DIET QUALITY AND PERFORMANCE OF CATTLE ON FOREST AND GRASSLAND RANGE[1]

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Summary

Cattle performance and diet quality on forest and grassland range in the Blue Mountains of eastern Oregon were evaluated over a 3-year period. Esophageally fistulated cows were used for the evaluation of diet quality. Pregnant yearling heifers were used for the evaluation of livestock performance. Data indicated that forest and grasslands offer diverse environments in terms of forage quality and beef cattle production. Forest diets contained more crude protein in early and late summer. *In vitro* organic matter digestibility of cattle diets was lower on the grasslands than on the forest pasture in early and late summer but was superior on the grasslands in the fall, provided that summer precipitation and fall regrowth occurred. Cattle gains were similar for both types in late spring, but greater for forest cattle in early and late summer. Cattle on grasslands gained more in the fall if precipitation occurred in late summer. Crude protein and digestible energy intake analyses revealed that digestible energy was the first-limiting nutrient. Grasslands may be most efficiently utilized in the spring, while use of forests between mid-July and mid-September should be advantageous because of higher quality forage. In years with late summer precipitation, cattle gains might be improved by returning cattle to the grasslands in mid-September. This type of grazing strategy has the potential to improve beef production over that obtained from the grazing of each type separately throughout the grazing season.

(Key Words: Forest Grazing, Crude Protein, Digestible Energy, Daily Gain.)

Introduction

Mountain grassland and forest vegetation types occupy large areas throughout the Rocky Mountains from Arizona and New Mexico to Canada. Historically, little management has been applied to these ranges. Grazing units are large and usually grazed season-long. The demand for red meat production on these lands is increasing, but, at the same time, various environmental quality standards are being imposed that restrict grazing (Forest-Range Task Force, 1972).

One such restriction is a change from season-long grazing to systems designed to provide periods of nonuse. As grazing systems are initiated, the possibility exists to incorporate into the plans mixes of specific vegetation types with different potentials for beef production. Conceivably, a land area so managed would yield more beef per hectare than an area managed by conventional grazing.

Nutritional differences exist among various vegetation types (Cook and Harris, 1968). The efficiency of livestock production could be improved if grazing were conducted on specific vegetation types in a way that took advantage of differing peaks in forage quality.

Information dealing directly with the integration of vegetation types so as to increase efficiency of livestock production is inadequate. The few studies reporting such data indicate

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that livestock performance can be increased by correct timing of grazing for each vegetation type. Complementary grazing studies of different vegetation types have been reported by Long and Landers (1960), Valentine (1967), Cook and Harris (1968), Smoliak (1968), Currie (1969) and Smoliak and Slen (1974).

The objectives of this study were (1) to measure quality changes in cattle diets and the average daily gain of animals throughout the three grazing seasons, and (2) to determine whether forest and grassland ranges could be incorporated into a complementary grazing system to increase livestock production.

Experimental Site and Procedure

The study site was located on the Starkey Experimental Forest and Range 48 km southwest of La Grande, Oregon. The topography of the Starkey Range is characterized by moderately deep canyon drainages separating broad rolling uplands (Skovlin *et al.*, 1976). Elevations range from 1,080 to 1,525 meters. The soils of the study area have been described by Strickler (1966). The average annual precipitation is approximately 53 cm, and comes as snow and rainfall in the winter and spring. In approximately 1 year out of 2, there is sufficient summer rainfall to result in fall regrowth on grassland areas.

A complete description of the vegetation in the study area has been given by Ganskopp (1978). The grassland vegetation is primarily a bluebunch wheatgrass-Sandberg bluegrass *(Agropyron sipcatum-Poa sandbergii)* habitat type. The forest vegetation consists of ponderosa pine-Idaho fescue *(Pinus ponderosa-Festuca Idahoensis)*, Douglas fir-snowberry *(Pseudotsuga menziesii-Symphoricarpos albus)* and Douglas fir-ninebark *(Pseudotsuga menziesii-Physocarpus malvaceus)* habitat types, as described by Daubenmire and Daubenmire (1968) and Daubenmire (1970). Holechek (1980) reported the percentage canopy cover and the average percentage by weight of the primary forage species in cattle diets on the forest and grassland pastures (tables 1 and 2).

