

# TECHNICAL NOTE

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## PRINCIPLES OF SEEDBED PREPARATION FOR CONSERVATION SEEDINGS

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**Figure 1. A clean, firm seedbed ready to plant - note foot prints sinking less than 1/2 inch.**

Success in establishing pasture, rangeland and other conservation seedings requires careful planning and timely seedbed preparation. Since plant breeding was first developed by man, cereal grains have been bred to increase emergence and improve uniform establishment making it possible to establish successful grain crops with imperfect seedbed conditions. Conversely, most perennial grass, forb, legume and shrub seeds used in conservation seedings are generally small, germinate slowly, and have not evolved for rapid and uniform establishment like small grains, making seedbed preparation much more important. Seedbed preparation techniques for conservation plantings should be selected to best suit the site conditions, the species to be seeded and available equipment. The goals of seedbed preparation are to retain the maximum amount of soil moisture, control competing vegetation, improve seed to soil contact, and allow for the proper seeding depth, germination and emergence of the species to be seeded in the conservation planting.

## **SEEDBED PREPARATION**

**The ideal seedbed is uniformly firm, has soil moisture near the surface, is free from competing vegetation and is well-packed underneath with small surface clods or a light mulch of residue to prevent soil erosion.**

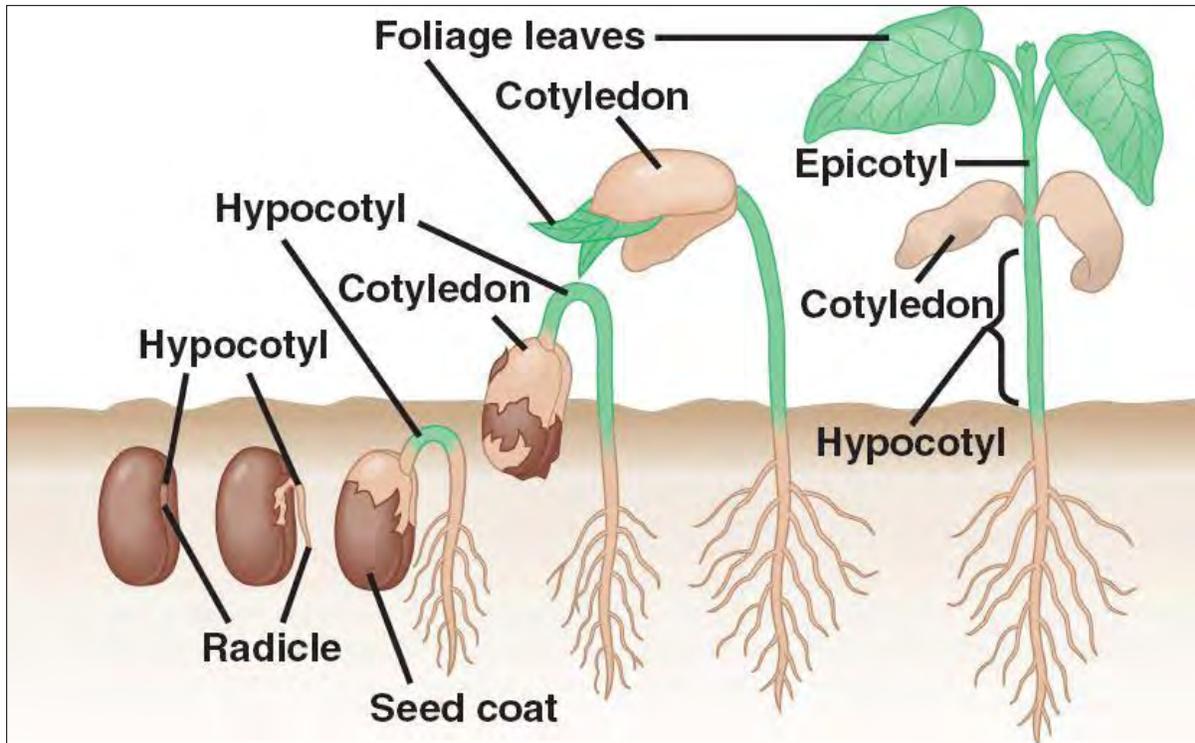
In the Inland Northwest and Intermountain West, inspections of hundreds of plantings in the past 65 years have shown the most common cause of conservation seeding failures is from poor seedbed preparation. Seedbed preparation deficiencies include soil looseness, dryness near the surface, and excessive weed competition. Other establishment failure causes include seeding too deep, seeding at the wrong time of year, drought, plant disease, poor quality seed, improper grazing management, and insect/pest outbreaks. Some factors such as weather, disease and pest outbreaks are often out of our control but if we do everything in our power to provide as ideal a seedbed as possible, the chances of having a good stand establish increases and may compensate for the negative factors beyond our control.

