels of biological effectiveness and of nutrient capture and conversion efficiency among the 12-month management strategies are highly variable. A biologically effective management strategy meets the biological requirements of the plants, facilitates the functioning of ecological processes at potential levels, and counterbalances problematic biological conditions inherent in the grassland ecosystem. Biologically effective management practices produce the most biological advantages and the fewest biological disadvantages.

A management strategy that improves the efficiency of nutrient capture and conversion increases the quantity of herbage and nutrients produced on a land base and effectively captures a high proportion of the produced nutrients by combining pasture and forage types so that the herbage production curves and nutritional quality curves are coordinated with the 12-month dietary quantity and quality requirement curves of cow production periods. Efficient conversion of nutrients into a saleable product can be performed by modern high-performance livestock when nutrients are available for consumption at the times and in the amounts that the livestock require during each production period.

The availability of crude protein to livestock was different on the various management strategies. The crude protein content of grazingland-forage feed provided to cows was below livestock requirements for 273 days on the 12-month repeated seasonal, 196 days on the 6.0-month seasonlong and 4.5-month seasonlong, 259 days on the 4.0-month deferred, and 15 days, some years, on the 4.5-month twice-over rotation management strategies. Supplemental crude protein was made available to the cows for 197 days on the 12-month repeated seasonal and for 90 days on the 6.0-month seasonlong, 4.5-month seasonlong, and 4.0-month deferred management strategies. Crude protein was deficient in the livestock feed for 76 days on the 12-month repeated seasonal, 106 days on the 6.0-month seasonlong and 4.5-month seasonlong, and 169 days on the 4.0-month deferred management strategies. The crude protein content of harvested-forage feed provided to cows was below livestock requirements for 333 days on the mature crested wheatgrass hay, 243 days on the late-cut oat forage hay, and 45 days on the late-cut forage barley hay management strategies, and supplemental crude protein was provided to the cows.

The weight production performance levels of the cows and calves on the four traditional management strategies were below the genetic capabilities of the animals because amounts of nutrients were deficient in the feed during long portions of the 12-month production cycle. Modern high-performance cattle have reduced levels of production efficiency when their diet is deficient in nutrients. Nutrient deficiency in the cattle diet for long periods results in calf weaning weights below potential and in high annual expenses for cow maintenance.

Crude protein supplementation was not required on the twice-over rotation management strategy because grazing periods on crested wheatgrass, native rangeland, and Altai wildrye pastures were coordinated so that the nutritional quality of the various forage types and the nutritional requirements of the livestock matched over the entire grazing season; this coordination of nutrient supply and demand improved the individual animal performance.

Unfertilized crested wheatgrass pastures have adequate crude protein levels for lactating cows during May and most of June. Fertilized crested wheatgrass pastures have adequate crude protein during May and the early portion of June.

The native range forage on the twice-over rotation management strategy was not deficient in crude protein during the period from early August until the end of the grazing season, unlike the forage on the traditional management strategies. The grazing periods on the twice-over rotation system are coordinated with grass growth stages, and a small amount of leaf material is removed between the third-leaf stage and the flowering stage. This timed defoliation activates secondary tiller development from axillary buds, activates plant physiological mechanisms, and stimulates rhizosphere organism activity that increases nutrient flow and plant growth (Manske 1999 c): the result is increased plant basal cover, increased aboveground herbage biomass, and improved nutritional quality of herbage. The increases in herbage quantity and quality permit increased stocking rates, reduced acreage required to carry a cow-calf pair for the season, and increased total accumulated weight gain.

Manipulation of secondary tiller growth of grasses on the native range pastures of the twice-over system improves livestock performance for two to two and a half months, until late September or mid October, but the biology of native grass plants does not permit extending this improved performance longer. Nutritional quality of native range herbage is

below the requirements of lactating cows after mid October, and grazing animals must be moved to an alternative forage source if their nutritional requirements are to be met.

Perennial grass forages that meet the nutritional requirements of lactating cows after mid October include Altai and Russian wildryes. The wildryes are excellent fall pastures because they retain nutrient quality in the aboveground portions of the plant until about mid November, much later than do other types of perennial grasses, in which translocation of aboveground cell components and the resulting decreases in crude protein levels occur relatively early during the grazing season.

Annual cereal hay was fed to the cows on the twice-over rotation management strategy for 167 days, or 5.5 months. This harvested forage had high production costs per acre but had the lowest feed costs per day and per production period. Harvested forages can provide low-cost livestock feed when the produced nutrients are efficiently captured and the forage production and harvest costs are prorated across relatively large quantities of nutrients per acre.

The annual cereal hay used as harvested feed on the twice-over rotation management strategy was forage barley cut at the milk stage. It was cut at an early plant growth stage so that the maximum quantity of crude protein would be captured per acre. This harvest time resulted in the lowest cost per unit of nutrient possible and the lowest feed cost during the nongrowing season. Forage plant growth patterns do not produce the greatest amount of crude protein and the greatest amount of dry matter at the same time. Planning the harvest time to capture the greatest amount of dry matter results in harvest of forage with the lowest cost per unit of dry matter but not in harvest of the forage with the lowest feed costs. Forage barley hay cut at the milk stage captured around 600 pounds of crude protein per acre, at a cost of $0.11 per pound of crude protein. At a forage cost that ranged between $0.16 and $0.30 per day, forage barley hay was the lowest-cost forage. Early cut forage barley has greater crude protein content than the amount required by cows. High-quality forage barley hay would not be fed alone, but would be supplemented with some amount of low-cost roughage. The feed costs for forages that are harvested to yield the greatest amount of crude protein and supplemented with roughage are lower than the feed costs for forages that are harvested to yield the greatest amount of dry matter and supplemented with crude protein, such as mature crested wheatgrass hay

The 4.5-month twice-over rotation management strategy is the most biologically effective and nutrient-efficient management strategy. Cows on this management strategy produced 603.62 pounds of calf on 11.68 acres, at a total 12-month feed cost of $171.00, or at a cost of $0.28 per pound of calf weaning weight, with a net return after pasture and forage costs of $251.53 per cow-calf pair and $21.54 per acre.

Table 1. Twelve-month pasture and forage costs for the 12-month repeated seasonal management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	15	15
Herbage Wt	lb/ac	725	580	480	780	1450	870	725
Forage Wt	lb/ac	180	145	125	195	363	218	180
Forage DM/AU	lb/d	24	24	27	30	30	30	30
Production Cost	$/ac	8.76	8.76	8.76	8.76	8.76	8.76	8.76
Forage DM Cost	$/ton	97.33	120.83	140.16	89.85	48.26	80.37	97.33
Land Area/Mo	ac	4.00	4.97	6.48	4.62	2.52	4.20	5.00
Land Area/PP	ac	4.27	14.90	9.72	4.77	11.32	2.10	2.50
Land Cost/Mo	$/mo	35.04	43.54	56.76	40.47	22.08	36.79	43.80
Land Cost/PP	$/pp	37.41	130.52	85.15	41.79	99.16	18.40	21.90
Forage Cost/D	$/d	1.17	1.45	1.89	1.35	0.72	1.21	1.46
Forage Cost/Mo	$/mo	35.10	43.50	56.70	40.50	21.60	36.30	43.80
Forage Cost/PP	$/pp	37.44	130.50	85.05	41.85	98.64	18.40	21.90
Crude Protein	%	4.8	4.8	9.2	16.3	9.6	4.8	4.8
Crude Protein	lb/ac	8.64	6.96	11.50	31.79	34.85	10.46	8.64
Cost CP	$/lb	1.01	1.26	0.76	0.28	0.25	0.34	1.01
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	2.51
Supplementation								
Roughage/D	lb/d							
CP/D	lb/d	0.34	0.72	0.25	0.0	0.0	1.21	1.21
Sup. Cost/PP	$/pp	3.26	19.44	3.38	0.0	0.0	5.45	5.45
Total Feed Cost	$/pp	40.70	149.94	88.43	41.85	98.64	23.85	27.35
Cost/D	$/d	1.27	1.67	1.97	1.35	0.72	1.59	1.82

