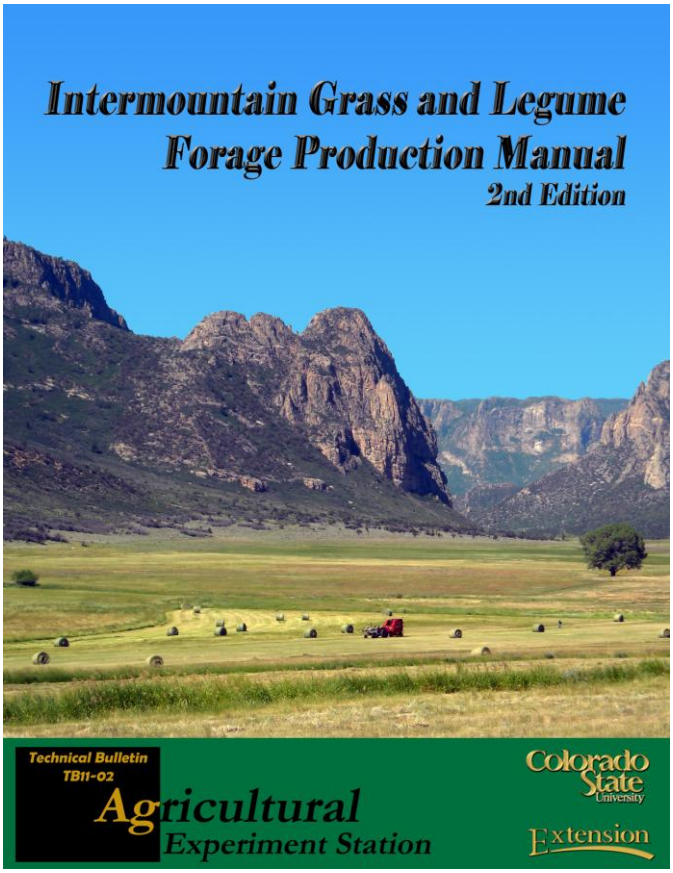

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Section I

Irrigated Pasture/Mountain Meadows

Chapter 3

Establishment and Renovation of Pastures, Hayfields, and Mountain Meadows

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Understanding and carefully following procedures that lead to successful establishment of perennial grasses and legumes is critical to insure long-term productivity of stands. The seeds of grasses and legumes are generally small and contain few energy reserves which mean they must not be planted too deep in order to successfully emerge from the soil. Once emerged, the plants must then be watered frequently (if irrigation water is available) until their root systems have developed. These are just two of the factors that can lead to poor stands or stand failures compared to the relative ease of establishing many other crops such as wheat or corn. In this chapter, we will discuss procedures to improve establishment of perennial grasses and legumes using conventional tillage and seeding methods as well as how to successfully renovate existing stands by overseeding or interseeding.

Land Preparation

Land preparation is very important whether you are seeding rangeland, irrigated pastures, or hayfields. For irrigated pastures and hayfields, conventional seedbed preparation generally consists of plowing, disking (generally twice), leveling, rollerpacking, and establishing water furrows if using flood irrigation. However, some of these operations may be left out of the preparation. Plowing and land planing do not have to be done if at least the top two inches of soil are mellow and a disking operation will eliminate any existing plant competition.

Weed control on sites to be seeded should be implemented before actual seedbed preparation takes place. If the field is plowed, this will take care of most weed problems for a short period of time. If plowing is not done, then disking or herbicides may be needed to control weed populations. When undesirable perennial plants are present, it is generally important to initiate suppression or control methods before seeding, sometimes as much as a year in advance. Obviously, control measures that involve tillage would need to be done prior to planting, however, many chemical control measures (herbicides) for perennial plants are also important to initiate prior to new seedings. This is especially true for seedings that involve legumes (alfalfa, clover, birdsfoot trefoil, etc.). Herbicides that are active on perennial weeds or brush will often damage legumes. It is extremely important to consult the herbicide label for time intervals required between herbicide application and planting grasses or legumes.

Seedbed preparation for non-irrigated sites should not involve plowing or deep tillage if at all possible. Precipitation is minimal in the intermountain region, so try to avoid any tillage operations that will significantly dry out the soil. Harrowing or light disking should suffice for seedbed preparation if tillage is required.

