

The Quandary of Utilization and Preference

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THE terms "range use" and "range utilization" have been variously applied. Generally, "range use" implies past as well as current treatment including intensity of grazing, kind of livestock, season grazed, distribution of livestock, or any combination of these. Range administrators and range operators use a multitude of indexes to judge range use including extent of soil erosion, trampling, vigor of the important forage plants, abundance of the undesirable species, accumulation of litter or aftermath remaining after grazing ceases, and utilization of current season's growth. Range use frequently is placed in a general classification such as heavy, moderate, or light, and condition of the range is a result of this use.

The term "utilization" or better, "percent utilization," rightly refers to the amount of total herbage production which has been removed currently. Utilization has been defined by the Society of American Foresters (1944) as the degree to which animals have removed the current growth of herbage. This may be expressed in percentage of height of stems, number of stems, or total weight.

Many methods have been proposed for measuring the percent of utilization of range plants; however, the accuracy and interpretation of the measurements obtained have varied widely (Stoddart and Smith, 1943; Heady, 1949). As a result, the concept of utilization and the method of calculating percent utilization are not well understood and remain controversial subjects.

Adequacy of standard utilization measurement methods depends upon what

information is desired and what application is to be made of the data.

The percent utilization sometimes is based upon correct utilization, but more often is based upon percent of current year's growth ungrazed, and commonly is calculated from stubble height, twig length, or amount of forage left on the ground. The percent utilization determined by these methods generally is an expression of an average from many plants. Utilization sometimes is determined by less detailed analyses such as a single direct estimate from the entire grazing complex including both plant and animal appearance.

Utilization may also have a more restricted meaning or interpretation; the utilization concept may be based primarily upon the welfare of a specific plant. The plant must have sufficient photosynthetic tissue to support the physiological requirements of the plant, to provide for optimum root development and to furnish an adequate supply of nutrients to carry the plant over periods of stress. As a means of appraising forage utilization, it is helpful to have some knowledge of the tolerance various plant species have for forage removal under usual conditions. However, there is no exact degree of tolerance for a specific percentage of herbage removal that can be attached to a species with significance as "proper utilization" unless the application is confined to specific areas of remarkable similarity. Proper utilization for any particular species of forage plant must be defined according to plant association, site condition, and whether the plant is grazed

during the growing period, after maturity, or both.

Some authors (Campbell, 1937; Stoddart and Smith, 1943; Heady, 1949) have emphasized the importance of measuring utilization on the basis that sustained forage production is dependent upon the degree of utilization. Thus, it would appear that an accurate index to proper utilization would be basic to managing ranges. However, if management is based upon the ecological principles considered in range condition and range trend analyses, it is not necessary for the rancher or land administrator to make precise determinations of percent utilization for individual forage species. Even though past forage utilization is responsible for the condition of the range, general observations appraising utilization and vigor of plants are sufficient basis upon which to adjust for improvement. However, it should be pointed out that accurate measurement of percentage of forage removal by grazing is of great importance to the research worker and must be properly interpreted in evaluating both plant and animal responses.

Methods calculating weight removed by grazing from stubble height of grasses are known as the volume-height or height-weight methods. They assume that there is a relationship for each species between percent of height removed and percent of weight removed as the plant is grazed. Conversion tables have been constructed whereby stubble height is converted to percent of plant weight removed (Campbell, 1938; Crafts, 1938; Lommasson, 1938). The degree of utilization of browse likewise has been determined by calculating the percent of current year's growth that has been removed based on length of grazed and ungrazed twigs (Nelson, 1930; Hormay, 1943).

Almost all methods of measuring plant

utilization are based upon length or weight of the grazed compared to the ungrazed plant stem. The accuracy of these methods depends upon whether utilization is measured soon enough after grazing that no regrowth takes place. Error in measurement also may result from assuming that growth rate is the same on the ungrazed stem as on the stem being grazed intermittently.

