INTRODUCTION

OUR COMMERCIAL SOUTHERN PINES

By Carlock Johnson

In the preparation of this paper I immediately encountered a problem much beyond my power to handle with my limited time and knowledge.

This huge area consists of approximately 164,000,000 acres of timber land. The greater portion of this area is in private ownership consisting of extensive unbroken tracts. There are only 3,000,000 acres of land in National Forests in this entire area. However, the Federal Government is rapidly acquiring more land by means of purchase.

After consideration I have divided my work into a brief resume of the four leading species of pine which are found in this section. Each species is treated as a separate part and bears no connection with any other portion of the paper. The descriptions are not recommended as a thorough nor last word decision upon the trees.

To do justice to any one species would entail the writing of a complete book. However, I do believe the papers contain a good summary of the main silvicultural problems encountered by any person dealing with them.

The short description of the pulpwood industry was placed in the thesis for a definite purpose. It was intended to call the readers' attention to one of the many possibilities of the Forestry in the Southern Pine area. The stands of pine have been badly neglected and ravished by liquidating forest owners. As a result, countless acres are now in a state of depletion, and many stands are now growing at only a fraction of their normal producing capacity.

The South contains possibilities for forest products which no other area in the United States can equal. Should we allow neglect and greedy
profiteers to rob prosterity of their heritage? The answer is, of course, "No". But if this is the answer, what do you, "Mr. John Public" intend to do about it?
LOBLOLLY PINE

This pine, commonly referred to as Loblolly, Rosemary, "Old Field," or Shortleaf pine is undoubtedly one of the South's greatest resources.

The range of Pinus Taeda ranged over an extensive area. The natural occurrence lies from South Delaware and E. Maryland, over lower Piedmont section and extends south and west to Texas and Southern Arkansas. In these regions it does best upon deep alluvial soils of bottom lands or fresh, shallow swamps. Here it may often reach a height of one hundred and forty-eight feet at the age of one hundred and fifty-four years. Diameters may reach seventy-five inches.

Growth is fairly rapid, although varying with site factors. Trees twelve years in age may often have a diameter of ten inches. It makes a more rapid growth than Longleaf pine. Slash pine will make a more rapid growth during the first twenty years of life. However, during the fifty years Loblolly will forge ahead. When the trees reach the age of eighty years, the Loblolly growth curve breaks down rapidly, while the Slash pine curve is only slightly deflected. The best growth is made in open stands. Dense stands tend to cause smaller trees. At thirty years of age there is often a difference of five inches in diameter between the two densities.

Dense stands encourage the formation of long, clean, straight stems. Shortleaf pine is naturally a limby tree. By growing in dense stands the loss in increment is offset by the increased value due to the higher quality of the lumber. The best growth is often found in old abandoned farm lands. Here the soil is usually deeper and of a higher quality than the average forest lands. Moderate temperature and abundant rainfall are two factors
which accelerate growth. Forest fires materially reduce the increment. This is due to both mechanical damage to the tree and deterioration of the site.

The commonly used log scale in this region is the Doyle log rule. The reason for its use seems to be merely a matter of precedent. It is certain that it cannot be due to the accuracy of the rule itself. This log rule gives a decidedly low scale for all logs below twenty-eight inches in diameter. In cases, where second growth timber is being marketed, it is pure folly to sell by such a scale. Timber sales on all National Forest lands are scaled with the Scribner Decimal C. This is decidedly more accurate. Private operators would be materially benefited by use of such a rule. Volumes in average stands will vary from twenty to fifty thousand board feet. The density of stocking and degree of fire damage will be the major reasons for the variance.

Stands are often not fully stocked. In a few cases they may even be over-stocked. Thinnings in Loblolly pine have been carried on a profitable basis. This is especially true where there is a ready market for pulpwood, poles, firewood and crossties. Thinning will materially increase the rate of growth and the final size of the remaining timber. Thinnings are seldom profitable when the final crop is to be utilized as pulpwood, crossties, etc.

Young stands should be grown fairly dense. This will help insure clean, straight boles. It will also encourage natural pruning of the lower limbs. Thinnings are sometimes made when the stand is between five and ten years of age. This is usually a rather expensive operation, since there is seldom any market for the resultant thinnings. In some cases it may cause over-thinning of the stand. This will result in understocking of the stand.
at a later date. Young trees are very susceptible to shock. Sudden release by a heavy thinning may cause a decided decrease in annual increment for an indefinite period following such a cutting. Thinning of the stand to produce a maximum quantity of high quality lumber should consist of three separate cuttings. The first cut should be made when the stand is about fifteen years of age. It should be rather light. The second cut may be somewhat heavier. This will remove the suppressed and weaker trees. The second cutting should occur at the twenty-fifth year. The last cutting often is the heaviest of all. It should remove all but those trees which are desired for the final crop. All suppressed and inferior trees will be removed at this time. The final cutting can be made when the trees are about forty years old. The thinnings secured may be marketed in the form of small products. Pulpwood and crossties are two uses for which the thinnings may be used.

Pruning of Loblolly pine can seldom be advised when done upon a commercial scale. The labor expenses are high. This cost will offset the increased value of the final timber crop. In some cases it may be advisable. In cases where the growth and stand are exceptional, it might be economically feasible to carry on such a program within a limited scale. In such cases, young trees below three inches in diameter should not be pruned. When pruned, the lower whorl of branches only should be removed the first year. The next whorl should be removed the following season, etc. In this way the work may be done without a disastrous if not fatal shock to the trees. The bole of the tree is thus cleaned and the knotty core kept to a minimum.

Loblolly pine stands should not be cut below the age of twenty years if the crop is to be used as lumber. At this age the most profitable market would be as pulpwood or crossties.
The trees are just entering the period of the largest annual increment. Cutting of the stand will therefore materially decrease the average annual financial returns for the rotation.

The growth curve in most cases reaches the highest peak at fifty years of age. This is the logical rotation for the stand. However, no definite rotation can be fixed. Site, market, and silvicultural needs are factors which will materially affect any set rotation period. If the stand has been systematically thinned should be equal to nearly one-fourth the total crop of the area. The lumber should be much higher in quality and selling price.

