

Diagnostic Examination of the Value Captured from Land Natural Resources by Twelve Month Forage Management Strategies for Range Cows

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The traditionally assumed premise that the source of revenue from beef production has been from the sale of livestock weight has directed the focus on improving animal performance in order to raise profit margins for the beef production industry. Consequently, pasture and harvested forage, labor, and equipment have been considered to be the costs of production. Profits result when the paid costs of production are lower than the value received from the sale of livestock weight. After numerous decades of improvements in animal performance, high production costs and low profit margins continue to be problems for the beef production industry.

The beef production industry has neglected to recognize the importance of forage nutrients as the source of livestock weight gain and failed to simultaneously improve the efficiencies of forage management systems. The swine, poultry, and dairy industries have switched to efficient feed management systems that evaluate feed costs from the cost per unit of the nutrients. Low profit problems persist in the beef industry as a result of the mismatch of forage nutrients required and forage nutrients available between modern, high-performance cattle and traditional low-performance old-style livestock forage management practices.

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. She also requires 27% more energy and 41% more crude protein per day during the lactation period. 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 (Manske 2008).

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.

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 acre and 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 acre and 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.

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.

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).

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 acre and per day are important diagnostic values 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 acres per cow needed during a production period determine the forage feed costs per acre. 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.

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. Diagnostic examinations were conducted on three 12-month forage management strategies: the Repeated Seasonal, No Hay, the Traditional Seasonlong, and the Biologically Effective Twice-over Rotation. The beef cattle nutrient requirements were from NRC 1996 and BCRC 1999. The harvested forage data were from Manske and Carr 2000. The pasture forage data and the cow and

calf performance data were from Manske 2001, 2002, 2003a, 2003b, 2004, and 2008. The methods used were from Manske 2008.

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.

Range Cow Production Periods

Dry Gestation

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).

Third Trimester

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).

Early Lactation

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).

Spring Lactation

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).

Summer Lactation

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).

Fall Lactation

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).

Repeated Seasonal, No Hay

Dry Gestation

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 (table 1). 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 and \$8.86 per acre, or \$1.48 per day. 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 \$3.27 per acre. 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.

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.

Third Trimester

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 (table 1). 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 per period. Total feed costs would be \$174.73 per period and \$9.38 per acre, or \$1.94 per day. 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 \$2.63 per acre. The net returns after pasture costs were a loss of \$125.67 per cow-calf pair and a loss of \$6.75 per acre. The cost of calf fetus weight gain was \$2.49 per pound.

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.

Early Lactation

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 (table 1). 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 and \$8.76 per acre, or \$2.10 per day. 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 \$5.25 per acre. 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.

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 (\$-3.51) 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.

Spring Lactation

Native rangeland managed as a repeated seasonal pasture was evaluated during the spring lactation production period for 31 days between early and late May (table 1). 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 and \$8.76 per acre, or \$1.35 per day. 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 \$8.18 per acre. 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.

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.

Summer Lactation

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 (table 1). 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 and \$8.76

per acre, or \$0.72 per day. 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 \$15.30 per acre. 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.

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.

Fall Lactation

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 (table 1). 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 and \$11.13 per acre, or \$1.71 per day. 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 \$8.22 per acre. 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.

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.

12-month Season

The 12-month repeated seasonal management strategy with native rangeland and reserved native rangeland pastures was a high-cost forage management strategy (table 1). 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 \$-135.61 per cow was an extremely high loss and at \$-2.45 per acre was a moderate loss. 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. 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 (mid November to late April) resulting in a high loss of \$193.40 per cow and a high loss of \$5.57 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.

Table 1. Twelve month costs and returns on the No Hay Repeated Seasonal management strategy for 1200 lb cow with 8 month old calf born mid March.

