Grazing Habits, Diet and Performance of Sheep on Alpine Ranges[1,2]

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Highlight

An Alpine range, average elevation 3,200m, was divided. One portion was fenced and sheep were allowed to graze it freely, the other was managed by a herder. The grazing season was for 60 days during July and August. Diet samples for botanical analyses were collected by esophageal fistulated sheep. Generally the grazing behavior of the free sheep was similar to the herded group except that the band was somewhat more loosely organized in the absence of a herder. Nitrogen and in vitro digestibility of diet samples were slightly lower and fiber and cellulose slightly higher from the free grazed sheep. There were no differences in the botanical composition of diet samples from the two groups. The sheep ate more forbs early in the grazing period. They were more selective in choice of grass and sedge species than in choice of forb species eaten. There were no differences in lamb gains during the grazing period.

Alpine range in the central Rocky Mountains is an important range resource consisting of more than two million hectares. In 1959 alpine ranges were included in over 300 sheep and 40 cattle allotments on National Forests (Wasser and Retzer, 1966). Despite widespread use of the alpine by sheep, little is known of their diet, habits, and performance.

Sheep producers have constant problems in obtaining competent labor to herd sheep. Methods of management are needed which reduce the labor requirements, yet maintain the productivity of the sheep herd and the range.

The objectives of this study were: (1) To determine grazing activities, diet, and performance of sheep on alpine ranges and (2) to evaluate these characteristics under herder and herderless management.

Experimental Procedures

This study was conducted on the Shoshone National Forest near Cody, Wyoming. Two sheep allotments were used. The Meeteetse Creek Allotment was grazed by herded sheep while the Carter Mountain Allotment was fenced and sheep grazed it freely. Each sheep allotment consisted of about 648 hectares of alpine range. The mean elevation of the range was 3,200 meters. The topography was a steeply rolling mountain top surrounded by a rim which dropped precipitously about 300 meters to a forested foothill area (Fig. 1).

Vegetation on the area was typical of much of the alpine zone in this region. The number of plant species present on the area was large (Table 1). Whiproot clover,[4] alpine avens, and dwarf clover dom-

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[4] Scientific names of plants are given in Table 1.

FIG. 1. A view of the Carter Mountain allotment. Note the sheep grazing in a loosely organized band and the rim rock in the background.

inated the foliage cover on both allotments.

About 1,200 Rambouillet ewes and their lambs grazed on each allotment from early July to mid-September. Each band grazed, under the supervision of a herder, for the remainder of the year on the surrounding foothills and deserts.

Diet samples were obtained periodically from five esophageal-fistulated wethers in each band. The wethers remained with the bands throughout the summer. There were 8 diet samples obtained per period per collector wether on the free group and 4 samples per period per collector wether on the herded group. Samples were collected alternately in the early morning or evening when the bands of sheep were normally observed to graze.

Sulfuric acid was added to the samples in 1966 to limit bacterial digestion until the samples could be placed in cold storage. In 1967, the samples were washed with cold water until saliva was removed and then refrigerated immediately. They were later divided into halves for botanical and chemical analyses.

Botanical composition was determined by the microscopic point method of Heady and Torell (1959) using 100 points per sample. Our data (unpublished) would indicate that 100 points were adequate if percentage composition was reported. Ash and Kjeldahl nitrogen were determined by AOAC (1960) methods. Cellulose was determined by a modification of the Crampton and Maynard (1939) procedure in which the alcohol and benzene washes were omitted. Fiber and lignin were determined by the ADF method described by Van Soest (1963). Digestible dry matter was estimated by the in vitro method of Tilley and Terry (1963).