Sound and vigorous trees under a twelve inch diameter should not be cut for saw logs. The manufacturing costs exceed the returns from the lumber. The lumber itself is of an inferior grade. If left standing they may cut in a second cutting a few years later. Their rapid growth will have converted them into a valuable log by this time. Stumps should cut below a height of twelve inches. In the past it has been a common practice to leave much higher stumps. The resulting waste of merchantable timber has often exceeded the logging cost of the area.

Seed trees should be left with due regard to location and characteristics. These trees should be sound with large crowns. They should be wind-firm and located at points of advantage in seed distribution. At least two to four trees should be left upon each acre.

All slash should be kept away from the boles of living trees. Insects which may attack slash will often enter into the trunks of living trees directly from the slash. This is especially true in the case of Dendroctonus Frontalis. At all times during logging, there should be the least possible
damage to reproduction.

Natural reproduction is usually assured if a source of seed has been left on the cut-over lands.

Loblolly pine does not reproduce by sprouting. Seed crops occur every three years with an abundance of fertile seed. The germination percent averages sixty percent. Some seed is produced every year, although it takes two years to mature the seed. The best seed is secured from the center of the cone. The seeds mature in the fall and germinate the following spring. The seedlings will grow from five to eight inches in height during the first year. There is no damage to seedlings from hogs.

In some cases it becomes necessary to practice artificial regeneration. This is frequently the case on logged off areas which have been burned over or have had no provisions made for the leaving of seed trees.

The Clarke-McNary Act of 1924 has been of great aid in the reforestation program in this region. By cooperation with the federal government many of the states have established nurseries of their own. Planting stock is distributed from these nurseries under the rules set forth by the Act.

Seed is gathered in the fall just before the cones have opened. The best cones are gathered from the upper portion of the trees. This work may be greatly facilitated by gathering the cones on an area in conjunction with a logging operation. The seeds average twenty thousand to the pound. In the average nursery, one pound of seed will produce between five and seven thousand six month old seedlings.

Nursery beds are prepared upon the standard rules. Beds are made four feet wide and twelve feet long. One half pound of seed is sown broadcast in each bed. The soil should be well worked sandy soil. If possible, the beds
should be cultivated thoroughly the fall before planting. All seeding should be done in the spring. Once the seeds have been sown, a wooden roller may be used to press them into the soil. The beds are then covered with burlap or straw. If fine sand is used it should be sifted onto the bed to a depth of one-eighth inch. In no case should old garden soil be used in the beds. This soil will contain weed seeds and may even be responsible for subsequent damping off attacks. Slightly acid soils may be used. These may be obtained from new lands or from present forest floors.

Watering of the seed beds is a vital part of successful nursery work. The moisture content of the soil should be carefully watched during dry weather. It should never be allowed to become very low. During the germination period, the seed beds should be kept continuously moist. An overhead watering system is suggested for this work.

Germination will take place within two or three weeks.

Damping off is a serious menace to nursery work in this region. This disease will be most apt to attack during the first two or three weeks of the seedlings' lives. Hot, humid weather is especially favorable for these attacks.

Steam treatment of the beds before planting may tend to prevent this attack. A sulphuric acid solution is a very good preventative.

When the seedlings are one year old they should be lifted and placed in the transplant bed. Here they should be left for one year. Plants thus treated are hardy and have a root system which is well developed. One year seedlings may be used for planting purposes. However, the mortality rate is very high. From an economical standpoint it is much better to use 1-1 stock.

Planting should be done in the late winter or early spring, except in the more southern states. Dry falls and severe winters will invariably result in excessive leaving and a considerable loss of the planted stock. If planting
is done in the late spring the result is usually a high loss in the planted stand. Once the spring growth has started, the trees should never be transplanted. If this is done the results are usually fatal to the young plants.

Once the plants have been lifted from the beds the roots should always be kept moist. Top-roots should be pruned back if they are over eight inches long.

The plants should be set firmly in the soil when planted. The dirt should be firmly around the roots. Roots should always be placed in a natural position and never be cramped or doubled up.

There are several methods of planting used for Loblolly pine.

In good soil where the topography is fairly level, plowed furrows may often be used to an advantage. The furrows are plowed about six feet apart. The plants are dropped in at six foot intervals by a man who follows the plow. Another man follows covering up the plants.

Dibbles or spades are commonly used where the topography is more broken. On a loose sandy soil a dibble is much to be preferred. The dibble is worked by one man who is followed by another carrying the seedlings. The seedlings are dropped into the slot made by the dibble and the dirt pressed around the roots with the planter's foot. Spades and mattocks are used in rocky and difficult soil. Two men can plant from nine to twelve hundred trees per day on an average operation.

Planting costs are variable depending upon many factors. The two largest influences are exerted by labor and topography. Results are best when the planting is 6' x 6'. This spacing will equal one thousand seven hundred and forty-two plants per acre planted. When planted at this spacing, the ground will be completely shaded by a closed canopy at an early date. Since Loblolly
pine is naturally of a bushy tendency, it is highly desirable that this be discouraged during youth. On thin or easily eroded soil, the spacing may be reduced to 5' x 5'.

Grazing should be excluded from planted areas for at least five years after planting. It has been proven economically unsound to attempt cultivation after planting. The high cost much more than exceeds the cost of replacement of the dead plants.
FIG. 1.—NATURAL REPRODUCTION OF LOBLOLLY PINE ON CUT-OVER LAND.

FIG. 2.—INTERIOR OF A RAPIDLY GROWING LOBLOLLY PINE FOREST, 10 YEARS OLD, ON AN OLD FIELD.
Bul. 64, Forest Service, U. S. Dept of Agriculture.

PLATE II.

FIG. 1.—LOBLOLLY PINE FOREST, WITH HEWED TIES READY TO SHIP.

FIG. 2.—FOREST OF LOBLOLLY PINE AND HARDWOODS ON FAIRLY WELL DRAINED FERTILE SOIL.
This pine is commonly known throughout the Southern States and South East Atlantic sea-boards as Shortleaf, Rosemary or Yellow Pine. In some localities it is vaguely referred to as "old field" pine and "sprouting" pine.

It is found in twenty four states which constitutes its natural range. The true range extends from Southern New York through New Jersey, Pennsylvania, West Virginia, Southern Ohio, Southern Indiana, Missouri, Southern Kansas, Eastern Oklahoma, and Eastern Texas, and all states south of these.

The tree is a rapid grower and endures adverse conditions fairly well. It has the unusual ability to sprout if killed back during early life. This sprouting occurs from the root collar by means of adventitious buds. The ability to sprout is ordinarily lost after the tree reaches the age of fifteen or twenty years.

