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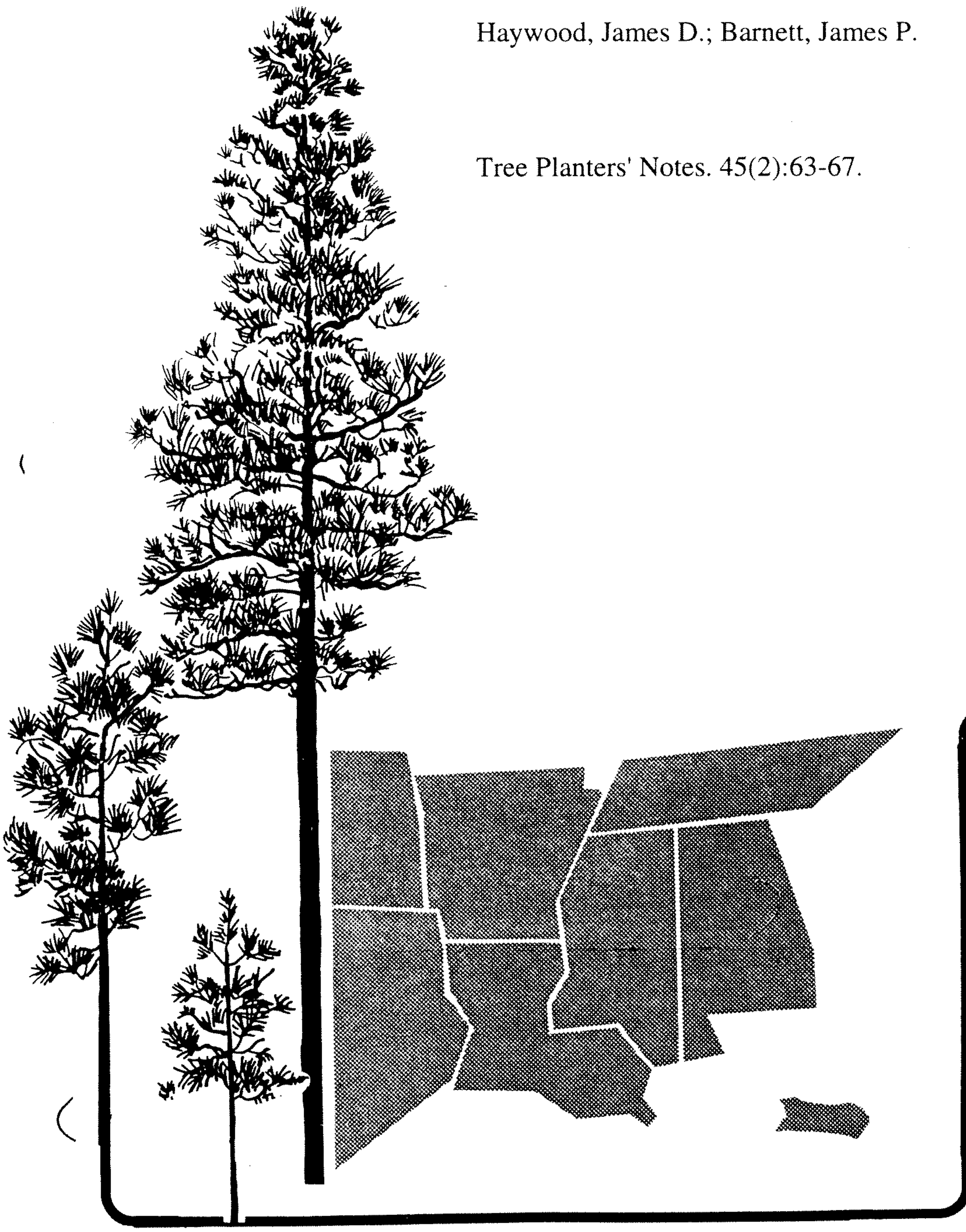

Southern Forest Experiment Station

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Comparing Methods of Artificially Regenerating Loblolly and Slash Pines: Container Planting, Bareroot Planting, and Spot Seeding

James D. Haywood and James P. Barnett

Silviculturalist and project leader, USDA Forest Service
Southern Forest Experiment Station, Pineville, Louisiana

