New Pine Planting Strategies for the Western Gulf States

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Introduction

The structure of forest industry has experienced major changes over the last few years, both domestically and globally. Mills are closing, companies are merging, and forest products corporations are divesting their lands. The demand for small-diameter trees in the southern United States has diminished largely due to the amount of wood fiber and wood products now available from other countries around the world. As a result, countries that have traditionally depended upon the southern United States for fiber (for example, Japan) are now being supplied by other global markets. In addition, rising costs associated with fuel, labor, equipment, and environmental regulations have all contributed to significant increases in stand establishment and management costs.

To stay competitive, healthy, and profitable, foresters and forest landowners in the United States must use efficient stand establishment strategies. This paper outlines several new strategies beyond the normal course of plantation establishment (for example, proper site preparation, seedling care, and competition control).

Traditional Pine Strategies

In the early stages of a pine plantation, maximizing seedling survival is a primary management concern. Historically, stand establishment would typically fail only on those rare occasions when summer months were excessively hot and dry for extended periods. Summer months, however, are becoming increasingly hot and dry in the Western Gulf region of the southern United States. The Keetch/Byram Drought Index (KBDI) is a measure originally intended to determine forest fire potential. The index measures drought by combining average temperature and rainfall into a calibrated scale between 0 and 800 units, with 800 being the most extreme drought condition. KBDI can also be used to track long-term weather patterns.

Figure 1 illustrates the KBDI for Texas during the past 100 years. The red line indicates the long-term average drought index for the state. Drought indices above that line indicate years that are hotter and drier than average. The purple line is the long-term average index of these hotter, drier years. Conversely, the yellow line is the long-term average index of the cooler, wetter years. The curved black line indicates the trends for the last 100 years.

Obviously there are annual fluctuations between hotter-drier and cooler-wetter years, but the general trend suggests that Western Gulf States are in the early stages of a cyclical, 25-year hot/dry period. As this cycle continues, early seedling survival and stand establishment will remain problematic. This adds an additional burden on foresters and forest landowners when considering pine planting strategies.

There are several silvicultural alternatives to the traditional planting scenario, however, that can optimize economic yields of southern pine plantations in the Western Gulf region. These silvicultural strategies entail planting seedlings with high survival and growth potential at the optimum time of the year at an optimum density. In addition, these management decisions also strive to provide the seedlings with the nutrients and freedom from pests needed to fulfill their growth potential.

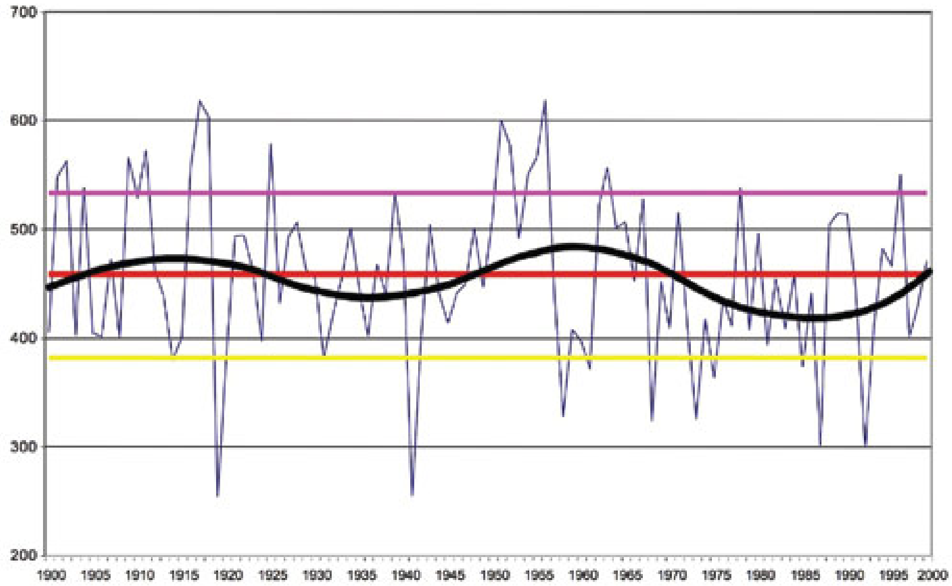

Figure 1—Long-term, yearly Keetch/Byram drought index for Texas (adapted from Taylor and Murphrey 2002).

