Costs-Returns of Forage Management Strategies for Range Cows during the Nongrazing Season

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Introduction

Most beef producers view feeding livestock during the nongrazing season as a major expense. However, economical forage sources can turn feeding livestock during this time from expense into income. The weight added to a calf during the dry gestation, third trimester, and early lactation production periods has economic value when the calf is sold. If the value of the calf weight is less than the cost of forage during the nongrazing season, the forage costs are an expense, but if the value of the calf weight is greater than the costs of the forage, the difference is income. The costs of forage types used for feed during the nongrazing season vary greatly, and the use of the most economical feed is critical to ensuring positive profit margins. This study evaluated fourteen forage types used to feed range cows during the nongrazing season and determined whether feeding each type was an expense or yielded income.

Procedure

This study was conducted at the NDSU Dickinson Research Extension Center, located in western North Dakota. Forage types were evaluated as livestock feed during the nongrazing season, a period of about 5.5 months from mid November to late April, when air temperatures are low, liquid water is scarce, physiological plant processes are slow, foliage production is minimal in dormant perennial plants, and biologically active grass material is unavailable as livestock feed. The harvested-forage treatments were identified by the forage type fed during the nongrazing season: forage barley hay, oat forage hay, pea forage hay, forage lentil hay, oat-pea forage hay, and crested wheatgrass hay. The pasture-forage treatments were reserved native rangeland and cropland aftermath pastures. Pasture and forage costs were evaluated against calf weight value to determine the profit or loss. Pasture and forage costs evaluated were production costs per acre, forage dry matter costs per ton, crude protein yield and cost per pound, land area per animal unit, and livestock forage, supplement, and total feed costs. 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). Pasture rent value of $8.76 per acre was used to determine costs of native rangeland pastures. The value of $2.00 per acre was used for cropland aftermath grazing costs. Land rent values of $22.07 per acre for cropland and $14.22 per acre for 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. Production costs per acre, forage dry matter costs per ton, and crude protein yield and cost per pound were taken from Manske (2002a). Livestock forage costs, crude protein supplementation costs, and roughage supplementation costs were taken from Manske (2002b).

Range cow daily nutritional requirements, which change with cow size and production period, were taken from NRC (1996). An average 1200-pound range cow with a calf born in mid March requires 4143 pounds of dry matter, 2202 pounds of energy (TDN), and 339 pounds of crude protein during the 167-day (5.5-month) nongrazing season from mid November until late April. The dry matter and nutrients need to be provided from the forage type selected.

An assumed price of $0.70 per pound was used to determine the economic value of calf weight for both the birth weight and the accumulated weight. The pasture and forage costs for the third trimester and for the early lactation production periods were used to determine cost per pound for the calf birth weight and for the calf accumulated weight, respectively. The pasture and forage costs for the dry gestation, third trimester, and early lactation production periods were used to determine cost per pound for the nongrazing-season calf weight. A positive profit margin can be achieved for beef production during a low market with calf weight value at $0.70 per pound at weaning time when the

average forage-feed costs are $0.62 or less per day, forage dry matter costs are $48.00 or less per ton, and crude protein costs are $0.25 or less per pound.

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.

Nongrazing-season production periods

Grazingland-forage types and harvested-forage types were evaluated during the 167-day nongrazing season, the period from mid November to late April. 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 calves were born in mid March, at an average weight of 95 pounds. The early lactation production period was 45 days from mid March to late April.

Harvested-forage types

The harvested forages were evaluated as hay cut by swathing and rolled into large round bales. One forage barley hay treatment was cut at the milk stage and another was cut at the hard dough stage. One oat forage hay treatment was cut at the milk stage and another was cut at the hard dough stage. One pea forage hay treatment was cut at an early plant growth stage and another was cut at a late plant stage. One forage lentil hay treatment was cut at an early plant growth stage and another was cut at a late plant stage. 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.

Pasture and harvested-forage treatments

Reserved native rangeland pasture with range cake

Grazed forage from separate reserved native rangeland pastures stocked at proper rates was evaluated as livestock feed during each of the three production periods of the nongrazing season. Crude protein was supplemented with range cake as required during the dry gestation, third trimester, and early lactation production periods.

Cropland aftermath pasture; mature crested wheatgrass hay with range cake

Grazed forage from cropland aftermath pastures was evaluated as livestock feed during the dry gestation production period and crude protein was not supplemented. A harvested forage consisting of crested wheatgrass hay cut late, at the mature plant stage, was evaluated as livestock feed during the third trimester and early lactation production periods. Crude protein was supplemented with range cake as required during these two production periods.

Mature crested wheatgrass hay with range cake

A harvested forage consisting of crested wheatgrass hay cut late, at the mature plant stage, was evaluated as livestock feed during the nongrazing season. Roughage was supplemented during the dry gestation production period, and crude protein was supplemented with range cake as required during the third trimester and early lactation production periods.

Mature crested wheatgrass hay with range cake and alfalfa-corn silage

A harvested forage consisting of crested wheatgrass hay cut late, at the mature plant stage, was evaluated as livestock feed during the nongrazing season. Roughage was supplemented during the dry gestation production period. Crude protein was supplemented with range cake as required during the third trimester production period. The mature crested wheatgrass hay was supplemented with alfalfa hay and corn silage to meet cow nutrient requirements during the early lactation production period.

Crested wheatgrass hay cut early

A harvested forage consisting of crested wheatgrass hay cut early, at the boot stage, was evaluated as livestock feed during the nongrazing season. Roughage was supplemented as required during the dry gestation, third trimester, and early lactation production periods.

Forage barley hay cut early

A harvested forage consisting of forage barley hay cut early, at the milk stage, was evaluated as livestock feed during the nongrazing season. Roughage was supplemented as required during the dry gestation, third trimester, and early lactation production periods.

Forage barley hay cut late

A harvested forage consisting of forage barley hay cut late, at the hard dough stage, was evaluated as livestock feed during the nongrazing season. Roughage was supplemented during the dry gestation and third trimester production periods, and crude protein was supplemented with range cake as required during the early lactation production period.

Oat forage hay cut early

A harvested forage consisting of oat forage hay cut early, at the milk stage, was evaluated as livestock feed during the nongrazing season. Roughage was supplemented as required during the dry gestation, third trimester, and early lactation production periods.

Oat forage hay cut late

A harvested forage consisting of oat forage hay cut late, at the hard dough stage, was evaluated as livestock feed during the nongrazing season. Roughage was supplemented during the dry gestation production period, no supplementation was required during the third trimester production period, and crude protein was supplemented with range cake as required during the early lactation production period.

Pea forage hay cut early

A harvested forage consisting of pea forage hay cut at an early plant stage was evaluated as livestock feed during the nongrazing season. Roughage was supplemented as required during the dry gestation, third trimester, and early lactation production periods.

