4 Artificial Pine Regeneration

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Artificial regeneration can be defined as the planting of trees or broadcasting of seeds for the regeneration of forest land.

The most common and successful method for artificially regenerating pine trees is through planting. It is important to note, however, that planting in and of itself does not guarantee success. The overall success of your planting operation depends on a number of factors including these: matching the species to the site, seedling quality, proper handling and planting of seedlings, and in some cases, the proper use of direct seeding. We will discuss all of these factors in this chapter.

Matching the Species to the Site

Four commercially important southern pines are planted each year in Mississippi. These include loblolly pine, shortleaf pine, slash pine, and longleaf pine. The choice of the species to plant is the decision of the landowner because on many sites more than one of these species will grow.

- **Loblolly Pine**

The most widely planted species is loblolly pine. Loblolly pine naturally grows well throughout most of Mississippi and currently produces more than half the total timber volume harvested across Mississippi annually. The landowner needs to be aware of several insects and diseases that are pests of Loblolly pine (see Chapter 13). Also, Loblolly pine is susceptible to damage from ice and wind storms that periodically strike Mississippi.

- **Shortleaf Pine**

Another commercially important pine is shortleaf pine. Shortleaf pine grows naturally throughout Mississippi; however, it is rarely planted. Loblolly pine is favored for its rapid growth rates. However, shortleaf pine is a viable alternative on well-drained and drought-prone sites in north Mississippi and where damage from ice is severe. Shortleaf pine is resistant to fusiform rust but is very susceptible to southern pine beetles.

- **Slash Pine**

The natural range of slash pine includes the lower gulf coastal plain, which includes the southernmost counties in Mississippi. Slash pine is sometimes planted in the lower coastal plain for pulpwood, saw log, and pole production. Natural stands tend to grow very slowly if not thinned early to maintain sufficient room for the crowns to mature. Slash pine has been planted further north in recent years, only to suffer from ice damage and severe fusiform rust in-

fections. In many cases, sites suitable for slash pine in the lower coastal plain have been planted to loblolly pine, which is faster growing and is more resistant to fusiform rust. Slash pine is, however, better suited for the strong winds associated with hurricanes along the coast. On suitable sites in the lower coastal plain, it may be advantageous to plant slash pine to help reduce the damage inflicted by future hurricanes.

• **Longleaf Pine**

Longleaf pine once dominated the lower coastal plain forests of Mississippi. The natural range of longleaf extends from the coast to Claiborne County on the west and Kemper County to the east. The longleaf forests have declined because of extensive logging in the 19th and 20th centuries, changes in land use, and a reduction in fire frequency. Across its range, longleaf pine has been replaced by loblolly pine and mixed hardwoods. Periodic fires once kept competing vegetation at bay, which enabled the more fire-resistant Longleaf pine to dominate the landscape.

An issue many landowners have with longleaf pine is the grass stage. Longleaf pine is unique among the southern pines and is only one of three pines in North America that have a grass stage. During this grass stage, very little height growth occurs. This grass stage may last for up to 8 years or more, but it can be shortened by using high-quality seedlings in containers, proper planting techniques, and adequate site preparation with herbaceous weed control, especially during the first growing season.

Longleaf pine is less susceptible than the other southern pines to fusiform rust, southern pine beetles, and other insect pests. It can be planted on appropriate lower coastal plain sites. Planting longleaf pine too far north will leave it susceptible to ice damage. Also, in some areas, seedlings are susceptible to the brown spot needle blight fungus. When brown spot infestations are severe and prolonged, seedlings will die. Table 1 compares many traits of the four southern pine species discussed above:

Table 1: A comparison of traits found in commercially important southern pine species in Mississippi.