These ideas require a strategic paradigm shift for many landowners and natural resource managers, because the goal is not to minimize cost per acre; rather, the goal of economic success is to minimize the cost per unit of wood produced. Minimizing the production cost per unit of wood requires wise investment on practices that have the best, long-term benefits on survival and growth and not simply "pinching pennies." It requires landowners and managers to plan beyond the pulpwood stage of the stand and use practices that promote production of relatively more sawtimber and less pulpwood.

New Strategies

Container Stock

Bareroot loblolly pine (*Pinus taeda*) seedlings (fig. 2) are most commonly used for reforestation in the Western Gulf States because they are easily and affordably produced in large quantities in nurseries. Bareroot seedlings are relatively fragile, however, and are susceptible to wounding. These injuries can occur from seemingly insignificant events at all points along the reforestation timeline, from the time they are lifted at the nursery to final planting.

Sunny, windy days, common throughout the planting season, can quickly desiccate and kill bareroot seedlings; coordinating planting operations with suitable weather can be difficult. Consequently, private landowners are often forced to plant on inappropriate days, especially in March, causing greater loss of seedlings resulting in poor initial stocking.

The conventional tactic for overcoming survival problems has been to plant more seedlings, sometimes more than twice needed, for full stand occupancy, hoping that enough "left-overs" will remain for suitable stand density. However, this strategy is silviculturally and economically flawed. Seedlings rarely die in an evenly distributed pattern. As a result, the stand may contain sufficient stems per acre to represent a fully-stocked stand, but growing space is not optimized and production will suffer. Furthermore, cost of extra seedlings

Figure 2—Quality produced bareroot loblolly pine seedling just after lifting from a nursery bed.

reduces economic yields because the cost is carried for the entire rotation.

Container seedlings offer several benefits over conventional bareroot seedlings. Container ("plug") seedlings (fig. 3), as the name implies, are seedlings grown in small-capacity containers that resemble thin flowerpots. Unlike bareroot seedlings, where the seedlings are grown in beds with no barrier confining the root system, a container seedling's root system remains confined to a particular shape from the time of seed germination (or propagation) to the time of planting.

With container seedlings, the root system, soil medium, and sometimes the container itself stays intact until the seedling is in the ground. The potting medium in which the seedling grows insulates the root system from damage. Because of this, container seedlings tend to suffer fewer injuries throughout the planting process than bareroot seedlings. Consequently, the use of container seedlings has been shown to decrease mortality over a wide range of sites. For example, a 13-year container versus bareroot loblolly pine growth study at Louisiana State University's Hill Farm Research Station found that container seedling survival exceeded that of the bareroot seedlings by 16% on a particularly harsh site (well-drained, gravelly, loamy fine sand). Well-drained, sandy soils are among the most problematic soils on which to establish and profitably manage loblolly pine plantations in the Western Gulf region.

Figure 3—Quality loblolly pine "plug" illustrating the intact, protective soil medium.

Container seedling survival has also been shown to be significantly improved on wet sites. A study in southwest Louisiana, on deep, poorly drained silt loam alfisols on level ground, showed that survival of container seedlings was 21% higher than that of bareroot seedlings.

Some foresters, however, may be concerned about the possibility of poor root development from container seedlings after planting. This phenomenon is usually only a problem with stock that has been left in the container too long and has become root-bound, when they are planted with the wrong type of implement, or in heavy clay soils. Others may be reluctant to use container stock because of the extra cost per seedling (U.S. $0.04 to $0.06 for bareroot versus U.S. $0.12 to $0.16 per container seedlings). Container seedlings, however, have a higher survival potential than bareroot seedlings because their intact root systems give them a superior ability to take up moisture and nutrients immediately after planting. Because of their higher survival potential, it is not necessary to plant relatively high numbers of seedlings and hope for "leftovers" to ensure good stand establishment. As such, establishment costs using container seedlings are comparable to establishment costs using bareroot seedlings. Consider again the northwest Louisiana study mentioned earlier. The trees in the study are old enough to adequately project future yields with Virginia Tech University's newest plantation model, FASTLOB. Projected yields at age 25 are shown in figure 4. The container stock had greater total yield and produced relatively more sawtimber than did the bareroot stock. Furthermore, the internal rate of return (IRR) for each stocktype, calculated from the estimated yields and real-world management costs, indicated that container stock provided higher returns (8.7%) than bareroot stock (7.3%).

