

Mechanical Site Preparation for Forestry in Mississippi



Site preparation is a general term used to describe silvicultural treatments applied to logging debris, vegetation, the forest floor, or soil to make the site suitable for regeneration. Two different categories of site preparation are used in forestry: chemical and mechanical. Chemical site preparation involves applying herbicides to control vegetation that could compete with planted seedlings. This practice is probably more familiar to most forest landowners than mechanical work. Chemical site preparation is cheaper to implement than mechanical treatments and has less potential for damaging the site. Therefore, chemical site preparation is used much more extensively than mechanical methods.

Nevertheless, mechanical site preparation may be necessary to correct certain physical site issues. These include residual debris, poor drainage, compaction, and rutting. Since mechanical site preparation may involve the physical disturbance of soils, understanding the effect on site productivity is essential. Mechanical site preparation techniques are still used in some situations because they can achieve a particular goal that chemical site preparation alone cannot. This publication will discuss both pros and cons of mechanical treatments for site preparation in Mississippi. Treatment expenses are estimated based on average costs in the southeastern United States.

The Soil Resource

Soil is formed through a series of complex physical, chemical, and biological interactions. These interactions are driven by climate and are influenced on a smaller scale by the local topography and biota. All of these factors working together transform geologic material into soil over time—*very* long periods of time. Soil development can require hundreds to thousands of years, which means soil is not a renewable resource. Soil conservation, then, is extremely important when using mechanical disturbance to prepare a site for regeneration.

In forested soils, organic matter accumulates on top of mineral soil in the form of fallen leaves, branches, and fruit. It is called the litter layer or duff. The litter layer acts much like mulch, insulating soil from extremes of heat and cold. Decomposition of this litter into humus provides food to a host of soil organisms, as well as nutrients to plants and animals. These soil organisms mix decomposing humus into the upper mineral soil, forming topsoil. In the warm, humid climate of Mississippi, most

nutrient recycling within the forest ecosystem occurs in the topsoil. That is, topsoil fertility drives site quality. Its protection is crucial to maintaining site productivity.

Mowing

Mowing, also known as clipping or bush hogging, involves severing vegetation (herbaceous and small-diameter woody species) near ground level using a bush hog or other similar implement. This practice is probably the most familiar of the mechanical treatments discussed in this publication. However, it is also probably the least beneficial from a forestry or wildlife standpoint. Very little soil disturbance takes place when mowing, so it cannot be used to correct soil compaction and drainage problems. In addition, mowing does not typically kill competing vegetation—soon after treatment, mown vegetation regrows.

The primary benefit of mowing as a mechanical treatment is improved planting conditions. Planting seedlings is more efficient, and proper plant spacing is more easily obtained for a short period of time after mowing. This can result in lower planting costs in some situations. While mowing is not typically used for site preparation in forest management, vendors should be easy to find. Per-acre costs should average somewhere between \$20 for retired fields or pastures to \$40 in areas with numerous small, woody stems.



Figure 1. Example of mowing before planting seedlings. Photo by Damon Hollis, Tennessee Wildlife Resources Agency.

Another form of mowing, known as mulching or shredding, involves using specialized equipment to clear older, larger-diameter woody stems that disrupt planting or other management goals. This form of site preparation is too costly (\$200 to \$500 per acre) for the vast majority of forestry site preparation situations. However, mulching is sometimes used for clearing small acreages in urban settings and in some wildlife management efforts. As with traditional mowing efforts, mulching rarely provides adequate long-lasting control of the vegetation that it initially removes. Subsequently, the practice is typically considered of low value in most forestry applications.



Figure 2. Example of mulching older, undesirable hardwoods. Note the presence of stumps and the potential for future stump sprouting. Photo by Damon Hollis, Tennessee Wildlife Resources Agency.

Shearing

Natural regeneration of less desirable species and logging debris can pose problems in regeneration efforts of harvested areas. Logging debris and residual stems can also impede planting. Attempts to correct these problems with mechanical treatments generally include shearing, chopping, or a combination of mechanical techniques. Shearing involves attaching a blade to the front of a bulldozer and cutting (shearing) residual stems or woody debris on the desired area. Two types of blades have been used for shearing. A large, slanted, sharpened blade with a sharpened point at one end (K-G blade) was the most widely used in the 1970s and 1980s. Beginning in the

1990s, managers started using a V-shaped blade with a sharpened point on the front of the V. Residual stems are cut at ground level, and logging debris is displaced to the side, thereby clearing a lane for planting. For this reason, shearing usually lowers planting costs. Very little shearing is used currently, so vendors are relatively hard to find. Treatment costs will vary but average around \$180 per acre.

