# Utilization of Winter Range Forage by Sheep[1]

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TO obtain basic information on the sheep's diet under winter range conditions, a study was conducted on a typical desert range in west-central Utah. The purpose was to determine which forage plants were eaten, factors which affect the selection, amount consumed daily, and factors which limit consumption. With this information, recommendations can be made that are in keeping with sound management practices.

The study area consisted of two sheep allotments in three broad valleys in a region of low parallel mountain ranges. The mountain chains average seven or eight miles in width, are often steep, and contain numerous coves and canyons which furnish winter grazing for sheep. The valley basins are from 10 to 15 miles in width, flat near their centers, and slope gently upward to the mountains (Fig. 1).

This region has an annual precipitation of 6 or 7 inches, occurring principally as spring rains and winter snows, with occasional summer showers. Sub-zero temperatures usually occur during the winter for extended periods. The summers have long periods of drought with maximum midday temperatures above 90°F.

Soils of the region are highly variable. Poor drainage, coupled with low precipitation result in concentrations of soil salts at some place in the soil profile. This appears near the surface on the valley bottoms but is found at somewhat greater depths on the foothill slopes.

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## REVIEW OF LITERATURE

A method designed to measure the forage consumption and diet of grazing sheep must consider the abundance and composition of the vegetation, habits of the animal, season of year or stage of plant growth, climatic conditions, and management practices (3–6).

Doran (6) found that the relative amount of time ewes spent grazing grasses, weeds, and browse was closely correlated with the relative abundance of each class of plant. Stapledon and Jones (15) and Cook, *et al.* (2) have shown sheep to be highly selective in their diet, preferring the more succulent leaves and twigs to the coarser stems.

Smuts and Marias (14) found that forage consumption increased or decreased almost proportionately to increased or decreased average daily weight of sheep. Stapledon and Jones (15) found that the quantity of herbage consumed by grazing sheep varied widely from day to day, believed to be caused by varying moisture content of the herbage, or possible varying botanical and chemical composition of the pasturage. Woodman, *et al.* (16) found that sheep consumed more pounds of dry matter when on green pasture than when subsisting out-of-doors on diets composed of hay, swedes, and concentrates.

Methods for determining forage con-

sumption have been used more in the field of pasture research than in range research. A common procedure used by pasture investigators (8, 9, 12, 15) consists of clipping the forage from a representative section of the area before grazing and from another representative section after grazing. The difference between the two figures represents the amount consumed. The disadvantages of this procedure have been reviewed by Garrigus and Rusk (11).