*“Good seed to soil contact required”*. This phrase is seen in almost all seeding documents but people typically don’t give it much thought. This section provides some of the logic that went into the phrase.

In general, most seeds simply require water, oxygen, and favorable temperatures for germination. Germination is a three step process – seeds imbibe water, chemical reactions occur to turn the endosperm into a useable form to fuel cell growth, and cells begin dividing and growing (see illustration of germinating bean seed).

Seeds that are subject to alternate wetting and drying cycles are not very likely to germinate. The enzymes involved in breaking down the endosperm are limited and have a short life span. After a couple wet and dry cycles the seed will simply run out of active enzymes and die.

**Maintaining seed moisture is critical for optimal germination.**



**Illustration of germinating bean seed. Seeds require water, oxygen and heat to germinate. Proper seed to soil contact is crucial to successful germination.**

Seeds that have good contact with soil are less likely to experience widely fluctuating wet-dry cycles because the soil transfers water efficiently to the germinating seed allowing it to grow roots into the deeper soil moisture. Good seedbed preparation provides for seed to soil contact by creating the ideal soil “firmness” (see Figure 1). When soil is too loose (Figure 2), air in the soil increases the amount of wetting and drying cycles in the soil. In contrast, when a seedbed is too firm, it is difficult to get the seed into the soil. A seed lying on the surface is very likely to experience widely fluctuating wet-dry cycles. A uniformly firm seedbed allows for proper seeding depth when either drill or broadcast seeding methods are used. Seed laying on the soil surface is dependent on timely atmospheric moisture for complete germination. Timely rains are not normal in the Inland Northwest or the Intermountain West.

There are two basic methods of seedbed preparation.

**Conventional or clean tillage** – Conventional seedbeds are prepared in two phases, first with plows (Figure 3), disks (Figures 4 and 5), chisels (Figure 10), or sweeps (Figure 11), commonly referred to as primary tillage. After the primary tillage is completed, final seedbed preparation is performed to smooth and firm the seedbed. Roller harrows or culti-packers (Figure 8), packers (Figure 9) or spike tooth (Figure 6) and spring tooth harrows (Figure 7) are used to firm and smooth the final seedbed. Conventional tillage is not recommended for saline or sodic soils because conventional tillage brings salts to the surface, and destroys soil structure and surface residue. Prescribed fire to remove plant residue, herbicidal control of vegetation, and shallow disking or harrowing where practical on rangelands may provide a weed free and firm seedbed. **The final seedbed**

**needs to be firm enough to leave human footprints less than ½ inch deep. The firmer the seedbed, the better.**

**Standing stubble** – Conservation seeds can be inter-seeded directly into most weed-free cereal grain stubble on coarse to medium textured soils. Stubble that is free of volunteer grain and weeds provides a firm seedbed and a favorable micro-climate for seedling establishment. Grain straw should be removed from the field or shredded and uniformly scattered. This will improve seed-to-soil contact and reduce potential toxicity from the chaff. Ground disturbance of standing stubble with tillage implements will disturb the soil and cause a flush of volunteer grain. Winter wheat stubble is not recommended for fall conservation seedings after grain harvest due to volunteer grain and weeds that germinate overwinter or during early spring. Application of a broad spectrum herbicide is recommended to control weeds and volunteer grain prior to planting conservation seedings in standing stubble. If weeds cannot be controlled with herbicides, then conventional tillage is recommended and may need to be used in combination with herbicide treatments.