For irrigated sites, a fine, firm, weed-free seedbed that is conducive to good irrigation will optimize seed germination and seedling survival. A firm seedbed is essen-

tial for all planting situations, both irrigated and dryland. Firm seedbeds allow for good seed-to-soil contact, help retain moisture in the top one to three inches, and prevent excessive seeding depths. A good definition of a firm seedbed would be when a person walks on a prepared seedbed, they should not make a footprint deeper than a half inch. Following any type of tillage, rollerpacking also known as cultipacking, or roller harrowing, is an essential operation to firm the soil prior to seeding (Fig.1).

Fig. 1. Example of a cultipacker (top photo) and the firm seedbed (bottom photo) it can create prior to seeding into cultivated ground. Although a fine, firm seedbed is ideal in most situations, in this example, the soil is high in clay and it is actually good to see the small clods on the surface. If clay soils are worked too fine (i.e. powdery), they will form a hard crust following wetting from rain or irrigation which can impede emergence of many grass and legume seedlings. (Photos by Jenna Meeks and Joe Brummer)

How to Seed

Optimum seeding depth for most grasses and small seeded legumes is ¼ to ½ inch. Actual depth will depend on soil type and seed size. Larger seeded species or species planted in sandy soils can be planted approximately ½ inch deep. Smaller seeded species or species planted in clay soils should be planted approximately ¼ inch deep.

A drill designed to specifically seed grasses and legumes will significantly improve establishment success. The most important feature of a good grass/legume drill is some form of depth control on the openers that allows the seed to be placed no deeper than the recommended ¼ to ½ inch. Some drills have fixed depth bands on the openers; some have adjustable rubber wheels on the openers, while others use an adjustable press wheel that limits penetration of the openers (Fig. 2).

Most standard grain drills have little or no means of controlling seeding depth, especially at the shallow depths required for grasses and legumes. Compared to broadcast seeding, a drill provides more uniform depth of seed placement and better seed-to-soil contact. Broadcasting seed can be substituted for drilling; however, the seeding rate should be doubled to account for poor seed placement.

There is one other type of seeder that works fairly well when planting grasses and legumes (especially legumes) into prepared (tilled) seedbeds. It is commonly referred to as a Brillion seeder (Fig. 3). This machine consists of a leading row of cultipacker wheels which firms the seedbed (this generally eliminates the need for rollerpacking prior to seeding) and then one or more seed boxes which meter the seed onto the soil surface. A smaller row of cultipacker wheels follows behind and presses the seed into the soil. This is basically a modified form of broadcast seeding, but since better seed-to-

Fig. 2. Close-up of a double-disk opener with depth bands on a Truax grass/legume drill. Also, note the rubber press wheels that follow the double-disk openers and firm the seed in the soil. (Photo by Jenna Meeks)

soil contact is achieved, a seeding rate of 1.5 times (not twice) the drilled rate is generally recommended.

Seeding with a Cover Crop Or into Stubble

It is not uncommon to seed perennial grasses and legumes with an annual cover crop. Advantages of cover crops include weed suppression and protection of seedlings from wind blasting and erosion, especially on sandy soils. In addition, the annual crop can be harvested for hay. However, there are some disadvantages that must be considered. Annuals have a much faster growth rate and can quickly outcompete the grass and legume seedlings for light, water, nutrients, and space, thus lowering establishment success. Annual cover crops basically act as weeds.

Oats are one of the most common annuals used for cover crops. To minimize competition, the seeding rate for oats or any cover crop should be reduced by 30 to 50% of the normal rate for grain or hay production. The ideal seeding rate for oats used as a cover crop is between 15 and 30 lbs/ac. Additionally, the cover crop should be removed for hay as soon as possible (early heading). Cover crops are not always bad, but they require careful management to insure successful establishment of the grasses and legumes.

Another approach to seeding grasses and legumes is to no-till seed into stubble (standing plant stems). The stubble basically acts as a cover crop, buffering seedlings from the wind, improving soil moisture, and decreasing soil temperatures and weed competition. However, since the stubble is not alive, it does not compete directly with the establishing seedlings.

The only drawback to this approach is that it requires the use of a heavier duty drill with some type of leading coulter to loosen the soil in front of the opener. There are numerous no-till drills available with this option, but some type of depth control is still critical to insure that the seeds are not planted too deep. Placing the seed too deep is one of the leading causes of poor establishment when seeding grasses and legumes.

