Direct Seeding
A Forest Regeneration Alternative

Direct seeding is one method of starting a crop of trees by artificial means. Artificial regeneration means that the seed or seedlings are brought to the site, not distributed naturally from trees on or around the area. Direct seeding is when seeds from a desirable species of tree are planted on an area by hand or from the air. Direct seeding is an option often overlooked by private landowners when they consider how to regenerate forest lands.

Another, and more common, form of artificial forest regeneration is planting tree seedlings. Both methods have advantages and disadvantages, depending on the particular situation. Either method offers the opportunity to introduce a new species on an area. When a site is currently occupied by undesirable species, the only way to convert the area is to eliminate the existing cover and replace it with seed or seedlings of desirable species.

Advantages of Direct Seeding

Lower Initial Cost

The most notable advantage of direct seeding is the lower initial cost as compared to planting seedlings. The cost of direct seeding is usually one-third to one-half of the cost of planting seedlings. Seed is less expensive than seedlings, and sowing costs are usually less than planting costs.

Easier to Use in Remote Areas

Another advantage is that direct seeding is easier to use in remote or inaccessible areas. Although most of the forest land in the Southeast is less rugged and more easily accessible than some land in western states, there are areas where it is difficult to move equipment, supplies, and labor. In those situations, it is easier to broadcast seed by hand or from the air than to plant seedlings.

Root Systems of Trees are Natural

The root systems of trees that develop from direct seeding are considered natural. When seedlings are planted, the root system may be distorted or end up in an "L" or "J" shape if the planting hole is not deep enough. A distorted root system reduces the growth of the seedling, and shallow planting usually reduces the survival rate of the trees.

Timing Is Important

You can cover large areas quickly, especially when direct seeding is done aerially. Also, there is a longer time span to complete the work. Plant seedlings while they are still dormant and when the planting site is cool and moist. Depending on the species, direct seeding can be done in the fall or the spring with many more days available to complete the seeding.

Sow longleaf pines in the fall (before mid-December) or in the early spring. Sow loblolly, shortleaf, and slash pines in mid- and late spring. Frequently, oak acorns are sown successfully in winter or early spring, but acorns may be sown any time of year. This provides flexibility when sowing areas that may be flooded during winter. One last advantage of direct seeding that relates to timing is the quick response following a fire, flood, or other natural disaster.

Disadvantages of Direct Seeding

Reduced Control of Spacing and Stocking

The most notable disadvantage of direct seeding is reduced control over spacing and stocking (number of trees). The number of seed sown is based on assumptions of survival. It is always possible that too many trees will survive, resulting in an overcrowded situation that usually requires a precommercial thinning to correct. Precommercial thinning literally involves cutting or killing some trees before they reach commercial size so the remaining trees can grow better.

The opposite situation is also true, and survival may not be adequate to stock an area fully with trees. In this situation, supplemental seed sowing is required to get enough trees to occupy the site fully.

Either corrective measure costs money, and money saved in the initial costs could be lost. Even when survival rates are acceptable, the spacing of the trees is not as uniform as in planted seedling areas, and cultural operations throughout the rotation are not as easily accomplished, especially those requiring moving equipment across the area.

The problem of spacing is worse on steep slopes where seed are washed downhill after rainfall, resulting in loss of seed and highly uneven distribution. For these reasons, direct seeding is *not* recommended for steep slopes.

High Mortality in Droughty Soils

Another disadvantage of direct seeding is the high mortality rate on extremely droughty sites, especially sandy soils. During the first month after germination, the root system of the seedling is still near the soil surface. If the soil dries out excessively, the tiny seedling dies, so direct seeding is *not* recommended for excessively droughty areas.

Longer Rotations and Lower Yields

When compared to plantations of planted seedlings, areas that have been directly seeded usually require longer rotations and produce lower merchantable yields. This may or may not be a disadvantage, depending on an economic analysis of initial and subsequent costs, goals of ownership, and financial ability of the owner.

Growing trees is much like growing most other crops in that the more money that is put into management, the bigger and better the final yield, up to a certain point. However, a good crop of timber can be grown in stands that are started by direct seeding.

Appropriate Sites for Direct Seeding

Basically, any site you can plant with seedlings can also be directly seeded. The only exceptions are the excessively droughty areas previously discussed, or where soil pH is alkaline. Loblolly and shortleaf pines can be sown on most such sites throughout Mississippi. Longleaf and slash pines prefer a warmer climate and can be sown in southern Mississippi, although longleaf is commonly planted in northern Alabama. Hilly terrain there may present challenges to sowing longleaf with regard to uniform seed dispersal. Meanwhile, bottomland oak species are more sensitive to topographic positions in the landscape. Usually several species of oak are sown and matched to site positions (Rousseau et al., 2008).

