Bulletin No. 314 - Grass Establishment on Wyoming Dryland

University of Wyoming Agricultural Experiment Station
Grass Establishment
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By

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INTRODUCTION

A NATURAL VEGETATIVE COVER depends on a balance of nature which is frequently disturbed either by natural causes or by man. Fire, flood, and drought take their own toll or indirectly cause temporary excess of grazing by wild animals and domestic livestock. Man, too, by cutting of the forest, cultivation, and drainage may cause similar disturbances, any of which may necessitate artificial reseeding.

Normally there are balanced relationships between the soil and the plants which result in plant societies; for example in Wyoming, correlated with rainfall and elevation are the deserts, the plains, the sagebrush transitions, the timbered mountain slopes, and the alpine summits, to name only the most obvious. The balance between plants and soil, and between different species of plants, is a reality only at a given time. Over any period there is a change, the geologic processes of erosion and soil building, and the change in the make-up of plant associations as the soil changes.

While good range management—through the proper period of grazing use by the kind and numbers of livestock best suited to the area—can forestall all but the most unusual causes of overgrazing, there still remain the fire hazard, abandonment of cultivation, drainage, and other activities which are normal in agricultural pursuits. Artificial revege-

ACKNOWLEDGMENT

The work reported in the section "Seeding in the Plains" was started by W. W. Austin, formerly assistant chief of the Regional Nursery Division, Soil Conservation Service, Lincoln, Nebraska, in cooperation with the Wyoming Experiment Station and the Federal Bureau of Plant Industry. The Research Division of the Soil Conservation Service entered into this work in 1940. A. L. Nelson, formerly agronomist in the Bureau of Plant Industry and superintendent of the Archer Field Station, has actively participated in this work from the beginning.

† This bulletin supersedes Bulletin 299, "Dryland Grass Seeding in Wyoming," by O. K. Barnes, R. L. Lang, and A. A. Beetle.

*Respectively: Associate Agronomist, Soil Conservation Service, Research Division; and Associate Agronomists, University of Wyoming.
tion can be used to (1) heal scars made by forest burns, (2) make sagebrush lands more productive, (3) heal road cuts and aid in the maintenance of highways, (4) restore more rapidly the productive capacity of abandoned farm land, and (5) alleviate gully, sheet, and streambank erosion, (6) increase grazing capacity, and (7) prolong the green feed seasons.

The benefits of reseeding have now been so well publicized that reseeding is widely recognized as a profitable practice leading directly to ranch improvement. With this increased interest has come a lessened demand for all-purpose grasses (formerly usually crested wheatgrass or timothy) and a quickened acceptance of specialized forage crops, e.g. tall wheatgrass for alkali, intermediate wheatgrass for late spring grazing, Russian wildrye for fall grazing, and consequent restriction of crested wheatgrass to early spring usage.

Pellet seeding, briefly popular because oversold, has been discredited by research findings (Barnard, 1950). Much more is known about reseeding than is put into practice. Many chances to protect disturbed areas, or to increase productivity, are neglected. Reseeding in desert areas has been very limited, since it is recognized that ordinary methods are not adapted to these arid conditions. More extensive reseeding in these areas may be a result of the building of water-spreading ditches and dikes being developed by the Missouri Valley flood-control projects.

The objective in this report is to bring together a summary of artificial reseeding work as to the methods of seeding and as to species adapted to various non-irrigated situations in Wyoming.

GENERAL RANGE-RESEEDING RECOMMENDATIONS

The general recommendations for seeding of drylands in Wyoming may be grouped under eight headings:

1. Adaptation
   Select a species or mixture to seed which is adapted to the climate, soil, and specific grazing needs involved.

2. Seed Quality
   Obtain clean seed of high germination.

3. Seedbed Preparation
   The seedbed must be firm and relatively free from competition. Seldom can a stand be established in undisturbed native vegetation.

—3—
4. Depth of Seeding

The seed must be placed at proper depth in the soil. The general rules for depth of planting are: (1) the larger the seed the deeper it may be planted (thus smooth brome may be planted deeper than timothy); and (2) the sandier the soil the deeper the seed may be planted. Thus any species may be planted deeper on a sandy soil than on a heavy soil type. On sandy loam soils, seeds about the size of crested wheatgrass should be covered with about one-half inch of soil. Broadcasting seed with no coverage generally results in failure.

5. Time of Seeding

Cool-season grasses, such as crested or intermediate wheatgrass, may be seeded either in early spring or early fall. If in early spring, the operation should be done as early as it is possible to get the machinery on the land. If seeded in fall, the planting should not be on a clean, fine seedbed, for the stand may be lost from wind action. A clean grain stubble gives a firm seedbed with protection from blowing. Warm-season grasses, such as blue grama or buffalograss, should be seeded only in late spring.

6. Including a Legume

For a longer sustained production, a legume should be included with the grass. On dryland areas, alfalfa and sweet clover will stay in the mixture longer than other legumes.

