Forage Costs of Harvested-Forage Treatments for Range Cows during the Nongrowing Season

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Introduction

The pasture-forage factors that contribute to high beef production costs in the Northern Plains need to be identified before the profit margin can be improved. Achieving this determination requires that management practices be scientifically evaluated for pasture and harvested-forage costs, which constitute the greatest portion of the total annual production costs for a beef cow and calf. Because the daily requirements for cows differ with production period, proper evaluation of management strategies comprises two steps: evaluation of forage costs for each production period and evaluation of the management strategies for livestock production periods as components within complete management systems. Effectively reducing livestock production costs for range cows by reducing 12-month pasture and harvested-forage costs during the cows' production periods requires an understanding of the production costs of common traditional practices and the costs of readily available alternative management practices.

This study evaluated harvested forage hays to determine the forage costs for range cows during the cows' production periods of the nongrowing season, a period of about 5.5 months from mid November to late April when air and soil temperatures are low, liquid water is scarce, and growing grass material is unavailable as livestock feed. The harvested-forage treatments were identified by the forage type fed during the nongrowing season: forage barley hay, oat forage hay, pea forage hay, forage lentil hay, oat-pea forage hay, and crested wheatgrass hay. The treatment costs evaluated were land rent value per acre, production costs per acre, cost per unit of forage dry matter, cost per unit of nutrient, land area per animal unit, and forage feed costs per day, per month, or per production period.

Procedure

This study was conducted at the NDSU Dickinson Research Extension Center, located in western North Dakota. Forage dry matter yield per acre and percent crude protein data for annual cereal and annual legume hays and perennial domesticated grass hays 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). 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 production costs for forage types. Supplemental crude protein was added as 20% crude protein range cake, at a cost of $120.00 per ton. Supplemental forage dry matter was added as roughage, at a cost of $35.00 per ton. Range cow daily nutritional requirements, which change with cow size and production period, were taken from NRC (1996). Dry matter and crude protein requirements were determined for range cows with an average weight of 1200 pounds.

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. 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, per month, or per production period 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 feed costs per day were multiplied by 30 days per month, 30.5 days per month, or the number of days per production period.

Harvested-forage treatments

One harvested-forage type was used for each treatment during the production periods of the nongrowing season. Each cow production period during the nongrowing season was considered separately. For each forage type, the cow production periods were then combined as components of a complete nongrowing-season 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 harvested forages were cut by swathing and were then rolled into large round bales. 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. Late crested wheatgrass hay was cut at a mature plant stage. Early crested wheatgrass hay was cut at the boot stage.

Results

This study evaluated and compared eleven harvested-forage treatments for the total feed costs and the harvested-forage costs for the dry gestation, third trimester, and early lactation production periods. Costs related to forage production are taken from Manske and Carr 2000b. Total livestock feed costs for 12-month pasture-forage management strategies are taken from Manske 2001. Forage costs for harvested-forage treatments are shown in tables 1-6. Forage and supplement costs for the nongrowing-season treatments are shown in tables 7-9.

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 has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound.

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 the dry gestation period would require 0.07 acres per month and 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 the third trimester period would require 0.09 acres per month and 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 the early lactation period would require 0.13 acres per month and 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 early cut forage barley hay treatment would require 0.54 acres to produce forage to feed during the three production periods of the nongrowing season. Harvested forage would cost $37.52 and supplementation would cost $26.69 per season. Total feed costs for this treatment would be $64.21 per season, or $0.38 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 has production costs of $70.35 per acre, forage dry matter costs of $27.40 per ton, and crude protein costs of $0.15 per pound.

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 the dry gestation period would require 0.09 acres per month and 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 the third trimester period would require 0.12 acres per month and 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 the early lactation period would require 0.16 acres per month and 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 late-cut forage barley hay treatment would require 0.70 acres to produce forage to feed during the three production periods of the nongrowing season. Harvested forage would cost $51.59 and supplementation would cost $13.58 per season. Total feed costs for this treatment would be $65.17 per season, or $0.39 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 has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound.

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 the dry gestation period would require 0.08 acres per month and 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 the third trimester period would require 0.10 acres per month and 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 the early lactation period would require 0.15 acres per month and 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 early cut oat forage hay treatment would require 0.63 acres to produce forage to feed during the three production periods of the nongrowing season. Harvested forage would cost $43.43 and supplementation would cost $20.89 per season. Total feed costs for this treatment would be $64.32 per season, or $0.39 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 has production costs of $74.53 per acre, forage dry matter costs of $26.40 per ton, and crude protein costs of $0.17 per pound.