These are the three types of areas where direct seeding has the greatest application:

1. remote or inaccessible sites (previously discussed),
2. poor or low-productivity sites where growth of the trees would not make the cost of planting operations economically feasible, and
3. any area of land where a minimal investment is absolutely essential.

The last category is perhaps the most important because many private landowners cannot afford the cost of intensive site preparation and planting. It is better to direct seed these areas rather than to allow them to grow up "naturally," which usually results in mostly undesirable species and brush taking over the area.

Species Selection

Virtually any species of tree can be grown by direct seeding on the appropriate site. Most owners want to grow a crop of trees for timber production, so this limits the list of species. Four major factors affect species selection: goals of ownership, geographic location, hazard potential, and seed availability.

You must decide *the goals of ownership* first, since they control the choices in the other categories. If you want to grow pine timber, your list of choices is different from a landowner who wants to produce habitat for squirrels.

Geographic location and *hazard potential* basically state that the species should be matched to the site. Putting the species on the site where it grows best with the least likelihood of loss results in the most successful direct seeding efforts. This means you need a substantial amount of information on the site and the tree species, and you should get professional advice before starting.

Seed availability is the last, but not least, item to consider. You must purchase the seeds or collect and prepare them. Collecting seeds requires a considerable effort, but it is not nearly as difficult as preparing them. Pine seeds have to be de-winged and oak acorns have to be de-capped, and then the seed must be stratified. Stratification involves storing the seed at a certain cold temperature for an exact time period to promote germination.

After stratification, most seeds need to be treated with an insecticide, fungicide, and animal repellent before sowing. Unless you are familiar with all these procedures, the best alternative is to purchase seed that has already been treated and tested. Consult "Forest Seedling Availability from In-state and Regional Nurseries, 2015–2016" (Kushla, 2015) for vendors that sell seed. After purchase, sow the seed as soon as possible. If storage is required, store stratified pine seed at a temperature between 25 and 40 degrees Fahrenheit. Store oak acorns at 35 degrees Fahrenheit.

Site Preparation

Site preparation for direct seeding of pines and oaks must accomplish two purposes. First, the mineral soil must be exposed. You can do this by burning or disking the area if it is an old field. Sow pine seed directly on the soil

surface. Most oaks, however, will establish best if the acorn is planted 2 inches deep. For either choice, the mineral soil must be exposed to the seed.

Second, some degree of competition control is highly desirable. Burning and disking reduce the initial amount of competing vegetation, although resprouting will certainly occur. If economically feasible, an application of herbicides is beneficial in areas where the competing vegetation is well established and hard to control. An added benefit from competing vegetation control is the reduced predation by animals on the seed. In areas with little competition control, small animals can eat nearly all the acorns that have been sown.

Sowing Seed

You can sow pine seed aerially or on the ground by hand or machine. Aerial seeding of oak acorns usually results in poor survival unless you take subsequent measures to cover the seed with soil.

Sowing rates are influenced by various factors, including condition of the site, quality of the seed, method of seed distribution, and number of trees desired. Sowing seed by hand requires fewer seed but requires more labor and more time. A helicopter can seed 2,000 acres per day, and aerial work is the only practical way to seed areas that are inaccessible or where debris restricts ground movement. Most private landowners in the same general area can combine their work and employ aerial seeding services. Seed distribution from the air is referred to as *broadcast* work.

Another form of broadcasting is ground distribution with a cyclone seeder. Depending on the site conditions, one person can cover 12 to 15 acres per day. These cyclone seeders are adjustable to accommodate various seed sizes and result in uniform seed distribution across the area.

The other two forms of ground seeding are *row* seeding and *spot* seeding. Both of these methods require much less seed per acre than broadcasting. In row seeding, seeds are dropped 1 to 2 feet apart along parallel lines of travel across the area. This is slightly slower than broadcasting, since rows are usually 8 to 10 feet apart. If site conditions are unfavorable for survival, make your rows closer together to ensure better stocking on the area.

You can use spot seeding for pine and oak regeneration. In pine seeding, a fire rake is often used to clear a spot on the ground, usually 1 to 2 feet in diameter, and five to eight seeds are dropped in the clearing. These spots are normally on a spacing of 8 by 8 feet, but you can reduce the spacing for areas with poor survival conditions. **Table 1** gives critical information on the seed and sowing rates for the major southern yellow pine species. These rates are average recommendations, and you can modify them to meet different stocking requirements and site conditions.

Table 1. Recommended sowing rates.