In central Louisiana, loblolly (Pinus taeda *L.) and slash* (P. elliottii *Engelm. var.* elliottii) *pines were artificially regenerated by three methods: (1) planting 14-week-old container stock, (2) planting 1+0 bareroot stock, and (3) spot seeding. A common seed source was used for each species for all regeneration methods. Spot seeding was done by sowing 10 repellent-treated seeds per spot on the same 2.44- by 2.44-m (8- by 8-ft) spacing used for planting. Each seeded spot was thinned to one seedling after establishment was certain. After 15 growing seasons, loblolly and slash pines in the container and bareroot plantings had out-produced the spot-seeded trees. Loblolly pines on the container, bareroot, and seeded plots yielded 146.2, 163.9, and 96.7 m^3/ha, respectively. Slash pines on the container, bareroot, and seeded plots yielded 190.1, 178.8, and 149.4 m^3/ha, respectively. The seeded trees were younger from seed than the bareroot stock, and this is reflected in stand volume. Although container stock was only 14 weeks old at planting, growth was comparable to that of the bareroot seedlings. Results show that seeding can be a low-cost regeneration alternative if some reduction in volume is acceptable.* Tree Planters' Notes 45(2):63–67; 1994.

Bareroot seedlings are the preferred planting stock in the South because they are relatively inexpensive to produce and are generally reliable. However, container planting and direct seeding are alternative regeneration techniques with several advantages over bareroot planting (Brissette and others 1991, Derr and Mann 1971). Container stock of uniform size can be quickly produced. Production flexibility allows container seedlings to be planted throughout an extended planting season, provided soil moisture and climatic conditions remain favorable. Container seedlings perform well on adverse sites and allow faster planting rates than bareroot seedlings. Direct seeding costs are usually lower than planting costs. Seeding is less labor intensive, and large tracts can be seeded quickly, freeing workers for other duties.

Container planting and direct seeding also have disadvantages (Brissette and others 1991, Derr and Mann 1971). Trees produced in containers will likely cost more than bareroot stock grown in existing nurseries. Container seedlings are bulky to transport and must be handled differently from bareroot seedlings. Because container seedlings may be smaller initially, severe herbaceous competition may reduce their early development. Seeds and newly germinated seedlings are more vulnerable to predators and adverse weather conditions than planted seedlings. Thus, direct seeding is less dependable than planting, and trees are not established in rows unless additional care and expense are taken in seed placement.

Because each of these three methods of artificial regeneration has advantages and disadvantages, the field performance of loblolly (*Pinus taeda* L.) and slash (*P. elliottii* Engelm. var. *elliottii*) pines was evaluated for the three methods: (1) container planting, (2) bareroot planting, and (3) direct seeding at predetermined spots (spot seeding). Spot seeding was used to better control future stand density and spacing so more direct individual tree growth comparisons with the two planting methods would be possible.

Methods

Study area. The site is a gently sloping (1 to 30%) Beauregard silt loam (Plinthaquic Paleudult, fine-silty, siliceous, thermic) in central Louisiana. The Beauregard silt loam is normally a productive soil for pine management with site indices of 85 to 90 at 50 years (Haywood and Toliver 1989, Kerr and others 1980). The main limitations on tree growth are low natural fertility and a perched water table. Average yearly (57.5 in or 146 cm) and winter/spring seasonal (30.2 in or 77 cm) precipitation during the 15-year study were similar to the 42-year average precipitation amounts recorded nearby.

The pine stand was clearcut in 1973, and residual trees and logging debris were single-chopped with a rolling drum chopper. Competing vegetation was restrained by at least one controlled burn before 1978, and the area was again burned in the winter of 1978 before plot installation. By this time, debris and stumps had deteriorated. The plant cover was predominately bluestem (*Andropogon* spp. and *Schizachyrium* spp.) and panicum (*Panicum* spp. and *Dichanthelium* spp.) grasses, forbs, and scattered small hardwoods.

The area was treated with an ant poison to reduce losses to Texas leaf-cutting (*Atta texana* Buckl.) and fire (*Solenopsis* spp.) ants. The plots were rotary mowed to reduce grass and brush competitors after the 2nd, 9th, 12th, and 14th growing seasons.

Planting stock. All seeds were obtained from a local source in central Louisiana and stratified for 30 days before use. The container seedlings were grown at Pineville, Louisiana, in Keyes' Tree Starts® and Styroblocks® for 14 weeks before outplanting. Both Tree Starts and Styroblocks had a volume of 65 cm^3 (4.0 in^3). The Tree Starts were a molded mixture of organic and inorganic materials. A peat-vermiculite mixture was used as the growth medium in the Styroblocks. Two kinds of containers were used because there was an insufficient supply. However, seedlings from both containers were of equal quality and size.