7. Rate of Seeding

From 6 to 10 pounds of grass seed per acre with from one to two pounds of alfalfa and sweet clover should be seeded. Generally the higher the rainfall the higher the seeding rate.

8. Management after Seeding

If the seeding is in the spring, the area should be protected from grazing until summer of the following year. Fall-seeded and established areas may usually be grazed lightly the following fall after the plants have matured. Dense stands of annual weeds on the area should be mowed early so that they do not take too much moisture from the new seedlings.

SEEDING IN THE MOUNTAINS

The high elevations in Wyoming present a problem in revegetation distinct from that of the plains, desert, or sagebrush transition. Most of this land is potentially either forest or meadow. Fire has been the principal disturbing influence and probably will continue to be. Al-
though the effects of fire may be lessened, such areas have usually been neglected.

On truly alpine areas, usually above 10,000 feet, little is known of the plants that can be sown. There is need to develop a commercial source of seed of some plant which is adapted to this extreme. The best possibilities would appear to lie in selection of tufted hairgrass (*Deschampsia caespitosa*) for wet sites and sheep fescue (*Festuca ovina*) (the alpine form), or Idaho fescue (*Festuca idahoensis*), for dry sites. The only other grasses reported to any extent above tree line include five bentgrasses, (*Agrostis bakeri*), (*A. humilis*), (*A. idahoensis*), (*A. ros-sae*), and (*A. thurberiana*), and four bluegrasses, (*Poa alpina*), (*P. arctica*), (*P. lettermannii*), and (*P. rupicola*). With addition of alpine foxtail (*Alopecurus alpinus*) the end is reached of the alpine grasses in Wyoming. While these grasses may be managed for best production on their preferred sites, it is not likely that seed of any will be available in the near future commercially or that they will be reseeded except by nature.

Between the alpine zone and the lower transition belts of sagebrush and deerbrush lie the principal timbered slopes of Wyoming, largely within national forest boundaries and for the most part between 8,000 and 10,000 feet elevation. Within this belt may be found fully one-half of the roughly 200 grasses known in Wyoming. Of these about 9 are strictly aquatics; another 15 are primarily associated with open meadows. The rest occur on a variety of slopes, exposures, and soils supplying the principal feed for cattle and sheep in mixed associations.

The nine aquatic grasses are shortawn foxtail (*Alopecurus aequalis*), American sloughgrass (*Bechmannia sylvigachne*), brookgrass (*Cata-brosa aquatica*), drooping woodreed (*Cinna latifolia*), and the five mannagrasses, (*Glyceria borealis*), (*G. elata*), (*G. grandis*), (*G. pauci-flora*), and (*G. striata*). Since disturbance in these areas is rare, there is seldom any necessity for reseeding aquatics. However, these grasses, as well as certain aquatic sedges and rushes, should be kept in mind for planting around newly formed bodies of water behind dams. Although these species will spread naturally and fairly rapidly, a program of planting will greatly hasten increase in wildlife about such areas.

The 15 meadow grasses include some of the best-known grasses in Wyoming and some for which seed is most available. They are common redtop (*Agrostis alba*), the two bentgrasses, (*A. exarata* and *A. hiemalis*), smooth brome (*Bromus inermis*), bluejoint reedgrass (*Cala-
An easy place to reseed

—Soil Conservation Service

A difficult place to reseed

—Soil Conservation Service
magrostis canadensis), northern reedgrass (C. inexpansa), orchardgrass (Dactylis glomerata), tufted hairgrass (Deschampsia caespitosa), meadow fescue (Festuca elatior), meadow barley (Hordeum brachyatherum), reed canarygrass (Phalaris arundinacea), timothy (Phleum pratense), and the two blue grasses, (Poa palustris and P. pratensis). Abundance of any of these in mountain meadows may be considered as an indication of good conditions. Of these, tufted hairgrass is the best of the natives and is widely recognized as indicating native meadows of high quality. Of the introduced and cultivated grasses, timothy has received the most attention and produces hay of good quality, particularly if cut at proper stage of maturity. Smooth brome, increasingly important, is slowly replacing timothy as the most important hay grass in Wyoming, up to about 9,000 feet elevation. Although it is among 20 species, 10 of which were grasses on which dryland establishment experiments were reported in Station Bulletin 16 (1893), smooth brome has not even yet reached its full potential in Wyoming. Above 9,000 feet elevation, better success is still obtained with timothy. Smooth bromegrass shows particular promise in mixture with alfalfa and/or other legumes.

As there was little experimental evidence of the adaptability of various new introduced grasses and of many natives to the different altitudinal conditions common in the mountains, an adaptation nursery was established at each of three elevations in 1948. The lowest of these nurseries was established at the experimental farm west of Laramie, Wyoming, at an elevation of approximately 7,400 feet above sea level. The next higher nursery was established on Pole Mountain at an elevation of 8,500 feet, and the highest was established in the upper limits of the spruce/fir at an approximate elevation of 10,500 feet.