Species	Seeds per pound[1]	Sowing method	Sowing rate per acre	
			number	pounds[2]
Longleaf	4,700	Broadcast	15,000	3.24
		Rows[3]	2,900	0.63
		Spots[4]	4,350	0.94
Slash	14,500	Broadcast	14,000	1.11
		Rows[3]	2,900	0.23
		Spots[4]	4,350	0.35
Loblolly	18,400	Broadcast	12,000	0.75
		Rows[3]	2,150	0.14
		Spots[4]	3,650	0.23
Shortleaf	48,000	Broadcast	20,000	0.48
		Rows[3]	4,350	0.10
		Spots[4]	5,800	0.14

Source: Campbell, 1982, as shown in Barnett, 2014.
[1]Wakeley's averages.
[2]Weights based on stratified repellent-treated seed that are 100 percent sound.
[3]Rows 10 feet apart for all species. Spacing within rows, 1.5 feet for longleaf and slash, 2 feet for loblolly, and 1 foot for shortleaf.
[4]Spots spaced 6 by 10 feet, six seed per spot for longleaf and slash, five per spot for loblolly, and eight per spot for shortleaf.

When spot seeding acorns, plan to sow about 1,500 to 2,400 acorns per acre, or allow 18 to 30 square feet per acorn. For instance, a spacing of 3 feet between acorns in the row and 10 feet between rows has shown good results (approximately 1,500 seed per acre). Since the acorn needs to be covered with soil, a metal bar or even a sharp stick should be used to make a hole in the ground for the acorn. For best results for most oaks, make holes consistently 2 inches deep. You might want to construct a hand device to make holes of consistent depths. USDA Forest Service personnel at Stoneville have developed a hand tool that makes holes of a consistent depth. An added advantage to this tool is that you do not have to bend over to put the acorn in the hole.

Safety

It is important to remember that treated seed have toxic chemicals on them. Never handle these treated seed in any way without suitable personal protective equipment, such as latex gloves and a breather mask.

Evaluation of Seeding

Since many variables affect the success of direct seeding work, careful inventories are required to evaluate the results. As mentioned, too many or too few seedlings

may result, and more than a casual stroll across the area is required to determine the amount and distribution of the seedlings present. At least one inventory is essential at the end of the first growing season following seeding. Depending on the results of this sampling, you might need a second inventory after the second or third growing season.

Regardless of the number of sample plots used, remember to distribute the plots evenly across the entire area. Map out a grid system before sampling, and locate plots according to the grid system.

Sample plots should be mil-acre (one-thousanth of an acre) size for broadcast areas. This is a circular plot with a radius of 3 feet 8.7 inches, which can be measured using string from a center point or by making a permanent plot by bending some stiff wire into a circle of the appropriate size.

Twenty-five is the minimum number of plots for any seeded area. On large areas, one plot per acre has been used successfully. During the inventory, count the number of seedlings in each plot and record the data separately for each plot.

To get the number of seedlings per acre on the area, a two-step procedure is involved:

1. Get an average number of seedlings per plot by dividing the total number of counted seedlings by the total number of plots.
2. Multiply the average number of seedlings per plot by 1,000 = average number of seedlings per acre.

To determine the stocking percentage:

$$\frac{\text{Total number of plots with 1 or more seedlings}}{\text{Total number of plots}} \times 1000 = \text{Stocking percentage}$$

A successful seeding operation is one that results in 1,000 to 3,000 seedlings per acre with 55 percent stocking rates. If the inventory indicates fewer than 1,000 seedlings per acre or less than 55 percent stocking, wait until the end of the second growing season and take an intensive inventory before reseeding or planting. Areas with more than 2,500 seedlings per acre at the end of the first growing season should be resampled at the end of the third year to determine if a precommercial thin is necessary.

Row seeding and spot seeding require different sampling approaches for best accuracy. The mil-acre method may be used with confidence if enough samples are taken.

Summary

If proper procedures are followed, 80 percent of direct seeding operations are considered successful. Obviously, however, direct seeding requires a great deal of background knowledge and training. For best results, consult a professional forester who has experience in this type of work.

Additional Reading

Barnett, J.P. 2014. *Direct Seeding Southern Pines: History and Status of a Technique Developed for Restoring Cutover Forests.* USDA Forest Service, Southern Research Station, General Technical Report 187, Asheville, NC. 44p.

Kushla, J.D. 2015. Forest Seedling Availability from In-state and Regional Nurseries, 2015–2016, MTN 4E. Department of Forestry, Mississippi State University. 10p. Contact your local MSU Extension office to request a copy.

Rousseau, R., A. Ezell & J. Hodges. 2008. Publication 2004 *Bottomland Hardwood Management: Species/Site Relationships*. Mississippi State University Extension Service.

Publication 1588 (POD-01-19)

Revised by **John D. Kushla**, PhD, Extension/Research Professor, North Mississippi Research and Extension Center, from the original by **Andrew W. Ezell**, PhD, Professor and Head, Forestry.