TECHNICAL NOTE

USDA-Natural Resources Conservation Service
Boise, Idaho - Bozeman, Montana - Spokane, Washington

PLANT MATERIALS TN NO. 10 **JANUARY 2008 REVISION**

PASTURE AND RANGE SEEDINGS PLANNING-INSTALLATION-EVALUATION-MANAGEMENT

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Seeding range, pasture, conservation cover and other situations can be challenging. A complete resource inventory to determine soil type, climatic parameters and existing vegetation should be conducted. The need to revegetate a parcel of land should be based on a desired future condition or goal. It requires patience, time and expense.

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INTRODUCTION

Seeding can be an excellent tool for improving or changing vegetation to meet resource objectives. However, if a vegetative inventory shows a desirable and healthy existing plant community, it is possible that good management practices applied correctly to existing vegetation may be more economical than seeding the site to new or improved species. A careful economic analysis of the planned seeding is recommended.

Many grass, forb, legume, and shrub releases are available for the different soil and climatic conditions in the Intermountain West. Using performance tested plant materials that have been released provides an opportunity to improve current vegetation to meet planning objectives.

Before beginning any land improvement by seeding, two basic questions must be answered.

1. What is the primary goal or purpose of the planting?
   - A. Increased and improved forage and/or hay for livestock and/or wildlife.
   - B. Provide an earlier, later or longer grazing season.
   - C. Control erosion and stabilize watershed.
   - D. Reduce wildfire hazards.
   - E. Provide cover, nesting, and escape habitat for wildlife.
   - F. Control wind – barriers for fields, homes, farmsteads and feedlots.
   - G. Nutrient management.
   - H. Change plant community composition or rehabilitate native plant communities.

2. Is seeding practical?
   - A. Is the soil type capable of supporting a different plant community?
   - B. Will the soil and water holding capacity of the soil allow seeding and support higher production?
   - C. Do undesirable plants dominate or have the potential to dominate the site?
   - D. Can the site be conventionally tilled or will herbicides be required for site preparation?
   - E. Are there site limitations for conventional seeding equipment?
   - F. Is the existing stand capable of meeting the producers goals with manipulation and/or management?

   Some basic principals must be followed to ensure a successful seeding.
   - Competition must be controlled
   - Seedbed preparation and firmness
   - Seed quality
   - Seeding methods
   - Time of seeding
   - Seeding depth
   - Proper post seeding management

The species to seed is dependant on:

- Purpose of seeding
- Availability of seed
- Mean annual precipitation and seasonal distribution
- Elevation
- Minimum temperatures
- Soil type and properties
- Site exposure
- If irrigated, reliability of water supply

Limiting factors are accentuated in dry climates where moisture, its seasonal distribution and amount available are most critical. The water holding capacity of the soil affects the species composition of natural vegetation found on the site and the selection of species that can be successfully planted. Climatic range and adaptation for each species must be investigated.

Species must be tolerant or adapted to soil limitations. Major soil limitations for vegetation are droughtiness, texture (fine or coarse), restrictive layers or pans, wetness, salinity or sodicity, acidity (pH), depth and chemical toxicity or severe nutrient imbalances. Other soil limitations include slope, stoniness and the amount and quality of surface soil materials. Information on species adaptation to precipitation and soils are included in Table 1, Description of Species Characteristics.

For additional information including species characteristics, seeding depths and seeding rates refer to Idaho Technical Note No. 24 Grass, Grass-Like, Forb, Legume and Woody Species for the Intermountain West (http://www.id.nrcs.usda.gov/programs/plant.html) and Idaho Technical Note No. 11 Idaho Forage Handbook, University of Idaho Extension Bulletin 547 (not available electronically).

SPECIES SELECTION

When selecting species for pasture plantings, the species should provide adequate forage when it is most needed, withstand expected grazing intensity, provide adequate soil protection, be sustainable and suppress invasive species. Other factors of major importance when choosing a species for a particular site and purpose include competitive ability, longevity, livestock preference and distinctive growth habits.

Dryland Pasture Plantings

Under normal conditions, only perennial species should be considered on non-irrigated sites. Perennial plants provide a dependable source of highly nutritious forage and do not require annual seeding.

Determine your objectives and complete good resource inventories of the site before making species selections. Plant species should be selected on the basis of what they can contribute to the objectives. They must be adapted to the conditions of the site. The planned seeding must be within the landowner's economic ability and they must also be able to complete the planting with available manpower and equipment. Desirable pasture species characteristics include more than the ability to produce high yields. Among other important characteristics are nutritive value – Table 2;

palatability – Table 3; preference by growth stage - Table 4; regrowth characteristics - Table 5; and soil protection qualities.

Introduced species – Siberian wheatgrass, crested wheatgrass, Russian wildrye, forage kochia and alfalfa are species best adapted to areas receiving less than 12 inches of annual precipitation. Altai wildrye, intermediate or pubescent wheatgrass, and alfalfa perform best in areas receiving 12-18 inch of annual precipitation. Meadow brome, smooth brome (not generally recommended for forage plantings), tall fescue, orchardgrass, small burnet, alfalfa, sainfoin, cicer milkvetch and birdsfoot trefoil perform best at 15 inches or more annual precipitation. On wet soils, creeping foxtail, timothy, tall fescue, cicer milkvetch, birdsfoot trefoil and clover species should be considered.

'Bozoisky Select' Russian Wildrye
Saline Tolerant Species Study

Photo by:
Mark Majerus, Manager
Bridger Plant Materials Center

On wet saline sites that have a water table within 3 feet of the soil surface, consider the following species: beardless wildrye, tall wheatgrass, 'Newhy' wheatgrass, slender wheatgrass, Altai wildrye, tall fescue, western wheatgrass and strawberry clover.

On dry saline sites consider Russian wildrye, tall wheatgrass, slender wheatgrass, western wheatgrass, crested wheatgrass and Siberian wheatgrass. For additional information on saline sites, see Idaho Plant Materials Technical Note No. 9 Plants for Saline to Sodic Soil Conditions. http://www.id.nrcs.usda.gov/programs/plant.html

Adapted forbs and legumes should always be considered in pasture plantings. They add diversity, forage yield and contribute to improved soil and forage quality. Small burnet is a non-bloat forb and legumes such as sainfoin, birdsfoot trefoil and cicer milkvetch have low bloat potential as compared to alfalfa.

Irrigated Pasture Plantings - Mixtures vs. Single Specie Plantings

When two or more species are used in the same irrigated seeding mixture, their relative palatability is of major importance. If the species differ in palatability, it is certain the more palatable species will decline from excessive utilization by grazing animals. Unless intensive grazing management techniques are initiated, this may ultimately result in a single species stand mixed with weedy

patches. Without high levels of management, the more palatable plants are commonly lost. A good example is tall fescue which is very competitive and less palatable than many other irrigated forage species. Because of these traits, it should generally be planted in a monoculture unless alternate row planting techniques are utilized, with a legume in alternate rows to the tall fescue.

Grass-legume mixtures, however, are desirable for many situations and objectives:

1. Mixtures have proven value in controlling soil erosion, improving soil tilth and fertility and in reducing water runoff.
2. Mixtures normally utilize space more efficiently, reducing the potential invasion by weeds and the need of herbicides for weed control.
3. Feed trials indicate grass-legume mixtures are as nutritious and productive in terms of livestock products as legumes alone.
4. Forage yields are equal to or greater than non-mixed legumes or grasses.
5. Mixtures are more suitable for use as silage and can also be used for hay and pasture.
6. A grass-legume mixture has less bloat hazard than a straight legume seeding. To help avoid bloat problems, a mix of 25-40% bloat type legume and 60-75% grass is recommended.
7. As the legume portion of a mixture declines over time, the grass portion of the mix will help maintain forage yields.
8. Many producers find it easier to gauge pasture condition and readiness when a legume is present.

Simple mixes of one grass and one legume are recommended for irrigated seedings. They produce as much forage as complex mixtures and are easier to manage and graze uniformly. They require less total seed and are easier to establish in alternate rows, which is desirable and recommended when possible.

Alternate Row Planting
Russian Wildrye-Alfalfa

Photo by:
Larry Holzworth
Plant Materials Spec.
Montana - Wyoming

On irrigated sites, annual forage species, such as cereal grains and ryegrass may be a viable alternative based on the clients' objectives.

