PALATABILITY for SHEEP and YIELD of HAY and PASTURE GRASSES *at Union, Oregon*

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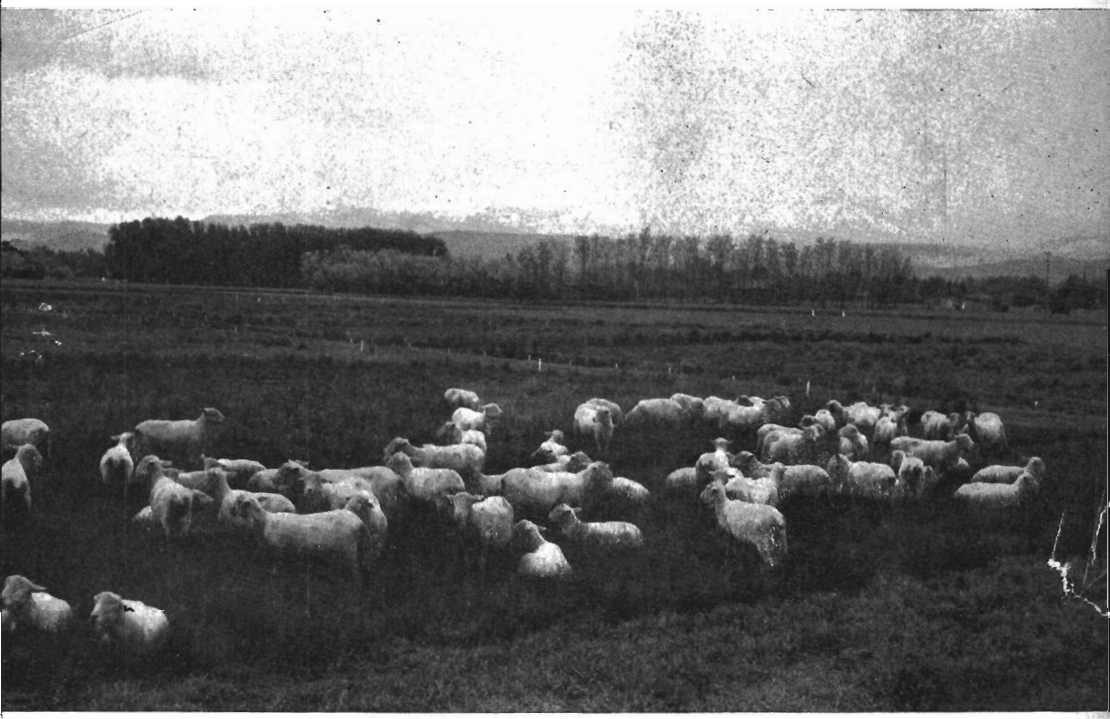

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Palatability for Sheep and Yield of Hay and Pasture Grasses at Union, Oregon*

By

D. E. Richards and Virgil B. Hawk†

INTRODUCTION‡

GRASSES for a land use program developed around a grassland agriculture must meet several specific requirements. Among these requirements a relatively high palatability is important because, combined with yield and conservation factors, feeding value determines the ultimate use of a grass.

Information is available to a limited degree on the average yields of grasses but there are comparatively few published data on preference of livestock for grasses under eastern Oregon conditions. Observations by stockmen show that the various grasses differ widely in attractiveness to animals. This bulletin reports the results of studies made at Union, Oregon, of relative palatability of forages to sheep. Some of the more important common, native, and recently introduced grasses were tested from 1940 to 1944. The grasses were grazed and also fed as hay and the percentage eaten was determined as a measure of palatability. Yields of the grasses were obtained and observations made on the adaptation of these grasses to local conditions. With yield, palatability, and adaptation in mind, recommendations have been made for hay and pasture seeding in a soil conservation program for eastern Oregon.

HAY TRIALS

METHODS

A grass nursery was established at Union, Oregon, in 1935 to study grasses and legumes for forage production and soil conservation. Approximately 200 strains representing 90 species of grasses

* Cooperative investigations between the Eastern Oregon Livestock Branch of the Oregon Agricultural Experiment Station and the Nursery Division of the Soil Conservation Service, U. S. Department of Agriculture.

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‡ The conscientious assistance of Kenneth Minnick, formerly assistant in farm crops at the Eastern Oregon Livestock Branch Experiment Station, in conducting the trials is acknowledged. Dr. A. L. Hafenrichter, Chief, Regional Nursery Division, Soil Conservation Service, assisted materially in formulating plans and in preparing the manuscript, as did several others on the staffs of the cooperating agencies.

and 70 accessions of 40 legumes have been tested in the nursery. (See Figure 1.) Some of the most promising grasses were selected for studies of their relative palatability when fed to sheep as hay during a four-year period.

Approximately 25 pounds of hay from each of 20 species of grasses, including wheat, was harvested at the bloom stage from nursery rows with a sickle. Hay of three species of legumes was cut in some years. Canada wild-rye and tall wheatgrass was harvested at both the boot and bloom stage during two years. The Fairway strain of crested wheatgrass was used; the strains of other species were typical and representative of the average of the species. The green hays were field-cured and immediately stored under roof to avoid damage from weathering. As a measure of quality, the percentages of leaves, stems, and heads were determined during two years. Chemical determinations of the percentage of protein of leaf, stem, and head fractions were made according to official methods.*

Young, pregnant ewes of a fine-wool breed were used in the trials. The sheep selected were healthy animals and at no time during the trials were any of the animals sick and no deaths occurred. In order to maintain uniformity of age and condition among the

Photograph by Eastern Oregon Livestock Branch Experiment Station.

Figure 1. Some 90 species of grasses and 40 species of legumes have been compared in the cooperative grass nursery established in 1935. A small part of the nursery is shown as it appeared in 1936.

* The writers are indebted to Dr. I. R. Haag of the Oregon Agricultural Experiment Station for these analyses which were made in accordance with official methods of agricultural chemists.

four years a different lot of sheep was used each year. The average weight, daily gain, daily amount of hay eaten and refused, and percentage consumed together with the breed and number of ewes are given in Table 1.

The sheep had been accustomed to a daily ration of mixed grass hay for several weeks prior to the trial period. Before the tests were begun the sheep were enclosed in the feeding pen and fed mixed grass hay for three days. The size of the feeding pen was 15 x 40 feet and it was located inside a closed shed. The hay was offered in open, readily accessible feed racks. Salt and water were available at all times and no grain was fed before or during the trial period. The same person fed the sheep each day and the observers were persons with whom the animals were acquainted. Dogs and other animals were excluded. The hays were fed during January of the winter following harvest, which is about the middle of the normal winter hay feeding period in eastern Oregon.

Except for the first year, a daily ration of 5-pound portions each of five hays including a check were fed "free-choice" to five ewes each day. The first year four sheep were used and the daily ration was 4-pound samples each of five hays, except at the end of the period when slight variation in the amount fed was necessary because of lack of hay of some species. Thus the average amount of hay fed daily per head the first year was 4.88 pounds compared with 5.00 pounds during the other three years. The sheep were fed regularly each day at 7:00 a.m. and 4:30 p.m. One-half of the daily hay ration was offered in the morning and the remainder at the evening feeding. The refused hay was removed and weighed at the end of each feeding period.

The various hays were grouped according to estimated palatability and growth type. Except in a few cases, each species was fed in at least four and not more than six groups. Some groups consisted of palatable grasses, other groups were composed of relatively unpalatable species and the remaining groups were mixtures of palatable and unpalatable species. No grass was fed in the same group more than once and, except for the check and the legumes, no hay was fed more than two days in succession. Logical grouping was found to be the key to an accurate study of relative palatability. As the trial progressed from year to year more accurate groupings were possible. The grouping of species for testing is recorded in Table 2. The check hay in 1940 and 1941 was pea and barley mixed hay and the check in 1942 and 1943 was native wild grass hay. The check was fed daily with each group. As shown in Table 1 the days

on trial varied from 18 to 27 depending on the number of species tested each year.

The preference of the sheep for the various hays was determined by weighing the amount of uneaten hay of each species at the morning and evening feeding. This is essentially the method used by Waters (21) or Method III described by Eckles (6) as the amount refused when a standard quantity of hay is offered. The method is sometimes called the "cafeteria method." Observations and notes were made on the preference of the sheep for a particular hay or plant part. The final figure on percentage of each hay eaten was calculated by averaging the data obtained at the morning and evening feeding and for all groupings during the trial period. These data are given in detail in Table 2.

RESULTS

Preference for hay species

Sheep have a decided preference for certain hays according to the average percentage hay eaten as given in Table 3. These data indicate that the various grass hays fed for more than one year may, as suggested by Milton (15), be divided into three palatability groups as follows:

Most palatable (85-95%)	Moderately palatable (70-85%)	Least palatable (50-70%)
Crested wheatgrass	Orchardgrass	Bulbous barley
Smooth brome*	Tall oatgrass	Wheat hay
Beardless wheatgrass	Meadow fescue	Tall wheatgrass
Big bluegrass	Beardless wild-rye	Alta fescue
Meadow foxtail	Erect brome	Canada wild-rye
Timothy		Reed canarygrass
		Michels rye

* Based on three years as the results in 1942 are not considered typical.

Among the highly palatable grasses tested there were two distinct types. The first consists of the dryland grasses — namely, crested wheatgrass, beardless wheatgrass, and big bluegrass. One reason for the large amounts of these hays consumed was that the sheep ate a considerable quantity of the fine stems. It appears that these three species have possibilities for hay where it is too dry to raise hay from the more common hay grasses. The second type comprises the hay-meadow grasses such as smooth brome, meadow foxtail, and timothy. These three grasses have soft leaves and stems which were eaten readily by the sheep.

It is the general opinion that such grass species as orchardgrass, tall oatgrass, and meadow fescue are better for pasture than for hay. The data from this trial are in agreement. At the hay stage these

grasses contain a high proportion of unpalatable stems. The beardless wild-rye hay tested was very similar to "wild hay" fed to sheep in eastern Oregon where native meadows may contain nearly pure stands of this grass. While the preference of the sheep for beardless wild-rye was not marked at the bloom stage, it was superior to Canada wild-rye in palatability. Leaves of erect brome are covered with pubescence that the sheep apparently did not like. Davies (5) reported that pubescense lowers palatability.

The least palatable grasses were species containing a high percentage of coarse stems and leaves. They are not preferred by sheep as hay and the average amount eaten was less than 70 per cent. Species such as alta fescue, tall wheatgrass, reed canarygrass, and Canada wild-rye are in this group. Since the hay used in this test was grown in rows, the growth was more rank than when grown in the average meadow. Also, earlier harvesting would increase palatability according to a test conducted in 1942 with two grasses. The average percentages eaten at the boot stage and the bloom stage are given below:

Type of hay	Average amount eaten
	Per cent.
Canada wild-rye cut at bloom stage	57
Canada wild-rye cut at boot stage	68
Tall wheatgrass cut at bloom stage	48
Tall wheatgrass cut at boot stage	60

When Canada wild-rye was cut at bloom, the usual hay stage, the stems and leaves were very coarse as illustrated in Figure 2. The sheep preferred leafier and softer species which were available to them in this "free-choice" test. When Canada wild-rye was cut before bloom, the sheep relished the hay and ate a much higher percentage of it. The results were nearly the same with tall wheatgrass. These data agree with the findings of Sotola (19), Waters (21), Willard (23), Hendry (9), and Beaumont, et al. (3). It is believed that early harvest may be a good method of utilizing some of the coarse, high yielding grasses with special adaptation, but as pointed out by Waters (21), it might reduce the life of the grass stand.

Bulbous barley and Michels rye resemble grain hay much more closely than they do grass hay. For this reason they were compared with wheat hay which is very commonly fed to sheep. None was particularly palatable and Michels rye was definitely the least palatable.

Sainfoin is a perennial legume somewhat similar to alfalfa. When cut for hay in the bloom stage the sheep preferred it to alfalfa.

This was particularly noted in the palatability of the stems of the two legumes. White sweetclover was tested only one year and it was the least palatable of the legumes. Alkali weed (*Bassia hyssopifolia* (Pall) Volk.) was not a satisfactory hay in this trial.

Photograph by Soil Conservation Service.

Figure 2. The Canada wild-rye hay on the left which was cut in the boot stage was more palatable than the same species on the right, cut at the bloom stage.

