THE CASE FOR NATURAL REGENERATION

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In this age of machine planting and airplane seeding, forest regeneration by self-sown seeds (natural regenration) is seldom in the limelight. The notion is prevalent that our future forests will be largely spewed forth from the rear of an airplane or set out in precise rows by machine. Perhaps this is so. However, before we rocket off to explore the forests of another planet, let us dwell for a moment on the possibilities of natural regeneration on at least some of our southern pinelands. This may be a good idea in the face of some retrenchment and cost-cutting now current in many southern forestry operations.

Natural regeneration should be considered a forestry technique—like planting or direct seeding—to be prescribed for the prompt and heavy restocking of forest land with commercially desirable tree species. A major challenge to the forester is to determine which regeneration technique will do the job at the least cost on a given area. As a guide, description of some developments in the natural regeneration of loblolly pine shall be attempted. Much of the information to be presented is from the Virginia-Carolina coastal plain—an area where loblolly pine is the major commercial conifer and reaches its maximum development (heights up to 130 feet in 50 years). However, physiological differences between tree species and wide variations of soil and climate within the range of a major species require local interpretations of the described results. Basically this is a research job, but action agencies can help with pilot-plant tests.

It has been said that poor seed production is rarely a silvicultural bottleneck in itself. Given a favorable climate, a good seedbed, and absence of rodents and of sharply competing vegetation, the requisite amount of seed for the successful regeneration of the forest can usually be produced. But if any of the above factors are distinctly unfavorable, success may be impossible even with the highest possible seed yield. Even so, the primary problem is to supply the greatest amount of seed feasible under the silvical and economic conditions of the forest type and region(*2*). In essence, this has been the goal of researchers since about 1940 in the loblolly pine type

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of the Carolina-Virginia area (*3*). A principal difficulty develops in timing —that is, to provide the required amount of seed soon enough after logging or seedbed preparation. In the main this has led to the use of a seed-tree system of regeneration by many forest managers. Specifications are now available for gauging the number of seed trees needed in relation to size and fruitfulness of available trees, condition of the seedbed, and stocking of reproduction desired (*8*). To stimulate seed production, the release of seed trees three to five years in advance of harvest is also a recommended practice.

The successful regeneration of many coastal plain loblolly pine stands proves the usefulness of the seed-tree method. An example is the Able Chance on the Francis Marion National Forest, a mature loblolly stand cut over in 1950 to a residual of four seed trees per acre (Figure 1). Seedbed preparation involved tractor logging followed by a spring burn. By the end of the third growing season 3,100 seedlings per acre restocked 92 per cent of the area. Ten years later the area is fast developing into a pulpwood

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FIGURE 1. Seed tree cutting, Able Chance, Francis Marion National Forest, 1950.

stand and under current management objectives will eventually become a fully stocked stand of high quality sawtimber.

Admittedly there are some shortcomings associated with the seed-tree system. One is the large investment in seed trees with possible losses from wind and lightning. Another is that a rapidly deteriorating seedbed necessitates meeting seed requirements in the first year after logging or seedbed preparation. This is often the case on the better or brushier sites. Thus, in poor seed years the number of trees needed becomes prohibitively large. Furthermore, the seed-tree system has small application in pulpwood size stands because of limited cone production from individual young trees. Finally there is always the job of seed tree removal; when delayed, it may seriously damage sapling stands.

Seed may also be provided by uncut strips. Some advantages result in marking, logging, and later removal, but there is less control of seed supply (*8*).

There is a fast developing interest in a seed-in-place technique which eliminates the need for leaving seed trees on many timber tracts. The idea here is to take advantage of the seed producing capacity of the total stand of trees. Since well-stocked loblolly pine stands in the Carolina-Virginia coastal plain frequently produce ample crops of seed, clearcutting after the peak of the annual seedfall but prior to germination gives promise of becoming a popular regeneration technique. In a given year, cone crop forecasts permit preliminary planning (*1*). Much of the confidence develops from long-term seedfall records such as those maintained on the Santee Experimental Forest in South Carolina (Figure 2). These show that annual production in 40- to 50-year-old managed stands is usually well over 100 thousand sound seeds per acre, averaging around 350 thousand. In uncut stands of the same age, production is somewhat less, averaging about 270 thousand viable seeds per year. The past seed year (1960–1961) was the poorest recorded in fifteen years. Even so, most of the managed stands produced enough for regeneration purposes, although the uncut did not. Fortunately, poor seed years are infrequent. In fifteen years, only three were classed as poor as compared to five "bumper" and seven good years (Figure 3).