Although only a few years’ data have been collected from the two lowest nurseries, these data seem to indicate that tall wheatgrass (Agropyron elongatum), intermediate wheatgrass (Agropyron intermedium) and Canada wildrye (Elymus canadensis) are the most productive at the lowest elevation, although Russian wildrye, Primar slender wheatgrass, and western wheatgrass were equally well established.

Crested wheatgrass, smooth brome, Russian wildrye, Primar slender wheatgrass, and meadow foxtail (Alopecurus pratensis) have all appeared to be well adapted at the 8,500-foot level.

Russian wildrye and tall wheatgrass are not equally at home in the high elevations. The two introduced grasses in many respects are opposites, the first contrast being in their seeding habits. The higher and
Slender Wheatgrass Seeded in the Pole Mountain Nursery Area. Elevation 8500 Feet
colder, the better the chances that Russian wildrye will seed. In contrast, with tall wheatgrass no seed has been obtained at Laramie (elevation 7,200 feet), nor can seed be expected at still higher elevations.

Although producing abundant forage and blooming with regularity at Laramie, tall wheatgrass finds the season too short or too cold to produce mature seed. At the higher nursery at Pole Mountain in the Medicine Bow national forest, both forage production and bloom decline.

Another contrast between the two grasses is found in their soil preference. Russian wildrye, while very drouth-resistant and the best of the fall grasses from standpoint of palatability and cold resistance, does not tolerate highly alkaline conditions. On the other hand, tall wheatgrass is well adapted to strongly alkaline soils and also retains its vigorous forage production; and it remains palatable under such conditions.

Two new nurseries were established in 1951 in the Big Horn Mountains to test methods of establishment and species adaptation. These nurseries are located at approximately 6,800 feet and 9,000 feet elevation.

Information obtained from all of these nurseries will be of great value in the future in recommending the proper species for high-elevation sites in need of revegetation.

**SEEDING IN THE DESERT**

The desert lands of Wyoming are considered to be those having less than 10 inches of precipitation annually. In their natural state these lands usually support vegetation which is predominantly browse, although there is a scattered stand of drouth-resistant grasses and forbs mixed in with the browse.

On the lowlands, which are usually quite alkaline in character, the saltbushes (*Atriplex* spp.) and greasewood (*Sarcobatus vermiculatus*) are the dominant species present. However, there may be present considerable amounts of such grasses as squirreletail (*Sitanion hystrix*), western wheatgrass (*Agropyron smithii*), and saltgrass (*Distichlis stricta*), depending upon alkalinity of the soil.

On the higher lands, which do not contain as great concentration of alkali, the predominant shrubs are sagebrush (*Artemisia tridentata*), shadscale (*Atriplex confertifolia*), winterfat (*Eurotia lanata*), and various species of rabbitbrush (*Chrysothamnus*). The most commonly found grass and grasslike species are thickspike wheatgrass (*Agropyron dasystachyum*), Indian ricegrass (*Oryzopsis hymenoides*), Sandberg's bluegrass (*Poa secunda*), and threadleaf sedge (*Carex filifolia*).
Many other species of shrubs, forbs, and grasses are present usually in minor quantities, but the above-named plants are those most common to the desert areas.

Because of low rainfall and the tendency for alkali conditions to be prevalent, seeding in the desert areas is quite hazardous. The species used must be adapted to these conditions of extreme aridity and alkaline soils.

Generally it is best to use a method of seeding which will put the seed at proper depth under the soil. However, under conditions of very sandy soils it may be possible to obtain good stands by broadcast seeding with no further treatment than the trampling by sheep as they graze over the area during the following fall and winter. Outstanding examples of this may be noted by two experiments carried out by the United States Grazing Service in the vicinity of Rock Springs, Wyoming.

The first of these experiments was a hand broadcasting in early May of 1940 of one strip (approximately 10 acres) each of crested wheatgrass (*Agropyron cristatum*), slender wheatgrass (*Agropyron trachycaulum*), and western wheatgrass (*Agropyron smithii*). Of the three species used, only the crested wheatgrass has become established, persisting to date. Inspected in September 1951, this seeding of crested wheatgrass showed an excellent stand of vigorous plants and many young plants, apparently from seed produced on the area.

A Young Stand of Crested Wheatgrass Seeded into a Sagebrush Area in the Red Desert
The second seeding trial referred to above was an airplane seeding on April 12, 1946. The area seeded was 1,250 acres at the rate of 5 1/2 pounds of crested wheatgrass seed per acre. In the fall of 1947 this area showed a good stand of crested wheatgrass seedlings which were apparently well established, and it is expected that they will persist as well as the hand-broadcast seeding previously described. It must be emphasized that both of these trials were on very sandy soils and that on these soils the seeds tend to become covered because of action of the elements as well as by movement of sheep during their winter grazing of the area.

