



*Technical Guidelines
For
East Texas Tree (Hardwood) Establishment and Quality Assurance*

Definition

Planting of hardwood seedlings in the area east of I-45 known as the Pineywoods Region of East Texas and primarily in the Natural Resource Conservation Service (NRCS) Major Land Resource Area (MLRA) Regions 87B, 133B, 150A, and 152B

Purpose

- Establish or reinforce a stand of trees
- Encourage and expand economically desirable wood production
- Improve quality of soil, air, and water resources
- Provide suitable wildlife habitat
- Protect watersheds
- Enhance aesthetic value

Where Applicable

- Open fields
- Understocked woodlands
- Prepared sites

Species to Consider

Any native hardwood species including sawtooth oak suitable for a given situation can be planted. Species suitability should be determined by site (e.g. bottomland vs. upland) and the primary purpose of planting (wood production vs. wildlife habitat). There are many resources available to assist in determining which hardwood species should be planted to achieve the landowner's objective. The following publications should be referred to when matching species to site:

Baker, J. B., and W. M. Broadfoot. 1979. A practical field method of site evaluation for commercially important southern hardwoods. USDA Forest Service General Technical Report SO-26. www.srs.fs.usda.gov/pubs/865

Broadfoot, W. M. 1976. Hardwood suitability for and properties of important Midsouth soils. USDA Forest Service Research Paper SO-127. www.treesearch.fs.fed.gov/pubs/24537

Types of Plantings

When planting hardwoods, there are two main types of plantings, area plantings and group plantings. Area plantings involve planting bottomland sites for wood production and/or wildlife habitat enhancement. Group plantings, or mott plantings, are done mainly for wildlife habitat enhancement and aesthetics.

Seedling Size

In contrast to pine seedlings, which are usually planted while small, hardwood seedlings should be good-sized and sturdy. Bareroot seedlings should have a top length of at least 18 inches, and the diameter at root-collar should be at least 3/8 inch. Root length should be 8 to 10 inches. Container, balled or burlapped seedlings can vary greatly in size and usually are planted as is without culling.

Planting Date

Planting should be done during optimal conditions when soil moisture is adequate and when seedlings are dormant. Planting should be completed between December 1 and March 1 for Northeast Texas (north of Interstate 20) and December 1 and February 15 for Southeast Texas. Reforestation activities may be restricted if environmental conditions create a high risk for survival of the planted seedlings.

Planting Rate

Typical spacing for hardwood seedlings planted for wood production are 12' x 12', 10' x 10', and less. If planting is primarily for wildlife then spacings of 12' x 12', 15' x 15', and 20' x 20' are recommended. Upon completion of planting the total number of trees per acre should be within 15 percent of the bid specification on the low side and 10 percent on the high side. Although overall per acre stocking of a tract may be within the allowable stocking range, it is undesirable for some areas to be overstocked and some areas to be understocked. When planting adjacent to borders or fences allow enough space for future fire suppression efforts or other equipment if necessary.

The following table shows some possible spacing with allowable margins:

Spacing (ft.)	Trees per Acre (TPA)	Allowable Range (TPA)
8 x 8	681	579 – 750
6 x 9	806	685 - 887
7 x 9	691	587 – 760
6 x 10	726	617 – 799
7 x 10	622	529 – 685
8 x 10	545	463 – 599
9 x 10	484	411 – 532
10 x 10	435	370 – 479
8 x 11	495	421 – 545
6 x 12	605	514 - 666
8 x 12	454	386 - 499
10 x 12	363	309 - 399
10 x 15	290	247 - 319
15 x 15	203	173 - 223
10 x 20	217	184 - 239
15 x 20	145	123 - 160

Planting Method

Machine or hand tool planting must be done using equipment capable of producing a 10-inch deep planting slit. For hand planting, dibble bars, planting shovels and sharpshooter shovels can be used but must have blades at least three inches wide. Creating an hourglass-shaped hole with a dibble bar is unacceptable. When using a dibble bar, a second hole is required to close the bottom of the first hole. The following technical guides can be referenced for additional information as well as illustrations demonstrating proper planting techniques for both hand and machine planting operations.