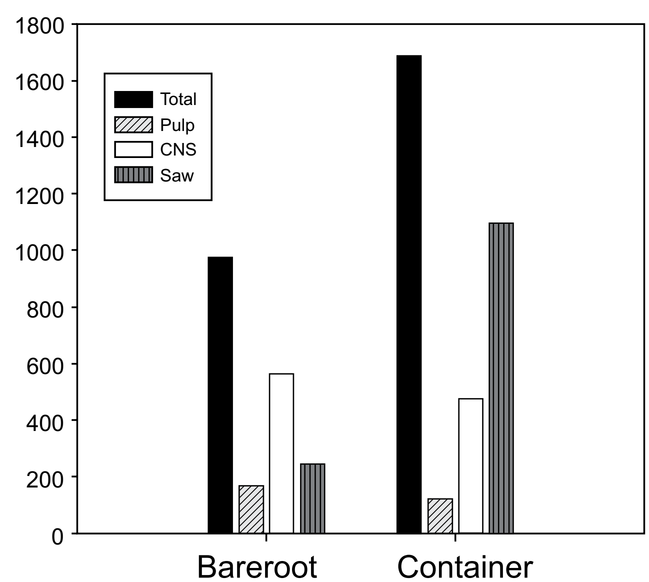

Figure 4—Projected yield (in U.S. dollars per acre) at age 25 for bareroot stock versus container stock. Base age is 13, and the modeling scenarios include thinning when stand basal area and trees/acre reach full site occupancy (SDI 220).

Planting Season

We can improve further upon the volume gains of container seedlings by planting earlier than the traditional season. Planting in fall can improve tree survival and growth because seedlings have more time to grow adequate root systems and acclimate to the site before summer months arrive. Research suggests that container loblolly pine seedlings planted in mid to late October grow more in both diameter and height than seedlings planted during the traditional planting season. The differences are especially significant when compared to seedlings planted in March and on well-drained, droughty sites.

Preliminary data from a study at Texas A&M University Agricultural Research and Extension Center in northeast Texas shows that fall-planted container loblolly pine seedlings had greater total tree height than did the seedlings planted the following spring (March). On average, fall-planted seedlings were about 16 cm (6.3 in) taller than spring-planted bareroot seedlings at the end of their second growing season. In addition to growth, survival was improved with fall planting. Fall-planted, container seedlings had 94% versus 83% survival over spring-planted bareroot seedlings.

A study in southwest Louisiana comparing slash pine (*Pinus elliottii*) bareroot seedlings and container rooted cuttings found the same trend (fig. 5). At the end of the second growing season, the seedlings planted in September were about 25 cm (10 in) taller than the bareroot seedlings planted in March, and even taller than container seedlings planted in January. This study also showed a 27% increase in survival for fall-planted container stock versus spring-planted bareroot stock. Container seedling survival remained fairly constant across the various planting months while survival of bareroot seedlings ranged from 54 to 95%.

Fall-planted loblolly pine container stock has higher survival and growth than bareroot seedlings planted during the traditional planting season. Differences are even more pronounced when compared to bareroot seedlings planted in March, which is the month when many non-industrial forest owners must plant due to planting vendor availability. Growth differences are largely due to fall-planted seedlings having additional time to acclimate to the site, recover from transplant injury, and develop healthy root systems before the hot, dry summer months arrive.

