How to Reseed Utah Range Lands

A. Perry Plummer  
Intermountain Forest and Range Experiment Station

Richard M. Hurd  
Intermountain Forest and Range Experiment Station

C. Kenneth Pearse  
Intermountain Forest and Range Experiment Station

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HOW TO RESEED
UTAH RANGE LANDS

RESEARCH PAPER NUMBER 1.

CHOOSE FAVORABLE SITES

PLAN EARLY

BUY SUITABLE SEED

MAKE CORRECT MIXTURES

USE EFFECTIVE METHODS

MANAGE WISELY

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
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HOW TO RESEED UTAH RANGE LANDS

By
A. Perry Plummer, Richard M. Hurd, and C. Kenneth Pearse

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Additional low cost forage is urgently needed by Utah's range livestock industry. Seeding of depleted tracts in accordance with recently developed methods and principles will help supply this forage and is entirely feasible. Where the value of the increased forage will repay the cost of planting, careful reseeding of selected sites is fully justified.

The important part that reseeding can play in restoring ranges to their former capacity has been demonstrated. Although satisfactory results can be obtained on many sites during average or better years, much more study is needed to insure consistent success in abnormal years and to extend reseeding to all ranges where it is needed. Present information, even when correctly applied, cannot eliminate failures. However, the chances for success will be best if the procedures and principles that have been developed are applied with discrimination and close attention is given to details.

Respectively Asst. Forest Ecologist, Jr. Range Examiner, and Conservationist, Intermountain Forest and Range Experiment Station, Ogden, Utah
PRINCIPLES OF ARTIFICIAL REVEGETATION

A comprehensive series of experiments has served to clarify and define certain simple yet basic principles of artificial revegetation. Intensive research has been conducted in Ephraim Canyon on the Manti National Forest, and near Ogden. Other experimental plantings have been made near Logan, Mantua, Farmington, Benmore, Pinto, at the Desert Range Branch Station west of Milford, and at several other places.

Separate attacks are being made upon each specific phase of the reseeding problem. The suitability and value for range reseeding of 250 species are being tested, and some of these species have been found adapted to each of the problem areas covered by this report.

The efficiency of many methods of seedbed preparation and planting has been tested. These include railing, plowing, disking, harrowing, burning, drilling, and broadcasting with and without various methods of covering on prepared and unprepared ground, on snow, and on ashes. Plantings have been made at all seasons of the year, and at various rates, row spacings, and depths.

In each test the nature of the soil, climate, and existing vegetation has been recorded to serve as a guide for recognizing tracts on which best results can be expected.

The conclusions from these experiments have been fully substantiated by observations on old test plantings and large-scale seedings made throughout Utah by public agencies and ranchers. The principles which have thus been developed and which must be recognized for successful reseeding of range lands are as follows:

- Select only the better sites.

The most satisfactory stands are obtained where the soil is deep, dark-colored, and of good tilth, and where the moisture supply is above average. Seeding on shallow, infertile, rocky soils, or on rough sloping land not only is difficult and expensive, but is less likely to be successful. The more productive sites should be seeded first. A good indicator of productivity and the chance for successful reseeding is the vigor and density of the existing low-value vegetation. In the sagebrush zone, for example, planted species will establish themselves better and produce more forage where dense stands of large vigorous sagebrush plants grew before reseeding.
Choose adapted species.

It should be self-evident that only species adapted to the soil and climate should be planted, yet many failures are due to the use of unadapted species. Likewise those species that will not maintain themselves under proper grazing should not be considered. Learn as much as possible about the growth requirements of suggested species as well as the growing conditions where they will be planted. Seed grown locally or under similar climatic conditions should be used whenever available.

Use mixtures wherever possible.

Mixtures take advantage of local soil and moisture differences better than do single species and are more nutritious and productive. Grazing of new stands can be started sooner if fast-growing species are included in the mixture.

Use sufficient seed but avoid overseeding.

Correct seeding rate is dependent upon the efficiency of the method of seeding and the purity, germination, and size of the seed used. The use of excessive seed is wasteful and may result in stands of low production because of competition for moisture among the plants.

The recommended seeding rates are based on good seed and efficient methods of planting. They should not be increased unless the seed is known to be of poor quality. Since standards of purity and germination for seed of most species used in range reseeding have not been set up, the buyer should examine the seed for purity and soundness. Germination tests which may be made by the State Seed Laboratory, are desirable.

Plant at the proper season.

The best time for planting is usually just before the season when precipitation can be expected to keep the soil of the root zone reasonably moist for a month or more of growing weather. Fall planting at low and intermediate elevations is generally best. On well prepared firm seedbeds early spring planting has given good results. On high mountain range lands planting in early summer or late fall is preferable.

Cover seed adequately.

The moisture supply for inadequately covered seed is usually so uncertain that germination is poor, or the young seedlings die before the roots can reach a more dependable source. Broadcasting without proper covering is successful only where moisture conditions are unusually favorable. Bulbous bluegrass, which does well when
broadcast without covering, is an exception. Even very young seedlings of this species become dormant during dry periods and resume growth with the advent of more favorable conditions.

