Meadow Forage Quality, Intake, and Milk Production of Cows

C. L. STREETER, C. B. RUMBURG, T. H. HALL, AND E. G. SIEMER

Highlight: *A native mountain meadow was grazed by cows through the summer and fall of 1970 near Gunnison, Colorado. Nutrient concentration and in vitro digestibility were measured from forage samples collected from esophageally-fistulated cows. Total fecal excretion was estimated by the Cr_2O_3 dilution technique. Forage consumption was calculated from digestibility and fecal-excretion data. Milk production of cows was determined at biweekly intervals by measuring calf weights before and after nursing, followed by machine milking.*

The cell-wall constituent (CWC) content of the diet increased from 47.2 to 62.1% from mid-June to mid-October. CWC digestibility decreased from 72.8 to 52.3% during the same period. The nitrogen concentration of the diet decreased from 3.1 to 1.2%; whereas the nitrogen concentration in standing forage decreased from 3.8 to 1.4%. Dry-matter consumption averaged 14.7, 12.0, 10.5, and 10.3 kg per day, and mean milk production was 6.0, 4.4, 4.0, and 3.0 kg in 14 hours for Brown Swiss, Charolais x Angus, and San Juan Basin and Commercial Hereford cows, respectively. Daily dry-matter consumption did not change significantly as the season advanced. Daily milk production declined from 5.7 in April to 2.0 kg in November. Animals selectively grazed bluegrass regrowth on drier sites, leaving abundant sedge growth on lightly-grazed wet sites. This grazing pattern resulted in high dietary nutrient levels throughout most of the season.

An increase in cell-wall constituents (CWC) and a decrease in digestibility and nitrogen concentration in the diet of grazing cows with advancing season is typical of the decrease in forage nutritive value with advancing plant maturity (Streeter et. al., 1968; Bedel, 1971). However, forage available to cattle grazing irrigated meadows is in many stages of initial growth and regrowth, and thus the nutritive value of the diet depends on the forage selected by the grazing cows.

Furr and Nelson (1964) found that milk produced by beef cows was positively related to level of nutrients consumed, and negatively related to advancing lactation. They also found a high correlation between the weaning weight of calves and milk production of the dam.

This study was conducted to determine seasonal changes in nutritive value of forage consumed and the amount of milk produced by four breeding groups of cows grazing native mountain meadows. Hall (1971) documented differences in calf production among the four breeding groups.

At the time this article was written, the authors were assistant professor of animal science, Colorado State University; research agronomist and superintendent, Agricultural Research Service and Colorado State University; assistant animal scientist; and associate professor of agronomy, Colorado State University. Streeter's present address is Buffalo Gap, South Dakota, and Hall's is Box 177, Palisade, Nebraska.

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Materials and Methods

The experimental area was located 6 miles north of Gunnison, Colo., at an elevation of 2,438 m. The vegetation consisted of sedges (*Carex, Eleocharis*), rushes (*Juncus*), grasses (*Poa, Hordeum, Agropyron, Phleum, Deschampsia*), clovers (*Trifolium*), and numerous forbs. Grasses predominated on dry sites, and sedges on wet sites. The meadow was fertilized with 112 kg/ha of nitrogen in May, 1970, and was irrigated intermittently during the season.

Animals grazed 5.7 ha of meadow from June 6 to July 10, 1970, at which time they were allowed to graze an additional 2.75 ha of meadow until November 8.

Dietary samples were obtained from three esophageally-fistulated dry cows: two 2-year-old Herefords and one 4-year-old Charolais x Angus. Samples of grazed forage were obtained during four periods: June 16-21, July 26-31, September 8-13, and October 18-23. The forage collections were made each morning during 30- to 45-minute grazing periods on each of six days per trial. Fecal excretion and milk production was measured from twelve 4-year-old cows from four breeding groups (3 Brown Swiss, 3 Charolais x Angus, 4 linecross purebred Herefords from the San Juan Basin Research Center, and 2 commercial Herefords).

Fecal excretion was estimated using chromic oxide (Cr_2O_3) as an external indicator. One capsule containing 10g Cr_2O_3 suspended in oil was administered orally with a balling gun each morning and evening for 16 days/trial. Rectal grab samples of the feces were collected twice daily at the time of Cr_2O_3 administration during the last 6 days of each trial. Daily samples for each animal were composited for the 6 days and stored in the frozen state until after the trial.