The rate of growth is largely dependent upon site conditions. It will grow well upon sites which are too deficient in potash, nitrogen, and phosphoric acid to support many hardwood species. On dry sites it will develop an extensive root system.

The best growth is usually found on clay or gravel loam soils, where it prefers the southern exposures. It thrives under abundant moisture but will resist mild droughty periods if not too prolonged in length.

Stands occur both in pure and mixed nature. When mixed, the associates are usually hardwoods. Due to this, each type requires a different silvicultural method of treatment.

Pure stands are ordinarily fairly even aged. The suggested method of logging is some form of clear cutting. Clear cutting with seed trees may be used. This allows for a more or less uniform scattering of seed over the
entire area. The seed trees may be harvested and used for local use after reproduction has been secured and established. Since there is a constant demand for local farm materials, this seems like a very good solution.

In many cases the seed trees may not occur naturally in the stand. Under a system of silviculture where thinnings are made, it is possible to remedy this. By regulating the thinnings so as to favor the formation of certain trees, four to ten good seed trees may be secured without a material increase in cost. The number of trees needed will depend upon the location of the tree in regards to the surrounding topography. The age of the tree and its height will also be a limiting factor. The ideal tree will have a well developed crown with a deep, wind-firm root system. All seed trees should be marked before logging operations begin. This may be satisfactorily done by using white paint. In this way, all other merchantable material will be removed leaving only the desired trees on the area. Trees below thirty-five years of age may be profitably retained as growing stock for a second crop. If this is done, the competing hardwoods should be cut also. These trees usually consist of sassafras, dogwood and persimmon. If left they will soon over-top the saplings and suppress them for some time.

In unevenaged stands it is often desirable to cut through the area in two distinct operations. The first time through, the larger and dominant trees are removed. After about ten years the remainder of the stand can be logged. This method will materially reduce this number of small logs taken from the stand. Groups of seedlings will readily establish themselves in the openings left by the felled trees. In this way reproduction is insured before removal of the crop.
Clear cutting in strips is often times employed with varying degrees of success. The strips of felled timber may be four times as wide as the standing trees height. In this way four-fifths of the stand would be removed during the first cut. The second cut would therefore be of relative small size. In some cases market conditions would prohibit this. If this is true, the strips may be left in nearly equal size. All strips should be cut at right angles to the prevailing winds. This insures good seed dissemination.

Thinnings can be made at any time of the year in this region except during the period from April to September. At this time beetles are extremely active. They are readily attracted to the freshly cut timber and will often attack the nearby living trees. Periods of drought also encourage insect attacks.

In mixed stands where the pine is mixed with hardwoods, it is desirable to encourage the pine reproductions at the expense of its competitors. This is true because of its more rapid growth and greater general use. Due to its compact crown and ability to grow with only overhead light, this tree is able to keep pace with or even overtop hardwoods, which have originated from coppice. In many regions hogs have helped in creating pure stands of pine reproduction in the mixed types. They use the hardwood nuts for food and help prepare a seed bed for the pine seed. They do little or no damage to Shortleaf pine.

If logging is carried on with removal of hardwoods in mind the broad-leaves should be cut during the period from late June until early September. At this time their sprouting capacity is at its lowest point.
In mixed stands the crowns of the conifers are usually larger than those grown in pure stands. Therefore, earlier and more abundant seed production may be expected. About five to eight seed trees should be left upon each acre cut.

The selection and clear cut systems are both applicable to stands of this nature. In most cases the selection method is the best. Here the groups of Shortleaf found in the hardwood stands are really mixture stands of pure Shortleaf pine. Therefore, they should be treated as such. However, it should be constantly kept in mind that it is desirable to eliminate the deciduous species when ever possible.

Reforestation by means of natural seeding is usually quite successful on most areas, provided there is an available source of seed. The seed disseminates very well being light in weight. The attached seed wing is quite large in proportion to the body of the seed. It will freely scatter to a distance of three or four times the height of the parent tree.

The seed matures in the fall of the year, when the cones open and release it onto the ground. Good seed crops are usually formed every third year, although some seed is produced every year. The seed lies dormant through the winter, germinating in the early spring. The main loss of seeds is caused by rodents and birds. However, insects also use them for food.

Old abandoned farm lands are readily taken over by this pine. If condi-
tions are suitable, a heavy stand of reproduction will be established within a few years. However, many others are composed of a mixture of Shortleaf pine, "scrub" or "bush" pine, and such hardwoods as hickory, red oak, sassafras, persimmon, dogwood, sweet gum and other inferior species. These are of low
commercial value and should be discouraged. Removal of the inferior species may be profitable in some instance.

Shortleaf pine is the only important commercial pine which reproduced by means of sprouts. The vigor of this growth is very good, often growing as much as two feet in height during one year. Young trees killed back by fire and frost show this reproductive capacity to a marked degree. However, a too severe fire will result in the loss of this power.

Artificial reforestation is often necessary. This is particularly true where logging operations have been followed by severe fires or repeated burnings.

Direct seedings are practically invariably a failure. The cost is extremely high, depending upon the locality and labor used. Loss from rodents will often run as high as seventy-five percent. The results are unsure and the establishment will be so sparse as to necessitate planting in order to close the canopy. Direct seeding ordinarily can not be recommended for this species.

Wild stock has been used very successful throughout the entire range. Such stock should be taken from old fields and along the streams. Here they are more vigorous and easily secured. Three year old seedlings should be eight to ten inches high when grown upon these sites. The roots are branched and well developed. Seedlings taken from the denser timbered areas are not so desirable. Such plants have rarely attained a height of over six or seven inches when they are three years old. As a result they are incapable of making as rapid growth as the others. Insufficient and unstable sources of stock is the main objection to this plan of reforestation.

The most practical method of securing planting stock is by means of nursery propagation.
Nursery sites should be selected with care. An abundant and constant supply of water is essential at all times. The soil should be slightly acid if possible and well drained. A southern exposure gives the best growth rate.

Seed beds are ordinarily laid out in rows. Each bed is four feet wide and twelve feet in length. The beds are cultivated and prepared, after which the seed is sown broadcast. The usual number of seeds required for each bed is about thirteen thousand. After sowing, the seed may be pressed into the soil by means of a wooden roller or plank. The beds are then covered by a layer of burlap or clean sand. Abundant moisture is necessary for a high germination percent. This is usually between sixty and seventy percent.

