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Ex Officio
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Range Forage Production in Relation to
Time and Frequency of Harvesting*

By Robert Lang and O. K. Barnes†

INTRODUCTION

A great many studies have been conducted in determining the effect of frequent clipping on the yield and well-being of various pasture and range grasses. However, most of these studies have been conducted at a great distance from the plains of eastern Wyoming and have consequently been made under different climatic conditions and, in general, with different species than those common to eastern Wyoming.

The clipping studies as reported herein were not intended to be carried out in such a manner as to simulate any particular degree or intensity of grazing. However, if they were to be compared to grazing they would only compare with the most extremely heavy grazing that it would be possible to imagine.

The object of this bulletin is to show how some of the common native grasses in southeastern Wyoming vary in their ability to produce under frequent clipping and to point out some possible grazing practices which may take advantage of the facts as brought out by these clipping studies.

The portion of this study dealing with the short grasses has been carried on for two years and the portion dealing with the mid-grasses for only one year. Thus it may be seen that it is preliminary. However, the results for the two-year period of study were so strikingly similar, and both the two-year work and the one-year work gave such highly significant differences when analyzed statistically that, although this work is not conclusive, it might be expected that similar results would be obtained if the same experiment were conducted over a longer period of years with observations as to more direct application of these results to grazing management.

*This study was in cooperation with the Research Division of the Soil Conservation Service, the Office of Dry Land Agriculture of the Bureau of Plant Industry, and the State Farms Department of the University of Wyoming.

†Assistant Professor of Agronomy of the University of Wyoming, and Assistant Agronomist of the Soil Conservation Service respectively.
REVIEW OF LITERATURE

A great many clipping experiments similar to the one herein reported have been carried out by various investigators in the United States. These experiments have been conducted with various grass species but there were notably few which were carried out with blue grama or buffalo grass, which are the dominant species in the great plains area.

The following review of literature gives the response to clipping by a number of relatively common grass species in various parts of the United States.

In discussing the value of the clipped quadrat method of study, Culley et al.,* state that clipping treatment

"fails to simulate grazing by livestock exactly, but in spite of the differences, many of which may be overcome, clipped quadrats when carefully selected and conducted, can be of immense value to actual grazing studies. Results can be obtained at rather low costs to show the comparative maintenance, yield and quality of forage species under known varying intensities of harvesting, with the effects of given amounts and character of rainfall upon production. The method already has aided greatly in the determination of correct utilization of range and pasture forage, ***

Sampson and Malmsten working in the Wasatch mountains of Utah found that clipping mountain brome (Bromus polyanthus) five times during the growing season at one inch above the ground resulted in killing all of the plants during the first year. Other plots of mountain brome and plots of violet wheatgrass (Agropyron violaceum) which were harvested four, two, and one times per season at one inch above the ground over a three-year period gave results as summarized in the table at the top of page 5.

In the above summarized experiment those plots which were harvested four times during the season were first clipped one month after the beginning of growth and then clipped at monthly intervals. The plots which were harvested twice each season were first clipped at seed maturity and then again at the end of the

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*Small figures refer to list of literature cited at the end of the bulletin.
growing season. The plots which were harvested only once each season were clipped at seed maturity.

The time of harvesting undoubtedly exerted considerable influence on the results obtained.

Canfield conducted an experiment in New Mexico which was designed to determine the effect of intensity and frequency of clipping on the density and yield of black grama (*Bouteloua eriopoda*) and tobosa grass (*Hilaria mutica*). One series of black grama plots was harvested at one inch above the ground and the second series was harvested at two inches above the ground. Within each series plots were harvested at intervals of two weeks, four weeks, six weeks, and end of season.

A similar plan was used with tobosa except that the plants were harvested at two inches and four inches above the ground instead of one inch and two inches as was the case with black grama.

In summarizing this experiment, Canfield states that:

“Clipping experiments on semidesert black grama range indicate clearly that persistent cropping of all herbage of this grass to a 2-inch height or less eventually results in destructive reduction of tuft area regardless of frequency of seasonal harvesting; it reduces forage yield to zero; it prevents survival and even estab-
lishment of reproduction of the forage grass; it entirely outweighs all beneficial effects of above-average rainfall; and the end result is rapid and critical deterioration of the black grama site through excessive wind and water erosion.

“Black grama quadrats clipped periodically during the growing season to a height of 1 inch made substantial gains in tuft areas the first year, one of unusually favorable growth, but these gains were short-lived. Losses in the second and third season more than consumed these increases and continued to the end of the experiment. Similarly, quadrats periodically clipped to 2 inches made early gains that were wiped out by subsequent losses. The 1-inch end-of-season quadrat lost from the beginning of the experiment. The similarly clipped 2-inch quadrat maintained a total tuft area above that of the beginning only into the seventh year.

“There were several fluctuations in the tuft areas of the quadrats during the 11 years covered by the experiment, but the general dominant trend prevailed to such a degree that by the end of the 1935 growing season not one quadrat of either the 1-inch or the 2-inch black grama series retained as much as 4 per cent of the original tuft area. This condition was due in part to clipping and part to the loss of sand mulch about the base of the plants. The harvesting of all grass stems permitted the sand mulch that is so essential to the well-being of black grama plants to be swept away by the winter and spring winds.

“It may be concluded that the persistent grazing by cattle, during or even at the end of the grazing season, of all stems of black grama, in pure stands on semidesert sandy ranges, down to 2 inches or less will practically destroy the black grama stand in a period of 10 years; it can be expected to reduce the forage yield by one-half in 3 or 4 years.