Pea forage hay cut late

A harvested forage consisting of pea forage hay cut at a late plant stage was evaluated as livestock feed during the nongrazing season. Roughage was supplemented as required during the dry gestation, third trimester, and early lactation production periods.

Forage lentil hay cut early

A harvested forage consisting of forage lentil hay cut at an early plant stage was evaluated as livestock feed during the nongrazing season. Roughage was supplemented as required during the dry gestation, third trimester, and early lactation production periods.

Forage lentil hay cut late

A harvested forage consisting of forage lentil hay cut at a late plant stage was evaluated as livestock feed during the nongrazing season. Roughage was supplemented as required during the dry gestation, third trimester, and early lactation production periods.

Oat-pea forage hay

A harvested forage consisting of oat-pea forage hay was evaluated as livestock feed during the nongrazing season. Roughage was supplemented as required during the dry gestation, third trimester, and early lactation production periods.

The terms “herbage” and “forage” are not synonymous. Herbage is the total amount of aboveground biomass of herbaceous plants like

grasses and forbs. Forage is the portion of the herbage that can be removed without detriment to the plants and can provide feed for grazing animals or be harvested mechanically for feeding.

Forage plants in pastures saved for grazing during fall and winter are categorized as reserve forage in this study. Some articles in the popular press have incorrectly used the term "stockpiled forage" to refer to late-season pastures. The word "stockpile" is not correctly used to refer to natural resources or living organisms. Manufactured products, like steel pipe, charcoal briquets, diesel fuel, lumber, and processed food, can be stockpiled at storage locations during periods of surplus and used later in their original stored condition during periods of deficiency. Natural resources, like iron ore, lignite coal, and crude oil deposits, that are left in place as raw material until needed for manufacturing products are reserves, not stockpiles. Living organisms, like trees in a forest and fish in the ocean, that are left in place until needed and continue biological processes of life, growth, and death are reserves, not stockpiles. Perennial grass resources that are left in place and saved as unprocessed pasture forage until needed in fall and winter are living organisms that continue to change their dry matter weight and nutritional quality during the growing season and the nongrowing season and are, therefore, reserves, not stockpiles. The term "stockpiled forage" can correctly be used to refer only to processed forages that do not change in dry matter or nutrient content during storage.

Results

This study evaluated and compared two pasture-forage and twelve harvested-forage treatments for the forage costs and the total feed 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 pasture-forage and harvested-forage management strategies are taken from Manske 2001. Forage costs for pasture-forage and harvested-forage treatments are shown in tables 1-7.

Pasture-forage costs

Reserved native rangeland pasture

Reserved native rangeland pasture during the 32-day dry gestation production period has a crude protein content of around 4.8%. Late-season native range forage has pasture rent 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 reserved native rangeland pasture would require 4.00 acres per month, or 4.27 acres during the dry gestation production period. The reserved pasture forage would cost $37.44 per production period. An additional 0.34 lbs of crude protein per day would need to be supplemented, at a cost of $3.26 per period. Total forage and supplement costs during the dry gestation period would be $40.70, or $1.27 per day.

Reserved native rangeland pasture during the 90-day third trimester production period has a crude protein content of around 4.8%. Late-season native range forage has pasture rent 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 reserved native rangeland pasture would require 4.97 acres per month, or 14.90 acres during the third trimester production period. The reserved pasture forage would cost $130.50 per production period. An additional 0.72 lbs of crude protein per day would need to be supplemented, at a cost of $19.44 per period. Total forage and supplement costs during the third trimester period would be $149.94, or $1.67 per day.

Reserved native rangeland pasture during the 45-day early lactation production period has a crude protein content of around 9.2%. Early spring native range forage has pasture rent 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 reserved native rangeland pasture would require 6.48 acres per month, or 9.72 acres during the early lactation production period. The reserved pasture forage would cost $85.05 per production period. An additional 0.25 lbs of crude protein per day would need to be supplemented, at a cost of $3.38 per period. Total forage and supplement costs during the early lactation period would be $88.43, or $1.97 per day.

The reserved native rangeland treatment would require 28.89 acres to produce forage to feed during the three production periods of the nongrazing season. Reserved forage would cost $252.99 and supplementation would cost $26.08 per season. Total feed costs for this treatment would be $279.07 per season, or $1.67 per day.

Cropland aftermath pasture and mature crested wheatgrass hay

Crop aftermath pasture of annual cereal stubble has very low crude protein content during the 32-day dry gestation production period. Cropland aftermath forage has pasture rent costs of $2.00 per acre and

forage dry matter costs of $29.63 per ton. A cow grazing cropland aftermath pasture would require 6.63 acres per month, or 7.10 acres during the dry gestation production period. The crop aftermath forage would cost $14.20 per production period. Additional crude protein was not supplemented even though the forage was below the requirements of a dry gestating cow. Total forage and supplement costs during the dry gestation period would be $14.20, or $0.44 per day.

Mature crested wheatgrass hay has a crude protein content of 6.4%. During the 90-day third trimester production period, crested wheatgrass hay cut late 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 the third trimester production period would require 0.45 acres per month, or 1.35 acres per period. The mature 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.

Mature crested wheatgrass hay has a crude protein content of 6.4%. During the 45-day early lactation production period, crested wheatgrass hay cut late would be fed at 27.0 lbs DM/day to provide 1.7 lbs CP/day. An additional 1.01 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 production period would require 0.51 acres per month, or 0.76 acres per period. The mature 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 cropland aftermath pasture and mature crested wheatgrass hay treatment would require 9.21 acres to produce forage to feed during the three production periods of the nongrazing season. Forage would cost $94.75 and supplementation would cost $22.52 per season. Total feed costs for this treatment would be $117.27 per season, or $0.70 per day.