The seed-in-place technique is also useful in short-rotation silviculture. For most conifers, individual trees do not produce significant amounts of seed in early life. When a tree is young, much of its energy is utilized in vegetative growth; in middle and later ages, a great part of the energy is directed to reproductive processes (*7*). Nevertheless, some loblolly pine trees have produced cones at seven years of age containing a fair to high propor-

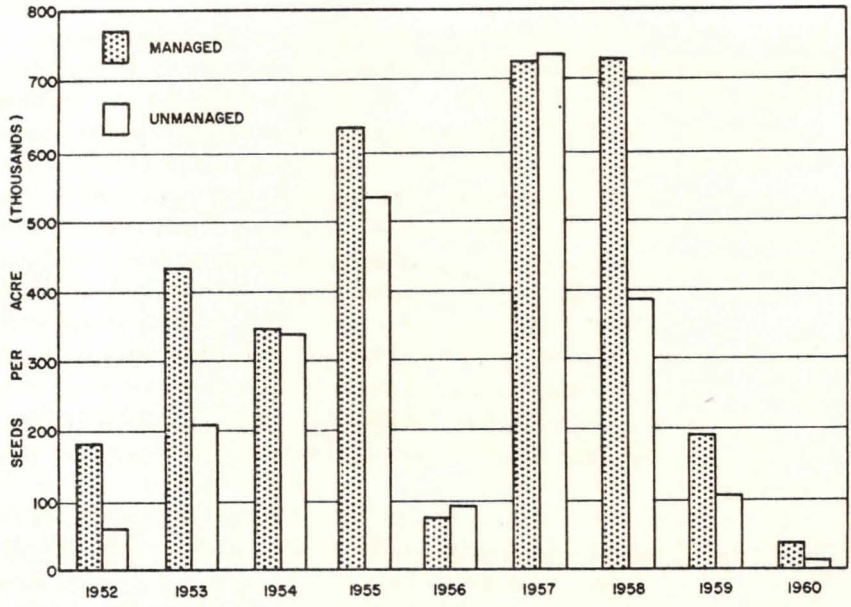

FIGURE 2. Sound seed production from managed and unmanaged loblolly pine stands, forty to fifty years old.

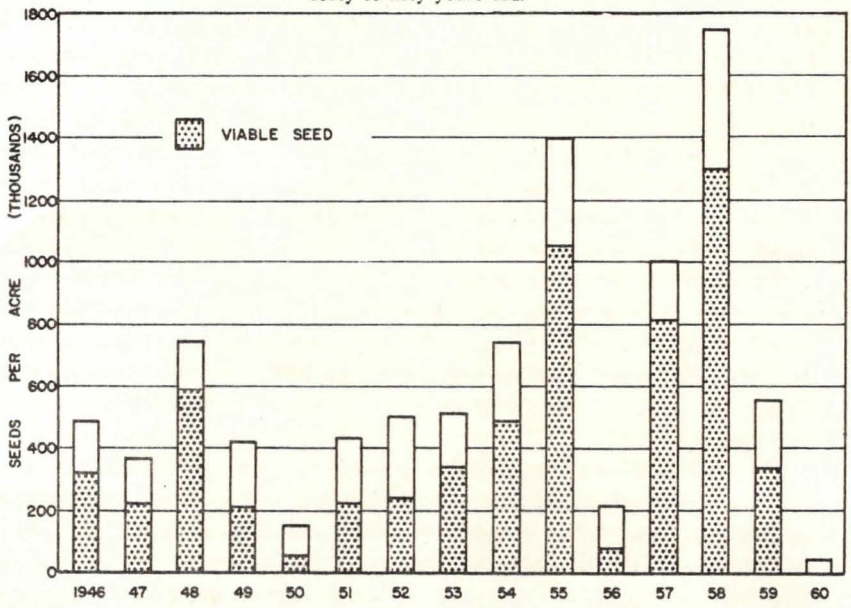

FIGURE 3. Fifteen-year record of loblolly pine seedfall in a young sawtimber stand between ages of thirty-five and fifty years.

tion of viable seeds(*6*). Generally, the minimum age for production of commercial quantities of loblolly seed is around twelve to fifteen years. Optimum levels of production begin at about age thirty-five and continue beyond sixty years(*7*). I believe loblolly pine stands should produce quantities of seed sufficient for natural regeneration sometime between the ages of fifteen and thirty-five, probably beginning around twenty years. A recently established study in the locale of the Santee Experimental Forest aims to determine the relationships of age, site, and stocking to seed production in fifteen- to thirty-year-old loblolly pine stands. Final results will be available in about five years.