		Production Period						12-month Season
		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	
Days		32	90	45	31	137	30	365
Forage Type		Native Range	Native Range	Native Range	Native Range	Native Range	Native Range	
Forage DM Weight	lbs/ac	180.0	145.0	125.0	195.0	363.0	199.0	197.76
Production Costs	\$/ac	8.76	8.76	8.76	8.76	8.76	8.76	8.76
Forage DM Costs	\$/ton	97.33	120.83	140.16	89.85	48.26	88.85	88.59
Crude Protein	%	4.8	4.8	9.2	16.3	9.6	4.8	7.10
CP Yield	lbs/ac	8.6	6.96	11.5	31.79	34.85	9.55	14.13
* CP Costs (\leq \$0.25)	\$/lb	1.01	1.26	0.76	0.28	0.25	0.92	0.62
Forage Allocation	lbs/pp	960.0	2700.0	1350.0	930.0	4110.0	900.0	10950.0
* Land Area	ac	5.33	18.62	10.80	4.77	11.32	4.60	55.44
Roughage Allocation	lbs/pp	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CP Supp.	lbs/pp	1.6	38.7	0.0	0.0	0.0	36.3	76.6
Forage Costs	\$/pp	46.75	163.12	94.64	41.85	98.64	40.30	485.30
Roughage Costs	\$/pp	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CP Supp. Costs	\$/pp	0.48	11.61	0.0	0.0	0.0	10.90	22.99
Total Feed Costs	\$/pp	47.23	174.73	94.64	41.85	98.64	51.20	508.29
Feed Cost/Acre	\$/ac	8.86	9.38	8.76	8.76	8.76	11.13	9.17
* Cost/Day (\leq \$0.62)	\$/d	1.48	1.94	2.10	1.35	0.72	1.71	1.39
Accumulated Calf Wt.	lbs	24.92	70.08	81.00	55.80	246.60	54.00	532.40
Weight Value @ \$0.70/lb	\$	17.44	49.06	56.70	39.06	172.62	37.80	372.68
Gross Return/Acre	\$	3.27	2.63	5.25	8.18	15.30	8.22	6.72
Net Return/c-cpr	\$	-29.79	-125.67	-37.94	-2.79	73.98	-13.40	-135.61
* Net Return/acre	\$	-5.59	-6.75	-3.51	-0.58	6.54	-2.91	-2.45
*Cost/lb of Calf Gain (\leq \$0.42)	\$	1.90	2.49	1.17	0.75	0.40	0.95	0.95

* Factors with diagnostic value in selection of low cost-high return forage types and 12 month management strategies.

Traditional Seasonlong

Dry Gestation

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 \$35.14 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 (table 2) would require 0.47 acres, and the forage would cost \$13.21 per production period. Total forage and supplement costs would be \$13.55 per period and \$28.83 per acre, or \$0.42 per day. 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 \$37.11 per acre. The net returns after feed costs were \$3.89 per cow-calf pair and \$8.28 per acre. The cost of calf fetus weight gain was \$0.54 per pound.

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 (\$35.14/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 (\$3.89) per cow and (\$8.28) 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.

Third Trimester

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 (table 2) 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 and \$75.79 per acre, or \$0.32 per day. 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 \$129.11 per acre. 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.

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.

Early Lactation

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 (table 2) 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 and \$116.24 per acre, or \$0.54 per day. 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 \$285.00 per acre. 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.

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.

Spring Lactation

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 (table 2). 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 and \$8.76 per acre, or \$0.52 per day. 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 \$22.05 per acre. 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.

Crested wheatgrass grassland grazed as 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.

Summer Lactation

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 (table 2). 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 and \$8.76 per acre, or \$0.81 per day. 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 \$15.78 per acre. 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.

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.

Fall Lactation

The traditional management strategy had a separate native rangeland pasture for fall grazing and was evaluated during the fall lactation production period for 30 days between mid October and mid November (table 2). Native rangeland forage had pasture rent value or production costs of \$8.76 per acre and forage dry matter costs of \$79.28 per ton. The stocking rate was adjusted from the summer rates to match the reduction in fall herbage biomass. A cow grazing during the fall lactation period was allotted 4.07 acres at a forage cost of \$35.65 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 1.07 lbs per cow per day at a cost of \$9.63 per period. Total forage feed costs were \$45.28 per period and \$11.13 per acre, or \$1.51 per day. 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 \$4.75 per acre. The net returns after pasture costs were a loss of \$25.96 per cow-calf pair and a loss of \$6.38 per acre. The cost of calf weight gain was \$1.64 per pound.

Native rangeland forage grazed 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 for 30 days during the fall 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 cost. The forage dry matter cost (\$79.28/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 high land area (4.07 acres/month) per cow caused the

forage costs per period to be high. The total daily forage feed costs (\$1.51/day) were high. The total feed costs (\$45.28/period) were greater than the low market value of the accumulated calf weight causing a high loss in returns after feed costs (\$-25.96) per cow and a high loss in returns after feed costs (\$-6.38) per acre. The cost per pound of calf weight gain (\$1.64/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.