One negative feature often associated with shearing is stump sprouting of less desirable species. Several studies have reported an increase in stocking of light-seeded, fast-growing pioneer species like sweetgum compared to heavier-seeded, slower-growing species like oaks. If species like sweetgum are undesirable or controlling woody vegetation is a priority, shearing is not recommended.



Figure 3. A V-blade attached to a bulldozer. Photo by Brady Self.



Figure 4. This windrowed site is ready for replanting. Photo by Brady Self.

Research has shown that shearing may cause increased soil compaction and decreased soil organic matter. The weight of bulldozers used to perform shearing causes compaction in the upper layers of soil. Furthermore, if operators are not careful during shearing efforts, displaced residual stems and logging debris could cause a reduction in soil organic matter content. This loss is intensified if the site is windrowed, which is when sheared material is pushed into rows across the area being treated. These rows are often burned to remove the consolidated debris. The practice typically removes much of a site's nutrient load and deposits it in relatively narrow bands.



Figure 5. This windrowed site is ready for replanting after being burned. Note the amount of topsoil in the windrow. Photo by Brady Self.

Chopping

Chopping or roller-drum chopping consists of pulling one or two cylindrical metal drums, usually filled with water and with large blades attached, with a bulldozer across a site in an attempt to crush and chop residual vegetation and logging debris. This is done to provide easy access for planting crews and to reduce vegetative competition. However, chopping often does not provide acceptable results; chopped vegetation often resprouts. Most research indicates that chopping is relatively ineffective in killing hardwoods. In addition, because it is broken up into smaller pieces, organic matter decays rapidly in chopped areas, which may lower nutrient availability to planted seedlings.

Besides failing to control competition, chopping is relatively ineffective as a means of correcting soil compaction or drainage issues. If residual stem and debris disposal are of little concern, chopping has little to no benefit. While not as damaging as shearing and windrowing, equipment passes back and forth over the treated area during chopping and may result in soil compaction problems. Similar to shearing, vendors that offer chopping as a treatment may be difficult to find. If a vendor can be found nearby, chopping costs per acre should be around \$140.



Figure 6. A drum chopper being pulled by a bulldozer. Photo by Andrew Ezell.



Figure 7. Drum-chopped vegetation. Note the resprout potential of severed woody stems. Photo by Andrew Ezell.

Disking

One negative effect of site preparation treatments such as shearing and chopping is the possibility of increasing undesirable woody species. This is less of a problem in areas being disked regularly, and of minimal concern on former agricultural areas. Disking typically involves pulling a double-gang disk across the site to be regenerated. The soil is mixed and loosened, and competing plant roots are severed. Disking is sometimes recommended for site preparation of retired fields to encourage establishment of light-seeded tree species. However, research has shown as many as twice the number of stems of light-seeded tree species (e.g., sweetgum, elm, sugarberry, cottonwood, sycamore, ash) in undisked areas than in disked areas. This is most likely caused by the formation of large soil clods, which increase soil drying and temperature.

Disking can, however, improve growth and survival of planted seedlings. Some research has indicated that seedlings planted in disked areas exhibited greater height growth, diameter growth, and seedling survival than those planted in undisked areas. In contrast, other studies have contradicted these findings, indicating either negative or insignificant effects on survival and growth of planted seedlings. Several of these studies have observed that subsoiling may be a more appropriate technique for breaking compaction layers in retired agricultural areas in the Lower Mississippi Alluvial Valley. Subsoiling incurs less cost, creates less potential for erosion, and is generally more effective. In addition, subsoiling does not encourage the flush of competing herbaceous vegetation commonly found with disking.

Disking for forestry site preparation is rarely used. As a result, vendors offering the treatment may be difficult to find, especially in areas with difficult terrain or heavy debris loads. Per-acre costs will range from \$10 in former agricultural field settings to \$45 on cutover tracts.



Figure 8. Site preparation disking before planting trees. Photo by Brady Self.



Figure 9. Proper disking for site preparation should use disk systems capable of breaking up woody root systems and debris. Note broken stumps inside disking treatment. Photo by Brady Self

Subsoiling

Subsoiling, also known as ripping, is a practice that fractures restrictive layers often found in retired agricultural fields. It can increase tree growth and survival by solving the problems associated with compacted soils. Studies have indicated improved seedling height and diameter growth as a result of increased moisture availability, more uniform planting depths, better deep-root development, and subsequent soil exploitation. These benefits are especially helpful in low-moisture and low-fertility conditions because seedlings are able to absorb nutrients and water more readily and efficiently. Subsoiling also helps achieve accurate seedling densities. Once performed, planting crews can plant along the subsoil slit without concern for row spacing.