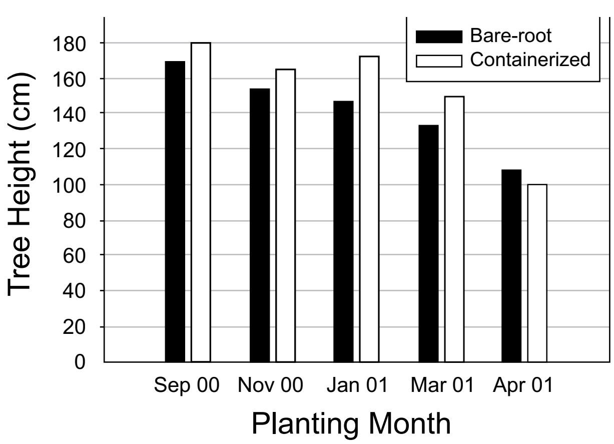

Figure 5—Comparison of mean height growth for container loblolly pine stock versus bareroot stock over five planting dates (adapted from Akgul and others 2004).

Initial Stand Density

With the planting strategies above, seedling survival and growth during the early years of the rotation can be improved. By incorporating these new strategies, foresters and forest landowners can plan for success rather than failure. With higher seedling survival potential, the number of seedlings planted per acre can be reduced by more than half. This strategy better promotes fully stocked stands with seedlings that are evenly distributed throughout the site, and may possibly eliminate other management activities during the early part of a stand's life, such as costs associated with pre-commercial thinning.

The conventional view of pine plantation management is that high stand densities are needed to improve wood quality, minimize juvenile wood, and maximize fiber production per acre. However, landowners seldom realize premiums for slow-growing trees. Currently, when a premium is paid, it is typically for the quantity of physically attractive trees (straight, free of knots, and so on) and not for the number of growth rings per inch or proportion of juvenile wood. Also, because of the growth pattern of loblolly pine, height growth is largely independent of stand density. In other words, high stand densities are not required to influence loblolly pine to grow tall and straight. Tree height in a lower density stand, within reason, will equal the height of trees in a higher density stand. Diameter is highly related to stand density. As a result, moderate to high stand densities severely restrict diameter growth. Lower planting densities are required to maximize individual tree volume and quickly attain higher value products.

Figure 6 shows the volume of wood products harvested from a 21-year-old loblolly pine plantation planted at five different densities in northwest Louisiana. The best overall yields came from stands planted at 200 to 600 seedlings/ac (500 to 1500 seedlings/ha). Because of the optimum mix of chip-n-saw to sawtimber, the best returns per acre were around 300 trees/ac (750 trees/ha). While total volumes are relatively consistent, sawtimber production increases as stand density decreases, and chip-n-saw and pulpwood volumes generally decrease. Whenever low planting densities are discussed, concern arises over the tree's physical appearance and log properties. Figure 7 shows a 15-year-old stand planted at Louisiana State University AgCenter Calhoun Research Station on 6 by 16 ft (2 by 5 m) spacing. Many of the station's visitors have been impressed by the log form and diameter of these trees. The 450 trees/ac (1125 trees/ha) fall in the middle of the 300 to 600 trees/ac (750 to 1500 trees/ha) identified in the previous study as being optimum.

Putting It All Together

The study in northwest Louisiana integrates several of the practices previously discussed. To understand how planting density affected returns, two widely-spaced management scenarios—one with bareroot seedlings and one with container seedlings—were compared to a conventional management scenario. The wide spaced plots were planted

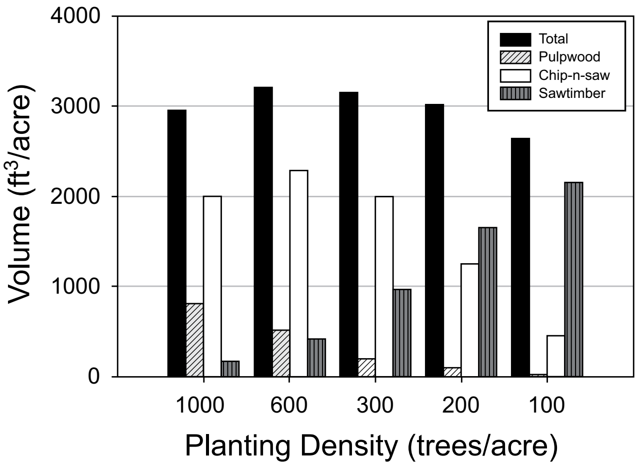

Figure 6—Volume of pulpwood, chip-n-saw, and sawtimber obtained at five different planting densities (adapted from Blazier and Clason forthcoming).