In the meantime, some general information is on hand from a preliminary investigation made in 1959 (Table 1). This shows that production from an unthinned 20- to 25-year-old stand amounted to 9,000 sound seed per acre as compared to 24,000 in an adjoining thinned stand of the same age, or about 10 per cent of the yield from comparable 50-year-old stands. Other studies in mature stands on the Santee indicate an average loss of 30 per cent of the seedfall to rodents and birds(*4*). They further show that

TABLE 1. 1959 seed production from various loblolly pine stands, Santee Experimental Forest.

Stand Age (Yrs.)	Treatment	Seed Production		
		Total (M/A.)	Sound (M/A.)	Sound (%)
20-25	Unthinned	31	9	29
20-25	Thinned	57	24	42
40-50	Uncut	216	109	50
40-50	Selection cuts (3)	324	150	46
40-50	Improvement cuts (2)	341	225	66

seven viable seeds are required to establish one seedling in an average year on a seedbed prepared with prescribed fire. These figures indicate that an adequate catch of 2,400 established seedlings might have been expected from the aforementioned thinned stand and a marginal catch of 900 seedlings from the young unthinned stand. The 1959 seedfall, based on the fifteen years of record on the experimental forest, was 74 per cent of average. This indicates that in better seed years results should be even more encouraging.

It appears that a seed-in-place technique is best applied during a four- to five-month period, although its benefits last somewhat longer. In the proximity of the Santee Experimental Forest the average date of beginning lies between November 15 and December 1, when 50 to 75 per cent of the

seed has fallen (Figure 4). From then on, clearcutting can continue until about April 1, when heavy germination of seed takes place (Figure 5). At that time, and during the early part of the growing season, there may be a heavy loss of the more or less succulent and fragile seedlings due to logging activity. Consequently it would be desirable to leave some seed trees during this period. However, with the hardening off of the seedlings later in the growing season, the chance of damage lessens. Clearcutting, over what are now actually seedlings-in-place, can be resumed after about August 1 with only a small loss of seedlings. Logging of short logs in dry weather helps keep the damage down.

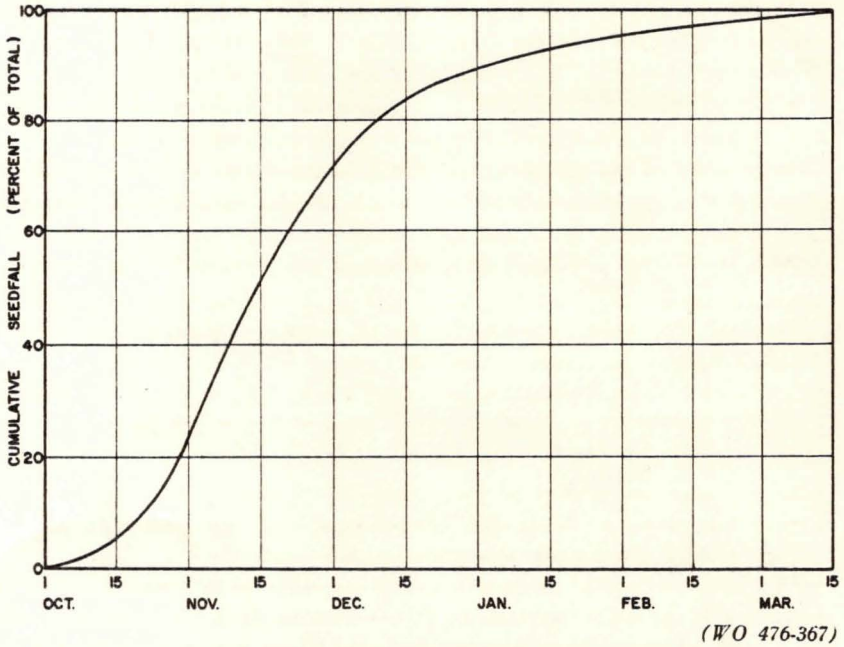

FIGURE 4. Average rate of loblolly pine seedfall as determined from fifteen-year record in a small sawtimber stand.

A pilot plant test in a fifty-year old stand comparing regeneration from seed-in-place with the later released seedlings-in-place resulted in about equal numbers of three-year-old seedlings. However, the seed-in-place seedlings averaged 2.5 feet in height as compared to 1.4 feet for the seedlings-in-place, which spent most of the first growing season in the shade of the overwood. Chances are that the height differential will make little difference in ultimate yields. Incidentally, the loblolly pine stand averaged 14,000

board feet of sawlogs (Scribner log rule) and 3 cords of pulpwood per acre. This was a conventional tractor logging operation involving short logs only and pulpwood tops.

