TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE
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SEEDBED PREPARATION and SEED to SOIL CONTACT

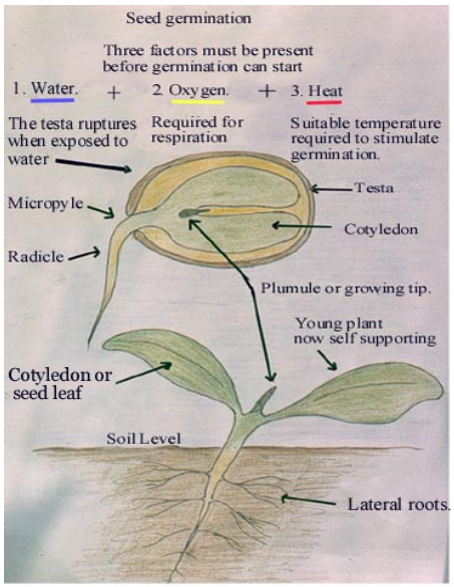
This Technical Note is a compilation of portions of several old Technical Notes that addressed seedbed preparation. Many of them are redundant and out of date; yet, much of the information in these old documents is still useful.

This Technical Note #6 is subdivided into the following Sections:

Section 6.1 – Seed to Soil Contact
Section 6.2 – Seedbed Preparation for Most Grass and Legume Seedings
Section 6.3 – Critical Area Site Preparation and Seeding
Section 6.4 – Site Preparation for Installing Live Plants

SECTION 6.1 Seed to Soil Contact

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



By and large most grass and legume seeds simply require water 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.

Seeds that are subject to wetting and drying are very likely not to germinate. The enzymes involved in breaking down the endosperm are limited and have a short "life span". It doesn't take a rocket scientist to figure out that after a couple wet and dry cycles the seed will simply run out of active enzymes. Maintaining seed moisture is critical for optimal germination.

Seeds that have good contact to soil are less likely to experience widely fluctuating wet-dry cycles because the soil transfers water efficiently to the seed. In contrast, a seed lying on the surface is very likely to experience widely fluctuating wet-dry cycles. They are dependent on timely atmospheric moisture for complete germination. Timely rains are not the norm in the dryland portions of the Pacific Northwest!

SECTION 6.2 Seedbed Preparation for Most Grass and Legume Seedings

Successful establishment of grasses and legumes requires quality seedbed preparation and seeding. An extensive survey by Dr. H.A. McDonald of Cornell University showed that of the grass acreage planted each year:

One-third usually results in a good stand
One-third is a total loss
One-third is poor and of doubtful productivity.

In the Pacific Northwest, the examinations of hundreds of plantings during the past 65 years have shown the most common cause of failures to be:

Poor or inadequate seedbed preparation including looseness, dryness near the surface, and excessive weed competition.

Seeding too deep, usually because of a poorly prepared seedbed or no depth control.

Seeding too late. Seedbed preparation began too late, moisture was not kept near the surface, and the expected rains either did not occur or were of insufficient duration. Even under irrigation, failures sometimes occur.

Example of seed planted in a loose seed bed, resulting in a poor stand of wheat planted in a loose seedbed. Photo courtesy of University of Nebraska Institute of Agriculture and Natural Resources Cooperative Extension.

Other failures covered by poor luck include – weed competition, drought, wireworms, poor seed, damping off, and grasshoppers.

Increasing pounds of seed/acre does not compensate for poor seedbed preparation. If seedings are left to chance, "poor luck" happens often.

I. Reasons for preparing a seedbed:
   a. To eliminate competition by killing weeds and other plants. It is easier to kill weeds before planting than afterwards.
   b. To save moisture by eliminating competing vegetation.
   c. To firm the ground so small seeds can come in contact with moisture
   d. To help ensure a shallow depth of seed placement.

II. How to prepare a spring seedbed (conventional):

a. Deep-cultivate in the fall for spring seedings. Following a sod crop, allow one or two intervening crops before returning to hay, pasture, or other sod crop.
b. Leave the field rough over the winter.
c. Harrow or shallow-cultivate early in the spring to break down large clods.
d. Rod weed a few days prior to planting to kill weeds.
e. Cultipack the field just before seeding if the soil is loose attempt to pack.

Cultipacker for legume crops. Photo courtesy of University of Arkansas Department of Agronomy.

III. How to prepare a spring seedbed (no till):

a. Control weeds in the fall with an application of glyphosate. Do not disturb the residue.
b. Control weeds in the spring with an application of glyphosate. Do not disturb the residue. Warning- light tillage or a light harrowing will dislodge residue that will rake-up in the drill.