	PINE SPECIES			
TRAIT	**Loblolly**	**Slash**	**Longleaf**	**Shortleaf**
Fusiform Rust Resistance	2**	3	1	1
Susceptibility to Southern Pine Beetle	2	3	4	1
Drought Resistance	3	4	2	3
Cold Tolerance	2	4	3	1
Resistance to Ice Damage	2	4	3	1
Tolerance to Poor Drainage	2	1	3	3
Fertility Requirements	2	1	3	3
Resistance to Stand Stagnation	3	4	3	2
Resistance to Wind Damage	4	2	2	3

** Adapted from Ezell, et al 2001.*
***Ranking: High =1, Low = 4*

Comparing Species

Species selection in Mississippi is normally easy since loblolly pine is preferred on most sites. Landowners in the southern coastal plain are faced with several alternatives and must compare species to determine which is best for their sites and their long-term goals. The common problem is deciding between loblolly pine and slash pine. Slash pine has historically been favored along the lower coastal plain, not only for timber production, but also for the production of resin and turpentine. However, the rapid growth and flexible site-requirements for loblolly pine have resulted in an increase in acres planted to loblolly pine.

The following comparisons should clarify slash-loblolly pine selection in the lower coastal plain. It is critical to match the species to the site. Soil properties and drainage are often used to decide between planting slash pine or loblolly pine on a particular site. Some generalizations have been made to compare loblolly, slash, longleaf, and shortleaf pines in the coastal plain:

- Slash pine is usually preferred on poorly drained lower coastal plain flat wood sites; loblolly is better suited on well-drained sites.

- Slash pine grows better than loblolly on poorly drained sites where phosphorus is limited if the site is not fertilized. (A soil test can determine if your site is deficient in phosphorus.)

- On well-drained sites with a moderate occurrence of fusiform rust, both loblolly and slash pine perform about the same.

- Longleaf and slash pines are well suited for resin and turpentine production.

- Slash pines have been genetically improved for fusiform rust resistance. Loblolly pine has been genetically improved for faster growth.

- Loblolly pine is more susceptible to attack by southern pine beetles than slash or longleaf pines.

- In areas prone to high winds from tropical storms and hurricanes, slash pine and longleaf pine are better able to withstand damage than loblolly pine or shortleaf pine.

One last thing to keep in mind is the level of genetic improvement that you want your seedlings to have. Landowners have a choice of getting seedlings from either state or private nurseries that offer a selection of genetically improved seedlings, first generation, low density, containerized, 1.5 generation, etc. The choice of what to plant often depends upon your own resources and goals. However, understanding how these genetically improved seedlings are made, and what it all means, will allow you to make a better informed decision on which seedlings you plant.

What Is a Genetically Improved Seedling?

Forest-tree improvement is the process of selectively breeding trees under controlled conditions to produce genetically superior trees and seed. For southern pines, this process began by selecting superior trees in natural stands in the 1960's. Superior trees were selected based on such factors as good form and fast growth. After several of these superior trees were selected in the field, scions, or branch tips, were collected and grafted onto seedlings in an orchard. An orchard is a type of nursery where seed will ultimately be collected from trees of known parents.

The grafted seedling takes on the characteristics of the grafted tip and is grown in the orchard. These grafted seedlings are planted in combination with other grafted and nongrafted seedlings. After about 10 to 15 years, these seedlings begin to flower and produce seed. These seeds are first-generation seeds.

The first-generation seeds are planted and become first-generation seedlings. These seedlings are said to be "improved." Some of these seedlings are subsequently planted in a progeny test. A progeny test allows for the seed orchard manager to take periodic measurements of the seedlings. The ultimate goal of this is to determine which of the first-generation seedlings have the best traits. The seed orchard manager then selectively breeds the best of these first-generation seedlings to create a second- generation seedling. Second-generation seedlings are said to be "advanced generation." Third-generation seedlings would be made in the same manner by selectively breeding the best of the second-generation seedlings.

In addition to the first, second, and third generation seedlings already discussed, there are also 1.5-generation seedlings. A 1.5-generation seedling is a first-generation seedling that comes from a parent first-generation tree that has proven to have very good characteristics, such as rapid height or diameter growth over a longer time period.