“The clipping experiment with tobosa grass, conducted as it was to 2- and 4-inch heights, and on a grass the forage value of which practically vanishes with maturity, produced somewhat different results. These indicate that clipping first induces an expansion of tuft area, but the rate and extent of expansion are dependent on clipping frequency and the permanency of increases
in tuft area is governed by its closeness. Cropping all herbage to 2 inches represents greater untilization than tobosa grass can withstand, but clipping to 4 inches encourages growth of tuft area, maintains a high yield of valuable forage, and stimulates vegetative reproduction. Expansion of tobosa grass tuft areas was in part due to a tendency of the plants to expand laterally when vertical growth is cut off.

"By the end of the first season, quadrats clipped at intervals had increased their tuft areas in direct proportion to the frequencies of clipping. The indication is that an increase in tobosa ground cover may be expected during the first year on areas closely grazed during the growth period; also that areas cropped at weekly intervals have a tendency to increase tuft area at a greater rate than those less frequently grazed. Not all of these increases, however, were permanent. The three quadrats of the 2-inch series clipped at intervals during the period of growth supported, in 1925, before being cropped, an aggregate ground cover of 24.81 dm. After 11 years these same quadrats retained a ground cover of 15.30 dm., showing a net loss of 9.51 dm., or 38 per cent. After 11 seasons of clipping, the 4-inch quadrats had increased in tuft area from 25.81 to 56.10 cm.—a net gain of 117 per cent.

"During drought, serious losses of tuft area, from which the plants do not readily recover, may be expected in tobosa grass when all herbage is cropped at a height of 2 inches at 1- and 2-week intervals. It may be concluded, indeed, that successive seasons of frequent grazing of all herbage of tobosa grass to a height of 2 inches will in a few years result in evidence of over-utilization—tuft area will drop, plants will lose vigor, and unpalatable weeds will begin to invade the site—all showing that overgrazing of the range prevails.

"The lack of permanent damage to site from any intensity of clipping except that at 2 inches at 1- and 2-week intervals is explained by the fact that areas commonly occupied by tobosa grass are the heaviest clay soils, which are not easily eroded by wind action. Although these soils contain a high silt fraction and are highly susceptible to water erosion, the lack of drainage in these flat-bottomed swales leaves very little opportunity for adverse water action."
Savage and Jacobson\textsuperscript{12} working at Hays, Kansas, on the effects of drought on blue grama and buffalo grass found that moderate clipping of these short grasses to control shading favored the spread of these species. Also continuous clipping at \( \frac{1}{2} \) inch during the drought year 1934 maintained a higher percentage of live plants than did the plots clipped \( \frac{1}{4} \) inches high or 2 inches. They report that continuous, close grazing had the opposite effect on the cover by these 2 species. No doubt the trampling effects along with the continuous close grazing explains the difference in response to these 2 methods of harvesting. This report covered work for only one year.

Robertson\textsuperscript{8} in clipping grass seedlings, obtained results as summarized in the following table:

<table>
<thead>
<tr>
<th></th>
<th>Bouteloua gracilis</th>
<th>Bromus inermis</th>
<th>Koeleria cristata</th>
<th>Poa pratensis</th>
<th>Stipa spartea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per cent of the seed-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lings alive at the end</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of 4 clippings ..........</td>
<td>92</td>
<td>68</td>
<td>100</td>
<td>100*</td>
<td>75</td>
</tr>
<tr>
<td>Yield of frequently</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>clipped plants in per</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cent of yield of plants</td>
<td>6</td>
<td>4</td>
<td>20</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>clipped at end of season.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\*Three clippings of this species.

Biswell and Weaver\textsuperscript{2} in clipping experiments with transplanted sods of Andropogon furcatus, Andropogon scoparius, Panicum virgatum, Bouteloua gracilis, Poa pratensis, Bouteloua curtipendula, and Buchloe dactyloides found that

“The total dry weight of tops from the clipped sod ranged from 13.1 per cent (Panicum virgatum) to 47.5 per cent (Bouteloua curtipendula) of that of the same species unclipped after transplanting. In Buchloe dactyloides, where stolons were permitted to grow, it was 63.1 per cent. In all cases there was a considerable decrease in the ground cover as the stand of the weakened grasses became thinner.”
In the above experiment the clipped sods were harvested at 14 day intervals and the controls were harvested at the end of the season.

Aldous\(^1\), reporting on clipping experiments carried out in Kansas, found that on pastures where big and little bluestem were the dominant grasses the yield varied inversely with the frequency of clipping, but that the vegetation from the most frequently clipped plots had the highest nutritive content. He also found that frequent clipping lowered the density and changed the composition of the vegetative type.

At Mandan, North Dakota, Sarvis\(^11\) found that plants clipped annually gave a higher yield on a dry weight basis than those clipped frequently.

An experiment conducted by Graber \textit{et al}\(^5\), in Wisconsin showed that blue grass cut close and frequently yielded approximately 56 per cent as much as that cut only at maturity the first year of treatment. It yielded 86 per cent as much the second year of treatment, and when cut only once at maturity on the third year (to test the residual effect of the previous years of frequent clipping) yielded only 19 per cent as much as the plot which had always been cut at maturity only.