Covering seed of most species from 1/4 to 3/4 inch results in satisfactory emergence. Small seed should not be planted deeper than 1/2 inch. Deeper covering is desirable on light sandy soils and shallower covering on heavy clays.

Reduce competition from undesirable plants.

Undesirable plants that use much of the available moisture prevent the establishment of high-yielding stands of reseeded species. Therefore it is necessary to reduce dense stands of such plants as sagebrush or cheatgrass 2 which would compete directly with the species to be seeded. Russianthistle, and other annual weeds which make most of their growth in late summer do not seriously compete with reseeded species and are frequently beneficial in conserving soil moisture and protecting the seedlings. Lands supporting such weeds usually require no treatment before planting.

Apply wise range management.

Seedlings are easily damaged by grazing and young plants should be permitted to make seed heads before they are grazed. Thereafter reseeded stands should be grazed in accordance with recognized practices developed for native ranges.

PRECAUTIONS TO OBSERVE

Satisfactory stands will not result from haphazard planting on poorly selected areas. Effort should be applied only where sizable and lasting benefits can be obtained. Consider carefully the following questions before deciding to plant a particular tract:

Is reseeding needed to improve this range?

If enough good forage plants are present and only better management is needed to bring about marked improvement, reseeding is seldom justified. First consideration should be given those areas on which most or all of the valuable forage plants have disappeared.

Is precipitation sufficient?

An annual precipitation in excess of 8 inches with at least 2 to 3 inches falling during the spring growing season is usually required for successful planting.

2/ Cheatgrass (Bromus tectorum) is also referred to as cheatgrass brome, broncograss, or junegrass.
Are the soil and topography suitable?

Ranges with infertile or shallow soils naturally produce little forage and cannot justify reseeding. Poor accessibility, rough topography, rocky soils, or other adverse conditions make reseeding difficult. More favorable tracts will yield greater returns and should be given first consideration.

How will reseeding affect the year-round feed supply?

Reseeding may be impractical on rough summer ranges in some regions where summer feed supplies are critical. In such cases improvement of easily seeded spring-fall ranges have helped solve the summer range problem by permitting a shorter grazing season on these areas where feed is most limited. Reseeding of spring-fall ranges with early growing grasses has also reduced the feeding of hay or concentrates and thus has been especially valuable.

Can the correct management be applied after seeding?

Reseeding should not be attempted unless the original causes of range depletion have been corrected. Reseeded stands will be damaged by overstocking, too early grazing, or undue concentration just as surely as were the original stands. Seeded areas should be grazed lightly or protected completely until the stand is at least one year old.

Successful reseeding will be insured, insofar as that is possible, if the foregoing principles are carefully applied. Although further study is needed to clarify many important relationships, the following recommendations are based upon the best available information and can be applied with considerable confidence.

RECOMMENDATIONS FOR RESEEDING UTAH RANGE LANDS

These recommendations are presented in a specific manner, but since they cover broad areas it may be necessary to modify them in accordance with local growing conditions, availability of seed, and facilities for doing the work. Such modifications will be satisfactory if they conform to the foregoing principles.

Valley Lands and Adjacent Foothills

Valley and foothill lands which can be successfully reseeded occur throughout much of the state. These lands range in elevation from 4,000 to 6,000 feet. Annual precipitation varies from 8 to 18 inches, most of which comes during the winter and spring. The main growing period is between March and June. The summer months are
characterized by high temperatures, little rainfall, and dormant vegetation. Fall precipitation is erratic but usually sufficient for the renewal of plant growth.

The original cover was chiefly grass and sagebrush with small amounts of rabbitbrush. Because of past overuse and fire, sagebrush, rabbitbrush, cheatgrass, and Russianthistle have largely replaced the valuable herbaceous plants. Saltgrass stands of naturally low grazing value occur on moist, moderately alkaline soils. Reseeding can be applied on lands supporting: (1) Russianthistle, (2) dense stands of cheatgrass, (3) dense sagebrush and rabbitbrush stands, and (4) saltgrass. Recommendations for successful reseeding cannot as yet be made for the winter ranges on the east and west deserts, or for pinyon-juniper lands.

Stands of Russianthistle and other annual weeds which result from recent abandonment or recent burning are as a rule exceptionally favorable for reseeding. Little competition is offered the reseeded species and the areas are generally free of physical obstacles. It is desirable to plant these lands before they are occupied by cheatgrass or sagebrush, both of which make reseeding more difficult and costly.

1. Treatment before planting. None needed.

2. Seed mixture.

<table>
<thead>
<tr>
<th>Species</th>
<th>Heavy clay soils (pounds per acre)</th>
<th>Lighter soils (pounds per acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crested wheatgrass</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Bluestem wheatgrass</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Bulbous bluegrass</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>5</td>
</tr>
</tbody>
</table>

If it is impossible to obtain the other species, plant crested wheatgrass at 4 to 5 pounds per acre. Do not substitute for crested wheatgrass.