Fig. 3. A Brillion seeder being used to plant alfalfa into a clean-tilled seedbed in the spring. (Photo by Joe Brummer)

A number of warm-season annual forages are commonly grown to produce stubble into which grasses and legumes are seeded, including sorghum, sorghum-sudangrass, and millet. These crops are generally planted in June and harvested for hay in late summer or early fall. To adequately protect the seedlings, these forage species should be harvested at an average stubble height of 6 inches. Harvesting in early to mid August would allow for seeding of desired grasses or legumes by the end of August. Because many of the plants will produce some regrowth when harvested in August, it is often advisable to spray the stubble with glyphosate to totally kill the plants before seeding to eliminate any possibility of competition for water, nutrients, etc. The stubble can also be left to stand over the winter and seeded into the following spring. Seeding into cereal crop stubble following wheat or barley harvest is also acceptable, but the stubble should not be too tall and the straw must be baled and removed prior to seeding. Seeding into stubble is an excellent way of establishing grasses.

Seeding Time

Planting dates will vary depending on elevation, rainfall, availability of irrigation water, etc. For non-irrigated sites, planting during the dormant season after soil temperatures fall below 40° to 42° F (seeds will not germinate below these temperatures) is often the most successful. The window for seeding will vary by location, but typically occurs in the fall after the soil has cooled below the critical level for germination and before the ground freezes. This means that dormant seedings will need to occur sooner at higher compared to lower elevations (Table 1). Every year is different, so you need to adjust time of seeding based on current environmental conditions. The one caution with dormant seedings is not to plant too early. It is not unusual to get a cold snap in the fall and get excited about seeding only to see it warm up enough to germinate the seeds you planted which then promptly die when it freezes. The idea is for seeds to lay dormant until late winter or early spring when soil temperatures increase to above the critical level at which time they will germinate. This approach basically mimics what happens in nature and takes advantage of winter and early spring moisture which is often more reliable compared to late spring and early summer moisture in many areas.

Firm seedbeds allow for good seed-to-soil contact, help retain moisture, and prevent excessive seeding depths

There has been some work in the Tri River Area of Colorado that suggests a March seeding date is more successful than a November or December date when drilling grass in non-irrigated areas during the dormant season. When seed is planted in the late fall, freezing and thawing "fluffs" the soil which causes the top 1 to 2 inches to dry out and the shallow planted grass seed either does not germinate or quickly dries out once it does germinate and does not survive. When seeded in March, the action of the drill (i.e. press wheels) helps to firm the seedbed which then remains firm since the major freezing and thawing season has passed. This generally refers to areas that are 6,000 feet elevation or less.

Spring seedings (April-May) are generally not recommended or are only marginally successful on non-irrigated sites in western Colorado as well as many areas in the intermountain region. Successful establishment under dryland conditions is all dependent on precipitation patterns in your specific area and May and June are typically some of the driest months in many areas. It is not uncommon to get enough moisture for seeds

Table 1. Basic guidelines for when to seed perennial grasses and legumes on non-irrigated and irrigated sites.

Dryland/Non-irrigated
Less than 6,000 feet elevation Dormant season - November through March (as long as the ground is not frozen)
6,000 to 7,500 feet elevation Dormant season - October 15 to November 15 Spring seeding - April (marginal success) Late summer seeding - August 15 to September 15
7,500 to 9,500 feet elevation Dormant season - September 15 to October 15 Spring seeding - not recommended Late summer seeding - August
Irrigated Pastures & Hayfields
Spring seeded - April
Late summer seeding - August 1 to September 15
Dormant season Less than 6,000 ft. elevation - November through March (as long as the ground is not frozen) 6,000 to 7,500 ft. elevation - October 15 to November 15 7,500 to 9,500 ft. elevation - September 15 to October 15

to germinate, but not enough over time to allow the plants to develop root systems sufficient to sustain growth. Dryland seedings have been successful in areas that receive monsoonal moisture in mid-July and August by seeding in late June or early July just ahead of that stormy period.

For irrigated sites, it is best to plant in the spring or late summer and then apply water as soon as possible following seeding. If you have irrigation water, there is no need to take advantage of winter and early spring moisture by seeding during the dormant season. The only reasons why you would want to seed during the dormant season are that you have more time available due to less activities or the field you want to seed tends to be too wet in the spring. If you decide to seed during the dormant season, then the same general environmental considerations and time frames as discussed above for dryland seedings would apply.