When fields include multiple soil types or moisture conditions, mixes of multiple grasses or grass-legume-forb mixes may be desirable. Complex mixtures are most practical in mountainous or rolling areas and areas having a variety of soil and moisture conditions and/or where there are special considerations such as livestock and wildlife utilizing the same area. In many situations the addition of a forb such as small burnet will add diversity to the planting and legumes such as alfalfa or low bloat legumes such as sainfoin, birdsfoot trefoil and cicer milkvetch will have advantages through their contribution to soil nitrogen and animal nutrition. As the number of species in a mixture increase, the management level must also increase to maintain the composition and health of the stand.

Single species seedings or single grass-single legume seedings are usually advisable in areas with fairly uniform soil, terrain and moisture conditions. They are easier to seed and establish, are more uniformly palatable and require a lower level of management than multiple species seedings. Some suggested grass-legume mixtures for the Intermountain West are shown in Table 6. The table also includes moisture requirements for stand establishment and maintenance.

Range Plantings

Native species - When selecting species for native seedings, a good place to start is to determine the soils on the site from a soil survey and then look at the ecological site description (Rangeland Productivity and Plant Composition Table in the published soil survey) assigned to that soil to determine the native species expected to exist on that soil series. Select 4 to 6 major species in similar percentages found in the site description for your seeding mixture. It is good to keep in mind that you are only beginning the site rehabilitation process and planting all species found in the ecological site description is not realistic, practical or even possible. In addition, some species may not be commercially available.

Complex native mixtures may be required to meet objectives in some rangeland areas. They are most commonly implemented for mountainous or rolling areas and areas having a variety of soil and moisture conditions.

Native mixtures provide a number of benefits:

- Many areas have variable topographic and soil moisture conditions. Each species in a mixture will produce most efficiently on the specific site or micro-site which matches its ecological requirements.
- Since species establish different root systems, a mixed native seeding realizes more efficient use of soil moisture and nutrients which also helps to suppress invasive plants.
- Species vary in growth and production habits. Quality forage is available through a greater part of the season in a mixed stand of species with differing periods of lush growth and dormancy. This is beneficial to both livestock and wildlife.
- Native forbs have a favorable influence by providing diversity and attributes desirable to wildlife.
- Both native and non-native legumes have a favorable influence on other plants in mixtures through nitrogen fixation.

Native Species Planting

Photo by:
Steve Ray, DC
Driggs, Idaho

SEEDBED PREPARATION

Success in establishing pasture and rangeland seedings requires careful planning and timely land preparation. Unlike cereal grains; grass, forb, legume and shrub seeds are generally small and germinate slowly. They should generally be seeded from ¼ to ½ inch deep for optimal seed-soil contact.

Seedbeds should be weed free, level, firm and moist prior to planting. The seedbed should be firm enough that a person's heel-print does not go deeper than ¼- ½ inch into the prepared seedbed. All weeds need to be controlled to reduce competition and to facilitate seedling establishment.

Each producer has a unique set of machinery and many different tillage methods can be used to prepare a seedbed. If the proper equipment and experience is not available, the producer should make arrangements with individuals that have the right type of equipment and experience to prepare a proper seedbed and to seed the site.

Two methods of seedbed preparation are recommended.

> Conventional or Clean Tillage – This type of seedbed can be prepared with plows, discs, chisels, tool-bars using sweeps or other types of equipment. After the tillage operation is completed, the land should be smoothed and firmed using equipment such as a roller harrow, cultipacker, spike tooth harrow or other implement to firm the final seedbed. The seed is then planted directly into the prepared seedbed using a disc or furrow type drill. A variation to this seedbed is used in the northern Intermountain west. Instead of packing the seedbed after cultivation(s), the seedbed is left loose and weed free. Heavy split packer

wheels mounted on the drill firm the soil in the row and the seed is placed in the row behind the packer wheels.

Standing Stubble – Seed can also be interseeded directly into most cereal grain stubble on coarse to medium textured soils. Stubble that is free from weeds and volunteer grain provides a firm seedbed and a favorable micro-climate for seedling establishment. Winter wheat stubble is not recommended for fall dormant plantings due to grassy weeds and volunteer grain that commonly germinate over winter or in early spring. Furthermore, grain straw should be removed from the field or shredded and uniformly scattered. This improves the seed-to-soil contact and reduces chaff toxicity. Harrowing and other chaff spreading operations will disturb the soil and normally cause a flush of volunteer grain. An application of a broad spectrum herbicide such as glyphosate will control this flush. Double disc or deep furrow drills with acra-plant™ openers are recommended for planting into stubble. In addition, if weeds are a problem, spraying the field with appropriate herbicides prior to seeding is recommended. If the weedy competition can not be controlled using chemicals alone, then conventional tillage and herbicide combinations are recommended.

Competing vegetation must be controlled for any planting to be successful. It is often advisable to grow small grain crops for 1-2 years prior to the final seeding. Tillage and labeled herbicides used under small grain production can economically control weeds and reduce the number of weed seeds in the soil. It also allows high levels of organic matter (root and shoot mass) time to decompose into mineral soil. High organic matter soils make poor seedbeds because they are difficult to firm and they also tend to dry rapidly, resulting in poor seed-to-soil contact for proper seedling germination and establishment conditions. This rotation is especially important to consider when renovating old pasture or hayland because it also helps to break disease and insect cycles.

Many landowners want “instant” results and try to interseed into existing plant communities. Numerous studies have shown that interseeding into existing plant communities almost always fails. This is because there is too much competition for water and nutrients from the established existing vegetation. In addition, there may be allelopathic effects from living and/or dying and decaying vegetation. **Therefore, interseeding is not recommended.** Plantings where existing vegetation can be completely destroyed with labeled non-selective herbicides prior to seeding with interseeding type equipment have been successful when the site is irrigated or receives 15 inches or more mean annual precipitation. However, it should be fully understood that these plantings are still more risky than conventional land preparation methods.

An exception to this rule is on very wet soil locations where conventional land preparation is not possible. ‘Garrison’ creeping foxtail can be established in an existing stand of less palatable species including Baltic rush (wiregrass) and sedges. This species is very opportunistic and aggressive on wet sites. The seed can be broadcast by feeding Garrison hay (during winter feeding periods when the soil is dry and firm or frozen) and allowing livestock trampling to plant seed. With proper irrigation and fertilization, Garrison can establish and eventually crowd out less-desirable species over a 6-10 year or longer period.

FERTILIZER

Dryland Pasture

Research on dryland pasture indicates that fertilization is not economical on sites with less than 15 inches of mean annual precipitation.

Irrigated and High Precipitation Dryland Pasture

A long-term supply of phosphorus, potassium and sulfur are needed to enhance root growth and should be applied prior to land preparation at rates determined by a soil analysis and a nutrient budget developed based on Extension Service fertilization guides.

Nitrogen fertilizer should not be applied before the stand is seeded or during the first growing season. Nitrogen generally benefits annual grasses and weeds at the expense of the more slowly establishing perennial species.

Legumes – When seed is properly inoculated, legumes can fix nitrogen from N_2 in the atmosphere and therefore need little or no additional nitrogen from fertilizer. However, legumes require relatively large amounts of phosphorus, potassium and sulphur, and will respond to additions of these nutrients as fertilizer when they are not adequately supplied by the soil. If nitrogen is available in the soil from fertilizer, legumes will use it at the expense of the rhizobium nitrogen fixing process. If nitrogen is added to a grass – legume mixture, both will respond well, but the legume will in effect become dependant on the commercial source, just as grass does. Excessive nitrogen fertilization will eventually shift plant composition toward a greater percentage of grass. Legumes generally respond to phosphorus when the soil analysis shows this element to be in the low to medium range and to potassium and sulphur when the soil analysis shows these elements to be deficient. Follow the recommended rates based on the appropriate fertilizer guides.

Grasses – Grasses require relatively large amounts of nitrogen fertilizer and smaller amounts of phosphorus, potassium and sulphur. Where moisture conditions are favorable, grasses will respond to high rates of nitrogen fertilizer and moderate rates of phosphorus, potassium and sulphur on soils deficient in these elements. Fertilizer guides commonly recommend up to 150 pounds of nitrogen per acre based on a required soil test.