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 the dry gestation period would require 0.10 acres per month and 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 the third trimester period would require 0.13 acres per month and 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 the early lactation period would require 0.14 acres per month and 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 late-cut oat forage hay treatment would require 0.70 acres to produce forage to feed during the three production periods of the nongrowing season. Harvested forage would cost $57.50 and supplementation would cost $11.11 per season. Total feed costs for this treatment would be $68.61 per season, or $0.41 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 has production costs of $79.96 per acre, forage dry matter costs of $55.00 per ton, and crude protein costs of $0.15 per pound.

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 the dry gestation period would require 0.08 acres per month and 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 the third trimester period would require 0.11 acres per month and 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 the early lactation period would require 0.15 acres per month and 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 early cut pea forage hay treatment would require 0.64 acres to produce forage to feed during the three production periods of the nongrowing season. Harvested forage would cost $50.69 and supplementation would cost $41.15 per season. Total feed costs for this treatment would be $91.84 per season, or $0.55 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 has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound.

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 the dry gestation period would require 0.07 acres per month and would cost $6.08 per production 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 the third trimester period would require 0.08 acres per month and 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 the early lactation period would require 0.12 acres per month and 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 late-cut pea forage hay treatment would require 0.50 acres to produce forage to feed during the three production periods of the nongrowing season. Harvested forage would cost $43.40 and supplementation would cost $31.30 per season. Total feed costs for this treatment would be $74.70 per season, or $0.45 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 has production costs of $59.69 per acre, forage dry matter costs of $71.60 per ton, and crude protein costs of $0.17 per pound.

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 the dry gestation period would require 0.12 acres per month and 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 the third trimester period would require 0.15 acres per month and 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 the early lactation period would require 0.23 acres per month and 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 early cut forage lentil hay treatment would require 0.93 acres to produce forage to feed during the three production periods of the nongrowing season. Harvested forage would cost $57.50 and supplementation would cost $45.31 per season. Total feed costs for this treatment would be $102.81 per season, or $0.62 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 has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound.

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 the dry gestation period would require 0.08 acres per month and 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 the third trimester period would require 0.10 acres per month and 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 the early lactation period would require 0.14 acres per month and 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 late-cut forage lentil hay treatment would require 0.61 acres to produce forage to feed during the three production periods of the nongrowing season. Harvested forage would cost $43.43 and supplementation would cost $32.20 per season. Total feed costs for this treatment would be $75.63 per season, or $0.45 per day.

Oat-pea forage hay

Oat-pea forage hay has a crude protein content of 12.5%. Oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.15 per pound.

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 the dry gestation period would require 0.07 acres per month and 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 the third trimester period would require 0.09 acres per month and 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 the early lactation period would require 0.13 acres per month and 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 oat-pea forage hay treatment would require 0.52 acres to produce forage to feed during the three production periods of the nongrowing season. Harvested forage would cost $50.69 and supplementation would cost $25.06 per season. Total feed costs for this treatment would be $75.75 per season, or $0.45 per day.

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 has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound.

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 the dry gestation period would require 0.44 acres per month and 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 $30.00 per period. Production of mature crested wheatgrass hay to feed during the third trimester period would require 0.45 acres per month and would cost $46.80 per production period. Total forage and supplement costs during the third trimester period would be $76.80, or $0.85 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 the early lactation period would require 0.51 acres per month and 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 mature crested wheatgrass hay treatment would require 2.58 acres to produce forage to feed during the three production periods of the nongrowing season. Harvested forage would cost $93.67 and supplementation would cost $43.84 per season. Total feed costs for this treatment would be $137.51 per season, or $0.82 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 has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound.

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 the dry gestation period would require 0.24 acres per month and 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 the third trimester period would require 0.30 acres per month and 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 the early lactation period would require 0.43 acres per month and 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 early cut crested wheatgrass hay treatment

would require 1.80 acres to produce forage to feed during the three production periods of the nongrowing season. Harvested forage would cost $47.22 and supplementation would cost $31.59 per season. Total feed costs for this treatment would be $78.81 per season, or $0.47 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 the three production periods with early cut forage barley, early cut oat forage, early cut pea forage, late-cut pea forage, early cut forage lentil, late-cut forage lentil, oat-pea forage, and early cut crested wheatgrass 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 forage barley hay during the early lactation period, late-cut oat forage hay during the early lactation period, and late-cut crested wheatgrass hay during the third trimester and early lactation 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.