12-month Season

The 12-month traditional seasonlong management strategy with a summer native rangeland pasture and complementary spring crested wheatgrass and fall native rangeland pastures and harvested forage of mature crested wheatgrass hay and oat forage hay cut late was a typical low profit margin management strategy. The 12-month forage feed costs at \$239.76 per year and \$0.66 per day was high, the 12-month forage crude protein costs at \$0.30 per pound were high, and the 12-month calf weight gain costs at \$0.43 per pound were moderate. The 12-month land area per cow at 19.71 acres was large. The 12-month returns after feed costs at \$147.79 per cow and at \$7.50 per acre were low.

Table 2. Twelve month costs and returns on the Traditional 4.5 Month Seasonlong management strategy for 1200 lb cow with 8 month old calf born mid March.

		Production Period						12-month Season
		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	
Days		32	90	45	31	137	30	365
Forage Type		Crested Hay Late	Oat Hay Late	Oat Hay Late	Crested Wheat	Native Range	Native Range	
Forage DM Weight	lbs/ac	1600.0	5667.0	5667.0	495.0	320.0	221.0	506.83
Production Costs	\$/ac	28.11	74.53	74.53	8.76	8.76	8.76	12.16
Forage DM Costs	\$/ton	35.14	26.40	26.40	35.39	54.75	79.28	47.91
Crude Protein	%	6.4	7.8	7.8	16.8	8.4	4.8	8.1
CP Yield	lbs/ac	102	435	435	83.36	23.68	10.61	40.85
* CP Costs (\leq \$0.25)	\$/lb	0.28	0.17	0.17	0.11	0.37	0.83	0.30
Forage Allocation	lbs/pp	748.8	2160.0	1215.0	930.0	4110.0	900.0	10063.8
* Land Area	ac	0.47	0.38	0.21	1.88	12.70	4.07	19.71
Roughage Allocation	lbs/pp	19.2	0.0	0.0	0.0	0.0	0.0	19.2
CP Supp.	lbs/pp	0.0	0.0	27.9	0.0	0.0	32.1	60.0
Forage Costs	\$/pp	13.21	28.80	16.04	16.47	111.25	35.65	221.42
Roughage Costs	\$/pp	0.34	0.0	0.0	0.0	0.0	0.0	0.34
CP Supp. Costs	\$/pp	0.0	0.0	8.37	0.0	0.0	9.63	18.00
Total Feed Costs	\$/pp	13.55	28.80	24.41	16.47	111.25	45.28	239.76
Feed Cost/Acre	\$/ac	28.83	75.79	116.24	8.76	8.76	11.13	12.16
* Cost/Day (\leq \$0.62)	\$/d	0.42	0.32	0.54	0.52	0.81	1.51	0.66
Accumulated Calf Wt.	lbs	24.92	70.08	85.50	59.21	286.33	27.60	553.64
Weight Value @ \$0.70/lb	\$	17.44	49.06	59.85	41.45	200.43	19.32	387.55
Gross Return/Acre	\$	37.11	129.11	285.00	22.05	15.78	4.75	19.66
Net Return/c-cpr	\$	3.89	20.26	35.44	24.98	89.18	-25.96	147.79
* Net Return/acre	\$	8.28	53.32	168.76	13.29	7.02	-6.38	7.50
* Cost/lb of Calf Gain (\leq \$0.42)	\$	0.54	0.41	0.29	0.27	0.39	1.64	0.43

* Factors with diagnostic value in selection of low cost-high return forage types and 12 month management strategies.

Biologically Effective Twice-over Rotation

Dry Gestation

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 (table 3) 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 and \$114.10 per acre, or \$0.36 per day. 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 \$174.40 per acre. 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.

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.

Third Trimester

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 (table 3) 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 and \$125.40 per acre, or \$0.38 per day. 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 \$181.70 per acre. 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.

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.

Early Lactation

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 (table 3) 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 and \$122.50 per acre, or \$0.49 per day. 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 \$332.50 per acre. 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.

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.

Spring Lactation

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 (table 3). 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 and \$21.26 per acre, or \$0.51 per day. 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 \$63.08 per acre. 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.

Crested wheatgrass grassland grazed as a 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.

Summer Lactation

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 (table 3). 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 and \$8.76 per acre, or \$0.58 per day. 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 \$23.55 per acre. 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.

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.

Fall Lactation

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 (table 3). 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 and \$41.75 per acre, or \$0.66 per day. 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 \$89.20 per acre. 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.

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.

