INCREASING VALUE CAPTURED FROM THE LAND NATURAL RESOURCES

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Increasing Value Captured from the Land Natural Resources:
An Evaluation of Pasture Forage and Harvested Forage Management Strategies for Each Range Cow Production Period

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The purpose of this research project is to identify the factors that affect livestock pasture forage and harvested forage costs and to determine which factors can be controlled by management to improve profit margins from the production of beef and to increase the new wealth generated from the land natural resource without depletion of future production.

The three major areas of investment for a beef operation are the land, the cattle, and the labor and equipment. The natural tendency for agricultural producers to focus on the product sold at market has placed an industry wide priority on the livestock when management and economic decisions are made. This traditional approach assumes the livestock to be the source of revenue and the dry matter weight to be the sought after product from grazinglands and haylands for livestock forage feed. However, this long held paradigm has not reduced production costs nor increased income for beef producers.

Traditional management strategies for grazinglands and haylands concentrate on a single use of the land as feed for livestock, promote harvesting greater amounts of forage dry matter weight, and compensate for deficiencies in forage nutritional qualities with the practices of crude protein supplementation, creep feeding, and early weaning. These traditional practices are inherently inefficient at capturing forage produced nutrients and consequently they only generate a small portion of the potential new wealth from the land resources.

Forage dry matter does not have a real economic value because it is not incorporated into the beef weight produced. The dry matter is simply the carrier of the nutrients it contains; therefore, the cost of the forage dry matter is only indirectly related to forage feed costs. The nutrients are the valuable products produced by forage plants on the land. The cow processes the forage nutrients and produces milk resulting in calf weight accumulation. This calf weight is the commodity sold at the market, nevertheless, the original source of the income from the sale of beef weight is the forage nutrients. The renewable forage nutrients are the primary unit of production in a beef operation, and they are the source of new wealth from agricultural use of grazingland and hayland resources.

The major forage produced nutrients are energy (TDN) and crude protein. Crude protein is deficient in beef cattle forage based diets earlier in the growing season than energy. A pound of crude protein has a greater impact on the natural resources of an ecosystem to produce and a greater influence on the cost of livestock forage feed than the production of a pound of energy. The energy (TDN) produced by forage plants is part of the ecosystem's carbon cycle. Plants capture and fix carbon from atmospheric carbon dioxide with the hydrogen from soil water during the process of photosynthesis which converts energy from the sun into chemical energy. The assimilated carbon is combined in several ways to form various types of sugars and starches that are collectively called carbohydrates (CHO). These carbohydrates can be used as an energy source by the plant or by the herbivore that consumes plant parts. Capturing energy by fixing carbon has a relatively low impact on organisms that possess chlorophyll and on the ecosystem resources. The crude protein produced by forage plants is part of the ecosystem's nitrogen cycle. Inorganic nitrogen is taken up by plant roots from the surrounding rhizosphere and, through complex processes, the plant combines the inorganic nitrogen with carbon, hydrogen, and oxygen to synthesize different kinds of amino acids which are combined to produce various types of very large organic compounds called proteins. After parts of the plant are consumed by herbivores or parts of the plant die, the large nitrogenous compounds comprising the herbivore excreta or the dead plant material are broken down and converted from organic nitrogen into inorganic nitrogen through numerous complex stages by soil organisms in the rhizosphere. Transforming nitrogen from inorganic nitrogen to organic nitrogen and back to inorganic nitrogen is complex and has a great impact on many organisms at multiple trophic levels and on the ecosystem resources.

The quantity of new wealth generated from agricultural use of land resources is limited by the biological capacity of the forage plants to produce herbage and nutrients from soil, sunlight, water, and carbon dioxide and by the effectiveness of management treatments in capturing value from plant production. Increasing value captured from the land requires using management strategies that place priority on plant health and stimulate ecological biogeochemical processes, enhance vegetative plant growth, capture a high proportion of the produced nutrients, and efficiently convert these nutrients into saleable commodities such as calf weight.

The quantity of crude protein captured per acre as livestock feed is the factor that has the greatest influence on the costs of pasture forage and harvested forage and on the amount of new wealth generated from the land resources. The weight of crude protein captured per acre is related to the percent crude protein content and the weight of the forage dry matter at the time of grazing or haying. The cost per pound of crude protein is determined by the weight of the crude protein captured per acre prorated against the forage production costs which include the land costs, equipment costs, and labor costs per acre. Reductions in livestock feed costs result from capturing greater quantities of crude protein per acre. Capturing greater quantities of the produced crude protein from a land base causes a reduction in the amount of land area required to feed a cow-calf pair and results in lowering the forage feed costs because the forage production costs per acre are spread over a greater number of pounds of crude protein.

Reductions in forage dry matter costs, forage production costs, land rent costs, equipment costs, or labor costs may cause some reduction in cash expenditures but reductions in these costs do not directly regulate livestock forage feed costs because these costs do not respond proportionally to the variation in quantities of forage needed to provide livestock with adequate amounts of nutrients resulting from the differences in the weight of crude protein captured per acre through the grazing or haying of various forage types at different plant growth stages.

Generally, perennial and annual grass forages that are grazed or hayed at a mature plant stage, after flowering, are high-cost forages; the quantity of dry matter per acre is greater causing a reduction in production costs per ton of forage dry matter, however, the quantity of crude protein per acre is lower causing an increase in cost per pound of crude protein and requiring greater land area to provide adequate feed for a cow-calf pair resulting in an increase of forage feed costs. Perennial grass forages that are grazed or hayed at an early plant stage, after the three and a half new leaf stage and before flowering, and annual cereal forages that are cut between the boot stage and the milk stage are low-cost forages; the quantity of forage dry matter per acre is less causing an increase in production costs per ton of forage dry matter but the quantity of crude protein captured per acre is greater causing a decrease in cost per pound of crude protein and requiring less land area to provide adequate feed for a cow-calf pair resulting in a decrease of forage feed costs.

Generally, legume forages yield the greatest weight of crude protein per acre 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 legume forages when plants are cut one time per year during a late full-growth stage resulting in lower forage feed costs. Legume forages cut at early plant growth stages yield higher crude protein percentages but because the weight of the crude protein captured per acre is lower, the cost per pound of crude protein is higher and the forage feed costs are higher.

Selection of pasture forage types and harvested forage types that effectively increase new wealth generated from land natural resources and reduce forage feed costs during each range cow production period can be made through comparisons of the cost per pound of captured crude protein, cost per day of forage feed, cost per pound of calf weight gain, land area required per cow-calf pair, and returns after feed costs per acre. Counterintuitively, comparisons of the traditional evaluation criteria of forage dry matter costs, forage production costs, land rent costs, equipment costs, or labor costs do not identify pasture forage types and harvested forage types that provide low forage feed costs.

This study uses forage feed production costs and returns after feed costs to compare and evaluate pasture forage types and harvested forage types during range cow production periods. This study is not a complete economic analysis of total livestock production costs or a study in livestock marketing schemes.

A positive profit margin can be achieved for a 12-month period from the production of beef during a low market cycle with calf weight valued at $0.70 per pound at weaning time when the forage feed costs average $0.62 or less per day, captured crude protein

costs average $0.25 or less per pound, and calf weight gain costs average $0.42 or less per pound.

Procedure

This study determines and compares forage feed costs and returns after feed costs of pasture forage types and harvested forage types during range cow production periods. Production periods were differentiated when there was a change in cow nutrient requirements or a change in forage type use resulting from biological variations in plant growth curves. The 12-month range cow production cycle included the development and growth of a calf starting from late middle gestation in mid November through birth in mid March and continuing until weaning during the consecutive mid November.

The format of this report is intended to assist beef producers with the evaluation of the pasture forage and harvested forage management practices that they currently use and to assist in the development of efficient and biologically effective pasture forage and harvested forage strategies that reduce forage feed costs, increase returns after feed costs, and increase new wealth captured from the land resources.

Pasture forage and harvested forage costs of feed to meet range cow dry matter and crude protein requirements and the resulting net returns after feed costs per cow-calf pair and per acre were determined for each of the different range cow production periods 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 captured crude protein per acre; then, production costs per acre were divided by pounds of captured crude protein per acre.

Grazingland area per cow-calf pair per month and per production period were determined in two stages: first, pounds of forage dry matter per acre were divided by pounds of forage dry matter required per cow-calf pair per day to derive number of grazing days per acre; then, the average number of days per month (30.5d) or the number of days per production period was divided by the number of grazing days per acre. Pasture forage costs per production period was determined by multiplying the acres of grazingland per cow-calf pair per production period by the production cost per acre.

Harvested forage land area per cow-calf pair per production period was determined in two stages: first, pounds of crude protein required per cow per day during the production period were divided by percentage of crude protein of forage type to derive pounds of forage dry matter to provide as feed per cow-calf pair 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 the number of days per production period. Harvested forage cost per production period was determined by multiplying the pounds of harvested forage to feed per cow-calf pair per production period by the harvested forage cost per pound.

Roughage supplementation costs per production period were determined in three stages: first, the pounds of harvested forage to feed per cow-calf pair per day were subtracted from the pounds of harvested forage allocation per cow-calf pair per day; next, the pounds of roughage supplementation to feed per cow-calf pair per day was multiplied by the number of days per production period; then, the pounds of roughage supplement per period was multiplied by the market cost of the roughage per pound.

Crude protein supplementation costs per production period were determined in three stages: first, the pounds of crude protein provided by the forage allocation per day was subtracted from the pounds of crude protein required per cow per day; next, the pounds of crude protein supplementation to feed per cow-calf pair per day was multiplied by the number of days per production period; then, the pounds of crude protein supplement per period was multiplied by the market cost of the crude protein per pound.

Total feed cost per production period were determined by the sum of the pasture or harvested forage costs and the roughage or crude protein supplementation costs per production period. The total feed costs per production period were divided by the number of days per production period to determine the total feed cost per day.

Dollar value of calf weight gain per production period was 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, calf weight gain per period was multiplied by an assumed low market value of $0.70 per pound. The low market value of $0.70 per pound was used to evaluate and identify pasture forage and harvested forage types that would produce positive returns after feed costs during low portions in the cattle cycle. Net returns after feed costs per cow-calf pair was determined by subtracting the total feed costs per production period from the dollar value of calf weight gain per production period. Net returns after feed costs per acre was determined by dividing the net returns after feed costs per cow-calf pair per production period by the number of acres per cow-calf pair per period. Costs per pound of calf weight gain per production period were determined by dividing the total feed costs per production period by the pounds of calf weight accumulated per period.

The terms "herbage" and "forage" are not synonymous. Herbage is the total amount of aboveground biomass of herbaceous plants like grasses and forbs. Forage is the portion of the herbage that can be removed without detriment to the plants and can provide feed for grazing animals or be harvested mechanically for feeding. About 50% of the herbage produced by a perennial plant on grazinglands must remain with the plant to sustain healthy and productive growth. About 50% of the herbage biomass produced during the growing season can be removed from the plant without harmful effects to plant health. The amount of forage ingested by grazing livestock is actually only about 50% of this quantity, or about 25% of the aboveground herbage biomass on seasonlong and single-grazing-period treatments. The remainder of the herbage that can be removed is broken from the plant, soiled by animal waste, consumed by insects and wildlife, and lost to other natural processes.

Forage plants in pastures saved for grazing during fall and winter are categorized as reserved 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 in reference with 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 prestored 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.

Base Line Forage and Livestock Data

The base line pasture forage and harvested forage data and cow and calf weight performance data used in the current study to determine 12-month range cow production period forage feed costs and returns after forage costs were developed from numerous pasture forage and harvested forage management research projects conducted at the NDSU Dickinson Research Extension Center, located in western North Dakota.

Herbage weight for pasture forage types (tables 1-5) were based on the means of the average monthly herbage biomass data (Manske 2003c) collected by the clipping method during the period grazed on pasture management treatments involved in grazingland research projects conducted between 1983 and 1998 (Manske 2001). Forage dry matter weight was 25% of the pasture herbage weight (Manske 2003c). Percent crude protein data for native rangeland and crested wheatgrass forages during the period grazed (tables 1-5) were taken from Whitman et al. (1951) and Manske (1999a, b, c). Herbage weight data used in determination of stocking rates for the native rangeland repeated seasonal treatments were collected monthly from ungrazed plots (Manske 2001). Grazing dates and stocking rates for pasture forage types were means of data collected on the grazingland research projects (Manske 2001). Monthly herbage dry matter yield per acre on spring seeded winter cereal pastures (tables 1 and 5) was taken from Manske (2004). Herbage dry matter yield per acre on standing corn pastures (tables 1 and 2) was taken from Nelson et al. (2002).

Forage dry matter yield per acre and percent crude protein for annual crop varieties harvested as hay were collected on agronomic forage crop studies and reported annually (Carr 1995-1999). A summary of harvested forage production data for annual cereal

and annual legume hays and perennial domesticated grass hay (table 6) were reported by Manske and Carr (2000).

Average production costs per acre for pasture forage types and harvested forage types (Manske 2002) were determined by adding applicable average land rent per acre from western North Dakota (table 8), average custom farm work rates (Beard 1998) (table 9), average seed costs per acre (Swenson and Haugen 1999) (table 10), and average custom baling rate per half ton of hay (table 9). Production costs do not include costs of fertilizer, pesticides, or transporting of feed, forages, and livestock unless specified. One pasture treatment of crested wheatgrass was fertilized annually with 50 pounds of nitrogen per acre at an average cost of $12.50 per acre. The pasture rent value of $8.76 per acre was used to determine costs for native rangeland and domesticated grassland grazingland (table 8). The value of $2.00 per acre was used for cropland aftermath grazing costs (table 8). 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 harvested forage types (table 8). Supplemental crude protein was provided as 20% crude protein range cake at a cost of $120.00 per ton ($0.30/lb CP). Supplemental forage dry matter was provided as roughage at a cost of $35.00 per ton ($0.0175/lb) (Manske 2001). Production costs per acre ($126.67), crude protein supplementation per day (0.54 lb/d), and feed costs per day ($1.23/d) for standing corn pastures were taken from Nelson et al. (2002).

Commercial Hereford and Angus-Hereford cows with calves were used on the pasture forage treatments. Individual animals were weighed on and off each treatment and at biweekly or monthly intervals during the grazing season. Average livestock weight data collected during a production period (tables 1-5) were used to determine cow and calf weight performance (Manske 2003a, b). Cow performance on spring seeded winter cereal pastures (tables 1 and 5) was taken from Manske (2004). Cow performance on standing corn pastures (tables 1 and 2) was taken from Nelson et al. (2002). Calf fetus weight gain was estimated to be 0.78 pounds per day from an average birth weight of 95 pounds accumulated over 122 days during the 32-day dry gestation period and the 90-day third trimester period (table 7). Calf weight gain on harvested forage treatments was estimated to be 1.90 pounds per day during the early lactation period and 2.00 pounds per day during spring, summer, and fall lactation periods (table 7).

Range cow daily nutritional requirements, which change with cow size, level of milk production, and production period (table 11) were taken from NRC (1996). Pasture forage dry matter allocation is a little greater than cow dry matter intake requirements. Daily dry matter allocation of pasture forage is 26 lbs for 1000 lb cows, 30 lbs for 1200 lb cows, and 33 lbs for 1400 lb cows (Manske 2003c) (table 12). Cow nutrient requirements change during the different production periods. The time of year during which the production periods occur is effected by the calf birth date. During this study, the dry matter and crude protein requirements for range cows with an average weight of 1200 lbs and an average calf birth date in mid March were used. The 12-month sequence of range cow production periods is shown in table 13. The dollar value of calf weight accumulated during each range cow production period was determined by the assumed low market price of $0.70 per pound.

Pasture Forage Types

The pasture forage types evaluated during the dry gestation production period were: native rangeland repeated seasonal, cropland aftermath, spring seeded winter cereal, and standing corn seasonal pastures. The pasture forage types evaluated during the third trimester production period were: native rangeland repeated seasonal and standing corn seasonal pasture. The pasture forage type evaluated during the early lactation production period was: native rangeland repeated seasonal. The pasture forage types evaluated during the spring lactation production period were: native rangeland repeated seasonal, 6.0-month seasonlong, crested wheatgrass unfertilized, crested wheatgrass extended use, and crested wheatgrass fertilized pastures. The pasture forage types evaluated during the summer lactation production period were: native rangeland repeated seasonal, 6.0-month seasonlong, 4.5-month seasonlong started early June, deferred grazing, and twice-over rotation management strategies. The pasture forage types evaluated during the fall lactation production period were: native rangeland repeated seasonal, 6.0-month seasonlong, 5.5-month seasonlong, deferred grazing, and 4.5-month seasonlong started mid June management strategies and Altai wildrye, cropland aftermath, and spring seeded winter cereal seasonal pastures.

Procedures to determine forage feed costs and returns after feed costs for pasture forage types during range cow production periods.

A. Select calf birth month: mid March
B. Select cow size on 1 June: 1200 lbs
C. Select range cow production period: table 13
D. Select pasture forage type: tables 1-5
E. Complete the following steps

1. Forage weight per acre is equal to
   mean monthly pasture herbage weight per acre during period grazed multiplied by 25% (tables 1-5).

2. Production cost per acre is equal to
   land rent per acre (table 8) plus any custom farm work costs (table 9).

3. Forage dry matter cost per pound is equal to
   production cost per acre (#2) divided by forage weight per acre (#1).

4. Forage dry matter cost per ton is equal to
   forage dry matter cost per pound (#3) multiplied by 2000 pounds (1 ton).

5. Crude protein weight per acre is equal to
   forage weight per acre (#1) multiplied by % crude protein of forage type (tables 1-5).

6. Crude protein cost per pound is equal to
   production cost per acre (#2) divided by pounds of crude protein per acre (#5).

7. Pounds of pasture forage allocation per cow-calf pair per day is equal to
   30 lb/d for 1200 lb cows (table 12).

8. Number of grazing days per acre on pasture forage types is equal to
   forage weight per acre (#1) divided by pounds of forage allocation per cow-calf pair per day (#7).

9. Acres of grazingland per cow-calf pair per month is equal to
   average number of days per month (30.5d) divided by number of grazing days per acre (#8).

10. Acres of grazingland per cow-calf pair per production period is equal to
    number of days per period (table 13) divided by number of grazing days per acre (#8).

11. Pasture forage cost per production period is equal to
    acres of grazingland per cow-calf pair per period (#10) multiplied by production cost per acre (#2).

12. Pounds of crude protein supplementation per day is equal to
    pounds of crude protein required per cow per day (table 11) minus (pounds of forage allocation per cow-calf pair per day (#7) multiplied by % crude protein of forage type (tables 1-5)).

13. Pounds of crude protein supplementation per production period is equal to
    pounds of crude protein supplementation per day (#12) multiplied by number of days per period (table 13).

14. Crude protein cost per production period is equal to
    pounds of crude protein supplementation per period (#13) multiplied by market cost of crude protein per pound ($0.30/lb CP).

15. Total feed costs per production period is equal to
    forage cost per period (#11 for pasture forage) plus supplementation costs per period (#14 for crude protein supplement).

16. Total feed costs per day is equal to
    total feed costs per production period (#15) divided by number of days per period (table 13).

17. Calf accumulated weight per production period is equal to
    weight of calf at end of period minus weight of calf at beginning of period (tables 1-5, calf gain/period).

18. Dollar value of calf weight per production period is equal to
    calf weight accumulated during production period (#17) multiplied by market price per pound ($0.70/lb).

19. Net returns after feed costs per cow-calf pair is equal to
    dollar value of calf weight per period (#18) minus total feed cost per period (#15).

20. Net returns after feed costs per acre is equal to
    net returns per cow-calf pair (#19) divided by number of acres per cow-calf pair per period (#10).

21. Cost per pound of calf weight gain per production period is equal to
    total feed costs per period (#15) divided by pounds of calf weight accumulated per period (#17).

Harvested Forage Types

The selected harvested forage types were evaluated during each range cow production period as hay cut by swathing and rolled into large round bales. Late crested wheatgrass hay was cut at a mature plant stage. Early crested wheatgrass hay was cut at the boot stage. Forage barley hay was cut both at the milk stage and at the hard dough stage. Oat forage hay was cut both at the milk stage and at the hard dough stage. Pea forage hay was cut at both early and late plant stages. Forage lentil hay was cut at both early and late plant stages. Oat-pea forage hay was cut at compromised plant stages of later than optimum for oat and earlier than optimum for pea.

Procedures to determine forage feed costs and returns after feed costs for harvested forage types during range cow production periods.

A. Select calf birth month: mid March
B. Select cow size on 1 June: 1200 lbs
C. Select range cow production period: table 13
D. Select harvested forage type: table 6
E. Complete the following steps

1. Forage weight per acre is equal to
   the harvested forage weight per acre removed by harvest methods (table 6).

2. Production cost per acre is equal to
   land rent per acre (table 8) plus custom farm work costs (table 9) plus seed cost per acre (table 10) plus baling cost [baling rate/1000 lbs (table 9) multiplied by (forage weight per acre (#1) divided by 1000 lbs (½ ton))].

3. Forage dry matter cost per pound is equal to
   production cost per acre (#2) divided by forage weight per acre (#1).

4. Forage dry matter cost per ton is equal to
   forage dry matter cost per pound (#3) multiplied by 2000 pounds (1 ton).

5. Crude protein weight per acre is equal to
   forage weight per acre (#1) multiplied by % crude protein of forage type (table 6).

6. Crude protein cost per pound is equal to
   production cost per acre (#2) divided by pounds of crude protein per acre (#5).

7. Pounds of harvested forage allocation per cow-calf pair per day is equal to
   pounds of dry matter intake required per cow per day (table 11) or use pounds of pasture forage allocation per cow-calf pair per day which is 30 lb/d for 1200 lb cows (table 12).

8. Pounds of harvested forage to feed per cow-calf pair per day is equal to
   pounds of crude protein intake required per cow per day (table 11) divided by % crude protein of forage type (table 6).

9. Pounds of harvested forage to feed per cow-calf pair per production period is equal to
   pounds of harvested forage to feed per day (#8) multiplied by number of days per period (table 13).

10. Acres of land harvested per cow-calf pair per production period is equal to
    pounds of harvested forage to feed per period (#9) divided by forage weight per acre (#1), (table 6, land area/period).

11. Harvested forage cost per production period is equal to
    pounds of harvested forage to feed per cow-calf pair per period (#9) multiplied by harvested forage cost per pound (#3).

12. Pounds of roughage supplementation per day is equal to
    pounds of harvested forage allocation per cow-calf pair per day (#7) minus pounds of harvested forage to feed per cow-calf pair per day (#8).

13. Pounds of roughage supplementation per production period is equal to
    pounds of roughage supplementation per day (#12) multiplied by number of days per period (table 13).

14. Roughage cost per production period is equal to
    pounds of roughage supplementation per period (#13) multiplied by market cost of roughage per pound ($0.0175/lb).

15. Pounds of crude protein supplementation per day is equal to
    pounds of crude protein required per cow per day (table 11) minus (pounds of forage allocation per cow-calf pair per day (#7) multiplied by % crude protein of forage type (table 6)).

16. Pounds of crude protein supplementation per production period is equal to
    pounds of crude protein supplementation per day (#15) multiplied by number of days per period (table 13).

17. Crude protein cost per production period is equal to
    pounds of crude protein supplementation per period (#16) multiplied by market cost of crude protein per pound ($0.30/lb).

18. Total feed costs per production period is equal to
    forage cost per period (#11) plus supplementation costs per period (#14 for roughage supplement) or (#17 for crude protein supplement).

19. Total feed costs per day is equal to
    total feed costs per production period (#18) divided by number of days per period (table 13).

20. Calf accumulated weight per production period is equal to
    weight of calf at end of period minus weight of calf at beginning of period (table 7).

21. Dollar value of calf weight is equal to
    calf weight accumulated during production period (#20) multiplied by market price per pound ($0.70/lb)

22. Net returns after feed costs per cow-calf pair is equal to
    dollar value of calf weight per period (#21) minus total feed cost per period (#18).

23. Net returns after feed costs per acre is equal to
    net returns per cow-calf pair (#22) divided by number of acres per cow-calf pair per period (#10).

24. Cost per pound of calf weight gain per production period is equal to
    total feed costs per period (#18) divided by pounds of calf weight accumulated per period (#20).

Table 1. Vegetation and livestock production values on pasture forage types during the dry gestation period.

	Native Rangeland Repeated Seasonal	Cropland Aftermath Seasonal Pasture	Spring Seeded Winter Cereal Seasonal Pasture	Standing Corn Seasonal Pasture
Production Period	Dry Gestation	Dry Gestation	Dry Gestation	Dry Gestation
Days	32	32	32	32
Herbage Wt. lb/ac	725	270	2487	9940
Forage Wt. lb/ac	180	135	1745	3840
Crude Protein %	4.8			
Crude Protein lb/ac	8.64			
Acres/Month ac	5.08	6.63	0.53	0.24
Acres/Period ac	5.33	7.10	0.56	0.25
Cow Gain/Day lb		-1.14	1.05	3.30
Cow Gain/Acre lb		-4.82	60.14	422.40
Cow Gain/Period lb		-36.48	33.68	105.60
Calf Gain/Day lb	0.78	0.78	0.78	0.78
Calf Gain/Acre lb	4.68	3.51	44.50	99.68
Calf Gain/Period lb	24.92	24.92	24.92	24.92

Table 2. Vegetation and livestock production values on pasture forage types during the third trimester and early lactation periods.

	Native Rangeland Repeated Seasonal	Standing Corn Seasonal Pasture	Native Rangeland Repeated Seasonal
Production Period	Third Trimester	Third Trimester	Early Lactation
Days	90	90	45
Herbage Wt. lb/ac	580	9940	480
Forage Wt. lb/ac	145	3840	125
Crude Protein %	4.8		9.2
Crude Protein lb/ac	6.96		11.50
Acres/Month ac	6.31	0.24	7.32
Acres/Period ac	18.62	0.70	10.80
Cow Gain/Day lb		0.86	
Cow Gain/Acre lb		110.57	
Cow Gain/Period lb		77.40	
Calf Gain/Day lb	0.78	0.78	1.80
Calf Gain/Acre lb	3.76	100.11	7.50
Calf Gain/Period lb	70.08	70.08	81.00

Table 3. Vegetation and livestock production values on pasture forage types during the spring lactation period.

	Native Rangeland Repeated Seasonal	Native Rangeland 6.0-m Seasonlong	Crested Wheatgrass Unfertilized	Crested Wheatgrass Unfertilized Extended Use	Crested Wheatgrass Fertilized
Production Period	Spring Lactation	Late Spring Lactation	Spring Lactation	Spring and Early Summer Lactation	Spring Lactation
Days	31	16	31	76	31
Herbage Wt. lb/ac	780	906	1980	2192	4960
Forage Wt. lb/ac	195	226	495	548	1240
Crude Protein %	16.3		16.8		
Crude Protein lb/ac	31.79		83.36		
Acres/Month ac	4.62	4.04	1.82	1.67	0.73
Acres/Period ac	4.77	2.10	1.88	4.16	0.75
Cow Gain/Day lb		0.14	1.95	0.91	2.68
Cow Gain/Acre lb		1.09	32.15	16.63	110.77
Cow Gain/Period lb		2.30	60.45	69.16	83.08
Calf Gain/Day lb	1.80	1.80	1.91	1.79	2.18
Calf Gain/Acre lb	11.70	13.64	31.49	32.70	90.11
Calf Gain/Period lb	55.80	28.80	59.21	136.04	67.58

Table 4. Vegetation and livestock production values on pasture forage types during the summer lactation period.

	Native Rangeland Repeated Seasonal	Native Rangeland 6.0-m Seasonlong	Native Rangeland 4.5-m Seasonlong	Native Rangeland Deferred Grazing	Native Rangeland Twice-over Rotation
Production Period	Summer Lactation	Summer Lactation	Summer Lactation	Late Summer Lactation	Summer Lactation
Days	137	137	137	92	137
Herbage Wt. lb/ac	1450	906	1280	1649	1794
Forage Wt. lb/ac	363	226	320	412	449
Crude Protein %	9.6				
Crude Protein lb/ac	34.85				
Acres/Month ac	2.52	4.04	2.86	2.22	2.04
Acres/Period ac	11.32	18.10	12.70	6.70	9.00
Cow Gain/Day lb		0.14	0.34	0.32	0.62
Cow Gain/Acre lb		1.09	3.67	4.40	9.44
Cow Gain/Period lb		19.66	46.58	29.44	84.94
Calf Gain/Day lb	1.80	1.80	2.09	1.80	2.21
Calf Gain/Acre lb	21.78	15.63	22.55	24.73	33.64
Calf Gain/Period lb	246.60	282.87	286.33	196.50	302.77

Table 5. Vegetation and livestock production values on pasture forage types during the fall lactation period.

	Native Rangeland Repeated Seasonal	Native Rangeland 6.0-m Seasonlong	Native Rangeland 5.5-m Seasonlong	Native Rangeland Deferred Grazing	Native Rangeland 4.5-m Seasonlong
Production Period	Fall Lactation	Fall Lactation	Fall Lactation	Fall Lactation	Early Fall Lactation
Days	30	30	30	30	15
Herbage Wt. lb/ac	797	891	1423	1649	973
Forage Wt. lb/ac	199	223	356	412	243
Crude Protein %	4.8				
Crude Protein lb/ac	9.55				
Acres/Month ac	4.60	4.04	2.53	2.22	3.26
Acres/Period ac	4.60	4.04	2.53	2.18	1.63
Cow Gain/Day lb		-1.74	-0.82	-0.74	-0.52
Cow Gain/Acre lb		-12.90	-9.77	-9.96	-4.75
Cow Gain/Period lb		-52.20	-24.60	-22.20	-7.74
Calf Gain/Day lb	1.80	0.59	0.92	0.77	1.35
Calf Gain/Acre lb	11.83	4.38	10.90	10.36	6.71
Calf Gain/Period lb	54.00	17.73	27.60	23.10	20.33

Table 5 (cont). Vegetation and livestock production values on pasture forage types during the fall lactation period.

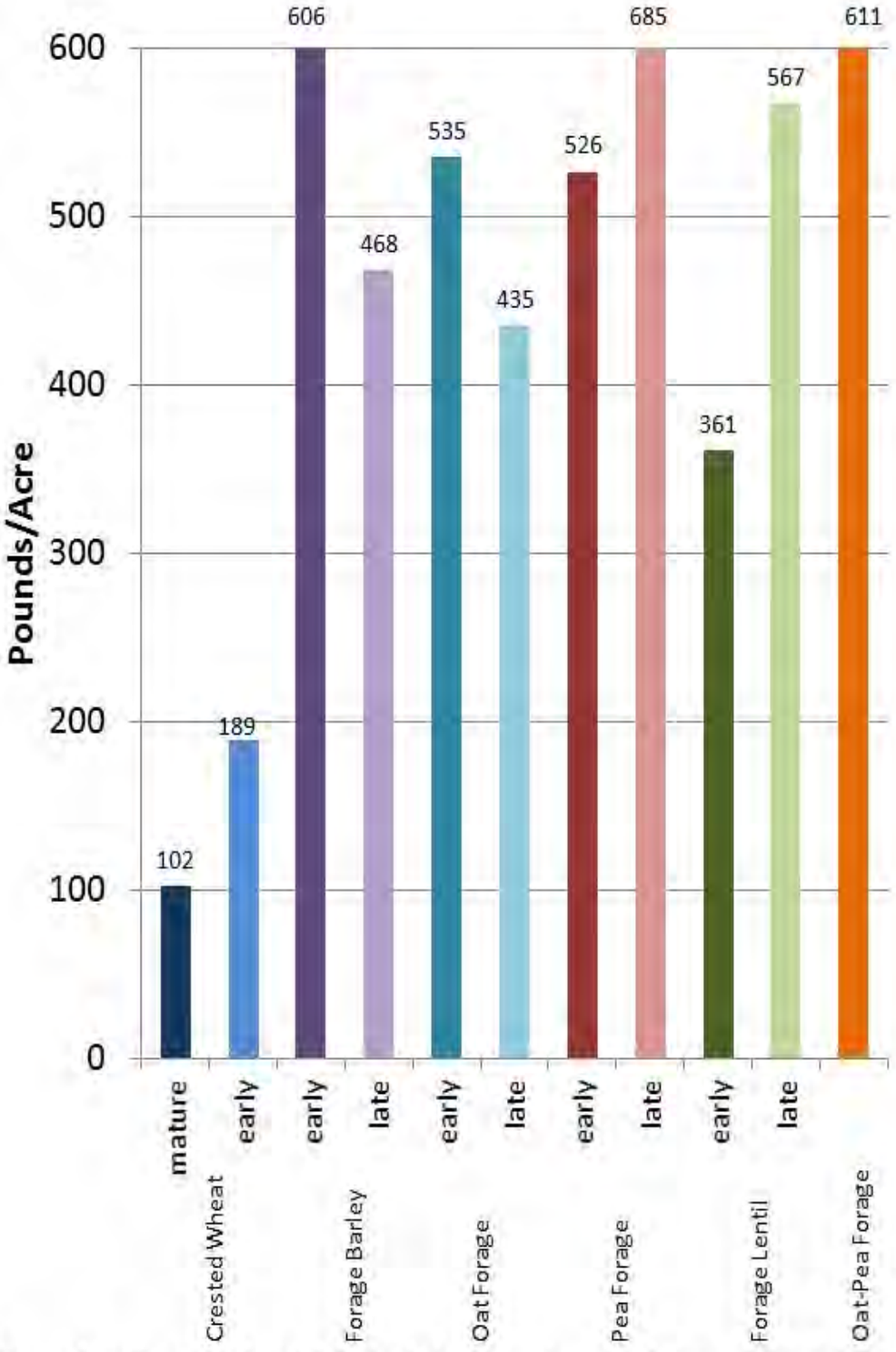
	Altai Wildrye	Cropland Aftermath	Spring Seeded Winter Cereal
Production Period	Fall Lactation	Fall Lactation	Fall Lactation
Days	30	30	30
Herbage Wt. lb/ac	2590	270	
Forage Wt. lb/ac	648	135	1908
Crude Protein %			
Crude Protein lb/ac			
Acres/Month ac	1.39	6.63	0.47
Acres/Period ac	1.39	6.63	0.47
Cow Gain/Day lb	0.55	-1.61	1.05
Cow Gain/Acre lb	11.87	-7.27	67.02
Cow Gain/Period lb	16.50	-48.17	31.50
Calf Gain/Day lb	1.73	0.42	2.00
Calf Gain/Acre lb	37.96	1.90	127.66
Calf Gain/Period lb	52.77	12.57	60.00

Table 6. Vegetation production values on harvested forage types during range cow production periods.

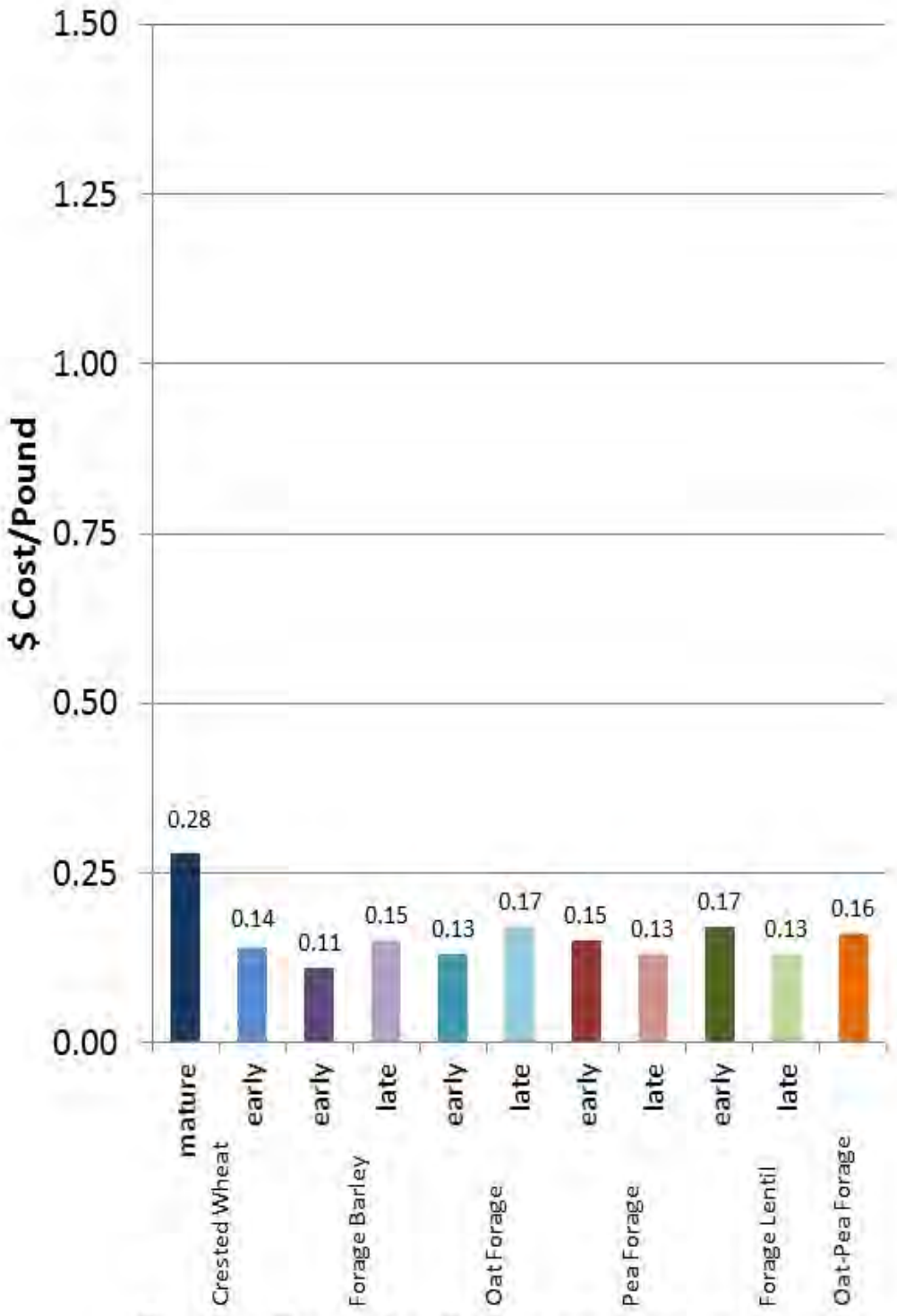
		Crested Wheatgrass mature	Crested Wheatgrass early	Forage Barley early	Forage Barley late	Oat Forage early	Oat Forage late
Herbage Wt.	lb/ac						
Forage Wt.	lb/ac	1600	1300	4733	5133	4667	5667
Crude Protein	%	6.4	14.5	13.0	9.2	11.5	7.8
Crude Protein	lb/ac	102	189	606	468	535	435
Land Area/Period							
Dry Gestation	ac	0.47	0.26	0.08	0.10	0.09	0.11
Third Trimester	ac	1.35	0.89	0.27	0.36	0.31	0.38
Early Lactation	ac	0.76	0.65	0.20	0.24	0.23	0.21
Spring Lactation	ac	0.58	0.41	0.13	0.16	0.14	0.16
Summer Lactation	ac	2.57	1.82	0.56	0.73	0.64	0.73
Fall Lactation	ac	0.56	0.40	0.12	0.16	0.14	0.16

Table 6 (cont). Vegetation production values on harvested forage types during range cow production periods.

		Pea Forage early	Pea Forage late	Forage Lentil early	Forage Lentil late	Oat-Pea Forage
Herbage Wt.	lb/ac					
Forage Wt.	lb/ac	2800	4650	1667	3867	5143
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein	lb/ac	526	685	361	567	611
Land Area/Period						
Dry Gestation	ac	0.09	0.07	0.13	0.09	0.07
Third Trimester	ac	0.32	0.25	0.46	0.30	0.26
Early Lactation	ac	0.23	0.18	0.34	0.22	0.19
Spring Lactation	ac	0.15	0.12	0.21	0.14	0.12
Summer Lactation	ac	0.65	0.51	0.95	0.60	0.53
Fall Lactation	ac	0.14	0.11	0.21	0.13	0.12



Crude Protein Weight Captured per Acre on Harvested Forages During Range Cow Production Periods



Crude Protein Costs per pound on Harvested Forages During Range Cow Production Periods

Table 7. Estimated calf weight performance on harvested forage types during range cow production periods.

Production Periods	Days	Calf Gain per Day lb	Calf Gain per Period lb
Dry Gestation	32	0.78	24.92
Third Trimester	90	0.78	70.08
Early Lactation	45	1.90	85.50
Spring Lactation	31	2.00	62.00
Summer Lactation	137	2.00	274.00
Fall Lactation	30	2.00	60.00

Table 8. Land rent values for western North Dakota.

		Cropland*	Hayland*	Grazingland*	Cropland Aftermath
Mean rent	$/ac	22.07	14.22	8.76	2.00

*Data from North Dakota Agricultural Statistics Service

Table 9. Custom farm work rates in North Dakota.

		Annual Cereal Hay	Annual Legume Hay	Cereal Legume Hay	Perennial Grass Hay
Min till drill	$/ac	9.32	9.32	9.32	
Swath/Condition	$/ac	6.76	6.76	6.76	
Swathing	$/ac				5.31
Custom Work	$/ac	16.08	16.08	16.08	5.31
Baling/1000 lbs	$	5.36	5.36	5.36	5.36

Data from North Dakota Agricultural Statistics Service (Beard 1998)

Table 10. Seed costs per acre.

		Barley	Oat	Pea	Lentil	Oat-Pea
Seed Cost	$/ac	4.69	6.00	23.80	12.60	29.80

Data from NDSU Extension Service (Swenson and Haugen 1999)

Table 11. Intake dry matter and crude protein requirements for range cows with average milk production during the livestock production periods.

Production Period		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation
Days		32	90	45	31	137	30
1000 lb Cows							
Dry Matter	lb/d	21	21	24	24	24	24
Crude Protein	lb/d	1.30	1.64	2.52	2.30	2.30	2.30
1200 lb Cows							
Dry Matter	lb/d	24	24	27	27	27	27
Crude Protein	lb/d	1.49	1.87	2.73	2.51	2.51	2.51
1400 lb Cows							
Dry Matter	lb/d	27	27	30	30	30	30
Crude Protein	lb/d	1.67	2.13	2.94	2.70	2.70	2.70

Data from NRC 1996

Table 12. Daily dry matter allocation for cows grazing pasture forage.

		1000 lb cow	1200 lb cow	1400 lb cow
Dry Matter	lb/d	26	30	33

Data from Manske 2003c

Table 13. Range cow production periods for calf birth in mid March.

Production Periods	Days	Months of Occurrence
Dry Gestation	32	mid November to mid December
Third Trimester	90	mid December to mid March
Mean Calf Birth		mid March
Early Lactation	45	mid March to late April
Spring Lactation	31	early May to late May
Summer Lactation	137	early June to mid October
Fall Lactation	30	mid October to mid November
Mean Calf Weaning		mid November

Evaluation of Pasture Forage and Harvested Forage Types during the Dry Gestation Production Period

Results

The dry gestation production period was 32 days during late fall from mid November to mid December. The dry gestation production period has the lowest nutrient requirements because there is no nursing calf or milk production and the developing fetus is still small during middle gestation and does not have high nutrient demands. Heavy cows can lose weight during this period without detrimental future effects on reproduction and production performance. Cows with moderate body condition should maintain body weight because the cost to replace lost pounds is greater during other production periods. Thin cows should gain weight during this period because each pound gained requires less feed and costs less than weight gained during other production periods. Pasture forage and harvested forage costs and returns after feed costs were determined for a 1200-pound range cow during the dry gestation production period. The cow requires a daily intake of 24 lbs dry matter (DM) at 6.2% crude protein (CP) (1.49 lbs CP/day).

Pasture Forage Types

Reserved native rangeland managed as a repeated seasonal pasture was evaluated during the dry gestation production period for 32 days between mid November and mid December (tables 14 and 18). Native rangeland forage during the fall dormancy period has a crude protein content of around 4.8%. Late-season native rangeland forage has pasture rent value or production costs of $8.76 per acre, forage dry matter costs of $97.33 per ton, and crude protein costs of $1.01 per pound. A cow grazing during the dry gestation production period would require 5.33 acres (5.08 acres per month) at a forage cost of $46.75 per production period. The crude protein content of mature native rangeland forage is below the requirements of a cow in the dry gestation stage, and crude protein would need to be supplemented at 0.05 lbs per cow per day at a cost of $0.48 per period. Total feed costs would be $47.23 per period, or $1.48 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after pasture costs were a loss of $29.79 per cow-calf pair and a loss of $5.59 per acre. The cost of calf fetus weight gain was $1.90 per pound (table 20).

Cropland aftermath of annual cereal stubble managed as a seasonal pasture was evaluated during the dry gestation production period for 32 days between mid November and mid December (tables 14 and 18). Cropland aftermath of annual cereal stubble has very low crude protein content and does not meet the requirements of a dry gestating cow. Cropland aftermath forage had pasture rent value or production costs of $2.00 per acre and forage dry matter costs of $29.63 per ton. A cow grazing cropland aftermath pasture would require 7.10 acres (6.63 acres per month) and the 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 costs during the dry gestation period would be $14.20, or $0.44 per day (table 19). Dry cows lost 1.14 lbs per day and lost 4.82 lbs per acre; accumulated weight loss was 36.48 lbs per period. Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after pasture costs were $3.24 per cow-calf pair and $0.46 per acre. The cost of calf fetus weight gain was $0.57 per pound (table 20).

Spring seeded winter cereal (winter rye) managed as a seasonal pasture was evaluated during the dry gestation production period for 32 days between mid November and mid December (tables 14 and 18). Spring seeded winter cereal forage had production costs of $41.75 per acre and forage dry matter costs of $47.85 per ton. A cow grazing during the dry gestation period was allotted 0.56 acres at a forage cost of $23.41 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total feed costs were $23.41 per period, or $0.73 per day (table 19). Cow weight gain was 1.05 lbs per day and 60.14 lbs per acre; accumulated weight gain was 33.68 lbs. Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after pasture costs were a loss of $5.97 per cow-calf pair and a loss of $10.66 per acre. The cost of calf fetus weight gain was $0.94 per pound (table 20).

Standing corn managed as a seasonal pasture was evaluated during the dry gestation production

period for 32 days between mid November and mid December (tables 14 and 18). Standing corn forage had production costs of $126.67 per acre (Nelson et al. 2002) and forage dry matter costs of $65.97 per ton. A cow grazing during the dry gestation period was allotted 0.25 acres. Daily forage utilization averaged 77.7 lbs/cow with 61% to 65% of the forage wasted. Intake and wasted forage would cost $31.67 per production period. An additional 0.54 lbs of crude protein per day would need to be provided at a cost of $7.71 per period (Nelson et al. 2002) (table 19). Total forage and supplement costs would be $39.38 per period, or $1.23 per day (Nelson et al. 2002). Cow weight gain was 3.30 lbs per day and 422.40 lbs per acre; accumulated weight gain was 105.6 lbs. Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after pasture costs were a loss of $21.94 per cow-calf pair and a loss of $87.76 per acre. The cost of calf fetus weight gain was $1.58 per pound (table 20).

Harvested Forage Types

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of around 6.4%. This low-quality perennial grass 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. Late-cut crested wheatgrass hay would be fed at 23.4 lbs DM/day to provide 1.5 lbs CP/day. An additional 0.6 lbs of roughage per day would need to be provided, at a cost of $0.34 per period. Production of late-cut crested wheatgrass hay to feed during the dry gestation production period (tables 15 and 18) would require 0.47 acres, and the forage would cost $13.12 per production period. Total forage and supplement costs would be $13.46 per period, or $0.42 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after feed costs were $3.98 per cow-calf pair and $8.47 per acre. The cost of calf fetus weight gain was $0.54 per pound (table 20).

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of around 14.5%. This high-quality perennial grass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 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 production period (tables 15 and 18) would require 0.26 acres, and the forage would cost $6.72 per production period. Total forage and supplement costs would be $14.40 per period, or $0.45 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after feed costs were $3.04 per cow-calf pair and $11.69 per acre. The cost of calf fetus weight gain was $0.58 per pound (table 20).

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 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 production period (tables 16 and 18) would require 0.08 acres, and the forage would cost $5.12 per production period. Total forage and supplement costs would be $12.12 per period, or $0.38 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after feed costs were $5.32 per cow-calf pair and $66.50 per acre. The cost of calf fetus weight gain was $0.49 per pound (table 20).

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. 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 production period (tables 16 and 18) would require 0.10 acres, and the forage would cost $7.04 per production period. Total forage and supplement costs would be $11.41 per period, or $0.36 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf,

and the net returns after feed costs were $6.03 per cow-calf pair and $60.30 per acre. The cost of calf fetus weight gain was $0.46 per pound (table 20).

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 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 production period (tables 16 and 18) would require 0.09 acres, and the forage would cost $6.08 per production period. Total forage and supplement costs would be $12.24 per period, or $0.38 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after feed costs were $5.20 per cow-calf pair and $57.78 per acre. The cost of calf fetus weight gain was $0.49 per pound (table 20).

Oat forage 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. 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 production period (tables 16 and 18) would require 0.11 acres, and the forage would cost $8.00 per production period. Total forage and supplement costs would be $10.74 per period, or $0.34 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after feed costs were $6.70 per cow-calf pair and $60.91 per acre. The cost of calf fetus weight gain was $0.43 per pound (table 20).

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. 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 production period (tables 17 and 18) would require 0.09 acres, and the forage would cost $7.04 per production period. Total forage and supplement costs would be $16.06 per period, or $0.50 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after feed costs were $1.38 per cow-calf pair and $15.33 per acre. The cost of calf fetus weight gain was $0.64 per pound (table 20).

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 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 production period (tables 17 and 18) would require 0.07 acres, and the forage would cost $6.08 per production period. Total forage and supplement costs would be $13.75 per period, or $0.43 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after feed costs were $3.69 per cow-calf pair and $52.71 per acre. The cost of calf fetus weight gain was $0.55 per pound (table 20).

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. 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 production period (tables 17 and 18) would require 0.13 acres, and the forage would cost $8.00 per production period. Total forage and supplement costs would be $17.63 per period, or $0.55 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after feed costs were a loss of $0.19 per cow-calf pair and a loss of $1.46 per acre. The cost

of calf fetus weight gain was $0.71 per pound (table 20).

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 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 production period (tables 17 and 18) would require 0.09 acres, and the forage would cost $6.08 per production period. Total forage and supplement costs would be $13.86 per period, or $0.43 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after feed costs were $3.58 per cow-calf pair and $39.78 per acre. The cost of calf fetus weight gain was $0.56 per pound (table 20).

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.16 per pound. Oat-pea forage hay would be fed at 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 hay to feed during the dry gestation production period (tables 17 and 18) would require 0.07 acres, and the forage would cost $7.04 per production period. Total forage and supplement costs would be $13.82 per period, or $0.43 per day (table 19). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 24.92 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $17.44 per calf, and the net returns after feed costs were $3.62 per cow-calf pair and $51.71 per acre. The cost of calf fetus weight gain was $0.55 per pound (table 20).

Discussion

Pasture Forage Types

Reserved native rangeland forage grazed as a repeated seasonal pasture during the dry gestation production period was high-cost forage because the quantities of crude protein captured per acre were low and the quantity of forage dry matter available per acre was low. Total forage costs for reserved native rangeland pastures was high, even though the equipment costs, labor costs, land rent per acre, and forage production costs per acre were low, because the input costs do not directly regulate livestock forage feed costs. The cost per pound of crude protein ($1.01/lb CP) was very high because the quantity of crude protein captured per acre was very low. The crude protein content of the forage was below the requirements of a dry cow making it necessary to provide purchased supplement crude protein. The forage dry matter cost ($97.33/ton) was very high because the quantity of forage weight per acre was low. The low forage weight per acre made it necessary to use more than double the land area that would have been needed during the summer period to provide a cow with adequate forage dry matter for a month in the same pasture. The large land area (5.33 acres) per cow caused the forage costs per period to be high. The total daily forage and supplemental crude protein costs ($1.48/day) were very high. The total feed costs were greater than the low market value of the accumulated calf fetus weight causing a high loss in returns after feed costs ($-29.79) per cow and a moderate loss in returns after feed costs ($-5.59) per acre. The cost per pound of calf fetus weight gain ($1.90/lb) was extremely high because of the low forage dry matter yields per acre, the low crude protein content in the forage, the large land area per cow, and growth in weight of the fetus was relatively slow.

Cropland aftermath of annual cereal stubble grazed as a seasonal pasture during the dry gestation production period was high-cost forage because of the low quantity of forage dry matter available per acre and the extremely low quantities of crude protein contained in the forage resulting in cow weight loss of greater than a pound per day. The forage dry matter cost ($29.63/ton) was low because the equipment costs, labor costs, and forage production costs per acre were low and the land rent per acre was very low. The low forage weight per acre made it necessary to provide a large land area (7.10 acres) per cow. The total daily feed costs ($0.44/day) were low because the land rent per acre was very low. The total feed costs were not much lower than the low market value of the accumulated calf fetus weight resulting in low returns after feed costs ($3.24) per cow and extremely low returns after feed costs ($0.46) per acre. The cost per pound of calf fetus weight gain ($0.57/lb) was moderately high mainly because of the cost of the large land area required per cow. The cost of the lost cow weight is the major problem from using annual cereal stubble as forage. Cropland aftermath is an excellent place for dry cows

to roam during fall and winter, however, a full ration of harvested forage should be provided.

Spring seeded winter cereal (winter rye) grazed as a seasonal pasture during the dry gestation production period was high-cost forage because the moderate production costs per acre were greater than the low market value of the accumulated calf fetus weight resulting in moderate losses after feed costs per cow and per acre. The winter cereal is seeded during the spring in order for the plants to develop large enough root systems to survive water stress periods during the growing season. On the average, there are two months with water deficiencies great enough to cause water stress in plants each growing season. Only 6% of the past 114 years have not had growing season months with water deficiency. The quantity of herbage available during fall and winter grazing of spring seeded winter cereal pastures is related to the severity and duration of the water stress conditions during the growing season and to the depth of packed snow and ice during the nongrowing season. The forage dry matter cost ($47.85/ton) was moderate because the production costs per acre were moderate. The land area (0.56 acres) per cow was relatively small because greater than 70% of the herbage was consumed as forage, however, the total daily forage costs ($0.73/day) were high because only a modest quantity of herbage biomass was produced as a result of growing season water stress. The total feed costs were greater than the low market value of the accumulated calf fetus weight causing a moderate loss in returns after feed costs ($-5.97) per cow and a moderate loss in returns after feed costs ($-10.66) per acre. The high total forage cost was the cause for the high cost per pound of calf fetus weight gain ($0.94/lb). This seeded forage seasonal pasture strategy would be a low-cost forage and yield positive returns after feed costs during moderate water deficiency years in which the herbage biomass production was 3000 to 3200 pounds or greater per acre.

Standing corn grazed as a seasonal pasture during the dry gestation production period was high-cost forage because of the extremely high production costs per acre and the extremely high quantity of unutilized wasted forage. The forage dry matter cost ($65.97/ton) was high because of the low percentage (38%) of herbage consumed as forage. The land area (0.25 acres) per cow was small because of the high herbage biomass produced during exceptionally good growing season conditions with low water deficiency. Corn herbage biomass production would be expected to be low during growing season conditions with normal water deficiency. The crude protein content of the forage was below the requirements of a dry cow making it necessary to provide purchased supplemental crude protein. The weight gained by the cows was more than three pounds per day. The total daily forage and supplemental crude protein costs ($1.23/day) were very high because of the low crude protein content in the forage and the high cost of forage dry matter per ton. The total feed costs were greater than the low market value of the accumulated calf fetus weight causing a high loss in returns after feed costs ($-21.94) per cow and an extremely high loss in returns after feed costs ($-87.76) per acre. The cost per pound of calf fetus weight gain ($1.58/lb) was extremely high because of the high quantity of wasted forage, the low crude protein content in the forage, and growth in weight of the fetus was relatively slow.

Harvested Forage Types

Crested wheatgrass hay cut at a mature growth stage and fed during the dry gestation production period was moderate-cost forage. Basically, the dry gestation production period is the only period that the nutrient content of mature crested wheatgrass hay meets the dietary requirements of range cows and is the only period that mature crested wheatgrass hay is lower cost, by a few cents, than crested wheatgrass hay cut at the boot stage. The forage dry matter cost ($34.80/ton) was moderate for mature crested wheatgrass hay and lower than the forage dry matter cost per ton for early cut crested wheatgrass hay because greater dry matter weight of the mature crested wheatgrass hay was harvested per acre. The cost per pound of crude protein ($0.28/lb CP) was high for mature crested wheatgrass hay and double the cost per pound of crude protein for early cut crested wheatgrass hay because of the lower crude protein weight in the mature crested wheatgrass hay harvested per acre. The land area (0.47 acres) per cow for mature crested wheatgrass hay was small but greater than the land area required per cow for early cut crested wheatgrass hay because of the greater crude protein weight per acre in the early cut crested wheatgrass hay. The total daily forage cost ($0.42/day) for mature crested wheatgrass hay was low because very little supplemental roughage was needed to be provided. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in low returns after feed costs ($3.98) per cow and ($8.47) per acre. The cost per pound of calf fetus weight gain ($0.54/lb) was moderate because the production costs per acre were moderate and mature crested wheatgrass hay met the nutrient requirements of dry range cows.

Crested wheatgrass hay cut at the boot growth stage and fed during the dry gestation production period was moderate-cost forage. The forage dry matter cost ($40.80/ton) was moderate for early cut crested wheatgrass hay and was greater than the forage dry matter cost per ton for mature crested wheatgrass hay because crested wheatgrass hay cut at the boot stage harvested lower forage dry matter weight per acre than crested wheatgrass hay cut at a mature growth stage. The cost per pound of crude protein ($0.14/lb CP) was low for early cut crested wheatgrass hay and lower than the cost per pound of crude protein for mature crested wheatgrass hay because of the greater crude protein weight in the early cut crested wheatgrass hay harvested per acre. The land area (0.26 acres) per cow for early cut crested wheatgrass hay was small and less than the land area required per cow for mature crested wheatgrass hay because of the greater crude protein weight per acre in the early cut crested wheatgrass hay. The forage cost of early cut crested wheatgrass hay was low but the total daily forage feed cost ($0.45/day) was moderate because more than half of the ration forage was supplemental roughage which added substantially to the total forage costs. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in low returns after feed costs ($3.04) per cow and in moderate returns after feed costs ($11.69) per acre. The cost per pound of calf fetus weight gain ($0.58/lb) was moderate mainly because of the additional supplemental roughage costs.

Forage barley hay cut at the milk growth stage and fed during the dry gestation production period was low-cost forage. The production costs per acre were high for early cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($28.80/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.11/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.08 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.38/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in low returns after feed costs ($5.32) per cow and in high returns after feed costs ($66.50) per acre. The cost per pound of calf fetus weight gain ($0.49/lb) was moderate because growth in weight of the fetus was relatively slow.

Forage barley hay cut at the hard dough growth stage and fed during the dry gestation production period was low-cost forage. The production costs per acre were high for late cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($27.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut forage barley hay was greater than the cost per pound of crude protein for early cut forage barley hay because of the lower crude protein weight harvested per acre in the late cut forage barley hay. The land area (0.10 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.36/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in low returns after feed costs ($6.03) per cow and in high returns after feed costs ($60.30) per acre. The returns after feed costs per acre were lower for late cut forage barley hay than for early cut forage barley hay because late cut forage barley hay had slightly higher crude protein cost per pound and slightly larger land area per cow than early cut forage barley hay. The cost per pound of calf fetus weight gain ($0.46/lb) was moderate because growth in weight of the fetus was relatively slow.

Oat forage hay cut at the milk growth stage and fed during the dry gestation production period was low-cost forage. The production costs per acre were high for early cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($29.60/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.09 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.38/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in low returns after feed costs ($5.20) per cow and in high returns after feed costs ($57.78) per acre. The cost per pound of calf fetus weight gain ($0.49/lb) was

moderate because growth in weight of the fetus was relatively slow.

Oat forage hay cut at the hard dough growth stage and fed during the dry gestation production period was low-cost forage. The production costs per acre were high for late cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($26.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut oat forage hay was greater than the cost per pound of crude protein for early cut oat forage hay because of the lower crude protein weight harvested per acre in the late cut oat forage hay. The land area (0.11 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.34/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in low returns after feed costs ($6.70) per cow and in high returns after feed costs ($60.91) per acre. The cost per pound of calf fetus weight gain ($0.43/lb) was moderate because growth in weight of the fetus was relatively slow.

Pea forage hay cut at an early growth stage and fed during the dry gestation production period was low-cost forage. However, pea forage hay cut at a late growth stage has lower forage costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for early cut pea forage hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($55.00/ton) was high because of the modest forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.09 acres) per cow was very small because of the high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.50/day) were low because of the low cost of crude protein per pound and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in very low returns after feed costs ($1.38) per cow and in moderate returns after feed costs ($15.33) per acre. The cost per pound of calf fetus weight gain ($0.64/lb) was high because of the modest forage dry matter production and the high supplemental roughage costs.

Pea forage hay cut at a late growth stage and fed during the dry gestation production period was low-cost forage. Late cut pea forage hay has lower forage costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for late cut pea forage hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($37.40/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.07 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.43/day) were low because of the low cost of crude protein per pound, the high forage dry matter production per acre, and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in low returns after feed costs ($3.69) per cow and in high returns after feed costs ($52.71) per acre. The cost per pound of calf fetus weight gain ($0.55/lb) was moderate because growth in weight of the fetus was relatively slow.

Forage lentil hay cut at an early growth stage and fed during the dry gestation production period was low-cost forage. However, forage lentil hay cut at a late growth stage has lower forage costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for early cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($71.60/ton) was high because of the modest forage dry matter yield per acre. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.13 acres) per cow was very small because of the high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.55/day) were low because of the low cost of crude protein per pound and the very small land area per cow. The total feed costs were greater than the low market value of the accumulated calf fetus weight causing low losses in returns after feed costs ($-0.19) per cow and ($-1.46) per acre. The cost per pound of calf fetus weight gain ($0.71/lb) were high because of the modest forage dry matter production and the high supplemental roughage costs.

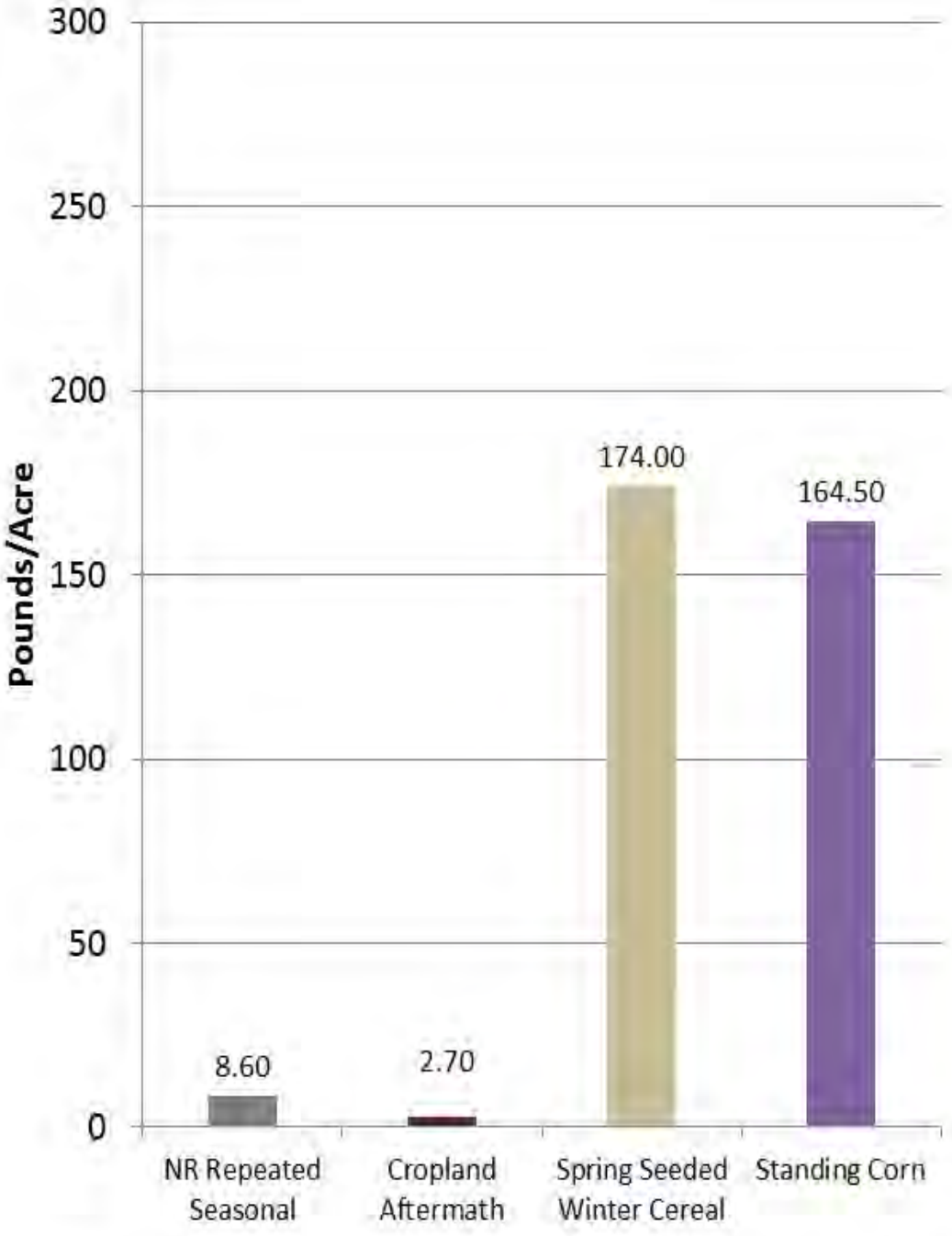
Forage lentil hay cut at a late growth stage and fed during the dry gestation production period was low-cost forage. Late cut forage lentil hay has lower forage costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for late cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($37.00/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.09 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.43/day) were low because of the low cost of crude protein per pound, the high forage dry matter production per acre, and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in low returns after feed costs ($3.58) per cow and in high returns after feed costs ($39.78) per acre. The cost per pound of calf fetus weight gain ($0.56/lb) was moderate because growth in weight of the fetus was relatively slow.

Oat-pea hay cut at compromised plant growth stages and fed during the dry gestation production period was low-cost forage. However, seeding oat forage separately on half of the field and cutting it at an early growth stage and seeding pea forage separately on half of the field and cutting it at a late growth stage will result in lower production costs per acre, lower forage dry matter costs per ton, lower costs per pound of crude protein, lower total forage feed costs per day, lower costs per pound of calf weight gain, greater net returns after feed costs per cow, and about the same net returns after feed costs per acre as oat-pea forage seeded together and cut at compromised growth stages. The production costs per acre were very high for oat-pea hay because the equipments costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($37.20/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.16/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.07 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.43/day) were low because of the low cost of crude protein per pound, the high forage dry matter production per acre, and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in low returns after feed costs ($3.62) per cow and in high returns after feed costs ($51.71) per acre. The cost per pound of calf fetus weight gain ($0.55/lb) was moderate because growth in weight of the fetus was relatively slow.

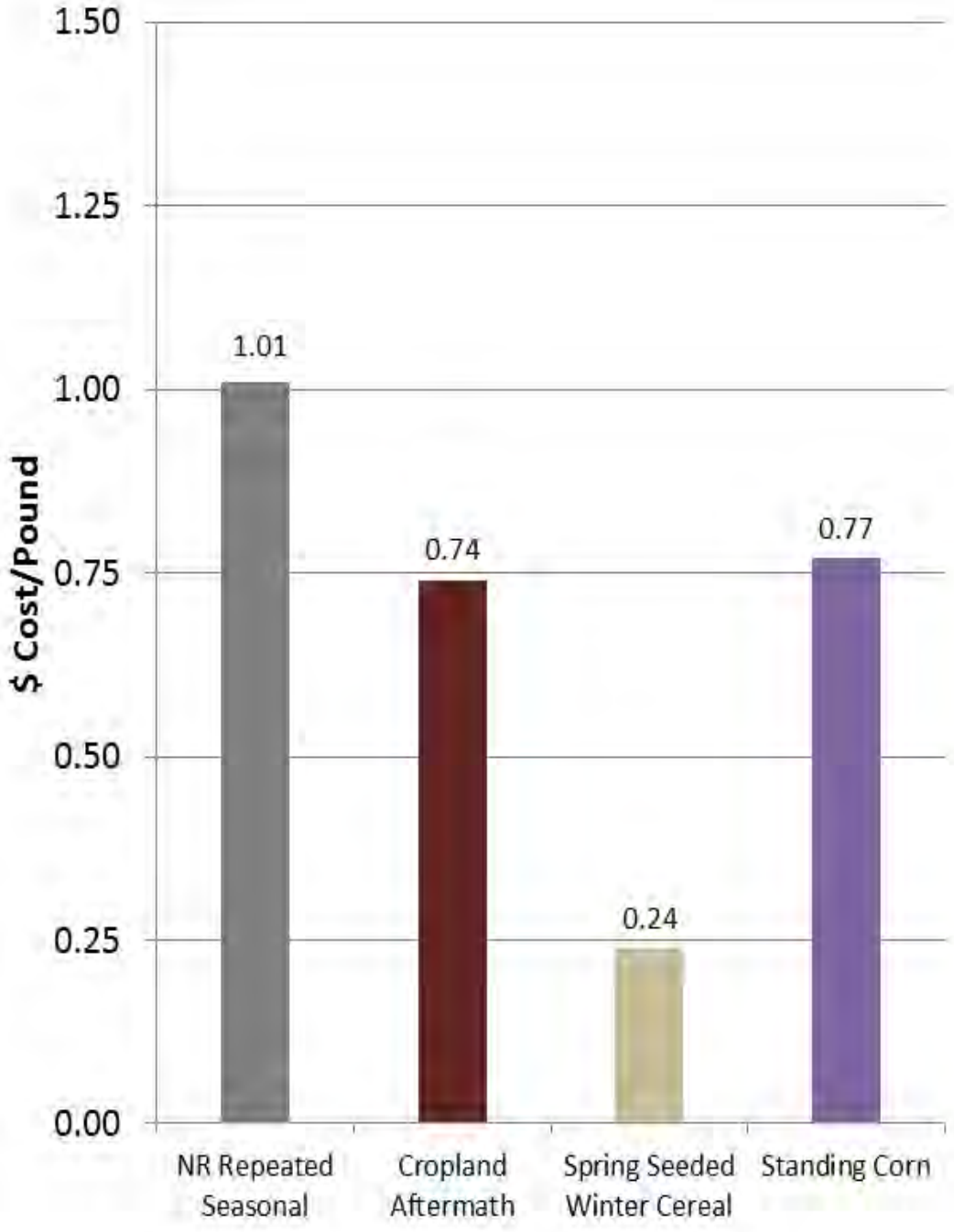
Table 14. Costs and returns for pasture forage types grazed by range cows during the 32-day dry gestation production period.