IV. How to prepare a fall seedbed (conventional):

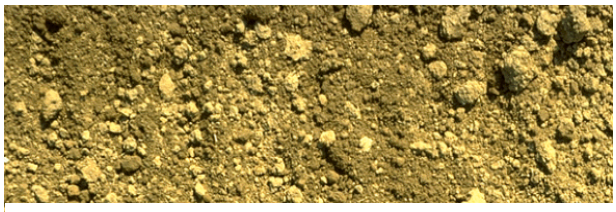
a. Deep-cultivate in the fall after harvest of the previous crop if residues are extremely high and winter annual weeds are dense. Delay deep-cultivation until spring if residues are light and weed densities are low.
b. Fallow the soil for one growing season. Expect loose dry soil in the fall.
c. If early fall rains occur, harrow the soil to firm it and control emerging weeds. If rains do not occur, let the field set.
d. Delay seeding until after the soil temperatures are cold.

V. How to prepare a fall seedbed (no till):

a. Control weeds in the fall after harvest of the previous crop with an application of glyphosate or short-lived soil active herbicide. Do not disturb the residue.
b. Control weeds in the spring and summer with applications of glyphosate. Do not disturb the residue. Warning- light tillage or a light harrowing will dislodge residue that will rake-up in the drill.
c. Delay seeding until after the soil temperatures are cold.

VI. A good seedbed is:

a. Uniformly firm, well packed underneath with small clods and/or light mulch o
b. the surface to prevent erosion.
c. Has moisture near the surface so that shallow planted seeds can begin and continue to take up soil moisture.
d. Is free from weeds and competing vegetation.



Small uniform clods make this a well prepared seed bed ready to plant in once settled. Photo courtesy of University of Arkansas Department of Agronomy.

VII. Summary Thoughts

a. If you are in a true summer fallow area (14" or less) – fall seed
   If you are in an established recrop area (16" +) – spring seed
   If you are in a transition zone (14-16") - spring or fall seed
b. Do not get hung up on the kind of tillage equipment.
c. A firm seedbed is essential for spring seedings.
d. Dry seedbeds do not pack. Concentrate on keeping the seed shallow.
e. Beware of drilling on hard surfaced stubble ground. Good soil coverage over the seed can be difficult to obtain. Monitor how the drill is performing through out the planting and make adjustments as needed.
f. If the seedbed is not reasonable to support a grain crop, then it is probably not feasible to seed grass/legumes. Remember, grains have been bred for quality emergence – grasses are mostly selections.

SECTION 6.3 Critical Area Site Preparation and Seeding

Critical Areas by NRCS definition are those sites that have or are expected to have high erosion rates, and sites that have physical, chemical or biological conditions that prevent the establishment of vegetation with normal practices.

Revegetation of critical areas requires adherence to the principles and practices that have proven successful. Some necessary principles and practices are:

- Good water management measures
- Elimination of competition
- Preparation of a good seedbed
- Quality seed of adapted species
- Seed at the proper season, rate, and depth
- Fertilize, mulch, and protect until cover is fully established
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Water Management

Water control or disposal is a primary problem overlooked in site preparation. Long slopes create problems by concentrating flow, therefore increasing its velocity and cutting action.

Properly designed ditches, waterways, diversions, terraces, culverts, and other structures are essential to the stability of revegetated areas.

Conversely, some sites are low in moisture. Adequate moisture must be available during the establishment period. Placing soil and shaping can be very effective measures to hold water in the soil. Mulches can retard evaporative losses.

Severe erosion damage from poor water management such as this costs millions of dollars annually. Photo courtesy of the James River Association.

Soil Considerations

Suitable soils for seeding are loams, silt loams, and clays, or a combination of materials mixed with sand or gravel, with sufficient permeability to absorb moisture as it falls and retain 0.75" of water in the surface foot. Neutral pH soils, or at least those within a range of 6-8 are best for plant growth. Acid soils below 6.0 should be limed. A soil test is the best means to determine the amount of lime requirement. On denuded sites such as construction sites, nutrient poor subsoil is all that is available. This material frequently offers little more then a place for plants to anchor. All nutrients and water must be supplied.

Well structured, well drained Palouse Silt Loam soil. Photo courtesy of Danielle Rohde.

There is no substitute for good topsoil. With proper foresight, and no great additional cost, topsoil can often be stockpiled for use at a later time. When placing topsoil, the subsurface must be roughened so there will be no cleavage layer or sudden texture change which will cause the soil to slip when wet. Four inches of topsoil greatly increases the probability of success in revegetation. However, there is no purpose in covering coarse gravel or rock cuts with topsoil unless a foot of or more is applied. This gets expensive and may not be practical.

Proper Slopes

Each kind of disturbed material has its own angle of repose both in its original state, as in cuts, or when used loose, as in a fill. Good compaction allows a steeper angle.

