Diagnostic Examination of the Value Captured from Land Natural Resources by Forage Management Strategies for Range Cows During the Nongrowing Season

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The beef production industry has focused on the improvement in animal performance for several decades and has neglected to simultaneously improve the efficiencies of forage management systems. 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 proportional to the animals greater size. Feeding modern high-performance cattle with traditional pasture and harvested forage management technology developed for the old-style low-performance cattle causes a mismatch in the quantity of forage nutrients needed and the amount of forage nutrients available between the modern cattle with high nutrient requirements and the traditional low quality forage management practices. Traditional forage management practices inhibit the modern beef animal from performing at its genetic capacity, 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 animal production. Modern cattle perform at greater efficiency when their nutritional demands are met during each production period.

Development of low cost-high return forage management strategies for modern high-performance livestock during the nongrowing season presents a huge challenge because few nutritious green forage plants are readily available. The 197 day nongrowing period from mid October to late April includes the 30 day fall lactation, the 32 day dry gestation, the 90 day third trimester, and the 45 day early lactation production periods. Evaluation of pasture forage types and harvested forage types that meet nutrient and dry matter requirements of modern range cows during the production periods that occur in the nongrowing season is complicated. The quantifiable factors that should be included in the evaluation of forage management strategies during the nongrowing season are harvested or grazed forage dry matter weight per acre, captured crude protein weight per acre, land area per cow or 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 per pound, and forage feed costs per acre and per day including the supplemental roughage or crude protein costs directly affect 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.

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 feed types that have forage feed costs of $0.62 or less per day, calf weight gain costs of $0.42 or less per pound, 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.

Forage management strategies are developed by selection of pasture forage types or harvested forage types for use in sequence during the range cow production periods that occur in the nongrowing season. Diagnostic examinations were conducted on three forage management strategies: the Repeated Seasonal, No Hay, the Traditional Seasonlong, and the Biologically Effective Twice-over Rotation; and on forage strategies with three harvested forage types, each cut at two growth stages: crested wheatgrass hay cut at the boot stage and mature stage, oat forage hay cut at the milk stage and the hard dough stage, and forage barley hay cut at the milk stage and the hard dough stage. 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.

Repeated Seasonal, No Hay

The Repeated Seasonal, No Hay management strategy (table 1) uses four separate native rangeland pastures during the 197 day nongrowing period from mid October to late April with a total of 39.35 acres allocated per cow. The forage allocation is 30.0 lbs DM/day/cow with a total of 5910.0 lbs DM/pp to provide 343.08 lbs CP/pp, at a cost of $344.81/pp, with an additional 76.6 lbs CP/pp supplemented at a cost of $22.99/pp. Total forage and crude protein costs would be $367.80/pp and $9.35 per acre, or $1.87 per day. Calf accumulated weight gain during the 197 day nongrowing period was estimated to be 230.0 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $161.00 per calf and $4.09 per acre. The net returns after feed costs were a loss of $206.80 per cow-calf pair and a loss of $5.26 per acre. The cost of calf weight gain was $1.60 per pound.

Traditional Seasonlong

The Traditional Seasonlong management strategy (table 1) uses one native rangeland pasture for 30 days and feeds harvested forages for 167 days during the 197 day nongrowing period from mid October to late April with 4.07 acres of pastureland, 0.47 acres of hayland, and 0.59 acres of cropland hay for a total of 5.13 acres allocated per cow. The forage allocation is 900 lbs DM from the pastureland, 748.8 lbs DM from the hayland, and 3375.0 lbs DM from cropland hay for a total of 5023.8 lbs DM/pp from the land to provide 354.37 lbs CP/pp, at a cost of $93.70/pp, with an additional 19.2 lbs roughage/pp at a cost of $0.34/pp, and with an additional 60.0 lbs of supplemental CP at a cost of $18.00/pp. Total forage, roughage, and crude protein costs would be $112.04/pp and $21.84 per acre, or $0.57 per day. Calf accumulated weight gain during the 197 day nongrowing period was estimated to be 208.1 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $145.67 per calf and $28.40 per acre. The net returns after feed costs were $33.63 per cow-calf pair and $6.56 per acre. The cost of calf weight gain was $0.54 per pound.