Subsoiling is performed by pulling a 3- to 6-inch-wide shank through the soil behind a tractor. Typical cutting depths are between 16 and 24 inches using straight or parabolic shanks with or without winged tips. A common problem with traditional subsoiling is the time needed for the trench (also known as a slit) to close properly. Sometimes as much as a year and several rain events are needed for proper closure of large trenches created by wide shanks. Soil drying during the growing season can cause open cracks; seedling mortality ensues when root systems are exposed to the drying effects of air in these opened trenches. In addition, large soil clods (especially in heavy clay soils) often form along the subsoil trench when using parabolic shanks. These may impede tree planting. Both of these soil conditions can cause substantial problems.



Figure 10. Subsoiling using a parabolic shank subsoiler. Note the relatively open trench and the large soil clods along the trench surface. Photo by Randy Rousseau.

No-till subsoil systems can minimize soil disturbance in forestry site preparation. These no-till subsoil systems typically use a $\frac{3}{4}$ - to 1-inch-wide straight shank with or without a winged tip. Cutting depths are typically between 15 and 18 inches. These subsoil units are specifically designed to prevent surface disturbance and large clods in heavy clay soils. Planting can proceed as soon as 1 month post-treatment. Cracking along the subsoil trench may still occur but is much less likely.



Figure 11. Subsoil trench cut using a no-till subsoil system. Photo by Brady Self.



Figure 12. A seedling planted in a sealed subsoil trench 1 month after being plowed using a no-till subsoil system. Photo by Brady Self.

Whether using a no-till or traditional system, subsoiling exposes less mineral soil than other forms of mechanical site preparation. This is beneficial because undesirable pioneer woody species need mineral soil for establishment. Of the various mechanical treatments available, subsoiling is typically less expensive and more easily performed because contractors are readily available and the treatment is simple to implement. When using agricultural equipment to subsoil former agricultural fields, the practice may cost less than \$20 per acre. However, when subsoiling for typical forestry prescriptions, costs average between \$40 and \$50 per acre. A notable exception to this pricing is in clearcuts, which often have downed woody material, stumps, and steep terrain. Subsoiling in clearcut scenarios typically costs between \$75 and \$100 per acre.



Figure 13. Subsoiling along topographic contours in a recently clearcut area. Photo by Carl Branson, Mississippi Department of Wildlife, Fisheries, and Parks.

Bedding

Bedding, also known as hipping or mounding, is typically performed using a moldboard plow, offset disk, levee plow, or furrow plow. Soil is turned inward, creating a planting bed 3 to 6 feet wide and between 6 inches and 2 feet high. Bedding is typically used to establish seedlings on poorly drained soils. Because bedding raises seedling roots out of on-site water, increased seedling survival has been documented in areas that were inundated or saturated regularly.

Bedding can also increase early growth of seedlings through improved soil aeration and drainage, concentrated organic matter and nutrients, and short-term competition control. However, bedding has proven harmful when used on some drier sites. When considering bedding as a site preparation option, remember that the practice is designed to elevate root systems above saturated soils. When used properly, the benefits are obvious. Conversely, when used on dry sites or in drought years, bedding may result in increased seedling mortality when seedling roots dry out.



Figures 14 (above) and 15 (below). Offset double-shank subsoil system often used in cutovers. Note heavy-duty construction for increased shear-stress on tracts with increased roots and stumps. Photos by Brady Self and Andrew Ezell.

Figure 16. Site recently bedded in an attempt to elevate the rooting zones for seedlings to be planted. Photo by Brady Self.



Combination Plowing

Combination plowing combines subsoiling and bedding into one mechanical treatment. Typically, a subsoil shank and coulter are pulled in front of a bedding plow. Problems with soil compaction, poor drainage, and vegetative competition are reduced, and growth and survival of planted seedlings is improved. This technique is relatively common in pine plantation establishment on upland sites and has provided satisfactory growth and survival results; however, the practice has not been widely used in hardwood efforts. This is primarily because of the cost—\$180 to \$225 per acre for low logging debris/flat sites—and carrying that cost throughout a lengthy rotation of hardwood timber.

Combination plowing for forestry site preparation is expensive (but cheaper than multiple passes). Consequently, most landowners do not elect to use the treatment. However, it is available through a number of vendors. Costs increase with increases in logging debris and difficulty of terrain.



Figure 17. A combination-plowed area ready for planting seedlings. Photo by Brady Self.

Summary

Mechanical site preparation can be useful for regeneration efforts. However, performing effective mechanical site preparation can be cost-prohibitive in some cases. Choose site preparation methods on a case-by-case basis, and consult with a forestry professional when selecting appropriate forestry management techniques. Give careful consideration to site-specific soil conditions, techniques that might be used to correct problems, and the budget available to perform mechanical site preparation.

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By **A. Brady Self**, PhD, Associate Extension Professor, and **John D. Kushla**, PhD, Extension/Research Professor, Forestry.



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