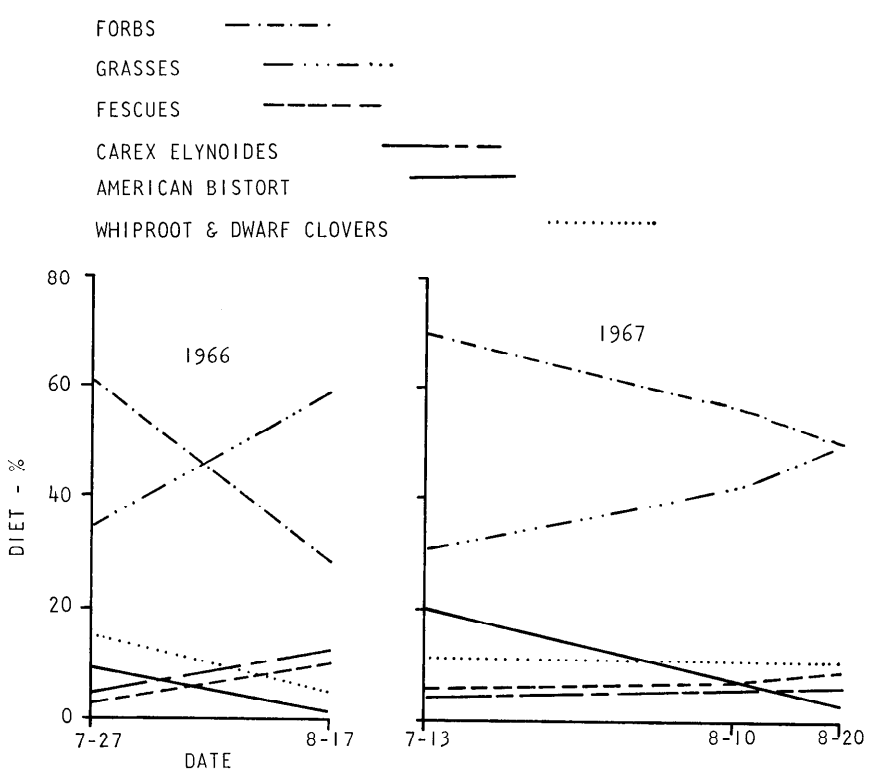

FIG. 2. Seasonal composition of the diet of free grazing sheep on Carter Mountain allotment.

Behavior

In 1966, the unherded sheep behaved in much the same manner as herded sheep. However, the flock occasionally split into three groups; later regrouping to form a single band. The herd frequently used the same areas for bedgrounds.

The unherded sheep generally remained in a single band in 1967. They would infrequently split into two or rarely three groups for short periods of time. They showed no particular preference for geographic areas and grazed in a very loose herd, often spreading over an area

of more than a square mile. When bedding they tended to band together in one group.

The behavior of unherded sheep on Carter Mountain was in contrast to that observed by Jones and Paddock (1966) on an alpine range in Colorado. Their sheep developed a very loosely organized behavior when left unherded for the entire year. Band integrity was not maintained. Behavioral patterns of the unherded sheep in our study may have been conditioned by herding during the remaining 10 months of the year. The breed of sheep may also have been influential. Rambouillets, which were used in this study, have pronounced gregarious habits. Jones and Paddock (1966) reported the behavior of Columbia sheep which may not have as strong a herding instinct.

Botanical Composition of the Diet

The average diet of sheep on the two allotments was very similar. The diet was composed of a large number of species, no one of which was dominant (Table 2). The most important species included whiproot clover, dwarf clover, American bistort, alpine avens, and the fescues. Of the two fescues, red fescue was by far the most abundant in the diet. This group of seven species accounted for about 67 percent of the average diet.

None of these species were placed high in Johnson's (1962) preference rating of alpine forage species in Wyoming. Only *Carex elynoides* was found to be a major producer of sheep forage on alpine ranges in the central Rocky Mountains (Paulsen, 1960).

Forbs made up 52 percent of the diet on the Carter Mountain Allotment and 65 percent on the Meeteetse Creek Allotment. The forb-grass ratio was higher in 1967 than in 1966. This discrepancy may have been related to the relatively warm, dry summer of 1966 which resulted in early disintegration of the forbs.