3. Planting.

A. Season. Fall.

In localities where fall rains can be depended upon, planting in September or early October is best. Where fall rains are uncertain, later planting is better.

B. Method. Disk drill or lister drill in rows 12 inches apart.
On steep, rough, or rocky land where a drill cannot be used, broadcast seed at 1 1/2 times the rate specified for drilling and cover with disk, self-clearing, or spiketooth harrow.

C. Depth. One-half to three-fourths inch.

Dense stands of cheatgrass result from burning or from the abandonment of plowed lands. Large tracts of dense cheatgrass are characteristic of spring-fall ranges. Utilization of soil moisture is so complete that the density and vigor of the cheatgrass must be effectively reduced before seeding. This is generally true even on areas burned the year of seeding.

1. Treatment before planting. Kill most of the cheatgrass.

Flow with a Wheatland or moldboard plow in the spring before seed heads are out. Best kills are obtained if plowing is done during clear weather when the surface soil is dry. Disking, spiketooth harrowing, or burning are usually inadequate.

A less positive but sometimes more practical time for this operation is in the fall after cheatgrass has germinated.

Partial elimination of cheatgrass which may prove adequate can be combined with planting with the use of the lister drill.

The danger of erosion on steep slopes makes it inadvisable to denude them to prepare for seeding until additional information has been secured.

2. Seed mixtures. Same as for Russianthistle stands (page 6).

3. Planting. Same as for Russianthistle stands (page 6).

Dense sagebrush and rabbitbrush stands in which the palatable plants have been largely eliminated or replaced by cheatgrass and other inferior species occur throughout Utah. Such low-yielding ranges result from invasion of sagebrush or rabbitbrush on abandoned cultivated, improperly burned, or overgrazed lands. Rabbitbrush has often formed dense stands on those burned ranges where it was formerly mixed with sagebrush and grass. Reseeding is difficult because the brush hinders planting and competes with the reseeded species for moisture.

1. Treatment before planting. Effectively reduce the brush cover.
Sagebrush and rabbitbrush can be torn up and much of it killed by Wheatland plows. Self-clearing harrows, and rail drags are also effective when sagebrush occurs in nearly pure stands. Rabbitbrush and other species which sprout readily from the roots cannot be satisfactorily reduced by railing. Wheatland plows are most effective where they can be used.

Planned burning is an effective and economical means of eliminating sagebrush. However, for the sake of soil and moisture conservation, the complete removal of the brush cover is undesirable on many sites. In any case burning should not be used where adequate fire control cannot be provided. Accidental burns should be seeded the year of the burn if possible.

2. Seed mixtures. Same as for Russianthistle stands (page 6).

3. Planting.
   A. Season. Same as for Russianthistle stands (page 6).

On accidentally burned land too steep for drilling, seed should be broadcast at $1\frac{1}{2}$ times the rate specified for drilling and covered by a disk, self-clearing, or spiketooth harrow.

Where uprooted brush is so thick as to prevent drilling, broadcast before using Wheatland plow, rail drag, or self-clearing harrow. Where deep plowing with the Wheatland plow is necessary and would result in covering the seed too deeply, broadcast seed on the rough ground immediately after plowing. Soil sloughing will generally provide adequate covering of the seed but use of a brush drag is desirable. Seed can be broadcast by a man riding on the tractor used to pull the implement or a seeding attachment may be provided for the Wheatland plow.

C. Depth. One-half to three-fourths inch.

Saltgrass often occurs as a dense sod where the soil is moderately alkaline. Large tracts of such lands are found in most counties throughout Utah. Reseeding can be successful on those lands which are fairly well drained when the competition from the saltgrass has been effectively reduced.
1. Treatment before planting. Kill most of the saltgrass.

Plow, disk, and harrow in early spring as soon as ground can be worked.

Plowing in the fall followed by disking and harrowing in the spring should also prove satisfactory.

2. Seed mixture.

| Smooth brome | 4 pounds per acre |
| Tall oatgrass | 4 " " " |
| Meadow fescue | 3 " " " |
| Perennial ryegrass | 3 " " " |
| Yellow sweetclover | 2 " " " |
| **Total** | **16** |

If it is impossible to obtain tall oatgrass or perennial ryegrass, plant the other species in the proportions indicated and at a total rate of about 16 pounds per acre. Smooth brome, meadow fescue, and yellow sweetclover should always be included in the mixture.