After germination has taken place the burlap should be removed. At this time there should be between five and six thousand seedlings within the bed. This is equivalent to one hundred plants to the square foot. Beds should be watered at least every other day. During dry weather it is best to water every day if possible. An overhead water system is best for nurseries of this type. During the hotter part of the summer, shades should be provided when the temperature reaches a dangerous height. These may be economically constructed from lath or small boards.

The first two or three weeks after germination is the time when greatest loss from damping-off is experienced. This is especially true during periods of warm humid weather. Drying the soil is one way of checking the spread of this disease. Spraying the ground with a solution of sulphuric acid is one of the best controls practiced.

When the plants have spent one year in the seed bed they should be lifted and placed in the transplant bed. After remaining here for another
year they are ready for planting.

Considerable care must be taken in lifting the transplants. The top root should be pruned off at a length of six inches. They should be wrapped in wet sphagnum moss immediately after lifting and stored in a cool, dark room. If this is not possible they should be bundled and heeled into the ground. The foliage should remain exposed.

Cloudy weather is ideal for planting work. The plants should be spaced 6' x 6' or twelve thousand and ten plants to the acre. The common method is to plant the trees in individual holes made by means of a dibble or a spade. However, on old fields a plowed furrow is often used at a considerable saving in expense. The average cost of planting an acre 6' x 6' will be around ten dollars. All planting should be done in the spring except in the Northern regions. This is to prevent frost damage. An average mortality of fifteen percent may be expected.

Grazing should be excluded from planted areas for the first five years.

Intensive fire protection is an absolute essential. A fire will invariably result in practically a total loss during the first few years. Thinning may be profitably made in Shortleaf pine stands. There are two methods of making these cutting.

In a "low" thinning the smaller diseased, less vigorous and deformed trees are removed. This favors the larger and better formed trees which will be favored for the final crop. This keeps the land more nearly at its full capacity. Since size and quality of the final material will determine the financial returns this will probably give the greatest profit. The main thing is to wait until the thinnings have reached a merchantable age. This
is usually true when they are between fifteen and twenty years old. In this way they may be made to pay for themselves. The material may be used for fuel, poles, crossties, pulpwood, or small saw timber. This type of thinning should always be used in thinning young pines.

In "high" thinnings, the larger or dominant trees are removed. The smaller trees are given the increased room for expansion and are retained. In this way the suppressed trees are allowed to recover their normal growth rate. This method is commonly used by private owners. It has the distinct advantage of being practical at frequent periods during the life of the operations. Periodic cuts may be made at ten year intervals under this system.

Shortleaf pine is of no commercial value as a source of naval stores. The gum checks its flow very rapidly. This causes often chippings and consequently high expense. What gum is secured is low both in quality and quantity.

Fire is undoubtedly one of the greatest barriers to sustained yield in the south. There is a built-up indifference to forest fire protection among most people in this region. Annual fires are expected and ignored throughout many regions.

Fire makes scars on the older trees thus allowing entrance of both fungi and insects. It also materially weakens the tree mechanically and lessens its vitality. Lessening of annual increment and excessive windthrow may often be directly traceable to this cause. Damage to reproduction by fire is practically beyond estimate. Young stands of reproduction may be nearly entirely destroyed. Logged off lands may be denuded until the only hope for them lies in artificial reforestation plus intensive protection methods.

Until some form of fire protection is instigated, there is little hope for future forest crops in many localities.
Fig. 1.—A crowded 20-year-old shortleaf pine stand with 1,440 trees per acre, yielding a large quantity of fence poles but a small yield of saw timber.

Fig. 2.—Well-stocked 30-year-old shortleaf stand on good site. Tree density of 230 per acre (8 inches and over) yielded 9,700 feet of saw timber. Arkansas National Forest.

Stands showing the relation between density and production of saw timber.
Fig. 1.—Encroachment of Shortleaf on Successively Abandoned Portions of Cotton Field. Stands of Six Different Ages.

Fig. 2.—Very Dense Stand of 9-Year-Old Seedlings, 42,000 Trees Per Acre. Note Close Relation Between Density and Development.

Shortleaf Encroaching Upon Fields Under Cultivation.
FIG. 1.—VIEW THROUGH THE TOPS OF THE TREES SHOWN BELOW.

FIG. 2.—LOWER PORTION OF TRUNKS. TREES 160 YEARS OLD, 20 TO 28 INCHES IN DIAMETER, AND ABOUT 110 FEET IN HEIGHT.

TWO VIEWS OF A GROUP OF MATURE SHORTLEAF PINE TREES, SHOWING THE NARROW CROWN AND STRAIGHT CLEAN BOLE TYPICAL OF THE SPECIES.
SLASH PINE

Slash pine (Pinus Caribea) is a decidedly important tree of the Southern States.

The range of this species lies from Charleston, South Carolina westward through Southern Georgia, Alabama, Mississippi, and Southern Louisiana and south nearly to Southern extremity of Florida.

It will grow readily upon poorly drained flatlands and the borders of swamps; thus making it ideally suited for many regions of these states where swamps and low elevations are very common. It is very adaptable as regards to site and will grow practically anywhere in its range except in deep, dry, sandy ridges. Here it does not exist naturally. It reaches its maximum when grown upon sandy, loamy, moist sites.

It is a decidedly aggressive species. In many cases it has taken over lands which were formerly occupied by Longleaf pine. It will tolerate highly acid soil conditions. However, in areas which have an underlying sub-pan, it grows in a more or less dwarfed condition. In the "pine barren" hills of Western Florida and Southern Mississippi, where the soils are extremely dry, it is seldom found. However, it is occasionally found occupying the lowland areas where there is available moisture.