		Native Rangeland Repeated Seasonal	Cropland Aftermath Seasonal Pasture	Spring Seeded Winter Cereal Pasture	Standing Corn Pasture
Days		32	32	32	32
Growth Stage		Dormant	Post-harvest	Vegetative	Mature
Herbage Weight	lb/ac	725	270	2487	9940*
Forage DM Weight	lb/ac	180	135	1745	3840
Costs/Acre					
Land Rent	$	8.76	2.00	22.07	
Custom Work	$	-		16.08	
Seed Cost	$	-		3.60	
Baling Costs	$	-			
Production Costs	$/ac	8.76	2.00	41.75	126.67*
Forage DM Costs	$/ton	97.33	29.63	47.85	65.97
Crude Protein	%	4.8			
Crude Protein Yield	lb/ac	8.64			
Crude Protein Cost	$/lb	1.01			
Forage Allocation	lb/d	30.0	30.0	30.0	30.0
Land Area/Period	ac	5.33	7.10	0.56	0.25
Forage Costs/Period	$/pp	46.75	14.20	23.41	31.67
Supplementation					
Roughage/Day	lb/d				
Crude Protein/Day	lb/d	0.05			0.54*
Sup. Cost/Period	$/pp	0.48			7.71
Total Feed Cost	$/pp	47.23	14.20	23.41	39.38
Cost/Day	$/d	1.48	0.44	0.73	1.23*
Accumulated Calf Wt.	lbs	24.92	24.92	24.92	24.92
Weight Value @$0.70/lb	$	17.44	17.44	17.44	17.44
Net Return/c-c pr	$	-29.79	3.24	-5.97	-21.94
Net Return/acre	$	-5.59	0.46	-10.66	-87.76
Cost/lb of Calf Gain	$	1.90	0.57	0.94	1.58

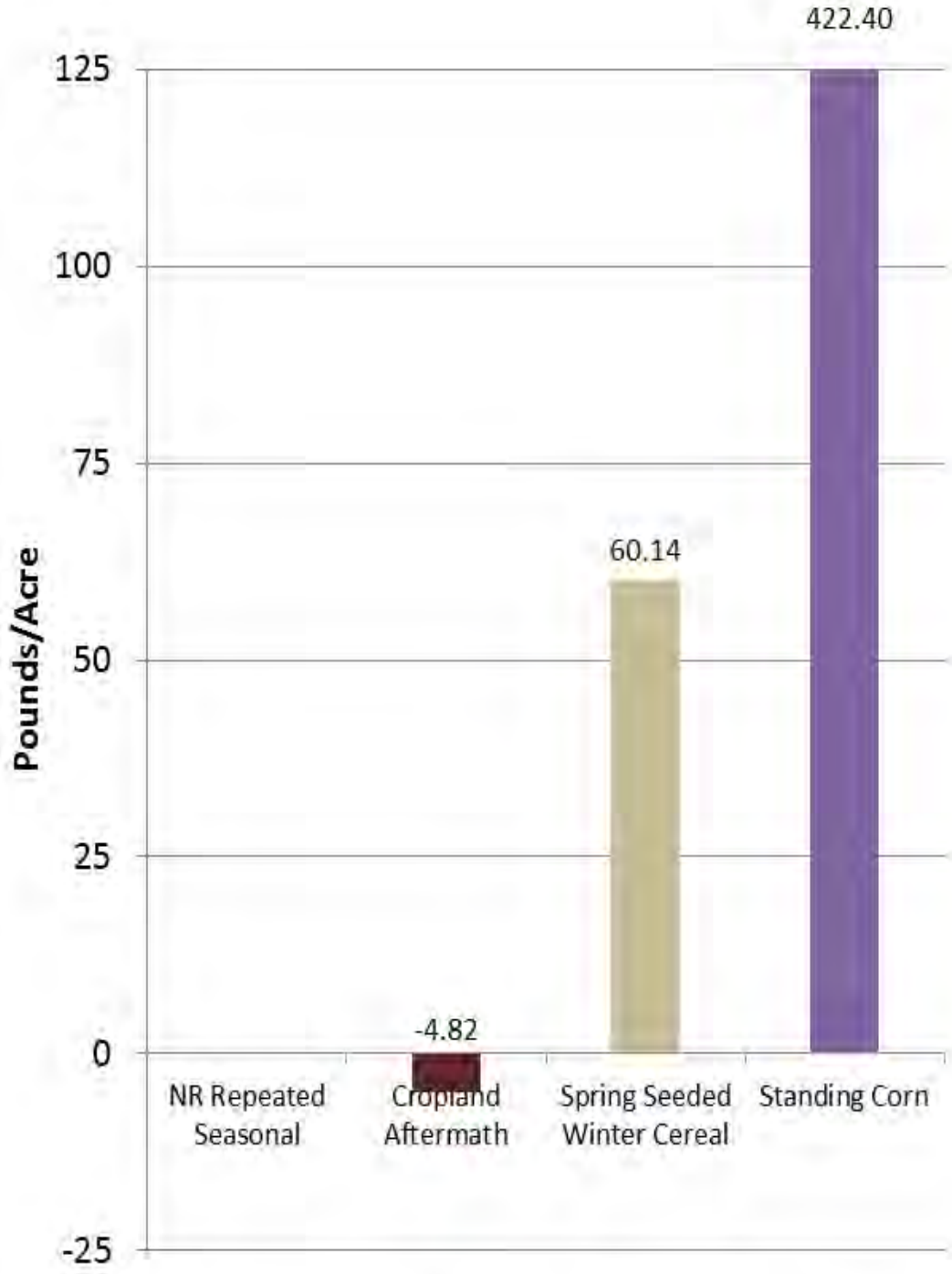
*Data from Nelson et al. 2002



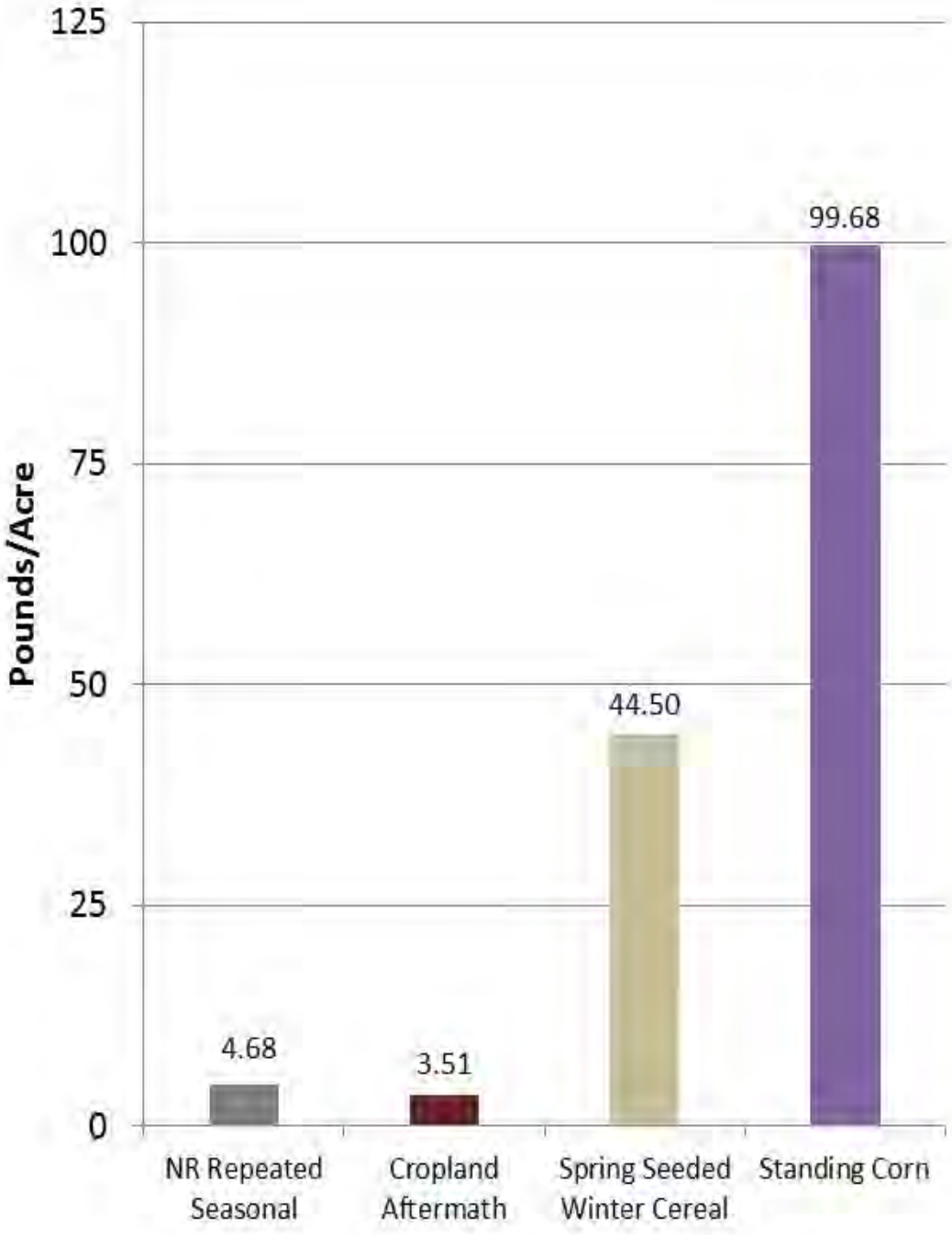
Crude Protein Weight Captured per Acre on Pasture Forages During Dry Gestation



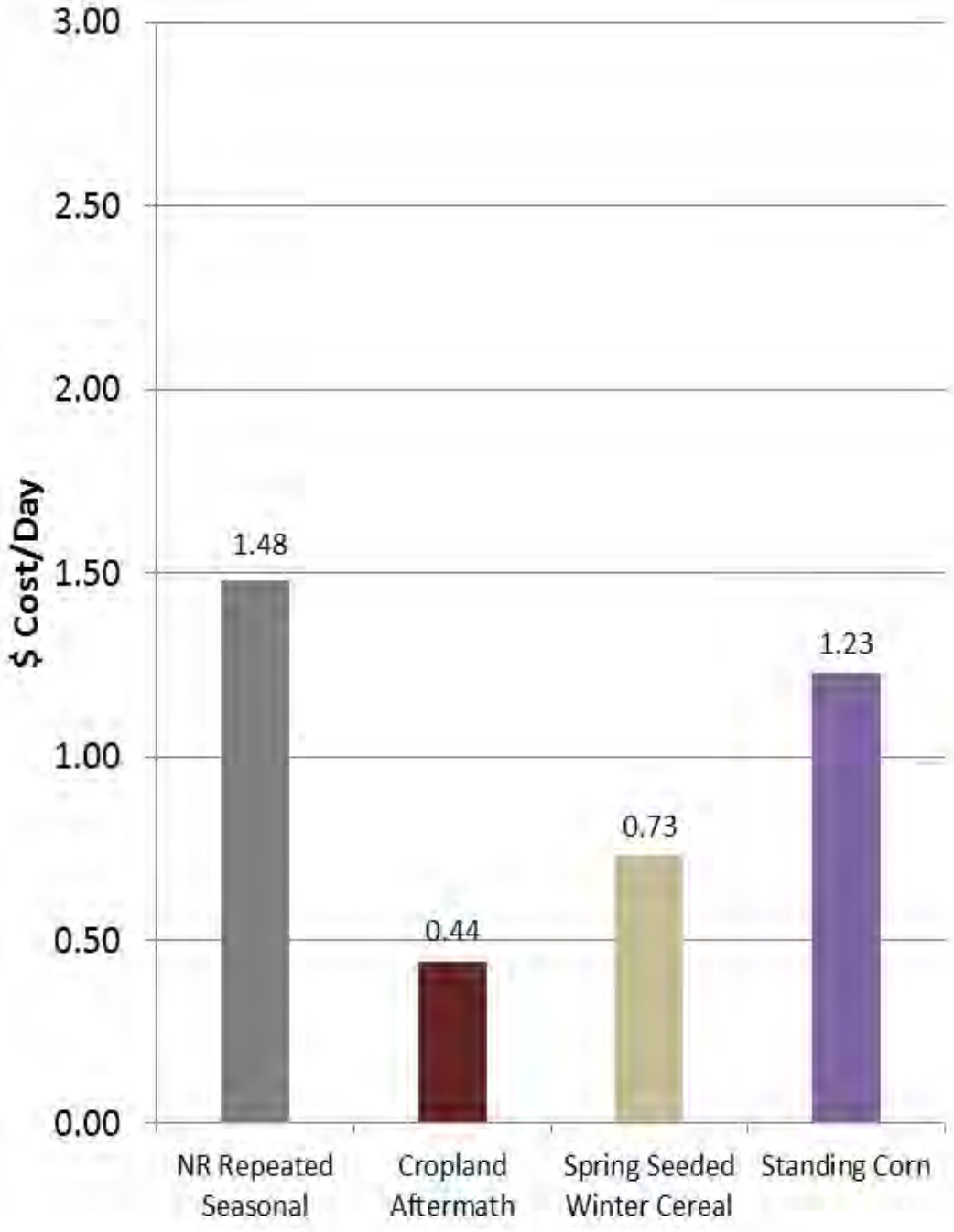
Crude Protein Cost per Pound
on Pasture Forages During Dry Gestation



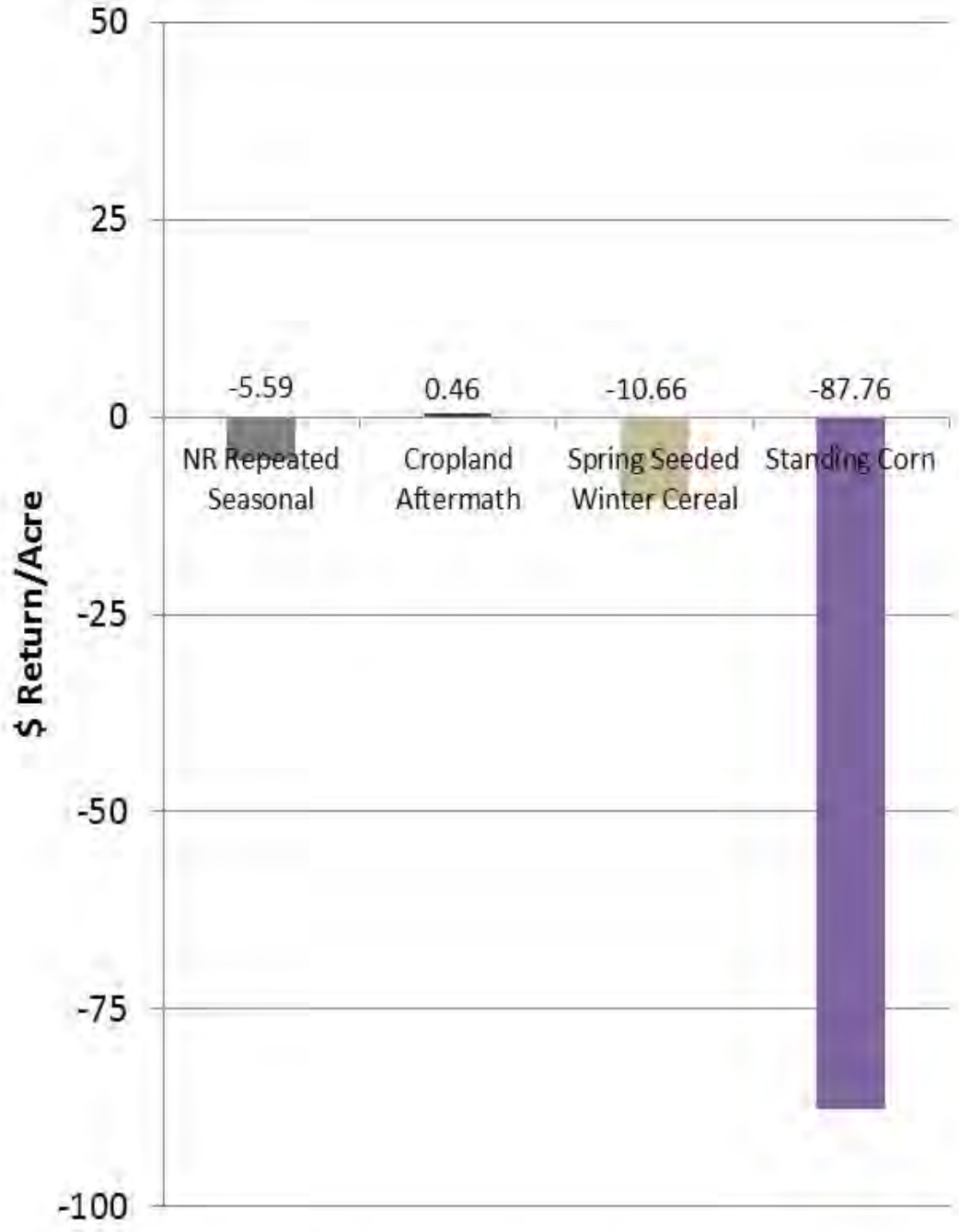
Cow Weight Gain per Acre on Pasture Forages During Dry Gestation



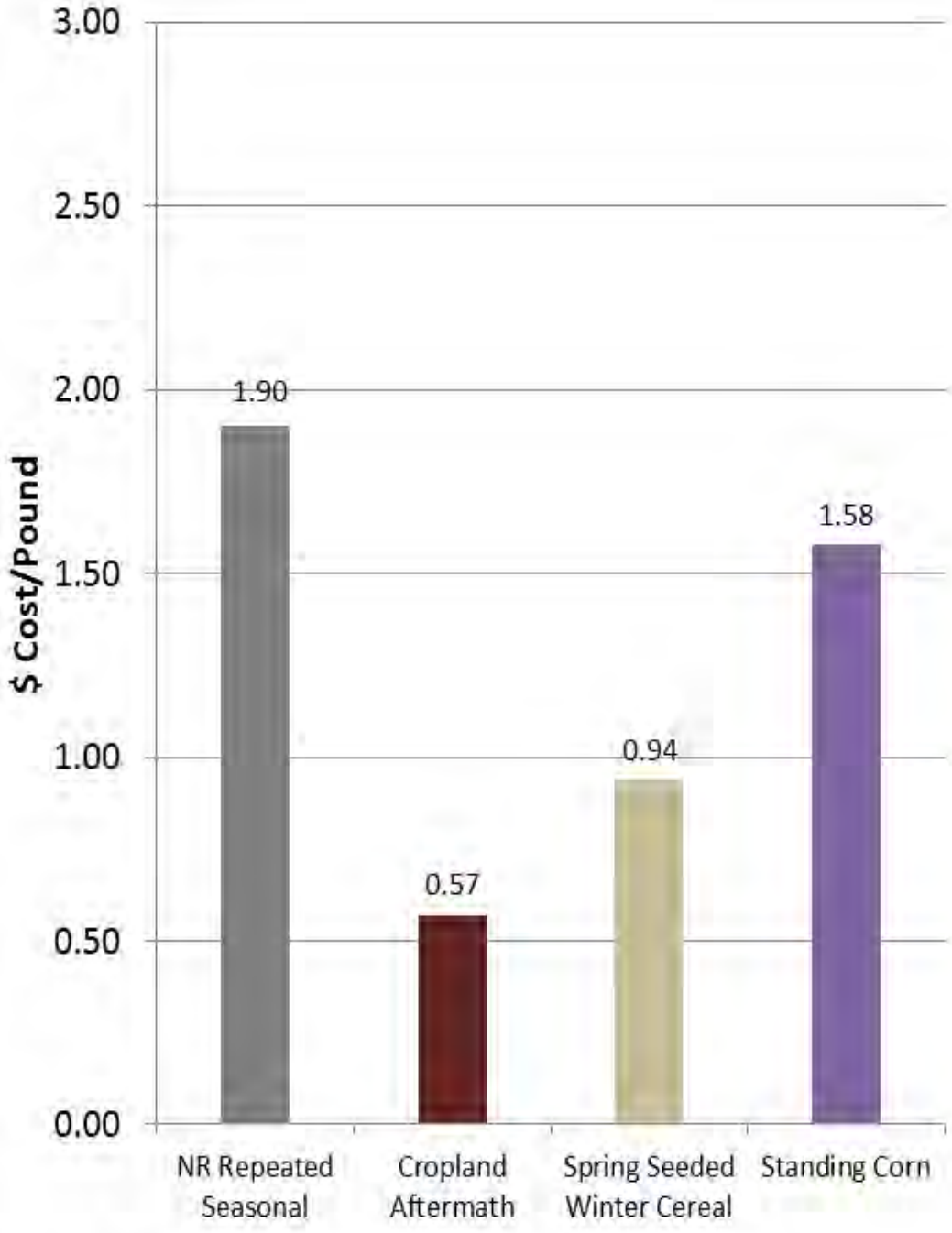
Calf Weight Gain per Acre on Pasture Forages During Dry Gestation



Forage Feed Costs per Day
on Pasture Forages During Dry Gestation



Returns After Feed Costs per Acre on Pasture Forages During Dry Gestation



Calf Weight Gain Costs per Pound on Pasture Forages During Dry Gestation

Table 15. Costs and returns for perennial grass harvested forage types to be fed to range cows during the 32-day dry gestation production period.

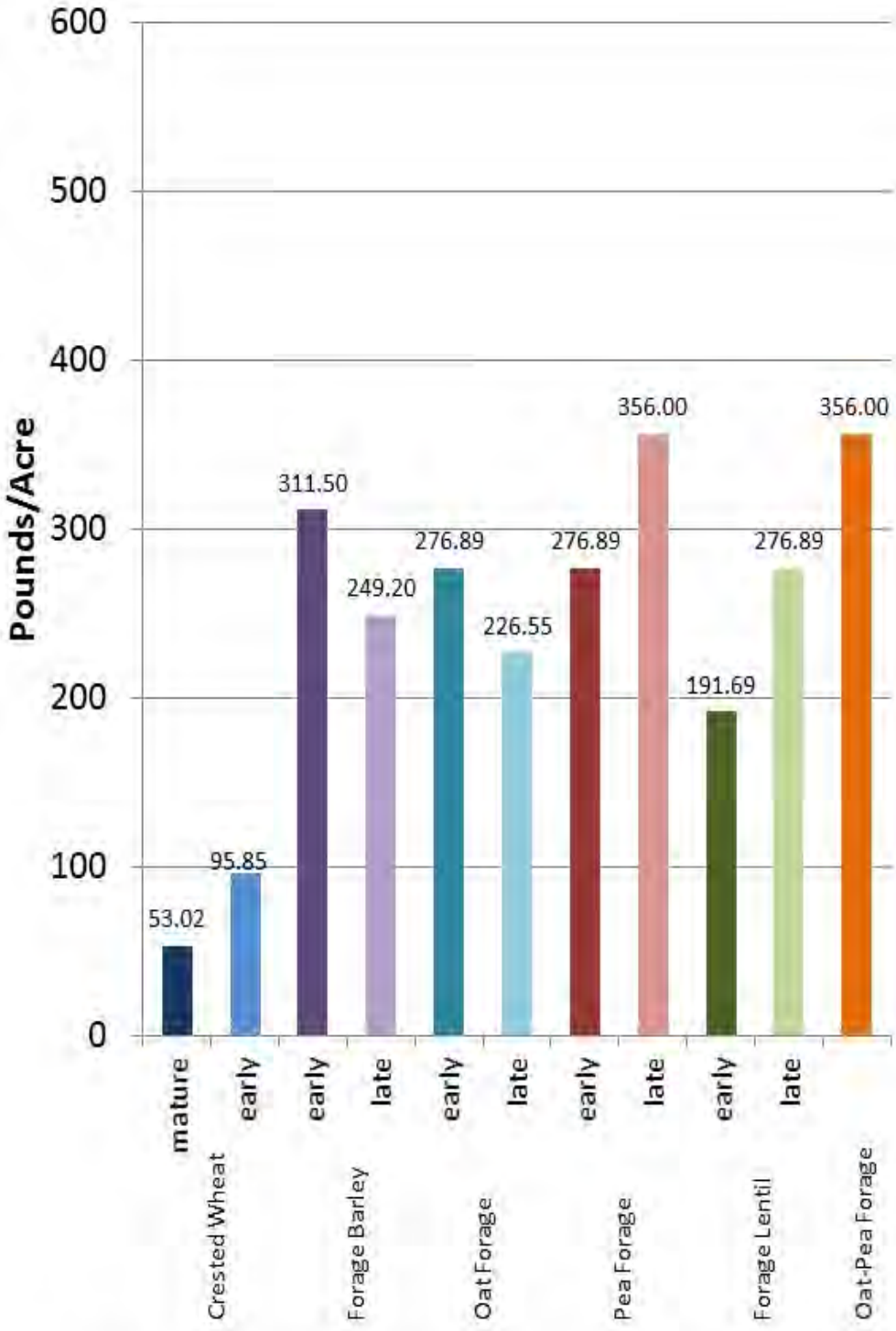
		Crested Wheatgrass Hay	Crested Wheatgrass Hay
Days		32	32
Growth Stage		Mature	Boot Stage
Herbage Weight	lb/ac	-	-
Forage DM Weight	lb/ac	1600	1300
Costs/Acre			
Land Rent	$	14.22	14.22
Custom Work	$	5.31	5.31
Seed Cost	$	-	-
Baling Costs	$	8.58	6.97
Production Costs	$/ac	28.11	26.50
Forage DM Costs	$/ton	34.80	40.80
Crude Protein	%	6.4	14.5
Crude Protein Yield	lb/ac	102	189
Crude Protein Cost	$/lb	0.28	0.14
Forage Allocation	lb/d	23.4	10.3
Land Area/Period	ac	0.47	0.26
Forage Costs/Period	$/pp	13.12	6.72
Supplementation			
Roughage/Day	lb/d	0.6	13.7
Crude Protein/Day	lb/d		
Sup. Cost/Period	$/pp	0.34	7.68
Total Feed Cost	$/pp	13.46	14.40
Cost/Day	$/d	0.42	0.45
Accumulated Calf Wt.	lbs	24.92	24.92
Weight Value @$0.70/lb	$	17.44	17.44
Net Return/c-c pr	$	3.98	3.04
Net Return/acre	$	8.47	11.69
Cost/lb of Calf Gain	$	0.54	0.58

Table 16. Costs and returns for annual cereal harvested forage types to be fed to range cows during the 32-day dry gestation production period.

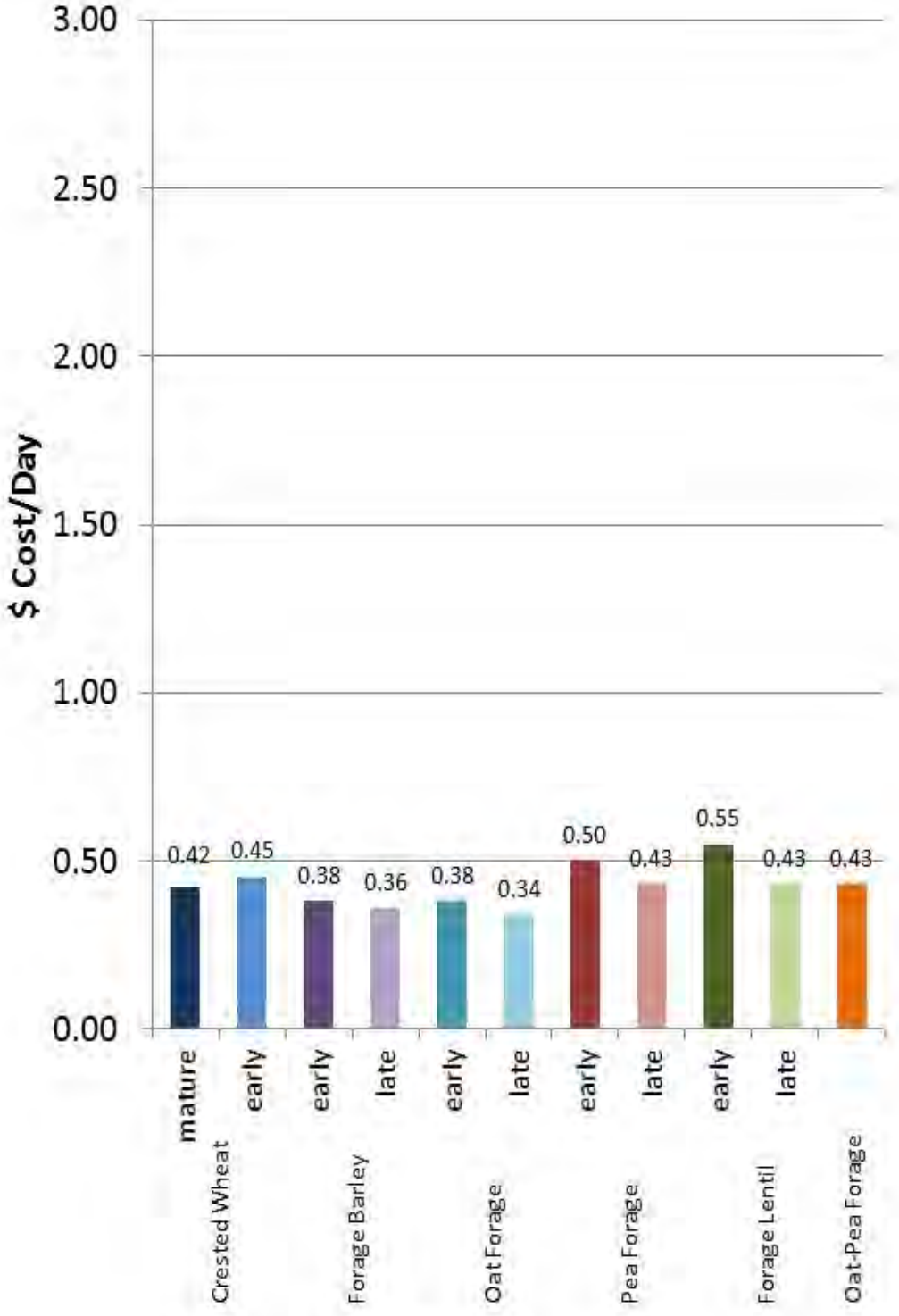
		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Days		32	32	32	32
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Forage Allocation	lb/d	11.5	16.2	13.0	19.1
Land Area/Period	ac	0.08	0.10	0.09	0.11
Forage Costs/Period	$/pp	5.12	7.04	6.08	8.00
Supplementation					
Roughage/Day	lb/d	12.5	7.8	11.0	4.9
Crude Protein/Day	lb/d				
Sup. Cost/Period	$/pp	7.00	4.37	6.16	2.74
Total Feed Cost	$/pp	12.12	11.41	12.24	10.74
Cost/Day	$/d	0.38	0.36	0.38	0.34
Accumulated Calf Wt.	lbs	24.92	24.92	24.92	24.92
Weight Value @$0.70/lb	$	17.44	17.44	17.44	17.44
Net Return/c-c pr	$	5.32	6.03	5.20	6.70
Net Return/acre	$	66.50	60.30	57.78	60.91
Cost/lb of Calf Gain	$	0.49	0.46	0.49	0.43

Table 17. Costs and returns for annual legume harvested forage types to be fed to range cows during the 32-day dry gestation production period.

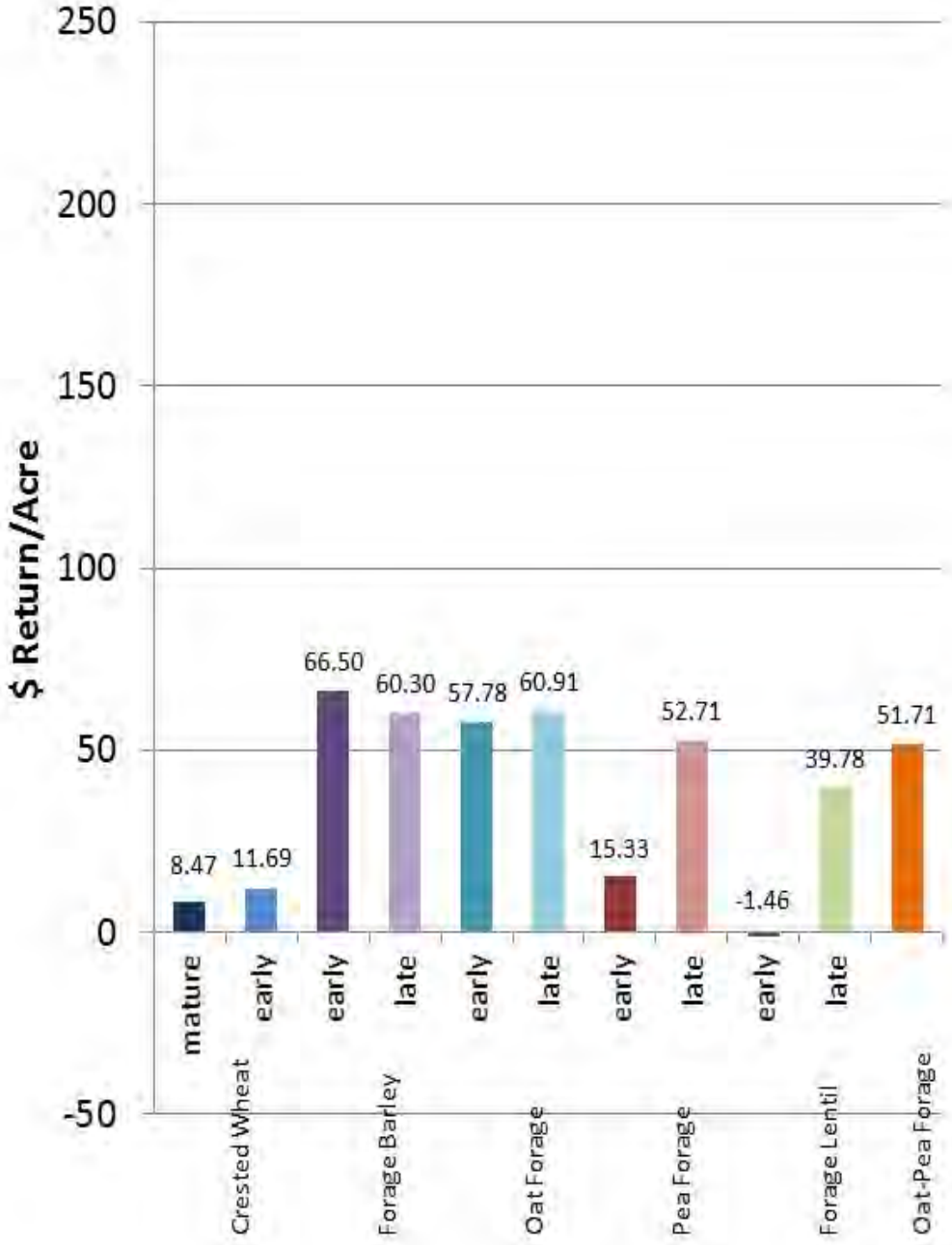
		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Days		32	32	32	32	32
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Forage Allocation	lb/d	7.9	10.3	6.8	10.1	11.9
Land Area/Period	ac	0.09	0.07	0.13	0.09	0.07
Forage Costs/Period	$/pp	7.04	6.08	8.00	6.08	7.04
Supplementation						
Roughage/Day	lb/d	16.1	13.7	17.2	13.9	12.1
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	9.02	7.67	9.63	7.78	6.78
Total Feed Cost	$/pp	16.06	13.75	17.63	13.86	13.82
Cost/Day	$/d	0.50	0.43	0.55	0.43	0.43
Accumulated Calf Wt.	lbs	24.92	24.92	24.92	24.92	24.92
Weight Value @$0.70/lb	$	17.44	17.44	17.44	17.44	17.44
Net Return/c-c pr	$	1.38	3.69	-0.19	3.58	3.62
Net Return/acre	$	15.33	52.71	-1.46	39.78	51.71
Cost/lb of Calf Gain	$	0.64	0.55	0.71	0.56	0.55



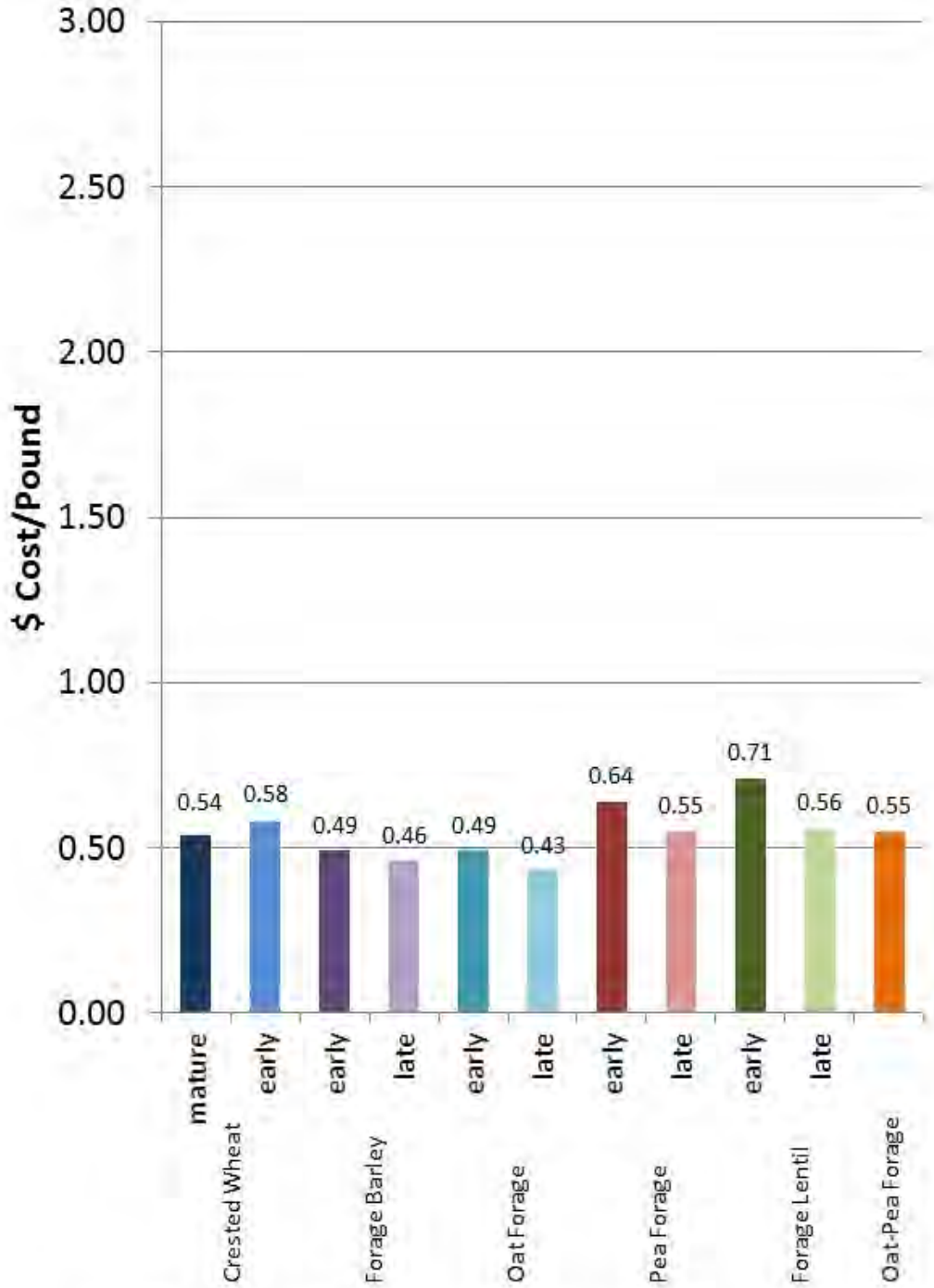
Calf Weight Gain per Acre on Harvested Forages During Dry Gestation



Forage Feed Costs per Day on Harvested Forages During Dry Gestation



Returns After Feed Costs per Acre on Harvested Forages During Dry Gestation



Calf Weight Gain Costs per Pound on Harvested Forages During Dry Gestation

Table 18. Feed quantity and land area for forage types used during the 32-day dry gestation production period.

Forage Types	Daily Feed per Cow			Dry Gestation Period Feed one Cow for 32 days			
	Forage lb/d	Roughage lb/d	Crude Protein lb/d	Forage lb/pp	Roughage lb/pp	Crude Protein lb/pp	Land Area ac/pp
Pasture Forage Types							
Native Rangeland Repeated Seasonal	30.0		0.05	960.0		1.60	5.33
Cropland Aftermath	30.0			960.0			7.10
Spring Seeded Winter Cereal	30.0			960.0			0.56
Standing Corn	30.0		0.54	960.0		17.28	0.25
Harvested Forage Types							
Crested Wheat, mature	23.4	0.6		748.8	19.2		0.47
Crested Wheat, early	10.3	13.7		329.6	438.4		0.26
Forage Barley, early	11.5	12.5		386.0	400.0		0.08
Forage Barley, late	16.2	7.8		518.4	249.6		0.10
Oat Forage, early	13.0	11.0		416.0	352.0		0.09
Oat Forage, late	19.1	4.9		611.2	156.8		0.11
Pea Forage, early	7.9	16.1		252.8	515.2		0.09
Pea Forage, late	10.3	13.7		329.6	438.4		0.07
Forage Lentil, early	6.8	17.2		217.6	550.4		0.13
Forage Lentil, late	10.1	13.9		323.2	444.8		0.09
Oat-Pea Forage	11.9	12.1		380.8	387.2		0.07

Table 19. Summary of feed costs for forage types used during the 32-day dry gestation production period.

Forage Types	Forage Costs $/pp	Roughage Costs $/pp	Crude Protein Costs $/pp	Total Feed Costs $/pp	Daily Feed Costs $/d
Pasture Forage Types					
Native Rangeland Repeated Seasonal	46.75		0.48	47.23	1.48
Cropland Aftermath	14.20			14.20	0.44
Spring Seeded Winter Cereal	23.41			23.41	0.73
Standing Corn	31.67		7.71	39.38	1.23
Harvested Forage Types					
Crested Wheat, mature	13.12	0.34		13.46	0.42
Crested Wheat, early	6.72	7.68		14.40	0.45
Forage Barley, early	5.12	7.00		12.12	0.38
Forage Barley, late	7.04	4.37		11.41	0.36
Oat Forage, early	6.08	6.16		12.24	0.38
Oat Forage, late	8.00	2.74		10.74	0.34
Pea Forage, early	7.04	9.02		16.06	0.50
Pea Forage, late	6.08	7.67		13.75	0.43
Forage Lentil, early	8.00	9.63		17.63	0.55
Forage Lentil, late	6.08	7.78		13.86	0.43
Oat-Pea Forage	7.04	6.78		13.82	0.43

Table 20. Summary of returns after feed costs for forage types used during the 32-day dry gestation production period.

Forage Types	Gross Return @$0.70/lb $/calf	Net Return per C-C pr $/pr	Net Return per acre $/ac	Calf Gain Cost $/lb
Pasture Forage Types				
Native Rangeland Repeated Seasonal	17.44	-29.79	-5.59	1.90
Cropland Aftermath	17.44	3.24	0.46	0.57
Spring Seeded Winter Cereal	17.44	-5.97	-10.66	0.94
Standing Corn	17.44	-21.94	-87.76	1.58
Harvested Forage Types				
Crested Wheat, mature	17.44	3.98	8.47	0.54
Crested Wheat, early	17.44	3.04	11.69	0.58
Forage Barley, early	17.44	5.32	66.50	0.49
Forage Barley, late	17.44	6.03	60.30	0.46
Oat Forage, early	17.44	5.20	57.78	0.49
Oat Forage, late	17.44	6.70	60.91	0.43
Pea Forage, early	17.44	1.38	15.33	0.64
Pea Forage, late	17.44	3.69	52.71	0.55
Forage Lentil, early	17.44	-0.19	-1.46	0.71
Forage Lentil, late	17.44	3.58	39.78	0.56
Oat-Pea Forage	17.44	3.62	51.71	0.55

Evaluation of Pasture Forage and Harvested Forage Types during the Third Trimester Production Period

Results

The third trimester production period was 90 days during winter from mid December to mid March. The third trimester production period has increased nutrient requirements. Although the cow has no calf at her side and is not producing milk, the developing fetus is growing at an increasing rate. The weight gain from the fetus and related fluid and tissue is about one pound per day during the last 2 or 2.5 months when the fetus is growing very rapidly (BCRC 1999). It is important that higher-quality forage that meets the nutritional requirements be provided during this period to maintain the weight of cows in moderate or good body condition and to ensure a strong, healthy calf. Feeding forages containing insufficient nutrients during this period causes a reduction in cow body condition and results in delayed estrual activity and a delay in rebreeding. Pasture forage and harvested forage costs and returns after feed costs were determined for a 1200-pound range cow during the 90-day third trimester production period. The cow requires a daily intake of 24 lbs dry matter (DM) at 7.8% crude protein (CP) (1.87 lbs CP/day).

Pasture Forage Types

Reserved native rangeland managed as a repeated seasonal pasture was evaluated during the third trimester production period for 90 days between mid December and mid March (tables 21 and 25). Native rangeland forage during the fall and winter dormancy period has a crude protein content of around 4.8%. Late-season native rangeland forage has pasture rent value or production costs of $8.76 per acre, forage dry matter costs of $120.83 per ton, and crude protein costs of $1.26 per pound. A cow grazing during the third trimester would require 18.62 acres (6.31 acres per month) at a forage cost of $163.12 per production period. The crude protein content of mature native rangeland forage is below the requirements of a cow in the third trimester, and crude protein would need to be supplemented at 0.43 lbs per cow per day at a cost of $11.61 period. Total feed costs would be $174.73 per period, or $1.94 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after pasture costs were a loss of $125.61 per cow-calf pair and a loss of $6.75 per acre. The cost of calf fetus weight gain was $2.49 per pound (table 27).

Standing corn managed as a seasonal pasture was evaluated during the third trimester production period for 90 days between mid December and mid March (tables 21 and 25). Standing corn forage had production costs of $126.67 per acre (Nelson et al. 2002) and forage dry matter costs of $65.97 per ton. A cow grazing during the third trimester period was allotted 0.70 acres. Daily forage utilization averaged 77.7 lbs/cow with 61% to 65% of the forage wasted. Intake and wasted forage would cost $89.07 per production period. An additional 0.54 lbs of crude protein per day would need to be provided at a cost of $21.67 per period (Nelson et al. 2002). Total forage and supplement costs would be $110.74 per period, or $1.23 per day (Nelson et al. 2002) (table 26). Cow weight gain was 0.86 lbs per day and 110.57 lbs per acre; accumulated weight gain was 77.40 lbs. Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after pasture costs were a loss of $61.68 per cow-calf pair and a loss of $87.76 per acre. The cost of calf fetus weight gain was $1.58 per pound (table 27).

Harvested Forage Types

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of around 6.4%. This crested wheatgrass hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. Mature crested wheatgrass hay would be fed at 24.0 lbs DM/day to provide 1.5 lbs CP/day. The nutrient content of mature crested wheatgrass hay is below the dietary requirements of a cow in the third trimester. An additional 0.33 lbs of crude protein per day 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 (tables 22 and 25) would require 1.35 acres, and the forage would cost $38.02 per production period. Total forage and supplement costs would be $47.04 per period, or $0.52 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns

after feed costs were $2.02 per cow-calf pair and $1.50 per acre. The cost of calf fetus weight gain was $0.67 per pound (table 27).

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of around 14.5%. This crested wheatgrass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 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 (tables 22 and 25) would require 0.89 acres, and the forage would cost $23.40 per production period. Total forage and supplement costs would be $40.88 per period, or $0.45 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after feed costs were $8.18 per cow-calf pair and $9.19 per acre. The cost of calf fetus weight gain was $0.58 per pound (table 27).

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 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 (tables 23 and 25) would require 0.27 acres, and the forage would cost $18.90 per production period. Total forage and supplement costs would be $33.86 per period, or $0.38 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after feed costs were $15.20 per cow-calf pair and $56.30 per acre. The cost of calf fetus weight gain was $0.48 per pound (table 27).

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. 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 (tables 23 and 25) would require 0.36 acres, and the forage would cost $26.10 per production period. Total forage and supplement costs would be $31.93 per period, or $0.35 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after feed costs were $17.13 per cow-calf pair and $47.58 per acre. The cost of calf fetus weight gain was $0.46 per pound (table 27).

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 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 (tables 23 and 25) would require 0.31 acres, and the forage would cost $21.60 per production period. Total forage and supplement costs would be $33.73 per period, or $0.37 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after feed costs were $15.33 per cow-calf pair and $49.45 per acre. The cost of calf fetus weight gain was $0.48 per pound (table 27).

Oat forage 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. 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 (tables 23 and 25) would require 0.38 acres, and the forage would cost $28.80 per production period. Total forage feed costs would be $28.80 per period, or $0.32 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after feed costs were $20.26 per cow-calf pair and $53.32 per acre. The cost of calf fetus weight gain was $0.41 per pound (table 27).

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. 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 (tables 24 and 25) would require 0.32 acres, and the forage would cost $25.20 per production period. Total forage and supplement costs would be $47.41 per period, or $0.53 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after feed costs were $1.65 per cow-calf pair and $5.16 per acre. The cost of calf fetus weight gain was $0.68 per pound (table 27).

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 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 (tables 24 and 25) would require 0.25 acres, and the forage would cost $21.60 per production period. Total forage and supplement costs would be $38.93 per period, or $0.43 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after feed costs were $10.13 per cow-calf pair and $40.52 per acre. The cost of calf fetus weight gain was $0.56 per pound (table 27).

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. 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 (tables 24 and 25) would require 0.46 acres, and the forage would cost $28.80 per production period. Total forage and supplement costs would be $53.06 per period, or $0.59 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after feed costs were a loss of $4.00 per cow-calf pair and a loss of $8.70 per acre. The cost of calf fetus weight gain was $0.76 per pound (table 27).

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 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 (tables 24 and 25) would require 0.30 acres, and the forage would cost $21.60 per production period. Total forage and supplement costs would be $39.40 per period, or $0.44 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after feed costs were $9.66 per cow-calf pair and $32.20 per acre. The cost of calf fetus weight gain was $0.56 per pound (table 27).

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.16 per pound. Oat-pea forage hay would be fed at 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 (tables 24 and 25) would require 0.26 acres, and the forage would cost $25.20 per production period. Total forage and supplement costs would be $39.38 per period, or $0.44 per day (table 26). Calf fetus weight gain was assumed to be 0.78 lbs per day; accumulated weight gain was 70.08 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $49.06 per calf, and the net returns after feed costs were $9.68 per cow-calf pair and $37.23 per acre. The cost of calf fetus weight gain was $0.56 per pound (table 27).

Discussion

Pasture Forage Types

Reserved native rangeland forage grazed as a repeated seasonal pasture during the third trimester production period was high-cost forage because the quantities of crude protein captured per acre were low and the quantity of forage dry matter available per acre was low. Total forage costs for reserved native rangeland pastures was high, even though the equipment costs, labor costs, land rent per acre, and forage production costs per acre were low, because the input costs do not directly regulate livestock forage feed costs. The cost per pound of crude protein ($1.26/lb CP) was extremely high because the quantity of crude protein captured per acre was extremely low. The crude protein content of the forage was below the requirements of a gestating cow making it necessary to provide purchased supplemental crude protein. The forage dry matter cost ($120.83/ton) was extremely high because the quantity of forage weight per acre was low. The low forage weight per acre made it necessary to use 2.5 times the land area that would have been needed during the summer period to provide a cow with adequate forage dry matter for a month in the same pasture. The large land area (18.62 acres) per cow caused the forage costs per period to be high. The total daily forage and supplemental crude protein costs ($1.94/day) were extremely high. The total feed costs were greater than the low market value of the accumulated calf fetus weight causing an extremely high loss in returns after feed costs ($-125.67) per cow and a moderate loss in returns after feed costs of ($-6.75) per acre. The cost per pound of calf fetus weight gain ($2.49/lb) was extremely high because of the very low crude protein and very low forage dry matter yields per acre, the large land area per cow, and growth in weight of the fetus was relatively slow.

Standing corn grazed as a seasonal pasture during the third trimester production period was high-cost forage because of the extremely high production costs per acre and the extremely high quantity of unutilized wasted forage. The forage dry matter cost ($65.97/ton) was high because of the low percentage (38%) of herbage consumed as forage. The land area (0.70 acres) per cow was small because of the high herbage biomass produced during exceptionally good growing season conditions with low water deficiency. Corn herbage biomass production would be expected to be low during growing season conditions with normal water deficiency. The crude protein content of the forage was below the requirements of a gestating cow making it necessary to provide purchased supplemental crude protein. The weight gained by the cows was less than a pound per day. The total daily forage and supplemental crude protein costs ($1.23/day) were very high because of the low crude protein content in the forage, the high cost of supplemental crude protein, and the low percent of herbage consumed as forage. The total feed costs were greater than the low market value of the accumulated calf fetus weight causing a very high loss in returns after feed costs ($-61.68) per cow and an extremely high loss in returns after feed costs ($-87.74) per acre. The cost per pound of calf fetus weigh gain ($1.58/lb) was extremely high because of the high production costs per acre, the high percent of wasted herbage, and growth in weight of the fetus was relatively slow.

Harvested Forage Types

Crested wheatgrass hay cut at a mature growth stage and fed during the third trimester production period was moderate-cost forage. The forage dry matter cost ($34.80/ton) was moderate for mature crested wheatgrass hay and lower than the forage dry matter cost per ton for early cut crested wheatgrass hay because greater dry matter weight of the mature crested wheatgrass hay was harvested per acre. The cost per pound of crude protein ($0.28/lb CP) was high for mature crested wheatgrass hay and double the cost per pound of crude protein for early cut crested wheatgrass hay because of the lower crude protein weight in the mature crested wheatgrass hay harvested per acre. The land area (1.35 acres) per cow for mature crested wheatgrass hay was small but greater than the land area required per cow for early cut crested wheatgrass hay because of the greater crude protein weight per acre in the early cut crested wheatgrass hay. The crude protein content of the mature crested wheatgrass forage was below the requirements of a gestating cow making it necessary to provide purchased supplemental crude protein. The total daily forage and supplemental crude protein costs ($0.52/day) were moderate because the total supplemental crude protein costs were moderate. The total feed costs were slightly lower than the low market value of the accumulated calf fetus weight resulting in very low returns after feed costs ($2.02) per cow and ($1.50) per acre. The cost per pound of calf fetus weight gain ($0.67/lb) was high because of the additional supplemental crude protein costs needed because mature crested wheatgrass hay did not meet the nutrient requirements of gestating range cows and growth in weight of the fetus was relatively slow.

Crested wheatgrass hay cut at the boot growth stage and fed during the third trimester production period was moderate-cost forage. The forage dry matter cost ($40.80/ton) was moderate for early cut crested wheatgrass hay and was greater than the forage dry matter cost per ton for mature crested wheatgrass hay because crested wheatgrass hay cut at the boot stage harvested lower forage dry matter weight per acre than crested wheatgrass hay cut at a mature growth stage. The cost per pound of crude protein ($0.14/lb CP) was low for early cut crested wheatgrass hay and lower than the cost per pound of crude protein for mature crested wheatgrass hay because of the greater crude protein weight in the early cut crested wheatgrass hay harvested per acre. The land area (0.89 acres) per cow for early cut crested wheatgrass hay was small and less than the land area required per cow for mature crested wheatgrass hay because of the greater crude protein weight harvested per acre in the early cut crested wheatgrass hay. The forage cost of early cut crested wheatgrass hay was low but the total daily forage feed cost ($0.45/day) was moderate because slightly under half of the ration forage was supplemental roughage which added substantially to the total forage costs. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in moderate returns after feed costs ($8.18) per cow and ($9.19) per acre. The cost per pound of calf fetus weight gain ($0.58/lb) was moderate mainly because of the additional supplemental roughage costs.

Forage barley hay cut at the milk growth stage and fed during the third trimester production period was low-cost forage. The production costs per acre were high for early cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($28.80/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.11/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.27 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.38/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total forage feed costs for early cut forage barley hay was slightly greater than the total forage feed costs for late cut forage barley hay because of the greater quantity of supplemental roughage in the forage ration for early cut forage barley hay. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in moderate returns after feed costs ($15.20) per cow and in high returns after feed costs ($56.30) per acre. The cost per pound of calf fetus weight gain ($0.48/lb) was moderate because growth in weight of the fetus was relatively slow.

Forage barley hay cut at the hard dough growth stage and fed during the third trimester production period was low-cost forage. The production costs per acre were high for late cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($27.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut forage barley hay was greater than the cost per pound of crude protein for early cut forage barley hay because of the lower crude protein weight harvested per acre in the late cut forage barley hay. The land area (0.36 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.35/day) were low because of the high crude protein content and the high forage dry matter production. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in moderate returns after feed costs ($17.13) per cow and in high returns after feed costs ($47.58) per acre. The returns after feed costs per acre were lower for late cut forage barley hay than for early cut forage barley hay because late cut forage barley hay had slightly higher crude protein cost per pound and slightly larger land area per cow than early cut forage barley hay. The cost per pound of calf fetus weight gain ($0.46/lb) was moderate because growth in weight of the fetus was relatively slow.

Oat forage hay cut at the milk growth stage and fed during the third trimester production period was low-cost forage. The production costs per acre were high for early cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($29.60/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.31 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.37/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total feed costs were lower than the low market value of the

accumulated calf fetus weight resulting in moderate returns after feed costs ($15.33) per cow and in high returns after feed costs ($49.45) per acre. The cost per pound of calf fetus weight gain ($0.48/lb) was moderate because growth in weight of the fetus was relatively slow.

Oat forage hay cut at the hard dough growth stage and fed during the third trimester production period was low-cost forage. The production costs per acre were high for late cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($26.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut oat forage hay was greater than the cost per pound of crude protein for early cut oat forage hay because of the lower crude protein weight harvested per acre in the late cut oat forage hay. The land area (0.38 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage feed costs ($0.32/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total forage feed costs for late cut oat forage hay were lower than the total forage feed costs for early cut oat forage hay because of the greater quantity of supplemental roughage in the forage ration for early cut oat forage hay. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in moderate returns after feed costs ($20.26) per cow and in high returns after feed costs ($53.32) per acre. The cost per pound of calf fetus weight gain ($0.41/lb) was moderate because growth in weight of the fetus was relatively slow.

Pea forage hay cut at an early growth stage and fed during the third trimester production period was low-cost forage. However, pea forage hay cut at a late growth stage has lower forage feed costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for early cut pea forage hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($55.00/ton) was high because of the modest forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.32 acres) per cow was small because of the high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.53/day) were low because of the low cost of crude protein per pound and the small land area per cow. The total feed costs were slightly lower than the low market value of the accumulated calf fetus weight resulting in very low returns after feed costs ($1.65) per cow and in low returns after feed costs ($5.16) per acre. The cost per pound of calf fetus weight gain ($0.68/lb) was high because of the modest forage dry matter production per acre and the high supplemental roughage costs.

Pea forage hay cut at a late growth stage and fed during the third trimester production period was low-cost forage. Late cut pea forage hay has lower forage feed costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for late cut pea forage hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($37.40/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.25 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.43/day) were low because of the low cost of crude protein per pound, the high forage dry matter production per acre, and the small land area per cow. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in moderate returns after feed costs ($10.13) per cow and in high returns after feed costs ($40.52) per acre. The cost per pound of calf fetus weight gain ($0.56/lb) was moderate because growth in weight of the fetus was relatively slow.

Forage lentil hay cut at an early growth stage and fed during the third trimester production period was low-cost forage. However, forage lentil hay cut at a late growth stage has lower forage feed costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for early cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($71.60/ton) was high because of the modest forage dry matter yield per acre. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.46 acres) per cow was small because of the high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.59/day) were low because of the low cost of crude protein per pound and the small land area per cow. The total feed costs were greater than the low market value of

the accumulated calf fetus weight causing moderate losses in returns after feed costs ($-4.00) per cow and ($-8.70) per acre. The cost per pound of calf fetus weight gain ($0.76/lb) was high because of the modest forage dry matter production per acre and the high supplemental roughage costs.

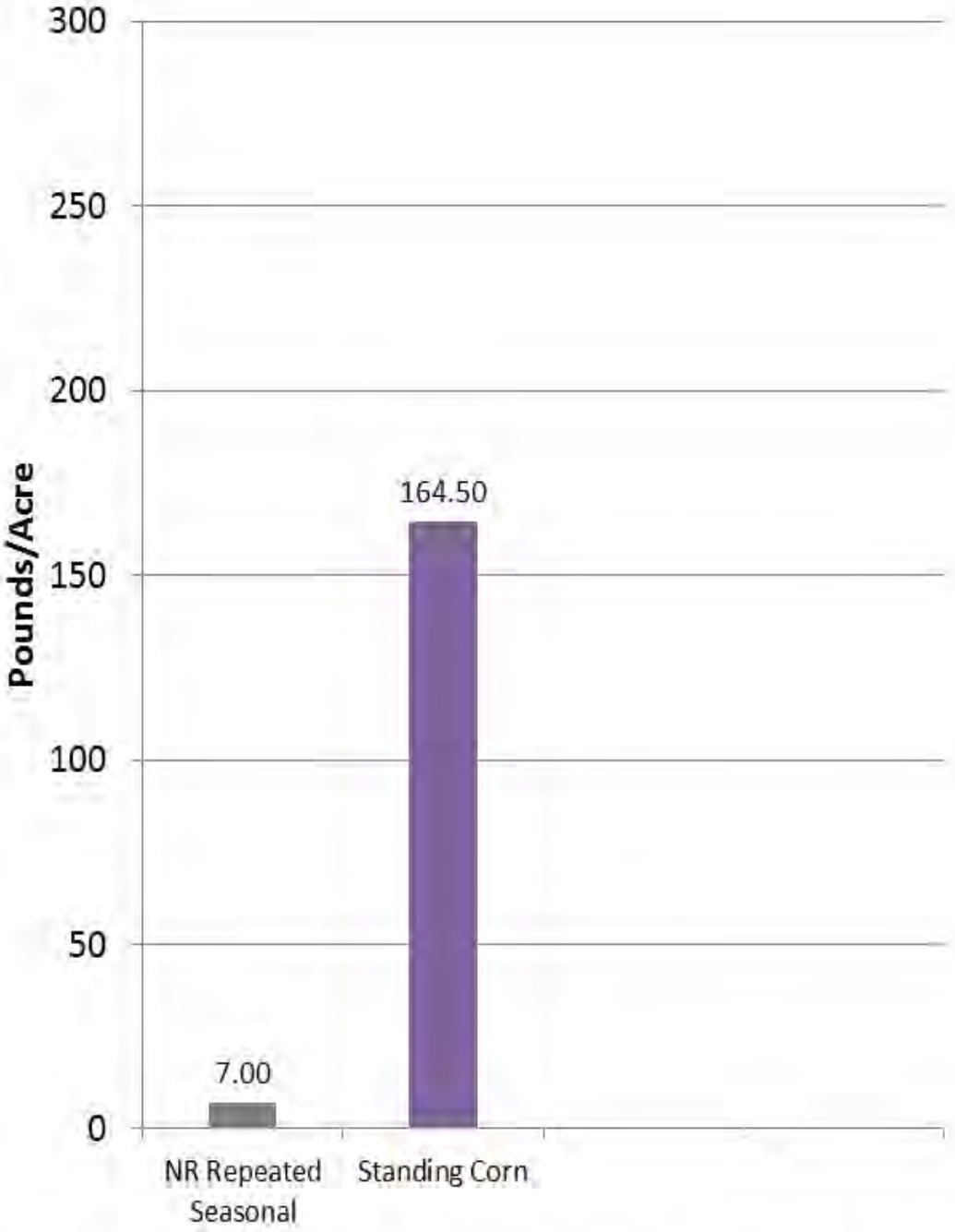
Forage lentil hay cut at a late growth stage and fed during the third trimester production period was low-cost forage. Late cut forage lentil hay has lower forage feed costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for late cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($37.00/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.30 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.44/day) were low because of the low cost of crude protein per pound, the high forage dry matter production per acre, and the small land area per cow. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in moderate returns after feed costs ($9.66) per cow and in moderate returns after feed costs ($32.20) per acre. The cost per pound of calf fetus weight gain ($0.56/lb) was moderate because growth in weight of the fetus was relatively slow.

Oat-pea hay cut at compromised plant growth stages and fed during the third trimester production period was low-cost forage. However, seeding oat forage separately on half of the field and cutting it at an early growth stage and seeding pea forage separately on half of the field and cutting it at a late growth stage will result in lower production costs per acre, lower forage dry matter costs per ton, lower costs per pound of crude protein, lower total forage feed costs per day, lower costs per pound of calf weight gain, greater net returns after feed costs per cow, and greater net returns after feed costs per acre than oat-pea forage seeded together and cut at compromised growth stages. The production costs per acre were very high for oat-pea hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($37.20/ton) was moderate because of the high forage dry matter production per acre. The cost per pound of crude protein ($0.16/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.26 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.44/day) were low because of the low cost of crude protein per pound, the high forage dry matter production per acre, and the small land area per cow. The total feed costs were lower than the low market value of the accumulated calf fetus weight resulting in moderate returns after feed costs ($9.68) per cow and in high returns after feed costs ($37.23) per acre. The cost per pound of calf fetus weight gain ($0.56/lb) was moderate because growth in weight of the fetus was relatively slow.

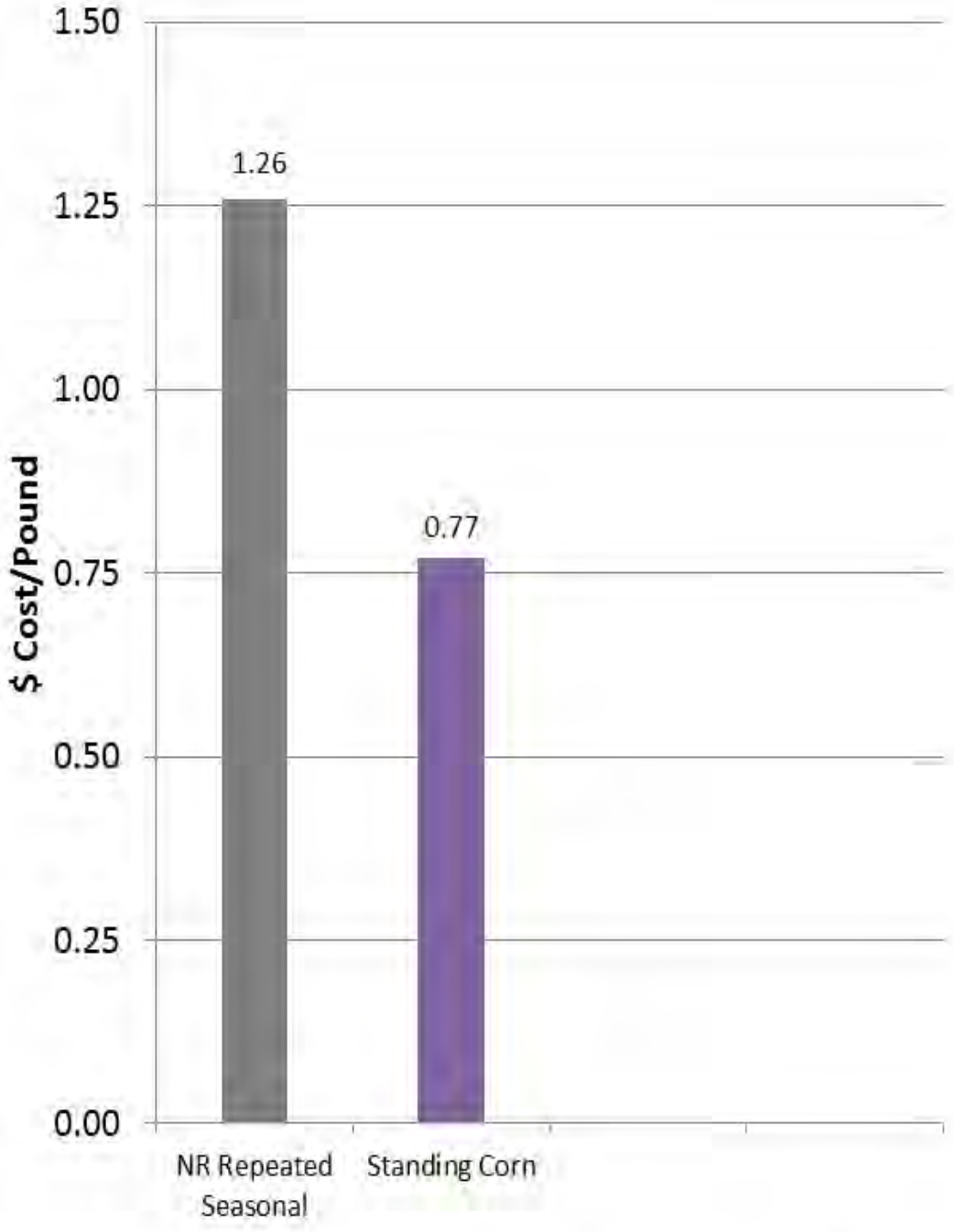
Table 21. Costs and returns for pasture forage types grazed by range cows during the 90-day third trimester production period.

		Native Rangeland Repeated Seasonal	Standing Corn Seasonal Pasture
Days		90	90
Growth Stage		Dormant	Mature
Herbage Weight	lb/ac	580	9940*
Forage DM Weight	lb/ac	145	3840
Costs/Acre			
Land Rent	$	8.76	
Custom Work	$		
Seed Cost	$		
Baling Costs	$		
Production Costs	$/ac	8.76	126.67*
Forage DM Costs	$/ton	120.83	65.97
Crude Protein	%	4.8	
Crude Protein Yield	lb/ac	6.96	
Crude Protein Cost	$/lb	1.26	
Forage Allocation	lb/d	30.0	30.0
Land Area/Period	ac	18.62	0.70
Forage Costs/Period	$/pp	163.12	89.07
Supplementation			
Roughage/Day	lb/d		
Crude Protein/Day	lb/d	0.43	0.54*
Sup. Cost/Period	$/pp	11.61	21.67
Total Feed Cost	$/pp	174.73	110.74
Cost/Day	$/d	1.94	1.23*
Accumulated Calf Wt.	lbs	70.08	70.08
Weight Value @$0.70/lb	$	49.06	49.06
Net Return/c-c pr	$	-125.67	-61.68
Net Return/acre	$	-6.75	-87.74
Cost/lb of Calf Gain	$	2.49	1.58

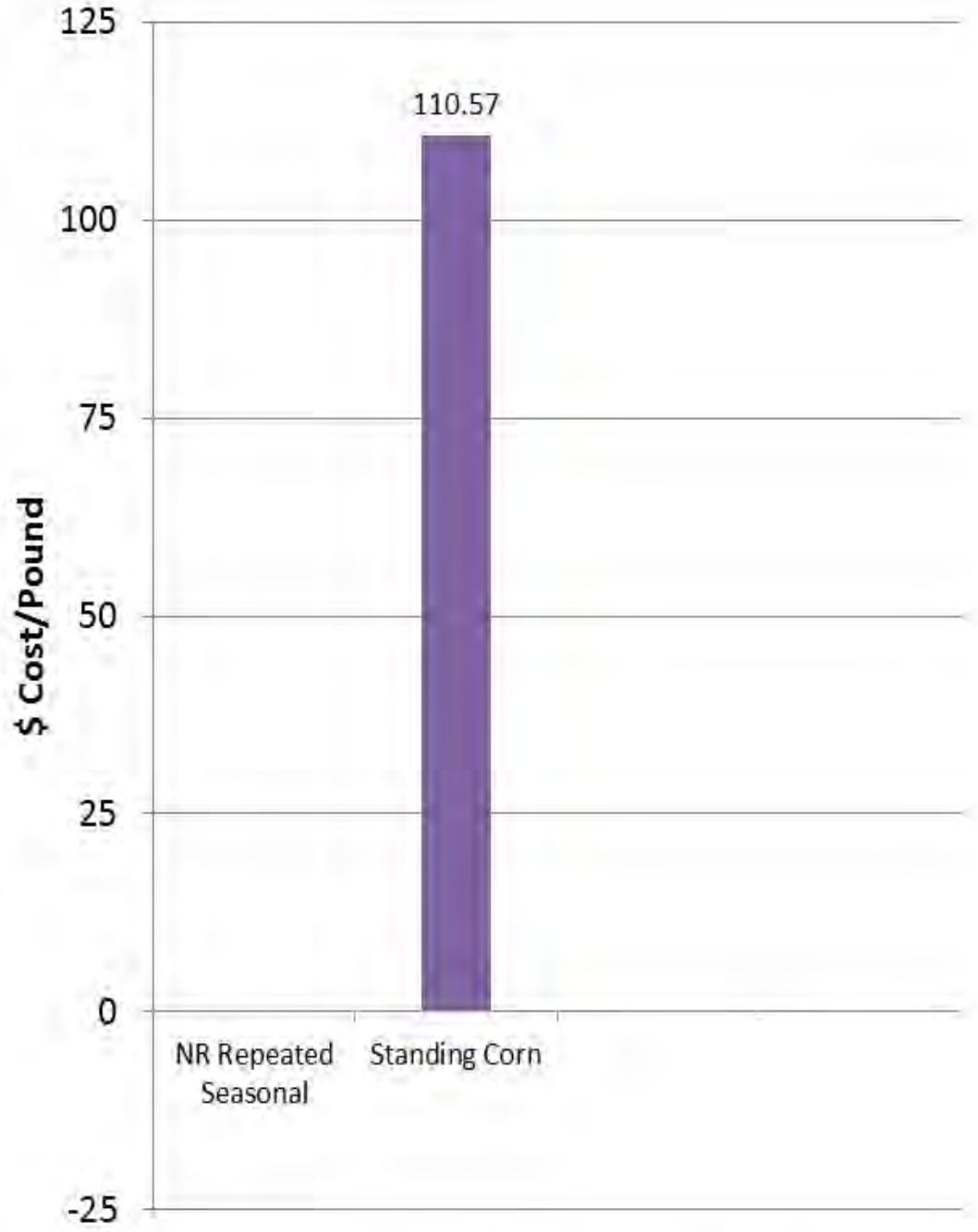
*Data from Nelson et al. 2002



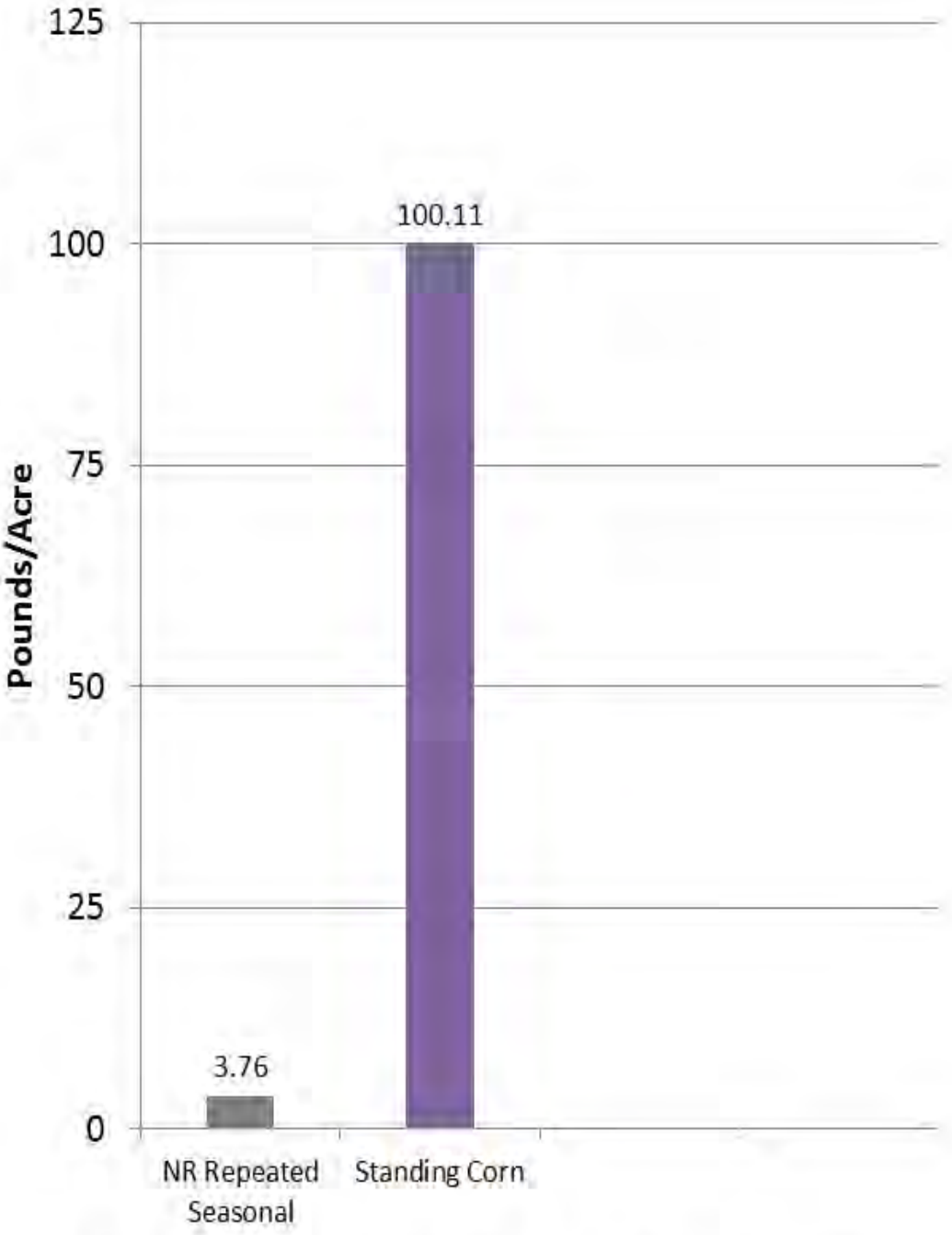
Crude Protein Weight Captured per Acre on Pasture Forages During Third Trimester



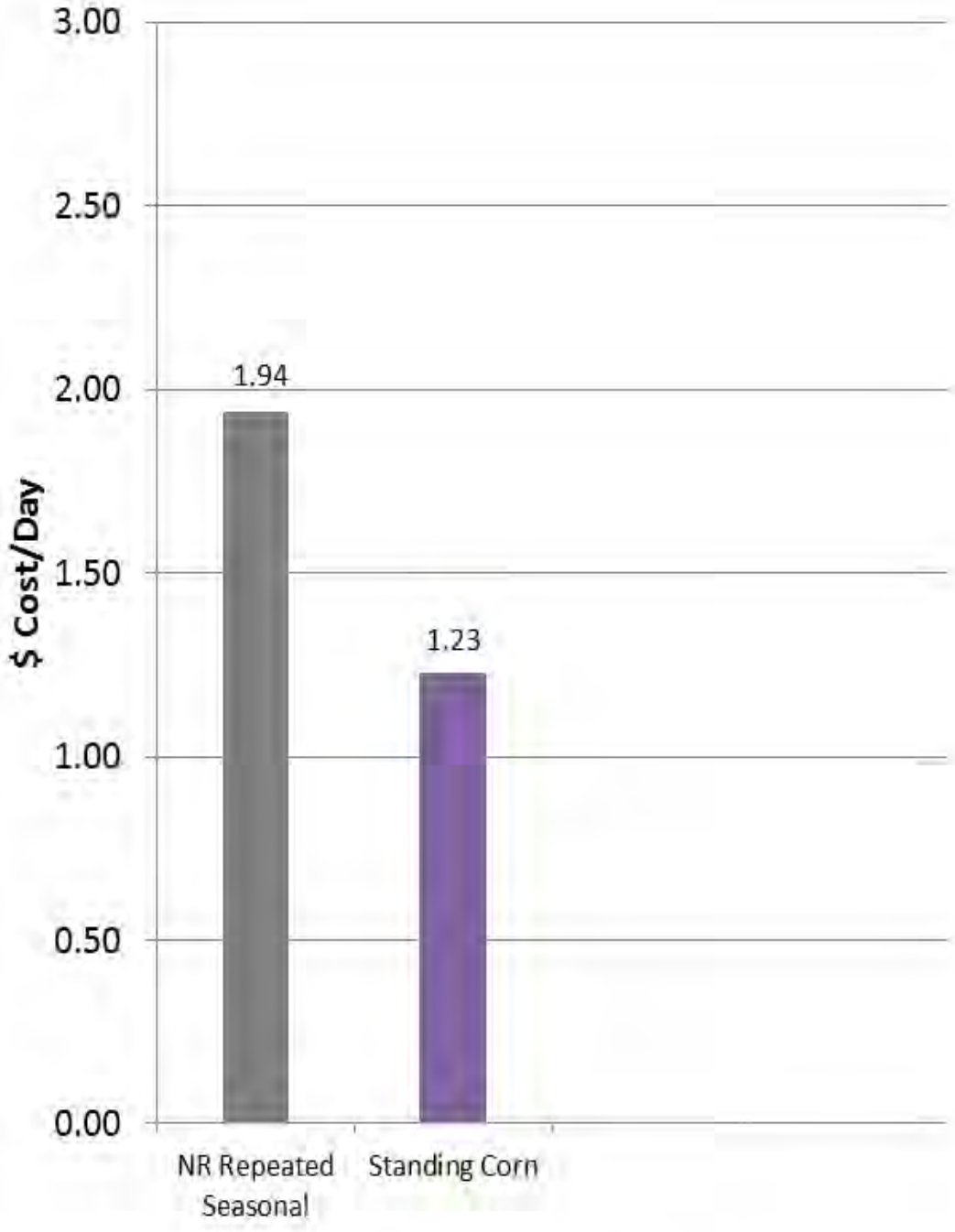
Crude Protein Cost per Pound
on Pasture Forages During Third Trimester



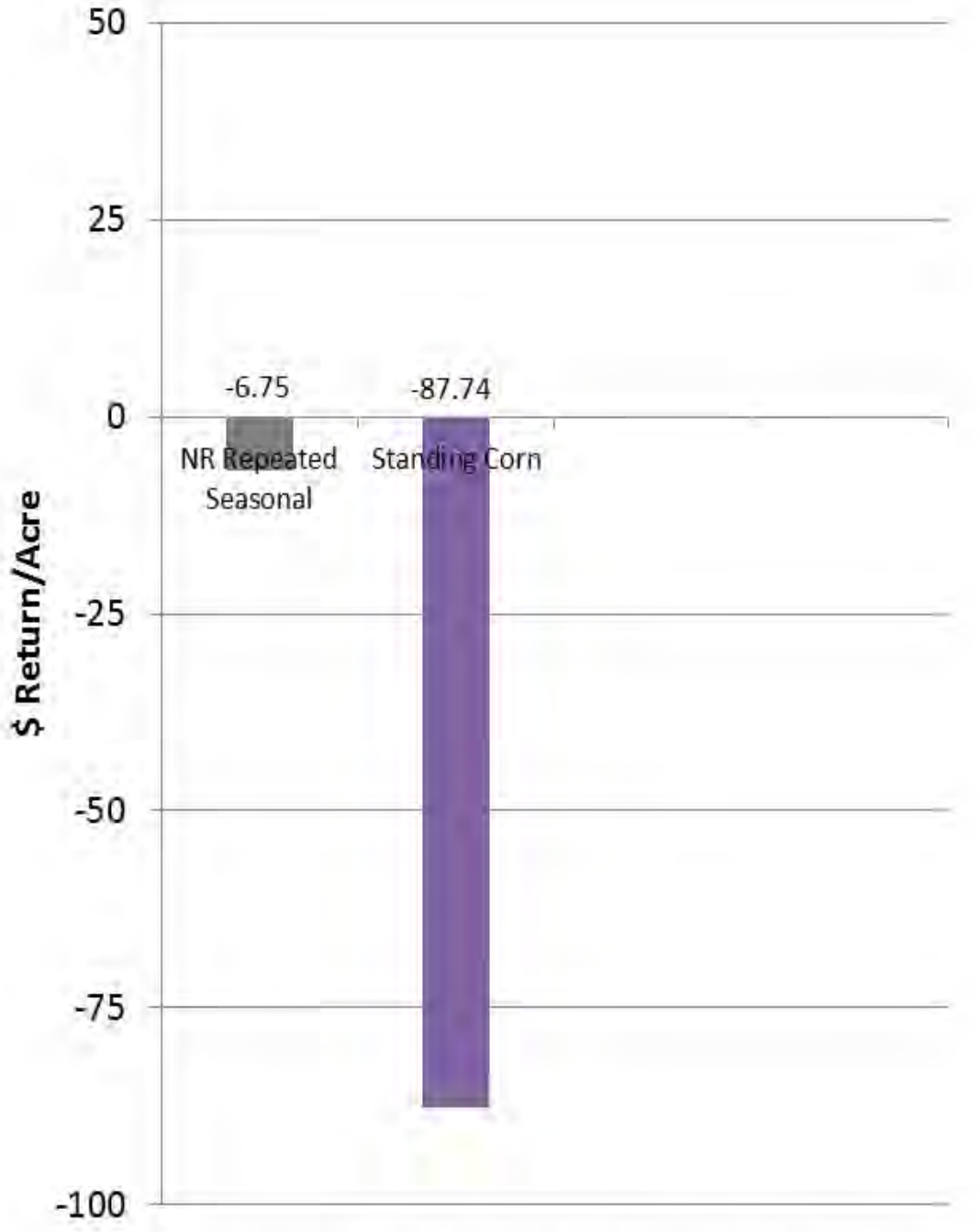
Cow Weight Gain per Acre
on Pasture Forages During Third Trimester



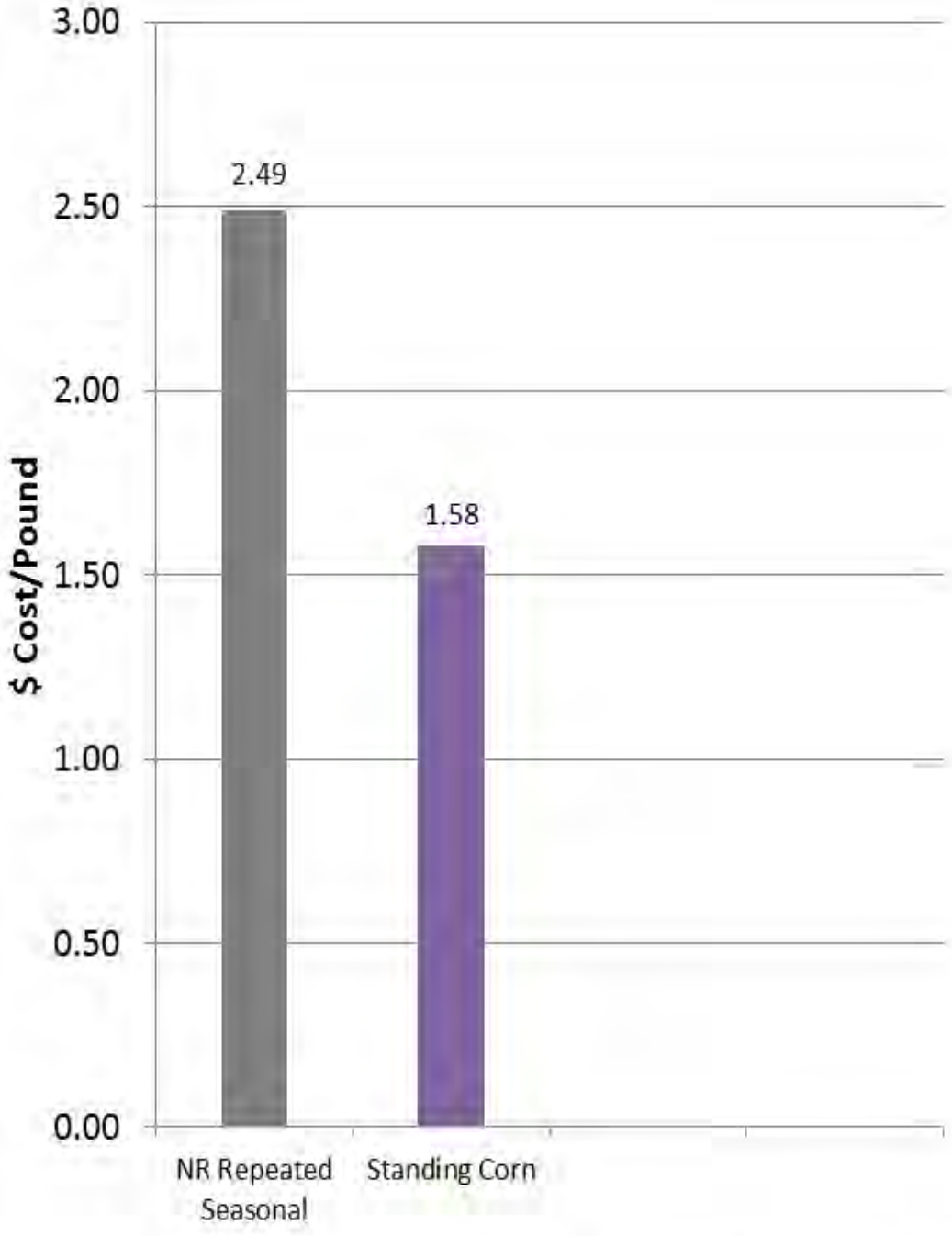
Calf Weight Gain per Acre on Pasture Forages During Third Trimester



Forage Feed Costs per Day
on Pasture Forages During Third Trimester



Returns After Feed Costs per Acre on Pasture Forages During Third Trimester



Calf Weight Gain Costs per Pound on Pasture Forages During Third Trimester

Table 22. Costs and returns for perennial grass harvested forage types to be fed to range cows during the 90-day third trimester production period.