DETERMINING UTILIZATION OF CRESTED WHEATGRASS

During the spring of 1947 almost 4,000 crested wheatgrass (*Agropyron cristatum*) seedlings were moved to a field near Logan, Utah where they were space-planted 36 inches apart each way. One and one-half years later the plants were clipped in the fall to remove all old growth and thereafter allocated to various clipping treatments during the spring and early summer of each subsequent year.

Four of the treatments are herein discussed to show the forage production at several dates during 1949 and the total weight removed by the end of the grazing season. Each treatment included 20 plants randomly located in two blocks and those shown here involve plants clipped four times each year to a 3-inch stubble height. As shown in Table 1, plants under treatment 1 produced an average of 4,266 grams of forage compared to a check group of plants of the same size and age which produced 6,499 grams. At the end of the grazing season (June or July depending upon the treatment) the percent of total herbage production removed varied with each treatment and was dependent upon what was used as a measure of total production. Total production or "100 percent" herbage yield might be calculated from (a) total yield of check plants unclipped in the "grazing season" but harvested in the fall after growth has ceased or (b)

total yield from the specific treatment, including yield at each of four "grazing" periods plus herbage remaining in the fall after growth has ceased.

If the amount removed (percent utilization) is calculated as percentage of total yield for treatment 1, 81.7 percent was utilized during the spring. However, if percent removed is based on production

of times as in treatment 1 and at equal intervals, the removal on July 1 was 73.8 percent of its own total herbage production for the year but only 60.7 percent of the total herbage production of protected plants (Table 1, treatment 2).

If degree of use were measured as customary at the end of the grazing season (June 15 or July 1) by the height-

TABLE 1

Dry matter harvested and percent removed (utilization) when based upon total yield for each treatment and also when based upon total yield of unclipped plants

Plants were harvested at 3-inch stubble height. Data are average yield for the year 1949 only.

	CLIPPING DATE								TOTAL
	4-15	5-1	5-15	5-22	6-1	6-15	7-1	10-1	
<i>Treatment 1</i>									
Dry matter yield (grams)	313			2289			883	781	4266
Percent of total yield, accumulative	7.3			61.0			81.7	100	
Percent of unclipped plants	4.8			40.0			53.6	65.6	
<i>Treatment 2</i>									
Dry matter yield (grams)		1390			2137		423	1403	5353
Percent of total yield, accumulative		26.0			65.9		73.8	100	
Percent of unclipped plants		21.4			54.2		60.7	82.3	
<i>Treatment 3</i>									
Dry matter yield (grams)	295		1635			612		1969	4511
Percent of total yield, accumulative	6.5		43.2			56.7		100	
Percent of unclipped plants	4.0		29.1			38.5		68.8	
<i>Treatment 4</i>									
Dry matter yield (grams)		1186		1109		200		1958	4453
Percent of total yield, accumulative		26.6		51.5		56.0		100	
Percent of unclipped plants		18.2		35.3		38.4		68.5	
<i>Unclipped check</i>									
Dry matter yield (grams)								6499	6499
Percent of total yield, accumulative								100	
Percent of unclipped plants								100	

of comparable fall-clipped plants, the degree of utilization was only 53.6 percent. These figures are considerably different yet both are an expression of forage removal. Although 81.7 percent is the actual utilization, ordinary utilization determining methods, which use the ungrazed plant as a standard, would indicate 53.6 percent as correct.

When harvesting was delayed two weeks longer than in treatment 1, but the plants were clipped the same number

weight method, the utilization would be identical for all treatments since all were harvested at 3-inch height at this time. However, in reality utilization varied widely between treatments according to season of and interval between harvesting, and also it depended upon whether it was based on the yield or the unclipped check plants or on its own total herbage production.

Plants from treatment 1 in Table 1 were clipped at 3-inch height on April 15,

again on May 22 and again on July 1. Comparable unclipped plants had heights averaging 8 inches, 19 inches and 40 inches on these dates. Using height-weight charts for crested whcatgrass, utilization at these three dates when the plants were cut at 3-inches was 30, 57 and 75 percent, respectively. Utilization checks on July 1 would show only 75 percent utilization regardless of whether the plant had been "grazed" on April 15 and May 22.