Table 2. Twelve-month pasture and forage costs for the 6.0-month seasonlong management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	60	16	137	30	
Herbage Wt	lb/ac				906	906	891	
Forage Wt	lb/ac	1600	1600	1500	226	226	223	
Forage DM/AU	lb/d	24	24	30	30	30	30	
Production Cost	$/ac	28.11	28.11	37.50	8.76	8.76	8.76	
Forage DM Cost	$/ton	34.80	34.80	50.00	77.52	77.50	78.57	
Land Area/Mo	ac	0.44	0.45	0.60	4.04	4.04	4.04	
Land Area/PP	ac	0.47	1.35	1.20	2.10	18.10	4.04	
Land Cost/Mo	$/mo	6.26	6.40		35.39	35.39	35.39	
Land Cost/PP	$/pp	6.68	19.20		18.40	158.55	35.39	
Forage Cost/D	$/d	0.41	0.52	0.75	1.15	1.16	1.18	
Forage Cost/Mo	$/mo	12.32	15.60	22.50	35.39	35.39	35.39	
Forage Cost/PP	$/pp	13.12	46.80	45.00	18.40	158.55	35.39	
Crude Protein	%	6.4	6.4					
Crude Protein	lb/ac	102	102					
Cost CP	$/lb	0.28	0.28					
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	0.6						
CP/D	lb/d		0.33					
Sup. Cost/PP	$/pp	0.34	8.91	3.00				
Total Feed Cost	$/pp	13.46	55.71	48.00	18.40	158.55	35.39	
Cost/D	$/d	0.42	0.62	0.80	1.15	1.16	1.18	

Table 3. Twelve-month pasture and forage costs for the 4.5-month seasonlong management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac				1980	1280	270	
Forage Wt	lb/ac	1600	1600	1500	495	320	135	
Forage DM/AU	lb/d	24	24	30	30	30	30	
Production Cost	$/ac	28.11	28.11	37.50	8.76	8.76	2.00	
Forage DM Cost	$/ton	34.80	34.80	50.00	35.39	54.75	29.63	
Land Area/Mo	ac	0.44	0.45	0.60	1.82	2.86	6.63	
Land Area/PP	ac	0.47	1.35	0.90	1.88	12.70	6.63	
Land Cost/Mo	$/mo	6.26	6.40		15.94	25.05	13.26	
Land Cost/PP	$/pp	6.68	19.20		16.47	111.25	13.26	
Forage Cost/D	$/d	0.41	0.52	0.75	0.52	0.81	0.44	
Forage Cost/Mo	$/mo	12.32	15.60	22.50	15.60	24.30	13.26	
Forage Cost/PP	$/pp	13.12	46.80	33.75	16.47	111.25	13.26	
Crude Protein	%	6.4	6.4					
Crude Protein	lb/ac	102	102					
Cost CP	$/lb	0.28	0.28					
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	0.6						
CP/D	lb/d		0.33					
Sup. Cost/PP	$/pp	0.34	8.91	2.25				
Total Feed Cost	$/pp	13.46	55.71	36.00	16.47	111.25	13.26	
Cost/D	$/d	0.42	0.62	0.80	0.52	0.81	0.44	

Table 4. Twelve-month pasture and forage costs for the 4.0-month deferred management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	76	92	30	
Herbage Wt	lb/ac	270			2192	1649	1649	
Forage Wt	lb/ac	135	1600	1500	548	412	412	
Forage DM/AU	lb/d	24	24	30	30	30	30	
Production Cost	$/ac	2.00	28.11	37.50	8.76	8.76	8.76	
Forage DM Cost	$/ton	29.63	34.80	50.00	31.97	42.52	42.52	
Land Area/Mo	ac	6.63	0.45	0.60	1.67	2.22	2.22	
Land Area/PP	ac	7.10	1.35	0.90	4.16	6.70	2.18	
Land Cost/Mo	$/mo	13.26	6.40		14.63	19.53	19.53	
Land Cost/PP	$/pp	14.20	19.20		36.44	58.26	19.53	
Forage Cost/D	$/d	0.44	0.52	0.75	0.48	0.63	0.65	
Forage Cost/Mo	$/mo	13.26	15.60	22.50	14.40	19.45	19.53	
Forage Cost/PP	$/pp	14.20	46.80	33.75	36.44	58.26	19.53	
Crude Protein	%		6.4					
Crude Protein	lb/ac		102					
Cost CP	$/lb		0.28					
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d							
CP/D	lb/d		0.33					
Sup. Cost/PP	$/pp		8.91	2.25				
Total Feed Cost	$/pp	14.20	55.71	36.00	36.44	58.26	19.53	
Cost/D	$/d	0.44	0.62	0.80	0.48	0.63	0.65	

Table 5. Twelve-month pasture and forage costs for the 4.5-month twice-over rotation management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac				4960	1794	2590	
Forage Wt	lb/ac	4733	4733	4733	1240	449	648	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	68.21	68.21	68.21	21.26	8.76	8.76	
Forage DM Cost	$/ton	28.80	28.80	28.80	34.29	39.02	27.04	
Land Area/Mo	ac	0.07	0.09	0.13	0.73	2.04	1.39	
Land Area/PP	ac	0.07	0.27	0.20	0.75	9.00	1.39	
Land Cost/Mo	$/mo	1.54	1.99	2.87	15.52	17.87	12.18	
Land Cost/PP	$/pp	1.54	5.96	4.41	15.95	78.84	12.18	
Forage Cost/D	$/d	0.16	0.21	0.30	0.51	0.58	0.40	
Forage Cost/Mo	$/mo	4.80	6.30	9.00	15.30	17.40	12.00	
Forage Cost/PP	$/pp	5.12	18.90	13.50	15.95	78.84	12.00	
Crude Protein	%	13.0	13.0	13.0				
Crude Protein	lb/ac	606	606	606				
Cost CP	$/lb	0.11	0.11	0.11				
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	12.5	9.6	6.0	-	-	-	
CP/D	lb/d							
Sup. Cost/PP	$/pp	7.00	14.96	4.73				
Total Feed Cost	$/pp	12.12	33.86	18.23	15.95	78.84	12.00	
Cost/D	$/d	0.38	0.38	0.41	0.51	0.58	0.40	

Table 6. Twelve-month forage costs for mature crested wheatgrass harvested-forage management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac							
Forage Wt	lb/ac	1600	1600	1600	1600	1600	1600	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	28.11	28.11	28.11	28.11	28.11	28.11	
Forage DM Cost	$/ton	34.80	34.80	34.80	34.80	34.80	34.80	
Land Area/Mo	ac	0.44	0.45	0.51	0.56	0.56	0.56	
Land Area/PP	ac	0.47	1.35	0.76	0.58	2.57	0.56	
Land Cost/Mo	$/mo	6.26	6.40	7.25	7.96	7.96	7.96	
Land Cost/PP	$/pp	6.68	19.20	10.81	8.25	36.55	7.96	
Forage Cost/D	$/d	0.41	0.52	0.75	0.70	0.70	0.70	
Forage Cost/Mo	$/mo	12.30	15.60	22.50	21.00	21.00	21.00	
Forage Cost/PP	$/pp	13.12	46.80	33.75	21.70	95.90	21.00	
Crude Protein	%	6.4	6.4	6.4	6.4	6.4	6.4	
Crude Protein	lb/ac	102	102	102	102	102	102	
Cost CP	$/lb	0.28	0.28	0.28	0.28	0.28	0.28	
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	0.6						
CP/D	lb/d		0.33	1.00	0.78	0.78	0.78	
Sup. Cost/PP	$/pp	0.34	9.02	13.50	7.27	32.14	7.02	
Total Feed Cost	$/pp	13.46	55.82	47.25	28.97	128.04	28.02	
Cost/D	$/d	0.42	0.62	1.05	0.93	0.93	0.93	

