Expense or Income from Forage-Type Treatments for Range Cows during the Nongrowing Season

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Introduction

Most beef producers view feeding livestock during the nongrowing season as a major expense. However, economical forage sources can turn feeding livestock during this time from an expense into an 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 nongrowing 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 an income. The costs of forage types used for feed during the nongrowing 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 nongrowing season and determined whether feeding each type was an expense or an 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 nongrowing season, a period of about 5.5 months from mid November to late April, when air temperatures are low, liquid water is scarce, and growing grass material is unavailable as livestock feed.

The expense or income from fourteen forage-type treatments was compared. For each forage type, pasture-forage costs were evaluated against calf weight value to determine the profit or loss. Pasture-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. 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 4,143 pounds of dry matter, 2,202 pounds of energy (TDN), and 339 pounds of crude protein during the 167-day (5.5-month) nongrowing 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-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-forage costs for the dry gestation, third trimester, and early lactation production periods were used to determine cost per pound for the nongrowing-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.

Forage-type treatments

Fourteen grazingland-forage types and harvested-forage types were evaluated during the 167-day nongrowing 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.

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 the nongrowing 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 nongrowing 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 nongrowing season. Crude protein was supplemented with range cake as required during the dry gestation and third trimester production periods. The mature crested wheatgrass hay was supplemented with alfalfa hay and corn silage to meet 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 nongrowing 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 nongrowing 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 nongrowing 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 nongrowing 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 nongrowing 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 nongrowing 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 nongrowing 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 nongrowing 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 nongrowing season. Roughage was supplemented as required during the dry gestation, third trimester, and early lactation production periods
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Oat-pea forage hay

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

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

Costs-returns of forage types for range cows during the nongrowing season are shown in tables 1-4.

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 nongrowing 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 nongrowing season, or $1.67 per day during that 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 reserve 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 produced pasture-forage costs greater than the calf weight value. Reserve native range pastures supplemented with range cake returned a loss of $5.40 per acre.

Grazing 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 nongrowing season would require 9.21 acres, and the forage would cost $94.75. Cropland aftermath pastures were 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 lost 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 was fed would cost $22.52. Total forage and supplement costs would be $117.27 per nongrowing season, or $0.70 per day during that 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 nongrowing 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 nongrowing season, or $0.70 per day during that 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 nongrowing 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 nongrowing season, or $0.63 per day during that 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 nongrowing 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 nongrowing season, or $0.47 per day during that 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 nongrowing 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 nongrowing season, or $0.38 per day during that 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 nongrowing 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 nongrowing season, or $0.39 per day during that 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 nongrowing 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 nongrowing season, or $0.39 per day during that 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 nongrowing 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 nongrowing season, or $0.41 per day during that 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 nongrowing 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 nongrowing season, or $0.55 per day during that 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 nongrowing 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 nongrowing season, or $0.45 per day during that 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 nongrowing 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 nongrowing season, or $0.62 per day during that 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 nongrowing 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 nongrowing season, or $0.45 per day during that 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 nongrowing 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 nongrowing season, or $0.45 per day during that 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.

Net returns after pasture-forage costs per acre and per cow-calf pair are shown in table 5. 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 for the forage types. 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 and mature annual cereal hays and 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, 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.

Discussion

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 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.

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 nongrowing 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 valuable product from pastures and haylands is the nutrients, not the dry matter weight. The major determinant of 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 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 nongrowing season from a major expense into a source of substantial income.

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Table 1. Pasture and forage costs during the 167-day nongrowing 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 2. Costs-returns per cow-calf pair during the 167-day nongrowing 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 3. Costs-returns per acre during the 167-day nongrowing season.

Forage-Type Treatments	Production Cost $/ac	Acres per Nongrowing 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 4. Cost per pound of calf weight during nongrowing 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

Table 5. 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

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