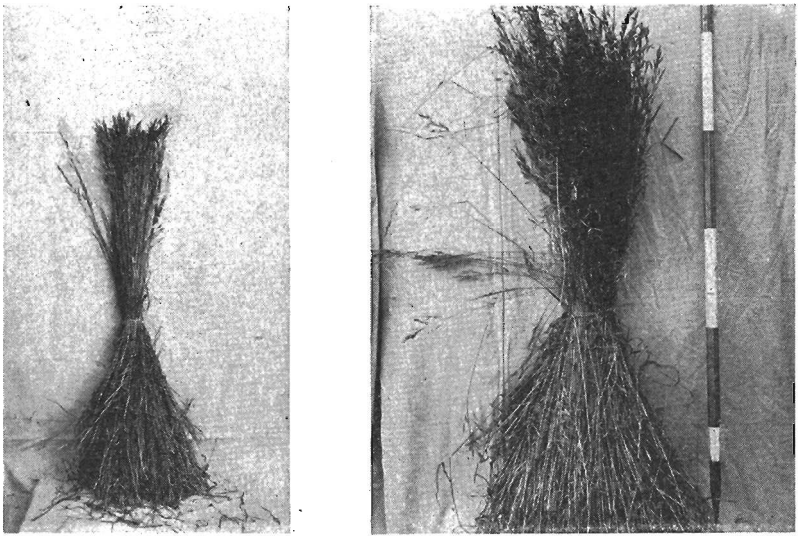
With the exception of 1942 the check hays were about medium in palatability and the average for the four years showed that the check, (pea and barley hay in 1940 and 1941 and wild grass hay in 1942 and 1943), was eaten in about the same percentage as the average of all the hays tested. The percentages were 80 and 77 per cent, respectively. All species that were, on the average, eaten to a greater extent than 80 per cent may be considered as palatable and those preferred to a lesser degree as relatively unpalatable.

Factors affecting palatability

Many factors, such as stage of maturity at harvest, which has been previously discussed, affect the relative palatability of grass hay. Some of these factors were studied to a limited extent.

It will be noted from a study of the data in Tables 2 and 3 that there was considerable variation in the palatability of hay of the same species from year to year. The relatively high palatability of all hays in 1940 may be ascribed partly to the use of larger ewes in the trial. Variations in preference among the four years, however, are a reflection of differences in hay quality within a particular species. A striking example is the low palatability of smooth brome in 1942 compared to other years. The fact that this difference is an expression of variations in hay quality may be partly determined by a study of the hay samples shown in Figure 3.

Relative palatability of a particular hay may be affected by the choice offered the animals, according to the data in Table 2. These daily records show that there were variations in the percentage of hay eaten of a particular species when it was fed in different groupings with other species. This evidence bears out the contention that palatability varies with the choice offered in a cafeteria-type test.



Photograph by Soil Conservation Service.

Figure 3. The smooth brome hay on the left which was fed in 1943 was leafier, contained more protein, and was more palatable than hay of the same species fed in 1942 and shown on the right. (Both pictures are to the same scale.)

The feeding of a single species in several carefully selected groups is essential in a trial of this type.

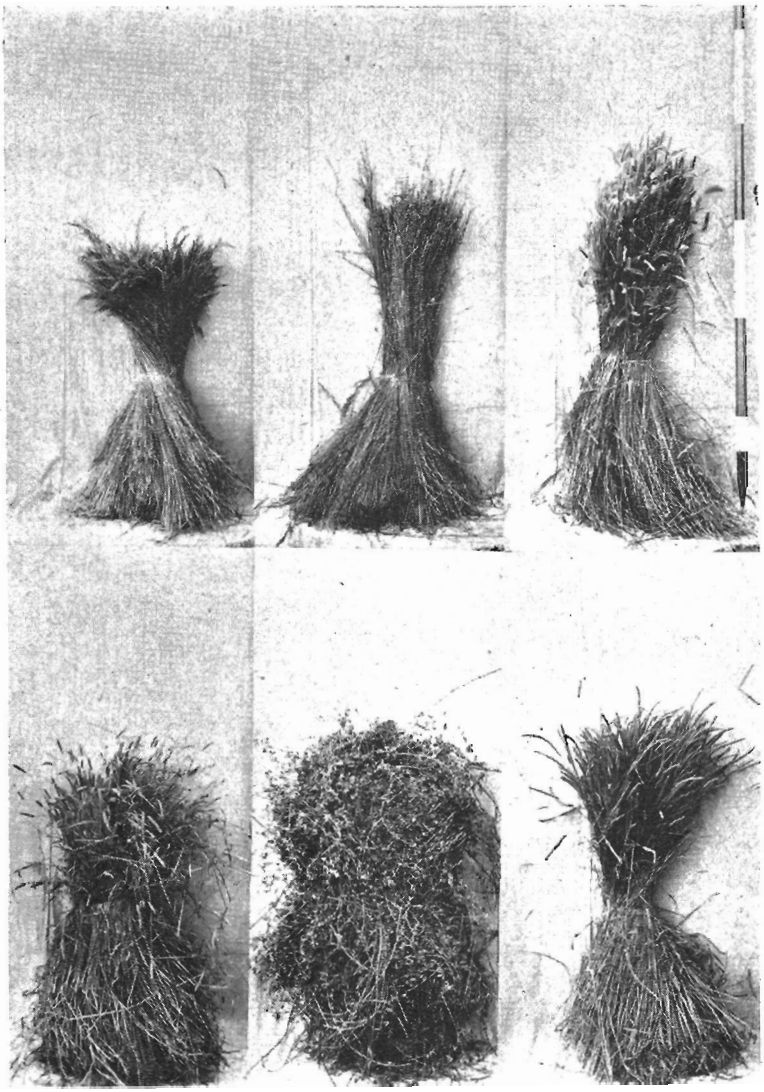
Since Davies (5) found that there was a difference in the palatability of leaves, stems, and heads of grasses, the percentage of leaves, stems, and heads was determined during two years by the method used by Hendry (9) for cereal hays. The per cent of crude protein (N $\times$ 6.25) was determined on the leaf, stem, and head fractions and calculated for the entire plant. These data are given in Table 4.

Leafiness might be used as an explanation for the variations in palatability between years within some species, but the relationship was not consistent. It is highly probable that leafiness has little to do with variations in palatability among species. Archibald et al. (1) found that crude protein had little relation to palatability and these data are in agreement.

Determination of factors other than percentage of leaves, stems, and heads, and percentage of protein would undoubtedly have clarified the relationship of these factors to palatability. Willard (23) found that sugar content of native grass hay was probably associated with palatability for cattle in Wyoming. Archibald et al. (1) found a close relationship between vitamin A (carotene) and palatability. Another physical factor that may be related to palatability is the breaking strength of the straw and the leaves (3). It is apparent from the literature cited and the data obtained in this trial that no single factor controls the palatability of various grasses and legumes as hay. The combination of factors affecting palatability are evidently of a complexity considerably beyond the scope of this trial or other tests reviewed.

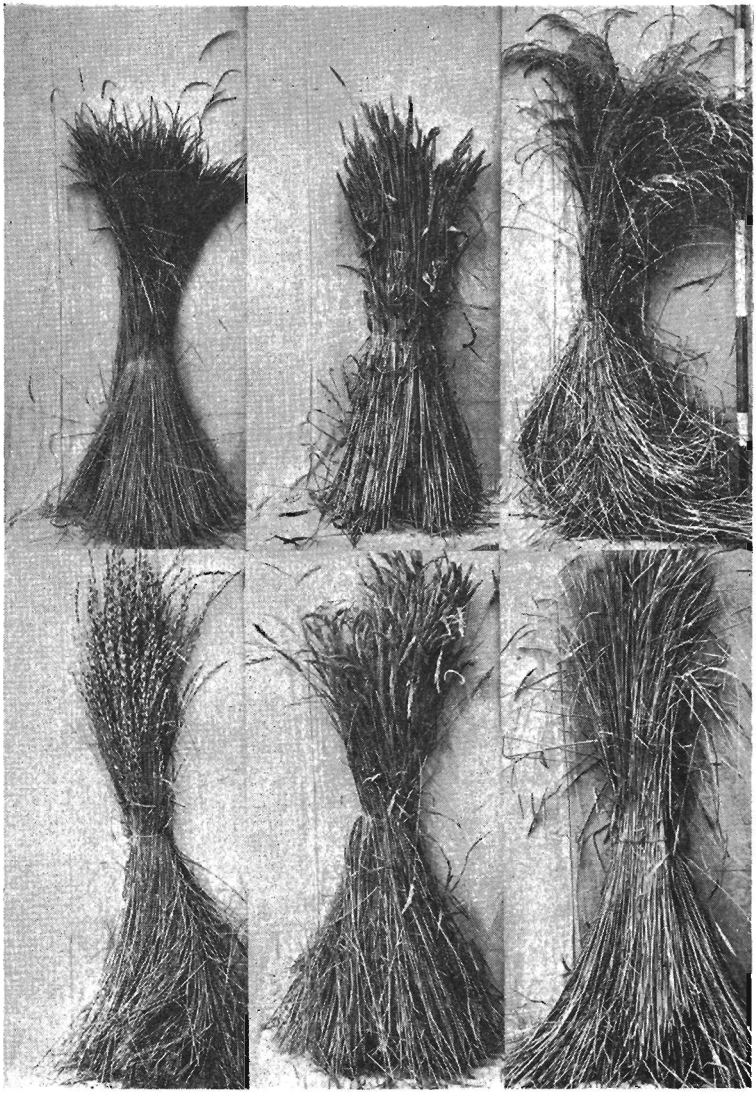
As shown in Table 2 the average consumption of the check hay in 1943 was 74 per cent with the daily figures ranging from 44 to 88 per cent for a difference of 44 per cent. The variation in percentage of the check eaten was apparently related to the palatability of the four test species offered on a particular day. The average percentage of hay eaten for the period in 1943 was 74 per cent while the daily percentage varied from 66 to 88 per cent for a difference of 22 per cent. Translated to pounds of hay per head per day the average was 3.7 pounds with a variation from 3.3 to 4.4 for a difference of 1.1 pounds. From these figures on percentage and amount of hay eaten daily it was concluded that palatability had an effect on hay intake by sheep.

It was noted from the beginning of the tests that the sheep ate more hay from the morning feeding than from the evening feeding, although less time was available for feeding. The difference between



Photograph by Soil Conservation Service.

Figure 4. Six more palatable hays that were harvested in 1941 and fed in January 1942.
Upper row, left to right: Big bluegrass, beardless wheatgrass, and crested wheatgrass.
Lower row, left to right: Meadow foxtail, alfalfa, and timothy.
(Composite photograph of six negatives taken at the same scale; scale is the same for Figure 5; scale may be determined by measurement of one-foot sections on range pole.)



Photograph by Soil Conservation Service.

Figure 5. Six less palatable hays which were harvested in 1941 and fed in January 1942. (See also Figure 4.)

Upper row, left to right: Beardless wild-rye, wheat hay, and alta fescue.

Lower row, left to right: Tall wheatgrass, reed canarygrass, and Michels rye.

percentage of hay eaten by day and at night is given in Table 1. This information indicates that, if a single feeding of hay is made, less waste would occur by an early morning feeding.

Yield in relation to palatability

It will be observed that the more palatable hays shown in Figure 4 are shorter and apparently lower yielding than the tall, coarse hays illustrated in Figure 5, which are less palatable. McCall et al. (14) stated that yield and feeding value of forage crops should be considered together. Hay yields at the bloom stage have been obtained in the grass nursery at Union since 1936. The average hay yields of some of the grasses for four years on the nursery rows where the hay samples were obtained for this trial are given in Table 5. These hay yields are combined with the average palatability of hay from each species and the yield of edible hay per acre has been calculated. The yields shown are typical of grasses under nursery conditions at the experiment station. Under the conditions obtained the net value of a large tonnage of coarse grass was reduced considerably by palatability of 70 per cent or less. On the other hand, some sacrifice in palatability may not be serious in case of high yield of a moderately palatable grass.

PASTURE TRIALS

METHODS

On the basis of preliminary trials (4), 20 pasture grasses were established in one-tenth-acre plots in 1940 for studies of relative palatability as pasture for sheep. All 20 were established but 2 failed to persist. The plantings were harvested for hay in 1941, and the aftermath grazed in the fall. In 1942, 1943, and 1944 the pasture was fenced and grazed during three periods each year. The number of sheep and the length of the period were adjusted to the estimated carrying capacity based on yield above a four-inch stubble. The sheep were allowed free access to each plot in what might be described as the cafeteria method of testing. Salt and water were available at all times. Two circular wire cages, as shown in Figure 6, were placed in each plot. Harvests, such as those obtained by Fuelleman and Burlison (8), were not made within the caged areas. The cages were used when observations were made, however, and notes taken on the preference of the sheep for particular grasses during the grazing period. To avoid dogs, the animals were corralled each night. The daylight grazing hours were from 6:30 a.m. to 5:30 p.m. To measure the yield of the grasses, a strip 1/100 acre in size was mowed across each plot before grazing, raked by hand, and weighed

immediately. In some cases, but not all, the green forage was dried and air-dry weights obtained. In most instances, notes were taken on height of plants, percentage of stand, maturity of plants, and the condition of the grasses as it might affect palatability. After completion of the grazing period, a second strip was clipped, the uneaten feed was weighed, and percentage of each grass eaten was calcu-

Photograph by Soil Conservation Service.