Calculated percent of utilization, by common methods which use the unclipped plant as a standard, usually give considerably lower figures than those calculated from actual yield. This results from reducing total production by intermittent forage removal during the grazing season. Only rarely does frequent harvesting give higher herbage yield than a single harvesting at the end of the growing season.

Thus many utilization studies must be interpreted in light of the existing conditions so that the results do not bias the application. Grazed plots often are compared to ungrazed or protected plots to determine percent utilized and pounds of forage or nutrients consumed. Under favorable conditions such as on irrigated pastures, grazed plants may produce more than protected plants, whereas, under arid range conditions the grazed plants ordinarily produce less than the ungrazed plants. This is an inherent error in the method and must be minimized before the results can be used with a high degree of reliability.

UTILIZATION AS AFFECTED BY PREFERENCE FOR CERTAIN PARTS OF PLANT

An animal's preference for one part of a plant over another part is an important consideration in the physiological re-

sponses of plants to a given grazing utilization and in the interpretation of correct grazing use.

During the summer grazing season of 1946, intensive sampling was done on a mountain range in northern Utah by the "before-and-after" utilization method in order to determine intensity of range use and species composition of the foraging sheep's diet (Cook, *et al*, 1948). It was found that animals always preferred leaves over stems and this preference for leaves increased as the season advanced.

The relative production of stems and leaves and the degree of utilization made on each for a few of the more important forage plants on summer ranges of northern Utah are shown in Table 2. Utilization of leaves of grasses and forbs averaged 29 and 70 percent, respectively; however, utilization of the entire plant was only 17 percent for grasses and 26 percent for forbs. In the case of browse, the degree of utilization of leaves more closely approached the calculated utilization of the entire plant. This was because leaves of browse produced the major portion of the current-year's forage production of the plant and were used three times heavier than stems.

In some species, especially forbs, only about 25 percent of the entire plant was utilized when 70 to 80 percent of the foliage was removed. Since the photosynthetic tissue in most forage plants is almost entirely in the leaves it would appear more correct to base utilization on the percent removal of leaves rather than percent of the total plant consumed. This would be especially important if utilization were being determined for plants whose stems produce a substantial quantity of the weight of the entire plant but make a small contribution to photosynthetic activity.

TABLE 2

Percent production and utilization by sheep of the various parts of plants for a few important summer range species*

SPECIES	PERCENT OF TOTAL PRODUCTION			PERCENT UTILIZATION			
	Stems	Leaves	Heads	Stems	Leaves	Heads	Total
<i>Agropyron subsecundum</i> (Bearded wheatgrass)	63	19	18	20	39	25	25
<i>Elymus glaucus</i> (Wild ryegrass)	75	19	6	6	20	20	9
Average grass	69	19	12	13	29	22	17
<i>Agastache urticifolia</i> (Nettleleaf horsemint)	57	33	10	6	60	36	26
<i>Senecio serra</i> (Sawtooth butterweed)	55	42	3	1	70	54	31
<i>Valeriana occidentalis</i> (Western valeriana)	80	17	3	10	80	2	22
Average forbs	64	31	5	6	70	31	26
<i>Amelanchier alnifolia</i> (Serviceberry)	20	80	—	26	62	—	55
<i>Symphoricarpos vaccinioides</i> (Snowberry)	24	76	—	7	29	—	24
Average browse	22	78	—	16	45	—	39

* Data based upon current year's growth only.

UTILIZATION AND PREFERENCE

Percent utilization under most conditions is considered an index to preference or palatability of a plant and hence comparative utilization expresses the avidity or relish an animal shows for one plant over another. Composition of the diet sometimes is incorrectly used as a measure of animal preferences instead of percent utilization, in which case the results are markedly different.