The main advantage for seeding irrigated sites in the spring is that plants have a full growing season for establishment and growth. Depending on elevation and the particular species seeded, you may or may not be able to harvest any forage the first year. At best, you may get one relatively good cutting of hay during the establishment year for most grass species. For irrigated pastures that are seeded in the spring, it is best to wait one full growing season before grazing. You may be able to graze late in the season or after plants have gone dormant, but then only at light levels. How you treat the newly establishing plants in the first year will often affect their vigor and long term productivity. Definitely do not graze if the plants can be easily pulled from the ground! The main disadvantage of seeding in the spring is that you are likely to have more weeds which can lead to poor establishment if they are not controlled.

Competition from weeds is one of the main reasons leading to stand failure when seeding perennial grasses and legumes. Another advantage of seeding in the late sum-

mer is that most plants are well established and ready for growth the following spring and can be grazed or hayed. With this approach, there is typically less down time when you are not producing any usable forage from your pasture or hayfield. For this approach to be successful, you must have access to adequate late summer/fall irrigation water to get the plants established and you must ensure that you seed 6 to 8 weeks before the first killing frost in your area to avoid winterkill. The typical planting time will fall between early August and mid September, depending on elevation.

One of the main advantages of late summer seedings is that there is typically less weed pressure

Renovation of Existing Pastures and Hayfields

Before considering renovation of an established pasture or hayfield, look at your overall management starting with the irrigation system. Water is the number one factor limiting forage productivity in the Intermountain West and a poorly designed or inefficient irrigation system can translate to reduced forage production. You should be in control of your water. Put it where you want, when you want, and in the amount needed. Without control of irrigation water, all other changes in pasture management, including renovation, will be limited in their effect. Secondly, determine if the existing forages are meeting your needs. The best management plan won't make the wrong species produce for you. Thirdly, once you have your irrigation water under control and the desired forages established, you can fine tune your pastures with fertilization, grazing management, and weed control. Determine the weak link in your management and address it.

To renovate a pasture is to make it new again, to make it a high producer of good quality forage. The primary method of renovating an established pasture or hayfield is by interseeding new species of grasses and legumes. It is also common to rip or aerate pastures in an effort to invigorate the existing plants. Although there are numerous testimonials from producers that ripping and aerating leads to increased productivity, there is little scientific evidence to support these claims. In fact, most of the scientific literature points to little or no increase (sometimes decreases) in productivity due to ripping and aerating. Please use caution if you decide to implement these techniques. More discussion of renovation using ripping and aerating will follow in a separate section.

Before attempting a renovation project, you must first ask yourself: Why do I want to renovate? Reasons to renovate may include replacing low producing species such as Kentucky bluegrass or weedy species such as foxtail barley, introducing nitrogen fixing legumes such as clover or alfalfa, or introducing a specialty grass like Garrison creeping meadow foxtail.

Species Composition

When is particular forage not working? This is a question you must answer for each individual situation. For example, a pasture dominated by Kentucky bluegrass may work well for a small horse pasture where durability of cover is more important than high forage production. On the other side of the coin, if you are raising steers for maximum daily gain, then the same Kentucky bluegrass pasture may not be acceptable.

Another example would be a wet, flood irrigated pasture that is dominated by sedges, rushes, or foxtail barley. In this instance, Garrison creeping meadow foxtail and timothy may be more desirable grasses.

Another example would be an orchardgrass/smooth brome pasture that continually needs nitrogen fertilizer to maintain production. A possible solution here would be to interseed a nitrogen fixing legume such as red clover or birdsfoot trefoil.

If stands of smooth brome are hard to maintain in saline soil conditions, consider interseeding tall fescue or Newhy hybrid wheatgrass that are more adapted to these soils.

Seeding recommendations (species selection) for different growing conditions are covered in Chapter 2.

Basic Methods of Renovating:

1. Remove existing plants using conventional tillage (plow, disk, etc.) and reseed.
2. Overseed desirable species into existing vegetation by broadcasting.
3. Interseed desirable species into the existing vegetation by drilling.
4. Significantly disturb the existing plant cover by ripping and aerating.