The growth of this species is extremely rapid in the earlier part of its rotation. It is especially rapid for about the first twenty years. The accompanying charts will give a general idea of its growth. On very wet or highly acid soils, on which it seeds very readily, Slash pine makes rather slow growth. At maturity it often has reached only medium size. Trees found upon such sites are marked by characteristically flattened tops.
Some studies have been made on the effect of turpentining upon the rate of growth of Slash Pine. All seem to indicate approximately the same answer. Almost all trees show a check in growth even when worked only on one face. Whereas when two or more faces are worked, there is a decided retardation of growth accompanied by a mechanical weakening of the tree. In cases where the trees are below twelve to fourteen inches in diameter, the growth is practically stopped. In cases, such as this, it would probably be better to completely work the tree until death results. In other words, trees below this diameter cannot be expected to serve as growing stock for a future lumber crop, if subjected to turpentining. In addition, working of trees exposes them to damage by both fire and insect. The most common insect being Buprestis Apricans or commonly called the Turpentine Borer. Fire creates a material weakening of the boles when burning in the exposed faces. In many cases operators rake accumulated litter away from the bases of the trees and then broadcast burn. This reduces the fire hazard to a minimum but also results in a heavy loss of reproduction. It should be practiced only periodically, if at all. Burning should be done in early spring and never be allowed to become uncontrolled. In many cases intensive fire protections combined with rapid fire breaks as strips will give as complete protection, without the loss of young growing stock.

Slash pine is commonly sold in the same mixture with Longleaf pine. It is the heaviest, hardest, and strongest of all commercial conifers in the United States. This was proven in recent tests made at The Forest Products Laboratory located in Madison, Wisconsin. Wood of this species will commonly weigh about forty-five pounds per cubic foot. Butt outs of mature trees show an average of nearly 55% summer-wood. In a section from the middle of the bole, measure-
merits show approximately 40% summerwood. This characteristic makes the wood highly desirable for construction timbers where strength is a deciding factor.

The uses of this wood are very many. The main uses of commercial lumber are for post, piles, joists and general construction purposes. Young "sap" pine are highly desirable for railroad ties. It is estimated that ninety percent all of "sap" ties cut are made from Slash pine. The pulp industry has realized the value of this wood. Today there are several pulp mills located in Georgia, Alabama, Mississippi and Louisiana.

The accompanying table will give an idea of the yields which may be expected in fully stocked stands. The yields have been tabulated according to a general classification of the sites. In studying the results shown, keep in mind the fact that this pine thrives on areas where other commercial pines have trouble in maintaining themselves.

Fully stocked stands are not common. When they do occur they are generally found to small areas. Such places as old abandoned farm lands are the most apt to contain stands of this nature.

In the production of Turpentine and resin, this pine excels all other native species for both quantity and quality.

The fresh gum comes forth as a limpid, honey-like substance. When distilled it contains more turpentine and less resin per gallon than does Longleaf pine. Topping may be begun later in the spring but can be continued much later into the fall of the year. This is probably due to the fact that Slash pine occupies the lower and colder areas than does the Longleaf. Also since it grows upon moister sites, it can run more through dry seasons.

One thing is decidedly in favor of this tree. There is practically no "scrape" as is common in Longleaf.
In many cases it has been claimed that Slash pine is more easily killed by working, than are other species. However, I doubt this. In most cases a subsequent investigation has shown that the trees have been very heavily worked. This is due to the greed of private operators who desire to reap a rapid and substantial profit in a short period of time. In many cases it has been found where trees between ages of seven to ten years have had two cups placed upon them. Trees between thirteen and twenty inches have had three cups placed upon them. This excessive drain upon the trees' vitality will almost invariably result in death. The flow of gum generally increases in proportion to the size of the tree at its d. b. h.

A more general discussion of turpentining practices will be taken up later.

Natural reproduction is usually good in the case of Pincus Caribea. This is true in cut over lands, only when sufficient care has been taken to allow for an available source of seed. If protected from fire, the young seedlings will soon stock and take over old fields and wet sites.

The tree produces a large quantity of seed during a seed year. Heavy seed years may be ordinarily expected every two or three years. There are approximately sixteen to eighteen thousand seeds to a pound. The seed may be expected to travel up to four hundred yards from the base of the seed trees. This is largely due to its extremely light weight and relatively large wings. The seed closely resembles that of Pincus echinata in many respects.

The trees produce cones at a young age. Cases have been recorded where trees twelve years of age have produced cones containing viable seed. On an average, however, an appreciable amount of cones are not produced until the tree reaches about sixteen years of age. The ideal seed tree will have a short clear trunk and a very heavy top. This will allow for a maximum amount
of good, viable seed. The relative vigor of the tree may be told by its full green foliage. Trees of the above characteristics are not very valuable for lumber. They ordinarily contain only low grade lumber at the best. Therefore they may be left in the woods to serve as seed trees, without an appreciable loss to the operator. As a rule, seed production begins at an earlier age in dense stands than in openly spaced individuals.

Slash pine seed is marked by a very high percentage of viability. This will run from seventy to eighty percent. It retains its viability over long periods in storage. Seed which was stored for a period of two years showed a germination of seventy percent within two weeks after having been sowed. Seed which had been stored for three years showed a germination ratio of twenty-eight percent. This seems to show that about three years is as long as the seed may be profitably stored.

The seed germinates in the fall within one month after leaving the cones. Heavy reproduction is very common. The success of germination is in proportion to the moisture content of the seed bed. Considerable moisture must be present in order to secure good results. As a rule therefore, moderately moist sites usually contain the heaviest stands of reproduction in the seedling stage. The nature of these sites also aids to protecting the seedlings from surface fires.

In cases where excessive grass or "pine-straw" have accumulated upon the ground, it is desirable that this be removed. This can satisfactorily be accomplished by controlled light burning. Burning should be done during the winter or early spring previous to the seed crop. At times it should be allowed to take place uncontrolled.

Fire protection is extremely important if successful regeneration is to
be secured. Seedlings are easily killed by light fires while between the ages of one to five years. At this stage there is no heavy bark to protect them. Trees from three to six years of age may be killed by "cool" surface fires. From this time on, the rapid height growth soon takes them beyond the fire "zone".

Fires weaken the trees mechanically and encourage attacks by both insects and fungi.

There are few stands in the South today, which haven't been subjected to repeated burnings. Each year millions of seedlings are killed due to this cause alone.

In the case of artificial reproduction many more problems are encountered. I will attempt to give a brief resume of these factors.

There are four distinct types of land where it is desirable to plant rather than to wait for natural reproduction to come it. One is logged off lands where insufficient seed trees have been left. At least three to six trees per acre are necessary to secure complete stocking. If less than this amount is present, it is likely that artificial means must be resorted to. In cases where the owner desires quick restocking of the area, it is often necessary to plant. In many cases lands may contain inferior stands due to the removal of pine by human agencies. In converting the area back to pine, it will be necessary to practice a reforestation program. And last comes sub-marginal agricultural land which has been abandoned. In many instances adjoining pine stands will reseed these fields. However, this will require time. It may be profitable to replant these lands rather than to wait for nature to take its course.