- Baker, J. B., and W. M. Broadfoot. 1979. A practical field method of site evaluation for commercially important southern hardwoods. USDA Forest Service General Technical Report SO-26. www.srs.fs.usda.gov/pubs/865
- Broadfoot, W. M. 1976. Hardwood suitability for and properties of important Midsouth soils. USDA Forest Service Research Paper SO-127. www.treearch.fs.fed.gov/pubs/24537

When machine planting, precautions must be taken to obtain proper depth of the trench (4 x 15 inches), correct tracking of the packing wheels, and close the trench properly. In addition, no debris should be allowed to fall into the slit. While planting, planted seedlings should be routinely checked to ensure the machine is properly packing the seedling within the planting trench. This can be done by grabbing the seedling with the thumb and forefinger at ground line and try to move the seedling up and down. Properly planted seedlings will not move. When planting with machine planters, planting furrows should follow the contour. Coordinate the release of seedlings with tractor speed to prevent “sweeping” of roots or shallow planting. Seedlings should be properly cared for during pickup, transportation, and storage to ensure they are not damaged or exposed to adverse conditions. Detailed instructions for seedling care can be found below and should be adhered to.

Both openland and wildland planting machines should be inspected before planting begins to ensure they are working correctly and seedlings are being planted correctly before planting the entire tract.

Proper Equipment for Hand Planting:

- Dibble bar – Should have a blade at least 10 to 12 inches long and 3 to 4 inches wide
- Sharpshooter/Planting shovels – Generally are planting shovels with reinforced blades that are 4 to 5 inches wide and 12 to 15 inches long
- Shovels, power augers, and post-hole diggers can also be used for hand planting seedlings as long as they can make the proper planting hole at the proper depth

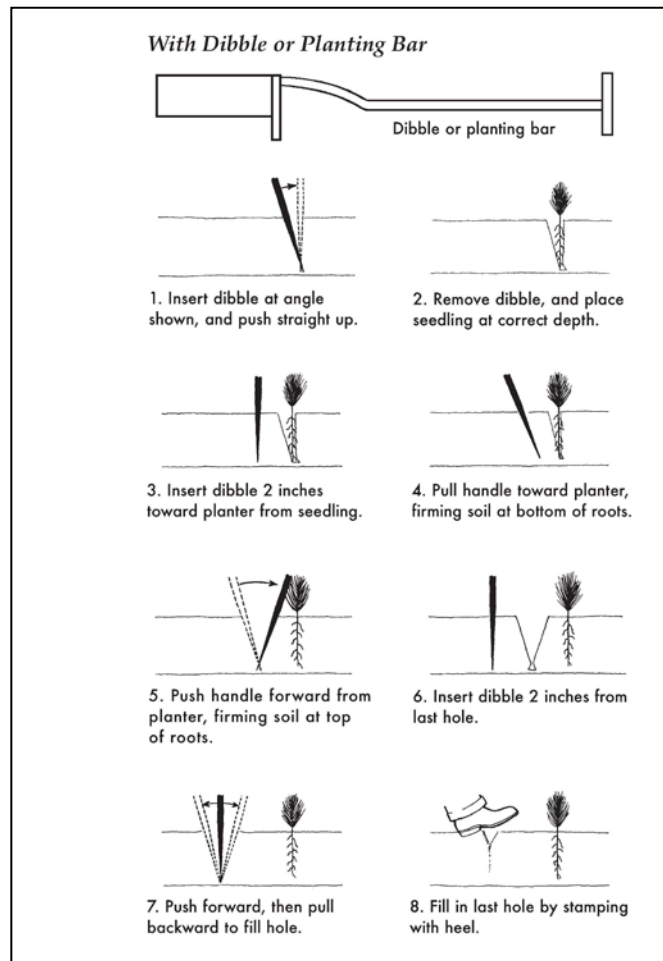
Proper Planting – Bareroot Seedlings:

- Correct depth – Planting tool should be inserted as deep as possible. Seedlings should be planted with the root collar 1 to 2 inches below ground level without J-rooting.
- Pack properly – Make sure soil is firmly packed around seedlings. This is accomplished by using the dibble bar (a second hole or slot is not necessary when using planting shovels) to make a second slot and levering the soil tight against the seedling. This second hole should be stomped closed after planting to minimize soil dryness. Check this by grasping the seedling with thumb and forefinger at ground level and move up and down, properly planted seedlings will not move up and down.