Foliage cover is related to the abundance (Table 1), but the re-

Table 1. Plant species and foliage cover (%) on the Meeteetse Creek (free grazing) and Carter Mountain (herded) allotments[1]

	Carter Mountain	Meeteetse Creek
Grasses	6.8	7.9
Scribner wheatgrass *Agropyron scribneri* Vasey	0.3	0.4
Tufted hairgrass *Deschampsia caespitosa* (L.) Beauv.	0.4	0.4
Fescues, sheep and red *Festuca ovina* L. and *F. rubra* L.	0.8	0.9
Prairie junegrass *Koeleria cristata* (L.) Pers.	1.0	1.3
Bluegrasses *Poa* spp.	4.0	4.5
Spike trisetum *Trisetum spicatum* (L.) Richt.	0.0	0.1
Other grasses	0.1	0.0
Sedges	3.9	7.3
Black and white scaled sedge *Carex albo-nigra* Mack	0.6	1.6
Ebony sedge *C. ebenea* Rydb.	0.0	0.5
C. elynoides Holm	1.2	1.5
Needle leaf sedge *C. obtusata* Lilj	1.6	3.3
Liddon sedge *C. petasata* Deway	0.1	0.1
Forbs	43.1	36.9
Western yarrow *Achillea lanulosa* Nutt.	0.0	0.2
Pale agoseris *Agoseris glauca* (Pursh) Raf.	1.0	1.2
Alpine pussytoes *Antennaria alpina* (L.) Gaertn.	0.4	0.5
Ballhead sandwort *Arenaria congesta* Nutt.	0.7	0.1
Twinflower sandwort *Arenaria obtusiloba* (Rydb.) Fern.	2.6	1.5
Orange arnica *Arnica fulgens* Pursh	0.5	0.6
Alpine sagewort *Artemisia scopulorum* Gray	0.2	2.2
Alpine kittentails *Besseya alpina* (Gray) Rydb.	1.0	0.6
Field cerastium *Cerastium arvense* L.	0.2	0.3
Tiny hawksbeard *Crepis nana* Richards	0.1	0.7
Darkthroat shooting-star *Dodecatheon pulchellum* (Raf.) Merr.	0.4	0.3

[1] Average of 75 transects selected to cover the range of conditions of each allotment. Each transect contained ten 8.8 × 17.6 cm. plots on which foliage cover was measured to the nearest 10 percent by the percentage area estimation method (Brown 1954).

Table 1. (*Continued*)

	Carter Mountain	Meeteetse Creek
Fleabane *Erigeron compositus* Pursh	0.0	0.2
One-flowered fleabane *Erigeron simplex* Greene	0.5	0.6
Bear River fleabane *Erigeron ursinus* D. C. Eaton	0.3	0.1
Longwooly eritrichium *Eritrichium elongatum* (Rydb.) Wight	0.2	0.2
Alpine avens *Geum rossii* (R. Br.) Ser.	8.6	12.3
Greene lupine *Lupinus greenei* A. Nels.	0.3	0.8
Spiked woodrush *Luzula spicata* (L.) D. C.	0.1	0.2
Alpine bluebells *Mertensia alpina* (Torr.) G. Don	0.0	0.1
Forget-me-not *Myosotis alpestris* Schmidt.	0.3	0.2
Parry loco *Oxytropis parryi* Gray	0.1	0.2
Elephanthead lousewort *Pedicularis groenlandica* Retz	0.0	0.1
Tufted phlox *Phlox caespitosa* Nutt.	1.3	1.0
Flowery phlox *Phlox multiflora* A. Nels.	1.4	1.1
Americanbistort knotweed *Polygonum bistortoides* Pursh	3.3	3.5
Viviparousbistort knotweed *Polygonum viviparum* L.	0.0	0.2
Blueleaved cinquefoil *Potentilla diversifolia* Lehm.	1.4	1.5
Yellowmountail flasespringparsley *Pseudocymopterus montanus* (Gray) C. & R.	4.6	1.6
Diamondleaf saxifrage *Saxifraga rhomboidea* Greene	0.3	0.2
Wormleaf stonecrop *Sedum stenopetalum* Pursh	0.5	1.0
Rosecrown stonecrop *Sedum rhodanthum* Gray	0.7	0.1
Fremont groundsel *Senecio fremontii* T. & G.	0.2	0.3
Moss silene *Silene acaulis* L.	0.0	0.1
Whiproot clover *Trifolium dasyphyllum* T. & G.	13.1	7.9
Dwarf clover *Trifolium nanum* Torr.	6.6	7.7
Parry clover *Trifolium parryi* Gray	0.8	1.5

lationship is inexact because of variations among life forms. In order to relate the foliage cover to the botanical composition of sheep diets determined by esophageal-fistulated sheep, simple correlations were caluclated between the percentage cover and the percent found in esophageal-fistula samples. The items correlated are shown in Table 3. There was a significant ($P < .05$) simple correlation of 0.675 between percent cover and the percent of the plants found in the esophageal samples.