On sea and lake-washed beaches, the angle of repose for sand is about 12:1. In hard rock, near vertical cuts can be made. For most disturbed loose or compacted cuts and fills in soil, a 3:1 slope should be the maximum. A good rule of thumb is "make the slope 10-degrees less steep than the angle of repose."

An example of a slope revegetated in various grasses. Photo courtesy of Pincock, Allen and Holt.

Seedbed Preparation

Ideal situations, as in a cultivated field are rarely encountered in disturbed areas. It is ecologically wise to disturb as small an area as necessary, to work with nature, utilize as much existing vegetation as possible, and to encourage the colonization of desirable species. The elimination of all competition may therefore not always be desirable, but weedy undesirable species should be eliminated. It is easier to eliminate weeds before seeding than after.

Mechanical site preparation will probably involve equipment that is not designed for traditional seedbed preparation operations. Dozers, track-hoes, anchor chain, and sheepfoot rollers are few pieces of equipment that might be used. It is wise to work with the equipment contractors when designing the revegetation plan. They can help you with determining what is feasible, what is

practical, and what level of impact to expect from the site preparation operations. It does no good to plan a revegetation project if the equipment operator refuses to implement the plan because the equipment operation would be unsafe or not feasible.

There are two types of seedbeds that should be considered:

- A firm seedbed with numerous small clods and/or shallow surface cracks.
- A loose seedbed with irregular surface.

A firm seedbed is preferred for grasses and legumes. Firm seedbeds help maintain moisture near the soil surface and control seeding depth. A firm seedbed should not be confused with a hardened (armor-plated) seedbed. Hardened seedbeds occur when the site has been allowed to settle for several weeks. All seed safe sites are filled with sediment so any applied seed ends up sitting on the surface and not germinating.

A loose seedbed with irregular a surface is preferred for woody species. The irregular surface helps retain moisture on slopes and slows water run-off. The loose seedbed is needed for proper root development of many tree species. Equipment that is commonly used to prepare irregular, loose seedbeds includes hodder-gougers, deep rippers on dozers, and track-hoes.

Chemically prepared seedbeds should be considered for sites that are unsafe and/or impractical to mechanically prepare. Herbicides are used to control unwanted vegetation. A survey of the existing vegetation of the site needs to be completed early in the planning process. This will help determine which herbicide is needed, safe plant-back period, and types of vegetation to use. In many cases a chemically prepared seedbed will result in a poor quality seedbed. Seed safe sites will be lacking, rodents and birds will predate upon the seeds, and mineral soil will not be exposed. Transplanting vegetation should be considered. While transplanting is costly, it can be very efficient.

Great Plains Seed Drill. Photo courtesy of University of Nebraska Institute of Agriculture and Natural Resources Cooperative Extension.

Drill Seeding

Seeding methods must be suited to the site, environment, seed, and available equipment. Drill seeding is generally limited to slopes less than 3:1. Good drills, when properly adjusted, will distribute the seed uniformly and at the proper depth. Less seed per acre is required for drill seedings than other seeding methods. Drilling is slow compared to aerial or broadcast seeding, but wherever it is possible to drill the advantages outweigh the disadvantages.

Broadcast Seeding

There are many types of broadcast seeders. Hand-powered, machine powered, tractor-pulled, helicopters, airplanes, and hydro seeders. All have advantages and limitations. Broadcasting is faster and cheaper than drilling. Broadcast

Trillion Seed Broadcaster. Photo courtesy of Trillion.

seeding is suited for seedbeds that are loose, steep, and/or rough. Broadcast seeding rates are higher than drill seeding rates. Factors such as wind, difficult terrain, and machinery limitations impede seed distribution. Soil surface factors and predation limit the number of seeds that fall into safe sites. Most seeding guides recommend that broadcast seeding rates are double the drill seeding rates. In some instances, the rates may need to be adjusted even higher. However, increasing the seeding rate is a poor option to offset poor seeding technique. Always consider seedbed preparation options such as mulching before resorting to higher seeding rates.

Aerial seeding a wetland restoration project. Photo courtesy of Louisiana Department of Natural Resources

Aerial Seeding

Aerial seeding is the only practical way burned-over forest areas and many other sites can be planted. It is the quickest way to distribute seed over a large area. Optimal soil and moisture conditions for seeding may not coincide with good or safe flying conditions.

Airplanes are best suited to large, gentle sloping and elongated areas, such as uniform-width roadsides or construction strips. To get uniform seed distribution, a quiet day and uniform flying height is necessary. On wide areas, flagmen or a system of markers are needed for guidance of the pilots. A nearby landing strip or field cuts down on excessive flying time.