Grass–Legume Mixtures – It is not possible to apply fertilizer to supply the ideal combination of elements for both grasses and legumes. If nitrogen is applied to a grass-legume mixture, the grass will tend to increase at the expense of the legume. The legume will use some nitrogen fertilizer and obtain less from the atmosphere. In effect, some of the nitrogen applied is wasted because it is used in place of nitrogen that the legume would have fixed from the atmosphere. However, grasses do not obtain nitrogen directly from the legume and usually produce higher yields when fertilized with both nitrogen and phosphorus than when fertilized with phosphorus alone. In many cases, better results have been obtained from applying phosphate and potassium fertilizers at relatively high rates every 2-3 years than from applying the same amounts in annual applications. Do not attempt this with applications of nitrogen because of potential pollution to surface and ground water sources from runoff and leaching. Split applications according to the plant needs and soil type are recommended.

You can gradually increase the amount of grass in a mixed planting by applying larger amounts of nitrogen and increase or maintain the amount of legume in the mixture by applying larger amounts of phosphorus, potassium and sulphur.

Broadcast application is the most common method of applying nitrogen fertilizer to established forage stands. It is best to fertilize forages in the fall or very early spring to provide an opportunity for natural precipitation to move the fertilizer into the root zone before the growing season. To avoid volatilization and loss of nitrogen to the atmosphere, fall and spring applications should be made when the soil temperatures are less than 50 degrees. Never apply fertilizer to frozen ground or over snow cover. Caution should be used to avoid runoff on clayey soils or deep percolation on sandy soils.

Nitrogen fertilizers are soluble and move readily in moist soils. Response to nitrogen application is usually rapid if moisture conditions are favorable. However, nitrogen fertilizers, particularly urea, may be lost by volatilization if they remain on the soil surface during warm, dry weather. On irrigated land, mid-season applications of nitrogen should be watered in immediately. Split applications following each haying or grazing event are recommended for nitrogen fertilization.

Phosphorus does not move as readily in soils. Therefore response to surface-applied phosphate fertilizers will not be as rapid or usually as dramatic as the response to nitrogen applications. Some research indicates a positive response from deep banding phosphorus into established stands. Residual responses are common for 2-3 years after application. On soils deficient in phosphorus, a relatively high rate of phosphate should be applied and worked in to the soil during land preparation prior to seeding the grass-legume mixture. Many fertilizer companies have special equipment equipped with coulters and narrow shanks that can deep band fertilizer with minimal disturbance to the pasture.

Application rates can be determined by taking soil tests and developing a nutrient budget based on Extension Service fertilizer guide recommendations.

Caution: Always consider water quality implications for all fertilizer applications.

Rangeland
Fertilizer application is not recommended for rangeland plantings.

PLANTING

Grass, forb, legume and woody seeds generally feed through a seed drill at variable rates because of differences in seed size, seed shape and seed weight. Because of these differences, seed mixtures tend to separate with heavy seed migrating to the bottom and light seed migrating toward the top of the drill box as the drill bounces across the field during the seeding operation.

When planting a mixture of different-sized seeds, it is recommended that a carrier such as rice hulls be used to facilitate the drilling operation. Idaho Technical Note No. 7 Mixing Seed with Rice Hulls provides details on how to complete seed - rice hull mixtures.
(http://www.id.nrcs.usda.gov/programs/plant.html)

Under rangeland conditions, grass-forb-legume-shrub stands can be planted in late fall or early spring dormant plantings. The rule of thumb for dormant fall plantings is to have the seed in the ground late enough so seed does not germinate until spring and for spring plantings to plant the seed as early as you can possibly get on the ground with planting equipment. However, if the soil is not moist to a depth of 12" in the spring, the possibility of increased stand failure exists. Deferring the planting until fall might be advisable if spring & summer rains are historically low. Refer to state conservation practice Standards (327, 512 and 550) for additional guidance on plantings dates.

In general, a grass or grain drill equipped with an agitator, double disc openers, depth bands and packer wheels is the ideal drill for planting grass and grass-legume mixtures. This type of equipment provides ideal seed placement at proper depths, with good seed-to-soil contact for moisture retention. Seeding difficulties can often arise when the drill is filled too full. Never fill a drill more than ½ full. Filling the drill to the top frequently results in seed bridging on one or more openers. Other difficulties arise when the drill is not properly calibrated and/or in poor operating condition. Always check the drill before filling it. Rusty gears, grease globs, mouse nests, hornet nests, and bag string frequently collect in the slots of the feed mechanism. All will interfere with proper seed flow. Cracked, plugged and kinked delivery tubes, plugged tubes also interfere with seed flow. Refer to Idaho Plant Materials Technical Note No. 19, Calibrating a Seed Drill for Conservation Plantings.

With a properly prepared seedbed, many shortcomings of a drill can be overcome. For example, a good firm seedbed will allow a drill without depth bands to place seed at the proper depth if the spring tension on the openers is reduced. If the drill is not equipped with press wheels, chains can be installed behind the openers and/or the field can be rolled or cultipacked following planting to ensure good seed-soil contact. Drills equipped with furrow openers can be modified by fastening delivery tubes behind the openers so the seed falls into the furrow and is properly firmed or pressed with the packer wheels.

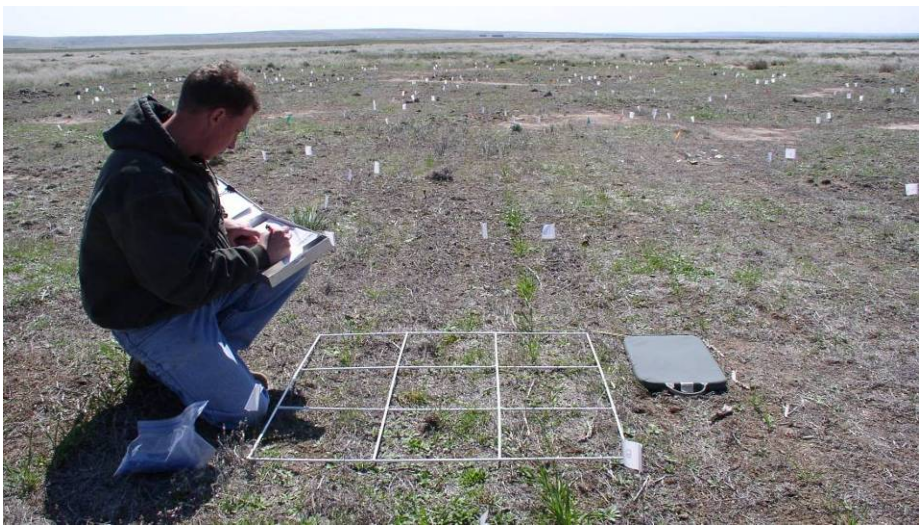
Companion or nurse crops (usually small grains) compete for soil moisture, light and nutrients. They reduce seedling vigor and growth, and delay, suppress and shorten the productive life of the stand. Companion crops are not generally recommended under dryland conditions. Cereal grain companion crops, at a rate of 15 pounds pure live seed (PLS) per acre may be recommended under dryland conditions if the soils tend to crust or are prone to high rates of erosion. Companion crops are less damaging under irrigated conditions if they are seeded at light rates (½ or less of the normal seeding rate for that small grain crop) and harvested for hay.

Under irrigated pasture conditions, grass and grass-legume seedings can be seeded following small grain harvest after the most severe heat of the summer in late summer or early fall. It is important to control volunteer grain and weeds before seeding so that it does not compete with the seeding. You should have at least 6 weeks of growing season before the first expected fall frost and the planting should be irrigated immediately and often to initiate germination and stand establishment.

When planting into standing grain stubble, drill across or at an angle to the row direction of the grain stubble. This will ensure that most of the seed will be planted into mineral soil rather than into stubble from the previous crop.

EVALUATION OF SEEDINGS

Judging the success of a new seeding is very difficult, especially during the first season because the plants are small and difficult to identify. Inspect seedings periodically during the establishment period, since failures in stand establishment may still occur after initial seedling emergence.



Planting Evaluation
Derek Tilley

Photo by: Loren St. John

The primary reasons for seeding failures besides inadequate precipitation are the lack of attention to planting practices including:

1. Elimination of competition – existing vegetation will out-compete seedlings trying to establish. Competition must be controlled to improve chance of establishing seeding.

2. Seedbed preparation – the cultural treatments needed to produce a suitable medium for germination, establishment and growth. A firm weed free seedbed is essential.