In addition simple correlations were calculated by dividing the forage cover and the esophageal data into two groups. The correlations between percent cover and the percent found in esophageal samples were .003 for grasses and sedges ($P > .05$) and 0.848 for forbs ($P < .05$). Thus, the sheep apparently ate grasses and sedges according to preference and not in relationship to abundance. The fescues were preferred to other grasses and sedges even though their abundance was much less than the bluegrasses or the sedges. The sheep apparently ate the forbs according to their abundance as measured by foliage cover. However, the sheep selectively ate appreciable amounts of only seven of the 14 forbs which were available in considerable amounts according to cover measurements.

Seasonal selectivity of the sheep was generally pronounced (Figs. 2 and 3). Forbs furnished 66 percent of the diet in the early summer of 1966. This decreased to 31 percent in late summer. Forbs generally furnished more of the diet in 1967 than in 1966. On the herded Meeteetse Creek Allotment in 1967 no seasonal decrease was noted. This may be related to the increased availability of forbs throughout the season with the relatively cool moist climate of 1967.

The seasonal shift from forbs to grasses and grasslikes was associated with a relatively small number of species. The shift was due largely

to a change from American bistort to fescues and *Carex elynoides*. In 1967, however, when the forb/grass ratio remained constant on the herded Meeteetse Creek Allotment, American bistort decreased from 25 percent of the diet in mid-summer to 1 percent of the diet in late summer. Dwarf and whiproot clovers increased proportionately.

The abundance of alpine avens in the diet did not vary during the season. Instead, it made up a remarkably constant 10 percent of the diet.

Chemical Composition of the Diet

Average chemical composition of the diet did not vary significantly between allotments (Table 4). Nitrogen was the only chemical constituent to vary significantly within the grazing season. Dietary nitrogen was high in the early part of the season and decreased with time on both allotments (Figs. 4 and 5). The nitrogen level was generally above the requirements for ewes and fattening lambs (NRC 1964). However, the nitrogen level in late August, 1967, on the herded Meeteetse Creek allotment was at the minimum requirement for lambs.

The in vitro dry matter digestibilities of the 1967 dietary samples are shown in Figure 6. Early samples were not taken in the Meeteetse Creek Allotment (herded) because the band of sheep had not reached the alpine portion of the range at that time. The in vitro digestibility was higher in the herded Meeteetse Creek Allotment than in the free grazing Carter Mountain Allotment in the early and later August sampling periods. The dry matter digestibility of the forages was relatively high throughout the grazing period which is an indication of the high quality of alpine range. The lowest dry matter digestibility (50%) was at the earliest sampling date. Since the fistulated sheep had been on the range for a period of only 5 days, this may be too soon for adaptation to a new diet. The nitrogen content and in vitro digesti-

Table 2. Botanical composition (%) of the diet of sheep on two sheep allotments in the alpine zone.[1]