Table 7. Twelve-month forage costs for early crested wheatgrass harvested-forage management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac							
Forage Wt	lb/ac	1300	1300	1300	1300	1300	1300	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	26.50	26.50	26.50	26.50	26.50	26.50	
Forage DM Cost	$/ton	40.80	40.80	40.80	40.80	40.80	40.80	
Land Area/Mo	ac	0.24	0.30	0.43	0.40	0.40	0.40	
Land Area/PP	ac	0.26	0.89	0.65	0.41	1.82	0.40	
Land Cost/Mo	$/mo	3.41	4.27	6.11	5.69	5.69	5.69	
Land Cost/PP	$/pp	3.64	12.66	9.24	5.83	25.88	5.69	
Forage Cost/D	$/d	0.21	0.26	0.38	0.35	0.35	0.35	
Forage Cost/Mo	$/mo	6.30	7.80	11.40	10.50	10.50	10.50	
Forage Cost/PP	$/pp	6.72	23.40	17.10	10.85	47.95	10.50	
Crude Protein	%	14.5	14.5	14.5	14.5	14.5	14.5	
Crude Protein	lb/ac	189	189	189	189	189	189	
Cost CP	$/lb	0.14	0.14	0.14	0.14	0.14	0.14	
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	13.72	11.10	8.17	12.69	12.69	12.69	
CP/D	lb/d							
Sup. Cost/PP	$/pp	7.68	17.48	6.43	6.88	30.42	6.66	
Total Feed Cost	$/pp	14.40	40.88	23.53	17.73	78.37	17.16	
Cost/D	$/d	0.45	0.45	0.52	0.57	0.57	0.57	

Table 8. Twelve-month forage costs for the early cut forage barley harvested-forage management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac							
Forage Wt	lb/ac	4733	4733	4733	4733	4733	4733	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	68.21	68.21	68.21	68.21	68.21	68.21	
Forage DM Cost	$/ton	28.80	28.80	28.80	28.80	28.80	28.80	
Land Area/Mo	ac	0.07	0.09	0.13	0.12	0.12	0.12	
Land Area/PP	ac	0.07	0.27	0.20	0.13	0.56	0.12	
Land Cost/Mo	$/mo	1.54	1.99	2.87	2.65	2.65	2.65	
Land Cost/PP	$/pp	1.54	5.96	4.41	2.87	12.36	2.65	
Forage Cost/D	$/d	0.16	0.21	0.30	0.28	0.28	0.28	
Forage Cost/Mo	$/mo	4.80	6.30	9.00	8.40	8.40	8.40	
Forage Cost/PP	$/pp	5.12	18.90	13.50	8.68	38.36	8.40	
Crude Protein	%	13.0	13.0	13.0	13.0	13.0	13.0	
Crude Protein	lb/ac	606	606	606	606	606	606	
Cost CP	$/lb	0.11	0.11	0.11	0.11	0.11	0.11	
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	12.5	9.6	6.0	10.7	10.7	10.7	
CP/D	lb/d							
Sup. Cost/PP	$/pp	7.00	14.96	4.73	5.80	25.65	5.62	
Total Feed Cost	$/pp	12.12	33.86	18.23	14.48	64.01	14.02	
Cost/D	$/d	0.38	0.38	0.41	0.47	0.47	0.47	

Table 9. Twelve-month forage costs for the late-cut forage barley harvested-forage management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac							
Forage Wt	lb/ac	5133	5133	5133	5133	5133	5133	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	70.35	70.35	70.35	70.35	70.35	70.35	
Forage DM Cost	$/ton	27.40	27.40	27.40	27.40	27.40	27.40	
Land Area/Mo	ac	0.09	0.12	0.16	0.16	0.16	0.16	
Land Area/PP	ac	0.10	0.36	0.24	0.16	0.73	0.16	
Land Cost/Mo	$/mo	1.99	2.65	3.53	3.53	3.53	3.53	
Land Cost/PP	$/pp	2.21	7.95	5.30	3.53	16.11	3.53	
Forage Cost/D	$/d	0.22	0.29	0.41	0.38	0.38	0.38	
Forage Cost/Mo	$/mo	6.60	8.70	12.30	11.40	11.40	11.40	
Forage Cost/PP	$/pp	7.04	26.10	18.45	11.78	52.06	11.40	
Crude Protein	%	9.2	9.2	9.2	9.2	9.2	9.2	
Crude Protein	lb/ac	468	468	468	468	468	468	
Cost CP	$/lb	0.15	0.15	0.15	0.15	0.15	0.15	
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	7.8	3.7		2.7	2.7	2.7	
CP/D	lb/d			0.25				
Sup. Cost/PP	$/pp	4.37	5.83	3.38	1.46	6.47	1.42	
Total Feed Cost	$/pp	11.41	31.93	21.83	13.24	58.53	12.82	
Cost/D	$/d	0.36	0.35	0.49	0.43	0.43	0.43	

Table 10. Twelve-month forage costs for the early cut oat harvested-forage management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac							
Forage Wt	lb/ac	4667	4667	4667	4667	4667	4667	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	69.17	69.17	69.17	69.17	69.17	69.17	
Forage DM Cost	$/ton	29.60	29.60	29.60	29.60	29.60	29.60	
Land Area/Mo	ac	0.08	0.10	0.15	0.14	0.14	0.14	
Land Area/PP	ac	0.09	0.31	0.23	0.14	0.64	0.14	
Land Cost/Mo	$/mo	1.77	2.21	3.31	3.09	3.09	3.09	
Land Cost/PP	$/pp	1.99	6.84	5.08	3.09	14.12	3.09	
Forage Cost/D	$/d	0.19	0.24	0.35	0.33	0.33	0.33	
Forage Cost/Mo	$/mo	5.70	7.20	10.50	9.90	9.90	9.90	
Forage Cost/PP	$/pp	6.08	21.60	15.75	10.23	45.21	9.90	
Crude Protein	%	11.5	11.5	11.5	11.5	11.5	11.5	
Crude Protein	lb/ac	535	535	535	535	535	535	
Cost CP	$/lb	0.13	0.13	0.13	0.13	0.13	0.13	
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	11.0	7.7	3.3	8.2	8.2	8.2	
CP/D	lb/d							
Sup. Cost/PP	$/pp	6.16	12.13	2.60	4.45	19.66	4.31	
Total Feed Cost	$/pp	12.24	33.73	18.35	14.68	64.87	14.21	
Cost/D	$/d	0.38	0.37	0.41	0.47	0.47	0.47	

