

**ESTABLISHMENT SPECIFICATIONS
TREE/SHRUB ESTABLISHMENT
CODE 612**

ARTIFICIAL REGENERATION

1. PLANTING SEEDLINGS

Seedling Sources. Care must be taken that the seed sources come from the same geographic area in which seedlings will be planted. Seedlings grown by the Federal, State, timber industry and other commercial nurseries that can provide seedlings from certified seed sources with 150-mile North-South zone of the planting site will be acceptable. Containerized timber crop seedling must fit the same certification requirement. Seedlings should be ordered at least 6 months prior to the planting season. Balled or burlap/container grown planting stock for urban planting must be suited for the "Hardiness Zone" of the site. This information is generally provided on the tag attached to tree.

Seedling Quality. Only quality seedlings should be planted. General standard for bare root and containerized seedlings are given below:

Bare Root Seedlings ¹		
Standard	Pine	Hardwood
Minimum Root Collar Diameter	1/4"	3/8"
Preferred Height	5-14"	12-18"
Root Length	5-8"	8-10"
Number of Lateral Roots	4-8	4-8
Containerized Seedlings ¹		
	Pine	Hardwood ²
Minimum Root Collar Diameter	1/8"	-----
Preferred Height	6-8"	-----
Root Length	4-6	-----
Number of Lateral Roots	Numerous but not Circled	-----

¹ Longleaf Pine Seedling standards. Bare root: minimum root collar (1/2"), needle length (8"), root length (5-8") and lateral roots (numerous). Containerized: minimum root collar (1/4"), needle length (4"), root length (3.5-6") and lateral roots (numerous with no circling root visible).

² Information for hardwood containers not available.

Seedling Care. Proper seedling care from nursery lifting or removal from containers to planting is paramount to the success of tree planting. Seedlings should be chilled immediately after lifting or removal, transported in refrigerated vans and stored in coolers (35° F to 45° F) at the distribution point. Plant immediately after receiving the seedlings. If planting can't be completed immediately, keep seedlings moist and store in a cooler at 35° F to 45° F for no more than two weeks. If storage will be longer, heel in the seedlings until ready to plant for no longer than four weeks. When planting take only the seedlings that will be planted in a day to the site. Keep seedlings on the planting site cool and in the shade, making sure seedlings are protected from the sun and wind. Transfer seedlings from nursery container to a planting bag containing moist sphagnum or peat moss. Never carry seedlings in your hand while planting because roots will dry out. At the end of the day, heel in the loose seedlings or pack them in peat moss and wrap tightly with waterproof paper.

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Spacing and Stocking. Pine seedlings planted for timber products will be spaced that trees will grow normally until the first thinning. Stocking is adequate when there are 300-450 evenly spaced live seedlings at the end of the first growing season. Seedling planting spacing and densities for timber production are:

- 8' x 8' = 680 seedlings per acre
- 9' x 9' = 540 seedlings per acre
- 12' x 8' = 450 seedlings per acre
- 10' x 10' = 435 seedlings per acre
- 14' x 8' = 390 seedlings per acre
- 16' x 8' = 340 seedlings per acre

Pine seedlings planted for wildlife or silvopasture production will be spaced to ensure understory growth and development. Stocking is adequate when there are 200-400 evenly spaced live seedlings at the end of the first growing season. Seedling planting spacing and densities for wildlife and silvopasture are:

- 12' x 8' = 450 seedlings per acre
- 10' x 10' = 435 seedlings per acre
- 14' x 8' = 390 seedlings per acre
- 16' x 8' = 340 seedlings per acre
- 12' x 12' = 303 seedlings per acre
- 24' x 8' = 225 seedlings per acre

Hardwood seedlings planting spacing and densities for timber production can be either 10' x 10' (435 seedlings per acre) or 12' x 12' (303 seedlings per acre). Stocking is adequate when there are 200-350 evenly spaced live seedlings at the end of the first growing season. Wildlife habitat plantings may begin at 12' x 12' (303 seedling per acre) but may be adjusted up or down depending on goals and conditions. Never plant closer than 8' x 8' (680 seedling per acre).