3. Planting.

A. Season. Early spring.

B. Method. Disk drill in rows 6 inches apart.

C. Depth. One-half inch.

Winter rye has proved valuable for furnishing quick forage on many valley and foothill lands. However, rye pastures generally must be thought of as sources of temporary feed, and they cannot fully take the place of reseeding to perennial plants. For best results the ground should be prepared as recommended for reseeding perennial grasses on the same sites. Rye drilled at 35 to 40 pounds per acre at 1/2 to 1 1/2 inches deep in late August or early September will usually furnish considerable forage the following spring. When rye is broadcasted the rate should be increased to 45 or 50 pounds per acre and covered to the specified depth by harrowing. Since, rye is an annual and depends entirely upon seed for the continuation of the stand, it must be permitted to mature seed or else be planted every year. When rye stands are allowed to reseed they may remain productive 3 or 4 years, especially when disked or harrowed during the recommended planting season. Michels rye, a variety of winter rye, should be used in the same manner.

Perennial grasses should not be seeded with rye in an attempt to obtain a permanent forage crop after the rye has disappeared.
Mountain Lands

Bordering the valley and foothill ranges, these mountainous grazing lands extend to elevations of 10,500 feet. Precipitation varies from 14 to more than 30 inches depending largely upon elevation. At the lower elevation growth starts in late April or early May and is generally delayed 15 days with every increase in elevation of 1,000 feet.

The appearance of the mountain range lands changes greatly with elevation and exposure. Those plants which occur throughout the lower elevations occupy only the dry and exposed slopes at higher elevations. For this reason the nature of the plant cover now existing on any given range rather than its elevation is used in classifying the areas suitable for planting. Reseeding can be conducted successfully (1) on mountain brush lands, (2) in aspen stands, and (3) on high, weedy subalpine ranges. As yet suitable recommendations cannot be made for those openings which are covered with dense stands of tarweed (*Madia glomerata*).

Mountain brush lands on which the more valuable forage plants have disappeared occur on large tracts at the lower and intermediate elevations. Gambel oak is the most characteristic species but the openings and flats especially suited for reseeding are occupied by mixtures or pure stands of sagebrush, rabbitbrush, and snowberry with smaller amounts of other shrubs. With the exception of a few small brush-free openings, reseeding is costly and difficult because of the obstacles to planting and competition to reseeded species. Slopes too steep for the operation of ordinary machinery should be avoided. The reseeding of such slopes is ordinarily necessary only where erosion is likely to be excessive.

1. Treatment before planting. Same as for dense sagebrush and rabbitbrush stands in valley and foothill lands (page 7).

Burning should not be attempted when completely adequate fire control cannot be provided or where the erosion hazard is high.

On small areas of rough topography where heavy power equipment is not adapted, plow furrows 3 to 5 feet apart on the contour. Horses can be used to good advantage.
2. Seed mixture.

<table>
<thead>
<tr>
<th>Species</th>
<th>Dry sites (pounds per acre)</th>
<th>Av. moisture conditions (pounds per acre)</th>
<th>Deep, moist soils (pounds per acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crested wheatgrass</td>
<td>3*</td>
<td>2*</td>
<td>-</td>
</tr>
<tr>
<td>Smooth brome</td>
<td>3*</td>
<td>4*</td>
<td>4*</td>
</tr>
<tr>
<td>Tall oatgrass</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Mountain brome</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Slender wheatgrass</td>
<td>-</td>
<td>2</td>
<td>2*</td>
</tr>
<tr>
<td>Bluestem wheatgrass</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>10</strong></td>
<td><strong>10</strong></td>
</tr>
</tbody>
</table>

*These species should always be present in the mixture. If it is impossible to obtain the other grasses, plant the starred species at 1 1/2 times the rate indicated.

3. Planting.

A. Season. Late summer to November.

B. Method. Same as for dense sagebrush and rabbitbrush stands on valley and foothill lands (page 7).

On contour-furrowed areas broadcast at 1 1/2 times the rate specified for drilling immediately after plowing.

C. Depth. One-half to three-fourths inch.

Aspen stands occur principally at the intermediate elevations. Wherever the understory has been destroyed, reseeding of aspen stands is highly desirable because of the absence of competition from herbaceous plants and the favorable soil and moisture conditions. Dense stands of trees, down timber, and surface roots, however, prohibit the effective use of machines. Reseeding of the openings in aspen which are occupied by brushy species is covered in the recommendations for mountain brush lands.

1. Treatment before planting. None needed.

2. Seed mixture.

<table>
<thead>
<tr>
<th>Species</th>
<th>6 pounds per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountain brome</td>
<td>6</td>
</tr>
<tr>
<td>Smooth brome</td>
<td>&quot;      &quot;</td>
</tr>
<tr>
<td>Slender wheatgrass</td>
<td>&quot;      &quot;</td>
</tr>
<tr>
<td>Tall oatgrass</td>
<td>&quot;      &quot;</td>
</tr>
<tr>
<td>Orchardgrass</td>
<td>&quot;      &quot;</td>
</tr>
<tr>
<td>Timothy</td>
<td>2</td>
</tr>
</tbody>
</table>

**Total** 20
If it is impossible to obtain the other grasses, use the following mixture: smooth brome - 8, slender wheatgrass - 6, timothy - 3.