Proper Planting – Container Grown, Balled, and Burlapped Seedlings:

- Holes should be dug 1 ½ to 2 times the diameter of the container or root ball and should be no more than 1 inch deeper than the height of the root ball or soil depth in the container.
- Trees should be planted no deeper than previously grown. However, for trees grown in containers where a non-soil media was used, a small layer of backfill should be spread atop the root ball to minimize excessive drying through wick action.
- For trees planted in very poorly drained sites, root balls should be 2 inches above the existing grade so that a mound is formed. This will facilitate drainage and improve soil aeration in these situations.
- When possible large container seedlings should be watered-in the same day as planted. One or two gallons of water per tree should be sufficient.
- Container seedlings can be mulched with some type of organic mulch. Pine bark or wood chips will work fine and mulch should be at least 1 inch deep and the mulched area should be at least 2 feet in diameter.

The following illustration shows proper hand planting technique:



The following criteria will be used to judge whether a hardwood seedling has been properly planted:

- Soil must have adequate moisture at time of planting and must be packed firmly around the planted seedling. All seedlings must pass a “pull” test (i.e. seedlings must remain firmly in place when pulled on at ground level with the thumb and forefinger).
- Roots should be planted vertically with only lateral roots in a horizontal plane. A root angle of up to 30 degrees from the vertical is permissible.
- Roots should not be twisted, balled, or planted in U-, V-, J-, or L-shaped manner. Plantable seedlings (not culls) properly planted otherwise, may have a J- or L-shaped bend at the end of the roots if the bend does not exceed one inch. Lateral root exposure should be minimal.
- Seedlings must be planted such that the root collar is 1 to 2 inches below ground level.

Seedling Care

Seedlings come in both boxes and bags but both should be placed in cold storage as soon as possible. Once seedlings are removed from cold storage they should be planted within two weeks of removal.

Proper care of seedlings from lifting and packaging until they are actually planted is extremely important. The most vital precautions involve keeping the seedlings moist, not allowing them to dry out, freeze, or experience excessive heat, and storing them properly until the seedlings are properly planted. During transport from pickup point to the tract, bags/boxes must not be stored more than three deep. Cold storage is highly recommended for bagged seedlings whenever possible. Dormant seedlings can be held at temperatures from 32 – 40° F for no more than 10 weeks. If cold storage is not possible, then seedlings may be placed on racks. When storing on racks, bags should be kept in shade, protected from wind and weather, and not allowed to dry out or freeze. Bags should be stored no more than three deep and rotated every few days. Exposure to freezing temperatures and air temperatures greater than 70° F for two hours is unacceptable and can result in a major decrease in seedling survival. Steps must be taken to protect seedlings if they are left on the job site overnight (i.e., covering or storing in a structure and stacking properly).

Small tears in bags should be patched with duct tape. Tears that cannot be fixed with tape will require placing the torn bag in another seedling bag. Torn seedling bags should not be placed in garbage bags as the seedlings are more susceptible to overheating. The date and seedling type information must remain with the seedlings. Prior to taping, torn bags should be checked to make sure the seedlings have adequate moisture

Damage to seedlings should be avoided during handling. Seedlings should never be ripped apart, as this can damage the root systems, foliage or cambium. Never allow seedlings to dry out, freeze, or get too warm. Exposure of the root system in the open for more than 20 minutes should be avoided. Trees culled ahead of time should be covered with wet burlap or Terra-sorb® or soaked in water if the 20-minute period is exceeded. Seedlings should be covered in the planting trays or kept moist by other means (e.g. Terra-sorb®). Bags should not be exposed to direct sunlight, as this can cause lethal heating of the seedlings. Internal bag temperatures greater than 65° F can be lethal.

