How Far Can Seed Be Moved?

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How far it pays to move forest tree seed has been a serious question for nearly two centuries.

Baldwin (1942) traces discussion of it back to an anonymous Swedish author writing in 1769.

Use of seed from the wrong source can eliminate any chance of profit from a plantation. Weidman (1939), for example, reports a northern Idaho test of 20 races of ponderosa pine, one of which, after 9 years of successful growth, suffered 100 percent mortality in a colder-than-average winter. Leon Minckler (personal communication) reports extensive to complete killing of North and South Carolina races of loblolly pine in the Central States by winter temperatures that did negligible harm to Maryland loblolly of comparable ages. At 35 years, the mean annual increments of three loblolly stocks originating 350 to 450 miles from a planting site at Bogalusa, La., were from 47 percent to as little as 20 percent of the mean annual increment of local Louisiana stock (fig. 1).

In extreme cases like these, when stock of distant geographic origin produces only a fifth as much wood as local stock, or no wood whatever, it is easy to name specific sources from which seed should not be obtained.

Most of the evidence from studies of racial variation is, however, less clear and more difficult to interpret. The immediately practical questions

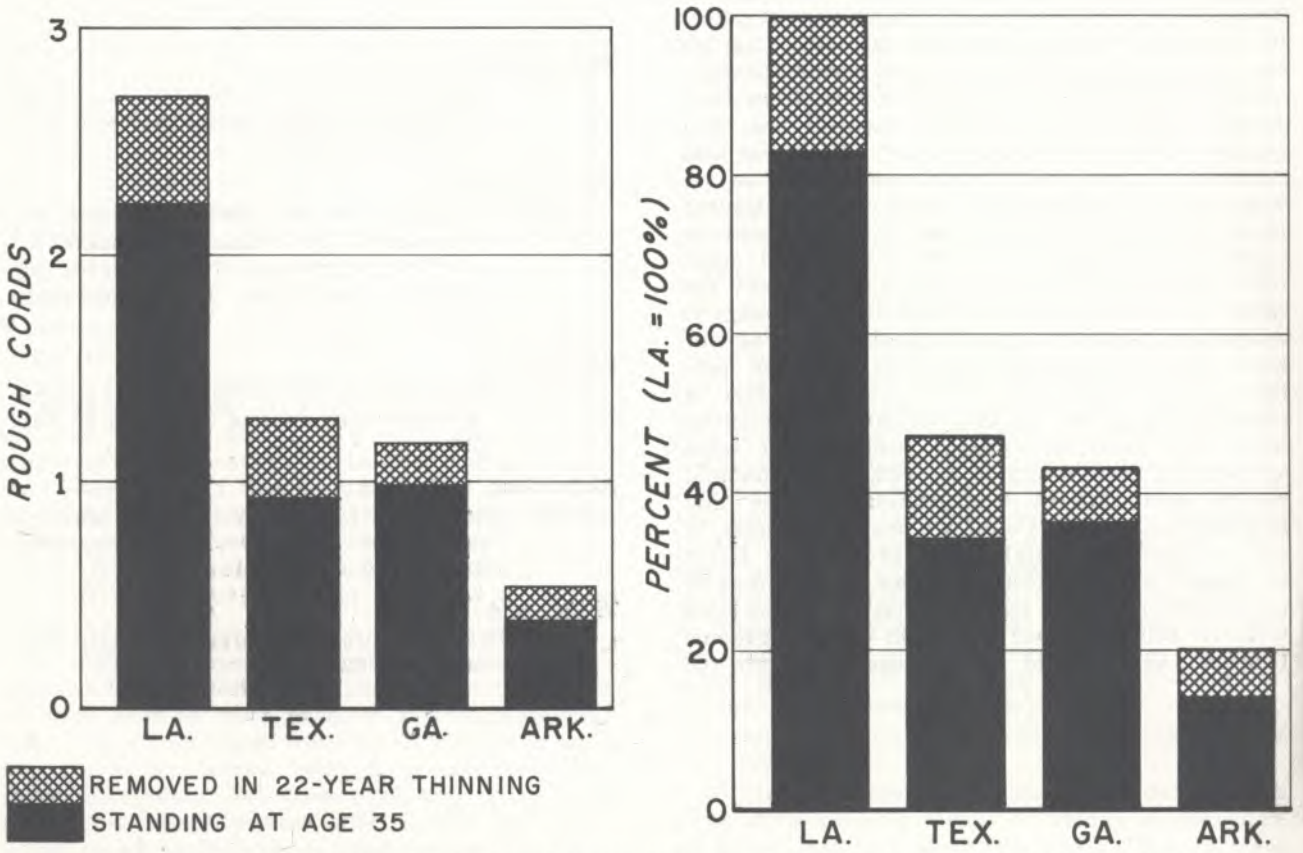

FIGURE 1.—Absolute and relative mean annual increments per acre, at 35 years, of loblolly pines of four geographic origins, planted at Bogalusa, La. The four sources, from left to right, were 50, 350, 450, and 350 miles from the planting site.

of how far one may venture from the planting locality to get seed when the local seed crop is inadequate, and of which of several moderately distant sources to choose, are hard to answer. Furthermore, the best answers we can give today cannot be considered final. They will require revision and amendment as new studies are established and reported and as trends in existing studies change with the passage of time.

Surveys of variation in the morphological characters or wood specific gravity of native stands, such as those Thor (Thorbjornsen 1961) and Wheeler and Mitchell (1959) reported at the Sixth and Fifth Southern Conferences, are of little practical help in choosing a source of seed for a planting program. Often such surveys deal with characters (like shape of seeds or size of pollen grains) that, while important in basic research, have no direct bearing on the survival, growth, or form of planted trees. In any event they fail to distinguish between the effects of the genetic makeup of a race