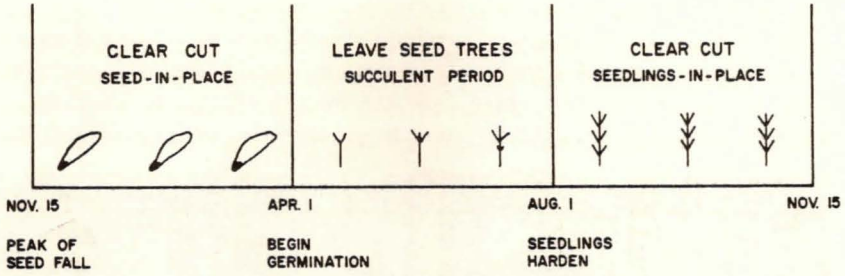

FIGURE 5. Suggested schedule for seed-in-place regeneration method, South Carolina coastal plain.

A majority of the loblolly pine stands in the Virginia-Carolina coastal plain have heavy understories of hardwoods and shrubs which require control measures for successful pine regeneration. Prescribed burning for understory control and seedbed preparation is well suited to the requirements for the natural regeneration of loblolly pine. More than a decade of research on the Santee Experimental Forest conclusively showed that either dormant or growing season fires can be used effectively without damage to the pine overwood or to the prevalent sandy loam soils of the coastal plain(5). The findings apply mainly to relatively pure loblolly pine stands above sapling size. These are generally characterized by uniform fuel conditions, comprised mostly of pine needles and similar fine materials. A basic requirement is that the understory hardwoods and brush be mainly under two inches d.b.h. for effective control by fire.

The simplest procedure requires only periodic winter-prescribed fires. This may be described as learning to live with the inferior hardwoods and shrubs of the understory, because their rootstocks are not killed by dormant season burns. A chief danger is that some growing space is invariably captured by broad-leaved species at time of regeneration. The situation can be worsened by poor scheduling of the terminal winter fire if, after the main seedfall, most of the seed is destroyed. Seed trees must then be left. Before these can seed the area, additional site preparation may be needed to control interim sprout growth.

A more progressive burning program than the foregoing involves the use of growing-season or summer fires. As a minimum, a summer burn for regeneration is made some time during the last growing season prior to the

final harvest cut. The best timing is just before the beginning of the annual seedfall. However, any time after June 1 should be adequate and certainly better than any dormant season fire because of lesser sprout growth and no seed loss to fire.

A more intensive regeneration technique involves a succession of annual or biennial summer fires, especially in areas of dense underbrush or limited seed production. Two or three fires are usually enough to eradicate or weaken much of the understory and to prepare the seedbed (Figure 6).

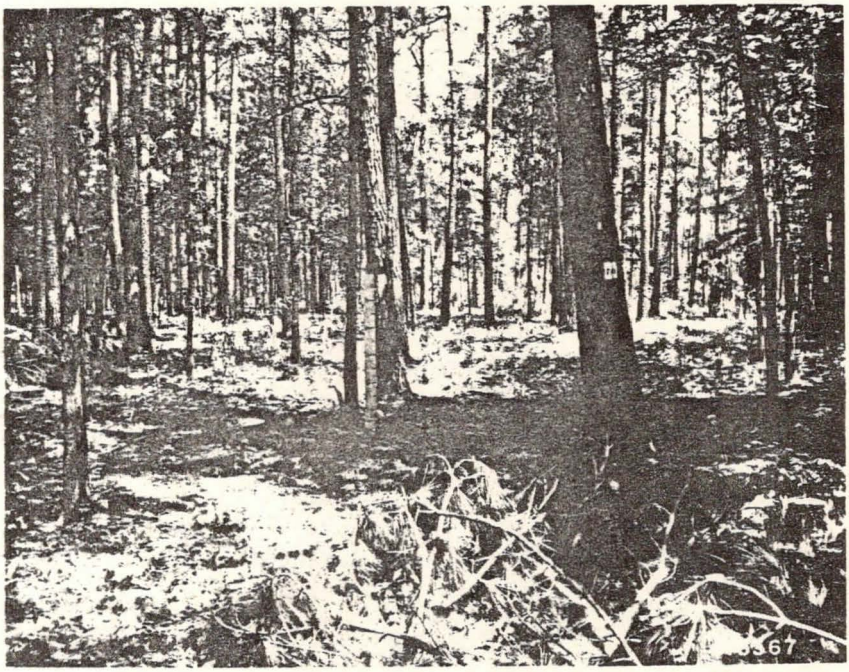

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FIGURE 6. After four prescribed burns the understory is no longer a problem in this fifty-year-old stand of loblolly pine now ready for regeneration.