There are two reasons why planting of slash pine is to be favored over
Longleaf pine.

Slash pine grows much more rapidly for the first twenty years, than does Longleaf. Where pulp wood posts and small products are desired, this is paramouncy the deciding factor.

Slash pine yields more gum per tree than does Longleaf. The gum is of a better quality and brings a larger financial return. This results in it being extensively used for the establishment of turpentine orchards.

Soil requirements for Slash pine are negligible to a certain extent. It will grown nearly anywhere in its natural range. Exceptions to this statement have previously been noted. Best growth is secured upon sandy, loamy, and fairly well drained sites. Excessive water results in poor quality of trees.

Methods of securing artificial regeneration have been varied both in program and success.

Broadcast seeding has been attempted. In securing an average stocked stand of one year seedlings, it was necessary to use four to six pounds of seed per acre planted. This work may be accomplished at a total cost of between ten and thirteen dollars for each acre sown. This cost is very high.

The biggest loss here occurs from the attacks of birds and rodents. These predators may soon clean up a large portion of the seen thrown over the area.

In general the plan has been very unsuccessful and is not recommended for practice in most areas.

Spot seeding is practicable after the methods described under reforest-
ation of Longleaf pine. As a rule the results are about the same as for broadcast seeding. However, the cost is only about eight dollars for each acre thus treated.

Use of wild stock for planting purposes is very successful in areas where it may be economically used.

Seedlings for this purpose cannot be less than ten inches nor more than eighteen inches high. In other words, they should be one year stock. Plants should be puddled immediately after lifting and kept in very moist packing until planted. When planted they should be firmly placed in the soil with the top coat straight and at full length if possible. If the coat is too long it may be cut off at about ten inches in length.

Planting should be done in fall or early spring before annual growth has begun. Cloudy and rainy weather makes ideal reforestation days. Trees planted during such periods have shown a survival percentage of as high as ninety-seven per cent.

The main objection to this method is the scarcity of available stock. Only certain areas can supply stock and then not enough for general use.

In nursery grown seedlings lie the future of reforestation in Slash pine areas. Transplants may be grown cheaply and under ideal conditions. Therefore, this method is becoming increasingly popular in the South.

Seed is gathered from native stands. These should be harvested during September, just before being released by the cones. The seed is carefully kept segregated in regards to altitude at which grown and date gathered. The best seed usually comes from middle aged trees with large crowns. Twelve to fifteen bushels of cones is about the average number of days harvest for a crew of two men. One pound of cleaned seed may be secured from one
bushel of cones. One pound contains around fourteen thousand seeds on an average.

In the locations of nurseries, care must be taken to have an ample supply of water available at all times. Periodic droughts often occur, to which the young seedlings will readily fall victims. Sandy loamy soil is best.

Seed beds should be laid out in a regular manner. Ordinarily the conventional size of four by twelve feet is used. About one pound of seed is sown in each bed of this size.

The seed should be sown in the bed after it has been cultivated and all weeds and stones removed. Then one quarter inch of fine soil can be sifted over the seeds. Seeding is done during the month of February. As a final precaution against birds, rodents, and drying, cover the beds with clean straw to a depth of one inch.

Germination takes place in from eight to ten days. The success of the germination will vary with the weather conditions; warm moist weather is ideal. Under ordinary conditions at least sixty per cent germination may be expected. This will give in the neighborhood fifty seedlings per square foot.

Weeding should be done at least once a week for a period of nine weeks. By this time the plants will be large enough to compete with the encroaching vegetation. However, better results are obtained if the weeds are kept down until the seedlings are six inches high.

Watering is very important. The seed beds should be sprinkled at least every other day for the first six weeks. After this critical period, it will be probable that watering once a week will be sufficient. However this will largely be dependent upon the weather.
Transplanting should be done during the months of November and December. This will give the plants time to adjust themselves to their new surroundings before spring growth begins. Never transplant after the annual spring growth has begun. Neither should planting be attempted when the soil is so dry as to need watering. Frost damage is negligible in this region.

In planting the stand two factors are necessary to keep in mind. These are: (1) Type of tree desired; and (2) Products desired. If this is done, the following spacings will be best to observe:

<table>
<thead>
<tr>
<th>Product</th>
<th>Spacing in Feet</th>
<th>No. of Trees per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poles and piling</td>
<td>6' x 6'</td>
<td>1,210</td>
</tr>
<tr>
<td>Lumber, poles and crossties</td>
<td>8' x 8'</td>
<td>680</td>
</tr>
<tr>
<td>Turpentine and lumber</td>
<td>9' x 9' or 10' x 10'</td>
<td>538</td>
</tr>
<tr>
<td>Turpentine</td>
<td>12' x 12'</td>
<td>312</td>
</tr>
</tbody>
</table>

If the cost is not too great, the areas may be prepared before being planted. This should be done by removing excessive brush and weeds which hinder the growth of the young transplants.

A good sized crew for planting jobs may consist of ten men. One man with a horse may be used to lay off rows by means of a "scooter" plow. Two men will follow, listing the furrows and making a flat bed. Two other men, using dibbles, will dig the planting holes. One man drops the seedlings into the holes. Three men are responsible for the actual covering of the seedlings. The tenth man is usually a foreman in charge of the crew.

In all cases the crew must keep together in order to prevent drying of the roots. Crews of this size should plant fifteen to twenty acres per day, depending upon spacing used.
The following chart gives a general idea of the total cost of planting in Southern Georgia.

<table>
<thead>
<tr>
<th>Spacing</th>
<th>Trees per Acre</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>6' x 6'</td>
<td>1210</td>
<td>$4.50</td>
</tr>
<tr>
<td>7' x 7'</td>
<td>889</td>
<td>4.15</td>
</tr>
<tr>
<td>8' x 8'</td>
<td>680</td>
<td>3.75</td>
</tr>
<tr>
<td>9' x 9'</td>
<td>538</td>
<td>3.75</td>
</tr>
<tr>
<td>10' x 10'</td>
<td>436</td>
<td>3.70</td>
</tr>
</tbody>
</table>
FIGURE 50.—A. Vigorous slash pine seed trees have caused a dense stocking of new growth all about them. B. Commercial plantation of slash pine in Louisiana, which has been planted 3 years. The trees are 4 years old, having been transplanted after 1 year's growth in a nursery. They are spaced 6 by 8 feet apart or about 900 trees to the acre.
Figure 23.—Representative good commercial plantation of slash pine in Washington Parish, La.: A, Four years after planting; B, 7 years; C, 8 years. (All views from the same platform, 12 feet above the ground.)
The Pacific Coast has its Douglas Fir, the Northeast has the Eastern White Pine, and the South boasts, and justly so, of the Longleaf Pine. This tree is suffering from devastation much the same as the other important commercial species.