3. Seeding – placing the seed at the proper depth (seeding too deep is very common) with good seed-soil contact at the proper time to ensure timely germination and establishment.

4. Protection of planting from grazing and/or traffic following seeding is critical to allow adequate time for seedlings to establish. A good rule of thumb is when plants are producing seedheads, they are well established.

Other common causes for seeding failure include inadequate moisture and/or unfavorable soil conditions. Seed may germinate but fail to emerge due to a soil crust. After emergence, seedlings may die because of adverse climatic conditions or damage from pests. In some cases failure may occur during the second year under unusually dry weather conditions.

Seeding failure represents an expensive risk. When a failure occurs and is recognized early, reseeding is possible, salvaging a part of the seedbed preparation expense. Perhaps only a portion of a seeding will have to be replanted; and careful evaluation of seeding success will identify the areas that need to be reseeded.

Plantings should be inspected as soon as possible after plant emergence. If an obvious failure is recognized early there may be time to allow reseeding to capitalize on stored soil moisture. Reseeding should occur before May at lower elevations (valley bottoms such as the Snake River Plain) to no later than late May at higher mountain elevations. Refer to the Conservation Practice Standards in the Field Office Technical Guide for timing of seeding practices. If adequate germination and emergence has occurred, the summer survival should be evaluated that fall. If failure is noted at that time, reseeding without complete seedbed preparation may still be possible as long as the site has few weeds.

Care must be used especially in evaluating dryland and rangeland seedings since first year results may be misleading unless closely examined. Often good seedling establishment is masked by heavy weed growth. Many such stands have been plowed up and reseeded, when another year of deferment and observation could have allowed the seeded perennials to become fully established and eliminate the weeds through competition.

The criteria for successful plantings should be based upon some quantitative measure of stand establishment. This might be seedlings per foot of seeded row or plants per unit area. The absolute values related to various success ratings will vary with site, year, species, and measurement method. Thus, a stand density which would be considered poor on a well drained, moist upland site might be excellent on a drier semi-desert site. For these reasons the criteria to be applied to any particular seeding should be based on local experience, observation and production potential of the site.

In addition to quantitative data on stand establishment, the examiner should note the kinds and amounts of weeds and desirable non-seeded perennials that have established. In some cases weed control may be necessary to allow seedling establishment.

A careful evaluation must be made before deciding to re-apply the practice or destroy a potential stand. The following factors should be considered when establishing guidelines for non-irrigated sites.

Plant Density

When examining seedings there are several things that should be observed. These include number of seedlings, uniformity of distribution of seedlings over the site and presence of undesirable weed species. The density of plants comprising a successful seeding will vary considerably from place to place, but if seedling plants are uniformly distributed with a minimum amount of undesirable species, the seeding probably is establishing successfully.

Some native species may be particularly slow to establish, so that full stands may not be present the first few years especially if a species is known to have dormant or hard seed. It is essential to watch and manage native seedings for two or more years before deciding whether they are successful. Similarly, most rapid-growing introduced species should establish a rather solid stand during the first year to year and a half after seeding. When evaluating the success of mixtures it is important to note the relative abundance of each species seeded. It is not uncommon for species

such as fourwing saltbush, sagebrush and other shrubs to not even be observed in a 1 to 2 year old planting, but 4 years later a good plant population of the species exists in the stand.

Plant densities that produce successful stands vary from site to site. The objective of each seeding should be to achieve densities that normally are expected for key species in the ecological site description. A survey of the literature shows that a seeding will stabilize at a density typical for the native plant community of that site, with some qualifications.

1. A monoculture seeding of species such as crested wheatgrass, may establish at densities below potential, eventually producing large "wolf" plants with bare spaces between.

2. Diverse mixtures of grasses, forbs, legumes, and shrubs with varying rooting depths and plant phenologies will generally result in maximum densities because soil moisture use during the growing season is optimized.

Rule-of-thumb: *The target plant density for a seeding should be the total density of mature plants for the key species listed in the ecological site description.*

The following table of plant density data from seedings in the Intermountain West indicates that for most sites suitable for reseeding, plant densities will vary based on climate and soil quality.

PLANT DENSITY GUIDE

Mean Annual Precipitation	Ecological Site	Target Density plants/sq. ft.
22"+	Loamy	3.0 - 5.0
	Shallow, Gravelly, Stony, Eroded, etc.	2.0 - 4.0
16"-22"	Loamy	2.0 - 4.0
	Shallow, Gravelly, Stony, Eroded, etc.	1.0 - 3.0
12"-16"	Loamy	1.0 - 3.0
	Shallow, Gravelly, Stony, Eroded, etc.	0.8 - 2.0
10"-12"	Loamy	0.7 - 2.0
	Shallow, Gravelly, Stony, Eroded, etc.	0.5 - 2.0
<10"	Loamy	0.5 - 2.0
	Shallow, Gravelly, Saline, Calcareous, etc.	0.3 - 2.0

Hull and Holmgren (1964), found plant densities of well-established seedings to be relatively insensitive to seeding rates. Seeding rates exceeding 25 seeds/ft^2, generally produced the same plant densities as the seeding rate of 20- 25 seeds/ft^2 in the second or third growing season following planting. High seeding rates might be warranted on sites with very adverse conditions such as intense weed competition, soil crusting, and/or when seed quality is quite poor. Higher seeding rates may also be warranted with species with very small seed size and especially when seed is broadcast planted and a fairly high percentage of seed applied to the sight is not expected to find favorable sites for plant establishment.

In summary, target plant densities for most ecological sites in the Intermountain West are between approximately 0.5- 3.0 plants/ft^2. However, target densities are site specific.

Adjust upward for higher precipitation, downward for lower precipitation and problem soils. Observation of similar ecological sites and reseeded areas will help establish target densities. Stand densities measured after the first growing season (or any subsequent season), should equal or exceed the target density for the site.

Photo by: Mark Stannard

Plant Vigor

Seedlings reaching the three-leaf stage (or beyond), and generally in healthy condition, have greater than a 90 percent chance of becoming established on most ecological sites suitable for seeding (Johnson 1986, White and Currie 1980).

Rule-of-thumb: *Stand counts should apply to seedlings with 3 or more true leaves, and in overall healthy condition. There should be none to slight evidence of insects, disease, or physical damage to the plants.*

Time of Evaluation

Stand counts at the end of the first growing season usually correlate strongly with seeding rates, and can often exceed the target density for the site. If the three-leaf stage and target density rules are being used, a planting can be evaluated at any time following seeding and is judged inadequate until there are a sufficient number of three-leaved seedlings to equal the target density. A reasonable time to check is at the end of the first growing season. If the mixture contains species with hard (or dormant) seed, and if stands are inadequate following the first growing season, evaluation can continue into the second growing season. Only in exceptional circumstances (such as extended drought) should close evaluation need to continue past the second growing season.

> **Rule-of-thumb:** *A seeding may be evaluated any time before or at the end of the second growing season.*

Replanting Versus Natural Recruitment

Plant succession on abandoned cropland was documented in southern Idaho (Piemeisel 1938, 1951), and northeastern Colorado (Costello 1944). These classic fundamental studies can be used as a basis for making sound judgments as to whether to reseed a field with an inadequate stand.

In the Intermountain West, generally Russian thistle, *Salsola kali*; cheatgrass, *Bromus tectorum*; tumble mustard, *Sisymbrium altissimum*; and sometimes other species such as goatsbeard or salsify, *Tragopogon dubius* play an important role in succession on abandoned cropland fields. The year following abandonment, the greatest source of seed is provided by Russian thistle as the previous year's plants tumble across the field depositing

seed. These seeds germinate and grow into large individual plants, which often completely cover the field and produce enormous seed crops.

The second year is also dominated completely by Russian thistle, but plants are usually single-stemmed, stunted, and produce very little seed. The seed bank is replenished by mustard and cheatgrass invading from adjacent areas. The third year may be dominated by mustards (*Descurania* and *Sisymbrium* spp.), and sporadic, large patches of cheatgrass. However; for the next 15 to 20 years and often more, solid stands of cheatgrass dominate the field. In cheatgrass zones of the Columbia Basin, Great Basin and Snake River Plain, a sub-climax of cheatgrass may persist indefinitely. In other areas, perennial grasses may slowly increase in importance 15 to 30 years after the field is abandoned.