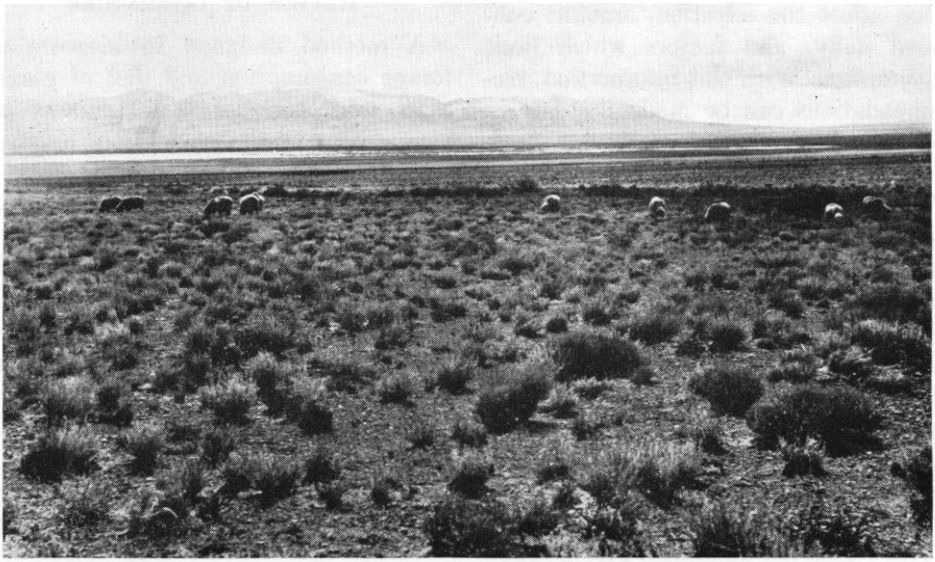

FIG. 1. Typical saltbush desert range in west-central Utah

Another approach to the problem of determining forage consumption is the dry matter ratio method (11). This procedure involves the collection of the feces voided each day by the grazing animal, and the determination of digestibility of the dry matter consumed in digestion stalls either with the same animals to be used in the grazing trials (11) or with similar animals (16). The forage consumption is then calculated using the percentage digestibility of the dry matter and the dry matter voided each day in the feces.

Gallup, *et al.* (10) emphasized that feed intake could be determined for animals on pasture if some "tracer" material could be found. Experiments by these investigators with silica as the tracer material proved unsatisfactory because of the inclusion of some soil in the diet. Forbes and Garrigus (8) have shown that the lignin-ratio technique could be used to determine feed intake of grazing animals. The lignin-ratio method is based on the assumption that lignin, a constituent of plant material, is not digested by the animal. Forage consumption is then determined from the percentage of lignin in the forage, the quantity of dry matter excreted, and the lignin in the dry matter excreted, as follows: pounds of dry matter consumed =

$$\frac{\text{pounds dry matter excreted} \times \text{percent lignin in dry matter excreted}}{\text{percent lignin in dry matter consumed.}}$$

## METHOD OF PROCEDURE

This study was conducted during the winter grazing seasons of 1946–47 and

1947–48 on typical saltbush range in the Great Basin area of Utah.

The diet of the grazing animals was determined by the "before and after" method used by Cook, *et al.* (3) which consisted of random sampling of all forage species before grazing and again after grazing. The difference in weight between the before-grazing sample and the after-grazing sample was a measure of the percentage utilization of each species.

Percent utilization and forage production for each species were used to calculate the composition of the diet. On each area grazed at approximately weekly intervals from three to six 900-foot transects were established for collecting plant material. Grazing periods within the season were arbitrarily separated on the basis of days spent in local grazing areas.

Samples were analyzed for lignin as outlined by Ellis, *et al.* (7). Then, by difference between before-grazing and after-grazing samples, lignin content of the diet was determined.

The forage consumption of wether lambs and yearlings was determined for each grazing period by the use of the lignin-ratio method (7). Forage consumption for older sheep was calculated by using the 0.73 power of the body weight as outlined by Brody (1).

Feces were collected in each period from wethers by means of specially constructed fecal bags attached to the animal. Collections were started four days after the beginning and continued until the close of each grazing period. The bags were emptied once daily. The feces were accumulated for the period and preserved in a mixture of 97 parts alcohol and 3 parts hydrochloric acid. At the close of the period, the accumulated feces of each animal were weighed, thoroughly mixed, and a 2 pound aliquot obtained for oven dry matter and lignin determination.

## Results and Discussion

The winter grazing season normally begins early in November, and sheep start to leave the winter range in early April, most herds having left the area by the last of April. Continuous sampling followed this same schedule as closely as possible.

Some browse plants, Utah juniper (*Juniperus utahensis*), pinon pine (*Pinus monophylla*), and other less important species, totaled 8.53 percent of the species composition but normally were not grazed. These plants were sampled only occasionally, or not at all. Sampled forage averaged 91.47 percent of the total plant composition and was calculated in all cases to represent more than 98 percent of the forage grazed.

During the 1946–47 grazing season data were obtained from a rather extensive area where two sheep herds grazed. During the second winter the study was conducted on only one sheep allotment and with one small band of experimental sheep.

### *Forage production, utilization, and composition of the diet*

Browse produced an average of 73 percent of the forage available to the sheep during the winter seasons, grasses produced 26 percent and a forb (Russian-thistle) one percent.

Average utilization was approximately the same for both grasses and browse (Table 1). During the first part of the grazing season browse species were utilized to a greater degree than grasses, but during succeeding months the use ratio was reversed. Browse was preferred during the early season because of the abundance of fruit and leaves remaining on these species. The leaves and fruit

were removed by grazing and shattering as the season progressed and the preference decreased accordingly.