Twice-over Rotation

The Twice-over Rotation management strategy (table 1) uses spring seeded cropland pasture for 30 days and feeds harvested forages for 167 days during the 197 day nongrowing period from mid October to late April with 0.47 acres of cropland pasture and 0.55 acres of cropland hay for a total of 1.02 acres allocated per cow. The forage allocation is 900 lbs DM from cropland pasture and 2669.4 lbs DM from cropland hay for a total of 3569.4 lbs DM from the land to provide 449.09 lbs CP at a cost of $61.39/pp, with an additional 1473.6 lbs of supplemental roughage at a cost of $25.63/pp. Total forage and roughage costs would be $87.02/pp and $85.31 per acre, or $0.44 per day. Calf accumulated weight gain during the 197 day nongrowing period was estimated to be 240.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $168.35 per calf and $165.05 per acre. The net returns after feed costs were $81.33 per cow-calf pair and $79.74 per acre. The cost of calf weight gain was $0.34 per pound.

Table 1. Costs and returns for three management strategies that provide forage fed to 1200 lb cow for 197 days during fall lactation, dry gestation, third trimester, and early lactation periods.

		Repeated Seasonal, No Hay	Traditional Seasonlong	Twice-over Rotation
Days		197	197	197
Forage DM Weight	lbs/ac	150.56	973.68	3455.85
Production Costs	$/ac	8.76	18.10	59.53
Forage DM Costs	$/ton	116.37	37.18	34.45
Crude Protein	%	5.8	7.0	11.00
CP Yield	lbs/ac	8.7	67.79	377.40
* CP Costs (≤ $0.25)	$/lb	1.01	0.27	0.16
Forage Allocation	lbs/pp	5910.0	5023.8	3569.4
* Land Area	ac	39.35	5.13	1.02
Roughage Allocation	lbs/pp	0.0	19.2	1473.6
CP Supp.	lbs/pp	76.6	60.0	0.0
Forage Costs	$/pp	344.81	93.70	61.39
Roughage Costs	$/pp	0.0	0.34	25.63
CP Supp. Costs	$/pp	22.99	18.00	0.0
Total Feed Costs	$/pp	367.80	112.04	87.02
Feed Cost/Acre	$/ac	9.35	21.84	85.31
* Cost/Day (≤ $0.62)	$/d	1.87	0.57	0.44
Accumulated Calf Wt.	lbs	230.00	208.10	240.5
Weight Value @ $0.70/lb	$	161.00	145.67	168.35
Gross Return/Acre	$	4.09	28.40	165.05
Net Return/c-cpr	$	-206.80	33.63	81.33
* Net Return/acre	$	-5.26	6.56	79.74
*Cost/lb of Calf Gain (≤ $0.42)	$	1.60	0.54	0.34

* Factors with diagnostic value in selection of low cost-high return forage types.