3. Planting.
   A. Season. September and October.
   B. Method. Broadcast.
   C. Depth. No covering of seed needed. Aspen leaves form adequate cover.

Weedy subalpine ranges which no longer contain valuable forage plants occur in large tracts at the higher elevations in Utah. Such ranges offer excellent opportunities for reseeding because of favorable rainfall. However, the short growing seasons and compact soils often prevent the rapid development of the reseeded stands. Once the stands are established an abundance of forage is usually produced.

Competition from the weedy cover must be reduced before successful stands can be assured. Comparatively level tracts offer the best opportunities for reseeding to increase the forage supply. The steeper slopes should be planted only in connection with an erosion control program.

1. Treatment. Reduce weedy cover.

Flow with a Wheatland or moldboard plow 4 to 6 inches deep anytime during the summer or fall. Self-clearing and heavy disk harrows are also satisfactory if the weedy cover is not dense. However, superior stands will result from plowing.

2. Seed mixture.

<table>
<thead>
<tr>
<th>Species</th>
<th>Dry sites (pounds per acre)</th>
<th>Av. moisture conditions (pounds per acre)</th>
<th>Moist to wet meadows (pounds per acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountain brome</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Slender wheatgrass</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Smooth brome*</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Tall oatgrass</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Timothy*</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Orchardgrass</td>
<td>-</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Kentucky bluegrass*</td>
<td>-</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Meadow fescue</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>13</strong></td>
<td><strong>14</strong></td>
</tr>
</tbody>
</table>
*These species should always be present in the mixture. If it is impossible to obtain the other grasses, double the rate of the starred grasses.

3. Planting.

A. Season. Early summer and late fall.

Although planting can be done throughout the summer and fall, late summer and early fall plantings are likely to be injured by drought, winter killing, or frost heaving.

B. Method. Disk drill in rows 12 inches apart. Six-inch spacing is recommended on moist to wet meadows.

If it is impossible to drill, the seed should be broadcast at 1 1/2 times the rate specified for drilling immediately after plowing with a Wheatland or moldboard plow. Soil sloughing will generally provide adequate covering of the seed, but use of brush drag or harrow is desirable. Where self-clearing harrows are used, seed should be broadcast before harrowing. This can be done by a man riding on the tractor used to pull the harrow.

C. Depth. One-half inch.

SPECIES USEFUL FOR RANGE RESEEDING

Species cited in recommendations

Only species that have been well tested, and for which commercial supplies of seed are available have been included in the recommended mixture.

Bulbous bluegrass (Poa bulbosa) is best adapted to the lighter soils of the valley and foothill ranges. Although it does not provide a large amount of forage it starts growth early in the spring and is grazed with relish at this time. Because of the shallow root system this perennial bunchgrass depends chiefly on the current season's precipitation for the volume of feed produced. Starting growth early in the spring, bulbous bluegrass produces seed (bulbils) and dries up about the same time as cheatgrass.

The ability of the seedlings of this grass to become dormant during dry weather and renew growth with additional moisture makes establishment possible without the need of seed covering.
Kentucky bluegrass (*Poa pratensis*) is useful for seeding the moist flats and meadows in the mountainous range lands. Being a sod-former, this grass reproduces and spreads by rootstocks and will stay productive under heavy grazing.

Under range conditions it is slow to develop, but thin stands usually thicken rapidly. The volume of forage produced is not as great as that of most other species. The inclusion of Kentucky bluegrass in a mixture on suitable sites, however, is highly desirable because of the green feed it furnishes in the early and late part of the growing season. When used alone the seed should be sown at a rate of 12 to 15 pounds per acre and should be covered to a depth of 1/4 inch. Because low quality seed is on the market, careful attention should be given to the germination percentage when the seed is purchased.

Mountain brome (*Bromus carinatus*) is found throughout the mountain range lands of Utah. While it occurs in some favorable foothill ranges, it does best in the aspen and subalpine zones.

Mountain brome is a tall perennial bunchgrass which produces a large amount of palatable forage. Although comparatively short-lived, it produces an abundance of large seed and reseeds itself readily. On adapted sites it is aggressive and spreads rapidly. A small seed crop is frequently produced the first year after planting. For pure stands it should be planted at about 15 pounds per acre. Locally grown seed is preferable.

Smooth brome (*Bromus inermis*) is a hardy, aggressive, long-lived perennial which forms a dense sod by means of many rootstocks. It has been widely used in irrigated pastures and has proved to be the most generally successful species for reseeding the mountain range lands.

Smooth brome shows a marked tendency to become sod-bound, but the inclusion of adapted bunchgrasses in mixtures with it helps to prevent sod-binding and increases production. When sown alone 10 to 12 pounds per acre is recommended.

Meadow fescue (*Festuca elatior*) is a perennial bunchgrass well suited for reseeding moderately moist to wet mountain range lands and the moist, slightly alkaline, saltgrass valley lands. It is fast-growing, productive, and highly palatable to all classes of stock.