and the effects of the environment in which the race occurs. Growth-chamber and laboratory studies are sometimes more helpful guides. Characteristically, though, growth-chamber and similar studies cover such a brief portion of a tree's life cycle that they supply only a fraction of the information needed. With few exceptions, therefore, the practical guides to choice of seed source have been conventional provenance tests, in which stocks representing several different geographic origins have been planted together in one place and observed for a number of years under field conditions.

Provenance tests are not all equally reliable or useful, however.

To justify generalization about racial variation within a species, a provenance test must include stocks representing a considerable portion of the species' range—preferably all of it. To distinguish races clearly and to indicate their geographical distributions, the test must include stocks representing numerous sources not too widely or irregularly spaced.

To yield dependable information, the stocks representing the various sources must be replicated in the plantation and planted in random arrangement within replications; the planting site must be relatively uniform; all stocks must be planted at essentially the same time; and the nursery treatment, lifting, packing, and shipping of all stocks must be as nearly identical as possible. A provenance test is a specialized form of progeny test and should adhere to the same exacting standards as other progeny tests (Wakeley et al. 1960). Close scrutiny of the records, however, will show that very few provenance tests, and practically none of the older ones, have don? so.

Finally, conclusions must be drawn cautiously, if at all, from the earliest remeasurements of a provenance test, lest later developments show them to have been both premature and misleading. Let me illustrate briefly what I mean.

In the ponderosa pine study reported by Weidman (1939), the stock of Coconino origin grew fastest the first few years, and at 10 years excelled all other stocks but one in height, and equalled that one. At 10 years it might easily have been selected as best for planting in northern Idaho. By the 20th year, however, its average height was less than that of 12 of the 18 other stocks still surviving in the study.

Similar reversals have occurred in southern pine provenance tests. In the study established at Bogalusa, La., with four loblolly pine stocks from the 1925 seed crop, the Texas stock was very significantly taller than the Georgia stock at 15 and 22 years, and taller even at 28 years. By the 35th year, however, the Georgia stock had overtopped the Texas stock (fig. 2).