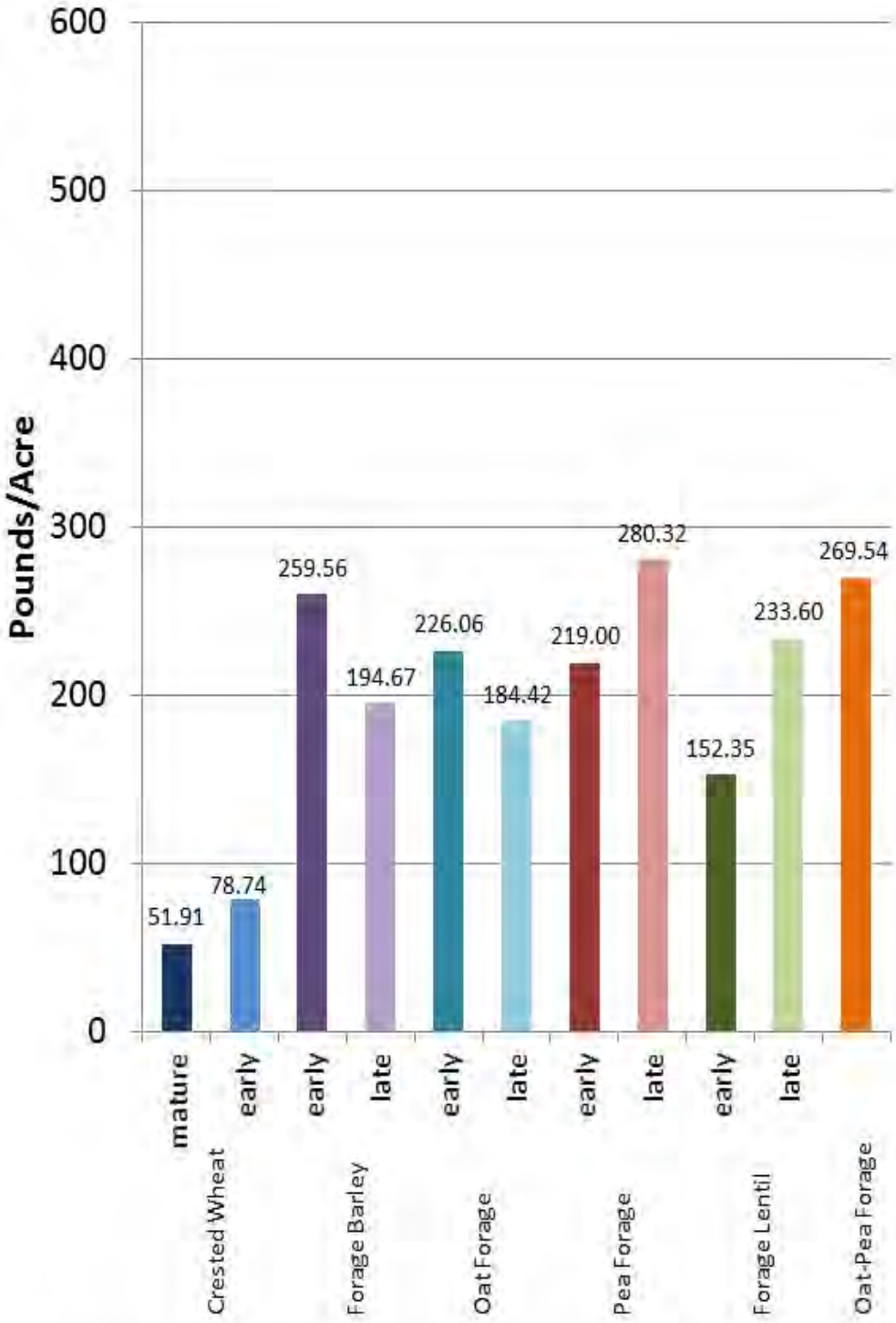
		Crested Wheatgrass Hay	Crested Wheatgrass Hay
Days		90	90
Growth Stage		Mature	Boot Stage
Herbage Weight	lb/ac	-	-
Forage DM Weight	lb/ac	1600	1300
Costs/Acre			
Land Rent	$	14.22	14.22
Custom Work	$	5.31	5.31
Seed Cost	$	-	-
Baling Costs	$	8.58	6.97
Production Costs	$/ac	28.11	26.50
Forage DM Costs	$/ton	34.80	40.80
Crude Protein	%	6.4	14.5
Crude Protein Yield	lb/ac	102	189
Crude Protein Cost	$/lb	0.28	0.14
Forage Allocation	lb/d	24.0	12.9
Land Area/Period	ac	1.35	0.89
Forage Costs/Period	$/pp	38.02	23.40
Supplementation			
Roughage/Day	lb/d		11.1
Crude Protein/Day	lb/d	0.33	
Sup. Cost/Period	$/pp	9.02	17.48
Total Feed Cost	$/pp	47.04	40.88
Cost/Day	$/d	0.52	0.45
Accumulated Calf Wt.	lbs	70.08	70.08
Weight Value @$0.70/lb	$	49.06	49.06
Net Return/c-c pr	$	2.02	8.18
Net Return/acre	$	1.50	9.19
Cost/lb of Calf Gain	$	0.67	0.58

Table 23. Costs and returns for annual cereal harvested forage types to be fed to range cows during the 90-day third trimester production period.

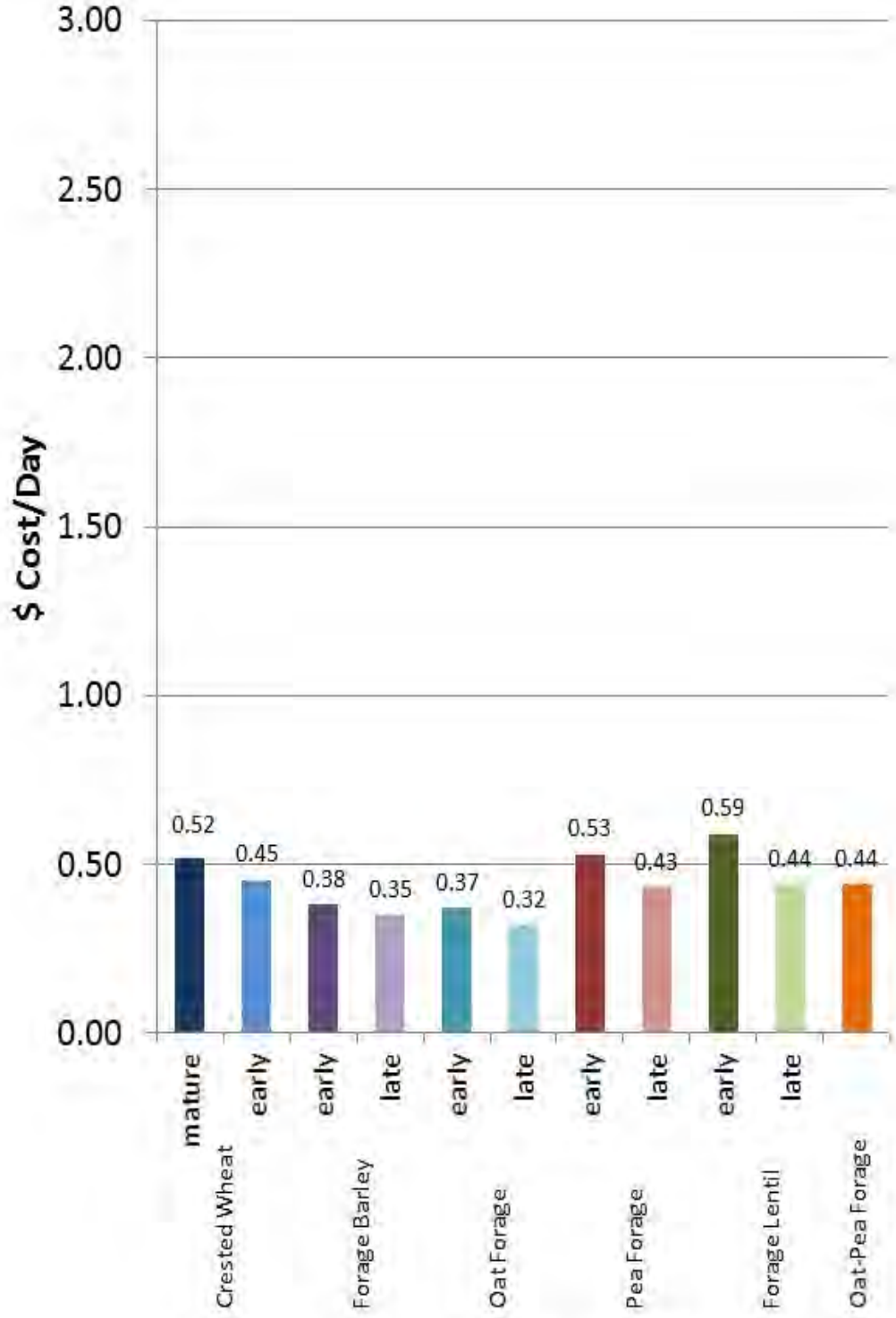
		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Days		90	90	90	90
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Forage Allocation	lb/d	14.4	20.3	16.3	24.0
Land Area/Period	ac	0.27	0.36	0.31	0.38
Forage Costs/Period	$/pp	18.90	26.10	21.60	28.80
Supplementation					
Roughage/Day	lb/d	9.6	3.7	7.7	
Crude Protein/Day	lb/d				0.0
Sup. Cost/Period	$/pp	14.96	5.83	12.13	0.0
Total Feed Cost	$/pp	33.86	31.93	33.73	28.80
Cost/Day	$/d	0.38	0.35	0.37	0.32
Accumulated Calf Wt.	lbs	70.08	70.08	70.08	70.08
Weight Value @$0.70/lb	$	49.06	49.06	49.06	49.06
Net Return/c-c pr	$	15.20	17.13	15.33	20.26
Net Return/acre	$	56.30	47.58	49.45	53.32
Cost/lb of Calf Gain	$	0.48	0.46	0.48	0.41

Table 24. Costs and returns for annual legume harvested forage types to be fed to range cows during the 90-day third trimester production period.

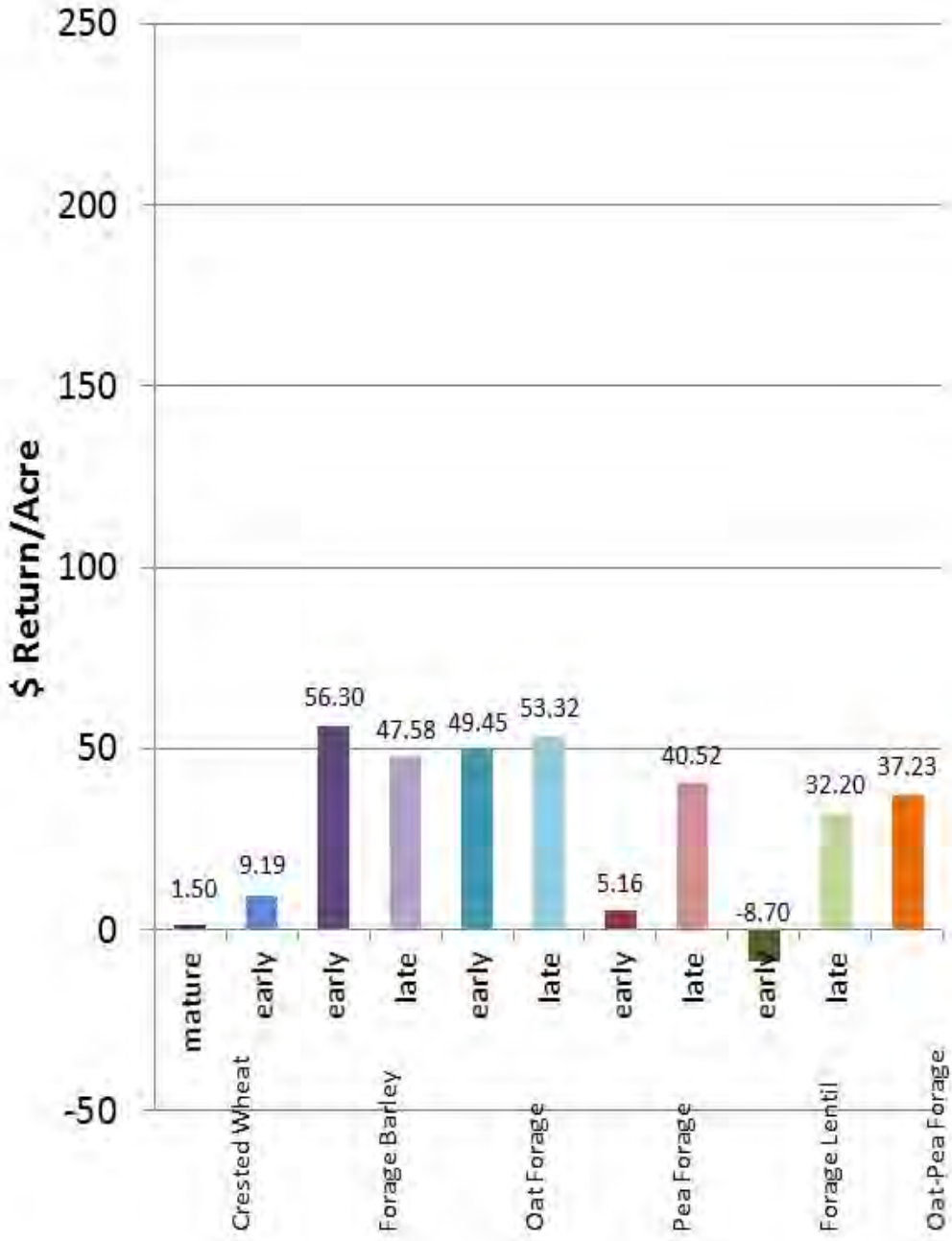
		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Days		90	90	90	90	90
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Forage Allocation	lb/d	9.9	13.0	8.6	12.7	15.0
Land Area/Period	ac	0.32	0.25	0.46	0.30	0.26
Forage Costs/Period	$/pp	25.20	21.60	28.80	21.60	25.20
Supplementation						
Roughage/Day	lb/d	14.1	11.0	15.4	11.3	9.0
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	22.21	17.33	24.26	17.80	14.18
Total Feed Cost	$/pp	47.41	38.93	53.06	39.40	39.38
Cost/Day	$/d	0.53	0.43	0.59	0.44	0.44
Accumulated Calf Wt.	lbs	70.08	70.08	70.08	70.08	70.08
Weight Value @$0.70/lb	$	49.06	49.06	49.06	49.06	49.06
Net Return/c-c pr	$	1.65	10.13	-4.00	9.66	9.68
Net Return/acre	$	5.16	40.52	-8.70	32.20	37.23
Cost/lb of Calf Gain	$	0.68	0.56	0.76	0.56	0.56



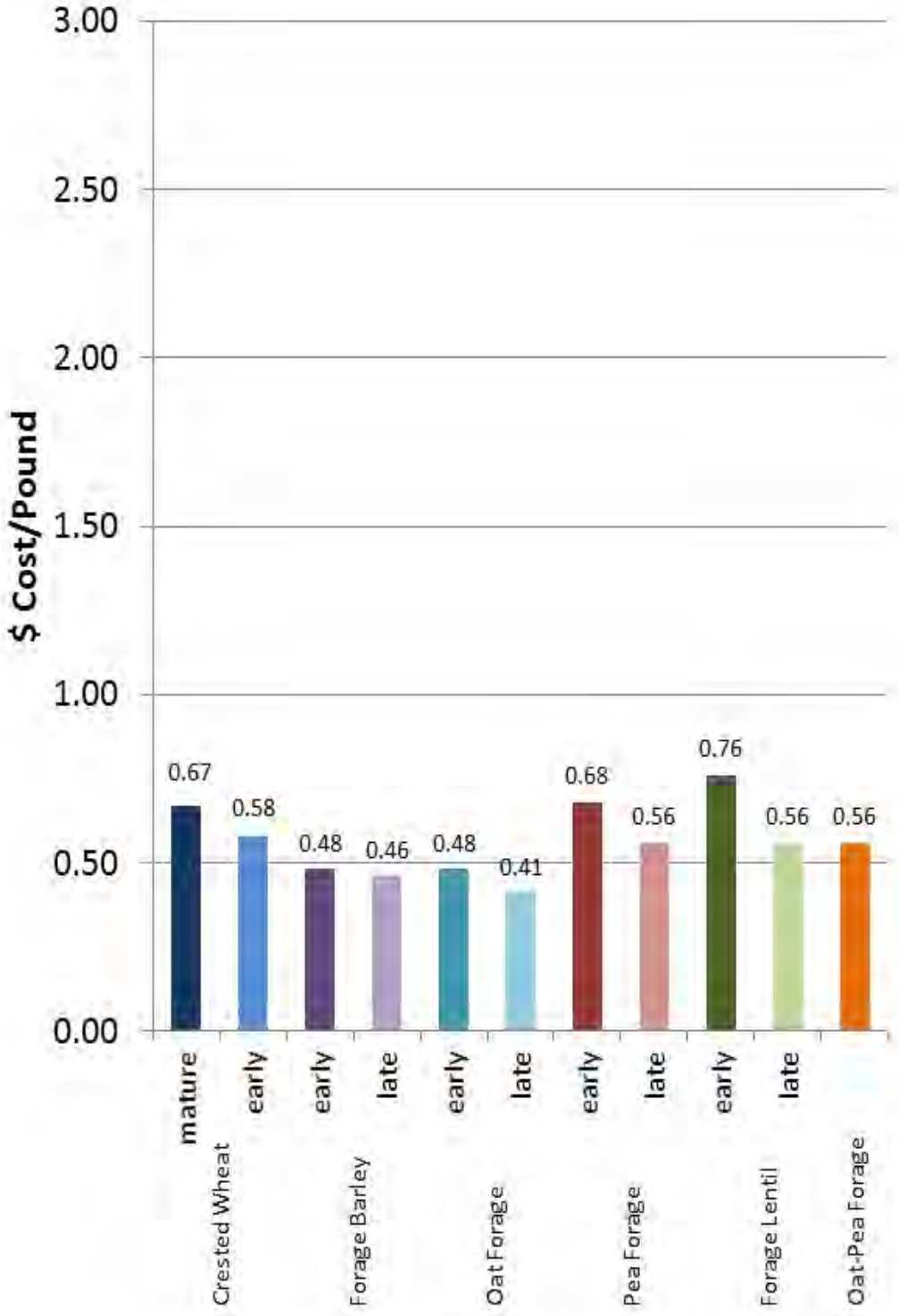
Calf Weight Gain per Acre on Harvested Forages During Third Trimester



Forage Feed Costs per Day on Harvested Forages During Third Trimester



Returns After Feed Costs per Acre on Harvested Forages During Third Trimester



Calf Weight Gain Costs per Pound on Harvested Forages During Third Trimester

Table 25. Feed quantity and land area for forage types used during the 90-day third trimester production period.

Forage Types	Daily Feed per Cow			Third Trimester Period Feed one Cow for 90 days			
	Forage lb/d	Roughage lb/d	Crude Protein lb/d	Forage lb/pp	Roughage lb/pp	Crude Protein lb/pp	Land Area ac/pp
Pasture Forage Types							
Native Rangeland Repeated Seasonal	30.0		0.43	2700.0		38.7	18.62
Standing Corn	30.0		0.54	2700.0		48.6	0.70
Harvested Forage Types							
Crested Wheat, mature	24.0		0.33	2160.0		30.1	1.35
Crested Wheat, early	12.9	11.1		1161.0	999.0		0.89
Forage Barley, early	14.4	9.6		1296.0	864.0		0.27
Forage Barley, late	20.3	3.7		1827.0	333.0		0.36
Oat Forage, early	16.3	7.7		1467.0	693.0		0.31
Oat Forage, late	24.0			2160.0			0.38
Pea Forage, early	9.9	14.1		891.0	1269.0		0.32
Pea Forage, late	13.0	11.0		1170.0	990.0		0.25
Forage Lentil, early	8.6	15.4		774.0	1386.0		0.46
Forage Lentil, late	12.7	11.3		1143.0	1017.0		0.30
Oat-Pea Forage	15.0	9.0		1350.0	810.0		0.26

Table 26. Summary of feed costs for forage types used during the 90-day third trimester production period.

Forage Types	Forage Costs $/pp	Roughage Costs $/pp	Crude Protein Costs $/pp	Total Feed Costs $/pp	Daily Feed Costs $/d
Pasture Forage Types					
Native Rangeland Repeated Seasonal	163.12		11.61	174.73	1.94
Standing Corn	89.07		21.67	110.74	1.23
Harvested Forage Types					
Crested Wheat, mature	38.02		9.02	47.04	0.52
Crested Wheat, early	23.40	17.48		40.88	0.45
Forage Barley, early	18.90	14.96		33.86	0.38
Forage Barley, late	26.10	5.83		31.93	0.35
Oat Forage, early	21.60	12.13		33.73	0.37
Oat Forage, late	28.80			28.80	0.32
Pea Forage, early	25.20	22.21		47.41	0.53
Pea Forage, late	21.60	17.33		38.93	0.43
Forage Lentil, early	28.80	24.26		53.06	0.59
Forage Lentil, late	21.60	17.80		39.40	0.44
Oat-Pea Forage	25.20	14.18		39.38	0.44

Table 27. Summary of returns after feed costs for forage types used during the 90-day third trimester production period.

Forage Types	Gross Return @$0.70/lb $/calf	Net Return per C-C pr $/pr	Net Return per acre $/ac	Calf Gain Cost $/lb
Pasture Forage Types				
Native Rangeland Repeated Seasonal	49.06	-125.67	-6.75	2.49
Standing Corn	49.06	-61.68	-87.74	1.58
Harvested Forage Types				
Crested Wheat, mature	49.06	2.02	1.50	0.67
Crested Wheat, early	49.06	8.18	9.19	0.58
Forage Barley, early	49.06	15.20	56.30	0.48
Forage Barley, late	49.06	17.13	47.58	0.46
Oat Forage, early	49.06	15.33	49.45	0.48
Oat Forage, late	49.06	20.26	53.32	0.41
Pea Forage, early	49.06	1.65	5.16	0.68
Pea Forage, late	49.06	10.13	40.52	0.56
Forage Lentil, early	49.06	-4.00	-8.70	0.76
Forage Lentil, late	49.06	9.66	32.20	0.56
Oat-Pea Forage	49.06	9.68	37.23	0.56

Table 27. Summary of returns after feed costs for forage types used during the 90-day third trimester production period.

Forage Types	Gross Return @$0.70/lb $/calf	Net Return per C-C pr $/pr	Net Return per acre $/ac	Calf Gain Cost $/lb
Pasture Forage Types				
Native Rangeland Repeated Seasonal	49.06	-125.67	-6.75	2.49
Standing Corn	49.06	-61.68	-87.74	1.58
Harvested Forage Types				
Crested Wheat, mature	49.06	2.02	1.50	0.67
Crested Wheat, early	49.06	8.18	9.19	0.58
Forage Barley, early	49.06	15.20	56.30	0.48
Forage Barley, late	49.06	17.13	47.58	0.46
Oat Forage, early	49.06	15.33	49.45	0.48
Oat Forage, late	49.06	20.26	53.32	0.41
Pea Forage, early	49.06	1.65	5.16	0.68
Pea Forage, late	49.06	10.13	40.52	0.56
Forage Lentil, early	49.06	-4.00	-8.70	0.76
Forage Lentil, late	49.06	9.66	32.20	0.56
Oat-Pea Forage	49.06	9.68	37.23	0.56

Evaluation of Pasture Forage and Harvested Forage Types during the Early Lactation Production Period

Results

The early lactation production period was 45 days during early spring from mid March to late April. The early lactation production period has the greatest nutritional requirements of the production periods because the birth of the calf initiates production of increasing amounts of milk and the reproductive organs require repair and pre-conditioning to promote the rapid onset of the estrus cycle. Cows gaining weight during this period will produce milk in quantities at or near the animals' genetic potential. Cows increasing in body condition will have adequate time to complete at least one estrus cycle prior to the start of the breeding season; this rapid recovery improves the percentage of cows that conceive in the first cycle of the breeding season (BCRC 1999). Feeding forages containing insufficient nutrients during this period causes a reduced cow body condition that results in milk production at levels below the animals' genetic potential and in a delayed onset of estrual activity so that the period between calving and the first estrus cycle is lengthened and conception rates in the cow herd are reduced. Pasture forage and harvested forage costs and returns after feed costs were determined for a 1200-pound range cow during the early lactation production period. The cow requires a daily intake of 27 lbs dry matter (DM) at 10.1% crude protein (CP) (2.73 lbs CP/day).

Pasture Forage Types

Reserved native rangeland managed as a repeated seasonal pasture was evaluated during the early lactation production period for 45 days between mid March and late April (tables 28 and 31). Forage on native rangeland pasture during early spring has a crude protein content of around 9.2%. Early spring native rangeland forage has pasture rent value or production costs of $8.76 per acre, forage dry matter costs of $140.16 per ton, and crude protein costs of $0.76 per pound. A cow grazing during the early lactation period would require 10.80 acres (7.32 acres per month) at a forage cost of $94.64 per production period. The crude protein content of early spring native rangeland forage is below the requirements of a cow during early lactation, however, crude protein was not supplemented. Total feed costs would be $94.64 per period, or $2.10 per day (table 32). Calf weight gain was assumed to be 1.80 lbs per day; accumulated weight gain was 81.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $56.70 per calf, and the net returns after pasture costs were a loss of $37.94 per cow-calf pair and a loss of $3.51 per acre. The cost of calf weight gain was $1.17 per pound (table 33).

Harvested Forage Types

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of around 6.4%. This crested wheatgrass hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. Mature crested wheatgrass hay would be fed at 27.0 lbs DM/day to provide 1.7 lbs CP/day. The nutrient content of mature crested wheatgrass hay is below the dietary requirements of a cow during early lactation. An additional 1.0 lb 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 (tables 28 and 31) would require 0.76 acres, and the forage would cost $21.38 per production period. Total forage and supplement costs would be $34.91 per period, or $0.78 per day (table 32). Calf weight gain was assumed to be 1.90 lbs per day; accumulated weight gain was 85.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $59.85 per calf, and the net returns after feed costs were $24.94 per cow-calf pair and $32.82 per acre. The cost of calf weight gain was $0.41 per pound (table 33).

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of around 14.5%. This crested wheatgrass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 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 (tables 28 and 31) would require 0.65 acres, and the forage would cost $17.10 per production period. Total forage and supplement costs would be $23.53 per period, or $0.52 per day (table 32). Calf weight gain was assumed to be 1.90 lbs per day; accumulated weight gain was 85.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $59.85

per calf, and the net returns after feed costs were $36.32 per cow-calf pair and $55.88 per acre. The cost of calf weight gain was $0.28 per pound (table 33).

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 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 (tables 29 and 31) would require 0.20 acres, and the forage would cost $13.50 per production period. Total forage and supplement costs would be $18.23 per period, or $0.41 per day (table 32). Calf weight gain was assumed to be 1.90 lbs per day; accumulated weight gain was 85.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $59.85 per calf, and the net returns after feed costs were $41.62 per cow-calf pair and $208.10 per acre. The cost of calf weight gain was $0.21 per pound (table 33).

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. 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 (tables 29 and 31) would require 0.24 acres, and the forage would cost $16.65 per production period. Total forage and supplement costs would be $20.03 per period, or $0.45 per day (table 32). Calf weight gain was assumed to be 1.90 lbs per day; accumulated weight gain was 85.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $59.85 per calf, and the net returns after feed costs were $39.82 per cow-calf pair and $165.92 per acre. The cost of calf weight gain was $0.23 per pound (table 33).

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 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 (tables 29 and 31) would require 0.23 acres, and the forage would cost $15.75 per production period. Total forage and supplement costs would be $18.35 per period, or $0.41 per day (table 32). Calf weight gain was assumed to be 1.90 lbs per day; accumulated weight gain was 85.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $59.85 per calf, and the net returns after feed costs were $41.50 per cow-calf pair and $180.43 per acre. The cost of calf weight gain was $0.21 per pound (table 33).

Oat forage 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. Late-cut oat hay would be fed at 27.0 lbs DM/day to provide 2.1 lbs CP/day. An additional 0.62 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 (tables 29 and 31) would require 0.21 acres, and the forage would cost $16.04 per production period. Total forage and supplement costs would be $24.41 per period, or $0.54 per day (table 32). Calf weight gain was assumed to be 1.90 lbs per day; accumulated weight gain was 85.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $59.85 per calf, and the net returns after feed costs were $35.44 per cow-calf pair and $168.76 per acre. The cost of calf weight gain was $0.29 per pound (table 33).

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. 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 (tables 30 and 31) would require 0.23 acres, and the forage would cost $18.45 per production period. Total forage and supplement costs would be $28.37 per period, or $0.63 per day (table 32). Calf weight gain was assumed to be 1.90 lbs per day; accumulated weight gain was 85.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $59.85 per calf, and the net returns after feed costs were $31.48 per cow-calf pair and

$136.87 per acre. The cost of calf weight gain was $0.33 per pound (table 33).

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 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 (tables 30 and 31) would require 0.18 acres, and the forage would cost $15.75 per production period. Total forage and supplement costs would be $22.05 per period, or $0.49 per day (table 32). Calf weight gain was assumed to be 1.90 lbs per day; accumulated weight gain was 85.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $59.85 per calf, and the net returns after feed costs were $37.80 per cow-calf pair and $210.00 per acre. The cost of calf weight gain was $0.26 per pound (table 33).

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. 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 (tables 30 and 31) would require 0.34 acres, and the forage would cost $20.70 per production period. Total forage and supplement costs would be $32.12 per period, or $0.71 per day (table 32). Calf weight gain was assumed to be 1.90 lbs per day; accumulated weight gain was 85.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $59.85 per calf, and the net returns after feed costs were $27.73 per cow-calf pair and $81.56 per acre. The cost of calf weight gain was $0.38 per pound (table 33).

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 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 (tables 30 and 31) would require 0.22 acres, and the forage would cost $15.75 per production period. Total forage and supplement costs would be $22.37 per period, or $0.50 per day (table 32). Calf weight gain was assumed to be 1.90 lbs per day; accumulated weight gain was 85.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $59.85 per calf, and the net returns after feed costs were $37.48 per cow-calf pair and $170.36 per acre. The cost of calf weight gain was $0.26 per pound (table 33).

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.16 per pound. Oat-pea forage hay would be fed at 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 production period. Production of oat-pea forage hay to feed during the early lactation period (tables 30 and 31) would require 0.19 acres, and the forage would cost $18.45 per production period. Total forage and supplement costs would be $22.55 per period, or $0.50 per day (table 32). Calf weight gain was assumed to be 1.90 lbs per day; accumulated weight gain was 85.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $59.85 per calf, and the net returns after feed costs were $37.30 per cow-calf pair and $196.32 per acre. The cost of calf weight gain was $0.26 per pound (table 33).

Discussion

Pasture Forage Types

Reserved native rangeland forage grazed as a repeated seasonal pasture during the early lactation production period was high-cost forage because the quantities of crude protein captured per acre were low and the quantity of forage dry matter available per acre was very low. Total forage costs for reserved native rangeland pastures was high, even though the equipment costs, labor costs, land rent per acre, and forage production costs per acre were low, because the input costs do not directly regulate livestock forage feed costs. The cost per pound of crude protein ($0.76/lb CP) was very high because the quantity of crude protein captured per acre was low. The crude protein content of the forage was below the requirements of a lactating cow, however, crude protein was not supplemented. The forage dry matter cost ($140.16/ton) was excessively high because the

quantity of forage weight per acre was extremely low. The low forage weight per acre made it necessary to use about three times the land area that would have been needed during the summer period to provide a cow with adequate forage dry matter for a month in the same pasture. The large land area (10.80 acres) per cow caused the forage costs per period to be very high. The total daily forage feed costs ($2.10/day) were extremely high. The total feed costs were greater than the low market value of the accumulated calf weight causing a very high loss in returns after feed costs ($-37.94) per cow and a moderate loss in returns after feed costs ($-3.50) per acre. The cost per pound of calf weight gain ($1.17/lb) was very high because of the low forage dry matter yields per acre, the low crude protein content in the forage, and the large land area per cow-calf pair.

Harvested Forage Types

Crested wheatgrass hay cut at a mature growth stage and fed during the early lactation production period was moderate-cost forage. The forage dry matter cost ($34.80/ton) was moderate for mature crested wheatgrass hay and lower than the forage dry matter cost per ton for early cut crested wheatgrass hay because greater dry matter weight of the mature crested wheatgrass hay was harvested per acre. The cost per pound of crude protein ($0.28/lb CP) was high for mature crested wheatgrass hay and double the cost per pound of crude protein for early cut crested wheatgrass hay because of the lower crude protein weight in the mature crested wheatgrass hay harvested per acre. The land area (0.76 acres) per cow for mature crested wheatgrass hay was small but greater than the land area required per cow for early cut crested wheatgrass hay because of the greater crude protein weight per acre in the early cut crested wheatgrass hay. The crude protein content of the mature crested wheatgrass forage was below the requirements of a lactating cow making it necessary to provide purchased supplemental crude protein. The total daily forage and supplemental crude protein costs ($0.78/day) were high because the total supplement crude protein costs were high. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($24.94) per cow and ($32.82) per acre. The cost per pound of calf weight gain ($0.41/lb) was moderate because of the additional supplemental crude protein costs that were needed because mature crested wheatgrass hay did not meet the nutrient requirements of lactating range cows.

Crested wheatgrass hay cut at the boot growth stage and fed during the early lactation production period was moderate-cost forage. The forage dry matter cost ($40.80/ton) was moderate for early cut crested wheatgrass hay and was greater than the forage dry matter cost per ton for mature crested wheatgrass hay because crested wheatgrass hay cut at the boot stage harvested lower forage dry matter weight per acre than crested wheatgrass hay cut at a mature growth stage. The cost per pound of crude protein ($0.14/lb CP) was low for early cut crested wheatgrass hay and lower than the cost per pound of crude protein for mature crested wheatgrass hay because of the greater crude protein weight in the early cut crested wheatgrass hay harvested per acre. The land area (0.65 acres) per cow for early cut crested wheatgrass hay was small and less than the land area required per cow for mature crested wheatgrass hay because of the greater crude protein weight harvested per acre in the early cut crested wheatgrass hay. The forage cost of early cut crested wheatgrass hay was low but the total daily forage feed cost ($0.52/day) was moderate because slightly less than a third of the ration forage was supplemental roughage which added substantially to the total forage feed costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($36.32) per cow and in high returns after feed costs ($55.88) per acre. The cost per pound of calf weight gain ($0.28/lb) was low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Forage barley hay cut at the milk growth stage and fed during the early lactation production period was low-cost forage. The production costs per acre were high for early cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($28.80/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.11/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.20 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.41/day) were low because of the low cost of crude protein per pound and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($41.62) per cow and in extremely high returns after feed costs ($208.10) per acre. The cost per pound of calf weight gain ($0.21/lb) was very low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Forage barley hay cut at the hard dough growth stage and fed during the early lactation production period was low-cost forage. The production costs per acre were high for late cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($27.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut forage barley hay was greater than the cost per pound of crude protein for early cut forage barley hay because of the lower crude protein weight harvested per acre in the late cut forage barley hay. The land area (0.24 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.45/day) were low because of the low cost of crude protein per pound and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($39.82) per cow and in very high returns after feed costs ($165.92) per acre. The cost per pound of calf weight gain ($0.23/lb) was very low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Oat forage hay cut at the milk growth stage and fed during the early lactation production period was low-cost forage. The production costs per acre were high for early cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($29.60/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.23 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.41/day) were low because of the low cost of crude protein per pound and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($41.50) per cow and in very high returns after feed costs ($180.43) per acre. The cost per pound of calf weight gain ($0.21/lb) was very low because of the low cost per pound of crude protein and the very small land area per cow-calf pair .

Oat forage hay cut at the hard dough growth stage and fed during the early lactation production period was low-cost forage. The production costs per acre were high for late cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($26.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut oat forage hay was greater than the cost per pound of crude protein for early cut oat forage hay because of the lower crude protein weight harvested per acre in the late cut oat forage hay. The land area (0.21 acres) per cow was small because of the high forage dry matter yield per acre. The crude protein content of the forage was below the requirements of a lactating cow making it necessary to provide purchased supplemental crude protein. The total daily forage and supplemental crude protein costs ($0.54/day) were moderate because of the high cost of the supplemental crude protein. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($35.44) per cow and in very high returns after feed costs ($168.76) per acre. The cost per pound of calf weight gain ($0.29/lb) was low because of the very small land area per cow-calf pair.

Pea forage hay cut at an early growth stage and fed during the early lactation production period was moderate-cost forage. However, pea forage hay cut at a late growth stage has lower forage feed costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for early cut pea forage hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($55.00/ton) was high because of the modest forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.23 acres) per cow was very small because of the high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.63/day) were moderate because of the high supplemental roughage costs and the modest forage dry matter production per acre. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($31.48) per cow and in very high returns after feed costs ($136.87) per acre. The cost per pound of calf weight gain ($0.33/lb) was moderately low because of the modest forage dry matter production per acre and the high supplemental roughage costs.

Pea forage hay cut at a late growth stage and fed during the early lactation production period was low-cost forage. Late cut pea forage hay has lower forage feed costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for late cut pea forage hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($37.40/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.18 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.49/day) were low because of the low cost of crude protein per pound, the high forage dry matter production per acre, and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($37.80) per cow and in extremely high returns after feed costs ($210.00) per acre. The cost per pound of calf weight gain ($0.26/lb) was low because of the low cost per pound of crude protein, the high forage dry matter production per acre, and the very small land area per cow-calf pairs.

Forage lentil hay cut at an early growth stage and fed during the early lactation production period was low-cost forage. However, forage lentil hay cut at a late growth stage has lower forage feed costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for early cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($71.60/ton) was high because of the modest forage dry matter yield per acre. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.34 acres) per cow was small because of the high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.71/day) were high because of the high supplemental roughage costs and the modest forage dry matter production per acre. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($27.73) per cow and in high returns after feed costs ($81.56) per acre. The cost per pound of calf weight gain ($0.38/lb) was moderately low because of the modest forage dry matter production per acre and the high supplemental roughage costs.

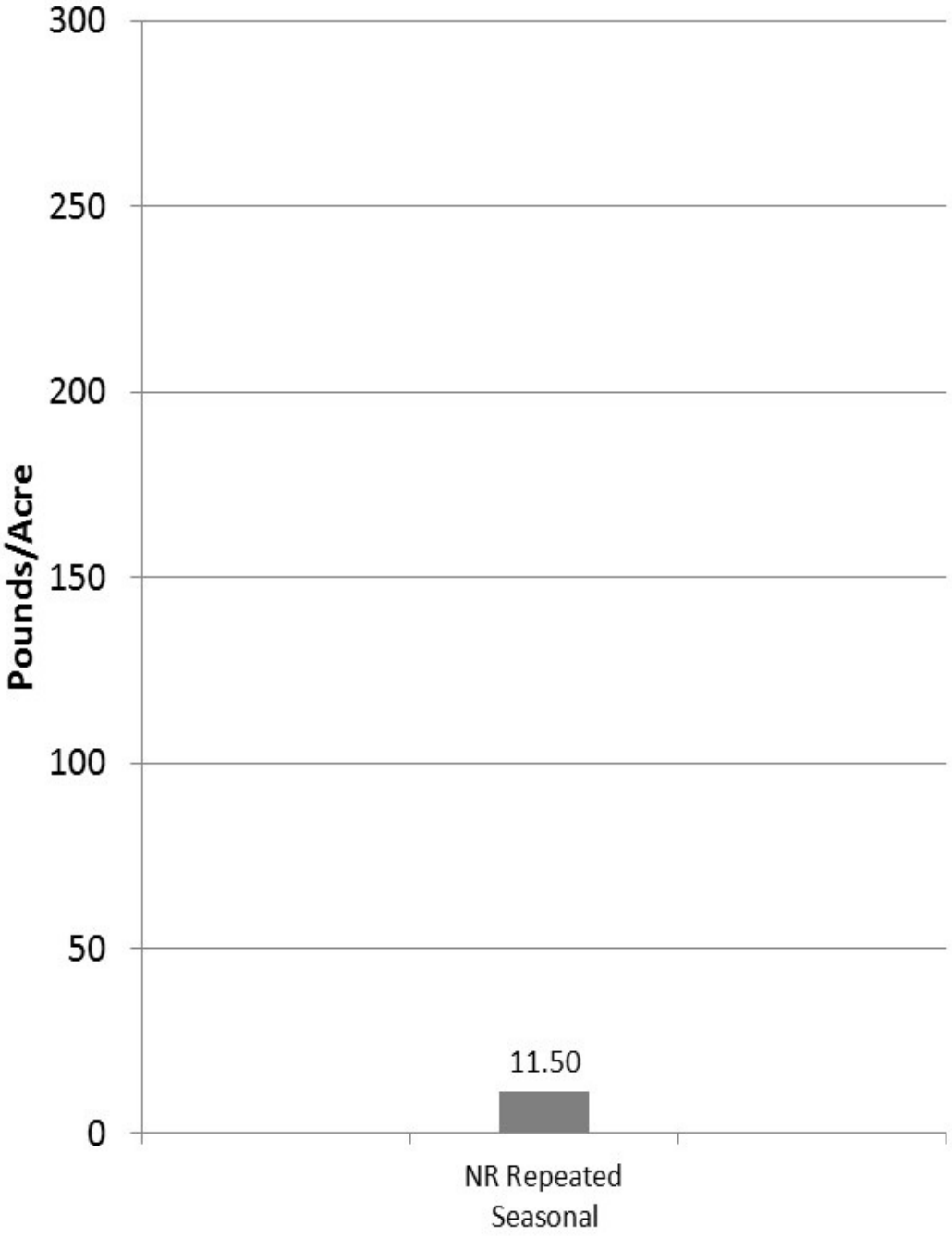
Forage lentil hay cut at a late growth stage and fed during the early lactation production period was low-cost forage. Late cut forage lentil hay has lower forage feed costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for late cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($37.00/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.22 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.50/day) were low because of the low cost of crude protein per pound, the high forage dry matter production per acre, and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($37.48) per cow and in very high returns after feed costs ($170.36) per acre. The cost per pound of calf weight gain ($0.26/lb) was low because of the low cost per pound of crude protein, the high forage dry matter production per acre, and the very small land area per cow-calf pair.

Oat-pea hay cut at compromised plant growth stages and fed during the early lactation production period was low-cost forage. However, seeding oat forage separately on half of the field and cutting it at an early growth stage and seeding pea forage separately on half of the field and cutting it at a late growth stage will result in lower production costs per acre, lower forage dry matter costs per ton, lower costs per pound of crude protein, lower total forage feed costs per day, lower costs per pound of calf weight gain, greater net returns after feed costs per cow, and greater net returns after feed costs per acre than oat-pea forage seeded together and cut at compromised growth stages. The production costs per acre were very high for oat-pea hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($37.20/ton) was moderate because of the high forage dry matter production per acre. The cost per pound of crude protein ($0.16/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.19 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.50/day) were low because of the low cost of crude protein per pound, the high forage dry matter production per acre, and the very small land area per cow. The total feed costs

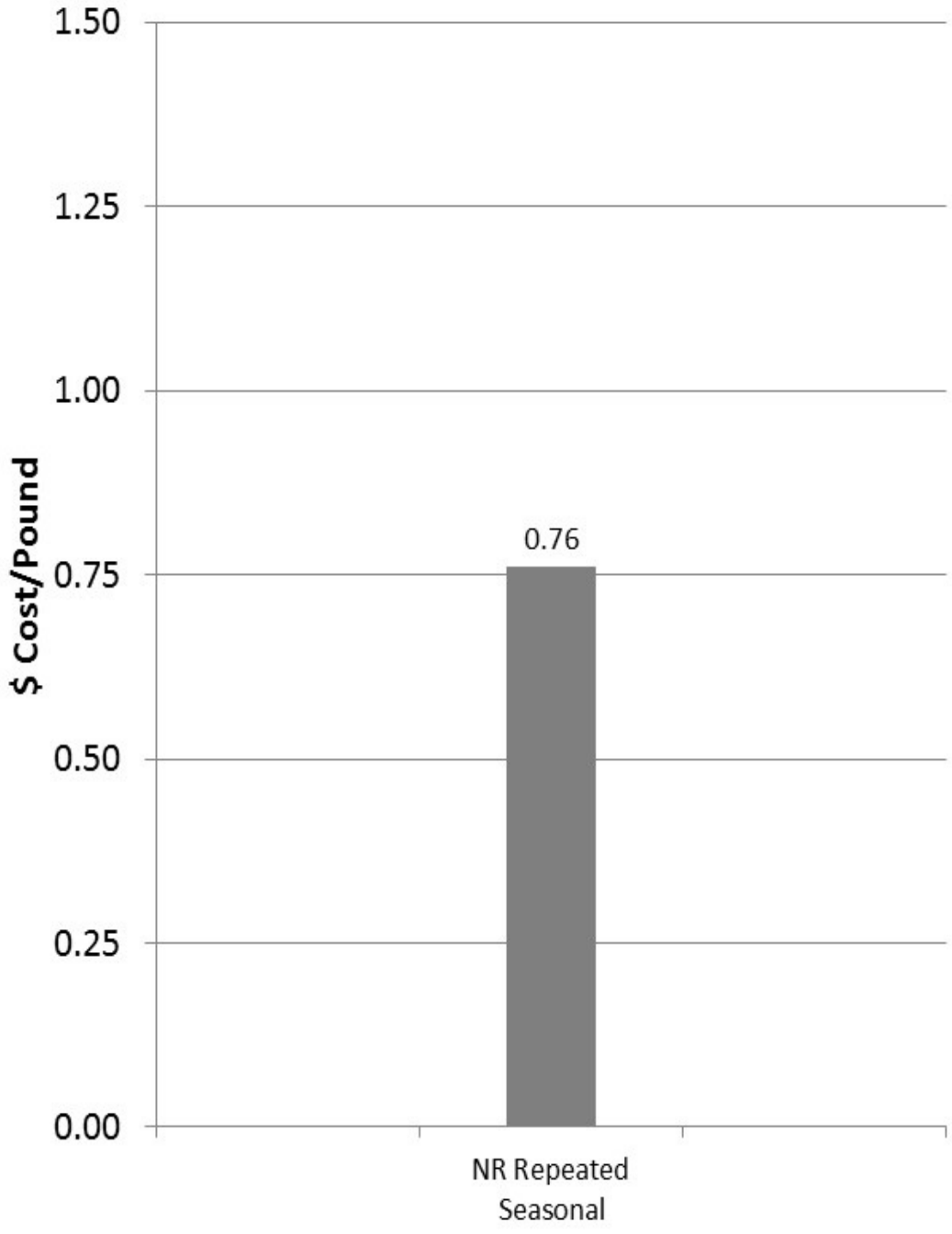
were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($37.30) per cow and extremely high returns after feed costs ($196.32) per acre. The cost per pound of calf weight gain ($0.26/lb) was low because of the low cost per pound of crude protein, the high forage dry matter production per acre, and the very small land area per cow-calf pair.

Table 28. Costs and returns for pasture forage types and perennial grass harvested forage types to be fed to range cows during the 45-day early lactation production period.

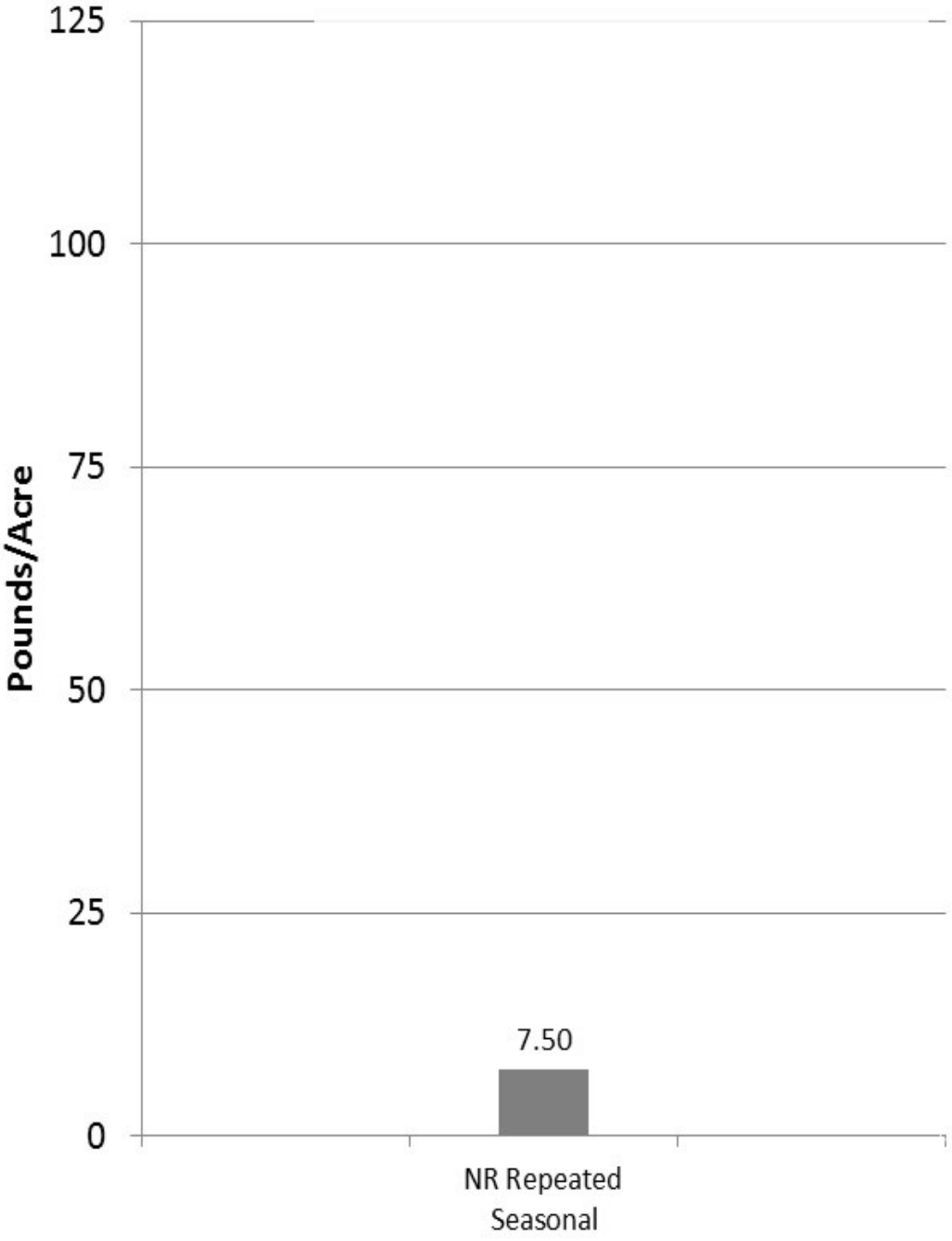
		Native Rangeland Repeated Seasonal	Crested Wheatgrass Hay	Crested Wheatgrass Hay
Days		45	45	45
Growth Stage		Early Spring	Mature	Boot Stage
Herbage Weight	lb/ac	480	-	-
Forage DM Weight	lb/ac	125	1600	1300
Costs/Acre				
Land Rent	$	8.76	14.22	14.22
Custom Work	$	-	5.31	5.31
Seed Cost	$	-	-	-
Baling Costs	$	-	8.58	6.97
Production Costs	$/ac	8.76	28.11	26.50
Forage DM Costs	$/ton	140.16	34.80	40.80
Crude Protein	%	9.2	6.4	14.5
Crude Protein Yield	lb/ac	11.50	102	189
Crude Protein Cost	$/lb	0.76	0.28	0.14
Forage Allocation	lb/d	30.0	27.0	18.8
Land Area/Period	ac	10.80	0.76	0.65
Forage Costs/Period	$/pp	94.64	21.38	17.10
Supplementation				
Roughage/Day	lb/d			8.2
Crude Protein/Day	lb/d		1.00	
Sup. Cost/Period	$/pp		13.50	6.43
Total Feed Cost	$/pp	94.64	34.91	23.53
Cost/Day	$/d	2.10	0.78	0.52
Accumulated Calf Wt.	lbs	81.00	85.50	85.50
Weight Value @$0.70/lb	$	56.70	59.85	59.85
Net Return/c-c pr	$	-37.94	24.94	36.32
Net Return/acre	$	-3.51	32.82	55.88
Cost/lb of Calf Gain	$	1.17	0.41	0.28



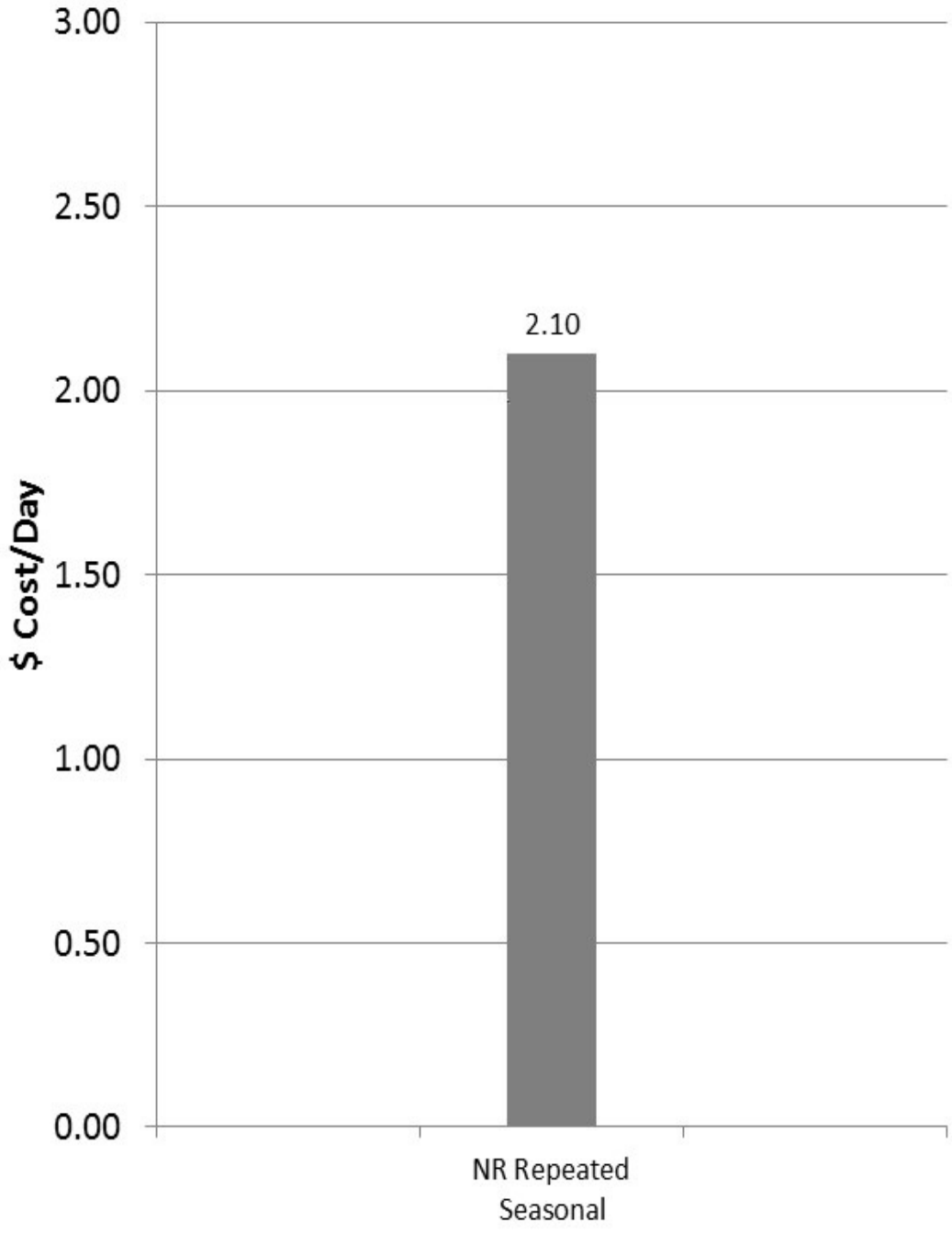
Crude Protein Weight Captured per Acre on Pasture Forages During Early Lactation



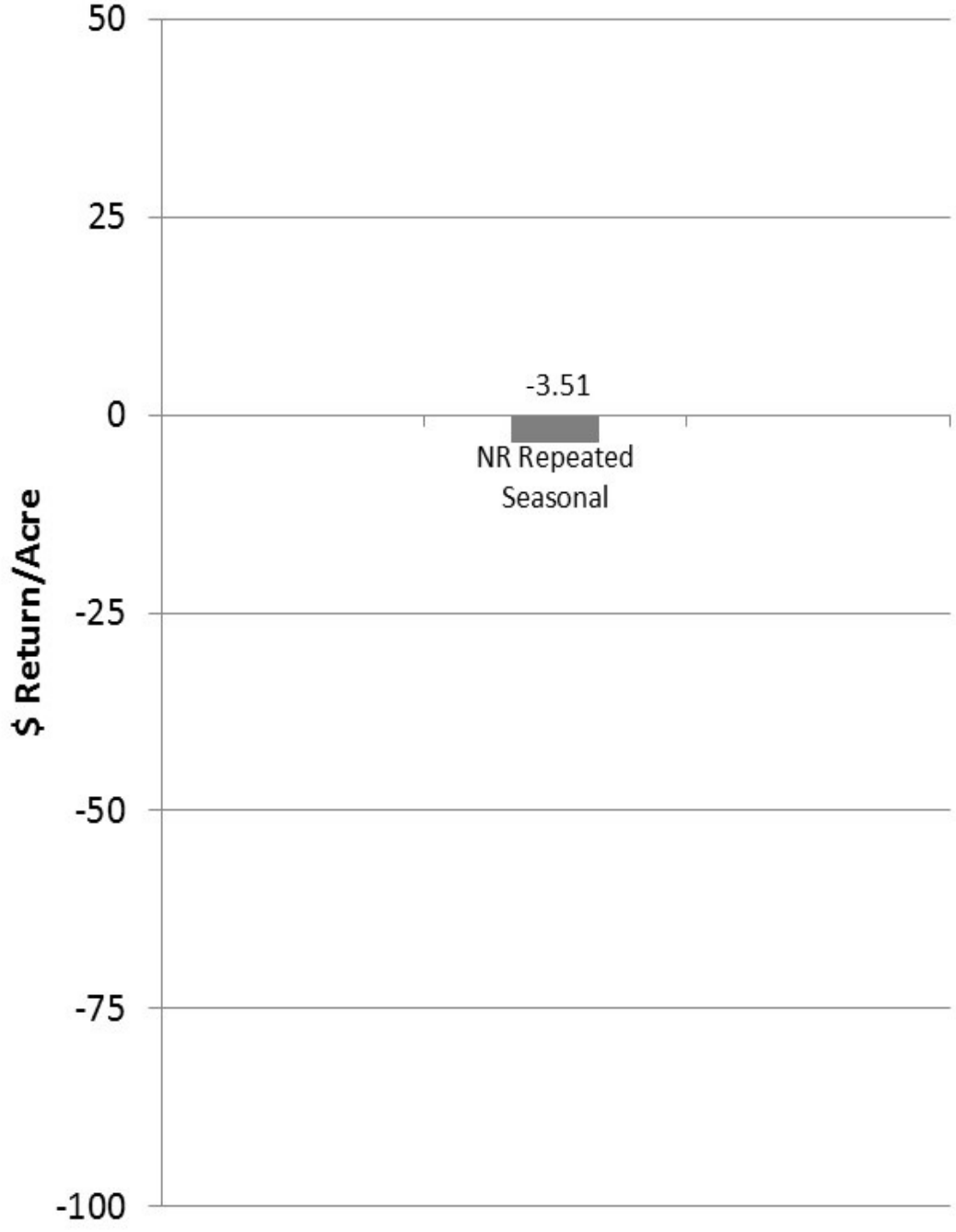
Crude Protein Cost per Pound
on Pasture Forages During Early Lactation



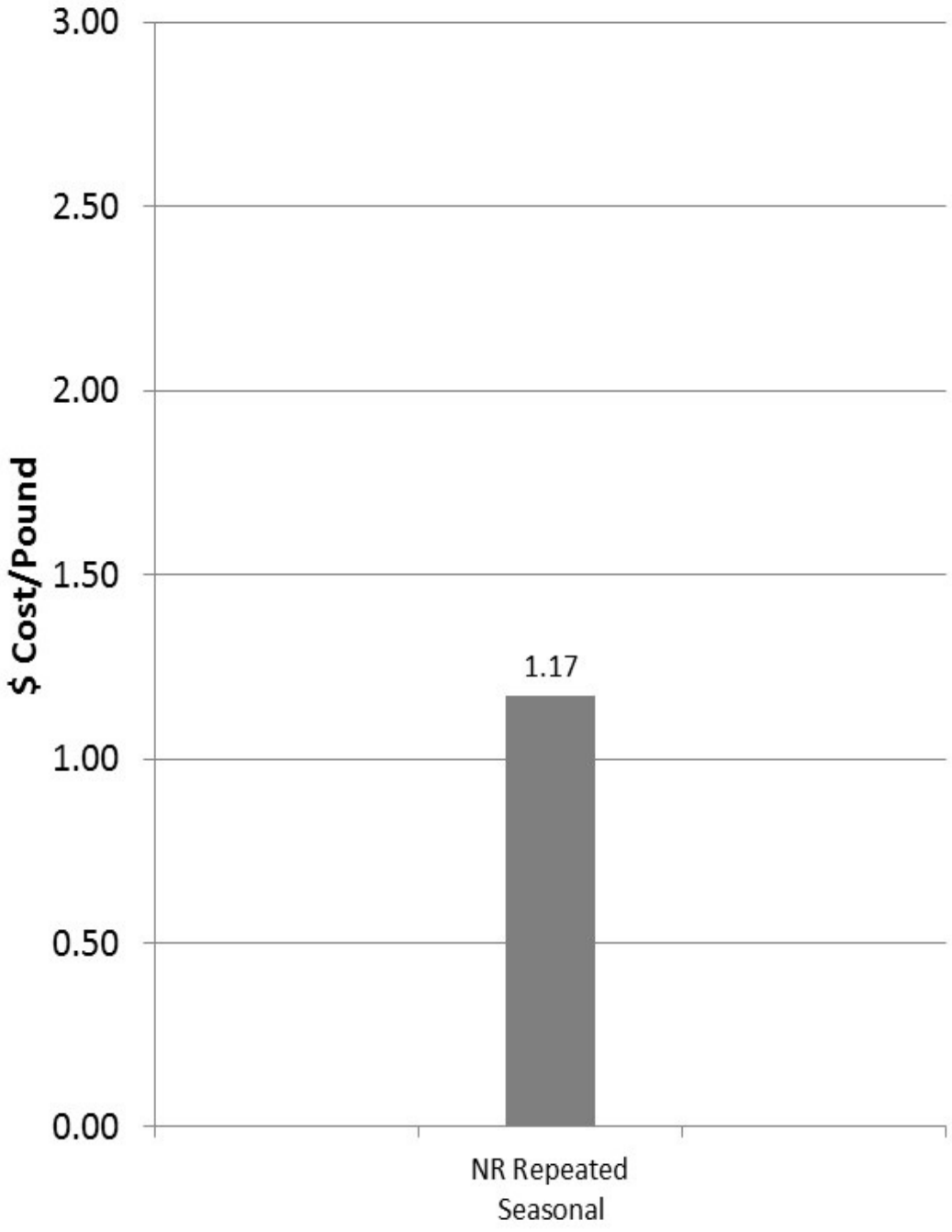
Calf Weight Gain per Acre on Pasture Forages During Early Lactation



Forage Feed Costs per Day
on Pasture Forages During Early Lactation



Returns After Feed Costs per Acre
on Pasture Forages During Early Lactation



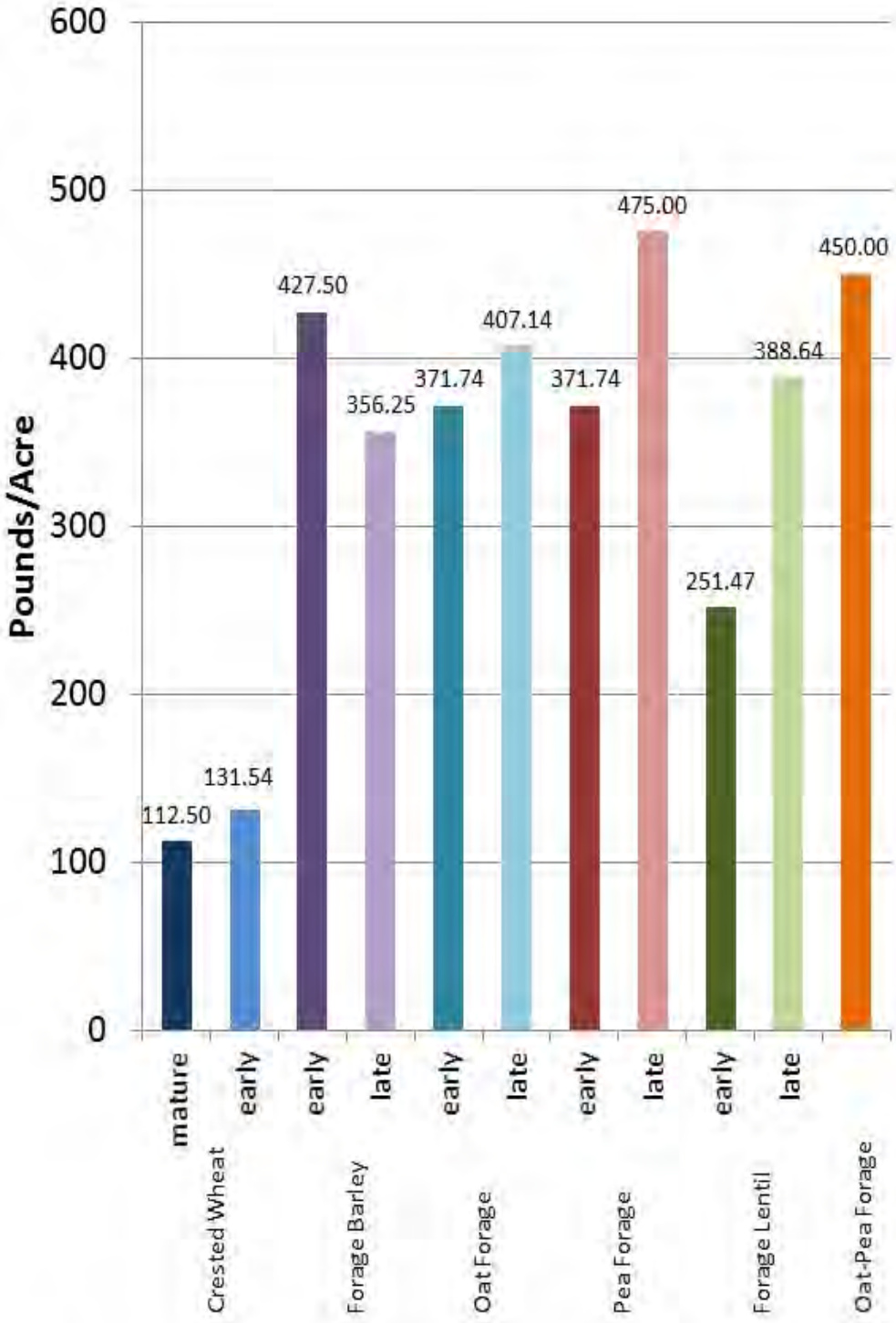
Calf Weight Gain Costs per Pound on Pasture Forages During Early Lactation

Table 29. Costs and returns for annual cereal harvested forage types to be fed to range cows during the 45-day early lactation production period.

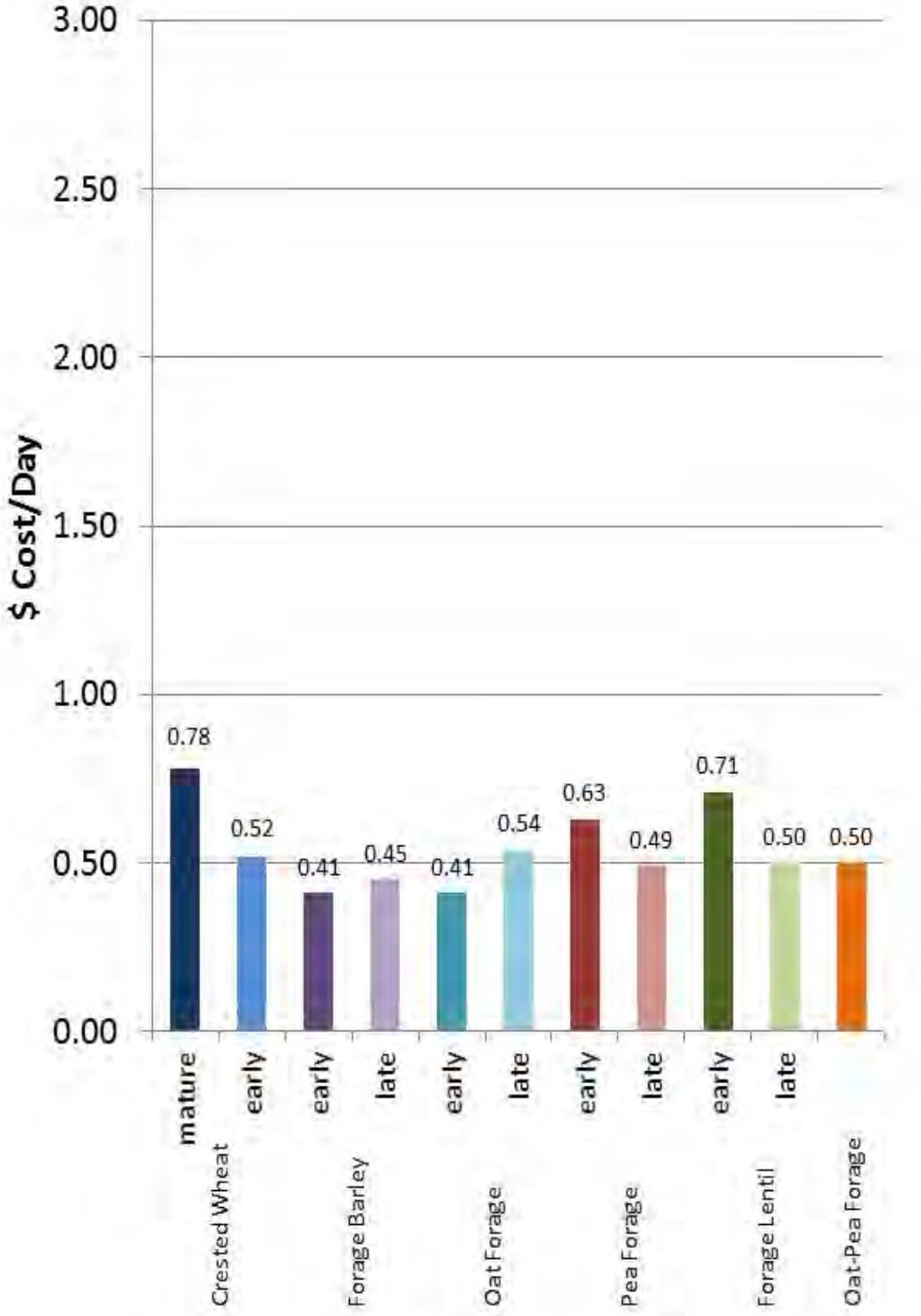
		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Days		45	45	45	45
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Forage Allocation	lb/d	21.0	27.0	23.7	27.0
Land Area/Period	ac	0.20	0.24	0.23	0.21
Forage Costs/Period	$/pp	13.50	16.65	15.75	16.04
Supplementation					
Roughage/Day	lb/d	6.0		3.3	
Crude Protein/Day	lb/d		0.25		0.62
Sup. Cost/Period	$/pp	4.73	3.38	2.60	8.37
Total Feed Cost	$/pp	18.23	20.03	18.35	24.41
Cost/Day	$/d	0.41	0.45	0.41	0.54
Accumulated Calf Wt.	lbs	85.50	85.50	85.50	85.50
Weight Value @$0.70/lb	$	59.85	59.85	59.85	59.85
Net Return/c-c pr	$	41.62	39.82	41.50	35.44
Net Return/acre	$	208.10	165.92	180.43	168.76
Cost/lb of Calf Gain	$	0.21	0.23	0.21	0.29

Table 30. Costs and returns for annual legume harvested forage types to be fed to range cows during the 45-day early lactation production period.