Christmas trees should be spaced a minimum of 6' x 6' (1210 seedlings per acre). Between row spacing should accommodate maintenance equipment. A rule of thumb is to add at least 3-4" to the width of the largest piece of equipment that will be used.

Tree spacing for all other reasons should be based on the landowners' objectives, species, growth characteristics (height and form), future management plans, program restraints and the needs of woody species (e.g. shade tolerance).

Site Preparation. The purpose is to control unwanted vegetation that will interfere with the survival and growth of the new stand, to improve soil conditions for seedling survival, and to improve the effectiveness and success of the planting operation. The and intensity of land preparation will vary according to species to be planted, the type of ground cover and the degree of erosion hazard.

For wood production plantings site preparation will be required on areas where heavy stands of grass or weeds are present, where conversion from low grade hardwood or from mixed pine-hardwood is planned or when heavy clay soil or abandoned crop land requires ripping on the contour to increase survival.

For longleaf bare root and containerized seedlings, a well-prepared site is necessary. Remove weed competition before planting using broadcast or banded herbicide applications, burning, mechanical treatments or a combination of the three. On agricultural lands or pastures having a tillage pan or a shallow argillic layer, subsoiling is required. If white-fringe beetle larvae are present in a pasture, removing the vegetation residue in the planting row is required to create an insect free three-foot wide strip.

Site preparation is not required critical area plantings.

For other plantings, breaking or disking to the degree that a clean cultivable seedbed is provided should prepare the land. Avoid cultivating deeper than 3 inches. A minimum treatment is to destroy competing vegetation in a 3-foot wide band down the tree row. This may be accomplished with herbicides or by cultivation. Polypropylene woven fabric or organic mulches may be used as a weed barrier instead of cultivation or use of herbicides.

Planting Methods

1. Bare Root Pine and Hardwood Seedlings. Machine or hand planting, if done properly, can achieve the desired results. Furrows or hole must free of trash and large enough so that roots will not be bound. Planting should be done under optimum conditions, when the soil is neither too wet nor too dry. Do not plant into frozen soil. Hand planting with a planting bar or "dibble" is suited for small acreage or where site preparation left the ground too litter for machinery. Use the dibble to make a hole in which the seedling is inserted. Place all roots in the hole, ensuring that none are turned upward in the bottom of the hole ("J-rooted"). Plant seedlings (pine and hardwood) about 1" deeper than they grew in the nursery bed (evidence by the root collar). In deep sands, plant seedlings about 2-4" deeper. Longleaf pine seedling seedlings should be planted with the root collar at or slightly above ground level. An experienced hand planter can plant 800-1000 seedlings per day. A machine planter is pulled behind a tractor or bulldozer and makes a slit or furrow with a modified subsoiler point. A person riding on the planter places one seedling at a time in the slit. The furrow is then closed around the seedling by two rollers or packing wheels to lock the seedling in place. In good weather, a two-person crew (planter and tractor operator) can plant 5,000 to 10,000 seedlings per day.
2. Containerized Pine Seedling. Hand or machine planted in the same manner as bare root seedlings.
3. Balled or Burlap/Container Stock. Plant when soils are moist. Do not handle trees when temperature is below freezing. Plant at or slightly below the depth the stock grew in the nursery or container. Prepare the planting hole big enough to accommodate the roots in their normal position. Pack soils around the roots firmly. Form a ridge around the tree large enough to catch and hold water.

Planting Dates.

1. Bare Root Stock: Mid-Dec. To Mid-March
Containerized Pine Stock: Optimum range Dec. to March; Maximum range Oct. to April (early and late planting dates depend on soil moisture availability).
2. Containerized Pine Stock: Optimum range Dec. to March; Maximum range Oct. to April (early and late planting dates depend on soil moisture availability).
3. Balls and Burlap/Container Stock: May be planted year-round if watered frequently.

Planted Seedling Protection.