Renovation by Conventional Tillage

The ultimate in renovation involves complete destruction of the existing plant cover and replacing it with another using conventional tillage and seeding practices. This method was discussed above and is machinery and labor intensive. Conventional tillage is often impractical due to rocky soil conditions, excessive sod build-up, or steepness of the ground. Costs can easily approach $100 or more per acre. In mountain meadow areas, costs as high as $500 per acre have been incurred due to the difficulty in breaking up the sod mat following plowing. Once the soil is exposed, it is susceptible to erosion and can be difficult to flood irrigate. Seedings are also vulnerable to invasion by weeds. This method does provide an excellent seedbed which leads to relatively quick establishment of the seeded forages compared to overseeding or interseeding.

Renovation by Broadcast Overseeding

Overseeding by broadcasting the seed is an inexpensive, but marginally effective means of adding an improved grass or legume to an established pasture. This method requires using a hand or mechanical broadcast spreader to distribute the seed. The major drawback with broadcast seeding is there is little or no seed-to-soil contact. Without seed-to-soil contact, seeds seldom germinate, and those that do wither and die before their tiny roots reach the soil. Forages with large seeds like smooth brome, wheatgrasses, and sainfoin are less likely to establish than forages with small seeds like timothy or alsike clover. The larger seeds hang up in the established forage and thatch whereas the smaller, denser seeds find their way to the soil where they can root and grow.

Success with broadcast seeding is greatly increased by harrowing or feeding hay to livestock on the new seeding. Dragging with an English harrow or meadow drag knocks the seed to the soil where it can germinate. The hoof action of animals imprints the seed into the soil, often planting it nearly as effectively as a grass drill.

Broadcast overseedings are generally more successful when planted in the fall. The freezing and thawing of the soil over the winter helps to incorporate the seed and improve seed-to-soil contact. Due to poor seed-to-soil contact with broadcast seeding, it is necessary that seeding rates be doubled over the recommended drilled rate.

The following tips will help improve the success of plant establishment when broadcast seeding:

1. Suppress the existing vegetation
   - Heavy grazing
     - Use temporary electric fencing to concentrate animals and graze

as evenly as possible, leaving about 2 inches or less of stubble
- Close mowing
  - As close to the ground as possible
  - Flail-type mowers work well for this
- Glyphosate herbicide
  - Goal is to suppress, not kill the existing vegetation
  - Rate will depend on species present, generally ¾ to 1.5 qts/acre
  - Lighter rates for species such as Kentucky bluegrass and orchardgrass
  - Heavier rates for species such as smooth brome and tall fescue
  - Apply 2 to 3 weeks prior to seeding when existing plants are 6 to 8 inches tall

2. Rough up the soil surface with a harrow
   - English, spike, spring tooth, or disk-type harrow
3. Spread seed
   - Do not mix small, round, hard seeds (e.g. alfalfa) with large, odd-shaped seeds (e.g. smooth brome)
   - Results in uneven distribution of seed
   - If you have mixed size seeds, keep them separate and make 2 or more trips over the field varying the distance between passes based on how far the spreader throws each type of seed
4. Lightly harrow or drag pasture to cover seed
   -Can also graze for a short period of time (< 7 days)
5. Keep surface wet for 6 to 8 weeks with frequent, light irrigations

Renovation by Interseeding with a Drill

Inerseeding with a drill is an excellent alternative to conventional tillage and seeding or broadcast overseeding. Interseeding involves placing the seed directly into the existing sod which improves seed-to-soil contact compared to broadcast overseeding. Benefits of interseeding include lower costs compared to complete tillage and the existing plants act as a cover crop that suppresses weeds and reduces soil erosion potential, especially if flood irrigating. Depending on if the existing vegetation is suppressed or not and to what degree, generally at least a partial hay crop can be obtained during the year of seeding.