Earlier seeding trials in vicinity of Church Buttes, Uinta County, were conducted in winter of 1940, spring of 1941, and spring of 1943. Although six grass species were tried on some of these tests, a check in 1951 showed that fair to good stands were attained only with crested wheatgrass and western wheatgrass. The plots of species which had the best stands were those on which the area had been disked after broadcasting the seed to attain seed coverage.

Other seeding trials also in vicinity of Church Buttes were started in the fall of 1944 and repeated each spring and fall through fall 1949. Four species were seeded in replicated plots. The seed was broadcast and covered with a disc. The species used have been varied since the original 1944 seeding with the following results:

1. Fair to excellent stands were obtained with crested wheatgrass seeded either in early spring (usually April) or early fall (about September 10), from every seeding during the 5-year period.

2. Western wheatgrass and intermediate wheatgrass were substituted for four-wing saltbush in 1946 and Indian ricegrass in 1947. Satisfactory stands were obtained only from the fall 1948 seeding.

3. Fair to no stands were obtained with Russian wildrye.

4. Poor to no stands were obtained with Indian ricegrass and four-wing saltbush.

A trial of seeding with pitting was conducted north of Wamsutter, Sweetwater County. It was found that crested wheatgrass could be established in the pits made by the eccentric one-way disc where the stand of native vegetation was not too dense. Excellent stands were obtained in seeding with pitting on a salt-sage flat, and fair stands in a sagebrush and wheatgrass type. But no stands resulted where the native grasses were in good stand before the pitting and seeding operation.
In summing up the available data regarding desert seeding trials, it should be noted that, of the species tried to date, crested wheatgrass has proved to be the outstanding successful species, with western wheatgrass as the second most easily established.

Some soil cover for the seed should be given if at all possible. Broadcasting followed by disking gives some cover for the seed in addition to eliminating a portion of the brush usually present.

Broadcasting with no mechanical covering, either by hand or by airplane, has proved successful on very sandy soil types but must be considered a more risky procedure than one in which some type of mechanical covering may be attained.

**SEEDING IN THE PLAINS**

**Extent of Research**

As has been previously indicated, the greatest amount of grass seeding has been accomplished in the plains of Eastern Wyoming. Likewise the greatest amount of research pertaining to seeding has been conducted in this area.

A. L. Nelson reported in 1933 on a study of grass establishment and species adaptation at the Archer Substation. The work reported here is an elaboration of his earlier study.

Most of the seeding studies reported here have been on cultivated lands, although a small amount of work has been conducted in attempting to establish grasses and/or legumes in the unbroken native range.

**Species Seeded for Adaptation Studies**

Between 1936 and 1948, grass-adaptation nurseries of more than 30 species and strains were established at the Archer, Sheridan, and Gillette Substations in the plains area of Wyoming.

With a few minor exceptions the same species succeeded at all three locations. The Sheridan Substation has a slightly higher average precipitation than either of the other two locations. During the periods of these tests the precipitation was about 2 inches above the long-time average for Sheridan, whereas at least one year of moisture deficiency occurred at the other two locations.

Standard crested wheatgrass, fairway crested wheatgrass, western wheatgrass, and Russian wild rye were the outstanding species for all three locations from standpoint of ease of establishment and ability to resist weed competition and drouth.
Indian ricegrass, green needlegrass, slender wheatgrass, and smooth brome were apparently adapted at these locations but are not equal to the above grasses in yield or ability to compete against weeds.

Blue grama produced satisfactory stands only at the Archer Substation in later trials. The early failures with this species probably were due to use of fall and early-spring seeding dates in the early adaptation trials. Late-spring seeding was found to be the proper time to seed blue grama, and such seedings have been successful at Archer. Successful establishment of blue grama properly seeded could be expected at the other locations or under similar conditions.

Species that became established but were short-lived from lack of ability to persist against weed competition, to drouth, or to lack of winter hardiness included:

- Beardless wheatgrass
- Bluebunch wheatgrass
- Sand dropseed
- Prairie junegrass
- Canada wildrye
- Sandberg bluegrass
- Nevada bluegrass
- Mountain brome

Other species became established in the first year but survived only when planted in 35-inch rows. The following species appeared to have little or no value for reseeding in the plains area:
Intermediate wheatgrass and tall wheatgrass have recently received considerable attention for reseeding. Both species appear important for reseeding in Wyoming but have been included in tests for only a short period. Preliminary results indicate that intermediate wheatgrass is well adapted to the better dryland situations, but not equal to crested wheatgrass on extremely dry areas. Tall wheatgrass appears to be the most promising grass for reseeding alkali areas.

Stiffhair wheatgrass also appears to have promise for dryland seedings. This species is very similar in growth form and habits to intermediate wheatgrass. Both of these wheatgrasses were included in a pasture study started at the Archer Substation in 1950. Even though 1950 was a dry year at this location, both species became well established and are being used for an early cutting of hay and for fall and winter pasturing.