Figure 6. One of the wire cages used to protect a portion of the pasture plot from grazing as a check for estimating utilization by ocular inspection. Some of the ewes used in trial in 1942 are shown in the background. The grass in this particular plot is mountain brome.

lated. Then the entire pasture was clipped to a four-inch stubble and allowed to make regrowth for the next grazing. Clipping at the end of a short test period would tend to equalize effect of variable utilization. This method varied from those used by Rogler (18) and Hurd and Pearse (11); in both of these studies the animals were left on the pasture for the entire season. Clipping is the method recommended by Stapledon (20) for handling pastures where variations in palatability occur; clipping should assist in keeping palatability at a maximum.

Lush et al. (12) state that relative palatability of pasture grasses may be determined by several methods such as (a) tabulating the number of animals grazing on individual plots at definite intervals of

time; (b) with row crops, daily estimates of the lineal footage of rows grazed; and (c) interval of time required per animal unit to graze a given area completely. The technique used in this trial could be considered a fourth method.

Because the grasses were seeded without a legume the pastures were fertilized each fall with a maintenance application of 200 pounds of ammonium sulphate per acre. A small, unfertilized, check strip was left on each plot. From the work of others, particularly Lush (13), it is recognized that fertilizer application may affect palatability. There may not be a relationship, however, between a uniform fertilizer application and relative palatability by species. On the basis of the check strip it was the opinion of the authors that either fertilizer had no effect on variations in palatability among species or the maintenance application was too light to affect results. Since the observed increase in yield was not great the latter assumption is probably the most logical.

RESULTS

Grazing capacity for entire pasture

The amount of feed available from the pastures varied considerably among the three grazing periods and the three years of trial. Climatic conditions may have been partly responsible; Fuelleman and Burlison (8) found that consumption and yield of forage are very markedly affected by rainfall and temperature. According to the summary in Table 6 participation was progressively less during the three years of grazing. The gradual decrease in sheep days of grazing for the three years as shown in Table 7, however, often occurs with pure grass pastures as they grow older (7). It is believed that cold, dry weather in March had an effect on the growth, succulence, and palatability of the pastures at the first grazing period during the three years of testing. The general average for the five years of the plantings indicates that it was wetter and warmer than normal. Precipitation and temperatures, however, are probably critically related to pasture growth only at specific periods, and in a winter rainfall area succulent growth and high yields are normally favored in spring and early summer. It will be noted that rather high grazing capacities were obtained in the July and August grazing periods. Since these were obtained during dry months, subirrigation was responsible for the higher yields of the pasture grass at the second and third grazing periods than would normally be obtained under range or dryland pasture conditions in eastern Oregon.

The low grazing capacity in the last period of the first year was the result of poor growth in hot, dry weather. The large amount of

feed available because of excessively delayed grazing was responsible for the large number of sheep days of grazing for the first period of the same year. Better adjustment of grazing periods was obtained in the next two years. The amount of feed eaten per sheep day varied but slightly during the three years. The pastures averaged slightly more than 500 sheep days of grazing per acre annually for the three years.

Palatability of pasture grasses

Percentage consumption of the pasture grasses shown in Table 8 is based on the amount eaten above a four-inch stubble. This amount of stubble was considered sufficient for soil protection and for maintenance of grass vigor under the pasture management system used. The assumption that a uniform height of stubble for all species is a basis of utilization calculations may not be safe or tenable. After reviewing the data given in Table 8 with the daily notes on the preference of the sheep for particular grasses it was the conclusion of the authors that palatability of the grasses could be expressed as percentage grass eaten by sheep. It is realized, however, that only broad generalizations can be made and that final determination of palatability is dependent on development and use of standard methods of determination (12).

The eighteen grasses listed in Table 8 may be divided into three palatability classes as were the hay grasses. Those species in the three classes are as follows:

Most palatable (90-100%)	Moderately palatable (80-90%)	Least palatable (50-89%)
Smooth brome	Creeping red fescue	Alta fescue
Orchardgrass	Mountain brome	Slender wheatgrass
Meadow foxtail	Standard crested wheatgrass	Chewings fescue
Meadow fescue	Fairway crested wheatgrass	Erect brome
Tall oatgrass	Canada wild-rye	Beardless wild-rye
Creeping timothy	Pubescent wheatgrass	Big bluegrass

Observations made indicate that the 6 grasses averaging 90 per cent or more utilization of the forage available under conservative grazing were highly palatable. The 6 grasses with the lowest percentage utilization (less than 80 per cent) were avoided by the sheep until late in the grazing period. The six grasses that were utilized to the extent of 80 to 90 per cent were unpalatable at some one season of the year. For instance, the two strains of crested wheatgrass were palatable during the first two periods, but were unpalatable in late summer, while chewings fescue and creeping red fescue were quite palatable then but were avoided earlier in the year.

Smooth brome and orchardgrass were consistently palatable at all seasons but considering the bulk of feed available the palatability of tall oatgrass was most striking.

The high yield of tall oatgrass, meadow fescue, and meadow foxtail as shown in Table 9 may have slightly reduced the percentage of feed eaten as shown in Table 8. All three grasses, however, were among the 6 highest yielding grasses and the 6 most palatable grasses. Observations of the grazing sheep proved beyond any reasonable doubt that high yield had little effect on the percentage of alta fescue and big bluegrass consumed by sheep in this trial. Variation in seasonal palatability of pubescent wheatgrass had more effect on utilization of the grass by sheep than did yield. The low yields of creeping timothy, creeping red fescue, and mountain brome did make less feed available but it was noted that the sheep relished these grasses at most periods of grazing.

Big bluegrass was unpalatable during all nine periods. The extremely great difference in palatability of big bluegrass as hay and as pasture cannot be explained on the basis of these trials. It has happened with other grasses. For example, in Montana it was found that Fairway crested wheatgrass was more palatable than Standard crested wheatgrass as hay (24) while Standard was recommended for pasture in preference to Fairway because of low palatability of Fairway (16). Big bluegrass has been observed by the authors to be highly palatable under other conditions. Observations indicate that it is highly palatable only in early spring before a majority of the grasses are ready to graze. In late spring and during the summer and fall, the leaves are wiry and tough. The data from this trial are in general agreement with the findings by Hurd and Pearse (11) that dryland grasses were less palatable for cattle than grasses adapted to more humid sites.

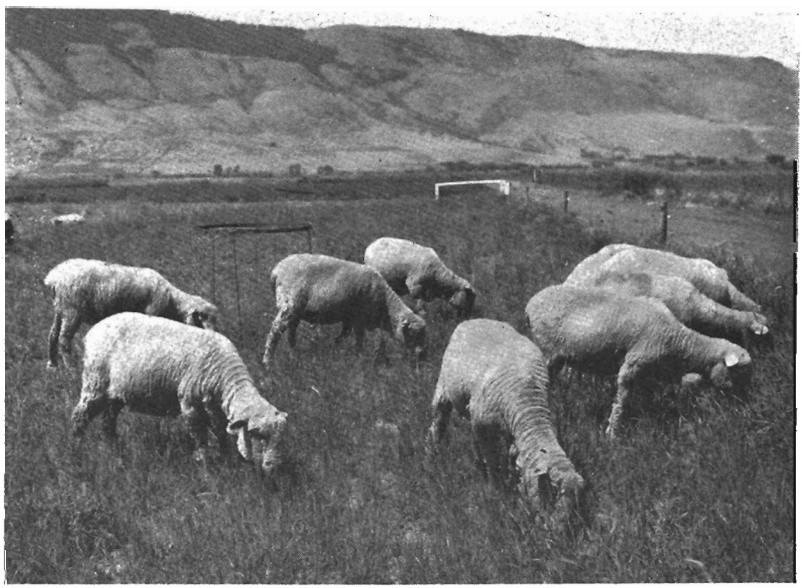
Under a climate not so closely related to eastern Oregon conditions, Fuelleman and Burlison (8) found that smooth brome and orchardgrass were highly palatable when growth and consumption are a criterion of palatability. Erect brome, which has pubescent or hairy leaves, was relatively unpalatable to sheep, but pubescent wheatgrass was fairly palatable. Davies (5) observed that meadow foxtail and tall fescue were not consistently highly palatable and the same was observed in this trial.

Considering both percentage utilization above a four-inch stubble and observations made during grazing, the following relationship existed between comparable species or strains: Standard crested wheatgrass was more palatable than Fairway crested wheatgrass, meadow fescue than alta fescue, smooth brome than erect brome,

creeping red fescue than chewings fescue, and Canada wild-rye than beardless wild-rye. The method of grazing by the sheep on Standard crested wheatgrass is shown in Figure 7.

Yield of pasture grasses

Lush et al. (12) stated that palatability observations are of value mainly when considered along with yields and growth characteristics of a crop. Consideration was given to yield and growth characteristics in this trial. Tall oatgrass was outstanding in production of feed at all periods in every year according to the data in Table 9.



Photograph by Soil Conservation Service.

Figure 7. Sheep grazing on Standard crested wheatgrass in the pasture plots at Union, Oregon, in 1942. This photograph shows a tendency for the sheep to graze at the base of the plants.

Meadow fescue and alta fescue were high yielding but, contrary to expectations, the yield of alta fescue was not markedly greater than meadow fescue. As shown in Table 9, 7 grasses averaged more than 4,000 pounds of green feed per year and only 4 grasses were unsatisfactory in yield, producing less than 2,500 pounds per year. Creeping timothy neither persisted nor produced under grazing. Mountain brome was a short-lived grass and should be pastured the first two years for best results.

All the grasses produced their greatest yields in 1942 or 1943. The maintenance of production into the third year, which was dry, was best with pubescent wheatgrass, tall oatgrass, and alta fescue. The first 9 grasses listed in Table 9 can probably be depended on to produce pasture for a number of years under conditions similar to those at Union, Oregon. Continued production of pasture grasses at a stable rate is important and facilitates planned pasture management. Of the grasses tested pubescent wheatgrass, alta fescue, and crested wheatgrass produced in 1944 more than 50 per cent of their 1942 yields. The other species varied from 0 to 50 per cent.

Production by grazing periods was slightly higher in the first period than in the second and both were superior to the third. Species outstanding in production of early season feed were meadow foxtail, tall oatgrass, and crested wheatgrass. Those with best production at a slightly later period were meadow fescue, alta fescue, pubescent wheatgrass, Canada wild-rye, and beardless wild-rye. Only tall oatgrass, meadow fescue, slender wheatgrass and pubescent wheatgrass could be counted on to produce late in the season. Smooth brome and orchardgrass were consistently palatable at all seasons but low yields reduced their value for pasture. It should be repeated that tall oatgrass was outstanding in production of feed and in palatability at all periods every year. (See Figure 8.)

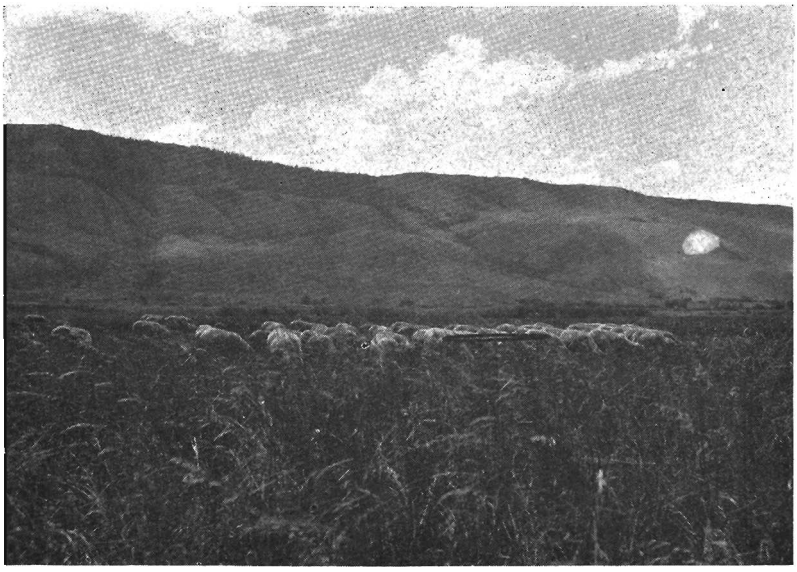
Grazing capacity by species

A combination of yield and palatability under proper use determines the amount of edible feed available for use by animals. An attempt is made to express net pasturage available by species as animal unit days per acre in Table 10 (animal unit days are sheep days divided by five). These calculations indicate that only 2 grasses, tall oatgrass and meadow fescue, were outstanding under the conditions of this experiment. The 7 other grasses, averaging more than 100 animal unit days of grazing per acre, are considered satisfactory. The remaining 9 grasses were either too low yielding, short-lived, or unpalatable to meet the test.