**Figure 2. A soft, loose seedbed - footprints sinking greater than 1 inch deep.**

Some planting sites (usually spring planted small grain fields with straw removed and/or evenly distributed) may require only one or two tillage operations to prepare a seedbed. Tillage kills weeds and incorporates residue. Chemical weed control in lieu of tillage does not provide the benefit of mixing residue into the soil. Usually a combination of tillage and chemical weed

control treatments is best for suppressing grassy weed infestations (cheatgrass, quackgrass, medusahead, and ventenata) in old CRP fields. With minimum till drills and the proper herbicides, seeding directly into cereal grain stubble can be successful. Seedbeds prepared by conventional tillage will need to be packed to firm the seedbed before seeding.

The presence of weeds (and especially noxious weeds) will also determine the methods used to prepare a good seedbed and to have a successful seeding. Seeding fields with significant weed populations must be delayed until weeds are controlled. Refer to the ID-OR-WA Pacific Northwest Weed Management Handbook <http://weeds.ippc.orst.edu/pnw/weeds> and MT-UT-WY Weed Management Handbook <http://www.invasive.org/weedcd/pdfs/wmh.pdf> for information on herbicides that can be used for weed control during seedbed preparation and establishment. Other sources of information include extension specialists, county weed control supervisors and chemical dealers. Guidelines for Integrated Pest Management (Code 595) are available in the electronic Field Office Technical Guide (eFOTG) section IV, Practice Standards. Always read, understand, and follow label instructions when applying herbicides.

When planning a seeding, it is important to know the history of chemical use on the field, especially the previous 2-3 years prior to the planned seeding. Many herbicides have residual carryover that may cause seeding failure. Any potential herbicide carryover must be addressed by delaying the seeding, establishing a cover crop and/or changing species to be planted. Check the herbicide label to determine restrictions on replant intervals for the species you are planning to seed and also for the minimum time after establishment that a herbicide can be used to control reinvading weeds.

If a cover crop is necessary, refer to guidelines for Cover Crop (Code 340) in eFOTG. It is often advisable to grow small grains for one to two years before the final conservation seeding. The use of cover crops is one of the best methods available for thorough control of noxious weeds prior to establishment of a conservation seeding. Tillage and labeled herbicides used for small grain production will economically control weeds and help to reduce the weed seed bank in the soil. Cover crops allow time for high levels of organic matter (roots and shoots) from the previous vegetative cover to break down and decompose into mineral soil. Soils high in organic matter from long term perennial sod make poor seedbeds because they are difficult to firm and also tend to dry rapidly, resulting in poor seed-to-soil contact for germination and establishment. Cover crops can also help to break disease and insect cycles and are especially useful when renovating old pasture or hayland.

Seeding into poor condition rangeland, pasture or CRP also requires control of existing annual and perennial vegetation. This may be accomplished through the use of tillage, herbicides and prescribed fire. Prescribed fire may be used to reduce litter and weaken existing perennial vegetation. However, the proper timing of prescribed fire must be taken into account. Burning at the wrong time of year may actually stimulate some species in the existing cover that are to be removed. For example, smooth brome can be reduced with fire if burning occurs at the tiller elongation stage (typically the 5 leaf stage) but fire increases smooth brome at other times of the year. Many bunch grasses burn quickly and are less susceptible to fire damage. In especially thick bunchgrass plant communities, fire may stay longer in the culms, resulting in heat transfer to the ground and into plant crowns, killing the plant. In crested wheatgrass, there is usually little

heat transfer into the soil, so the tillers and root system are usually undamaged. For rhizomatous grasses, late spring fires generally reduce cover, flowering and biomass, while early spring fires can increase the stand. Prescribed fire may only be most useful for removal of litter and caution needs to be exercised if the desired effect is to weaken existing vegetation. Be sure to check state and local rules and regulations governing prescribed fire.

A typical scenario to prepare a seedbed that currently is in perennial vegetation would be:

- Shred or burn to remove existing litter that will make control difficult
- Apply herbicides 1<sup>st</sup> spring - again in fall if greenup occurs
- Apply herbicides again in 2<sup>nd</sup> spring – again in 2<sup>nd</sup> fall if greenup occurs
- Plant new seed mixture – dormant planting after October 20 to November 1 with no-till drill

Or

- Plow 1<sup>st</sup> spring
- Disk 1<sup>st</sup> fall
- Disk 2<sup>nd</sup> spring
- 2<sup>nd</sup> fall disk and prepare seed bed (roller harrow, cultipacker – firm seedbed)
- Plant new seed mixture – dormant planting after October 20 to November 1

The standard herbicide mixture used by the Aberdeen Plant Materials Center for killing grass stands is 64 oz/ac glyphosate with 16 oz/ac 2, 4-D. The 2,4-D enhances movement of the glyphosate into the roots and provides some residual effect. Grass should be actively growing with less than 6 inches of new growth at time of application.