Forage Production: Hay yields were determined by clipping the grass at about bloom stage. From each drilled plot three permanent square-meter plots were clipped to determine yields. Any regrowth that occurred was not included in these yields; in some years this would add a considerable amount. The hay yields obtained from seedings at the Archer and Sheridan Substations are given in Table 1.

Later studies show that the fairway crested wheatgrass does not maintain its production quite as well as the standard strain, although the difference is small. Either strain ranks at the top in production among the species tested on the plains.

Western wheatgrass, while lower in hay production than crested wheatgrass, has proved to be a valuable, hardy species in reseeding work. This species produces the most ground cover of any of the grasses included in these trials.

Russian wildrye is strictly a pasture-type grass, although it was included with these other species for hay measurements.

As may be noted from Table 1, smooth brome ranked high in forage yield among the species tested at Sheridan. However, in other studies reported by Sheridan, and over a longer period, smooth brome seeded without a legume shows a yield about 25 percent below crested
Table 1—Hay Yields from Drilled Grass Plots

<table>
<thead>
<tr>
<th>Species</th>
<th>Lbs. per acre, air-dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard crested wheatgrass</td>
<td>1304</td>
</tr>
<tr>
<td>Fairway crested wheatgrass</td>
<td>1792</td>
</tr>
<tr>
<td>Western wheatgrass</td>
<td>991</td>
</tr>
<tr>
<td>Russian wildrye</td>
<td>646</td>
</tr>
<tr>
<td>Green needlegrass</td>
<td>485</td>
</tr>
<tr>
<td>Indian ricegrass</td>
<td>353</td>
</tr>
<tr>
<td>Smooth brome</td>
<td>599</td>
</tr>
<tr>
<td>Mountain brome</td>
<td>575</td>
</tr>
<tr>
<td>Canada wildrye</td>
<td>Not inc.</td>
</tr>
<tr>
<td>Sandberg bluegrass</td>
<td>Not inc.</td>
</tr>
<tr>
<td>Grass-legume mixture</td>
<td>1133</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>Archer</th>
<th>Sheridan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard crested wheatgrass</td>
<td>1304</td>
<td>1792</td>
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<tr>
<td>Fairway crested wheatgrass</td>
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<td>1815</td>
</tr>
<tr>
<td>Western wheatgrass</td>
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<td>1124</td>
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<td>Russian wildrye</td>
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<td>1098</td>
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<tr>
<td>Green needlegrass</td>
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<td>1317</td>
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<td>Indian ricegrass</td>
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<tr>
<td>Smooth brome</td>
<td>599</td>
<td>1779</td>
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<tr>
<td>Mountain brome</td>
<td>575</td>
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<tr>
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<tr>
<td>Sandberg bluegrass</td>
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<td>463</td>
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<tr>
<td>Grass-legume mixture</td>
<td>1133</td>
<td>1868</td>
</tr>
</tbody>
</table>

(1) Average yields for 1940 to 1942 at Archer and 1939 to 1942 at Sheridan Substations.
(2) Mixture includes 20% western wheatgrass and 20% crested wheatgrass, 10% blue grama, 20% green needlegrass, 20% Russian wildrye, and 10% Ladak alfalfa. At Sheridan, smooth brome (10%) was included in this mixture at the expense of 10% western wheatgrass. All other species were in the same proportions as above. Rate of seeding was approximately 10 pounds per acre.

wheatgrass. At Archer smooth brome ranked low in yield. The stand has persisted, but moisture conditions are a little below the requirement for good production.

The grass/legume mixture at Sheridan produced about the same volume of hay as crested wheatgrass alone. At Archer it was slightly under the production of crested wheatgrass alone for the 3-year period considered in these yield comparisons. It is probable that, if yields had been measured over a longer period, presence of a legume would show the mixture to better advantage in comparison with the grasses seeded alone.

Seedbed Preparation

Preparation of a suitable seedbed is an important step in getting a successful stand of grass. Grasses need to be seeded on a firm seedbed with as little competition from weeds as possible.

Comparison of grass seedings was made on summer fallow, small-grain stubble, corn stubble, and sudan-grass stubble. During the period of this study, 1940 to 1943, favorable moisture conditions prevailed. Consequently, large differences between methods of seeding did not
develop. However, certain points were emphasized by the situation and the general trends brought out.

Seedings on summer fallow and corn stubble generally resulted in good stands when planted in spring. Planting on this type of seedbed in fall is risky because of wind action during winter. For this reason the average stand establishment was higher on stubble land than from fallow or corn stubble when the four dates of seeding are considered. Use of a nurse crop of small grain seeded with grass or at the time the grass is seeded proved to be poor practice. The nurse crop failed to protect the grass seedlings during winter and offered excessive competition to grass establishment during the first growing season. In some instances the nurse crop noticeably set the grass stand back several years.

All of the indications from this study have been that seeding into relatively clean stubble is the best seedbed. Protection is afforded the seedlings against wind damage during winter besides some shading during the first growing season. Sudan-grass stubble was the outstanding seedbed. This stubble was stronger and held up better than small-grain stubble. However, satisfactory stands were obtained on both types.