In spite of the variation in degree of use for the forage classes among periods, the percent of the seasonal diet composed of grass and browse was almost directly proportional to the abundance of the respective forage classes. However, some individual species constituted a much greater percentage of the diet than their respective proportions of the forage production would suggest.

The species composing the diet varied markedly from time to time, as influenced by site, weather, abundance of species present, and intensity of use.

Shadscale was generally abundant on most areas and produced the largest quantity of available forage (Table 1). However, the degree of use was never heavy. The weighted utilization for the winter seasons ranged from 13 to 22 percent of the current year's growth. Because of its wide-spread distribution it constituted from 13 to 48 percent of

TABLE 1

*Average available forage, utilization, and composition of the diet for two winter grazing seasons 1946–48 by species and forage classes*

| SPECIES | AVAILABLE FORAGE | | UTILIZATION BY WEIGHT | | DIET BY WEIGHT | |
|---|---|---|---|---|---|---|
| | 1946–47 | 1947–48 | 1946–47 | 1947–48 | 1946–47 | 1947–48 |
| | *percent* | | *percent* | | *percent* | |
| *Artemisia nova* (black sage) | 4.7 | 2.7 | 43.5 | 43.2 | 11.4 | 5.0 |
| *Artemisia spinescens* (bud sage) | 0.3 | — | 52.7 | — | 0.9 | — |
| *Atriplex confertifolia* (shadscale) | 26.7 | 50.5 | 12.7 | 22.5 | 12.6 | 48.4 |
| *Chrysothamnus stenophyllus* (yellowbrush) | 16.6 | 5.0 | 20.5 | 38.5 | 11.3 | 8.2 |
| *Ephedra nevadensis* (jointfir) | 2.4 | 1.0 | 0.6 | 17.4 | 0.1 | 1.0 |
| *Eurotia lanata* (winterfat) | 27.7 | 2.0 | 36.2 | 17.0 | 44.8 | 1.3 |
| *Grayia spinosa* (hop-sage) | 0.2 | 0.1 | 47.1 | 0.2 | 0.4 | 0.1 |
| *Gutierrezia sarothrae* (snake weed) | 1.8 | 2.7 | 12.1 | 23.1 | 1.1 | 2.6 |
| *Lycium andersonii* (desert thorn) | 0.1 | — | 0.0 | — | — | — |
| *Tetradymia spinosa* (horsebrush) | 0.9 | — | 0.0 | — | — | — |
| Browse total | 81.4 | 64.0 | 24.4* | 24.3* | 82.6 | 66.6 |
| *Agropyron spicatum* (bunch wheatgrass) | 3.5 | — | 26.6 | — | 3.7 | — |
| *Aristida longiseta* (three-awn) | 0.1 | 1.3 | 5.6 | 27.4 | 0.1 | 1.5 |
| *Bouteloua gracilis* (blue grama) | 0.2 | 5.1 | 0.0 | 37.6 | 0.0 | 8.2 |
| *Bromus tectorum* (downy brome) | — | 0.3 | — | 16.0 | — | 0.2 |
| *Hilaria jamesii* (galleta) | 3.2 | 8.2 | 23.8 | 14.6 | 2.5 | 5.2 |
| *Oryzopsis hymenoides* (Indian ricegrass) | 7.4 | 4.6 | 41.6 | 31.7 | 9.8 | 6.3 |
| *Sitanion hystrix* (squirreltail) | 0.2 | — | 54.6 | — | 0.3 | — |
| *Sporobolus cryptandrus* (sand dropseed) | 4.0 | 13.8 | 5.9 | 17.6 | 1.0 | 10.4 |
| *Stipa comata* (needle & thread) | — | 0.8 | — | 38.9 | — | 1.3 |
| *Triodia pilosa* (hairy triodia) | — | 0.3 | — | 25.2 | — | 0.2 |
| Grass total | 18.6 | 34.4 | 26.1* | 22.7* | 17.4 | 33.3 |
| *Salsola kali*, var. *tenuifolia* (Russian-thistle) | — | 1.6 | — | 1.9 | — | 0.1 |
| GRAND TOTAL | 100.0 | 100.0 | 24.7* | 23.4* | 100.0 | 100.0 |

* Weighted average.

the seasonal diet. Use was heaviest during the fore-part of the winter before seeds and leaves had shattered appreciably. Later use was lighter except while other species were covered by snow. In the spring, even the new succulent shoots were but lightly utilized.