Grazing was conducted in 1976, 1977 and 1978 on two forest and two grassland pastures with similar capacities. A rest rotation grazing system was used with each vegetation type. This rotation involved the grazing of one pasture all season in 1976 and resting of the other. In 1977, cattle were grazed on the

TABLE 1. PERCENTAGE COVER OF THE PRIMARY FORAGE SPECIES ON THE GRASSLAND AND THEIR PERCENTAGE BY WEIGHT CONTRIBUTION TO CATTLE DIETS

Species	% cover[a]	% in diet[b]
Bluebunch wheatgrass *(Agropyron spicatum)*	25	28
Cheatgrass brome *(Bromus tectorum)*	1	1
Idaho fescue *(Festuca Idahoensis)*	15	29
Prairie junegrass *(Koeleria cristata)*	3	3
Sandberg bluegrass *(Poa sandbergii)*	30	8
Western needlegrass *(Stipa occidentalis)*	1	1
Total grasses	80	80
Western yarrow *(Achillea millefolium lanulosa)*	1	3
Arrowleaf balsamroot *(Balsamorhiza sagittata)*	T[c]	2
Wyeth eriogonum *(Eriogonum beracleoides)*	6	2
Lupine *(Lupinus* spp.)	1	1
Mules ear wyethia *(Wyethia amplexicaulis)*	T[c]	1
Total forbs	16	14
Common snowberry *(Symphoricarpos albus)*	3	4
Total shrubs	4	6

[a]Cover data were pooled across pastures.

[b]Diet samples were pooled across years and periods.

[c]T = trace.

TABLE 2. PERCENTAGE COVER OF THE PRIMARY FORAGE SPECIES ON THE FOREST AND THEIR PERCENTAGE BY WEIGHT CONTRIBUTION TO CATTLE DIETS

Species	% cover[a]	% in diet[b]
Bluebunch wheatgrass *(Agropyron spicatum)*	3	5
Elk sedge *(Carex geyeri)*	6	12
Pinegrass *(Calamagrostis rubescens)*	3	4
One-spike danthonia *(Danthonia unispicata)*	3	1
Idaho fescue *(Festuca Idahoensis)*	17	23
Western fescue *(Festuca occidentalis)*	3	6
Kentucky bluegrass *(Poa pratensis)*	2	4
Sandberg bluegrass *(Poa sandbergii)*	3	1
Total grasses	47	61
Western yarrow *(Achillea millefolium lanulosa)*	2	2
Heart-leafed arnica *(Arnica cordifolia)*	2	4
Wyeth eriogonum *(Eriogonum heracleoides)*	2	T[c]
Lupine *(Lupinus* spp.)	3	1
Cluster tarweed *(Madia glomerata)*	3	. . .
Total forbs	28	16
Bearberry *(Arctostaphylos uva-ursi)*	1	T[c]
Ninebark *(Physocarpus malvaceus)*	8	5
Wax current *(Ribes cereum)*	1	1
Spiraea *(Spiraea betulifolia lucida)*	2	5
Common snowberry *(Symphoricarpos albus)*	10	11
Total shrubs	25	23

[a]Cover data were pooled across pastures.

[b]Diet samples were pooled across years and periods.

[c]T = trace.

pasture rested in 1976 until midseason, when they were moved to the second pasture. In 1978, cattle were grazed all season on the pasture rested in 1976. The grazing season lasted 120 days in each year of the study. Cattle were placed on the pastures on June 20 and removed on October 10. The forest and grassland pastures were delineated so that approximately the same amount of forage was available on each. The stocking rate (3.2 ha/AUM) and the grazing system used were similar to National Forest allotments in the immediate area and represented a degree of forage utilization recommended for most National Forest land in the west. The performance of animals on the pastures was evaluated in late spring (June 20 to July 18), early summer (July 19 to August 15), late summer (August 16 to September 12) and fall (September 13 to October 10). Livestock performance on each pasture was measured with 18 pregnant yearling heifers. Heifers were weighed without shrink at the onset of grazing and at the end of each period.