Crested Wheatgrass Hay, Boot Stage

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 (table 2). Early cut crested wheatgrass hay would be fed during the fall lactation period at 17.3 lbs DM/day to provide 2.5 lbs CP/day, at a cost of $10.50 per period, with an additional 12.7 lbs of roughage fed per day, at a cost of $6.66 per period. Total forage and roughage costs during the fall lactation would be $17.16 per period, or $0.57 per day. Early cut crested wheatgrass hay would be fed during the dry gestation period at 10.3 lbs DM/day to provide 1.5 lbs CP/day, at a cost of $6.72 per period, with an additional 13.7 lbs of roughage fed per day, at a cost of $7.68 per period. Total forage and roughage costs during the dry gestation would be $14.40 per period, or $0.45 per day. Early cut crested wheatgrass hay would be fed during the third trimester period at 12.9 lbs DM/day to provide 1.9 lbs CP/day, at a cost of $23.40 per period, with an additional 11.1 lbs of roughage per day, at a cost of $17.48 per period. Total forage and roughage costs during the third trimester would be $40.88 per period, or $0.45 per day. Early cut crested wheatgrass hay would be fed during the early lactation period at 18.8 lbs DM/day to provide 2.7 lbs CP/day, at a cost of $17.10 per period, with an additional 8.2 lbs of roughage per day, at a cost of $6.43 per period. Total forage and roughage costs during the early lactation would be $23.53 per period, or $0.52 per day.

Early cut crested wheatgrass hay would be fed during the 197 day nongrowing period from mid October to late April at 2855.6 lbs DM/pp from 2.2 acres to provide 415.5 lbs CP/pp, at a cost of $57.72/pp, with an additional 2187.4 lbs of roughage/pp, at a cost of $38.25/pp. Total forage and roughage costs would be $95.97/pp and $43.62 per acre, or $0.49 per day. Calf accumulated weight gain during the 197 day nongrowing period was estimated to be 240.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $168.35 per calf and $76.52 per acre. The net returns after feed costs were $72.38 per cow-calf pair and $32.90 per acre. The cost of calf weight gain was $0.40 per pound (table 2).

Crested Wheatgrass Hay, Mature Stage

Crested wheatgrass hay cut late, at the mature 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 (table 2). Late cut crested wheatgrass hay would be fed during the fall lactation period at 30.0 lbs DM/day to provide 1.9 lbs CP/day, at a cost of $15.84 per period, with an additional 0.59 lbs of crude protein fed per day, at a cost of $5.31 per period. Total forage and crude protein costs during the fall lactation would be $21.15 per period, or $0.71 per day. Late cut crested wheatgrass hay would be fed during the dry gestation period at 23.4 lbs DM/day to provide 1.5 lbs CP/day, at a cost of $13.12 per period, with an additional 0.6 lbs of roughage fed per day, at a cost of $0.34 per period. Total forage and roughage costs during the dry gestation would be $13.46 per period, or $0.42 per day. Late cut crested wheatgrass hay would be fed during the third trimester period at 24.0 lbs DM/day to provide 1.5 lbs CP/day, at a cost of $38.02 per period, with an additional 0.33 lbs of crude protein per day, at a cost of $9.02 per period. Total forage and crude protein costs during the third trimester would be $47.04 per period, or $0.52 per day. Late cut crested wheatgrass hay would be fed during the early lactation period at 27.0 lbs DM/day to provide 1.7 lbs CP/day, at a cost of $21.38 per period, with an additional 1.0 lbs of crude protein per day, at a cost of $13.50 per period. Total forage and crude protein costs during the early lactation would be $34.88 per period, or $0.78 per day.

Late cut crested wheatgrass hay would be fed during the 197 day nongrowing period from mid October to late April at 5023.8 lbs DM/pp from 3.14 acres at a cost of $88.36/pp, with 19.2 lbs of roughage at a cost of $0.34/pp, and with 92.4 lbs crude protein at a cost of $27.83/pp. Total forage, roughage, and crude protein costs would be $116.53/pp and $37.11 per acre, or $0.59 per day. Calf accumulated weight gain during the 197 day nongrowing period was estimated to be 240.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $168.35 per calf and $53.61 per acre. The net returns after feed costs were $51.82 per cow-calf pair and $16.50 per acre. The cost of calf weight gain was $0.48 per pound (table 2).