If a grass seeding is rated a failure after two growing seasons, a decision to reseed depends on the objectives of the land owner or land manager and the conservation program involved. If weedy plant cover is adequate based on knowledge of successional patterns, reseeding may not be required to control erosion. However, with conservation programs such as CRP, failing to reseed may result in the increase of many additional acres of poor condition weed infested land, minimize future production potential and likely create an incentive to return the land to cropland. Successional data indicates that abandoned cropland will not return to at least fair condition before 25 to 30 years, if ever.

> **Rule-of-thumb:** *Sites where stands are rated as failures should be reseeded unless natural succession is judged to result in at least fair condition range after 10 years. Judgment should be based on the number of desirable perennial grass species present on the site and documented knowledge of successional patterns in the immediate area.*

Natural Recruitment

Natural recruitment of seed from seeded species is a factor to consider when sampling densities are less than adequate, and the conservationist must decide whether reseeding is necessary. Species such as crested wheatgrass and bluebunch wheatgrass recruit or reseed very poorly in most cases, whereas bluegrass and fescue species tend to reseed prolifically. Vegetative spread also should be considered, and is important for sod-type species such as creeping foxtail, western wheatgrass, thickspike wheatgrass, streambank wheatgrass, intermediate wheatgrass and pubescent wheatgrass.

Sampling Methods

Stand evaluation methods can be employed with varying levels of complexity.

One practical method is:

1. Walk (or drive your ATV) perpendicular or diagonally to the drill rows across the field and appraise the variability of the stand. Remember there will nearly always be more than one site-soil condition within a reseeded area, so appraise the stand based on the various soils and their inherent production potential.

2. On the way back, sample representative areas of the field using a pace transect. Record the number of three-leaved (or more) seedlings in a 9.6 square foot plot; (smaller plot frames may be used where the plant density is high); walk ten paces (or drive your ATV an equivalent distance), and record again; repeat counting until 10 stops have been made. Divide the total number of plants counted by 96 to calculate the number of plants per square foot.

3. Complete at least three, 10-stop samples in each field, with more in larger fields as judged necessary (and based on site uniformity), by the conservationist. Two-out-of-three samples (67%), should fall within, or exceed, the target density range for the site.

4. Identify large areas of poor seedling establishment and judge whether those areas should be reseeded based on considerations addressed above, the land managers' objectives, and other factors.

An informal Job Sheet is attached at the end of this paper and can be used to document your stand establishment data. More intensive sampling procedures are often necessary to meet conservation program support documentation when an appeal has been filed. Procedures should be tailored to the needs of each program. It is recommended that a State Specialist be consulted in designing valid sampling procedures for program appeals.

IRRIGATION WATER MANAGEMENT

Sprinkler, furrow or flood irrigation methods are suitable for forage stand establishment. Light, frequent sprinkler irrigations are best for establishing stands because the surface soil can be kept moist until the seedlings germinate and emerge from the soil. Crusting which occurs when the soil surface is allowed to dry out and prevents seedlings from emerging can also be broken or softened by roller, rotary hoe or by sprinkler or furrow irrigation.

For established stands, it is important to fill the soil profile to at least the rooting depth of each forage species during each scheduled irrigation. The soils should be allowed to dry before livestock and/or harvesting equipment are allowed on the field to reduce soil compaction problems.

POST SEEDING MANAGEMENT

More established seedings fail for lack of post seeding treatment and grazing management than for any other reason.

No forage improvement, including seeding, should be considered a substitute for good management.

The investment made in a seeding project will only be as sound as the management that follows.

Early control of weeds eliminates competition and allow establishment of a vigorous stand. Weeds can be controlled using labeled herbicides or by mowing above the desired seedlings and prior to seed set by the weeds.

Seedlings must receive adequate protection until they become established plants. As a general rule, grazing should be deferred until the first seed crop is mature, after which only light grazing during that season should be allowed. Grazing deferment may need to occur through the end of the second or third growing season under non-irrigated conditions. Establishment may take even longer for native species plantings.

Not only are plants more easily overgrazed during the establishment period, they can sometimes be pulled out of the ground by grazing animals. This occurs because their root systems are not established enough to fully anchor the plant. Test this by pulling plants by hand. If you can uproot them, a grazing animal surely can.

ESTABLISHED SEEDING MANAGEMENT

Irrigated Pasture Management

Several cultural practices are recommended for maintaining productive irrigated pasture.

- Legume-grass mixtures can be manipulated by fertilizer applications. Grass is stimulated by nitrogen and legumes are stimulated by phosphorus. Proper combinations of nutrients can help maintain the desired species composition. Apply fertilizer in split applications when possible as indicated by soil tests to enhance the efficiency of fertilizer used and to reduce potential fertilizer loss and contamination of surface and subsurface water.

- Irrigate according to plant and soil needs. Irrigation water should be applied immediately following grazing. Do not graze a pasture while it is being irrigated or until the soils have dried to avoid soil compaction problems.

- The combination of grazing and periodic haying may improve the persistence of legumes over grazing alone.

- Mowing may not be necessary to knock down old wolfy plants if pastures are intensively managed. However, animal numbers may not be adequate to efficiently harvest the forage during periods of rapid growth. Some pastures may need to be harvested by haying or mowing.

- Weeds are generally not a problem when pastures are properly managed. However, when weed problems are identified, they should be controlled.

- Harrowing to breakup and distribute manure is recommended, especially prior to green-up in the spring.

- Feeding hay on irrigated pasture causes compacted soils and reduces forage production potential. If hay is fed on irrigated pasture, light mechanical tillage is recommended to improve infiltration and soil aeration.

- Many irrigated pasture species require re-establishment every 10-15 years to maintain high levels of production. In the short term, forage yields can be increased or maintained for

many species including those prone to becoming sod-bound by proper fertilization and by chiseling or light discing to break up the sod which tends to increase top growth in rhizomatous species.

Grazing and Haying Management
All species vary in their ability to withstand grazing and haying pressure. Although some species can withstand excessive utilization, their future productivity is unquestionably reduced with continued heavy use. To counter this potential loss of productivity, minimum plant height and stubble height recommendations for pre and post grazing and haying have been developed, as shown in Table 7.

The development and implementation of a prescribed grazing plan is essential to ensure proper grazing management and long-term survival and productivity of all plantings.

Prescribed Grazing is managing the controlled harvest of vegetation with grazing animals to improve or maintain: 1) the health and vigor of the plant communities, 2) the quantity and quality of forage for livestock health and productivity, 3) water quality and quantity, 4) riparian and watershed function, 5) soil condition and erosion reduction, 6) quantity and quality of food and/or cover available for wildlife, and 7) promote economic stability through grazing land sustainability.

The prescribed grazing plan uses guidelines provided in the Prescribed Grazing standard (528) and address time, intensity, frequency and duration of grazing.

The plan will include the following components:

- A forage inventory of quantity and quality of available forage for each management unit
- An inventory of the grazing animals
- A Livestock Forage Balance Worksheet that includes the forage demands of wildlife species
- Client actual use and season-of-use documentation, if available
- A system that describes livestock movements, periods of grazing, deferment, rest, season of use, grazing schedule, and other treatment activities such as fertilization, manure management, irrigation water management, and pest management for each management unit. Herd movements may be shown on maps, in tables, or described in a narrative
- Re-growth periods when appropriate will be described
- A monitoring plan to determine trend, and to make adjustments in the prescription and determine if objectives are being met
- Identify alternatives to deal with extremes in weather, fire and other factors that can affect forage production

The plan may require facilitating practices such as fencing, water developments and trails, as well as accelerating practices such as brush management and pasture or range planting.