Diet samples from each pasture were collected from four cows fitted with esophageal fistulas. Additionally, four steers were grazed for the determination of total fecal output for intake estimations (Holechek, 1980). All experimental animals grazed continuously throughout the grazing season as part of the stocking rate on each pasture. This number of animals was considered adequate for determining diet quality with 95% confidence (Van Dyne, 1968). Diet samples from each cow on each pasture were collected twice every other week during all 3 years of study. Collections on the forest and grassland were always made during the same week. This resulted in the collection of 16 samples from each pasture for each period. Cows were moved to preselected areas and allowed to feed uninhibited until at least 1 kg of grazed forage was acquired. Samples from the esophageal fistulas were dried in

a forced-air oven at 40 C for 7 days and then ground through a 40-mesh screen. Crude protein was determined by AOAC (1970) methods. Because of differences ($P<.05$) in ash content between various samples, data are presented on an organic matter basis. *In vitro* organic matter digestibility (IVOMD) was determined by the technique of Tilley and Terry (1963) as modified by Vavra *et al.* (1973). Acid detergent fiber (ADF) and lignin were determined by the permanganate method of Van Soest and Wine (1968).

Digestible energy (DE) values were predicted from IVOMD with the following regression equation developed by Rittenhouse *et al.* (1971): kilocalories DE/kilogram dry matter = .039 (organic matter digestibility) − .10. DE and crude protein were expressed on an actual intake basis with the values of Holechek (1980), and were then compared to the DE and crude protein requirements for growing yearling heifers gaining .3 kg/day (NRC, 1976). Metabolizable energy (ME) listed by the NRC (1976) was converted to DE by the NRC conversion: DE in megacalories/kilogram = ME in megacalories/kilogram × 1.22.

Statistical comparisons were made between the forest and grassland pasture data within each period and year. A completely randomized design with a one-way classification model and a standard F-test were used for all comparisons (Steel and Torrie, 1960). Covariance analysis was used to adjust average daily gains for initial weights at the beginning of each period.

Results and Discussion

Crude protein concentrations in cattle diets showed no seasonal variation during any year of the study (table 3). Skovlin (1967) reported that bluebunch wheatgrass and Idaho fescue, two of the primary forage species consumed in this study (tables 1 and 2), exhibited considerable seasonal and annual variation in crude protein content, which he attributed to amount and distribution of precipitation. With the exceptions of the early summer of 1977 and late summer of 1978, precipitation was adequate during the 3 years of this study to promote regrowth of grasses on the grassland and to provide enough immature actively growing plant tissue to sustain acceptable crude protein levels in the diets.

In six of the seven comparisons in which significant differences between dietary crude protein concentrations were found, forest diets contained more crude protein than grassland diets. On the grassland, maintenance of crude protein concentration in the diet was linked to precipitation and forage regrowth. Precipitation did not cause substantial regrowth of forage in the forest. This was noted earlier by Skovlin (1967), who found that tree overstory intercepted the moisture so that little reached the soil and, consequently, little regrowth occurred. Other factors also contributed to the production of forage with higher crude protein content under a forest canopy than on grassland. Cattle in the forest were able to select a diet that contained shrubs and elk sedge (table 2). Shrubs are reported to maintain relatively high levels of crude protein after reaching maturity (Cook and Harris, 1950). Skovlin (1967) noted that elk sedge maintained its crude protein content later in the grazing season than grasses did and showed less seasonal and annual variation. Also, plants growing in the shade usually have greater crude protein concentrations than the same species

TABLE 3. AVERAGE PERCENTAGE CRUDE PROTEIN ON AN ORGANIC MATTER BASIS IN CATTLE DIETS FROM THE FORESTS AND GRASSLANDS IN 1976, 1977 AND 1978

Sampling period	1976		1977		1978	
	Forest	Grassland	Forest	Grassland	Forest	Grassland
Late spring	12.8[a]	14.7[b]	12.2	11.1	13.6[a]	11.4[b]
Early summer	10.7	10.4	10.4[a]	8.7[b]	12.1[a]	10.4[b]
Late summer	14.4	12.8	11.0	10.0	10.9[a]	8.2[b]
Fall	12.6	11.5	10.8	10.1	11.3	10.5

[a,b]Means within sampling period and year with different superscripts differ ($P<.05$).