Table 11. Twelve-month forage costs for the late-cut oat harvested-forage management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac							
Forage Wt	lb/ac	5667	5667	5667	5667	5667	5667	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	74.53	74.53	74.53	74.53	74.53	74.53	
Forage DM Cost	$/ton	26.40	26.40	26.40	26.40	26.40	26.40	
Land Area/Mo	ac	0.10	0.13	0.14	0.16	0.16	0.16	
Land Area/PP	ac	0.11	0.38	0.21	0.16	0.73	0.16	
Land Cost/Mo	$/mo	2.21	2.87	3.09	3.53	3.53	3.53	
Land Cost/PP	$/pp	2.43	8.39	4.63	3.53	16.11	3.53	
Forage Cost/D	$/d	0.25	0.32	0.46	0.43	0.43	0.43	
Forage Cost/Mo	$/mo	7.50	9.60	13.80	12.90	12.90	12.90	
Forage Cost/PP	$/pp	8.00	28.80	20.70	13.33	58.91	12.90	
Crude Protein	%	7.8	7.8	7.8	7.8	7.8	7.8	
Crude Protein	lb/ac	435	435	435	435	435	435	
Cost CP	$/lb	0.17	0.17	0.17	0.17	0.17	0.17	
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	4.9						
CP/D	lb/d		0.0	0.62	0.40	0.40	0.40	
Sup. Cost/PP	$/pp	2.74	0.0	8.37	3.72	16.44	3.60	
Total Feed Cost	$/pp	10.74	28.80	29.07	17.05	75.35	16.50	
Cost/D	$/d	0.34	0.32	0.65	0.55	0.55	0.55	

Table 12. Twelve-month forage costs for the early cut pea harvested-forage management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac							
Forage Wt	lb/ac	2800	2800	2800	2800	2800	2800	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	79.96	79.96	79.96	79.96	79.96	79.96	
Forage DM Cost	$/ton	55.00	55.00	55.00	55.00	55.00	55.00	
Land Area/Mo	ac	0.08	0.11	0.15	0.14	0.14	0.14	
Land Area/PP	ac	0.09	0.32	0.23	0.15	0.65	0.14	
Land Cost/Mo	$/mo	1.77	2.43	3.31	3.09	3.09	3.09	
Land Cost/PP	$/pp	1.99	7.09	5.08	3.31	14.35	3.09	
Forage Cost/D	$/d	0.22	0.28	0.41	0.38	0.38	0.38	
Forage Cost/Mo	$/mo	6.60	8.40	12.30	11.40	11.40	11.40	
Forage Cost/PP	$/pp	7.04	25.20	18.45	11.78	52.06	11.40	
Crude Protein	%	18.9	18.9	18.9	18.9	18.9	18.9	
Crude Protein	lb/ac	526	526	526	526	526	526	
Cost CP	$/lb	0.15	0.15	0.15	0.15	0.15	0.15	
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	16.1	14.1	12.6	16.7	16.7	16.7	
CP/D	lb/d							
Sup. Cost/PP	$/pp	9.02	22.21	9.92	9.06	40.04	8.79	
Total Feed Cost	$/pp	16.06	47.41	28.37	20.84	92.10	20.19	
Cost/D	$/d	0.50	0.53	0.63	0.67	0.67	0.67	

Table 13. Twelve-month forage costs for the late-cut pea harvested-forage management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac							
Forage Wt	lb/ac	4650	4650	4650	4650	4650	4650	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	86.87	86.87	86.87	86.87	86.87	86.87	
Forage DM Cost	$/ton	37.40	37.40	37.40	37.40	37.40	37.40	
Land Area/Mo	ac	0.07	0.08	0.12	0.11	0.11	0.11	
Land Area/PP	ac	0.07	0.25	0.18	0.12	0.51	0.11	
Land Cost/Mo	$/mo	1.54	1.77	2.65	2.43	2.43	2.43	
Land Cost/PP	$/pp	1.54	5.52	3.97	2.65	11.26	2.43	
Forage Cost/D	$/d	0.19	0.24	0.35	0.33	0.33	0.33	
Forage Cost/Mo	$/mo	5.70	7.50	10.50	9.90	9.90	9.90	
Forage Cost/PP	$/pp	6.08	21.60	15.75	10.23	45.21	9.90	
Crude Protein	%	14.4	14.4	14.4	14.4	14.4	14.4	
Crude Protein	lb/ac	685	685	685	685	685	685	
Cost CP	$/lb	0.13	0.13	0.13	0.13	0.13	0.13	
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	13.7	11.0	8.0	12.6	12.6	12.6	
CP/D	lb/d							
Sup. Cost/PP	$/pp	7.67	17.33	6.30	6.84	30.21	6.62	
Total Feed Cost	$/pp	13.75	38.93	22.05	17.07	75.42	16.52	
Cost/D	$/d	0.43	0.43	0.49	0.55	0.55	0.55	

Table 14. Twelve-month forage costs for the early cut forage lentil harvested-forage management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac							
Forage Wt	lb/ac	1667	1667	1667	1667	1667	1667	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	59.69	59.69	59.69	59.69	59.69	59.69	
Forage DM Cost	$/ton	71.60	71.60	71.60	71.60	71.60	71.60	
Land Area/Mo	ac	0.12	0.15	0.23	0.21	0.21	0.21	
Land Area/PP	ac	0.13	0.46	0.34	0.21	0.95	0.21	
Land Cost/Mo	$/mo	2.65	3.31	5.08	4.63	4.63	4.63	
Land Cost/PP	$/pp	2.87	10.15	7.50	4.63	20.97	4.63	
Forage Cost/D	$/d	0.25	0.32	0.46	0.43	0.43	0.43	
Forage Cost/Mo	$/mo	7.50	9.60	13.80	12.90	12.90	12.90	
Forage Cost/PP	$/pp	8.00	28.80	20.70	13.33	58.91	12.90	
Crude Protein	%	21.8	21.8	21.8	21.8	21.8	21.8	
Crude Protein	lb/ac	361	361	361	361	361	361	
Cost CP	$/lb	0.17	0.17	0.17	0.17	0.17	0.17	
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	17.2	15.4	14.5	18.5	18.5	18.5	
CP/D	lb/d							
Sup. Cost/PP	$/pp	9.63	24.26	11.42	10.04	44.35	9.71	
Total Feed Cost	$/pp	17.63	53.06	32.12	23.37	103.26	22.61	
Cost/D	$/d	0.55	0.59	0.71	0.75	0.75	0.75	

Table 15. Twelve-month forage costs for the late-cut forage lentil harvested-forage management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac							
Forage Wt	lb/ac	3867	3867	3867	3867	3867	3867	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	71.48	71.48	71.48	71.48	71.48	71.48	
Forage DM Cost	$/ton	37.00	37.00	37.00	37.00	37.00	37.00	
Land Area/Mo	ac	0.08	0.10	0.14	0.13	0.13	0.13	
Land Area/PP	ac	0.09	0.30	0.22	0.14	0.60	0.13	
Land Cost/Mo	$/mo	1.77	2.21	3.09	2.87	2.87	2.87	
Land Cost/PP	$/pp	1.99	6.62	4.86	3.09	13.24	2.87	
Forage Cost/D	$/d	0.19	0.24	0.35	0.33	0.33	0.33	
Forage Cost/Mo	$/mo	5.70	7.20	10.50	9.90	9.90	9.90	
Forage Cost/PP	$/pp	6.08	21.60	15.75	10.23	45.21	9.90	
Crude Protein	%	14.7	14.7	14.7	14.7	14.7	14.7	
Crude Protein	lb/ac	567	567	567	567	567	567	
Cost CP	$/lb	0.13	0.13	0.13	0.13	0.13	0.13	
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	13.9	11.3	8.4	12.9	12.9	12.9	
CP/D	lb/d							
Sup. Cost/PP	$/pp	7.78	17.80	6.62	7.00	30.93	6.77	
Total Feed Cost	$/pp	13.86	39.40	22.37	17.23	76.14	16.67	
Cost/D	$/d	0.43	0.44	0.50	0.56	0.56	0.56	

Table 16. Twelve-month forage costs for oat-pea harvested-forage management strategy.