Harvested-forage costs

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 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 the third trimester period would require 0.09 acres per month, 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 the early lactation period would require 0.13 acres per month, 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 early cut forage barley hay treatment would require 0.54 acres to produce forage to feed during the three production periods of the nongrazing 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 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 the third trimester period would require 0.12 acres per month, 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 the early lactation period would require 0.16 acres per month, 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 late-cut forage barley hay treatment would require 0.70 acres to produce forage to feed during the three production periods of the nongrazing 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 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 the third trimester period would require 0.10 acres per month, 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 the early lactation period would require 0.15 acres per month, 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 early cut oat forage hay treatment would require 0.63 acres to produce forage to feed during the three production periods of the nongrazing 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 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 the third trimester period would require 0.13 acres per month, 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 the early lactation period would require 0.14 acres per month, 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 late-cut oat forage hay treatment would require 0.70 acres to produce forage to feed during the three production periods of the nongrazing 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 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 the third trimester period would require 0.11 acres per month, 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 the early lactation period would require 0.15 acres per month, 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 early cut pea forage hay treatment would require 0.64 acres to produce forage to feed during the three production periods of the nongrazing 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 the forage 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 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 the early lactation period would require 0.12 acres per month, 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 late-cut pea forage hay treatment would require 0.50 acres to produce forage to feed during the three production periods of the nongrazing 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 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 the third trimester period would require 0.15 acres per month, 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 the early lactation period would require 0.23 acres per month, 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 early cut forage lentil hay treatment would require 0.93 acres to produce forage to feed during the three production periods of the nongrazing 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 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 the third trimester period would require 0.10 acres per month, 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 the early lactation period would require 0.14 acres per month, 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 late-cut forage lentil hay treatment would require 0.61 acres to produce forage to feed during the three production periods of the nongrazing 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 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 the third trimester period would require 0.09 acres per month, 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 the early lactation period would require 0.13 acres per month, 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 oat-pea forage hay treatment would require 0.52 acres to produce forage to feed during the three production periods of the nongrazing 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 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 the third trimester period would require 0.45 acres per month, 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 the early lactation period would require 0.51 acres per month, 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 mature crested wheatgrass hay treatment would require 2.58 acres to produce forage to feed during the three production periods of the nongrazing season. Harvested forage would cost $93.67 and supplementation would cost $22.86 per season. Total feed costs for this treatment would be $116.53 per season, or $0.70 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 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 the third trimester period would require 0.30 acres per month, 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 the early lactation period would require 0.43 acres per month, 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 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 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, late-cut crested wheatgrass hay during the third trimester and early lactation periods, and reserved native rangeland pastures during the dry gestation, third trimester, and early lactation periods. Standard sources of roughage and crude protein supplementation were used in this study in order to evaluate the differences among the forage types. Not all types of supplements have these same costs, and selective substitution could reduce the supplementation expenses.

Table 1. Forage costs for the pasture-forage treatments.

		Reserved Native Rangeland			Crop Aftermath, Mature Hay		
		Dry	Third	Early	Dry	Third	Early
Season		Late		Early	Late		Early
Days		32	90	45	32	90	45
Herbage Wt	lb/ac	725	580	480	270		
Forage Wt	lb/ac	180	145	125	135	1600	1600
Forage DM/AU	lb/d	24	24	27	24	24	27
Production Cost	$/ac	8.76	8.76	8.76	2.00	28.11	28.11
Forage DM Cost	$/ton	97.33	120.83	140.16	29.63	34.80	34.80
Land Area/Mo	ac	4.00	4.97	6.48	6.63	0.45	0.51
Land Area/PP	ac	4.27	14.90	9.72	7.10	1.35	0.76
Land Cost/Mo	$/mo	35.04	43.54	56.76	13.26	6.40	7.25
Land Cost/PP	$/pp	35.41	130.52	85.15	14.20	19.20	10.81
Feed Cost/D	$/d	1.17	1.45	1.89	0.44	0.52	0.75
Feed Cost/Mo	$/mo	35.10	43.50	56.70	13.26	15.60	22.50
Feed Cost/PP	$/pp	37.44	130.50	85.05	14.20	46.80	33.75
Crude Protein	%	4.8	4.8	9.2		6.4	6.4
Crude Protein	lb/ac	8.64	6.96	11.50		102	102
Cost CP	$/lb	1.01	1.26	0.76		0.28	0.28
Cow CP/D	lb/d	1.49	1.87	2.73	1.49	1.87	2.73
Supplementation							
Roughage/D	lb/d						
CP/D	lb/d	0.34	0.72	0.25		0.33	1.00
Sup. Cost/PP	$/pp	3.26	19.44	3.38		9.02	13.50
Total Feed Cost	$/pp	40.70	149.94	88.43	14.20	55.82	47.25
Cost/D	$/d	1.27	1.67	1.97	0.44	0.62	1.05

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

		Early Cut			Late Cut		
		Dry	Third	Early	Dry	Third	Early
Season		Late		Early	Late		Early
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 3. 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 4. 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 5. 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 6. 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 7. Forage costs for crested wheatgrass harvested-forage treatments.

		Mature			Early		
		Dry	Third	Early	Dry	Third	Early
Season		Late		Early	Late		Early
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	9.02	13.50	7.68	17.48	6.43
Total Feed Cost	$/pp	13.46	55.82	47.25	14.40	40.88	23.53
Cost/D	$/d	0.42	0.62	1.05	0.45	0.45	0.52

Summary of pasture-forage and harvested-forage costs

Pasture and forage costs during the dry gestation, third trimester, and early lactation production periods during the nongrazing season are shown in tables 8-11. Total feed costs during the 32-day dry gestation production period ranged between $10.74 per period, or $0.34 per day, and $40.70 per period, or $1.27 per day. Reserved native rangeland pasture had the highest costs. Forage barley hay and oat forage hay had the lowest costs. Early cut pea forage hay and early cut forage lentil hay had costs greater than $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 $149.94 per period, or $1.67 per day. Reserved native rangeland pasture had the highest costs. Mature crested wheatgrass hay had the highest harvested-forage 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 $88.43 per period, or $1.97 per day. Reserved native rangeland pasture had the highest costs. Mature crested wheatgrass hay had the highest harvested-forage 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 pasture-forage and harvested-forage treatments during the nongrazing season ranged between $64.21 per season, or $0.38 per day, and $279.07 per season, or $1.67 per day. Reserved native rangeland pasture had the highest costs. Mature crested wheatgrass hay had the highest harvested-forage 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 during the nongrazing season

Forage costs of pasture-forage and harvested-forage management treatments for range cows during the 167-day nongrazing season are shown in table 12.

Production costs per acre for annual cereal and annual legume hays were considerably greater than those for perennial grass hays and pasture forages. 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 pasture forage, 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 or grazing late-season pastures. This interpretation of forage production costs per acre has been the basis for numerous management strategies for range cows during the nongrazing 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 grazing and 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), 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 nongrazing 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 hay, 2.58 acres for late-cut crested wheatgrass hay, 9.21 acres for crop aftermath, and 28.89 for reserved native rangeland pastures. Reserved native rangeland and crop aftermath pastures required the largest land area. Crested wheatgrass hay cut at a mature plant stage required the largest harvested-forage 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. When the amount of the produced nutrients captured from a land base is greater, the land area required by each animal unit will be smaller and the production costs will be lower.

During the nongrazing 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 ($0.70/day and $116.53/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. Reserved native rangeland pastures ($1.67/day and $279.07/season) and cropland aftermath pastures ($0.70/day and $117.27/season) had the highest livestock feed costs.

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 nongrazing season.

Table 8. Forage and supplement costs for pasture-forage treatments.