Production periods

Total feed costs during the 32-day dry gestation production period ranged between $10.74 per period, or $0.34 per day, and $17.63 per period, or $0.55 per day. Forage barley hay and oat forage hay had the lowest costs. Early cut pea forage hay and early cut forage lentil hay had costs greater than $15.00 per period or $0.47 per day. The other forage types had costs lower than $14.50 per period or $0.45 per day.

Total feed costs during the 90-day third trimester production period ranged between $28.80 per period, or $0.32 per day, and $76.80 per period, or $0.85 per day. Mature crested wheatgrass hay had the highest costs, and forage barley hay and oat forage hay had the lowest costs. Early cut pea forage hay and early cut forage lentil hay had costs greater than $45.00 per period or $0.50 per day. The other forage types had costs $0.45 or lower per day and less than $41.00 per period.

Total feed costs during the 45-day early lactation production period ranged between $18.23 per period, or $0.41 per day, and $47.25 per period, or $1.05 per day. Mature crested wheatgrass hay had the highest costs, and early cut forage barley hay and early cut oat forage hay had the lowest costs. Late-cut oat forage hay, early cut pea forage hay, and early cut forage lentil hay had costs greater than $28.00 per period or $0.62 per day. The other forage types had costs lower than $25.00 per period or $0.55 per day.

Total feed costs for the harvested-forage treatments during the nongrowing season ranged between $64.21 per season, or $0.38 per day, and $137.51 per season, or $0.83 per day. Mature crested wheatgrass hay had the highest costs, and early cut forage barley hay had the lowest costs. Early cut pea forage hay and early cut forage lentil hay had costs greater than $90.00 per season or $0.54 per day. The other forage types had costs lower than $79.00 per season or $0.47 per day.

Harvested forages cut at plant stages that yield greater amounts of crude protein per acre have lower costs per unit of nutrient and are relatively low-cost forages that help reduce livestock production costs. Early crested wheatgrass, early forage barley, early oat forage, late pea forage, late forage lentil, and oat-pea forage hays have crude protein costs below $0.25 per pound and feed costs below $0.62 per day. Use of these forages reduces livestock feed costs so that profit margins are positive even when calves are sold at $0.70 per pound.

Forage costs

Forage costs of harvested-forage management treatments for range cows during the 167-day nongrowing season are shown in table 10.

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

The costs per unit of forage dry matter reflect the relationships between the production costs per acre and the amount of dry matter cut for hay. The forage dry matter costs for perennial grass hays ($34.80 and $40.80/ton) and annual cereal ($26.40 to $29.60/ton) and annual legume ($37.00 to $71.60/ton) hays express this relationship. Forage dry matter costs per ton were greater for harvested forages cut early than for the same forage type cut late because the production costs per acre were shared by fewer pounds of forage dry matter yield for the early cut forages.

Cost of harvested forage per unit of weight is commonly used to compare different forage types. 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 the 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. Forage dry matter costs per unit of weight do not accurately reflect livestock production costs because of the variable quantity of nutrients contained within the dry matter and the resulting differences in the amount of dry matter needed to provide adequate quantities of nutrients for livestock.

Cost per unit of nutrient is an important indicator of livestock forage costs. Nutrient cost per unit of weight is related to the forage dry matter cost and the quantity of nutrients per unit of forage weight. Crude protein costs for early cut perennial grass hay ($0.14/lb) and annual cereal hays ($0.11 and $0.13/lb) were lower than crude protein costs for the same forage types cut late ($0.28, $0.15 and $0.17/lb, respectively). Crude protein costs for late-cut annual legume hays ($0.13 and $0.13/lb) were lower than crude protein costs for the same forage types cut early ($0.15 and $0.17/lb). High-quality forages have lower costs per unit of nutrient than low-quality forages at the same cost per unit of dry matter weight. Even high-quality forages with a higher cost per unit of dry matter weight may actually be less costly feed because less of the high-quality forage is needed to meet the nutritional requirements of the livestock.