Other Seedling Terms

There are other terms used in describing seedlings. The following list contains several commonly used terms that you may encounter when ordering seedlings:

Containerized Seedlings: These are seedlings grown in a greenhouse in plastic tubes rather than in a nursery bed. They have a fully intact, well-developed root system and are more expensive than traditional nursery bed seedlings.

Low Density: Seedlings typically grown in nursery beds at 25 seedlings per square foot. Low-density seedlings are grown at 18 seedlings per square foot, or at a "lower density" in the nursery bed. These low-density seedlings typically have better developed stems and roots.

Morphologically Improved: Seedlings that have been selected for good form and quality in the nursery. They are often called low-density seedlings .

Why Plant Genetically Improved Seedlings?

Because of the time involved with growing and creating improved seedlings, they cost more than unimproved seedlings. Also, costs increase with each generational increase, usually by about a penny per seedling. However, genetically improved seedlings will, on average, generate greater volumes and provide a larger return on your regeneration investment. A rule of thumb concerning genetically improved seedlings is that each generation increase in improvement (for example, from first generation to second generation) will result in a 10 percent increase in growth. The increase in growth has three benefits for the landowner. First, there is an increase in volume over a given period of time. Second, faster growth results in earlier thinnings and shorter rotation lengths. Third, because of increased growth, there are potential early changes in product class. In other words, you may be able to get higher value chip-n-saw wood at a second thinning than lower value pulpwood.

Seed Source and Planting Zones

Seedlings are now available for private landowners from more sources than ever before. It is important to remember that seedlings produced out of state may or may not be appropriate for planting in certain areas of Mississippi. When ordering seedlings, especially from out-of-state nurseries, make sure you ask about the geographic origin of the seed source. Most nurseries will not knowingly sell you seedlings that will be unsuccessful in the area you are planting.

Ordering Seedlings

Once you have selected the species you want to plant, it's time to order your seedlings. Planning ahead is crucial to ensure that you get the seedlings you want. Most state and private nurseries start taking seedling orders in mid-summer. You should place your seedling order early to ensure that you get enough of the seedlings you want to meet your planting needs.

A number of decisions should be made before ordering your seedlings. These decisions include the species, the number of seedlings you need, and when and how they will be delivered. In many cases, your consultant, or the tree-planting company contracted to plant your trees, will have already taken these issues into account. Make sure that you, your consultant, and tree planter understand exactly what it is you want.

To determine the number of seedlings to order, consider the following items:

- How many acres do you want to plant? Acreage can be determined by actual field measurements, or it can be estimated from maps, aerial photos, or other records.

- What is the spacing you will use? Most pine plantations today are established with about 600 trees per acre. This number is flexible and is based on landowner objectives and seedling availability.

Seedlings are planted at different spacings to achieve the desired density, or number of trees per acre (Table 2). The general trend is to increase the space between rows. This improves access for harvesting equipment during thinning operations and for fire-fighting equipment in the event of a wildfire.

- When ordering seedlings, make an allowance for cull seedlings. In the past, this cull factor was as high as 10 percent. Today, with improved nursery practices, equipment, and seedling quality, a cull factor of 1-2 percent should be more than sufficient.

A minimum number of seedlings planted per acre may be required for state or federal cost-share programs. Make sure you know what those requirements are. For questions about the Forest Resources Development Program (FRDP), contact your county office of the Mississippi Forestry Commission. For information about the Conservation Reservation Program (CRP), or Wetlands Reserve Program (WRP), contact your local USDA Service Center.