Dietary and fecal samples were dried at 50°C and ground through a 1.0-mm screen. Dietary samples were analyzed for total nitrogen by Kjeldahl and for cell-wall constituents (CWC) by the procedure of Goering and Van Soest (1970). Fecal samples were analyzed for CWC (Goering and Van Soest, 1970) and chromic oxide (Williams, David, and Iismaa, 1962).

Digestibility of the CWC in the dietary samples was established in vitro as described by Scales (1972). Inoculum was obtained from a steer on a daily diet of grass hay, 454 g of supplemental soybean meal, and free-choice trace-mineralized salt. In vivo digestibility was predicted from in vitro digestibility, as described by Streeter et al. (1971). Total dry-matter (DM) consumption was calculated as follows:

$$\text{DM consumed} = \frac{(\text{Fecal DM excretion} \times 100)\ (\%\ \text{Fecal CWC})}{(100 - \%\ \text{In vivo dig. CWC})\ (\%\ \text{Dietary CWC})}$$

Milk production was measured every 14 days, beginning April 30 and ending November 8. In the evening before the day of milk collection, cows were injected with 2 ml oxytocin, and the udders were evacuated with a milking machine. Cows were turned into pasture overnight, and the calves were penned nearby with access to hay and water. At 7:00 am on collection day, each calf was weighed and then allowed to

Table 1. Seasonal changes in cell-wall constituents (CWC, %), in vitro digestibility (%) of CWC, and nitrogen (%) in diets of cows grazing native meadows.

Time period	Diet characteristic		
	CWC	In vitro CWC digestibility	Nitrogen
June 16-21	47.2	72.8	3.07
July 26-31	55.8	58.4	2.37
Sept. 8-13	59.7	53.3	1.67
Oct. 18-23	62.1	52.3	1.20
Mean[1]	56.2 ± 0.4	59.2 ± 2.8	2.08 ± 0.03

[1] Mean ± S.E.

nurse. When the calf finished nursing, it was reweighed. The cow was injected with 2 ml of oxytocin and milked dry by machine. Milk production was estimated as the increase in calf weight plus weight of milk collected by milking machine.

Herbage samples were collected weekly from 1-m^2 quadrats within 6 m square. Samples were analyzed for dry-matter and total nitrogen (A.O.A.C., 1960). Phosphorus was determined according to the procedure of Bolin and Stamberg (1944), and color was developed according to the procedure of Barton (1948), except that the $(NH_4)_6Mo_7O_{24}$ solution used was 0.25% (W/V) rather than 0.40%.

Data were analyzed by analysis of variance. Standard errors of the means were computed for all data, and some means were compared by Duncan's multiple-range test.

Results and Discussion

From mid-June until mid-October, CWC concentration of the diet increased from 47.2% to 62.1%; digestibility of the CWC decreased from 72.8% to 52.3%; and nitrogen concentration decreased from 3.07% to 1.20% (Table 1).

Nitrogen concentration of standing herbage decreased with time. The decrease was more pronounced in herbage from wet sites than in herbage from dry sites (Fig. 1). Changes in phosphorus concentration in the herbage (not shown) paralleled nitrogen concentration. Mean percent P in herbage was 0.287 (SE = 0.007) and 0.267 (SE = 0.006) from dry and wet sites, respectively.

It was observed that cows preferred to graze the dry sites, and they grazed them continuously throughout the study period. This grazing pattern is evidenced by the similarity in nitrogen concentrations of dietary samples (Table 1) and herbage samples from dry sites (Fig. 1). Intensive grazing left little forage on the dry sites on any date (Fig. 2), and immature forage was relatively high in nitrogen, even late in the season. Grazing intensity was not severe enough to prevent abundant herbage accumulation on wet sites, with a concomitant dilution of nitrogen and phosphorus concentrations.