		Reserved Native Rangeland	Cropland Aftermath and Mature Crested Wheatgrass Hay
Dry Gestation			
Land Area	ac/pp	4.27	7.10
Forage	$/pp	37.44	14.20
Supplement	$/pp	3.26	
Feed Cost	$/pp	40.70	14.20
Third Trimester			
Land Area	ac/pp	14.90	1.35
Forage	$/pp	130.50	46.80
Supplement	$/pp	19.44	9.02
Feed Cost	$/pp	149.94	55.82
Early Lactation			
Land Area	ac/pp	9.72	0.76
Forage	$/pp	85.05	33.75
Supplement	$/pp	3.38	13.50
Feed Cost	$/pp	88.43	47.25
Nongrazing Season			
Total Land Area	acres	28.89	9.21
Total Forage	$	252.99	94.75
Total Supplement	$	26.08	22.52
Total Feed Cost	$	279.07	117.27
Cost/Day	$	1.67	0.70

Table 9. 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
Nongrazing 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 10. 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
Nongrazing 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 11. 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	9.02	17.48
Feed Cost	$/pp	55.82	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
Nongrazing Season			
Total Land Area	acres	2.58	1.80
Total Forage	$	93.67	47.22
Total Supplement	$	22.86	31.59
Total Feed Cost	$	116.53	78.81
Cost/Day	$	0.70	0.47

Table 12. Forage costs of pasture-forage and harvested-forage management treatments for range cows during the 167-day nongrazing season.

	Production Costs	Forage Dry Matter Costs	Crude Protein Costs	Land Area per nongrazing season	Feed Costs per nongrazing 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	116.53	0.70
Crested Wheatgrass Early Hay	26.50	40.80	0.14	1.80	78.81	0.47
Reserved Native Range	8.76	122.13	1.04	28.89	279.07	1.67
Crop Aftermath and Mature Crested Wheatgrass Hay	7.98	43.72		9.21	117.27	0.70

Calf weight value and net returns after pasture-forage costs

Costs-returns of forage-type treatments for range cows during the nongrazing season are shown in tables 13-16.

Reserved native rangeland pasture with range cake

Reserved native rangeland pasture had production costs of $8.76 per acre and forage dry matter costs of $122.13 per ton. A 1200-pound cow would require 28.89 acres of properly stocked native range pasture for the 167-day nongrazing season, and the forage to feed the animal would cost $252.99. Crude protein supplementation with range cake would cost $26.08. Total forage and supplement costs would be $279.07 per nongrazing season, or $1.67 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $1.58 per pound. Calf weight gain during the early lactation production period was 1.80 pounds per day, and accumulated weight gain was 81 pounds, at a cost of $1.09 per pound. Total calf weight was 176 pounds, at a cost of $1.59 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $123.20 per calf. The net returns after pasture-forage costs were a loss of $155.87 per cow-calf pair grazing reserved native rangeland pastures.

Cows grazing reserved native rangeland pastures would capture 8.74 pounds of crude protein per acre; the prorated cost of the nutrient would be $1.04 per pound. This high cost of crude protein would produce pasture-forage costs greater than the calf weight value. Reserved native range pastures supplemented with range cake would return a loss of $5.40 per acre.

Grazed cropland aftermath; mature crested wheatgrass hay with range cake

Cropland aftermath and mature crested wheatgrass hay had production costs of $7.98 per acre and forage dry matter costs of $43.72 per ton. Production of cropland aftermath and mature crested wheatgrass hay to feed a 1200-pound cow during the 167-day nongrazing season would require 9.21 acres, and the forage would cost $94.75. Forage from cropland aftermath pastures was not supplemented with crude protein, even though the forage was below the crude protein requirements of a dry gestating cow. Dry cows grazing cropland aftermath lost an average of 1.14 lbs per day and an average of 4.82 lbs per acre; accumulated weight loss was 36.48 lbs per period, which is about half of one body condition score. This weight loss is an additional cost for thin cows and cows in moderate condition but not for heavy cows. Crude protein supplementation with range cake while mature crested wheatgrass hay is fed would cost $22.52. Total forage and supplement costs would be $117.27 per nongrazing season, or $0.70 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.59 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.55 per pound. Total calf weight was 180.5 pounds, at a cost of $0.65 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $9.08 per cow-calf pair grazing cropland aftermath and fed mature crested wheatgrass hay.

Haying crested wheatgrass at the mature stage captured 102 pounds of crude protein per acre; the prorated cost of the nutrient was $0.28 per pound. Grazing cropland aftermath and feeding mature crested wheatgrass hay supplemented with range cake returned $0.99 per acre above pasture-forage costs.

Mature crested wheatgrass hay with range cake

Mature crested wheatgrass hay had production costs of $28.11 per acre and forage dry matter costs of $34.80 per ton. Production of mature crested wheatgrass hay to feed a 1200-pound cow during the 167-day nongrazing season would require 2.58 acres, and the forage would cost $93.67. Roughage supplementation would cost $0.34 and crude protein supplementation with range cake would cost $22.52. Total forage and supplement costs would be $116.53 per nongrazing season, or $0.70 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.59 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.55 per pound. Total calf weight was 180.5 pounds, at a cost of $0.65 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $9.82 per cow-calf pair fed mature crested wheatgrass hay supplemented with range cake.

Haying crested wheatgrass at the mature stage captured 102 pounds of crude protein per acre; the prorated cost of the nutrient was $0.28 per pound. Mature crested wheatgrass hay supplemented with range cake returned $3.81 per acre above pasture-forage costs.

Mature crested wheatgrass hay with range cake and alfalfa-corn silage

Mature crested wheatgrass hay had production costs of $28.11 per acre and forage dry matter costs of $34.80 per ton. Production of mature crested wheatgrass hay to feed a 1200-pound cow during the 167-day nongrazing season would require 2.72 acres, and the forage would cost $77.92. Nutrient supplementation would cost $11.50 for range cake and $15.75 for alfalfa-corn silage. Total forage and supplement costs would be $105.17 per nongrazing season, or $0.63 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.59 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.42 per pound. Total calf weight was 180.5 pounds, at a cost of $0.58 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $21.18 per cow-calf pair fed mature crested wheatgrass hay.

Haying crested wheatgrass at the mature stage captured 102 pounds of crude protein per acre; the prorated cost of the nutrient was $0.28 per pound. Mature crested wheatgrass hay supplemented with range cake and alfalfa-corn silage returned $7.79 per acre above pasture-forage costs.

Crested wheatgrass hay cut early

Crested wheatgrass hay cut early, at the boot stage, had production costs of $26.50 per acre and forage dry matter costs of $40.80 per ton. Production of early cut crested wheatgrass hay to feed a 1200-pound cow during the 167-day nongrazing season would require 1.80 acres, and the forage would cost $47.22. Roughage supplementation would cost $31.59. Total forage and supplement costs would be $78.81 per nongrazing season, or $0.47 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.43 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.28 per pound. Total calf weight was 180.5 pounds, at a cost of $0.44 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $47.54 per cow-calf pair fed early cut crested wheatgrass hay.