Root pruning can be performed in the field if necessary. Roots should be pruned using a sharp instrument. Pruning lateral roots is only permissible if their total length exceeds 7 inches. Roots may only be pruned if they exceed 7 inches and may only be pruned back to a 7 inch length.

Storage of seedlings before planting and during transport:

- Seedlings should be picked up from the nursery as close to the planting date as possible
- Store seedlings in cold storage until the planting date
- Keep containers closed to minimize root drying
- Seedlings should be transported in an enclosed trailer if possible but at the very minimum they should be covered to protect containers from possible wind damage

Storage of seedlings during planting:

- When possible only take as many seedlings to the tract that can be planted in 1 day
- When on site, seedlings should be stored in the shade, in a structure, or under an insulated tarp to protect them from excessive heat and cold
- Container temperatures should remain above freezing and below 65° F

Bareroot seedlings should be inspected and culled prior to planting and seedlings that do not meet the proper specs should be discarded. If the number of cull seedlings in a bag exceeds 10%, the nursery producing the seedlings should be contacted.

The inspector should look for the following problems:

- Small root collar diameters – seedlings with root collars less than 3/8”
- Crown less than 18 inches in length – from the root collar to the bud should be greater than 18”
- Tap root not 8 inches – tap roots should be greater than 8”
- No lateral roots – seedlings should have several lateral roots coming off the tap root
- J- or L-rooting – seedlings with taproots that are J’s or L’s out of the container
- Dry seedlings – seedlings that are very dry (usually due to damage to the container and/or improper storage)
- Disease – seedlings that show signs of or have galls
- Discoloration or stem weak – usually indicates the seedlings have become overheated in the bag and will not survive if planted
- Moldy or rotten odor – usually indicates the bag has overheated and/or there was too much moisture in the sealed bag.
- Bag data- lift date, storage date, correct species, variety and related seedling information for the site

Protection

Grazing should be excluded from all planted sites for the first five years or until the terminal bud is 4-5 feet above ground level. Any earlier grazing must be approved by the funding agency. Damage from grazing will be the liability of the landowner. The livestock stocking rate should be acceptable for the available forage as defined by local professionals.

Firebreaks should be constructed around the perimeter of the planted site to reduce the probability of a wildfire entering the property. In the event a wildfire enters the site firebreaks will assist firefighters in controlling the wildfire. Larger plantations of more than 50 acres should have firebreaks established through the tract to minimize potential risk from wildfire.

When applicable it may be necessary to treat for insects and disease particularly for Texas leaf cutting ants and pocket gophers. Texas A&M Forest Service pest control specialists should be consulted for additional information on pesticides and control methods.

Seedlings are often damaged prior too or following inspection by pest or wildlife. Pest damage should be noted in comments but should not count against the vendor if noticed during inspections. The following pests can damage seedlings after planting:

- Texas leaf cutting ants – These ants are typically found on sites having sandy soils. They harvest green vegetation and store it underground to grow a fungus that is used for food. They typically do most of their damage to pine seedlings during the winter when there is little green vegetation except for evergreens. When possible the site should be treated before planting begins.
- Livestock – Livestock should be kept off planting sites for a minimum of 4 to 5 years because they will bite off trees, pull them up, and/or stomp them as they graze.
- Deer – Deer at times will bite tops off seedlings while they are small but as the trees grow to 3 or 4 feet tall deer will rub their antlers on them.
- Hogs – Hogs will root up freshly planted trees, especially on machine-planted jobs where the soil had been loosened by the planting machine.
- Rabbits – Rabbits will at times bite seedlings off making them appear like they were snipped off by a knife or pair of scissors.
- Gophers – Gophers will attack the roots of a seedling and sometimes pull the seedling completely in the ground as they feed. Small dirt mounds are typically present in the areas where seedlings are being damaged. When possible gophers should be controlled before planting begins.

Environmental Considerations

All Texas Best Management Practices (BMPs) for forestry should be followed during all reforestation and other silvicultural operations. Texas BMP guidelines can be viewed at http://texasforestservicetamu.edu/sustainable/bmp_manual or by visiting your local Texas A&M Forest Service office.