	Carter Mountain (free grazing)			Meeteetse Creek (herded)			
	1966	1967	Avg.	1966	1967	Avg.	Avg.
Grasses and grasslikes	47	41	44	41	22	32	32
Scribner wheatgrass	0	1	0	0	0	0	0
Blackandwhitescaled sedge	2	2	2	1	1	1	2
C. bigelovii	4	2	3	1	3	2	2
Ebony sedge	2	2	2	1	0	0	1
C. elynoides	9	6	8	11	2	6	7
Needleleaf sedge	6	0	3	6	0	3	3
Tufted hairgrass	2	1	2	1	1	1	2
Fescues, sheep and red	13	15	14	14	10	12	13
Prairie junegrass	3	3	3	1	2	2	2
Alpine bluegrass (*Poa alpina* L.)	2	6	4	2	2	2	3
Muttongrass (*Poa fendleriana* (Steud.) Vasey)	1	1	1	0	0	0	0
Forbs	45	58	52	52	77	65	58
Orange arnica	1	0	0	1	1	1	0
Alpine besseya	2	1	2	1	3	2	2
Paintbrush (*Castilleja* sp.)	0	0	0	1	0	1	0
Field cerastium	0	0	0	1	0	0	0
Fleabane	0	2	1	0	1	0	0
One-flowered fleabane	1	0	0	1	1	1	0
Bear River fleabane	0	1	0	0	1	0	0
Alpine avens	7	12	10	10	11	10	10
Green lupine	0	0	0	0	1	0	0
Forget-me-not	1	2	2	1	1	1	2
Americanbistort knotweed	5	11	8	14	15	14	11
Blueleaved cinquefoil	0	0	0	1	0	0	0
Yellowmountain falsespringparsley	0	1	0	1	0	0	0
Wormleaf stonecrop	0	3	2	1	4	2	2
Whiproot clover	11	17	14	8	19	14	14
Dwarf clover	10	5	8	8	18	13	10
Parry clover	0	2	1	0	0	0	0

[1]Species representing less than 1% of the diet have been omitted from the table.

Table 3. Relation between botanical composition (%) of esophageal samples and the cover (%) of plants.[1]

Use order	Esophageal samples	Cover estimate
Grasses and sedges		
Fescues, sheep and red	13	0.85
Carex elynoides	7	1.40
Needleleaf sedge	3	2.50
Alpine bluegrass	3	4.30
Blackandwhitescaled sedge	2	1.10
C. bigelovii	2	0.10
Tufted hairgrass	2	0.40
Prairie junegrass	2	1.15
Ebony sedge	1	0.25
Total	35	12.05

[1]Species recorded were 1% or greater in either esophageal samples or in cover estimates. The remaining 14% in esophageal samples were 1% of the composition or less.

Table 3. (*Continued*)

Use order	Esophageal samples	Cover estimate
Forbs		
Whiproot clover	14	10.50
Americanbistort knotweed	11	3.40
Alpine avens	10	10.45
Dwarf clover	10	7.15
Alpine besseya	2	0.80
Forget-me-not	2	0.25
Wormleaf stonecrop	2	0.25
Pale agoseris	0	1.10
Twinflower sandwort	0	2.05
Alpine sagewort	0	1.20
Flowery phlox	0	1.25
Tufted phlox	0	1.15
Blueleaved cinquefoil	0	1.45
Yellowmountain falsespringparsley	0	3.20
Total	51	41.20

bility of dietary samples indicated that the sheep were able to select a high quality diet on alpine range. The dietary digestibility differences on the two allotments may be a reflection of the higher forb content in the herded Meeteetse Creek samples particularly at the later dates (Figs. 2 and 3).

The chemical composition of dietary samples (Table 4) also indicated that the sheep on the herded Meeteetse Creek Allotment were selecting a higher quality diet since the nitrogen tended to be higher and fibrous components lower in these samples.