There are numerous types of interseeding or no-till type drills available that can be used to interseed into existing pastures and hayfields. Some are better than others when seeding into heavy sod conditions like those typically found in mountain meadows. The John Deere 1550 Powr-till drill has been used successfully to interseed in mountain meadows and other heavy sod situations (Fig. 4). It is the only drill available that has power-driven coulters to open slots in the sod. The coulters are powered by

Fig. 4. A John Deere 1550 Powr-till drill being used to interseed legumes into a mountain meadow in the spring. Note the trailing dust cloud created by the tilling action of the rotating coulters on this drill. (Photo by Joe Brummer)

the PTO on the tractor and typically cut slots in the sod about ¾" deep by ¾" wide thus reducing competition in that narrow band. This drill works best for interseeding small seeded forages such as alfalfa, clovers, birdsfoot trefoil, and timothy. Although it has not been manufactured for a number of years, used units can be located if you look hard enough. Because of all the moving parts, maintenance and upkeep on this drill can be quite high.

Fig. 5. A Truax grass/legume drill being used to interseed grasses into a thin stand in the spring. This is only one of many examples of drills that can be used to interseed existing pastures, hayfields, and mountain meadows. (Photo by Joe Brummer)

There are numerous interseeders available that are ground driven (e.g. Great Plains, Tye, Haybuster, and Truax brands, (Fig. 5). Most have rolling coulters that slice the sod followed by double-disk openers that make a small furrow into which the seed is dropped. The openers are then followed by press wheels that close the furrow and firm the seed. For best results, the drill should have some form of depth control on the openers such as depth bands or gauge wheels to avoid planting the seed any deeper than ¼ to ½" (Fig. 6). Emergence of most forage seeds will be hindered if planted deeper than ½" (generally, the smaller the seed, the shallower it should be planted).

In addition to drills that have double-disk openers, there are a couple of manufactures that use leading coulters followed by either rigid or flexible shank openers. The

Fig. 6. A John Deere 750 no-till drill being used to interseed alfalfa into a mountain meadow. Note the rubber gauge wheels on the openers of this drill that keep the seed from being planted too deep. Unlike drills with depth bands, these gauge wheels can be adjusted so you can plant different types of seed (e.g. alfalfa versus oats) at different depths. (Photo by Joe Brummer)

Tar-King Plant-O-Vator uses an aggressive, rigid shank opener to create a furrow that is approximately 5" deep by 3" wide (Fig. 7).

It essentially tills the soil in the furrow which reduces competition from existing vegetation and creates a fine, mellow seedbed given that the soil is not too wet. Fertilizer can effectively be placed below the seed which is a nice feature. The two main drawbacks to this drill are that it seeds on 12" centers and fields with rocks in the top 6" are problematic, although spring loaded shanks are available as an option.

The Atichison Seedmatic uses a spring tine shank with an inverted T opener (a.k.a. Baker Boot). Although not as aggressive as the Tar-King, it does loosen the soil and creates a shallow slot into which both seed and fertilizer can be dropped. The action of the inverted T opener prunes the surface roots of existing plants which reduces competition in the area of the slot. This drill works well in soils that do not have an accumulation of organic matter at the surface. Many mountain meadow soils have up to a 4" layer of organic matter (peat) and the openers on this drill do not work as well under those conditions.

Fig. 7. A Tar-King Plant-O-Vator being used to interseed legumes into a mountain meadow. This is one of the few examples of an interseeding drill that uses a rigid shank (lower photo) to open up the existing sod. The shank is capable of placing fertilizer in the bottom of the slot, if desired, as the machine is pulled through the field. Seed is then placed shallower so that the roots grow into the fertilizer. Note that this drill eliminates some of the competition from existing plants and can create a nice, fine seedbed as long as the soil is not too moist (right photo). (Photos by Joe Brummer)

Apart from the few exceptions noted above, most interseeding drills do little to reduce competition from the existing vegetation. Just as with broadcast overseeding (see above recommendations), reducing plant competition prior to interseeding greatly increases the success of stand establishment. The most successful method involves spraying with glyphosate herbicide at least two weeks prior to seeding. Depending on the rate used, species present and timing of application, control of the existing vegetation will range from just suppression to actual kill. Plants are more likely to only be suppressed following spring application of glyphosate when they are growing rapidly versus fall application when they are moving carbohydrates into the root system. One quart of glyphosate per acre is adequate to suppress most existing vegetation. Where herbicide usage is feasible, it can significantly improve establishment of seedlings by restricting competition. One significant drawback, however, is that the pasture or hayfield is opened up for possible weed invasion. To reduce plant competition in a pasture, existing plants can be heavily grazed before seeding and up until germination. Do not graze after germination as trampling and grazing will kill the emerging seedlings. For smaller acreages, close mowing is also a feasible option for reducing competition. For this method to be effective, mow as close to the ground as possible using a flail (preferred) or rotary-type mower.