Meadow fescue should ordinarily be planted in mixtures with smooth brome and other adapted species. Because of its lack of aggressiveness, its use alone is seldom recommended.

Tall oatgrass (*Arrhenatherum elatius*) has been used successfully from valley to mountain range lands wherever the soil does not become dry for extended periods. Good stands are readily obtained and when once established it usually reseeds itself.
This grass is a deep-rooted perennial bunchgrass which produces an abundance of early and late forage. Early spring growth and rapid development make it useful in mixtures. The light, fluffy husk around the seed may prevent even distribution when drilled unless the seed has been run through a hammer mill.

Orchardgrass (Dactylis glomerata) grows well at the intermediate and high elevations where the soil remains fairly moist throughout most of the summer. Once established it is capable of withstanding extended periods of drought.

Orchardgrass is a long-lived, deep-rooted bunchgrass which is resistant to grazing. It starts growth early in the season and produces a medium amount of palatable forage. This species should seldom be planted in a pure stand.

Winter rye (Secale cereale) when planted in early fall germinates and establishes itself quickly. The following spring it ordinarily furnishes a considerable amount of forage and is especially valuable as an early source of spring feed. Since it is an annual it depends upon seed for the continuation of the stand. It is more drought-resistant than wheat and is capable of growing on poor soils, but it is most useful on sites similar to those used for dry farming.

Michels rye, Michels hybrid, or Michels grass (a variety of winter rye) has much the same growth habit and adaptation as the common winter rye. The individual plants of this grass have more basal leaves than rye, but are a little slower in developing. Some plants may live more than one year, but even these are not strongly perennial. Seed is available at most dealers and where it can be purchased at about the same price as rye, it may be used in place of rye or mixed with it.

Perennial ryegrass (Lolium perenne) is a short-lived perennial suitable for planting moderately moist alkaline saltgrass range lands. It should never be seeded pure for permanent pasture, since it usually persists only 2 or 3 years, but where planted in a mixture it furnishes valuable forage while the longer-lived species are becoming established.

Yellow sweetclover (Melilotus officinalis) is best adapted to those soils which can be expected to remain moist for at least a month after emergence occurs. White sweetclover is very similar but is coarser and slightly less drought-resistant. They are well adapted to moderately moist alkaline soils. Once established they grow rapidly and are fairly drought-resistant. These sweetclovers are biennials producing seed in the second year and depend upon this seed crop for their continued existence. Where soil moisture is adequate good volunteer stands may be produced for several years.
The young seedlings are very susceptible to cold injury and therefore sweetclovers should be planted either in early fall or in the spring.

Sweetclovers are advantageous in a mixture of grasses since they furnish variety to the feed and also enrich the soil through the addition of nitrogen. The grasses will eventually crowd them out, but the forage and fertility furnished in the early development of the pasture make them worthwhile.

Bluestem or western wheatgrass (Agropyron smithii). This native grass can be most successfully established on the fine-textured or heavy soils of the valleys and lower mountainous slopes where the annual precipitation is in excess of 12 inches. Because of the slow root growth in the seedling stage, it is a difficult species to get established unless moisture conditions are favorable during its early development. A sparse initial stand will frequently spread rapidly in the second and later years.

Bluestem wheatgrass is drought-resistant, long-lived, and customarily forms an open sod under dry conditions. It is very resistant to grazing use and furnishes a good supply of moderately palatable feed. Planting this species alone is not generally recommended because of the risk involved in securing a stand. On adapted sites it is a good species to plant in combination with crested wheatgrass.

Crested wheatgrass (Agropyron cristatum). This hardy, long-lived, deep-rooted bunchgrass is the most generally successful species for seeding the low valleys, foothills, and lower mountainous slopes of Utah. Good stands have been produced on well-drained soils ranging from clay to sand.

Crested wheatgrass is a comparatively fast grower and stands of 2 years or more produce an abundance of moderately palatable forage even under adverse climatic conditions. It grows very early in the spring and is best grazed at that time. Fairway crested wheatgrass is a fine-leaved strain that has won some favor, but does not appear especially superior for range plantings. The seed should be sown 4 to 6 pounds per acre.

Slender wheatgrass (Agropyron trachycaulum) is a bunchgrass that occurs natively in Utah over wide variations of soils and elevations. For reseeding purposes it is best adapted to mountain range lands where the annual precipitation is in excess of 14 inches. Under such conditions good stands of palatable forage are produced.

The amount and leafiness of the forage, drought resistance, and the rate of development varies greatly depending upon the source of the seed. For this reason it is best to buy seed produced under conditions that approach, as nearly as possible, the conditions under which it will be planted. When sown alone, 8 to 12 pounds of seed per acre is generally required.
Timothy (*Phleum pratense*) is well adapted for reseeding mountain meadows and other sites where the soil does not become dry for long periods during the summer. It is shade-tolerant and grows well in open timber types. Timothy becomes established quickly and reseeds itself readily.

This species produces an abundance of highly palatable forage and will withstand moderate grazing.