In general, duckfooting or disking the stubble before seeding showed no advantage over drilling the seed directly into the stubble. The advantage of prior tillage, of course, comes from reduced competition from weeds and volunteer grain. The disadvantage comes from having a loose and often rough, uneven seedbed. Under the conditions of this study this disadvantage had as much or more effect on the grass stand than did competition from weeds or volunteer grain. Tillage for spring seedings showed very slight advantage over no tillage yet not enough to justify the operation.

Under conditions where a dense weed or volunteer-grain stand exists in the stubble, a tillage operation prior to seeding the grass would be advisable. Packing the seedbed after tillage or seeding operation will generally improve the stand.

**Implements and Methods**

A single-disc surface drill and double-disc deep-furrow-type drill were the two types of implements tested in this study. The deep-furrow drill gave slightly better results than the surface drill, as it throws up a ridge and plants the seed into firmer and moister ground. During the period of this study there was no great difference between these two drills, although, if both types were available, the deep-furrow drill appears best under conditions at this location; in addition, on weedy ground without prior tillage, the deep-furrow type would have the
advantage of eliminating more weed competition than the surface drill would.

Date of Seeding

Four dates of seeding during this 3-year period were compared. The early September and early April dates were distinctly superior to the early May dates of seeding and slightly better than the late October seeding of the cool-season species such as western wheatgrass, crested wheatgrass, and Russian wildrye. There was little difference between the seedings made at approximately September 10 and April 1 each year on stubble land. On clean-tilled ground, in one year out of the three, the grass stand for fall seedings was almost a total failure because of wind action; consequently, clean-tilled land should be seeded in early April to obtain the best stands with least risk of failure.

Blue grama grass seedings in fall failed completely, and the May seedings were far superior to those made in early April. Blue grama is a warm-season grass and it appears that seeding during the fore part of May is the best date for this species.

Smooth brome grass seeded in early September or early May resulted in better stands than when it was seeded in late October or early April.

Mixtures of cool-season grasses with sweet clover and alfalfa seeded in spring resulted in the best stands of alfalfa. In 1946 there was four times as much alfalfa in the mixture seeded in early April of 1940 and 1941 as in the early fall seeding made during these same two years.

Depth of Seeding

Excepting for a broadcast type of seeding and that made at one-half to one-inch depth with the surface drill, comparative studies of seeding depth were not undertaken. The shallow seeding with the surface drill was accomplished by letting the discs just ride the surface. This resulted in covering the seed by about one-fourth inch of soil and generally gave satisfactory stands although not equal to deeper seedings.

All available information and general observations indicate that crested wheatgrass and other grasses of similar size of seed should not be covered more than an average of one inch of soil and preferably one-half to three-quarters of an inch. For blue grama, a maximum seeding depth of about one-quarter inch is recommended.

The small seeded grasses should be covered with less soil than large seeded grasses, and the depth of seeding for any species would be less in a heavy type of soil than in a sandy type of soil.
Table 2—Crested Wheatgrass Hay Yields

<table>
<thead>
<tr>
<th></th>
<th>7-in. drill rows (Pounds per acre)</th>
<th>35-inch rows (Pounds per acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archer Substation (2-yr. av.)</td>
<td>1462</td>
<td>1323</td>
</tr>
<tr>
<td>Sheridan Substation (9-yr. av.)*</td>
<td>1925</td>
<td>1875</td>
</tr>
</tbody>
</table>

*Taken from Annual Reports of Sheridan Substation.

Row Spacing

Data collected at the Archer and Sheridan Substations indicate that hay yields are slightly higher from drilled plantings than from the wide-spaced rows. See Table 2.

In extremely dry years the wide-spaced rows have shown some advantage in production. However, the average yields have not shown the wide-row spacing to be advantageous. The actual ground cover on established drilled stands of crested wheatgrass has run approximately double the amount of cover on established 35-inch row plantings.

There appears to be some variation in species response to close vs. wide-spaced plantings. Russian wildrye in the few comparisons made shows a somewhat higher yield in wide-spaced plantings. Western wheatgrass often becomes quite dense after a few years; the drilled plantings are, of course, the first to thicken. In dry years an excessively thick stand of western wheatgrass shows the greatest decline in forage production. However, for crested wheatgrass, which is the principal species used at this time for reseeding, the results indicate no advantage for wide-spaced row plantings for forage or hay production. Nelson reported in 1933 on a row-spacing study at Archer. A 5-year average hay yield shows 1224 pounds of crested wheatgrass per acre with 35-inch rows as compared to 1220 pounds from 7-inch row spacing. This study reported very slight differences for a mixture of alfalfa and crested wheatgrass in rows 17 inches apart as compared with rows 3 1/2 inches apart.

