DIRECT SEEDING. AND PLANTING OF LOBLOLLY PINE ON THE HIGHLAND RIM IN TENNESSEE

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Large areas of the eastern Highland Rim are presently covered with relatively unproductive hardwood forests. The main species found on this gently rolling land are southern red oak, scarlet oak, post oak and blackjack oak. Because of soil conditions and previous fires, log quality is generally poor and the rate of growth slow. Most of these "oak barren" lands have a fragipan 18 to 36 inches below the surface that severely restricts root penetration. Site index for oak is about 50.

Although no pines are native to the area, loblolly pine plantations have developed satisfactorily and are presently being thinned for pulpwood. While the native oak forests have little commercial value, it appears that loblolly pine pulpwood and small sawtimber may be grown profitably. The potential profit derived from such plantations will largely be determined by the expense of converting the oak forests to stands of loblolly pine.

Seeding vs. Planting

An experiment was established in the fall and winter 1961-62 to determine the most efficient way of establishing loblolly pine on the University of Tennessee Highland Rim Forestry Field Station near Tullahoma. The experiment included 115 acres. All commercial trees on the area were cut, and the remaining trees larger than 3 inches d.b.h. were killed by injectors. Two different methods of site preparation were used: 1) Double disking with a bulldozer, and 2) plowing fire lanes. There was an untreated control. Regeneration was established on all three types by either hand planting (planting bar) or direct seeding. The seeding operation was accomplished with a cyclone seeder on the disked sites, by hand broadcasting in the fire lanes, and on the sites with no preparation by a Panama Direct Seeder. A split-plot design with three replications was employed, site preparation being the main treatment.

Most of the treatments produced excellent stocking. After five growing seasons only, the combination of no site preparation and direct seeding produced an understocked stand (table 1). But disking and direct seeding resulted in a density of 2,471 trees per acre. Apparently, one pound of seed per acre was too much for this well-prepared site.

Most of the treatments have aided in good height growth. Only a combination of no site preparation and direct seeding brought about poor height growth (table 2). Most of the pines in this treatment are overtopped by competing hardwoods and are not expected to survive. A large number of the trees in the "fire lane and seeding" treatment is also becoming suppressed. Survival and growth of planted trees have been excellent for all site preparations. But direct seeding tended to yield too few or too many trees per acre and to slow growth.

None of the four treatments produced an acceptable stand (table 4). The use of a modified seeder increased stocking significantly (at the 5-percent

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TABLE 1.—*Stocking, trees per acre*

Treatment	Establishment	1 year	2 years	3 years	5 years
		Number	*Number*	*Number*	*Number*
Disking and planting	861 seedlings	836	879	886	873
Disking and seeding	1 lb. seed	2,813	2,291	2,393	2,471
Fire lane and planting	735 seedlings	765	731	724	743
Fire lane and seeding	.5 lb. seed	1,378	702	654	630
No site prep. and planting	847 seedlings	838	854	843	870
No site prep., stocked seed spots	2,000 spots	434	383	332	370

TABLE 2.—*Average height*

Treatment	1 year	2 years	3 years	5 years
	Feet	*Feet*	*Feet*	*Feet*
Disking and planting	.95	2.76	4.50	10.63
Disking and seeding	.47	1.28	2.35	7.08
Fire lane and planting	.81	2.01	3.46	9.31
Fire lane and seeding	.36	.85	1.83	5.46
No site prep. and planting	.93	2.20	3.51	8.65
No site prep. and seeding	.39	.75	1.62	3.75

TABLE 3.—*Establishment cost*

Treatment	Seed or seedlings	Planting labor	Site prepara-tion	Release	Total	Relative cost percent
	Dollars/ acre	*Dollars/ acre*	*Dollars/ acre*	*Dollars/ acre*	*Dollars/ acre*	*Dollars/ acre*
Disking and planting	4.00	8.40	18.00	1.25	31.65	216
Disking and seeding	4.00	.30	18.00	1.25	23.55	161
Fire lane and planting	4.00	6.85	10.00	1.25	22.10	151
Fire lane and seeding	2.00	.55	10.00	1.25	13.80	94
No site prep. and planting	4.00	9.40	0.00	1.25	14.65	100
No site prep. and seeding	2.00	3.50	0.00	1.25	6.75	46

level). Burning also improved stocking, but even the best combination of treatments produced less than 400 stocked seed spots per acre following two growing seasons.

The combination that resulted in best stocking-burning and a modified seeder-unfortunately also produced seedlings with significantly slower growth rates (table 5). Probably, the removal of most of the organic matter around the seedlings made the trees more susceptible to drought.