Red top cut closely and frequently yielded 56 per cent as much as a similar plot cut only at maturity during the first year of the experiment. During the second year of treatment the closely and frequently clipped plot yielded 53 per cent as much as the one cut only at maturity. During the third year the closely and frequently cut plot was cut only once at maturity in the same manner as was the check plot. This was again to test the residual effect of the previous years of frequent clipping and it yielded 63 per cent as much as did the plot which had always been cut only at maturity.

Experiments conducted by Ellett and Carrier\(^5\) on blue grass pastures in Virginia showed a decreased yield from frequently clipped plots, but concluded that the decrease was more than compensated for by the increase in the quality of the frequently clipped vegetation.
In the Wallowa National Forest of Oregon, Sampson found that when *Festuca viridula* was clipped three times during each growing season for a period of three consecutive years the vegetative growth decreased each year.

Weaver and Hansen carried out clipping experiments with big bluestem (*Andropogon furcatus*), needle grass (*Stipa spartea*), prairie dropseed (*Sporobolus heterolepis*), and June grass (*Koeleria cristata*) in eastern Nebraska. In each case the plants were clipped frequently during the growing season at 1.5 inches from the ground and the yield compared to similar plots which were clipped only in the fall.

Regarding big bluestem they found that the:

"Total yield of the clipped plants was only 61 per cent as great as the control the first year, 41 per cent as great the second, and 48 per cent the third. The increased percentage the third season over the second was due to more favorable conditions for growth; the yield of the control was 6.7 per cent greater than that of the second year. The percentage of the total annual yield during the early period of growth decreased from 42 to 36 and then to 26 (1937 to 1939). This was probably owing to the depletion of the stored food in the rhizomes of the big bluestem.

"By August 5th the first year, bluegrass had made great increases throughout the plots. The following spring the soil was almost completely covered with bluegrass, although very little was found in the control. About 60 per cent of the basal cover consisted of bluegrass and only 30 per cent of big bluestem.

"A continuous cover of bluegrass was established by the third summer. It made repeatedly a vigorous growth after each cutting except during the very hot and dry month of August. In appearance, it was almost identical with that of a well-established bluegrass pasture.

"On May 25, 1940, when the grass was 8 inches tall, three square meters of control big bluestem was clipped at the soil surface, the forbs removed, and the grass dried and weighed. Here no bluegrass was found. Big bluestem was only 4 inches tall in the clipped plot where the bluegrass had headed sparingly, owing to a dry spring.
Average yield of the bluestem in the plot was only 15 per cent as great as the control. Bluegrass constituted 80 per cent of the yield of grasses in the clipped plots. That the bluestem was much weakened was further shown by the fact that unclipped plants in the large plot were only 9 inches tall by midsummer while the controls were 20 inches. All these changes occurred under conditions of clippings which were much less severe than those of close grazing.

In clipping studies with needle grass these authors, Weaver & Hansen,14 found that in the first year the "yields of the controls exceeded those of clipped plants by 5.5 per cent." In the second year

"only a few living bunches remain at the first clipping, on May 28, 1938, and these were poorly furnished with stems ***. Needle grass was only 13 inches tall and had produced no flower stalks. This was in striking contrast to the controls which were about 2 feet high and had an abundance of fruiting stalks 44 inches tall. Average yield was only 25 per cent of that of the first of that of the first clipping in 1937, which was made 14 clipping in 1937, which was made 14 days earlier. Average number of living bunches per quadrat had decreased from 28 to 10, and average number of stems per bunch from 40 to 10.

"At the time of clipping on August 25th, all of the needle grass in three of the quadrats was dead; the average yield was .24 gm. The soil surface was hard and cracks had appeared, and all but 5 per cent of the surface was bare.

"Half of the quadrats had no living needle grass on September 17th and mere remnants occurred in the remainder. These produced only a fraction of a gram per square meter. Total partial yields average 23.7 gm. which was less than 5 per cent of that of the control."

Regarding prairie dropseed these authors found "the yield of the clipped plants exceeded that of the controls by 18 per cent" the first year.

"The same bunches were again clipped on June 3rd of the next year. Average number of stems had decreased from 99 to only 19; height growth was less, and the
yield (.72 gm.) only 11 per cent as great ** *. Because of the poor growth, cutting was delayed until August 3rd. By this time ten bunches had died and the number of stems, height, and dry weight were again greatly reduced. By October 4th all bunches were dead, despite the fact that the controls made a better growth than in 1937. They had increased considerably in number of stems and height and the yield had increased nearly threefold.

In clipping June grass these authors found the average yield of the frequently clipped plots was greater than the yield of the controls for the first year. However, "during the second season of cutting there were only 30 stems per bunch, a decrease of 13; the controls had 48 which was 12 less than in 1937. Stems of the clipped plants were shorter but the controls much taller than before. While the yield of the controls was reduced by 10 per cent the plants clipped in June as well as October suffered a loss of 51 per cent. This loss would have been even higher if the five plants that died had entered into the calculation.

"A new lot of plants clipped in 1938 only showed similar trends, two bunches dying. Thus the very harmful effect of clipping or grazing upon this specie is apparent."

Regarding the feed value of young or immature grass such as would be obtained from frequently clipped plots, Semple et al., states that:

"Immature pasturage, including both grasses and legumes, has feeding properties similar to those of high-protein concentrates, such as the oil-mill byproducts. It is especially well supplied with protein, minerals, and vitamins. About 100 pounds of young leafy grass, when grazed, containing 25 pounds of dry matter, will provide enough carbohydrate to produce about 50 pounds of milk and enough protein to produce about 70 pounds net, including the carbohydrates and protein required for maintenance. Therefore, if young grass is to be supplemented it should be with a feed rich in carbohydrates, such as the grains.