Helicopters, although more expensive to operate, are more versatile than airplanes. They are better suited to rough country and odd areas. Flying level over rolling terrain can be maintained. Because of this and the downdraft of the rotor, uniform seed distribution is more easily obtained than with the airplane.

Hydroseeding

Hydroseeding is preferred for slopes where drilling is not feasible and there is access to the area by trucks. A ready source of water and rapid method of filling the tank are necessary to achieve efficiency in operation. It is best to apply the seed and slow release fertilizer (if included) in one operation, followed by the fiber mulch in the second operation. When seed and mulch are applied together, much of the seed is hung up on the mulch where it cannot come in direct contact with the soil.

Hydroseeding a grass field. Photo courtesy of FINN Hydroseeding.

Grass sod cells ready to implant. Photo courtesy of Invisiblestructures.com

Vegetative Plantings

Sodding and sprigging are often the cheapest and most efficient methods on critical areas. Sod grown specifically for projects such as wetland restoration

plantings can be contract grown. Allow at least 12 months notice to sod contractors.

Sprigs, cuttings, and live plants are readily available for many species. It is important to plan early and work with nurseries to ensure that plant materials are available, of adequate size, and of the proper genetic stock.

Care must be taken when transplanting live plants. Follow recommendations provided by the nursery and the Plant Materials

Specialist.

Mechanical sprigger for plantings. Photo courtesy of fhsu.edu/biology.

Post-Seeding and Planting Maintenance

One should never expect a critical area planting to maintain itself. Nutrients are frequently lacking, weeds become an issue, and adverse weather conditions can decimate a stand. At a bare minimum, a weed management plan needs to be included in the conservation plan. It may take 2-3 years for a critical area planting to fully establish.

SECTION 6.4 Site Preparation for Installing Live Plants

Live plants, rooted and/or unrooted, are commonly used in many plantings. Success rates can be very high and many times are the most efficient means of vegetating a site.

Consider the factors that will adversely impact your plants. For example, rodent girdling, weed competition, deer browse, ponded water, shallow soil, and/or herbicide drift are a few factors. Good site preparation will reduce the level of impact of the important factors. There is no single best method to prepare a site for live plants. Each technique has advantages and disadvantages.

Clean Tillage

Clean tillage inverts the soil, buries plant residues, and controls weeds by shearing off the roots. It generally involves 2 or more operations. The first operation frequently involves a heavy disk or cultivator. The soil is worked as deep as possible and the surface is left fairly rough. A typical first operation will occur when the weeds are actively growing. The following operation(s) are shallower and break down large soil clods and make the surface easier to operator planting equipment.

Field cultivation. Photo courtesy of International Harvester.

Advantages:

- Competing vegetation effectively controlled
- Hard packed soil loosened.
- Eases operation of planting equipment
- Destroys rodent refuge

- Efficient preparation of large sites
- Exposed soil warms rapidly in the spring allowing transplants to use winter moisture stored in the soil
- Laying weed barrier is relatively simple

Disadvantages:

- Desirable existing vegetation (such as large trees) is either destroyed or interfere with operation of tillage equipment
- Not practical for steep ground, small sites, wet soils
- Soils are subject to erosion

Chemical Preparation

Chemical preparation controls existing vegetation and leaves surface residues largely undisturbed. Single application of a broad spectrum herbicide such as glyphosate is the most common chemical preparation technique. Two applications are sometimes recommended for especially weedy sites.

Advantages:

- Many weed species are effectively controlled at economical rates
- Application equipment is readily available
- Site size has little bearing on efficiency
- Surface residues protect the soil from erosion

Disadvantages

- Rodent refuge is maintained
- Surface residues interfere with planting operations
- Laying weed barrier is very difficult

Common field rodent detrimental to cuttings. Photo courtesy of Ambush Pest Control.

Grub hoe. Photo courtesy of Railroad Tools and Solutions, LLC.

Scalping

Scalping involves removing the top 1-4 inches of soil to expose mineral soil. Scalping is normally done by hand using an implement such as a grub hoe. Tractor and construction implements that undercut and throw the burden to the side are sometimes used to remove strips of top soil and leave intact strips. Scalping is generally done either at planting or within a few days of planting. NRCS usually recommends that an area 2' x 2' be scalped for each transplant. Scalping a larger area would be beneficial but not practical if the scalping is done by hand.

Advantages:

- Competing vegetation is removed from the immediate planting area
- Mineral soil is exposed and planting is easier
- Difficult sites such as steep slopes are accessible
- Soil erosion hazard is decreased since only a small percentage of the total site has exposed mineral soil

Disadvantages:

- Vegetation along the perimeter of the scalped area will compete with the transplant.
- Rodent refuge is not destroyed
- Can be costly