Land area per animal unit, an important factor in beef production costs, is related to the amount of nutrients captured per acre and the amount of nutrients required by a cow. Land area required to produce forage nutrients to feed a 1200-pound cow during the three production periods of the nongrowing season was 0.50 to 0.61 acres for oat-pea and late-cut legume hays, 0.54 to 0.63 acres for early cut cereal hays, 0.70 acres for late-cut cereal hays, 0.64 to 0.93 acres for early cut legume hays, 1.80 acres for early cut crested wheatgrass, and 2.58 acres for late-cut crested wheatgrass hay. Crested wheatgrass hay cut at a mature plant stage required the largest land area, and forage barley cut at the milk stage, pea forage cut late, and oat-pea hay required the smaller land areas. Costs of the land area required to provide adequate quantities of forage nutrients for a cow contribute substantially to total production costs. The greater the amount of the produced nutrients captured from a land base, the smaller the land area required by each animal unit and the lower the production costs.

During the nongrowing season, livestock forage-feed costs per day and per season for early cut crested wheatgrass hay ($0.47/day and $78.81/season) were a little more than half the feed costs for mature-cut crested wheatgrass hay ($0.82/day and $137.51/season). The feed costs for early cut annual cereal hays ($0.38 and $0.39/day) were lower than the feed costs for late-cut annual cereal hays ($0.39 and $0.41/day). The feed costs for late-cut annual legume hays ($0.45 and $0.45/day) were lower than the feed costs for early cut annual legume hays ($0.55 and $0.62/day). The feed costs for annual cereal and late-cut annual legume hays were less than $0.45 per day and $76.00 per season. The feed costs for oat-pea hay ($0.45/day) were similar to the feed costs for late-cut legume hays.

Perennial grass hays yield greater pounds of crude protein per acre when harvested during early developmental stages, around the boot stage to the flowering stage. Annual cereal hays yield greater pounds of crude protein per acre when harvested during early developmental stages, around the flowering stage to milk stage. Annual legume hays generally yield greater pounds of crude protein per acre when harvested during the middle and late stages of development. Cereal-legume mixed hays have generally not produced greater quantities of forage dry matter or pounds of crude protein per acre than have annual cereals or annual legumes seeded separately, because of the differences in the optimum times to harvest annual cereals and annual legumes. Cutting forage hays at their optimum harvest times reduces livestock feed costs per day and per month because the cost per pound of crude protein is lower when greater pounds of crude protein per acre are captured during harvest. Mature crested wheatgrass hay had the highest livestock forage-feed costs (greater than $0.62/day and $105.00/season). Forage barley cut at the milk stage had the lowest feed costs ($0.38/day and $64.00/season) for range cows during the nongrowing season.

Projected forage costs

The individual cow data for the harvested-forage treatments were projected to a herd of 300 cows (table 11). The differences in the land area required for forage nutrient production and in the total 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 nutrients for 300 cows during the nongrowing season was 150 to 183 acres for late-cut legume hay, 156 acres for oat-pea forage hay, 162 to 189 acres for early cut cereal hays, 210 acres for late-cut cereal hay, 192 to 279 acres for early cut legume hays, 540 acres for early cut crested wheatgrass hay, and 774 acres for mature crested wheatgrass hay. Mature crested wheatgrass hay required 40% 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 the nongrowing season ranged between $19,000 and $23,000 for early cut cereal hays, late-cut cereal hays, late-cut legume hays, and oat-pea forage hays. Total feed costs for early cut crested wheatgrass hay were less than $24,000 per season. Total feed costs for early cut legume hays were between $27,000 and $31,000 per season. Total feed costs for mature crested wheatgrass hay were greater than $41,000 per season. Feed costs for forage barley hays and early cut oat forage hays were less than half the feed costs for mature crested wheatgrass hay. Feed costs for late-cut legume hay, late-cut oat forage hay, and oat-pea forage hay management strategies were less than 60% of the feed costs for mature crested wheatgrass hay. Feed costs for early cut legume hays were less than 80% of the feed costs for mature crested wheatgrass hay. Mature crested wheatgrass hay was an expensive forage for beef cows during the nongrowing season.

Discussion

Harvested forages are usually viewed as expensive feeds because the production costs per acre are greater than pasture rent per acre and a high percentage of the harvested-forage production costs consist of labor and equipment costs. Some harvested forages are expensive, but not all harvested forages are high-cost feeds. Harvested forages cut at plant stages that yield great amounts of dry matter and low amounts of crude protein per acre have high costs per unit of nutrient and generally are expensive forages that increase livestock production costs.

Traditionally, crested wheatgrass and smooth bromegrass, domesticated perennial grass hays, are cut late, after the seed heads have developed and plants have reached maximum height. This practice yields about the year's potential amount of forage dry matter per acre 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 treatment has livestock feed costs considerably greater than the feed costs for the annual cereal and annual legume forage management treatments. Mature crested wheatgrass hay is expensive livestock feed because it has high costs per pound of crude protein.