"The grass from high-yielding pastures generally contains more water than the grass from low-yielding pas-
tures. The minimum quantity of dry matter contained in pasture grasses is approximately 15 per cent and occurs early in the season. Grass from an irrigated pasture clipped four times in the season of 1929 at Huntley, Montana, averaged 23.8 per cent of dry matter. The dry-matter content of grass from six pasture plots at Beltsville, Md., clipped 7 or 8 times from the early part of May to the early part of October, varied on an average from 24 per cent in May to about 44 per cent in August.

"In the spring, when the new grass is beginning to grow, the water content may be as much as 85 per cent. Therefore, a 1,000-pound animal would have to eat 100 pounds of such fresh green forage to obtain 15 pounds of dry matter, which is but little more than the requirement for maintenance.

"As pasture plants mature the percentages of protein and minerals decrease. Air-dried bromegrass in North Dakota cut on May 10 contained 18.5 per cent of crude protein, whereas that cut on July 25 contained only 9.2 per cent. Within the same time the ash content decreased from 11.9 to 5.7 per cent.

"Samples of Nevada bluegrass, violet wheatgrass, and Letterman needlegrass from Utah contained in the dry matter 25 per cent of protein on June 24, 11 per cent on August 9, 10 per cent on August 29, 6 per cent on September 18, and 5 per cent on October 7. If such forage is cut about the same time the seed matures, the plants contain only about 40 per cent of water. With so much greater growth and lower moisture content, the grazing animals can readily get not only enough dry matter for maintenance but also plenty for fattening. Forty pounds of such forage would contain 24 pounds of dry matter, which is practically a full feed for a 1,000-pound animal. If the same forage is cut twice during the season, the water content of the fresh forage would be about 54 per cent. When cut four times a season the average water content is about 79 per cent.

"The crude-fiber content, on the basis of the dry matter, is higher in immature grass than in most concentrates, but digestion experiments have shown that the fiber of immature grass is as digestible as its other nutrients and those of concentrates in general. It is only after the toughening of grass begins, which happens at about
the flowering stage, that the crude fiber of pasturage becomes difficult to digest and hinders the digestion of its other nutrients. The average of digestibility of the dry matter of immature grass is approximately 71 per cent, whereas that of hay from similar plants at a more mature stage is about 59 per cent.

"In general, closely grazed pasture produces about two-thirds as much dry matter as the same plants would produce if they were allowed to grow nearly to maturity and then cut for hay. However, as the dry matter of immature grass is more digestible than the dry matter of hays made from mature grass, the pasturage produces about three-fourths as much digestible nutrients as the hay."

Most of the work to determine the effect of frequent clipping on the root development of grasses indicates that root development is retarded or stopped by this practice. However, Laird, experimenting with grasses in Florida, states that "Mowing sufficiently to prevent seed formation produced better developed root systems with Bermuda and centipede grass than did non-mowing. However, this was not the case with St. Augustine grass." He also states with regard to top growth that "Frequent mowing (two to three times per week) seemed to bring about a more vegetative state with some grasses than it did with others. This was particularly true with centipede and Bermuda grasses." However, Laird does not indicate the weight of top growth removed under frequent mowing as compared to one mowing at end of the season.

Numerous other investigators are in agreement with those previously cited in that frequent clipping of grasses throughout the growing season will reduce the total yield of vegetation as compared to a single clipping at the end of the growing season.

LOCATION OF STUDY

This study was conducted on the Archer Field Station which is located approximately ten miles east of Cheyenne in Laramie County, Wyoming.
DESCRIPTION OF THE AREA

Southeastern Wyoming is on the edge of the Great Plains region. The topography is level to gently rolling and the mean annual rainfall is approximately 14 inches.

The vegetation is quite typical of the Great Plains area. On the flat lands the dominant grass is blue grama (Bouteloua gracilis). Mixed with the blue grama in varying proportions is buffalo grass (Buchloe dactyloides) which is the second dominant. Western wheat grass (Agropyron Smithii), needle and thread grass (Stipa comata), Sandberg's bluegrass (Poa secunda), and June grass (Koeleria cristata) are found in scattered stands with the above-named dominants.

The main perennial weed on this flat land is false mallow (Malvastrum coccineum). Various annuals are usually present but those found most commonly are plains plantain (Plantago Purshii), annual peppergrass (Lepidium apetalum), and beggars ticks (Lappula occidentalis).

Two semi-shrubs are found quite commonly. These are pasture sage (Artemisia frigida) and aromatic sage (Artemisia aromatica).

The vegetation as described for these flat lands will be referred to in the remainder of this report as type I.

On the south slopes the vegetative type is usually quite different from the flat lands. Here the vegetation takes on a mid-grass aspect and although blue grama and buffalo grass are present they have yielded their dominance to western wheat grass, needle and thread grass, and Sandberg bluegrass.

The annual weeds are usually quite sparse and the perennials are found more frequently. The semi-shrubs are the same here as on the flat lands.

The vegetation as described for the south slopes will be referred to in the remainder of this report as type II.

On the north slopes the vegetation is characteristically a mixture of the two types previously described. It has the aspect of the flat lands but has considerably more of the mid-grasses, such as western wheat grass, needle and thread grass, and Sandberg bluegrass, in its composition.