**Other useful and promising species**

Of the several hundred species that have been tested for range reseeding, many have proved useful for certain limited conditions while others promise to be generally valuable but have not yet been adequately tested and so cannot be generally recommended. Some of these species are:

**Alfalfa (*Medicago sativa*)** has produced satisfactory stands when seeded on those valley, foothill, and lower mountain ranges where soil and moisture conditions are above average. Once established it is quite drought-resistant. This legume is a valuable addition in a grass mixture because of its ability to add nitrogen to the soil and to provide variety in the feed. Seed of several strains, of which Utah Common and Lidak are well suited to range reseeding, can be obtained at most dealers.

**Bulbous barley (*Hordeum bulbosum*)** is a robust introduced bunchgrass that has been used only experimentally in Utah. This rapid-growing species appears to be highly palatable and best adapted to the mountain brush type. It is necessary to treat the seed in a hammer mill to remove the beards and other appendages before it can be drilled. Seed is not yet commercially available.

**Big bluegrass (*Poa ampla*)** occurs natively in Utah throughout a considerable range in elevation, but is best adapted to the fertile soils in the foothill region. When planted on good soils it becomes established rapidly and produces a large amount of palatable forage. It is especially valuable as an early source of spring feed. In the fall it ordinarily renews growth to provide again a desirable source of feed.

This perennial bunchgrass should not be grazed until it has become firmly established. Young plants are often uprooted by grazing animals. Seed as yet is relatively scarce, but it is available through those dealers specializing in range grass seed.

**Indian ricegrass or sandgrass (*Oryzopsis hymenoides*)**, a native bunchgrass of Utah's valley and desert ranges, is usually found on sandy soils. This deep-rooted, long-lived, drought-resistant grass is slow to develop under the adverse conditions where it is most useful. Even on desert ranges where the precipitation is normally very low it produces a considerable quantity of palatable forage.
Delayed germination of the seed makes the time of emergence uncertain. The use of seed more than 1 year old is recommended. Experimental tests show that seed properly scarified emerges satisfactorily. As yet no large-scale plantings of scarified seed have been attempted. The usefulness of this grass will be increased when better processes to overcome delayed germination are developed. Seed is now available at some dealers, but because of the limited supply it is expensive. Seed may be harvested from native stands with combines at reasonable cost.

Bearded wheatgrass (Agropyron subsecundum) occurs natively in Utah and is ordinarily found at intermediate elevations among the aspen and mountain brush. This long-lived bunchgrass is deep-rooted, aggressive, and produces a large amount of palatable forage. Good stands have been obtained from seedings and the plants grow rapidly, often producing seed the first year. As yet only a limited amount of seed is on the market.

Bearded bluebunch wheatgrass (Agropyron spicatum) and beardless bluebunch wheatgrass (Agropyron inerme) are very similar in growth requirements and appearance. These native species are adapted to the benchlands and well-drained areas of the valley and foothill ranges where they formerly occurred as a major constituent of the vegetation.

These grasses are drought-resistant, long-lived, and deep-rooted. Although slower to become established than crested wheatgrass, they produce substantial amounts of forage even under adverse conditions. Because of their early growth they are especially valuable on spring ranges. It is seldom possible to purchase pure lots of either of these wheat grasses, but a mixture of the two can be obtained from those firms specializing in range grass seed. A mixture will facilitate drilling especially if beardless bluebunch wheatgrass is the major species.

Siberian wheatgrass (Agropyron sibericum) is very similar to crested wheatgrass and appears to be suited to much the same conditions. From tests so far made it does not appear to excel crested wheatgrass in any respect. Seed is not yet commercially available.

Stiffhair wheatgrass (Agropyron trichophorum). This wheatgrass is a recent introduction that appears to be best suited for seeding the valley and foothill ranges. It is somewhat slower than crested wheatgrass to become established, but develops short rootstocks which form a heavy sod and produces considerable herbage. Seed is not yet commercially available.

Tall wheatgrass (Agropyron elongatum) is a large vigorous bunchgrass recently introduced. Preliminary plantings show that it probably will be useful for reseeding the valley, foothill, and lower mountain ranges. It produces a large amount of herbage and a good seed crop. Seed is not yet commercially available.
Blue wildrye (Elymus glaucus) is a native of Utah which is adapted to a variety of soil and moisture conditions on the mountain ranges at the lower and intermediate elevations. Best results from planting have been obtained in the mountain brush type where it becomes established readily, grows rapidly, and produces a good seed crop and considerable amount of palatable forage. Seed is obtainable from only a few dealers and because of its scarcity is comparatively high-priced. The awns or beards on this seed make it difficult to drill and de-awned seed should be used wherever possible.

Canada wildrye (Elymus canadensis) is a native robust, tuft-forming species that may have limited usefulness for reseeding the lower mountain brush and more favorable sites in the foothills. Its resistance to grazing has yet to be determined. The awned or bearded seed does not readily pass through a drill and consequently de-awned seed should be used. Seed is obtainable only from those dealers specializing in range grass seed.