Renovation of Old Grass Stands

In another study at Archer, it was found that production of many of the dryland grasses starts falling off four or five years after establishment. Under the grazing conditions practiced at this station, production after eight years had declined 50 percent or more. From this point a study was started to compare possible methods of restoring the productivity of these grasses by mechanical means and fertilizers. This
study has not progressed far enough to show conclusively what can be done. Some of the treatments that severely disturb the cover show promise of increasing forage production. However, preliminary yield measurements show only a few hundred pounds of increase in hay production. Since these treatments involve considerable expense in power and machinery, it would probably require larger increases in forage production to justify them. The treatments that appear at all effective so far are those that severally disturb the cover and in doing this, the amount of surface left without cover is greatly increased. This increase in bare ground appears to reduce the advantage of mechanical tillage and renovation of these old grass stands. More records will be obtained on this study further to determine the value of mechanical treatments for improving old stands of these seeded grasses.

Fertilizers

Some preliminary trials with fertilizers on old seeded pastures of crested wheatgrass, western wheatgrass, and Russian wildrye grass gave the following results:

Forage production was increased with application of commercial nitrate fertilizer or manure, but no response was obtained with phosphate at the Archer location. Of the three species mentioned, crested wheatgrass gave greatest response in forage production.

The combination of nitrogen fertilizer and renovation gave greater response than either fertilizer or renovation alone.

Crested wheatgrass plots fertilized with 300 pounds of ammonium nitrate per acre in 1950 yielded approximately 400 pounds of hay per acre more than non-treated plots in 1950, and approximately 500 pounds of hay per acre more than these checks in 1951.

Plots treated with 300 pounds of ammonium nitrate per acre in 1951 yielded about 2500 pounds more hay per acre than the non-treated checks in 1951. It may be noted that the amount of response to nitrogen applications in these dryland areas is dependent upon amount and distribution of rainfall, which was more favorable during 1951 than in 1950.

Applications of manure at rate of 10 tons per acre gave similar results to those mentioned but had greater carryover effect into the second year.

It was noted that spring applications of nitrogen or manure greatly stimulated seed production of Russian wildrye grass the year following application of the fertilizer.
SUMMARY AND CONCLUSIONS

Seeding of certain types of range lands in Wyoming is an important range-improvement practice. Establishment of grass, which was once thought to be a very difficult and hazardous undertaking, has been proved, through research, to be a relatively simple and successful procedure in many areas, if attention is paid to the small details of seeding methods and to selection of species best adapted to the site involved.

Wyoming has great diversity of topography, climatic conditions, and soils, and consequently no single species or establishment method can be recommended for all. General recommendations as to seed coverage, preparation of a firm seedbed, elimination of competition, etc., may well be applied to all locations, but the varieties must be selected for their adaptation to site, and the actual method of putting the seed into the soil must be modified to conform to the physical characteristics of the site involved.

Less is known about species adaptation and seeding methods for the high elevations than for other areas. However, many of the newer cultivated species and strains of grasses, as well as many of the natives, are showing promise for the mountain areas. Principal grasses which seem to be promising for high-elevation seedings are: timothy, crested wheatgrass, intermediate wheatgrass, Primar slender wheatgrass, Russian wildrye, smooth brome, and such natives as tufted hairgrass.

On the desert areas, where the annual precipitation averages under 10 inches, consistently good results have been obtained only with seedings of crested wheatgrass. Seeding in the early fall (about September 10) and early spring (about April 10) have been equally successful in establishing this species. Western wheatgrass and Russian wildrye seedings have infrequently given fair to good stands under desert conditions.

The greatest amount of research pertaining to grass seeding has been conducted on the plains area of Eastern Wyoming. The species which were most easily established and apparently best adapted to this area were crested wheatgrass, western wheatgrass, Russian wildrye, intermediate wheatgrass, and stiffhair wheatgrass. Blue grama grass is well adapted to the area but more difficult to establish.

Early spring and early fall seeding dates were about equally successful in establishment of the early-season grasses, and late spring seeding was the only date when blue grama was successfully established.

Clean crop stubble was the best seedbed, being superior to clean, cultivated land principally because of reduced damage to seedlings through wind action. Type of drill used appeared to have little effect upon stand as long as the seed was planted at proper depth.

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Nurse crops proved detrimental to a grass seeding. The seeding of a legume with the grass was found to maintain the yield of the area at high level for a greater period of years than where the grass was seeded alone.
# APPENDIX