When using chemicals for herbaceous weed or pest control, follow all regulations and directions on the label. Pesticide applicators must have a certified applicator license from the Texas Department of Agriculture (TDA). All chemicals must be federally and locally registered for proper use.

All application of herbicides and pesticides must be done with extreme precaution to avoid potential pollution of food and water supplies.

Quality Assurance

Quality assurance (planting inspection) should be completed within 5-10 days (ideally within 48 hours) of the planting operation being completed. Failing to complete planting inspections within 5 days does not allow enough timing to replant areas or an entire tract if necessary and may cause the replanting to be postponed until the next planting season. Also if it is determined the cause of a failing inspection is due to poor contractor performance and/or seedling quality then the landowner can hold the contractor and/or nursery responsible within a timely manner. In the past, planting inspections that have been conducted several months after completion of the planting operation have created problems in determining the cause of the failed planting practice and thus leading the contractor and/or the nursery not being held responsible. Furthermore, landowners are not able to request cost share reimbursement until the tract has

passed inspection. Delaying planting inspections causes the landowner to carry the cost of the operation longer without compensation, which often creates economic hardship.

The forestry or natural resource professional involved in the tree planting planning should be notified at the time planting is started to allow site visits early in the process and to avoid later problems.

The following list of quality assurance guidelines should be used when conducting any planting inspection.

Parameters for Conducting Planting Inspection

Before beginning an inspection, you will need the following equipment:

- Tract map with plot grid
- Compass or GPS to find plots
- Something to measure plot radius – (1/100th acre is 11.778 ft; 1/50th acre is 16.7 ft; 1/20th acre is 26.3 ft)
- Writing utensils
- Seedling inspection sheet
- Calculator
- Pin flags to mark plots
- Sharpshooter to check for underground problems
- Seedling specifications – species, variety, nursery, quantity
- Planting specifications – spacing, mechanical/hand, etc
- Weather conditions during planting and at the time of the inspection should be documented

Acreage, plot size, and job quality can determine the number of plots needed. Seedling row width should be considered when determining the plot size. The following parameters for selecting plot size should be used at the discretion of the District forester:

- Row widths less than 12 feet** - 1/100th, 1/50th, and 1/20th acre plots can be used
- Row widths 12 to 15 feet** - 1/50th and 1/20th acre plots can be used
- Row widths greater than 15 feet** - 1/20th acre plots should be used

The following provides a guide in determining number of plots needed per acre and plot spacing by tract acreage:

Tract size	1/100 th acre plots	Spacing feet (chains)	1/50 th acre plots	Spacing feet (chains)	1/20 th acre plots	Spacing feet (chains)
1 to 50 acres	1 per acre	211' x 211' (3.2 x 3.2)	1 per 2 acres	295' x 295' (4.5 x 4.5)	1 per 5 acres	467' x 467' (7.1 x 7.1)
51 to 100 acres	1 per 2 acres	295' x 295' (4.5 x 4.5)	1 per 4 acres	417' x 417' (6.3 x 6.3)	1 per 7.5 acres	572' x 572' (8.7 x 8.7)
101+ acres	1 per 3 acres	361' x 361' (5.5 x 5.5)	1 per 6 acres	511' x 511' (7.8 x 7.8)	1 per 10 acres	660' x 660' (10 x 10)

Tract maps can be created with plots laid out on the proper spacing to fulfill the requirements provided above using newer versions of ArcGIS, TexSARS or other GIS mapping software. Also GPS units can be loaded with shapefiles with plot locations overlaid. Either method can be used to identify and navigate to each plot.

Once at the tract, the inspector should orient their self and use their map to navigate to plot 1.