Many landowners want “instant” results and try to interseed into existing plant communities. Numerous studies have shown interseeding into existing plant communities almost always fails due to competition for water and nutrients from the existing vegetation. In addition, there may be allelopathic effects from living and decaying vegetation. **Interseeding with no control of existing vegetation is not recommended.** Plantings where existing vegetation can be completely killed with herbicides prior to seeding and seeded with no-till drills have been successful when the site is irrigated or receives 15 inches or more annual precipitation. It should be fully understood that no-till seedings have a higher risk of stand failure than conventional seedbed preparation with tillage.

An exception to the interseeding rule is on very wet soils where conventional land preparation is not possible. ‘Garrison’ creeping foxtail can be established into a stand of less palatable species such as rush and sedges. Creeping foxtail is very opportunistic and aggressive once established on wet sites. Seed can be broadcast when the site is frozen or by feeding Garrison hay and allowing livestock to trample the seed into the soil surface. With proper management (irrigation, fertilization, livestock management), Garrison will establish and eventually crowd out less desirable species over a 6 to 10 year period.

## TILLAGE EQUIPMENT

**Moldboard plows** (Figure 3) operate optimally at depths of four to ten inches and completely turn the soil over. It is one of the most effective tools in controlling grasses because it buries most of the plant and seed deep enough to prevent germination and re-establishment. Moldboard plowing works best when there is little or no residue on the surface to allow complete inversion. In some cases, it is recommended to rip tough sod prior to moldboard plowing. The disadvantage of the moldboard plow is that it is expensive (takes time and large amounts of horse power), little or no residue is left on the soil surface for erosion control, and additional tillage will be necessary to smooth and firm the seedbed. Moldboard plowing is not recommended for rangeland seeding of native plants.



**Figure 3. Moldboard plow**

**Disk plows** (wheatland plow and rangeland plow, see Figure 4) are composed of circular cutting blades (disks) set on a common axle(s) attached to a frame. Disk plows have one set of disks (disk gang) that inverts the soil by moving the soil in one direction. The number, size, and weight of the disks vary depending on the type of site preparation required. The disk plow does not plow as deeply or reduce weed competition as effectively as a moldboard plow and it does not maintain residue on the surface for erosion control or leave clods. Disk plows will work better under dry soil conditions and handle more residue and shrubby growth than a moldboard plow. Disk plows will also allow more soil moisture to escape than sub surface tillage equipment.



**Figure 4. Disk plow**

**Offset disks** (tandem disks, disk harrows, see Figure 5) are similar to disk plows in that they have disks but there is a minimum of 2 disk gangs that are set at opposing angles to allow mixing of soil and residue from side to side. One set of disks throws the soil outward and the other gang throws the soil inward. The effect of offset disks on the soil is similar to effects from a disk plow.