		Dry Gestation	Third Trimester	Early Lactation	Lactation	Lactation	Lactation	
Season		Late Fall	Winter	Early Spring	Spring	Summer	Early Fall	Late
Days		32	90	45	31	137	30	
Herbage Wt	lb/ac							
Forage Wt	lb/ac	5143	5143	5143	5143	5143	5143	
Forage DM/AU	lb/d	24	24	27	30	30	30	
Production Cost	$/ac	95.52	95.52	95.52	95.52	95.52	95.52	
Forage DM Cost	$/ton	37.20	37.20	37.20	37.20	37.20	37.20	
Land Area/Mo	ac	0.07	0.09	0.13	0.12	0.12	0.12	
Land Area/PP	ac	0.07	0.26	0.19	0.12	0.53	0.12	
Land Cost/Mo	$/mo	1.54	1.99	2.87	2.65	2.65	2.65	
Land Cost/PP	$/pp	1.54	5.74	4.19	2.65	11.70	2.65	
Forage Cost/D	$/d	0.22	0.28	0.41	0.38	0.38	0.38	
Forage Cost/Mo	$/mo	6.60	8.40	12.30	11.40	11.40	11.40	
Forage Cost/PP	$/pp	7.04	25.20	18.45	11.78	52.06	11.40	
Crude Protein	%	12.5	12.5	12.5	12.5	12.5	12.5	
Crude Protein	lb/ac	611	611	611	611	611	611	
Cost CP	$/lb	0.15	0.15	0.15	0.15	0.15	0.15	
Cow CP/D	lb/d	1.49	1.87	2.73	2.51	2.51	2.51	
Supplementation								
Roughage/D	lb/d	12.1	9.0	5.2	9.9	9.9	9.9	
CP/D	lb/d							
Sup. Cost/PP	$/pp	6.78	14.18	4.10	5.37	23.74	5.20	
Total Feed Cost	$/pp	13.82	39.38	22.55	17.15	75.80	16.60	
Cost/D	$/d	0.43	0.44	0.50	0.55	0.55	0.55	

Table 17. Forage and supplement costs for pasture-forage 12-month management strategies.

		12-M Repeated Seasonal	6.0-M Seasonlong	4.5-M Seasonlong	4.0-M Deferred	4.5-M Twice-over Rotation
Dry Gestation						
Land Area	ac/pp	4.27	0.47	0.47	7.10	0.07
Forage	$/pp	37.44	13.12	13.12	14.20	5.12
Supplement	$/pp	3.26	0.34	0.34		7.00
Third Trimester						
Land Area	ac/pp	14.90	1.35	1.35	1.35	0.27
Forage	$/pp	130.50	46.80	46.80	46.80	18.90
Supplement	$/pp	19.44	8.91	8.91	8.91	14.96
Early Lactation						
Land Area	ac/pp	9.72	1.20	0.90	0.90	0.20
Forage	$/pp	85.05	45.00	33.75	33.75	13.50
Supplement	$/pp	3.38	3.00	2.25	2.25	4.73
Spring Lactation						
Land Area	ac/pp	4.77	2.10	1.88	4.16	0.75
Forage	$/pp	41.85	18.40	16.47	36.44	15.95
Supplement	$/pp	0.0		0.0		0.0
Summer Lactation						
Land Area	ac/pp	11.32	18.10	12.70	6.70	9.00
Forage	$/pp	98.64	158.55	111.25	58.26	78.84
Supplement	$/pp	0.0				0.0
Fall Lactation						
Land Area	ac/pp	4.60	4.04	6.63	2.18	1.39
Forage	$/pp	40.30	35.39	13.26	19.53	12.00
Supplement	$/pp	10.90				0.0
Total Land Area	acres	49.58	27.26	23.93	22.39	11.68
Total Forage	$	433.78	317.26	234.65	208.98	144.31
Total Supplement	$	36.98	12.25	11.50	11.16	26.69
Total Feed Cost	$	470.76	329.51	246.15	220.14	171.00
Cost/Day	$	1.29	0.90	0.67	0.60	0.47

Table 18. Forage and supplement costs for domesticated grass hay 12-month management strategies.

		Crested Wheatgrass Hay Late-Cut	Crested Wheatgrass Hay Early Cut
Dry Gestation			
Land Area	ac/pp	0.47	0.26
Forage	$/pp	13.12	6.72
Supplement	$/pp	0.34	7.68
Third Trimester			
Land Area	ac/pp	1.35	0.89
Forage	$/pp	46.80	23.40
Supplement	$/pp	9.02	17.48
Early Lactation			
Land Area	ac/pp	0.76	0.65
Forage	$/pp	33.75	17.10
Supplement	$/pp	13.50	6.43
Spring Lactation			
Land Area	ac/pp	0.58	0.41
Forage	$/pp	21.70	10.85
Supplement	$/pp	7.27	6.88
Summer Lactation			
Land Area	ac/pp	2.57	1.82
Forage	$/pp	95.90	47.95
Supplement	$/pp	32.14	30.42
Fall Lactation			
Land Area	ac/pp	0.56	0.40
Forage	$/pp	21.00	10.50
Supplement	$/pp	7.02	6.66
Total Land Area	acres	6.29	4.43
Total Forage	$	232.27	116.52
Total Supplement	$	69.29	75.55
Total Feed Cost	$	301.56	192.07
Cost/Day	$	0.83	0.53

Table 19. Forage and supplement costs for annual cereal hay 12-month management strategies.

		Forage Barley Hay Early-Cut	Forage Barley Hay Late-Cut	Oat Hay Early Cut	Oat Hay Late-Cut
Dry Gestation					
Land Area	ac/pp	0.07	0.10	0.09	0.11
Forage	$/pp	5.12	7.04	6.08	8.00
Supplement	$/pp	7.00	4.37	6.16	2.74
Third Trimester					
Land Area	ac/pp	0.27	0.36	0.31	0.38
Forage	$/pp	18.90	26.10	21.60	28.80
Supplement	$/pp	14.96	5.83	12.13	0.0
Early Lactation					
Land Area	ac/pp	0.20	0.24	0.23	0.21
Forage	$/pp	13.50	18.45	15.75	20.70
Supplement	$/pp	4.73	3.38	2.60	8.37
Spring Lactation					
Land Area	ac/pp	0.13	0.16	0.14	0.16
Forage	$/pp	8.68	11.78	10.23	13.33
Supplement	$/pp	5.80	1.46	4.45	3.72
Summer Lactation					
Land Area	ac/pp	0.56	0.73	0.64	0.73
Forage	$/pp	38.36	52.06	45.21	58.91
Supplement	$/pp	25.65	6.47	19.66	16.44
Fall Lactation					
Land Area	ac/pp	0.12	0.16	0.14	0.16
Forage	$/pp	8.40	11.40	9.90	12.90
Supplement	$/pp	5.62	1.42	4.31	3.60
Total Land Area	acres	1.35	1.75	1.55	1.75
Total Forage	$	92.96	126.83	108.77	142.64
Total Supplement	$	63.76	22.93	49.31	34.87
Total Feed Cost	$	156.72	149.76	158.08	177.51
Cost/Day	$	0.43	0.41	0.43	0.49

Table 20. Forage and supplement costs for annual legume hay 12-month management strategies.