Oat Forage Hay, Milk Stage

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 (table 2). Early cut oat forage hay would be fed during the fall lactation period at 21.8 lbs DM/day to provide 2.5 lbs CP/day, at a cost of $9.90 per period, with an additional 8.2 lbs of roughage fed per day, at a cost of $4.31 per period. Total forage and roughage costs during the fall lactation would be $14.21 per period, or $0.47 per day. Early cut oat forage hay would be fed during the dry gestation period at 13.0 lbs DM/day to provide 1.5 lbs CP/day, at a cost of $6.08 per period, with an additional 11.0 lbs of roughage fed per day, at a cost of $6.16 per period. Total forage and roughage costs during the dry gestation would be $12.24 per period, or $0.38 per day. Early cut oat forage hay would be fed during the third trimester period at 16.3 lbs DM/day to provide 1.9 lbs CP/day, at a cost of $21.60 per period, with an additional 7.7 lbs of roughage per day, at a cost of $12.13 per period. Total forage and roughage costs during the third trimester would be $33.73 per period, or $0.37 per day. Early cut oat forage hay would be fed during the early lactation period at 23.7 lbs DM/day to provide 2.7 lbs CP/day, at a cost of $15.75 per period, with an additional 3.3 lbs of roughage per day, at a cost of $2.60 per period. Total forage and roughage costs during the early lactation would be $18.35 per period, or $0.41 per day.

Early cut oat forage hay would be fed during the 197 day nongrowing period from mid October to late April at 3603.5 lbs DM/pp from 0.77 acres to provide 415.5 lbs CP/pp, at a cost of $53.33/pp, with an additional 1439.5 lbs of roughage/pp, at a cost of $25.20/pp. Total forage and roughage costs would be $78.53/pp and $101.99 per acre, or $0.40 per day. Calf accumulated weight gain during the 197 day nongrowing period was estimated to be 240.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $168.35 per calf and $218.64 per acre. The net returns after feed costs were $89.82 per cow-calf pair and $116.65 per acre. The cost of calf weight gain was $0.32 per pound (table 2).

Oat Forage Hay, Hard Dough Stage

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 (table 2). Late cut oat forage hay would be fed during the fall lactation period at 30.0 lbs DM/day to provide 2.34 lbs CP/day, at a cost of $11.88 per period, with an additional 0.17 lbs of crude protein fed per day, at a cost of $1.53 per period. Total forage and crude protein costs during the fall lactation would be $13.41 per period, or $0.45 per day. Late cut oat forage hay would be fed during the dry gestation period at 19.1 lbs DM/day to provide 1.5 lbs CP/day, at a cost of $8.00 per period, with an additional 4.9 lbs of roughage fed per day, at a cost of $2.74 per period. Total forage and roughage costs during the dry gestation would be $10.74 per period, or $0.34 per day. Late cut oat forage hay would be fed during the third trimester period at 24.0 lbs DM/day to provide 1.9 lbs CP/day, at a cost of $28.80 per period. Total forage costs during the third trimester would be $28.80 per period, or $0.32 per day. Late cut oat forage hay would be fed during the early lactation period at 27.0 lbs DM/day to provide 2.1 lbs CP/day, at a cost of $16.04 per period, with an additional 0.62 lbs of crude protein per day, at a cost of $8.37 per period. Total forage and crude protein costs during the early lactation would be $24.41 per period, or $0.54 per day.

Late cut oat forage hay would be fed during the 197 day nongrowing period from mid October to late April at 4886.2 lbs DM/pp from 0.86 acres at a cost of $64.72/pp, with 156.8 lbs of roughage at a cost of $2.74/pp, and with 33.0 lbs crude protein at a cost of $9.90/pp. Total forage, roughage, and crude protein costs would be $77.36/pp and $89.95 per acre, or $0.39 per day. Calf accumulated weight gain during the 197 day nongrowing period was estimated to be 240.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $168.35 per calf and $195.75 per acre. The net returns after feed costs were $90.99 per cow-calf pair and $105.80 per acre. The cost of calf weight gain was $0.32 per pound (table 2).