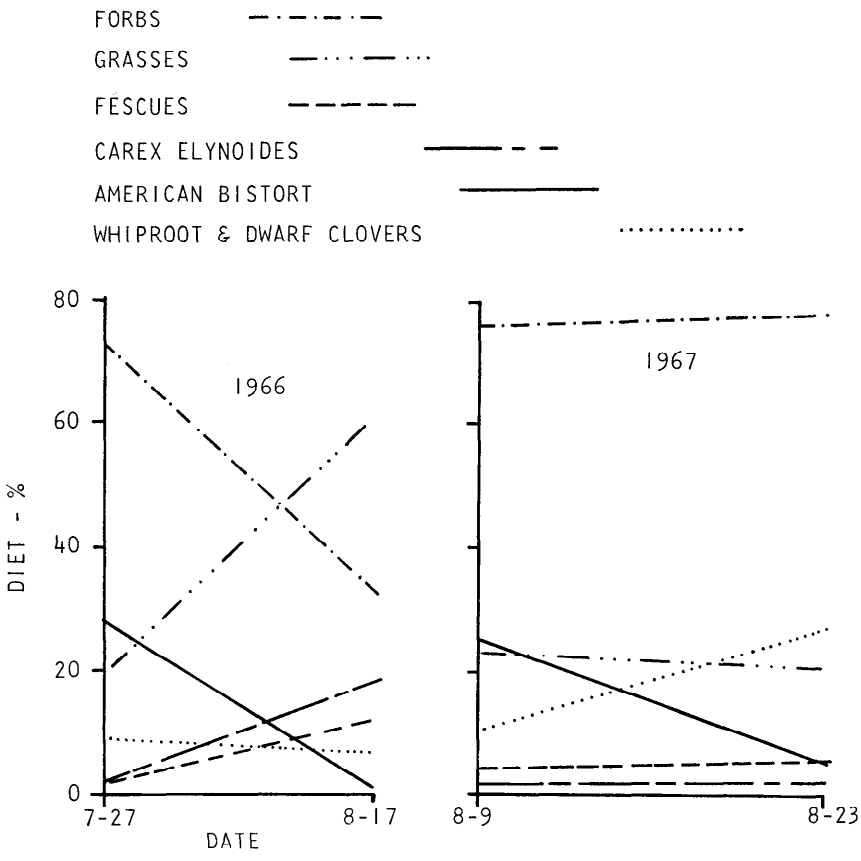

FIG. 3. Seasonal composition of the diet of herded sheep on Meeteetse Creek allotment.

Sheep Performance

There were no significant differences in the weight gains of lambs or ewes due to management of sheep (Table 5). Performance was not as good in 1966 as in 1967 for both groups. This was probably due to differences in forage production as influenced by environmental differences between the two years. The lamb gains in 1967 were good for lambs of this weight and age, but in 1966 the lamb gains were adequate but less than is usually expected on alpine range.

It is apparent that sheep can be managed successfully under fence on alpine range with no loss of performance. The sheep apparently ate a higher quality diet on the Meeteetse Creek Allotment (herded) as indicated by chemical composition and in vitro dry matter digestibility. However, these differences were not great enough to affect the performance of sheep. They could have overcome these differences by eating a greater quantity of forage on Carter Mountain (free). The differences in diet quality were probably more a reflection of differences in the allotments than of management practices.

Summary and Conclusions

A two year study on the dietary habits and behavior of sheep under the supervision of a herder (herded) or grazed under fence (free) on alpine summer range indicated that:

1. Lamb gains and ewe weights were similar in herded and free bands of sheep. Gains in 1967 were good and reflected the performance usually expected on alpine ranges.

2. Alpine range was high in dietary quality as indicated by in

Table 4. Chemical composition (%) of the diet of sheep grazing alpine range.[1]

	Carter Mountain (free grazing)		Meeteetse Creek (herded)	
	Mean	SE	Mean	SE
Ash	14.1	4.0	13.5	3.8
Nitrogen	1.9	0.6	2.3	0.6
Fiber	42.3	11.6	38.2	10.5
Cellulose	30.2	8.4	28.7	7.8
Lignin	11.9	2.1	11.0	3.3

[1]Data were averaged over all sampling periods in 1966 and 1967.

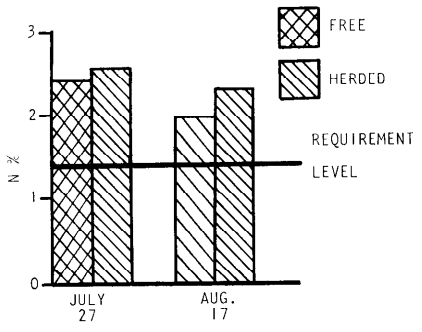

FIG. 4. Dietary nitrogen of herded and free sheep in 1966 on two alpine ranges.