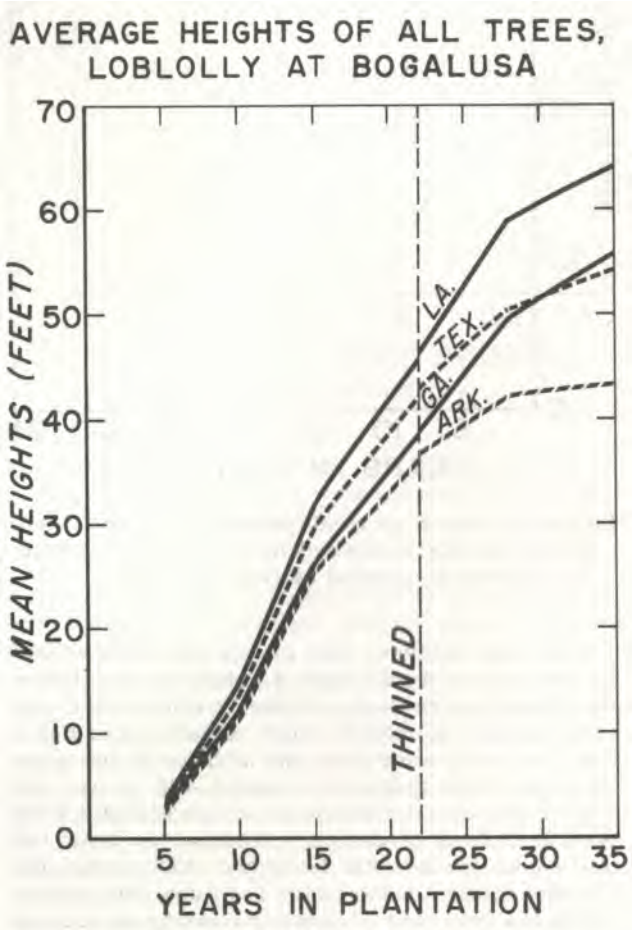

FIGURE 2.—Mean heights of all trees of stocks representing four sources of loblolly pine seed from the 1925 crop, planted at Bogalusa, La.

Through the 15th year of this same study at Bogalusa, the Texas and Arkansas stocks survived better than the local Louisiana stock. By the 35th year, the survival of the Texas stock had fallen slightly below, and the survival of the Arkansas

stock had fallen significantly below, that of the Louisiana stock (fig. 3).

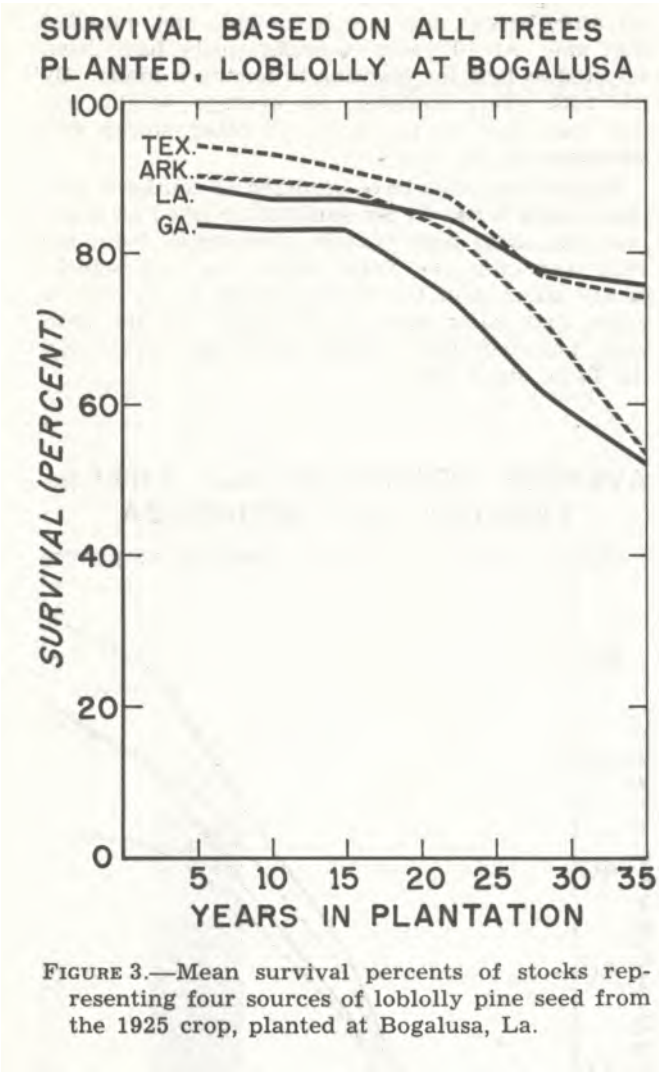

FIGURE 3.—Mean survival percents of stocks representing four sources of loblolly pine seed from the 1925 crop, planted at Bogalusa, La.