Forage Barley Hay, Milk Stage

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 (table 2). Early cut forage barley hay would be fed during the fall lactation period at 19.3 lbs DM/day to provide 2.5 lbs CP/day, at a cost of $8.40 per period, with an

additional 10.7 lbs of roughage fed per day, at a cost of $5.62 per period. Total forage and roughage costs during the fall lactation would be $14.02 per period, or $0.47 per day. Early cut forage barley hay would be fed during the dry gestation period at 11.5 lbs DM/day to provide 1.5 lbs CP/day, at a cost of $5.12 per period, with an additional 12.5 lbs of roughage fed per day, at a cost of $7.00 per period. Total forage and roughage costs during the dry gestation would be $12.12 per period, or $0.38 per day. Early cut forage barley hay would be fed during the third trimester period at 14.4 lbs DM/day to provide 1.9 lbs CP/day, at a cost of $18.90 per period, with an additional 9.6 lbs of roughage per day, at a cost of $14.96 per period. Total forage and roughage costs during the third trimester would be $33.86 per period, or $0.38 per day. Early cut forage barley hay would be fed during the early lactation period at 21.0 lbs DM/day to provide 2.7 lbs CP/day, at a cost of $13.50 per period, with an additional 6.0 lbs of roughage per day, at a cost of $4.73 per period. Total forage and roughage costs during the early lactation would be $18.23 per period, or $0.41 per day.

Early cut forage barley hay would be fed during the 197 day nongrowing period from mid October to late April at 3188.0 lbs DM/pp from 0.67 acres to provide 415.5 lbs CP/pp, at a cost of $45.92/pp, with an additional 1855.0 lbs of roughage/pp, at a cost of $32.31/pp. Total forage and roughage costs would be $78.23/pp and $116.76 per acre, or $0.40 per day. Calf accumulated weight gain during the 197 day nongrowing period was estimated to be 240.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $168.35 per calf and $251.27 per acre. The net returns after feed costs were $90.12 per cow-calf pair and $134.51 per acre. The cost of calf weight gain was $0.32 per pound (table 2).

Forage Barley Hay, Hard Dough Stage

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 (table 2). Late cut forage barley hay would be fed during the fall lactation period at 27.3 lbs DM/day to provide 2.5 lbs CP/day, at a cost of $11.40 per period, with an additional 2.7 lbs of roughage fed per day, at a cost of $1.42 per period. Total forage and roughage costs during the fall lactation would be $12.82 per period, or $0.43 per day. Late cut forage barley hay would be fed during the dry gestation period at 16.2 lbs DM/day to provide 1.5 lbs CP/day, at a cost of $7.04 per period, with an additional 7.8 lbs of roughage fed per day, at a cost of $4.37 per period. Total forage and roughage costs during the dry gestation would be $11.41 per period, or $0.36 per day. Late cut forage barley hay would be fed during the third trimester period at 20.3 lbs DM/day to provide 1.9 lbs CP/day, at a cost of $26.10 per period, with an additional 3.7 lbs of roughage per day, at a cost of $5.83 per period. Total forage and roughage costs during the third trimester would be $31.93 per period, or $0.35 per day. Late cut forage barley hay would be fed during the early lactation period at 27.0 lbs DM/day to provide 2.48 lbs CP/day, at a cost of $16.65 per period, with an additional 0.25 lbs of crude protein per day, at a cost of $3.38 per period. Total forage and crude protein costs during the early lactation would be $20.03 per period, or $0.45 per day.

Late cut forage barley hay would be fed during the 197 day nongrowing period from mid October to late April at 4379.4 lbs DM/pp from 0.86 acres at a cost of $61.19/pp, with 663.6 lbs of roughage at a cost of $11.62/pp, and with 11.25 lbs crude protein at a cost of $3.38/pp. Total forage, roughage, and crude protein costs would be $76.19/pp and $88.59 per acre, or $0.39 per day. Calf accumulated weight gain during the 197 day nongrowing period was estimated to be 240.5 lbs. When calf accumulated weight was assumed to have a value of $0.70 per pound, the gross return was $168.35 per calf and $195.75 per acre. The net returns after feed costs were $92.16 per cow-calf pair and $107.16 per acre. The cost of calf weight gain was $0.32 per pound (table 2).