The cost of livestock feed is regulated primarily by the cost per unit of weight of the nutrients contained in the forage. The nutrient cost per unit of weight is determined by the weight of the nutrients harvested per acre prorated against the land costs, production costs, equipment costs, and labor costs per acre.

The weight of nutrients harvested per acre is related to the percent nutrient content and the weight of the forage dry matter at the time of cutting. The quantity curves of these two factors are different from each other throughout the growing season, 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 at which the curves for percent nutrient content and weight of forage dry matter cross.

The two curves cross at the flowering growth stage for grass plants, including 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. Crested wheatgrass cut at the boot stage had lower costs per pound of crude protein than crested wheatgrass cut at a mature stage of growth. 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 full-growth stage. 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.

Generally, the lowest-cost livestock feed 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. Evaluation of harvested forages should be based on costs per unit of weight of the nutrients.

Conclusion

The feed costs from harvested forage during the nongrowing season are widely assumed to be the cause of high beef production costs. Domesticated perennial grass hay harvested by the traditional practice of cutting plants late, at a mature growth stage, is, without a doubt, expensive livestock feed. Traditional comparisons of labor costs and cash-flow costs are the basis for the long-held belief that grazing native rangeland during the nongrowing season is a less costly feed source than harvested forages. Popular slogans like “Graze longer and save money” are used as management guidelines because it seems reasonable that to let a cow graze her own feed would be cheaper than to run a swather, baler, and feed wagon. The logic of this argument is valid only when or if the effectiveness of nutrient capture for the grazing method and the effectiveness of nutrient capture for the haying method are nearly the same. The problem is that these methods of harvesting forage for use during the nongrowing season differ greatly in their effectiveness of nutrient capture. Grazing cows capture only about 8.7 pounds of crude protein per acre during the nongrowing season; with this practice crude protein costs are over $1.00 per pound and livestock feed costs are $1.67 per day. Cutting forage barley at the milk stage is a more effective method of harvesting nutrients; it captures 606 pounds of crude protein per acre at a prorated cost of $0.11 per pound and results in livestock feed costs of $0.38 per day.

The effectiveness of nutrient capture by various forage harvest methods can be evaluated and compared through determination of the cost per pound of nutrient captured. 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 the nutrient cost per unit of weight and the cost of livestock feed. Generally, the forage harvest methods that capture crude protein at $0.25 or less per pound and provide feed for livestock at $0.62 or less per day will permit positive net returns from beef production when the value of the calf weight produced is $0.70 or greater per pound.

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Table 1. Forage costs for the forage barley harvested-forage treatments.

		Early Cut			Late Cut		
		Dry Gestation	Third Trimester	Early Lactation	Dry Gestation	Third Trimester	Early Lactation
Season		Late Fall	Winter	Early Spring	Late Fall	Winter	Early Spring
Days		32	90	45	32	90	45
Herbage Wt	lb/ac						
Forage Wt	lb/ac	4733	4733	4733	5133	5133	5133
Forage DM/AU	lb/d	24	24	27	24	24	27
Production Cost	$/ac	68.21	68.21	68.21	70.35	70.35	70.35
Forage DM Cost	$/ton	28.80	28.80	28.80	27.40	27.40	27.40
Land Area/Mo	ac	0.07	0.09	0.13	0.09	0.12	0.16
Land Area/PP	ac	0.07	0.27	0.20	0.10	0.36	0.24
Land Cost/Mo	$/mo	1.54	1.99	2.87	1.99	2.65	3.53
Land Cost/PP	$/pp	1.54	5.96	4.41	2.21	7.95	5.30
Feed Cost/D	$/d	0.16	0.21	0.30	0.22	0.29	0.41
Feed Cost/Mo	$/mo	4.80	6.30	9.00	6.60	8.70	12.30
Feed Cost/PP	$/pp	5.12	18.90	13.50	7.04	26.10	18.45
Crude Protein	%	13.0	13.0	13.0	9.2	9.2	9.2
Crude Protein	lb/ac	606	606	606	468	468	468
Cost CP	$/lb	0.11	0.11	0.11	0.15	0.15	0.15
Cow CP/D	lb/d	1.49	1.87	2.73	1.49	1.87	2.73
Supplementation							
Roughage/D	lb/d	12.5	9.6	6.0	7.8	3.7	
CP/D	lb/d						0.25
Sup. Cost/PP	$/pp	7.00	14.96	4.73	4.37	5.83	3.38
Total Feed Cost	$/pp	12.12	33.86	18.23	11.41	31.93	21.83
Cost/D	$/d	0.38	0.38	0.41	0.36	0.35	0.49

Table 2. Forage costs for the oat harvested-forage treatments.