Container seedlings were fertilized with 20-19-18 nitrogen/phosphorus/potassium at 150 ppm nitrogen through a watering system each time they were watered during the last 10 weeks of the 14-week growing period. The greenhouse environment was kept at 24 ± 5 °C (75.2 ± 9 °F) with a 16-hr photoperiod.

The 1+0 bareroot seedlings were sown in 1977 at the Louisiana Department of Agriculture and Forestry's Columbia Nursery according to standard nursery practices. Characterization of the container and bareroot stock before planting showed that the container seedlings were consistently smaller than the bareroot stock. The direct-seeded seeds were treated with standard bird and rodent repellents (Derr and Mann 1971).

Plot establishment. For both loblolly and slash pine, plots for each regeneration method were installed in a randomized complete block design with 4 blocks serving as replicates, for a total of 12 plots per species (three stock types by four blocks). Plots were 13 rows of 13 trees (or spots) each spaced at 2.44 by 2.44 m (0.10-ha gross plot).

Outplanting and seeding. The 1+0 bareroot seedlings were hand planted at a 2.44- by 2.44-m (8- by 8-ft) spacing in February 1978. Seeding was also done in February on the same 2.44- by 2.44-m spacing by sowing 10 repellent-treated seeds per hand-raked 30-cm (11.8-in) -diameter spot. Seeds were placed on the soil and lightly pressed into the surface, but left uncovered. Thus, the seeded trees were actually 1 year younger than the bareroot trees. The 14-week-old container seedlings were planted in holes made by a punch at the same spacing in April 1978. Container planting was delayed because the seedlings had not developed sufficiently to plant until April.

Dead seedlings in both plantings were replaced with transplants in early June to ensure that plot stocking was comparable. The bareroot replacements had been kept in 1-liter (1.1-qt) pots; the container replacements were held within the greenhouse. Each seeded spot was thinned to one seedling after establishment was certain.

Control of stocking allowed individual tree and plot volume growth comparisons to be made on a more biologically sound basis, which was the same reason we controlled stocking and spacing on the seeded plots. Regardless, Haywood and Tiarks (1990) found that analyses of pine growth and yield data sets that did or did not include inplanted trees resulted in the same statistical conclusions. Mortality that occurred after replanting and thinning of seeded plots was due to a lack of seedling vigor, predators, or the elements. Therefore, the reported survival at age 15 years reflected the long-term survival potential of each stocking type.

Measurements and data analysis. On 8 trees for each of 8 rows within the central area of each plot (0.04 ha or 0.1 acre), total height measurements were taken after the 1st through 5th, 10th, and 15th growing seasons. After 10 growing seasons, tree stems were examined for fusiform rust galls, which are caused by *Cronartium quercuum* (Berk.) Miyabe ex. Shirai f. sp. *fusiforme* Burdsall & Snow. After the 15th growing season, diameter-at-breast-height (dbh) and survival measurements were taken. Outside-bark volumes were calculated using Baldwin and Feduccia's formula for loblolly pine (1987) and Lohrey's formula for slash pine (1985).

For each pine species, height, dbh, volume per tree, survival, stand volume, and fusiform rust data were analyzed by analysis of variance. Mean comparisons were made with preplanned orthogonal comparisons (probability > F-value = 0.05): container plus bareroot planting versus spot seeding and container planting versus bareroot planting.

Results and Discussion

After 5 years, container and bareroot loblolly pine seedlings were an average of 1 m taller than the seeded seedlings (figure 1). The difference in average loblolly pine height between the two plantings and the seeded plots increased to 1.5 m (4.9 ft) by age 15. From the 5th through the 15th growing seasons, container and bareroot slash pines were an average of 1 m (3.3 ft) taller than the seeded slash pines. Campbell (1985) had similar results; he found that 20-year-old loblolly and slash pines that had been broadcast sown into a grass rough were 2 and 1 m (6.6 and 3.3 ft) shorter than planted loblolly and slash pines, respectively. The height differences between the container and bareroot plantings were not significant for either species (table 1). These results confirm earlier ones showing that superior performance of container over bareroot stock occurs only under stressful conditions (Barnett and McGilvray 1993).

For loblolly pine, the container and bareroot plantings had significantly greater dbh than the seeded plots (table 1). However, for slash pine, the difference in dbh between the average for the container and bareroot plantings and the seeded plots was not significantly different (probability > F-value = 0.06).