The vegetation as noted for the north slopes will be hereafter referred to as type III.
METHOD OF STUDY

This range clipping study was started in 1940 on a short-grass type which is the major vegetative type in this portion of the state. Twelve square meter plots were permanently established and protected against livestock by means of iron cages covered with 2-inch wire netting. These cages were taken up in the fall after the livestock were removed. Treatment plots were approximately 35 feet apart and the six replicates were located across the vegetative type so that the No. 1 and 6 replicates were more than ¼ mile apart.

The first clipping was made during the first week of June. The plan of study called for reclipping every three weeks or at approximately this interval whenever sufficient regrowth was available to harvest. This usually amounted to about ¾ of an inch of leaf growth on the blue grama and buffalo grass. See Figures I and II. All vegetation was clipped at ground level, i.e., at the crown. In 1940 a total of four clippings were obtained from the major species, blue grama and buffalo grass. At times when available moisture was low only a limited number of plants sent up new leaves. In such instances if leaf growth and number of plants were judged sufficient, clippings were made on the scheduled date. Yields in August and September were of this nature.

All grasses were clipped by species and placed separately in paper bags. All weeds were harvested together. Samples were air dried and then oven dried.

In 1941 the same plots were again protected, and clipped in the same manner as in previous years. However, it was necessary to reduce the size of area to be clipped to 4 square feet which was centered within the original square meter area. They were then weighed, without the paper bag, to the closest mg. Random samples of all grasses and weeds were obtained during the weighing and oven dried at 110° C. for 48 hours and moisture percentage calculated. All samples were then placed on a 10 per cent moisture basis.

In addition to continuing the above plots another series of 12 plots was established on the same vegetative type in 1941.
Figure I (left) and Figure II (right) illustrate a frequently clipped plot on the short grass type (Type I) before and after clipping. Figure I shows the regrowth which occurred between July 22 and August 22, 1941. At this time this plot had been clipped three times during the current season. These pictures are of the first year group and the average yield obtained when this picture was taken (August 22, 1941) was 49.5 pounds of blue grama—buffalo grass per acre. Figure II, also taken August 22, 1941, represents the appearance of the frequently clipped plots after each clipping. All pictures were furnished by A. L. Nelson, Superintendent of Archer Field Station.
Random location of these plots placed them about 150 feet away from the previously established plots.

A similar arrangement of 12 plots was also established on a south slope that supports mainly midgrasses, see Figures III and IV. This type has been previously described and designated as type II. Likewise 12 plots were established on a north slope which had been designated as type III.

Identical methods were employed with these newly established plots as were used with those started in 1940. On all plots a permanent area of 4 square feet was harvested. Field figures in the various tables represent the mean yield from the six replications of the treatment. Tests of significance have been calculated by the analysis of variance method.

SUMMARY OF TABLES

The yield of blue grama and buffalo grass obtained on Type I in 1940 was 48.4 per cent greater when clipped frequently during the growing season than the yield obtained when the herbage was removed only once, at the end of the growing season. The yield from the same plots in 1941 was 48.8 per cent greater under a system of frequent clipping. The yield from plots established and clipped for the first time in 1941 was 51.0 per cent greater when clipped frequently as compared to similar plots clipped only at the end of the growing season. All yields reported are on an air dry basis containing approximately 10 per cent moisture. See Table I.

The yield of blue grama and buffalo grass from type II where they are sub-dominant showed no significant difference between the two methods of harvesting in 1941, although 5 out of the 6 replicates yielded more under frequent clipping. See Table II.

On type III, blue grama and buffalo grass produced 98.2 per cent more forage in 1941 when clipped frequently than similar plots clipped only at the end of the growing season. See Table III.

The midgrasses, which included western wheatgrass, needle and thread grass, Sandberg bluegrass with traces of June grass
Figure III (left). This picture shows a close view of the midgrass type (Type I). Pictures taken August 22, 1941.

Figure IV (right). This picture shows a frequently clipped plot on Type II which has just been clipped.
and slender wheatgrass, gave the opposite response to that made by blue grama and buffalo grass. Significantly higher yields were obtained when these grasses were clipped only once at the end of the season. See Table II.

Most weeds occurring on type I and type III were annuals. A significantly higher yield of weeds was obtained from those plots clipped only once as compared to those clipped frequently on these two types.

Weeds on type II were mainly perennials and the largest yield was obtained by frequent clipping. See Table II.

**TABLE I**

**YIELD† OF SHORT GRASSES AND WEEDS UNDER FREQUENT AND END OF SEASON CLIPPING FROM TYPE I**

**FREQUENTLY CLIPPED PLOTS**

<table>
<thead>
<tr>
<th>Clipping dates</th>
<th>1940</th>
<th>1941</th>
<th>1940</th>
<th>1941</th>
<th>1940</th>
<th>1941</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short grasses</td>
<td></td>
<td>Weeds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Year plots were established</td>
<td></td>
<td>Year plots were established</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1940</td>
<td>1941</td>
<td>1940</td>
<td>1941</td>
<td>1940</td>
<td>1941</td>
</tr>
<tr>
<td>June 4........</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June 27........</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July 22.........</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug. 31, 1940</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug. 23, 1941</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct. 20..........</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total from frequently clipped plots...</td>
<td>233.5‡</td>
<td>416.9‡</td>
<td>427.9‡</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

†All yield figures are in pounds per acre at 10 per cent moisture.‡Significant at the 1 per cent point.