TABLE 4. AVERAGE PERCENTAGE ACID DETERGENT FIBER ON AN ORGANIC MATTER BASIS IN CATTLE DIETS ON THE FOREST AND GRASSLAND IN 1976, 1977 AND 1978

Sampling period	1976		1977		1978	
	Forest	Grass-land	Forest	Grass-land	Forest	Grass-land
Late spring	48.9[a]	57.1[b]	57.0	58.3	54.3	55.0
Early summer	50.4[a]	46.9[b]	58.4	58.4	58.7	56.7
Late summer	61.9	59.8	56.4[a]	62.9[b]	57.5[a]	61.8[b]
Fall	64.2	66.3	59.9[a]	66.4[b]	59.2[a]	64.1[b]

[a,b]Means within sampling period and year with different superscripts differ (P<.05).

growing in the sun (Roberts, 1926; McEwen and Dietz, 1965), because stage of development is often retarded.

ADF content of the diets differed (P<.05) between pastures (table 4) in the late spring and early summer of 1976 and in the late summer and fall of 1977 and 1978. Higher (P<.05) ADF content on the grassland in the late summer and fall of 1977 and 1978 indicated that the forage present was more mature than that on the forest, supporting the previous discussion.

Cattle diets on the forest contained more lignin (P<.05) during the late summer and fall of 1976, early summer and fall of 1977 and early and late summer of 1978 (table 5). Diets of cattle grazing the forest also showed the greatest seasonal variation in lignin concentration. We hypothesized that shrub consumption increased lignin content of the diet. However, quantification of this factor is difficult. Current year's growth of shrubs does not contain excessive quantities of lignin. As cattle consume shrubs, current year's growth is taken first and becomes less available as the season progresses. Cattle on the forest consumed shrubs continually during all periods and in all years (Holechek, 1980), from a low of 10% in late summer of 1977 to a high of 47% in late summer of 1978, with an overall average consumption of 23% (table 2). Skovlin *et al.* (1976) reported annual shrub production on the Starkey Range to be 12.3 kg/ha. Consumption at the level reported herein would mean that, by the second half of the grazing season, cattle were forced to consume older, more mature shrub material. Also, lignin content in the diets was greatest in 1976 and 1978, years when pasture changes did not occur and utilization was heavier.

Generally, IVOMD of cattle diets (table 6) was superior on the forest in early and late summer. In the falls of 1976 and 1977, cattle on grassland selected diets that were significantly more digestible. Precipitation in these 2 years was sufficient to produce enough re-

TABLE 5. AVERAGE PERCENTAGE LIGNIN IN CATTLE DIETS ON AN ORGANIC MATTER BASIS IN CATTLE DIETS ON THE FOREST AND GRASSLAND IN 1976, 1977 AND 1978

Sampling period	1976		1977		1978	
	Forest	Grass-land	Forest	Grass-land	Forest	Grass-land
Late spring	14.5	12.9	13.0	12.1	13.0	11.6
Early summer	11.7	14.4	16.8[a]	11.7[b]	13.3[a]	10.4[b]
Late summer	18.8[a]	13.9[b]	13.3	13.1	19.7[a]	13.4[b]
Fall	20.2[a]	16.4[b]	15.5[a]	11.0[b]	14.5	16.1

[a,b]Means within sampling period and year with different superscripts differ (P<.05).

TABLE 6. AVERAGE PERCENTAGE *IN VITRO* ORGANIC MATTER DIGESTIBILITY OF CATTLE DIETS FROM THE FOREST AND GRASSLAND IN 1976, 1977 AND 1978

Sampling period	1976		1977		1978	
	Forest	Grass-land	Forest	Grass-land	Forest	Grass-land
Late spring	64.4[a]	60.2[b]	59.3	57.5	59.7	58.8
Early summer	61.1	58.5	52.7[a]	47.1[b]	62.0[a]	56.6[b]
Late summer	58.6	57.1	55.1[a]	44.8[b]	53.0	51.0
Fall	49.7[a]	57.5[b]	48.8[a]	54.1[b]	52.6[a]	45.8[b]

[a,b]Means within sampling period and year with different superscripts differ ($P<.05$).

growth to influence the percentage IVOMD. Forest cattle also consumed diets that were significantly higher in lignin during the same periods in 1976 and 1977. On the forest, low IVOMD values were associated with the larger lignin values; this pattern was not apparent on the grassland.