Black sage was available only in the foothills and seldom dominated extensive areas. However, it was available to sheep in small quantities most of the season. Its sparseness prevented it from becoming important in the diet, but it was closely used on all areas where it was present. The utilization was occasionally as high as 65 percent of the current year's growth. This removed most growth that was readily accessible.

Winterfat produced a large quantity of forage on many sections of the winter range, but either because of past overuse or unfavorable growing conditions, it did not produce more than 7 percent of the total available forage on any of the lower foothill areas. Some were entirely lacking in this species. However, in some of the valley basins pure stands were found. These areas were generally grazed when light snows occurred or when sheep wanted to move out of the foothills. Winterfat was readily eaten everywhere it occurred. Where it was dominant, the use was often as high as 60 percent, compared to only 15 to 20 percent utilization in mixed stands where it made up less than 10 percent of the vegetation composition.

Bud sage was not abundant probably because of its high palatability and resulting overuse in past years. Sheep frequently grazed 70 percent of this species during the first grazing contact. This represented all that they could readily take, and only stumps of shoots and a limited amount of leafy material protected by coarse wood remained.

Yellowbrush was present on most of the grazing allotments and occasionally represented as much as one-third of the available forage. The use of yellowbrush appeared to be determined by site. When it occurred on the alluvial slopes, use was light and often negligible, and where the species was grazed it appeared to be the same plants that had been grazed year after year. When the species occurred in the rocky foothills, use was usually heavy, often destructively so.

Snakeweed was found on most areas but seldom exceeded 3 percent of the total herbage production. Only on local areas where past overuse was evident did this species become abundant. Snakeweed was lightly used throughout most of the season, and contributed less than 3 percent to the average seasonal diet.

Jointfir was not abundant on most of the range and received light use in most areas. However, during periods of heavy snow this plant was used rather heavily and constituted appreciable amounts of the diet for brief intervals.

Hop-sage was not widely distributed over the range and did not become important in the diet except during the early spring when new growth was eaten.

Blue grama, a low growing grass, was unavailable to grazing a large portion of the winter because of snow, but in the relatively snow-free periods it occasionally produced as much as 10 percent of the total available forage and made up a substantial portion of the diet. During years of poor forage production this species produces only limited available forage because of low growth.

Sand dropseed was present in various quantities. Around old bed grounds and along sheep trails it was abundant but was only moderately utilized. When other species were plentiful this species was used lightly or not at all.

Galleta grass, similar to blue grama in growth form but slightly taller, produced

from 3 to 8 percent of the total available feed. Forage produced by this species is somewhat coarse and only moderately palatable to sheep, yet, it is a plant that withstands drought and abuse well.

Indian ricegrass was distributed sparsely over most of the grazing allotments and occasionally produced as much as 25 percent of the total forage. This species is one of the most palatable grasses throughout the winter grazing season and produces early spring growth which is highly preferred and generally grazed heavily before animals leave the winter range.

Squirreltail was green most of the winter and was closely used, but only a small quantity was available, so it was not an important species in the diet. Most plants were found under the protection of shrubs and not available to the grazing sheep.

Three-awn grass produced a coarse, wiry forage that was not particularly palatable. This species never made up more than 2 percent of the diet. It was abundant only around old bed grounds and sheep drive ways or where the range showed past abuse.

Needle-and-thread grass was not abundant, but its green growth within the old leaf sheath made it rather palatable to sheep and locally it constituted appreciable quantities of the diet.