TABLE 1 – Species Characteristics and Adaptation to Moisture and Soils

GRASSES	Native or Introduced	Bunch or Sod	Precipitation Zone Optimum XXX Below Opt. ///// 8 12 16 20 +	Adaptation to Soils Sand Sandy Silty Clayey Clay	Shallow Soils	Calcareous Soils	Salinity Tolerant	Acid Tolerant	Irrigation Response	Wetness	Extreme Drought	Dry Periods
Bluegrass, Big	N	B	//XXXXXX//	clay loam – silt loam					x			x
Bluegrass, Canada	I	S	//XXX	clay loam – silt loam	x				x	x		
Bluegrass, Kentucky	I	S	//XXX	clay loam – silt loam				x	x	x		
Bluegrass, Sandberg	N	B	//XXXXXX//	loam – clay loam	x	x					x	x
Brome, Meadow	I	B	//XXXXX	clay – silt loam					x			x
Brome, Mountain	N	B	//XXXX	clay – silt loam					x			
Brome, Smooth	I	S	//XXXXX	clay loam – silt loam					x			
Canarygrass, Reed	I	S	//XXX	clay – silt loam				x	x	x		
Dropseed, Sand	N	B	///XXXXXXX//	fine sandy loam - sand	x	x	x				x	x
Fescue, Hard	I	B	//XXXX	clay – silt loam	x			x	x			x
Fescue, Idaho	N	B	//XXX	clay loam – silt loam				x				x
Fescue, Red	I	S	//XX	clay – silt loam	x				x			x
Fescue, Sheep	I	B	//XXXXXX//	clay – silt loam	x	x		x	x			x
Fescue, Tall	I	B	//XXX	clay – silt loam			x	x	x	x		
Foxtail, Creeping	I	S	//XXX	clay - loam				x	x	x		
Hairgrass, Tufted	N	B	//XXX	clay – silt loam				x		x		
Junegrass, Prairie	N	B	//XXXXXX	silt loam - sand	x	x						x
Needlegrass, Green	N	B	//XXXXXX	silt loam – sandy loam					x			x
Needlegrass, Thurber	N	B	//XXXXXX//	silt loam – sandy loam	x	x					x	x
Needle&Thread	N	B	//XXXXXX//	sand – fine sandy loam							x	x
Orchardgrass	I	B	//XXX	clay – silt loam		x			x			x
Ricegrass, Indian	N	B	//XXXXX//	fine sandy loam - sand							x	x
Ryegrass, Perennial	I	B	//XXXX	clay loam – sandy loam				x	x			
Sacaton, Alkali	N	B	//XXXXX//	sandy loam – silt loam	x	x	x			x	x	x
Squirreltail, Big	N	B	//XXXX//	clay loam - silt loam	x	x					x	x
Squirreltail, B.brush	N	B	//XXXXX//	Clay loam – silt loam	x	x					x	x
Switchgrass	N	S	//XXX	silt loam to loam					x			

TABLE 1 – Species Characteristics and Adaptation to Moisture and Soils

GRASSES	Native or Introduced	Bunch or Sod	Precipitation Zone 8 12 16 20 +	Adaptation to Soils Sand Sandy Silty Clayey Clay	Shallow Soils	Calcareous Soils	Salinity Tolerant	Acid Tolerant	Irrigation Response	Wetness	Extreme Drought	Dry Periods
Timothy	I	B	//XXX	clay – silt loam				x	x	x		
Wheatgrass, Beardless	N	B	//XXXXXX//	clay – silt loam			x		x			x
Wheatgrass, Bluebunch	N	B	//XXXXXX//	clay loam – silt loam								x
Wheatgrass, Crested AGCR	I	B	//XXXXX//	clay – silt loam								x
Wheatgrass, Crested AGDE	I	B	//XXXXXX//	clay – silt loam							x	x
Wheatgrass, Crested Cross	I	B	//XXXXXX//	clay – silt loam							x	x
Wheatgrass, Intermediate	I	S	//XXXXX//	clay loam – silt loam					x			x
Wheatgrass, Newhy - hybrid	I	S	//XXXX//	clay loam – silt loam		x	x		x	x		
Wheatgrass, Pubescent	I	S	//XXXXX//	clay loam – silt loam					x			x
Wheatgrass, Siberian	I	B	//XXXXXX//	clay loam – silt loam							x	x
Wheatgrass, Slender	N	B	//XXXXXX//	clay loam – silt loam	x	x	x					x
Wheatgrass, Snake River	N	B	//XXXXXX//	Clay loam – silt loam							x	x
Wheatgrass, Streambank	N	S	//XXXXXX//	Clay loam – silt loam	x						x	x
Wheatgrass, Tall	I	B	//XXXXX//	clay – silt loam			x		x	x		x
Wheatgrass, Thickspike	N	S	//XXXXXX//	clay loam – silt loam							x	x
Wheatgrass, Western	N	S	//XXXXX//	clay – silt loam			x			x		x
Wildrye, Altai	I	B	//XXXXX//	clay – silt loam			x					
Wildrye, Basin	N	B	//XXXXXX//	silt loam– sandy loam		x	x				x	x
Wildrye, Beardless	N	S	//XXXXX/	clay – silt loam		x	x					
Wildrye, Blue	N	B	//XXX	clay loam – silt loam				x	x			
Wildrye, Canada	N	B	//XXXX	loam – sandy loam				x	x			
Wildrye, Mammoth	I	S	//XXXXX//	clay loam–sandy loam		x	x				x	x
Wildrye, Russian	I	B	//XXXXXXX//	clay loam – silt loam		x	x		x		x	x

TABLE 1 – Species Characteristics and Adaptation to Moisture and Soils

FORBS - LEGUMES	Native or Introduced	Annual-Biennial-Per	Precipitation Zone 8 12 16 20 +	Adaptation to Soils Sand Sandy Silty Clayey Clay	Shallow Soils	Calcareous Soils	Salinity Tolerant	Acid Tolerant	Irrigation Response	Wetness	Extreme Drought	Bloat Tendency
Alfalfa	I	P	//XXXXXX	silt loan –sandy loam					x			x
Balsamroot, Arrowleaf	N	P	//XXXXXX//	silt loan –sandy loam							x	
Burnet, Small	I	P	//XXXXXX	clay loam – silt loam					x			
Clover, Alsike	I	B	//XXX	clay loam-sandy loam					x	x		x
Clover, Red	I	B	//XXX	clay loam-sandy loam					x			x
Clover, Strawberry	I	P	//XXX	clay loam-sandy loam			x		x	x		x
Clover, White	I	P	//XXX	clay loam-sandy loam					x	x		x
Crownvetch	I	P	//XXXX	silt loam-sandy loam								
Flax, Blue	N	P	//XXXX//	silt loam-sandy loam	x						x	
Globemallow	N	P	//XXXXX//	clay loam-sandy loam	x	x	x				x	
Milkvetch, Cicer	I	P	//XXXXX	clay- sandy loam					x	x		
Penstemon, Venus	N	P	//XXXX	clay loam-silt loam					x			
Penstemon, Firecracker	N	P	//XXXXX//	clay loam-silt loam	x	x					x	
Penstemon, Palmer	N	P	//XXXXX//	clay loam-silt loam	x	x					x	
Penstemon, Rocky Mtn.	N	P	//XX	clay loam-silt loam					x			
Sagewort, Louisiana	N	P	//XXXXX//	clay loam-silt loam	x	x					x	
Sainfoin	I	P	//XXXX	silt loam-sandy loam					x			
Sweetclover, White	I	B	//XXXX//	clay loam-silt loam	x	x	x		x			x
Sweetclover, Yellow	I	B	//XXXX//	clay loam-silt loam	x	x	x		x			x
Sweetvetch	N	P	//XXXX//	clay loam-silt loam							x	
Trefoil, Birdsfoot	I	P	//XX	clay loam-sandy loam					x	x	x	
Yarrow, Western	N	P	///XXXXXXXX	clay loam-silt loam					x	x	x	