Table 2: Spacing and the resulting seedlings per acre.*

Spacing (Feet)	Number of Seedlings Per Acre	Spacing (Feet)	Number of Seedlings Per Acre
6x8	907	9 x 9	537
6x9	806	9 x 10	484
6x10	726	9 x 11	436
6x11	660	9 x 12	403
6x12	605		
		10 x 10	435
7x7	888	10 x 11	396
7x8	777	10 x 12	363
7x9	691		
7x10**	**622**	12 x 11	330
7x11	565	12 x 12	302
7x12	518	12 x 15	242
8x8	**680**	15 x 7	414
8x9	**605**	15 x 8	363
8x10	**544**	15 x 9	322
8x11	495	15 x 10	290
8x12	453	15 x 15	193

**** Adapted from Ezell, et al.***
*****Values in bold type represent common planting densities***

For example, the number of seedlings you need to order for planting 35 acres at 7-feet x 10-feet spacing:

1. 7-feet x10-feet spacing = 622 seedlings per acre (Table 2)

2. 35 acres x 622 seedlings per acre = 21,770 seedlings

3. 1% cull factor: 21,770 x .01=218 seedlings

4. 21,770 + 218 = 21,988 total seedlings needed.

5. Round up to the next thousand = 22,000 seedlings needed*

****Pine seedlings are sold by the thousand, so always round up to the nearest thousand to ensure you have enough seedlings.***

Delivery Dates

Planting season typically begins in December and runs through mid-March. These dates can be extended somewhat based on weather conditions. However, the most successful planting comes from seedlings lifted from the nursery beds in January and February.

Planting too early can result in seedlings not being dormant when lifted, creating more "transplant" shock. Hard frosts can kill seedlings that have not gone dormant. This dormant period is also called hardening off. Hardening off occurs when the seedling is fully dormant and is no longer growing. Fully hardened-off seedlings can be kept in cold storage for up to 8 weeks.

If large acreages are to be planted, or if you expect delays during the planting, arrange with the nursery to ship seedlings at different times to accommodate the planting schedule and to get the seedlings planted as soon as possible after lifting.

Seedling Storage and Care

Pine seedlings are typically packed and shipped in open-ended bales, wax-coated cardboard boxes, or bags. These packages are specially designed to protect the seedlings during shipping and storage.

Proper storage conditions must be present before planting to ensure the seedlings will be suitable to plant. It is best to plant seedlings as soon as possible. Never store seedlings that were lifted early or late during the planting season because they may not be totally dormant.

When you receive the seedlings from the nursery, ensure that they are protected from high temperatures, freezing temperatures, direct sunlight, and wind. If you pick up the seedlings from the nursery or from some other distribution point, make sure you can keep the seedlings cool and damp for the trip home. Arrange to pick up seedlings in the afternoon and schedule long-distance hauling so that it's done during the night when it's coldest outside. If an open truck or trailer is used, cover the seedlings with some kind of tarp or canvas to protect them from wind. Make sure air can circulate around the seedling boxes/bags/bundles to ensure that heat doesn't build up.

To prevent water loss from open-ended bales, avoid exposing the bales to wind and sun during transport. Avoid stacking bundles more than two bundles high because the weight will damage seedlings on the bottom of the stack as well as reduce air flow, thereby, increasing the potential for heat buildup on the bottom.

If possible, place your seedlings in a cold-storage facility. Dormant seedlings can be kept for several weeks at temperatures of 33-36ºF and high relative humidity. Baled seedlings may require watering to keep the roots and tops wet. Always allow excess water to drain from the bales to prevent mold from forming on the seedlings. Damage from a lack of water drainage is evidenced by a sour smell and discolored seedlings.

Most landowners do not have access to cold-storage facilities, which makes it even more important to plant seedlings as soon as possible after receiving them. When seedlings can't be planted immediately, a landowner may have to rely on storing them in a garage or shed where the temperature cannot be controlled, but where the seedlings can be kept out of the wind and sun. Warm weather will severely limit the amount of time seedlings can be stored in this manner.

If seedlings freeze, let them thaw out before separating or planting them. Immersing them in cool water for up to an hour can help them thaw out more quickly. Freeze-damaged root systems will appear to be limp and discolored. These roots will slough off very easily during handling. Discard all seedlings that have freeze damage.