		Pea Hay Early Cut	Pea Hay Late-Cut	Forage Lentil Hay Early-Cut	Forage Lentil Hay Late-Cut	Oat-Pea Hay
Dry Gestation						
Land Area	ac/pp	0.09	0.07	0.13	0.09	0.07
Forage	$/pp	7.04	6.08	8.00	6.08	7.04
Supplement	$/pp	9.02	7.67	9.63	7.78	6.78
Third Trimester						
Land Area	ac/pp	0.32	0.25	0.46	0.30	0.26
Forage	$/pp	25.20	21.60	28.80	21.60	25.20
Supplement	$/pp	22.21	17.33	24.26	17.80	14.18
Early Lactation						
Land Area	ac/pp	0.23	0.18	0.34	0.22	0.19
Forage	$/pp	18.45	15.75	20.70	15.75	18.45
Supplement	$/pp	9.92	6.30	11.42	6.62	4.10
Spring Lactation						
Land Area	ac/pp	0.15	0.12	0.21	0.14	0.12
Forage	$/pp	11.78	10.23	13.33	10.23	11.78
Supplement	$/pp	9.06	6.84	10.04	7.00	5.37
Summer Lactation						
Land Area	ac/pp	0.65	0.51	0.95	0.60	0.53
Forage	$/pp	52.06	45.21	58.91	45.21	52.06
Supplement	$/pp	40.04	30.21	44.35	30.93	23.74
Fall Lactation						
Land Area	ac/pp	0.14	0.11	0.21	0.13	0.12
Forage	$/pp	11.40	9.90	12.90	9.90	11.40
Supplement	$/pp	8.79	6.62	9.71	6.77	5.20
Total Land Area	acres	1.58	1.24	2.30	1.48	1.29
Total Forage	$	125.93	108.77	142.64	108.77	125.93
Total Supplement	$	99.04	74.97	109.41	76.90	59.37
Total Feed Cost	$	224.97	183.74	252.05	185.67	185.30
Cost/Day	$	0.62	0.50	0.69	0.51	0.51

Table 21. Pasture and forage costs of pasture management strategies for range cows with calves during the lactation production period.

	Production Costs $/ac	Forage Dry Matter Costs $/ton	Crude Protein Costs $/lb	Land Area per Period ac	Feed Costs per Period $	Feed Costs per day $	Cost/lb Calf Gain $
12-M Repeated Seasonal							
Spring Pastures	8.76	89.85	0.28	4.77	41.85	1.35	0.75
Summer Pastures	8.76	48.26	0.25	11.32	98.64	0.72	0.40
Fall Pastures	8.76	88.85	0.68	4.60	51.20	1.71	0.95
Lactation Period	8.76			20.69	191.69	0.97	0.54
6.0-M Seasonlong							
Spring Pastures	8.76	77.52		2.10	18.40	1.15	0.64
Summer Pastures	8.76	77.50		18.10	158.55	1.16	0.56
Fall Pastures	8.76	78.57		4.04	35.39	1.18	1.99
Lactation Period	8.76			24.24	212.34	1.16	0.64
4.5-M Seasonlong							
Spring Pastures	8.76	35.39		1.88	16.47	0.52	0.27
Summer Pastures	8.76	54.75		12.70	111.25	0.81	0.39
Fall Pastures	2.00	29.63		6.63	13.26	0.44	1.05
Lactation Period	6.63			21.21	140.98	0.71	0.39
4.0-M Deferred							
Spring Pastures	8.76	31.97		4.16	36.44	0.48	0.27
Summer Pastures	8.76	42.52		6.70	58.26	0.63	0.30
Fall Pastures	8.76	42.52		2.18	19.53	0.65	0.85
Lactation Period	8.76			13.04	114.23	0.58	0.32
4.5-M Twice-over							
Spring Pastures	21.26	34.29		0.75	15.95	0.51	0.24
Summer Pastures	8.76	39.02		9.00	78.84	0.58	0.26
Fall Pastures	8.76	27.04		1.39	12.00	0.40	0.23
Lactation Period	9.60			11.14	106.79	0.54	0.25

Table 22. 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 (4.5-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 ADG	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 ADG	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 23. 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 (4.5-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 ADG	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 ADG	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 24. 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)*		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			
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 ADG	lbs			-0.52	-0.82	-2.65	-0.74
Cow Gain/Acre	lbs			-2.76	-9.77	-39.50	-9.96
Cow Gain/Period	lbs			-7.74	-24.60	-79.40	-22.20
Calf ADG	lbs	1.80	1.80	1.35	0.92	0.59	0.77
Calf Gain/Acre	lbs	12.86	10.80	6.17	10.90	8.82	10.36
Calf Gain/Period	lbs	27.00	27.00	20.33	27.60	17.73	23.10

*Based on estimated calf weight

Table 25. 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 ADG	lbs	0.55	-1.61
Cow Gain/Acre	lbs	11.87	-7.27
Cow Gain/Period	lbs	16.50	-48.17
Calf ADG	lbs	1.73	0.42
Calf Gain/Acre	lbs	37.96	1.90
Calf Gain/Period	lbs	52.77	12.57

Table 26. 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	159.26	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	12.18
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 27. 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 ADG	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 ADG	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

Table 28. Pasture-forage returns for production season between calf birth and weaning by 12-month management strategy.

		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	243	243	243	243	243
Acres/Season	ac	30.41	25.44	22.11	13.94	11.34
Acres/Month	ac	3.80	3.18	2.76	1.74	0.95
Feed Cost/Season	$	280.12	260.34	176.98	150.23	125.02
Calf Gain/Season	lb	437.40*	443.40	443.61	441.14	508.62
Wt. Value @ $0.70/lb	$	306.18	310.38	310.53	308.80	356.03
Calf ADG	lb/d	1.80	1.82	1.83	1.81	2.09
Calf Gain/Acre	lb/ac	14.38	17.43	20.06	31.65	44.85
Net Return/c-c pr	$	26.06	50.04	133.55	158.57	231.01
Net Return/acre	$	0.86	1.97	6.04	11.38	20.37
Cost/lb Accumulated Wt	$	0.64	0.59	0.40	0.34	0.25

*Calf weight estimation based on 1.80 lbs average daily gain.

Table 29. Pasture-forage returns for 12-month production period by 12-month management strategy.

		12-M Repeated Seasonal	6.0-M Seasonlong	4.5-M Seasonlong	4.0-M Deferred	4.5-M Twice-over Rotation
Length of 12-months	days	365	365	365	365	365
Acres/12-months	ac	49.58	27.26	23.93	22.39	11.68
Acres/Month	ac	4.13	2.27	1.99	1.87	0.97
Feed Cost/12-months	$	470.76	329.51	246.15	220.14	171.00
Calf Weaning Wt	lb	532.40*	538.40	538.61	536.14	603.62
Wt. Value @ $0.70/lb	$	372.68	376.88	377.03	375.30	422.53
Wt/Day of Age	lb/d	2.19	2.22	2.22	2.21	2.48
Calf Gain/12-month acres	lb/ac	10.74	19.75	22.51	23.95	51.68
Net Return/cow	$	-98.08	47.37	130.88	155.16	251.53
Net Return/12-month acres	$	-1.98	1.74	5.47	6.93	21.54
Cost/lb Weaning Wt	$	0.88	0.61	0.46	0.41	0.28

*Calf weight estimation based on 1.80 lbs average daily gain and 95 lbs birth weight.

Table 30. Pasture-forage feed costs per production period and supplement costs by 12-month management strategy.

		12-M Repeated Seasonal	6.0-M Seasonlong	4.5-M Seasonlong	4.0-M Deferred	4.5-M Twice-over Rotation
Dry Gestation	$	37.44	13.12	13.12	14.20	5.12
Third Trimester	$	130.50	46.80	46.80	46.80	18.90
Early Lactation	$	85.05	45.00	33.75	33.75	13.50
Spring Lactation	$	41.85	18.40	16.47	36.44	15.95
Summer Lactation	$	98.64	158.55	111.25	58.26	78.84
Early	$	18.40				
Fall Lactation	$		35.39	13.26	19.53	12.00
Late	$	21.90				
Total Forage Cost	$	433.78	317.26	234.65	208.98	144.31
Supplement Cost	$	36.98	12.25	11.50	11.16	26.69
Total Feed Cost	$	470.76	329.51	246.15	220.14	171.00

Table 31. Cost per pound of calf weight by 12-month management strategy.