12-month Season

The 12-month twice-over rotation management strategy with native rangeland pastures and complementary crested wheatgrass and spring seeded winter cereal pastures and early and late cut forage barley hay and late cut pea hay was a low-cost forage management strategy (table 3). The 12-month forage feed costs at \$0.50 per day were low, the 12-month forage crude protein costs at \$0.16 per pound were low, and the 12-month calf weight gain costs at \$0.30 per pound were very low. The 12-month land area per cow at 10.77 acres was small. The 12-month returns after feed costs at \$245.79 per cow was very high and at \$22.82 per acre was high. The 12-month twice-over rotation management strategy does have all of the critical diagnostic cost factors below the threshold values and this management strategy does have the greatest returns after feed costs per cow-calf pair and per acre.

Table 3. Twelve month costs and returns on the Biologically Effective Twice-over Rotation management strategy for 1200 lb cow with 8 month old calf born mid March.

		Production Period						12-month Season
		Dry Gestation	Third Trimester	Early Lactation	Spring Lactation	Summer Lactation	Fall Lactation	
Days		32	90	45	31	137	30	365
Forage Type		Barley Hay Late	Barley Hay Early	Pea Hay Late	Crested Wheat	Native Range	Spring Seeded Winter Cereal	
Forage DM Weight	lbs/ac	5133.0	4733.0	4650.0	1240.0	449.0	1908.0	788.86
Production Costs	\$/ac	70.35	68.21	86.87	21.26	8.76	41.75	14.50
Forage DM Costs	\$/ton	27.40	28.80	37.40	34.29	39.02	43.77	36.76
Crude Protein	%	9.2	13.0	14.4	17.1	9.8	12.2	11.1
CP Yield	lbs/ac	468	606	685	212.6	43.8	109.0	87.2
* CP Costs (\leq \$0.25)	\$/lb	0.15	0.11	0.13	0.10	0.20	0.18	0.16
Forage Allocation	lbs/pp	518.4	1296.0	855.0	930.0	4110.0	900.0	8609.4
* Land Area	ac	0.10	0.27	0.18	0.75	9.00	0.47	10.77
Roughage Allocation	lbs/pp	249.6	864.0	360.0	0.0	0.0	0.0	1473.6
CP Supp.	lbs/pp	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Forage Costs	\$/pp	7.04	18.90	15.75	15.95	78.84	19.70	156.18
Roughage Costs	\$/pp	4.37	14.96	6.30	0.0	0.0	0.0	25.63
CP Supp. Costs	\$/pp	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Feed Costs	\$/pp	11.41	33.86	22.05	15.95	78.84	19.70	181.81
Feed Cost/Acre	\$/ac	114.10	125.40	122.50	21.26	8.76	41.75	16.88
* Cost/Day (\leq \$0.62)	\$/d	0.36	0.38	0.49	0.51	0.58	0.66	0.50
Accumulated Calf Wt.	lbs	24.92	70.08	85.50	67.58	302.77	60.00	610.85
Weight Value @ \$0.70/lb	\$	17.44	49.06	59.85	47.31	211.94	42.00	427.60
Gross Return/Acre	\$	174.40	181.70	332.50	63.08	23.55	89.20	39.70
Net Return/c-cpr	\$	6.03	15.20	37.80	31.36	133.10	22.30	245.79
* Net Return/acre	\$	60.30	56.30	210.00	41.82	14.79	47.45	22.82
* Cost/lb of Calf Gain (\leq \$0.42)	\$	0.46	0.48	0.26	0.24	0.26	0.33	0.30

* Factors with diagnostic value in selection of low cost-high return forage types and 12 month management strategies.

Value Captured from the Land

The Repeated Seasonal, No Hay, the Traditional Seasonlong, and the Biologically Effective Twice-over Rotation 12-month forage management strategies were implemented on an hypothetical starter ranch that had a land base of 4 sections with 60 acres nonagricultural and 2500 acres of the appropriate forage types for each management strategy to determine the value of new wealth captured from the land natural resources (table 4).

The Repeated Seasonal, No Hay management strategy had 2500 acres of native rangeland divided into 6 pastures for each cow production period. A 1200 pound cow with a calf required 55.44 acres of grazingland; the starter ranch provided forage feed for 45 cows. The pasture forage costs on the 240 acre dry gestation pasture was \$2125.35, on the 840 acre third trimester pasture was \$7862.85, on the 486 acre early lactation pasture was \$4258.80, on the 215 acre spring lactation pasture was \$1883.25, on the 510 acre summer lactation pasture was \$4438.80, and on the 209 acre fall lactation pasture was \$2304.00, for a total 12 month pasture forage feed cost of \$22,873.05 and \$9.17 per acre. The mean heifer-steer weaning weight was 532.40 pounds, for a total production of 23,958.0 pounds of calf live weight per year. When calf accumulated weight was assumed to have a value of \$0.70 per pound, the gross return was \$16,770.60 per herd year and \$6.72 per acre. The net return after pasture forage feed costs was a loss of \$6,102.45 per year and a loss of \$2.45 per acre. The mean cost of calf weight gain was \$0.95 per pound.