There are 3 basic times in which to interseed. The first is in the spring prior to the start of irrigation. For most locations, this will occur sometime between early March and mid-May. The advantages of spring seedings are that plants have the entire growing season in which to establish plus irrigation water is readily available. The drawback to spring seeding is that the existing vegetation is extremely vigorous and must be suppressed, generally with herbicides to achieve the best results. The second time to seed is in late summer (August for most locations) following haying or heavy grazing. The major criteria are that you need late summer irrigation water and 6 to 8 weeks of growth before the first hard frost. For some mountain meadow areas, this means seeding needs to occur in mid July. The third time to interseed is during the dormant season (mid October to March). Generally, there is no need to seed during this time period if the site is irrigated. Why put the seed in the ground where it will lay for several months prior to germinating and can be scavenged by birds and rodents? Dormant season seedings are most useful when renovating dryland sites and you are trying to take advantage of winter moisture to germinate plants in the spring.

Cost of interseeding is somewhat expensive, approximately $10 to $25 per acre for drilling plus seed, herbicides, etc. Higher costs for drilling are associated with smaller

acreages because of the extra time spent turning around at the end of the field. Ripper-type drills are also more expensive to operate because they require the use of higher horsepower tractors and you can only travel 3 to 3.5 mph. The John Deere Powr-till drill is also more expensive to operate because it is subject to slower ground speeds.

To give the seeds every opportunity to germinate and survive, follow these recommendations:

1. Graze, mow, or apply an herbicide to reduce plant competition.
2. Use a good interseeder that places the seed in contact with the soil at ¼ to ½ inch deep.
3. For a given species, cut the recommended full seeding rate for drilling (Tables 1 and 2 in Chapter 2) by ⅓ to ⅔ depending on your particular situation (i.e. amount of bareground present, ability to suppress existing vegetation, weed competition present, etc.). To assist you in your seeding rate decisions, contact your local NRCS or Extension office.
4. Do not seed in wet soil conditions or during precipitation.
5. Seed parallel to contour ditches.
6. When using the John Deere Powr-till drill, drag a harrow across rows to help cover seed.
7. Graze after seeding but before germination to help pack seed and reduce competition from existing vegetation.
8. Do not graze seedlings in the first year.
9. Do not fertilize with nitrogen during establishment (nitrogen fertilizer can favor competing plants).
10. Fertilize with phosphorus, according to soil test recommendations, to assist legume establishment.
11. Irrigate with frequent, light applications of water to favor seedling establishment.
12. Be patient! Newly interseeded grasses and legumes may not be obvious in the stand for two to three years.

Fig. 8. An AerWay® aerator is used to punch slots in the existing sod as the teeth, which are approximately 8 inches in length, roll across the ground. (Photo by Joe Brummer)

Renovation by Ripping and Aerating

Ripping and aerating are other common methods of trying to renovate low producing pastures and hayfields (Fig. 8). Although numerous producers employ these methods of renovation, there is little scientific evidence to support claims of increased productivity. There may be situations in which forage productivity does increase following application of these techniques, but most of the scientific literature points to little or no increase in productivity and decreases are not uncommon (Fig. 9).

Because few studies have been conducted to evaluate the potential benefits of these techniques, we do not fully understand where they do and do not work. The bottom line is to use caution before buying a piece of equipment and implementing these techniques on a large scale. If possible, borrow or lease a pasture ripper or aerator and run your own test on a small section of your

Fig. 9. A homemade ripper-type aerator (top photo) being used to cut slots (bottom photo) about 4 inches deep every 6 inches in the existing sod of a mountain meadow. In this trial, ripping reduced hay yields by over 30%. (Photos by Joe Brummer)

field being sure to leave untreated control strips.

With caution in mind, there may be some situations in which ripping and aerating are beneficial. On heavy clay soils, grazing or haying when the soil is wet can lead to compaction problems. When compaction occurs, the ability of plant roots to penetrate the soil and capture nutrients and water is limited. Movement of water and nutrients into the soil is also limited. These factors can lead to decreased productivity over time. The potential for ripping or aerating the soil to alleviate compaction and restore productivity increases in relationship to the severity of soil compaction. For example, productivity of a pasture that had been grazed for 26 years by dairy cows was doubled by aerating with an AerWay® type aerator which fractured a severely compacted soil layer that was evident between 4 and 5 inches. The bulk density of the soil at those depths was over twice what it was at 1 to 2 inches deep.