		12-M Repeated Seasonal*	6.0-M Seasonlong	4.5-M Seasonlong	4.0-M Deferred	4.5-M Twice-over Rotation
Cost/lb Birth Wt	$	1.58	0.59	0.59	0.59	0.36
Cost/lb Calf Gain						
Early Lactation	$	1.09	0.42	0.42	0.42	0.21
Spring Lactation	$	0.75	0.64	0.27	0.27	0.24
Summer Lactation	$	0.40	0.56	0.39	0.30	0.26
Fall Lactation	$	0.95	1.99	1.05	0.85	0.23
Cost/lb Accumulated Wt	$	0.64	0.59	0.40	0.34	0.25
Cost/lb Weaning Wt	$	0.88	0.61	0.46	0.41	0.28

*Based on estimated calf weight

Table 32. Projection of returns for production from 300 cows by 12-month management strategy.

		12-M Repeated Seasonal	6.0-M Seasonlong	4.5-M Seasonlong	4.0-M Deferred	4.5-M Twice-over Rotation
# Cows	#	300	300	300	300	300
Acres/12-month	ac	14,874	8,178	7,179	4,728	3,504
Total Feed Costs	$	141,228	98,853	73,845	66,042	51,300
Calf Weight Value @ $0.70/lb	$	111,804	113,064	113,109	112,590	126,759
Net Return	$	-29,424	14,211	39,264	46,548	75,459

Table 33. Projection of returns for production from 5,000 acres by 12-month management strategy.

		12-M Repeated Seasonal	6.0-M Seasonlong	4.5-M Seasonlong	4.0-M Deferred	4.5-M Twice-over Rotation
# Cows	#	100	183	209	317	428
Acres/12-month	ac	5,000	5,000	5,000	5,000	5,000
Total Feed Costs	$	47,076	60,300	51,445	69,784	73,188
Calf Weight Value @ $0.70/lb	$	37,268	68,969	78,799	118,970	180,843
Net Return	$	-9,808	8,669	27,354	49,186	107,655

Table 34. Projection of feed costs for production of 300 range cows by 12-month harvested-forage management strategy.

12-month Harvested-Forage Management Strategy	Number of Cows	Acres per 12-months	Total Feed Costs
	#	acres	$
Crested Wheatgrass Hay Cut Late	300	1887	96,762
Crested Wheatgrass Hay Cut Early	300	1329	57,621
Forage Barley Hay Cut Early	300	405	47,016
Forage Barley Hay Cut Late	300	525	44,928
Oat Forage Hay Cut Early	300	465	47,424
Oat Forage Hay Cut Late	300	525	53,253
Pea Forage Hay Cut Early	300	474	67,491
Pea Forage Hay Cut Late	300	372	55,122
Forage Lentil Hay Cut Early	300	690	75,615
Forage Lentil Hay Cut Late	300	444	55,701
Oat-Pea Forage Hay	300	387	55,590

Discussion

The grazingland-forage and harvested-forage costs evaluated during this study were pasture or land rent values per acre; production costs per acre; costs per unit of dry matter; costs per unit of nutrient (crude protein); land area per animal unit; forage feed costs per day, per month, or per production period; and costs per pound of calf weight gain.

Pasture and land rent values ranged from $2.00 to $22.07 per acre. Production costs ranged from $2.00 to $95.52 per acre. Cost of forage dry matter ranged from $26.40 to $140.16 per ton. These three costs are important, but none of them should be the sole criterion on which management decisions are based. Production costs per acre and pasture or land rent per acre do not accurately reflect livestock pasture-forage 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 production costs or land rent values per acre. Forage dry matter costs per unit of weight do not accurately reflect livestock pasture-forage 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.

The common harvested-forage types in the Northern Plains are crested wheatgrass and smooth bromegrass hay cut late, at a mature plant stage. The costs for smooth bromegrass hay are nearly the same as the costs for crested wheatgrass hay. Most harvested forages intended as feed for beef cattle are still bought and sold by some measure of forage weight, like pounds, tons, or bales. Placing priority on the cost of forage weight has led to the common practice of comparing harvested-forage costs by forage cost per ton and to the development of the misconception that the harvested forage with the lowest cost per ton is the lowest-cost livestock feed. Generally, the lowest-cost livestock forage from a harvested-forage type is the hay with the lowest cost per pound of nutrient, which results from harvesting at the plant growth stage when that forage type yields its greatest weight of nutrients per acre.

Traditionally, domesticated perennial grass hays are cut late, after the seed heads have developed and plants have reached maximum height. This practice yields about the potential amount of forage dry matter per acre at a moderately low cost per ton, but the low yield in weight of nutrients per acre causes high nutrient costs. The land costs, production costs, equipment costs, and labor costs per acre are lower for mature crested wheatgrass hay than for annual cereal and annual legume forages. However, the mature crested wheatgrass forage management strategy has livestock feed costs considerably greater than the feed costs for the annual cereal and annual legume forage management strategies. Mature crested wheatgrass hay is expensive livestock feed because it has high costs per pound of crude protein. The high livestock feed costs that result from feeding mature domesticated perennial grass hay have incorrectly led to the perception that all harvested forages are expensive feed.

Cost per unit of nutrient is an important indicator of livestock pasture-forage production costs. The cost of livestock feed is regulated primarily by the cost per unit of weight of the nutrients contained in the forage. Nutrient cost per unit of weight is related to the forage dry matter costs and the quantity of nutrients per unit of forage weight. Evaluation of grazingland forages and harvested forages should be based on costs per unit of weight of the nutrients. The costs per unit of nutrient (crude protein) on the grazingland-forage and harvested-forage strategies ranged from $0.11 to $1.26 per pound. The differences in nutrient content affect the amounts of dry matter needed to provide adequate quantities of nutrients for livestock. A 1200-pound cow with a calf born in March requires 836 pounds of crude protein for a 12-month period. The cost per pound of crude protein directly affects the total pasture-forage production costs for that cow. The nutrient cost per unit of weight is determined by the weight of the nutrients grazed or harvested per acre prorated against the land costs, production costs, equipment costs, and labor costs per acre.

The weight of nutrients captured per acre is related to the percent nutrient content and the weight of the forage dry matter at the time of grazing or cutting. The percent crude protein content and dry matter weight of the forage first increase and then decrease as the growing season progresses and plants mature. These changes are reflected in the quantity curves for the two factors. The quantity curves of these two factors are different, and curves of various types of forage plants have different shapes. The greatest percent crude protein occurs during early plant growth stages, and then the quality level declines as the plants develop. Percent nutrient content declines at a greater rate in grasses than in legumes. The weight of the forage dry matter per acre increases during the early growth stages until the maximum plant height is reached, and then the dry matter weight decreases as the plants dry during senescence. The rate of growth to peak dry matter weight is greater in grasses than legumes. The greatest amount of crude protein per acre does not

occur at the peak percent crude protein or the peak dry matter weight per acre but at the plant growth stage during which the percent nutrient content and weight of forage dry matter curves cross.

The two curves cross at the flowering growth stage for grass plants, including native and domesticated perennial grasses and annual cereal grasses. The cost per pound of crude protein is lower for perennial grasses and annual cereal forages when plants are cut early, between the boot stage and the early milk stage. Forage barley and oat forage hay cut early at the milk stage had lower costs per pound of crude protein than their respective forage types cut later, at the hard dough stage.