Only four southern-pine provenance tests of major importance were installed before the Southwide Pine Seed Source Study (Wakeley 1959; 1961), and of these only the loblolly study established at Bogalusa, La., with seed from the 1925 crop, has gone through a full pulpwood rotation-35 years. All four of these earlier provenance tests suffered from various defects of design, execution, or both. In the study of loblolly from the 1925 crop, the extreme contrast between the Louisiana and Arkansas stocks from age 15 onward must be discounted somewhat because of the nonrandom arrangement of sources in the replicated rows. Except for the results obtained with seed sent to the Union of South Africa (Sherry 1947), an ambitious study established with seed from the generally abundant 1935 crop was practically a total loss.

Ten or more conventional southern-pine provenance tests of potentially major importance have been established since the Southwide Study, and reports on them are appearing with increasing frequency. Several are superior to the Southwide Study in design, sampling, or execution, but none is as broad in scope, and it is not beyond possibility that some of the first conclusions drawn from them will have to be revised.

We have, in short, an insufficient basis on which to lay down any final rules for the movement of the forest tree seed principally used for reforestation in the South.

I feel, however, that we are in far better position to lay down tentative rules than we were 10 or even 5 years ago. The 10th year analyses of the Southwide Study, plus forthcoming publications on other studies, may enable us to improve such tentative rules even within the next 12 months.

Personally, I have no doubt whatever that economically important racial variation associated with geographic location exists in all four principal species of southern pine.

Such variation is clearly very great in loblolly and shortleaf. Stocks from opposite extremes of the ranges of these two species differ conspicuously in their requirements for optimum survival and growth. There is good evidence that, even within individual States, loblolly pine varies in susceptibility to fusiform rust, and, toward the western limit of its range, in drought resistance.

Racial variation, though present, seems to me to be least in slash pine, particularly in those portions of the species' range in which seed is collected commercially.

The picture of racial variation in longleaf pine is still somewhat obscure. The species is difficult to plant successfully, slow to commence height growth, and prone to brown-spot infection. For these reasons, results of provenance tests take longer to obtain than with other species, and tend to be erratic. My personal impression is that longleaf exhibits less racial variation than loblolly and shortleaf, but considerably more than slash pine.

Certain extremely long movements of seed have had catastrophic results. They obviously should be avoided in practice, especially when they have been tried several times. Longleaf from seed collected in Hillsborough County, Fla., has twice made a very poor showing in States north and west of Florida. Shortleaf seed from the central and southern Atlantic States and the Gulfcoast States has been tried three times in Pennsylvania without success. North and South Carolina loblolly stocks have succumbed to cold in Central States locations in which Maryland loblolly has survived.

Noncatastrophic but still economically serious setbacks have occurred when longleaf, loblolly, and shortleaf stocks have been tested at shorter but still considerable distances from their points of origin. In a majority of instances in the Southwide Pine Seed Source Study and other studies, the setbacks have taken one of two forms. Either the stock from a distant source has survived well but grown poorly, or the survivors, although fairly rapid in growth, have been few in number.

There are indications, though there is hardly as yet conclusive proof, that a few geographic races of southern pines are capable of both good survival and good growth, even at very great distances from their points of origin. Longleaf pine from Baldwin County, Ala., and loblolly pine from Onslow County, N. C., have exhibited such wide adaptability to varied conditions, each in two sets of plantations established with different seed lots collected from different stands in different years.

For the first 3 to 5 years, shortleaf and loblolly stocks of northern origin have generally outgrown stocks of southern origin when planted with them in the northern portions of the species' ranges, while in the southern parts of the ranges southern stocks have generally outgrown northern stocks (figs. 4 and 5). In some cases, though not in all, the tendency has persisted through the 10th year (figs. 6 and 7). There seems to me to be good evidence that variations in both temperature and day length, each of which is strongly correlated with latitude, are involved in this pattern of growth behavior.

As a rule, though again with some exceptions, an east-and-west movement of southern pines in the same general latitude seems to affect growth less than does movement for an equal distance north and south.