Haying crested wheatgrass at the boot stage captured 189 pounds of crude protein per acre; the prorated cost of the nutrient was $0.14 per pound. Early cut crested wheatgrass hay returned $26.14 per acre above pasture-forage costs.

Forage barley hay cut early

Forage barley hay cut early, at the milk stage, had production costs of $68.21 per acre and forage dry matter costs of $28.80 per ton. Production of early cut forage barley hay to feed a 1200-pound cow during the 167-day nongrazing season would require 0.54 acres, and the forage would cost $37.52. Roughage supplementation would cost $29.69. Total forage and supplement costs would be $64.21 per nongrazing season, or $0.38 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.36 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.21 per pound. Total calf weight was 180.5 pounds, at a cost of $0.36 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $62.14 per cow-calf pair fed early cut forage barley hay.

Haying forage barley at the milk stage captured 606 pounds of crude protein per acre; the prorated cost of the nutrient was $0.11 per pound. Early cut forage barley hay returned $115.07 per acre above pasture-forage costs.

Forage barley hay cut late

Forage barley hay cut late, at the hard dough stage, had production costs of $70.35 per acre and forage dry matter costs of $27.40 per ton. Production of late-cut forage barley hay to feed a 1200-pound cow during the 167-day nongrazing season would require 0.70 acres, and the forage would cost $51.59. Crude protein supplementation would cost $3.38 and roughage supplementation would cost $10.20. Total forage and supplement costs would be $65.17 per

nongrazing season, or $0.39 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.34 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.26 per pound. Total calf weight was 180.5 pounds, at a cost of $0.36 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $61.18 per cow-calf pair fed late-cut forage barley hay.

Haying forage barley at the hard dough stage captured 468 pounds of crude protein per acre; the prorated cost of the nutrient was $0.15 per pound. Late-cut forage barley hay returned $87.49 per acre above pasture-forage costs.

Oat forage hay cut early

Oat forage hay cut early, at the milk stage, had production costs of $69.17 per acre and forage dry matter costs of $29.60 per ton. Production of early cut oat forage hay to feed a 1200-pound cow during the 167-day nongrazing season would require 0.63 acres, and the forage would cost $43.43. Roughage supplementation would cost $20.89. Total forage and supplement costs would be $64.32 per nongrazing season, or $0.39 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.36 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.21 per pound. Total calf weight was 180.5 pounds, at a cost of $0.36 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $62.03 per cow-calf pair fed early cut oat forage hay.

Haying oat forage at the milk stage captured 535 pounds of crude protein per acre; the prorated cost of the nutrient was $0.13 per pound. Early cut oat forage hay returned $98.46 per acre above pasture-forage costs.

Oat forage hay cut late

Oat forage hay cut late, at the hard dough stage, had production costs of $74.53 per acre and forage dry matter costs of $26.40 per ton. Production of late-cut oat forage hay to feed a 1200-pound cow during the 167-day nongrazing season would require 0.70 acres, and the forage would cost $57.50. Crude protein supplementation would cost $8.37 and roughage supplementation would cost $2.74. Total forage and supplement costs would be $68.61 per nongrazing season, or $0.41 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.30 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.34 per pound. Total calf weight was 180.5 pounds, at a cost of $0.38 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $57.74 per cow-calf pair fed late-cut oat forage hay.

Haying oat forage at the hard dough stage captured 435 pounds of crude protein per acre; the prorated cost of the nutrient was $0.17 per pound. Late-cut oat forage hay returned $82.49 per acre above pasture-forage costs.

Pea forage hay cut early

Pea forage hay cut at an early plant stage had production costs of $79.96 per acre and forage dry matter costs of $55.00 per ton. Production of early cut pea forage hay to feed a 1200-pound cow during the 167-day nongrazing season would require 0.64 acres, and the forage would cost $50.69. Roughage supplementation would cost $41.15. Total forage and supplement costs would be $91.84 per nongrazing season, or $0.55 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.50 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.33 per pound. Total calf weight was 180.5 pounds, at a cost of $0.51 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $34.51 per cow-calf pair fed early cut pea forage hay.

Haying pea forage at an early plant stage captured 526 pounds of crude protein per acre; the prorated cost of the nutrient was $0.15 per pound. Early cut pea forage hay returned $53.92 per acre above pasture-forage costs.

Pea forage hay cut late

Pea forage hay cut at a late plant stage had production costs of $86.87 per acre and forage dry matter costs of $37.40 per ton. Production of late-cut pea forage hay to feed a 1200-pound cow during the 167-day nongrazing season would require 0.50 acres, and the forage would cost $43.40. Roughage supplementation would cost $31.30. Total forage and supplement costs would be $74.70 per nongrazing season, or $0.45 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.41 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.26 per pound. Total calf weight was 180.5 pounds, at a cost of $0.41 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $51.65 per cow-calf pair fed late-cut pea forage hay.

Haying pea forage at a late plant stage captured 685 pounds of crude protein per acre; the prorated cost of the nutrient was $0.13 per pound. Late-cut pea forage hay returned $103.30 per acre above pasture-forage costs.

Forage lentil hay cut early

Forage lentil hay cut at an early plant stage had production costs of $59.69 per acre and forage dry matter costs of $71.60 per ton. Production of early cut forage lentil hay to feed a 1200-pound cow during the 167-day nongrazing season would require 0.93 acres, and the forage would cost $57.50. Roughage supplementation would cost $45.31. Total forage and supplement costs would be $102.81 per nongrazing season, or $0.62 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.56 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.38 per pound. Total calf weight was 180.5 pounds, at a cost of $0.57 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $23.54 per cow-calf pair fed early cut forage lentil hay.

Haying forage lentil at an early plant stage captured 361 pounds of crude protein per acre; the prorated cost of the nutrient was $0.17 per pound. Early cut forage lentil hay returned $25.31 per acre above pasture-forage costs.

Forage lentil hay cut late

Forage lentil hay cut at a late plant stage had production costs of $71.48 per acre and forage dry matter costs of $37.00 per ton. Production of late-cut forage lentil hay to feed a 1200-pound cow during the 167-day nongrazing season would require 0.61 acres, and the forage would cost $43.43. Roughage supplementation would cost $32.20. Total forage and supplement costs would be $75.63 per nongrazing season, or $0.45 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.41 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.26 per pound. Total calf weight was 180.5 pounds, at a cost of $0.42 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $50.72 per cow-calf pair fed late-cut forage lentil hay.

Haying forage lentil at a late plant stage captured 567 pounds of crude protein per acre; the prorated cost of the nutrient was $0.13 per pound. Late-cut forage lentil hay returned $83.15 per acre above pasture-forage costs.