TABLE 1 – Species Characteristics and Adaptation to Moisture and Soils

SHRUBS	Native or Introduced	Evergreen or Decid.	Precipitation Zone 8 12 16 20 +	Adaptation to Soils Sand Sandy Silty Clayey Clay	Shallow Soils	Calcareous Soils	Salinity Tolerant	Wetness	Extreme Drought			
Bitterbrush, Antelope	N	D	//XXXXXX//	clay loam-silt loam								
Ceanothus, Snowbrush	N	E	//XXXXX	silt loam-sandy loam								
Chokecherry	N	D	//XXXXXX//	silt loam-sandy loam								
Current, Golden	N	D	//XXXXXX//	silt loam-sandy loam								
Current, Wax	N	D	//XXXXXX//	silt loam-sandy loam								
Dogwood, Redosier	N	D	//XXXX	silt loam-sandy loam				x				
Kochia, Forage	I	D	XXXXXXXX//	silt loam-sandy loam	x	x	x		x			
Mahogany, Curlleaf	N	D	//XXXXXX//	silt loam-sandy loam	x	x			x			
Mahogany, B. Mountain	N	D	//XXXXX	silt loam-sandy loam	x	x						
Rabbitbrush, Green	N	D	//XXXXXX//	clay loam-sandy loam		x			x			
Rabbitbrush, Rubber	N	D	//XXXXXX//	clay loam-sandy loam		x			x			
Rose, Woods	N	D	//XXXXX//	silt loam-sandy loam								
Sagebrush, Basin Big	N	E	//XXXX//	silt loam-sand			x		x			
Sagebrush, Mountain Big	N	E	//XXXX//	clay loam-sandy loam								
Sagebrush, Wyoming Big	N	E	//XXXXX//	clay loam-sandy loam		x			x			
Sagebrush, Black	N	E	//XXXXX//	clay loam-sandy loam	x	x			x			
Saltbush, Fourwing	N	D	//XXXXXX//	silt loam-sandy loam			x		x			
Saltbush, Gardner	N	D	//XXXXXX//	clay-sandy loam	x	x	x		x			
Serviceberry	N	D	//XXXXX//	silt loam-sandy loam			x					
Silverberry	N	D	//XXXXX//	silt loam-sandy loam								
Snowberry	N	D	//XXXXX//	silt loam-sandy loam								
Sumac, Skunkbush	N	D	//XXXXX//	silt loam-sandy loam					x			
Winterfat	N	E	//XXXXXXX//	silt loam-sandy loam	x	x	x		x			

TABLE 2

Three year average of percent crude protein obtained at 15 day intervals

	Percent Crude Protein										
Species	6-1	6-15	7-1	7-15	8-1	8-15	9-1	9-15	10-1	Aver.	Rank
Nordan Crested Wheatgrass	13.6	9.3	7.2	5.8	4.5	4.3	3.8	3.5	3.4	6.16	13
Fairway Crested Wheatgrass	12.9	9.7	7.1	5.7	4.9	4.2	3.6	3.4	3.0	6.06	14
Tall Wheatgrass	12.4	10.0	8.6	7.4	6.0	5.3	4.2	3.6	3.3	6.76	7
Intermediate Wheatgrass	12.1	9.5	7.7	6.1	4.9	4.6	3.6	3.2	2.8	6.06	14
Pubescent Wheatgrass	12.1	10.4	8.6	6.9	5.2	5.5	4.5	4.1	3.3	6.73	8
Beardless Wheatgrass	13.0	9.7	7.0	6.6	5.0	4.7	4.1	3.9	3.2	6.36	11
Slender Wheatgrass	10.8	8.3	6.4	4.8	3.8	3.2	2.9	2.6	2.4	5.02	17
Mountain Brome[1]	10.4	8.1	6.2	4.6	2.3	2.4	2.1	2.5	2.4	4.56	18
Smooth Brome	10.3	7.9	6.5	4.6	4.6	4.7	3.8	3.5	3.0	5.54	15
Green Needlegrass	13.7	10.4	9.1	7.5	5.8	5.6	5.0	5.0	4.6	7.41	4
Big Bluegrass[1]	10.2	7.1	5.4	4.8	4.2	3.8	3.6	3.8	3.4	5.15	16
Timothy	12.2	10.5	8.7	7.1	5.8	4.9	4.1	3.4	3.2	6.66	9
Orchardgrass[1]	13.5	10.4	8.2	8.0	7.1	6.3	5.2	4.8	4.7	7.58	3
Russian Wildrye	14.9	11.3	9.4	8.0	7.1	6.2	6.4	5.1	4.1	8.06	2
Canada Wildrye	12.0	10.3	7.7	6.8	5.9	6.2	4.4	3.5	2.8	6.62	10
Standard Crested, 36" rows	14.1	11.0	8.8	7.0	5.9	5.0	4.0	3.5	2.8	6.90	6
Russian Wildrye, 36" rows	15.6	12.6	9.5	9.8	8.3	7.9	6.6	6.2	5.1	9.07	1
Big Bluegrass[1], 36" rows	10.6	8.2	7.4	6.0	5.5	5.8	4.2	4.3	3.9	6.21	12
Average	12.6	9.7	7.8	6.6	5.4	5.0	4.2	3.9	3.4		

[1] Two year average

Shaded values show peak protein periods.

Source: This information appeared as Table 5 in Dubbs, Arthur, 1966. Yield, Crude Protein, and Palatability of Dryland Grasses in Central Montana. Mont. Ag. Exp. Sta. Bul. 604. 18pp.

TABLE 3

Summary of Palatability of grasses to sheep and heifers at three stages of growth as determined by total percent of forage consumed during each period*

	Total Percent Consumed During Dates Indicated								
	Year 1 Sheep			Year 2 Sheep			Year 3 Heifers		
Species	5-15 to 6-12	6-13 to 7-26	7-27 to 8-27	5-1 to 5-29	5-30 to 6-30	7-1 to 8-26	5-18 to 6-15	7-1 to 7-29	7-30 to 9-12
Nordan Crested Wheatgrass	98	20	10	70	15	15	95	25	10
Fairway Crested Wheatgrass	95	50	0	50	35	35	95	50	50
Tall Wheatgrass	75	60	15	30	10	50	85	45	60
Intermediate Wheatgrass	98	85	0	30	25	0	95	75	50
Pubescent Wheatgrass	98	85	20	25	40	0	95	75	60
Beardless Wheatgrass	0	45	0	3	0	0	60	95	50
Slender Wheatgrass	85	85	0	40	55	45	90	95	50
Mountain Brome	85	80	25	50	60	100	100	90	95
Smooth Brome	98	98	95	100	95	100	95	95	95
Green Needlegrass	75	70	0	60	0	0	90	95	75
Big Bluegrass	0	35	0	5	0	0	80	20	80
Timothy	100	98	90	100	100	100	95	98	95
Orchardgrass	100	98	98	100	100	100	95	95	98
Russian Wildrye	95	100	95	95	100	100	90	100	98
Canada Wildrye	90	98	0	80	100	90	90	95	90
Standard Crested, 36" rows	95	25	5	60	85	20	95	15	10
Russian Wildrye, 36" rows	90	100	95	75	95	100	90	100	98
Big Bluegrass, 36" rows	0	25	10	10	0	0	60	15	35

Source: This information appeared as Table 11 in Dubbs, Arthur, 1966. Yield, Crude Protein, and Palatability of Dryland Grasses in Central Montana. Mont. Ag. Exp. Sta. Bul. 604. 18pp.

Table 4

Sheep Preference for Grass Varieties by Growth Stage - Preference is Expressed as a Percentage of the Most Preferred Grass.

Species	Vegetative	Boot	Anthesis	Seed- Ripe	Mean
Orchardgrass ‘Latar’	94	100	100	87	95
Orchardgrass ‘Pomar’	100	95	76	88	90
Mountain Rye	83	88	87	100	90
Smooth Brome ‘Manchar’	80	88	87	90	86
Barley, Bulbous	83	82	67	100	83
Pubescent Wheatgrass ‘Topar’	59	81	73	83	74
Bottlebrush Squirreltail	69	75	44	86	69
Tall Fescue ‘Alta’	52	81	58	80	68
Crested Wheatgrass ‘Nordan’	61	68	49	78	64
Indian Ricegrass ‘Nezpar’	57	67	56	72	63
Crested Wheatgrass ‘Fairway’	46	72	44	72	59
Meadow Brome ‘Regar’	56	70	42	64	58
Russian Wildrye	41	77	44	64	57
Tall Wheatgrass	37	63	49	71	55
Basin Wildrye	11	77	53	74	54
Beardless Wheatgrass ‘Whitmar’	33	61	31	52	44
Bluebunch Wheatgrass	39	23	24	67	38
Hard Fescue ‘Durar’	15	32	11	45	26
Salina Wildrye	4	7	2	7	5

Source: Shewmaker, G.E., H.F. Mayland, R.C. Rosenau, and K.H. Asay. 1989. Silicon in C-3 Grasses: Effects on Forage Quality and Sheep Preference. J. Range Management. 42(2):122-127. Study was conducted at NW Irrigation and Soils Research Laboratory, USDA-ARS, Kimberly, Idaho.