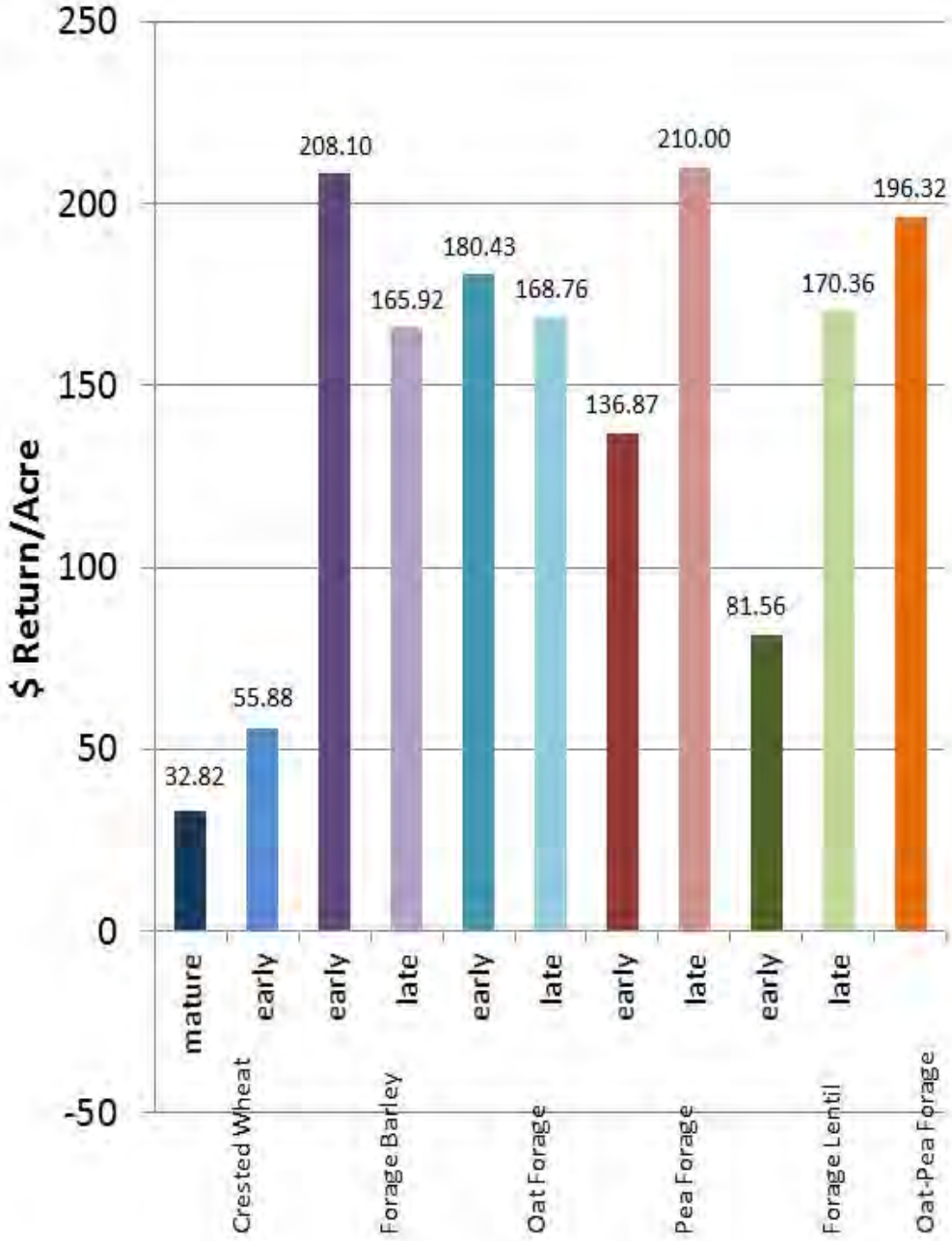
		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Days		45	45	45	45	45
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Forage Allocation	lb/d	14.4	19.0	12.5	18.6	21.8
Land Area/Period	ac	0.23	0.18	0.34	0.22	0.19
Forage Costs/Period	$/pp	18.45	15.75	20.70	15.75	18.45
Supplementation						
Roughage/Day	lb/d	12.6	8.0	14.5	8.4	5.2
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	9.92	6.30	11.42	6.62	4.10
Total Feed Cost	$/pp	28.37	22.05	32.12	22.37	22.55
Cost/Day	$/d	0.63	0.49	0.71	0.50	0.50
Accumulated Calf Wt.	lbs	85.50	85.50	85.50	85.50	85.50
Weight Value @$0.70/lb	$	59.85	59.85	59.85	59.85	59.85
Net Return/c-c pr	$	31.48	37.80	27.73	37.48	37.30
Net Return/acre	$	136.87	210.00	81.56	170.36	196.32
Cost/lb of Calf Gain	$	0.33	0.26	0.38	0.26	0.26



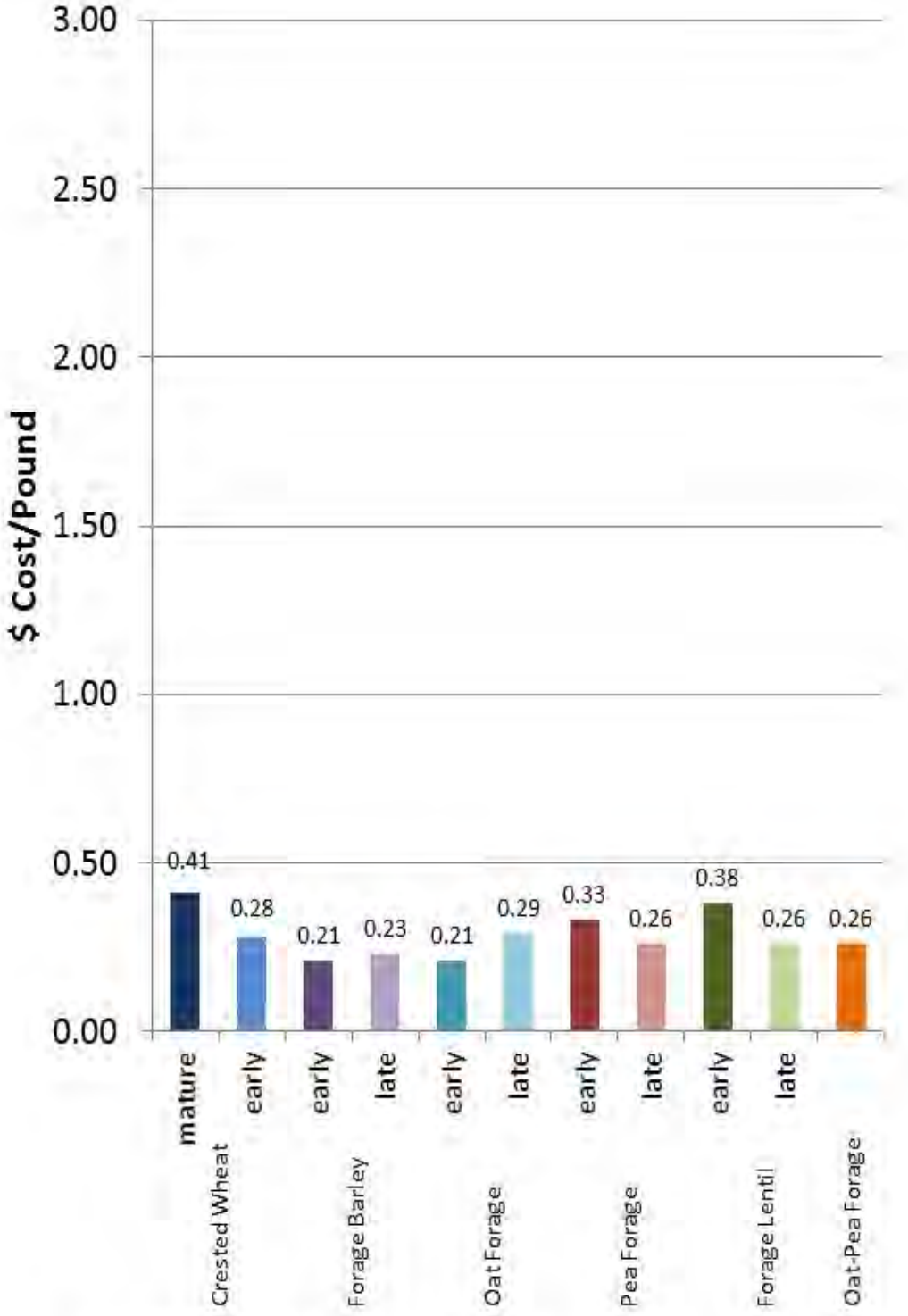
Calf Weight Gain per Acre on Harvested Forages During Early Lactation



Forage Feed Costs per Day on Harvested Forages During Early Lactation



Returns After Feed Costs per Acre on Harvested Forages During Early Lactation



Calf Weight Gain Costs per Pound on Harvested Forages During Early Lactation

Table 31. Feed quantity and land area for forage types used during the 45-day early lactation production period.

Forage Types	Daily Feed per Cow			Early Lactation Period Feed one Cow for 45 days			
	Forage lb/d	Roughage lb/d	Crude Protein lb/d	Forage lb/pp	Roughage lb/pp	Crude Protein lb/pp	Land Area ac/pp
Pasture Forage Types							
Native Rangeland Repeated Seasonal	30.0			1350.0			10.80
Harvested Forage Types							
Crested Wheat, mature	27.0		1.00	1215.0		45.00	0.76
Crested Wheat, early	18.8	8.2		846.0	369.0		0.65
Forage Barley, early	21.0	6.0		945.0	270.0		0.20
Forage Barley, late	27.0		0.25	1215.0		11.25	0.24
Oat Forage, early	23.7	3.3		1066.5	148.5		0.23
Oat Forage, late	27.0		0.62	1215.0		27.9	0.21
Pea Forage, early	14.4	12.6		648.0	567.0		0.23
Pea Forage, late	19.0	8.0		855.0	360.0		0.18
Forage Lentil, early	12.5	14.5		562.5	652.5		0.34
Forage Lentil, late	18.6	8.4		837.0	378.0		0.22
Oat-Pea Forage	21.8	5.2		981.0	234.0		0.19

Table 32. Summary of feed costs for forage types used during the 45-day early lactation production period.

Forage Types	Forage Costs $/pp	Roughage Costs $/pp	Crude Protein Costs $/pp	Total Feed Costs $/pp	Daily Feed Costs $/d
Pasture Forage Types					
Native Rangeland Repeated Seasonal	94.64			94.64	2.10
Harvested Forage Types					
Crested Wheat, mature	21.38		13.50	34.91	0.78
Crested Wheat, early	17.10	6.43		23.53	0.52
Forage Barley, early	13.50	4.73		18.23	0.41
Forage Barley, late	16.65		3.38	20.03	0.45
Oat Forage, early	15.75	2.60		18.35	0.41
Oat Forage, late	16.04		8.37	24.41	0.54
Pea Forage, early	18.45	9.92		28.37	0.63
Pea Forage, late	15.75	6.30		22.05	0.49
Forage Lentil, early	20.70	11.42		32.12	0.71
Forage Lentil, late	15.75	6.62		22.37	0.50
Oat-Pea Forage	18.45	4.10		22.55	0.50

Table 33. Summary of returns after feed costs for forage types used during the 45-day early lactation production period.

Forage Types	Gross Return @$0.70/lb $/calf	Net Return per C-C pr $/pr	Net Return per acre $/ac	Calf Gain Cost $/lb
Pasture Forage Types				
Native Rangeland Repeated Seasonal	56.70	-37.94	-3.51	1.17
Harvested Forage Types				
Crested Wheat, mature	59.85	24.94	32.82	0.41
Crested Wheat, early	59.85	36.32	55.88	0.28
Forage Barley, early	59.85	41.62	208.10	0.21
Forage Barley, late	59.85	39.82	165.92	0.23
Oat Forage, early	59.85	41.50	180.43	0.21
Oat Forage, late	59.85	35.44	168.76	0.29
Pea Forage, early	59.85	31.48	136.87	0.33
Pea Forage, late	59.85	37.80	210.00	0.26
Forage Lentil, early	59.85	27.73	81.56	0.38
Forage Lentil, late	59.85	37.48	170.36	0.26
Oat-Pea Forage	59.85	37.30	196.32	0.26

Evaluation of Pasture Forage and Harvested Forage Types during the Spring Lactation Production Period

Results

The spring lactation production period was 31 days from early May until late May. The spring lactation production period has nutritional requirements slightly reduced from those of the previous period. The quantity of milk produced continues to increase until the peak is reached during the later part of the second month or the early part of the third month after calving (BCRC 1999). Cows gaining weight during this period produce milk in quantities at or near the animals' genetic potential. Providing harvested forages or pasture forages with high nutrient content prior to and during breeding season stimulates ovulation in the cows; cows with improving body condition start estrus cycles earlier and can rebreed in 80 to 85 days after calving (BCRC 1999). The rate of calf weight gain continues to increase during the spring period. Calves that are around a month old in early May have developed enough to take advantage of the high levels of milk produced by cows grazing high-quality forage on domesticated grass spring complementary pastures and add weight at high rates. Pasture forage and harvested forage costs and returns after feed costs were determined for a 1200-pound range cow with a calf during the spring lactation production period. A grazing cow with a calf requires an allocation of 30 lbs of pasture forage dry matter per day. The cow requires a daily intake of 27 lbs dry matter (DM) at 9.3% crude protein (CP) (2.51 lbs CP/day).

Pasture Forage Types

Native rangeland managed as a repeated seasonal pasture was evaluated during the spring lactation production period for 31 days between early and late May (tables 34 and 38). Native rangeland grass plants have not reached the three and a half new leaf growth stage and are not physiologically ready for grazing during the spring lactation production period in May. Native rangeland forage during the spring has a crude protein content of around 16.3%. Spring native rangeland forage had pasture rent value or production costs of $8.76 per acre, forage dry matter costs of $89.85 per ton, and crude protein costs of $0.28 per pound. A cow grazing during the spring lactation period required 4.77 acres (4.62 acres per month) at a forage cost of $41.85 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $41.85 per period, or $1.35 per day (table 39). Calf weight gain was 1.80 lbs per day and 11.70 lbs per acre; accumulated weight gain was 55.80 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $39.06 per calf, and the net returns after pasture costs were a loss of $2.79 per cow-calf pair and a loss of $0.58 per acre. The cost of calf weight gain was $0.75 per pound (table 40).

Native rangeland managed as a 6.0-month seasonlong pasture was evaluated during the spring lactation production period for 16 days between mid and late May (tables 34 and 38). Native rangeland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $77.52 per ton. A cow grazing during the spring lactation period was allotted 2.10 acres (4.04 acres per month) at a forage cost of $18.40 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $18.40 per period, or $1.15 per day (table 39). Cow weight gain was 0.14 lbs per day and 1.09 lbs per acre; accumulated weight gain was 2.30 lbs. Calf weight gain was 1.80 lbs per day and 13.64 lbs per acre; accumulated weight gain was 28.80 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $20.16 per calf, and the net returns after pasture costs were $1.76 per cow-calf pair and $0.83 per acre. The cost of calf weight gain was $0.64 per pound (table 40).

Crested wheatgrass seeded domesticated grassland managed as an unfertilized complementary spring pasture was evaluated during the spring lactation production period for 31 days between early and late May (tables 34 and 38). Unfertilized crested wheatgrass forage during the spring has a crude protein content of around 16.8%. Crested wheatgrass grassland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $35.39 per ton. A cow grazing during the spring lactation period required 1.88 acres at a forage cost of $16.47 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $16.47 per period, or $0.52 per day (table 39). Cow weight gain was 1.95 lbs per day and 32.15 lbs per acre; accumulated weight gain was 60.45 lbs. Calf weight gain was 1.91 lbs per day and 31.49 lbs per acre; accumulated weight gain was 59.21 lbs. When calf accumulated weight was assumed to have a value

of $0.70 per pound, the gross return was $41.45 per calf, and the net returns after pasture costs were $24.98 per cow-calf pair and $13.29 per acre. The cost of calf weight gain was $0.27 per pound (table 40).

Crested wheatgrass seeded domesticated grassland managed as an unfertilized early seasonal extended use pasture was evaluated during the spring and early summer lactation production periods for 76 days between early May and mid July (tables 34 and 38). Crested wheatgrass grassland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $31.97 per ton. A cow grazing during the early season was allotted 4.16 acres (1.67 acres per month) at a forage cost of $36.44 per grazing period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $36.44 per period, or $0.48 per day (table 39). Cow weight gain was 0.91 lbs per day and 16.63 lbs per acre; accumulated weight gain was 69.16 lbs. Calf weight gain was 1.79 lbs per day and 32.70 lbs per acre; accumulated weight gain was 136.04 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $95.23 per calf, and the net returns after pasture costs were $58.78 per cow-calf pair and $14.13 per acre. The cost of calf weight gain was $0.27 per pound (table 40).

Crested wheatgrass seeded domesticated grassland managed as a fertilized complementary spring pasture was evaluated during the spring lactation production period for 31 days between early and late May (tables 34 and 38). Crested wheatgrass grassland forage had pasture rent value of $8.76 per acre and 50 lbs nitrogen per acre applied during the first week of April had costs of $12.50 per acre; the resulting production costs were $21.26 per acre, and forage dry matter costs were $34.29 per ton. A cow grazing during the spring lactation period was allotted 0.75 acres at a forage cost of $15.95 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $15.95 per period, or $0.51 per day (table 39). Cow weight gain was 2.68 lbs per day and 110.77 lbs per acre; accumulated weight gain was 83.08 lbs on 0.75 acres. Calf weight gain was 2.18 lbs per day and 90.11 lbs per acre; accumulated weight gain was 67.58 lbs on 0.75 acres. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $47.31 per calf, and the net returns after pasture costs were $31.36 per cow-calf pair and $41.82 per acre. The cost of calf weight gain was $0.24 per pound (table 40).

Harvested Forage Types

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of 6.4%. This crested wheatgrass hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. Mature crested wheatgrass hay would be fed at 30.0 lbs DM/day to provide 1.9 lbs CP/day. An additional 0.59 lbs of crude protein per day would need to be provided, at a cost of $5.49 per period. Production of mature crested wheatgrass hay to feed during the spring lactation period (tables 35 and 38) would require 0.58 acres, and the forage would cost $16.37 per period. Total forage and supplement costs would be $21.86 per period, or $0.71 per day (table 39). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 62.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $43.40 per calf, and the net returns after feed costs were $21.54 per cow-calf pair and $37.14 per acre. The cost of calf weight gain was $0.35 per pound (table 40).

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of 14.5%. This crested wheatgrass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 17.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.7 lbs of roughage per day would need to be provided, at a cost of $6.88 per period. Production of early cut crested wheatgrass hay to feed during the spring lactation period (tables 35 and 38) would require 0.41 acres, and the forage would cost $10.85 per period. Total forage and supplement costs would be $17.73 per period, or $0.57 per day (table 39). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 62.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $43.40 per calf, and the net returns after feed costs were $25.67 per cow-calf pair and $62.61 per acre. The cost of calf weight gain was $0.29 per pound (table 40).

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 19.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 10.7 lbs of roughage per day would need to be provided, at a cost of $5.80 per period. Production of early cut forage barley hay to feed during the spring lactation period

(tables 36 and 38) would require 0.13 acres, and the forage would cost $8.68 per period. Total forage and supplement costs would be $14.48 per period, or $0.47 per day (table 39). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 62.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $43.40 per calf, and the net returns after feed costs were $28.92 per cow-calf pair and $222.46 per acre. The cost of calf weight gain was $0.23 per pound (table 40).

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. Late-cut forage barley hay would be fed at 27.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 2.7 lbs of roughage per day would need to be provided, at a cost of $1.46 per period. Production of late-cut forage barley hay to feed during the spring lactation period (tables 36 and 38) would require 0.16 acres, and the forage would cost $11.78 per period. Total forage and supplement costs would be $13.24 per period, or $0.43 per day (table 39). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 62.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $43.40 per calf, and the net returns after feed costs were $30.16 per cow-calf pair and $188.50 per acre. The cost of calf weight gain was $0.21 per pound (table 40).

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 21.8 lbs DM/day to provide 2.5 lbs CP/day. An additional 8.2 lbs of roughage per day would need to be provided, at a cost of $4.45 per period. Production of early cut oat forage hay to feed during the spring lactation period (tables 36 and 38) would require 0.14 acres, and the forage would cost $10.23 per period. Total forage and supplement costs would be $14.68 per period, or $0.47 per day (table 39). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 62.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $43.40 per calf, and the net returns after feed costs were $28.72 per cow-calf pair and $205.14 per acre. The cost of calf weight gain was $0.24 per pound (table 40).

Oat forage 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. Late-cut oat hay would be fed at 30.0 lbs DM/day to provide 2.3 lbs CP/day. An additional 0.17 lbs of crude protein per day would need to be provided, at a cost of $1.58 per period. Production of late-cut oat forage hay to feed during the spring lactation period (tables 36 and 38) would require 0.16 acres, and the forage would cost $12.28 per period. Total forage and supplement costs would be $13.86 per period, or $0.45 per day (table 39). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 62.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $43.40 per calf, and the net returns after feed costs were $29.54 per cow-calf pair and $180.12 per acre. The cost of calf weight gain was $0.22 per pound (table 40).

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. Early cut pea forage hay would be fed at 13.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 16.7 lbs of roughage per day would need to be provided, at a cost of $9.06 per period. Production of early cut pea forage hay to feed during the spring lactation period (tables 37 and 38) would require 0.15 acres, and the forage would cost $11.78 per period. Total forage and supplement costs would be $20.84 per period, or $0.67 per day (table 39). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 62.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $43.40 per calf, and the net returns after feed costs were $22.56 per cow-calf pair and $150.40 per acre. The cost of calf weight gain was $0.34 per pound (table 40).

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 17.4 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.6 lbs of roughage per day would need to be provided, at a cost of $6.84 per period. Production of late-cut pea forage hay to feed during the spring lactation period would (tables 37 and 38) require 0.12 acres, and the forage would cost $10.23 per period. Total forage and supplement costs would be $17.07 per period, or $0.55 per day (table

39). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 62.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $43.40 per calf, and the net returns after feed costs were $26.33 per cow-calf pair and $219.42 per acre. The cost of calf weight gain was $0.28 per pound (table 40).

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. Early cut forage lentil hay would be fed at 11.5 lbs DM/day to provide 2.5 lbs CP/day. An additional 18.5 lbs of roughage per day would need to be provided, at a cost of $10.04 per period. Production of early cut forage lentil hay to feed during the spring lactation period (tables 37 and 38) would require 0.21 acres, and the forage would cost $13.33 per period. Total forage and supplement costs would be $23.37 per period, or $0.75 per day (table 39). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 62.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $43.40 per calf, and the net returns after feed costs were $20.03 per cow-calf pair and $58.91 per acre. The cost of calf weight gain was $0.38 per pound (table 40).

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 17.1 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.9 lbs of roughage per day would need to be provided, at a cost of $7.00 per period. Production of late-cut forage lentil hay to feed during the spring lactation period (tables 37 and 38) would require 0.14 acres, and the forage would cost $10.23 per period. Total forage and supplement costs would be $17.23 per period, or $0.56 per day (table 39). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 62.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $43.40 per calf, and the net returns after feed costs were $26.17 per cow-calf pair and $186.93 per acre. The cost of calf weight gain was $0.28 per pound (table 40).

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.16 per pound. Oat-pea forage hay would be fed at 20.1 lbs DM/day to provide 2.5 lbs CP/day. An additional 9.9 lbs of roughage per day would need to be provided, at a cost of $5.37 per period. Production of oat-pea forage hay to feed during the spring lactation period (tables 37 and 38) would require 0.12 acres, and the forage would cost $11.78 per period. Total forage and supplement costs would be $17.15 per period, or $0.55 per day (table 39). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 62.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $43.40 per calf, and the net returns after feed costs were $26.25 per cow-calf pair and $218.75 per acre. The cost of calf weight gain was $0.28 per pound (table 40).

Discussion

Pasture Forage Types

Native rangeland forage grazed as a repeated seasonal pasture during the spring lactation production period was high-cost forage because the quantities of crude protein captured per acre were low and the quantity of forage dry matter available per acre was low, despite the equipment costs, labor costs, land rent per acre, and forage production costs per acre being low. The cost per pound of crude protein ($0.28/lb CP) was high because the quantity of crude protein captured per acre was low. The forage dry matter cost ($89.85/ton) was very high because the quantity of forage weight per acre was low. The low forage weight per acre made it necessary to use about two times the land area that would have been needed during the summer period to provide a cow with adequate forage dry matter for a month in the same pasture. The large land area (4.77 acres) per cow caused the forage costs per period to be high. The total daily forage feed costs ($1.35/day) were very high. The total feed costs were greater than the low market value of the accumulated calf weight causing a moderate loss in returns after feed costs ($-2.79) per cow and a low loss in returns after feed costs ($-0.58) per acre. The cost per pound of calf weight gain ($0.75/lb) was high because the low crude protein and low forage dry matter yields per acre, and the large land area per cow-calf pair.

Native rangeland forage grazed as a 6.0-month seasonlong pasture during the spring lactation production period was high-cost forage because the quantity of forage dry matter available per acre was low, despite the equipment costs, labor costs, land rent per acre, and forage production costs per acre being low. The forage dry matter cost ($77.52/ton)

was very high because the quantity of forage weight per acre was low. The low forage availability per acre was a major cause of the low cow and calf weight performance. The large land area (4.00 acres/month) per cow caused the forage costs per period to be high. The total daily forage feed costs ($1.15/day) were very high. The total feed costs were lower than the low market value of the accumulated calf weight resulting in very low returns after feed costs ($1.76) per cow and in extremely low returns after feed costs ($0.83) per acre. The cost per pound of calf weight ($0.64/lb) were high because of the low forage dry matter yields per acre, the low animal weight performance, and the large land area per cow-calf pair.

Crested wheatgrass grassland grazed as an unfertilized complementary pasture during the spring lactation production period was low-cost forage because the quantities of crude protein captured per acre were seasonally high, the quantity of forage dry matter available per acre was seasonally high, and the equipment costs, labor costs, land rent per acre, and forage production costs per acre were low. The cost per pound of crude protein ($0.11/lb CP) was low because of the seasonally high crude protein weight contained in the forage. The forage dry matter cost ($35.39/ton) was moderate because of the rapid early season forage dry matter production. The land area (1.88 acres) per cow was small because of the seasonally high crude protein and seasonally high forage dry matter yields per acre. The total daily forage feed costs ($0.52/day) were low because of the low cost of crude protein per pound and the small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($24.98) per cow and in moderate returns after feed costs ($13.29) per acre. The cost per pound of calf weight gain ($0.27/lb) was low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Crested wheatgrass grassland grazed as an unfertilized early seasonal extended use pasture during the spring and early summer lactation production periods was low-cost forage, however, grazing a single pasture of crested wheatgrass past the third week of June was detrimental to cow and calf weight performance and to herbage biomass production diminishing the benefits of early season crested wheatgrass pastures. The equipment costs, labor costs, land rent per acre, and forage production costs per acre were low. The forage dry matter cost ($31.97/ton) was low because of the rapid early season forage dry matter production. The land area (4.16 acres) per cow was small because of the seasonally high forage dry matter yield per acre. However, the stocking rate used for this pasture forage type was too high to sustain high herbage and livestock production. The total daily forage feed costs ($0.48/day) were low because of the small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderately high returns after feed costs ($58.78) per cow and in moderate returns after feed costs ($14.13) per acre. The cost per pound of calf weight gain ($0.27/lb) was low because of the small land area per cow-calf pair.

Crested wheatgrass grassland grazed as a fertilized complementary pasture during the spring lactation production period was low-cost forage because the quantities of crude protein and the quantities of forage dry matter available per acre were seasonally high. The production costs per acre were moderate. The forage dry matter cost ($34.29/ton) was low because of the rapid early season forage dry matter production. The land area (0.75 acres) per cow was small because of the seasonally high forage dry matter yield per acre. The total daily forage feed costs ($0.51/day) were low because of the small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($31.36) per cow and in high returns after feed costs ($41.82) per acre. The cost per pound of calf weight gain ($0.24/lb) was very low because of the seasonally high crude protein and seasonally high forage dry matter production and the small land area per cow-calf pair.

Harvested Forage Types

Crested wheatgrass hay cut at a mature growth stage and fed during the spring lactation production period was high-cost forage. The forage dry matter cost ($34.80/ton) was moderate for mature crested wheatgrass hay and lower than the forage dry matter cost per ton for early cut crested wheatgrass hay because greater dry matter weight of the mature crested wheatgrass hay was harvested per acre. The cost per pound of crude protein ($0.28/lb CP) was high for mature crested wheatgrass hay and double the cost per pound of crude protein for early cut crested wheatgrass hay because of the lower crude protein weight in the mature crested wheatgrass hay harvested per acre. The land area (0.58 acres) per cow for mature crested wheatgrass hay was small but greater than the land area required per cow for early cut crested wheatgrass hay because of the greater crude protein weight per acre in the early cut crested

wheatgrass hay. The crude protein content of the mature crested wheatgrass forage was below the requirements of a lactating cow making it necessary to provide purchased supplemental crude protein. The total daily forage and supplemental crude protein costs ($0.71/day) were high because of the additional supplemental crude protein costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($21.54) per cow and in moderate returns after feed costs ($37.14) per acre. The cost per pound of calf weight gain ($0.35/lb) was moderately low because of the additional supplemental crude protein costs.

Crested wheatgrass hay cut at the boot growth stage and fed during the spring lactation production period was moderate-cost forage. The forage dry matter cost ($40.80/ton) was moderate for early cut crested wheatgrass hay and was greater than the forage dry matter cost per ton for mature crested wheatgrass hay because crested wheatgrass hay cut at the boot stage harvested lower forage dry matter weight per acre than crested wheatgrass hay cut at a mature growth stage. The cost per pound of crude protein ($0.14/lb CP) was low for early cut crested wheatgrass hay and lower than the cost per pound of crude protein for mature crested wheatgrass hay because of the greater crude protein weight in the early cut crested wheatgrass hay harvested per acre. The land area (0.41 acres) per cow for early cut crested wheatgrass hay was small and less than the land area required per cow for mature crested wheatgrass hay because of the greater crude protein weight harvested per acre in the early cut crested wheatgrass hay. The forage cost of early cut crested wheatgrass hay was low but the total daily forage feed cost ($0.57/day) was moderate because about 42% of the ration forage was supplemental roughage which added substantially to the total forage feed costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($25.67) per cow and in high returns after feed costs ($62.61) per acre. The cost per pound of calf weight gain ($0.29/lb) was low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Forage barley hay cut at the milk growth stage and fed during the spring lactation production period was low-cost forage. The production costs per acre were high for early cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($28.80/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.11/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.13 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.47/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The forage costs for early cut forage barley hay were lower than the forage costs for late cut forage barley hay. However, the total forage feed costs for early cut forage barley hay was slightly greater than the total forage feed costs for late cut forage barley hay because of the greater quantity of supplemental roughage in the forage ration for early cut forage barley hay. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($28.92) per cow and in extremely high returns after feed costs ($222.46) per acre. The cost per pound of calf weight gain ($0.23/lb) was very low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Forage barley hay cut at the hard dough growth stage and fed during the spring lactation production period was low-cost forage. The production costs per acre were high for late cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($27.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut forage barley hay was greater than the cost per pound of crude protein for early cut forage barley hay because of the lower crude protein weight harvested per acre in the late cut forage barley hay. The land area (0.16 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.43/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($30.16) per cow and in very high returns after feed costs ($188.50) per acre. The returns after feed costs per acre were lower for late cut forage barley hay than for early cut forage barley hay because late cut forage barley hay had slightly higher crude protein cost per pound and slightly larger land area per cow than early cut forage barley hay. The cost per pound of calf weight gain ($0.21/lb) was very low because of the low cost per

pound of crude protein and the very small land area per cow-calf pair.

Oat forage hay cut at the milk growth stage and fed during the spring lactation production period was low-cost forage. The production costs per acre were high for early cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($29.60/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.14 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.47/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($28.72) per cow and in extremely high returns after feed costs ($205.14) per acre. The cost per pound of calf weight gain ($0.24/lb) was very low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Oat forage hay cut at the hard dough growth stage and fed during the spring lactation production period was low-cost forage. The production costs per acre were high for late cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($26.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut oat forage hay was greater than the cost per pound of crude protein for early cut oat forage hay because of the lower crude protein weight harvested per acre in the late cut oat forage hay. The land area (0.16 acres) per cow was very small because of the high forage dry matter yield per acre. The crude protein content of the forage was below the requirements of a lactating cow making it necessary to provide purchased supplemental crude protein. The total daily forage and supplemental crude protein costs ($0.45/day) were moderately low because of the additional cost of the supplemental crude protein. The forage costs for early cut oat forage hay were lower than the forage costs for late cut oat forage hay. However, the total forage feed costs for late cut oat forage hay were slightly lower than the total forage feed costs for early cut oat forage hay because of the quantity of supplemental roughage in the forage ration for early cut oat forage hay. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($29.54) per cow and in very high returns after feed costs ($180.12) per acre. The cost per pound of calf weight gain ($0.22/lb) was very low because of the very small land area per cow-calf pair.

Pea forage hay cut at an early growth stage and fed during the spring lactation production period was moderate-cost forage. However, pea forage hay cut at a late growth stage has lower forage feed costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for early cut pea forage hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($55.00/ton) was high because of the modest forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.15 acres) per cow was very small because of the high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.67/day) were high because of the modest forage dry matter production per acre and the high supplemental roughage costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($22.56) per cow and in very high returns after feed costs ($150.40) per acre. The cost per pound of calf weight gain ($0.34/lb) was low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Pea forage hay cut at a late growth stage and fed during the spring lactation production period was low-cost forage. Late cut pea forage hay has lower forage feed costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for late cut pea forage hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($37.40/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.12 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.55/day) were low because of the low cost of crude protein per pound and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($26.33) per cow

and in extremely high returns after feed costs ($219.42) per acre. The cost per pound of calf weight gain ($0.28/lb) was low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

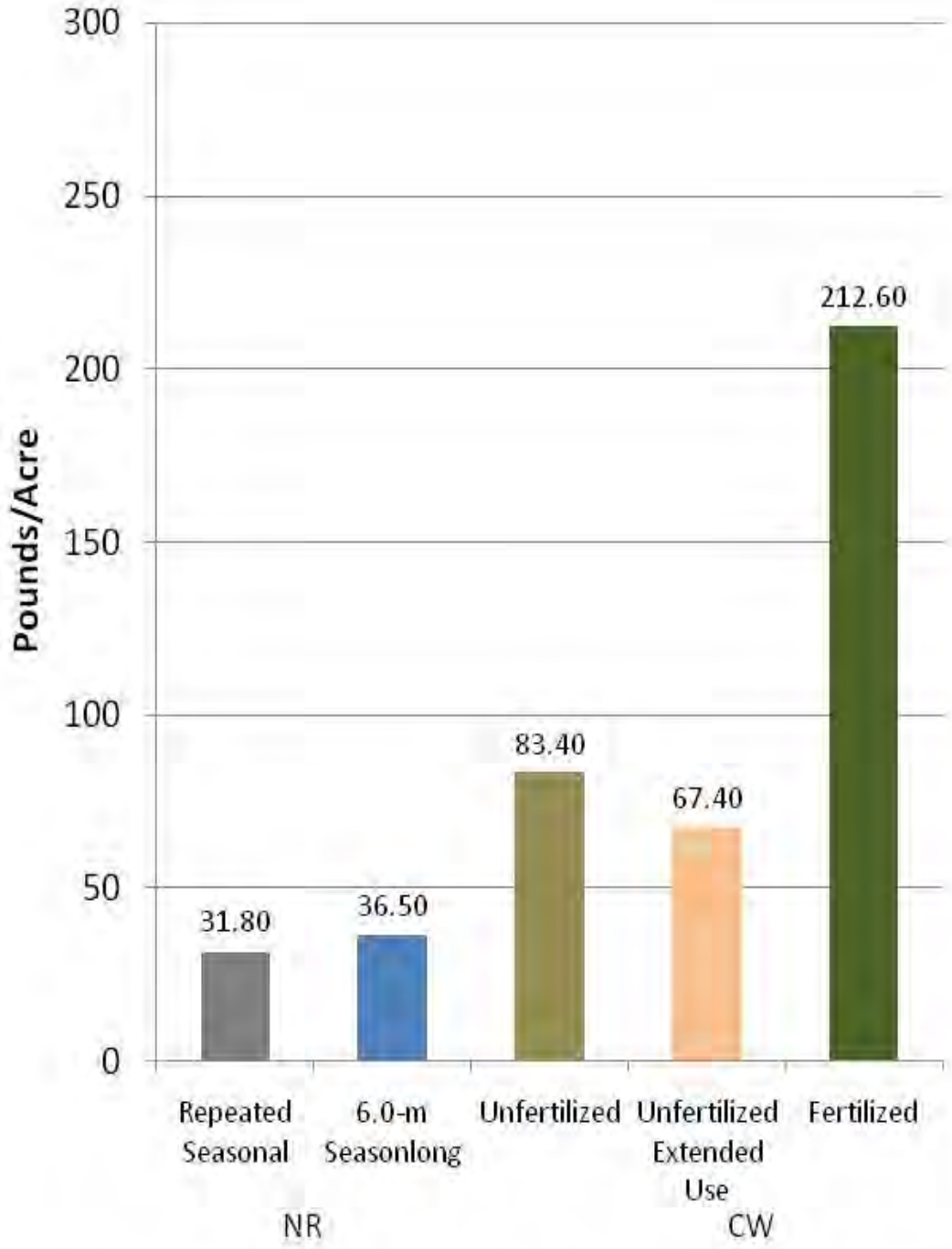
Forage lentil hay cut at an early growth stage and fed during the spring lactation production period was low-cost forage. However, forage lentil hay cut at a late growth stage has lower forage feed costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for early cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($71.60/ton) was high because of the modest forage dry matter yield per acre. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.21 acres) per cow was very small because of the high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.75/day) were high because of the modest forage dry matter production per acre and the high supplemental roughage costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($20.03) per cow and in high returns after feed costs ($58.91) per acre. The cost per pound of calf weight gain ($0.38/lb) was low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Forage lentil hay cut at a late growth stage and fed during the spring lactation production period was low-cost forage. Late cut forage lentil hay has lower forage feed costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for late cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($37.00/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.14 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.56/day) were low because of the low cost of crude protein per pound and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($26.17) per cow and in very high returns after feed costs ($186.93) per acre. The cost per pound of calf weight gain ($0.28/lb) was low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

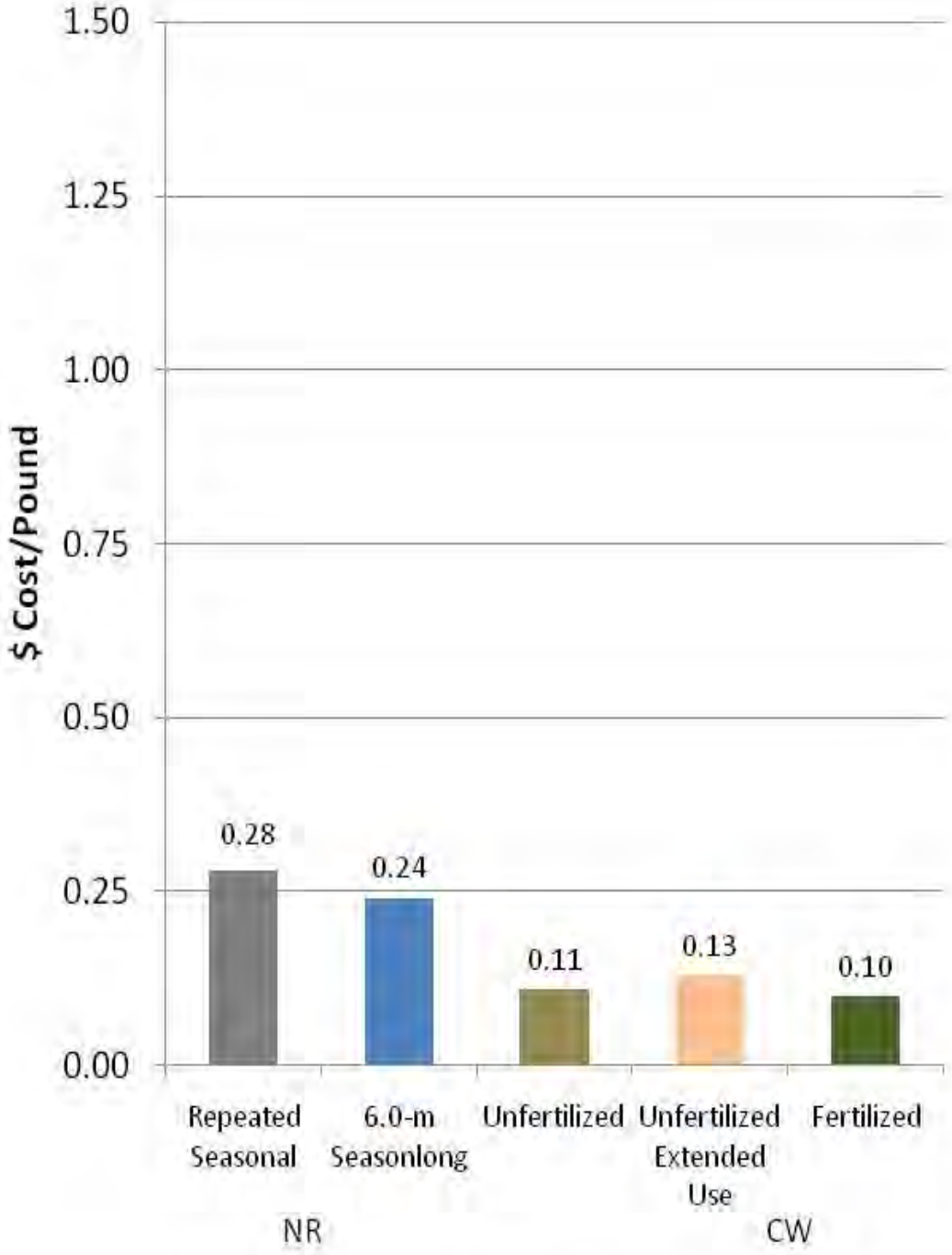
Oat-pea hay cut at compromised plant growth stages and fed during the spring lactation production period was low-cost forage. However, seeding oat forage separately on half of the field and cutting it at an early growth stage and seeding pea forage separately on half of the field and cutting it at a late growth stage will result in lower production costs per acre, lower forage dry matter costs per ton, lower costs per pound of crude protein, lower total forage feed costs per day, lower costs per pound of calf weight gain, greater net returns after feed costs per cow, and greater net returns after feed costs per acre than oat-pea forage seeded together and cut at compromised growth stages. The production costs per acre were very high for oat-pea hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($37.20/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.16/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.12 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.55/day) were low because of the low cost of crude protein per pound and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($26.25) per cow and in extremely high returns after feed costs ($218.75) per acre. The cost per pound of calf weight gain ($0.28/lb) was low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Table 34. Costs and returns for native rangeland and domesticated grassland pasture forage types to be grazed by range cows during the 31-day spring lactation production period.

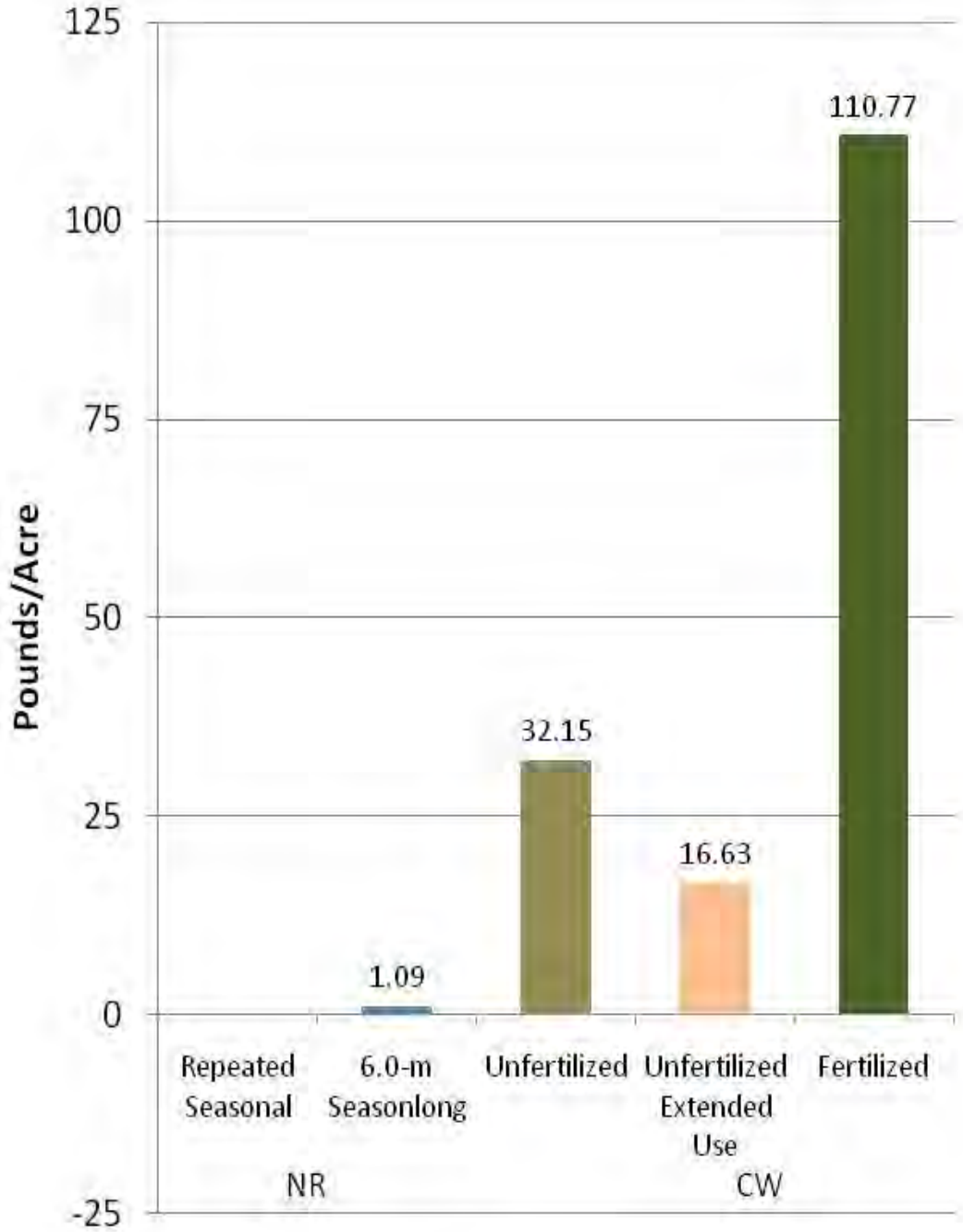
		Native Rangeland Repeated Seasonal	Native Rangeland 6.0-m Seasonlong	Crested Wheatgrass Unfertilized	Crested Wheatgrass Unfertilized Extended Use	Crested Wheatgrass Fertilized
Days		31	16	31	76	31
Growth Stage		spring	spring	spring	spring	spring
Herbage Weight	lb/ac	780	906	1980	2192	4960
Forage DM Weight	lb/ac	195	226	495	548	1240
Costs/Acre						
Land Rent	$	8.76	8.76	8.76	8.76	8.76
Custom Work	$					12.50
Seed Cost	$					
Baling Costs	$					
Production Costs	$/ac	8.76	8.76	8.76	8.76	21.26
Forage DM Costs	$/ton	89.85	77.52	35.39	31.97	34.29
Crude Protein	%	16.3		16.8		
Crude Protein Yield	lb/ac	31.79		83.36		
Crude Protein Cost	$/lb	0.28		0.11		
Forage Allocation	lb/d	30.0	30.0	30.0	30.0	30.0
Land Area/Period	ac	4.77	2.10	1.88	4.16	0.75
Forage Costs/Period	$/pp	41.85	18.40	16.47	36.44	15.95
Supplementation						
Roughage/Day	lb/d					
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp					
Total Feed Cost	$/pp	41.85	18.40	16.47	36.44	15.95
Cost/Day	$/d	1.35	1.15	0.52	0.48	0.51
Accumulated Calf Wt.	lbs	55.80	28.80	59.21	136.04	67.58
Weight Value @$0.70/lb	$	39.06	20.16	41.45	95.23	47.31
Net Return/c-c pr	$	-2.79	1.76	24.98	58.78	31.36
Net Return/acre	$	-0.58	0.83	13.29	14.13	41.82
Cost/lb of Calf Gain	$	0.75	0.64	0.27	0.27	0.24



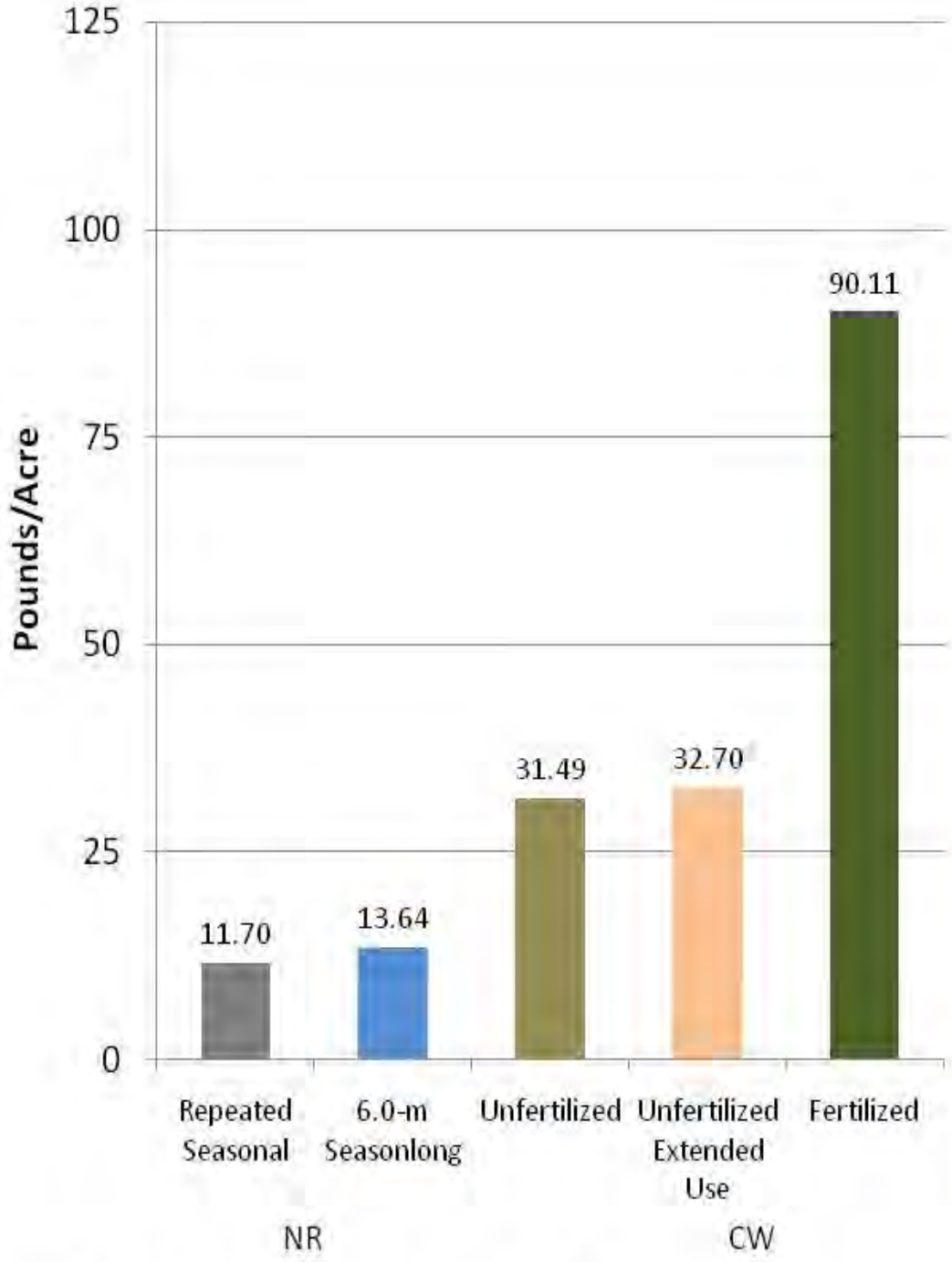
Crude Protein Weight Captured per Acre on Pasture Forages During Spring Lactation



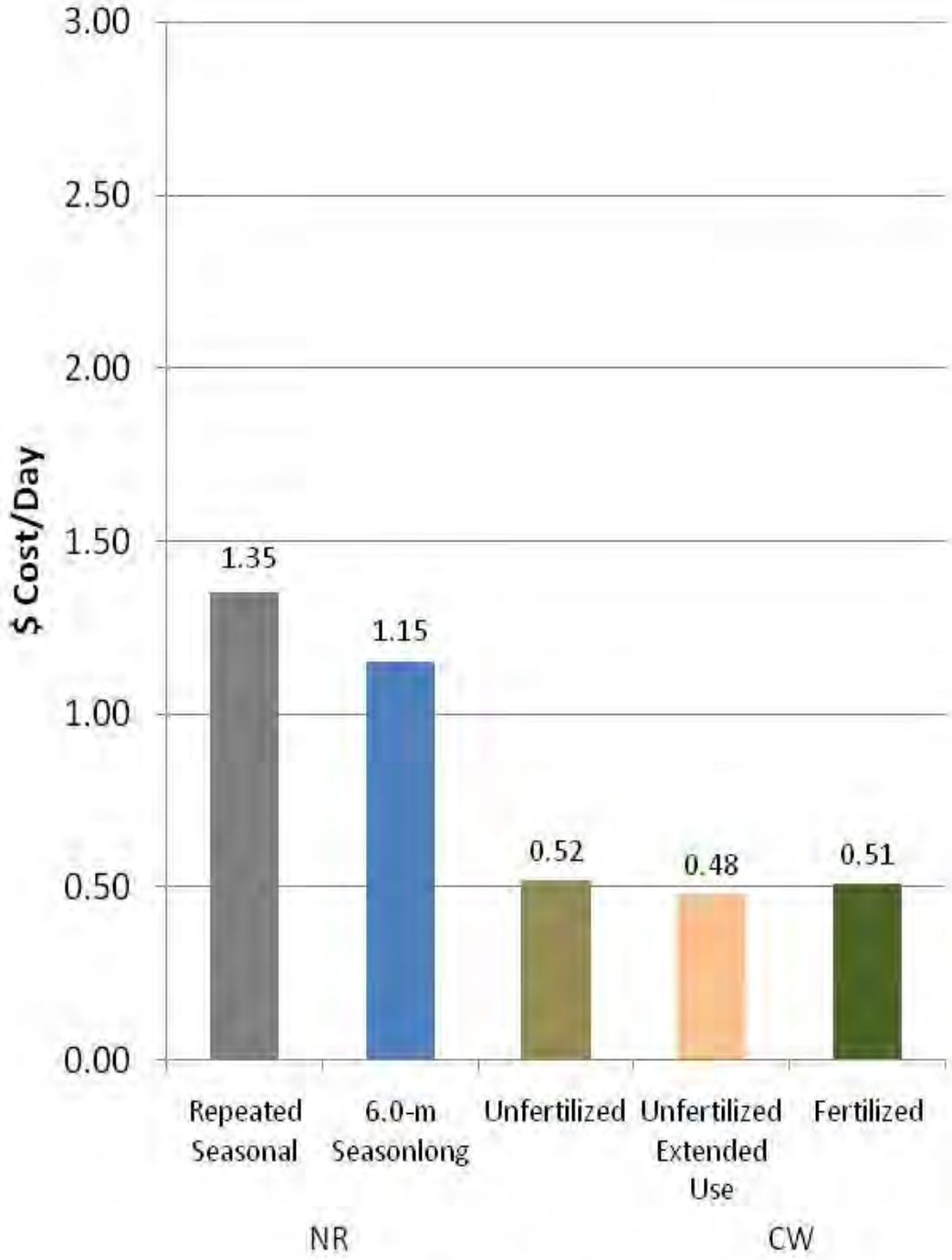
Crude Protein Cost per Pound
on Pasture Forages During Spring Lactation



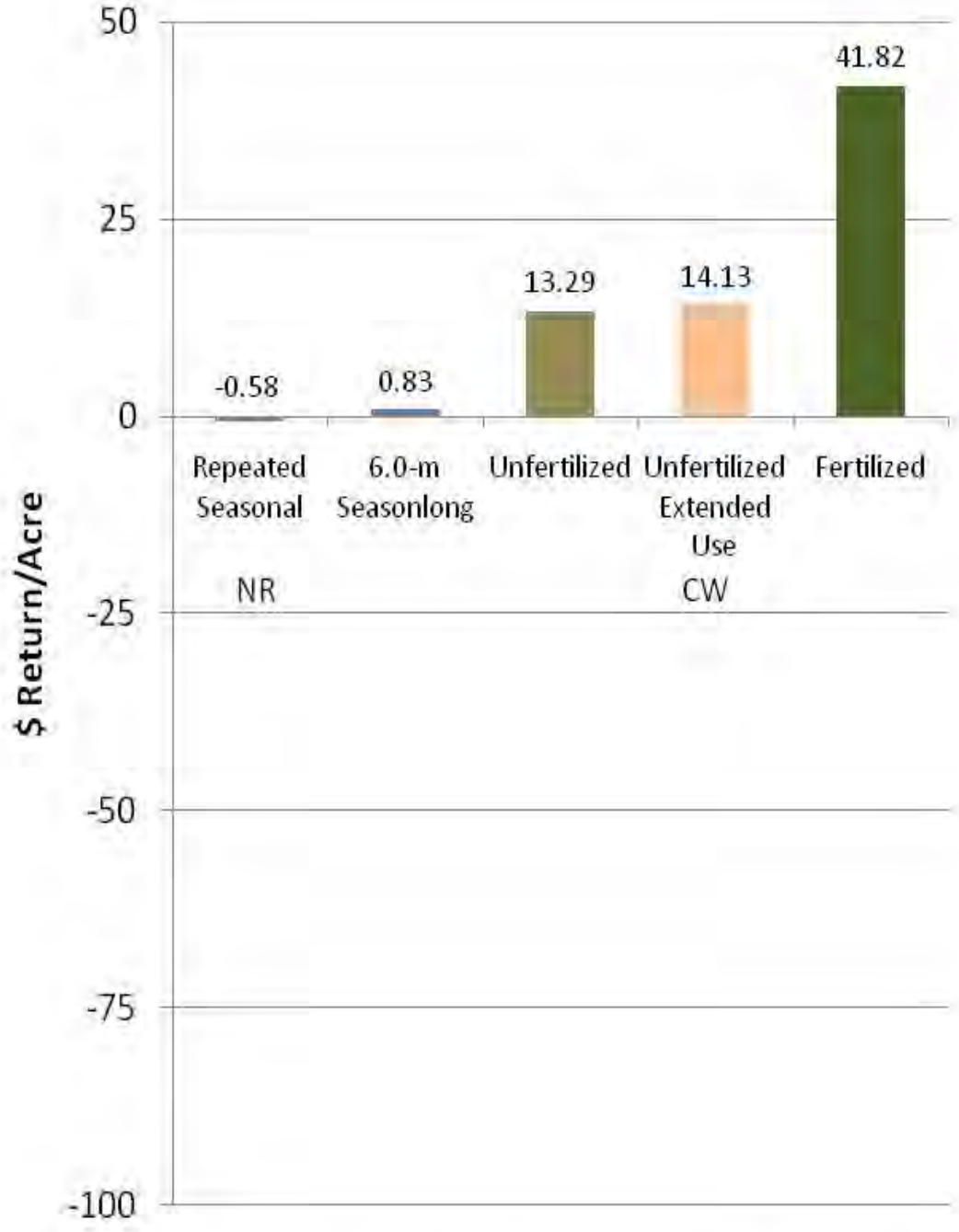
Cow Weight Gain per Acre on Pasture Forages During Spring Lactation



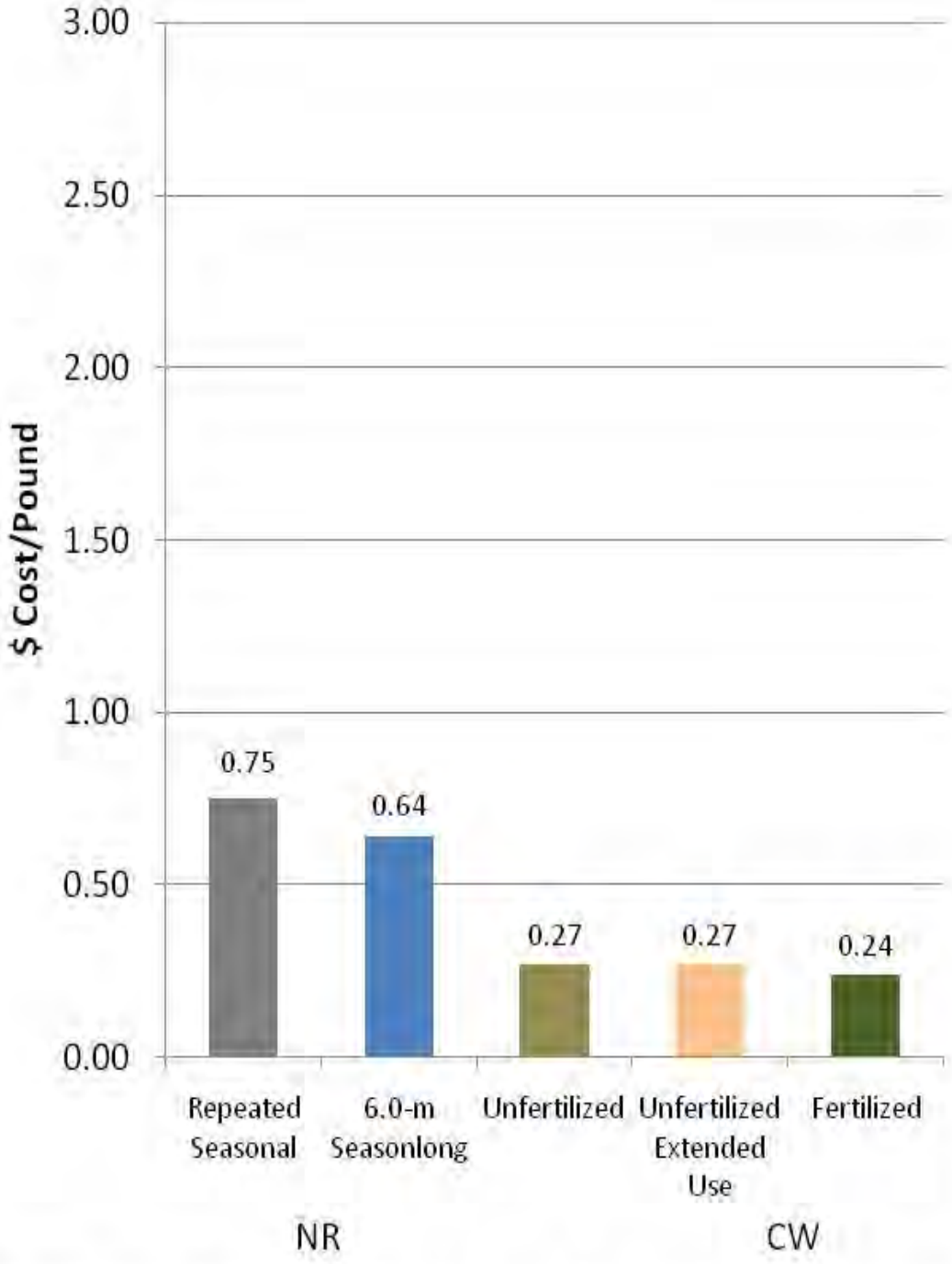
Calf Weight Gain per Acre on Pasture Forages During Spring Lactation



Forage Feed Costs per Day
on Pasture Forages During Spring Lactation



Returns After Feed Costs per Acre on Pasture Forages During Spring Lactation



Calf Weight Gain Costs per Pound on Pasture Forages During Spring Lactation

Table 35. Costs and returns for perennial grass harvested forage types to be fed to range cows during the 31-day spring lactation production period.

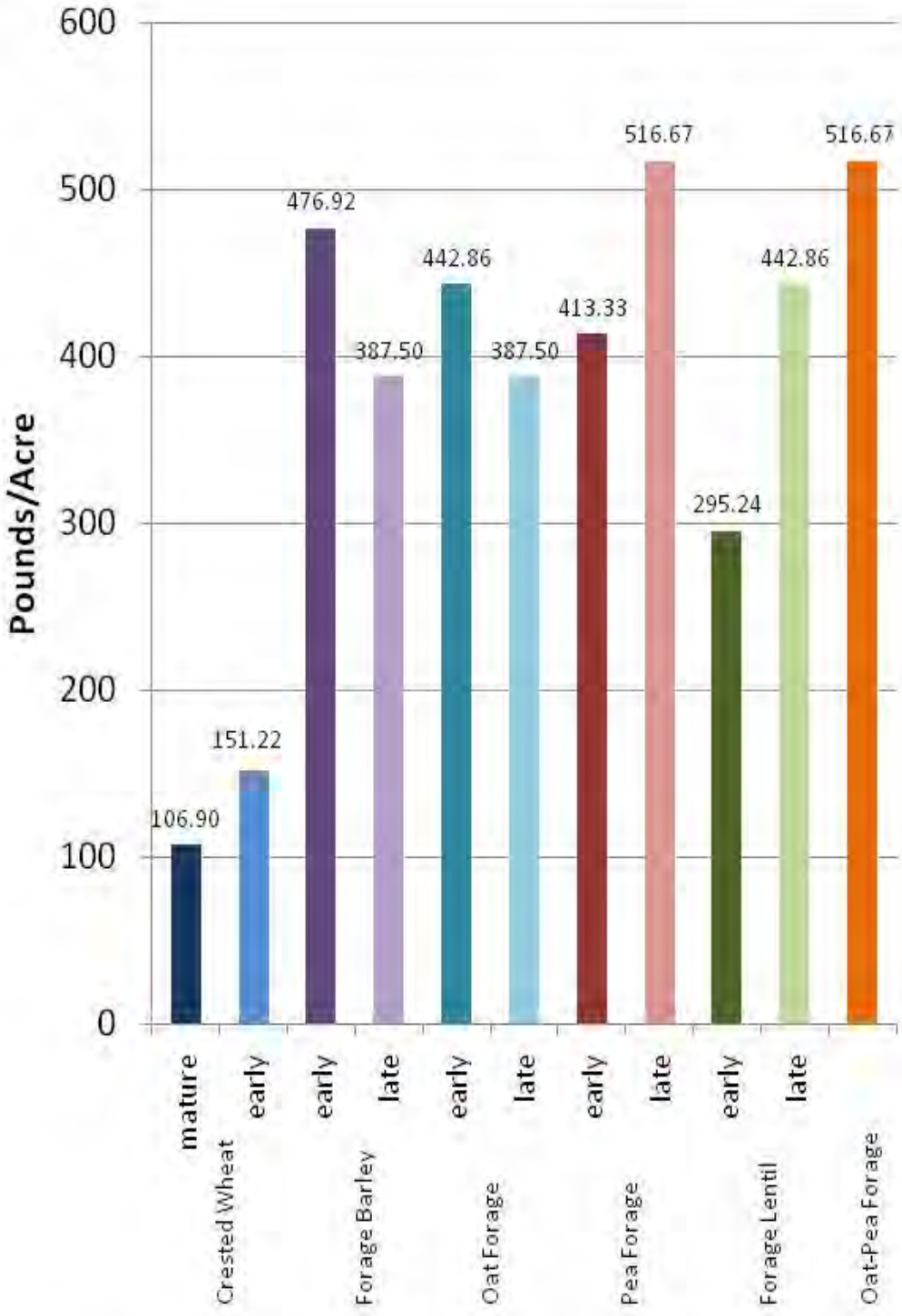
		Crested Wheatgrass Hay	Crested Wheatgrass Hay
Days		31	31
Growth Stage		Mature	Boot stage
Herbage Weight	lb/ac	-	-
Forage DM Weight	lb/ac	1600	1300
Costs/Acre			
Land Rent	$	14.22	14.22
Custom Work	$	5.31	5.31
Seed Cost	$	-	-
Baling Costs	$	8.58	6.97
Production Costs	$/ac	28.11	26.50
Forage DM Costs	$/ton	34.80	40.80
Crude Protein	%	6.4	14.5
Crude Protein Yield	lb/ac	102	189
Crude Protein Cost	$/lb	0.28	0.14
Forage Allocation	lb/d	30.0	17.3
Land Area/Period	ac	0.58	0.41
Forage Costs/Period	$/pp	16.37	10.85
Supplementation			
Roughage/Day	lb/d		12.7
Crude Protein/Day	lb/d	0.59	
Sup. Cost/Period	$/pp	5.49	6.88
Total Feed Cost	$/pp	21.86	17.73
Cost/Day	$/d	0.71	0.57
Accumulated Calf Wt.	lbs	62.0	62.0
Weight Value @$0.70/lb	$	43.40	43.40
Net Return/c-c pr	$	21.54	25.67
Net Return/acre	$	37.14	62.61
Cost/lb of Calf Gain	$	0.35	0.29

Table 36. Costs and returns for annual cereal harvested forage types to be fed to range cows during the 31-day spring lactation production period.

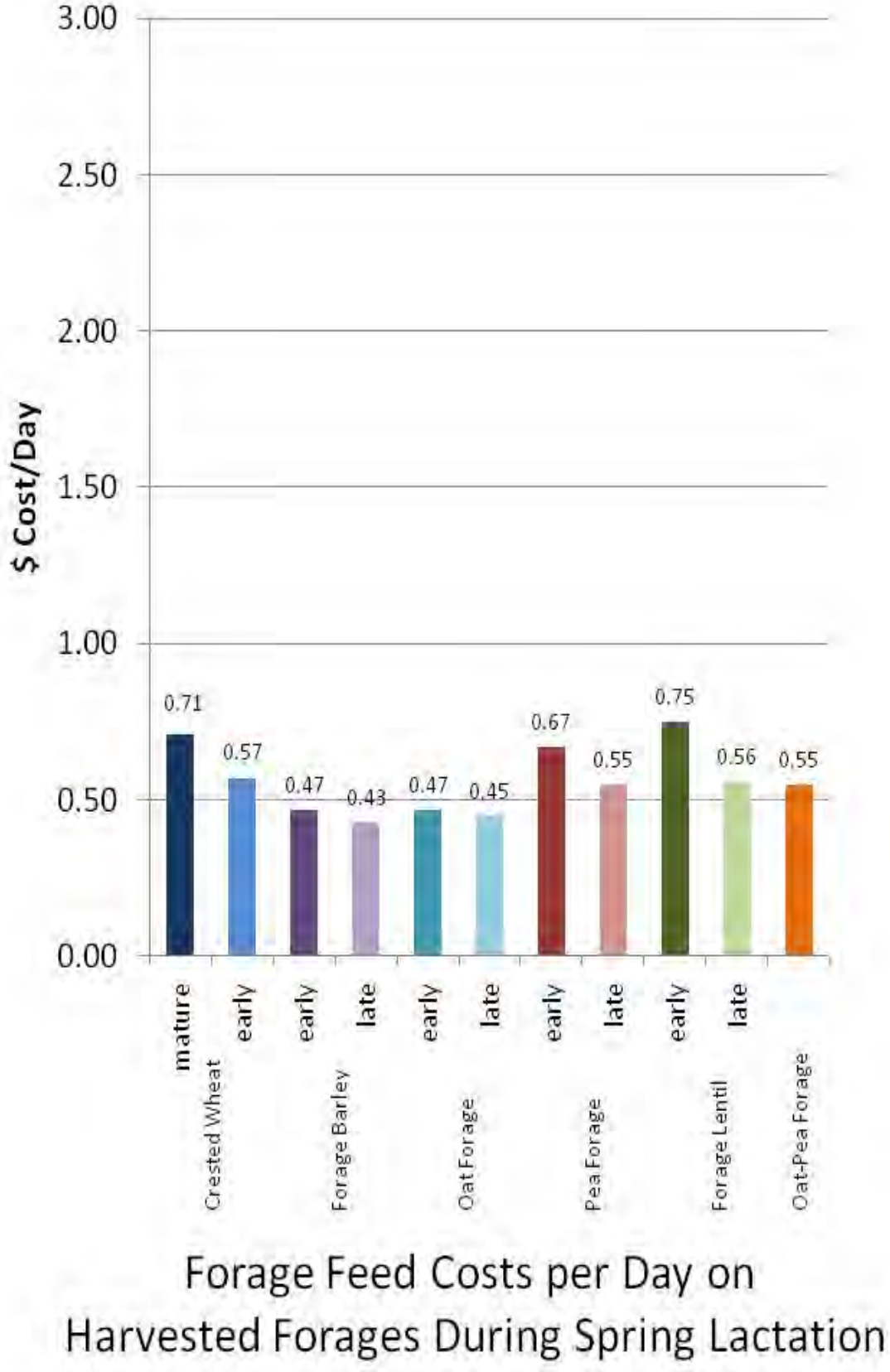
		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Days		31	31	31	31
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Forage Allocation	lb/d	19.3	27.3	21.8	30.0
Land Area/Period	ac	0.13	0.16	0.14	0.16
Forage Costs/Period	$/pp	8.68	11.78	10.23	12.28
Supplementation					
Roughage/Day	lb/d	10.7	2.7	8.2	
Crude Protein/Day	lb/d				0.17
Sup. Cost/Period	$/pp	5.80	1.46	4.45	1.58
Total Feed Cost	$/pp	14.48	13.24	14.68	13.86
Cost/Day	$/d	0.47	0.43	0.47	0.45
Accumulated Calf Wt.	lbs	62.0	62.0	62.0	62.0
Weight Value @$0.70/lb	$	43.40	43.40	43.40	43.40
Net Return/c-c pr	$	28.92	30.16	28.72	29.54
Net Return/acre	$	222.46	188.50	205.14	180.12
Cost/lb of Calf Gain	$	0.23	0.21	0.24	0.22

Table 37. Costs and returns for annual legume harvested forage types to be fed to range cows during the 31-day spring lactation production period.