1. Grazing must be excluded from newly planted plantations until trees attain a height that damage for livestock is minimal. Pine plantations should be 3-5 years old and hardwood plantations should be 15-20 years old and longleaf plantations should be 8'-12' tall. All plantations should be protected from harmful grazing (See Prescribed Grazing Standard Code 528A)
2. Fire protection is necessary for all plantations. Firebreaks should be established. (See Firebreak Standard Code 394)
3. Insects can damage recently planted seedlings.

Replanting. If first year seedling survival for pine and hardwood meets minimum survival rates with uniformly distributed trees then replanting will not be required. If plantations have large openings

larger than 50 feet across caused by mortality then the opening should be planted within two growing seasons. Losses caused by fire or drought should be replanted within two growing seasons. Adequate site preparation should precede all replanting operations.

2. CUTTINGS

Planting Material. Use cuttings prepared during the dormant season from wood of the previous season's growth. The cuttings should be taken from healthy, moderately vigorous stock plants growing in full sunlight. At least two nodes should be included in the cutting. Cuttings should be at least 1/4 inch and preferably 3/8 to 3/4 inches in diameter. They should be at least 12 inches long and 15 to 20 inches where practical. The top should be horizontal and the bottom should be beveled at a 45-degree angle.

Site Preparation. Method and intensity of land preparation depends on management objectives. Maximum treatment would consist of double chopping by disking the entire site, subsoiling on 12'x12' grid and applying recommended rates of nitrogen in the subsoil trench. Minimum treatment would consist of double chopping by disking and subsoiling.

Planting Method. Cuttings should be soaked in water 2-3 days prior to planting and should be kept cool during the planting operation. They should be hand planted at the grid intersections of the subsoil trenches leaving 2 inches of the cutting above ground level. Soil should be packed firmly around cuttings with no air pockets remaining in the planting hole. Plant under optimum moisture conditions between Dec. 1 and March 15, avoiding freezing weather and frozen soil. Planting spacing and density should be 12'x12' and 302 stems per acre.

Other Considerations. Hard mast species can be planted between the initial planting rows two years after establishment. Hard mast species will be planted at 12'x24' spacing at 150 seedling per acre.

3. Direct Seeding.

The alternate method of artificial regeneration is direct seeding. Direct seeding is useful on sites where access, terrain or drainage make planting seedling impossible. While results are usually less predictable and more time is required for stand establishment, the initial cost can be less than that of planted seedlings. Additional disadvantages are unfavorable climate conditions cause complete failure, longer rotation are needed, and lower yields result from direct seeding because stand density is not controlled.

Seed Storage.

Pine. Store seeds from loblolly, shortleaf and slash dry at a temperature between 35° and 40°. Longleaf seed do not store well and are best planted in the fall after collection.

Acorns. Prior to collecting acorns, test their soundness by floating them in water. Sound acorns generally sink. Except overcup oak which floats. White oak acorns will store well, if possible plant soon after collection. Red oak acorns can be stored in polyethylene bags at 35° F.

Pecan and Hickory. These nuts can be stored moist for several years at 40° F.

Ash. Store cleaned seed dry at 40° F.

Site Preparation. Seed germination is enhanced by exposing mineral soil and by controlling competing vegetation and by removing cover for rodents. Seedbed should be prepared using herbicides, burning, mechanical methods or a combination. Be aware of the potential for soil erosion.

Seed Testing. Test seed viability prior to planting. Pine seed germination must be at least 80% (on a sound seed basis). Float acorns to ensure planting only the sound seed.

Seed Treatment Prior to Planting. Treat pine seed with approved bird and rodent repellent prior to planting.

Seed Stratification.

Longleaf Pine	Not Required
Loblolly Pine	60 Days at 35°F
Shortleaf Pine	45-60 Days at 35°F
Slash Pine	30 Days at 35°F
"White Oaks"	Not Required
"Red Oaks"	Soak 1-2 Days
Hickory	Not Required if planted in the fall Otherwise, 30-90 Days at 35°F
Ash	Room Temperature of 30 Days, then Cold (40°F) stratification for 60 Days

Seeding Dates.