Preparing Seedlings for Planting

Seedlings of various sizes and qualities may be present in your order. Nurseries typically do a good job of selling consistently high-quality seedlings, and some nurseries even grade them to a uniform size before packaging. Others try to grow uniform seedlings in the nursery beds to reduce handling when they are lifted. In either case, it is important to grade the seedlings before planting. Remove the ones that are too small or too large. Discard seedlings with poor root systems, broken stems, missing bark, missing needles, or that are otherwise damaged.

Before seedlings are taken to the field and given to the planters, they should be graded in a cool, high humidity area that is protected from wind and sun. As seedlings are removed from their packages, dip the roots in water or some other medium to keep them moist. Do not allow seedlings to sit in water for more than an hour. Allowing planters to grade seedlings in the field slows down the planting and can result in cull- seedlings being planted.

One or two people should be able to handle the grading and any root pruning that needs to be done. Grading guidelines are provided in Table 3:

Table 3: Grading guideline for southern pines.*

Species	Height (Inches)	Root Collar (Inches)	Condition of Stem	Needles/ Fascicle	Winter Bud
Lobolly & Slash Pine	6-12	1/8+	Stiff, Woody	2's and 3's	Usually Present
Longleaf Pine	8 Clipped, 12 unclipped	1/2+	Not Present	Large, 2's and 3's and free of brown spot	Thickly Scaled
Shortleaf Pine	6-10	1/8+	Stiff, Woody	2's and 3's	Usually Present

**** Adapted from Ezell, et al 2001.***

An optimum root system is 6 to 8 inches long with at least 5 or more strong first-order lateral roots that are at least 3 inches long. Use seedlings with root systems that are 5 to 6 inches long with good lateral root development. If root systems are more than 8 inches long, the seedlings will be difficult to plant correctly without special care and supervision during planting.

Any root pruning that takes place should be done by the graders, never by the planters in the field. Pruning in the field results in roots being torn off, ultimately leading to poor survival. Prune roots with scissors, shears, hatchets, or machetes by making a single clean cut and removing as few of the roots as possible. It is important to keep the root system proportional with the stem. Prune roots to no less than 8 inches for seedlings with 8-12 inches in tops.

Seedling Care in the Field

In addition to proper storage, you must also take care of seedlings in the field if your tree planting is to be successful. Take only as many seedlings to the field as you will need that day. If possible, have them delivered to the planting site twice a day to keep seedlings as fresh as possible.

The quality of your seedlings will decline quickly if they are handled poorly in the field. Keep the seedlings out of the wind and sun to so that they will stay cool, damp, and fresh. Ensure that there is good ventilation around the seedling packages to keep heat from building up. To keep heat from building up, do not place seedlings under a tarp during the day in the field. At night, a tarp can be used to keep the seedlings from freezing.

When giving seedlings to planters, open and empty one container/package at a time. Planters should carry the seedlings in bags or buckets with some water in the bottom to keep the roots cool and moist. Never allow seedlings to be carried by hand with the roots exposed while planting.

Planting

The key to the survival of your planted seedlings is the ability of their roots to quickly begin taking up nutrients and water. Seedlings should be planted in moist mineral soil where water can be readily taken up by the roots.

Depending on the site, both hand and machine planting can be used successfully. Large, clear, and open tracts may be more easily planted by machine than by hand. Small tracts of land or irregularly-shaped tracts with fair amounts of debris on site may be better suited for hand planting.

When machine planting, it is critical that the planting depth be properly set. Planting too deeply will cause the seedling roots to dry out, and planting at too shallow a depth will result in u-rooted seedlings. Both will result in high mortality. Regardless of the planting method, plant seedlings at the correct spacing and depth so that the roots are not deformed and the soil is properly packed around the roots. This will eliminate air pockets that will cause the seedlings to die.