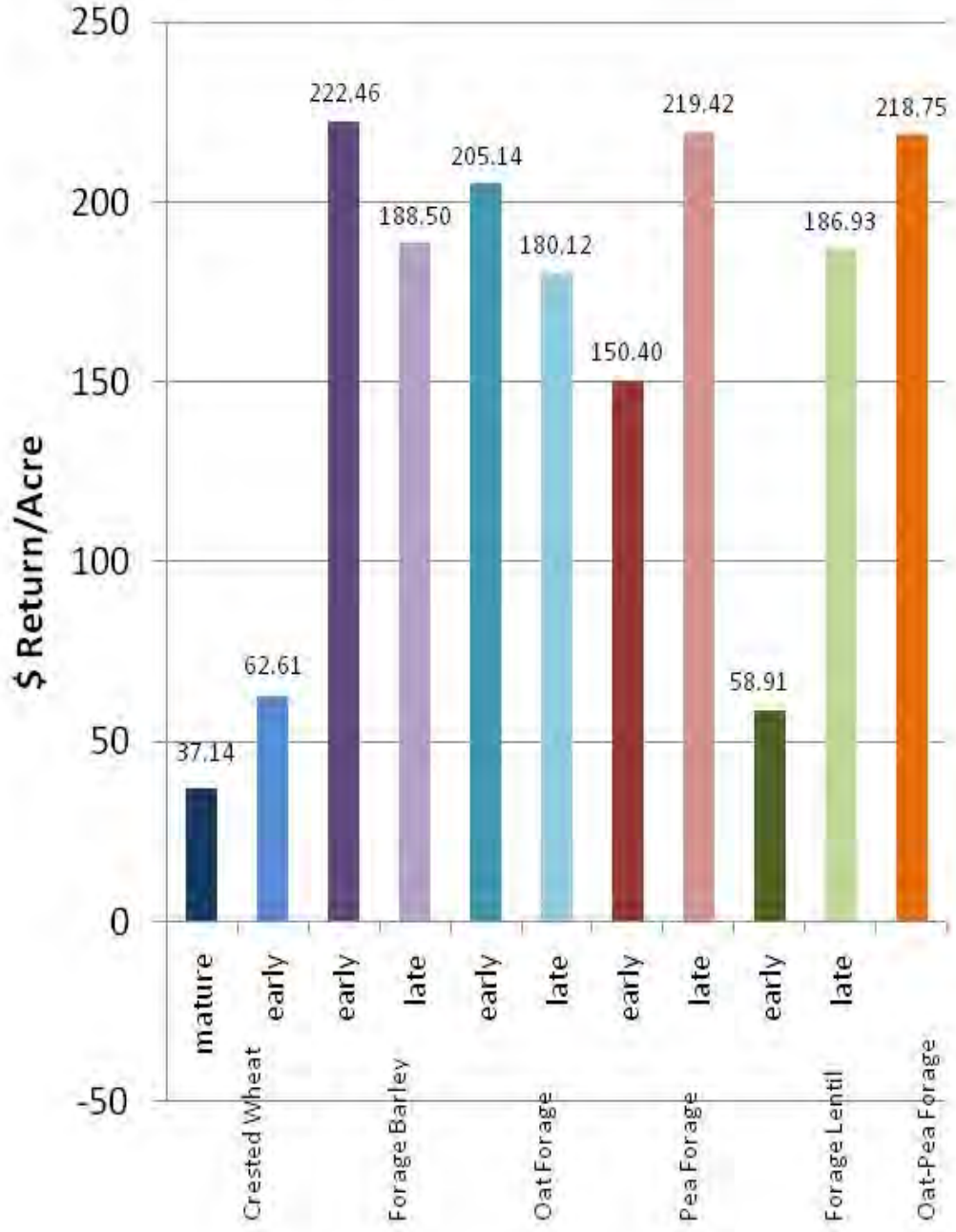
		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Days		31	31	31	31	31
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Forage Allocation	lb/d	13.3	17.4	11.5	17.1	20.1
Land Area/Period	ac	0.15	0.12	0.21	0.14	0.12
Forage Costs/Period	$/pp	11.78	10.23	13.33	10.23	11.78
Supplementation						
Roughage/Day	lb/d	16.7	12.6	18.5	12.9	9.9
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	9.06	6.84	10.04	7.00	5.37
Total Feed Cost	$/pp	20.84	17.07	23.37	17.23	17.15
Cost/Day	$/d	0.67	0.55	0.75	0.56	0.55
Accumulated Calf Wt.	lbs	62.0	62.0	62.0	62.0	62.0
Weight Value @$0.70/lb	$	43.40	43.40	43.40	43.40	43.40
Net Return/c-c pr	$	22.56	26.33	20.03	26.17	26.25
Net Return/acre	$	150.40	219.42	58.91	186.93	218.75
Cost/lb of Calf Gain	$	0.34	0.28	0.38	0.28	0.28



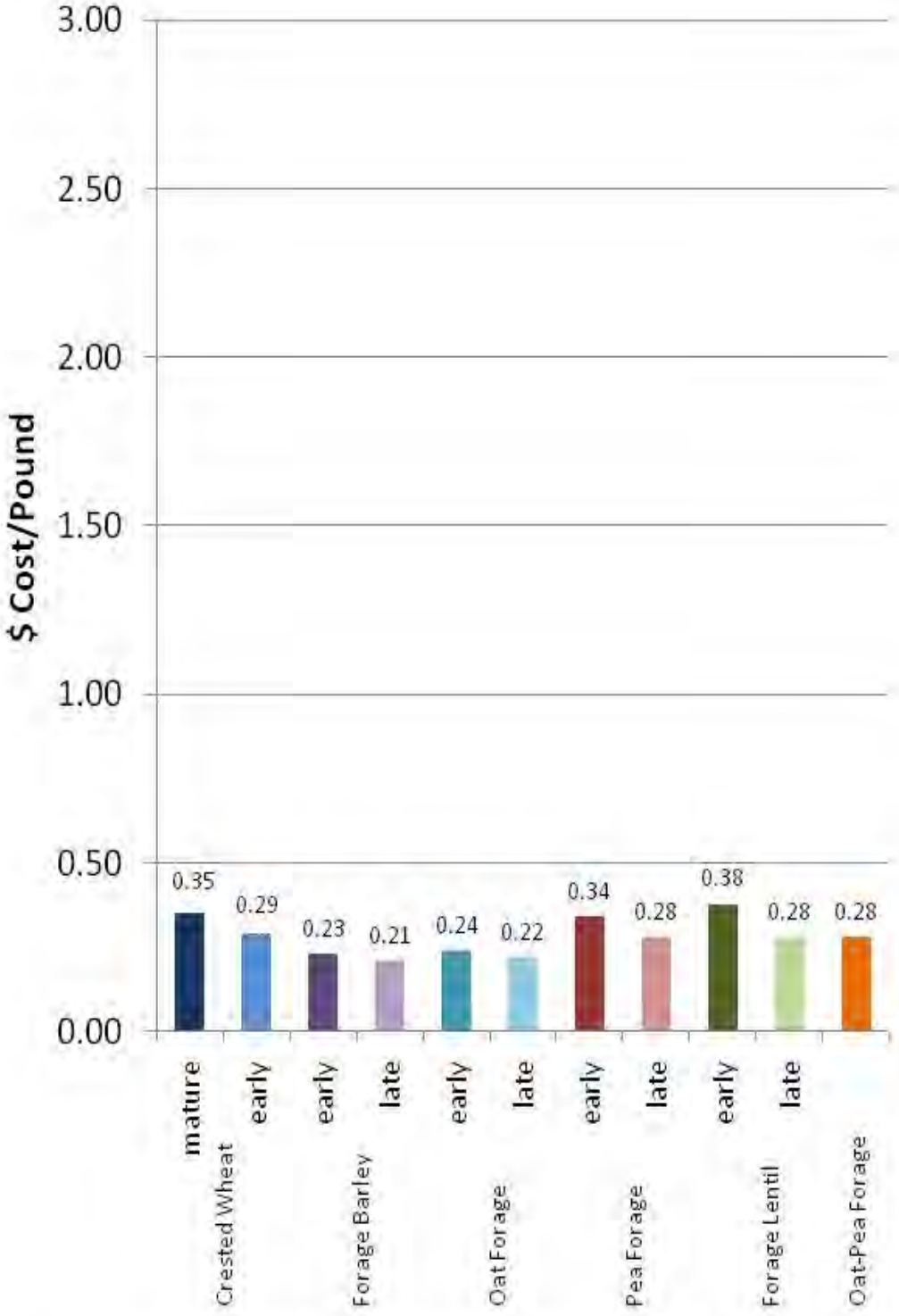
Calf Weight Gain per Acre on Harvested Forages During Spring Lactation



Forage Feed Costs per Day on Harvested Forages During Spring Lactation



Returns After Feed Costs per Acre on Harvested Forages During Spring Lactation



Calf Weight Gain Costs per Pound on Harvested Forages During Spring Lactation

Table 38. Feed quantity and land area for forage types used during the 31-day spring lactation production period.

Forage Types	Daily Feed per Cow			Spring Lactation Period Feed one Cow for 31 days			
	Forage lb/d	Roughage lb/d	Crude Protein lb/d	Forage lb/pp	Roughage lb/pp	Crude Protein lb/pp	Land Area ac/pp
Pasture Forage Types							
Native Rangeland Repeated Seasonal	30.0			930.0			4.77
6.0-m Seasonlong (16d)	30.0			480.0			2.10
Crested Wheatgrass Unfertilized	30.0			930.0			1.88
Unfertilized (76d)	30.0			2280.0			4.16
Fertilized	30.0			930.0			0.75
Harvested Forage Types							
Crested Wheat, mature	30.0		0.59	930.0		18.29	0.58
Crested Wheat, early	17.3	12.7		586.3	393.7		0.41
Forage Barley, early	19.3	10.7		598.3	331.7		0.13
Forage Barley, late	27.3	2.7		846.3	83.7		0.16
Oat Forage, early	21.8	8.2		675.8	254.2		0.14
Oat Forage, late	30.0		0.17	930.0		5.27	0.16
Pea Forage, early	13.3	16.7		412.3	517.7		0.15
Pea Forage, late	17.4	12.6		539.4	390.6		0.12
Forage Lentil, early	11.5	18.5		356.5	573.5		0.34
Forage Lentil, late	17.1	12.9		530.1	399.9		0.14
Oat-Pea Forage	20.1	9.9		623.1	306.9		0.12

Table 39. Summary of feed costs for forage types used during the 31-day spring lactation production period.

Forage Types	Forage Costs $/pp	Roughage Costs $/pp	Crude Protein Costs $/pp	Total Feed Costs $/pp	Daily Feed Costs $/d
Pasture Forage Types					
Native Rangeland Repeated Seasonal	41.85			41.85	1.35
6.0-m Seasonlong (16d)	18.40			18.40	1.15
Crested Wheatgrass Unfertilized	16.47			16.47	0.52
Unfertilized (76d)	36.44			36.44	0.48
Fertilized	15.95			15.95	0.51
Harvested Forage Types					
Crested Wheat, mature	16.37		5.49	21.86	0.71
Crested Wheat, early	10.85	6.88		17.73	0.57
Forage Barley, early	8.68	5.80		14.48	0.47
Forage Barley, late	11.78	1.46		13.24	0.43
Oat Forage, early	10.23	4.45		14.68	0.47
Oat Forage, late	12.28		1.58	13.86	0.45
Pea Forage, early	11.78	9.06		20.84	0.67
Pea Forage, late	10.23	6.84		17.07	0.55
Forage Lentil, early	13.33	10.04		23.37	0.75
Forage Lentil, late	10.23	7.00		17.23	0.56
Oat-Pea Forage	11.78	5.37		17.15	0.55

Table 40. Summary of returns after feed costs for forage types used during the 31-day spring lactation production period.

Forage Types	Gross Return @$0.70/lb $/calf	Net Return per C-C pr $/pr	Net Return per acre $/ac	Calf Gain Cost $/lb
Pasture Forage Types				
Native Rangeland Repeated Seasonal	39.06	-2.97	-0.58	0.75
6.0-m Seasonlong (16d)	20.16	1.76	0.83	0.64
Crested Wheatgrass Unfertilized	41.45	24.98	13.29	0.27
Unfertilized (76d)	95.23	58.78	14.13	0.27
Fertilized	47.31	31.36	41.82	0.24
Harvested Forage Types				
Crested Wheat, mature	43.40	21.54	37.14	0.35
Crested Wheat, early	43.40	25.67	62.61	0.29
Forage Barley, early	43.40	28.92	222.46	0.23
Forage Barley, late	43.40	30.16	188.50	0.21
Oat Forage, early	43.40	28.72	205.14	0.24
Oat Forage, late	43.40	29.54	180.12	0.22
Pea Forage, early	43.40	22.56	150.40	0.34
Pea Forage, late	43.40	26.33	219.42	0.28
Forage Lentil, early	43.40	20.03	58.91	0.38
Forage Lentil, late	43.40	26.17	186.93	0.28
Oat-Pea Forage	43.40	26.25	218.75	0.28

Evaluation of Pasture Forage and Harvested Forage Types during the Summer Lactation Production Period

Results

The summer lactation production period was 137 days from early June until mid October. The summer lactation production period has nutritional requirements above maintenance. The greater part of the additional nutrients is for the production of milk for the nursing calf, and a smaller amount is for the support of an embryo at the early stages of development. The nutritional quality of the forage during the summer plays a role in maintaining the pregnancy. Cows maintaining or improving body condition have lower rates of embryo loss than cows losing body condition (BCRC 1999). The quantity of milk produced during the summer period declines from peak levels. The nutritional quality of the forage affects the rate of decrease. If the forage quality is at or above the animals' nutritional requirements, cows can maintain milk production near their genetic potential during most of the lactation period (BCRC 1999). Cows with higher milk production produce heavier calves at weaning. Cows grazing pasture treatments with forage quality insufficient to meet animal nutritional requirements have milk production below their genetic potential and produce calves that are lighter at weaning and have higher costs per pound of weight gained. Pasture forage and harvested forage costs and returns after feed costs were determined for a 1200-pound range cow with a calf during the summer lactation production period. A grazing cow with a calf requires an allocation of 30 lbs of pasture forage dry matter per day. The cow requires a daily intake of 27 lbs dry matter (DM) at 9.3% crude protein (CP) (2.51 lbs CP/day).

Pasture Forage Types

Native rangeland managed as a repeated seasonal pasture was evaluated during the summer lactation production period for 137 days between early June and mid October (tables 41 and 45). Native rangeland forage during mid summer has a crude protein content of around 9.6%. Summer native rangeland forage had pasture rent value or production costs of $8.76 per acre, forage dry matter costs of $48.26 per ton, and crude protein costs of $0.25 per pound. A cow grazing during the summer lactation period required 11.32 acres (2.52 acres per month) at a forage cost of $98.64 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $98.64 per period, or $0.72 per day (table 46). Calf weight gain was 1.80 lbs per day and 21.78 lbs per acre; accumulated weight gain was 246.60 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $172.62 per calf, and the net returns after pasture costs were $73.98 per cow-calf pair and $6.54 per acre. The cost of calf weight gain was $0.40 per pound (table 47).

Native rangeland managed as a 6.0-month seasonlong pasture was evaluated during the summer lactation production period for 137 days between early June and mid October (tables 41 and 45). Native rangeland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $77.50 per ton. A cow grazing during the summer lactation period was allotted 18.10 acres (4.04 acres per month) at a forage cost of $158.55 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $158.55 per period, or $1.16 per day (table 46). Cow weight gain was 0.14 lbs per day and 1.09 lbs per acre; accumulated weight gain was 19.66 lbs. Calf weight gain was 1.80 lbs per day and 15.63 lbs per acre; accumulated weight gain was 282.87 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $198.01 per calf, and the net returns after pasture costs were $39.46 per cow-calf pair and $2.18 per acre. The cost of calf weight gain was $0.56 per pound (table 47).

Native rangeland managed as a 4.5-month seasonlong pasture was evaluated during the summer lactation production period for 137 days between early June and mid October (tables 41 and 45). Native rangeland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $54.75 per ton. A cow grazing during the summer lactation period was allotted 12.70 acres (2.86 acres per month) at a forage cost of $111.25 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $111.25 per period, or $0.81 per day (table 46). Cow weight gain was 0.34 lbs per day and 3.67 lbs per acre; accumulated weight gain was 46.58 lbs. Calf weight gain was 2.09 lbs per day and 22.55 lbs per acre; accumulated weight gain was 286.33 lbs. When calf accumulated weight was assumed to have a value of

$0.70 per pound, the gross return was $200.43 per calf, and the net returns after pasture costs were $89.18 per cow-calf pair and $7.02 per acre. The cost of calf weight gain was $0.39 per pound (table 47).

Native rangeland managed as a deferred grazing pasture was evaluated during the summer lactation production period for 92 days between mid July and mid October (tables 41 and 45). Native rangeland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $42.52 per ton. A cow grazing during the late summer lactation period was allotted 6.70 acres (2.22 acres per month) at a forage cost of $58.26 per deferred grazing period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $58.26 per period, or $0.63 per day (table 46). Cow weight gain was 0.32 lbs per day and 4.40 lbs per acre; accumulated weight gain was 29.44 lbs. Calf weight gain was 1.80 lbs per day and 24.73 lbs per acre; accumulated weight gain was 196.50 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $137.55 per calf, and the net returns after pasture costs were $79.29 per cow-calf pair and $11.83 per acre. The cost of calf weight gain was $0.30 per pound (table 47).

Native rangeland managed as a three pasture twice-over rotation system was evaluated during the summer lactation production period for 137 days between early June and mid October (tables 41 and 45). Native rangeland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $39.02 per ton. A cow grazing during the summer lactation period was allotted 9.00 acres (2.04 acres per month) at a forage cost of $78.84 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $78.84 per period, or $0.58 per day (table 46). Cow weight gain was 0.62 lbs per day and 9.44 lbs per acre; accumulated weight gain was 84.94 lbs. Calf weight gain was 2.21 lbs per day and 33.64 lbs per acre; accumulated weight gain was 302.77 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $211.94 per calf, and the net returns after pasture costs were $133.10 per cow-calf pair and $14.79 per acre. The cost of calf weight gain was $0.26 per pound (table 47).

Harvested Forage Types

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of 6.4%. This crested wheatgrass hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. Mature crested wheatgrass hay would be fed at 30.0 lbs DM/day to provide 1.9 lbs CP/day. An additional 0.59 lbs of crude protein per day would need to be provided, at a cost of $24.25 per period. Production of mature crested wheatgrass hay to feed during the summer lactation period (tables 42 and 45) would require 2.57 acres, and the forage would cost $72.34 per period. Total forage and supplement costs would be $96.59 per period, or $0.71 per day (table 46). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 274.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $191.80 per calf, and the net returns after feed costs were $95.21 per cow-calf pair and $37.05 per acre. The cost of calf weight gain was $0.35 per pound (table 47).

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of 14.5%. This crested wheatgrass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 17.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.7 lbs of roughage per day would need to be provided, at a cost of $30.42 per period. Production of early cut crested wheatgrass hay to feed during the summer lactation period (tables 42 and 45) would require 1.82 acres, and the forage would cost $47.95 per period. Total forage and supplement costs would be $78.37 per period, or $0.57 per day (table 46). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 274.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $191.80 per calf, and the net returns after feed costs were $113.43 per cow-calf pair and $62.32 per acre. The cost of calf weight gain was $0.29 per pound (table 47).

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 19.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 10.7 lbs of roughage per day would need to be provided, at a cost of $25.65 per period. Production of early cut forage barley hay to feed during the summer lactation period

(tables 43 and 45) would require 0.56 acres, and the forage would cost $38.36 per period. Total forage and supplement costs would be $64.01 per period, or $0.47 per day (table 46). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 274.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $191.80 per calf, and the net returns after feed costs were $127.79 per cow-calf pair and $228.20 per acre. The cost of calf weight gain was $0.23 per pound (table 47).

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. Late-cut forage barley hay would be fed at 27.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 2.7 lbs of roughage per day would need to be provided, at a cost of $6.47 per period. Production of late-cut forage barley hay to feed during the summer lactation period (tables 43 and 45) would require 0.73 acres, and the forage would cost $52.06 per period. Total forage and supplement costs would be $58.53 per period, or $0.43 per day (table 46). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 274.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $191.80 per calf, and the net returns after feed costs were $133.27 per cow-calf pair and $182.56 per acre. The cost of calf weight gain was $0.21 per pound (table 47).

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 21.8 lbs DM/day to provide 2.5 lbs CP/day. An additional 8.2 lbs of roughage per day would need to be provided, at a cost of $19.66 per period. Production of early cut oat hay to feed during the summer lactation period (tables 43 and 45) would require 0.64 acres, and the forage would cost $45.21 per period. Total forage and supplement costs would be $64.87 per period, or $0.47 per day (table 46). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 274.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $191.80 per calf, and the net returns after feed costs were $126.93 per cow-calf pair and $198.33 per acre. The cost of calf weight gain was $0.24 per pound (table 47).

Oat forage 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. Late-cut oat hay would be fed at 30.0 lbs DM/day to provide 2.3 lbs CP/day. An additional 0.17 lbs of crude protein per day would need to be provided, at a cost of $6.99 per period. Production of late-cut oat hay to feed during the summer lactation period (tables 43 and 45) would require 0.73 acres, and the forage would cost $54.25 per period. Total forage and supplement costs would be $61.24 per period, or $0.45 per day (table 46). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 274.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $191.80 per calf, and the net returns after feed costs were $130.56 per cow-calf pair and $178.85 per acre. The cost of calf weight gain was $0.22 per pound (table 47).

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. Early cut pea forage hay would be fed at 13.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 16.7 lbs of roughage per day would need to be provided, at a cost of $40.04 per period. Production of early cut pea forage hay to feed during the summer lactation period (tables 44 and 45) would require 0.65 acres, and the forage would cost $52.06 per period. Total forage and supplement costs would be $92.10 per period, or $0.67 per day (table 46). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 274.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $191.80 per calf, and the net returns after feed costs were $99.70 per cow-calf pair and $153.38 per acre. The cost of calf weight gain was $0.34 per pound (table 47).

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 17.4 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.6 lbs of roughage per day would need to be provided, at a cost of $30.21 per period. Production of late-cut pea forage hay to feed during the summer lactation period (tables 44 and 45) would require 0.51 acres, and the forage would cost $45.21 per period. Total forage and supplement costs would be $75.42 per period, or $0.55 per day (table 46). Calf weight gain was assumed to be 2.00 lbs per

day; accumulated weight gain was 274.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $191.80 per calf, and the net returns after feed costs were $116.38 per cow-calf pair and $228.20 per acre. The cost of calf weight gain was $0.28 per pound (table 47).

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. Early cut forage lentil hay would be fed at 11.5 lbs DM/day to provide 2.5 lbs CP/day. An additional 18.5 lbs of roughage per day would need to be provided, at a cost of $44.35 per period. Production of early cut forage lentil hay to feed during the summer lactation period (tables 44 and 45) would require 0.95 acres, and the forage would cost $58.91 per period. Total forage and supplement costs would be $103.26 per period, or $0.75 per day (table 46). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 274.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $191.80 per calf, and the net returns after feed costs were $88.54 per cow-calf pair and $93.20 per acre. The cost of calf weight gain was $0.38 per pound (table 47).

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 17.1 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.9 lbs of roughage per day would need to be provided, at a cost of $30.93 per period. Production of late-cut forage lentil hay to feed during the summer lactation period (tables 44 and 45) would require 0.60 acres, and the forage would cost $45.21 per period. Total forage and supplement costs would be $76.14 per period, or $0.56 per day (table 46). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 274.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $191.80 per calf, and the net returns after feed costs were $115.66 per cow-calf pair and $192.77 per acre. The cost of calf weight gain was $0.28 per pound (table 47).

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.16 per pound. Oat-pea forage hay would be fed at 20.1 lbs DM/day to provide 2.5 lbs CP/day. An additional 9.9 lbs of roughage per day would need to be provided, at a cost of $23.74 per period. Production of oat-pea forage hay to feed during the summer lactation period (tables 44 and 45) would require 0.53 acres, and the forage would cost $52.06 per period. Total forage and supplement costs would be $75.80 per period, or $0.55 per day (table 46). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 274.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $191.80 per calf, and the net returns after feed costs were $116.00 per cow-calf pair and $218.27 per acre. The cost of calf weight gain was $0.28 per pound (table 47).

Discussion

Pasture Forage Types

Native rangeland forage grazed as a repeated seasonal pasture during the summer lactation production period was moderate-cost forage because the quantities of crude protein captured per acre were moderate and the quantity of forage dry matter available per acre was moderate. The equipment costs, labor costs, land rent per acre, and forage production costs per acre were low. The cost per pound of crude protein ($0.25/lb CP) was moderate because of the moderate quantity of crude protein weight contained in the forage. The forage dry matter cost ($48.26/ton) was high because of the moderate quantity of forage dry matter production. The large land area (11.32 acres) per cow caused the forage costs per period to be high. The total daily forage feed costs ($0.72/day) were high. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($73.98) per cow and in low returns after feed costs ($6.54) per acre. The cost per pound of calf weight gain ($0.40/lb) was moderately high because of the moderate crude protein and moderate forage dry matter yields per acre and the large land area per cow-calf pair.

Native rangeland forage grazed as a 6.0-month seasonlong pasture during the summer lactation production period was high-cost forage because the quantity of forage dry matter available per acre was low and the crude protein content in the forage was low after early August, despite the equipment costs, labor costs, land rent per acre, and forage production costs per acre being low. The forage dry matter cost ($77.50/ton) was very high because the quantity of forage weight per acre was low. The low forage availability per acre and low

crude protein content in the forage were major causes of the low cow and calf weight performance per acre. The large land area (18.10 acres) per cow caused the forage costs per period to be high. The total daily forage feed costs ($1.16/day) were very high. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($39.46) per cow and in very low returns after feed costs ($2.18) per acre. The cost per pound of calf weight ($0.56/lb) was high because of the low forage dry matter yields per acre, the low animal weight performance per acre, and the large land area per cow-calf pair.

Native rangeland forage grazed as a 4.5-month seasonlong pasture during the summer lactation production period was high-cost forage because the quantity of forage dry matter available per acre was low and the crude protein content in the forage was low after early August, despite the equipment costs, labor costs, land rent per acre, and forage production costs per acre being very low. The forage dry matter cost ($54.75/ton) was high because the quantity of forage weight per acre was low. The low forage availability per acre and the low crude protein content in the forage after early August were major causes of the low cow and calf weight performance per acre. The large land area (12.70 acres) per cow caused the forage costs per period to be high. The total daily forage feed costs ($0.81/day) were high. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($89.18) per cow and in low returns after feed costs ($7.02) per acre. The cost per pound of calf weight ($0.39/lb) was moderately low because of the low forage dry matter yields per acre, the low crude protein content of the forage during the latter portion of the grazing season, the low animal weight performance per acre, and the large land area per cow-calf pair.

Native rangeland forage managed as a deferred grazing pasture during the summer lactation production period was high-cost forage because the quantity of forage dry matter available per acre was moderate and the crude protein content in the forage was low during the grazing season, despite the equipment costs, labor costs, land rent per acre, and forage production costs per acre being very low. The forage dry matter cost ($42.52/ton) was moderate because the quantity of forage weight per acre was moderate. The low crude protein content in the forage was a major cause of the low cow and calf weight performance per acre. The moderate land area (2.22 acres/months) per cow was achieved because grazing did not start until after peak herbage biomass was produced and a very high proportion of the aboveground herbage was removed by grazing. The total daily forage feed costs ($0.63/day) were high. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($79.29) per cow and in moderate returns after feed costs ($11.83) per acre. The cost per pound of calf weight gain ($0.30/lb) were moderately low because of the low crude protein content in the forage and the low animal weight performance per acre.

Native rangeland forage grazed as a twice-over rotation system during the summer lactation production period was the lowest-cost native rangeland forage because of the increase in herbage production through vegetative reproduction of grass plants and the crude protein content of the forage met the lactating cows requirements for most of the grazing season. The equipment costs, labor costs, land rent per acre, and forage production costs per acre were low. The forage dry matter cost ($39.02/ton) was low because of the stimulated additional herbage production per acre. The greater quantity of forage dry matter available per acre and the greater crude protein content in the forage were the major causes for the greater cow and calf weight performance per acre. The small land area (2.04 acres/month) per cow-calf pair was achieved because of the stimulated vegetative reproduction and the resulting increases in herbage biomass production. The total daily forage feed costs ($0.58/day) were low. The total feed costs were lower than the low market value of the accumulated calf weight resulting in very high returns after feed costs ($133.10) per cow and in high returns after feed costs ($14.79) per acre. The cost per pound of calf weight gain ($0.26/lb) was low because of the high forage dry matter yields per acre, the high crude protein content in the forage during the grazing season, the high animal weight performance per acre, and the small land area per cow-calf pair.

Harvested Forage Types

Crested wheatgrass hay cut at a mature growth stage and fed during the summer lactation production period was high-cost forage. The forage dry matter cost ($34.80/ton) was moderate for mature crested wheatgrass hay and lower than the forage dry matter cost per ton for early cut crested wheatgrass hay because greater dry matter weight of the mature crested wheatgrass hay was harvested per acre. The cost per pound of crude protein ($0.28/lb CP) was high for mature crested wheatgrass hay and double the cost per pound of crude protein for early cut

crested wheatgrass hay because of the lower crude protein weight in the mature crested wheatgrass hay harvested per acre. The land area (2.57 acres) per cow for mature crested wheatgrass hay was small but greater than the land area required per cow for early cut crested wheatgrass hay because of the greater crude protein weight per acre in the early cut crested wheatgrass hay. The crude protein content of the mature crested wheatgrass forage was below the requirements of a lactating cow making it necessary to provide purchased supplemental crude protein. The total daily forage and supplemental crude protein costs ($0.71/day) were high because of the additional supplemental crude protein costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($95.21) per cow and in moderate returns after feed costs ($37.05) per acre. The cost per pound of calf weight gain ($0.35/lb) was moderately low because of the additional supplemental crude protein costs.

Crested wheatgrass hay cut at the boot growth stage and fed during the summer lactation production period was moderate-cost forage. The forage dry matter cost ($40.80/ton) was moderate for early cut crested wheatgrass hay and was greater than the forage dry matter cost per ton for mature crested wheatgrass hay because crested wheatgrass hay cut at the boot stage harvested lower forage dry matter weight per acre than crested wheatgrass hay cut at a mature growth stage. The cost per pound of crude protein ($0.14/lb CP) was low for early cut crested wheatgrass hay and lower than the cost per pound of crude protein for mature crested wheatgrass hay because of the greater crude protein weight in the early cut crested wheatgrass hay harvested per acre. The land area (1.82 acres) per cow for early cut crested wheatgrass hay was small and less than the land area required per cow for mature crested wheatgrass hay because of the greater crude protein weight harvested per acre in the early cut crested wheatgrass hay. The forage cost of early cut crested wheatgrass hay was low but the total daily forage feed cost ($0.57/day) was moderate because about 42% of the ration forage was supplemental roughage which added substantially to the total forage costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in very high returns after feed costs ($113.43) per cow and in high returns after feed costs ($62.32) per acre. The cost per pound of calf weight gain ($0.29/lb) was low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Forage barley hay cut at the milk growth stage and fed during the summer lactation production period was low-cost forage. The production costs per acre were high for early cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($28.80/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.11/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.56 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.47/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The forage costs for early cut forage barley hay were lower than the forage costs for late cut forage barley hay. However, the total forage feed costs for early cut forage barley hay was slightly greater than the total forage feed costs for late cut forage barley hay because of the greater quantity of supplemental roughage in the forage ration for early cut forage barley hay. The total feed costs were lower than the low market value of the accumulated calf weight resulting in very high returns after feed costs ($127.79) per cow and in extremely high returns after feed costs ($228.20) per acre. The cost per pound of calf weight gain ($0.23/lb) was very low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Forage barley hay cut at the hard dough growth stage and fed during the summer lactation production period was low-cost forage. The production costs per acre were high for late cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($27.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut forage barley hay was greater than the cost per pound of crude protein for early cut forage barley hay because of the lower crude protein weight harvested per acre in the late cut forage barley hay. The land area (0.73 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.43/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total feed costs were lower than the low market value of the accumulated calf weight resulting in very high returns after feed costs ($133.27) per cow and in very high

returns after feed costs ($182.56) per acre. The returns after feed costs per acre were lower for late cut forage barley hay than for early cut forage barley hay because late cut forage barley hay had slightly higher crude protein cost per pound and slightly larger land area per cow than early cut forage barley hay. The cost per pound of calf weight gain ($0.21/lb) was very low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Oat forage hay cut at the milk growth stage and fed during the summer lactation production period was low-cost forage. The production costs per acre were high for early cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($29.60/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.64 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.47/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total feed costs were lower than the low market value of the accumulated calf weight resulting in very high returns after feed costs ($126.93) per cow and in extremely high returns after feed costs ($198.33) per acre. The cost per pound of calf weight gain ($0.24/lb) was very low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Oat forage hay cut at the hard dough growth stage and fed during the summer lactation production period was low-cost forage. The production costs per acre were high for late cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($26.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut oat forage hay was greater than the cost per pound of crude protein for early cut oat forage hay because of the lower crude protein weight harvested per acre in the late cut oat forage hay. The land area (0.73 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The crude protein content in the forage was below the requirements of a lactating cow making it necessary to provide purchased supplemental crude protein. The total daily forage and supplemental crude protein costs ($0.45/day) were moderately low because of the additional cost of supplemental crude protein. The forage costs for early cut oat forage hay were lower than the forage costs for late cut oat forage hay. However, the total forage feed costs for late cut oat forage hay were lower than the total forage feed costs for early cut oat forage hay because of the quantity of supplemental roughage in the forage ration for early cut oat forage hay. The total feed costs were lower than the low market value of the accumulated calf weight resulting in very high returns after feed costs ($130.56) per cow and in very high returns after feed costs ($178.85) per acre. The returns after feed costs per acre were lower for late cut oat forage hay than for early cut oat forage hay because late cut oat forage hay had slightly higher crude protein cost per pound and slightly larger land area per cow than early cut oat forage hay. The cost per pound of calf weight gain ($0.22/lb) was very low because of the small land area per cow-calf pair.

Pea forage hay cut at an early growth stage and fed during the summer lactation production period was moderate-cost forage. However, pea forage hay cut at a late growth stage has lower forage feed costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for early cut pea forage hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($55.00/ton) was high because of the modest forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.65 acres) per cow was small because of the high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.67/day) were moderate because of the modest forage dry matter production per acre and the high supplemental roughage costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($99.70) per cow and in very high returns after feed costs ($153.38) per acre. The cost per pound of calf weight gain ($0.34/lb) was moderately low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Pea forage hay cut at a late growth stage and fed during the summer lactation production period was low-cost forage. Late cut pea forage hay has lower forage feed costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for late cut pea forage hay because the equipment costs, labor costs,

seed costs, and land rent per acre were high. The forage dry matter cost ($37.40/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.51 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.55/day) were low because of the low cost of crude protein per pound and the small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in very high returns after feed costs ($116.38) per cow and in extremely high returns after feed costs ($228.20) per acre. The cost per pound of calf weight gain ($0.28/lb) was low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

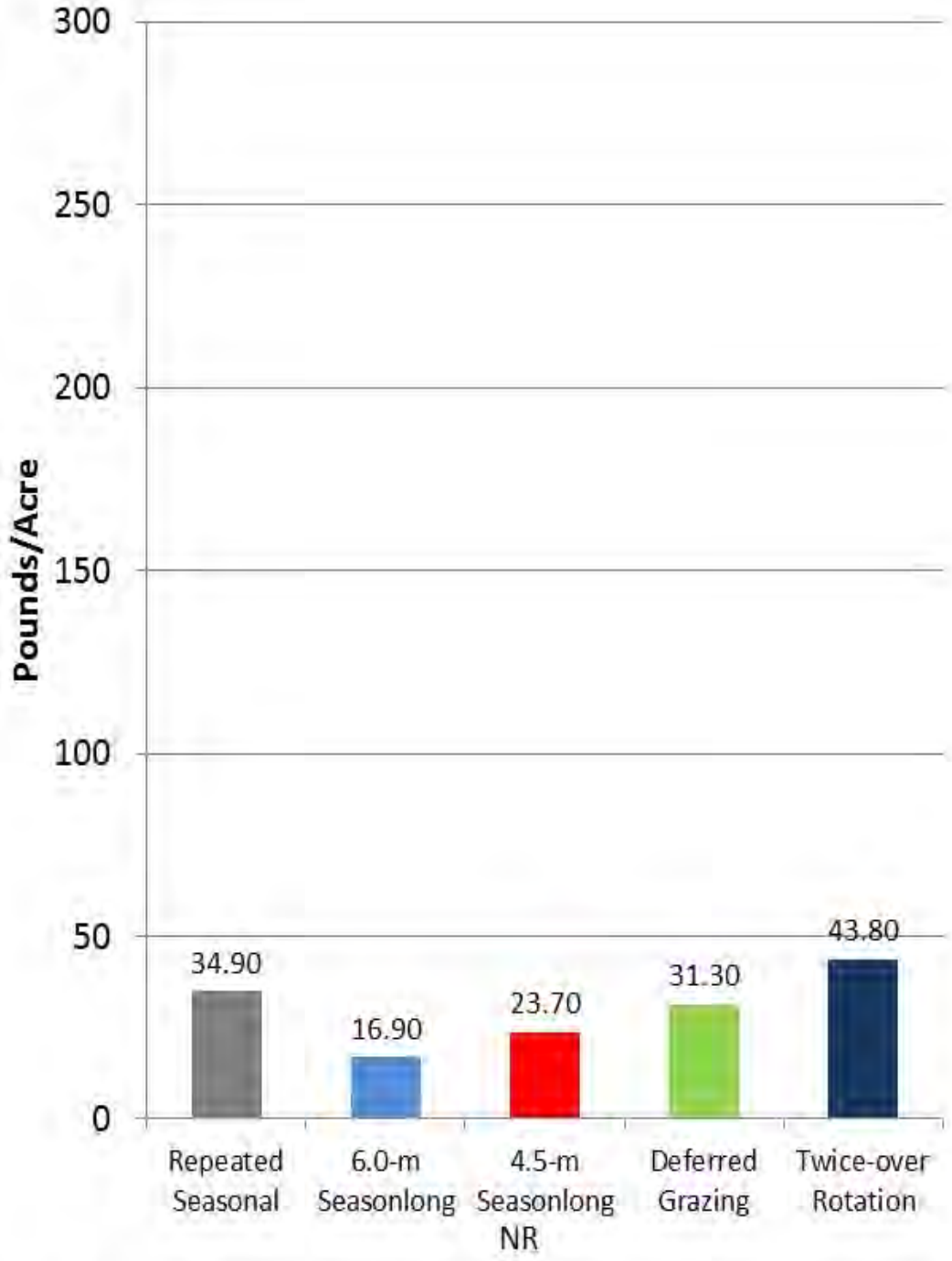
Forage lentil hay cut at an early growth stage and fed during the summer lactation production period was high-cost forage. However, forage lentil hay cut at a late growth stage has lower forage feed costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for early cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($71.60/ton) was high because of the modest forage dry matter yield per acre. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.95 acres) per cow was small because of the high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.75/day) were high because of the modest forage dry matter production per acre and the high supplemental roughage costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in high returns after feed costs ($88.54) per cow and ($93.20) per acre. The cost per pound of calf weight gain ($0.38/lb) was moderately low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Forage lentil hay cut at a late growth stage and fed during the summer lactation production period was low-cost forage. Late cut forage lentil hay has lower forage feed costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for late cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($37.00/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.60 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.56/day) were low because of the low cost of crude protein per pound and the small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in very high returns after feed costs ($115.66) per cow and in extremely high returns after feed costs ($192.77) per acre. The cost per pound of calf weight gain ($0.28/lb) was low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

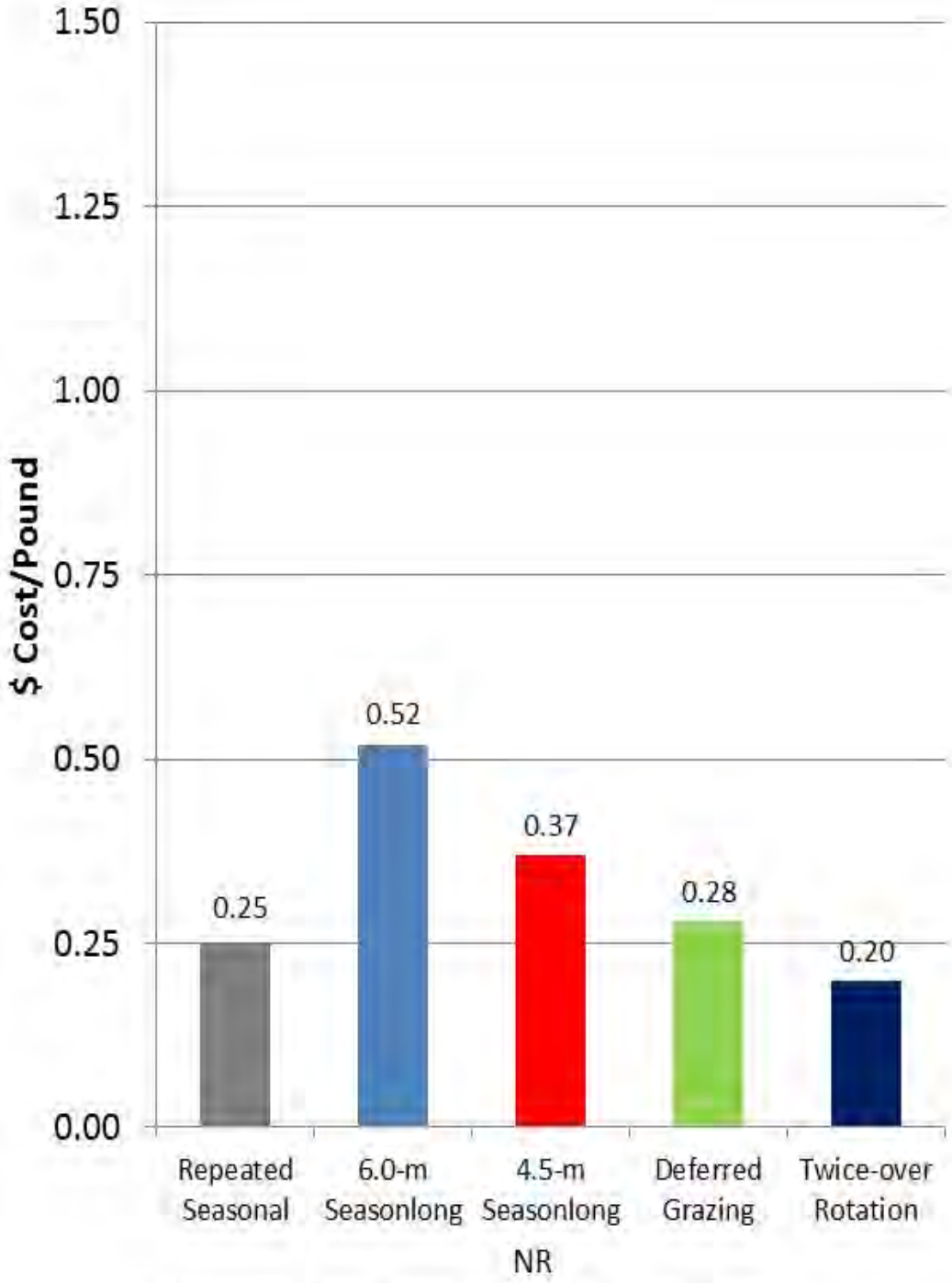
Oat-pea hay cut at compromised plant growth stages and fed during the summer lactation production period was low-cost forage. However, seeding oat forage separately on half of the field and cutting it at an early growth stage and seeding pea forage separately on half of the field and cutting it at a late growth stage will result in lower production costs per acre, lower forage dry matter costs per ton, lower costs per pound of crude protein, lower total forage feed costs per day, lower costs per pound of calf weight gain, greater net returns after feed costs per cow, and greater net returns after feed costs per acre than oat-pea forage seeded together and cut at compromised growth stages. The production costs per acre were very high for oat-pea hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($37.20/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.16/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.53 acres) per cow was small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.55/day) were low because of the low cost of crude protein per pound and the small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in very high returns after feed costs ($116.00) per cow and in extremely high returns after feed costs ($218.77) per acre. The cost per pound of calf weight gain ($0.28/lb) was low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Table 41. Costs and returns for native rangeland pasture forage types to be grazed by range cows during the 137-day summer lactation production period.

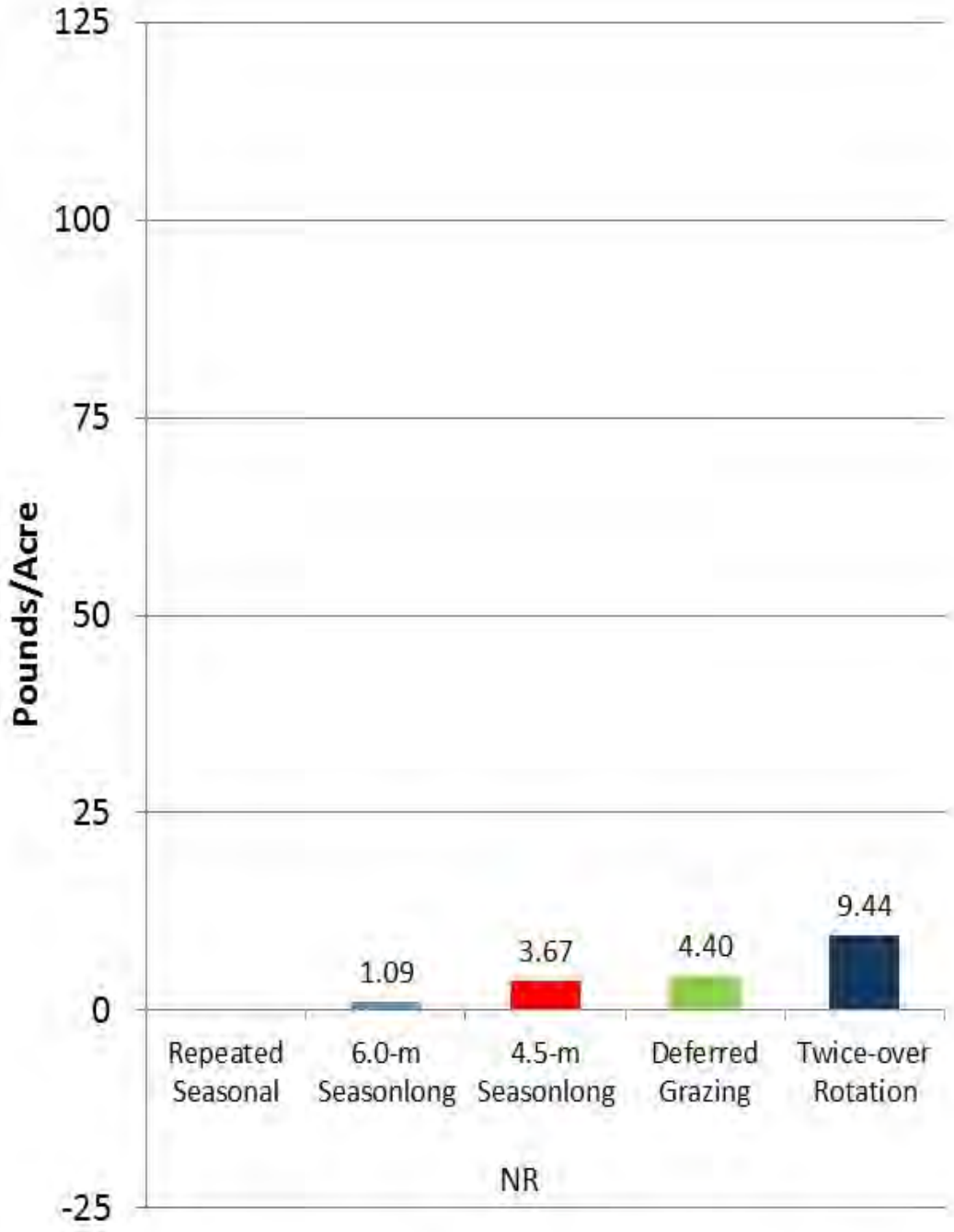
		Native Rangeland Repeated Seasonal	Native Rangeland 6.0-m Seasonlong	Native Rangeland 4.5-m Seasonlong	Native Rangeland Deferred Grazing	Native Rangeland Twice-over Rotation
Days		137	137	137	92	137
Growth Stage		summer	summer	summer	summer	summer
Herbage Weight	lb/ac	1450	906	1280	1649	1794
Forage DM Weight	lb/ac	363	226	320	412	449
Costs/Acre						
Land Rent	$	8.76	8.76	8.76	8.76	8.76
Custom Work	$					
Seed Cost	$					
Baling Costs	$					
Production Costs	$/ac	8.76	8.76	8.76	8.76	8.76
Forage DM Costs	$/ton	48.26	77.50	54.75	42.52	39.02
Crude Protein	%	9.6				
Crude Protein Yield	lb/ac	34.85				
Crude Protein Cost	$/lb	0.25				
Forage Allocation	lb/d	30.0	30.0	30.0	30.0	30.0
Land Area/Period	ac	11.32	18.10	12.70	6.70	9.00
Forage Costs/Period	$/pp	98.64	158.55	111.25	58.26	78.84
Supplementation						
Roughage/Day	lb/d					
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp					
Total Feed Cost	$/pp	98.64	158.55	111.25	58.26	78.84
Cost/Day	$/d	0.72	1.16	0.81	0.63	0.58
Accumulated Calf Wt.	lbs	246.60	282.87	286.33	196.50	302.77
Weight Value @$0.70/lb	$	172.62	198.01	200.43	137.55	211.94
Net Return/c-c pr	$	73.98	39.46	89.18	79.29	133.10
Net Return/acre	$	6.54	2.18	7.02	11.83	14.79
Cost/lb of Calf Gain	$	0.40	0.56	0.39	0.30	0.26



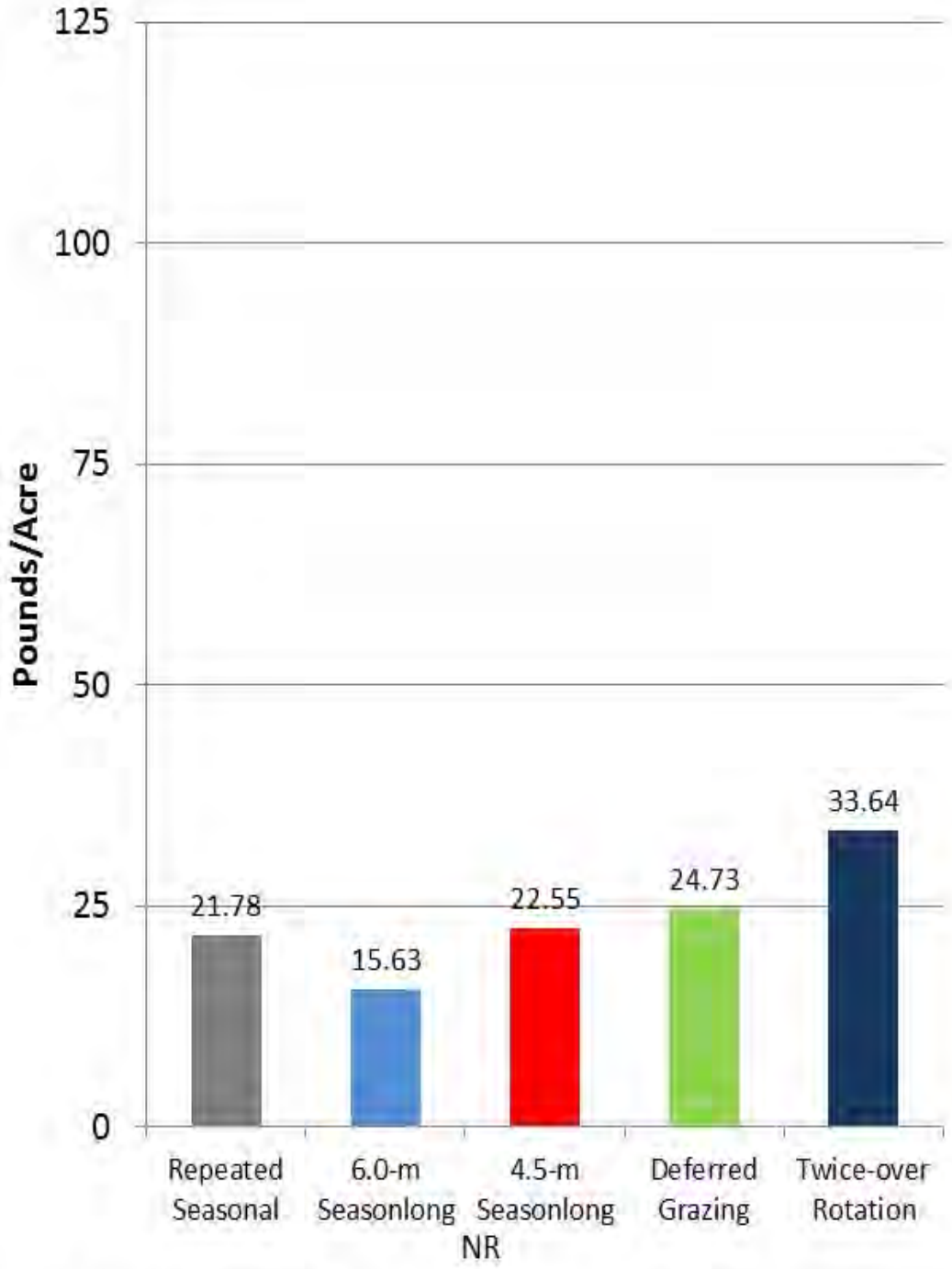
Crude Protein Weight Captured per Acre on Pasture Forages During Summer Lactation



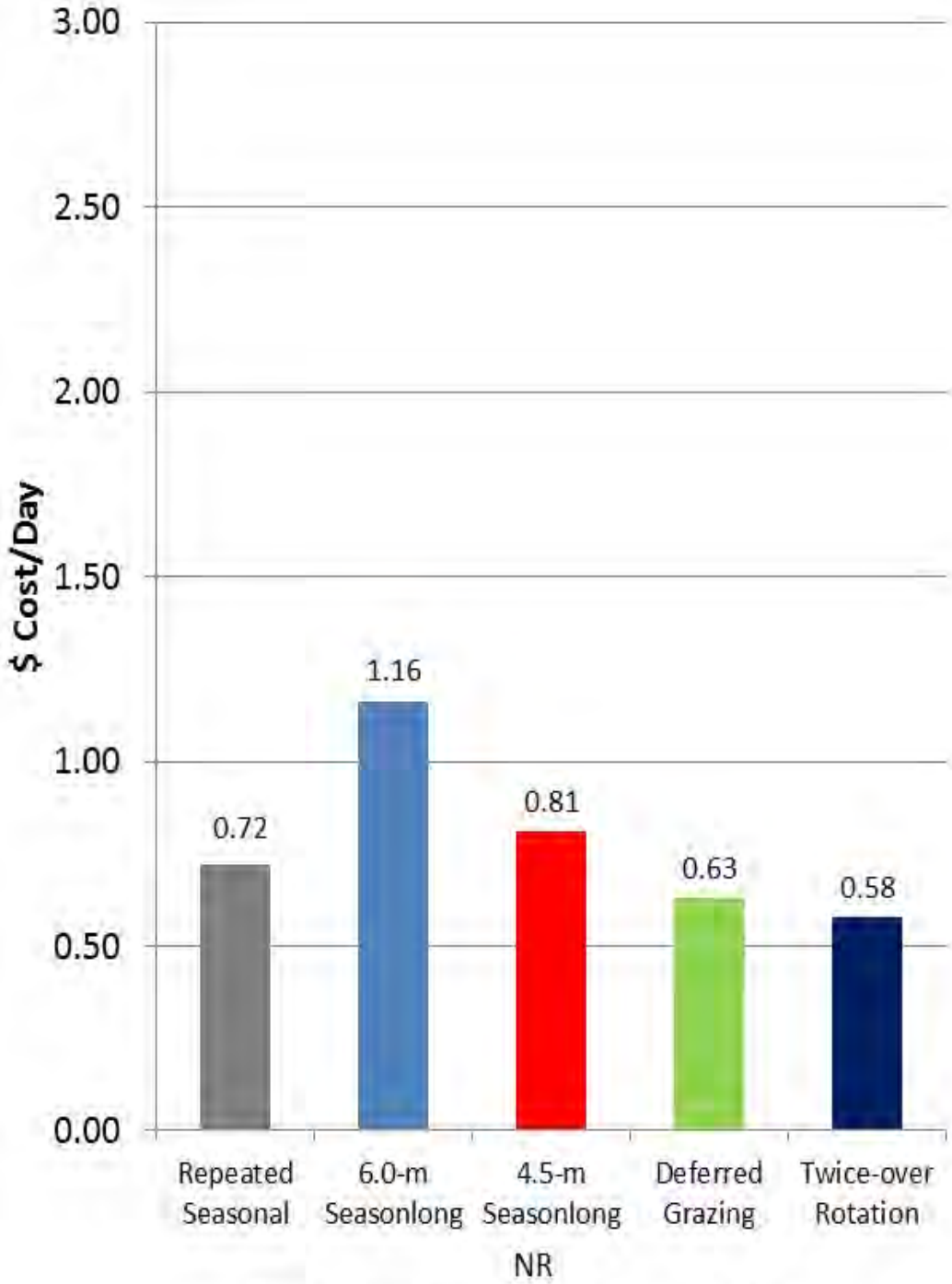
Crude Protein Cost per Pound
on Pasture Forages During Summer Lactation



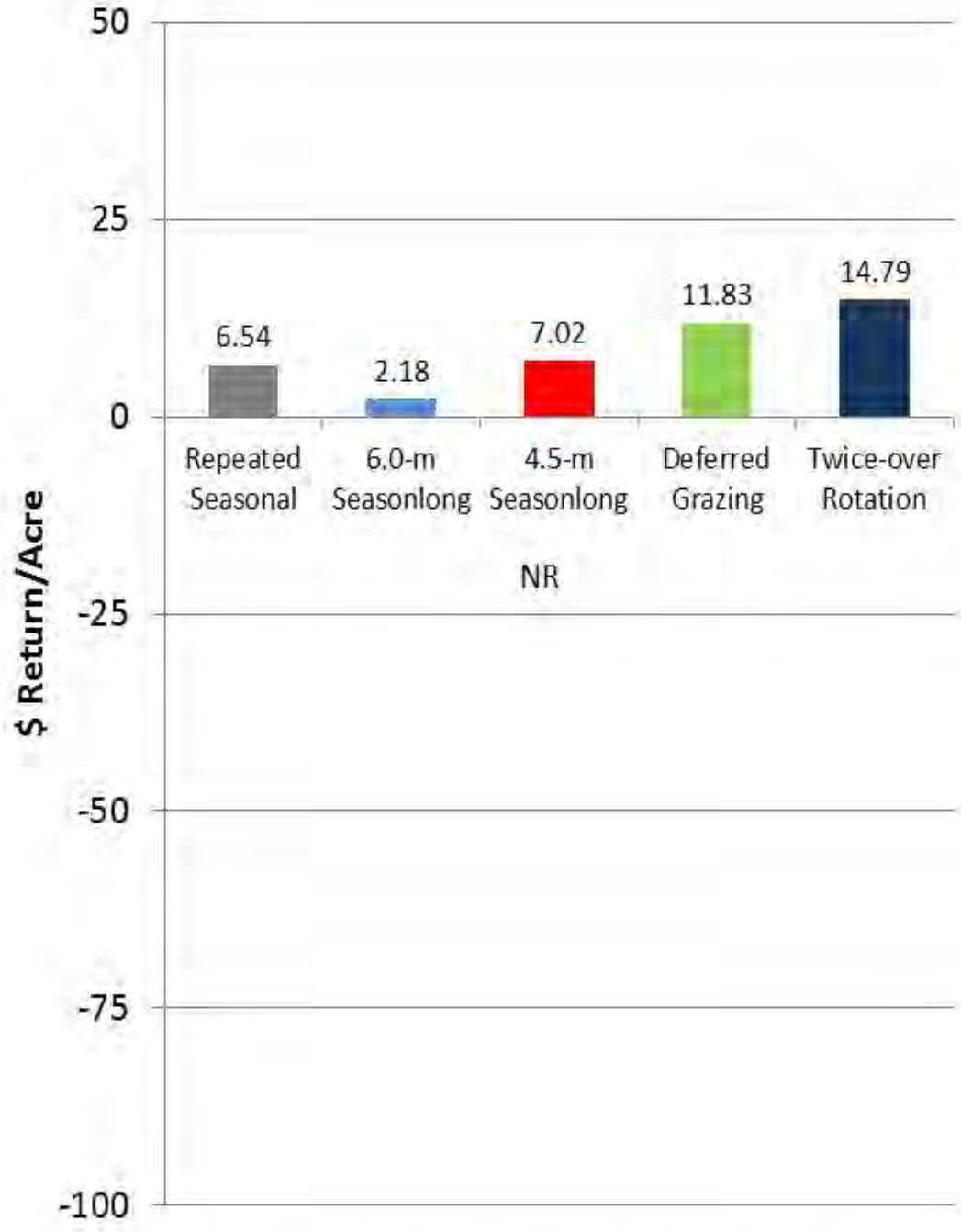
Cow Weight Gain per Acre on Pasture Forages During Summer Lactation



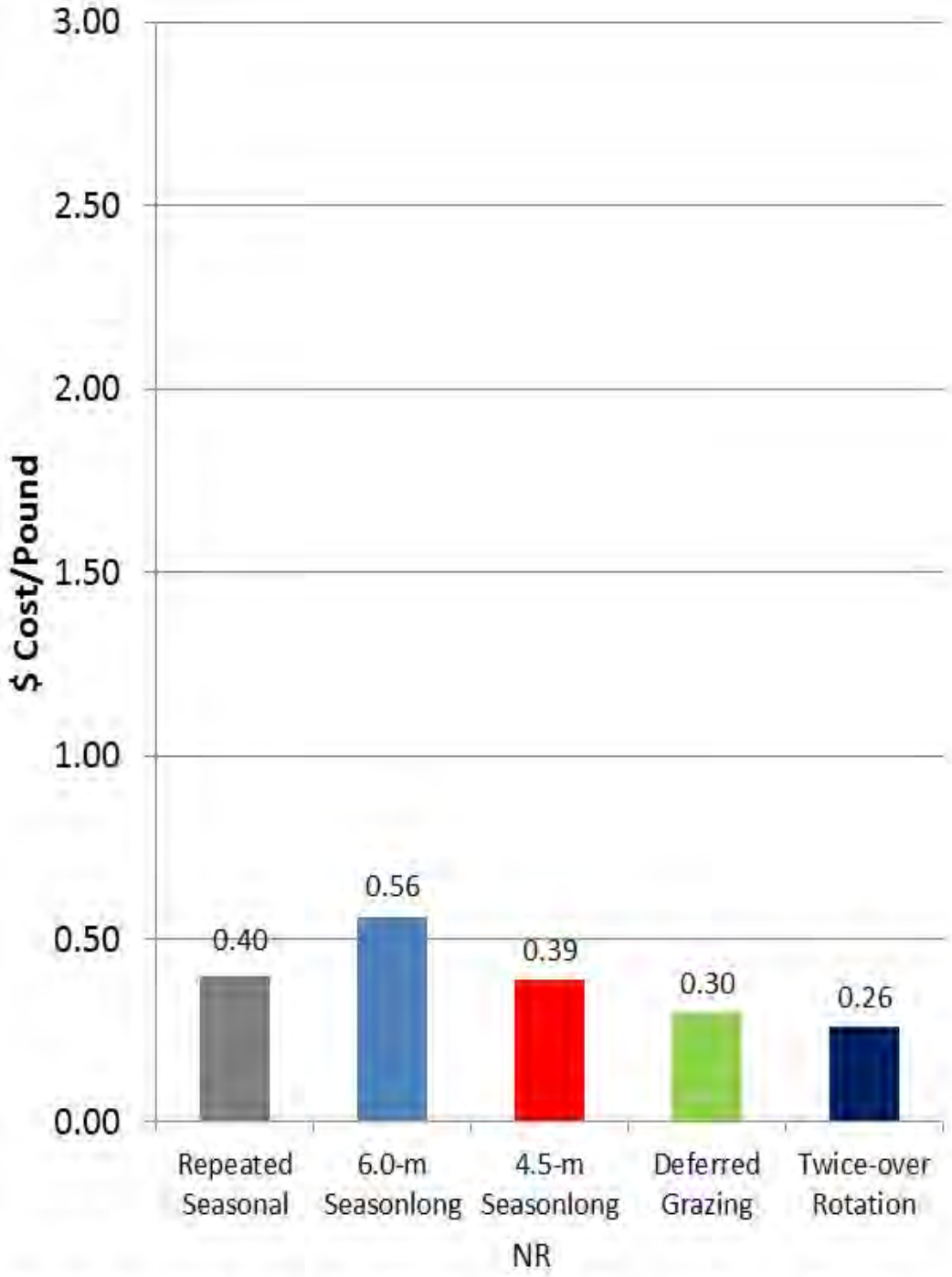
Calf Weight Gain per Acre on Pasture Forages During Summer Lactation



Forage Feed Costs per Day
on Pasture Forages During Summer Lactation



Returns After Feed Costs per Acre
on Pasture Forages During Summer Lactation



Calf Weight Gain Costs per Pound on Pasture Forages During Summer Lactation

Table 42. Costs and returns for perennial grass harvested forage types to be fed to range cows during the 137-day summer lactation production period.

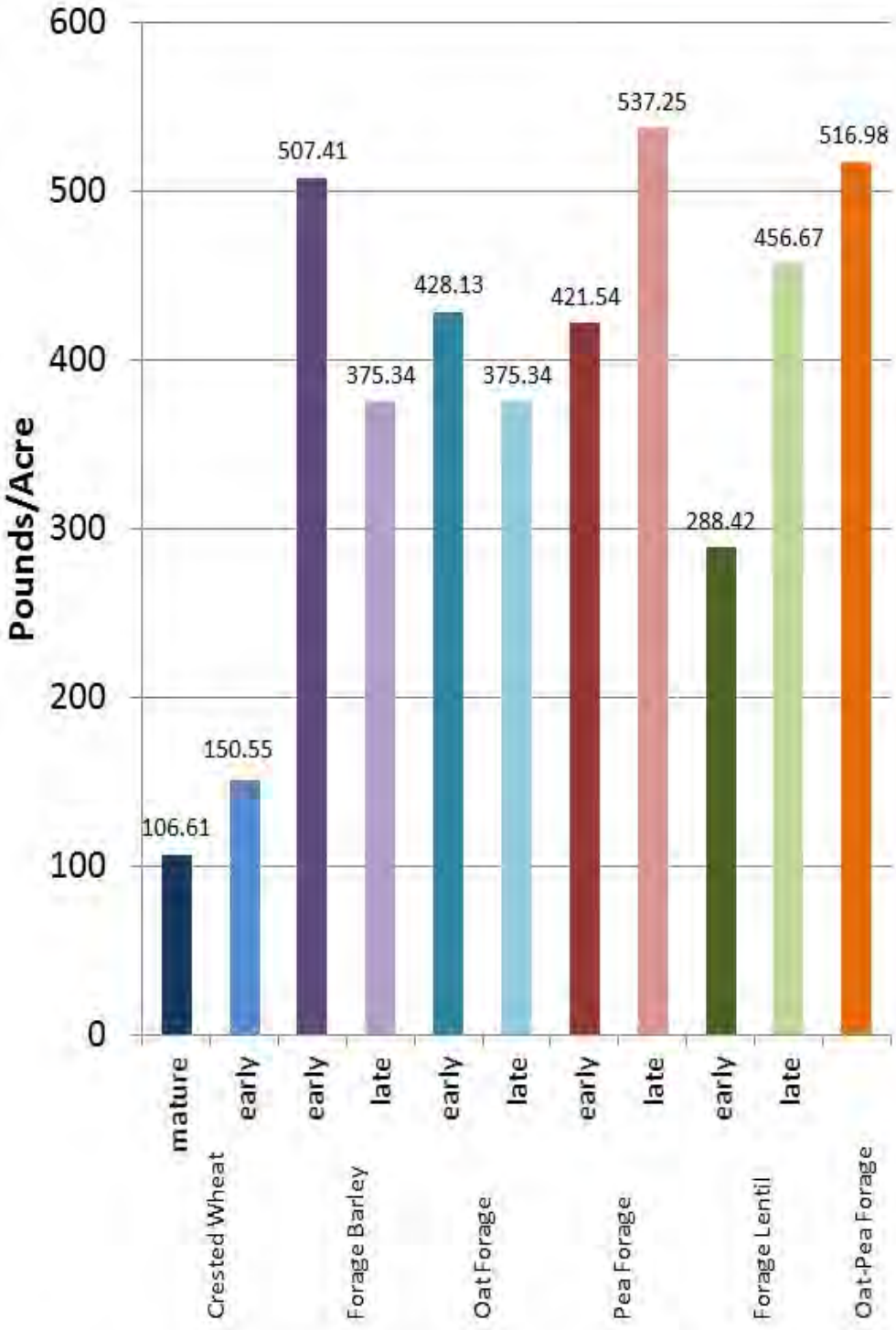
		Crested Wheatgrass Hay	Crested Wheatgrass Hay
Days		137	137
Growth Stage		Mature	Boot stage
Herbage Weight	lb/ac	-	-
Forage DM Weight	lb/ac	1600	1300
Costs/Acre			
Land Rent	$	14.22	14.22
Custom Work	$	5.31	5.31
Seed Cost	$	-	-
Baling Costs	$	8.58	6.97
Production Costs	$/ac	28.11	26.50
Forage DM Costs	$/ton	34.80	40.80
Crude Protein	%	6.4	14.5
Crude Protein Yield	lb/ac	102	189
Crude Protein Cost	$/lb	0.28	0.14
Forage Allocation	lb/d	30.0	17.3
Land Area/Period	ac	2.57	1.82
Forage Costs/Period	$/pp	72.34	47.95
Supplementation			
Roughage/Day	lb/d		12.7
Crude Protein/Day	lb/d	0.59	
Sup. Cost/Period	$/pp	24.25	30.42
Total Feed Cost	$/pp	96.59	78.37
Cost/Day	$/d	0.71	0.57
Accumulated Calf Wt.	lbs	274.0	274.0
Weight Value @$0.70/lb	$	191.80	191.80
Net Return/c-c pr	$	95.21	113.43
Net Return/acre	$	37.05	62.32
Cost/lb of Calf Gain	$	0.35	0.29

Table 43. Costs and returns for annual cereal harvested forage types to be fed to range cows during the 137-day summer lactation production period.

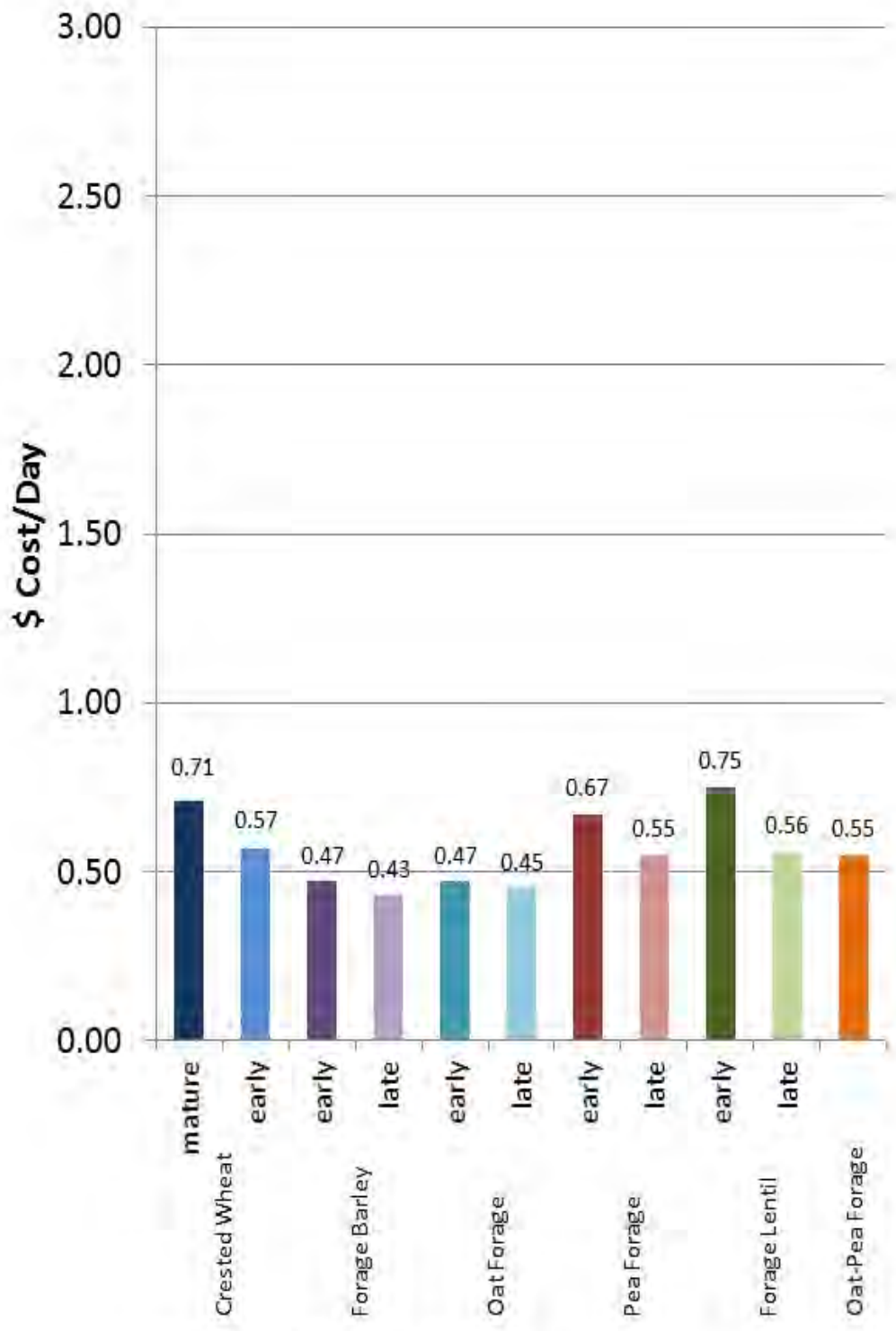
		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Days		137	137	137	137
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Forage Allocation	lb/d	19.3	27.3	21.8	30.0
Land Area/Period	ac	0.56	0.73	0.64	0.73
Forage Costs/Period	$/pp	38.36	52.06	45.21	54.25
Supplementation					
Roughage/Day	lb/d	10.7	2.7	8.2	
Crude Protein/Day	lb/d				0.17
Sup. Cost/Period	$/pp	25.65	6.47	19.66	6.99
Total Feed Cost	$/pp	64.01	58.53	64.87	61.24
Cost/Day	$/d	0.47	0.43	0.47	0.45
Accumulated Calf Wt.	lbs	274.0	274.0	274.0	274.0
Weight Value @$0.70/lb	$	191.80	191.80	191.80	191.80
Net Return/c-c pr	$	127.79	133.27	126.93	130.56
Net Return/acre	$	228.20	182.56	198.33	178.85
Cost/lb of Calf Gain	$	0.23	0.21	0.24	0.22

Table 44. Costs and returns for annual legume harvested forage types to be fed to range cows during the 137-day summer lactation production period.