Table 5 Regrowth Characteristics of Selected Irrigated Forage Grasses

Species	30 Day Regrowth - Inches 0 2 4 6 8 10 12 14 16	Average For Three Years
'Latar' Orchardgrass	XXXXXXXXXXXXXXXXXXXXXXXXXX	13.8
'Paiute' Orchardgrass	XXXXXXXXXXXXXXXXXXXXXXXXXXXX	14.0
'Napier' Orchardgrass	XXXXXXXXXXXXXXXXXXXXX	11.8
'Potomac' Orchardgrass	XXXXXXXXXXXXXXXXXXXXXXXXXX	13.6
'Regar' Meadow Brome	XXXXXXXXXXXXXXXXXXXXXXXXXXX	13.8
'Manchar' Smooth Brome	XXXXXXXXXXXXXXXXXXXX	11.8
'Alta' Tall Fescue	XXXXXXXXXXXXXXXXXXX	10.2
'Fawn' Tall Fescue	XXXXXXXXXXXXXXXXXXXX	11.0
'Durar' Hard Fescue	XXXXXXXXXXXXXXXXX	9.6
'Garrison' Creeping Foxtail	XXXXXXXXXXXXXXXXX	9.8
'Climax' Timothy	XXXXXXXXXXXXXXX	8.8
'Bastian' Perennial Ryegrass	XXXXXXXXXXXXX	7.6
Standard Timothy	XXXXXXXXXXXXX	7.7

Notes:
Latar Orchardgrass - responds to irrigation rapidly – quickest following harvest - good choice where rust is not a problem
Paiute Orchardgrass - similar regrowth to Latar and Potomac – more drought tolerant – good choice under 18" of irrigation
Napier Orchardgrass – slower regrowth than other Orchardgrasses – not recommended
Potomac Orchardgrass – regrowth similar to Latar – resistant to rust – good choice with rust resistance
Regar Meadow Brome – 1st to 6" years 2 and 3 – averages 7-10 days earlier to reach 6" height – very heat tolerant – good choice
Manchar Smooth Brome – 2nd to 6" years 2 and 3 - poorer regrowth than Regar – not heat tolerant – will sod bound – use for erosion
Alta and Fawn Tall Fescue – early green-up, suffered from early frost – stayed green longer - poor regrowth – use in saline areas
Durar Hard Fescue – early green-up, suffered from early frost – stayed green – poor regrowth – use for erosion control only
Garrison Creeping Foxtail – difficult to establish - performs best in wet sites – good drought tolerance – responds to high fertility
Timothy – not tolerant of high pH soils – not as drought tolerant as Garrison – poorly suited to Snake R. soils – use in high elevation
Bastian P. Ryegrass – excellent seedling vigor – open winters severely reduced stand – not recommended in mid-upper Snake River

Source: Irrigated Pasture Grass Variety Trial, Bill Hazen, University of Idaho Extension Service. October 1991. 3p. unpublished.
Magic Valley, Idaho - Three years of data (1987-1990), 5 replications, 30 day average height following first harvest

TABLE 6

Recommended Grass-Legume Mixtures for Hay, Pasture and Silage

Mixture[1]	Full Irrigation[2]	Short Irrigation[2]	Non-Irrigated Min. Precipitation[2]
Alfalfa and Orchardgrass	X	No	18"+
Alfalfa and Meadow Brome	X	X	14"+
Alfalfa and Tall Fescue	X	No	18"+
Alfalfa and Intermediate Wheatgrass	No	X	12"+
Alfalfa and Russian Wildrye	X	X	12"+
Sweetclover and Russian Wildrye	X	X	12"+
Birdsfoot Trefoil and Orchardgrass	X	No	18"+
Birdsfoot Trefoil and Creeping Foxtail	X	No	18"+
Birdsfoot Trefoil and Canarygrass	X	No	18”+
Cicer Milkvetch and Orchardgrass	X	X	18"+
Cicer Milkvetch and Meadow Brome	X	X	14”+
Cicer Milkvetch and Tall Fescue	X	No	18"+
Ladino Clover and Creeping Foxtail	X	No	18"+
Alsike or Red Clover and Creeping Foxtail	X	X	18"+
Sainfoin and Intermediate Wheatgrass	No	X	14"+
Sainfoin and Meadow Brome	X	X	14"
Sainfoin and Orchardgrass	X	No	18"

Notes:
[1] Alternate row planting of grass and legume is recommended when possible to ensure good establishment of both species. Do not plant tall fescue, creeping foxtail or Russian wildrye and legume in same row.
[2] Irrigation as indicated or water-table w/in 3 feet of the soil surface to meeting minimum precipitation levels; Double seeding rate if seed is broadcast; Smooth brome is not recommended for hay and pasture due to poor regrowth characteristics; Short season irrigation indicates enough water to produce one crop of hay; Orchardgrass is not adapted to areas with frequent spring and fall frosts (mountain valleys).

TABLE 7 Growth Stage for Grazing or Harvesting Forage [1]/

Plant Species - Common Name	Minimum Plant Height (inches) Reached Prior to Initiating Grazing or Hay Harvesting	Minimum Stubble Height (inches) Recommended to Remain at End of Grazing or Hay Harvesting Season
Rangeland		
Big Bluegrass	6	4
Nevada Bluegrass	5	3
Sandberg Bluegrass	4	3
Mountain Brome	6	4
Idaho Fescue	5	3
Tufted Hairgrass	5	3
Prairie Junegrass	5	3
Needlegrass species	6	3
Needle-and-Thread, Columbia, Letterman, and Thurber		
Indian Ricegrass	6	3
Nebraska Sedge	6	3
Bluebunch Wheatgrass	6	4
Slender Wheatgrass	6	4
Streambank Wheatgrass	4	3
Thickspike Wheatgrass	6	4
Western Wheatgrass	4	3
Basin Wildrye*	10	6
Beardless Wildrye	5	4
Pastureland - Grass		
Annual Grasses	3	2
Kentucky Bluegrass	5	3
Smooth Brome	6	4
Meadow Brome	6	4
Reed Canarygrass	8	4
Cereals Grains	8	4
Tall Fescue	6	4
Creeping Foxtail	6	4
Orchardgrass	6	4
Millets	8	4
Sudan grass/Sorghum-Sudan	8	4
Timothy	6	4
Crested Wheatgrass	6	3
Intermediate Wheatgrass	8	4
Pubescent Wheatgrass	8	4
Siberian Wheatgrass	6	3
Tall Wheatgrass	8	6
Altai Wildrye	6	5
Russian Wildrye	8	4

TABLE 7 Growth Stage for Grazing or Harvesting Forage [1]/ (continued)

Plant Species - Common Name	Minimum Plant Height (inches) Reached Prior to Initiating Grazing or Hay Harvesting	Minimum Stubble Height (inches) Recommended to Remain at End of Grazing or Hay Harvesting Season
Pastureland - Legumes		
Alfalfa	6	4
Alsike Clover	4	3
Ladino Clover	6	3
Red Clover	6	3
White Clover	6	3
Cicer Milkvetch	4	3
Sainfoin	12	6
Sweetclover	8	4
Birdsfoot Trefoil	5	3
Hairy Vetch	8	4

1/ NOTES:

- Remove livestock before minimum height is reached on the majority of the forage.
- Recovery period will vary according to the climatic conditions, soil moisture and fertility, and amount of leaf area remaining after grazing.
- Following initial planting, legumes should not be grazed until they have been hayed at least once or they have set seed.
- Basin wildrye has a very high growing point and can be seriously damaged when grazed during active growth in spring and early summer. Grazing in late fall and winter.

Job Sheet For Determining Stand Establishment On Pasture, Range, And Conservation Seedings

Tract No/Field No:_____ NRCS Tech:_____ Date:_____

Transect 1	Species 1	Species 2	Species 3	Transect 2	Species 1	Species 2	Species 3	Transect 3	Species 1	Species 2	Species 3
Stop	*ex. 1 or B. Whtg.*			Stop				Stop			
1				1				1			
2				2				2			
3				3				3			
4				4				4			
5				5				5			
6				6				6			
7				7				7			
8				8				8			
9				9				9			
10				10				10			
Total				Total				Total			
	ex. 3	*ex. 3*	*ex. 2*								

Grand Total:_____ Grand T. / 9.6=____ Grand Total:_____ Grand T. / 9.6=____ Grand Total:_____ Grand T. / 9.6=___

ex: 8 *ex. 0.83*

Average number of seedlings/ft^2 [(Grand total / 9.6) / 3} = _____

No. of stops exceeding target population level/Comments: _____

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