On unburned seedbeds Russell and Mignery (1968) obtained, under very similar conditions, seed spot stockings of 10 percent with the standard seeder and 25 percent with the modified seeder after one growing season. That result compares well with 9 and 20 percent in the present study. Russell and Mignery found that seeding later in the spring

(April and May) resulted in much better stocking.

Although planting on disked sites produced slightly better growth than planting on unprepared sites, this difference does not appear to justify the extra cost. Establishment costs of disking and planting were more than twice that of planting without site preparation (table 3). Assuming a pulpwood rotation of 30 years on this land and an interest rate of 5 percent, the compounded cost of conversion, using disking and planting, will be $228.50 per acre. If a stumpage of $5.00 per cord is assumed, 46 cords per acre must be grown in 30 years to recover costs of establishment.

The private landowner must reduce conversion costs if the venture is to be financially sound. This can be done by planting without site preparation. Using the assumptions of a 30-year rotation and a 5-percent interest rate, the compounded cost is only

TABLE 4.—*Stocked seed spots per acre*

Treatment	1 year	2 years
	Number	*Number*
Seeder:		
standard, no burn	187	153
modified, no burn	397	309
standard, burn	309	309
modified, burn	473	394

$63.30. Excluding, as before, taxes and land costs and assuming a stumpage of $5.00 per cord, a return of $86.70 per acre may be obtained if the growth rate amounts to 1 cord per acre per year.

Burning and Direct Seeding

Because some site preparation is necessary for establishing loblolly pine by direct seeding and because this site preparation must be cheap, another experiment was started in 1963, using fire to remove litter and reduce hardwood competition. All commercial trees on a 35-acre tract were cut, and the remaining trees over 3 inches d.b.h. were killed by injectors. Two main treatments (burned *versus* unburned) and two split-plot treatments (standard *versus* modified Panama seeder) were used. In place of the small scalper on the end of the standard Panama seeder, the modified seeder had a fire rake attached. About 2,000 spots per acre, with 3-4 stratified seeds per spot, were established in March.

TABLE 5.—*Average height*

Treatment	1 year	2 years
	Feet	*Feet*
Seeder:		
standard, no burn	.50	.99
modified, no burn	.51	.96
standard, burn	.52	1.00
modified, burn	.56	.77

Conclusions

Results from the direct seeding tests are in general agreement with those obtained by Russell (1964) and Russell and Mignery (1968). Although spot seeding generally produced inadequate stocking in this study, the relatively poor performance may partly be explained by the early seeding dates. Both furrow seeding in fire lanes and broadcast sowing on disked sites produced excellent stocking.

To recommend direct seeding on the Highland Rim of Tennessee, some evidence is needed that this method of regeneration will produce the greatest economic return to the landowner. No such evidence is available in the literature. The data presented in this study, although not conclusive, indicate that any substantial reduction in establishment cost obtained by direct seeding may be offset by other disadvantages. Direct seeding without site preparation may, under favorable conditions, result in satisfactory stocking of loblolly pine seedlings. However, the risk of failure is high. The question remains whether the savings in establishment costs using direct seeding warrant the acceptance of the risk.

When the trees were 5 years old, about 2 years of growth had been lost if direct seeded was compared with planted trees on unprepared sites (table 2). Similar results have been reported by Harrington (1959). Based on establishment costs in the present study, an increase in yield of 3 cords per acre of planted stands over seeded stands would be required at the first thinning (15 years) to offset the higher cost of planting seedlings. Five-year growth data indicate that the planted trees will produce at least 2 more cords per acre at 15 years than the seeded trees, leaving little or no savings to pay for the risk of poor stocking.

Seeding in furrows (fire lanes) gave adequate stocking, but produced slower growth than planting without site preparation. Costs of the two treatments were about the same. Disking and seeding is a rather expensive treatment, and a precommercial thinning may be needed with the high stem density obtained in this study. Merrifield *et al.* (1968) point out that the "uniform distribution of stems in planted stands may make earlier, heavier thinnings possible, thereby increasing total yield during the rotation."

It is essential that landowners keep the establishment cost of pulpwood plantations as low as possible. However, based on the limited information available, direct seeding, with or without site preparation, cannot be generally recommended on the "oak barrens" of the Highland Rim.

The forest at the Highland Rim Field Station has had a history of repeated wild fires and therefore may have considerably less brush and small hardwood trees than that found on other parts of the eastern Highland Rim. When the hardwood understory is dense, planting without site preparation will not be successful. Burning and silvicide injection may reduce hardwood competition sufficiently to permit the planted seedlings to develop normally. This type of site preparation is usually cheaper than disking, but for private nonindustrial

landowners it may be more profitable to leave such dense stands for hardwood production.

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