**PLOTS CLIPPED AT END OF SEASON**

<table>
<thead>
<tr>
<th>Plot</th>
<th>1940</th>
<th>1941</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct. 20</td>
<td>170.8</td>
<td>280.1</td>
</tr>
<tr>
<td></td>
<td>283.3</td>
<td>77.9</td>
</tr>
<tr>
<td></td>
<td>680.3*</td>
<td>602.7*</td>
</tr>
</tbody>
</table>

*Significant at the 5 per cent point.
### TABLE II

**YIELD† OF MIDGRASSES, SHORT GRASSES AND WEEDS UNDER FREQUENT AND END OF SEASON CLIPPING FROM TYPE II**

**Frequently Clipped Plots**

<table>
<thead>
<tr>
<th>Clipping dates</th>
<th>MIDGRASSES Plots established in 1941</th>
<th>SHORT GRASSES Plots established in 1941</th>
<th>WEEDS Plots established in 1941</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First year of clipping pounds</td>
<td>First year of clipping pounds</td>
<td>First year of clipping pounds</td>
</tr>
<tr>
<td>June 4</td>
<td>696.2</td>
<td>122.5</td>
<td>156.1</td>
</tr>
<tr>
<td>June 27</td>
<td>66.9</td>
<td>96.0</td>
<td>26.4</td>
</tr>
<tr>
<td>July 22</td>
<td>85.0</td>
<td>91.2</td>
<td>11.0</td>
</tr>
<tr>
<td>August 23</td>
<td>21.9</td>
<td>50.4</td>
<td>15.1</td>
</tr>
<tr>
<td>October 20</td>
<td>12.2</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total from frequently clipped plots</strong></td>
<td>882.2</td>
<td>360.1</td>
<td>208.6‡</td>
</tr>
</tbody>
</table>

†Yield figures are in pounds per acre at 10 per cent moisture.

**Plots Clipped at End of Season**

| October 20 | 1,564.4‡ | 273.7 | 69.6 |

‡Significant at the 1 per cent point.
### TABLE III

**YIELD† OF SHORT GRASSES AND WEEDS UNDER FREQUENT AND END OF SEASON CLIPPING FROM TYPE III**

**Frequently Clipped Plots**

<table>
<thead>
<tr>
<th>Clipping dates</th>
<th>Short grasses</th>
<th>Weeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plots established in 1941</td>
<td>Plots established in 1941</td>
</tr>
<tr>
<td></td>
<td>First year of clipping pounds</td>
<td>First year of clipping pounds</td>
</tr>
<tr>
<td>June 4.</td>
<td>183.0</td>
<td>471.1</td>
</tr>
<tr>
<td>June 27.</td>
<td>147.7</td>
<td>5.8</td>
</tr>
<tr>
<td>July 22.</td>
<td>131.5</td>
<td>6.7</td>
</tr>
<tr>
<td>August 23.</td>
<td>65.2</td>
<td>0.0</td>
</tr>
<tr>
<td>October 20.</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total from frequently clipped plots</td>
<td>527.4†</td>
<td>483.6</td>
</tr>
</tbody>
</table>

†Yield figures are in pounds per acre at 10 per cent moisture.  
‡Significant at the 1 per cent point.

**Plots Clipped at End of Season**

| October 20.            | 266.1 | 752.4* |

*Significant at the 5 per cent point.
FORAGE PRODUCED BY THE SHORT GRASSES

In 1940 on type I blue grama, with small quantities of buffalo grass included, had produced 81.4 pounds of air dry forage by June 4. This amount was equal to just slightly less than ½ of the total season’s production on the plots clipped only at the end of the season.

During the next 3 weeks a total of .58 of an inch of precipitation fell. This amount came in 8 scattered showers varying from .02 to .16 of an inch. Apparently these light, scattered showers were not sufficient to produce plant growth. Consequently no yields could be obtained for grass or weeds on June 27, 1940.

On July 1, 3, and 4, approximately ½ inch of rain fell on each of the 3 days followed by 5 light showers between July 4 and 22. By July 22 good regrowth had developed and 155 pounds per acre of air dry blue grama and buffalo grass was harvested. This clipping yield was 90 per cent of the total season production obtained by clipping only at the end of the season. The total of these two clippings was 236.4 pounds or 38.4 per cent more than the end of season clipped plots.

August 20 was the first date for an appreciable rain following the July 22 harvest. On August 20 a rain measuring .64 of an inch fell. During the month up to this date a total of .14 of an inch fell in 3 scattered showers. Consequently it was the last of August before any regrowth developed, and the amount then was very small, 5.2 pounds of air dry forage per acre. During the period between July 22 and August 31 clippings, a total of 1.33 inches of rain fell in 9 different days. Of these 9 showers only 2 were of any consequence, being .64 and .25 of an inch respectively on August 20 and 23.

This last harvest from these frequently clipped plots was made at the same time the end of the season clipped plots were harvested, September 15. During this period beginning August 31 a total of 1.19 inches of rain fell. At least 3 of the rains were in amounts so distributed to be effective in increasing the soil moisture. The yield for the October, 1940 clipping was about 12 pounds of air dry forage per acre. This yield as well
as that from the previous clipping would be of little importance from a grazing standpoint.

The data for 1940 show that the total yield obtained by frequent clipping exceeded the one clipping by approximately 48.4 per cent. Discounting the small yields of August and September, frequent clipping still obtained 38.0 per cent more forage from the short grasses than did one clipping only. Light, scattered showers that occurred in 1940 produced little growth. When the rains were about \( \frac{1}{2} \) inch or more the plants responded.