Longleaf pine	Oct. - Nov.
Loblolly, Shortleaf and Slash	Mid Feb. - Mid April
"white oaks"	Fall - Winter
"red oaks", Pecan and Hickory	Nov. - May
Ash	Fall - Spring

Seeding Methods. Seed can be planted/sown by hand or mechanically. Small seed, such as pine, must be in contact with mineral soil and left uncovered. Large seeds such as acorns can be planted to a depth of 6 inches, 2-3 inches is more practical and seems to favor germination.

Hand planting small seed. Broadcast hand seeding methods include hand sowing and the cyclone type seeders. An extender such as sawdust may be useful for keeping seeding rates within rough limits. Spot seeding is an alternative on small tracts. No special equipment is required and seed use is reduced one-third to one-half of broadcast methods. Clear a one-foot square spot, drop 3-6 seeds per spot and lightly press seed into the soil. About 1000 spots, spaced 4'x10', will give adequate stocking.

Hand planting of large seed. Plant seed using a sharpshooter shovel, dibble or commercial acorn planter.

Mechanical planting. Small seed can be broadcast using fixed wing aircraft or helicopters, or ground equipment. Specially designed row planter or modified soybean planters can be used to sowing acorns and other large seeds in strips or furrow.

Seed Care.

Pine. Keep seed cool during transport from storage to the planting site.

Hardwood (Acorn and Nuts). Transfer from storage to the planting site only the seed to be planted in a day, smaller amounts are even better. Pack seed in ice for transport and temporary storage. Supply the planter in small batches so that seed stay cool as long as possible.

Seeding Rates.**Pine Lbs./Acre**

Species	Seed/lb.	Pounds per Acre for:			
		Broad cast	Disked	Rows	1000 spots/ac
Longleaf	4,500	1	3/4	1/2	1/3
Loblolly	18,500	3	2	1 1/2	1 1/2
Shortleaf	45,000	1/2	1/4	1/4	1/4
Slash	13,000	1	3/4	3/4	1/2

Hardwood (Acorns and Nuts). Plant about 1,200 to 1,500 seed/acre. Best spacing is from 10'x3' to 12'x2.5'.

Selected Oaks Lbs./Acre

Willow, Cherrybark, Southern Red or Laurel Oak	2-3 lbs./ac
Water Oak	4 lbs./ac
Overcup Oak	8 lbs./ac
Sawtooth Oak	10 lbs./ac
Nutall, White or Shumard	12 lbs./ac
Pecan or Hickory	10-12 lbs./ac
Swamp Chestnut Oak	15-20 lbs./ac

Species Mixtures. When seeding hardwoods, consideration should be given to planting a mixture of species. Use species of similar site and soil tolerance.

NATURAL REGENERATION.

This regeneration practice uses existing seed sources to establish areas to native trees and shrubs. Wind, water or wildlife usually accomplishes seed dispersal. A natural seed source can be used if it is located within a reasonable distance of the regeneration area.

Pine. There are three silvicultural regeneration harvest practices used for naturally regenerating pine stands. (See Forest Stand Improvement, Code 666)

1. Seed Tree
2. Shelterwood
3. Clear-cut

Methods 1 and 2 are practices that leave a specific number of seed trees per acre. These trees are selected on stem form, diameter at breast height and spacing and will be removed once regeneration is present. The clear-cut regeneration harvest removes all trees. The seed source is provided by either in place seed or pines bordering the harvest area. Maximum width of the harvest area should be 400 feet and located perpendicular to the prevailing winds.

Hardwood. A natural seed source can be used if it is located within a 300 feet of the regeneration area and seed dispersal is wind blown light seeded species, such as ash, sweetgum, maple, sycamore, elm, cottonwood and willow. On upland sites, the shelterwood regeneration harvest practice can be used to achieve regeneration. Backwater flooding will disperse overcup oak, hickory, tupelo and

baldcypress. Dispersal distance will be dependent on the flooding regime of the area. Recommendations for this type of regeneration should be done on a site basis and in consultation with the appropriate specialist.