For both pine species, the container and bareroot plantings had significantly greater outside-bark volume per tree than the seeded plots (table 1). After 15 years, volume per loblolly pine averaged 104, 99, and 85 dm^3, and volume per slash pine averaged 144,

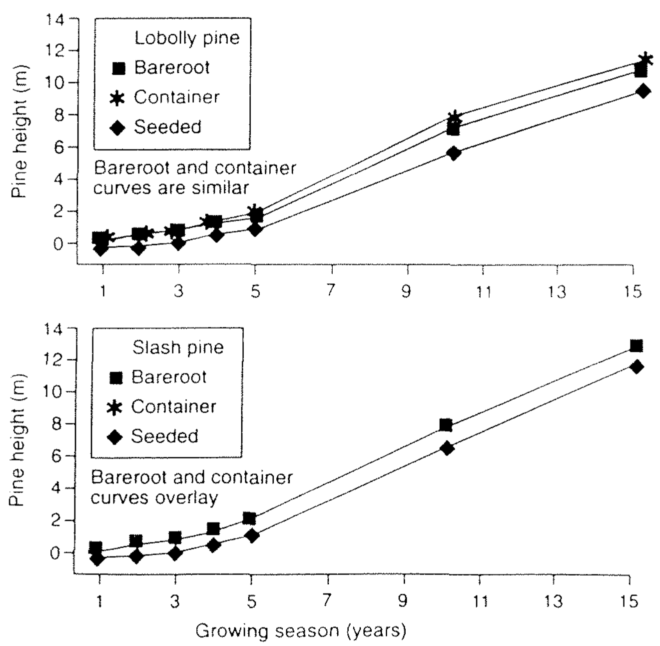

Figure 1—*Average height of loblolly* **(top)** *and slash* **(bottom)** *pine from the 1st through the 15th growing seasons.*

155, and 126 dm^3 on the container, bareroot, and seeded plots, respectively. Because Campbell (1985) broadcast seeds, his range in volume-per-tree differences after 15 growing seasons was greater than for this experiment.

It is difficult to separate the influence of survival on individual tree growth and yield per unit area. However, all three variables—percentage survival, volume per tree, and volume per hectare—can be useful in evaluating treatment effects, especially for long-term field studies.

As with volume per tree, long-term loblolly pine survival was significantly greater for the container (94%) and bareroot (88%) plantings than for the seeded (68%) plots after 15 years (table 1). Therefore, the 15-year-old loblolly pine also had significantly greater yields for the container (164 m^3/ha) and bareroot (146 m^3/ha) plantings than for the seeded (97 m^3/ha) plots. Campbell's 15-year-old loblolly pine studies yielded 248 and 174 m^3/ha on the planted and broadcast-sown treatments, respectively (1985).

For this experiment, average long-term slash pine survival values on the container (79%) and bareroot (68%) plantings were not significantly different from those on the seeded (70%) plots after 15 years (table 1). However, because of the differences in individual tree size, the 15-year-old container and bareroot plantings yielded somewhat more volume than the seeded plots: 190, 179, and 149 m^3/ha, respectively (probability > F-value = 0.07). Campbell's 15-year-old slash pine yielded 151 and 162 m^3/ha on the planted and broadcast-sown treatments, respectively (1985).

Slash pine was the most productive species on all treatments at this Paleudult silt loam site, although the study design would not allow us to prove this outcome statistically. Regardless, loblolly has been shown to be more productive than slash pine on other Paleudult soils (Haywood and others 1990).

After 10 growing seasons, 7% of the loblolly and 13% of the slash pine trees had stem infections caused by fusiform rust (data not shown). These levels of infection by age 10 are generally low for central Louisiana (Cain 1978, Derr and Mann 1970). There were no regeneration-method differences for either species.

Conclusions

Evidently, either container or bareroot planting stock can be used with little or no effect on mid- to late-rotation yields for either loblolly or slash pine.