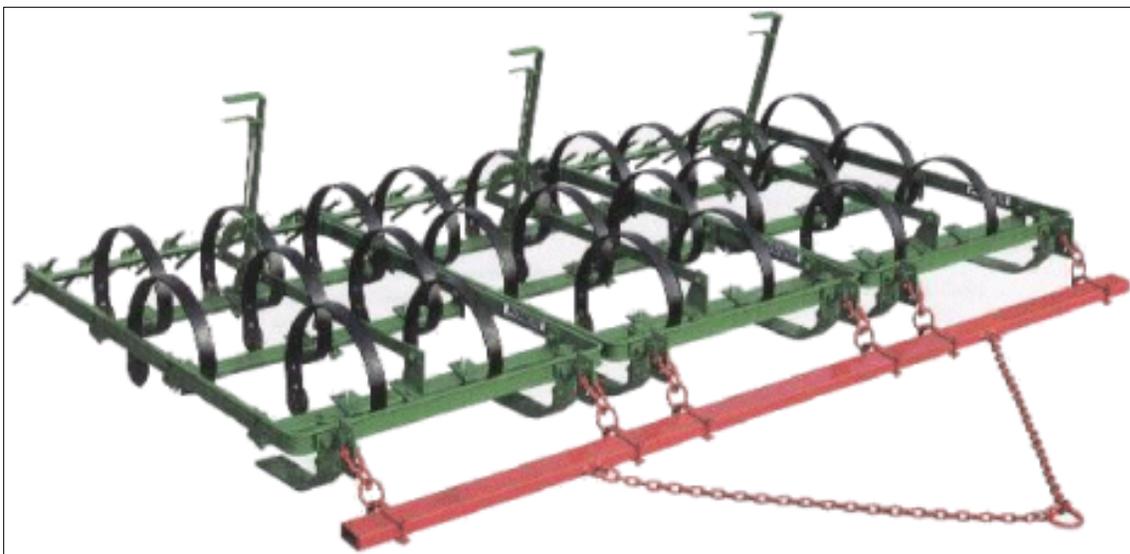


**Figure 5. Offset disk**

**Harrows** (Figures 6 and 7) are effective when smoothing is needed. They also accomplish some compaction though not as much as packers. Spike tooth harrows tend to leave the surface smooth and more subject to blowing than do spring tooth harrows. Spike tooth harrows can be adjusted to penetrate the soil more deeply to create soil conditions similar to an offset disk. Spring tooth harrows are more effective in preventing soil blowing because they leave more clods on the surface.



**Figure 6. Spike tooth harrow**



**Figure 7. Spring tooth harrow**

**Packers** (Figures 8 and 9) are the most universally missing piece of equipment for final seedbed preparation. A seedbed is sufficiently firm when a persons' footprints across the field sink no deeper than  $\frac{1}{4}$  -  $\frac{1}{2}$  inch. There are other methods to accomplish packing to some degree:

Tandem disks compacts a deep, loose seedbed if the soil is moist. It does not pack the top few inches, so is not very satisfactory.

A well- weighted harrow or other heavy drag such as a railroad tie or a piece of a railroad track can be used on seedbeds with low amounts of residue and with a low hazard of soil erosion.

Seed drills are sometimes used twice – the first operation as a packer and the second operation for seeding. Evidence of the value of drill packing can be seen in many fields where corners have been drilled twice or in the tractor tire prints, having much better stands than the remainder of the field.

Culti-packers combine a spring tooth harrow with a packer in order to stir the soil and pack the seedbed at the same time. The harrow is set to a soil depth where moisture is located (if not too deep) to bring up the moisture and kill weeds and then the packer firms the soil and allows the soil moisture to stay near the surface where it is available for seed germination (if seeding occurs immediately after the culti-packing operation. On irrigated fields, the culti-packer may need to go over the field 2-3 times in order to get a firm seedbed. The second and third operation would be accomplished with the harrow out of the ground.

Irrigation floats or levelers and shop-made rubber tire packers can also be used to create a well-compacted seedbed.



**Figure 8. Culti-packer**



**Figure 9. Shop made rubber tire packer**

**Sub-surface** tillage equipment as the name implies, cuts vegetation below the soil surface and maintains residue on the soil surface for erosion control. Chisels and rippers (figure 10) are effective in breaking up compacted soil layers and working heavy residue. Blades and sweeps (field cultivators, see Figure 11) are most effective in maintaining surface residue. These implements leave the soil loose, which makes them effective for weed control but do not make firm seedbeds. They should be operated at the greatest depth in the first operation of the season and each succeeding operation should be at a shallower depth, reducing the thickness of the layer of loose surface soil and tending to maintain greater soil moisture closer to the surface.

Rod weeders (Figure 12) are very effective when used in the last one or two tillage operations prior to seeding. If soil moisture is present, rod weeders do a good job of firming the soil near the soil surface while killing weeds and destroying a minimum amount of residue. Conservation seeds can be planted into a rod weeded surface. The major disadvantage of a rod weeder is that it pulverizes the soil, making it susceptible to erosion.



**Figure 10. Chisel or ripper**



**Figure 11. Sweep (field cultivator)**



**Figure 12. Rod weeder**

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## References

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