Persistence of grass stands

The estimated stand percentages are given in Table 11. The stand of four grasses at the end of the trial can be determined by a study of Figure 9. As found in studies in North Dakota (22) certain grasses persisted under pasture and others declined as the stands grew older. Mountain brome, creeping timothy, and Canada wild-rye were short-lived and died out severely. Michels rye and thickspike wheatgrass were originally included in the trial, but the first died after the hay crop was removed and the second was not adapted.

Both were plowed out and the plots seeded to mountain rye and bulbous barley in 1943. In spite of the fact that these last two species were grazed with the other plots during the establishment year they survived with good stand and produced 7,535 and 2,416 pounds, respectively, of palatable green forage per acre in 1944.



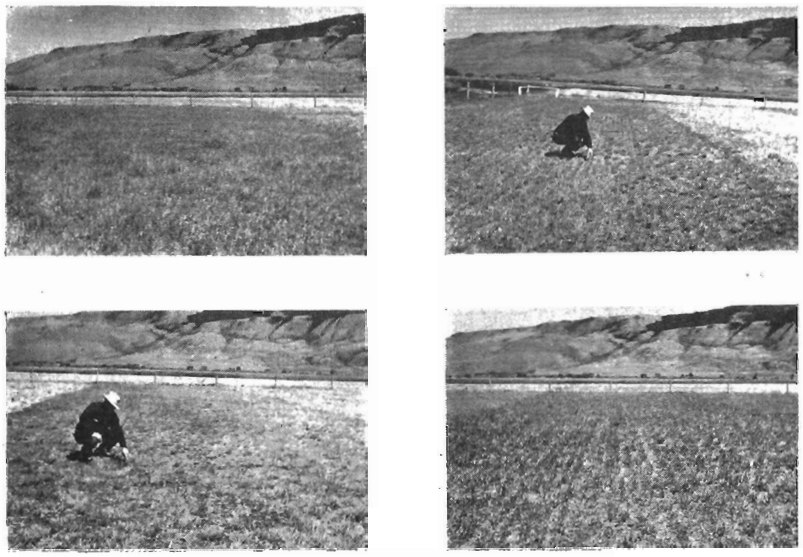
Photograph by Soil Conservation Service.

Figure 8. In spite of the tall, rank growth of the tall oatgrass, which had an average height of 32 inches and was in bloom at the second grazing period in 1942, the sheep ate 84 per cent of the available feed. The grass was succulent, however, as evidenced by a percentage of dry matter of 23 per cent compared with an average for all grasses of 34.6 per cent.

These notes and data on the permanency of stand of various grasses when used for pasture are useful in the selection of species for grazing. Combined with yield data and palatability observations logical seedings can be made. It should be considered that the use group composed of rapid-developing, high-yielding but short-lived grasses has a place in short-ley pastures equal in value to the position occupied by the slow-developing and long-lived grasses in long-ley pastures.

Ground cover was estimated by the square foot density method during two summers and is also given in Table 11. These data indicate that ground cover expressed as percentage basal density is not always related to yield or estimated percentage stand. Examples are the data for tall oatgrass, smooth brome, and creeping timothy. Den-

sity combined with height measurements given in Table 12 gave a rough estimate of yield. Basal density is related to the ability of a grass to protect the soil from erosion. Under conditions at Union, Oregon, the fescues, orchardgrass, and meadow foxtail produced good ground cover. No emphasis should or can be placed on the variation in basal density between the two years as the estimates were made by two technicians. The average of the two determinations, however, should give an accurate estimate of the ground cover produced by the grasses at the average most productive period.



Photographs by the Soil Conservation Service.

Figure 9. The stands of meadow foxtail and Standard crested wheatgrass (*upper, left to right*), Fairway crested wheatgrass and meadow fescue (*lower, left to right*) were still good at the end of the pasture trial at Union, Oregon. Other grasses with good stands included alta fescue, smooth brome, pubescent wheatgrass, tall oatgrass, slender wheatgrass, orchardgrass, creeping red fescue, and big bluegrass.

Related data on performance of pasture grasses

While the information is not complete, data available on percentage air-dry matter in the green pasture forage are given in Table 12. It is generally agreed that air-dry or oven-dry weights are the most satisfactory and accurate method of expressing yields. Succulence is related to percentage of dry matter and is an important factor affecting palatability according to Davies (5) and Archibald et al. (1). The data in Table 12, while fragmentary, indicate that

variations in palatability among species and grazing seasons may be related to percentage dry matter.

Plant height data in Table 12 indicate that grazing, in most cases, was not begun before "range readiness." At some periods grazing was begun at too late a date.

Notes in Table 12 on stage of maturity at several grazing periods demonstrate that it is not possible to have 20 pasture grasses at the same stage of maturity at any particular period. Maturity is undoubtedly related to palatability according to several references previously cited.

It should be repeated that these trials were conducted with sheep and that the data obtained may be applied directly only to sheep. Other investigators cited previously have tested the palatability of grasses to almost every type of livestock, as well as chickens (25) and grasshoppers (10). While Ritchey (17) states that there was apparently a relationship between palatability for rabbits and cattle, Arnold (2) found difference in the preference of the two for range forage. It is the general consensus of opinion that palatability varies with the class of livestock.

DISCUSSION

After consideration of data from several years of testing it was concluded that the grasses tested could be divided into three logical groups with respect to palatability for sheep as hay. Within these groups the selection of a hay grass is dependent on factors other than palatability, Such factors are: climatic and edaphic adaptation, economic and cultural requirements, and the ability of the grass to grow in mixtures with a hay legume such as alfalfa.

Crested wheatgrass, beardless wheatgrass, and big bluegrass are adapted to the low rainfall areas, smooth brome is intermediate in that respect, timothy must have favorable moisture conditions, and meadow foxtail grows on wet or flooded soils. Seed of timothy, crested wheatgrass, and smooth brome is most readily available. Establishment is a problem only with big bluegrass and meadow foxtail and stands can and have been obtained with both species. Crested wheatgrass and smooth brome have been widely used in alfalfa-grass mixtures and big bluegrass has been successfully grown with alfalfa at Union and elsewhere. Final determination of the grass or grasses to use for hay depends on local application of all factors.

With respect to those grasses which are mediocre in palatability many of them can be put to better uses than hay production. Certain grasses that are low in palatability as hay must, under certain conditions, be used for that purpose. Examples are: Reed canarygrass,

which is well suited to flooded areas; beardless wild-rye, which comprises large areas of native hay in southeastern Oregon; and wheat hay, which is often the only available hay in dry farm areas. If conditions require the use of less palatable grasses, palatability can be increased by early harvest.

The factors affecting relative palatability within a species can be best summarized by the word "quality." Vigorous stands harvested at the proper stage and cured and stored without damage will produce high quality hay if a "hay" grass is used.

Yield and palatability can compensate each other. A high yielding grass that is low in palatability might be better under some conditions than a highly palatable but low yielding species. The importance of hay palatability depends on the class, condition, and use of the livestock. It was found in this trial that palatability affected hay intake by sheep.

In the preliminary trials of pasture palatability reported it was found that pasture grasses could also be divided into three palatability classes. It is also recognized that the factors of yield, adaptation, and contemplated forage and conservation use affect the final selection of a grass.

For the greatest grazing capacity tall oatgrass, meadow fescue, and meadow foxtail could be recommended for subirrigated pastures on soil similar to that in the Grande Ronde Valley. Orchardgrass, smooth brome, and creeping red fescue are palatable but would be low yielding unless stimulated by a legume and heavy applications of manure. Crested wheatgrass is the recommended dryland pasture grass and in this trial, as in the Northern Great Plains (16) (18), the Standard strain was more palatable than Fairway as pasture.

The use of fine-leaved fescues as lawn grasses might be encouraged and from observations made in the pasture palatability trial creeping red fescue is less wiry and is easier to mow than chewings fescue. There is some evidence in the literature (1) (25) that the fine-leaved fescues have a tendency to be unpalatable and the same tendency was noted in this trial.

Under the conditions of this trial alta fescue was less palatable than meadow fescue. Significant though this may be, it should not preclude the use of alta fescue in pastures. The longevity, drought hardiness, alkali tolerance, high yield, and continued productivity of alta fescue are all factors in its favor.

Certain pasture grasses produce abundantly at particular seasons and show a seasonal variation in palatability. The best season of use for certain grasses is probably as shown in the following outline.

Spring	*Summer*	*Fall*
Meadow foxtail	Alta fescue	Alta fescue
Crested wheatgrass	Meadow fescue	Meadow fescue
Big bluegrass	Pubescent wheatgrass	Creeping red fescue
Tall oatgrass	Tall oatgrass	Tall oatgrass

Study of the information available from the trials with grasses for hay and pasture when fed to sheep indicates that there are certain grasses that make good hay and others that should be used for pasture. Under the conditions of these experiments and in the area applicable the following recommendations are made for the guidance of the reader. Besides the data available in this writing the following statements are tempered by supplemental nursery studies, literature cited previously, and observations made on farm and nursery seeding in the Pacific Northwest.

Orchardgrass, tall oatgrass and meadow fescue should be used as pasture grasses. Timothy should be used for hay but better grasses, such as smooth brome, are available. Until more data are available, big bluegrass, the new grass shown in Figure 10, should be handled for hay. Mountain brome and Canada wild-rye are best adapted for short-ley pastures, such as sweetclover-grass mixtures.

Photographs by Soil Conservation Service.

Figure 10. View of big bluegrass (*Poa ampla* P-2716) seeded in the Union Pasture Palatability Plots in the spring of 1940.

Tall wheatgrass, Canada wild-rye, and possibly other tall, coarse grasses made the best hay when harvested before blooming.

Since grasses vary considerably in palatability to sheep as hay and as pasture, if a palatable grass is desired one of the following should be seeded:

Hay grasses	*Pasture grasses*
Fairway crested wheat	Smooth brome
Smooth brome	Orchardgrass
Beardless wheatgrass	Meadow foxtail
Big bluegrass	Meadow fescue
Meadow foxtail	Tall oatgrass
Timothy	Standard crested wheat

Palatability and yield are two factors contributing to the selection of a grass to do a job. Some of the grasses that will produce a good yield of palatable feed are:

Hay grasses	*Pasture grasses*
Tall wheatgrass*	Tall oatgrass
Canada wild-rye*	Meadow fescue
Smooth brome	Pubescent wheatgrass
Timothy	Meadow foxtail
Big bluegrass	Alta fescue

BOTANICAL AND COMMON NAMES

List of botanical and common names of grasses, legumes, and forbs tested in the hay and pasture palatability trials with sheep at Union, Oregon.

Botanical name	*Common name*
Agropyron cristatum (L.) Beauv.	Crested wheatgrass
Agropyron dasystachyum (Hook.) Scribn.	Thickspike wheatgrass
Agropyron elongatum (Host.) Beauv.	Tall wheatgrass
Agropyron inerme (Scribn. and Smith) Rydb.	Beardless wheatgrass
Agropyron trachycaulum (Link.) Malte.	Slender wheatgrass
Agropyron trichophorum (Link.) Richt.	Pubescent wheatgrass
Alopecurus pratensis L.	Meadow foxtail
Arrhenatherum elatius (L.) Mert. & Koch.	Tall oatgrass

* Cut before bloom.

Bassia hyssopifolia (Pall.) Volk.	Alkali weed
Bromus erectus Huds.	Erect brome
Bromus inermis Leyss.	Smooth brome
Bromus marginatus Nees.	Mountain brome
Dactylis glomerata L.	Orchardgrass
Elymus canadensis L.	Canada wild-rye
Elymus triticoides Buckl.	Beardless wild-rye
Festuca elatior L.	Meadow fescue
Festuca elatior var. *arundinacea,* (Schreb.) Wimm.	Alta fescue
Festuca rubra L.	Red fescue
Festuca rubra var. *commutata* Gaud.	Chewings fescue
Hordeum bulbosum L.	Bulbous barley
Medicago sativa L.	Alfalfa
Melilotus alba Desr.	White sweetclover
Onobrychis vulgaris Hill.	Sainfoin
Phalaris arundinacea L.	Reed canarygrass
Phleum pratense L.	Timothy
Poa ampla Merr.	Big bluegrass
Secale montanum Guss.	Mountain rye
S. cereale L. x S. *montanum* Guss.	Michels rye
Triticum aestivum L.	Wheat

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TABLES

Table 1. AVERAGE DAILY GAINS, HAY EATEN, AND OTHER DATA FOR THE SHEEP USED IN THE HAY PALATABILITY TRIALS.