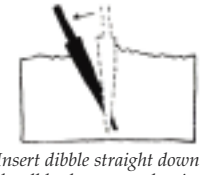
It is very important to have a written contract with the planter, specifying all planting details. This includes transportation and handling of seedlings, planting dates, number of seedlings and spacing, conditions when planting is to be suspended (the site is too wet or dry, freezing or summer-like temperatures). The contract should also specify guidelines for inspections during planting to insure that seedlings are properly planted before payment is made.

Hand Planting

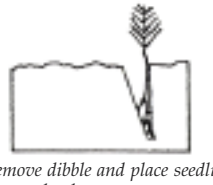
A good hand-planting crew can average about 1,000 seedlings per man-day, depending on the site, weather, etc. Most hand-planting crews in Mississippi use a tool called a "dibble bar" for planting. A dibble bar has a blade that is at least 4 inches wide and 10 inches long. Planters should carry seedlings in a bag, never in their hands as they walk across your site. Remember, it only takes a couple of minutes for a seedling that is exposed to wind and sun to dry out and die.

For successful planting, proper dibble bar technique is just as important as proper seedling handling (Figure 1):

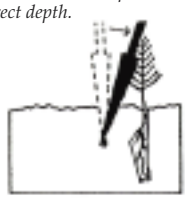
Figure 1. Proper Dibble Bar Technique



1. Insert dibble straight down in soil and pull back to open planting slit.

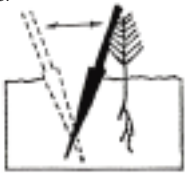


2. Remove dibble and place seedling at correct depth.



3. Insert dibble part way, push and twist forward closing top of planting slit.

4. Push dibble straight down to depth of blade.



5. Rock dibble back and forth to pack soil firmly against root.

6. Fill in last hole by stamping with heel.

It is important that there be a crew foreman or supervisor on site. It is the crew foreman's job to ensure that seedlings are being properly handled and planted. Any concerns you have should be brought to his attention first. The following items should be checked during the planting job:

• Check the distances between planted seedlings frequently both within and between rows to insure proper spacing.

• Use a shovel to check for air pockets around the roots of planted seedlings as well as the presence of any J-rooted seedlings (Figure 2)

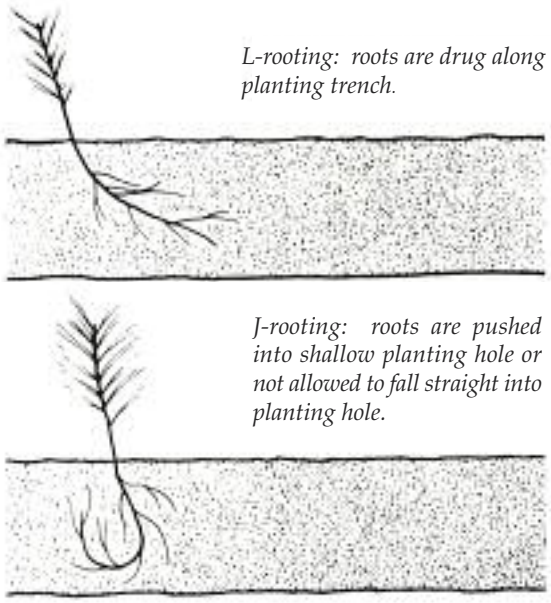
Be sure to report any inconsistencies with planting or concerns you may have with the crew foreman.

Machine Planting

Using the right machine on the right site can result in many thousands more seedlings planted per day. Just as with hand planting, frequently check planting performance to insure proper planting, especially when soils or the amount of debris on the site changes.

The planters should make sure that the packing wheels are set properly, to insure that there are no air pockets around the roots of your newly planted seedlings. Also, seedlings should be planted straight and at the proper depth. Planting them too quickly or not deep enough can result in L rooting (Figure 2) which will likely cause your seedling roots to dry out and die.