		Early Cut			Late Cut		
		Dry Gestation	Third Trimester	Early Lactation	Dry Gestation	Third Trimester	Early Lactation
Season		Late Fall	Winter	Early Spring	Late Fall	Winter	Early Spring
Days		32	90	45	32	90	45
Herbage Wt	lb/ac						
Forage Wt	lb/ac	4667	4667	4667	5667	5667	5667
Forage DM/AU	lb/d	24	24	27	24	24	27
Production Cost	$/ac	69.17	69.17	69.17	74.53	74.53	74.53
Forage DM Cost	$/ton	29.60	29.60	29.60	26.40	26.40	26.40
Land Area/Mo	ac	0.08	0.10	0.15	0.10	0.13	0.14
Land Area/PP	ac	0.09	0.31	0.23	0.11	0.38	0.21
Land Cost/Mo	$/mo	1.77	2.21	3.31	2.21	2.87	3.09
Land Cost/PP	$/pp	1.99	6.84	5.08	2.43	8.39	4.63
Feed Cost/D	$/d	0.19	0.24	0.35	0.25	0.32	0.46
Feed Cost/Mo	$/mo	5.70	7.20	10.50	7.50	9.60	13.80
Feed Cost/PP	$/pp	6.08	21.60	15.75	8.00	28.80	20.70
Crude Protein	%	11.5	11.5	11.5	7.8	7.8	7.8
Crude Protein	lb/ac	535	535	535	435	435	435
Cost CP	$/lb	0.13	0.13	0.13	0.17	0.17	0.17
Cow CP/D	lb/d	1.49	1.87	2.73	1.49	1.87	2.73
Supplementation							
Roughage/D	lb/d	11.0	7.7	3.3	4.9		
CP/D	lb/d					0.0	0.62
Sup. Cost/PP	$/pp	6.16	12.13	2.60	2.74	0.0	8.37
Total Feed Cost	$/pp	12.24	33.73	18.35	10.74	28.80	29.07
Cost/D	$/d	0.38	0.37	0.41	0.34	0.32	0.65

Table 3. Forage costs for the pea harvested-forage treatments.

		Early Cut			Late Cut		
		Dry Gestation	Third Trimester	Early Lactation	Dry Gestation	Third Trimester	Early Lactation
Season		Late Fall	Winter	Early Spring	Late Fall	Winter	Early Spring
Days		32	90	45	32	90	45
Herbage Wt	lb/ac						
Forage Wt	lb/ac	2800	2800	2800	4650	4650	4650
Forage DM/AU	lb/d	24	24	27	24	24	27
Production Cost	$/ac	79.96	79.96	79.96	86.87	86.87	86.87
Forage DM Cost	$/ton	55.00	55.00	55.00	37.40	37.40	37.40
Land Area/Mo	ac	0.08	0.11	0.15	0.07	0.08	0.12
Land Area/PP	ac	0.09	0.32	0.23	0.07	0.25	0.18
Land Cost/Mo	$/mo	1.77	2.43	3.31	1.54	1.77	2.65
Land Cost/PP	$/pp	1.99	7.09	5.08	1.54	5.52	3.97
Feed Cost/D	$/d	0.22	0.28	0.41	0.19	0.24	0.35
Feed Cost/Mo	$/mo	6.60	8.40	12.30	5.70	7.50	10.50
Feed Cost/PP	$/pp	7.04	25.20	18.45	6.08	21.60	15.75
Crude Protein	%	18.9	18.9	18.9	14.4	14.4	14.4
Crude Protein	lb/ac	526	526	526	685	685	685
Cost CP	$/lb	0.15	0.15	0.15	0.13	0.13	0.13
Cow CP/D	lb/d	1.49	1.87	2.73	1.49	1.87	2.73
Supplementation							
Roughage/D	lb/d	16.1	14.1	12.6	13.7	11.0	8.0
CP/D	lb/d						
Sup. Cost/PP	$/pp	9.02	22.21	9.92	7.67	17.33	6.30
Total Feed Cost	$/pp	16.06	47.41	28.37	13.75	38.93	22.05
Cost/D	$/d	0.50	0.53	0.63	0.43	0.43	0.49

Table 4. Forage costs for the forage lentil harvested-forage treatments.