- Mark the center of the plot with a pin flag numbered to match the plot number.
- Using a plot radius tape or device, count and check all seedlings in the specified plot radius.
- Seedlings should be checked for proper planting depth, proper closure of the hole, and proper packing of the seedling in soil. (See above ground problems section below)
- Results should be documented on the seedling inspection form
- When between plots (i.e. traveling from one plot to the next) carefully dig up two seedlings and check for underground planting problems but properly replant seedlings to maximize survival. This should not be required planting involving seedlings grown in containers. (See below ground problems section below)
- Results should be documented on the seedling inspection form
- Continue to next four plots and repeat.
- After plot 5 the inspector will need to calculate the excavation factor. The excavation factor is the percentage of good seedlings being dug up and can be calculated by dividing the number of good trees that have been dug up by the total number of seedlings that have been dug up. (See Calculating Excavation factor example below)

When inspecting seedlings the following problems should be checked for:

Underground Problems – Bareroot:

- J or L roots – Tap roots should be planted straight in the planting hole or slot. This is checked by carefully digging up seedlings (usually two unless you find reoccurring problems and then as many as four) at each plot to check for problems.
- Cull seedlings – Seedlings should have a top length of at least 18 inches, and the diameter at root-collar should be at least 3/8 inch. Root length should be 8 to 10 inches. Seedlings that do not meet these specs should be culled
- Tap root not 5 inches – Bareroot seedlings should have a minimum of a 5-inch taproot. If they do not, they should be culled.
- Improper pruning – Taproots and lateral roots should not be trimmed at all unless they are too long to plant without J- or L-rooting being a problem. Trimming should be kept at a minimum if the roots are determined to be too long.

Above Ground Problems:

- Spacing – Improper spacing will cause either too many or too few seedlings per acre.
- Too shallow or deep – Bareroot and container seedlings should be planted according to the previous specs (See proper planting section above)
- Not packed – To check that seedlings are properly packed, seedling should be grasped and gently tugged and have no up or down motion and remain firm in the ground. Seedlings that are not correctly packed will move up and down easily.
- Second dibble hole not closed – Additional holes used to pack seedlings should be stomped shut.
- Excessive lean in seedlings – Seedlings should not lean more than 30 degrees.
- Cull seedlings – Seedlings that do not meet the proper specs should be discarded.
- Exposed lateral roots – Lateral roots should not show above ground level.

Calculating Excavation Factor:

*After 5 plots
10 total trees dug up
1 J-root for a total of 9 good out of the 10
Good trees divided by total = percentage or in this case $9 \div 10 = 0.90$ or 90%*

The excavation factor should be calculated after every 5th plot. If at any time during the inspection the percentage falls below 90% the inspector should begin digging up four trees rather than two. While digging up four seedlings, if the percentage rises back above 90% then the inspector may resume digging up only two seedlings.

Once the entire tract has been inspected the inspector should then determine the total trees per acre. The total trees per acre should be within 15% below or 10% above the original planting prescription. Above ground problems should be documented for each plot and deducted from the plot total while below ground problems will be deducted from the total inspection number and both will be used to determine whether the tract passes or fails.

Fall Survival Inspections:

All tracts that are inspected in the spring after planting should be re-inspected in the fall to determine if enough seedlings have survived for a manageable stand in the future. These inspections should occur after summer weather has ended and significant moisture has been received. All surviving planted seedlings should be counted. **Because hardwoods are often planted at rates well below pine requirements, minimum survival should be around 80% of the trees per acre that were originally prescribed.** This can vary based on landowner objectives (Species planted, sawtimber production, wildlife, etc.).

Natural regeneration should also be counted and tallied separately at fall survival inspection. Natural regen numbers can either help or hurt management objectives. Low numbers of well-spaced natural regen can bring planted survival numbers up enough for a manageable stand.

A few reasons natural regeneration can hurt management objectives are too many seedlings, too many seedlings of the wrong species or genetic line, they tend to create uneven spacing in stands, etc.

Use of natural regeneration numbers at fall survival should be discussed with the landowner to make sure they are not adversely affecting his management objectives for the future.

Before beginning an inspection, you will need the following equipment:

- Tract map with plot grid
- Compass or GPS to find plots
- Something to measure plot radius
- Writing utensils
- Seedling survival inspection sheet (Some offices use the initial inspection form and others create their own)

As seedlings are tallied, any observed problems should be noted such as:

- Pest damage (Leaf cutter ants, hogs, deer, etc.)
- Large areas with low survival
- Human damage (Mowers, vehicle traffic, herbicides, etc)
- Herbaceous and woody competition

Underground problems do not need to be rechecked in the fall.