When data were pooled by pasture type within year, cattle on the forest gained more ($P<.05$) in 1978, but there were no pasture-related differences in gain in 1976 or 1977 (table 7). On a per period basis, data indicated that, during late spring, cattle performed equally well on the forest and on grassland. Cattle on the forest generally gained more during the early and late summer, except during the early summer of 1977. Diet quality on the forest surpassed that on the grasslands during these two periods (tables 3 and 6).

The relationship between actual amount of nutrients consumed (table 8) and requirements (NRC, 1976) reflects the differences noted by period and pasture in average daily gain. The NRC (1976) states that a 300-kg yearling heifer requires .63 kg of crude protein and 18.06 Mcal of DE daily for an average daily gain of .30 kilograms. With these figures used as a standard, crude protein consumption was less than required during six of the various periods over the 3 years of study, and DE was deficient during 14 of the periods. On mountain rangelands similar to those studies, DE appears to be the first-limiting nutrient.

Our results indicate that a grazing system in which both forest and grassland pastures are used would be most productive. The system would include grazing on the grassland in the late spring, followed by a move to the forest during early and late summer. Precipitation or lack of precipitation in the late summer or fall would determine whether cattle should be moved back to the grassland. Management of cattle in this way should improve the efficiency

TABLE 7. AVERAGE DAILY GAIN (KILOGRAMS) FOR CATTLE ON THE FOREST AND GRASSLAND IN 1976, 1977 AND 1978

Sampling period	1976		1977		1978	
	Forest	Grass-land	Forest	Grass-land	Forest	Grass-land
Late spring	−.06	+.22	+.63	+.50	+.67	+.80
Early summer	+.61[a]	+.43[b]	.00[a]	+.33[b]	+1.10[a]	+.41[b]
Late summer	+.51	+.41	+.72[a]	+.08	−.37	−.40
Fall	+.38	+.40	+.33	+.29	+.46[a]	+.28[b]
Mean daily gain	+.38	+.40	+.33	+.29	+.47[a]	+.27[b]

[a,b]Means within sampling period and year with different superscripts differ ($P<.05$).

TABLE 8. AVERAGE DAILY INTAKE OF CRUDE PROTEIN (KILOGRAMS) AND DIGESTIBLE ENERGY (MEGACALORIES) ON THE FOREST AND GRASSLAND IN 1976, 1977 AND 1978

Sampling period	1976		1977		1978	
	Forest	Grass-land	Forest	Grass-land	Forest	Grass-land
			Crude protein intake			
Late spring	.45[a]	.66[b]	.84	.76	.85	.80
Early summer	.68	.60	.63[a]	.51[b]	.72[a]	.63[b]
Late summer	.87[a]	.78[b]	.66[a]	.47[b]	.50[a]	.38[b]
Fall	.72	.66	.67	.70	.84[a]	.63[b]
			Digestible energy intake			
Late spring	11.4[a]	13.7[b]	20.6	19.9	18.8[a]	21.3[b]
Early summer	19.9[a]	17.1[b]	16.1[a]	14.4[b]	18.7[a]	17.3[b]
Late summer	18.2	17.6	17.2[a]	12.6[b]	12.4	12.1
Fall	14.7[a]	19.9[b]	16.0[a]	19.3[b]	19.9[a]	14.3[b]

[a,b]Means within sampling period and year with different superscripts differ ($P<.05$).

of beef production over exclusive use of either vegetation type. Rotation between the two types of vegetation should also improve beef production in areas where cattle are given free choice of both types. As noted by Harris (1954), cattle are reluctant to use forested areas except during drought or extremely hot periods or as an escape from insects.

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