Table 2. Costs and returns for three harvested forage types cut at two growth stages fed to 1200 lb cow for 197 days during fall lactation, dry gestation, third trimester, and early lactation production periods.

		Crested Wheatgrass		Oat Forage		Forage Barley	
		Boot Stage	Mature	Milk	Hard Dough	Milk	Hard Dough
Days		197	197	197	197	197	197
Forage DM Weight	lbs/ac	1300	1600	4667	5667	4733	5133
Production Costs	$/ac	26.50	28.11	69.17	74.53	68.21	70.35
Forage DM Costs	$/ton	40.80	34.80	29.60	26.40	28.80	27.40
Crude Protein	%	14.5	6.4	11.5	7.8	13.0	9.2
CP Yield	lbs/ac	189	102	535	435	606	468
*CP Costs (≤ $0.25)	$/lb	0.14	0.28	0.13	0.17	0.11	0.15
Forage Allocation	lbs/pp	2855.6	5023.8	3603.5	4886.2	3188.0	4379.4
*Land Area	ac	2.20	3.14	0.77	0.86	0.67	0.86
Roughage Allocation	lbs/pp	2187.4	19.2	1439.5	156.8	1855.0	663.6
CP Supp.	lbs/pp	0.0	92.4	0.0	33.0	0.0	11.25
Forage Costs	$/pp	57.72	88.36	53.33	64.72	45.92	61.19
Roughage Costs	$/pp	38.25	0.34	25.20	2.74	32.31	11.62
CP Supp. Costs	$/pp	0.0	27.83	0.0	9.90	0.0	3.38
Total Feed Costs	$/pp	95.97	116.53	78.53	77.36	78.23	76.19
Feed Cost/Acre	$/ac	43.62	37.11	101.99	89.95	116.76	88.59
*Cost/Day (≤ $0.62)	$/d	0.49	0.59	0.40	0.39	0.40	0.39
Accumulated Calf Wt.	lbs	240.50	240.50	240.50	240.50	240.50	240.50
Weight Value @ $0.70/lb	$	168.35	168.35	168.35	168.35	168.35	168.35
Gross Return/Acre	$	76.52	53.61	218.64	195.75	251.27	195.75
Net Return/c-cpr	$	72.38	51.82	89.82	90.99	90.12	92.16
*Net Return/acre	$	32.90	16.50	116.65	105.80	134.51	107.16
*Cost/lb of Calf Gain (≤ $0.42)	$	0.40	0.48	0.32	0.32	0.32	0.32

*Factors with diagnostic value in selection of low cost-high return forage types.

Value Captured from the Land

The forage management strategies used to feed range cows during the 197 day nongrowing season were ranked according to the quantity of value captured from the land natural resources (table 3). The top five forage management strategies captured great wealth from the land at $80 to $135 net return per acre after feed costs during low market value for calf weight at weaning (table 3). The generation of great wealth from the land resources requires the capture of great crude protein weight per acre. These five forage strategies produced adequate quantities of forage on small land areas of 1 acre or less to feed a range cow for 6.5 months and captured huge quantities of crude protein from 377 lbs to 606 lbs per acre in the forage feed (table 3), which produced large quantities of beef weight commodities per acre, resulting in great gross returns per acre and high net returns after forage feed costs per acre. The great quantities of crude protein weight captured in the forage per acre also resulted in low crude protein costs from $0.11 to $0.17 per pound, low total forage feed costs from $0.39 to $0.44 per day, and low calf weight gain costs from $0.32 to $0.34 per pound (tables 1 and 2).