Bunch wheatgrass occupied only local areas in the foothill-cedar types, therefore, representing a rather small percentage of the total available forage. This species was moderately used and represented about 4 percent of the diet during the 1946–47 winter grazing season.

Downy bromegrass was not present on most areas but occurred locally on old bed grounds and overused ranges where the soils did not contain a high content of salts. Even though it is a winter annual, growth was not available until spring. Only slight use was made of mature plants remaining from the previous year.

Hairy triodia was present only sparsely on small areas in the rocky foothills. The foliage was green most of the winter, however, the extremely low growth was not readily accessible to the animals and did not contribute any appreciable quantity to the diet.

Overused ranges generally showed a greater quantity of snakeweed, yellowbrush, three-awn grass, sand dropseed and downy bromegrass compared to ranges in good condition.

TABLE 2

*Average amount of forage consumed daily in each period by lambs averaging 85 pounds in weight compared to amount of forage available per acre.*

| PERIOD | DATE | DRY MATTER PRODUCED PER ACRE | DRY MATTER CONSUMED DAILY PER HEAD |
|---|---|---|---|
| | | *pounds* | *pounds* |
| 1 | Nov. 26 to Dec. 18 | 641.9 | 2.04 |
| 2 | Dec. 18 to Jan. 13 | 250.5 | 3.21 |
| 3 | Jan. 13 to Feb. 3 | 383.5 | 3.04 |
| 4 | Feb. 3 to March 10 | 278.1 | 3.71 |
| 5 | March 10 to April 4 | 260.2 | 2.99 |

All species that were being used to a degree greater than 40 to 50 percent were scarce and in a weakened state of production. This suggests that even though winter range plants may be in a dormant state, they cannot thrive under a management system that allows more than half their annual forage production to be removed by grazing.

### *Daily forage consumption*

On ranges that produce forage of low quality, the amount of feed consumed daily often determines whether or not a nutritional deficiency occurs in the diet of the grazing animal.

The daily forage consumption of the

eight wether lambs and yearlings, from which feces collections were taken provided the means of evaluating forage consumption. This phase of the study was carried on only during the grazing season of 1947–48.

The least amount of forage consumed per day (Table 2) was at the beginning of winter grazing season (period 1). This was thought to result from the handling of the animals and from a decrease in grazing time on the range. In addition considerably. The variation could be accounted for by cold weather, heavy snows, and grazing time on the range. However, the daily average voided for each period was rather uniform. From this study it seemed that amount of forage produced per acre was not a factor determining the daily consumption by grazing sheep. More important appeared to be the time actually spent grazing, which was directly influenced by the time the sheep were out on the

TABLE 3

*Forage consumption by lambs and yearling wethers and calculated forage consumption of an average sheep in each age class of an average range herd when using collection yearlings as the basis, compared to the recommended allowance of the National Research Council for pregnant ewes*

| SHEEP AGE CLASS | AVERAGE WEIGHT | AVERAGE FEED CONSUMED DAILY | | | RECOMMENDED ALLOWANCE OF NATIONAL RESEARCH COUNCIL* |
|---|---|---|---|---|---|
| | | Periods | | | |
| | | Feb. 3–Mar. 10 | Mar. 11–Apr. 4 | Avg. | |
| | *pounds* | *pounds* | | | *pounds* |
| Collection lambs | 85 | 3.71† | 2.99† | 3.35† | 3.00 |
| Collection yearlings | 117 | 3.39† | 2.78† | 3.09† | 3.20 |
| Lambs | 79 | 2.65 | 2.14 | 2.40 | 2.79 |
| Yearlings | 117 | 3.47 | 2.83 | 3.15 | 3.20 |
| 3 yr | 137 | 3.88 | 3.13 | 3.51 | 3.61 |
| 4 yr | 137 | 3.88 | 3.13 | 3.51 | 3.61 |
| 5 to 6 yr | 133 | 3.79 | 3.05 | 3.42 | 3.50 |
| Over 6 yr | 129 | 3.69 | 2.99 | 3.34 | 3.39 |
| Average | 122 | 3.56 | 2.88 | 3.22 | 3.35 |

* Oven dry basis.