The two curves for legumes cross at a later growth stage, when the plants are at full growth but before the leaves start drying from senescence. The cost per pound of crude protein is lower for annual legume forages when plants are cut one time during a late growth stage, when plants are at full growth. Early cut forage lentil hay and early cut pea forage hay were cut prior to the plant growth stage with the greatest amount of crude protein per acre, so these hays had greater costs per pound of crude protein than the same legume forage types cut at later plant growth stages.

The size and the cost of the land area required to provide adequate forage dry matter and nutrients for a cow contribute substantially to total pasture-forage production costs. The size of the land area ranged from 11.68 acres to 49.58 acres per animal unit on the grazingland-forage strategies and from 1.24 acres to 6.29 acres per animal unit on the harvested-forage strategies for a 12-month period. The costs of the land area ranged from $118.88 to $433.87 per animal unit on the grazingland-forage strategies and from $27.37 to $89.45 per animal unit on the harvested-forage strategies for a 12-month period. The land area cost, which includes the costs of dry matter and nutrients, constitutes from 69.5% to 92.2% and from 14.9% to 32.8% of the total beef production costs for a cow on the grazingland-forage strategies and on the harvested-forage strategies, respectively. These costs are affected by the efficiency of nutrient capture. The greater the quantity of the produced nutrients captured from a land base, the smaller the land area required by an animal unit and the lower the land costs per cow; the result is reduced total pasture-forage production costs.

The quantities of dry matter and nutrients produced per unit of land are affected by the health status of a grassland ecosystem. The implementation of a management strategy that improves the health performance levels of a grassland ecosystem and the efficiency of nutrient capture and conversion will increase the quantity of herbage and nutrients produced and the quantity of nutrients captured and converted, and will, therefore, help to reduce livestock pasture-forage production costs.

Forage cost is an important indicator of livestock pasture-forage production costs. Forage costs include production costs per acre, cost or weight of harvested or consumed dry matter, and cost or weight of harvested or consumed crude protein. Forage costs ranged from $144.31 to $433.78 per animal unit on the grazingland-forage strategies and from $92.96 to $232.27 per animal unit on the harvested-forage strategies for a 12-month period and from $0.40 to $1.19 per day on the grazingland-forage strategies and from $0.25 to $0.64 per day on the harvested-forage strategies.

Forage costs are the combined costs for livestock feed that is produced from the 12-month land base assigned to each animal-production unit. During periods in which the quantity or quality of this produced feed falls below the quantity or quality of the feed required by livestock, additional nutrients or dry matter from other sources need to be supplemented. The costs of supplemented nutrients or dry matter plus the forage costs are the total feed costs for an animal unit for a 12-month period. The total feed costs ranged from $171.00 to $470.76 per animal unit on the grazingland-forage strategies and from $149.76 to $301.56 per animal unit on the harvested-forage strategies for a 12-month period and from $0.47 to $1.29 per day on the grazingland-forage strategies and from $0.41 to $0.83 per day on the harvested-forage strategies.

Cost per pound of calf weight is an important diagnostic value for evaluation of the livestock pasture-forage production costs and of the efficiency of pasture-forage management strategies. The cost per pound of calf weight is the culmination of a management strategy's positive and negative effects on grass plant and livestock performance. Cost per pound of calf weight is the combined rent costs, production costs, dry matter costs, nutrient costs, land area costs, forage costs, supplementation costs, and the effects the management strategy's biological effectiveness and nutrient capture and conversion efficiency have on all pasture and forage costs. The management strategy that is the most biologically effective and that captures and converts nutrients most efficiently will have the lowest cost per pound of calf weight; the twice-over rotation management strategy has the lowest cost per pound of calf birth weight, accumulated weight, and weaning weight.

Conclusion

The profit margin of the beef production industry in the Northern Plains is low because the economic value for pounds of calf weight at market is close to the cost of producing the pounds of calf weight. Pasture and harvested-forage costs are the major portion of livestock production costs. The pasture-forage costs of traditional management practices and alternative management practices must be understood and the factors that contribute to high beef-production costs identified in order for livestock production costs to be effectively reduced.

Evaluation of the pasture and forage costs of 12-month management strategies has shown that these costs are largely determined by the biological effectiveness and nutrient capture and conversion efficiency of the management strategy. Reduction of pasture and forage costs requires improvement of the biological effectiveness and the nutrient capture and conversion efficiency of management strategies. These biological and nutritional aspects of 12-month pasture-forage management strategies can be increased through the improvement of four factors.

- increasing herbage and nutrient production by placing the biological requirements of plants and the ecosystem processes as the highest management priority and by coordinating grazing and harvest periods with plant growth stages.

- increasing nutrient capture efficiency by timing grazing and harvest periods to remove greater amounts of nutrients rather than greater amounts of dry matter. Supplementation of dry matter is lower cost than supplementation of crude protein.

- increasing nutrient conversion efficiency by providing adequate nutrients throughout the cows' 12-month production cycle because high-performance livestock perform at greater efficiencies when not limited by periods with nutrient deficiency.

- increasing pasture-forage system efficiency by combining pasture and forage types in a 12-month sequence so that the herbage production curves and nutritional quality curves are coordinated with the 12-month dietary quantity and quality requirement curves of cow production periods.

The 12-month pasture-forage management strategy that has great biological effectiveness, efficient nutrient capture, efficient nutrient conversion, and an efficient pasture-forage-livestock system will have lower production costs per pound of calf weight and higher profit margins.

Beef production is the last meat industry to improve the efficiency of feed management systems. Traditional pasture-forage management strategies used in the Northern Plains were developed during the era of low-performance livestock. During the past several decades, the type of livestock in the region has shifted to a fast-growing, high-performance animal, but pasture-forage management strategies have not been adjusted to take full advantage of modern livestock's genetic potential. Attempts to produce high-performance livestock though the use of traditional low-performance management practices that do not efficiently provide adequate feed result in calves with weaning weights below potential and in high annual expenses for cow maintenance.

The traditional pasture-forage management practices implemented in the region are not well suited to the modern beef animal. Combining old management practices and modern livestock leads to great inefficiencies in the capture of the nutrients produced on a land base and in the conversion of those nutrients into a saleable product. These inefficiencies contribute to high production costs. Reducing costs of beef production in the Northern Plains requires a change in some basic assumptions about effective management practices.

Traditional low-performance pasture-forage management practices focus on providing livestock with adequate dry matter and supplement nutrients only when absolutely necessary. Under these strategies, low-performance cows produced lightweight calves. These practices were successful for low-performance livestock because the animals had low production drain and were able to store nutrients when they were available and draw on nutrient stores from body fat during periods when forage quality was low.

High-performance livestock have high production drain and do not produce at potential levels under traditional strategies. These modern animals perform more efficiently when nutrients are provided as they are required during each production period. A high-performance cow can not produce a large healthy calf and high profit margins when depending on stored body fat and poor-quality feed. Beef production profit margins will remain small or decrease unless improved efficient 12-month pasture-forage management strategies are implemented.

In contrast to traditional practices, efficient management strategies for high-performance

livestock provide animals with adequate nutrients throughout the year and supplement dry matter when necessary. Producers can match forage nutrient supply to livestock nutrient demand by selecting appropriate combinations of pasture and harvested-forage types that grow well in the Northern Plains and by timing livestock use of those forages so that herbage production curves and nutritional quality curves of the plants match the dietary quantity and quality requirement curves of cow production periods.

Coordination of forage quality and quantity with livestock requirements is necessary for efficient feed management systems for beef production. This coordination improves individual animal performance, reduces acreage required to carry a cow-calf pair for the season, increases total accumulated weight gain, reduces costs per pound of accumulated calf weight, and increases net return after pasture-forage costs per cow-calf pair and per acre.

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