Determining the presence and severity of soil compaction before applying these techniques is essential to avoid yield reductions. The benefits (i.e. yield increases) of running the equipment over the ground must outweigh any negative impacts (i.e. injury) to the plants. Basically, any potential yield increase due to alleviation of a compacted soil layer can be offset by yield decreases due to plant injury. This is why overall yield increases are rarely measured except when the soil is severely compacted. Regardless of the type of equipment used, there will be some disturbance to plant crowns and root systems. Ripper type aerators cause more plant injury compared to rolling type aerators like the AerWay®. To determine the presence of a compacted soil layer, follow the guidelines in Table 2.

Table 2. Testing for Compacted Soil Layers

1. Use a moisture rod (i.e. steel rod with a small ball, slightly bigger in diameter than the rod, welded on the end) 4 to 6 ft in length. The rod will typically have a T-handle or palm-sized ball on the top to aid in pushing it into the ground.
2. When the soil is close to field capacity (i.e. after a good rain or within 24 hrs following irrigation), push the rod into the soil using steady, constant pressure.
3. If there is a compacted soil layer, you should feel an increase in resistance followed by a decrease when you break through the layer. The increased resistance is due to the compacted layer being dryer.
4. This same technique can be used to test for depth of water penetration following rain or irrigation.

Another common problem encountered with perennial pastures and hayfields is that they become sodbound. This occurs in fields that have been in production for a number of years and are dominated by strongly rhizomatous species such as smooth brome and creeping meadow foxtail. A common rec-

ommendation has been to rip or aerate sodbound fields in an effort to break up the dense rhizome layer that forms. Although it may seem logical that disturbing the rhizomes would stimulate new growth, research results in this area point to nitrogen deficiency as the main factor limiting growth. For example, a Canadian study looked at the combination of aeration with an AerWay® aerator and nitrogen fertilization at 5 sites dominated by smooth brome and found no response to aeration, but a significant response to nitrogen fertilization in almost all cases. You would be much further ahead to spend your money on some nitrogen fertilizer than spending time and fuel running an aerator or ripper through your pasture or hayfield.

Another condition that occurs primarily in mountain hay meadows is the formation of a layer of organic matter or peat-type material at the soil surface due to the slow decomposition of plant material in high elevation, cold environments. This layer can be up to 4 inches thick and contain as much as 5,000 pounds of nitrogen per acre. However, the nitrogen is mostly in organic forms which are not plant available. This leads to similar sodbound conditions as described above. Again, it seems logical that ripping or aerating these meadows would stimulate decomposition of the organic matter and subsequent release of nitrogen. However, this is not the case. A study conducted in the Gunnison, Colorado area compared the AerWay® aerator to ripping on either 6 or 12 inch centers. Basically, the more soil disturbance there was (least = AerWay®, greatest = ripped on 6 inch centers), the greater the decrease in hay yield. A 33% yield reduction was associated with ripping on 6 inch centers. It doesn't take an economist to figure out that this doesn't pay. Similar to the Canadian study cited above, hay yield of the mountain meadows did respond positively to additions of nitrogen fertilizer which indicates that the major factor limiting hay yield is nitrogen deficiency.

Ripping or aerating may have a place in mountain meadows when it comes to water management. Most mountain meadows have never been leveled and are still irrigated using the "wild flood" technique which consists of damming small feeder ditches so that they overflow. Low spots (bottoms) in the meadows quickly become saturated with standing water while areas that are higher, especially on side slopes, remain relatively dry. By ripping on the contour of the irrigation ditch, the slots catch and slow the flow of water down the slope which leads to better water infiltration on the slope and less water accumulation in the bottoms. In theory, more even water dispersal should translate to increased yields. However, this concept has not been scientifically tested and should be implemented with caution. You would definitely only want to rip or aerate the side sloping areas, not the bottoms. Otherwise you would risk yield reductions as described in the preceding paragraph.

In conclusion, use caution when ripping or aerating pastures and hayfields in an effort to improve productivity. The potential for no increase or significant decreases in yield when applying these techniques is high.