In 1941 the same plots which had been clipped frequently during the previous year, had produced 98.2 pounds of air dry blue grama and buffalo grass by June 4. This is practically the same yield on this date as in the previous year. Spring precipitation up to June 1 was 6.0 inches in 1941 and only 3.4 inches in 1940. Cold weather up to this date, among other possible influences, may account for similarity of the June 4 yields in the 2 years with their considerable difference in rainfall.

Newly established plots on type I had produced 104.6 pounds of air dry blue grama and buffalo grass by June 4, 1941. This difference of 6 pounds between yield on the old and new plots is not considered significant.

During the interval between June 4 and 27 in 1941 a total of 6.68 inches of rain was measured. Between June 5 and 10 6.47 inches of this total fell as slow steady rain with a considerable portion entering the soil. This was one of the wettest Junes on record.

The yield obtained June 27 on the old plots was 76.4 pounds per acre. The new plots produced 131.6 pounds per acre. Just why these plots differed so much on this date of clipping is not clear at this stage of the study. During the 3 week period ending June 27 cold, cloudy weather prevailed. This condition no doubt accounts for the rather low yields obtained on this date.

On July 22 the third clipping of the year resulted in yields of 148.8 pounds per acre on the old plots and 142.1 pounds of air dry blue grama and buffalo grass on the new plots. During this period a total of 1.32 inches of rain fell in 14 showers on scattered dates. All were showers of about .10 inch except one of
.51 of an inch on July 12. The carryover of soil moisture from the June rains into the warmer weather occurring in July was ample for abundant plant growth.

The fourth clipping was made August 23. During the month ending August 23 a total of 1.21 inches of rain fell in 9 showers on various dates. Only one rain of material consequence occurred. This was on August 12 and measured .57 of an inch. The yield of air dry blue grama and buffalo grass on this date was 93.4 pounds per acre on the old plots and 49.5 pounds on the new plots. Again the variation in yields on the old and new plots is rather large, the difference is reversed on this date, being in favor of the old plots, but at this stage of the study no explanation is attempted.

The 1940 yield in August was 5.2 pounds compared to 93.4 pounds in 1941. Precipitation for the comparable period was 1.33 inches in 1940 and came in 9 scattered showers, 2 of which equaled .9 of an inch. In 1941 a total of 1.21 inches fell between the July and August clipping in 9 showers, only one occurred of any consequence and amounted to .57 of an inch. Thus rainfall conditions were very similar but yields greatly different. This merely illustrates the continued influence of the heavy June rains.

The yield studies for 1941 bear out the trends shown in 1940. In percentages, the 1941 yields of air dry blue grama and buffalo grass from the plots established in 1940 show that forage equaling about 62 per cent of the total produced on plots harvested only once was removed up to June 27, and then these plots produced 242 pounds per acre during the remainder of the season, a yield practically equaling the total production from the plots harvested only at the end of the season.

Clippings in 1941 on plots situated on a steeper slope than those just discussed, but supporting principally a blue grama and buffalo grass cover shows about the same trend in yields of blue grama and buffalo grass. This location, designated as type III, supported a higher density of western wheat grass, needle and thread grass, and Sandberg blue grass than did type I, although it is distinctly a short grass type of cover.
On June 4, 1941, blue grama and buffalo grass had produced 183 pounds of air dry forage per acre. This amounted to about 70 per cent of the total season's yield obtained by the end of the season clipping. By June 27 these same plots had produced regrowth amounting to 147.7 pounds per acre. Up to this date this is a total yield of 330.7 pounds per acre compared to 266.1 pounds per acre obtained as the season's production under one clipping. By July 22 the frequently clipped plots had again produced 131.5 pounds of air dry forage per acre and again by August 23 regrowth produced 65.2 pounds. For the season this is a yield of 527.4 pounds of air dry blue grama and buffalo grass when clipped frequently, or 4 times in this case, as compared to 266.1 pounds from the plots clipped only at the end of the season.

On type II or the midgrass type where blue grama and buffalo grass are secondary to the midgrasses, these short grasses produced 360.1 pounds per acre by frequent clipping compared to 273.7 pounds on the plots clipped only once. By the analysis of variance method of testing for significant differences this higher yield by frequent clipping was not significant. Five of the six replicates frequently clipped produced more than five of the plots clipped once, but on one replicate the once a year clipping exceeded the yield of frequent clipping. A longer period of study will probably show more conclusively the trend of response blue grama and buffalo grass make to frequent clipping than did this first year's data.

DENSITY ON FREQUENT CLIPPED AND END OF SEASON CLIPPED PLOTS OF TYPE I

Basal density was measured in the late summer of 1941. These measurements were made only on the series of plots established in 1940. Six plots each were read for the frequent and one clipping treatment.

The average basal density of blue grama and buffalo grass was 14.18 per cent for those clipped frequently for the two years compared to 18.98 per cent for those plots clipped only once. By the analysis of variance this difference was significant at the five per cent point.
No readings were made in 1940 after one year of clipping but by observation there appeared to be little difference in plot density resulting from the two intensities of clipping.

In the future, as this study is continued, readings of density will be made on the different types each year.

FORAGE PRODUCED BY THE MIDGRASSES

Data for this group of grasses have been collected for only one year, 1941. However, results obtained here from the two methods of clipping are in accord with results obtained with similar species by workers in other states. The total air dry yield obtained by clipping 5 times during the season was equal to only 56 per cent of the total yield obtained by clipping only at the end of the season.