	1940	1941	1942	1943	Average
Average initial weight per head	145	127	136	110	130 lb.
Average final weight per head	151	139	148	117	139 lb.
Difference	+6	+12	+12	+7	+9 lb.
Average daily gain per head[1]	0.33	0.38	0.41	0.35	0.37 lb.
Average amount of hay eaten per head per day	4.25	3.49	3.80	3.72	3.82 lb.
Average amount of hay refused per head per day[2]	0.63	1.51	1.20	1.28	1.16 lb.
Average per cent hay eaten during test period	87	70	76	74	77
Average per cent hay eaten during day	89	74	77	75	79
Average per cent hay eaten during night	84	66	75	74	75
Number of days on test	18	27	25	20	23 days
Number of ewes	4	5	5	5	5
Breed of ewes	Delaine-Merino	Delaine-Merino	Rambouillet	Rambouillet	Fine-wooled breed

[1]Includes a few extra days when sheep were not fed test species.
[2]To study the relative palatability of the different grasses, the ewes were fed liberally, hence the large amount of waste hay.

Table 2. Variations in Percentage of Hay Eaten Daily by Sheep During the Four Years Trial at Union, Oregon.

Kind of hay	Jan. 4	Jan. 5	Jan. 6	Jan. 7	Jan. 8	Jan. 9	Jan. 10	Jan. 11	Jan. 12	Jan. 13	Jan. 14	Jan. 15	Jan. 16	Jan. 17	Jan. 18	Jan. 19	Jan. 20
A. *Hay eaten daily during trial in January 1940*	*Per cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
Check—pea and barley hay	....	85	87	83	82	83	85	87	83	90	80	90	85	82	90	88	82
Tall wheatgrass	....	88	....	....	....	....	91	....	97	....	86	....	....	....	75	95	....
Canada wild-rye	....	92	....	....	91	....	....	....	81	....	....	....	....	86	....	....	....
Alta fescue	....	82	....	....	....	....	75	....	78	....	....	68	....	....	....	....	....
Reed canarygrass	....	72	....	....	....	60	....	....	....	58	....	45	....	....	....	53	....
Beardless wheatgrass	....	....	97	....	....	....	....	....	....	....	....	....	93	....	95	....	....
Timothy	....	....	98	....	....	....	95	....	....	99	91	....	....	....	92	....	....
Big bluegrass	....	....	95	....	....	....	....	....	....	....	....	....	89	....	....	....	....
Orchardgrass	....	....	92	....	....	96	....	78	....	....	....	....	83	....	....	95	75
Smooth brome	....	....	....	99	....	....	....	96	....	....	93	....	....	98	99	....	100
Erect brome	....	....	....	91	....	....	94	....	....	96	....	....	....	93	....	....	99
Meadow fescue	....	....	....	88	....	92	....	....	90	....	....	....	78	....	....	....	....
Tall oatgrass	....	....	....	91	95	....	....	73	....	....	80	....	....	86	....	77	....
Wheat hay	....	....	....	....	85	....	....	93	....	75	....	88	....	....	....	....	....
Michels rye	....	....	....	....	78	82	....	....	....	....	....	92	....	....	....	....	....
Alfalfa	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	100
Sainfoin	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Sweetclover	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Average	....	84	94	90	86	83	88	85	86	84	86	77	86	89	90	82	91

Table 2. VARIATIONS IN PERCENTAGE OF HAY EATEN DAILY BY SHEEP DURING THE FOUR YEARS TRIAL AT UNION, OREGON—*Continued*

Kind of hay	Jan. 21	Jan. 22	Jan. 23	Jan. 24	Jan. 25	Jan. 26	Jan. 27	Jan. 28	Jan. 29	Jan. 30	Jan. 31	Feb. 1	Feb. 2	Feb. 3	Feb. 4	Average	Days fed
A. *Hay eaten daily during trial in January 1940*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
Check—pea and barley hay	92	88	....	....	....	....	....	....	....	....	....	....	....	....	....	86	18
Tall wheatgrass	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	89	6
Canada wild-rye	....	90	....	....	....	....	....	....	....	....	....	....	....	....	....	88	5
Alta fescue	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	76	4
Reed canarygrass	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	58	5
Beardless wheatgrass	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	95	3
Timothy	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	95	5
Big bluegrass	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	92	2
Orchardgrass	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	87	6
Smooth brome	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	98	6
Erect brome	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	95	5
Meadow fescue	90	....	....	....	....	....	....	....	....	....	....	....	....	....	....	87	5
Tall oatgrass	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	84	6
Wheat hay	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	85	4
Michels rye	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	84	3
Alfalfa	100	100	....	....	....	....	....	....	....	....	....	....	....	....	....	100	3
Sainfoin	100	100	....	....	....	....	....	....	....	....	....	....	....	....	....	100	2
Sweetclover	94	92	....	....	....	....	....	....	....	....	....	....	....	....	....	93	2
Average	95	94	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Table 2. VARIATIONS IN PERCENTAGE OF HAY EATEN DAILY BY SHEEP DURING THE FOUR YEARS TRIAL AT UNION, OREGON.—*Continued*

Kind of hay	Jan. 4	Jan. 5	Jan. 6	Jan. 7	Jan. 8	Jan. 9	Jan. 10	Jan. 11	Jan. 12	Jan. 13	Jan. 14	Jan. 15	Jan. 16	Jan. 17	Jan. 18	Jan. 19	Jan. 20
B. *Hay eaten daily during January 1941*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Check—pea and barley hay	....	82	67	74	66	69	73	76	61	63	65	70	66	68	59	75	62
Alta fescue	....	58	....	....	....	....	....	....	....	80	....	....	80	....	....	....	....
Tall wheatgrass	....	62	....	....	....	....	....	....	73	....	....	....	....	....	....	70	....
Canada wild-rye (bloom)	....	58	....	....	....	....	....	....	....	....	73	....	....	68	....	....	....
Reed canarygrass	....	50	....	....	....	....	....	45	....	....	....	41	....	40	....	....	....
Timothy	....	....	80	....	....	....	....	93	....	....	....	....	87	....	....	....	78
Beardless wheatgrass	....	....	67	....	....	....	....	....	87	....	....	....	....	....	87	....	85
Big bluegrass	....	....	71	....	....	....	....	....	....	80	....	....	....	....	....	89	....
Orchardgrass	....	....	79	....	....	....	84	....	....	....	....	86	....	....	....	....	....
Smooth brome	....	....	....	90	....	....	78	....	....	....	....	....	....	....	....	....	84
Tall oatgrass	....	....	....	92	....	88	87	....	....	....	....	....	82	....	....	....	81
Erect brome	....	....	....	55	....	....	....	83	....	....	....	....	....	....	....	87	....
Meadow fescue	....	....	....	58	....	....	....	....	....	62	....	....	....	....	80	....	....
Canada wild-rye (boot)	....	....	....	....	84	....	....	....	84	....	....	....	....	76	....	....	....
Wheat hay	....	....	....	....	46	....	41	....	....	....	....	....	....	....	73	....	....
Bulbous barley	....	....	....	....	61	....	....	....	....	....	77	....	....	60	....	....	....
Michels rye	....	....	....	....	20	....	....	48	....	....	....	39	....	....	....	....	....
Crested wheatgrass	....	....	....	....	....	86	....	....	89	....	....	80	....	....	....	....	....
Meadow foxtail	....	....	....	....	....	68	....	....	....	72	....	....	82	....	....	....	....
Beardless wild-rye	....	....	....	....	....	65	....	....	....	....	68	....	....	....	79	....	....
Alfalfa	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Sainfoin	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Bassia	....	....	....	....	....	....	....	....	....	....	52	....	....	....	....	50	....
Average	....	62	73	74	55	75	73	69	79	71	67	63	79	62	76	74	78

Table 2. VARIATIONS IN PERCENTAGE OF HAY EATEN DAILY BY SHEEP DURING THE FOUR YEARS TRIAL AT UNION, OREGON—*Continued*

Kind of hay	Jan. 21	Jan. 22	Jan. 23	Jan. 24	Jan. 25	Jan. 26	Jan. 27	Jan. 28	Jan. 29	Jan. 30	Jan. 31	Feb. 1	Feb. 2	Feb. 3	Feb. 4	Average	Days fed
B. *Hay eaten daily during January 1941*	*Per cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	
Check—pea and barley hay	58	65	59	57	61	59	66	54	58	58	56	....	....	....	....	65	27
Alta fescue	84	....	81	....	....	....	....	68	....	....	....	....	....	....	....	76	6
Tall wheatgrass	....	74	....	62	....	....	74	....	....	....	....	....	....	....	....	69	6
Canada wild-rye (bloom)	....	....	48	....	....	26	....	....	....	....	37	....	....	....	....	52	6
Reed canarygrass	....	....	....	....	50	....	33	....	....	....	....	....	....	....	....	43	6
Timothy	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	85	4
Beardless wheatgrass	....	....	....	....	....	....	....	91	....	....	....	....	....	....	....	83	5
Big bluegrass	....	87	....	....	89	....	77	....	....	....	....	....	....	....	....	82	6
Orchardgrass	....	....	....	86	....	72	....	78	....	....	....	....	....	....	....	81	6
Smooth brome	....	83	....	....	....	....	....	....	....	....	....	....	....	....	....	84	4
Tall oatgrass	....	....	....	....	....	74	80	....	....	....	....	....	....	....	....	83	7
Erect brome	....	....	....	....	....	....	....	75	....	....	....	....	....	....	....	75	4
Meadow fescue	....	....	....	88	....	....	....	....	....	....	....	....	....	....	....	72	4
Canada wild-rye (boot)	76	....	....	86	74	....	....	....	....	....	....	....	....	....	....	80	6
Wheat hay	....	....	64	....	....	....	....	....	....	....	....	....	....	....	....	56	4
Bulbous barley	....	....	....	....	....	....	....	....	....	46	....	....	....	....	....	61	4
Michels rye	37	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36	4
Crested wheatgrass	....	87	....	....	....	89	....	....	....	....	....	....	....	....	....	86	5
Meadow foxtail	....	....	83	....	78	....	....	....	....	....	....	....	....	....	....	77	5
Beardless wild-rye	77	....	....	....	....	....	....	....	....	....	....	....	....	....	....	72	4
Alfalfa	....	....	....	....	....	....	....	....	86	77	83	....	....	....	....	82	3
Sainfoin	....	....	....	....	....	....	....	....	69	74	78	....	....	....	....	74	3
Bassia	....	....	....	....	....	....	....	....	44	....	....	....	....	....	....	49	3
Average	66	79	67	76	70	64	66	73	64	64	64	....	....	....	....	....	....