Conditions where natural regeneration applies:

1. Areas flooded for long duration of time,
2. Areas that have silted which are quickly regenerated to highly competitive species. Example: Batture soils such as Commerce and Bruin soils, which are quickly dominated by willow and cottonwood making artificial regeneration less cost effective.
3. Narrow strips of land located adjacent to and surround by natural seed sources.

Species	Site	Soil	Tolerance**		pH Range
			Flooding	Shading	
Sweet pecan	Wide variety of well-drained sites, excluding droughty sites	Does best on well-drained loams of bottomlands	WT	I-M	4.8-7.5
Bitter pecan and water hickory	Bottomlands	Poorly- to moderately-drained clays and loams	MT	I	4.8-6.0
Black walnut	Terraces and uplands	Does best on deep, moist loams	I	I	4.6-8.2
Elm					
American	Well-drained bottomlands	Not demanding, but does best on rich, well-drained soils	I-WT	I-M	5.5-8.0
Cedar	Poorly drained bottomlands to uplands	Will grow on a variety of soils, but does best on deep rich soil	MT	M-T	5.2-8.0
Slippery	Well-drained bottomlands, terraces and uplands	Grows best on moist, rich soils of lower slopes and terraces	I	I-M	5.2-8.0
Winged	Dry, gravelly uplands to rich, moist bottomlands	Tight, silty soils to fertile loams	MT	I	5.5-7.0
Maple					
Boxelder	Moist bottomlands, but can grow on dry sites	Wide variety, but best on deep, alluvial soils	MT-WT	M	4.0-7.5
Florida sugar	Small, well-drained bottomlands and toe slopes	Deep, moist, well-drained	MT-WT	T	5.5-7.0
Red	Bottomlands and wet sites but can grow on dry sites	Wide variety of well- to poorly-drained soils	MT	T	4.5-7.5
Blackgum	Uplands and alluvial bottoms	Well-drained light-textured soils	MT	M-T	4.6-7.0
Birch, River	Stream banks	Silty shore lines	WT	M	4.5-6.0
Cottonwood	River bottoms and lower slopes along streams	Grows on deep sands and clays, but does best on well-drained fine sands and loams	MT-WT	I	5.5-7.5
Dogwood, flowering	Uplands	Grows on all soils but poorly drained clays and extremely deep sands	I	T	6.0-7.0
Hackberry/ Sugarberry	Bottomlands to uplands	Wide range except droughty soils	MT	M-T	5.0-7.0
Holly, American	Bottomlands to uplands	Growth is best on moist, well-drained soils	WT	T	5.6-6.5

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Species	Site	Soil	Tolerance**		pH Range
			Flooding	Shading	
Ash					
Green	Bottomlands including those that flood frequently	Fine-textured	MT	I-M	3.6-7.5
White	Uplands and terraces	Deep well-drained soils that have a good supply of soil moisture.	WT	M	4.5-6.2
White oak group:					
Bur oak	Wide variety	Loams and clays	WT	I	6.0-6.3
Overcup	Bottomlands	"Heavy", poorly drained alluvial clays	MT-T	M	3.6-5.5
Swamp chestnut	Small bottomlands and terraces	Well-drained	WT	I-M	3.6-6.2
White	Upland and terraces	Does best on well-drained loams	I	M	4.5-6.2
Red Oak group:					
Cherrybark	Moist bottomlands to uplands	Best suited to loamy well-drained soils	WT	I-M	4.5-6.2
Laurel	Bottomlands	Well-drained	MT	M	3.6-5.6
Live	Wide variety	Wide variety	I-WT	M	6.0-7.5
Nuttall	Bottomlands	"Heavy", poorly-drained alluvial clays	MT	I-M	3.6-6.8
Sawtooth	Uplands	Sandy clay to clay loam, best on loams	I	M	5.0-8.0
Shumard	Small bottomlands, terraces and uplands	Well-drained to dry	WT	I	4.4-6.2
Southern red	Uplands	Dry loams and clays	I	M	5.0-6.0
Water	Better-drained bottomlands to ridges	Silty clays to loams	WT	I	3.6-6.3
Willow	Bottomlands	Poorly-drained alluvial soils	MT	I-M	3.6-6.3
Hickories					
Bitternut, Pignut, & Bitternut	Moist to well-drained bottomlands	Does best on well-drained, alluvial soils	WT	M-T	4.5-5.5
Mockernut, Black	Uplands	Grows on a variety except poorly-drained clays and droughty sands	I	I-M	4.5-5.5