Table 1—*Characteristics and statistical information on loblolly and slash pine 15 years after outplanting*

Species and regeneration method	Height (m)	Dbh (cm)	Vol/tree (dm^3)	Survival (%)	Stand vol (m^3/ha)
Loblolly pine					
Container	11.4	14.5	103.5	94	163.9
Bareroot	11.1	14.0	99.3	88	146.2
Seeded	9.8	13.5	84.9	68	96.7
Means	10.8	14.0	95.9	83	135.6
Slash pine					
Container	13.2	15.9	144.0	79	190.1
Bareroot	13.2	16.3	155.4	68	178.8
Seeded	12.2	15.2	126.0	70	149.4
Means	12.9	15.8	141.8	72	172.8

Species and regeneration method	Probabilities > F-value				
	Height	Dbh	Vol/tree	Survival	Stand vol (m^3/ha)
Loblolly pine					
Seeded vs. container + bareroot	0.0060	0.0465	0.0438	0.0057	0.0007
Container vs. bareroot	0.4557	0.1990	0.5980	0.3669	0.1420
Error mean square	0.3285	0.2477	112.55	82.316	218.46
Slash pine					
Seeded vs. container + bareroot	0.0096	0.0555	0.0197	0.6814	0.0650
Container vs. bareroot	0.8366	0.3580	0.1910	0.2484	0.5528
Error mean square	1.3616	0.3335	121.48	126.11	643.74

Therefore, planting stock choices can be based on more immediate factors such as establishment costs, planting date, and site and climatic conditions likely to be encountered during the first growing season (Brissette and others 1991).

As expected, spot seeding was less effective than either planting method (Campbell 1985). However, the seeded trees were younger than planted bareroot stock. The container stock was about the same age as the seeded trees, but the initial greenhouse period allowed the container stock to develop rapidly and perform equally to bareroot material. Results showed that direct seeding can be a viable regeneration alternative, especially when regeneration costs are a limiting factor. Still, a definite decrease in individual tree size and, possibly, per hectare yields should be expected with direct seeding.

Literature Cited

Baldwin VC Jr, Feduccia DP. 1987. Loblolly pine growth and yield prediction for managed West Gulf plantations. Res. Pap. SO-236. New Orleans: USDA Forest Service, Southern Forest Experiment Station. 27 p.

Barnett JP, McGilvray JM. 1993. Performance of container and bareroot loblolly pine seedlings on bottomlands in South

Carolina. Southern Journal of Applied Forestry 17(2):80–83.
Brissette JC, Barnett JP, Landis TD. 1991. Container seedlings. In: Duryea ML, Dougherty PM, eds. Forest regeneration manual. Dordrecht, The Netherlands: Kluwer Academic Publishers: 117–141. Chapt. 7.
Cain MD. 1978. Planted loblolly and slash pine response to bedding and flat disking on a poorly drained site—an update. Res. Note SO-237. New Orleans: USDA Forest Service, Southern Forest Experiment Station. 5 p.
Campbell TE. 1985. Development of direct-seeded and planted loblolly and slash pines through age 20. Southern Journal of Applied Forestry 9(4):205–211.
Derr HJ, Mann WF Jr. 1970. Site preparation improves growth of planted pines. Res. Note SO-106. New Orleans: USDA Forest Service, Southern Forest Experiment Station. 3 p.
Derr HJ, Mann WF Jr. 1971. Direct-seeding pines in the South. Agric. Handb. 391. Washington, DC.: USDA. 68 p.
Haywood JD, Toliver JR. 1989. A comparison of loblolly pine growth and yield on pure pine and mixed pine-hardwood sites. In: Waldrop TA, ed. Proceedings, Pine-Hardwood Mixtures: A symposium on management and ecology of the type; 1989 April 18–19; Atlanta. Gen. Tech. Rep. SE-58. Asheville, NC: USDA Forest Service, Southeastern Forest Experiment Station: 117–122.
Haywood JD, Tiarks AE. 1990. Eleventh-year results of fertilization, herbaceous, and woody plant control in a loblolly pine plantation. Southern Journal of Applied Forestry 14(4):173–177.
Haywood JD, Tiarks AE, Shoulders E. 1990. Loblolly and slash pine height and diameter are related to soil drainage in winter on poorly drained silt loams. New Forests 4:81–96.
Kerr A Jr, Griffis BJ, Powell JW, and others. 1980. Soil survey of Rapides Parish, Louisiana. Alexandria, LA: USDA Soil Conservation Service and Forest Service, in cooperation with the Louisiana Agricultural Experiment Station. 86 p.
Lohrey RE. 1985. Stem volume, volume ratio, and taper equations for slash pine in the West Gulf region. In: Shoulders E, ed. Proceedings, 3rd Biennial Southern Silvicultural Research Conference; 1984 November 7–8; Atlanta. Gen. Tech. Rep. SO-54. New Orleans: USDA Forest Service, Southern Forest Experiment Station: 451–459.