Table 2. Variations in Percentage of Hay Eaten Daily by Sheep During the Four Years Trial at Union, Oregon—*Continued*

Kind of hay	Jan. 4	Jan. 5	Jan. 6	Jan. 7	Jan. 8	Jan. 9	Jan. 10	Jan. 11	Jan. 12	Jan. 13	Jan. 14	Jan. 15	Jan. 16	Jan. 17	Jan. 18	Jan. 19	Jan. 20
C. *Hay eaten daily in January and early February 1942*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per cent*
Check—wild hay	....	....	96	92	92	92	96	96	92	94	....	....	....	....	....	98	90
Crested wheatgrass	....	....	92	....	....	....	....	....	....	....	....	....	....	....	....	98	....
Beardless wheatgrass	....	....	92	....	....	....	....	86	....	....	....	....	....	....	....	....	....
Wheat hay	....	....	60	....	....	....	....	....	50	....	....	....	....	....	....	....	....
Alta fescue	....	....	40	....	....	....	....	....	....	38	....	....	....	....	....	....	....
Canada wild-rye (boot)	....	....	....	78	....	....	....	54	....	....	....	....	....	....	....	....	....
Tall wheatgrass (boot)	....	....	....	66	....	....	....	....	....	54	....	....	....	....	....	....	....
Canada wild-rye (bloom)	....	....	....	44	....	....	....	....	54	....	....	....	....	....	....	....	....
Tall wheatgrass (bloom)	....	....	....	52	....	....	....	....	....	....	....	....	....	....	....	....	46
Timothy	....	....	....	....	90	....	....	....	....	....	....	....	....	....	....	96	....
Beardless wild-rye	....	....	....	....	84	....	....	80	....	....	....	....	....	....	....	....	....
Meadow fescue	....	....	....	....	32	....	....	....	....	....	....	....	....	....	....	....	48
Reed canarygrass	....	....	....	....	48	....	....	....	42	....	....	....	....	....	....	....	....
Meadow foxtail	....	....	....	....	....	82	....	....	....	....	....	....	....	....	....	....	98
Smooth brome	....	....	....	....	....	64	....	40	....	....	....	....	....	....	....	....	....
Erect brome	....	....	....	....	....	50	....	....	....	28	....	....	....	....	....	....	....
Michels rye	....	....	....	....	....	24	....	....	....	....	....	....	....	....	....	24	....
Big bluegrass	....	....	....	....	....	....	86	....	....	....	....	....	....	....	....	....	96
Orchardgrass	....	....	....	....	....	....	72	....	88	....	....	....	....	....	....	....	....
Tall oatgrass	....	....	....	....	....	....	54	....	....	88	....	....	....	....	....	....	....
Bulbous barley	....	....	....	....	....	....	58	....	....	....	....	....	....	....	....	88	....
Sainfoin	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Alfalfa	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Average	....	....	76	66	69	62	73	71	65	60	....	....	....	....	....	81	76

Table 2. Variations in Percentage of Hay Eaten Daily by Sheep During the Four Years Trial at Union, Oregon—*Continued*

Kind of hay	Jan. 21	Jan. 22	Jan. 23	Jan. 24	Jan. 25	Jan. 26	Jan. 27	Jan. 28	Jan. 29	Jan. 30	Jan. 31	Feb. 1	Feb. 2	Feb. 3	Feb. 4	Average	Days fed
C. *Hay eaten daily January and early February 1942*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
Check—wild hay	96	98	96	94	90	98	96	98	96	86	94	92	89	90	88	94	25
Crested wheatgrass	....	....	100	....	....	....	....	100	....	....	....	84	....	....	....	95	5
Beardless wheatgrass	84	....	....	....	....	....	94	....	....	....	....	....	92	....	....	90	5
Wheat hay	....	....	....	....	....	58	....	....	....	....	80	....	....	80	....	66	5
Alta fescue	....	....	....	80	....	....	....	60	....	....	....	....	....	....	40	52	5
Canada wild-rye (boot)	....	....	....	....	....	78	....	....	....	....	60	....	....	....	....	68	4
Tall wheatgrass (boot)	....	....	....	....	40	....	....	....	80	....	....	....	....	....	....	60	4
Canada wild-rye (bloom)	....	....	....	50	....	....	....	....	78	....	....	....	....	....	....	57	4
Tall wheatgrass (bloom)	....	....	....	....	....	48	....	....	....	....	46	....	....	....	....	48	4
Timothy	84	....	....	....	94	....	....	....	....	94	....	....	....	....	....	92	5
Beardless wild-rye	..	....	68	....	....	....	48	....	66	....	....	....	....	....	....	69	5
Meadow fescue	....	82	....	....	....	....	66	....	....	....	....	....	....	....	....	57	4
Reed canarygrass	....	....	....	76	....	....	....	....	....	....	46	....	....	....	....	53	4
Meadow foxtail	....	....	98	....	98	....	....	....	....	94	....	....	....	....	....	94	4
Smooth brome	....	52	....	....	68	....	....	....	....	28	....	....	....	....	....	51	5
Erect brome	....	38	....	....	....	....	....	48	....	....	....	....	....	....	....	41	4
Michels rye	....	....	....	22	....	....	....	....	44	....	....	....	....	....	....	29	4
Big bluegrass	96	....	....	....	....	98	....	100	....	....	....	....	....	....	....	95	5
Orchardgrass	96	....	....	....	....	....	96	....	....	84	....	....	....	....	....	87	5
Tall oatgrass	....	94	80	....	....	....	....	....	....	....	....	....	....	....	....	79	4
Bulbous barley	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	73	2
Sainfoin	....	....	....	....	....	....	....	....	....	....	....	95	93	83	92	91	4
Alfalfa	....	....	....	....	....	....	....	....	....	....	....	78	67	57	82	71	4
Average	91	73	88	64	78	76	80	81	73	77	65	87	85	78	76	....	....

Table 2. VARIATIONS IN PERCENTAGE OF HAY EATEN DAILY BY SHEEP DURING THE FOUR YEARS TRIAL AT UNION, OREGON—*Continued*

Kind of hay	Jan. 4	Jan. 5	Jan. 6	Jan. 7	Jan. 8	Jan. 9	Jan. 10	Jan. 11	Jan. 12	Jan. 13	Jan. 14	Jan. 15	Jan. 16	Jan. 17	Jan. 18	Jan. 19	Jan. 20
D. *Hay eaten early in January 1943*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per cent*
Check—wild hay	62	64	44	82	74	70	88	80	80	86	76	82	76	78	76	70	74
Big bluegrass	74	....	....	....	90	....	....	....	64	....	82	....	....	....	....	....	....
Crested wheatgrass	88	....	....	....	....	94	....	....	....	96	....	96	....	....	....	....	....
Slender wheatgrass	62	....	....	....	....	....	50	....	....	....	....	....	....	68	....	50	....
Beardless wheatgrass	86	....	....	....	....	....	....	96	....	....	....	....	98	....	94	....	94
Sainfoin	....	90	....	....	92	....	....	....	....	....	....	....	....	84	....	....	88
Meadow foxtail	....	86	....	....	....	76	....	....	90	....	....	....	....	....	94	....	....
Timothy	....	70	....	....	....	....	74	....	....	60	70	....	80	....	....	....	....
Tall oatgrass	....	70	....	....	....	....	....	74	....	....	....	90	....	....	....	82	....
Smooth brome	....	....	86	....	90	....	....	....	....	....	....	....	....	....	88	94	....
Orchardgrass	....	....	66	....	....	78	....	....	....	....	....	....	....	86	....	....	76
Meadow fescue	....	....	90	....	....	....	92	....	80	....	....	64	92	....	....	....	....
Alta fescue	....	....	48	....	....	....	....	56	....	60	60	....	....	....	....	....	....
Canada wild-rye	....	....	....	46	42	....	....	....	....	36	....	....	....	....	22	....	....
Tall wheatgrass	....	....	....	54	....	58	....	....	....	....	64	....	60	....	....	42	....
Reed canarygrass	....	....	....	54	....	....	40	....	....	....	....	64	....	....	....	....	50
Mountain rye	....	....	....	96	....	....	....	84	94	....	....	....	....	92	....	....	....
Average	74	76	67	66	78	75	69	78	82	68	70	79	81	82	75	68	76

Table 2. VARIATIONS IN PERCENTAGE OF HAY EATEN DAILY BY SHEEP DURING THE FOUR YEARS TRIAL AT UNION, OREGON—*Continued*

Kind of hay	Jan. 21	Jan. 22	Jan. 23	Jan. 24	Jan. 25	Jan. 26	Jan. 27	Jan. 28	Jan. 29	Jan. 30	Jan. 31	Feb. 1	Feb. 2	Feb. 3	Feb. 4	Average	Days fed
D. *Hay eaten daily in January 1943*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	
Check—wild hay	58	72	82	....	....	....	....	....	....	....	....	....	....	....	....	74	20
Big bluegrass	....	86	....	....	....	....	....	....	....	....	....	....	....	....	....	79	5
Crested wheatgrass	98	....	....	....	....	....	....	....	....	....	....	....	....	....	....	94	5
Slender wheatgrass	....	....	54	....	....	....	....	....	....	....	....	....	....	....	....	57	5
Beardless wheatgrass	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	94	5
Sainfoin	94	....	....	....	....	....	....	....	....	....	....	....	....	....	....	90	5
Meadow foxtail	....	....	94	....	....	....	....	....	....	....	....	....	....	....	....	88	5
Timothy	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	71	5
Tall oatgrass	....	80	....	....	....	....	....	....	....	....	....	....	....	....	....	79	5
Smooth brome	94	....	....	....	....	....	....	....	....	....	....	....	....	....	....	90	5
Orchardgrass	....	76	....	....	....	....	....	....	....	....	....	....	....	....	....	76	5
Meadow fescue	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	84	5
Alta fescue	....	....	58	....	....	....	....	....	....	....	....	....	....	....	....	56	5
Canada wild-rye	....	....	44	....	....	....	....	....	....	....	....	....	....	....	....	38	5
Tall wheatgrass	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	56	5
Reed canarygrass	....	48	....	....	....	....	....	....	....	....	....	....	....	....	....	51	5
Mountain rye	94	....	....	....	....	....	....	....	....	....	....	....	....	....	....	92	5
Average	88	72	66	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Table 3. Relative Palatability of Grass and Legume Hays Based on Feeding Trials with Sheep and Expressed as Percentage Hay Eaten.

Kind of hay	Hay eaten of amount offered				
	1940	1941	1942	1943	Average
Hays fed for four years	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Beardless wheatgrass	95	83	90	94	91
Sainfoin	100	74	91	90	89
Big bluegrass	92	82	95	79	87
Timothy	95	85	92	71	86
Orchardgrass	87	81	87	76	83
Smooth brome	98	84	51	90	81
Tall oatgrass	84	83	79	79	81
Meadow fescue	88	72	57	84	75
Tall wheatgrass	89	69	48	56	66
Alta fescue	76	76	52	56	65
Canada wild-rye	88	52	57	38	59
Reed canarygrass	58	43	53	51	51
Hays fed for three years					
Crested wheatgrass	*	86	95	94	92
Beardless wheatgrass	†	83	90	94	89
Meadow foxtail	*	77	94	88	86
Timothy	†	85	92	71	83
Sainfoin	100	74	91	†	88
Alfalfa	100	82	71	*	84
Smooth brome	98	84	51	†	78
Erect brome	95	75	41	*	70
Wheat hay	85	56	66	*	69
Michels rye	84	36	29	*	50
Hays fed for two years					
Beardless wild-rye	*	72	69	*	71
Canada wild-rye	†	52	57	†	55
Bulbous barley	*	61	73	*	67
Wheat hay	†	56	66	*	61
Hays fed for one year					
Mountain rye	*	*	*	92	....
White sweetclover	93	*	*	*	....
Slender wheatgrass	*	*	*	57	....
Alkali weed (Bassia)	*	49	*	*	....
Hays fed as check and average for all hays					
Pea and barley check	86	65	*	*	76
Wild grass hay check	*	*	94	74	84
Both check hays	86	65	94	74	80
Average per cent eaten	87	70	76	74	77

* Hay not fed.
† Data eliminated to give comparable averages.

Table 4. Percentage Leaves, Stems and Heads of Grasses as Determined by Hand Separation of Plant Parts and the Percentage Protein in Some of the Hays Fed to Sheep to Determine Palatability.

Kind of hay	Percentage of plant parts								
	1942			1943			Average		
	Leaves	Stems	Heads	Leaves	Stems	Heads	Leaves	Stems	Heads
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Crested wheatgrass	24	56	20	37	51	12	30.5	53.5	16.0
Beardless wheatgrass	46	45	9	35	46	19	40.5	45.5	14.0
Big bluegrass	46	35	19	48	28	24	47.0	31.5	21.5
Meadow foxtail	49	34	17	56	35	9	52.5	34.5	13.0
Timothy	31	54	15	37	47	16	34.0	50.5	15.5
Orchardgrass	28	52	20	42	42	16	35.0	47.0	18.0
Smooth brome	25	61	14	46	41	13	35.5	51.0	13.5
Tall oatgrass	33	51	16	34	53	13	33.5	52.0	14.5
Meadow fescue	34	53	13	45	36	19	39.5	44.5	16.0
Alta fescue	32	50	18	37	48	15	34.5	49.0	16.5
Tall wheatgrass	40	47	13	49	39	12	44.5	43.0	21.5
Reed canarygrass	34	63	3	42	55	3	38.0	59.0	3.0
Canada wild-rye	44	44	12	37	47	16	40.5	45.5	14.0
Tall wheatgrass (boot)	70	28	2	....	....	....	.....	.....	.....
Tall wheatgrass (bloom)*	40	47	13	....	....	....	.....	.....	.....
Canada wild-rye (boot)	50	40	10	....	....	....	.....	.....	.....
Canada wild-rye (bloom)*	44	44	12	....	....	....	.....	.....	.....
Erect brome	22	57	21	....	....	....	.....	.....	.....
Smooth brome*	25	61	14	....	....	....	.....	.....	.....
Beardless wild-rye	65	30	5	....	....	....	.....	.....	.....
Bulbous barley	44	45	11	....	....	....	.....	.....	.....
Wheat hay	34	51	15	....	....	....	.....	.....	.....
Michels rye	27	60	13	....	....	....	.....	.....	.....
Mountain rye	....	....	....	37	44	19	.....	.....	.....
Slender wheatgrass	....	....	....	43	35	22	.....	.....	.....