Figure 2. "L" and "J" Rooting



Planting Conditions

The reason the planting season extends from December through March is that it is the coldest and, typically, the wettest time of year. The best planting conditions occur when the temperature is between 33 and 60 degrees fahrenheit, relative humidity is greater than 40 percent, and the wind speed is low. Also, the soil should be good and moist. Dry soils are not only difficult to plant in, but they also provide unsuitable conditions for early root growth and survival. Do not plant in freezing weather or summer-like conditions.

Container-Grown Seedlings

An increasing number of nurseries are producing containerized seedlings. These are seedlings that are grown in containers in a nursery greenhouse. These seedlings are often called "plugs." Containerized seedlings offer many advantages over traditional bare-root seedlings:

• The seedling roots are protected by the container they are in, making them less likely to be damaged during transport and planting.

• The planting season can be lengthened by planting earlier in October or later into April.

• Seedlings can be machine or hand planted—but whichever method is used, make sure that the planting hole is large enough to accommodate the entire "plug."

Evaluating Planted Stands

A simple method to determine trees per acre is to measure 100th acre plots throughout the plantation. A 100th acre plot has a radius of 11 feet, 9.3 inches. A center stake and a piece of string, twine, or bamboo pole cut to this length can be used to determine a plot. All seedlings within the plot are counted. For each plot, record in Table 2 the number of seedlings that are free to grow, the number of seedlings that are live but growing under weeds, and those that are dead. If the seedlings are dead, it is important to dig them up to determine why they died.

An adequate sample is about one plot per acre, with usually no more than 30 plots evenly distributed throughout the plantation. Each plot is recorded separately on the tally sheet (Table 4). Count the number of living seedlings with little weed competition (called "free-to-grow"), the number of live seedlings under heavy weed competition, and the number of dead seedlings. If the plantation has just been planted, assume all seedlings are free to grow. (Note that if the planting was in a grass pasture, it should not be con-

sidered free-to-grow unless scalping or adequate chemical site prep was done.) From these data, calculate free-to-grow, living and total seedlings per acre. Formulas can be found in Table 4. Percent survival can also be determined.

If competing vegetation is too thick to collect data on plots, row counts can be used instead. You can go down a row and count where 10 trees are supposed to be, based on the spacing. This will give you percent survival. A number of rows from across the plantation should be counted in this way to get an accurate estimate of survival for the entire plantation. Reasons for mortality could be accounted for in the same way as plots. Record data in Table 4.

Table 4: Pine plantation evaluation form. Measure one plot per acre up to 30 plots.

Determine stocking – Count number of trees in 100th Acre Plot = 11ft. 9.3 in. radius				Planting Quality: Evaluate seedling near plot center (also dead)	
Plot	**Number of Live Seedlings Free-To-Grow**	**Number of Live Seedlings Under Weeds**	**Number of Dead Seedlings**	**√ if Planting Quality Fails**	**Reason: L or U root, not packed, too shallow, root pruned,too deep-longleaf**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
Total	A=	B=	C=	D= # Plots Failing =	

** Adapted from Londo and Dicke, 2006.*

Evaluating the Data

Trees per acre. Plantation density is a personal decision based on your management objectives as well any requirements associated with a cost-share program. For most plantation spacing, plots should average 500 to 700 live seedlings per acre (Table 2). If the average seedling count is low, you should re-evaluate the site and decide on whether to re-establish the plantation. No plot should have less than 3 live seedlings (300 seedlings per acre).

New plantings. Replant if planting quality fails. Once a planting job passes inspection, the vendor should be paid.

First growing season. By late spring, the number of live free-to-grow seedlings should be well over 300 per acre. If weed competition is severe, herbicide release applications are warranted to release seedlings from competition. If the number of free-to-grow seedlings drops below 300 per acre, landowners have three viable options:

1. Do nothing. Look forward to having a mixed pine-hardwood stand (about half the value of a mature pine plantation).

2. Rehabilitate plantation. Apply release herbicide over the seedlings. A viable option only if release herbicide can control weeds. (Note that many herbicide rates sufficient to control woody competition may injure slash and longleaf seedlings in the first growing season. Always follow current herbicide label instructions.)