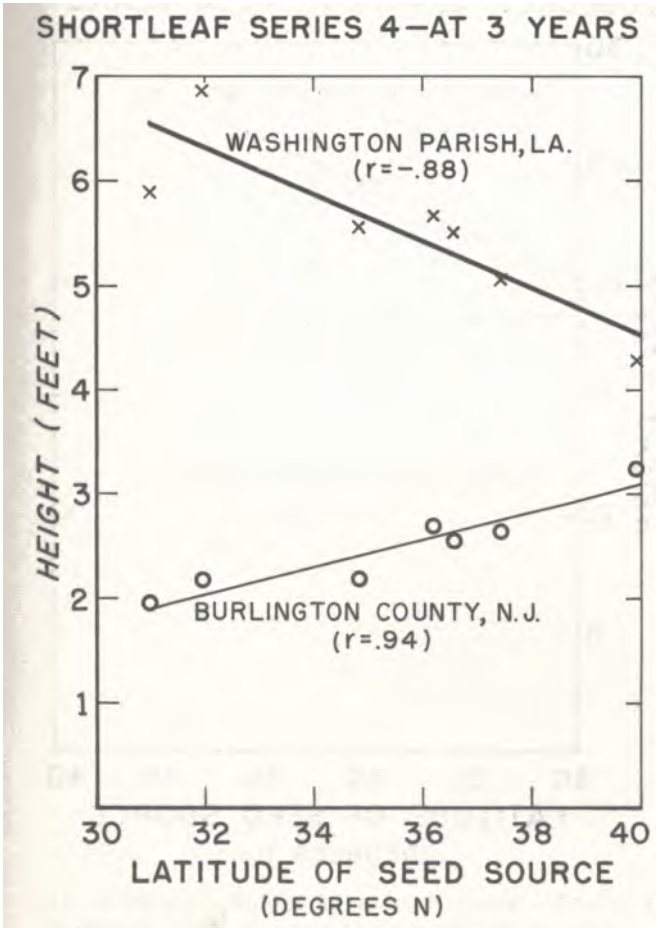

FIGURE 4.—Mean heights of shortleaf stocks at 3 years, over latitudes of seed sources, in northern and southern plantations.

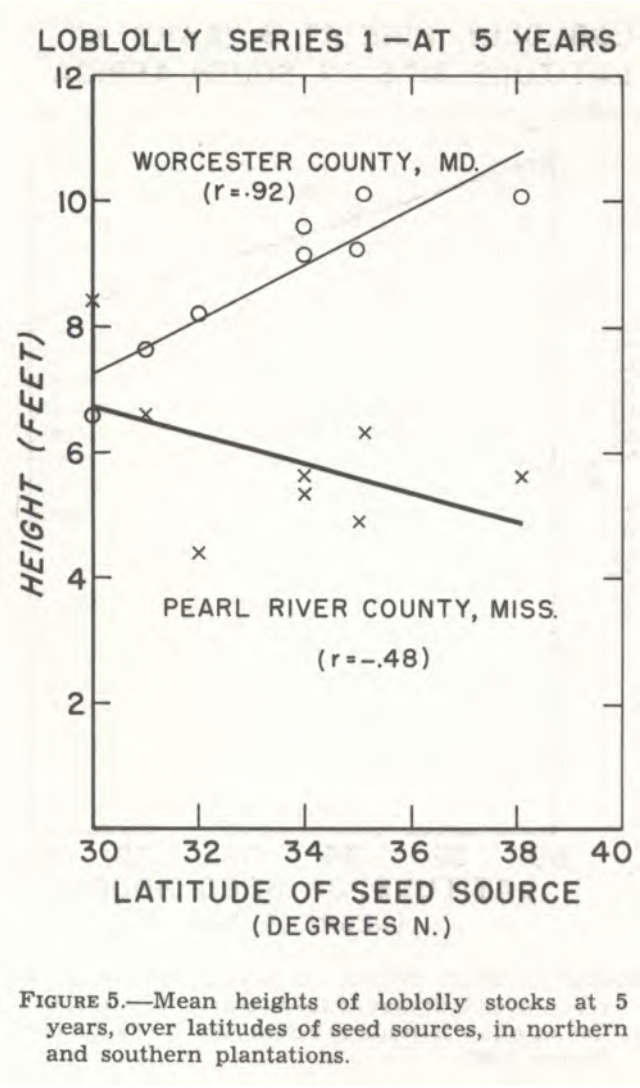

FIGURE 5.—Mean heights of loblolly stocks at 5 years, over latitudes of seed sources, in northern and southern plantations.