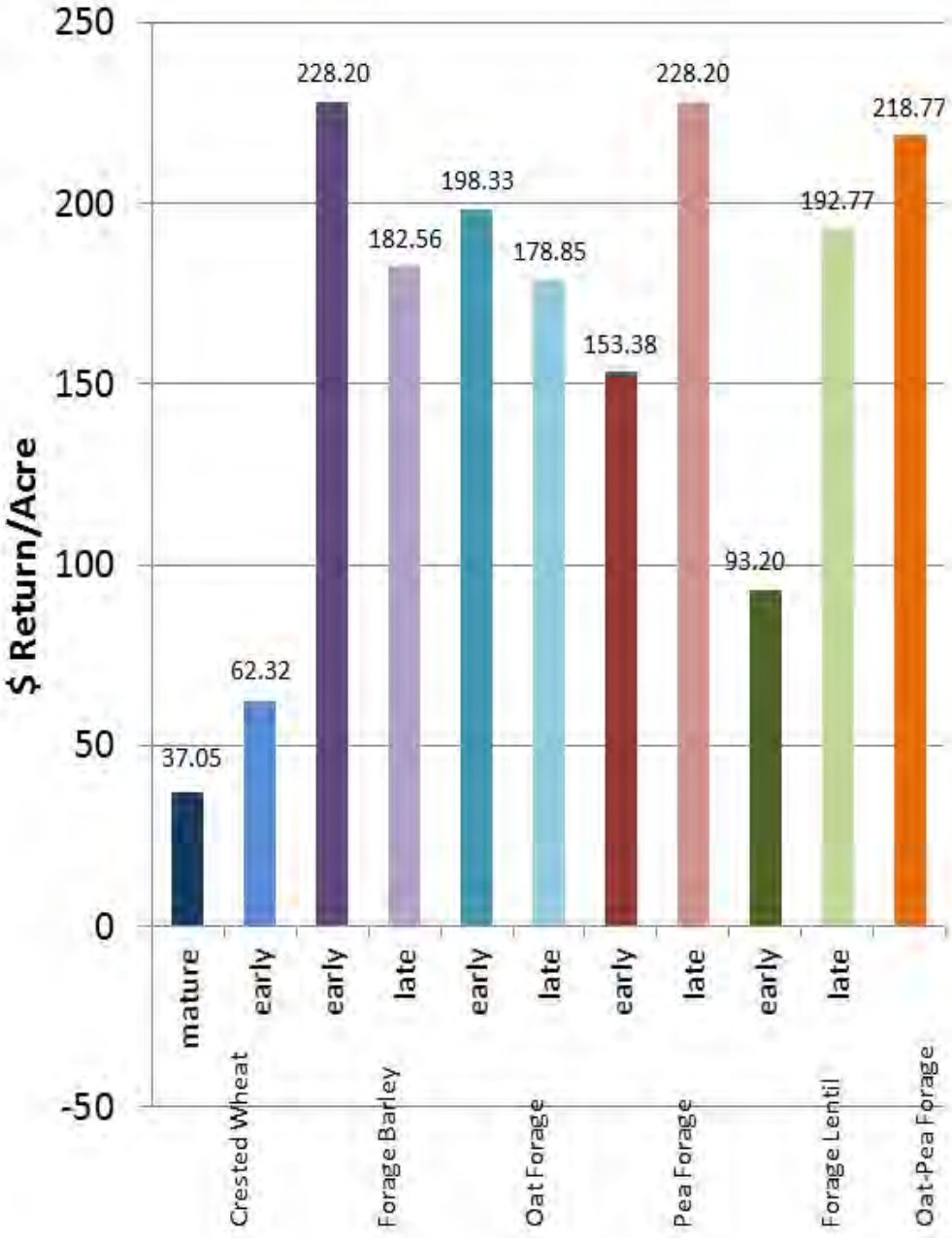
		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Days		137	137	137	137	137
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Forage Allocation	lb/d	13.3	17.4	11.5	17.1	20.1
Land Area/Period	ac	0.65	0.51	0.95	0.60	0.53
Forage Costs/Period	$/pp	52.06	45.21	58.91	45.21	52.06
Supplementation						
Roughage/Day	lb/d	16.7	12.6	18.5	12.9	9.9
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	40.04	30.21	44.35	30.93	23.74
Total Feed Cost	$/pp	92.10	75.42	103.26	76.14	75.80
Cost/Day	$/d	0.67	0.55	0.75	0.56	0.55
Accumulated Calf Wt.	lbs	274.0	274.0	274.0	274.0	274.0
Weight Value @$0.70/lb	$	191.80	191.80	191.80	191.80	191.80
Net Return/c-c pr	$	99.70	116.38	88.54	115.66	116.00
Net Return/acre	$	153.38	228.20	93.20	192.77	218.77
Cost/lb of Calf Gain	$	0.34	0.28	0.38	0.28	0.28



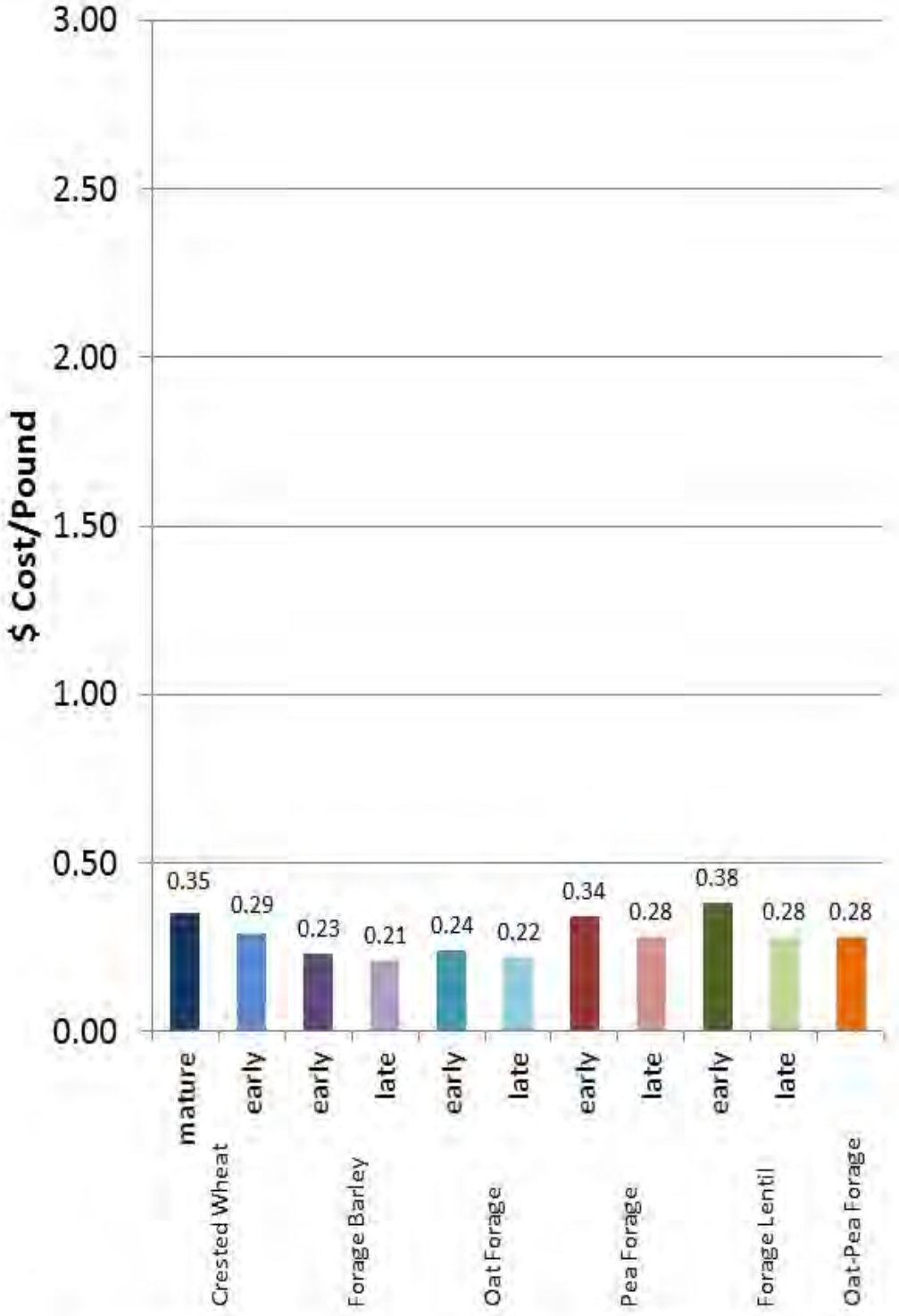
Calf Weight Gain per Acre on Harvested Forages During Summer Lactation



Forage Feed Costs per Day on Harvested Forages During Summer Lactation



Returns After Feed Costs per Acre on Harvested Forages During Summer Lactation



Calf Weight Gain Costs per Pound on Harvested Forages During Summer Lactation

Table 45. Feed quantity and land area for forage types used during the 137-day summer lactation production period.

Forage Types	Daily Feed per Cow			Summer Lactation Period Feed one Cow for 137 days			
	Forage lb/d	Roughage lb/d	Crude Protein lb/d	Forage lb/pp	Roughage lb/pp	Crude Protein lb/pp	Land Area ac/pp
Pasture Forage Types							
Native Rangeland Repeated Seasonal	30.0			4110.0			11.32
6.0-m Seasonlong	30.0			4110.0			18.10
4.5-m Seasonlong	30.0			4110.0			12.70
Deferred Grazing (92d)	30.0			2760.0			6.70
Twice-over Rotation	30.0			4110.0			9.00
Harvested Forage Types							
Crested Wheat, mature	30.0		0.59	4110.0		80.83	2.57
Crested Wheat, early	17.3	12.7		2370.1	1739.9		1.82
Forage Barley, early	19.3	10.7		2644.1	1465.9		0.56
Forage Barley, late	27.3	2.7		3740.1	369.9		0.73
Oat Forage, early	21.8	8.2		2986.6	1123.4		0.64
Oat Forage, late	30.0		0.17	4110.0		23.29	0.73
Pea Forage, early	13.3	16.7		1822.1	2287.9		0.65
Pea Forage, late	17.4	12.6		2383.8	1726.2		0.51
Forage Lentil, early	11.5	18.5		1575.5	2534.5		0.95
Forage Lentil, late	17.1	12.9		2342.7	1767.3		0.60
Oat-Pea Forage	20.1	9.9		2753.7	1356.3		0.53

Table 46. Summary of feed costs for forage types used during the 137-day summer lactation production period.

Forage Types	Forage Costs $/pp	Roughage Costs $/pp	Crude Protein Costs $/pp	Total Feed Costs $/pp	Daily Feed Costs $/d
Pasture Forage Types					
Native Rangeland Repeated Seasonal	98.64			98.64	0.72
6.0-m Seasonlong	158.55			158.55	1.16
4.5-m Seasonlong	111.25			111.25	0.81
Deferred Grazing (92d)	58.26			58.26	0.63
Twice-over Rotation	78.84			78.84	0.58
Harvested Forage Types					
Crested Wheat, mature	72.34		24.25	96.59	0.71
Crested Wheat, early	47.95	30.42		78.37	0.57
Forage Barley, early	38.36	25.65		64.01	0.47
Forage Barley, late	52.06	6.47		58.53	0.43
Oat Forage, early	45.21	19.66		64.87	0.47
Oat Forage, late	54.25		6.99	61.24	0.45
Pea Forage, early	52.06	40.04		92.10	0.67
Pea Forage, late	45.21	30.21		75.42	0.55
Forage Lentil, early	58.91	44.35		103.26	0.75
Forage Lentil, late	45.21	30.93		76.14	0.56
Oat-Pea Forage	52.06	23.74		75.80	0.55

Table 47. Summary of returns after feed costs for forage types used during the 137-day summer lactation production period.

Forage Types	Gross Return @$0.70/lb $/calf	Net Return per C-C pr $/pr	Net Return per acre $/ac	Calf Gain Cost $/lb
Pasture Forage Types				
Native Rangeland Repeated Seasonal	172.62	73.98	6.54	0.40
6.0-m Seasonlong	198.01	39.46	2.18	0.56
4.5-m Seasonlong	200.43	89.18	7.02	0.39
Deferred Grazing (92d)	137.55	79.29	11.83	0.30
Twice-over Rotation	211.94	133.10	14.79	0.26
Harvested Forage Types				
Crested Wheat, mature	191.80	95.21	37.05	0.35
Crested Wheat, early	191.80	113.43	62.32	0.29
Forage Barley, early	191.80	127.79	228.20	0.23
Forage Barley, late	191.80	133.27	182.56	0.21
Oat Forage, early	191.80	126.93	198.33	0.24
Oat Forage, late	191.80	130.56	178.85	0.22
Pea Forage, early	191.80	99.70	153.38	0.34
Pea Forage, late	191.80	116.38	228.20	0.28
Forage Lentil, early	191.80	88.54	93.20	0.38
Forage Lentil, late	191.80	115.66	192.77	0.28
Oat-Pea Forage	191.80	116.00	218.77	0.28

Evaluation of Pasture Forage and Harvested Forage Types during the Fall Lactation Production Period

Results

The fall lactation production period was 30 days from mid October until mid November. The fall lactation production period has nutritional requirements above maintenance. The greater part of the additional nutrients is for the production of milk for the nursing calf, and a smaller amount is for fetus development. The nutritional quality of the forage affects the quantities of milk produced. If forage quality is at or near animal nutritional requirements, milk production can be fairly high and rate of calf weight gain can be satisfactory (BCRC 1999). Forage quality of mature perennial grasses on traditionally managed pastures is below the requirements of a lactating cow. Forage-feed costs increase when the nutrient quality of the grass or forage provided does not meet the nutritional requirements of the cow. Cows lose body weight and body condition when body reserves are converted into milk production. The level of milk production and the rate of calf weight gain are low; the result is higher costs per pound of calf weight gained. Pasture forage and harvested forage costs and returns after feed costs were determined for a 1200-pound range cow with a calf during the fall lactation production period. A grazing cow with a calf requires an allocation of 30 lbs of pasture forage dry matter per day. The cow requires a daily intake of 27 lbs dry matter (DM) at 9.3% crude protein (CP) (2.51 lbs CP/day).

The costs of grazing native rangeland during the fall are considerably higher than the costs of grazing native rangeland during the summer. The weight of the herbage on fall pastures is only about 40% to 60% of the mid summer herbage weight on grasslands that have had no grazing all growing season. Native rangeland pasture forage during the fall has a crude protein content of around 4.8%, about half the content of mid summer herbage.

Pasture Forage Types

Native rangeland managed as a repeated seasonal pasture was evaluated during the fall lactation production period for 30 days between mid October and mid November (tables 48 and 53). Native rangeland forage during the fall has a crude protein content of around 4.8%. Fall native rangeland forage had pasture rent value or production costs of $8.76 per acre, forage dry matter costs of $88.85 per ton, and crude protein costs of $0.92 per pound. A cow grazing during the fall lactation period required 4.60 acres at a forage cost of $40.30 per production period. The crude protein content of mature native rangeland forage is below the requirements of a lactating cow during the fall, and crude protein would need to be supplemented at 1.21 lbs per cow per day at a cost of $10.90 per period. Total forage feed costs were $51.20 per period, or $1.71 per day (table 54). Calf weight gain was 1.80 lbs per day and 11.83 lbs per acre; accumulated weight gain was 54.00 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $37.80 per calf, and the net returns after pasture costs were a loss of $13.40 per cow-calf pair and a loss of $2.91 per acre. The cost of calf weight gain was $0.95 per pound (table 55).

Native rangeland managed as a 6.0-month seasonlong pasture was evaluated during the fall lactation production period for 30 days between mid October and mid November (tables 48 and 53). Native rangeland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $78.57 per ton. The stocking rate used during the summer lactation period was not adjusted to match the reduction in fall herbage biomass on this traditional grazing treatment. A cow grazing during the fall lactation period was allotted 4.04 acres at a forage cost of $35.39 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $35.29 per period, or $1.18 per day (table 54). Cows lost 1.74 lbs per day and lost 12.90 lbs per acre; accumulated weight loss was 52.20 lbs. Calf weight gain was 0.59 lbs per day and 4.38 lbs per acre; accumulated weight gain was 17.73 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $12.41 per calf, and the net returns after pasture costs were a loss of $22.98 per cow-calf pair and a loss of $5.69 per acre. The cost of calf weight gain was $1.99 per pound (table 55).

Native rangeland managed as a 5.5-month seasonlong pasture was evaluated during the fall lactation production period for 30 days between mid October and mid November (tables 48 and 53). Native rangeland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $49.21 per ton. The stocking rate

used during the summer lactation period was not adjusted to match the reduction in fall herbage biomass on this traditional grazing treatment. A cow grazing during the fall lactation period was allotted 2.53 acres at a forage cost of $22.16 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $22.16 per period, or $0.74 per day (table 54). Cows lost 0.82 lbs per day and lost 9.77 lbs per acre; accumulated weight loss was 24.60 lbs. Calf weight gain was 0.92 lbs per day and 10.90 lbs per acre; accumulated weight gain was 27.60 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $19.32 per calf, and the net returns after pasture costs were a loss of $2.84 per cow-calf pair and a loss of $1.12 per acre. The cost of calf weight gain was $0.80 per pound (table 55).

Native rangeland managed as a deferred grazing pasture was evaluated during the fall lactation production period for 30 days between mid October and mid November (tables 48 and 53). Native rangeland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $42.52 per ton. The high stocking rate used during the summer lactation period was not adjusted to match the reduction in fall herbage biomass on this traditional grazing treatment. A cow grazing during the fall lactation period was allotted 2.18 acres (2.22 acres per month) at a forage cost of $19.53 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $19.53 per period, or $0.65 per day (table 54). Cows lost 0.74 lbs per day and lost 9.96 lbs per acre; accumulated weight loss was 22.20 lbs. Calf weight gain was 0.77 lbs per day and 10.36 lbs per acre; accumulated weight gain was 23.10 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $16.17 per calf, and the net returns after pasture costs were a loss of $3.36 per cow-calf pair and a loss of $1.51 per acre. The cost of calf weight gain was $0.85 per pound (table 55).

Native rangeland managed as a 4.5-month seasonlong pasture started in mid June was evaluated during the fall lactation production period for 15 days between mid October to late October (tables 48 and 53). Native rangeland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $72.10 per ton. The stocking rate used during the summer lactation period was not adjusted to match the reduction in fall herbage biomass on this traditional grazing treatment. A cow grazing during the fall lactation period was allotted 1.63 acres (3.26 acres per month) at a forage cost of $14.28 for 15 days. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $14.28 per period, or $0.95 per day (table 54). Cows lost 0.52 lbs per day and lost 4.75 lbs per acre; accumulated weight loss was 7.74 lbs in 15 days. Calf weight gain was 1.35 lbs per day and 6.71 lbs per acre; accumulated weight gain was 20.33 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $14.23 per calf, and the net returns after pasture costs were a loss of $0.05 per cow-calf pair and a loss of $0.03 per acre. The cost of calf weight gain was $0.70 per pound (table 55).

Altai wildrye seeded domesticated grassland managed as a complementary fall pasture was evaluated during the fall lactation production period for 30 days between mid October and mid November (tables 49 and 53). Altai wildrye grassland forage had pasture rent value or production costs of $8.76 per acre and forage dry matter costs of $27.04 per ton. A cow grazing during the fall lactation period was allotted 1.39 acres at a forage cost of $12.18 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $12.18 per period, or $0.40 per day (table 54). Cow weight gain was 0.55 lbs per day and 11.87 lbs per acre; accumulated weight gain was 16.50 lbs. Calf weight gain was 1.73 lbs per day and 37.96 lbs per acre; accumulated weight gain was 52.77 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $36.94 per calf, and the net returns after pasture costs were $24.76 per cow-calf pair and $17.81 per acre. The cost of calf weight gain was $0.23 per pound (table 55).

Cropland aftermath of annual cereal stubble managed as a seasonal pasture was evaluated during the fall lactation production period for 30 days between mid October and mid November (tables 49 and 53). Cropland aftermath forage had pasture rent value or production 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 and the forage would cost $13.26 per production period. Additional crude protein was not supplemented even though the forage was below the requirements of a cow during fall lactation. Total forage feed costs were $13.26 per period, or $0.44 per day (table 54). Lactating cows lost 1.61 lbs per day and lost 7.27 lbs per acre; accumulated weight loss was 48.17 lbs. Calf weight gain was 0.42 lbs per day and 1.90 lbs per acre; accumulated weight gain was 12.57 lbs. When calf accumulated weight was

assumed to have a value of $0.70 per pound, the gross return was $8.80 per calf, and the net returns after pasture costs were a loss of $4.46 per cow-calf pair and a loss of $0.67 per acre. The cost of calf weight gain was $1.05 per pound (table 55).

Spring seeded winter cereal (winter rye) managed as a seasonal pasture was evaluated during the fall lactation production period for 30 days between mid October and mid November (tables 49 and 53). Spring seeded winter cereal forage had production costs of $41.75 per acre and forage dry matter costs of $43.77 per ton. A cow grazing during the fall lactation period was allotted 0.47 acres at a forage cost of $19.70 per production period. Additional roughage or crude protein were not supplemented on this pasture forage type. Total forage feed costs were $19.70 per period, or $0.66 per day (table 54). Cow weight gain was 1.05 lbs per day and 67.02 lbs per acre; accumulated weight gain was 31.50 lbs. Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after pasture costs were $22.30 per cow-calf pair and $47.45 per acre. The cost of calf weight gain was $0.33 per pound (table 55).

Harvested Forage Types

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of 6.4%. This crested wheatgrass hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. Mature crested wheatgrass hay would be fed at 30.0 lbs DM/day to provide 1.9 lbs CP/day. An additional 0.59 lbs of crude protein per day would need to be provided, at a cost of $5.31 per period. Production of mature crested wheatgrass hay to feed during the fall lactation period (tables 50 and 53) would require 0.56 acres, and the forage would cost $15.84 per period. Total forage and supplement costs would be $21.15 per period, or $0.71 per day (table 54). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after feed costs were $20.85 per cow-calf pair and $37.07 per acre. The cost of calf weight gain was $0.35 per pound (table 55).

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of 14.5%. This crested wheatgrass hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. Early cut crested wheatgrass hay would be fed at 17.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.7 lbs of roughage per day would need to be provided, at a cost of $6.66 per period. Production of early cut crested wheatgrass hay to feed during the fall lactation period (tables 50 and 53) would require 0.40 acres, and the forage would cost $10.50 per period. Total forage and supplement costs would be $17.16 per period, or $0.57 per day (table 54). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after feed costs were $24.84 per cow-calf pair and $62.10 per acre. The cost of calf weight gain was $0.29 per pound (table 55).

Forage barley hay cut early, at the milk stage, has a crude protein content of 13.0%. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. Early cut forage barley hay would be fed at 19.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 10.7 lbs of roughage per day would need to be provided, at a cost of $5.62 per period. Production of early cut forage barley hay to feed during the fall lactation period (tables 51 and 53) would require 0.12 acres, and the forage would cost $8.40 per period. Total forage and supplement costs would be $14.02 per period, or $0.47 per day (table 54). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after feed costs were $27.98 per cow-calf pair and $233.17 per acre. The cost of calf weight gain was $0.23 per pound (table 55).

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. Late-cut forage barley hay would be fed at 27.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 2.7 lbs of roughage per day would need to be provided, at a cost of $1.42 per period. Production of late-cut forage barley hay to feed during the fall lactation period (tables 51 and 53) would require 0.16 acres, and the forage would cost $11.40 per period. Total forage and supplement costs would be $12.82 per period, or $0.43 per day (table 54). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight

gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after feed costs were $29.18 per cow-calf pair and $182.38 per acre. The cost of calf weight gain was $0.21 per pound (table 55).

Oat forage hay cut early, at the milk stage, has a crude protein content of 11.5%. This oat forage hay has production costs of $69.17 per acre, forage dry matter costs of $29.60 per ton, and crude protein costs of $0.13 per pound. Early cut oat hay would be fed at 21.8 lbs DM/day to provide 2.5 lbs CP/day. An additional 8.2 lbs of roughage per day would need to be provided, at a cost of $4.31 per period. Production of early cut oat hay to feed during the fall lactation period (tables 51 and 53) would require 0.14 acres, and the forage would cost $9.90 per period. Total forage and supplement costs would be $14.21 per period, or $0.47 per day (table 54). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after feed costs were $27.79 per cow-calf pair and $198.50 per acre. The cost of calf weight gain was $0.24 per pound (table 55).

Oat forage 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. Late-cut oat hay would be fed at 30.0 lbs DM/day to provide 2.34 lbs CP/day. An additional 0.17 lbs of crude protein per day would need to be provided, at a cost of $1.53 per period. Production of late-cut oat hay to feed during the fall lactation period (tables 51 and 53) would require 0.16 acres, and the forage would cost $11.88 per period. Total forage and supplement costs would be $13.41 per period, or $0.45 per day (table 54). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after feed costs were $28.59 per cow-calf pair and $178.69 per acre. The cost of calf weight gain was $0.22 per pound (table 55).

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. Early cut pea forage hay would be fed at 13.3 lbs DM/day to provide 2.5 lbs CP/day. An additional 16.7 lbs of roughage per day would need to be provided, at a cost of $8.79 per period. Production of early cut pea forage hay to feed during the fall lactation period (tables 52 and 53) would require 0.14 acres, and the forage would cost $11.40 per period. Total forage and supplement costs would be $20.19 per period, or $0.67 per day (table 54). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after feed costs were $21.81 per cow-calf pair and $155.78 per acre. The cost of calf weight gain was $0.34 per pound (table 55).

Pea forage hay cut at a late plant stage has a crude protein content of 14.4%. This pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of $0.13 per pound. Late-cut pea forage hay would be fed at 17.4 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.6 lbs of roughage per day would need to be provided, at a cost of $6.62 per period. Production of late-cut pea forage hay to feed during the fall lactation period (tables 52 and 53) would require 0.11 acres, and the forage would cost $9.90 per period. Total forage and supplement costs would be $16.52 per period, or $0.55 per day (table 54). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after feed costs were $25.48 per cow-calf pair and $231.64 per acre. The cost of calf weight gain was $0.28 per pound (table 55).

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. Early cut lentil hay would be fed at 11.5 lbs DM/day to provide 2.5 lbs CP/day. An additional 18.5 lbs of roughage per day would need to be provided, at a cost of $9.71 per period. Production of early cut forage lentil hay to feed during the fall lactation period (tables 52 and 53) would require 0.21 acres, and the forage would cost $12.90 per period. Total forage and supplement costs would be $22.61 per period, or $0.75 per day (table 54). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after feed costs were $19.39 per cow-calf pair and $92.33 per acre. The cost of calf weight gain was $0.38 per pound (table 55).

Forage lentil hay cut at a late plant stage has a crude protein content of 14.7%. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37.00 per ton, and crude protein costs of $0.13 per pound. Late-cut forage lentil hay would be fed at 17.1 lbs DM/day to provide 2.5 lbs CP/day. An additional 12.9 lbs of roughage per day would need to be provided, at a cost of $6.77 per period. Production of late-cut forage lentil hay to feed during the fall lactation period (tables 52 and 53) would require 0.13 acres, and the forage would cost $9.90 per period. Total forage and supplement costs would be $16.67 per period, or $0.56 per day (table 54). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after feed costs were $25.33 per cow-calf pair and $194.85 per acre. The cost of calf weight gain was $0.28 per pound (table 55).

Oat-pea forage hay has a crude protein content of 12.5%. This oat-pea forage hay has production costs of $95.52 per acre, forage dry matter costs of $37.20 per ton, and crude protein costs of $0.16 per pound. Oat-pea forage hay would be fed at 20.1 lbs DM/day to provide 2.5 lbs CP/day. An additional 9.9 lbs of roughage per day would need to be provided, at a cost of $5.20 per period. Production of oat-pea forage hay to feed during the fall lactation period (tables 52 and 53) would require 0.12 acres, and the forage would cost $11.40 per period. Total forage and supplement costs would be $16.60 per period, or $0.55 per day (table 54). Calf weight gain was assumed to be 2.00 lbs per day; accumulated weight gain was 60.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $42.00 per calf, and the net returns after feed costs were $25.40 per cow-calf pair and $211.67 per acre. The cost of calf weight gain was $0.28 per pound (table 55).

Discussion

Pasture Forage Types

Native rangeland forage grazed as a repeated seasonal pasture during the fall lactation production period was high-cost forage because the quantities of crude protein captured per acre were low and the quantity of forage dry matter available per acre was low. Total forage costs for native rangeland grazed as a repeated seasonal pasture was high, even though the equipment costs, labor costs, land rent per acre, and forage production costs per acre were low, because the input costs did not directly regulate livestock forage feed costs. The cost per pound of crude protein ($0.92/lb CP) was very high because of the low quantity of crude protein weight contained in the forage. The crude protein content of the forage was below the requirements of a lactating cow making it necessary to provide purchased supplemental crude protein. The forage dry matter cost ($88.85/ton) was very high because of the low quantity of forage dry matter production. The low forage weight per acre made it necessary to use about two times the land area that would have been needed during the summer period to provide a cow with adequate forage dry matter for a month in the same pasture. The large land area (4.60 acres) per cow caused the forage costs per period to be high. The total daily forage and supplemental crude protein costs ($1.71/day) were extremely high. The total feed costs were greater than the low market value of the accumulated calf weight causing a high loss in returns after feed costs ($-13.40) per cow and a moderate loss in returns after feed costs ($-2.91) per acre. The cost per pound of calf weight gain ($0.95/lb) was very high because of the low crude protein and low forage dry matter yields per acre and the large land area per cow-calf pair.

Native rangeland forage grazed as a 6.0-month seasonlong pasture during the fall lactation production period was very high-cost forage because the quantity of forage dry matter available per acre was very low and the crude protein content of the forage was low. Total forage costs for native rangeland grazed as a 6.0-month seasonlong pasture was very high, even though the equipment costs, labor costs, land rent per acre, and forage production costs per acre were very low, because the input costs did not directly regulate livestock forage feed costs. The forage dry matter cost ($78.57/ton) was very high because the quantity of forage weight per acre was low. The low forage availability per acre and the low crude protein content in the forage were major causes for the low cow and calf weight performance per acre. The large land area (4.04 acres/month) per cow caused the forage costs per period to be high. The total daily forage feed costs ($1.18/day) were very high. The total feed costs were greater than the low market value of the accumulated calf weight causing a high loss in returns after feed costs ($-22.98) per cow and a moderate loss in returns after feed costs ($-5.69) per acre. The cost per pound of calf weight gain ($1.99/lb) was extremely high because of the low forage dry matter yield per acre, the low crude protein content in the forage, the low animal weight performance per acre, and the large land area per cow-calf pair.

Native rangeland forage grazed as a 5.5-month seasonlong pasture during the fall lactation production period was high-cost forage because the quantity of forage dry matter available per acre was moderate and the crude protein content of the forage was low. Total forage costs for native rangeland grazed as a 5.5-month seasonlong pasture was high, even though the equipment costs, labor costs, land rent per acre, and forage production costs per acre were very low, because the input costs did not directly regulate livestock forage feed costs. The forage dry matter cost ($49.21/ton) was high because the quantity of forage weight per acre was moderate. The moderate forage availability per acre and the low crude protein content in the forage were major causes for the low cow and calf weight performance per acre. The moderate land area (2.53 acres/month) per cow caused the forage costs per period to be high. The total daily forage feed costs ($0.74/day) were high. The total feed costs were greater than the low market value of the accumulated calf weight causing a moderate loss in returns after feed costs ($-2.84) per cow and a moderate loss in returns after feed costs ($-1.12) per acre. The cost per pound of calf weight gain ($0.80/lb) was high because of the moderate forage dry matter yield per acre, the low crude protein content in the forage, the low animal weight performance per acre, and the large land area per cow-calf pair.

Native rangeland forage grazed as a deferred pasture during the fall lactation production period was high-cost forage because the quantity of forage dry matter available per acre was moderate and the crude protein content of the forage was low. Total forage costs for native rangeland grazed as a deferred pasture was high, even though the equipment costs, labor costs, land rent per acre, and forage production costs per acre were very low, because the input costs did not directly regulate livestock forage feed costs. The forage dry matter cost ($42.52/ton) was high because the quantity of forage weight per acre was moderate. The moderate forage availability per acre and the low crude protein content in the forage were major causes for the low cow and calf weight performance per acre. The moderate land area (2.22 acres/month) per cow caused the forage costs per period to be high. The total daily forage feed costs ($0.65/day) were high. The total feed costs were greater than the low market value of the accumulated calf weight causing a moderate loss in returns after feed costs ($-3.36) per cow and a moderate loss in returns after feed costs ($-1.51) per acre. The cost per pound of calf weight gain ($0.85/lb) was very high because of the moderate forage dry matter yield per acre, the low crude protein content in the forage, the low animal weight performance per acre, and the moderate land area per cow-calf pair.

Native rangeland forage grazed as a 4.5-month seasonlong pasture during the fall lactation production period was high-cost forage because the quantity of forage dry matter available per acre was low and the crude protein content of the forage was low. Total forage costs for native rangeland grazed as a 4.5-month pasture was high, even though the equipment costs, labor costs, land rent per acre, and forage production costs per acre were very low, because the input costs did not directly regulate livestock forage feed costs. The forage dry matter cost ($72.10/ton) was high because the quantity of forage weight per acre was low. The low forage availability per acre and the low crude protein content in the forage were major causes for the low cow and calf weight performance per acre. The large land area (3.26 acres/month) per cow caused the forage costs per period to be high. The total daily forage feed costs ($0.95/day) were very high. The total feed costs were greater than the low market value of the accumulated calf weight causing a low loss in returns after feed costs ($-0.05) per cow and a low loss in returns after feed costs ($-0.03) per acre. The cost per pound of calf weight gain ($0.70/lb) was high because of the low forage dry matter yield per acre, the low crude protein content in the forage, the low animal weight performance per acre, and the large land area per cow-calf pair.

Altai wildrye grassland grazed as a complementary pasture during the fall lactation production period was low-cost forage because the quantities of crude protein captured per acre were seasonally high, the quantity of forage dry matter available per acre was seasonally high, and the equipment costs, labor costs, land rent per acre, and forage production costs per acre were low. The forage dry matter cost ($27.04/ton) was low because of the high late season forage dry matter production. The land area (1.39 acres) per cow was small because of the crude protein quantities retained in the aboveground plant parts and the seasonally high forage dry matter yield per acre. The total daily forage feed costs ($0.40/day) were low because of the small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($24.76) per cow and in moderate returns after feed costs ($17.81) per acre. The cost per pound of calf weight gain ($0.23/lb) was very low because of the quantity of crude protein contained in the aboveground plant parts, the high forage dry matter

yield per acre, and the small land area per cow-calf pair.

Cropland aftermath of annual cereal stubble grazed as a seasonal pasture during the fall lactation production period was high-cost forage because of the low quantity of forage dry matter available per acre and the extremely low quantities of crude protein contained in the forage resulting in cow weight loss of greater than a pound and a half per day and in low calf weight gain of less than half a pound per day. The forage dry matter cost ($29.63/ton) was low because the equipment costs, labor costs, and forage production costs per acre were low and the land rent per acre was very low. The low forage weight per acre made it necessary to provide a large land area (6.63 acres) per cow. The total daily forage feed costs ($0.44/day) were low because the land rent per acre was very low. The total feed costs were greater than the low market value of the accumulated calf weight causing a moderate loss in returns after feed costs ($-4.46) per cow and a low loss in returns after feed costs ($-0.67) per acre. The cost per pound of calf weight gain ($1.05/lb) was very high because of the low forage dry matter per acre, the low crude protein content in the forage, and the large land area required per cow-calf pair.

Spring seeded winter cereal (winter rye) grazed as a seasonal pasture during the fall lactation production period was moderate-cost forage because a relatively moderate quantity of forage dry matter was produced per acre. The winter cereal is seeded during the spring in order for the plants to develop large enough root systems to survive water stress periods during the growing season. On the average, there are two months with water deficiencies great enough to cause water stress in plants each growing season. Only 6% of the past 114 years have not had growing season months with water deficiency. The quantity of herbage available during fall and winter grazing of spring seeded winter cereal pastures is related to the severity and duration of the water stress conditions during the growing season and to the depth of packed snow and ice during the nongrowing season. The forage dry matter cost ($43.77/ton) was moderate because of the relatively moderate forage dry matter production. The land area (0.47 acres) per cow was relatively small because greater than 70% of the herbage was consumed as forage, however, the total daily forage feed costs ($0.66/day) were moderate because only a modest quantity of herbage biomass was produced as a result of growing season water stress. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($22.30) per cow and in high returns after feed costs ($47.45) per acre. The cost per pound of calf weight gain ($0.33/lb) was low because of the high quantity of forage available per acre, the high animal weight performance per acre, and the small land area per cow-calf pair.

Harvested Forage Types

Crested wheatgrass hay cut at a mature growth stage and fed during the fall lactation production period was high-cost forage. The forage dry matter cost ($34.80/ton) was moderate for mature crested wheatgrass hay and lower than the forage dry matter cost per ton for early cut crested wheatgrass hay because greater dry matter weight of the mature crested wheatgrass hay was harvested per acre. The cost per pound of crude protein ($0.28/lb CP) was high for mature crested wheatgrass hay and double the cost per pound of crude protein for early cut crested wheatgrass hay because of the lower crude protein weight in the mature crested wheatgrass hay harvested per acre. The land area (0.56 acres) per cow for mature crested wheatgrass hay was small but greater than the land area required per cow for early cut crested wheatgrass hay because of the greater crude protein weight per acre in the early cut crested wheatgrass hay. The crude protein content of the mature crested wheatgrass forage was below the requirements of a lactating cow making it necessary to provide purchased supplemental crude protein. The total daily forage and supplemental crude protein costs ($0.71/day) were high because of the additional supplemental crude protein costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($20.85) per cow and in moderate returns after feed costs ($37.07) per acre. The cost per pound of calf weight gain ($0.35/lb) was moderately low because of the additional supplemental crude protein costs.

Crested wheatgrass hay cut at the boot growth stage and fed during the fall lactation production period was moderate-cost forage. The forage dry matter cost ($40.80/ton) was moderate for early cut crested wheatgrass hay and was greater than the forage dry matter cost per ton for mature crested wheatgrass hay because crested wheatgrass hay cut at the boot stage harvested lower forage dry matter weight per acre than crested wheatgrass hay cut at a mature growth stage. The cost per pound of crude protein ($0.14/lb CP) was low for early cut crested wheatgrass hay and lower than the cost per pound of crude protein for mature crested wheatgrass hay because of the greater crude protein weight in the

early cut crested wheatgrass hay harvested per acre. The land area (0.40 acres) per cow for early cut crested wheatgrass hay was small and less than the land area required per cow for mature crested wheatgrass hay because of the greater crude protein weight harvested per acre in the early cut crested wheatgrass hay. The forage cost of early cut crested wheatgrass hay was low but the total daily forage feed cost ($0.57/day) was moderate because about 42% of the ration forage was supplemental roughage which added substantially to the total forage feed costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($24.84) per cow and in high returns after feed costs ($62.10) per acre. The cost per pound of calf weight gain ($0.29/lb) was low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Forage barley hay cut at the milk growth stage and fed during the fall lactation production period was low-cost forage. The production costs per acre were high for early cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($28.80/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.11/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.12 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.47/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The forage costs for early cut forage barley hay were lower than the forage costs for late cut forage barley hay. However, the total forage feed costs for early cut forage barley hay was slightly greater than the total forage feed costs for late cut forage barley hay because of the greater quantity of supplemental roughage in the forage ration for early cut forage barley hay. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($27.98) per cow and in extremely high returns after feed costs ($233.17) per acre. The cost per pound of calf weight gain ($0.23/lb) was very low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Forage barley hay cut at the hard dough growth stage and fed during the fall lactation production period was low-cost forage. The production costs per acre were high for late cut forage barley hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($27.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut forage barley hay was greater than the cost per pound of crude protein for early cut forage barley hay because of the lower crude protein weight harvested per acre in the late cut forage barley hay. The land area (0.16 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.43/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($29.18) per cow and in very high returns after feed costs ($182.38) per acre. The returns after feed costs per acre were lower for late cut forage barley hay than for early cut forage barley hay because late cut forage barley hay had slightly higher crude protein cost per pound and slightly larger land area per cow than early cut forage barley hay. The cost per pound of calf weight gain ($0.21/lb) was very low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Oat forage hay cut at the milk growth stage and fed during the fall lactation production period was low-cost forage. The production costs per acre were high for early cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($29.60/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.14 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.47/day) were low because of the low cost of crude protein per pound and the high forage dry matter production. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($27.79) per cow and in extremely high returns after feed costs ($198.50) per acre. The cost per pound of calf weight gain ($0.24/lb) was very low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Oat forage hay cut at the hard dough growth stage and fed during the fall lactation production

period was low-cost forage. The production costs per acre were high for late cut oat forage hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($26.40/ton) was low because of the high forage dry matter production. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The cost per pound of crude protein for late cut oat forage hay was greater than the cost per pound of crude protein for early cut oat forage hay because of the lower crude protein weight harvested per acre in the late cut oat forage hay. The land area (0.16 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The crude protein content of the forage was below the requirements of a lactating cow making it necessary to provide purchased supplemental crude protein. The total daily forage and supplemental crude protein costs ($0.45/day) were moderately low because of the additional cost of the supplemental crude protein. The forage costs for early cut oat forage hay were lower than the forage costs for late cut oat forage hay. However, the total forage feed costs for late cut oat forage hay were slightly lower than the total forage feed costs for early cut oat forage hay because of the quantity of supplemental roughage in the forage ration for early cut oat forage hay. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($28.59) per cow and in very high returns after feed costs ($178.69) per acre. The returns after feed costs per acre were lower for late cut oat forage hay than for early cut oat forage hay because late cut oat forage hay had slightly higher crude protein cost per pound and slightly larger land area per cow than early cut oat forage hay. The cost per pound of calf weight gain ($0.22/lb) was very low because of the very small land area per cow-calf pair.

Pea forage hay cut at an early growth stage and fed during the fall lactation production period was moderate-cost forage. However, pea forage hay cut at a late growth stage has lower forage feed costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for early cut pea forage hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($55.00/ton) was high because of the modest forage dry matter production. The cost per pound of crude protein ($0.15/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.14 acres) per cow was very small because of the high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.67/day) were high because of the modest forage dry matter production per acre and the high supplemental roughage costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($21.81) per cow and very high returns after feed costs ($155.78) per acre. The cost per pound of calf weight gain ($0.34/lb) was moderately low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Pea forage hay cut at a late growth stage and fed during the fall lactation production period was low-cost forage. Late cut pea forage hay has lower forage feed costs and greater revenue returns after feed costs than early cut pea forage hay. The production costs per acre were high for late cut pea forage hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($37.40/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.11 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.55/day) were low because of the low cost of crude protein per pound and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($25.48) per cow and in extremely high returns after feed costs ($231.64) per acre. The cost per pound of calf weight gain ($0.28/lb) was low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Forage lentil hay cut at an early growth stage and fed during the fall lactation production period was high-cost forage. However, forage lentil hay cut at a late growth stage has lower forage feed costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for early cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($71.60/ton) was high because of the modest forage dry matter yield per acre. The cost per pound of crude protein ($0.17/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.21 acres) per cow was small because of the moderately high crude protein yield per acre. The total daily forage and supplemental roughage costs ($0.75/day) were high because of the modest forage

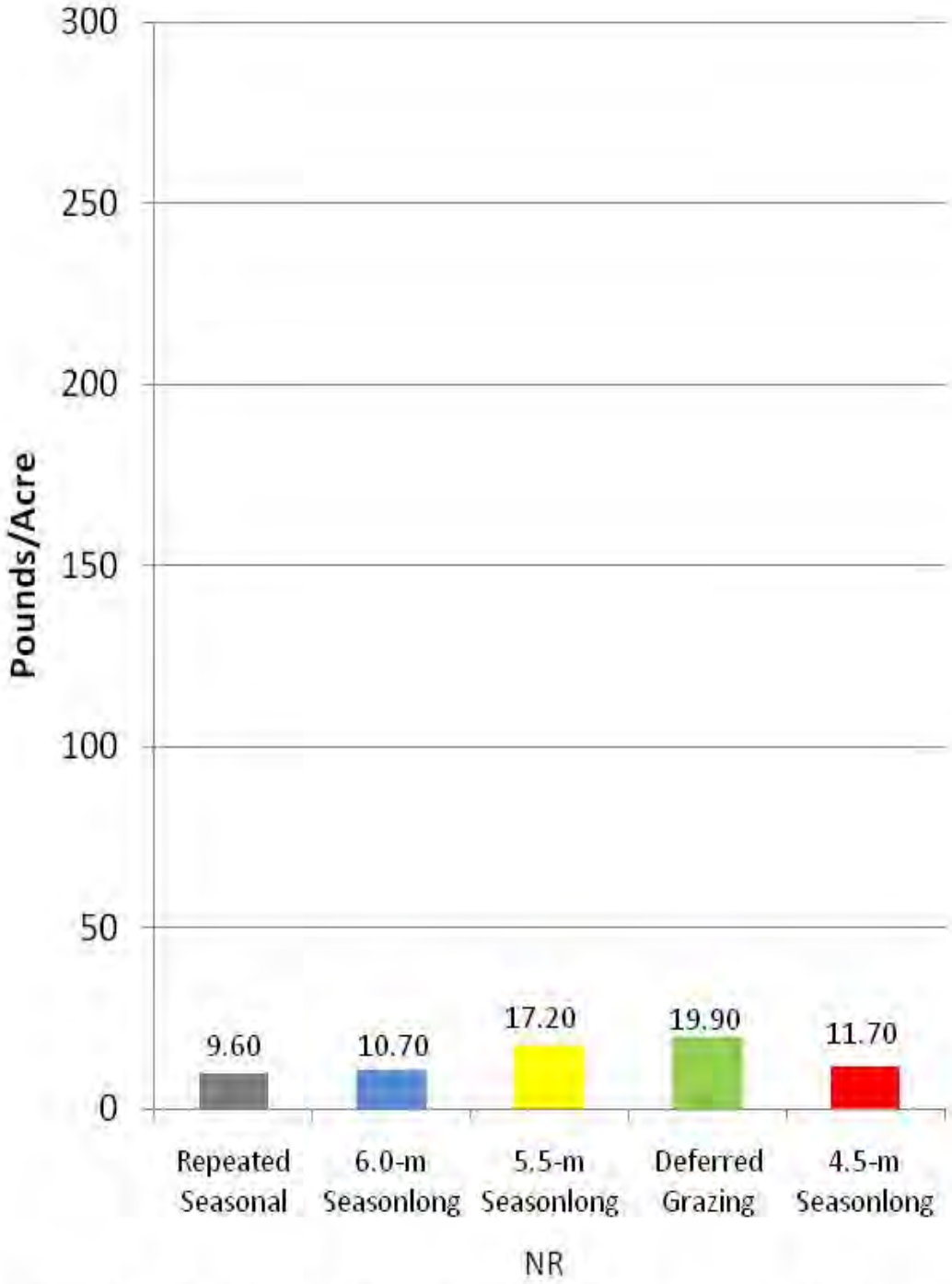
dry matter production per acre and the high supplemental roughage costs. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($19.39) per cow and in high returns after feed costs ($92.33) per acre. The cost per pound of calf weight gain ($0.38/lb) was moderately low because of the low cost per pound of crude protein and the small land area per cow-calf pair.

Forage lentil hay cut at a late growth stage and fed during the fall lactation production period was low-cost forage. Late cut forage lentil hay has lower forage feed costs and greater revenue returns after feed costs than early cut forage lentil hay. The production costs per acre were high for late cut forage lentil hay because the equipment costs, labor costs, and land rent per acre were high. The forage dry matter cost ($37.00/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.13/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.13 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.56/day) were low because of the low cost of crude protein per pound and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($25.33) per cow and in extremely high returns after feed costs ($194.85) per acre. The cost per pound of calf weight gain ($0.28/lb) was low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

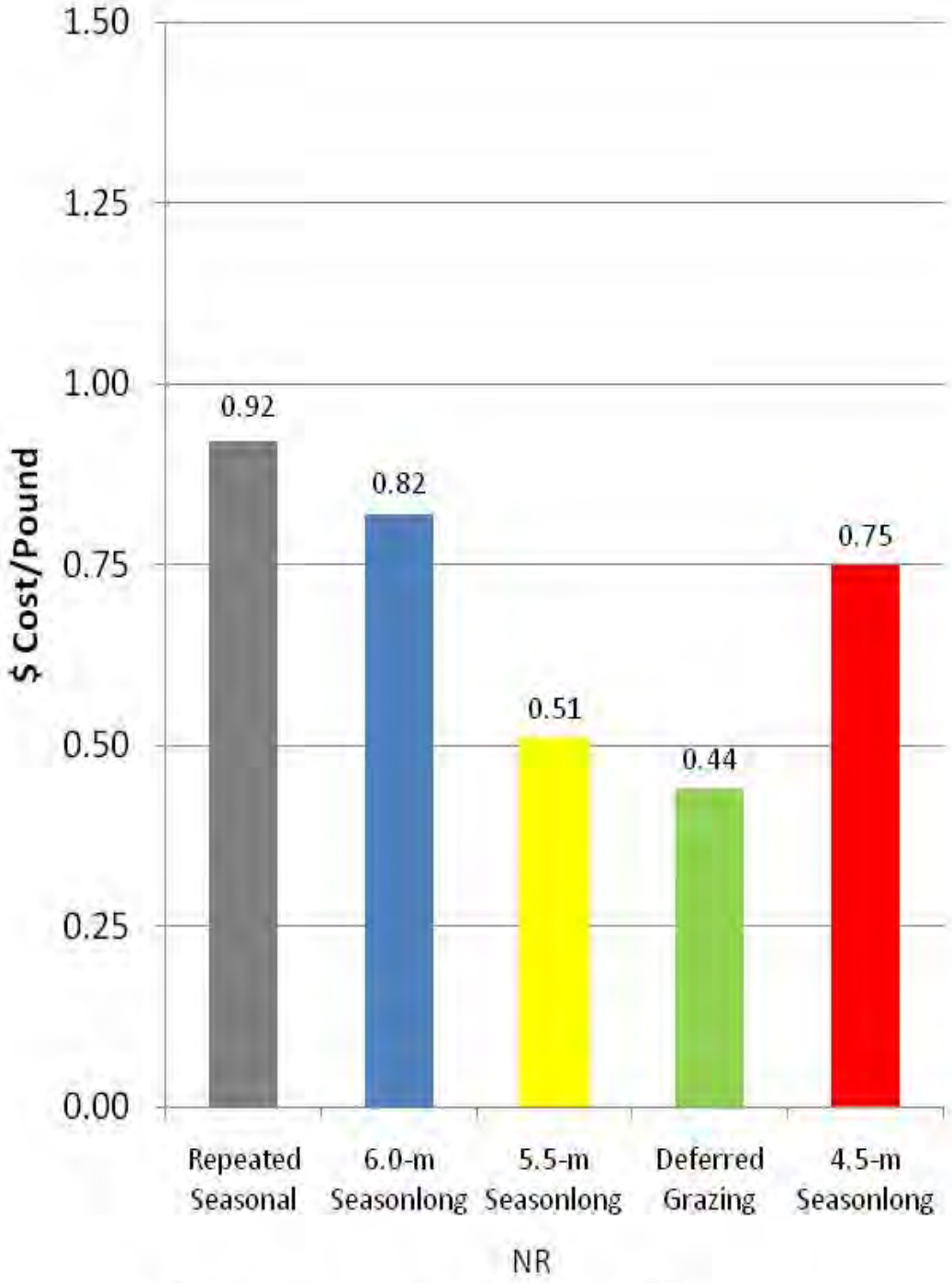
Oat-pea hay cut at compromised plant growth stages and fed during the fall lactation production period was low-cost forage. However, seeding oat forage separately on half of the field and cutting it at an early growth stage and seeding pea forage separately on half of the field and cutting it at a late growth stage will result in lower production costs per acre, lower forage dry matter costs per ton, lower costs per pound of crude protein, lower total forage feed costs per day, lower costs per pound of calf weight gain, greater net returns after feed costs per cow, and greater net returns after feed costs per acre than oat-pea forage seeded together and cut at compromised growth stages. The production costs per acre were very high for oat-pea hay because the equipment costs, labor costs, seed costs, and land rent per acre were high. The forage dry matter cost ($37.20/ton) was moderate because of the high forage dry matter production. The cost per pound of crude protein ($0.16/lb CP) was low because of the high crude protein weight contained in the forage. The land area (0.12 acres) per cow was very small because of the high crude protein and high forage dry matter yields per acre. The total daily forage and supplemental roughage costs ($0.55/day) were low because of the low cost of crude protein per pound and the very small land area per cow. The total feed costs were lower than the low market value of the accumulated calf weight resulting in moderate returns after feed costs ($25.40) per cow and in extremely high returns after feed costs ($211.67) per acre. The cost per pound of calf weight gain ($0.28/lb) was low because of the low cost per pound of crude protein and the very small land area per cow-calf pair.

Table 48. Costs and returns for native rangeland pasture forage types to be grazed by range cows during the 30-day fall lactation production period.

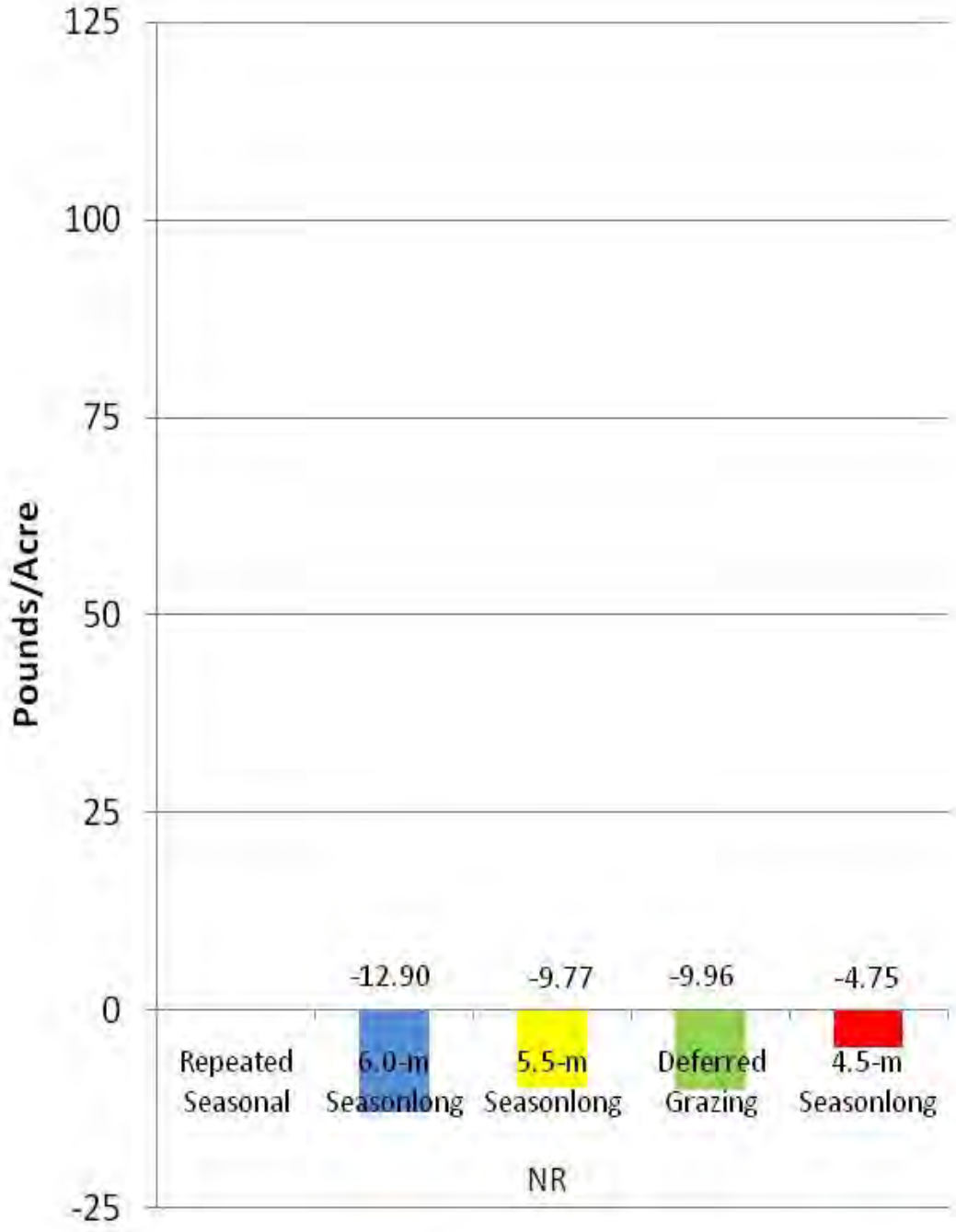
		Native Rangeland Repeated Seasonal	Native Rangeland 6.0-m Seasonlong	Native Rangeland 5.5-m Seasonlong	Native Rangeland Deferred Grazing	Native Rangeland 4.5-m Seasonlong
Days		30	30	30	30	15
Growth Stage		fall	fall	fall	fall	fall
Herbage Weight	lb/ac	797	891	1423	1649	973
Forage DM Weight	lb/ac	199	223	356	412	243
Costs/Acre						
Land Rent	$	8.76	8.76	8.76	8.76	8.76
Custom Work	$					
Seed Cost	$					
Baling Costs	$					
Production Costs	$/ac	8.76	8.76	8.76	8.76	8.76
Forage DM Costs	$/ton	88.85	78.57	49.21	42.52	72.10
Crude Protein	%	4.8				
Crude Protein Yield	lb/ac	9.55				
Crude Protein Cost	$/lb	0.92				
Forage Allocation	lb/d	30.0	30.0	30.0	30.0	26.0
Land Area/Period	ac	4.60	4.04	2.53	2.18	1.63
Forage Costs/Period	$/pp	40.30	35.39	22.16	19.53	14.28
Supplementation						
Roughage/Day	lb/d					
Crude Protein/Day	lb/d	1.21				
Sup. Cost/Period	$/pp	10.90				
Total Feed Cost	$/pp	51.20	35.39	22.16	19.53	14.28
Cost/Day	$/d	1.71	1.18	0.74	0.65	0.95
Accumulated Calf Wt.	lbs	54.00	17.73	27.60	23.10	20.33
Weight Value @$0.70/lb	$	37.80	12.41	19.32	16.17	14.23
Net Return/c-c pr	$	-13.40	-22.98	-2.84	-3.36	-0.05
Net Return/acre	$	-2.91	-5.69	-1.12	-1.51	-0.03
Cost/lb of Calf Gain	$	0.95	1.99	0.80	0.85	0.70



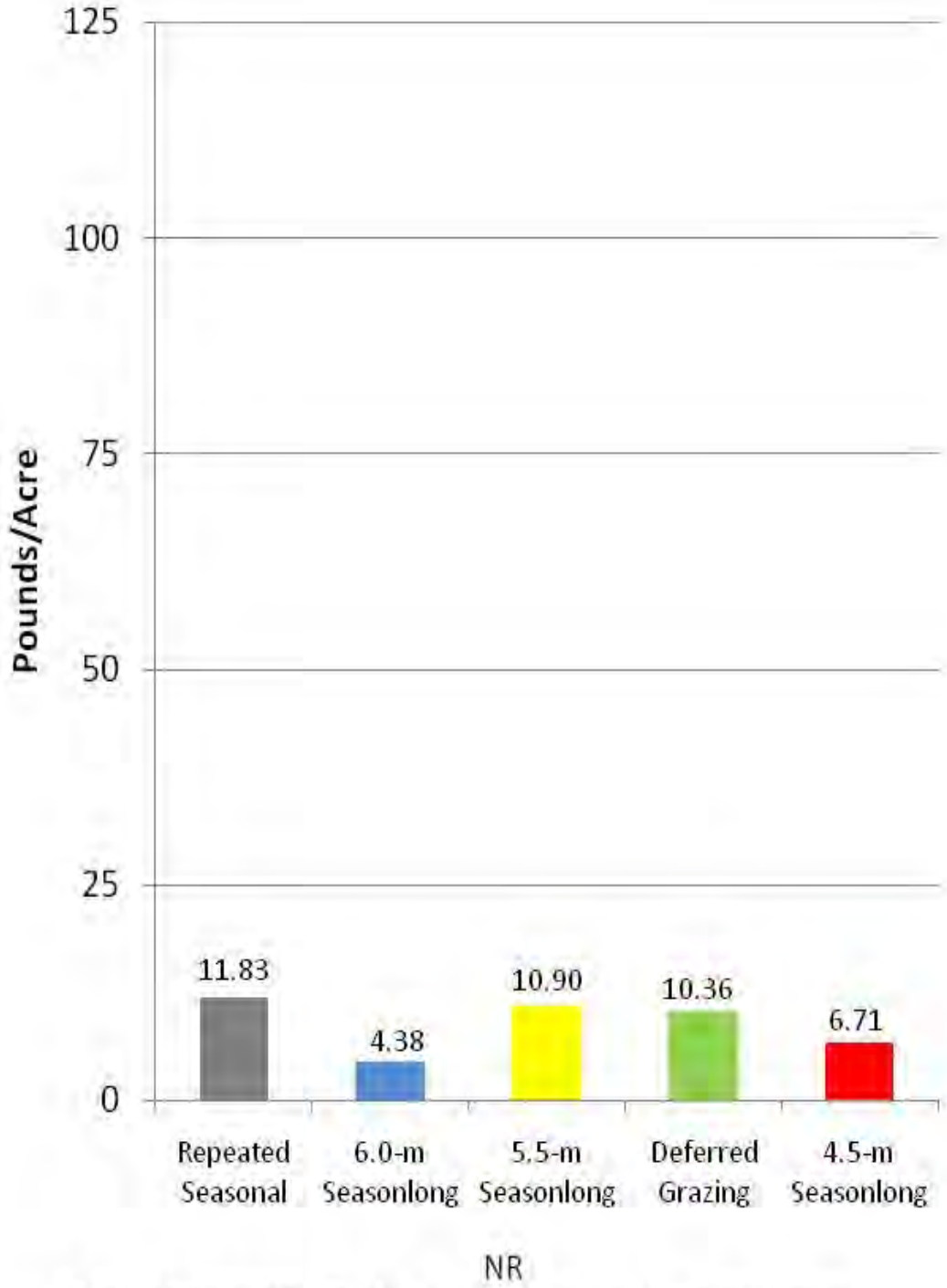
Crude Protein Weight Captured per Acre on Pasture Forages During Fall Lactation



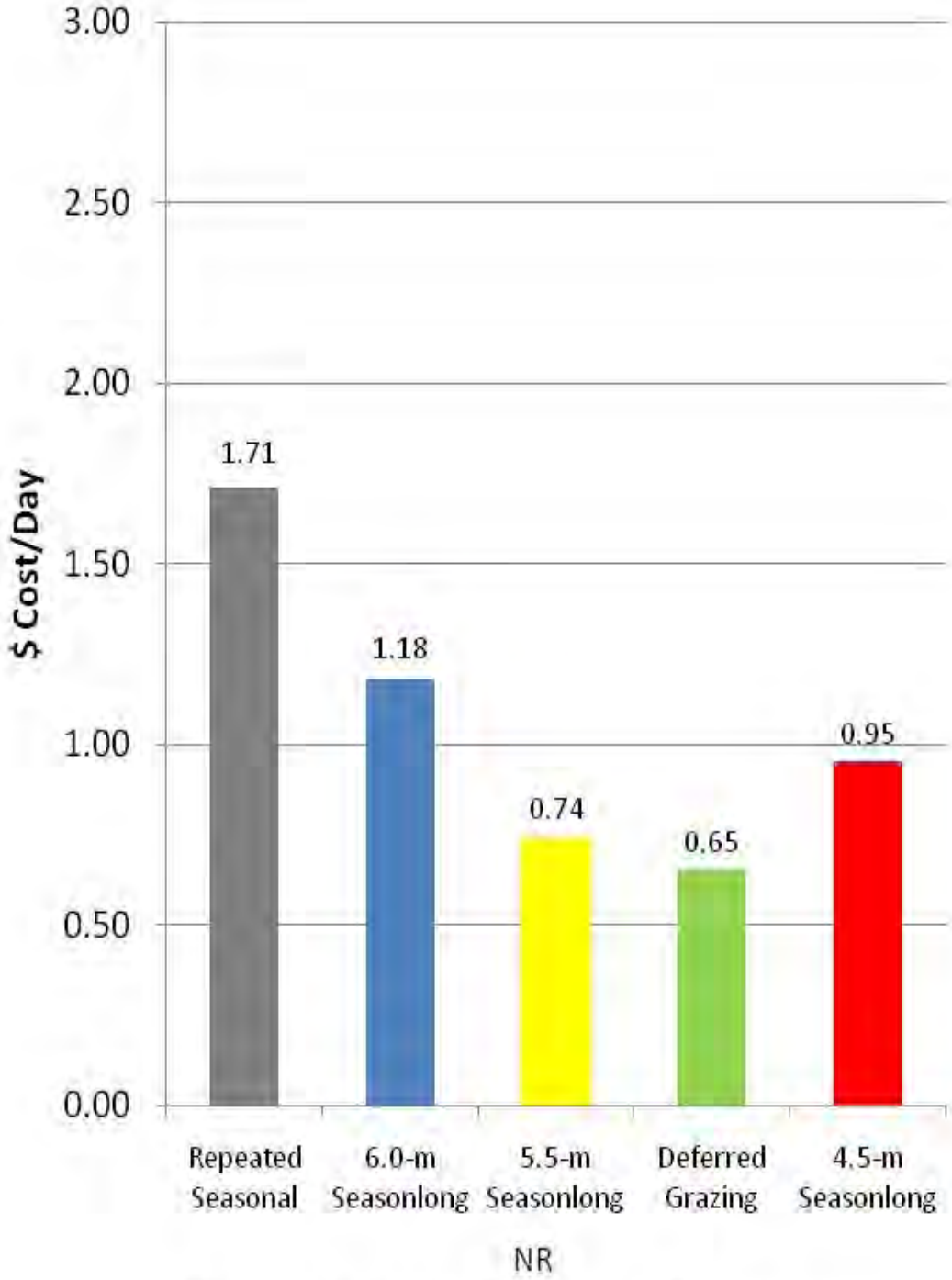
Crude Protein Cost per Pound
on Pasture Forages During Fall Lactation



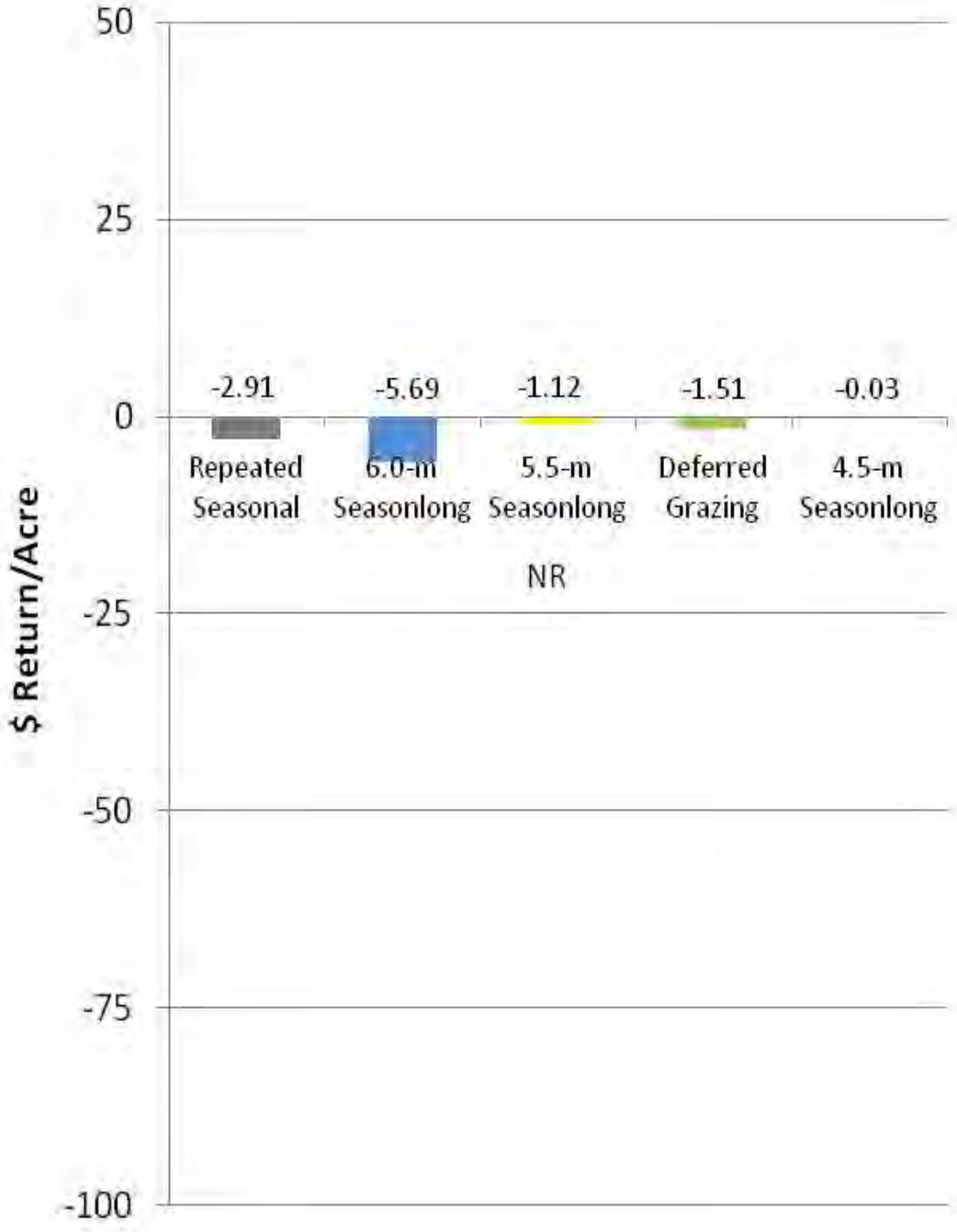
Cow Weight Gain per Acre on Pasture Forages During Fall Lactation



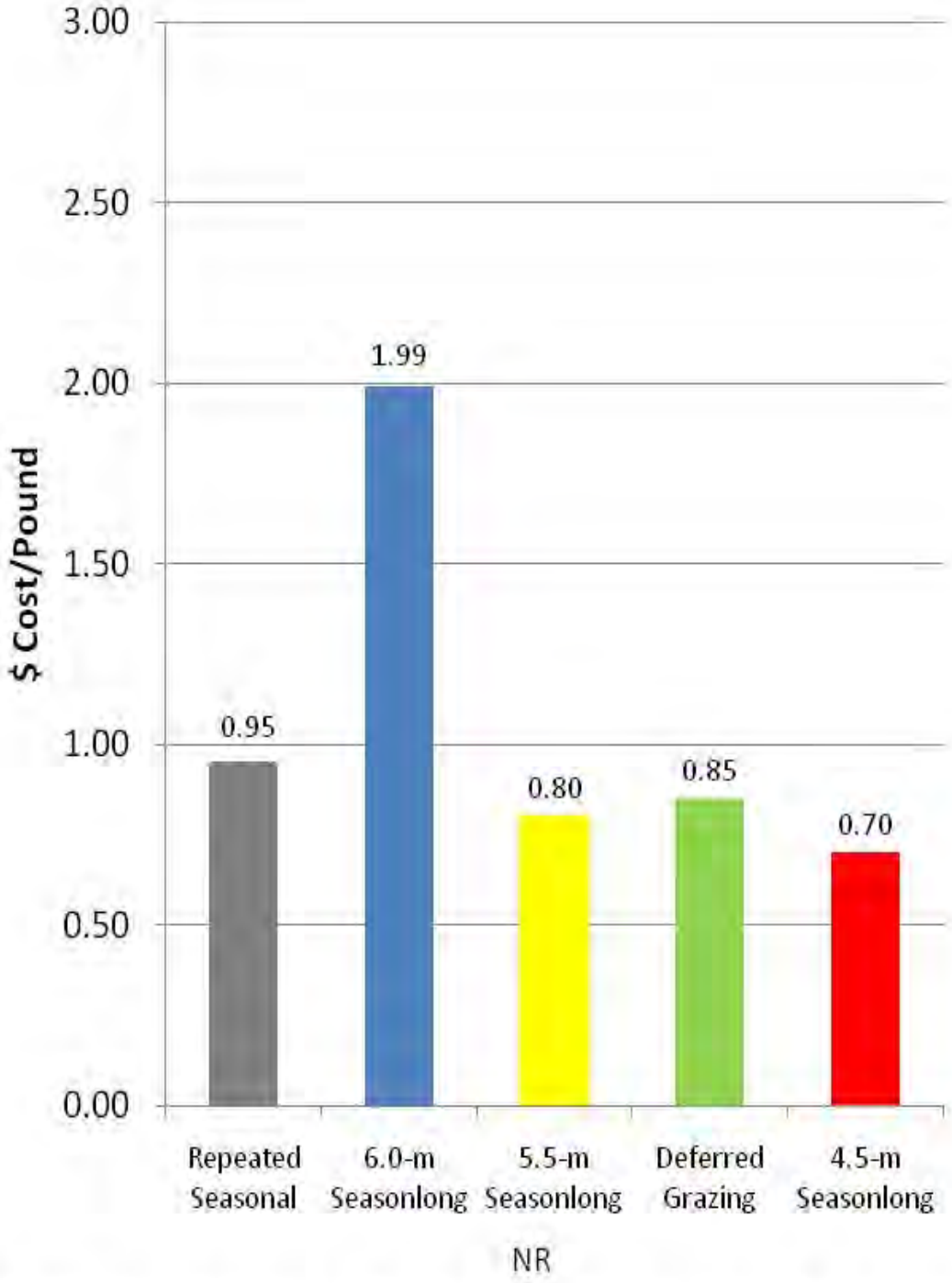
Calf Weight Gain per Acre on Pasture Forages During Fall Lactation



Forage Feed Costs per Day
on Pasture Forages During Fall Lactation



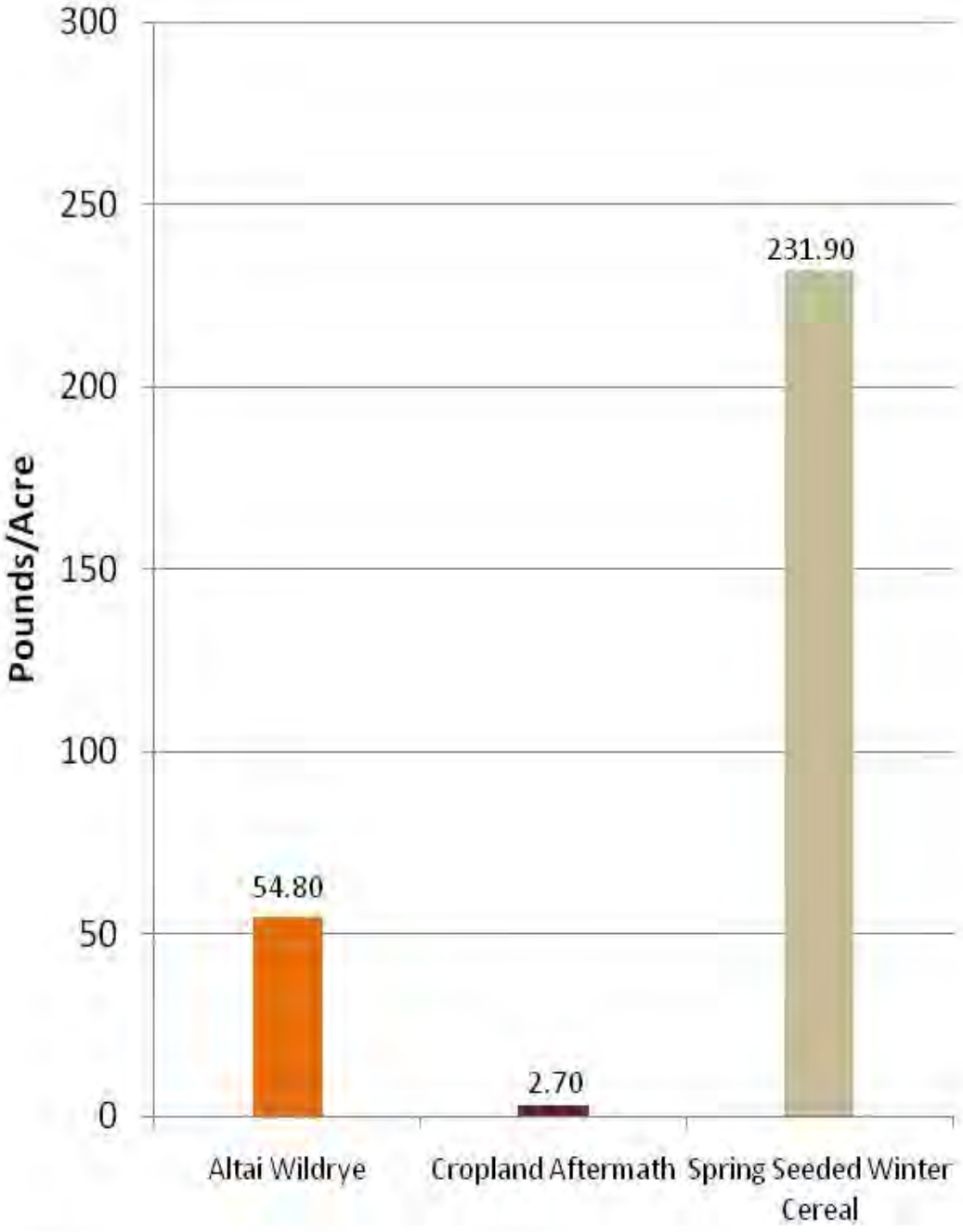
Returns After Feed Costs per Acre on Pasture Forages During Fall Lactation



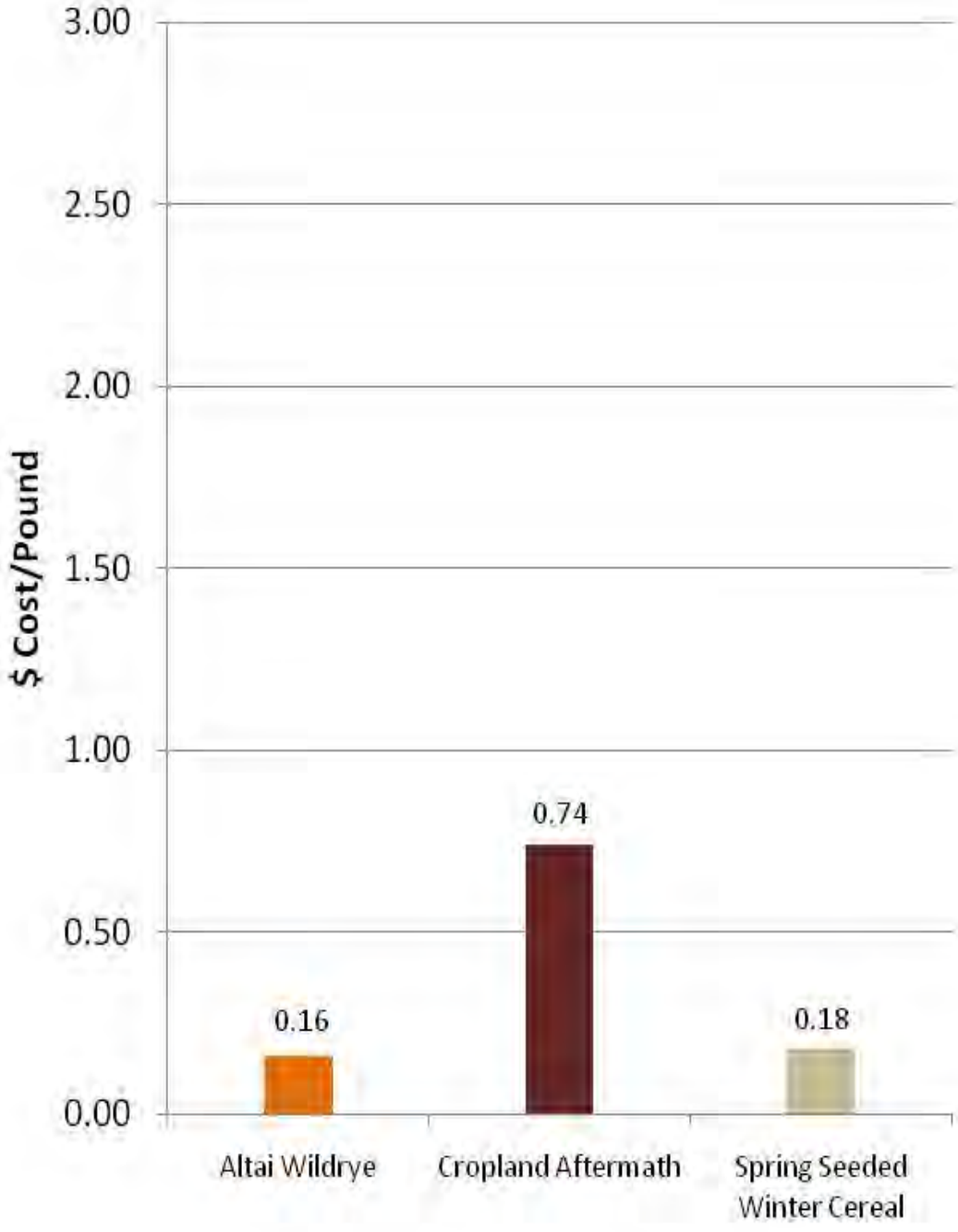
Calf Weight Gain Costs per Pound on Pasture Forages During Fall Lactation

Table 49. Costs and returns for domesticated grassland, cropland, and annual winter cereal pasture forage types to be grazed by range cows during the 30-day fall lactation production period.