Oat-pea forage hay

Oat-pea forage hay had production costs of $95.52 per acre and forage dry matter costs of $37.20 per ton. Production of oat-pea forage hay to feed a 1200-pound cow during the 167-day nongrazing season would require 0.52 acres, and the forage would cost $50.69. Roughage supplementation would cost $25.06. Total forage and supplement costs would be $75.75 per nongrazing season, or $0.45 per day during that 167-day period.

Calves were born in mid March, with an average weight of 95 pounds at a cost of $0.41 per pound. Calf weight gain during the early lactation production period was 1.90 pounds per day, and accumulated weight gain was 85.5 pounds, at a cost of $0.26 per pound. Total calf weight was 180.5 pounds, at a cost of $0.42 per pound. When calf weight was assumed to have a value of $0.70 per pound, the gross value was $126.35 per calf. The net returns after pasture-forage costs were $50.60 per cow-calf pair fed oat-pea forage hay.

Haying oat-pea forage captured 611 pounds of crude protein per acre; the prorated cost of the nutrient was $0.15 per pound. Oat-pea forage returned $97.31 per acre above pasture-forage costs.

Table 13. Pasture and forage costs during the 167-day nongrazing season.

Forage-Type Treatments	Forage Dry Matter Cost $/ton	Forage Cost $	Supplement Cost $	Total Feed Cost $	Cost per Day $/d
Reserved Native Range with cake	122.13	252.99	26.08	279.07	1.67
Cropland Aftermath and Mature Crested Wheatgrass with cake	43.72	94.75	22.52	117.27	0.70
Mature Crested Wheatgrass with cake	34.80	93.67	22.86	116.53	0.70
Mature Crested Wheatgrass with cake and alfalfa-silage	34.80	77.92	27.25	105.17	0.63
Crested Wheatgrass, Early	40.80	47.22	31.59	78.81	0.47
Forage Barley, Early	28.80	37.52	26.69	64.21	0.38
Forage Barley, Late	27.40	51.59	13.58	65.17	0.39
Oat Forage, Early	29.60	43.43	20.89	64.32	0.39
Oat Forage, Late	26.40	57.50	11.11	68.61	0.41
Pea Forage, Early	55.00	50.69	41.15	91.84	0.55
Pea Forage, Late	37.40	43.40	31.30	74.70	0.45
Forage Lentil, Early	71.60	57.50	45.31	102.81	0.62
Forage Lentil, Late	37.00	43.43	32.20	75.63	0.45
Oat-Pea Forage	37.20	50.69	25.06	75.75	0.45

Table 14. Costs-returns per cow-calf pair during the 167-day nongrazing season.

Forage-Type Treatments	Calf Weight lbs	Pasture-forage Cost per pound Calf Weight $/lb	Gross Value Calf Weight @$0.70/lb $	Forage and Supplement Cost per Cow-Calf Pair $	Net Return per Cow-Calf Pair $
Reserved Native Range with cake	176.0	1.59	123.20	279.07	-155.87
Cropland Aftermath and Mature Crested Wheatgrass with cake	180.5	0.65	126.35	117.27	9.08
Mature Crested Wheatgrass with cake	180.5	0.65	126.35	116.53	9.82
Mature Crested Wheatgrass with cake and alfalfa-silage	180.5	0.58	126.35	105.17	21.18
Crested Wheatgrass, Early	180.5	0.44	126.35	78.81	47.54
Forage Barley, Early	180.5	0.36	126.35	64.21	62.14
Forage Barley, Late	180.5	0.36	126.35	65.17	61.18
Oat Forage, Early	180.5	0.36	126.35	64.32	62.03
Oat Forage, Late	180.5	0.38	126.35	68.61	57.74
Pea Forage, Early	180.5	0.51	126.35	91.84	34.51
Pea Forage, Late	180.5	0.41	126.35	74.70	51.65
Forage Lentil, Early	180.5	0.57	126.35	102.81	23.54
Forage Lentil, Late	180.5	0.42	126.35	75.63	50.72
Oat-Pea Forage	180.5	0.42	126.35	75.75	50.60

Table 15. Costs-returns per acre during the 167-day nongrazing season.

Forage-Type Treatments	Production Cost $/ac	Acres per Nongrazing Season ac	Crude Protein Yield lb/ac	Crude Protein Cost $/lb	Net Return per Acre $
Reserved Native Range with cake	8.76	28.89	8.74	1.04	-5.40
Cropland Aftermath and Mature Crested Wheatgrass with cake	7.98	9.21	102	0.28	0.99
Mature Crested Wheatgrass with cake	28.11	2.58	102	0.28	3.81
Mature Crested Wheatgrass with cake and alfalfa-silage	28.11	2.72	102	0.28	7.79
Crested Wheatgrass, Early	26.50	1.80	189	0.14	26.41
Forage Barley, Early	68.21	0.54	606	0.11	115.07
Forage Barley, Late	70.35	0.70	468	0.15	87.40
Oat Forage, Early	69.17	0.63	535	0.13	98.46
Oat Forage, Late	74.53	0.70	435	0.17	82.49
Pea Forage, Early	79.96	0.64	526	0.15	53.92
Pea Forage, Late	86.87	0.50	685	0.13	103.30
Forage Lentil, Early	59.69	0.93	361	0.17	25.31
Forage Lentil, Late	71.48	0.61	567	0.13	83.15
Oat-Pea Forage	95.52	0.52	611	0.15	97.31

Table 16. Cost per pound of calf weight during nongrazing season.

Forage-Type Treatments	Birth Weight Cost per Pound $/lb	Accumulated Weight Cost per Pound $/lb	Calf Weight Cost per Pound $/lb
Forage Barley, Early	0.36	0.21	0.36
Oat Forage, Early	0.36	0.21	0.36
Forage Barley, Late	0.34	0.26	0.36
Oat Forage, Late	0.30	0.34	0.38
Pea Forage, Late	0.41	0.26	0.41
Oat-Pea Forage	0.41	0.26	0.42
Forage Lentil, Late	0.41	0.26	0.42
Pea Forage, Early	0.50	0.33	0.51
Forage Lentil, Early	0.56	0.38	0.57
Crested Wheatgrass, Early	0.43	0.28	0.44
Mature Crested Wheatgrass with cake and alfalfa-silage	0.59	0.42	0.58
Mature Crested Wheatgrass with cake	0.59	0.55	0.65
Cropland Aftermath and Mature Crested Wheatgrass with cake	0.59	0.55	0.65
Reserved Native Range with cake	1.58	1.09	1.59