The susceptibility of loblolly pine to fusiform rust does, however, vary conspicuously with longitude of seed source. While variations in susceptibility occur even within individual States, they seem to be overshadowed by a general tendency for susceptibility to decrease from east to west. The lower susceptibility of western stocks has been dramatically illustrated by a Southeastern Station study in Georgia, in which, at 5 years after planting, the percent trunk-infected in each of 14 Georgia and 3 north Florida stocks was from 4 to 10 times the percent trunk-infected in a single Arkansas stock planted among them.

If I were a land manager or company executive and had to decide in favor of one as against some other nonlocal source of seed, I would follow these 10 guides in making my choice.

1. I would assume that the farther I moved seed in any direction, the greater would be the risk of its being poorly adapted to the planting locality,

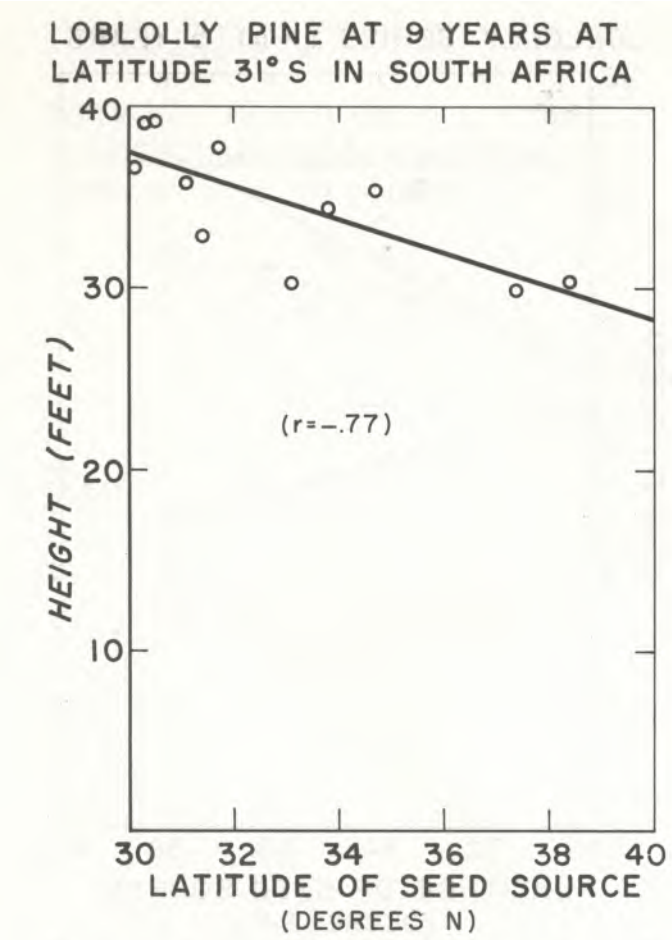

FIGURE 6.—Mean heights of loblolly stocks at 9 years, over latitudes of seed sources, in a plantation at a low latitude in South Africa (data from Sherry 1947).

and the more serious the maladaptation might be. The evidence to date does not justify saying it is always safe to move seed of a certain origin thus far and never safe to move it any farther.

2. I would avoid moving seed of any of the southern pines, even slash pine, over extreme distances, lest I duplicate one of several catastrophes already demonstrated. To avoid such extreme moves, I would go to considerable lengths to store seed of suitable origin in years of abundant production. As a last resort, I would suspend planting or seeding till seed of a suitable source became available.

3. I would be more cautious about moving seed of any of the southern pines a given distance north or south than about moving it an equal distance east or west. Going north or south involves a greater change in temperature, to which racial variation evidently is strongly related, and also a greater change in day length, to which loblolly and shortleaf races seem delicately adjusted and to which races of the other species may be adjusted also.