The Traditional Seasonlong management strategy had 2500 acres with 80 acres of cropland, 60 acres of hayland, and 2360 acres of pastureland divided into 6 portions for each cow production period. A 1200 pound cow with a calf required 19.71 acres for forage growth; the starter ranch provided forage feed for 126 cows. The forage feed costs on the 60 acre dry gestation hayland was \$1707.30, on the 50 acre third trimester cropland hay was \$3628.80, on the 30 acre early lactation cropland hay was \$3075.66, on the 240 acre spring lactation pasture was \$2075.22, on the 1600 acre summer lactation pasture was \$14,017.50, and on the 520 acre fall lactation pasture was \$5705.28, for a total 12 month pasture-harvested forage feed cost of \$30,209.76 and \$12.16 per acre. The mean heifer-steer weaning weight was 553.64 pounds, for a total production of 69,758.64 pounds of calf live weight

per year. When calf accumulated weight was assumed to have a value of \$0.70 per pound, the gross return was \$48,831.05 per herd year and \$19.66 per acre. The net return after pasture forage feed costs was \$18,621.29 per year and a net return per acre was \$7.50. The mean cost of calf weight gain was \$0.43 per pound.

The Biologically Effective Twice-over Rotation management strategy had 2500 acres with 237 acres of cropland, 0 acres of hayland, and 2263 acres of pastureland divided into 6 portions for each cow production period. A 1200 pound cow with a calf required 10.77 acres for forage growth; the starter ranch provided forage feed for 232 cows. The forage feed costs on the 23 acre dry gestation cropland hay was \$2647.12, on the 63 acre third trimester cropland hay was \$7855.52, on the 42 acre early lactation cropland hay was \$5115.60, on the 175 acre spring lactation pasture was \$3700.40, on the 2088 acre summer lactation triple pastures was \$18,290.88, and on the 109 acre fall lactation cropland pasture was \$4570.40, for a total 12 month pasture-harvested forage feed cost of \$42,179.92 and \$16.88 per acre. The mean heifer-steer weaning weight was 610.85 pounds, for a total production of 141,717.2 pounds of calf live weight per year. When calf accumulated weight was assumed to have a value of \$0.70 per pound, the gross return was \$99,202.04 per herd year and \$39.70 per acre. The net return after pasture forage feed costs was \$57,022.12 per year and a net return per acre was \$22.82. The mean cost of calf weight gain was \$0.30 per pound.

The 12-month forage management strategy that captured the greatest quantity of new wealth from the land natural resources was biologically effective and captured the greatest quantity of crude protein per acre and had the lowest cost per pound of crude protein that resulted in the greatest cow and calf weight gain per acre, the lowest land area per cow-calf pair, the lowest total annual feed cost per cow and the lowest feed cost per day per cow, which produced the greatest return after feed costs per cow-calf pair and per acre, and had the lowest cost for calf weight gain per pound.

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Table 4. Summary of twelve month costs and returns of the No Hay, Traditional, and Biologically Effective management strategies on a land base of 4 sections with 60 ac. nonag. and 2500 ac. forage.

		No Hay Repeated Seasonal	Traditional 4.5 month Seasonlong	Biologically Effective Twice-over Rotation
Forage Base	ac	2500	2500	2500
Land/Cow/Yr	ac	55.44	19.71	10.77
No. Cows	hd	45	126	232
Calf Wt./Yr	lbs	23,958.0	69,758.6	141,717.2
Gross Return	\$	16,770.60	48,831.05	99,202.04
Feed Costs	\$	22,873.05	30,209.76	42,179.92
Return-Feed Costs	\$	-6,102.45	18,621.29	57,022.12
Gross Return/acre	\$	6.72	19.66	39.70
Feed Costs/acre	\$	9.17	12.16	16.88
Return-Feed Costs/acre	\$	-2.45	7.50	22.82
Land Area				
Dry Gestation	ac	240	60	23
Third Trimester	ac	840	50	63
Early Lactation	ac	486	30	42
Spring Lactation	ac	215	240	175
Summer Lactation	ac	510	1600	2088
Fall Lactation	ac	<u>209</u>	<u>520</u>	<u>109</u>
Pastureland	ac	2500	2360	2263
Hayland	ac	0	60	0
Cropland	ac	0	80	237

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