Summary of net returns per acre and per cow-calf pair

Net returns after pasture-forage costs per acre and per cow-calf pair are shown in table 17. Forage types with high net returns were forage barley hay cut early, at $115.07/acre and $62.14/cow-calf pair; pea forage hay cut late, at $103.30/acre and $51.65/cow-calf pair; oat forage hay cut early, at $98.46/acre and $62.03/cow-calf pair; oat-pea forage hay, at $97.31/acre and $50.60/cow-calf pair; forage barley hay cut late, at $87.40/acre and $61.18/cow-calf pair; forage lentil hay cut late, at $83.15/acre and $50.72/cow-calf pair; and oat forage hay cut late, at $82.49/acre and $57.74/cow-calf pair. Forage types with moderate net returns were pea forage hay cut early, at $53.92/acre and $34.51/cow-calf pair; crested wheatgrass hay cut early, at $26.41/acre and $47.54/cow-calf pair; and forage lentil hay cut early, at $25.31/acre and $23.54/cow-calf pair. Forage types with low net returns were mature crested wheatgrass hay with range cake and alfalfa-corn silage, at $7.79/acre and $21.18/cow-calf pair; mature crested wheatgrass hay with range cake, at $3.18/acre and $9.82/cow-calf pair; and cropland aftermath and mature crested wheatgrass hay with range cake, at $0.99/acre and $9.08/cow-calf pair. The forage type with negative net returns was reserved native range with range cake, at -$5.40/acre and -$155.87/cow-calf pair.

The plant growth stage at which the forages were grazed or hayed affected the net returns. Late-cut forage lentil hay returned $57.84/acre and $27.18/cow-calf pair more than early cut forage lentil hay. Late-cut pea forage hay returned $49.38/acre and $17.14/cow-calf pair more than early cut pea forage hay. Early cut forage barley hay returned $27.67/acre and $0.96/cow-calf pair more than late-cut forage barley hay. Early cut oat forage hay returned $15.97/acre and $4.29/cow-calf pair more than late-cut oat forage hay. Early cut crested wheatgrass hay returned $22.60/acre and $37.72/cow-calf pair more than mature crested wheatgrass hay. Summer-grazed native range pastures managed with the twice-over system returned $20.19/acre and $288.97/cow-calf pair more than reserved native range pastures grazed during the nongrowing season.

Annual legume hays harvested during the middle and late plant stages of development yielded a greater weight of crude protein per acre than the same hay harvested at early stages. The late-cut annual legume hays had lower forage costs and livestock feed costs and greater net returns than early cut annual legume hays.

Annual cereal hays and perennial grass hays harvested during early stages of development yielded greater weight of crude protein per acre than the same hay harvested at late and mature stages. The early cut annual cereal hays and perennial grass hays had lower forage costs and livestock feed costs and greater net returns than late-cut annual cereal hays and mature perennial grass hays.

Cereal-legume hays have a mixture of forage types with different optimum harvest times. The mixed hays generally have greater forage costs and lower net returns per acre than the cereal and legume hays seeded separately and harvested at their respective optimum plant stages. Oat-pea forage hay returned $1.15/acre less than early cut oat forage hay and $5.99/acre less than late-cut pea forage hay. The opposite relationships occur when the separately seeded cereal and legume hays are harvested at plant stages different from their optimum growth stage. Oat-pea forage hay returned $14.82/acre more than late-cut oat forage hay and $43.39/acre more than early cut pea forage hay.

The three mature crested wheatgrass hay treatments with different combinations of nutrient supplements returned low value per acre and per cow-calf pair, with values ranging from $7.79 to $0.99 per acre and $21.18 to $9.08 per cow-calf pair. Traditionally, domesticated perennial grass hays like crested wheatgrass and smooth bromegrass are harvested at the mature plant stage after the seed heads have developed and plants have reached maximum height. This practice yields high forage dry matter weight per acre but low crude protein weight per acre. Mature domesticated perennial grass hays have high forage costs and livestock feed costs and low net returns per acre and per cow-calf pair.

The extended grazing treatment, reserved native rangeland with range cake, used no harvested forages. The production costs were low, but the forage costs and livestock feed costs were extremely high. The net returns were a loss of $5.40/acre and a loss of $155.87 per cow-calf pair. The herbage biomass per acre during the nongrowing season was less than 33% to 50% of the summer herbage biomass. The crude protein captured per acre during the nongrowing season was less than 20% to 33% of the amount available for capture during the summer.

Table 17. Net returns after pasture-forage costs per acre and per cow-calf pair for forage types.

Forage-Type Treatments	Net Return per Acre $/acre	Net Return per Cow-Calf Pair $/c-c pr
Forage Barley, Early	115.07	62.14
Oat Forage, Early	98.46	62.03
Forage Barley, Late	87.40	61.18
Oat Forage, Late	82.49	57.74
Pea Forage, Late	103.30	51.65
Oat-Pea Forage	97.31	50.60
Forage Lentil, Late	83.15	50.72
Pea Forage, Early	53.92	34.51
Forage Lentil, Early	25.31	23.54
Crested Wheatgrass, Early	26.41	47.54
Mature Crested Wheatgrass with cake and alfalfa-silage	7.79	21.18
Mature Crested Wheatgrass with cake	3.81	9.82
Cropland Aftermath and Mature Crested Wheatgrass with cake	0.99	9.08
Summer Native Range with Twice-Over System	14.79	133.10
Reserved Native Range with cake	-5.40	-155.87

Projected pasture-forage costs and net returns

The individual cow-calf pair data for the pasture-forage and harvested-forage treatments were projected to a herd of 100 cows and a herd of 300 cows (table 18). The differences in the land area required for forage nutrient production, in the total feed costs, and in net returns among the treatments result from the differences in the biological effectiveness and the nutrient capture and conversion efficiency of the various forage management strategies.

The land area required to produce the forage nutrients for 100 cows during the nongrazing season was 54 to 70 acres for annual cereal hays; 50 to 93 acres for annual legume hays; 180 acres for early crested wheatgrass hay; 272 acres for mature crested wheatgrass hay, alfalfa hay, and corn silage; 258 acres for mature crested wheatgrass hay; 921 acres for cropland aftermath pasture; and 2889 acres for reserved native rangeland pasture.

Total feed costs (forage and supplement) for 100 cows during the nongrazing season were $6,421 to $6,861 for annual cereal hays; $7,470 to $10,281 for annual legume hays; $7,881 for early crested wheatgrass hay; $10,517 for mature crested wheatgrass hay, alfalfa hay, and corn silage; $11,653 for mature crested wheatgrass hay; $11,727 for cropland aftermath pasture; and $27,907 for reserved native rangeland pasture.

Net returns after pasture-forage feed costs for 100 cows during the nongrazing season were $5,774 to $6,214 from annual cereal hays; $2,354 to $5,165 from annual legume hays; $4,754 from early crested wheatgrass hay; $2,118 from mature crested wheatgrass hay, alfalfa hay, and corn silage; $982 from mature crested wheatgrass hay; $908 from cropland aftermath pasture; and a loss of $15,587 from reserved native rangeland pasture.