Russian wildrye (Elymus junceus) is a hardy, introduced bunchgrass that has not yet been thoroughly tested under range conditions in Utah. It appears well adapted to the dry sites at the low and intermediate elevations. Good experimental stands have been obtained in which the plants have grown rapidly producing both an abundance of seed and herbage. In some other western states it is reputedly more aggressive than crested wheatgrass. Seed is not commercially available.

**EQUIPMENT USEFUL FOR RANGE RESEEDING**

Effective reseeding requires the use of effective implements and machinery. The efficiency for range reseeding of most types of farm and road machinery has been tested. Those that have been found most valuable are:

Disk grain drills provide one of the most efficient methods of evenly distributing and covering seed and should be used wherever feasible. On range lands a single disk drill usually cuts through weeds and trash and does a better planting job than does a double disk drill. On steep slopes a small drill with outrigger wheels is practical.

Most seed used for range seeding will feed through a grain drill if the box is but partially filled and if an agitator is used. An agitator may be readily attached to the grain box of most drills. However, some mixtures containing light or bearded seed may have to be poked into the feed mechanism by means of a stick or wire to insure even feeding. If light seed that has been processed in a hammer mill to remove the hulls or beards is available, the de-awned seed is usually well worth the extra cost.
The spacing of the rows can be adjusted by plugging some of the feed spouts.

Lister drills (often called lister or shovel type deep furrow drills) plant at the proper depth in deep broad furrows. They pull harder than disk drills but the furrows are advantageous in reducing competition and accumulating moisture.

Broadcast seeders are of various types but the most common are small "Cyclone," "Cahoon," or "Whirlwind" hand seeders and "end-gate" seeders which are attached to a wagon. The seed is thrown out in a wide swath at a uniform rate by a rapidly revolving disk. They provide better distribution than hand broadcasting.

Harrons (spiketooth, springtooth, and disk harrows). Spiketooth and springtooth harrows are useful for covering seed on loose soil, but clog where weeds are abundant. Disk harrows (often called disks) are effective on hard, rocky soils and do not clog readily. They are satisfactory implements for covering seed where drilling is impossible. Heavy disk harrows have often been used successfully in killing cheatgrass or breaking down sagebrush prior to seeding.

Self-clearing harrows (log or pipe harrows, Dixie drags) are useful for removing competition and covering seed on land too brushy or rocky for farm harrows. This implement was developed on the Dixie National Forest as an aid in reseeding range lands on that forest. The self-clearing harrow as shown in the sketch can easily be made from logs and short lengths of drill or other high quality steel and short chains and swivels. They consist of 3 to 10 logs attached by one end to an evener in such a manner that they are free to rotate. Logs should be 6 to 8 inches in diameter and 8 to 12 feet long. Six to eight holes are drilled through each log in a spiral arrangement and lengths of drill steel are forced through them to provide a series of radial teeth 6 inches long. Four- to six-inch well casings may be substituted for the logs for greater effectiveness and durability.
Rail drags. A drag made of railroad rails is effective in breaking down and killing sagebrush. Drags may be constructed according to several patterns, depending upon the material and facilities available. One of the most successful is shown in the accompanying figure. The front section is made from three 30-foot lengths of rail welded in the positions as indicated in the sketch. Each of the rear sections consist of two 15-foot rails welded together as shown. Three-foot lengths of 1-inch steel rods with eyes connect the front and rear sections and also run to the tractor. One-inch steel eye bolts connect the rods to the rails. On the front section the two outside eye bolts are 4 feet from the end, and are 3 feet from the end on the rear sections. The connecting rods of the rear section run to eye bolts 7 feet from the end of the front section. The distance from the tractor to the front section is 12 feet and 9 feet from the front to the rear sections.

Seed should be broadcast in front of the drag and will be covered by the ralling operation.

Wheatland plows, also known as disk tillers, disk plows, one-way disks, are used for plowing on dry farms. They resemble one section of a disk harrow in that the disks are all on one axis, but are much heavier and the disks are from 20 to 26 inches in diameter and are spaced from 8 to 12 inches apart. The Wheatland plow is useful in destroying sagebrush or in turning under cheatgrass or weeds prior to seeding. Where good kills can be obtained by plowing $1\frac{1}{2}$ to 2 inches deep, seed can be broadcast from the tractor in front of the disk tiller, thus preparing the ground and covering the seed in one operation. Where deeper plowing is necessary seed should be broadcast behind the plow or to the side of the tractor on the previously plowed strip.
Plows, both disk and moldboard, are useful in turning under weeds, cheatgrass, or small brush and loosening compact soils in preparation for seeding. Disk plows are better where brush is heavy or where rocks would damage a moldboard plow. The usefulness of both moldboard and disk plows for range reseeding is largely limited to the construction of contour furrows on sloping lands. More efficient machines have been developed for soil preparation on large tracts.