Originally it ranged from S. E. Virginia south to Florida and west to Texas in a broad belt from one hundred and fifty to two hundred miles inland. However, it has been heavily cut in North Carolina and Virginia. In these states it has been largely replaced by other species.

It is naturally a tree of the pure stand type. However, in regions of broken terrain, it may be interrupted by strips of hardwoods and other pines, which will be found occupying the moister sites. In the region of the Mississippi bluffs and along its Northern limit, it may be found mixed with Pinus Taeda and Pinus Caribea. On some of the flat and poorly drained sites on the coast, it is also found mixed with these two trees. However upon sites where it reaches its climax and maximum development, it is nearly always found in pure stands.

The virgin Longleaf pine forests are ordinarily conspicuous by their absence of seedlings. The stands are fairly dense, although the forest may be broken at irregular intervals by openings devoid of trees.

Seeds are produced in large quantities every six or seven years. On cut-over lands, however, crops are often produced at about four year intervals. This may be due to the sudden release of the seed trees from competition. However, no satisfactory explanation has been advanced.

The seeds are of fairly large size. By virtue of their weight, they
are able to penetrate through the heavy grassy covering of the forest and thus reach mineral soil. In very few cases can the failure of a seed crop by attributed to failure of the seed to reach mineral soil.

On the other hand, the large size of the seeds, make them a favorite food of rodents. The two main enemies are mice and ground squirrels. In some cases it might be highly desirable to spread poison throughout the area during a season of heavy seed. In this way the loss of rodents would be kept at a minimum.

An excellent bait for this type of work is prepared by the United States Department of Agriculture. The main constituents are grain, molasses, and strychnine. The author has seen cases of entire colonies of ground squirrels being destroyed in a few days by means of this control.

In many regions it is the practice to burn over the forest floor every few years. This is done for several reasons. Some practice this custom as an easy way to secure grass for grazing. Some do so in the belief that it improves the seed beds, while in many cases, the fires are entirely due to neglect and indifference on the part of the people.

The heavy weight of the seed allows it to penetrate to the mineral soil in most cases. There is no doubt but what the removal of grass and shrubs might lessen competition for the seedlings for a short time. But the damage done to present reproduction and site factors will far offset this. Due to the irregular seed crops of the species, and uncontrolled fire at the wrong time might result in the delay of natural regeneration for nearly a generation.

It has been estimated by Westveld that twelve or thirteen pounds of seed are necessary to satisfactorily reseed an acre of Longleaf pine in a virgin forest. As a healthy specimen with a normal crown and a d. b. h. of 16" will
produce from one and one half to two pounds of seed, the number of seed
trees necessary to leave may be easily computed. Due to the weight of the
seed, the average seeding distance from the seed tree will be approximately
two or three times the height of the tree.

Longleaf seedlings are a very distinct disadvantage when in competition
with other seedlings. The initial growth of this species is very slow.
The top may have a height growth of perhaps one inch, while a top root of
six inches may be developed. The first year it is very susceptible to
scorching or heat. During the cotyledon stage fire or excessive heat is
invariably fatal. As a form of protection against this, nature has equipped
it with an armor. This is in the form of a long sheath of needles which
covers it until it is approximately six inches high. After it has passed
this stage its annual height growth increases rapidly. In some cases it
may easily grow over one foot per year. During its early life it is very
sensitive to fire. However, after a few years it develops a thick bark
and becomes extremely fire resistant.

Hogs are extremely damaging to Longleaf pine reproduction. These
animals have developed an appetite for the tender bark and inner layers of
the roots of the young pine. All reproduction of this species is preyed
upon by hogs until it reaches about fourteen or fifteen years of age. At
this time the bark becomes tough and coarse, and the tenderer portions of
the roots are deep into the ground and well out of reach.

From then on they are seldom molested. Since these hogs usually are
owned by the poorer class of people and are allowed to roam in the forests
at large, they present one of the major problems which the forester must deal
with in a reforestation project.
Planting of Longleaf pine has been carried on extensively in Georgia under the direction of the State Forestry Department. Several different methods were tried in an effort to determine the best way to secure artificial reproduction upon cut-over areas.

Direct seeding was first attempted, but it was soon abandoned. The extremely high cost plus the low poor results soon made it apparent that this method was out of the question. It was found that at least five pounds of seed were required to cover one acre of ground. This seed could be secured at a cost of around two dollars per pound. The loss from rodents was extremely high; in some cases it ran nearly 100%.

Seed spotting was next attempted under this plan; small circular spots, about eighteen inches in diameter, are prepared. All vegetation is removed, and the soil is cultivated either with a hoe or a shovel. Then eight or ten seeds are placed in the spot and covered to the depth of one quarter inch. The spot is then covered with grass, straw or brush to protect it from birds.

The results of this plan depend upon two factors, which are uncontrollable in one case, and hard to handle in the other.

Weather conditions must be favorable for rapid germination and quick growth. Therefore abundant moisture is needed. This must continue until seedlings are past tender age. If this does not occur, the young seedlings will either die from drought or perish from excessive competition.

The seeds must be protected from rodents. This may be accomplished by shooting, poisoning, or trapping. In any case it is an expensive process. The combination of these two requirements usually spell defeat for the plan.

Under the seed spot planting program, it was found that the average amount of seed needed per acre was one half pound. Since there are 8,000 seeds in
the average pound of Longleaf pine seed, the cost of seed would be from one dollar and a half to two dollars per acre.

The cost of labor would be governed by the type of labor used. Negro workers are often used at a considerable saving.

The best results were secured by transplanting one year old seedlings gathered from wild stock. These plants did exceptionally well when planted in areas near where they had been dug. In all cases, the plants should be planted as soon as possible after being dug. Any undue exposure to the sun or heat will be fatal.