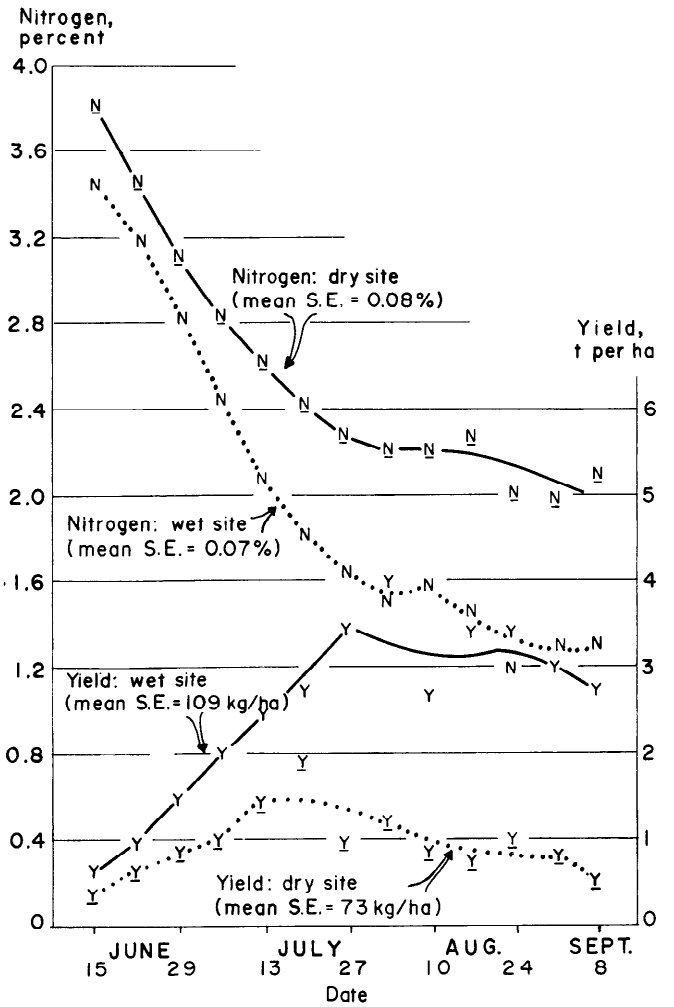

Fig. 1. *Seasonal changes in percent nitrogen and yield of herbage in tons/ha from six dry sites used intensively, and ten wet sites used late and only moderately.*

Table 2. Seasonal changes in dry-matter consumption (kg/day) of cows grazing native meadows.

Trial period	Breeding groups			
	Brown Swiss	Charolais x Angus	San Juan Basin Hereford	Commercial Hereford
No. of animals	3	3	4	2
June 16-21	14.1	12.7	12.5	11.8
July 26-31	15.0	11.7	10.1	10.2
Sept. 8-13	13.9	11.5	9.8	9.5
Oct. 18-23	15.8	12.1	9.8	9.8
Mean[1, 2]	14.7[a]	12.0[ab]	10.5[b]	10.3[b]

[1] S.E. = 1.01.
[2] Means with the same superscript do not differ from each other at 0.05 probability.

Brown Swiss cows consumed an average of 14.7 kg of dry-matter per day (Table 2), which was significantly greater ($P < 0.05$) than that for San Juan Basin (10.5 kg/day) and commercial Herefords (10.3 kg/day), but not significantly greater than that for Charolais x Angus (12.0 kg/day). Dry matter consumption for Brown Swiss and Charolais x Angus did not decrease as the season advanced. Commercial and San Juan Basin Herefords consumed less dry-matter as the season advanced, but the decrease in intake was not statistically significant ($P > 0.05$).

Many workers have shown that cows decrease their voluntary intake as forage becomes more mature. However, Raymond (1969) has pointed out that different forage species at the same level of digestibility may be eaten in quite different amounts. It has further been shown that forages very low in crude protein limit digestion and, hence, intake (Raymond, 1969). The critical level of protein is commonly in the range of 4 to 6%. However, protein in the diet of cows grazing native meadows was never less than 7.5%. In fact, protein values in hand-clipped samples never dropped below 7.5%. Protein intake exceeded recommended requirements (NRC, 1970) throughout the season, with the possible exception of the October period, and even then protein may have been adequate, considering the low level of milk production.