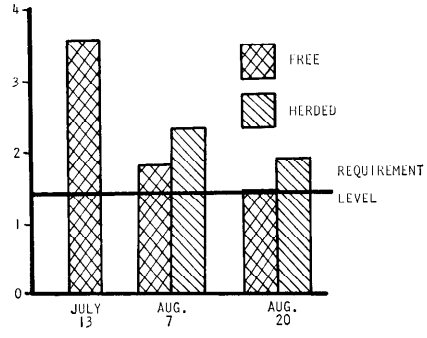

FIG. 5. Dietary nitrogen of herded and free sheep in 1967 on two alpine ranges.

vitro dry matter digestibility and nitrogen content.

3. A shift from forbs to grass occurred when forbs became less available due to utilization or disintegration, or less desirable due to maturity.

4. The sheep were more selective in their choice of grass and sedge species than for individual forb species. The proportion of forbs in the diet was related to the relative amount of these forbs which were available.

Table 5. Weights (kg) and gain (kg) of sheep grazing alpine range.

	Free grazing			Herded		
	1966	1967	Avg.	1966	1967	Avg.
Lambs						
Days	77	72	74.5	77	72	74.5
Initial wt.	30.9	30.7	30.8	35.9	35.9	35.9
Final wt.	37.2	44.8	41.0	42.9	48.8	45.9
Gain	6.3	14.1	10.2	7.0	12.9	10.0
ADG[1]	.08	.20	.14	.09	.18	.13
Ewes						
Initial wt.		61.6			66.9	
Final wt.		70.5			75.9	
Gain		8.9			9.0	
ADG[1]		.13			.12	

[1]Average daily gain.

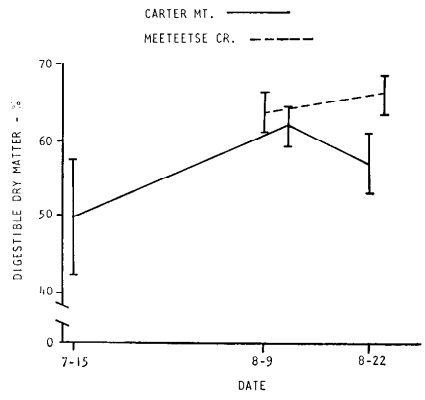

FIG. 6. Dietary in vitro dry matter digestibility of sheep. (The vertical lines are one standard deviation).

5. A two month period of grazing without a herder did not result in a large difference in the grazing habits of sheep.

6. Where feasible, sheep can be managed successfully without a herder on alpine ranges.

Literature Cited

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS. 1960. Official Methods of Analysis (9th Ed.). Washington, D. C.

BROWN, D. 1954. Method of surveying and measuring vegetation. Commonwealth Agr. Bur. Commonwealth Bur. Pastures Field Crops Bull. 42. 223 p.

CRAMPTON, E. W., AND L. A. MAYNARD. 1938. The relation of cellulose and lignin content to the nutritive value of animal feeds. J. Nutr. 15:383–395.

HEADY, H. F., AND D. T. TORELL. 1959. Forage preference exhibited by sheep with esophageal fistulas. J. Range Manage. 12:28–34.

JOHNSON, W. M. 1962. Vegetation of high-altitude ranges in Wyoming as related to use by game and domestic sheep. Wyo. Agr. Exp. Sta. Bull. 387. 31 p.

JONES, D. A., AND R. PADDOCK. 1966. You can't turn 'em loose . . . or can you? J. Range Manage. 19:96–98.

NATIONAL RESEARCH COUNCIL. 1964. Nutrient Requirements of Domestic Animals, No. 5 Nutrient Requirements of Sheep. Washington, D. C.

PAULSEN, H. A., JR. 1960. Plant cover and foliage use of alpine sheep

ranges in the central Rocky Mountains. Iowa State Coll. J. Sci. 34: 731–748.

TILLEY, J. M., AND R. A. TERRY. 1963. A two-stage technique for the *in vitro* digestion of forage crops. J. British Grassland Soc. 18:104–111.

VAN SOEST, P. J. 1963. Use of detergents in the analysis of fibrous feed. II. A rapid method for the determination of fiber and lignin. J. Ass. Offic. Agr. Chem. 46:829–835.

WASSER, C. H., AND J. L. RETZER. 1966. Ecology and utility of the central Rocky Mountain alpine zone. Proc. 9th Int. Grassland Congr., p. 357–361.