List of Scientific Names and Corresponding Common Names

## Grasses

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agropyron cristatum</td>
<td>Crested wheatgrass</td>
</tr>
<tr>
<td>A. dasystachyum</td>
<td>Thickspike wheatgrass</td>
</tr>
<tr>
<td>A. elongatum</td>
<td>Tall wheatgrass</td>
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<tr>
<td>A. intermedium</td>
<td>Intermediate wheatgrass</td>
</tr>
<tr>
<td>A. trichophorum</td>
<td>Stiffhair wheatgrass</td>
</tr>
<tr>
<td>A. smithii</td>
<td>Western wheatgrass</td>
</tr>
<tr>
<td>A. spicatum</td>
<td>Bluebunch wheatgrass</td>
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<td>A. trachycaulum</td>
<td>Slender wheatgrass</td>
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<td>Agrostis alba</td>
<td>Redtop</td>
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<td>A. bakeri</td>
<td>Baker bentgrass</td>
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<tr>
<td>A. exarata</td>
<td>Spike bentgrass</td>
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<tr>
<td>A. biemalis</td>
<td>Winter bentgrass</td>
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<tr>
<td>A. humilis</td>
<td>Alpine bentgrass</td>
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<td>A. idahoensis</td>
<td>Idaho bentgrass</td>
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<tr>
<td>A. palustris</td>
<td>Creeping bentgrass</td>
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<tr>
<td>A. rossae</td>
<td>Ross bentgrass</td>
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<tr>
<td>A. thurberiana</td>
<td>Thurber bentgrass</td>
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<tr>
<td>Alopecurus aequalis</td>
<td>Shortawn foxtail</td>
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<tr>
<td>A. alpinus</td>
<td>Alpine foxtail</td>
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<tr>
<td>Andropogon furcatus</td>
<td>Big bluestem</td>
</tr>
<tr>
<td>A. scoparius</td>
<td>Little bluestem</td>
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<tr>
<td>Beckmannia syzigachne</td>
<td>American sloughgrass</td>
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<tr>
<td>Bouteloua curtipendula</td>
<td>Sideoats grama</td>
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<tr>
<td>B. gracilis</td>
<td>Blue grama</td>
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<tr>
<td>B. birsuta</td>
<td>Hairy grama</td>
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<td>Bromus catharticus</td>
<td>Rescue brome</td>
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<td>B. inermis</td>
<td>Smooth brome</td>
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<tr>
<td>B. marginatus</td>
<td>Mountain brome</td>
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<tr>
<td>Calamagrostis canadensis</td>
<td>Bluejoint reedgrass</td>
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<tr>
<td>C. inexpansa</td>
<td>Northern reedgrass</td>
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<tr>
<td>Catabrosa aquatica</td>
<td>Brookgrass</td>
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<tr>
<td>Cinna latifolia</td>
<td>Drooping woodreed</td>
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<tr>
<td>Dactylis glomerata</td>
<td>Orchardgrass</td>
</tr>
<tr>
<td>Deschampsia caespitosa</td>
<td>Tufted hairgrass</td>
</tr>
<tr>
<td>Distichlis stricta</td>
<td>Inland saltgrass</td>
</tr>
<tr>
<td>Elymus canadensis</td>
<td>Canada wildrye</td>
</tr>
</tbody>
</table>
E. junceus
Festuca elatior
F. idahoensis
F. ovina
Glyceria borealis
G. elata
G. grandis
G. pauciflora
G. striata
Hordeum brachyatherum
Koeleria cristata
Lolium multiflorum
Oryzopsis hymenoides
Panicum virgatum
Phalaris arundinacea
Pleum pratense
Poa alpina
Poa arctica
Poa leterminni
Poa nevadensis
Poa palustris
Poa pratensis
Poa rubicola
Poa secunda
Sitanion hystrix
Sporobolus cryptandrus
Stipa viridula

Russian wildrye
Meadow fescue
Idaho fescue
Sheep fescue
Northern manna grass
Tall manna grass
American manna grass
Weak manna grass
Fowl manna grass
Meadow barley
Prairie junegrass
Italian ryegrass
Indian ricegrass
Switchgrass
Reed canarygrass
Timothy
Alpine bluegrass
Arctic bluegrass
Letterman bluegrass
Nevada bluegrass
Fowl bluegrass
Kentucky bluegrass
Timberline bluegrass
Sandberg bluegrass
Bottlebrush squirreltail
Sand dropseed
Green needlegrass

Plants Other Than Grasses

<table>
<thead>
<tr>
<th>Scientific Name</th>
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<tbody>
<tr>
<td>Artemisia tridentata</td>
<td>Big sagebrush</td>
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<tr>
<td>Atriplex confertifolia</td>
<td>Shadscale saltbush</td>
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<tr>
<td>A. sp.</td>
<td>Saltbush</td>
</tr>
<tr>
<td>Carex filifolia</td>
<td>Threadleaf sedge</td>
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<tr>
<td>Chrysanthemnus sp.</td>
<td>Rabbitbrush</td>
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<tr>
<td>Eruotia lanata</td>
<td>Common winterfat</td>
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<tr>
<td>Medicago sativa</td>
<td>Alfalfa</td>
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<tr>
<td>Melilotus officinalis</td>
<td>Yellow sweetclover</td>
</tr>
<tr>
<td>Sarcobatus vermiculatus</td>
<td>Black greasewood</td>
</tr>
</tbody>
</table>
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Sampson, A. W. 1913. The reseeding of depleted grazing lands to cultivated forage plants (with prefatory note by F. V. Coville). U.S.D.A. Bul. 4, 1-34, illus.

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