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Species	Site	Soil	Tolerance**		pH Range
			Flooding	Shading	
Magnolia, Southern	Bottomlands and low uplands	Grows best on rich, moist, well-drained loamy soils	WT	T	6.6-7.3
Mayhaw	Wet flats and bottomlands	Poorly-drained clays to well-drained loams	MT-VT	I	4.0-6.0
Mulberry, Red	Ridges in bottoms to uplands	Grows best on moist, well-drained soils along streams	WT-I	T	4.4-7.5
Persimmon	Alluvial bottoms and poorly drained uplands	Clay, heavy loams in bottoms; light, sandy soils of uplands (trees have slow growth)	MT-T	T	4.4-7.0
Plum	Uplands	Sandy to loamy soils	I	I	5.0-8.0
Poplar, yellow	Along streams and lower slopes	Grows best on deep, moist, loamy soils	I	I	4.5-7.0
Redbud	Uplands	Grows well in a variety of soil textures except coarse sands	I	T	6.1-7.5
Sweetgum	Bottomlands to uplands	Grows on all soils except poorly-drained clays and droughty sands	MT	I-M	5.1-7.5
Sycamore	Along streams and bottomlands	Grows best on sandy loam or loam with a good supply of ground water	MT	I-M	4.4-7.5
Willow, black	Water edges	Grows on almost any soil that has abundant moisture	T	I	4.5-9.0

* When wetness is a problem, most hardwoods will grow well on sites somewhat drier than those listed herein. Woody plants should **never** be planted on sites that are wetter than those to which they are adapted.

** Tolerance (Mature Trees)

Flooding: I = Intolerant of flooding

WT = Able to tolerate saturated or flooded soils for a short period

MT = Able to tolerate saturated or flooded soils for several months, but mortality is high if flooding persists during the growing season

T = Able to tolerate saturated or flooded soils for long periods during the growing season

Shading: I = Intolerant of shade

M = Moderately tolerant of shade

T = Tolerant of shade

NOTE: Information about planting other woody species may be found in the Windbreak Establishment, Code 390, standard or in the Wildlife Upland Habitat Management, Code 645, standard.

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SPECIES	SITE/SOIL
Loblolly pine	Acidic, coarse soils mostly; adapted to a wide range of sites but questionable on dry ridge tops and poorly drained soils with a hardpan. Grows where there is 40-60 inches of rainfall annually. Prefers humid long, hot summers and mild winters.
Longleaf pine	Acidic, coarse soils; best adapted to well-drained loamy sands.
Shortleaf pine	Prefers sandy-textured soils, but will grow well on clayey soils having good internal drainage.
Slash pine	Well adapted to dense, poorly drained, flatwoods and soils having a shallow claypan or hardpan, slow internal drainage, or a high water table. Site and geographic limitations due to its potential for root diseases on sandy soils and severe ice storm damage.
Virginia pine	Grows well on a variety of site, preferably loams, but is suited to well drained sands. Will not tolerate poorly drained sites. Popular Christmas tree species in Texas.
Leyland cypress	Best suited to sandy loams or "heavy" soils of east Texas. Do not plant on coarse sands or shallow soils.
Baldcypress	Although commonly found on poorly drained wet or frequently flooded sites, it will thrive on deep, moist, yet well-drained soils.