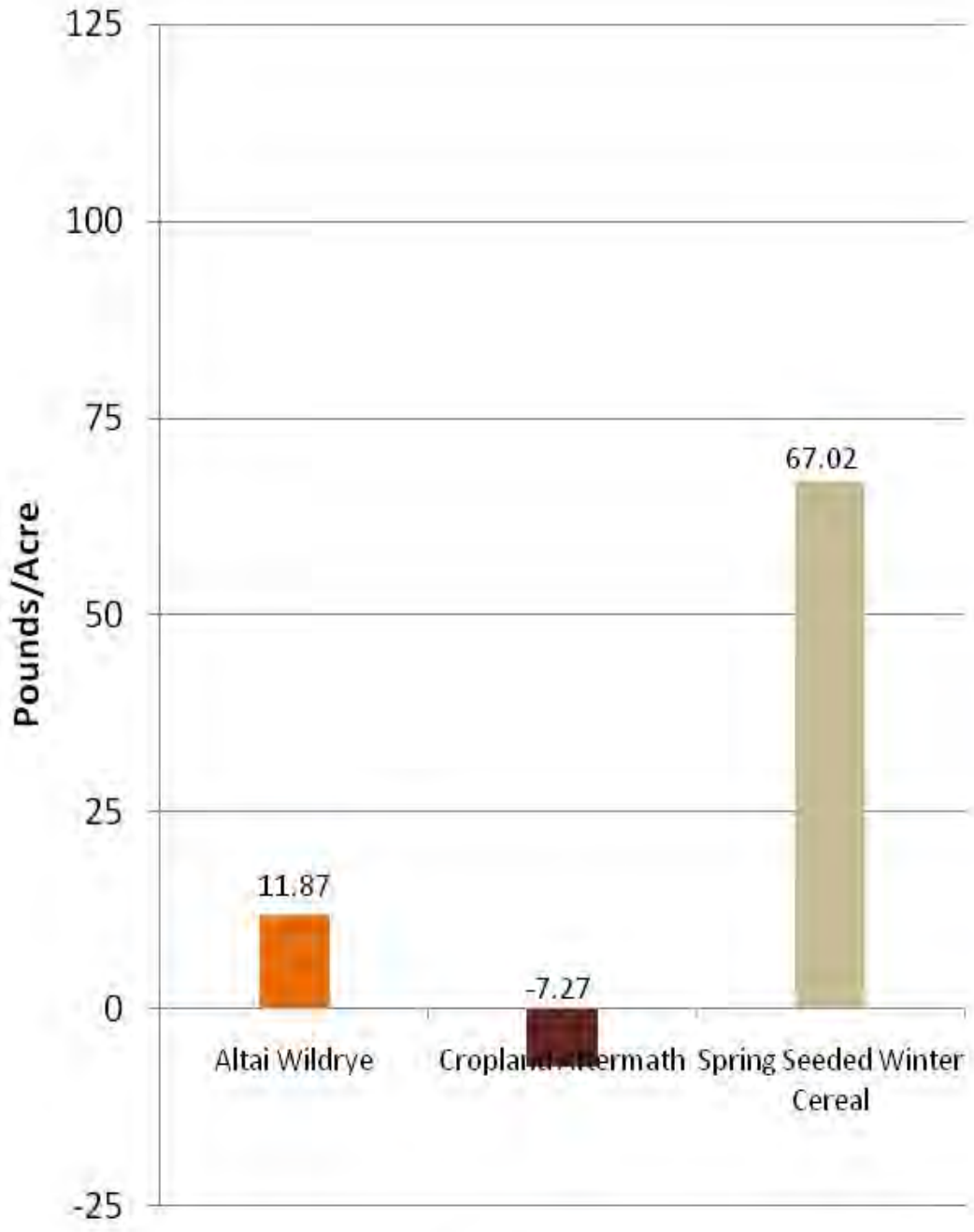
		Altai Wildrye Complementary Pasture	Cropland Aftermath Seasonal Pasture	Spring Seeded Winter Cereal Seasonal Pasture
Days		30	30	30
Growth Stage		fall	fall	Vegetative
Herbage Weight	lb/ac	2590	270	
Forage DM Weight	lb/ac	648	135	1908
Costs/Acre				
Land Rent	$	8.76	2.00	22.07
Custom Work	$			16.08
Seed Cost	$			3.60
Baling Costs	$			
Production Costs	$/ac	8.76	2.00	41.75
Forage DM Costs	$/ton	27.04	29.63	43.77
Crude Protein	%			
Crude Protein Yield	lb/ac			
Crude Protein Cost	$/lb			
Forage Allocation	lb/d	30.0	30.0	30.0
Land Area/Period	ac	1.39	6.63	0.47
Forage Costs/Period	$/pp	12.18	13.26	19.70
Supplementation				
Roughage/Day	lb/d			
Crude Protein/Day	lb/d			
Sup. Cost/Period	$/pp			
Total Feed Cost	$/pp	12.18	13.26	19.70
Cost/Day	$/d	0.40	0.44	0.66
Accumulated Calf Wt.	lbs	52.77	12.57	60.00
Weight Value @$0.70/lb	$	36.94	8.80	42.00
Net Return/c-c pr	$	24.76	-4.46	22.30
Net Return/acre	$	17.81	-0.67	47.45
Cost/lb of Calf Gain	$	0.23	1.05	0.33



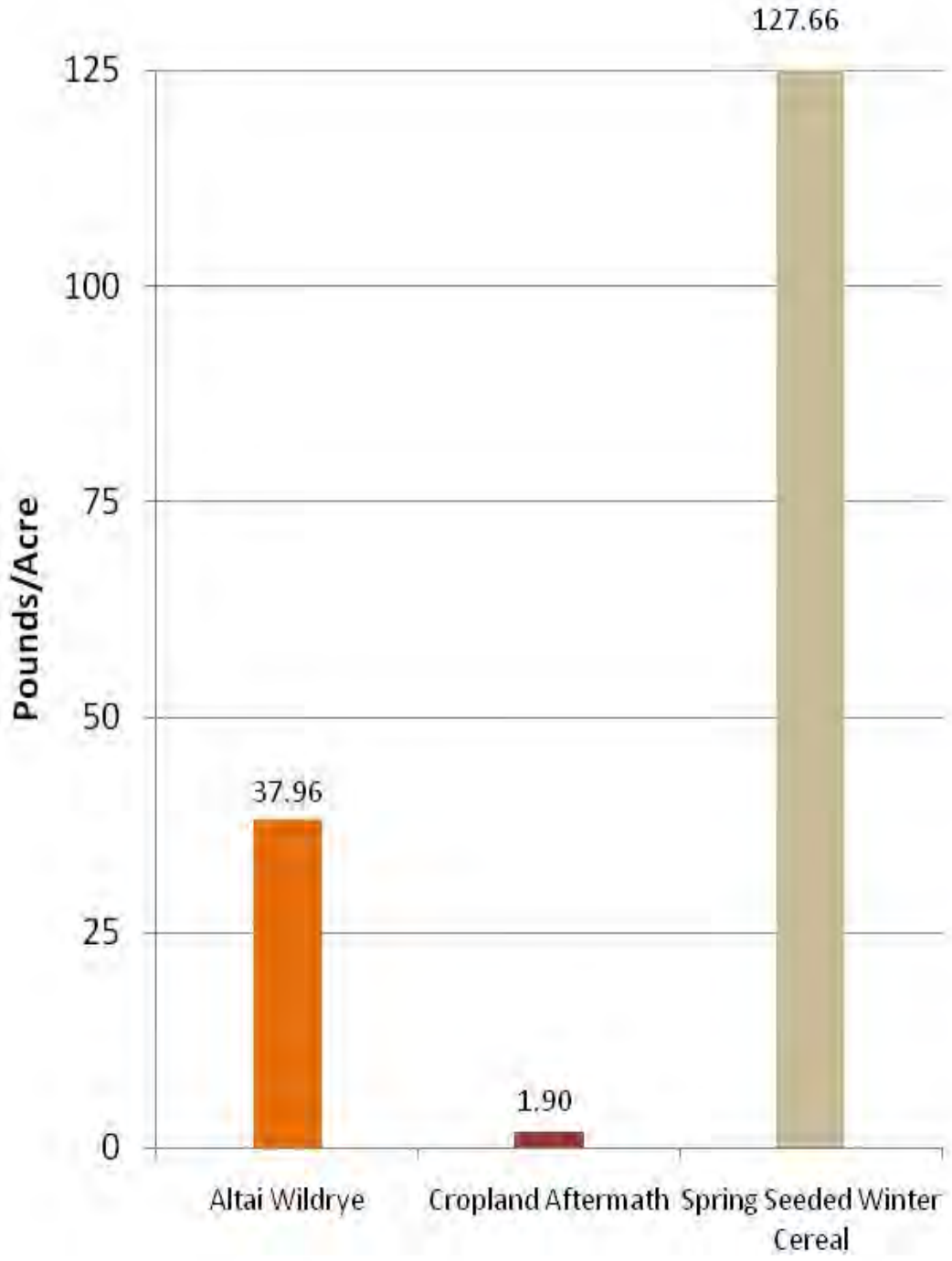
Crude Protein Weight Captured per Acre on Pasture Forages During Fall Lactation



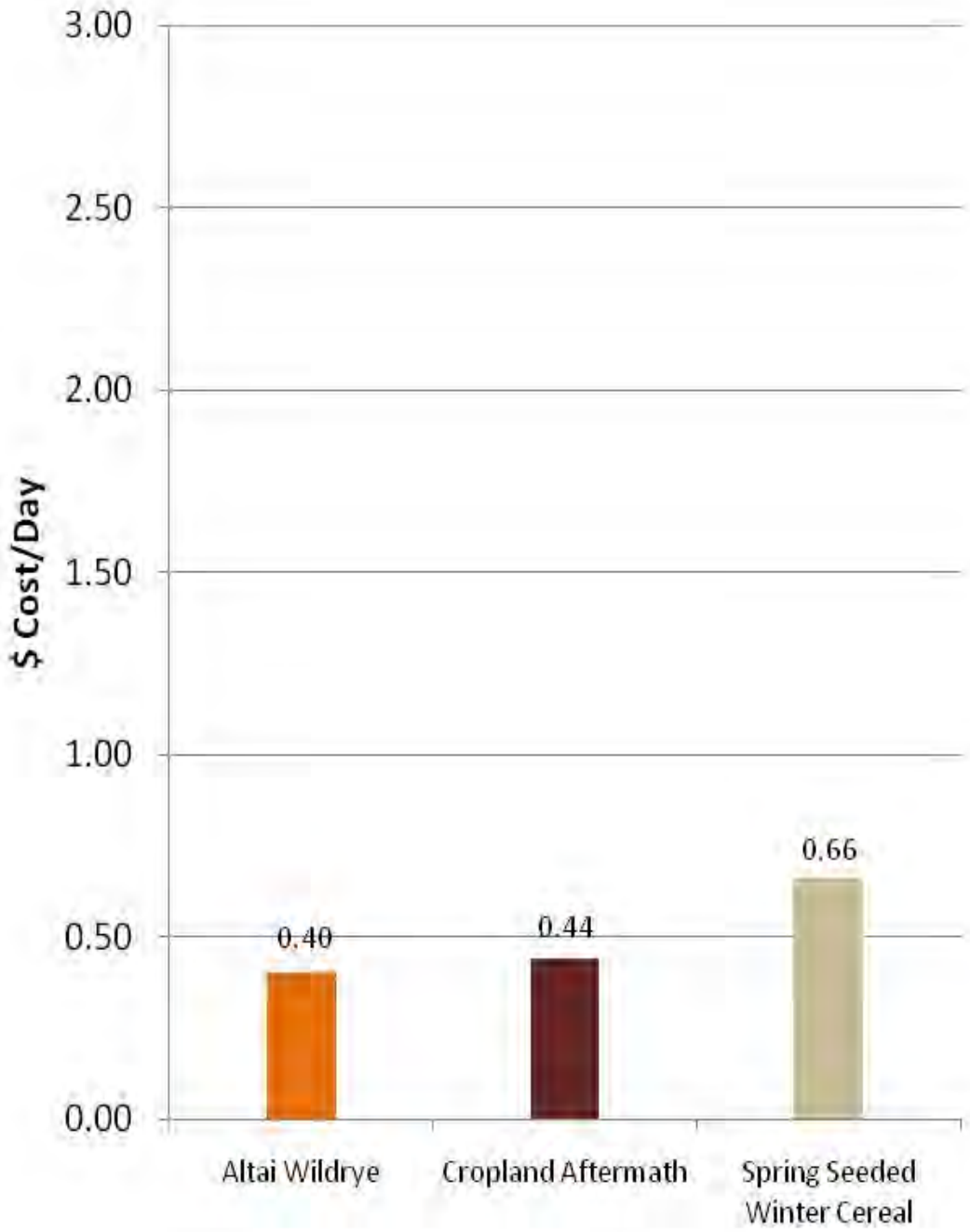
Crude Protein Cost per Pound
on Pasture Forages During Fall Lactation



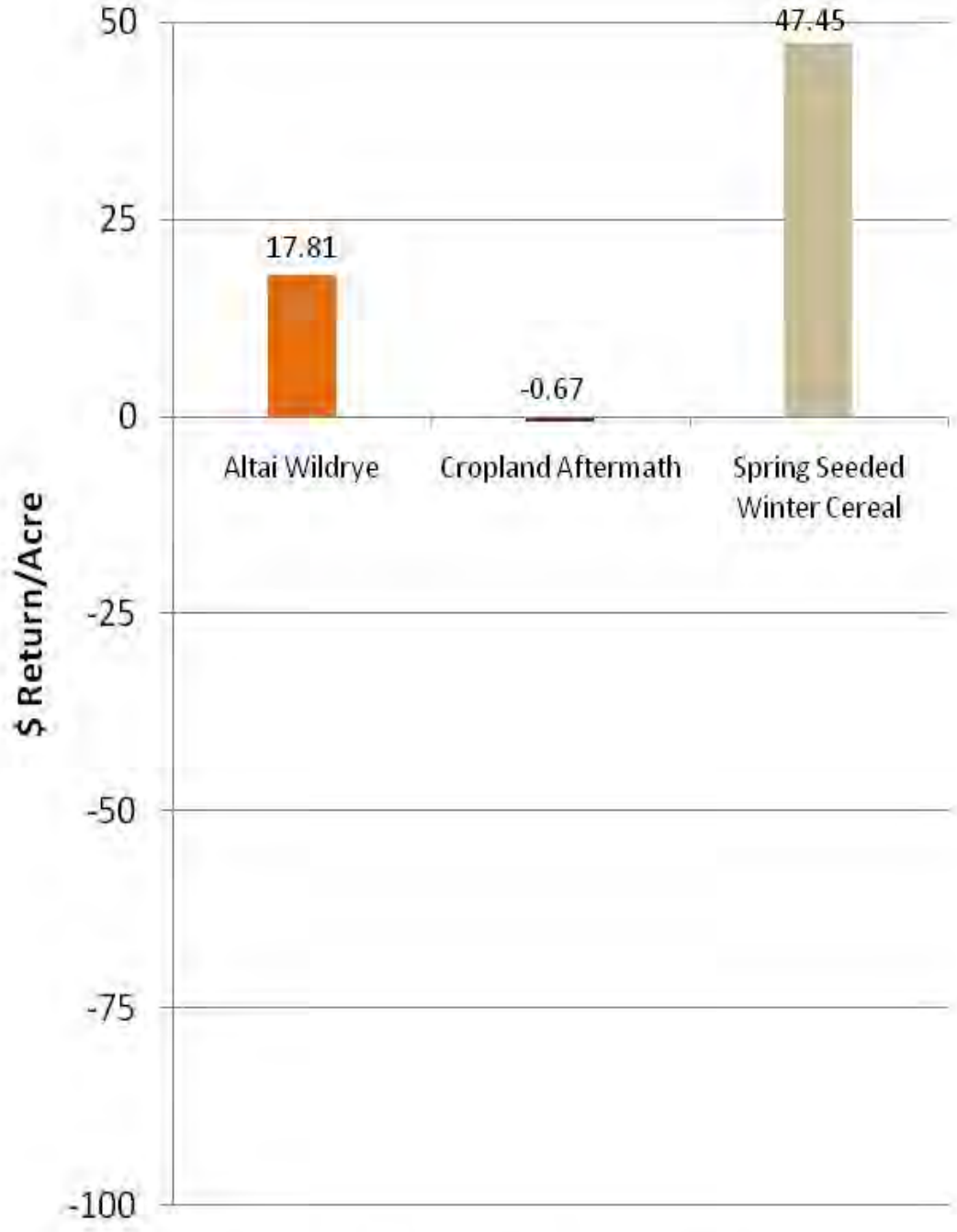
Cow Weight Gain per Acre on Pasture Forages During Fall Lactation



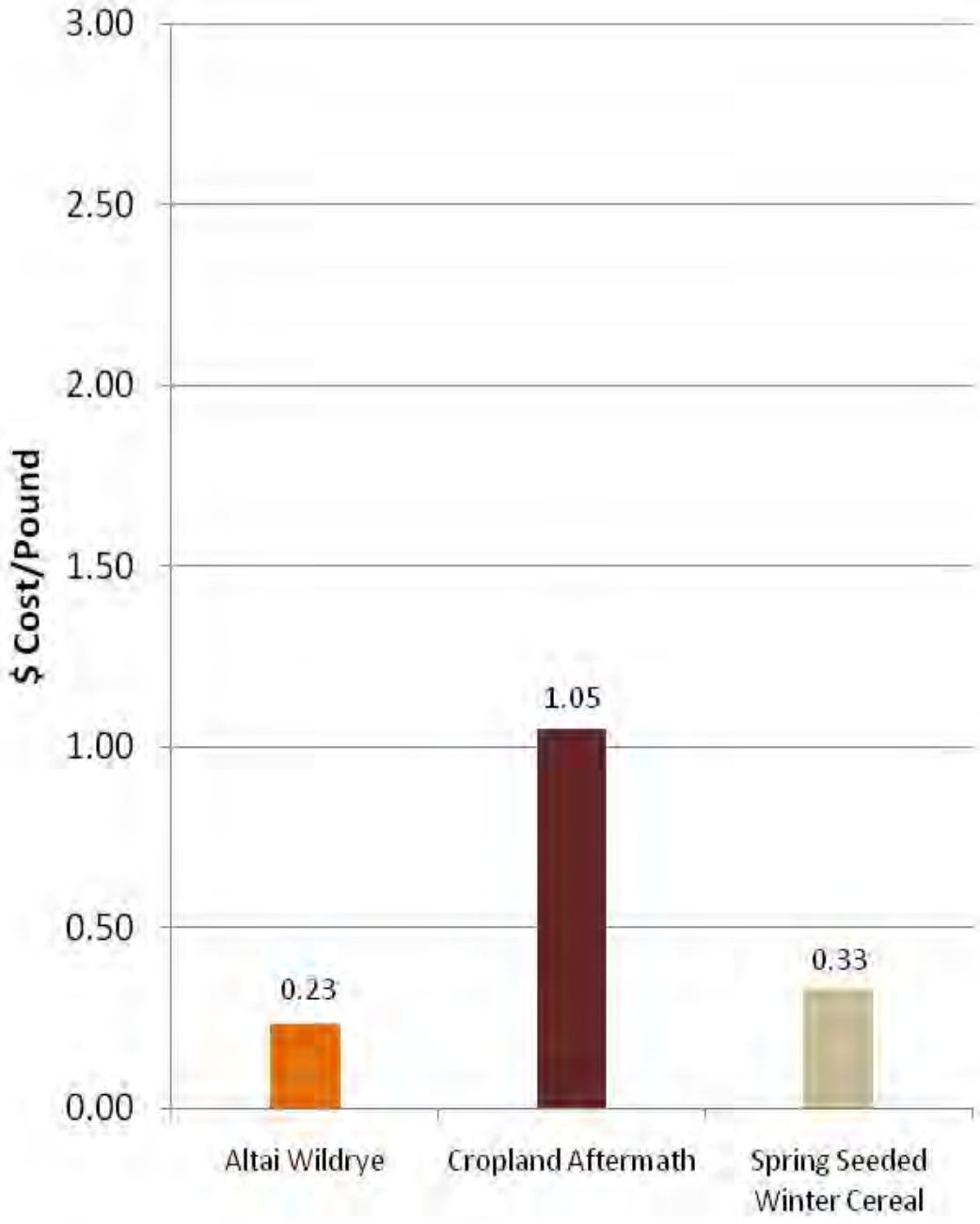
Calf Weight Gain per Acre on Pasture Forages During Fall Lactation



Forage Feed Costs per Day
on Pasture Forages During Fall Lactation



Returns After Feed Costs per Acre on Pasture Forages During Fall Lactation



Calf Weight Gain Costs per Pound on Pasture Forages During Fall Lactation

Table 50. Costs and returns for perennial grass harvested forage types to be fed to range cows during the 30-day fall lactation production period.

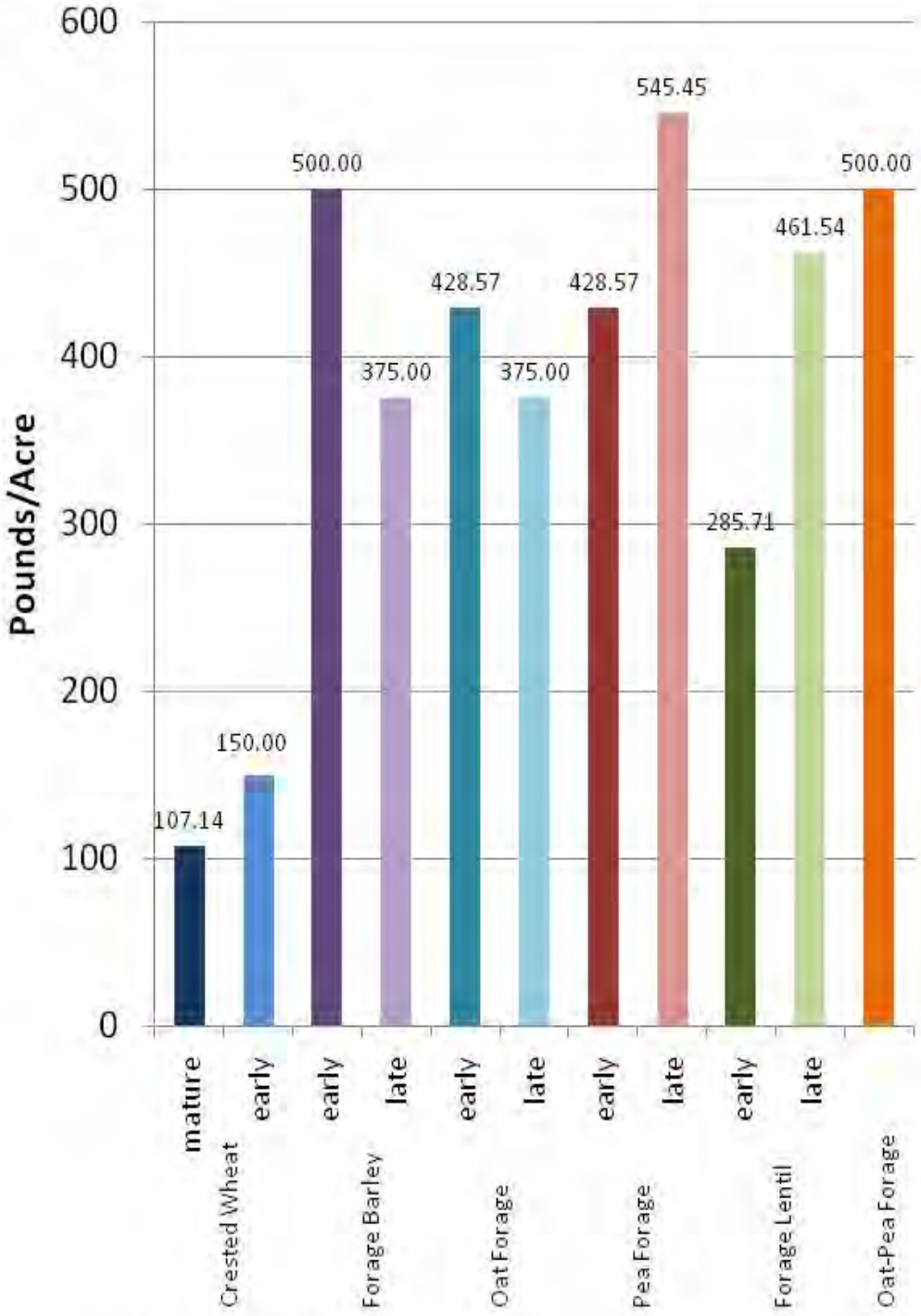
		Crested Wheatgrass Hay	Crested Wheatgrass Hay
Days		30	30
Growth Stage		Mature	Boot stage
Herbage Weight	lb/ac	-	-
Forage DM Weight	lb/ac	1600	1300
Costs/Acre			
Land Rent	$	14.22	14.22
Custom Work	$	5.31	5.31
Seed Cost	$	-	-
Baling Costs	$	8.58	6.97
Production Costs	$/ac	28.11	26.50
Forage DM Costs	$/ton	34.80	40.80
Crude Protein	%	6.4	14.5
Crude Protein Yield	lb/ac	102	189
Crude Protein Cost	$/lb	0.28	0.14
Forage Allocation	lb/d	30.0	17.3
Land Area/Period	ac	0.56	0.40
Forage Costs/Period	$/pp	15.84	10.50
Supplementation			
Roughage/Day	lb/d		12.7
Crude Protein/Day	lb/d	0.59	
Sup. Cost/Period	$/pp	5.31	6.66
Total Feed Cost	$/pp	21.15	17.16
Cost/Day	$/d	0.71	0.57
Accumulated Calf Wt.	lbs	60.0	60.0
Weight Value @$0.70/lb	$	42.00	42.00
Net Return/c-c pr	$	20.85	24.84
Net Return/acre	$	37.07	62.10
Cost/lb of Calf Gain	$	0.35	0.29

Table 51. Costs and returns for annual cereal harvested forage types to be fed to range cows during the 30-day fall lactation production period.

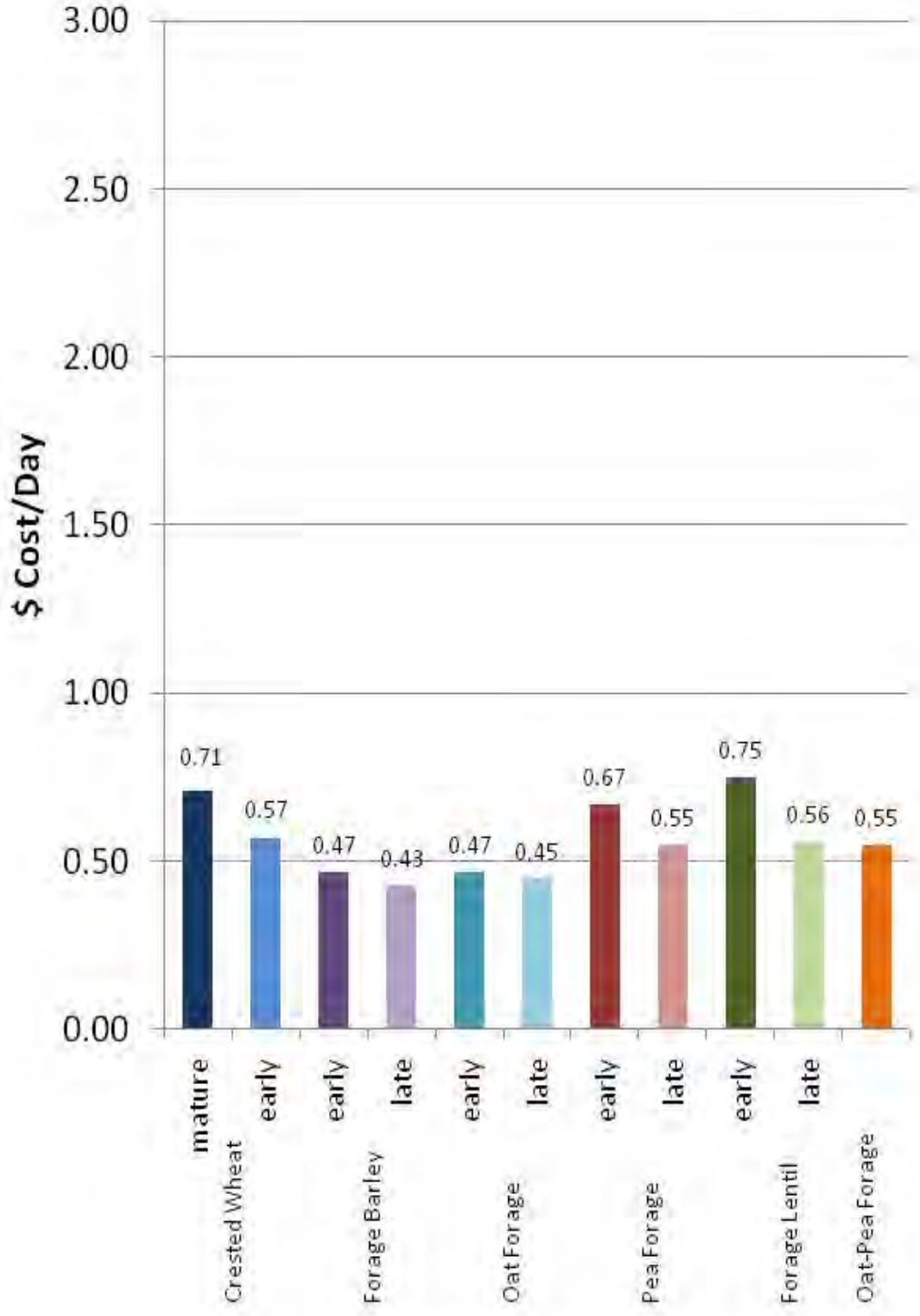
		Forage Barley Hay	Forage Barley Hay	Oat Forage Hay	Oat Forage Hay
Days		30	30	30	30
Growth Stage		Milk	Hard Dough	Milk	Hard Dough
Herbage Weight	lb/ac				
Forage DM Weight	lb/ac	4733	5133	4667	5667
Costs/Acre					
Land Rent	$	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08
Seed Cost	$	4.69	4.69	6.00	6.00
Baling Costs	$	25.37	27.51	25.02	30.38
Production Costs	$/ac	68.21	70.35	69.17	74.53
Forage DM Costs	$/ton	28.80	27.40	29.60	26.40
Crude Protein	%	13.0	9.2	11.5	7.8
Crude Protein Yield	lb/ac	606	468	535	435
Crude Protein Cost	$/lb	0.11	0.15	0.13	0.17
Forage Allocation	lb/d	19.3	27.3	21.8	30.0
Land Area/Period	ac	0.12	0.16	0.14	0.16
Forage Costs/Period	$/pp	8.40	11.40	9.90	11.88
Supplementation					
Roughage/Day	lb/d	10.7	2.7	8.2	
Crude Protein/Day	lb/d				0.17
Sup. Cost/Period	$/pp	5.62	1.42	4.31	1.53
Total Feed Cost	$/pp	14.02	12.82	14.21	13.41
Cost/Day	$/d	0.47	0.43	0.47	0.45
Accumulated Calf Wt.	lbs	60.0	60.0	60.0	60.0
Weight Value @$0.70/lb	$	42.00	42.00	42.00	42.00
Net Return/c-c pr	$	27.98	29.18	27.79	28.59
Net Return/acre	$	233.17	182.38	198.50	178.69
Cost/lb of Calf Gain	$	0.23	0.21	0.24	0.22

Table 52. Costs and returns for annual legume harvested forage types to be fed to range cows during the 30-day fall lactation production period.

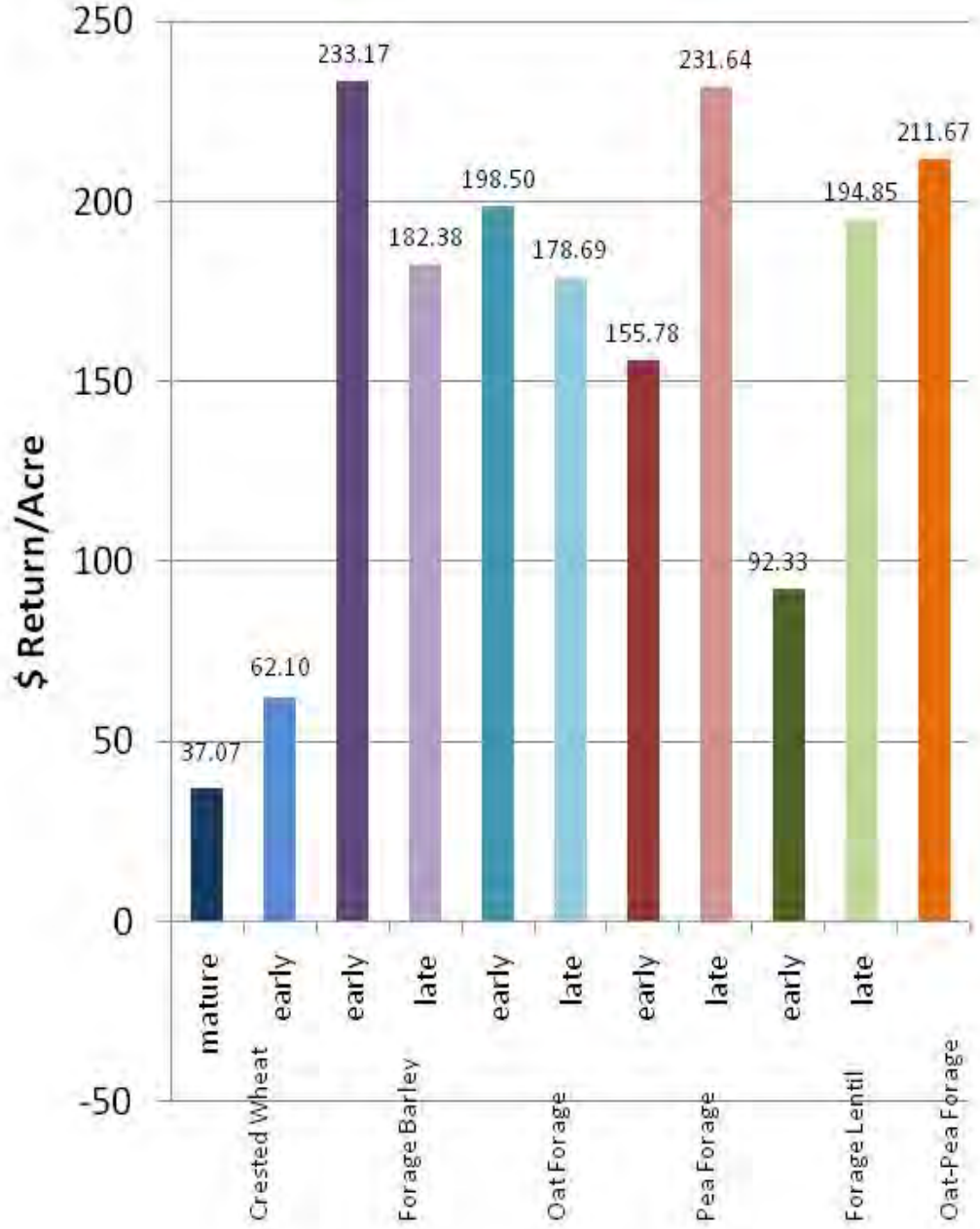
		Pea Forage Hay	Pea Forage Hay	Forage Lentil Hay	Forage Lentil Hay	Oat-Pea Hay
Days		30	30	30	30	30
Growth Stage		Early	Late	Early	Late	
Herbage Weight	lb/ac					
Forage DM Weight	lb/ac	2800	4650	1667	3867	5143
Costs/Acre						
Land Rent	$	22.07	22.07	22.07	22.07	22.07
Custom Work	$	16.08	16.08	16.08	16.08	16.08
Seed Cost	$	23.80	23.80	12.60	12.60	29.80
Baling Costs	$	15.01	24.92	8.94	20.73	27.57
Production Costs	$/ac	79.96	86.87	59.69	71.48	95.52
Forage DM Costs	$/ton	55.00	37.40	71.60	37.00	37.20
Crude Protein	%	18.9	14.4	21.8	14.7	12.5
Crude Protein Yield	lb/ac	526	685	361	567	611
Crude Protein Cost	$/lb	0.15	0.13	0.17	0.13	0.16
Forage Allocation	lb/d	13.3	17.4	11.5	17.1	20.1
Land Area/Period	ac	0.14	0.11	0.21	0.13	0.12
Forage Costs/Period	$/pp	11.40	9.90	12.90	9.90	11.40
Supplementation						
Roughage/Day	lb/d	16.7	12.6	18.5	12.9	9.9
Crude Protein/Day	lb/d					
Sup. Cost/Period	$/pp	8.79	6.62	9.71	6.77	5.20
Total Feed Cost	$/pp	20.19	16.52	22.61	16.67	16.60
Cost/Day	$/d	0.67	0.55	0.75	0.56	0.55
Accumulated Calf Wt.	lbs	60.0	60.0	60.0	60.0	60.0
Weight Value @$0.70/lb	$	42.00	42.00	42.00	42.00	42.00
Net Return/c-c pr	$	21.81	25.48	19.39	25.33	25.40
Net Return/acre	$	155.78	231.64	92.33	194.85	211.67
Cost/lb of Calf Gain	$	0.34	0.28	0.38	0.28	0.28



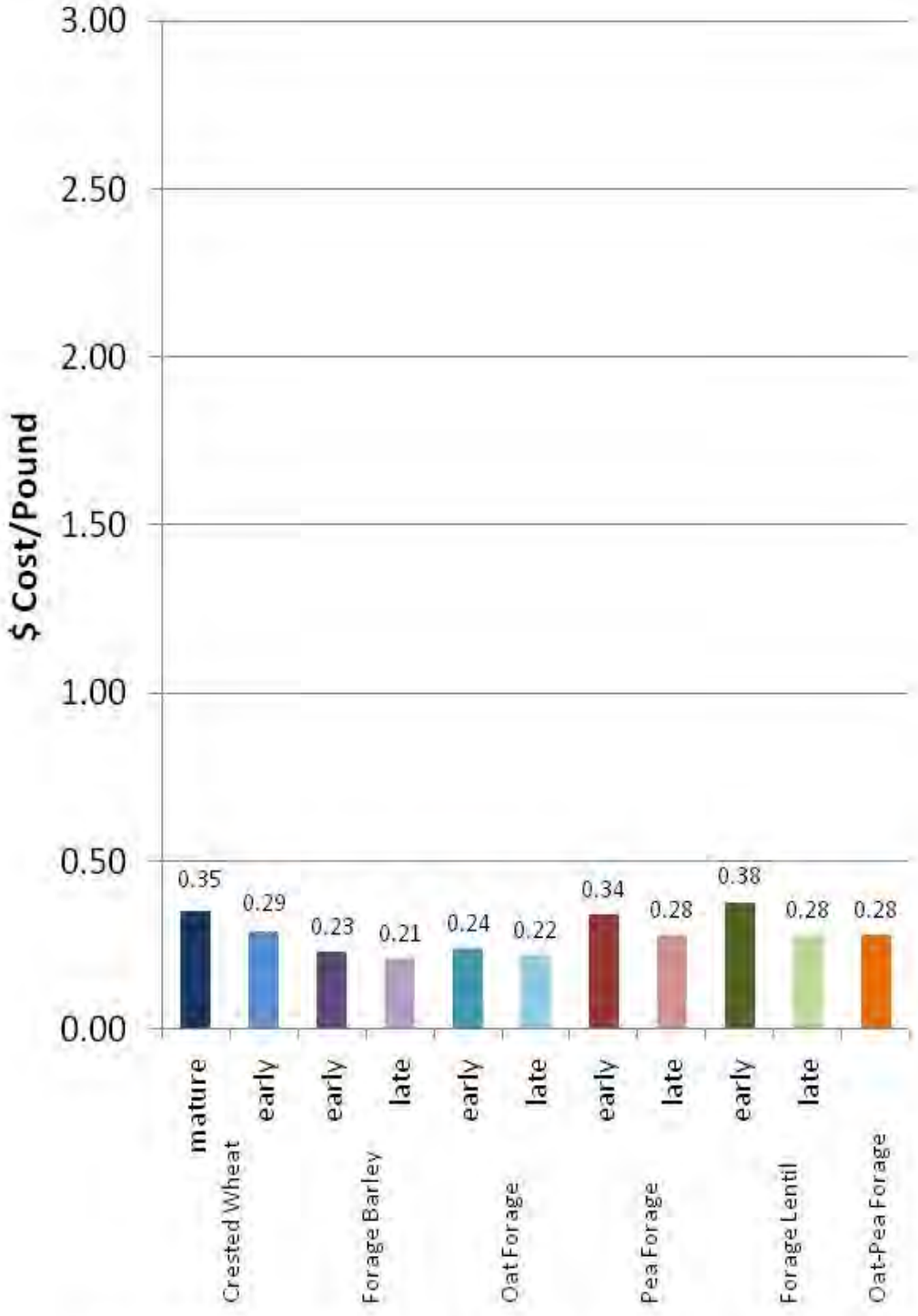
Calf Weight Gain per Acre on Harvested Forages During Fall Lactation



Forage Feed Costs per Day on Harvested Forages During Fall Lactation



Returns After Feed Costs per Acre on Harvested Forages During Fall Lactation



Calf Weight Gain Costs per Pound on Harvested Forages During Fall Lactation

Table 53. Feed quantity and land area for forage types used during the 30-day fall lactation production period.

Forage Types	Daily Feed per Cow			Fall Lactation Period Feed one Cow for 30 days			
	Forage lb/d	Roughage lb/d	Crude Protein lb/d	Forage lb/pp	Roughage lb/pp	Crude Protein lb/pp	Land Area ac/pp
Pasture Forage Types							
Native Rangeland Repeated Seasonal	30.0		1.21	900.0		36.30	4.60
6.0-m Seasonlong	30.0			900.0			4.04
5.5-m Seasonlong	30.0			900.0			2.53
Deferred Grazing	30.0			900.0			2.18
4.5-m Seasonlong (15d)	26.0			390.0			1.63
Altai Wildrye	30.0			900.0			1.39
Crop Aftermath	30.0			900.0			6.63
Spring Seeded Winter Cereal	30.0			900.0			0.47
Harvested Forage Types							
Crested Wheat, mature	30.0		0.59	900.0		17.70	0.56
Crested Wheat, early	17.3	12.7		519.0	381.0		0.40
Forage Barley, early	19.3	10.7		579.0	321.0		0.12
Forage Barley, late	27.3	2.7		819.0	81.0		0.16
Oat Forage, early	21.8	8.2		654.0	246.0		0.14
Oat Forage, late	30.0		0.17	900.0		5.10	0.16
Pea Forage, early	13.3	16.7		399.0	501.0		0.14
Pea Forage, late	17.4	12.6		522.0	378.0		0.11
Forage Lentil, early	11.5	18.5		345.0	555.0		0.21
Forage Lentil, late	17.1	12.9		513.0	387.0		0.13
Oat-Pea Forage	20.1	9.9		603.0	297.0		0.12

Table 54. Summary of feed costs for forage types used during the 30-day fall lactation production period.

Forage Types	Forage Costs $/pp	Roughage Costs $/pp	Crude Protein Costs $/pp	Total Feed Costs $/pp	Daily Feed Costs $/d
Pasture Forage Types					
Native Rangeland Repeated Seasonal	40.30		10.90	51.20	1.71
6.0-m Seasonlong	35.39			35.39	1.18
5.5-m Seasonlong	22.16			22.16	0.74
Deferred Grazing	19.53			19.53	0.65
4.5-m Seasonlong (15d)	14.28			14.28	0.95
Altai Wildrye	12.18			12.18	0.40
Cropland Aftermath	13.26			13.26	0.44
Spring Seeded Winter Cereal	19.70			19.70	0.66
Harvested Forage Types					
Crested Wheat, mature	15.84		5.31	21.15	0.71
Crested Wheat, early	10.50	6.66		17.16	0.57
Forage Barley, early	8.40	5.62		14.02	0.47
Forage Barley, late	11.40	1.42		12.82	0.43
Oat Forage, early	9.90	4.31		14.21	0.47
Oat Forage, late	11.88		1.53	13.41	0.45
Pea Forage, early	11.40	8.79		20.19	0.67
Pea Forage, late	9.90	6.62		16.52	0.55
Forage Lentil, early	12.90	9.71		22.61	0.75
Forage Lentil, late	9.90	6.77		16.67	0.56
Oat-Pea Forage	11.40	5.20		16.60	0.55

Table 55. Summary of returns after feed costs for forage types used during the 30-day fall lactation production period.

Forage Types	Gross Return @$0.70/lb $/calf	Net Return per C-C pr $/pr	Net Return per acre $/ac	Calf Gain Cost $/lb
Pasture Forage Types				
Native Rangeland Repeated Seasonal	37.80	-13.40	-2.91	0.95
6.0-m Seasonlong	12.41	-22.98	-5.69	1.99
5.5-m Seasonlong	19.32	-2.84	-1.12	0.80
Deferred Grazing	16.17	-3.36	-1.51	0.85
4.5-m Seasonlong (15d)	14.23	-0.05	-0.03	0.70
Altai Wildrye	36.94	24.76	17.81	0.23
Cropland Aftermath	8.80	-4.46	-0.67	1.05
Spring Seeded Winter Cereal	42.00	22.30	47.45	0.33
Harvested Forage Types				
Crested Wheat, mature	42.00	20.85	37.07	0.35
Crested Wheat, early	42.00	24.84	62.10	0.29
Forage Barley, early	42.00	27.98	233.17	0.23
Forage Barley, late	42.00	29.18	182.38	0.21
Oat Forage, early	42.00	27.79	198.50	0.24
Oat Forage, late	42.00	28.59	178.69	0.22
Pea Forage, early	42.00	21.81	155.78	0.34
Pea Forage, late	42.00	25.48	231.64	0.28
Forage Lentil, early	42.00	19.39	92.33	0.38
Forage Lentil, late	42.00	25.33	194.85	0.28
Oat-Pea Forage	42.00	25.40	211.67	0.28

Selection of Pasture Forage and Harvested Forage Types

The North American beef herd has been transformed over the past 40 to 50 years, and we now have high-performance, fast-growing meat animals with improved genetic potential and increased nutrient demands, nevertheless, the industry continues to use traditional pasture forage and harvested forage management technology developed for the old-style low-performance cow.

Modern, high-performance cattle are larger and heavier, gain weight more rapidly, produce more milk, and deposit less fat on their bodies than old-style cattle. The greater size of modern animals increases their nutrient demand, and their higher production levels increase the demand further so that the additional quantities of required nutrients are not simply proportionate to the animals' greater size.

A high-performance cow that has medium milk production and is 20% larger than an old-style animal requires 24% more energy and 33% more crude protein per year than the old-style animal. A high-performance cow requires 20% more energy and 24% more crude protein during the period from mid November to late April. She also requires 27% more energy and 41% more crude protein per day during the lactation period from early May to mid November (table 56). A high-performance cow that has high milk production requires 43% more energy and 72% more crude protein per day during the lactation period than the old-style cow (table 57).

The basic components of the traditional forage management practices have not changed in decades. Forage dry matter quantities are still used as the measure when producers make major pasture and harvested forage management decisions. Pasture stocking rates are determined from estimates of herbage dry matter production. Harvested forages are cut at the time when the greatest dry matter weight can be captured and hay is traded on the dry matter weight basis per bale or ton. Traditional forage management practices inhibit the modern beef animal from performing at its genetic capability, and the result is profit margins below potential. High-performance livestock do not have the fat reserves that old-style animals produced and could draw on when forage quality was insufficient. Periods with nutrient deficiency limit modern beef animals' production. Modern cattle perform at greater efficiency when their nutritional demands are met during each production period.

Results

Evaluation of pasture forage types and harvested forage types that meet nutrient and dry matter requirements of modern range cows during each of their production periods is complicated. The various pasture forage types and harvested forage types have complex differences in their management practices, production costs per acre, plant growth stages at time of grazing or haying, quantity of forage dry matter harvested per acre, and weight of nutrients captured per acre. These differences affect animal weight performance and influence forage feed costs making comparisons of forage types and management practices difficult.

Evaluation and selection of forage types should be based on systematic comparisons of quantitative information for the multiple factors that influence forage feed costs and returns after feed costs during each production period. The quantifiable factors that should be included in the evaluations of forage types are harvested or grazed forage dry matter weight per acre, captured crude protein weight per acre, land area per cow-calf pair, cow size, cow and calf weight performance, land rent costs, equipment and labor costs, seed costs, production costs per acre, forage dry matter costs, crude protein costs per pound, supplemental roughage or crude protein costs, total forage feed costs, forage feed costs per day, calf weight gain costs per pound, market value of calf weight, returns after feed costs per cow-calf pair, and returns after feed costs per acre.

All of these quantified factors are necessary for thorough comparisons of forage types, however, not all of the factors have equal diagnostic value in selection of low cost forage types or in identification of forage types that efficiently capture high value from the land natural resources. The quantitative values for land rent costs, equipment and labor costs, seed costs, production costs per acre, and forage dry matter costs influence livestock feed costs but do not directly regulate forage feed costs and consequently do not have diagnostic value in selection of low cost forage types. The quantitative values for crude protein costs per pound, calf weight gain costs during the periods the calf is at the side of the cow, and forage feed costs per day including the supplemental roughage or crude protein costs directly affects livestock feed costs and are the three most important factors with diagnostic value in selection of low cost

forage types. The quantitative values for size of land area per cow-calf pair, and returns after feed costs per acre are the two most important factors with diagnostic value in identification of forage types that efficiently capture high value from the land natural resources.

Production costs per acre for harvested forage types include land rent costs, seed costs, and equipment and labor costs to plant and harvest a forage type. Production costs per acre for pasture forage types include land rent costs plus any custom farm work costs. Production costs per acre for harvested forage types are greater than production costs for pasture forage types. However, neither production costs for harvested forage types or production costs for pasture forage types accurately reflects the respective forage feed costs because forage dry matter weight per acre and nutrient weight per acre captured through grazing or haying vary with forage type and plant growth stage, and these variations are not proportional with the production costs for harvested forage types and pasture forage types. None of the individual costs that compose the production costs per acre should be the criterion on which selection of forage types are based.

A comparison between a harvested forage type with high production costs and a pasture forage type with low production costs demonstrates that forage production costs do not directly regulate forage feed costs. During the 45-day early lactation production period from mid March to late April, forage barley hay cut at the milk stage had high production costs of $68.21 per acre and reserved native rangeland pasture had low production costs of $8.76 per acre. Forage barley hay produced 4733 pounds of dry matter and captured 606 pounds of crude protein per acre. Reserved native rangeland pasture had 125 pounds of forage dry matter and captured 11.5 pounds of crude protein per acre. The forage dry matter and crude protein requirements for a 1200 lb cow with a calf were provided from 0.20 acres of forage barley hay cut early and on 10.8 acres of reserved native rangeland pasture. The forage feed costs including total forage and supplemental roughage costs were $18.23 per production period, or $0.41 per day for the forage barley hay and the forage feed costs including total pasture forage costs were $94.64 per production period, or $2.10 per day for the reserved native rangeland pasture. Even though the production costs per acre for the reserved native rangeland pasture were a small fraction of the production costs per acre for the forage barley hay, the forage feed costs per day were more than five times greater on the reserved native rangeland pasture than the forage feed costs for the forage barley hay.

Cost of forage dry matter per ton is commonly used to compare different harvested forage types, but cost per ton of pasture forage dry matter consumed by grazing livestock is generally not considered by livestock producers when comparing costs of different management strategies. Many traditional late season grazing treatments would not be used if the pasture forage dry matter costs were known. The cost per ton of forage dry matter reflects the relationship between pasture rent per acre or production costs per acre and the quantity of forage dry matter consumed by grazing livestock or harvested for hay. Forage dry matter, however, does not have a real economic value because dry matter is not incorporated into the beef weight produced. The forage dry matter is simply the carrier of the nutrients it contains. The cost of forage dry matter per ton, or per pound, does not directly regulate the forage feed costs per day of forage types that meet cow daily dry matter requirements because forage dry matter costs do not respond proportionally to the variation in quantities of nutrients contained within the dry matter. The nutrient content of a forage type determines the quantity of forage dry matter needed to meet cow daily nutrient requirements.

A comparison between a hay that costs $50.00/ton and a hay that costs $70.00/ton fed during the 90-day third trimester to 1200 lb cows that require 24 lbs DM/day and 1.87 lbs CP/day demonstrates that the forage dry matter costs are not directly related to the forage feed costs.

The hay that costs $50.00/ton has a crude protein content of 6.0%. The $50.00/ton hay would be fed at 24.0 lbs DM/day to provide 1.44 lbs CP/day. The forage would cost $54.00 per production period. The crude protein content of this hay is below the dietary requirements of a cow in the third trimester. An additional 0.43 lbs of crude protein supplement per day would need to be provided, at a cost of $11.61 per period. Total forage and supplement costs would be $65.61 per period, or $0.73 per day.

The hay that costs $70.00/ton has a crude protein content of 16.0%. The $70.00/ton hay would be fed at 11.69 lbs DM/day to provide 1.87 lbs CP/day. The forage would cost $36.82 per production period. An additional 12.31 lbs of roughage supplement per day would need to be provided, at a cost of $19.39 per period. Total forage and supplement costs would be $56.21 per period, or

$0.62 per day. The hay that has the lower forage dry matter cost per ton does not have the lower forage feed cost per day.

Cost per pound of crude protein is an important indicator of forage feed costs per day. Crude protein cost per pound is related to the production cost per acre and the weight per acre of crude protein captured by grazing or haying. The proportion of produced crude protein weight captured by grazing or haying is a measure of the management strategy's efficiency. The efficiency of crude protein capture is reflected in the cost per pound of crude protein; the greater the efficiency, the lower the cost. The cost per pound of crude protein in feedstuffs directly regulates the forage feed costs per day of forage types that met cow daily crude protein requirements. Forage feed costs per day equals (lbs forage CP/d X cost/lb) plus (lbs supplemental CP/d X cost/lb) or forage feed costs per day equals (lbs forage CP/d X cost/lb) plus (lbs supplemental roughage/d X cost/lb).

A hay that contains 6.0% crude protein and costs $50.00/ton has crude protein costs of $0.42/lb. A hay that contains 16.0% crude protein and costs $70.00/ton has crude protein costs of $0.22/lb. The $50.00/ton hay would be fed to 1200 lb cows at 24.0 lbs DM/day during the third trimester and provide 1.44 lbs CP/day. An additional 0.43 lbs of crude protein supplement per day would need to be provided. The 1.44 lbs of forage crude protein costs $0.42/lb and $0.60/day; the 0.43 lbs of supplemental crude protein costs $0.30/lb and $0.13/day, with a total crude protein cost of $0.73 per day which equals the forage feed costs per day for the $50.00/ton hay with 6.0% crude protein. The $70.00/ton hay would be fed to 1200 lb cows at 11.69 lbs DM/day during the third trimester and provide 1.87 lbs CP/day. An additional 12.31 lbs of roughage supplement per day would need to be provided. The 1.87 lbs of forage crude protein costs $0.22/lb and $0.41/day; the 12.31 lbs of supplemental roughage costs $0.0175/lb and $0.21/day, with a total crude protein and supplemental roughage cost of $0.62/day which equals the forage feed costs per day for the $70.00/ton hay with 16.0% crude protein. The hay that has the lower crude protein cost per pound has the lower forage feed cost per day.

Calf weight gain costs per pound is an important diagnostic value for the evaluation of forage feed costs and comparisons of forage types. The cost per pound of calf accumulated weight is the culmination of a management strategy's positive and negative effects on forage plant production and cow and calf weight performance. Costs per pound of calf weight gain is the combined land rent costs, production per acre costs, forage dry matter costs, crude protein costs, land area per cow-calf pair costs, supplemental roughage or crude protein costs, and forage feed costs. The efficiency of a management strategy's capture of produced forage crude protein affects the cost per pound of accumulated calf weight. The forage type with the more biologically effective management strategy and that captures crude protein more efficiently will have the lower cost per pound of calf weight.

Forage feed costs per day is an important diagnostic value for the evaluation of total feed costs and comparisons of forage types. The forage costs include production costs per acre, forage dry matter costs, and crude protein costs. Forage costs are the combined costs for livestock feed that is produced on the land base assigned to a cow-calf pair during each production period. During periods in which the quantity or quality of the produced feedstuffs falls below the quantity or quality of the dietary requirements of the cow, additional roughage or crude protein from other sources need to be supplemented. The costs of supplemental roughage or crude protein plus the forage costs are the forage feed costs for a cow-calf pair for a production period. The number of days in a production period determine the forage feed costs per day.

Increasing value captured from the land natural resources requires a major paradigm shift from the traditional convention that considers the animal as the source of income and that manages the land to produce forage dry matter for livestock feed. The forage nutrients produced on the land sustain the growth in weight of livestock. Forage dry matter is simply the carrier of the nutrients it contains. Following removal of the nutrients, forage dry matter is deposited back on the land. The weight of the calf is the commodity sold at market but the calf weight is not the original source of the wealth. The renewable forage nutrients produced on the land are the original source of new wealth generated in the beef production industry. Generation of greater wealth requires the capture of greater crude protein weight per acre and its conversion into greater calf weight per acre.

Size of the land area per cow-calf pair and the returns after feed costs per acre are important diagnostic values for the comparisons of forage types and for the identification of forage types and management strategies that generate greater new wealth from the land resources. Land area per cow-

calf pair is determined by the acreage required to provide adequate quantities of forage dry matter and crude protein during a production period. The greater the quantity of crude protein weight captured from a land base, the smaller the land area required by a cow-calf pair. Land area costs make up 50% to 100% of the forage feed costs for pasture forage types and from 10% to 50% for harvested forage types. Reducing land area per cow-calf pair lowers forage feed costs. Reducing land area requires increasing crude protein production per acre and improving the efficiency of crude protein capture. The capture of greater crude protein weight per acre and its conversion into greater weight of beef produced per acre reduces the cost per pound of calf accumulated weight and increases the returns after feed costs per acre resulting in the generation of greater new wealth captured from the land resources.

A low market value for calf weight must be used during the evaluations of forage types for the purpose of being able to select forage types that provide positive returns after feed costs during the entire cattle cycle. Forage types that have forage feed costs of $0.62 or less per day, calf weight gain costs of $0.42 or less per pound during periods the calf is at the side of the cow, and crude protein costs of $0.25 or less per pound yield positive profit margins and efficiently capture high value from the land natural resources during low periods in the market when calf weight is valued at $0.70 per pound at weaning time.

The forage types that meet the low market selection criterion and efficiently capture high value from the land natural resources during the dry gestation production period from mid November to mid December are crested wheatgrass hay cut early, forage barley hay cut early or late, oat forage hay cut early or late, pea forage hay cut late, and forage lentil hay cut late (table 58).

The forage types that meet the low market selection criterion and efficiently capture high value from the land natural resources during the third trimester production period from mid December to mid March are crested wheatgrass hay cut early, forage barley hay cut early, oat forage hay cut early or late, pea forage hay cut late, and forage lentil hay cut late (table 59).

The forage types that meet the low market selection criterion and efficiently capture high value from the land natural resources during the early lactation production period from mid March to late April are crested wheatgrass hay cut early, forage barley hay cut early, oat forage hay cut early, pea forage hay cut late, and forage lentil hay cut late (table 60).

The forage types that meet the low market selection criterion and efficiently capture high value from the land natural resources during the spring lactation production period from early May to late May are crested wheatgrass unfertilized pasture, crested wheatgrass fertilized pasture, crested wheatgrass hay cut early, forage barley hay cut early, oat forage hay cut early, pea forage hay cut late, and forage lentil hay cut late (table 61).

The forage types that meet the low market selection criterion and efficiently capture high value from the land natural resources during the summer lactation production period from early June to mid October are twice-over rotation native rangeland pasture system, crested wheatgrass hay cut early, forage barley hay cut early, oat forage hay cut early, pea forage hay cut late, and forage lentil hay cut late (table 62).

The forage types that meet the low market selection criterion and efficiently capture high value from the land natural resources during the fall lactation production period from mid October to mid November are Altai wildrye pasture, spring seeded winter cereal pasture, crested wheatgrass hay cut early, forage barley hay cut early, oat forage hay cut early, pea forage hay cut late, and forage lentil hay cut late (table 63).

The forage types that do not meet the selection criterion and have high forage feed costs per day, high calf weight gain costs per pound, high crude protein costs per pound and/or low or negative returns after feed costs per acre were also identified during the evaluations.

The pasture forage types with high costs and negative returns after feed costs per acre are: spring seeded winter cereal pasture grazed during the dry gestation production period following weaning of the calf, standing corn pasture grazed during the dry gestation or third trimester production periods, reserved native rangeland pastures traditionally managed with grazing occurring during the dry gestation, third trimester, or early lactation production periods, and native rangeland pastures with grazing occurring during the fall lactation production period and managed traditionally as repeated seasonal, 6.0-month seasonlong, 5.5-month seasonlong, deferred grazing, and 4.5-month seasonlong started in mid June.

The pasture forage types with high costs and low returns after feed costs per acre are: native rangeland pastures managed traditionally as 6.0-month seasonlong with grazing starting in May before the grass plants develop three and a half new leaves during the spring lactation production period, and native rangeland pastures with grazing occurring during the summer lactation production period and managed traditionally as 6.0-month seasonlong, deferred grazing, and 4.5-month seasonlong started in early June.

The harvested forage types that are cut at plant growth stages with greater forage dry matter yield have lower returns after feed costs per acre than the same forage type cut at plant growth stages with greater crude protein yield. Crested wheatgrass hay cut at the mature growth stage has lower returns after feed costs per acre than crested wheatgrass hay cut at the boot stage. Forage barley and oat forage hays cut late at the hard dough stage have lower returns after feed costs per acre than forage barley and oat forage hays cut early at the milk stage. Pea forage and forage lentil hays cut early have lower returns after feed costs per acre than pea forage and forage lentil hays cut late. Oat and pea forage grown as a mixture and cut at compromised plant growth stages has higher costs and lower returns after feed costs per acre than when oat forage and pea forage hays are grown separately and harvested at their respective optimum plant growth stages.

The harvested forage types that require supplemental crude protein because of harvest at plant growth stages that yield greater forage dry matter weight have lower returns after feed costs per acre than the same forage type not requiring supplemental crude protein because of harvest at plant growth stages that yield greater crude protein weight. Crested wheatgrass hay cut at the mature growth stage requires supplemental crude protein during all of the production periods except the dry gestation production period and has lower returns after feed costs per acre than crested wheatgrass hay cut at the boot stage. Oat forage hay cut late at the hard dough stage requires supplemental crude protein during all production periods except the dry gestation and third trimester production periods and has lower returns after feed costs per acre than oat forage hay cut early at the milk stage. Forage barley hay cut late at the hard dough stage requires supplemental crude protein during the early lactation production period and has lower returns after feed costs per acre than forage barley hay cut early at the milk stage.

Discussion

Reduction of forage feed costs for pasture forage types can be accomplished by implementation of biologically effective grazing management that places priority on meeting the biological requirements of the plants and enhances the biogeochemical cycles in the ecosystem and that has grazing periods at the plant growth stages that capture the greatest weight of crude protein per acre. During the long history of coevolution with grazing animals, grass plants developed biological processes that help the plants withstand and recover from defoliation (Manske 2007). This complex of processes, called defoliation resistance mechanisms, accelerates both the growth rate of the grazed plant and its development of foliage and roots. Two biological processes of primary concern to grassland managers are the increased beneficial activity of soil organisms and the stimulation of vegetative reproduction by secondary tiller development from axillary buds. Grazing that removes a small amount of leaf area (25% to 33%) from the grass plant between the three and a half new leaf stage and flowering stage can trigger these beneficial responses.

There is a mutually beneficial relationship between the grass plant's root system and soil organisms. The narrow zone of soil around the roots of perennial grassland plants, the rhizosphere, contains bacteria, protozoa, nematodes, mites, springtails, and endomycorrhizal fungi. The grass plant's roots release carbon compounds, including sugars, to these rhizosphere organisms, and the organisms release mineral nitrogen that the plant's roots absorb. The endomycorrhizal fungi also provide phosphorus, other mineral nutrients, and water that the plant needs for growth. Activity of the soil microorganisms increases with the availability of carbon compounds in the rhizosphere, and the elevated microorganism activity results in an increase in nitrogen available to the grass plant. Grazing lead tillers between the three and a half new leaf stage and the flowering stage can increase the quantity of carbon compounds the defoliated plant releases into the rhizosphere. The increase in nitrogen produced by elevated rates of microorganism activity allows the plant to accelerate growth and recover more quickly from defoliation.

Most young grass plants in grassland ecosystems start not as seedlings but as vegetative tillers that grow from axillary buds on the crowns of an established plant. These vegetative tillers make up the majority of the plant population because they have a competitive advantage over seedlings. Tillers

initially draw support from the root systems of parent tillers, while seedlings must rely on their own less-developed structures.

Tiller development from axillary buds is regulated by lead tillers, through a process called lead tiller dominance. The lead tillers produce an inhibitory hormone that prevents the growth hormone from activating growth within axillary buds. Grazing that removes a small amount of young leaf tissue from the aboveground portion of lead tillers after the three and a half new leaf stage and before the flowering stage reduces the amount of the inhibitory hormone in the plant. With that inhibitory hormone reduced, the growth hormones stimulate vegetative reproduction, and secondary tillers develop from the previous year's axillary buds.

All grass species in the Northern Plains have strong lead tiller dominance except Kentucky bluegrass and meadow bromegrass, which have low levels of inhibitory hormones and relatively higher levels of tiller development. Plants with these growth characteristics have greater demands for water than grasses with strong lead tillers and cease growth processes during minor water deficiency periods.

Beneficial grass plant response to grazing depends on the timing of defoliation. Grazing grass plants prior to the third-leaf stage negatively affects grass growth. Early seasonal growth of grass plants depends on carbohydrates stored in the roots, rhizomes, and stem bases, and prematurely grazed plants are unable to replenish adequate amounts of carbohydrates to support active growth. Starting grazing after the three and a half new leaf stage and before the flowering stage allows plants to establish sufficient leaf area to produce adequate photosynthetic assimilates to meet leaf growth requirements and allows all leaf bud primordia in the apical meristem to develop into leaf buds.

If no defoliation occurs before the flowering stage, as on a deferred grazing strategy, the lead tiller inhibits vegetative tiller development until the inhibitory hormone production naturally declines during the flowering stage. This hormone reduction permits one axillary bud to grow and develop into a secondary tiller, which in turn produces inhibitory hormones that prevent growth of the other six to eight axillary crown buds. These dormant axillary buds are never activated and become senescent with the lead tiller. The lack of defoliation of lead tillers prior to the flowering stage diminishes recruitment of vegetative tillers, leading to decreased plant density and reduced rhizosphere organism activity; this reduction results in decreased conversion of soil organic nitrogen into inorganic nitrogen. No evidence has been found to suggest that grazing the lead tiller after it has reached the flowering stage has beneficial stimulatory effects on vegetative tiller development or rhizosphere organism activity.

The twice-over rotation grazing management system applies defoliation treatment to grass plants at the appropriate phenological growth stages to stimulate the defoliation resistance mechanisms and the activity of the symbiotic rhizosphere microorganisms. The coordinated defoliation improves plant health and stimulates biological and ecological processes within grass plants and the ecosystem so that beneficial changes to plant growth, soil organisms, and biogeochemical cycles in the ecosystem result. During the first grazing period, grasses are between the three and a half new leaf stage and flowering stage, the stages of plant development at which grazing stimulates the defoliation resistance mechanisms that increase tillering from axillary buds and enhance rhizosphere organism activity increasing the conversion of soil organic nitrogen into inorganic nitrogen. Increased vegetative reproduction by tillering contributes to the development of greater plant basal cover and to the production of greater grass herbage weight; increased activity of the soil organisms in the rhizosphere supplies the plant with greater quantities of nutrients to support additional growth.

Grazing native rangeland pastures during May is expensive, costing even more than feeding mature crested wheatgrass hay during the same period. Rangeland plants are not physiologically ready for grazing prior to the three and a half new leaf stage, and grazing prior to plant readiness causes a reduction in herbage biomass production of 45% to 75%. Delaying grazing on native rangeland until grass plants have reached the three and a half new leaf stage, in early June, requires the use of another forage type for earlier grazing. Some domesticated perennial cool-season grasses like crested wheatgrass and smooth bromegrass reach the three and a half new leaf stage three to five weeks earlier than native cool-season grasses and are dependable during May as early season spring pasture forage. The start of the grazing season on domesticated grass pastures is restricted to very late April or early May because no perennial grass in the Northern Plains reaches the three and a half new leaf stage before late April.

Unfertilized crested wheatgrass pastures provide forage at reasonable costs during May and early to mid June, but during the third week in June

the crude protein content drops below the requirements for lactating cows. Fertilized crested wheatgrass pastures provide forage at reasonable costs during May. Fertilization of crested wheatgrass pastures (applied during the first week of April) increased the amount of herbage biomass during May. The cost per ton for forage dry matter on fertilized pastures was about the same as the cost per ton for dry matter on unfertilized pastures, even though the cost of the fertilizer more than doubled the production costs per acre. Fertilization shortened by several weeks the effective period of use of domesticated grass spring complementary pastures by grazing livestock.

Grazed native rangeland pastures provide forage dry matter and crude protein at lower costs during the summer lactation production period from early June to mid October than during other times of the year. Cow and calf weight performance generally did not differ among native rangeland grazing strategies during the early grazing period of June to mid July, but during the latter portion of the grazing period, starting mid July or early August, animal weight performance on the traditional management strategies decreased successively as the grazing period progressed. Cows and calves on the twice-over rotation management strategy gained weight during the entire grazing period. Nutritional quality of native rangeland grasses decreases rapidly following the seed development stage, and the quality falls below 9.6% crude protein around mid July to early August on traditionally managed pastures. This large decrease in nutritional quality below 9.6% crude protein does not occur on the twice-over rotation strategy because of the stimulation of vegetative reproduction and secondary tiller development resulting from light defoliation on each of the three to six native rangeland pastures for 7 to 17 days during the first grazing period between early June and mid July when grass plants are between the three and a half new leaf stage and flowering stage. Manipulation of secondary tiller growth extends improved livestock weight performance for two to two and a half months until late September or mid October. The biology of native grass plants does not permit extending this improved weight performance longer. Nutritional quality of herbage on native rangeland grazed after mid October is insufficient to meet requirements of lactating cows.

Pasture forage types that meet the nutritional requirements of lactating cows after mid October include Altai and Russian wildryes. The wildryes are the only perennial grasses that retain nutrient quality in the aboveground portions of the plant after mid October until about mid November. No perennial grass in the Northern Plains retains sufficient nutritional quality to dependably meet the nutritional requirements of lactating cows later than mid November.

Grazing native rangeland during the fall and winter is commonly accepted as a low-cost, innocuous practice; however, costs of forage dry matter and crude protein on native rangeland during fall and winter are extremely high, and fall and winter grazing has the potential to degrade grassland ecosystems. The cost of grazing native rangeland during the fall and winter is high because the weight of the herbage on late-season pasture is only about half of the mid summer herbage weight and grazing livestock therefore require about twice as many acres per month in the fall and winter as they do during the summer. The nutritional quality of mature herbage during fall and winter is about half of the herbage nutrient content during summer; the crude protein content of mature native range forage is below the requirements of cows during the dry gestation, third trimester, and early lactation production periods and crude protein supplementation is needed.

Grazing mature rangeland during the fall and winter can have negative economic consequences beyond the fall and winter because the practice can remove or damage fall growth and other leaf material that the grass plant depends on to survive the winter and resume growth the next spring. Perennial grasses are perpetuated primarily through vegetative reproduction by tillering rather than through sexual reproduction. Very few perennial grasses grow from seed in established grasslands. Perennial grasses start growth of next year's plants in late summer or early fall, during winter hardening, the process of physiological preparation for the winter season. Warm-season grasses produce a relatively large bud but suspend additional growth until the next spring. Cool-season grasses produce tillers with one and a half to four leaves.

Fall tillers grow from axillary buds on the crowns of perennial grass species between mid August and the end of the active growing season and remain viable over the winter. These fall tillers continue growth as lead tillers the following spring, producing a high proportion of that season's herbage. After the lead tillers have flowered, secondary tillers can grow from axillary buds.

During the later portion of the growing season, the grass plant population consists of mature lead tillers, secondary tillers, and fall tillers. Mature

lead tillers that are near the completion of their life cycle and secondary tillers that have developed seed heads will not overwinter but will progress through a natural aging process called senescence. During this aging process, the cell components of the aboveground structures are translocated to belowground structures. The translocation of cell contents reduces the nutritional quality and the weight of the herbage. The nutritional quality of mature herbage during fall decreases to about 4.8% crude protein. The weight of the herbage is about 40% to 60% of the herbage weight during mid summer. Secondary tillers that have not entered the sexually reproductive stage and fall tillers will overwinter. These tillers retain active leaf material until the end of the growing season, when the chlorophyll fades and the leaves lose their green color, appearing brown like the leaves of lead tillers that have completed their growth cycle.

Perennial grasses remain alive and maintain physiological processes throughout the year, even during the winter. Winter dormancy for perennial grasses is not a period of total inactivity but a period of reduced biological activity. The crown, some portions of the root system, and some leaf tissue remain active by using stored carbohydrates. Winter survival and spring regrowth of secondary tillers and fall tillers depend on the plant's having adequate carbohydrate reserves.

The quantity of carbohydrates stored during the winter hardening process is closely related to the amount of active leaf material on each tiller. Tillers with abundant leaf area during late summer and early fall can store adequate quantities of carbohydrates to survive the winter and produce robust leaves the following spring. Generally, the greater the number of active leaves on tillers during the fall, the more robust the plants will be the following spring. Heavy grazing of grasslands during August to mid October removes sufficient leaf material from secondary and fall tillers that quantities of carbohydrates stored will be low. Tillers with low carbohydrate reserves may not survive until spring. It is suspected that fall tillers with fewer than one and a half leaves may be unable to store adequate carbohydrate reserves to survive the winter. Plants that have low carbohydrate reserves and survive the dormancy period produce tillers with reduced height and weight.

The rate at which plants respire, or use, stored carbohydrates during the winter is affected by the amount of insulation standing plant material and snow provide from the cold winter air temperatures. The greater the amount of insulation, the more slowly the plant draws on its carbohydrate reserves. When the standing herbage on a grassland is grazed short and most of the snow is blown off, very rapid respiration can occur and deplete carbohydrate reserves before spring, causing plant death called "winter kill".

On tillers that have overwintered, the leaf portions with intact cell walls can regreen early in the spring. The leaf portions with ruptured cell walls remain brown. The surviving leaves, with their brown tops and green bases, are most obvious soon after the snow melts. During the early portion of the growing season, overwintering tillers will have both carryover leaves and new current year's leaves. When the current year's early leaf growth has been exposed for several hours to air temperatures below 28° F, it may have large dry portions and appear similar to overwintering leaves. The green portion of the overwintered leaves provides photosynthetic products that, in combination with remaining stored carbohydrates, support the development and growth of new leaves and roots. The robustness of spring growth in plants that overwinter is dependent on the amount of surviving leaf area.