* Repeated for ease of comparison.

Table 4. Percentage Leaves, Stems and Heads of Grasses as Determined by Hand Separation of Plant Parts and the Percentage Protein in Some of the Hays Fed to Sheep to Determine Palatability.—*Continued*

Kind of hay	Percentage protein (N × 6.25) in plant parts and hay											
	1942				1943				Average			
	Leaves	Stems	Heads	Hay	Leaves	Stems	Heads	Hay	Leaves	Stems	Heads	Hay
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Crested wheatgrass	10.83	4.64	13.85	7.97	9.21	3.23	11.32	6.41	10.02	3.94	12.59	7.19
Beardless wheatgrass	9.91	4.00	8.97	7.17	11.70	5.07	11.05	8.53	10.81	4.54	10.01	7.85
Big bluegrass	6.80	3.07	9.16	5.94	8.70	4.78	10.44	8.02	7.75	3.93	9.80	6.98
Meadow foxtail	12.42	9.19	16.34	11.99	9.35	4.31	11.82	7.81	10.89	6.75	14.08	9.90
Timothy	7.90	2.31	11.77	5.46	8.81	3.15	12.71	6.77	8.36	2.73	12.24	6.12
Orchardgrass	8.40	3.47	10.43	6.24	8.05	3.18	10.63	6.42	8.23	3.33	10.53	6.33
Smooth brome	5.55	2.60	9.62	4.32	10.56	3.98	11.42	7.97	8.06	3.29	10.52	6.15
Tall oatgrass	8.89	3.82	11.26	6.76	7.95	3.40	12.07	6.07	8.42	3.61	11.67	6.42
Meadow fescue	6.63	3.29	9.88	5.28	9.61	4.07	12.07	8.03	8.12	3.68	10.98	6.66
Alta fescue	8.98	3.76	11.34	6.79	9.20	4.03	10.70	6.94	9.09	3.90	11.02	6.87
Tall wheatgrass	7.16	2.35	8.50	5.07	9.44	3.60	10.10	7.24	8.30	2.98	9.30	6.16
Reed canarygrass	10.68	2.57	12.43	5.62	12.93	3.51	11.86	7.72	11.81	3.04	12.15	6.67
Canada wild-rye	5.48	1.98	8.71	4.33	5.40	1.79	9.40	4.34	5.44	1.89	9.06	4.34
Tall wheatgrass (boot)	10.69	5.55	13.54	9.31	.....	.....	.....	.....	.....	.....	.....	.....
Tall wheatgrass (bloom)*	7.16	2.35	8.50	5.07	.....	.....	.....	.....	.....	.....	.....	.....
Canada wild-rye (boot)	8.46	2.96	11.39	6.55	.....	.....	.....	.....	.....	.....	.....	.....
Canada wild-rye (bloom)*	5.48	1.98	8.71	4.33	.....	.....	.....	.....	.....	.....	.....	.....
Erect brome	5.93	3.72	11.10	5.76	.....	.....	.....	.....	.....	.....	.....	.....
Smooth brome*	5.55	2.60	9.62	4.32	.....	.....	.....	.....	.....	.....	.....	.....
Beardless wild-rye	6.76	4.10	8.63	6.06	.....	.....	.....	.....	.....	.....	.....	.....
Bulbous barley	12.10	5.88	10.22	9.09	.....	.....	.....	.....	.....	.....	.....	.....
Wheat hay	11.35	3.97	10.34	7.43	.....	.....	.....	.....	.....	.....	.....	.....
Michels rye	6.79	3.26	12.47	5.41	.....	.....	.....	.....	.....	.....	.....	.....
Mountain rye	.....	.....	.....	.....	12.88	4.84	11.45	9.07	.....	.....	.....	.....
Slender wheatgrass	.....	.....	.....	.....	6.15	2.81	10.00	5.83	.....	.....	.....	.....

* Repeated for ease of comparison.

Table 5. Average Hay Yields in Nursery Rows from 1939 to 1942, Inclusive, Average Palatability from 1940 to 1943, Inclusive, and Calculated Yield of Edible Hay Based on Data from the Grass Nursery and Hay Palatability Trials at Union, Oregon.

Kind of hay	Hay yield per acre	Palatability	Edible hay per acre	Rank
	Tons	*Per cent*	*Tons*	
Crested wheatgrass	2.13	92	1.96	7
Smooth brome	2.48	91*	2.26	4
Beardless wheatgrass	0.99	91	0.91	15
Big bluegrass	2.21	87	1.92	8
Meadow foxtail	2.08	86	1.79	11
Timothy	2.45	86	2.11	5
Orchardgrass	1.89	83	1.57	13
Tall oatgrass	2.25	81	1.82	10
Meadow fescue	1.67	75	1.25	14
Erect brome	2.68	70	1.88	9
Wheat hay	3.00†	69	2.07	6
Tall wheatgrass	7.33	66	4.84	1
Alta fescue	3.64	65	2.37	3
Canada wild-rye	4.56	59	2.69	2
Reed canarygrass	3.22	51	1.64	12

* Average of three years considered typical.

† Average yield of wheat hays in plots at the Eastern Oregon Livestock Branch Experiment Station for a long period of years.

Table 6. Total Monthly Precipitation in Inches and Average Monthly Mean Temperature in Degrees F. at Union, Oregon, During the Establishment Years and Grazing Years for Grasses in the Pasture Yield and Palatability Trial. (Data from Records of the Eastern Oregon Livestock Experiment Station at Union, Oregon.)

Crop year	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
Total precipitation	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1939-40	.61	.52	.01	1.16	1.41	2.02	2.48	1.91	.80	.51	1.17	.00	12.60
1940-41	3.51	2.46	1.88	.61	.83	1.53	.48	1.31	3.70	3.72	1.05	1.90	22.98
1941-42	2.00	1.78	.98	1.99	.96	.97	1.10	2.04	3.68	2.55	.46	.48	18.99
1942-43	.14	.73	2.27	1.77	2.01	.96	.79	1.08	1.34	2.27	.67	.72	14.75
1943-44	.00	1.52	.53	.46	.22	1.16	.94	1.49	.73	3.34	.16	.07	10.62
5 year average	1.25	1.40	1.13	1.20	1.09	1.33	1.16	1.57	2.05	2.48	.70	.63	15.99
35 year normal	0.92	1.12	1.22	1.26	1.12	0.93	1.27	1.26	1.54	1.33	0.55	0.62	13.14
Average mean temperature	*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F*	*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F.*
1939-40	58	48	41	40	34	39	44	48	57	63	68	66	51
1940-41	61	52	35	37	37	40	44	48	54	58	68	66	50
1941-42	54	48	43	36	28	32	40	49	51	57	67	65	48
1942-43	58	51	40	34	26	36	39	51	49	54	65	63	47
1943-44	61	49	41	34	30	34	38	48	56	58	65	64	48
5 year average	58	50	40	36	31	36	41	49	53	58	67	65	49
35 year normal	56.6	48.1	39.1	31.9	29.1	33.4	40.1	47.1	53.2	59.4	66.6	65.0	47.5

Table 7. Dates and Number of Days Pastures Were Grazed and Number of Sheep Days Furnished by the Pastures and the Average Amount of Green Feed Eaten per Sheep Day During Three Years of Trial at Union, Oregon.

Grazing period	First grazing year, 1942			Second grazing year, 1943			Third grazing year, 1944			Average for three years	
	Dates pastured	Grazing days	Sheep days	Dates pastured	Grazing days	Sheep days	Dates pastured	Grazing days	Sheep days	Grazing days	Sheep days
1—late spring	May 23 to June 1	10	720	April 30 to May 8	9	434	May 3 to 5	3	280	7	478
2—summer	July 8 to 14	7	497	June 10 to 12	3	327	June 7 to 10	4	240	5	355
3—late summer	Sept. 30 to Oct. 2	3	150	July 27 to Aug. 4	9	540	Aug. 12 to 17	6	360	6	350
	Total	20	1,367	Total	21	1,301	Total	13	880	18	1,183
	Green feed eaten per sheep day: 5.8 pounds			Green feed eaten per sheep day: 6.4 pounds			Green feed eaten per sheep day: 6.0 pounds			Green feed eaten per sheep day: 6.1 pounds	

Table 8. Palatability of Pasture Grasses as Determined by Percentage of Grass Eaten by Sheep at Three Grazing Seasons During a Three-year Period at Union, Oregon

	Pasture grasses	Available grass eaten by sheep*															
		Grazing periods, 1942				Grazing periods, 1943				Grazing periods, 1944				Grazing periods, average			
		1	2	3	Average†	1	2	3	Average†	1	2	3	Average†	1	2	3	Average‡
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
1	Smooth brome	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
2	Akaroa orchardgrass	100	100	100	100	100	100	100	100	.....	100	100	100	100	100	100	100
3	Meadow foxtail	71	92	100	88	100	100	100	100	100	100	100	100	90	97	100	96
4	Meadow fescue	88	82	100	90	100	100	95	98	100	100	85	95	96	94	93	94
5	Tall oatgrass	77	84	100	87	100	100	95	98	100	100	85	95	92	95	93	93
6	Creeping timothy	100	100	.....	66	100	100	50	83	.....	.....	.....	.....	100	100	50	90
7	Creeping red fescue	73	100	100	91	100	75	90	88	100	80	.....	90	91	85	95	90
8	Mountain brome	100	100	25	75	95	100	100	98	.....	.....	.....	.....	98	100	63	87
9	Standard crested wheat	100	100	T§	66	100	100	85	95	100	100	80	93	100	100	55	85
10	Fairway crested wheat	87	100	T	62	100	100	85	95	91	100	80	90	93	100	55	83
11	Canada wild-rye	100	100	T	66	100	100	75	92	90	90	.....	90	97	97	38	82
12	Pubescent wheatgrass	80	83	.....	82	60	100	70	77	100	95	60	85	80	93	65	81
13	Alta fescue	56	91	100	82	80	30	85	65	30	90	85	68	55	70	90	72
14	Slender wheatgrass	100	75	.....	58	100	100	75	92	100	100	65	88	100	92	47	79
15	Chewings fescue	54	100	100	85	100	45	95	80	63	70	.....	67	72	72	98	78
16	Erect brome	68	100	.....	56	100	51	95	82	100	94	50	81	89	82	48	73
17	Beardless wild-rye	94	93	.....	62	100	31	70	67	69	90	.....	80	88	71	35	68
18	Big bluegrass	67	74	.....	47	95	54	60	70	36	75	10	40	66	68	23	52

* Based on amount of grass available above a 4-inch stubble which is necessary for soil protection and maintenance of pasture stand and vigor.
† Arithmetical average of three periods; for weighted average based on total available feed produced and eaten per year see Table 10.
‡ Grand average of individual figures by grazing periods and not of period averages.
§ T = Trace.

Table 9. Yield of Pasture Grasses in Pounds of Green Feed per Acre Above a Four-inch Stubble at Three Grazing Seasons During a Three-year Period at Union, Oregon.

	Pasture grasses	Green yield per acre*															
		Grazing periods, 1942				Grazing periods, 1943				Grazing periods, 1944				Grazing periods, average			
		1	2	3	Total	1	2	3	Total	1	2	3	Total	1	2	3	Total
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1	Tall oatgrass	6,370	6,470	1,830	14,670	4,700	3,210	3,130	11,040	1,300	3,030	2,490	6,820	4,120	4,240	2,480	10,840
2	Alta fescue	4,230	2,640	1,540	8,410	3,140	4,810	2,530	10,480	800	3,130	1,360	5,290	2,720	3,530	1,810	8,060
3	Meadow fescue	3,010	4,070	1,480	8,560	2,150	4,530	3,160	9,840	130	2,500	1,410	4,040	1,760	3,700	2,020	7,480
4	Pubescent wheatgrass	3,360	2,550	180	6,090	1,490	3,260	2,050	6,800	1,300	3,290	1,040	5,630	2,050	3,030	1,090	6,170
5	Meadow foxtail	4,730	2,480	510	7,720	2,970	1,610	1,820	6,400	620	1,510	510	2,640	2,770	1,870	950	5,590
6	Big bluegrass	3,090	2,520	1,610	7,220	1,320	1,480	2,240	5,040	640	460	680	1,780	1,680	1,490	1,510	4,680
7	Slender wheatgrass	2,720	2,310	650	5,680	1,650	1,250	2,680	5,580	540	1,050	920	2,510	1,640	1,540	1,420	4,600
8	Fairway crested wheat	2,370	890	780	4,040	2,810	1,560	450	4,820	1,390	790	640	2,820	2,190	1,080	620	3,890
9	Standard crested wheat	2,150	1,320	540	4,010	2,640	2,110	530	5,280	520	920	680	2,120	1,770	1,450	580	3,800
10	Erect brome	2,670	1,320	380	4,370	1,570	1,450	840	3,860	220	1,180	290	1,690	1,490	1,320	500	3,310
11	Smooth brome	1,270	1,560	400	3,230	1,650	1,920	1,260	4,830	90	1,050	460	1,600	1,000	1,510	710	3,220
12	Canada wild-rye	1,880	2,010	840	4,730	740	1,050	1,890	3,680	110	330	0	440	910	1,130	910	2,950
13	Beardless wild-rye	1,270	2,710	450	4,430	740	1,300	1,500	3,540	110	660	0	770	710	1,560	650	2,920
14	Akaroa orchardgrass	1,040	1,810	970	3,820	1,400	920	950	3,270	0	460	950	1,410	810	1,060	960	2,830
15	Chewings fescue	1,790	720	490	3,000	1,240	1,610	160	3,010	210	590	0	800	1,080	970	220	2,270
16	Creeping red fescue	1,920	900	790	3,610	910	630	240	1,780	190	400	0	590	1,010	640	340	1,990
17	Mountain brome	1,790	1,030	950	3,770	330	320	1,080	1,730	0	0	0	0	710	450	680	1,840
18	Creeping timothy	120	1,070	0	1,190	830	30	210	1,070	0	0	0	0	320	370	70	760

* Yield based on 1/100 acre strip lengthwise of plot.