† Determined by the lignin ratio method.

the range was dry and the sheep were watered infrequently. After the sheep became accustomed to being handled and carrying the fecal bags, experimental procedure had little effect upon forage consumption.

Consumption increased after period one until the last period when there was a slight decrease. During this period some spring growth appeared and sheep spent much of the time traveling in search of green forage.

Daily quantities of feces voided varied range and indirectly by climatic conditions and the character of the forage. This, of course, is assuming that at no time was the range overgrazed and that adequate forage was available except when covered by snow.

*Forage consumption by age classes*

The average daily forage consumption of lambs and yearlings, as compared with the recommended allowances of the National Research Council (13) is shown in Table 3. Average daily forage con-

sumption of the lambs used for collection was 3.35 pounds compared to 3.09 pounds for the yearlings. The yearlings weighed an average of 32 pounds more than the lambs, yet the daily forage intake was 0.26 pounds less. The recommended allowance for an 85-pound lamb is 3.00 pounds of moisture-free forage daily which is 0.35 pounds less than was actually determined (Table 3). The recommended allowance for a 117-pound yearling is 3.20 pounds of forage daily or 0.11 pounds more than was actually calculated in the present study. Since the National Research Council has allowed for a margin of safety, it appears that the data collected from yearling wethers are in close agreement with the recommended forage allowance. However, it appears that the recommended allowance for lambs is too low, especially under range conditions, since these sheep consumed more than the recommended allowance and left the winter range with only a slight gain.

Brody (1) has proposed that the 0.73 power of the body weight could be used to calculate the feed consumption of different age groups of maintenance sheep. Using wether yearlings as the basis, calculations have been made in Table 3 for other age classes of sheep in an average range herd. There is close agreement between the National Research Council allowances and the calculated forage consumption.

From these data it appears that yearling wethers can be used to obtain forage consumption of all age classes of sheep except lambs.

## Summary

A study was conducted on typical saltbush desert range in westcentral Utah during the years 1946 to 1948 to determine the quantity of forage available to sheep during the winter grazing season, the composition of the diet, and the daily forage consumption.

The forage was sampled by the "before and after" method which consisted of random sampling of all forage species before grazing and again after grazing. The difference in weight between the before-grazing sample and the after-grazing sample was a measure of the percentage utilization of each species.

Average total production was composed of 73 percent browse, 26 percent grass, and 1 percent forbs.

Average utilization for browse and grass was about the same, approximately 24 percent for each forage class. During the first part of the grazing season browse species received heavier use than grasses, but with advancement of season the utilization of grasses increased and utilization of browse decreased.

The percent of the seasonal diet composed of grass and browse was almost proportional to the abundance of each forage class on the range. This was not true, however, for individual species. Percent utilization for certain species varied widely and was dependent upon plant association, weather conditions, and general character of the individual plants.

Overused ranges generally had a greater quantity of snakeweed, yellowbrush, three-awn grass, sand dropseed, and downy bromegrass compared to ranges judged to be in good condition.

The average daily forage consumption of sheep was determined by the lignin-ratio method. Eight wether lambs and yearlings were equipped with fecal bags to facilitate collection of fecal matter voided daily. The quantity of forage produced per acre was not an important factor determining the daily consumption by grazing sheep. Forage consumption was influenced by the time actually spent grazing which was directly influenced by the time the sheep were out on the range

and indirectly by climatic conditions and character of the forage.

Average daily forage consumption of wether lambs weighing 85 pounds was 3.35 pounds compared to 3.09 pounds for yearlings weighing 117 pounds. The yearlings weighed an average of 32 pounds more than the lambs, yet, the daily forage intake was 0.26 pounds less. The data collected from yearling wethers is in close agreement with the recommended allowances of the National Research Council; however, it appears that the recommended allowance for lambs is too low for range conditions since all experimental lambs consumed more than the recommended allowance and left the winter range with only slight gains.

If lambs are used as a basis for calculating forage consumption for older animals by the 0.73 power function of the body weight, dry matter intake is too high but yearlings give figures that are in close agreement with the recommended allowances of the National Research Council.

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