The bottom three forage management strategies captured little wealth from the land resources at less than $17 net return per acre to a loss of greater than $5 per acre after feed costs (table 3). These three forage strategies required large land areas from greater than 3 acres to almost 40 acres to grow the forage dry matter for a range cow for 6.5 months and captured low quantities of crude protein from around 100 lbs to less than 10 lbs per acre (table 3), which was not enough. Supplemental crude protein at greater than 92 lbs to around 60 lbs per cow had to be purchased to meet animal nutrient requirements (tables 1 and 2). Low quantities of beef weight commodities were produced per acre because of the low quantities of crude protein weight captured per acre resulting in low gross returns per acre. The large land areas with low amounts of forage dry matter and low crude protein weight per acre resulted in high feed costs from $112 to $368 per cow, high crude protein costs from $0.27 to $1.01 per pound, high forage feed costs from $0.49 to $1.87 per day, and high calf weight gain costs from $0.48 to $1.60 per pound (tables 1 and 2).

The renewable forage nutrients are the primary unit of production in a range cow-calf operation because the nutrients are the source of new wealth generated from livestock agricultural use of land resources. The amount of new wealth generated from land natural resources is related to the quantity of forage crude protein captured per acre, not to the quantity of dry matter weight, so increasing economic wealth from beef production requires a paradigm shift to the use of biologically efficient forage management strategies that focus on capturing great quantities of crude protein weight per acre. Forage dry matter does not have a real economic value because it is not incorporated into the beef weight produced and it is returned to the land in a couple of days after ingestion. The dry matter is simply the carrier of the nutrients it contains.

Cutting forage hay at the plant growth stage when the greatest weight of crude protein can be captured per acre reduces the cost of crude protein per pound and reduces the size of land area needed per cow which decreases the forage feed costs per day. The weight of crude protein harvested per acre is related to the percent nutrient content and the weight of the forage dry matter at the time of cutting. The greatest weight of crude protein captured per acre is not at the growth stage with the highest percent crude protein. The greatest percent crude protein occurs during early plant growth stages when the weight of the forage dry matter is low. As the weight of plant dry matter increases until maximum plant height, the percent crude protein decreases. The flower growth stage is when grass plants, including perennial grasses and annual cereal grasses have the greatest weight of crude protein per acre. While for legumes, the greatest weight of crude protein per acre occurs at a late full growth stage just prior to when the bottom leaves dry from senescence. The later growth stage in legumes results because the rate of growth of dry matter weight accumulation and the rate of decline of percent crude protein are both slower in legumes than in grasses.

Biologically effective forage management strategies are based on increasing production of crude protein per acre, improving the efficiency of capturing produced forage crude protein, and improving the conversion of captured crude protein into a saleable commodity of beef weight that result in low costs for crude protein per pound, reduced land area per cow-calf pair, low total forage feed costs per day, and low costs per pound of accumulated calf weight gain which results in greater new wealth captured from the land natural resources.

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Table 3. Ranking according to the quantity of value captured from land natural resources by forage management strategies for range cows during the nongrowing season.

Forage Management Strategy	Land Area ac	Crude Protein per Acre lbs	Gross Return per Acre $	Feed Cost per Acre $	Net Return per Acre $
Forage Barley Milk Stage	0.67	606	251.27	116.76	134.51
Oat Forage Milk Stage	0.77	535	218.64	101.99	116.65
Forage Barley Hard Dough	0.86	468	195.75	88.59	107.16
Oat Forage Hard Dough	0.86	435	195.75	89.95	105.80
Twice-over Rotation	1.02	377.4	165.05	85.31	79.74
Crested Wheatgrass Boot Stage	2.20	189	76.52	43.62	32.90
Crested Wheatgrass Mature Stage	3.14	102	53.61	37.11	16.50
Traditional Seasonlong	5.13	67.8	28.40	21.84	6.56
Repeated Seasonal No Hay	39.35	8.7	4.09	9.35	-5.26

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