The land area required to produce the forage nutrients for 300 cows during the nongrazing season was 162 to 210 acres for annual cereal hays; 150 to 279 acres for annual legume hays; 540 acres for early crested wheatgrass hay; 816 acres for mature crested wheatgrass hay, alfalfa hay, and corn silage; 774 acres for mature crested wheatgrass hay; 2763 acres for cropland aftermath pasture; and 8667 acres for reserved native rangeland pasture.

Total feed costs (forage and supplement) for 300 cows during the nongrazing season were $19,263 to $20,583 for annual cereal hays; $22,410 to $30,843 for annual legume hays; $23,643 for early crested wheatgrass hay; $31,551 for mature crested wheatgrass hay, alfalfa hay, and corn silage; $34,959 for mature crested wheatgrass hay; $35,181 for cropland aftermath pasture; and $83,721 for reserved native rangeland pasture.

Net returns after pasture-forage feed costs for 300 cows during the nongrazing season were $17,322 to $18,642 from annual cereal hays; $7,062 to $15,495 from annual legume hays; $14,262 from early crested wheatgrass hay; $6,354 from mature crested wheatgrass hay, alfalfa hay, and corn silage; $2,946 from mature crested wheatgrass hay; $2,724 from cropland aftermath pasture; and a loss of $46,761 from reserved native rangeland pasture.

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 annual cereal hays and late-cut annual legume hays required to produce adequate forage. Cropland aftermath pasture and reserved native rangeland pasture required a great deal more land area than the harvested-forage types.

Early cut annual legume hays, mature crested wheatgrass hay, cropland aftermath pasture, and reserved native rangeland pasture were expensive forage for beef cows during the nongrazing 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.

Net returns after pasture-forage costs were high from annual cereal hays, late-cut annual legume hays, and oat-pea hay. Early crested wheatgrass hay and pea forage hay cut early had moderate net returns. Forage lentil hay cut early, mature crested wheatgrass hay with alfalfa hay and corn silage, mature crested wheatgrass hay, and crop aftermath pasture had low net returns. Reserved native rangeland pasture had negative net returns.

Table 18. Projection of net returns from 100-cow and 300-cow herds on forage management strategies during the 5.5-month nongrazing season.

Forage Management Strategies	100 Cows				300 Cows			
	Land Area	Total Feed Cost	Calf Weight Value @$0.70/lb	Net Return	Land Area	Total Feed Cost	Calf Weight Value @$0.70/lb	Net Return
	Acres	$	$	$	Acres	$	$	$
Reserved Native Range	2889	27,907	12,320	-15,587	8667	83,721	36,960	-46,761
Cropland Aftermath	921	11,727	12,635	908	2763	35,181	37,905	2724
Mature Crested Wheatgrass	258	11,653	12,635	982	774	34,959	37,905	2946
Mature Crested Wheatgrass, alfalfa hay, corn silage	272	10,517	12,635	2118	816	31,551	37,905	6354
Crested Wheatgrass, Early	180	7881	12,635	4754	540	23,643	37,905	14,262
Forage Barley, Early	54	6421	12,635	6214	162	19,263	37,905	18,642
Forage Barley, Late	70	6517	12,635	6118	210	19,551	37,905	18,354
Oat Forage, Early	63	6432	12,635	6203	189	19,296	37,905	18,609
Oat Forage, Late	70	6861	12,635	5774	210	20,583	37,905	17,322
Pea Forage, Early	64	9184	12,635	3451	192	27,552	37,905	10,353
Pea Forage, Late	50	7470	12,635	5165	150	22,410	37,905	15,495
Forage Lentil, Early	93	10,281	12,635	2354	279	30,843	37,905	7062
Forage Lentil, Late	61	7563	12,635	5072	183	22,689	37,905	15,216
Oat-Pea Forage	52	7575	12,635	5060	156	22,725	37,905	15,180

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 optimum plant stages that yield great amounts of crude protein per acre have low costs per unit of nutrient and are forages that provide low-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 were lower for mature crested wheatgrass hay than for annual cereal and annual legume forages. However, livestock feed costs for the mature crested wheatgrass forage treatment were considerably greater than 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 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 percent crude protein content and dry matter weight curves for a single forage type differ 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 in 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 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.

Grazing domesticated grassland and native rangeland pastures during the growing season provides low-cost forage for lactating beef cows because the amount of nutrients captured per acre is high in relation to forage production costs and because the animals' dietary requirements are met. Pasture-forage costs start to increase when the forage nutrient quality drops below the livestock requirements--sometime between mid July and early

August on traditionally managed pastures. Pasture-forage costs increase dramatically after mid October because the amount of nutrients captured per acre from the mature forage is low.

Extending the grazing season beyond mid October requires the use of forage types with low nutrient costs per pound. Such forages have a relatively high amount of nutrients captured per acre in proportion to forage production costs and are of sufficient quality to meet livestock dietary requirements. Of perennial grasses, only the wildryes retain nutrients in the aboveground parts of lead tillers into the fall and provide an economical forage for grazing after mid October. Altai wildrye provides low-cost forage for lactating beef cows from mid October to mid November. No perennial grass efficiently provides low-cost grazed forage beyond mid November, which is the end of the grazing season because perennial forage plants have low levels of biological activity and foliage growth is minimal.

Today's fast-growing, high performance cattle are genetically different from the old-style cattle and require greater quantities of nutrients throughout the production year. During the 5.5-month nongrazing season, from mid November to late April, the high-performance cow requires 20% more energy and 24% more crude protein than the old-style cow.

Extending grazing into the nongrowing season has traditionally been regarded as less expensive than feeding harvested forages; however, because of the high nutrient costs, having cows graze their own feed is not a low-cost strategy. Domesticated grass hay harvested at the mature stage is expensive feed because of the low quantity of nutrients captured per acre. Low-cost forages to feed beef cows during the nongrazing season, from mid November to late April, are provided from forage types when a high proportion of the produced nutrients are captured by efficient harvest management that results in low-cost nutrients. Several harvested annual cereal and annual legume hays cut at their optimum growth stage can be fed economically to range cows during the fall and winter.

Harvested forages cut at the growth stage that yields the greatest weight of nutrients per acre have low prorated costs per pound of nutrient and are low-cost forage. When the livestock feed costs are lower than the economic value of calf weight, the forage becomes a source of substantial income.

Conclusion

The feed costs from harvested forage fed during the nongrazing 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 grazed 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 nongrazing 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.

The valuable product from pastures and haylands is the nutrients, not the dry matter weight. The major factor determining pasture-forage costs is

the cost per pound of crude protein from a forage type. The cost per pound of crude protein is determined by the efficiency of nutrient capture for the harvest management of the forage type. The amount of income from or expense for a forage type is determined by the difference between the value of calf weight and the pasture-forage costs. Beef producers who determine the prorated costs per pound of nutrient and select a forage type that has lower feed costs than the value of calf weight have changed feeding beef cows during the nongrazing season from a major expense into a source of substantial income.

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