		Early Cut			Late Cut		
		Dry Gestation	Third Trimester	Early Lactation	Dry Gestation	Third Trimester	Early Lactation
Season		Late Fall	Winter	Early Spring	Late Fall	Winter	Early Spring
Days		32	90	45	32	90	45
Herbage Wt	lb/ac						
Forage Wt	lb/ac	1667	1667	1667	3867	3867	3867
Forage DM/AU	lb/d	24	24	27	24	24	27
Production Cost	$/ac	59.69	59.69	59.69	71.48	71.48	71.48
Forage DM Cost	$/ton	71.60	71.60	71.60	37.00	37.00	37.00
Land Area/Mo	ac	0.12	0.15	0.23	0.08	0.10	0.14
Land Area/PP	ac	0.13	0.46	0.34	0.09	0.30	0.22
Land Cost/Mo	$/mo	2.65	3.31	5.08	1.77	2.21	3.09
Land Cost/PP	$/pp	2.87	10.15	7.50	1.99	6.62	4.86
Feed Cost/D	$/d	0.25	0.32	0.46	0.19	0.24	0.35
Feed Cost/Mo	$/mo	7.50	9.60	13.80	5.70	7.20	10.50
Feed Cost/PP	$/pp	8.00	28.80	20.70	6.08	21.60	15.75
Crude Protein	%	21.8	21.8	21.8	14.7	14.7	14.7
Crude Protein	lb/ac	361	361	361	567	567	567
Cost CP	$/lb	0.17	0.17	0.17	0.13	0.13	0.13
Cow CP/D	lb/d	1.49	1.87	2.73	1.49	1.87	2.73
Supplementation							
Roughage/D	lb/d	17.2	15.4	14.5	13.9	11.3	8.4
CP/D	lb/d						
Sup. Cost/PP	$/pp	9.63	24.26	11.42	7.78	17.80	6.62
Total Feed Cost	$/pp	17.63	53.06	32.12	13.86	39.40	22.37
Cost/D	$/d	0.55	0.59	0.71	0.43	0.44	0.50

Table 5. Forage costs for oat-pea harvested-forage treatment.

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

Table 6. Forage costs for crested wheatgrass harvested-forage treatments.

		Mature			Early		
		Dry Gestation	Third Trimester	Early Lactation	Dry Gestation	Third Trimester	Early Lactation
Season		Late Fall	Winter	Early Spring	Late Fall	Winter	Early Spring
Days		32	90	45	32	90	45
Herbage Wt	lb/ac						
Forage Wt	lb/ac	1600	1600	1600	1300	1300	1300
Forage DM/AU	lb/d	24	24	27	24	24	27
Production Cost	$/ac	28.11	28.11	28.11	26.50	26.50	26.50
Forage DM Cost	$/ton	34.80	34.80	34.80	40.80	40.80	40.80
Land Area/Mo	ac	0.44	0.45	0.51	0.24	0.30	0.43
Land Area/PP	ac	0.47	1.35	0.76	0.26	0.89	0.65
Land Cost/Mo	$/mo	6.26	6.40	7.25	3.41	4.27	6.11
Land Cost/PP	$/pp	6.68	19.20	10.81	3.64	12.66	9.24
Feed Cost/D	$/d	0.41	0.52	0.75	0.21	0.26	0.38
Feed Cost/Mo	$/mo	12.30	15.60	22.50	6.30	7.80	11.40
Feed Cost/PP	$/pp	13.12	46.80	33.75	6.72	23.40	17.10
Crude Protein	%	6.4	6.4	6.4	14.5	14.5	14.5
Crude Protein	lb/ac	102	102	102	189	189	189
Cost CP	$/lb	0.28	0.28	0.28	0.14	0.14	0.14
Cow CP/D	lb/d	1.49	1.87	2.73	1.49	1.87	2.73
Supplementation							
Roughage/D	lb/d	0.6			13.72	11.10	8.17
CP/D	lb/d		0.33	1.00			
Sup. Cost/PP	$/pp	0.34	30.00	13.50	7.68	17.48	6.43
Total Feed Cost	$/pp	13.46	76.80	47.25	14.40	40.88	23.53
Cost/D	$/d	0.42	0.85	1.05	0.45	0.45	0.52

Table 7. Forage and supplement costs for annual cereal hay treatments.