Table 10. Total Annual Yield as Tons of Green Pasture Forage per Acre, Palatability as Percentage Feed Eaten Above a Four-inch Stubble and the Calculated Grazing Capacity in Animal Unit Days per Acre for Sheep on the Grasses During a Three-year Period in the Pasture Yield and Palatability Trial at Union, Oregon.

	Pasture grasses	Green feed yield per acre				Amount feed eaten				Grazing capacity per acre (animal unit days)			
		1942	1943	1944	Average	1942	1943	1944	Average	1942	1943	1944	Average
		Tons	*Tons*	*Tons*	*Tons*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*A.U.D.*	*A.U.D.*	*A.U.D.*	*A.U.D.*
1	Tall oatgrass	7.3	5.5	3.4	5.4	83	99	95	92	422	338	215	325
2	Meadow fescue	4.3	4.9	2.0	3.7	87	98	95	93	258	301	128	229
3	Alta fescue	4.2	5.2	2.6	4.0	75	58	80	71	217	188	140	182
4	Pubescent wheatgrass	3.0	3.4	2.8	3.1	80	91	90	87	169	193	168	177
5	Meadow foxtail	3.9	3.2	1.3	2.8	80	100	100	93	212	199	88	166
6	Slender wheatgrass	2.8	2.8	1.3	2.3	78	87	87	84	154	150	73	126
7	Standard crested wheat	2.0	2.6	1.1	1.9	87	98	94	93	120	161	66	116
8	Fairway crested wheat	2.0	2.4	1.4	1.9	73	99	91	88	102	148	86	112
9	Smooth brome	1.6	2.4	0.8	1.6	100	100	100	100	112	150	54	105
10	Akaroa orchardgrass	1.9	1.6	0.7	1.4	100	100	100	100	132	102	47	94
11	Erect brome	2.2	1.9	0.8	1.6	72	81	87	80	108	97	49	85
12	Big bluegrass	3.6	2.5	0.9	2.3	55	58	36	50	136	91	22	83
13	Canada wild-rye	2.4	1.8	0.2	1.5	82	87	90	86	134	99	13	82
14	Beardless wild-rye	2.2	1.8	0.4	1.5	84	61	87	77	128	67	22	72
15	Creeping red fescue	1.8	0.9	0.3	1.0	86	90	86	87	107	50	17	58
16	Chewings fescue	1.5	1.5	0.4	1.1	72	70	68	70	75	66	18	53
17	Mountain brome	1.9	0.9	0.0	0.9	75	100	.....	88	97	54	0	50
18	Creeping timothy	0.6	0.5	0.0	0.4	100	90	.....	95	41	30	0	24

Table 11. Estimated Per Cent Stand and Seeding Data on Grasses, Together with Estimated Basal Density as Determined by the Square Foot Density Method in the Pasture Yield and Palatability Trial at Union, Oregon. The Grasses Were Seeded on April 3, 1940 and the Arrangement of the Plots and the Accession Numbers of the Grasses Are Given.

Plot numbers, pasture grasses, and accession numbers*	Germination	Purity	Live, pure seed	Seeding rate per acre	Number of seeds per pound	Live, pure seeds per square foot	Estimated stand				Basal density			
							1940	1941	1942	1943	1944	1941	1942	Average
	Per cent	*Per cent*	*Per cent*	*Pounds*			*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
401 Crested wheatgrass—Standard	91	98	89	15	172,000	53	100	90	90	100	95	11.0	20.0	15.5
402 Thickspike wheatgrass—P-1822	90	76	68	20	156,000	49	80	50	50	0§	....	4.0	1.8	2.9
403 Crested wheatgrass—Fairway	95	95	90	15	243,000	75	50	75	50	100	85	14.3	25.1	19.7
404 Creeping timothy—S-50	90	86	77	20	1,200,000	424	†	90	100	100	0	38.4	45.0	41.7
405 Pubescent wheatgrass—PI-107,326	90	93	83	20	89,000	34	30	50	50	95	90	12.4	13.4	12.9
406 Tall oatgrass—Commercial	70	80	56	25	155,000	50	85	75	90	90	90	14.3	15.2	14.8
407 Slender wheatgrass—Commercial	95	98	93	18	178,000	68	90	90	90	90	90	14.7	17.2	16.0
408 Meadow fescue—Commercial	97	99	96	15	294,000	97	100	100	100	100	100	16.2	30.6	23.4
409 Meadow foxtail—PI-110,351	40	94	38	20	544,000	95	25	90	95	100	100	14.3	29.0	21.7
410 Alta fescue—FC 29366	96	95	91	15	216,000	68	90	100	95	100	100	17.2	26.0	21.6
411 Canada wild-rye—P-3355	94	98	92	20	80,000	34	80	85	95	65	25	8.7	13.0	10.9
412 Creeping red fescue—S-59	57	90	51	15	500,000	88	50	70	75	100	90	20.7	34.0	27.4
413 Erect brome—PI-98,277	98	95	93	20	212,000	52	75	75	95	95	80	13.1	14.2	13.7
414 Chewings fescue—Commercial	97	96	93	15	537,000	172	80	90	100	100	80	16.5	29.6	23.1
415 Smooth brome—PI-109-812	96	85	82	20	118,000	44	90	95	95	95	100	13.8	12.6	13.2
416 Big bluegrass—P-2716	62	86	53	15	920,000	168	30	80	85	85	90	12.0	12.0	12.0
417 Orchardgrass—Akaroa	82	87	71	15	488,000	119	100	95	100	90	90	21.2	23.4	22.3
418 Beardless wild-rye—P-3250	62	91	56	30	170,000	65	20	90	60	60	75	3.0	8.8	5.9
419 Mountain brome—P-3368	91	99	90	20	45,000	18	100	95	100	40	10	10.6	18.6	14.6
420 Michels rye—Commercial	90	99	89	40	15,000	12	95	100	0‡	....	....	0.0	0.0	0.0

* P—Accession numbers of the Soil Conservation Nurseries in the Pacific Coast Region. S—Accession numbers of the Plant Breeding Station at Aberstyth, Wales. FC—Accession numbers of the Division of Forage Crops and Diseases, U. S. Department of Agriculture. PI Accession numbers of the Division of Plant Exploration and Introduction, U. S. Department of Agriculture Commercial-seed of species same as that commonly available on the market.

† Originally seeded to beardless wheatgrass, P-3537, but poor stand was obtained and it was plowed out and the plot seeded to creeping timothy in the fall of 1940.

‡ Seeded to mountain rye P-4888, in the spring of 1943.

§ Seeded to bulbous barley, P-306, in the spring of 1943.

Table 12. Height in Inches, Stage of Maturity, and Per Cent Dry Matter in Green Forage Harvested from the Pasture Plots at Several Grazing Periods at Union, Oregon.

	Height									Stage of plant growth at grazing*								
	Grazing periods, 1942			Grazing periods, 1943			Grazing periods, 1944			Grazing periods, 1942			Grazing periods 1943			Grazing periods 1944		
Pasture grasses	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*									
Standard crested wheat	8	6	4	....	12	8	6	....	....	V-Bt	H*	V	....	H	V	V	....	....
Thickspike wheatgrass	8	....	7	....	....	....	....	....	....	V	....	V	....	D	....	....	....	....
Fairway crested wheat	9	10	6	....	10	6	7	....	....	V-Bt	B*	V	....	H*	Bt	V	....	....
Creeping timothy	2	10	2	....	2	7	....	....	....	V	B	V	....	V	H	D	....	....
Pubescent wheatgrass	12	28	7	....	14	17	8	....	....	V	H	V	....	Bt	B	V	....	....
Tall oatgrass	20	32	14	....	18	28	10	....	....	Bt	B	½H	....	H	B	Bt	....	....
Slender wheatgrass	8	18	5	....	9	16	5	....	....	V	B	V	....	Bt	H	V	....	....
Meadow fescue	9	18	9	....	13	18	3	....	....	V	B	V	....	H	B	V	....	....
Meadow foxtail	9	18	9	....	13	18	3	....	....	B	B*	V	....	H*	H*	V	....	....
Alta fescue	16	22	5	....	10	10	6	....	....	V	B*	V	....	H	H	V	....	....
Canada wild-rye	12	15	9	....	18	12	8	....	....	V	Bt	H	....	Bt	H	V	....	....
Creeping red fescue	8	20	10	....	9	18	4	....	....	Bt-H	B*	V	....	H	V	V	....	....
Erect brome	10	10	9	....	8	4	6	....	....	Bt-H	Bt*	V	....	H	V	V	....	....
Chewings fescue	10	15	6	....	15	7	6	....	....	Bt-H	B*	V	....	H	V	V	....	....
Smooth brome	7	8	5	....	10	3	4	....	....	Bt	B*	V	....	H	V	V	....	....
Big bluegrass	10	12	5	....	14	8	4	....	....	H	Bt*	V	....	B	V	Bt	....	....
Akaroa orchardgrass	16	14	11	....	18	13	10	....	....	V	B*	V	....	H*	V	V	....	....
Beardless wild-rye	7	10	10	....	11	9	2	....	....	V	Bt	V	....	Bt	V	V	....	....
Mountain brome	12	16	7	....	13	11	5	....	....	V	M*	V	....	....	V	V	....	....
Michels rye	....	....	....	....	....	....	....	....	....	D	....	....	....	V	V	V	....	....
Average	10	16	7	....	12	12	6	....	....									

* Symbols for stage of maturity: V=Vegetative; Bt=Boot; H=Headed; B=Bloom; M=Milk; D=Dead; *=Few heads.

Table 12. Height in Inches, Stage of Maturity, and Per Cent Dry Matter in Green Forage Harvested from the Pasture Plots at Several Grazing Periods at Union, Oregon—*Continued*.

Pasture grasses	Dry weight of green weight								
	Grazing periods, 1942			Grazing periods 1943			Grazing periods 1944		
	1	2	3	1	2	3	1	2	3
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Standard crested wheat	33	29	74	....	23	....	41	....	....
Thickspike wheatgrass	55	....	58	....	....	....	....	....	....
Fairway crested wheat	40	36	83	....	43	....	37	....	....
Creeping timothy	61	33	....	....	50	....	....	....	....
Pubescent wheatgrass	27	32	53	....	27	....	38	....	....
Tall oatgrass	25	23	46	....	23	....	37	....	....
Slender wheatgrass	43	36	50	....	30	....	48	....	....
Meadow fescue	27	31	41	....	21	....	49	....	....
Meadow foxtail	24	35	70	....	28	....	39	....	....
Alta fescue	27	33	41	....	25	....	57	....	....
Canada wild-rye	39	34	40	....	26	....	41	....	....
Creeping red fescue	32	43	47	....	37	....	44	....	....
Erect brome	33	41	64	....	28	....	38	....	....
Chewings fescue	30	44	57	....	34	....	46	....	....
Smooth brome	34	37	49	....	28	....	43	....	....
Big bluegrass	33	39	57	....	39	....	69	....	....
Akaroa orchardgrass	33	31	46	....	26	....	....	....	....
Beardless wild-rye	31	32	50	....	25	....	39	....	....
Mountain brome	30	34	32	....	33	....	....	....	....
Michels rye	....	....	....	....	....	....	....	....	....
Average	34	35	53	....	30	....	44	....	..

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