As an example, Table 3 shows the available forage, percent utilization, and foraging sheep's diet for a sagebrush winter range in central Utah. Preference rating based upon percent utilization was as follows: black sage first, Indian ricegrass second, and big sagebrush almost the lowest. However, if the preference ratings are based upon percent of each species in the diet, big sagebrush was the highest and black sage and Indian ricegrass were comparatively low.

Thus, the palatability rating of these plants differs greatly when based upon percentage utilized as compared to that based upon the actual diet of the animal. In either case, preference displayed by any animal will vary with plant association, type of growth, weather conditions, intensity of grazing, and general activity and whims of the animal.

For practical purposes, palatability or preference should be placed in four categories: good, fair, poor and worthless, rather than trying to attach an exact figure. Such a classification correctly would need to be arrived at by observing relative percent of utilization under normal range conditions where there are nearly equal quantities of all species being evaluated. However, such appraisals should not lose sight of the fact that many plants of low palatability frequently make up large quantities of the grazing animal's diet when abundant

in the floral composition. This does not necessarily occur only when other more palatable species are scarce or are all closely grazed but results merely from the greater frequency with which the more abundant species comes before the animal in the normal process of grazing. However, some species are avoided almost entirely and are said to be unpalatable. Only occasionally do animals actually seek a preferred species; rather they merely spend greater time foraging upon, and hence graze closer, the preferred plant upon which they chance to come.

TABLE 3

Percent available forage, degree of utilization, and composition in the foraging sheep's diet on sagebrush winter range in central Utah

SPECIES	PER-CENT AVAILABLE FORAGE	PER-CENT UTILIZED	PER-CENT IN DIET
<i>Agropyron spicatum</i> (Bunch wheatgrass)	2	20	2
<i>Hilaria jamesii</i> (Galleta grass)	4	50	12
<i>Oryzopsis hymenoides</i> (Indian ricegrass)	3	60	10
<i>Artemisia nova</i> (Black sage)	3	65	11
<i>Artemisia tridentata</i> (Big sagebrush)	66	12	45
<i>Chrysothamnus stenophyllus</i> (Yellow brush)	17	20	19
<i>Gutierrezia sarothrae</i> (Snake weed)	5	3	1

When forage plants are evaluated on a given range on the basis of economic importance to grazing animals both quantity present and percent utilization need to be considered. In ordinary range survey procedures such a determination is made in calculating the forage-acre-factor. The "forage factor" for each species is derived from the product of the percent utilization times the quantity

present on the range. Thus palatability does not include the abundance or scarcity of a species on the range and does not properly evaluate the economic importance of a plant unless considered with floral composition or abundance.

SUMMARY

Measurement and interpretation of utilization and preference of range plants are not well understood and have been controversial issues for many years.

The term "range use" refers to a general evaluation of interactions of both plant and animal complexes and, therefore, its measurement requires personal judgment of many variable criteria. However, the term "percent utilization" is restricted in meaning to the quantity of current herbage production actually removed in grazing.

In the present study production figures for crested wheatgrass clipped at various intervals during the spring and summer showed that percent utilization, when calculated on the basis of total yield from plants clipped only in the fall, was considerably lower than percent utilization based upon the total herbage production from plants clipped periodically during the spring grazing season. This was the result of reduced production caused by forage removal during the growing season.

In some cases it appears appropriate to base utilization upon the leaves rather than upon the entire plant since in some species, only 25 percent of the entire plant is utilized when as much as 75 percent of the photosynthetic tissue has been removed.

It was concluded that utilization measurements in plant response studies should consider (a) the portions of the plant being utilized, and (b) whether or not the plants were grazed during the growing season, after maturity, or both. In addi-

tion such measurements should be interpreted in light of the many variables involved so that results do not bias the application.

The preference or palatability of various species is correctly determined from the relative percent utilization when there are nearly equal quantities present on the range. Preference will vary widely according to local conditions and, for practical application, could be placed in as few as four categories such as good, fair, poor and worthless. Composition of the diet is not an accurate index to palatability because relative abundance of species as well as percent utilization determines the amount of each plant consumed.

This study emphasizes the need for more exact methodology and terminology when dealing with many range management techniques.

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