The sequence can be stopped at the discretion of the forest manager, following the establishment of a sufficient number of seedlings. Thus, we can have the seedlings-in-place before cutting.

In good seed years or in areas of known good seed production an alternative is a harvest cut after seedfall, following the last summer burn in the series. This then involves the previously described seed-in-place technique.

A prevalence of understory competitors above two inches d.b.h. requires

some treatment other than fire as do areas with flat or sparse fuels consisting mostly of hardwood leaves. Under these conditions some form of mechanical site preparation is required. Heavy, tractor-drawn disk-harrows are generally used. Treatment is done before or after logging, depending on the regeneration system to be employed.

Cost information is always of interest to forest land managers, although generally available on a case history basis and of limited application elsewhere. For the case of natural regeneration, some mention of its cost seems desirable. Here are some recent values obtained from a large timber operation in the Virginia-Carolina coastal plain: This organization has an annual loblolly pine regeneration program of 8,000 to 9,000 acres. They direct-seed or plant only those areas which cannot be regenerated naturally. Seedbed or site preparation is accomplished by fire or disking. The prescribed burning procedure is usually a combination of one winter and two summer fires, each one year apart. Disking is done with heavy equipment after logging and is either a single or double application as a given site may require. All of the direct seeding is from airplanes and on areas above thirty acres; smaller tracts are planted. Seed-in-place is the primary technique for natural regeneration in good seed years. On areas logged before seedfall, seed tree strips are left. In poor seed years direct seeding is the alternative treatment. Accordingly, the 1960 costs per acre are given in Table 2. Depending on site preparation method used, the average regeneration costs per acre for natural regeneration ranged from $4.00 to $19.00; for direct seeding, from $8.00 to $23.00; and planting from $20.00 to $35.00. These do not include the cost of controlling large hardwoods, which on the average acre amounts to about $6.00.

In conclusion, I am of the opinion that natural regeneration will continue to be a major means of reproducing loblolly pine in the Virginia-Carolina coastal plain area. Dependable seed production from managed stands, new methods, and lowcost seedbed preparation techniques, such as

TABLE 2. Loblolly pine regeneration costs, Virginia-Carolina coastal plain.

SITE PREPARATION	Cost Per A.
Prescribed burning (3 fires)	$ 4.35
Single disking (contract)	16.00
Double disking (contract)	19.00
DIRECT SEEDING	
Seed and sowing	$ 3.60
PLANTING	
Stock and planting	$15.60
HARDWOOD CONTROL	
Girdling and poisoning	$ 6.00

prescribed fire, give strength to any management program for loblolly pine in that area. Research and pilot plant tests should show the extent of application beyond the limits of the Virginia-Carolina coastal plain.

LITERATURE CITED

(1) ALLEN, PETER H., and KENNETH B. TROUSDELL. 1961. Loblolly pine seed production in the Virginia-North Carolina coastal plain. J. For. 59: 187-190.

(2) BAKER, FREDERICK S. 1950. Principles of silviculture. McGraw-Hill Book Co. Inc., New York. 414 pp.

(3) BARRETT, L. I. 1940. Observations on requirements for restocking cutover loblolly and shortleaf pine stands. U. S. For. Serv. Stheast. For. Exp. Sta. Tech. Note 40.

(4) LOTTI, THOMAS. 1959. Loblolly pine seed production and seedling crops in the lower coastal plain of South Carolina. J. For. 57: 580-581.

(5) LOTTI, THOMAS, R. A. KLAWITTER, and W. P. LEGRANDE. 1960. Prescribed burning for understory control in loblolly pine stands of the coastal plain. U. S. For. Serv. Stheast. For. Exp. Sta., Sta. Paper 116.

(6) U. S. FOREST SERVICE. 1948. Woody plant seed manual. U. S. Dep. Agric. Misc. Publ. 654. 416 pp.

(7) WAKELEY, PHILIP C. 1954. Planting the southern pines. U. S. Dep. Agric., Agric. Monogr. 18. 233 pp.

(8) WENGER, KARL F., and KENNETH B. TROUSDELL. 1958. Natural regeneration of loblolly pine in the South Atlantic coastal plain. U. S. Dep. Agric. Prod. Res. Rep. 13. 78 pp.