Figure 7—Fifteen-year-old stand planted on a 6 by 16 ft (2 by 5 m) spacing (450 trees/ac [1,125 trees/ha]) in Calhoun, LA. Average DBH = 11 in (28 cm).

at 6 by 24 ft (2 by 7 m) spacings. Due to the width of the rows, it was possible to strip apply Oust® and Velpar® on a 6 ft (2 m) swath during site preparation. It was then necessary to conduct two release treatments due to the aggressive encroachment of competing vegetation. The conventional treatment consisted of bareroot seedlings planted at 8 by 8 ft (2.4 by 2.4 m) spacing. The herbicides were the same as those used with the wide spacing, but were broadcast-applied. It was also only necessary to apply only one release treatment with the conventional scenario. Total yield of the widely spaced bareroots was by far the lowest of the three management scenarios (fig. 8). This shows that even on this dry site, the combination of poor survival and poor growth per tree results in an inadequate use of growing space. The widely spaced containers, however, produced total yields comparable to that of the benchmark conventional treatment. In addition, sawtimber yields were higher for the container trees.

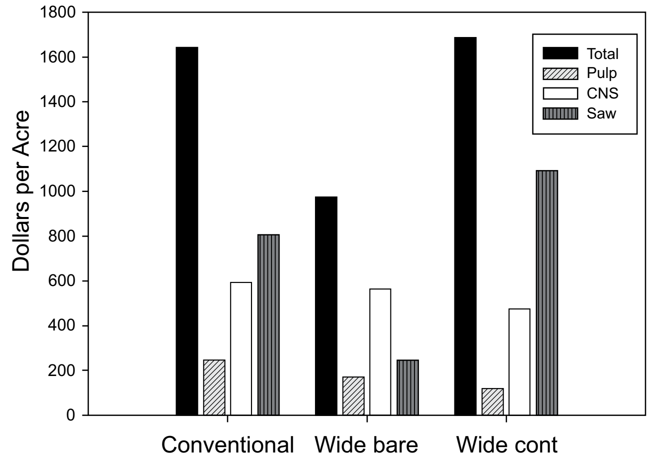

Figure 8—Product yield for 25 year rotation with seedlings planted at two different densities. Wide spacing also compares yield from bareroot stock and container stock. Product values (in U.S. dollars per acre) were derived from the current market values (as given in the latest quarterly report of the Louisiana Department of Agriculture and Forestry) of pulpwood and chip-n-saw (in cords) and sawtimber (in MBF).

Interestingly, when the height and diameter of the lowest live branches were measured at age 13, the results showed that the crowns of the wide-spaced trees were slightly more compact, with a higher height to the lowest live branch. However, branch diameter was about 0.4 in (1 cm) larger for the wide-spaced trees.

The widely spaced containers had the highest IRR of the three management scenarios. IRR of the conventional treatment was hampered by relatively higher costs early in the rotation for seedlings and broadcast site preparation. IRR was also hindered by poorer seedling survival and lower growth per tree. By contrast, the widely spaced containers had higher long-term survival and growth. Essentially, widely spaced containers had the highest IRR because more sawtimber per seedling planted was produced.

Conclusions

We have shown how implementing new strategies in reforestation can offer landowners and foresters powerful tools to successfully establish a profitable pine plantation. The bottom line with these new strategies is that you may:

1. Increase diameter and height growth;
2. Reduce the excessive production of unmarketable, small-diameter trees;
3. Reduce intraspecific competition;
4. Minimize or eliminate the need to perform future noncommercial thinnings; and
5. Reduce planting cost and waste.

No matter which strategy you choose, ALWAYS follow Best Seedling Care and Planting Practices. The information given in this publication is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement implied.

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