		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
Feed Cost	$/pp	12.12	11.41	12.24	10.74
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
Feed Cost	$/pp	33.86	31.93	33.73	28.80
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
Feed Cost	$/pp	18.23	21.83	18.35	29.07
Nongrowing Season					
Total Land Area	acres	0.54	0.70	0.63	0.70
Total Forage	$	37.52	51.59	43.43	57.50
Total Supplement	$	26.69	13.58	20.89	11.11
Total Feed Cost	$	64.21	65.17	64.32	68.61
Cost/Day	$	0.38	0.39	0.39	0.41

Table 8. Forage and supplement costs for annual legume hay treatments.

		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
Feed Cost	$/pp	16.06	13.75	17.63	13.86	13.82
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
Feed Cost	$/pp	47.41	38.93	53.06	39.40	39.38
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
Feed Cost	$/pp	38.37	22.05	32.12	22.37	22.55
Nongrowing Season						
Total Land Area	acres	0.64	0.50	0.93	0.61	0.52
Total Forage	$	50.69	43.40	57.50	43.43	50.69
Total Supplement	$	41.15	31.30	45.31	32.20	25.06
Total Feed Cost	$	91.84	74.70	102.81	75.63	75.75
Cost/Day	$	0.55	0.45	0.62	0.45	0.45

Table 9. Forage and supplement costs for domesticated grass hay treatments.

		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
Feed Cost	$/pp	13.46	14.40
Third Trimester			
Land Area	ac/pp	1.35	0.89
Forage	$/pp	46.80	23.40
Supplement	$/pp	30.00	17.48
Feed Cost	$/pp	76.80	40.88
Early Lactation			
Land Area	ac/pp	0.76	0.65
Forage	$/pp	33.75	17.10
Supplement	$/pp	13.50	6.43
Feed Cost	$/pp	47.25	23.53
Nongrowing Season			
Total Land Area	acres	2.58	1.80
Total Forage	$	93.67	47.22
Total Supplement	$	43.84	31.59
Total Feed Cost	$	137.51	78.81
Cost/Day	$	0.82	0.47

Table 10. Forage costs of harvested-forage management treatments for range cows during the 167-day nongrowing season.

	Production Costs	Forage Dry Matter Costs	Crude Protein Costs	Land Area per nongrowing season	Feed Costs per nongrowing season	Feed Costs per day
	$/ac	$/ton	$/lb	ac	$	$
Forage Barley Milk Stage Hay	68.21	28.80	0.11	0.54	64.21	0.38
Forage Barley Hard Dough Stage Hay	70.35	27.40	0.15	0.70	65.17	0.39
Oat Milk Stage Hay	69.17	29.60	0.13	0.63	64.32	0.39
Oat Hard Dough Stage Hay	74.35	26.40	0.17	0.70	68.61	0.41
Pea Forage Early Stage Hay	79.96	55.00	0.15	0.64	91.84	0.55
Pea Forage Late Stage hay	86.87	37.40	0.13	0.50	74.70	0.45
Forage Lentil Early Stage Hay	59.69	71.60	0.17	0.93	102.81	0.62
Forage Lentil Late Stage Hay	71.48	37.00	0.13	0.61	75.63	0.45
Oat-Pea Hay	95.52	37.20	0.15	0.52	75.75	0.45
Crested Wheatgrass Mature Hay	28.11	34.80	0.28	2.58	137.51	0.82
Crested Wheatgrass Early Hay	26.50	40.80	0.14	1.80	78.81	0.47

Table 11. Projection of feed costs for production of 300 range cows by harvested-forage treatment.

Harvested-Forage Treatments	Number of Cows	Acres per Season	Total Feed Costs
	#	acres	$
Forage Barley Hay Cut Early	300	162	19,263
Forage Barley Hay Cut Late	300	210	19,551
Oat Forage Hay Cut Early	300	189	19,296
Oat Forage Hay Cut Late	300	210	20,583
Pea Forage Hay Cut Early	300	192	27,552
Pea Forage Hay Cut Late	300	150	22,410
Forage Lentil Hay Cut Early	300	279	30,843
Forage Lentil Hay Cut Late	300	183	22,689
Oat-Pea Forage Hay	300	156	22,725
Crested Wheatgrass Hay Cut Late	300	774	41,253
Crested Wheatgrass Hay Cut Early	300	540	23,643

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