3. Start over. Apply herbicides at site-preparation rates and replant. Good option when weeds are too tough for release. (Be sure that all of the existing pines are also destroyed.)

Direct Seeding

Direct seeding is when seed from a desirable species are sown on an area, by hand or from the air. Direct seeding is overlooked by many private landowners as a reforestation option.

There are many advantages to using direct seeding over planting for regeneration:

- Lower initial costs compared to planting.
- Easier to use in remote areas.
- Root systems of trees are natural, no issues with J or L rooting.
- You can treat large areas quickly, with a larger window in which to get it done.

There are also a number of disadvantages to using direct seeding over planting for regeneration:

- As with natural regeneration (Chapter 3), you have no control over spacing and stocking of seedlings.
- Droughty soils will result in high mortality.
- It will take your stand longer to become established; thereby increasing rotation lengths while lowering yields.

Site Selection for Direct Seeding

Any site you can plant, you can also regenerate using direct seeding. The only exception would be on very droughty sites. In general, there are three types of sites that are ideally suited to direct seeding:

- Remote or inaccessible sites
- Sites with low or poor productivity where growth of trees would not make cost of planting economically feasible.
- Any area of land where a minimum investment is essential.

Species Selection for Direct Seeding

Any species can be grown by direct seeding on the right site. For more guidance on species selection, refer back to the species selection for planting.

Site Preparation

Site preparation for direct seeding of pines must accomplish two things. First, mineral soil must be exposed. This can be done by disking or burning. Forest floor and other material can be moved by hand using a rake if necessary. Seeds should be sown directly onto the soil surface.

Some degree of competition control would be highly desirable. Burning and disking will reduce competing vegetation in the short term, but they will not control vegetation in the long term. Not only will controlling competing vegetation help improve the survival and growth of your seedlings, it will reduce the amount of predation by animals on the seed.

Sowing the Seed

Sowing rates are affected by a number of factors, including site condition, seed quality, method of seed distribution, and number of trees desired. There are a number of methods for sowing seed, including from a helicopter, broadcasting from the ground with a cyclone spreader, row seedling, and spot seeding.

With a cyclone spreader, one person can cover 12-15 acres a day. Spreaders can be adjusted to accommodate various seed sizes and can provide uniform seed distribution across the area.

Row seeding seeds are dropped 1-2 feet apart along parallel lines across the area. This is slower than broadcasting since rows are usually 8-10 feet apart. Rows can be placed closer together to ensure better stocking if the site demands it. Spot seeding uses a rake or other tool to clear individual spots which are then seeded. Table 5 provides recommended sowing rates for southern pines.

Where To Purchase Seed

Many of the nurseries that sell seedlings also sell seed. Contact the nursery and ask for prices and species availability.

Table 5: Recommended sowing rates for southern pines.*

Species	Seeds/Pound	Sowing Method	Number of Seeds Per Acre	Pounds of Seed Per Acre
Longleaf	4,700	Broadcast Rows Spots	15,000 2,900 4,350	3.24 0.63 0.94
Slash	14,500	Broadcast Rows Spots	14,000 2,900 4,350	1.11 0.23 0.35
Loblolly	18,400	Broadcast Rows Spots	12,000 2,150 3,650	0.75 0.14 0.23
Shortleaf	48,000	Broadcast Rows Spots	20,000 4,350 5,800	0.48 0.10 0.14

** Adapted from Ezell, 1998.*

Summary

Forest regeneration has long-term implications on the environment, your finances, and the Mississippi economy. You have many options for reforesting your land. The choice of what you do is based upon your own objectives, your finances, and the site in question. Above all else, planning ahead is critical to making your reforestation a success, because forest regeneration is a process, not just an event. If you plan carefully, the chances that your reforestation efforts will be successful will increase dramatically.

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