The first harvest from the frequently clipped plots resulted in a yield of 696.2 pounds of air dry forage per acre of the midgrasses. This was on June 4 and the yield equaled 45 per cent of the yield obtained by end of the season clipping. The yield for June 4 was approximately 80 per cent of the total season’s yield for frequently clipped plots, illustrating the limited regrowth made by these species.

Sandberg blue grass showed some response to late summer and fall moisture and sent up many new leaves. The yield shown for October was principally this species. Western wheat grass showed some response during the summer to favorable moisture and temperature after being clipped. Needle and thread grass seems to rank second to western wheat in ability to start new growth after clipping. June grass made the least response after clipping.

Sufficient data have not been collected to make a definite statement as to the value, as feed, of the spring growth of these midgrasses as compared to these same plants when allowed to grow to maturity and harvested at the end of the season. Undoubtedly if the nutrients and digestibility of the 696.2 pounds harvested June 4 were considered, the difference in the total feed value would be much less than difference in forage weight be-
tween the two types of clippings. In 1940 chemical analyses were made of a few midgrass species harvested at different times of the year at Archer. These showed western wheat grass contained 19.17 per cent crude protein and 23.9 per cent crude fiber around June 4 as compared to 11.2 per cent crude protein and 29.6 per cent crude fiber on September 22. Larger differences than these probably exist for this group of grasses in years when moisture is more abundant than was the case in 1940. In such years the midgrasses generally grow quite rank and become coarse by the end of the season.

Different intensities of clipping should be carried out to determine the results of fewer clippings. For example, harvesting these midgrasses early in June, as was done in this first year, then not clipping again until at the end of the season. Perhaps this would result in making use of a relatively large yield when these grasses are quite nutritious and palatable, and possibly during the remainder of the season their growth plus the early season yield would more nearly approach the yield obtained with only one clipping.

Another factor regarding frequency of clipping midgrasses in this area which will bear further study is the ability of this group to maintain their stand under this clipping.

FORAGE PRODUCED BY THE WEEDS

Weeds were plentiful during the 1941 season. On the flat land and the gentle north slope where types I and III were located the principal weeds were annuals. They consisted mainly of plains plantain (*Plantago purshii*), annual peppergrass (*Lepidium apetalum*), and beggars ticks (*Lappula occidentalis*).

On these two types where annuals predominated the yield of weeds from frequently clipped plots was lower than from end-of-season clipped plots. This is to be expected as once these annuals were cut they made very little or no re-growth.

The average yield of weeds from the frequently clipped plots of types I and III was 403.4 pounds of air dry material per acre as compared to the average yield of weeds from the end-of-season clipped plots which was 681.9 pounds per acre.

*Made by Dr. O. C. McCreary, University of Wyoming Research Chemistry Department.*
On type II where the midgrasses were predominant the annual weeds were sparse and the perennials more common. These perennial weeds consisted mainly of *Malvastrum coccineum*, *Chrysopsis* spp., and *Pentstemon* spp. On this type the weeds yielded higher under frequent clipping than under end-of-season clipping.

The average yield of air dry material from weeds of type II frequently clipped plots was 202.67 pounds per acre as compared to 69.15 pounds per acre from the end-of-season clipped plots.

It may be noted that the yield of weeds was considerably less from type II where the midgrasses were dominant than from types I and III where the short grasses were dominant.

**SUMMARY**

Clipping experiments carried on at the Archer Field Station in southeastern Wyoming show that the short grasses yield more when harvested frequently at ground or crown level than they do when protected during the growing season and harvested after growth has ceased. This was true even on plots which had been harvested in this manner for two years with no apparent decrease in the density of perennial grasses.

Midgrasses were found to yield significantly higher under protection and harvesting at the end of the growing season than under frequent clipping, just the opposite reaction to that exhibited by the short grasses.

Annual forbs made the same response as the midgrasses, that is, lower yields under frequent clipping. Perennial forbs reacted in the same manner as the short grasses in giving a higher yield under frequent clipping.
CONCLUSIONS AND SUGGESTED PRACTICAL APPLICATION

These preliminary experiments indicate that the short grasses (*Bouteloua gracilis* and *Buchloe dactyloides*) will yield considerably more dry weight when harvested frequently than when protected to the end of season before clipping.

The midgrasses can be expected to yield considerably less under frequent clipping than under only one clipping at end of season.

The preliminary results obtained by these clipping experiments indicate that on a short grass range a system of grazing which would utilize some of the forage during June and July and the remainder at the end of the growing season would give a greater amount of more palatable forage than a system which deferred grazing until the end of the growing season.

Possibly a system of intensive rotation grazing wherein units of the pasture or range were utilized near to the maximum each month would produce a maximum amount of forage from the short grass areas.

The basal density of the short grasses was not observed to have been lowered after one year of frequent clipping. However, the density of these grasses after the second year of frequent clipping showed a slight decline.

If one expected to get the maximum amount of forage from a midgrass range it would be necessary to defer it until the end of the growing season. However, these grasses become relatively unpalatable when they mature as well as being high in fiber and low in protein. It is possible that the smaller amount received by frequent grazing would offset in quality the extra quantity received by end-of-season grazing.

ACKNOWLEDGMENT

Acknowledgment is made to Dr. O. C. McCreary of the Research Chemistry Department for the analysis of grass samples, and to A. L. Nelson, Superintendent of the Archer Field Station for helpful cooperation and the photographs used to make the illustrations.
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