The main objection to this plan is that such stock is hard to secure in large quantities. Longleaf pine is of very short height when only a year old. It grows in a natural cover of thick grass, which makes its locations extremely hard to find. In cases where seedlings may be secured in sufficient quantities and at a reasonable price, the use of wild stock is very desirable.

Nursery stock is probably the best solution to the problem. The State Nursery at Athens, Georgia will produce Longleaf seedlings at a price of about $2.50 per thousand. These seedlings are 1-0 stock.

Planting is best done between November 15 and March 1. In regions where mild winters are common, it is best to practice fall planting. This allows the young transplants to receive full benefit of the winter rains. It also insures planting before they have begun the spring growth. Seedlings should never be planted once they have begun the spring growth. Planting during this active stage in combination with the least drying of the roots will result in the death of the tree.

In Central Georgia, at the extremities of its northern range and regions
of higher altitude, spring planting should probably be practiced in order to eliminate frost damage.

Planting should be done before or after a heavy rain and during a cloudy period. This allows considerable moisture in the soil and reduces drying of roots to a minimum. Soil should be packed tightly to insure complete surrounding of the roots with dirt.

Spacing of the plants will vary with the plans of forest management. Close spacing usually causes high growth at the expense of diameter increment. It also increases natural pruning.

Longleaf has little tendency to branch out; therefore it can be given a fairly wide spacing. This is usually about 8' x 8' or 7' x 9' or approximately 680 trees per acre. This is in cases where lumber is the desired product.

To produce the maximum amount of naval stores and a low grade lumber, the spacing can be wider. The spacing should be 10' x 10' or 10' x 11'. The object being to develop large crowned trees with a big diameter. This will result in trees of short stature numbering 435 trees per acre.

To produce only naval stores, the spacing will be 12' x 12' or 13' x 13'. The trees will be squatty and low in stature with big diameters. These specimens will produce a maximum amount of gum. Pruning may often be necessary in order to facilitate harvesting of the crop. The average acre will contain 250 or 300 trees.

The average stand of Longleaf will vary from ten to fifteen thousand board feet per acre.

In 1916 the total cut-over area of this species was 42,100,000 A. Of
this acreage there was 22,400,000 A which had not restocked. Reasons for the failure of reproduction may be directly attributed to damage by fire following logging operations and improper logging methods with no provisions for the leaving of seed trees.

There was 8,600,000 A of remaining virgin stands. This was being cut over at the rate of 750,000 A per year; 80% of these operations were clear cutting. Besides this there was 1,200,000 A of second growth being cut or turpentinied every year, 50% being denuded of trees. Trees, too small for merchantable timber, were cut for poles or ties.

A good example of the type of logging this region has undergone, can be given from the records.

In 1914 there was a virgin stand of timber in Southern Georgia. This area was logged by steam equipment. The stand cruised fifteen thousand board feet per acre.

In 1925, a two chain strip was run for four miles through the tract. On each five acres of the tract, there averaged less than one 4" d. b. h. pine, and these were usually incapable of bearing seed. The number of seedlings averaged twenty-eight per acre. These were entirely advance growth; that is, they were present before the area was cut over.

This is not an unusual example of past practices in the southern pine region; on the contrary, it is a very common situation.
FIGURE 22.—Exceptionally well-developed planted longleaf pine 5 years from seed, in St. Tammany Parish, La. The top of the handkerchief in the row to the right is 4½ feet above the ground.

FIGURE 10.—Planted longleaf pine (left) and loblolly pine (right) after 8 years in the field. The loblolly pines are approximately even in height, whereas more than half the longleaf pines have not yet emerged from the grass.
FIGURE 54.—Effect of fire on growth as shown by last 4 years' growth at the tops of two long-leaf pines. Tree on left grew on land protected from fire. Note height and well-developed trunk. Tree on right survived repeated fires but was retarded in development and reduced in wood formation.
POSSIBILITIES OF PULP WOOD IN THE SOUTHERN PINE FORESTS

In the broad area vaguely referred to as "The Southern Pine Region" is found one of the greatest fields for future forestry. This area is ideally suited for forest growth. Wood increment as a whole is more rapid here than in any other region in the United States.

Southern pine as pulp wood for the manufacture of heavier kraft paper, is without a peer. The Fiber is long and exceptionally strong. By combination with shorter fibered woods, it is possible to utilize some inferior species which otherwise could not be used in this capacity. Timber lands are cheap in this region. Water is abundant and ready transportation is available in nearly all areas. There are large deposits of clay and sulphur which are ready for development.

The Northeastern United States was once the center of paper manufacture. Vast stands of spruce of hemlock and fir were cut ruthlessly in a wholesale liquidation program. Today these stands are badly depleted. In the meantime production in the Southern pine region has steadily increased. In 1924 the annual consumption of timber for pulpwood equalled 9,000,000 cords. In 1936 the industry consumed 23,000,000 cords. In 1921 there were twenty-six paper mills, while by 1924 there were thirty-six. In the meantime production had increased from 382,500 ton to 1,000,000 ton.

The most likely species for pulp wood production are probably Slash and Loblolly pine. Of these two Slash is to be preferred.

Slash pine makes a tremendous growth during youth. The following charts will indicate a comparison of its growth with that of spruce in the northeastern spruce region. Red spruce has been used as a comparative species.
The production of naval stores and pulp wood may be easily and profitably combined. The stands may be thinned to increase the production of turpentine. The thinnings find a ready market as pulp wood. When the mature trees have ceased to produce resin, they may be cut and marketed also. It is estimated that 26,000,000 cords of pulp wood could be produced annually merely as incidental to lumber production. This, or course, would entail much closer utilization than is now practiced.

Under intensive silviculture it would be possible to annually produce nearly 40,000,000 cords of pine pulp wood. In 1930 we imported 775,000,000 cords of pulp wood. Since then we have annually increased this amount by 110,000 cords. Are we not foolish to buy foreign raised material when we have an ideal source within our own boundaries? The land and ecological conditions are present. It is for the foresters of the future to recognize this fact and develop it.

The problem is not all up to the forestry profession. Legislative bodies must be made to see this. Laws which lighten the tax burden of the landowner must be enacted. Fire protection must be developed and the people educated in the prevention of fires.
Logging companies must provide for natural restocking of their cut-over lands. The whole industry is a challenge to the people of the South. Will they accept it?
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