Removal of the leaf area of the overwintering tillers by grazing during fall or winter deprives developing tillers of a major source of nutrients, increases the demand on low levels of carbohydrate reserves, and results in reduced leaf production. Reductions in leaf height for the major graminoids during the succeeding growing season range from 17% to 43%, and the contribution of herbage weight to the ecosystem biomass is greatly reduced.

The common assumption that grazing perennial grasses after they turn brown following a hard frost will not harm grass plants guides numerous fall and winter grazing practices. This popular belief is not consistent with the biology of grass growth and should not be used as a foundation for grazing management decisions because of the resulting reductions in grass production and increases in pasture forage costs the following year. Management strategies coordinated with the biological requirements of grass plants promote vigorous growth of tiller leaves and efficient capture of produced forage dry matter and crude protein. These characteristics result in considerable reductions in pasture forage costs for cows and calves.

Feeding low cost harvested forages is an economically and ecologically sound alternative to grazing livestock on fall and winter reserved native

range pasture. Harvested forages are usually viewed as expensive feeds because the production costs per acre are greater than pasture forage production costs 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.

Reduction of forage feed costs for harvested forage types can be accomplished by harvesting the forage type at the plant growth stages that capture the greatest weight of crude protein per acre. The weight of crude protein harvested per acre is related to the percent crude protein content and the weight of the forage dry matter at the time of cutting. The percent crude protein content and dry matter weight of forage plants both increase during early growth stages and then decrease as the growing season progresses and plants mature. These changes are reflected in the growth curves for the two factors. The percent crude protein content curve and the dry matter weight curve for a forage type are quite different from each other throughout the growing season. The various types of forage plants have crude protein and forage dry matter curves with different shapes. The greatest percent crude protein occurs during very early plant growth stages, and then the quality level declines as the plants develop. Percent crude protein 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 and cell contents are translocated from aboveground plant parts to the crown belowground. The rate of growth to peak dry matter weight is greater in grasses than in legumes.

Generally, the lowest cost livestock forage feed from harvested forage types is the hay with the lowest cost per pound of crude protein, which results by harvesting at the plant growth stage when the forage types yields the greatest weight of crude protein per acre. The greatest weight of crude protein per acre does not occur at the peak percent crude protein or at the peak dry matter weight per acre.

The greatest crude protein weight per acre occurs 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 hay cut at the boot stage had lower costs per pound of crude protein than crested wheatgrass hay cut at a mature stage of growth. Forage barley hay 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 greatest crude protein weight per acre occurs for legumes 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.

The modern beef animal is different than the old style cattle. Traditional forage type management practices developed for the old style cattle focus on forage dry matter yield and do not meet the dietary needs of modern livestock resulting in high forage feed costs and low or negative returns after feed costs per acre. Forage types that provide low cost feed for modern beef cows and have high returns after feed costs per acre are managed for high crude protein yield per acre. The quantity of crude protein captured per acre as livestock feed is the factor that has the greatest influence on the costs of pasture forage and harvested forage and on the amount of new wealth generated from the land natural resources.

Table 56. Difference in nutrient requirements between an old style 1000 lb range cow and an average production 1200 lb range cow.

Intake nutrient requirements for "Old Style" 1000 lb range cow, data from NRC 1996.

		Dry Gestation	Third Trimester	Early Lactation	Nongrowing Season	Lactation Spring, Summer, Fall	12-month Period
Dry Matter	lb/d	21.0	21.0	21.6	21.21	22.3	21.78
Energy (TDN)	lb/d	9.64	10.98	12.05	11.01	11.98	11.54
Crude Protein	lb/d	1.30	1.64	1.88	1.64	1.78	1.72

Intake nutrient requirements for 1200 lb range cow with average milk production, data from NRC 1996.

		Dry Gestation	Third Trimester	Early Lactation	Nongrowing Season	Lactation Spring, Summer, Fall	12-month Period
Dry Matter	lb/d	24.0	24.0	27.0	24.81	27.0	26.0
Energy (TDN)	lb/d	11.02	12.62	15.85	13.18	15.23	14.29
Crude Protein	lb/d	1.49	1.87	2.73	2.03	2.51	2.29

Percent greater nutrient requirements for average production 1200 lb cow than for old style 1000 lb cow.

		Dry Gestation	Third Trimester	Early Lactation	Nongrowing Season	Lactation Spring, Summer, Fall	12-month Period
Dry Matter	%	14.29	14.29	25.00	16.97	21.08	19.38
Energy (TDN)	%	14.32	14.94	31.54	19.71	27.13	23.83
Crude Protein	%	14.62	14.02	45.21	23.78	41.01	33.14

Table 57. Difference in nutrient requirements between an old style 1000 lb range cow and a high production 1200 lb range cow.

Intake nutrient requirements for "Old Style" 1000 lb range cow, data from NRC 1996.

		Dry Gestation	Third Trimester	Early Lactation	Nongrowing Season	Lactation Spring, Summer, Fall	12-month Period
Dry Matter	lb/d	21.0	21.0	21.6	21.21	22.3	21.78
Energy (TDN)	lb/d	9.64	10.98	12.05	11.01	11.98	11.54
Crude Protein	lb/d	1.30	1.64	1.88	1.64	1.78	1.72

Intake nutrient requirements for 1200 lb range cow with high milk production, data from NRC 1996.

		Dry Gestation	Third Trimester	Early Lactation	Nongrowing Season	Lactation Spring, Summer, Fall	12-month Period
Dry Matter	lb/d	24.1	24.2	29.2	25.53	29.08	27.45
Energy (TDN)	lb/d	11.07	12.73	18.0	13.83	17.17	15.64
Crude Protein	lb/d	1.50	1.90	3.36	2.22	3.06	2.67

Percent greater nutrient requirements for high production 1200 lb cow than for old style 1000 lb cow.

		Dry Gestation	Third Trimester	Early Lactation	Nongrowing Season	Lactation Spring, Summer, Fall	12-month Period
Dry Matter	%	14.76	15.24	35.19	20.37	30.40	26.03
Energy (TDN)	%	14.83	15.94	49.38	25.61	43.32	35.53
Crude Protein	%	15.38	15.85	78.72	35.37	71.91	55.23

Table 58. Summary of costs and returns after feed costs per acre for forage types used during the 32-day dry gestation production period.

Forage Types	Forage Feed Costs $/day	Calf Weight Costs $/lb	Crude Protein Costs $/lb	Land Area ac/c-cpr	Returns After Feed Costs $/acre
Pasture Forage Types					
Native Rangeland Repeated Seasonal	1.48	1.90	1.01	5.33	-5.59
Cropland Aftermath	0.44	0.57	0.74 est.	7.10	0.46
Spring Seeded Winter Cereal	0.73	0.94	0.24 est.	0.56	-10.66
Standing Corn	1.23	1.58	0.77 est.	0.25	-87.76
Harvested Forage Types					
Crested Wheat, mature	0.42	0.54	0.28	0.47	8.47
Crested Wheat, early	**0.45**	**0.58**	**0.14**	**0.26**	**11.69**
Forage Barley, early	**0.38**	**0.49**	**0.11**	**0.08**	**66.50**
Forage Barley, late	**0.36**	**0.46**	**0.15**	**0.10**	**60.30**
Oat Forage, early	**0.38**	**0.49**	**0.13**	**0.09**	**57.78**
Oat Forage, late	**0.34**	**0.43**	**0.17**	**0.11**	**60.91**
Pea Forage, early	0.50	0.64	0.15	0.09	15.33
Pea Forage, late	**0.43**	**0.55**	**0.13**	**0.07**	**52.71**
Forage Lentil, early	0.55	0.71	0.17	0.13	-1.46
Forage Lentil, late	**0.43**	**0.56**	**0.13**	**0.09**	**39.78**
Oat-Pea Forage	0.43	0.55	0.16	0.07	51.71

Bolded forage types meet the selection criterion and efficiently capture high value from the land natural resources.

Table 59. Summary of costs and returns after feed costs per acre for forage types used during the 90-day third trimester production period.

Forage Types	Forage Feed Costs $/day	Calf Weight Costs $/lb	Crude Protein Costs $/lb	Land Area ac/c-cpr	Returns After Feed Costs $/acre
Pasture Forage Types					
Native Rangeland Repeated Seasonal	1.94	2.49	1.26	18.62	-6.75
Standing Corn	1.23	1.58	0.77 est.	0.70	-87.74
Harvested Forage Types					
Crested Wheat, mature	0.52	0.67	0.28	1.35	1.50
Crested Wheat, early	**0.45**	**0.58**	**0.14**	**0.89**	**9.19**
Forage Barley, early	**0.38**	**0.48**	**0.11**	**0.27**	**56.30**
Forage Barley, late	0.35	0.46	0.15	0.36	47.58
Oat Forage, early	**0.37**	**0.48**	**0.13**	**0.31**	**49.45**
Oat Forage, late	**0.32**	**0.41**	**0.17**	**0.38**	**53.32**
Pea Forage, early	0.53	0.68	0.15	0.32	5.16
Pea Forage, late	**0.43**	**0.56**	**0.13**	**0.25**	**40.52**
Forage Lentil, early	0.59	0.76	0.17	0.46	-8.70
Forage Lentil, late	**0.44**	**0.56**	**0.13**	**0.30**	**32.20**
Oat-Pea Forage	0.44	0.56	0.16	0.26	37.23

Bolded forage types meet the selection criterion and efficiently capture high value from the land natural resources.

Table 60. Summary of costs and returns after feed costs per acre for forage types used during the 45-day early lactation production period.

Forage Types	Forage Feed Costs $/day	Calf Weight Costs $/lb	Crude Protein Costs $/lb	Land Area ac/c-cpr	Returns After Feed Costs $/acre
Pasture Forage Types					
Native Rangeland Repeated Seasonal	2.10	1.17	0.76	10.80	-3.51
Harvested Forage Types					
Crested Wheat, mature	0.78	0.41	0.28	0.76	32.82
Crested Wheat, early	**0.52**	**0.28**	**0.14**	**0.65**	**55.88**
Forage Barley, early	**0.41**	**0.21**	**0.11**	**0.20**	**208.10**
Forage Barley, late	0.45	0.23	0.15	0.24	165.92
Oat Forage, early	**0.41**	**0.21**	**0.13**	**0.23**	**180.43**
Oat Forage, late	0.54	0.29	0.17	0.21	168.76
Pea Forage, early	0.63	0.33	0.15	0.23	136.87
Pea Forage, late	**0.49**	**0.26**	**0.13**	**0.18**	**210.00**
Forage Lentil, early	0.71	0.38	0.17	0.34	81.56
Forage Lentil, late	**0.50**	**0.26**	**0.13**	**0.22**	**170.36**
Oat-Pea Forage	0.50	0.26	0.16	0.19	196.32

Bolded forage types meet the selection criterion and efficiently capture high value from the land natural resources.

Table 61. Summary of costs and returns after feed costs per acre for forage types used during the 31-day spring lactation production period.

Forage Types	Forage Feed Costs $/day	Calf Weight Costs $/lb	Crude Protein Costs $/lb	Land Area ac/c-cpr	Returns After Feed Costs $/acre
Pasture Forage Types					
Native Rangeland Repeated Seasonal	1.35	0.75	0.28	4.77	-0.58
6.0-m Seasonlong (16d)	1.15	0.64	0.24 est.	2.10	0.83
Crested Wheatgrass **Unfertilized**	**0.52**	**0.27**	**0.11**	**1.88**	**13.29**
Unfertilized (76d)	0.48	0.27	0.13 est.	4.16	14.13
Fertilized	**0.51**	**0.24**	**0.10 est.**	**0.75**	**41.82**
Harvested Forage Types					
Crested Wheat, mature	0.71	0.35	0.28	0.58	37.14
Crested Wheat, early	**0.57**	**0.29**	**0.14**	**0.41**	**62.61**
Forage Barley, early	**0.47**	**0.23**	**0.11**	**0.13**	**222.46**
Forage Barley, late	0.43	0.21	0.15	0.16	188.50
Oat Forage, early	**0.47**	**0.24**	**0.13**	**0.14**	**205.14**
Oat Forage, late	0.45	0.22	0.17	0.16	180.12
Pea Forage, early	0.67	0.34	0.15	0.15	150.40
Pea Forage, late	**0.55**	**0.28**	**0.13**	**0.12**	**219.42**
Forage Lentil, early	0.75	0.38	0.17	0.34	58.91
Forage Lentil, late	**0.56**	**0.28**	**0.13**	**0.14**	**186.93**
Oat-Pea Forage	0.55	0.28	0.16	0.12	218.75

Bolded forage types meet the selection criterion and efficiently capture high value from the land natural resources.

Table 62. Summary of costs and returns after feed costs per acre for forage types used during the 137-day summer lactation production period.

Forage Types	Forage Feed Costs $/day	Calf Weight Costs $/lb	Crude Protein Costs $/lb	Land Area ac/c-cpr	Returns After Feed Costs $/acre
Pasture Forage Types					
Native Rangeland Repeated Seasonal	0.72	0.40	0.25	11.32	6.54
6.0-m Seasonlong	1.16	0.56	0.52 est.	18.10	2.18
4.5-m Seasonlong	0.81	0.39	0.37 est.	12.70	7.02
Deferred Grazing (92d)	0.63	0.30	0.28 est.	6.70	11.83
Twice-over Rotation	**0.58**	**0.26**	**0.20 est.**	**9.00**	**14.79**
Harvested Forage Types					
Crested Wheat, mature	0.71	0.35	0.28	2.57	37.05
Crested Wheat, early	**0.57**	**0.29**	**0.14**	**1.82**	**62.32**
Forage Barley, early	**0.47**	**0.23**	**0.11**	**0.56**	**228.20**
Forage Barley, late	0.43	0.21	0.15	0.73	182.56
Oat Forage, early	**0.47**	**0.24**	**0.13**	**0.64**	**198.33**
Oat Forage, late	0.45	0.22	0.17	0.73	178.85
Pea Forage, early	0.67	0.34	0.15	0.65	153.38
Pea Forage, late	**0.55**	**0.28**	**0.13**	**0.51**	**228.20**
Forage Lentil, early	0.75	0.38	0.17	0.95	93.20
Forage Lentil, late	**0.56**	**0.28**	**0.13**	**0.60**	**192.77**
Oat-Pea Forage	0.55	0.28	0.16	0.53	218.77

Bolded forage types meet the selection criterion and efficiently capture high value from the land natural resources.

Table 63. Summary of costs and returns after feed costs per acre for forage types used during the 30-day fall lactation production period.

Forage Types	Forage Feed Costs $/day	Calf Weight Costs $/lb	Crude Protein Costs $/lb	Land Area ac/c-cpr	Returns After Feed Costs $/acre
Pasture Forage Types					
Native Rangeland Repeated Seasonal	1.71	0.95	0.92	4.60	-2.91
6.0-m Seasonlong	1.18	1.99	0.82 est.	4.04	-5.69
5.5-m Seasonlong	0.74	0.80	0.51 est.	2.53	-1.12
Deferred Grazing	0.65	0.85	0.44 est.	2.18	-1.51
4.5-m Seasonlong (15d)	0.95	0.70	0.75 est.	1.63	-0.03
Altai Wildrye	**0.40**	**0.23**	**0.16 est.**	**1.39**	**17.81**
Cropland Aftermath	0.44	1.05	0.74 est.	6.63	-0.67
Spring Seeded Winter Cereal	**0.66**	**0.33**	**0.18 est.**	**0.47**	**47.45**
Harvested Forage Types					
Crested Wheat, mature	0.71	0.35	0.28	0.56	37.07
Crested Wheat, early	**0.57**	**0.29**	**0.14**	**0.40**	**62.10**
Forage Barley, early	**0.47**	**0.23**	**0.11**	**0.12**	**233.17**
Forage Barley, late	0.43	0.21	0.15	0.16	182.38
Oat Forage, early	**0.47**	**0.24**	**0.13**	**0.14**	**198.50**
Oat Forage, late	0.45	0.22	0.17	0.16	178.69
Pea Forage, early	0.67	0.34	0.15	0.14	155.78
Pea Forage, late	**0.55**	**0.28**	**0.13**	**0.11**	**231.64**
Forage Lentil, early	0.75	0.38	0.17	0.21	92.33
Forage Lentil, late	**0.56**	**0.28**	**0.13**	**0.13**	**194.85**
Oat-Pea Forage	0.55	0.28	0.16	0.12	211.67

Bolded forage types meet the selection criterion and efficiently capture high value from the land natural resources.

Twelve-Month Forage Management Strategy Development and Evaluation

Twelve-month forage management strategies are developed by selection of a pasture forage type or a harvested forage type for use during each range cow production period. The combined sequence of assembled forage types composes a 12-month forage management strategy.

Twelve-month forage management strategy development that is based on traditional concepts treat livestock as the source of revenue and forage as the feedstuffs livestock eat. Traditional forage management strategies emphasize the use of land as feed for livestock and promote minimal use of harvested forages. Traditional selection criteria for forage types are based on the quantity of forage dry matter weight per acre and on low cash flow costs or low production costs per acre.

Twelve-month forage management strategy development that is based on biologically effective concepts treat forage crude protein produced on the land resources as the source of new wealth generation and the beef weight produced as the commodity sold at market. Biologically effective management strategies emphasize meeting plant biological requirements and promote stimulation of vegetative reproduction by tillering and enhancement of rhizosphere organism activity and the biogeochemical processes in the ecosystem. Biologically effective selection criteria for forage types are based on low forage feed costs per day, low forage crude protein costs per pound, low calf weight gain costs per pound, small land areas per cow, and high returns after feed costs per acre.

Pasture Forage Types

Results

The 12-month repeated seasonal management strategy (table 64) was developed from herbage biomass data collected monthly from ungrazed plots. This traditionally based strategy was evaluated as a sequence of six separate native rangeland pastures grazed at the proper stocking rate, with each pasture grazed repeatedly on consecutive years during one designated production period, and not grazed during any other production periods. A reserved native rangeland pasture was used during the dry gestation production period for 32 days from mid November to mid December. The forage dry matter yield per acre was low and the crude protein content of the pasture forage was below the dietary requirements of the cow with 1.6 pounds of supplemental crude protein provided. A large land area of 5.33 acres per cow was required. Even though the production costs per acre were low, reserved native rangeland pastures grazed during the dry gestation production period were high-cost forage with very high forage feed costs per day, very high forage crude protein costs per pound, and extremely high calf weight gain costs per pound. The returns after feed costs were a high loss per cow and a moderate loss per acre (table 64).

A reserved native rangeland pasture was used during the third trimester production period for 90 days from mid December to mid March. The forage dry matter yield per acre was low and the crude protein content of the pasture forage was below the dietary requirements of the cow with 38.7 pounds of supplemental crude protein provided. A large land area of 18.62 acres per cow was required. Even though the production costs per acre were low, reserved native rangeland pastures grazed during the third trimester production period were high-cost forage with extremely high forage feed costs per day, extremely high forage crude protein costs per pound, and extremely high calf weight gain costs per pound. The returns after feed costs were an extremely high loss per cow and a moderate loss per acre (table 64).

The calves were born in mid March. A reserved native rangeland pasture was used during the early lactation production period for 45 days from mid March to late April. The forage dry matter yield per acre was very low and the crude protein content of the pasture forage was below the dietary requirements of the cow, during which, no supplemental crude protein was provided. A large land area of 10.80 acres per cow was required. Even though the production costs per acre were low, reserved native rangeland pastures grazed during the early lactation production period were high-cost forage with extremely high forage feed costs per day, very high forage crude protein costs per pound, and very high calf weight gain costs per pound. The returns after feed costs were a very high loss per cow and a moderate loss per acre (table 64).

A native rangeland pasture was used during the spring lactation production period for 31 days from early May to late May. Native grass plants are not physiologically ready for grazing during May. The forage dry matter yield per acre was low and the quantity of crude protein captured per acre was low.

A large land area of 4.77 acres per cow was required. Even though the production costs per acre were low, native rangeland pastures grazed during the spring lactation production period before grass plants produce three and a half new leaves were high-cost forage with very high forage feed costs per day, high forage crude protein costs per pound, and high calf weight gain costs per pound. The returns after feed costs were a moderate loss per cow and a low loss per acre (table 64).

A native rangeland pasture was used during the summer lactation production period for 137 days from early June to mid October. The forage dry matter yield per acre was moderate and the crude protein content of the pasture forage was adequate for about 61 days and below the dietary requirements of the cow for about 76 days, during which, no supplemental crude protein was provided. A large land area of 11.32 acres per cow was required. Even though the production costs per acre were low, a single native rangeland pasture grazed during the summer lactation production period was moderate-cost forage with high forage feed costs per day, moderate forage crude protein costs per pound, and moderately high calf weight gain costs per pound. The returns after feed costs were high per cow and low per acre (table 64).

A native rangeland pasture was used during the fall lactation production period for 30 days from mid October to mid November. The forage dry matter yield per acre was low and the crude protein content of the pasture forage was below the dietary requirements of the cow with 36.3 pounds of supplemental crude protein provided. A large land area of 4.60 acres per cow was required. Even though the production costs per acre were low, a native rangeland pasture grazed during the fall lactation production period was high-cost forage with extremely high forage feed costs per day, very high forage crude protein costs per pound, and very high calf weight gain costs per pound. The returns after feed costs were a high loss per cow and a moderate loss per acre (table 64). The calves were weaned in mid November.

The 12-month repeated seasonal management strategy with native rangeland and reserved native rangeland pastures was a high-cost forage management strategy (table 64). The 12-month forage feed costs at $1.39 per day were very high, the 12-month forage crude protein costs at $0.62 per pound were very high, and the 12-month calf weight gain costs at $0.95 per pound were very high. The 12-month land area per cow at 55.44 acres was extremely large. The 12-month returns after feed costs at $-133.61 per cow was an extremely high loss and at $-2.41 per acre was a moderate loss (table 69). The 12-month repeated seasonal management strategy has no harvested forage feeds; the cattle graze six different pastures during the year. There are no equipment costs or labor costs charged to the forage feed costs. And yet, this management strategy has the highest forage feed costs per day, the highest forage crude protein costs per pound, the highest calf weight gain costs per pound, and the largest land area per cow. The returns after feed costs were the greatest loss per cow and the greatest loss per acre (tables 69 and 77). The elimination of equipment costs, labor costs, and harvested forage costs does not reduce beef production costs and improve profit margins.

The reserved native rangeland pastures grazed during the nongrowing season of the repeated seasonal management strategy gave the false impression of being low cost forage because the production costs per acre were low and no harvested forage was fed. However, because the forage dry matter yield per acre was about 40% of the forage dry matter yield during the summer period, the weight of crude protein capture per acre was about 20% to 25% of the crude protein capture per acre during the summer period, and the land area required per cow was greater than 2.5 times the land area required per cow during the summer period, the forage from the reserved pastures was high-cost. The cost of the forage was greater than the low market value of the calf weight accumulated during the nongrowing season resulting in a high loss of $191.40 per cow and a high loss of $5.51 per acre. Additional financial losses were derived as a result of the decision to use the pastures as reserved forage during the nongrowing season rather than to use the pastures as metabolically active forage during the growing season, which in effect, prevented the capture of the potential new wealth generated from the land resources. The potential revenue that could be captured from the forage crude protein produced on the land and available during the summer period ranges between $40 and $133 per cow and between $2 and $15 per acre depending on the management treatment implemented. This potential new wealth generated from the land resources that was not captured during the growing season was a major loss that should be considered when developing management plans that include reserved native rangeland pastures grazed during the nongrowing season.

The 6.0-month seasonlong management strategy is a simple traditional combination of a native rangeland pasture with a complementary reserved native rangeland pasture and mature crested wheatgrass hay (table 65). A reserved native rangeland pasture was grazed during the dry gestation production period for 32 days from mid November to mid December. The forage dry matter yield per acre was low and the crude protein content of the pasture forage was below the dietary requirements of the cow with 1.6 pounds of supplemental crude protein provided. A large land area of 5.33 acres per cow was required. Even though the production costs per acre were low, reserved native rangeland pastures grazed during the dry gestation production period were high-cost forage with very high forage feed costs per day, very high forage crude protein costs per pound, and extremely high calf weight gain costs per pound. The returns after feed costs were a high loss per cow and a moderate loss per acre (table 65).

Mature crested wheatgrass hay was fed during the third trimester production period for 90 days from mid December to mid March. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was below the dietary requirements of the cow with 30.1 pounds of supplemental crude protein provided. A small land area of 1.35 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the third trimester production period was moderate-cost forage with moderate forage feed costs per day, high forage crude protein costs per pound, and high calf weight gain costs per pound. The returns after feed costs were very low per cow and very low per acre (table 65).

The calves were born in mid March. Mature crested wheatgrass hay was fed during the early lactation production period for 45 days from mid March to late April. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was below the dietary requirements of the cow with 45.0 pounds of supplemental crude protein provided. A small land area of 0.76 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the early lactation production period was moderate-cost forage with high forage feed costs per day, high forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and moderate per acre (table 65).

Mature crested wheatgrass hay was fed during the early portion of the spring lactation production period for 15 days from early May to mid May. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was below the dietary requirements of the cow with 8.9 pounds of supplemental crude protein provided. A small land area of 0.28 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the first half of the spring lactation production period was high-cost forage with high forage feed costs per day, high forage crude protein costs per pound, and moderately low calf weight gain costs per pound. The returns after feed costs were moderate per cow and moderate per acre (table 65).

Grazing on a single native rangeland pasture started early in mid May before the grass plants had produced three and a half new leaves. The native rangeland pasture was grazed during the latter portion of the spring lactation production period for 16 days from mid May to late May. Continuation of feeding the high-cost mature crested wheatgrass hay for an additional 16 days would have been lower cost than starting grazing native rangeland too early. Native grass plants are not physiologically ready for grazing during May. The forage dry matter yield per acre was low and the quantity of crude protein captured per acre was low. A large land area of 2.10 acres per cow was allotted. Even though the production costs per acre were low, a native rangeland pasture grazed during the latter half of the spring lactation production period was high-cost forage with very high forage feed costs per day, high forage crude protein costs per pound, and high calf weight gain costs per pound. The returns after feed costs were very low per cow and extremely low per acre (table 65).

Grazing was continued on the single native rangeland pasture during the summer lactation production period for 137 days from early June to mid October. The forage dry matter yield per acre was moderate and the crude protein content of the pasture forage was adequate for about 61 days and below the dietary requirements of the cow for about 76 days, during which, no supplemental crude protein was provided. A large land area of 18.10 acres per cow was allotted. Even though the production costs per acre were low, a single native rangeland pasture grazed during the summer lactation production period was high-cost forage with very high forage feed costs per day, very high forage crude protein costs per pound, and high calf weight gain costs per pound.

The returns after feed costs were high per cow and very low per acre (table 65).

Grazing continued on the single native rangeland pasture during the fall lactation production period for 30 days from mid October to mid November. The forage dry matter yield per acre was low and the crude protein content of the pasture forage was below the dietary requirements of the cow, during which, no supplemental crude protein was provided. Even though the production costs per acre were low, native rangeland pasture grazed during the fall lactation production period was very high-cost forage with very high forage feed costs per day, very high forage crude protein costs per pound, and extremely high calf weight gain costs per pound. The returns after feed costs were a high loss per cow and a moderate loss per acre (table 65). The calves were weaned in mid November.

The 12-month 6.0-month seasonlong management strategy with a native rangeland pasture and a complementary reserved native rangeland pasture and mature crested wheatgrass hay was a high-cost forage management strategy (table 65). The 12-month forage feed costs at $0.96 per day were high, the 12-month forage crude protein costs at $0.47 per pound were high, and the 12-month calf weight gain costs at $0.65 per pound were high. The 12-month land area per cow at 31.96 acres was very large. The 12-month returns after feed costs at $25.83 per cow was moderately low and at $0.81 per acre was extremely low (table 69).

The deferred grazing management strategy is a traditional combination of delayed use of a native rangeland pasture with complementary crested wheatgrass and cropland aftermath pastures and mature crested wheatgrass hay (table 66). A cropland aftermath pasture was grazed during the dry gestation production period for 32 days from mid November to mid December. The forage dry matter available per acre was very low and the quantity of crude protein captured per acre was extremely low with the crude protein content of the pasture forage below the dietary requirements of the cow, during which, no supplemental crude protein was provided. A large land area of 7.10 acres per cow was allotted. Even though the production costs per acre were very low, cropland aftermath pasture of annual cereal stubble grazed during the dry gestation production period was high-cost forage with low forage feed costs per day, very high forage crude protein costs per pound, and moderately high calf weight gain costs per pound. The returns after feed costs were low per cow and extremely low per acre (table 66). The lost cow weight was the major cost from grazing cropland aftermath forage.

Mature crested wheatgrass hay was fed during the third trimester production period for 90 days from mid December to mid March. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was below the dietary requirements of the cow with 30.1 pounds of supplemental crude protein provided. A small land area of 1.35 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the third trimester production period was moderate-cost forage with moderate forage feed costs per day, high forage crude protein costs per pound, and high calf weight gain costs per pound. The returns after feed costs were very low per cow and very low per acre (table 66).

The calves were born in mid March. Mature crested wheatgrass hay was fed during the early lactation production period for 45 days from mid March to late April. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was below the dietary requirements of the cow with 45.0 pounds of supplemental crude protein provided. A small land area of 0.76 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the early lactation production period was moderate-cost forage with high forage feed costs per day, high forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and moderate per acre (table 66).

An unfertilized crested wheatgrass pasture was grazed during the spring lactation production period for 31 days from early May to late May. Grazing was extended on this single unfertilized crested wheatgrass pasture for an additional 45 days during the early portion of the summer lactation production period from early June to mid July. The forage dry matter yield per acre was moderate and the crude protein content of the pasture forage was adequate for about 51 days until the third week in June and below the dietary requirements of the cow for about 25 days, during which, no supplemental crude protein was provided. A small land area of 4.16 acres per cow was allotted. The stocking rate for this treatment was too high and the seasonal period of use was too long for the plants and livestock to sustain production at these high reported levels. The production costs per acre were low and an unfertilized crested wheatgrass pasture grazed during

the spring lactation and early summer lactation production periods was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were moderately high per cow and moderate per acre (table 66). However, this pasture forage management treatment as conducted and reported is not sustainable.

A native rangeland pasture was delay grazed during the latter portion of the summer lactation production period for 92 days from mid July to mid October. The forage dry matter yield per acre was moderate and the crude protein content of the pasture forage was adequate for about 16 days and below the dietary requirements of the cow for about 76 days, during which, no supplemental crude protein was provided. A moderate land area of 6.70 acres per cow was allotted. The stocking rate for this treatment was too high for the plants and livestock to sustain production at these high reported levels. The production costs per acre were very low and a native rangeland pasture grazed during the late summer lactation production period was high-cost forage with high forage feed costs per day, high forage crude protein costs per pound, and moderately low calf weight gain costs per pound. The returns after feed costs were high per cow and moderate per acre (table 66). However, this pasture forage management treatment as conducted and reported is not sustainable.

Grazing continued on the single native rangeland pasture during the fall lactation production period for 30 days from mid October to mid November. The forage dry matter yield per acre was low and the crude protein content of the pasture forage was below the dietary requirements of the cow, during which, no supplemental crude protein was provided. A moderate land area of 2.18 acres per cow was allotted. The stocking rate for this pasture was too high for the forage available during the summer period and this high stocking rate was not adjusted downward to match the reduction in aboveground forage dry matter during the fall period. Even though the production costs per acre were very low, a native rangeland pasture grazed during the fall lactation production period was high-cost forage with high forage feed costs per day, high forage crude protein costs per pound, and very high calf weight gain costs per pound. The returns after feed costs were a moderate loss per cow and a moderate loss per acre (table 66). The calves were weaned in mid November.

The 12-month deferred grazing management strategy with a native rangeland pasture and complementary crested wheatgrass and cropland aftermath pastures and mature crested wheatgrass hay was a high-cost forage management strategy (table 66). The 12-month forage feed costs at $0.58 per day were moderate, the 12-month forage crude protein costs at $0.31 per pound were high, and the 12-month calf weight gain costs at $0.39 per pound were moderate. The 12-month land area per cow at 22.25 acres was large but too small for a 1200 pound cow with calf. The 12-month returns after feed costs at $164.91 per cow was moderate and at $7.41 per acre was low (table 69).

The 4.5-month seasonlong management strategy is a traditional combination of a native rangeland pasture with complementary crested wheatgrass and cropland aftermath pastures and mature crested wheatgrass hay and oat forage hay cut late (table 67). Mature crested wheatgrass hay was fed during the dry gestation production period for 32 days from mid November to mid December. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was adequate to meet the dietary requirements of the cow with 19.2 pounds of supplemental roughage provided. A small land area of 0.47 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the dry gestation production period was moderate-cost forage with low forage feed costs per day, high forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were low per cow and low per acre (table 67).

Oat forage hay cut late was fed during the third trimester production period for 90 days from mid December to mid March. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was adequate to meet the dietary requirements of the cow. A small land area of 0.38 acres per cow was required. Even though the production costs per acre were high, late cut oat forage hay fed during the third trimester production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and high per acre (table 67).

The calves were born in mid March. Oat forage hay cut late was fed during the early lactation production period for 45 days from mid March to late April. The forage dry matter yield per acre was high and the crude protein content of the harvested forage

was below the dietary requirements of the cow with 27.9 pounds of supplemental crude protein provided. A small land area of 0.21 acres per cow was required. Even though the production costs per acre were high, late cut oat forage hay fed during the early lactation production period was low-cost forage with moderate forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were high per cow and very high per acre (table 67).

An unfertilized crested wheatgrass pasture was grazed during the spring lactation production period for 31 days from early May to late May. The forage dry matter yield per acre was high and the crude protein content of the pasture forage was adequate to meet the dietary requirements of the cow. A small land area of 1.88 acres per cow was required. The production costs per acre were low and an unfertilized crested wheatgrass pasture grazed during the spring lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were moderate per cow and moderate per acre (table 67).

A native rangeland pasture was grazed during the summer lactation production period for 137 days from early June to mid October. The forage dry matter yield per acre was moderate and the crude protein content of the pasture forage was adequate for about 61 days and below the dietary requirements of the cow for about 76 days, during which, no supplemental crude protein was provided. A large land area of 12.70 acres per cow was allotted. Even though the production costs per acre were very low, a single native rangeland pasture grazed seasonlong during the summer lactation production period was high-cost forage with high forage feed costs per day, high forage crude protein costs per pound, and moderately low calf weight gain costs per pound. The returns after feed costs were high per cow and low per acre (table 67).

A cropland aftermath pasture was grazed during the fall lactation production period for 30 days from mid October to mid November. The forage dry matter yield per acre was low and the extremely low crude protein content of the pasture forage was below the dietary requirements of the cow, during which, no supplemental crude protein was provided. A large land area of 6.63 acres per cow was allotted. Even though the production costs per acre were low and the land rent per acre was very low, a cropland aftermath pasture of annual cereal stubble grazed during the fall lactation production period was high-cost forage with low forage feed costs per day, very high forage crude protein costs per pound, and very high calf weight gain costs per pound. The returns after feed costs were a moderate loss per cow and a low loss per acre (table 67). The calves were weaned in mid November.

The 12-month 4.5-month seasonlong management strategy with a native rangeland pasture and complementary crested wheatgrass and cropland aftermath pastures and mature crested wheatgrass hay and oat forage hay cut late was a moderate-cost forage management strategy (table 67). The 12-month forage feed costs at $0.57 per day were moderate, the 12-month forage crude protein costs at $0.30 per pound were high, and the 12-month calf weight gain costs at $0.39 per pound were moderate. The 12-month land area per cow at 22.27 acres was large. The 12-month returns after feed costs at $169.38 per cow was moderate and at $7.61 per acre was low (table 69).

The twice-over rotation management strategy is a combination of biologically effective forage types identified to have low forage feed costs and to efficiently capture high value from the land natural resources. The biologically effective strategy consists of a three native rangeland pasture rotation system with complementary crested wheatgrass and Altai wildrye pastures and forage barley hay cut early (table 68). Forage barley hay cut early was fed during the dry gestation production period for 32 days from mid November to mid December. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 400.0 pounds of supplemental roughage provided. A very small land area of 0.08 acres per cow was required. Even though the production costs per acre were high, early cut forage barley hay fed during the dry gestation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were low per cow and high per acre (table 68).

Forage barley hay cut early was fed during the third trimester production period for 90 days from mid December to mid March. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 864.0 pounds of supplemental roughage provided. A small land area of 0.27 acres per cow was required. Even though the production costs per acre were high, early cut forage barley hay fed during the third trimester

production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and high per acre (table 68).

The calves were born in mid March. Forage barley hay cut early was fed during the early lactation production period for 45 days from mid March to late April. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 270.0 pounds of supplemental roughage provided. A very small land area of 0.20 acres per cow was required. Even though the production costs per acre were high, early cut forage barley hay fed during the early lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and very low calf weight gain costs per pound. The returns after feed costs were high per cow and extremely high per acre (table 68).

A fertilized (50 lbs N/acre applied during the first week of April) crested wheatgrass pasture was grazed during the spring lactation production period for 31 days from early May to late May. The forage dry matter yield per acre was high and the crude protein content of the pasture forage was high. A small land area of 0.75 acres per cow was required. The production costs per acre were moderate and a fertilized crested wheatgrass pasture grazed during the spring lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and very low calf weight gain costs per pound. The returns after feed costs were moderate per cow and high per acre (table 68).

Each of three native rangeland pastures were grazed for two periods during the summer lactation production period for 137 days from early June to mid October. The first grazing period of 15 days occurred between 1 June and 15 July (when lead tillers of grasses were between the three and a half new leaf stage and the flowering stage) and the second grazing period of 30 days occurred after 15 July and prior to mid October (when the secondary tillers of grasses had reached the third leaf stage). The first pasture grazed in the sequence was the last pasture grazed the previous year. The forage dry matter yield per acre was high and the high crude protein content of the pasture forage was adequate to meet the dietary requirements of the cow for about 122 days and was marginal to below the requirements for 15 days or less. A small land area of 9.00 acres per cow was required. The production costs per acre were low and three to six native rangeland pastures grazed in rotation during the summer lactation production period were low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were very high per cow and high per acre (table 68).

An Altai wildrye pasture was grazed during the fall lactation production period for 30 days from mid October to mid November. The forage dry matter yield per acre was high and the relatively high crude protein content of the pasture forage was adequate to meet the dietary requirements of the cow for most of the grazing period and marginal or slightly below the requirements during the latter portion of the period. A small land area of 1.39 acres per cow was required when the pasture had a high plant population. The production costs per acre were low and Altai wildrye pastures grazed during the fall lactation production period were low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and very low calf weight gain costs per pound. The returns after feed costs were moderate per cow and moderate per acre (table 68). The calves were weaned in mid November.

The 12-month twice-over rotation management strategy with native rangeland pastures and complementary crested wheatgrass and Altai wildrye pastures and early cut forage barley hay was a low-cost forage management strategy (table 68). The 12-month forage feed costs at $0.47 per day were low, the 12-month forage crude protein costs at $0.15 per pound were low, and the 12-month calf weight gain costs at $0.28 per pound were very low. The 12-month land area per cow at 11.69 acres was small. The 12-month returns after feed costs at $251.36 per cow was very high and at $21.50 per acre was high (table 69). The 12-month twice-over rotation management strategy does not have the lowest forage feed costs per day; it does not have the lowest forage crude protein costs per pound; it does not have the lowest calf weight gain costs per pound; it does not have the smallest land area per cow; and it does not have the greatest returns after feed costs per acre (tables 69 and 77). However, all of the critical cost factors were below the threshold values and this management strategy does have the greatest returns after feed costs per cow-calf pair (table 68).

Discussion

Traditionally managed pasture forage types provide forage dry matter feed at or near the cows requirements, however, crude protein is often

deficient. The biologically effective twice-over rotation strategy is managed to provide both forage dry matter and crude protein at the dietary requirements of the cow. The availability of sufficient crude protein for range cows at the required times and in the required amounts was different among the 12-month pasture forage management strategies (table 70). The crude protein content of the forage feed provided to the range cows was deficient for 298 days (82%) on the deferred grazing, 288 days (79%) on the 6.0-month seasonlong, 273 days (75%) on the repeated seasonal, 151 days (41%) on the 4.5-month seasonlong, and 15 days (4%) on the twice-over rotational management strategies. Supplemental crude protein was provided during 182 days (50%) on the 6.0-month seasonlong, 152 days (42%) on the repeated seasonal, 135 days (37%) on the deferred grazing, 45 days (12%) on the 4.5-month seasonlong, and 0 days (0%) on the twice-over rotation management strategies. Crude protein was deficient in the forage and not provided as supplement for 163 days (45%) on the deferred grazing, 121 days (33%) on the repeated seasonal, 106 days (29%) on the 6.0-month seasonlong, 106 days (29%) on the 4.5-month seasonlong, and 15 days or less (4%) on the twice-over rotation management strategies (table 70).

Crude protein deficiency in range cow diets greatly affects cow and calf weight performance and the quantity of calf weight produced per acre. Calf weight gain was 9.60 lb/ac on the repeated seasonal, 16.89 lb/ac on the 6.0-month seasonlong, 24.10 lb/ac on the deferred grazing, 24.19 lb/ac on the 4.5-month seasonlong, and 51.64 lb/ac on the twice-over rotation management strategies. The number of days per year that range cow forage feed is deficient in crude protein affects the weight of crude protein captured per acre and, in return, the quantity of new wealth generated from the land resources per acre. The returns after feed costs were $-2.41/ac on the repeated seasonal, $0.81/ac on the 6.0-month seasonlong, $7.41/ac on the deferred grazing, $7.61/ac on the 4.5-month seasonlong, and $21.50/ac on the twice-over rotation management strategies (table 69).

Modern, high-performance cattle have greater nutrient demand than old-style cattle and modern cattle perform at greater efficiency when their nutritional demands are met during each production period. Management strategies developed for old-style low-performance cattle were based on the traditional concepts of providing adequate forage dry matter at a low cash flow cost or a low production cost per acre. The traditional management strategies of repeated seasonal, 6.0-month seasonlong, deferred grazing, and 4.5-month seasonlong provided adequate quantities of forage dry matter that were deficient in crude protein for 41% to 82% of the days per year and even though supplemental crude protein was provided during some deficiency periods, the diets of the range cows were deficient in crude protein for 45% to 29% of the days per year. Using old-style traditional forage management strategies to provide forage feed for modern cattle results in low calf weight gain per acre and low returns after feed costs per acre.

Management strategies based on biologically effective concepts use forage types during their growth stages in which adequate crude protein and adequate dry matter are available to range cows at low forage feed costs per day and low forage crude protein costs per pound. The twice-over rotation management strategy efficiently captures a high proportion of the forage produced crude protein and generates considerable new wealth from the land resources per acre.

Harvested Forage Types

Results

Harvested forage management strategies were developed by using one harvested forage type during all of the range cow production periods. These management strategies were evaluated during a 12-month period not as designs for actual forage systems but to demonstrate that harvested forages are not always the high-cost forage they are assumed to be and to show that substantial revenue can be captured per acre by feeding harvested forage types. A 12-month management strategy comprised entirely of harvested forage types would include two or more forage types that would work together in a cropland rotation, such as, early cut forage barley hay and late cut pea forage hay seeded separately. An obvious practical application of 12-month harvested forage management strategies would be for the beef production operation that desires to expand the size of the cow herd but, for some reason, can not expand the size of the land base. The 12-month harvested forage management strategies provide a mechanism by which stockmen can produce relatively low-cost forage and feed for a greater number of cows on a smaller land base per cow.

Another practical application of 12-month harvested forage management strategies would be to provide low-cost forage for beef cow herds with calf birth dates at unconventional times. Cow herds with conventional calf birth dates (January through April)

can efficiently capture low-cost forage from domesticated and native range perennial grasses when grazing and cutting are properly coordinated with plant growth stages. However, with grazing, the herbage growth curves and nutritional quality curves of perennial grasses can not be effectively matched biologically with the nutrient requirements for cows with unconventional calf birth dates. The resulting inefficiency of nutrient capture would increase the costs of livestock feed and the costs of calf accumulated weight. Feed costs for cow herds with unconventional calf birth dates could be reduced with the use of low-cost annual cereal and annual legume hays harvested at their optimum plant growth stages.

The 12-month mature crested wheatgrass hay management strategy harvested the hay forage at the plant growth stage that captured the greatest quantity of forage dry matter per acre. Mature crested wheatgrass hay was fed during the dry gestation production period for 32 days from mid November to mid December. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was adequate to meet the dietary requirements of the cow with 19.2 pounds of supplemental roughage provided. A small land area of 0.47 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the dry gestation production period was moderate-cost forage with low forage feed costs per day, high forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were low per cow and low per acre (table 71).

Mature crested wheatgrass hay was fed during the third trimester production period for 90 days from mid December to mid March. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was below the dietary requirements of the cow with 30.1 pounds of supplemental crude protein provided. A small land area of 1.35 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the third trimester production period was moderate-cost forage with moderate forage feed costs per day, high forage crude protein costs per pound, and high calf weight gain costs per pound. The returns after feed costs were very low per cow and very low per acre (table 71).

The calves were born in mid March. Mature crested wheatgrass hay was fed during the early lactation production period for 45 days from mid March to late April. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was below the dietary requirements of the cow with 45.0 pounds of supplemental crude protein provided. A small land area of 0.76 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the early lactation production period was moderate-cost forage with high forage feed costs per day, high forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and moderate per acre (table 71).

Mature crested wheatgrass hay was fed during the spring lactation production period for 31 days from early May to late May. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was below the dietary requirements of the cow with 18.29 pounds of supplemental crude protein provided. A small land area of 0.58 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the spring lactation production period was high-cost forage with high forage feed costs per day, high forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and moderate per acre (table 71).

Mature crested wheatgrass hay was fed during the summer lactation production period for 137 days from early June to mid October. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was below the dietary requirements of the cow with 80.83 pounds of supplemental crude protein provided. A small land area of 2.57 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the summer lactation production period was high-cost forage with high forage feed costs per day, high forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were high per cow and moderate per acre (table 71).

Mature crested wheatgrass hay was fed during the fall lactation production period for 30 days from mid October to mid November. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was below the dietary requirements of the cow with 17.70 pounds of supplemental crude protein provided. A small land area of 0.56 acres per cow was required. The production costs per acre were moderate and mature crested wheatgrass hay fed during the fall lactation production period was high-cost forage with high

forage feed costs per day, high forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and moderate per acre (table 71). The calves were weaned in mid November.

The 12-month mature crested wheatgrass hay management strategy was a high-cost forage management strategy (table 71). The 12-month forage feed costs at $0.64 per day were high, the 12-month forage crude protein costs at $0.28 per pound were high, and the 12-month calf weight gain costs at $0.41 per pound were moderate. The 12-month land area per cow at 6.29 acres was small. The 12-month returns after feed costs at $168.54 per cow was moderate and at $26.79 per acre was moderate (table 77).

The 12-month crested wheatgrass hay cut early management strategy harvested the hay forage at the plant growth stage that captured the greatest quantity of forage crude protein per acre. Crested wheatgrass hay cut early was fed during the dry gestation production period for 32 days from mid November to mid December. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was moderate with 438.4 pounds of supplemental roughage provided. A small land area of 0.26 acres per cow was required. The production costs per acre were moderate and early cut crested wheatgrass hay fed during the dry gestation production period was moderate-cost forage with moderate forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were low per cow and moderate per acre (table 72).

Crested wheatgrass hay cut early was fed during the third trimester production period for 90 days from mid December to mid March. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was moderate with 999.0 pounds of supplemental roughage provided. A small land area of 0.89 acres per cow was required. The production costs per acre were moderate and early cut crested wheatgrass hay fed during the third trimester production period was moderate-cost forage with moderate forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and moderate per acre (table 72).

The calves were born in mid March. Crested wheatgrass hay cut early was fed during the early lactation production period for 45 days from mid March to late April. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was moderate with 369.0 pounds of supplemental roughage provided. A small land area of 0.65 acres per cow was required. The production costs per acre were moderate and early cut crested wheatgrass hay fed during the early lactation production period was moderate-cost forage with moderate forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were moderate per cow and high per acre (table 72).

Crested wheatgrass hay cut early was fed during the spring lactation production period for 31 days from early May to late May. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was moderate with 393.7 pounds of supplemental roughage provided. A small land area of 0.41 acres per cow was required. The production costs per acre were moderate and early cut crested wheatgrass hay fed during the spring lactation production period was moderate-cost forage with moderate forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were moderate per cow and high per acre (table 72).

Crested wheatgrass hay cut early was fed during the summer lactation production period for 137 days from early June to mid October. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was moderate with 1739.9 pounds of supplemental roughage provided. A small land area of 1.82 acres per cow was required. The production costs per acre were moderate and early cut crested wheatgrass hay fed during the summer lactation production period was moderate-cost forage with moderate forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were very high per cow and high per acre (table 72).

Crested wheatgrass hay cut early was fed during the fall lactation production period for 30 days from mid October to mid November. The forage dry matter yield per acre was moderate and the crude protein content of the harvested forage was moderate with 381.0 pounds of supplemental roughage provided. A small land area of 0.40 acres per cow was required. The production costs per acre were moderate and early cut crested wheatgrass hay fed during the fall lactation production period was

moderate-cost forage with moderate forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were moderate per cow and high per acre (table 72). The calves were weaned in mid November.

The 12-month crested wheatgrass hay cut early management strategy was a moderate-cost forage management strategy (table 72). The 12-month forage feed costs at $0.53 per day were moderate, the 12-month forage crude protein costs at $0.14 per pound were low, and the 12-month calf weight gain costs at $0.33 per pound were low. The 12-month land area per cow at 4.43 acres was small. The 12-month returns after feed costs at $211.48 per cow was high and at $47.74 per acre was high (table 77).

The 12-month forage barley hay cut early management strategy harvested the hay forage at the plant growth stage that captured the greatest quantity of forage crude protein per acre. Forage barley hay cut early was fed during the dry gestation production period for 32 days from mid November to mid December. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 400.0 pounds of supplemental roughage provided. A very small land area of 0.08 acres per cow was required. The production costs per acre were high and early cut forage barley hay fed during the dry gestation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were low per cow and high per acre (table 73).

Forage barley hay cut early was fed during the third trimester production period for 90 days from mid December to mid March. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 864.0 pounds of supplemental roughage provided. A small land area of 0.27 acres per cow was required. The production costs per acre were high and early cut forage barley hay fed during the third trimester production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and high per acre (table 73).

The calves were born in mid March. Forage barley hay cut early was fed during the early lactation production period for 45 days from mid March to late April. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 270.0 pounds of supplemental roughage provided. A very small land area of 0.20 acres per cow was required. The production costs per acre were high and early cut forage barley hay fed during the early lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and very low calf weight gain costs per pound. The returns after feed costs were high per cow and extremely high per acre (table 73).

Forage barley hay cut early was fed during the spring lactation production period for 31 days from early May to late May. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 331.7 pounds of supplemental roughage provided. A very small land area of 0.13 acres per cow was required. The production costs per acre were high and early cut forage barley hay fed during the spring lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and very low calf weight gain costs per pound. The returns after feed costs were moderate per cow and extremely high per acre (table 73).

Forage barley hay cut early was fed during the summer lactation production period for 137 days from early June to mid October. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 1465.9 pounds of supplemental roughage provided. A small land area of 0.56 acres per cow was required. The production costs per acre were high and early cut forage barley hay fed during the summer lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and very low calf weight gain costs per pound. The returns after feed costs were very high per cow and extremely high per acre (table 73).

Forage barley hay cut early was fed during the fall lactation production period for 30 days from mid October to mid November. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 321.0 pounds of supplemental roughage provided. A very small land area of 0.12 acres per cow was required. The production costs per acre were high and early cut forage barley hay fed during the fall lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and very low calf weight gain costs

per pound. The returns after feed costs were moderate per cow and extremely high per acre (table 73). The calves were weaned in mid November.

The 12-month forage barley hay cut early management strategy was a low-cost forage management strategy (table 73). The 12-month forage feed costs at $0.43 per day were low, the 12-month forage crude protein costs at $0.11 per pound were very low, and the 12-month calf weight gain costs at $0.27 per pound were very low. The 12-month land area per cow at 1.36 acres was very small. The 12-month returns after feed costs at $246.83 per cow was very high and at $181.49 per acre was extremely high (table 77).

The 12-month oat forage hay cut early management strategy harvested the hay forage at the plant growth stage that captured the greatest quantity of forage crude protein per acre. Oat forage hay cut early was fed during the dry gestation production period for 32 days from mid November to mid December. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 352.0 pounds of supplemental roughage provided. A very small land area of 0.09 acres per cow was required. The production costs per acre were high and early cut oat forage hay fed during the dry gestation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were low per cow and high per acre (table 74).

Oat forage hay cut early was fed during the third trimester production period for 90 days from mid December to mid March. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 693.0 pounds of supplemental roughage provided. A small land area of 0.31 acres per cow was required. The production costs per acre were high and early cut oat forage hay fed during the third trimester production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and high per acre (table 74).

The calves were born in mid March. Oat forage hay cut early was fed during the early lactation production period for 45 days from mid March to late April. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 148.5 pounds of supplemental roughage provided. A very small land area of 0.23 acres per cow was required. The production costs per acre were high and early cut oat forage hay fed during the early lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and very low calf weight gain costs per pound. The returns after feed costs were high per cow and very high per acre (table 74).

Oat forage hay cut early was fed during the spring lactation production period for 31 days from early May to late May. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 254.2 pounds of supplemental roughage provided. A very small land area of 0.14 acres per cow was required. The production costs per acre were high and early cut oat forage hay fed during the spring lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and very low calf weight gain costs per pound. The returns after feed costs were moderate per cow and extremely high per acre (table 74).

Oat forage hay cut early was fed during the summer lactation production period for 137 days from early June to mid October. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 1123.4 pounds of supplemental roughage provided. A small land area of 0.64 acres per cow was required. The production costs per acre were high and early cut oat forage hay fed during the summer lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and very low calf weight gain costs per pound. The returns after feed costs were very high per cow and extremely high per acre (table 74).

Oat forage hay cut early was fed during the fall lactation production period for 30 days from mid October to mid November. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 246.0 pounds of supplemental roughage provided. A very small land area of 0.14 acres per cow was required. The production costs per acre were high and early cut oat forage hay fed during the fall lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and very low calf weight gain costs per pound. The returns after feed costs were moderate per cow and extremely high per acre (table 74). The calves were weaned in mid November.

The 12-month oat forage hay cut early management strategy was a low-cost forage management strategy (table 74). The 12-month forage feed costs at $0.43 per day were low, the 12-month forage crude protein costs at $0.13 per pound were low, and the 12-month calf weight gain costs at $0.27 per pound were very low. The 12-month land area per cow at 1.55 acres was very small. The 12-month returns after feed costs at $245.47 per cow was very high and at $158.37 per acre was very high (table 77).

The 12-month pea forage hay cut late management strategy harvested the hay forage at the plant growth stage that captured the greatest quantity of forage crude protein per acre. Pea forage hay cut late was fed during the dry gestation production period for 32 days from mid November to mid December. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 438.4 pounds of supplemental roughage provided. A very small land area of 0.07 acres per cow was required. The production costs per acre were high and late cut pea forage hay fed during the dry gestation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were low per cow and high per acre (table 75).

Pea forage hay cut late was fed during the third trimester production period for 90 days from mid December to mid March. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 990.0 pounds of supplemental roughage provided. A small land area of 0.25 acres per cow was required. The production costs per acre were high and late cut pea forage hay fed during the third trimester production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and high per acre (table 75).

The calves were born in mid March. Pea forage hay cut late was fed during the early lactation production period for 45 days from mid March to late April. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 360.0 pounds of supplemental roughage provided. A very small land area of 0.18 acres per cow was required. The production costs per acre were high and late cut pea forage hay fed during the early lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were high per cow and extremely high per acre (table 75).

Pea forage hay cut late was fed during the spring lactation production period for 31 days from early May to late May. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 390.6 pounds of supplemental roughage provided. A very small land area of 0.12 acres per cow was required. The production costs per acre were high and late cut pea forage hay fed during the spring lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were moderate per cow and extremely high per acre (table 75).

Pea forage hay cut late was fed during the summer lactation production period for 137 days from early June to mid October. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 1726.2 pounds of supplemental roughage provided. A small land area of 0.51 acres per cow was required. The production costs per acre were high and late cut pea forage hay fed during the summer lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were very high per cow and extremely high per acre (table 75).

Pea forage hay cut late was fed during the fall lactation production period for 30 days from mid October to mid November. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 378.0 pounds of supplemental roughage provided. A very small land area of 0.11 acres per cow was required. The production costs per acre were high and late cut pea forage hay fed during the fall lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were moderate per cow and extremely high per acre (table 75). The calves were weaned in mid November.

The 12-month pea forage hay cut late management strategy was a low-cost forage management strategy (table 75). The 12-month forage feed costs at $0.50 per day were low, the 12-month forage crude protein costs at $0.13 per pound

were low, and the 12-month calf weight gain costs at $0.32 per pound were low. The 12-month land area per cow at 1.24 acres was very small. The 12-month returns after feed costs at $219.81 per cow was high and at $177.27 per acre was extremely high (table 77).

The 12-month forage lentil hay cut late management strategy harvested the hay forage at the plant growth stage that captured the greatest quantity of forage crude protein per acre. Forage lentil hay cut late was fed during the dry gestation production period for 32 days from mid November to mid December. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 444.8 pounds of supplemental roughage provided. A very small land area of 0.09 acres per cow was required. The production costs per acre were high and late cut forage lentil hay fed during the dry gestation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were low per cow and high per acre (table 76).

Forage lentil hay cut late was fed during the third trimester production period for 90 days from mid December to mid March. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 1017.0 pounds of supplemental roughage provided. A small land area of 0.30 acres per cow was required. The production costs per acre were high and late cut forage lentil hay fed during the third trimester production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and moderate calf weight gain costs per pound. The returns after feed costs were moderate per cow and moderate per acre (table 76).

The calves were born in mid March. Forage lentil hay cut late was fed during the early lactation production period for 45 days from mid March to late April. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 378.0 pounds of supplemental roughage provided. A very small land area of 0.22 acres per cow was required. The production costs per acre were high and late cut forage lentil hay fed during the early lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were high per cow and very high per acre (table 76).

Forage lentil hay cut late was fed during the spring lactation production period for 31 days from early May to late May. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 399.9 pounds of supplemental roughage provided. A very small land area of 0.14 acres per cow was required. The production costs per acre were high and late cut forage lentil hay fed during the spring lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were moderate per cow and very high per acre (table 76).

Forage lentil hay cut late was fed during the summer lactation production period for 137 days from early June to mid October. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 1767.3 pounds of supplemental roughage provided. A small land area of 0.60 acres per cow was required. The production costs per acre were high and late cut forage lentil hay fed during the summer lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were very high per cow and extremely high per acre (table 76).

Forage lentil hay cut late was fed during the fall lactation production period for 30 days from mid October to mid November. The forage dry matter yield per acre was high and the crude protein content of the harvested forage was high with 387.0 pounds of supplemental roughage provided. A very small land area of 0.13 acres per cow was required. The production costs per acre were high and late cut forage lentil hay fed during the fall lactation production period was low-cost forage with low forage feed costs per day, low forage crude protein costs per pound, and low calf weight gain costs per pound. The returns after feed costs were moderate per cow and extremely high per acre (table 76). The calves were weaned in mid November.

The 12-month forage lentil hay cut late management strategy was a low-cost forage management strategy (table 76). The 12-month forage feed costs at $0.51 per day were low, the 12-month forage crude protein costs at $0.13 per pound were low, and the 12-month calf weight gain costs at $0.32 per pound were low. The 12-month land area per cow at 1.48 acres was very small. The 12-month returns after feed costs at $217.88 per cow was high and at $147.22 per acre was very high (table 77).

Discussion

Some harvested forages are expensive, but not all harvested forages are high-cost feeds. Harvested forages cut at plant growth stages that yield great amounts of crude protein per acre have low costs per pound of crude protein and are low-cost forage feeds that efficiently capture high value from the land natural resources. Harvested forages cut at plant growth stages that yield great amounts of forage dry matter and low amounts of crude protein per acre have high costs per pound of crude protein and are high-cost forage feeds that only generate a small portion of the potential new wealth from the land resources.

Traditionally, domesticated perennial grass hays from crested wheatgrass and smooth bromegrass 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 crude protein per acre causes high crude protein costs per pound and high forage feed costs per day. Mature crested wheatgrass hay has lower returns after feed costs per acre than crested wheatgrass hay cut early at the boot stage because early cut crested wheatgrass hay captures nearly double the pounds of crude protein per acre. Forage barley and oat forage hays cut early at the milk stage and pea forage and forage lentil hays cut late capture greater crude protein yield per acre and have greater returns after feed costs per acre than forage barley and oat forage hays cut late at the hard dough stage and pea forage and forage lentil hays cut early, respectively.

Management Implications

Evaluation of the costs of the pasture forage and harvested forage types that compose 12-month forage management strategies has shown that these costs are largely determined by the biological effectiveness and crude protein capture and conversion efficiency of the management strategy. Reduction of forage feed costs requires implementation of management strategies that are biologically effective at stimulation of vegetative tillering and rhizosphere organism activity and are efficient at crude protein capture per acre and efficient at conversion of forage crude protein to a saleable product like calf weight. These biological and nutritional aspects of 12-month forage management strategies can be increased through the improvement of four factors.

- increasing herbage and crude protein production per acre by placing the biological requirements of plants and the ecosystem processes as the highest management priority and by coordinating grazing and harvest periods with plant growth stages.
- increasing crude protein capture efficiency by timing grazing and harvest periods to remove greater amounts of crude protein per acre rather than greater amounts of forage dry matter. Supplementation of dry matter roughage is lower cost than supplementation of crude protein.
- increasing nutrient conversion efficiency by providing adequate crude protein throughout the range cows' 12-month production cycle because high-performance livestock perform at greater efficiencies when not limited by periods with crude protein deficiency.
- increasing forage feed management system efficiency by combining pasture types and harvested forage types in a 12-month sequence so that the herbage production curves and crude protein quality curves are coordinated with the 12-month dietary quantity and quality requirement curves of range cow production periods.

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

Beef production is the last meat industry to improve the efficiency of forage feed management systems. The traditional management strategies used in the Northern Plains were developed during the era of low-performance livestock. During the past several decades the type of livestock in the region has shifted to a fast-growing, high-performance animal, but the forage feed management strategies have not been adjusted to provide crude protein at the times and in the amounts required by high-performance animals and to take full advantage of the livestock's genetic potential. Traditional management practices do not efficiently provide adequate forage feed for high-performance livestock to produce high profit margins. Biologically effective management strategies efficiently capture high proportions of the forage produced crude protein and generate considerable new wealth from the land natural resources.

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Table 64. Summary of 12-month pasture forage and harvested forage management strategy: Repeated Seasonal on native rangeland and reserved native rangeland pastures.

		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	12-month Season
Days		32 d	90 d	45 d	31 d	137 d	30 d	365 d
Repeated Seasonal Forage Type			Reserved Native Rangeland			Native Rangeland		
Land Area	ac	5.33	18.62	10.80	4.77	11.32	4.60	55.44
Crude Protein	$/lb	1.01	1.26	0.76	0.28	0.25	0.92	0.62
Forage Feed Cost	$	47.23	174.73	94.64	41.85	98.64	51.20	508.29
Cost/Day	$	1.48	1.94	2.10	1.35	0.72	1.71	1.39
Acc. Calf Wt.	lb	24.92	70.08	81.00	55.80	246.60	54.00	532.40
Return/c-cpr	$	-29.79	-125.67	-37.94	-2.79	73.98	-13.40	-135.61
Return/acre	$	-5.59	-6.75	-3.51	-0.58	6.54	-2.91	-2.45
Cost/lb Calf Gain	$	1.90	2.49	1.17	0.75	0.40	0.95	0.95

Table 65. Summary of 12-month pasture forage and harvested forage management strategy: 6.0-month Seasonlong on native rangeland with reserved native rangeland pastures and mature crested wheatgrass hay.

		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation		Summer Lactation	Fall Lactation	12-month Season
Days		32 d	90 d	45 d	15 d	16 d	137 d	30 d	365 d
6.0-month Seasonlong									
Forage Type		Reserved Native Range		Mature Crested Wheatgrass Hay			Native Range	Native Range	
Land Area	ac	5.33	1.35	0.76	0.28	2.10	18.10	4.04	31.96
Crude Protein	$/lb	1.01	0.28	0.28	0.28	0.28 est	0.52 est	0.82	0.47
Forage Feed Cost	$	47.23	47.04	34.91	10.65	18.40	158.55	35.39	352.17
Cost/Day	$	1.48	0.52	0.78	0.71	1.15	1.16	1.18	0.96
Acc. Calf Wt.	lb	24.92	70.08	85.50	30.00	28.80	282.87	17.73	539.90
Return/c-cpr	$	-29.79	2.02	24.94	10.42	1.76	39.46	-22.98	25.83
Return/acre	$	-5.59	1.50	32.82	37.14	0.83	2.18	-5.69	0.81
Cost/lb Calf Gain	$	1.90	0.67	0.41	0.35	0.64	0.56	1.99	0.65

Table 66. Summary of 12-month pasture forage and harvested forage management strategy: Deferred Grazing on native rangeland with complementary crested wheatgrass and cropland aftermath pastures and mature crested wheatgrass hay.

		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	12-month Season
Days		32 d	90 d	45 d	76 d	92 d	30 d	365 d
Deferred Grazing								
Forage Type		Cropland Aftermath	Mature Crested Wheatgrass Hay		Unfertilized Crested Wheatgrass	Native Rangeland		
Land Area	ac	7.10	1.35	0.76	4.16	6.70	2.18	22.25
Crude Protein	$/lb	0.74	0.28	0.28	0.13 est.	0.28 est.	0.44	0.31
Forage Feed Cost	$	14.20	47.04	34.91	36.44	58.26	19.53	210.38
Cost/Day	$	0.44	0.52	0.78	0.48	0.63	0.65	0.58
Acc. Calf Wt.	lb	24.92	70.08	85.50	136.04	196.50	23.10	536.14
Return/c-cpr	$	3.24	2.02	24.94	58.78	79.29	-3.36	164.91
Return/acre	$	0.46	1.50	32.82	14.13	11.83	-1.51	7.41
Cost/lb Calf Gain	$	0.57	0.67	0.41	0.27	0.30	0.85	0.39

Table 67. Summary of 12-month pasture forage and harvested forage management strategy: 4.5-month Seasonlong on native rangeland with complementary crested wheatgrass and cropland aftermath pastures and mature crested wheatgrass hay and oat forage hay cut late.

		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	12-month Season
Days		32 d	90 d	45 d	31 d	137 d	30 d	365 d
4.5-month Seasonlong								
Forage Type		Mature Crested Wheatgrass Hay	Oat Forage Hay cut late		Unfertilized Crested Wheatgrass	Native Range	Cropland Aftermath	
Land Area	ac	0.47	0.38	0.21	1.88	12.70	6.63	22.27
Crude Protein	$/lb	0.28	0.17	0.17	0.11	0.37 est.	0.74 est.	0.30
Forage Feed Cost	$	13.46	28.80	24.41	16.47	111.25	13.26	207.65
Cost/Day	$	0.42	0.32	0.54	0.52	0.81	0.44	0.57
Acc. Calf Wt.	lb	24.92	70.08	85.50	59.21	286.33	12.57	538.61
Return/c-cpr	$	3.98	20.26	35.44	24.98	89.18	-4.46	169.38
Return/acre	$	8.47	53.32	168.76	13.29	7.02	-0.67	7.61
Cost/lb Calf Gain	$	0.54	0.41	0.29	0.27	0.39	1.05	0.39

Table 68. Summary of 12-month pasture forage and harvested forage management strategy: Twice-over Rotation on native rangeland with complementary crested wheatgrass and Altai wildrye pastures and forage barley hay cut early.

		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	12-month Season
Days		32 d	90 d	45 d	31 d	137 d	30 d	365 d
Twice-over Rotation								
Forage Type			Forage Barley Hay cut early		Fertilized Crested Wheatgrass	Native Range	Altai Wildrye	
Land Area	ac	0.08	0.27	0.20	0.75	9.00	1.39	11.69
Crude Protein	$/lb	0.11	0.11	0.11	0.10 est.	0.20 est.	0.16 est.	0.15
Forage Feed Cost	$	12.12	33.86	18.23	15.95	78.84	12.18	171.18
Cost/Day	$	0.38	0.38	0.41	0.51	0.58	0.40	0.47
Acc. Calf Wt.	lb	24.92	70.08	85.50	67.58	302.77	52.77	603.62
Return/c-cpr	$	5.32	15.20	41.62	31.36	133.10	24.76	251.36
Return/acre	$	66.50	56.30	208.10	41.82	14.79	17.81	21.50
Cost/lb Calf Gain	$	0.49	0.48	0.21	0.24	0.26	0.23	0.28

Table 69. Summary of costs and returns after feed costs per acre for 12-month pasture forage management strategies.

12-month Management Strategies	Forage Feed Costs $/d	Calf Weight Costs $/lb	Crude Protein Costs $/lb	Land Area acre/c-cpr	Returns After Feed Costs $/acre
Repeated Seasonal	1.39	0.95	0.62	55.44	-2.41
6.0-m Seasonlong	0.96	0.65	0.47	31.96	0.81
Deferred Grazing	0.58	0.39	0.31	22.25	7.41
4.5-m Seasonlong	0.57	0.39	0.30	22.27	7.61
Twice-over Rotation	**0.47**	**0.28**	**0.15**	**11.69**	**21.50**

Bolded management strategies meet the selection criterion and efficiently capture high value from the land natural resources.

Table 70. Availability of sufficient crude protein for range cows on 12-month pasture forage management strategies.

12-month Management Strategies	Forage with Adequate Crude Protein		Forage Deficient in Crude Protein		Crude Protein Supplementation Provided		Crude Protein Supplementation Not Provided	
	Days	% of 12-mo	Days	% of 12-mo	Days	% of 12-mo	Days	% of 12-mo
Repeated Seasonal	92	25%	273	75%	152	42%	121	33%
6.0-m Seasonlong	77	21%	288	79%	182	50%	106	29%
Deferred Grazing	67	18%	298	82%	135	37%	163	45%
4.5-m Seasonlong	214	59%	151	41%	45	12%	106	29%
Twice-over Rotation	350	96%	15	4%	0	0%	15	4%

Table 71. Summary of 12-month pasture forage and harvested forage management strategy: Mature Crested Wheatgrass Hay.

		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	12-month Season
Days		32 d	90 d	45 d	31 d	137 d	30 d	365 d
Mature Crested Wheatgrass Hay								
Forage Type				Mature Crested Wheatgrass Hay				
Land Area	ac	0.47	1.35	0.76	0.58	2.57	0.56	6.29
Crude Protein	$ /lb	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Forage Feed Cost	$	13.46	47.04	34.91	21.86	96.59	21.15	235.01
Cost/Day	$	0.42	0.52	0.78	0.71	0.71	0.71	0.64
Acc. Calf Wt.	lb	24.92	70.08	85.50	62.00	274.00	60.00	576.50
Return/c-cpr	$	3.98	2.02	24.94	21.54	95.21	20.85	168.54
Return/acre	$	8.47	1.50	32.82	37.14	37.05	37.07	26.79
Cost/lb Calf Gain	$	0.54	0.67	0.41	0.35	0.35	0.35	0.41

Table 72. Summary of 12-month pasture forage and harvested forage management strategy: Crested Wheatgrass Hay cut early.

		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	12-month Season
Days		32 d	90 d	45 d	31 d	137 d	30 d	365 d
Crested Wheatgrass Hay cut early								
Forage Type				Crested Wheatgrass Hay cut early				
Land Area	ac	0.26	0.89	0.65	0.41	1.82	0.40	4.43
Crude Protein	$/lb	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Forage Feed Cost	$	14.40	40.88	23.53	17.73	78.37	17.16	192.07
Cost/Day	$	0.45	0.45	0.52	0.57	0.57	0.57	0.53
Acc. Calf Wt.	lb	24.92	70.08	85.50	62.00	274.00	60.00	576.50
Return/c-cpr	$	3.04	8.18	36.32	25.67	113.43	24.84	211.48
Return/acre	$	11.69	9.19	55.88	62.61	62.32	62.10	47.74
Cost/lb Calf Gain	$	0.58	0.58	0.28	0.29	0.29	0.29	0.33

Table 73. Summary of 12-month pasture forage and harvested forage management strategy: Forage Barley Hay cut early.

		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	12-month Season
Days		32 d	90 d	45 d	31 d	137 d	30 d	365 d
Forage Barley Hay cut early								
Forage Type				Forage Barley Hay cut early				
Land Area	ac	0.08	0.27	0.20	0.13	0.56	0.12	1.36
Crude Protein	$/lb	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Forage Feed Cost	$	12.12	33.86	18.23	14.48	64.01	14.02	156.72
Cost/Day	$	0.38	0.38	0.41	0.47	0.47	0.47	0.43
Acc. Calf Wt.	lb	24.92	70.08	85.50	62.00	274.00	60.00	576.50
Return/c-cpr	$	5.32	15.20	41.62	28.92	127.79	27.98	246.83
Return/acre	$	66.50	56.30	208.10	222.46	228.20	233.17	181.49
Cost/lb Calf Gain	$	0.49	0.48	0.21	0.23	0.23	0.23	0.27

Table 74. Summary of 12-month pasture forage and harvested forage management strategy: Oat Forage Hay cut early.

		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	12-month Season
Days		32 d	90 d	45 d	31 d	137 d	30 d	365 d
Oat Forage Hay cut early								
Forage Type				Oat Forage Hay cut early				
Land Area	ac	0.09	0.31	0.23	0.14	0.64	0.14	1.55
Crude Protein	$/lb	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Forage Feed Cost	$	12.24	33.73	18.35	14.68	64.87	14.21	158.08
Cost/Day	$	0.38	0.37	0.41	0.47	0.47	0.47	0.43
Acc. Calf Wt.	lb	24.92	70.08	85.50	62.00	274.00	60.00	576.50
Return/c-cpr	$	5.20	15.33	41.50	28.72	126.93	27.79	245.47
Return/acre	$	57.78	49.45	180.43	205.14	198.33	198.50	158.37
Cost/lb Calf Gain	$	0.49	0.48	0.21	0.24	0.24	0.24	0.27

Table 75. Summary of 12-month pasture forage and harvested forage management strategy: Pea Forage Hay cut late.

		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	12-month Season
Days		32 d	90 d	45 d	31 d	137 d	30 d	365 d
Pea Forage Hay cut late								
Forage Type				Pea Forage Hay cut late				
Land Area	ac	0.07	0.25	0.18	0.12	0.51	0.11	1.24
Crude Protein	$/lb	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Forage Feed Cost	$	13.75	38.93	22.05	17.07	75.42	16.52	183.74
Cost/Day	$	0.43	0.43	0.49	0.55	0.55	0.55	0.50
Acc. Calf Wt.	lb	24.92	70.08	85.50	62.00	274.00	60.00	576.50
Return/c-cpr	$	3.69	10.13	37.80	26.33	116.38	25.48	219.81
Return/acre	$	52.71	40.52	210.00	219.42	228.20	231.64	177.27
Cost/lb Calf Gain	$	0.55	0.56	0.26	0.28	0.28	0.28	0.32

Table 76. Summary of 12-month pasture forage and harvested forage management strategy: Forage Lentil Hay cut late.

		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	12-month Season
Days		32 d	90 d	45 d	31 d	137 d	30 d	365 d
Forage Lentil Hay cut late								
Forage Type				Forage Lentil Hay cut late				
Land Area	ac	0.09	0.30	0.22	0.14	0.60	0.13	1.48
Crude Protein	$/lb	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Forage Feed Cost	$	13.86	39.40	22.37	17.23	76.14	16.67	185.67
Cost/Day	$	0.43	0.44	0.50	0.56	0.56	0.56	0.51
Acc. Calf Wt.	lb	24.92	70.08	85.50	62.00	274.00	60.00	576.50
Return/c-cpr	$	3.58	9.66	37.48	26.17	115.66	25.33	217.88
Return/acre	$	39.78	32.20	170.36	186.93	192.77	194.85	147.22
Cost/lb Calf Gain	$	0.56	0.56	0.26	0.28	0.28	0.28	0.32

Table 77. Summary of costs and returns after feed costs per acre for 12-month harvested forage management strategies.

12-month Management Strategies	Forage Feed Costs $/d	Calf Weight Costs $/lb	Crude Protein Costs $/lb	Land Area acre/c-cpr	Returns After Feed Costs $/acre
Crested Wheat, mature	0.64	0.41	0.28	6.29	26.79
Crested Wheat, early	**0.53**	**0.33**	**0.14**	**4.43**	**47.74**
Forage Barley, early	**0.43**	**0.27**	**0.11**	**1.36**	**181.49**
Oat Forage, early	**0.43**	**0.27**	**0.13**	**1.55**	**158.37**
Pea Forage, late	**0.50**	**0.32**	**0.13**	**1.24**	**177.27**
Forage Lentil, late	**0.51**	**0.32**	**0.13**	**1.48**	**147.22**

Bolded management strategies meet the selection criterion and efficiently capture high value from the land natural resources.

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