4. Other things being equal, I should prefer to move seed east rather than west, and would consider moving it farther to the east than to the west, especially if I were planting on droughty sites. Longleaf, loblolly, and shortleaf pines from western sources may be somewhat slower growing than those from eastern sources, but do seem to be more drought resistant and hence to be capable of better survival in dry years and on dry sites.

5. I should be particularly cautious about moving loblolly very much to the west. Maryland loblolly has incurred relatively light rust infection wherever planted, but other eastern provenances, from North Carolina south to Florida, have generally proved markedly more rust susceptible than more westerly provenances from corresponding latitudes.

6. Even within these limitations, I would try to get seed from a source (such as Baldwin County, Ala., for longleaf or Onslow County, N. C., for loblolly) that had proved widely adaptable in at least two tests.

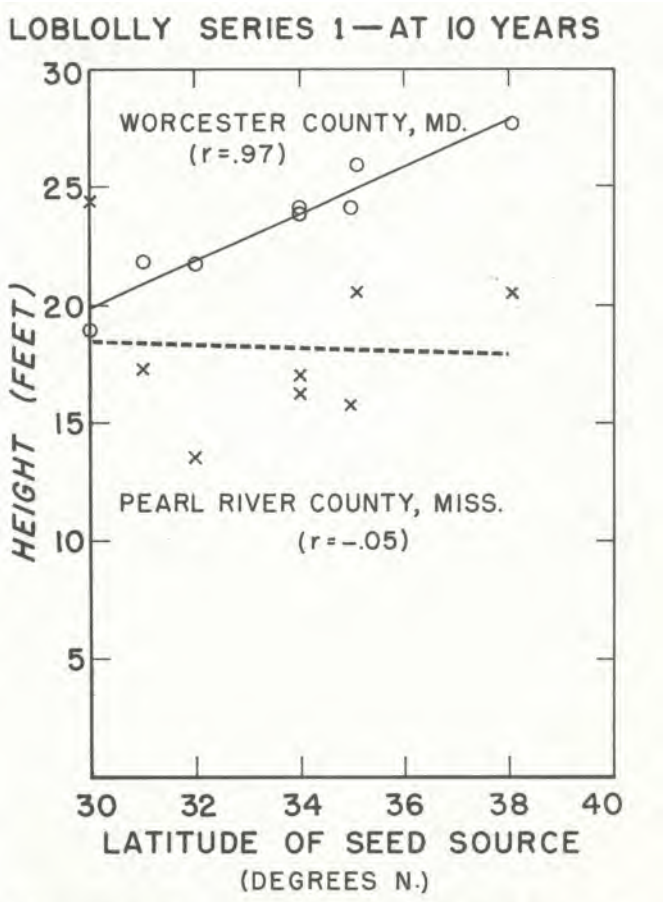

FIGURE 7.—Mean heights of loblolly stocks at 10 years in the same plantations as those shown in fig. 5. The relation of growth to latitude of seed source has become intensified in the northern plantation but dissipated in the southern one.

7. Although supporting evidence is not yet conclusive, I should be strongly inclined to limit planting of longleaf on the Carolina or Florida sandhills to stock grown from seed from the corresponding sandhill areas.

8. Within the range from the central Florida peninsula north to southern South Carolina and west to eastern Louisiana, I should be less apprehensive about unrestricted movement of slash pine seed than about similar movement of seed of the other three principal species. Even here, however, I should feel less free to move slash seed north or south than to move it east or west, and I should avoid getting seed from coastal-strip slash pine of a typical form for the species.

9. I should by no means depend upon correct provenance alone to insure good growth in my plantation, but should take care also to avoid getting seed from high-graded, inbred, or otherwise minus stands within the provenance chosen.

10. Though there is as yet no experimental evidence to support me, I believe I should risk moving genetically superior seed from plus stands, elite trees, or tested seed orchards slightly farther than I would move "run-of-the-woods" seed. Loss in growth resulting from the movement might be offset, at least in part, by a gain in growth resulting from selection. Under no circumstances, however, would I move seed-orchard or other improved seed over extreme distances. It is questionable, for example, whether any degree of selection and breeding would enable Maryland loblolly to equal the growth of ordinary Texas loblolly if both were planted in Texas. The same would be true of any other genetically improved southern pine seed moved an excessive distance from its geographic origin.