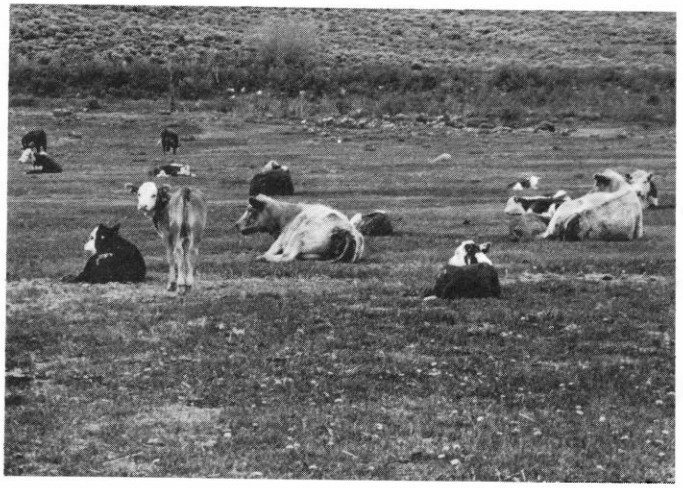

Fig. 2. *Cows and calves resting on a bluegrass meadow site in early June.*

Dry-matter intake estimates averaged 145, 141, and 125 g/$W^{3/4}$ (3.1, 3.2, and 2.8% of body weight) for Brown Swiss, Charolais x Angus, and the two groups of Herefords, respectively. Intake values appear to be slightly high, except for Herefords. High intake values would have resulted from overestimation of feces or underestimation of digestibility.

Brown Swiss cows produced an average of 6.0 kg milk/14-hour period (Table 3). Charolais x Angus and San Juan Basin Herefords produced 4.4 and 4.0 kg/14-hour period, respectively, which was significantly lower than Brown Swiss but not different from each other. Commercial Herefords produced 3.0 kg milk/14-hour period, which was significantly lower than all other groups. All cows produced less milk as the season advanced, with no significant differences in the rate of decline among the different groups.

Milk production fluctuated considerably during early lactation. Cows reached peak milk production about June 18, which averaged 60 days after calving. Abadia and Brinks (1972) reported beef cows reached peak production 30 to 45 days after calving; whereas, Gifford (1953) reported maximum milk yield between 30 and 60 days after calving. Decline in milk production was continuous after June 18. When calves reached 120 days of age (mid-August), there was essentially no residual milk in any of the breeding groups after nursing. However, calves may have consumed all their dam's milk before 120 days of age when allowed to run with the dams.

Table 3. Milk collected (kg) from four groups of cows after 14 hours (overnight) separation from their calves.

Date of milk collection	Breeding groups: Brown Swiss	Charolais x Angus	San Juan Basin Hereford	Commercial Hereford	Mean[1]
April 30	7.5	6.1	5.5	4.0	5.7
May 14	5.2	4.7	4.6	3.4	4.4
May 28	7.3	6.0	4.6	4.9	5.7
June 18	8.1	6.0	5.6	4.2	5.9
July 2	7.4	6.5	5.3	3.8	5.7
July 16	6.5	4.3	4.1	3.4	4.5
July 30	6.5	4.2	4.6	3.0	4.5
Aug. 13	6.7	4.7	4.0	2.5	4.4
Aug. 27	6.3	4.2	4.1	2.8	4.3
Sept. 9	5.1	4.9	4.6	3.2	4.4
Sept. 24	4.8	2.6	3.0	2.2	3.1
Oct. 8	5.2	3.8	3.1	2.7	3.7
Oct. 22	3.9	2.8	1.8	1.6	2.5
Nov. 8	3.7	2.0	1.3	1.3	2.0
Mean[2]	6.0[a]	4.4[b]	4.0[b]	3.0[c]	

[1] S.E. = 0.34.
[2] Means with the same superscript do not differ from each other at 0.05 probability.

Conclusions

1) Continuously grazed irrigated meadows produced forage sufficiently high in nitrogen concentration to meet recommended protein levels for lactating cows throughout the grazing season.

2) There was little or no decline in dry matter intake as the season progressed, which we attribute to the relatively high nutrient concentration in regrowth forage on bluegrass sites and abundant forage available on lightly grazed, wet sites.

3) Conclusions concerning differences among breeding groups must be regarded as tentative because of limited numbers. In general, Brown Swiss weighed more, had a higher daily intake, and produced more milk than the other three groups. Charolais x Angus and the two groups of Herefords had about the same mature weights, but the data suggest the possibility that the crossbred cows had a higher daily intake and produced slightly more milk than the Herefords. There was essentially no difference between the two groups of Herefords.

4) Continuous grazing of the meadow could eventually reduce the vigor of bluegrass because of heavy pressure on bluegrass sites.

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